YALYALUP
Mineral Sands Project

ENVIRONMENTAL REVIEW DOCUMENT
Version 3

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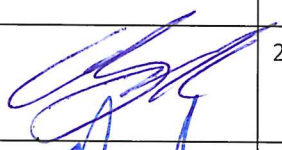
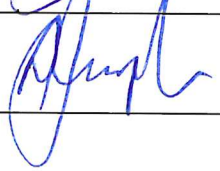
Craig Bovell	Doral Mineral Sands Pty Ltd OHS & E Superintendent	Reviewer		20/05/20
Andrew Templeman	Doral Mineral Sands Pty Ltd General Manager	Approver		20/05/20

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INVITATION TO MAKE A SUBMISSION

The Environmental Protection Authority (EPA) invites people to make a submission on environmental review of this proposal.

Doral Mineral Sands Pty Ltd proposes to develop, mine, rehabilitate and decommission the Yalyalup Mineral Sands Mine. The Proposal includes the development of mine pits and associated infrastructure, wet concentration processing plant, solar evaporation ponds, groundwater abstraction and water management infrastructure and process water dam. The life of mine is expected to be 4 to 5 years. The Environmental Review Document (ERD) has been prepared in accordance with the EPA's ***Procedures Manual (Part IV Divisions 1 and 2)***. The ERD is the report by the proponent on their environmental review which describes this proposal and its likely effects on the environment.

The ERD is available for a public review period of [4] weeks from 22 June 2020 closing on 19 July 2020.

Information on the proposal from the public may assist the EPA to prepare an assessment report in which it will make recommendations on the proposal to the Minister for Environment.

Why write a submission?

The EPA seeks information that will inform the EPA's consideration of the likely effect of the proposal, if implemented, on the environment. This may include relevant new information that is not in the ERD, such as alternative courses of action or approaches.

In preparing its assessment report for the Minister for Environment, the EPA will consider the information in submissions, the proponent's responses and other relevant information.

Submissions will be treated as public documents unless provided and received in confidence, subject to the requirements of the *Freedom of Information Act 1992*.

Why not join a group?

It may be worthwhile joining a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on, the information in the ERD.

When making comments on specific elements in the ERD:

- Clearly state your point of view and give reasons for your conclusions.
- Reference the source of your information, where applicable.
- Suggest alternatives to improve the outcomes on the environment.

What to include in your submission

Include the following in your submission to make it easier for the EPA to consider your submission:

- Your contact details – name and address.

- Date of your submission.
- Whether you want your contact details to be confidential.
- Summary of your submission, if your submission is long.
- List points so that issues are clear, preferably by environmental factor.
- Refer each point to the page, section and if possible, paragraph of the ERD.
- Attach any reference material, if applicable. Make sure your information is accurate.

The closing date for submissions is: 19 July 2020

The EPA prefers submissions to be made electronically via the EPA's Consultation Hub at https://consultation.epa.wa.gov.au.

Alternatively, submissions can be:

- Posted to: Chairman, Environmental Protection Authority, Locked Bag 33, Cloisters Square WA 6850, or
- Delivered to the Environmental Protection Authority, Level 4, The Atrium, 168 St Georges Terrace, Perth 6000.

If you have any questions on how to make a submission, please contact the EPA Services at the Department of Water and Environmental Regulation on 6364 7000.

SCOPING CHECKLIST

TASK NO.	REQUIRED WORK	SECTION
EPA Factor 1: Flora and Vegetation		
1	Undertake flora and vegetation surveys in accordance with *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA, 2016d) in areas that are likely to be directly or indirectly impacted as a result of the Proposal.	Appendix 4
2	Undertake a detailed review of soil information from existing exploration drilling/assay data, depth to groundwater, proposed dewatering extents, and specific water dependency of flora species/ecosystems within the area predicted to be impacted by the Proposal (i.e. dewatering).	4.2.3 Appendix 4
3	Describe the existing flora and vegetation within areas potentially directly or indirectly affected by the proposal including regional context. This will include work to relocate or confirm the absence of previous records of significant flora.	4.2.3 Appendix 4
4	Assess the cumulative direct and indirect impacts (such as direct clearing, drawdown of groundwater dependent ecosystems, weeds, fragmentation of vegetation, altered fire regime and dust) associated with the proposal to flora and vegetation by conducting quantitative analysis. This will include: • A summary of the known regional distribution of vegetation units. • The total area (in ha) of each vegetation unit within areas potentially directly or indirectly affected by the Proposal. • The area (in ha) of each vegetation unit to be impacted (directly or indirectly) in a 'worst case' scenario. • Maps illustrating the known recorded locations of conservation significant species. • Identification of vegetation units which may be Threatened or Priority Ecological Communities (TECs/PECs). This will include consultation with DBCA to determine whether any vegetation units potentially directly or indirectly affected by the Proposal are representative of State listed TECs/PECs. • Identification of any significant flora species within areas potentially directly or indirectly affected by the Proposal. • For each conservation significant species/community, including MNES, within areas potentially directly or indirectly affected by the Proposal, provide where possible:	4.2.3 4.2.5 Figures 4-1 to 4-7

TASK NO.	REQUIRED WORK	SECTION
	• Baseline information on their distribution (including know occurrences), ecology and habitat preferences at the Site level; • Information on the conservation value of each habitat type from a local and regional perspective; • If a population of a conservation significant species is present on the site, its size and the importance of that population from a local and regional perspective; • Map of weed and phytophthora dieback occurrences in areas likely to be directly or indirectly impacted by the proposal.	
5	Provide figures and tables showing the predicted extent of loss of vegetation and significant flora species from both direct and indirect impacts.	4.2.5 Figures 4-1 to 4-7
6	Provide discussion of the proposed management, monitoring and mitigation methods to be implemented to demonstrate that the design of the proposal has addressed the mitigation hierarchy to avoid and minimise impacts to flora and vegetation.	4.2.6 Appendix 4E (GDE) Appendix 5 (ASS) Appendix 7E (GWOS)
7	Provide details of the inherent and residual impacts to flora and vegetation before and after applying the mitigation hierarchy and identify whether the residual impacts are significant by applying the Significant residual Impact Model in the WA Environmental Offsets Guideline (Government of Western Australia, 2014).	4.2.7 Section 6
8	Quantify any significant residual impacts by completing the Offset Template, spatially defining the area of 'good' to 'excellent' native vegetation that will be disturbed as a result of the Proposal and propose an appropriate offsets package that demonstrates application of the WA Environmental Offsets Policy (Government of Western Australia, 2011) and Guideline (Government of Western Australia, 2014).	Section 6 Appendix 11
9	Prepare a Mine Closure Plan consistent with *Guidelines for Preparing Mine Closure Plans* (DMP and EPA, 2015) which considers the proposed rehabilitation methodologies to achieve successful progressive rehabilitation of all disturbed areas by mining to the agreed end landuse.	Appendix 3
10	Provide a statement of how the proponent considers the EPA's objective for this factor has been addressed.	4.2.7
EPA Factor 2: Terrestrial Fauna		
11	Conduct a desktop study and Level 1 Fauna Survey in accordance with *Technical Guidance – Terrestrial Fauna Surveys* (EPA, 2016g) and *Technical*	Appendix 6A

TASK NO.	REQUIRED WORK	SECTION
	Guidance – Sampling Methods for Terrestrial Vertebrate Fauna (EPA, 2016h) for Terrestrial Fauna within the Development Envelope. In addition, the desktop assessment and Level 1 survey will include consideration of fauna values associated with the creek system immediately to the west of the Development Envelope.	
12	Conduct a targeted Western Ringtail Possum assessment in areas containing suitable habitat within the Development Envelope in accordance with relevant EPA and Commonwealth guidance.	4.3.3 Appendix 6A
13	Conduct a targeted Black Cockatoo assessment in areas containing suitable habitat within the Development Envelope in accordance with relevant EPA and Commonwealth guidance.	4.3.3 Appendix 6A and 6B
14	Describe the terrestrial fauna including conservation significant and migratory species that occur or likely to occur within the Development Envelope.	4.3.3
15	Conduct targeted surveys for any other significant species, communities or habitats identified by the desktop study and Level 1 survey as potentially being present.	Appendix 6A
16	Assess direct and indirect impacts on fauna, conservation significant fauna, migratory species and fauna habitats, including specific consideration of direct and indirect impacts to the Vasse-Wonnerup Ramsar wetland and the creek system immediately west of the Development Envelope.	4.3.5
17	For each conservation significant species, including MNES recorded or likely to occur within the Development Envelope, provide where possible: • Baseline information on their distribution (including know occurrences), ecology and habitat preferences at the Site level; • Information on the conservation value of each habitat type from a local and regional perspective; • If a population of a conservation significant species is present on the site, its size and the importance of that population from a local and regional perspective; • Maps illustrating the known recorded locations of conservation significant species. Quantification of the area of habitat that is likely to be directly or indirectly impacted by the proposal, broken down by habitat use where appropriate (e.g. breeding habitat, foraging habitat).	4.3.5 Figures 4-8 to 4-10 Section 7 Appendix 6
18	Provide figures and tables showing the likely extent of habitat loss from direct and indirect impacts.	Figures 4-8 to 4-10
19	Provide discussion of the proposed management, monitoring, mitigation methods and rehabilitation to be implemented to demonstrate that the	4.3.6

TASK NO.	REQUIRED WORK	SECTION
	design of the proposal has addressed the mitigation hierarchy to avoid and minimise impacts terrestrial fauna.	
20	Provide details of the inherent and residual impacts to terrestrial fauna before and after applying the mitigation hierarchy and identify whether the residual impacts are significant by applying the Significant residual Impact Model in the WA Environmental Offsets Guideline (Government of Western Australia, 2014).	4.3.7 Section 6
21	Quantify any significant residual impacts by completing the Offset Template, spatially defining the area of 'good' to 'excellent' native vegetation that will be disturbed as a result of the proposal and propose an appropriate offsets package that demonstrates application of the WA Environmental Offsets Policy (Government of Western Australia, 2011) and Guideline (Government of Western Australia, 2014).	Section 6 Appendix 11
22	Prepare a Mine Closure Plan consistent with *Guidelines for Preparing Mine Closure Plans* (DMP and EPA, 2015) which addresses the need for progressive rehabilitation of habitat for conservation significant species.	Appendix 3
23	Provide a statement of how the proponent considers the EPA's objective for this factor has been addressed.	4.3.7
EPA Factor 3: Hydrological Processes		

24	Characterise the baseline hydrological and hydrogeological regimes, both at a local and regional level, including:
	• Geology;
	• Groundwater levels and flows;
	• Surface water and drainage features and flows;
	  • Connectivity between surface water and groundwater features including a conceptual site model;
	  • Figure depicting the sensitive receptors within the locality (i.e. Vasse-Wonnerup Ramsar wetland and local surface water bodies).
		4.4.3
		Appendix 7
		Figure 1-1

25	Undertake a targeted ASS investigation in areas proposed to be directly and indirectly disturbed by either excavation or dewatering, to determine the potential presence and distribution of ASS, and if present provide details of proposed management measures.	Appendix 5
26	Model the predicted extent, duration and recovery (including figures) of groundwater drawdown associated with mine pit dewatering. This will include, but not limited to: • Assessment of cumulative impacts from all pits and how recharge will vary over the life of the Project; • A formal sensitivity analysis and uncertainty analysis on all the aquifer properties included in the model and assess leakage	Appendix 7

TASK NO.	REQUIRED WORK	SECTION
	from the overlying aquifers. The model will also explore an extended period of below and above average rainfall.	
27	Prepare a conceptual water balance to determine the site water demands over the life of the project. This will include: • All fluxes (and their seasonal variations); • Discussion of the capacity to reuse surplus mine dewater; • Requirements for supplementary process water to be sourced from the Yarragadee aquifer.	Appendix 7
28	Discuss potential environmental impacts and benefits of identified surplus water management options (i.e. discharge of excess mine dewater, reuse on site, local water supply, aquifer recharge etc.) and discuss the most appropriate water management strategy for the Proposal.	4.4.5 Appendix 7
29	Model the predicted extent, duration and recovery of process water abstraction from the Yarragadee aquifer and assess potential impacts to other Yarragadee groundwater users.	4.4.5 Appendix 7
30	Conduct a surface water assessment to assess how proposed mine pits will impact on surface water flows to the Lower Sabina sub-catchment and the Vasse-Wonnerup Ramsar wetland.	4.4.5 4.6.5 Appendix 7
31	Assess potential impacts of groundwater drawdown from mine pit dewatering on water availability to nearby bore users, potential GDE's, ASS, surface water features and the Vasse-Wonnerup Ramsar wetland.	4.4.5 Appendix 4 Appendix 7
32	Demonstrate application of the mitigation hierarchy to avoid or minimise impacts to avoid and minimise impacts to Hydrological Processes.	4.4.6
33	Provide discussion of the proposed management, monitoring, trigger and contingency actions within environmental management plans, to ensure residual impacts (direct and indirect) are not greater than predicted.	4.4.6 Appendix 4E (GDE) Appendix 5 (ASS) Appendix 7E (GWOS)
34	Provide a statement of how the proponent considers the EPA's objective for this factor has been addressed.	4.4.7
EPA Factor 4: Inland Waters Environmental Quality		
35	Characterise the baseline hydrological and hydrogeological regimes, both at a local and regional level, including: • Geology; • Groundwater levels and flows;	4.4.3 Appendix 7 Figure 1-1

TASK NO.	REQUIRED WORK	SECTION
	• Background water quality • Surface water and drainage features and flows; • Connectivity between surface water and groundwater features including a conceptual site model; • Figure depicting the sensitive receptors within the locality (i.e. Vasse-Wonnerup Ramsar wetland and local surface water bodies	
36	Provide a detailed description of the design and location of the Proposal with the potential to impact surface water or groundwater.	4.4.3 Appendix 7
37	Prepare a conceptual water balance to determine the site water demands over the life of the project. This will include: • All fluxes (and their seasonal variations); • Discussion of the capacity to reuse surplus mine dewater; • Requirements for supplementary process water to be sourced from the Yarragadee aquifer.	4.4.3 Appendix 7
38	Identify the location(s) of any proposed discharges to the environment and assess possible impacts these may have on the environment.	4.4.5 Figure 1-2
39	Demonstrate application of the mitigation hierarchy to avoid and minimise impacts to Inland Waters Environmental Quality.	4.4.6
40	Provide discussion of the proposed management, monitoring, trigger and contingency actions to be implemented.	4.4.6 Appendix 4E (GDE) Appendix 5 (ASS) Appendix 7E (GWOS)
41	Provide a statement of how the proponent considers the EPA's objective for this factor has been addressed.	4.4.7
EPA Factor 5: Social Surroundings		
42	Prepare a detailed numerical noise model and conduct a noise impact assessment to identify all potential impacts to sensitive noise receptors associated with the proposal. The model will include all elements specified for a detailed noise assessment by previous EPA guidance (EAG No. 8) is included.	Appendix 8
43	Provision of a map showing the location of all noise sensitive premises adjacent to the Proposal or likely to be affected by the Proposal.	Figure 4-32

TASK NO.	REQUIRED WORK	SECTION
44	Commitment to investigate the use of Amenity Agreements should the modelled noise impacts show non-compliance with the Noise regulations	4.5.6
45	Discussion of noise management measures and contingencies.	4.5.6
46	Identify sites of cultural significance by conducting ethnographic and archaeological surveys of the Development Envelope.	4.5.7 Appendix 9
47	Assess potential impacts on any heritage sites and/or cultural associations and provide proposed management measures to avoid or minimise impacts (if identified).	4.5.8 Appendix 9
48	Provide a statement of how the proponent considers the EPA's objective for this factor has been addressed.	4.5.11

EXECUTIVE SUMMARY

Introduction

Doral Mineral Sands Pty Ltd (Doral) proposes to extract ore from the Yalyalup Mineral Sands Deposit (i.e. the Proposal), located ~11km southeast of Busselton, WA (Figure 1-1 and 1-2). The Proposal is within an area Doral have been granted Retention Licence R70/0052, which covers an area of approximately 2,290 hectares. The Mine is proposed to operate 24 hours a day, 7 days a week, however during evening and night time periods (7pm-7am) all mining activities at the pits will stop and only the Feed Prep and wet Concentrator plants will remain in operation.

The Proposal includes the development of mine pits and associated infrastructure, wet concentration processing plant, solar evaporation ponds, groundwater abstraction and water management infrastructure and process water dam. The Proposal involves the disturbance of ~453.34ha, comprising predominantly cleared pasture (~449.84ha) and degraded native vegetation (~3.5ha) within a Development Envelope of 924.8ha. The Proposal has an anticipated life of mine of 4 to 5years.

This document is an Environmental Review Document (ERD) prepared in accordance with *Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual* (EPA, 2016a) and the *Instructions and Template: Environmental Review Document* (EPA, 2018a). This document also satisfies the requirements for an accredited assessment under the *Environment Protection and Conservation Biodiversity Act 1999* (EPBC Act).

This ERD presents an environmental review of the Proposal including a detailed description of the key components, environmental impacts and proposed environmental management measures for the relevant environmental factors identified by the Environmental Scoping Document (ESD) (Doral, 2019).

Background and context

The Proposal was referred to the EPA under section 38 of the EP Act on 26 October 2017. On 3 January 2018 the EPA published its decision to formally assess the Proposal (Assessment No. 2141) under Part IV of the EP Act as a Public Environmental Review, with a four-week public review period for the ERD. The Key Environmental Factors identified for the Proposal are:

- Flora and Vegetation;
- Terrestrial Fauna;
- Hydrological Processes;
- Inland Waters Environmental Quality;
- Social Surroundings.

In addition, Air Quality was identified as an "Other Environmental Factor or Matter" relevant to the Proposal.

It should be noted that the Environmental Factors "Hydrological Processes" and "Inland Waters Environmental Quality", are now combined and addressed as "Inland Waters" as per *Statement of Environmental Principles, Factors and Objectives* (EPA, 2018b).

Doral prepared and submitted an ESD to the EPA on 1 March 2019, which was considered by the EPA at Meeting No. 1124 on 21 March 2019. The ESD was endorsed as providing an acceptable basis for the preparation of the ERD on 15 May 2019.

The Proposal was also referred to the Commonwealth DoEE (now Department of Agriculture, Water and the Environment, DAWE) on 1 November 2017 for consideration under the EPBC Act. On 8 February 2018, the DAWE determined that the Proposal is a Controlled Action and requires assessment and decision on approval under the EPBC Act (EPBC Reference: 2017/8094). The relevant MNES for the Proposal determined by DAWE are:

- Listed threatened species and communities (s18 and 18A)
    - Western Ringtail Possum *(Pseudocheirus occidentalis)* – Critically Endangered.
    - Whicher Range Dryandra *(Banksia squarrosa* subsp. *Argillacea)* – Vulnerable.
    - Vasse Featherflower *(Verticordia plumose* var. *vassensis)* – Endangered.
    - Shrublands on the southern Swan Coastal Plain Ironstones – Endangered.
- The ecological character of a declared Ramsar wetland (section 16 and 17B)
    - Vasse-Wonnerup Ramsar wetland system;
- Migratory species (section 20 and 20A)
    - Wood sandpiper *(Tringa glareola)* – Migratory;
    - Sharp-tailed sandpiper *(Calidris acuminate)* – Migratory;
    - Long-toed stint *(Calidris subminuta)* – Migratory.

During the preparation of the ERD, the following MNES were identified as being relevant and have also been assessed accordingly:

- Listed threatened species and communities (s18 and 18A):
    - Carnaby`s Black-Cockatoo *Calyptorhynchus latirostris* – Endangered.
    - Baudin's Black-Cockatoo *Calyptorhynchus baudinii* – Vulnerable.
    - Forest Red-tailed Black-Cockatoo *Calyptorhynchus banksii naso* – Vulnerable.

On 5 November 2019, Doral submitted a section 43A request to the EPA to make minor modifications and changes to the Proposal, whilst under assessment. The proposed request involved the following two elements:

1. Increase in the area of the Development Envelope to incorporate new internal road route from the on-site processing facility to the public road network (Ludlow-Hithergreen Rd) to avoid road widening and clearing native vegetation and fauna habitat along Princefield Road, resulting in an increase to the Development Envelope of 30.63ha.
2. Modification to the area and layout of mine pits and infrastructure resulting in an increase to the total disturbance footprint of 80.67ha within the revised Development Envelope.

The EPA provided consent for Doral to change the Proposal under section 43a of the EP Act on 9 January 2020.

Overview of the Proposal

The Proposal is to allow mining of the Yalyalup Mineral Sands Deposit. This includes dunal heavy mineral accumulation and two heavy mineral bearing strands. Ore from the deposit will be mined progressively via a series of open-cut pits using dry mining techniques to a maximum depth of ~10.5m. Dewatering of groundwater inflows into the pit will be required to enable dry mining to occur. Mining will be staged in order to minimise the area of disturbance (at any one time) with the aim of achieving focused and effective management of the environmental factors at each pit location, prior to moving onto the next pit location.

Processing of ore will commence in-pit and then slurry will be pumped from the feed preparation plant to the wet concentration plant for further processing. Waste clay (slime) and sand materials from processing of this ore will be combined and backfilled into the mine voids using co-flocculation (co-disposal system) where possible. Some clay material will be initially placed in a Tailing Storage Facility, herein referred to as Solar Evaporation Ponds (SEPs), to allow drying of the clay and recycling of water back to the process water dam (PWD) (return water), prior to being co–disposed into mine voids. The mined area will be rehabilitated back to pasture and/or native vegetation, depending on pre-mining conditions, consistent with the post-mine land use requirements.

HMC produced at the wet Concentrator plant will be stockpiled on site prior to transport to Doral's Picton Dry Separation Plant, located ~60km northeast of the mine, for separation using electrostatic processes. The Picton Dry Separation Plant has a licence to process HMC sourced from Doral's Yoongarillup Mine. Processing of HMC into products of zircon, ilmenite, and leucoxene has occurred since the Picton Dry Separation Plant was approved by Ministerial Statement No. 484 in 1998. Once processed, HMC products are hauled by truck to either the Bunbury Port or Fremantle Port for export. Processing activities at the Picton Dry Separation Plant and exporting of product are not part of this Proposal and are not further described in this referral document.

The Mine is proposed to operate 24 hours a day, 7 days a week, however during evening and night time periods (7pm-7am) all mining activities at the pits will stop and only the Feed Prep and wet Concentrator plants will remain in operation.

The key characteristics for the Proposal are summarised in Tables ES-1 and ES-2.

TABLE ES-1: SUMMARY OF THE PROPOSAL

Proposal title	Yalyalup Mineral Sands Mine
Proponent name	Doral Mineral Sands Pty Ltd
Short description	The Proposal is to develop, mine, rehabilitate and decommission the Yalyalup Mineral Sands Mine. The Proposal includes the development of mine pits and associated infrastructure, wet concentration processing plant, solar evaporation ponds, groundwater abstraction, water management infrastructure and process water dam. The life of mine is expected to be 4 to 5 years.

TABLE ES-2: LOCATION AND PROPOSED EXTENT OF PHYSICAL AND OPERATIONAL ELEMENTS

ELEMENT	LOCATION	EXTENT
Physical Elements		
Mine pits	Figure 1-2	Clearing of 0.79ha of native vegetation and disturbance of 259.43ha of pasture/planted species within the 924.8ha Development Envelope
Key Mine Infrastructure	Figure 1-2	Clearing of 0.10ha of native vegetation and disturbance of 22.97ha of pasture/planted within a 924.8ha Development Envelope
Other Supporting Infrastructure	Figure 1-2	Clearing of 2.61ha of native vegetation and disturbance of up to 167.43ha of pasture/planted within a 924.8ha Development Envelope
Operational Elements		
Groundwater Abstraction	-	Abstraction of up to 1.6 gigalitres (GL) per annum from the Yarragadee aquifer
Ore processing (HMC)	-	250,000 tonnes per annum

Summary of Potential Impacts, Proposed Mitigation and Outcomes

The key environmental factors, potential impacts and proposed mitigation and management measures to address potential impacts are summarised in Table ES-3.

TABLE ES-3: SUMMARY OF POTENTIAL IMPACTS, PROPOSED MITIGATION AND OUTCOMES

FLORA AND VEGETATION	
EPA Objective	To protect flora and vegetation so that biological diversity and ecological integrity are maintained.
Policy and Guidance	<u>EPA Policy and Guidance</u> *Statement of Environmental principles, Factors and Objectives* (EPA, 2018b)*;* *Environmental Factor Guideline – Flora and Vegetation* (EPA, 2016c); *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA, 2016d); *Instructions on how to Prepare Environmental Protection Act 1986 Part IV Environmental Management Plans* (EPA, 2016e)*;* *Environmental Offsets Policy, Perth, Western Australia (Government of Western Australia, 2011);* *Environmental Offsets Guidelines, Perth, Western Australia (Government of Western Australia, 2014).* <u>Other Policy and Guidance</u> Matters of National Environmental Significance. Significant Impact Guidelines 1.1. *Environmental Protection and Biodiversity Conservation Act 1999* (DoE, 2013)*;* *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPaC, 2012a)*;* *Guidelines for Preparing Mine Closure Plans* (DMP and EPA, 2015)*;* *Western Australian Water in Mining Guideline. Water licensing delivery report series. Report No. 12 (DoW, 2013);* *Conservation Advice Banksia squarrosa* subsp. *argillacea Whicher Range banksia, Whicher Range dryandra. Canberra: Department of the Environment* (Threatened Species Scientific Committee, 2015)*;* *Approved Conservation Advice for Verticordia plumosa 3* var. *vassensis (Vasse Featherflower). Canberra: Department of the Environment, Water, Heritage and the Arts* (DEWHA, 2008a)*;* *Shrubland Association on Southern Swan Coastal Plain Ironstone (Busselton area) (Southern Ironstone Association) Recovery Plan. Interim recovery plan no. 215. Department of Environment and Conservation* (Meissner & English, 2005)*;* *Threat abatement plan for disease in natural ecosystems caused by Phytophthora cinnamomi. Canberra, ACT: Commonwealth of Australia* (DoE, 2014)*;*

Potential Impacts	Direct loss of flora and vegetation from clearing activities. Indirect impacts on flora and vegetation from: • Groundwater abstraction (addressed under Hydrological Processes); • Fragmentation of vegetation; • Altered fire regime; • Dust from mining operations and vehicle movements; • Introduction and spread of weeds and phytophthora dieback; • Potential development of acid sulfate soils which may modify ecosystem functions.
Mitigation	Avoid The Proposal has been designed to avoid clearing of native vegetation within the Development Envelope as far as practicable and maximise the use of existing cleared areas. This has resulted in all but <1% of the disturbance area being located on cleared pasture. The small area of clearing (~3.5ha) comprises predominately degraded or completely degraded overstorey vegetation. The design of the Proposal has successfully avoided clearing the DBCA/EPBC listed TEC, SWAFCT10b – *"Shrublands on southern Swan Coastal Plain Ironstones (Busselton area)"* as well as all Threatened and Priority flora species present within the Development Envelope. Minimise A Flora and Vegetation Management Plan will be prepared to minimise potential impacts to flora and vegetation values and will include the following key management and monitoring actions: • Implementation of specific clearing procedures including demarcation of areas to be cleared; • Monitor vegetation health in GDEs (SWAFCT02 and SWAFCT10b) in areas predicted to be impacted during dewatering activities (refer to GDE Management Plan); • Incorporate weed management measures into the ongoing management of flora and vegetation. A GDE Management Plan (Appendix 4E) has been prepared by AQ2 (2020d) to minimise impacts to flora and vegetation values from indirect impacts associated with groundwater drawdowns. As detailed in the Plan, monitoring will comprise a combination of hydrological parameters and quantitative and qualitative vegetation measurements, ecophysiological measurements and health assessments using qualitative criteria. This will comprise:

	• Groundwater level monitoring in a network of six monitoring wells proximal to the GDEs;
	• Leaf Water Potential (LWP) monitoring of targeted species in each GDE communities (i.e. SWAFCT02 and SWAFCT10b);
	• The species selected for LWP monitoring will also be assessed for health monitoring using visual inspection and assessed using a scale based on that used by Lay and Meissner (1985).
	
	The following management response triggers and contingency measures will apply:
	
	• Leading indicators of risk such that management intervention can pre-empt the development of vegetation water stress:
	  o Hydrological triggers provide warning of the onset of a water regime that may cause water tress to develop;
	  o Ecophysiological triggers within the vegetation community provide a direct measure of current water status.
	• Lagging indicators designed to provide redundancy in risk identification and allow verification of success of management interventions.
	
	Triggers have been designed around parameters that may be affected by mining-induced changes to the water regime (i.e. groundwater levels and associated plant hydration status). Soil moisture is not included as a monitoring parameter because it is influenced by infiltrating rainfall and this will not be affected by mining.
	
	For all trigger exceedances the management response will be that water supplementation is required. Final design for the supplementation scheme will be completed during implementation of this GDE Management Plan. Supplementation will be based on a combination of:
	
	• Surface irrigation;
	• Subsurface irrigation in proximity to the groundwater table through either trenches or shallow spear-points.
	
	The supplementation scheme will have the following design criteria:
	
	• To supply enough water to offset declines in groundwater levels (i.e. to maintain levels within the natural range under the GDEs along McGibbon track. This will be determined using the existing groundwater model;
	• To prevent sustained periods of excessive inundation of the vadose zone that may result in water logging or reconfiguration of the root systems within the GDEs. This will be achieved by the use of sub-surface supplementation;
	• To be operationally effective and not subject to excessive clogging that may limit infiltration capacity. This will be assessed during engineering design of the scheme based on aquifer parameters derived during previous groundwater investigations;

	• To incorporate a monitoring programme that can be used to confirm the efficacy of the supplementation system. This will be achieved by the monitoring programme outlined in this Plan; • To utilise water of sufficient quality so as not to result in acidification or dieback within the GDEs along McGibbon track. In this regard, supplementation water will be sourced from the Yarragadee aquifer only. In addition, the following management plans and strategy will also be developed and implemented to minimise impacts to flora and vegetation: • Dust Management Plan; • Fire Management Plan; • Acid Sulfate Soil Management Plan (Appendix 5); • Groundwater Operating Strategy (Appendix 7E). Rehabilitate Doral has prepared a Mine Closure plan which will include the revegetation of an area of 4.7ha with local native species to counterbalance the clearing of 3.5ha of mostly degraded vegetation.
Outcomes	The outcomes to Flora and Vegetation after application of the mitigation hierarchy are: • An area of 4.7ha will be revegetated to counterbalance the clearing of 3.5ha of predominantly degraded vegetation with local native species; • Clearing for the Proposal represents disturbance to only 0.93% of the remaining Abba Plains soil-landscape system and 0.10% of the Abba vegetation complex; • Clearing for the Proposal will reduce the extent of two DBCA listed TEC's, SWAFCT01b and SWAFCT02 by 0.17ha and 0.63ha respectively. However, despite limited information being available about the regional extent of these TEC's, they are known to occur outside the Development Envelope; • Populations of Threatened and Priority listed flora species located within the Development Envelope will not be directly impacted by the Proposal; • Indirect drawdown impacts to ~1.81ha of the GDE, Wet Shrublands (SWAFCT02) is predicted to be moderately to severely impacted for 3-6 months in 2023;

	• Indirect drawdown impacts to ~0.34ha in the Ironstone Shrubland (SWAFCT10b) (EPBC listed TEC), although predicted to be low-moderate, has the potential to affect the population of nine *Banksia squarrosa* subsp. *Argillacea,* (listed as Threatened under the BC Act and Endangered under the EPBC Act); • Doral is committed to providing a suitable offset (land acquisition) to secure a positive environmental outcome for the Proposal on a 'like for like' principle (or as near to as practical) to offset the significant residual impacts of the Proposal to flora and vegetation values; • Doral considers that with the implementation of the proposed management and the acquisition of land via an offsets package, the EPA's objective to protect flora and vegetation so that biological diversity and ecological integrity are maintained, can be achieved.
TERRESTRIAL FAUNA	
EPA Objective	To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.
Policy and Guidance	<u>EPA Policy and Guidance</u> *Statement of Environmental principles, Factors and Objectives* (EPA, 2018b)*;* *Environmental Factor Guideline – Terrestrial Fauna* (EPA, 2016f); *Technical Guidance – Terrestrial Fauna Surveys* (EPA, 2016g); *Technical Guidance – Sampling Methods for Terrestrial Vertebrate Fauna* (EPA, 2016h); *Instructions on how to Prepare Environmental Protection Act 1986 Part IV Environmental Management Plans* (EPA, 2016e)*;* *Guidelines for Preparing Mine Closure Plans (DMP and EPA, 2015);* *Environmental Offsets Policy, Perth, Western Australia (Government of Western Australia, 2011);* *Environmental Offsets Guidelines, Perth, Western Australia (Government of Western Australia, 2014).* <u>Other Policy and Guidance</u> Matters of National Environmental Significance. Significant Impact Guidelines 1.1. *Environmental Protection and Biodiversity Conservation Act 1999* (DoE, 2013)*;* Significant impact guidelines for the vulnerable western ringtail possum (*Pseudocheirus occidentalis*) in the southern Swan Coastal Plain, Western Australia. Nationally threatened species and ecological communities. EPBC Act policy statement 3.10. (DEWHA, 2009);

	Survey guidelines for Australia's threatened mammals. EPBC Act survey guidelines 6.5. (DSEWPaC, 2011)*;* *Survey guidelines for Australia's threatened birds. Guidelines for detecting birds listed as threatened under the EPBC Act*. (DEWHA, 2010); *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy October 2012.* (DSEWPaC, 2012a)*;* *EPBC Act Referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo (endangered) Calyptorhynchus latirostris, Baudin's cockatoo (vulnerable) Calyptorhynchus baudinii, Forest red-tailed black cockatoo (vulnerable) Calyptorhynchus banksii naso* (DSEWPaC, 2012b)*;* *Conservation Advice Pseudocheirus occidentalis Western ringtail possum. Canberra: Department of the Environment and Energy* (Threatened Species Scientific Committee, 2018a)*;* *Conservation Advice Calyptorhynchus baudinii Baudin's cockatoo. Canberra: Department of the Environment and Energy* (Threatened Species Scientific Committee, 2018b)*;* *Western Ringtail Possum (Pseudocheirus occidentalis) Recovery Plan. Wildlife Management Program No. 58. Department of Parks and Wildlife, Perth, WA* (DPaW, 2017)*;* *Approved Conservation Advice for Calyptorhynchus banksii naso (Forest Red-tailed Black Cockatoo). Canberra: Department of the Environment, Water, Heritage and the Arts* (DEWHA, 2009)*;* *Forest Black Cockatoo (Baudin's Cockatoo Calyptorhynchus baudinii and Forest Redtailed Black Cockatoo Calyptorhynchus banksii naso) Recovery Plan. Department of Environment and Conservation, Western Australia* (Chapman, 2008)*;* *Carnaby's Cockatoo (Calyptorhynchus latirostris) Recovery Plan. Department of Parks and Wildlife, Perth, Western Australia* (DPaW, 2013). *Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia* (DoE, 2015a)*;* *Threat abatement plan for predation by the European red fox. DEWHA, Canberra* (DEWHA, 2008b)*;* *Wildlife Conservation Plan for Migratory Shorebirds. Canberra, ACT: Department of the Environment* (Commonwealth of Australia, 2015)*;* *EPBC Act Policy Statement 3.21 - Industry Guidelines for avoiding, assessing and mitigating impacts on EBBC Act listed migratory shorebird species* (DoE, 2015b).
Potential Impacts	Direct clearing of fauna habitat resulting in the loss or fragmentation of fauna habitat; Death, injury and/or displacement of fauna species, as a result of clearing and construction activities; Dewatering activities may affect GDE's and the ecological character of the Vasse-Wonnerup Ramsar wetland which may reduce the value of fauna habitat resulting in displacement of fauna and migratory species;

	Vehicle movements during construction and operation may result in the loss of individual fauna, especially less-mobile species, from vehicle strikes; Presence of artificial water bodies may result in the loss/injury of induvial fauna; Increase in the number of predatory introduced species; Light, noise and dust emissions could disrupt fauna behaviour or reduce the value of fauna habitat; Introduction and/or spread of *Phytophthora* dieback which may reduce the value of fauna habitat; Altered fire regime which may reduce available fauna habitat.
Mitigation	Avoid The Proposal has been designed to avoid the clearing of all but 3.5ha of fauna habitat within the Development Envelope. Of this 3.5ha, only 0.8ha is in good condition and of value to most fauna including WRP. The Site has been successfully designed to avoid all WRP dreys from direct impacts. Of the 1,053 Black Cockatoo potential breeding habitat trees (i.e. DBH >50cm or DBH >30cm for wandoo) present within the Development Envelope, Doral has avoided all but 102 trees (~10%). These trees are present as isolated scattered paddock trees. Of the total 54 potential breeding habitat trees containing hollows possibly suitable for breeding within the Development Envelope (from the 1,053 trees present), all but 5 will be avoided from direct clearing. No actual nesting trees or trees being used by Black Cockatoos are present within the Development Envelope. Minimise A Fauna Management Plan will be developed and implemented to address potential impacts to fauna of conservation significance and their associated habitat and will include the following key management actions: • Conduct pre-clearing surveys prior to the clearing of any vegetation and engage a licenced fauna handler/carer to capture and relocate fauna to adjacent vegetation, if required; • Vehicle speed on site will be restricted to minimise collision risk with fauna; • The site will be designed to reduce accessibility to artificial water bodies, for example by making use of fencing. In addition, the following management plans and strategy will also be developed and implemented to minimise impacts to fauna: • GDE Management Plan (Appendix 4E); • Flora and Vegetation Management Plan;

	• Fire Management Plan; • Groundwater Operating Strategy (Appendix 7E). **Rehabilitate** Doral has prepared a Mine Closure Plan which includes the revegetation of an area of 4.7ha with native vegetation (fauna habitat) to counterbalance the impacts of clearing.
Outcomes	No substantial impacts on any fauna species or overall biodiversity values are anticipated as a consequence of implementing the Proposal given the following: • Where impacts are anticipated, the degree of the impact is only expected to be very low and relate only to the loss of very small areas of habitat, primarily in the form of isolated and scattered paddock trees and/or overstory species; • Most of the species known or likely to occur are common and widely distributed such that a localised small reduction in their habitat extent would not change their conservation status; • A residual impact to 2.61ha of WRP habitat will remain after application of mitigation measures. This includes 0.8ha of WRP habitat from direct impact and ~1.81ha of potential indirect impact from dewatering of GDE (vegetation unit A2, SWAFCT02). • A residual impact of 132 (of a total 1,053 trees) Black Cockatoo potential breeding habitat trees, will remain after application of mitigation measures. This includes 102 trees from direct impact and 30 trees from potential indirect impact from dewatering of GDE (vegetation unit A2, SWAFCT02). No actual nesting trees or trees being used by Black Cockatoos will be affected. • Migratory bird species identified as MNES by DoEE are unlikely to utilise the Proposal area and indirect impacts to these species and habitat (i.e. Vasse-Wonnerup Ramsar wetland) from dewatering activities will not occur, as it is well outside the maximum extent of groundwater drawdown. • Water to be discharged from Site (0.082GL) during the winter 2023 period, will increase the annual flows of the Lower Sabina River and the Vasse Wonnerup Wetland catchments by 1.44% and 0.28%, respectively and will not adversely impact Migratory bird habitat; • Doral is committed to providing a suitable offset (land acquisition) to secure a positive environmental outcome for the Proposal on a 'like for like' principle (or as near to as practical) to offset the significant residual impacts of the Proposal to terrestrial fauna; • Doral considers that with the implementation of the above listed key mitigation measures and the acquisition of land via an offsets package, the EPA's objective to protect terrestrial fauna so that biological diversity and ecological integrity are maintained can be achieved.

INLAND WATERS	
EPA Objective	To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.
Policy and Guidance	<u>EPA Policy and Guidance</u> *Environmental Factor Guideline – Inland Waters* (EPA, 2016i). <u>Other Policy and Guidance</u> *Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000);* *Western Australian Water in Mining Guideline. Water licensing delivery report series. Report No. 12 (DoW, 2013);* *Hydrogeological Reporting Associated with a Groundwater Well Licence. Operational Policy 5.12. (DoW, 2009);* *Identification and investigation of acid sulfate soils and acidic landscapes (DER, 2015a);* *Treatment and management of soil and water in acid sulfate soil landscapes (DER, 2015b);* *Information Sheet on Ramsar Wetlands (RIS) – 2009-2014 version;* *Ecological Character Description for the VasseWonnerup Wetlands Ramsar Site in South-west Western Australia. Unpublished report to the Department of Environment and Conservation and Geographe Catchment Council Inc. by Wetland Research & Management. September 2007 (WRM, 2007);* *Swan Coastal Plain South Management Plan 2016. Management plan number 85. Department of Parks and Wildlife, Perth (DPaW, 2016).*
Potential Impacts	Dewatering of mine pits and drawdown of water table which may affect: • Water availability at surrounding superficial and Leederville aquifer users; • Potential GDE's and vegetation; • Acid Sulfate Soils; • Surface water courses; • Vasse-Wonnerup System Ramsar Wetland. Abstraction of process water from the Yarragadee aquifer may affect other users of the Yarragadee aquifer and the overlying Leederville aquifer. Reduction in surface water yield in the Lower Sabina River sub-catchment and Vasse-Wonnerup System Ramsar Wetland.

	Reduction in groundwater quality to the Superficial and Leederville aquifers as a result of dewatering potential ASS which may affect beneficial users of water. Reduction in surface water quality as a result of discharge of water in emergency situations, which may have a localised adverse effect on the receiving environment, such as the Lower Sabina River and the Ramsar Vasse-Wonnerup wetlands.

Mitigation	Avoid
	
	• Mining and dewatering of mine pits will be undertaken in a staged approach using passive dewatering techniques, as per the mining schedule, in order to:
	  o Avoid groundwater drawdown impacts to key ecological receptors; the Lower Sabina River, Abba River and the Vasse-Wonnerup Ramsar;
	  o Avoid exposing large areas of potential acidity at any one time;
	• A passive dewatering methodology using suction pumps to maintain a 0.5m saturated pit floor will be employed in order to:
	  o Avoid mining and actively dewatering the Leederville aquifer/formations;
	  o Avoid exposure of the pit floor to significant atmospheric oxygen.
	• Doral's production bore will be screened only within the confined Yarragadee aquifer and will not draw from the Leederville aquifer;
	• Doral will avoid collection of surface water runoff from intercepted upstream catchments by constructing diversions around the disturbance areas, allowing clean upgradient flows to flow around the disturbance areas and into their intended catchment (Lower Sabina) without intercepted site runoff from disturbed areas.
	
	Minimise
	
	A Draft Groundwater Operating Strategy (GWOS) has been developed by (AQ2, 2020c) (Appendix 7E) and will be finalised and submitted to DWER when applying for the 5C groundwater licences, both for the groundwater abstraction from the Superficial aquifer (during mine dewatering) and the Yarragadee aquifer (for water supply). The GWOS includes, but not limited to, a groundwater and surface water monitoring program to monitor abstraction, discharge, water levels and water quality to enable the assessment of potential impacts caused by mining operations and the development of contingency actions to mitigate the impacts.
	
	An Acid Sulfate Soil Management Plan (Appendix 5) will be implemented in order to minimise impacts associated with ASS and includes the following key management actions:
	
	• Mining will be staged in order to minimise the area of groundwater drawdown at any one time;
	• Dewatering will occur passively and a 0.5m saturated pit floor will be maintained;

	• Soils identified as ASS will be neutralised prior to backfilling or reuse; • Dewatering effluent will be maintained by the addition of a suitable alkaline material; • Groundwater and dewatering monitoring will be conducted during mining and dewatering for the Proposal. In addition to the GWOS and ASSMP, the following key mitigation measures, plans and procedures will be prepared and implemented: • Supply affected bore owners(including unlicensed bores and soaks) with supplementary water (where and when required); • Groundwater monitoring bores will be installed around conservation significant GDE's and monitored for changes in groundwater levels (in accordance with the GDE Management Plan and GWOS); • Provision of reticulation to groundwater dependent vegetation within McGibbon Track during periods of reduced water availability in areas predicted to have potentially moderate to severe impact (SWAFCT02 and SWAFCT10b) in accordance with the GDE Management Plan; • Placement of production bores has been selected to avoid impacts to other Yarragadee aquifer users as far as practicable; • Volumes of water abstracted from the Yarragadee aquifer will be recorded monthly; • Implementation of a Surface Water Management Plan; • Implementation of an Emergency Discharge- Pre-release of Discharge Procedure; • Implementation of an Emergency Discharge- Discharge Monitoring Procedure; • Placement of production bores has been selected to avoid impacts to other Yarragadee aquifer users; • Installation of a drop out dam to reduce suspended solids entering the process water dam, where excess water will be discharged from; • Increase buffering capacity in the process water dam (>pH5.5); • Doral will make every effort to maximise water recycling and to minimise water use. Process water will, in the first instance be sourced from recycled water and dewatering of the pits. Additional process water sourced from the Yarragadee aquifer bore will be used only after other resources have been fully utilised. Water will not be intentionally discharged offsite when it cannot be used for any other purpose. Rehabilitate Sand tails resulting from ore processing will be hydraulically returned to pit voids as a single waste stream and/or co-disposed with clay fines into pit voids, as soon as possible in order to return groundwater levels. This material will have been maintained in a saturated state,

	with conditions maintained at pH5.5 throughout the process. Furthermore, the unused (unreacted) lime sand that was added to the process at commencement of the ore processing sequence (i.e. at the in-pit hopper) will form part of this process stream, resulting in the addition of buffering capacity to the locations where this material is hydraulically returned.
Outcomes	• Maximum drawdown of 10.5m in the immediate mining area will be achieved, with the extent of predicted drawdown in the Superficial Aquifer generally located within the Development Envelope; • The maximum distance that drawdown of 0.1m extends outside of the perimeter of the mine disturbance area is 700m to the north, 250m to the south, 300m to the east and 450m to the west, at various times during the mine life for the dry climate scenario; • Two bores under Licence GWL180363 and three unlicenced bores (20005101, 20005166, and 20005169) that abstract water from the Superficial aquifer may experience short-term minor water level reductions during Q2 of 2022; • The minor drawdowns predicted in the Leederville aquifer will be local and only extend laterally but not vertically (owing to clayey layers within the sand); • The bores under Licences GWL67672, GWL94291 and GWL178017 that abstract water from the Leederville aquifer could be affected by dewatering, however, the drawdowns are predicted to be temporary in duration and minor; • Indirect drawdown impacts to ~1.81ha of the GDE, Wet Shrublands (SWAFCT02) (and associated WRP and Black Cockatoo habitat) is predicted to be severely impacted for 3-6 months in 2023; • Indirect drawdown impacts to ~0.34ha in the Ironstone Shrubland (SWAFCT10b) (DBCA/EPBC listed TEC), although predicted to be low-moderate, also has the potential to affect the population of nine *Banksia squarrosa* subsp. *Argillacea* (listed as Threatened under the BC Act and Endangered under the EPBC Act); • Water levels are predicted to return to pre-mining levels within 18 months of mine closure; • No adverse impacts on the Lower Sabina River, Abba River or Vasse-Wonnerup wetland are predicted from groundwater drawdown as they are located outside of the 0.1m drawdown contour; • Minimal reduction to surface water yields in the Lower Sabina River (~8%) and the Vasse-Wonnerup Ramsar wetland catchments (~1%) will occur as a result of the Proposal; • Excess water to be discharged from Site (0.082GL) during the winter 2023 period, will increase the annual flows of the Lower Sabina River and the Vasse Wonnerup Ramsar Wetland catchments by 1.44% and 0.28%, respectively. However, no reduction in water quality will occur due to strict water quality criteria being met as per the DWER licence conditions; • Modelling indicates that a total runoff volume that may require discharge under emergency situations following a large, rare, 100-yr rainfall event is ~0.45GL. This would increase annual flows to the Lower Sabina River and Vasse-Wonnerup Ramsar wetland catchments by 7.95% and 1.52%, respectively. However, it is unlikely to result in adverse impacts to downstream water quality as the water will be returned to the same catchment it would have discharged through prior to mining activities;

	• Proposed extraction of 1.6 GL/year from the Yarragadee aquifer is unlikely to have any adverse impacts on the water supply potentials of the aquifer systems, with a maximum drawdown of 0.6m. The 0.5m drawdown is estimated to extend no more than 1.3 km from the production bore; • There are no known bores that abstract water from the Yarragadee aquifer that are located within the extent of the 0.5m and 1m drawdown contours developed around the production bore (i.e. within 1.2 and 3.7km from the YA_PB01, respectively); • The closest Yarragadee aquifer production bore is located 4.5km from the Site (i.e. GWL156423, Turf Farm) and small drawdowns (between 0.25 and 0.5m) are predicted at this location due to extraction from YA_PB01; • With the implementation of the ASSMP no adverse impacts to groundwater quality are expected to occur to the beneficial users or environmental values (such as the Lower Sabina River and Vasse Wonnerup Wetland catchments); • Doral considers that with the implementation of the mitigation measures described above, the EPA's objective to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values and beneficial uses of water are protected, can be achieved.
SOCIAL SURROUNDINGS	
EPA Objective	To protect social surroundings from significant harm
Policy and Guidance	EPA Policy and Guidance *Environmental Factor Guideline – Social Surroundings* (EPA, 2016j).
Potential Impacts	Numerous residential premises located within 1km of the proposal may potentially be impacted by noise from construction, mining and processing operations. Disturbance to Registered Aboriginal Site.
Mitigation	NOISE Avoid • No night time mining or mobile machinery operation with the exception of the single 980K loader operating at the Feed Prep; • Location of fixed plant (Feed Prep and Concentrator) central to the Project and at furthest reasonable distance from surrounding residences; • Avoidance of Scenarios 2 and 3 (as modelled) on Sundays and Public holidays as determined by weather conditions and real time noise monitoring data at potentially affected residents;

	• Avoidance of Scenario 5 (as modelled) unless a land access/amenity agreement is in place with the affected residence. Minimise Noise management minimisation strategies incorporated into the Noise Management Plan will include, but not limited to the following: • Select quietest equipment available and install silencers to reduce exhaust noise where possible; • Install acoustic insulation and barriers strategically to fixed plant (Feed Prep and Concentrator) to reduce noise emissions; • Modify existing Yoongarillup McCloskey in-pit screen from diesel to electricity driven and run by a silenced generator; • Create strategically designed noise bunding around plant and mining areas to reduce noise emission; • Utilise real time monitoring equipment to manage mining activities under Scenarios 2, 3 and 5 on Monday to Saturdays, and Scenario 4 on Sunday and public holidays; • Ensure that no overburden fleet or ore fleet will operate simultaneously in the same mining block at any one time; • Restrict the operation of machinery relative to worst case weather conditions to minimise potential noise impacts; • Restrict the operation of ancillary machinery (water cart and grader) to operate during daytime only; • Establish preventative maintenance schedules for all vehicles, fixed plant and mobile equipment; • Educate employees and contractors on the importance and requirements for noise management prior to commencing work on the mine, as part of the site induction process; • Doral will actively seek amenity agreements with adjacent landowners; • Maintain ongoing effective dialogue with nearby residents to ensure noise impacts are communicated to Doral to allow for rapid resolution; • Regular monitoring of noise emissions at or near to the nearest residences to measure performance of the noise control measures and ensure compliance; • Continue to implement an effective public comment and complaint communication system to ensure all concerns are received, recorded and acted upon. <u>HERITAGE</u> Avoid

	• Doral will avoid construction of the crossing over the Abba River until a Section 18 consent under the AH Act has been approved by the Minister for Aboriginal Affairs. Minimise • Consent will be sought from the Minister of Aboriginal Affairs as per the Aboriginal Heritage Act in order to complete the construction of a crossing across the Abba River (DPLH 17354). <u>NOISE AND HERITAGE</u> Rehabilitate Doral has prepared a Mine Closure plan which will be implemented and includes the actions to be undertaken to return the amenity of the Proposal to pre-mining values.
Outcomes	• Doral are experienced at managing noise impacts associated with mineral sands mine sites. Noise levels associated with mining will be controlled as described above. Effective implementation of these noise management strategies, including the use of avoidance strategies, engineering controls and administrative controls for mine scheduling (including Amenity Agreements), will ensure noise emissions from the operations comply with the Noise Regulations; • With consent of a S18 Notice by the Minister of Aboriginal Affairs to construct a crossing across the Abba River (DPLH 17354) Doral is confident that impacts to registered Aboriginal Sites will be minimised; • With the above mitigation measures, Doral is confident the EPA objective to protect social surroundings from significant harm can be achieved.

TABLE OF CONTENTS

TABLES

PLATES

FIGURES

APPENDICES

1. INTRODUCTION

Doral Mineral Sands Pty Ltd (Doral) proposes to extract ore from the Yalyalup Mineral Sands Deposit (i.e. the Proposal), which is located ~11km southeast of Busselton, WA (Figure 1-1 and 1-2). The Proposal is within an area Doral have been granted Retention Licence R70/0052, which covers an area of approximately 2,290 hectares.

The Proposal includes the development of mine pits and associated infrastructure, wet concentration processing plant, solar evaporation ponds, groundwater abstraction and water management infrastructure and process water dam. The proposal involves the disturbance of ~453.34ha within a Development Envelope of 924.8ha, predominantly located on previously cleared farmland (~449.84ha) and has a life of mine of 4.5 to 5.5 years.

1.1. PURPOSE AND SCOPE

The purpose of this Environmental Review Document (ERD) is to present an environmental review of the Proposal including a detailed description of the key components, environmental impacts and proposed environmental management measures for the relevant environmental factors identified by the Environmental Scoping Document (ESD) (Doral, 2019) (Appendix 1). It should be noted that the Environmental Factors "Hydrological Processes" and "Inland Waters Environmental Quality", have been combined and addressed as "Inland Waters" as per *Statement of Environmental Principles, Factors and Objectives* (EPA, 2018b).

The ERD has been prepared in accordance with *Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual* (EPA, 2016a) and the *Instructions and Template: Environmental Review Document* (EPA, 2018a). This document also satisfies the requirements for an accredited assessment under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

1.2. PROPONENT

The Proponent for this Proposal is Doral Mineral Sands Pty (Doral).

Doral is a wholly owned subsidiary of Perth-based Doral Proprietary Limited, which itself is an unlisted public company owned by Iwatani International Corporation of Japan.

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1.3. ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

The Proposal will be assessed under the following primary environmental legislation:

- Part IV of the *Environmental Protection Act 1986* (WA) (EP Act);
- Part 8 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The EPA will review the draft Environmental Review Document (ERD) and when satisfied the ERD adequately addresses the requirements set out in the Environmental Scoping Document (ESD), the EPA will approve the ERD document to be released for a four-week public review period. Following the public review period, the EPA will provide the Proponent with summaries of all submissions received.

The matters raised in the submissions will be addressed by Proponent to the satisfaction of the EPA. The EPA will then assess the ERD, submissions, Proponent response to submissions, obtain advice from any other persons it considers appropriate and prepare and submit its report and recommendations to the WA Minister for the Environment.

The Minister for the Environment will subsequently publish the EPA report. As provided for under section 100(1) (d) of the EP Act, any person may lodge an appeal to the Minister against the findings or recommendations of the EPA assessment report within 14 days of publication of the report. Following determination of any appeals and consultation with decision-making authorities, the Minister will determine whether the Proposal should be implemented and if so, under what conditions.

1.3.1. ENVIRONMENTAL PROTECTION ACT 1986

The EP Act is the primary legislation governing environmental protection and impact assessment in Western Australia. Division 1 of Part IV of the EP Act provides for the referral and assessment of significant and strategic proposals.

If a Proposal is likely to have a significant effect on the environment, the Proposal should be referred to the EPA in accordance with section 38 of the EP Act. The EPA reviews the referral and decides whether to assess a referred Proposal. If the EPA decides to assess the Proposal the level of assessment will also be determined.

Where an assessment is required the EPA or the Proponent will prepare an ESD. The ESD outlines the preliminary key environmental factors and specifies the form, content, timing and procedure of the ERD to meet the requirements of section 40(3) of the EP Act. The ERD must be prepared in accordance with the ESD, the *Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual 2016* (EPA, 2016a) and associated environmental assessment guidance documents. The purpose of the ERD is to assess the impacts of the Proposal on the preliminary key environmental factors.

The EPA will review the draft ERD and when satisfied that the ERD adequately addresses the requirements set out in the ESD, the EPA will approve the ERD document to be released for a public review period (where required). Following the public review period, the EPA will provide summaries of submissions received to the Proponent.

The matters raised in the submissions will be addressed by Proponent to the satisfaction of the EPA. The EPA will then assess the ERD, submissions, Proponent response to submissions, obtain advice from any other persons it considers appropriate and prepare and submit its report and recommendations to the WA Minister for the Environment.

1.3.2. AUSTRALIAN GOVERNMENT LEGISLATION

The EPBC Act is administered by the Commonwealth Department of Agriculture, Water and the Environment (DAWE) (previously the Department of the Environment and Energy, DoEE) on behalf of the Commonwealth Minister for the Environment. If a Proposed Action will have, or is likely to have, a significant impact on a matter of national environmental significance (MNES), the Proposed Action must be referred to the Minister for a decision on whether assessment and approval is required under the EPBC Act.

The MNES are:

- World heritage properties;
- National heritage places;
- Wetlands of international importance (listed under the Ramsar Convention);
- Listed threatened species and ecological communities;
- Migratory species (protected under international agreements);
- Commonwealth marine areas;
- The Great Barrier Reef Marine Park;
- Nuclear Actions (including uranium mines);
- A water resource (in relation to coal seam gas development and large coal mining development).

If the Proposed Action is determined to be a Controlled Action, the proposal will be assessed in accordance with s87 of the EPBC Act, usually under an accredited assessment between the Commonwealth and the State of Western Australia. Under an accredited assessment, the Commonwealth has endorsed the State's environmental impact assessment (EIA) process, effectively delegating the responsibility of assessing the Proposal to the State.

1.4. OTHER APPROVALS AND REGULATIONS

1.4.1. LAND TENURE

The Proposal is located within an area Doral have been granted Retention Licence R70/0052, which covers an area of approximately 2,290 hectares. Parts of this Retention Licence are being converted to a Mining Lease during future environmental permitting.

The City of Busselton's Local Planning Scheme (LPS) No. 21 (TPS 21) shows the Proposal is zoned as 'Agriculture'. There are 22 Lots within the Development Envelope, however only 12 of these Lots will be directly disturbed for the proposal (i.e. mined or used for infrastructure) (Figure 1-3). Access to landowners' properties will be made available via access agreements. The lot numbers, landowners and land tenure that will be affected by this Proposal are summarised in Table 1-1.

TABLE 1-1: LAND TENURE AND LANDOWNER STATUS

LOT NUMBER	LANDOWNER	LAND TENURE
608	Private Ownership	Freehold
668	Private Ownership	Freehold

LOT NUMBER	LANDOWNER	LAND TENURE
667	Private Ownership	Freehold
103	Private Ownership	Freehold
104	Private Ownership	Freehold
729	Private Ownership	Freehold
1609	Private Ownership	Freehold
3752	Private Ownership	Freehold
1293	Private Ownership	Freehold
843	Private Ownership	Freehold
758	Private Ownership	Freehold
1426	Private Ownership	Freehold
3773	Private Ownership	Freehold
44	Department of Planning, Lands and Heritage	Unallocated crown land
n/a	McGibbon Track	Gazetted Road
n/a	Princefield Road	Gazetted Road

1.4.2. DECISION MAKING AUTHORITIES

The decision-making authorities (DMA's) listed in Table 1-2 have been identified for the Proposal.

TABLE 1-2: DECISION-MAKING AUTHORITIES

DECISION-MAKING AUTHORITY	RELEVANT LEGISLATION
Minister for Environment	*Environmental Protection Act 1986* *Biodiversity Conservation Act 2016*
Commonwealth Minister for Environment	*Environment Protection and Biodiversity Act 1999*
Minister for Water	*Rights in Water and Irrigation Act 1914*
Minster for Mines and Petroleum	*Mining Act 1978*
Minister for Aboriginal Affairs	*Aboriginal Heritage Act 1972*
Minister for Health	*Radiation Safety Act 1975*
Minister for Lands	*Land Administration Act 1997*
Department of Water and Environmental Regulation	Part V of the *Environmental Protection Act 1986* *Environmental Protection Regulations 1987*

DECISION-MAKING AUTHORITY	RELEVANT LEGISLATION
Department of Mines, Industry Regulation and Safety	*Mining Act 1978* *Mines Safety and Inspection Act 1994* *Mines Safety and Inspection Regulations 1995* *Dangerous Goods and Safety Act 2004*
Radiological Council of Western Australia	*Radiation Safety Act 1972*
City of Busselton	*Planning Development Act 2005*
Water Corporation	*Water Services Act 2012*

1.4.3. OTHER APPROVALS

In addition to approvals required from EPA and DAWE, the following other approvals are required for the Proposal are summarised in Table 1-3

TABLE 1-3: OTHER APPROVALS

PROPOSAL ACTIVITIES	LAND TENURE/ACCESS	TYPE OF APPROVAL	LEGISLATION REGULATING THE ACTIVITY
Mining and associated activities	Mining Tenement/ Freehold Land	Granting of Mining Tenement(s)	*Mining Act 1978*
Mining and associated activities	Mining Tenement/ Freehold Land	Mining Proposal Mine Closure Plan	*Mining Act 1978*
Construction of crossing over Abba River	Water Corporation Asset (Abba River drain)	Water Corporation consent	*Water Services Act 2012*
Disturbance to registered Aboriginal Site	Mining Tenement/ Freehold Land	Section 18 consent	Aboriginal heritage Act 1972
Construction and operation of mine and ore processing infrastructure and discharge of surplus water	Mining Tenement/ Freehold Land	Works Approval and Licence	Part V of the EP Act
Groundwater abstraction and water supply	Mining Tenement/ Freehold Land	26D and 5C Licence	*Rights in Water and Irrigation Act 1914*
Mine dewatering	Mining Tenement/ Freehold Land	26D and 5C Licence	*Rights in Water and Irrigation Act 1914*

2. THE PROPOSAL

2.1. BACKGROUND

The Proposal was referred to the EPA under section 38 of the EP Act on 26 October 2017. On 3 January 2018 the EPA published its decision to formally assess the Proposal (Assessment No. 2141) under Part IV of the EP Act as a Public Environmental Review, with a four-week public review period for the ERD.

Doral prepared and submitted an ESD to the EPA on 1 March 2019, which was considered by the EPA at Meeting No. 1124 on 21 March 2019. The ESD was endorsed as providing an acceptable basis for the preparation of the ERD on 15 May 2019. The final ESD is provided as Appendix 1.

The Proposal was also referred to the Commonwealth DAWE (then DoEE) on 1 November 2017 for consideration under the EPBC Act. On 8 February 2018, DAWE determined that the Proposal is a Controlled Action and requires assessment and decision on approval under the EPBC Act (EPBC Reference: 2017/8094) (Appendix 2). The relevant MNES for the Proposal are:

- Listed threatened species and communities (s18 and 18A)
    - Western Ringtail Possum *(Pseudocheirus occidentalis)* – Critically Endangered.
    - Whicher Range Dryandra *(Banksia squarrosa* subsp. *Argillacea)* – Vulnerable.
    - Vasse Featherflower *(Verticordia plumose* var. *vassensis)* – Endangered.
    - Shrublands on the southern Swan Coastal Plain Ironstones – Endangered.
- The ecological character of a declared Ramsar wetland (section 16 and 17B)
    - Vasse-Wonnerup Ramsar wetland system;
- Migratory species (section 20 and 20A)
    - Wood sandpiper *(Tringa glareola)* – Migratory;
    - Sharp-tailed sandpiper *(Calidris acuminate)* – Migratory;
    - Long-toed stint *(Calidris subminuta)* – Migratory.

The Proposal will be assessed by accredited assessment under Part IV of the EP Act.

2.2. CHANGES TO PROPOSAL UNDER S43A

On 5 November 2019, Doral submitted a section 43A request to the EPA to make minor modifications and changes to the Proposal, whilst under assessment. The proposed request involved the following two elements:

1. Increase in the area of the Development Envelope to incorporate new internal road route from the on-site processing facility to the public road network (Ludlow-Hithergreen Road) to avoid road widening and clearing native vegetation and fauna habitat along Princefield Road, resulting in an increase to the Development Envelope of 30.63ha.
2. Modification to the area and layout of mine pits and infrastructure resulting in an increase to the total disturbance footprint of 80.67ha within the revised Development Envelope.

Nature of proposed change

The original proposal intended to use Princefield Road, a local farm road that runs parallel to the proposed site, for haulage. Following consultation with the City of Busselton, to use Princefield Road for haulage, Doral would have to commit to upgrading the road, which would result in clearing approximately 0.2ha of native vegetation within the road reserve. This vegetation is considered of high value as it includes ~45 potential Black-Cockatoo breeding habitat trees and five priority flora species:

- *Loxocarya magna,* P3;
- *Acacia flagelliformis,* P4;
- *Grevillea brachystylis* subsp. *Brachystylis,* P3;
- *Calothamnus quadrifidus* subsp. *Teretifolius,* P4;
- *Loxocarya magna,* P3.

In order to avoid impacting high value vegetation and fauna along Princefield Road, Doral proposed to construct a new internal road to access Ludlow-Hithergreen Road, which was outside of the proposed Development Envelope referred to the EPA under section 38 of the EP Act. Due to the changes proposed for the haul road, the layout of the Proposal, including mine pits, key infrastructure and other supporting infrastructure, also required modification.

The overall outcome of the proposed changes are highlighted in the table below.

TABLE 2-1: PROPOSED CHANGES TO DISTURBANCE FOOTPRINT UNDER S43A

DISTURBANCE TYPE	REFERRAL/ESD (HA)	PROPOSED CHANGE (HA)	DIFFERENCE (HA)
Development Envelope	894.17	**924.80**	30.63
Mine Pits	334.32	**260.22**	-74.10
Associated infrastructure	7.85	0 (incorporated into Key Mine Infrastructure)	-7.85
Solar Evaporation Ponds	30.5	0 (incorporated into Key Mine Infrastructure	-30.5
Key Mine Infrastructure	Previously Associated Infrastructure and Solar Evaporation Ponds	**23.07**	23.07
Other Supporting Infrastructure	n/a	**170.05**	170.05
Total Disturbance Footprint	372.67	**453.34**	**80.67**

Overall there is an increase of 30.63ha to the Development Envelope and an increase of 80.67ha to the disturbance footprint due to modifications of mine pits, key mine infrastructure and other supporting infrastructure. While there is an increase in disturbance, clearing is almost entirely within cleared pasture/planted vegetation (78.84ha), with a small area of additional vegetation included for potential

disturbance (1.83ha). The native vegetation to be cleared is considered to be in degraded to completely degraded condition and has low value as potential fauna habitat.

On 9 January 2020, the EPA determined to consent to the proponent changes to the Proposal under section 43a of the EP Act. It was concluded the change to the Proposal will not include any additional environmental factors or different impacts to the environment and will result in a reduction in potential environmental impacts, in particular the impacts to Threatened fauna and Priority flora species. The changes also increase the level of confidence in the predicted impacts and the success of proposed mitigation for the Proposal.

Following the submission of the section 43A application, Doral identified the need to seek approval from the Water Corporation under the *Water Services Act 2012*, to construct the proposed crossing over the Abba River at the intended location. The intended location for the crossing, was identified as a Water Corporation drain and in accordance with the Water Corporation's "*Policy for Private Crossings on Water Corporation Drains No 0002 for PCY 239*":

> Any bridge over a Water Corporation drain can be constructed to the owner's satisfaction without conditions being imposed by the Corporation provided:
>
> 1. The Corporation is advised that it is intended to construct the bridge;
> 2. The bridge does not impede upon the waterway.

Following liaison with the Water Corporation, Doral are required to provide a detailed engineering design of the proposed bridge in order to satisfy the policy requirements.

2.3. JUSTIFICATION

Doral is a global supplier of the products of mineral sands mining (ilmenite, leucoxene, rutile and zircon). Continuation of mining is core to Doral's business and crucial to continue to deliver to a global market.

Doral have operated in the southwest region of Western Australia since 2002, predominantly at the Dardanup Mine which extracted ore from the Dardanup and Burekup Mineral Sands Deposits, located approximately 20km east of Bunbury. Operations ceased at the Dardanup Mine in December 2015 and the Site has been rehabilitated back to the agreed end landuse and is currently undergoing relinquishment.

Doral commenced mining the Yoongarillup Mineral Sands Deposit (Yoongarillup Mine), located 17km southeast of Busselton, in January 2017 in accordance with Ministerial Statement No. 1030. Mining is due to cease at the Yoongarillup Mine in 2020.

Doral also operates a Dry Separation Plant at Picton, 10km east of Bunbury, which receives HMC from Doral's Yoongarillup Mine.

Employing approximately 100 staff and contractors, Doral's business is a source of employment locally and provides business for suppliers, distributors and local services (e.g. mechanics, contractors, consultants). Doral contributes financial support to local schools, sporting groups, various volunteer groups, and annual local festivals and is considered a valuable member of the local community.

Mining operations at Doral's Yoongarillup Mine are anticipated to be completed in 2020. An alternative ore source is therefore required to continue to meet global demand and to ensure the continued employment of Doral's employees and contractors. Commencement of mining operations at the Yalyalup Mineral Sands Project at the beginning of 2021 will enable Doral to continue operating in the southwest of Western Australia and ensure employees and contractors are retained in the southwest and local support to communities continues.

2.3.1. ALTERNATIVES CONSIDERED

Doral have analysed the alternatives to mining the Yalyalup Mineral Sands Deposit. A discussion of the alternatives is provided as follows.

IS THIS PROPOSAL NEEDED

Doral is a global supplier of the products of mineral sands mining (ilmenite, leucoxene, rutile and zircon). Continuation of mining is core to Doral's business and crucial to continue to deliver to a global market.

Ilmenite, rutile, leucoxene (an alteration product of ilmenite) and HITI (which is a blend of ilmenite and leucoxene) are mainly used to make pure white, highly light refractive and ultra-violet light absorbing, Titanium Dioxide pigment for use in protective house and car paints; paper; plastics; ink; rubber; textiles; cosmetics; sun screens; leather and ceramics. Because titanium dioxide is non-toxic and biologically inert, it can be safely used in foodstuffs and pharmaceuticals. Super strong, lightweight and corrosion resistant titanium metals are also used in the construction of aircraft, spacecraft and motor vehicles, and for medical implants. Again, its non-reactive properties make titanium one of the few materials the human body will not reject; consequently, it is widely used in such medical operations as hip replacements and the installation of heart pacemakers. This super metal is also being increasingly used in the manufacture of strong, lightweight sports equipment, jewellery and other advanced engineering applications.

Zircon is used in ceramics, specialty castings and various refractory applications, where its resistance to high temperature and abrasion make it extremely valuable in the manufacturing processes as well as ceramics such as glazes for tiles and sanitary wear. In industry, it is mainly used as a raw material in making refractory bricks, furnace linings and producing pigments in the ceramic industry; where its opacity and hardness gives a whiteness and durability to tiles, sanitary ware and tableware. It is also utilized in a range of other high-tech industrial and chemical applications.

Doral's operations meet a global need for ilmenite, rutile and zircon and provide the West Australian community with employment. Doral currently abstracts ore to produce these products from its Yoongarillup Mine, which is scheduled for closure in 2020. An alternative ore source is required to continue to meet global demand and to ensure the continued employment of Doral's employees.

OTHER TECHNOLOGIES OR OPTIONS

Open cut mining of mineral sands is a well-established practice in Western Australia due to the shallow nature of the deposits, which generally occur between 5 to 10m deep in the region. Deposits are usually strand-like and occur at the location of ancient shorelines. Disturbance occurs only on the surface layers and not at depth compared to other forms of mining (e.g. iron ore mining can have pit depths of greater than 100-200m deep). The use of alternative technologies can be more expensive (e.g. horizontal drilling) and have their own associated impacts and may not result in fewer disturbances to the environment.

LOCATION OPTIONS

Doral are constrained spatially, as the location of mineral sands deposits are the targeted location, and in the southwest region these are largely associated from the foothills of the Whicher Scarp to the coast. The grade of HMC discovered through exploration drilling largely determines the areas that are viable and can be extracted for sale. In this case Doral have conducted extensive exploration drilling, and the results of aircore testing indicate the area contains viable mineral. Doral hold other tenements in the southwest, however economic resources have yet to be defined for these. As such limited environmental or technical studies have been undertaken on these tenements.

OPTIMISATION OF PROPOSAL TO MINIMISE ENVIRONMENTAL IMPACTS

The design of the Proposal and placement of mine pits is continually evaluated through stages of exploration drilling. Exploration drilling commenced in 2012 and since that time Doral have designed a series of mine pit configurations, resulting in the layout presented in this ERD for submission to the EPA.

The following design optimisations have been incorporated into the design and layout of the Proposal to minimise environmental impacts:

- Areas containing native vegetation have been avoided where possible (McGibbon Track) to minimise the need to clear vegetation;
- Utilising mine voids where possible for ponds and location of mine infrastructure to reduce the total area disturbed;
- Location of processing equipment in-pit (e.g. hopper) to minimise noise emissions to sensitive receptors;
- Incorporation of noise bunds to minimise potential noise impacts under certain wind conditions on nearby residences;
- Incorporation of several options for emergency discharge of water in the event of extended periods of heavy rainfall.

2.4. PROPOSAL DESCRIPTION

2.4.1. OVERVIEW AND KEY CHARACTERISTICS

The Proposal is to allow mining of the Yalyalup Mineral Sands Deposit located approximately 11km southeast of Busselton, Western Australia (Figure 1-1 and Figure 1-2). The Mine is proposed to operate 24 hours a day, 7 days a week, however during evening and night time periods (7pm-7am) all mining activities at the pits will stop and only the feed prep and wet Concentrator plants will remain in operation.

Ore from the deposit will be mined progressively via a series of open-cut pits using dry mining techniques. Dewatering of groundwater inflows into the pit will be required to enable dry mining to occur. Mining will be staged in order to minimise the area of disturbance (at any one time) with the aim of achieving focused and effective management of the environmental factors at each pit location, prior to moving onto the next pit location.

Processing of ore will commence in-pit and then slurry will be pumped from the feed preparation plant to the wet concentration plant for further processing. Waste clay and sand materials from processing of this ore will be combined and backfilled into the mine voids using co-flocculation (co-disposal system) where possible. Some material will be initially placed in a Tailing Storage Facility, herein referred to as Solar Evaporation Ponds (SEPs), to allow drying of the clay and recycling of water back to the process water dam (PWD) (return water), prior to being co–disposed into mine voids. The mined area will be rehabilitated back to pasture and/or native vegetation, depending on pre-mining conditions, consistent with the post-mine land use requirements.

HMC produced at the wet Concentrator plant will be stockpiled on site prior to transport to Doral's Picton Dry Separation Plant, located ~60km northeast of the mine, for separation using electrostatic processes. The Picton Dry Separation Plant has a licence to process HMC sourced from Doral's Yoongarillup Mine. Processing of HMC into products of zircon, ilmenite, and leucoxene has occurred since the Picton Dry Separation Plant

was approved by Ministerial Statement No. 484 in 1998. Once processed, HMC products are hauled by truck to either the Bunbury Port or Fremantle Port for export. Processing activities at the Picton Dry Separation Plant and exporting of product are not part of this Proposal and are not further described in this referral document.

Key characteristics for the Proposal are summarised in Table 2-2 and Table 2-3.

TABLE 2-2: SUMMARY OF THE PROPOSAL

Proposal title	Yalyalup Mineral Sands Mine
Proponent name	Doral Mineral Sands Pty Ltd
Short description	The Proposal is to develop, mine, rehabilitate and decommission the Yalyalup Mineral Sands Mine. The Proposal includes the development of mine pits and associated infrastructure, wet concentration processing plant, solar evaporation ponds, groundwater abstraction, water management infrastructure and process water dam. The life of mine is expected to be 4 to 5 years.

TABLE 2-3 LOCATION AND PROPOSED EXTENT OF PHYSICAL AND OPERATIONAL ELEMENTS

ELEMENT	LOCATION	EXTENT
Physical Elements		
Mine pits	Fig 1-2	Clearing of 0.79ha of native vegetation and disturbance of 259.43ha of pasture/planted species within the 924.8ha Development Envelope
Key Mine Infrastructure	Fig 1-2	Clearing of 0.10ha of native vegetation and disturbance of 22.97ha of pasture/planted within a 924.8ha Development Envelope
Other Supporting Infrastructure	Fig 1-2	Clearing of 2.61ha of native vegetation and disturbance of up to 167.43ha of pasture/planted within a 924.8ha Development Envelope
Operational Elements		
Groundwater Abstraction	-	Abstraction of up to 1.6 gigalitres (GL) per annum from the Yarragadee aquifer
Ore processing (HMC)	-	250,000 tonnes per annum

2.4.2. PRE-MINE ESTABLISHMENT WORKS

Pre-mine establishment activities will be undertaken between the hours of 7am to 7pm Monday to Saturday (excluding public holidays). The pre-mine establishment works are anticipated to commence from July 2021 and continue for a period of 4-6 months as shown in Table 2-4. Pre-mine establishment works to be conducted are:

- Sub–soil and surface drainage of paddocks;
- Construction of the Drop Out Dam (DOD) and Process Water Dam (PWD);
- Stripping of topsoil and available subsoil;

- Construction of SEPs;
- Construction of internal roads;
- Installation of production bores and associated water infrastructure (e.g. pipelines);
- Construction of two amenities buildings; one containing offices and lunchroom and a second for ablution facilities. A local government approved effluent disposal system;
- Construction of feed preparation plant, wet concentration plant and associated infrastructure;
- Construction of workshop and hardstand areas;
- Fencing where required (e.g. native vegetation areas and/or McGibbon Track).

2.4.3. MINING AND PROCESSING OF ORE

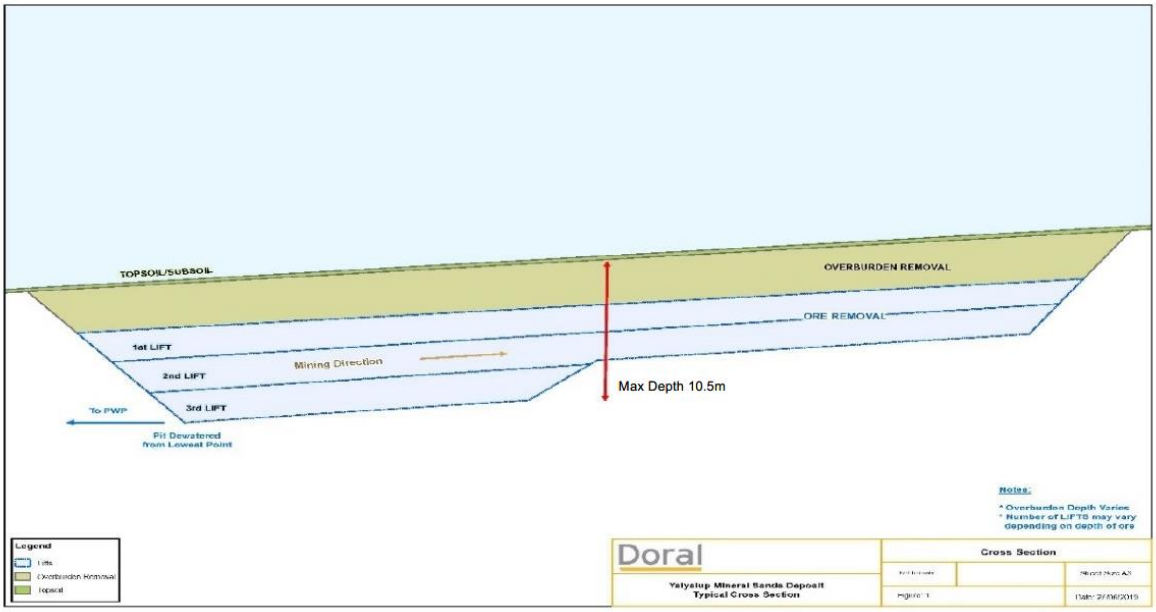
SURFACE ORE

Following the removal and stockpiling of topsoil and available subsoil, surface ore will be mined using front end loaders to feed a mobile in-pit screen to a depth of ~2-4mbgl.

ORE STRAND

The strandline deposit ore at Yalyalup will be mined progressively via a series of open-cut pits using dry mining techniques. Once the topsoil and available subsoil are stripped and stockpiled, overburden will be removed via excavators. Removed overburden (identified as ASS) will be treated and managed to neutralise acid sulfate soils (ASS) and either stockpiled for use as bunds or construction material or used in progressive backfill of previously mined areas. Exact depths of ore and overburden will vary for each pit, with current drill data suggesting mining will not exceed 10.5m below ground level (mbgl). Ore will be mined in a series of lifts, to the maximum depth of 10.5mbgl. Pits will be mined on a slight incline from the deepest point and then mined moving up-gradient in order to retain pit water within a sump at the deepest point on the pit floor (Plate 2-1). This form of dewatering is known as ‘passive’ as no dewatering apparatus (e.g. spears) are used to actively abstract water and groundwater drawdown below the base of the pit is highly unlikely to occur. Mine pit dewater is pumped from the sump to the PWD for reuse.

PLATE 2-1: Typical Drainage Control Cross Section



A Mine Schedule for the Proposal is provided below in Table 2-4.

TABLE 2-4: MINE SCHEDULE

	2021/22												2022/23												2023/24												2024/25											
Pit	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24	Jan-25	Feb-25	Mar-25	Apr-25
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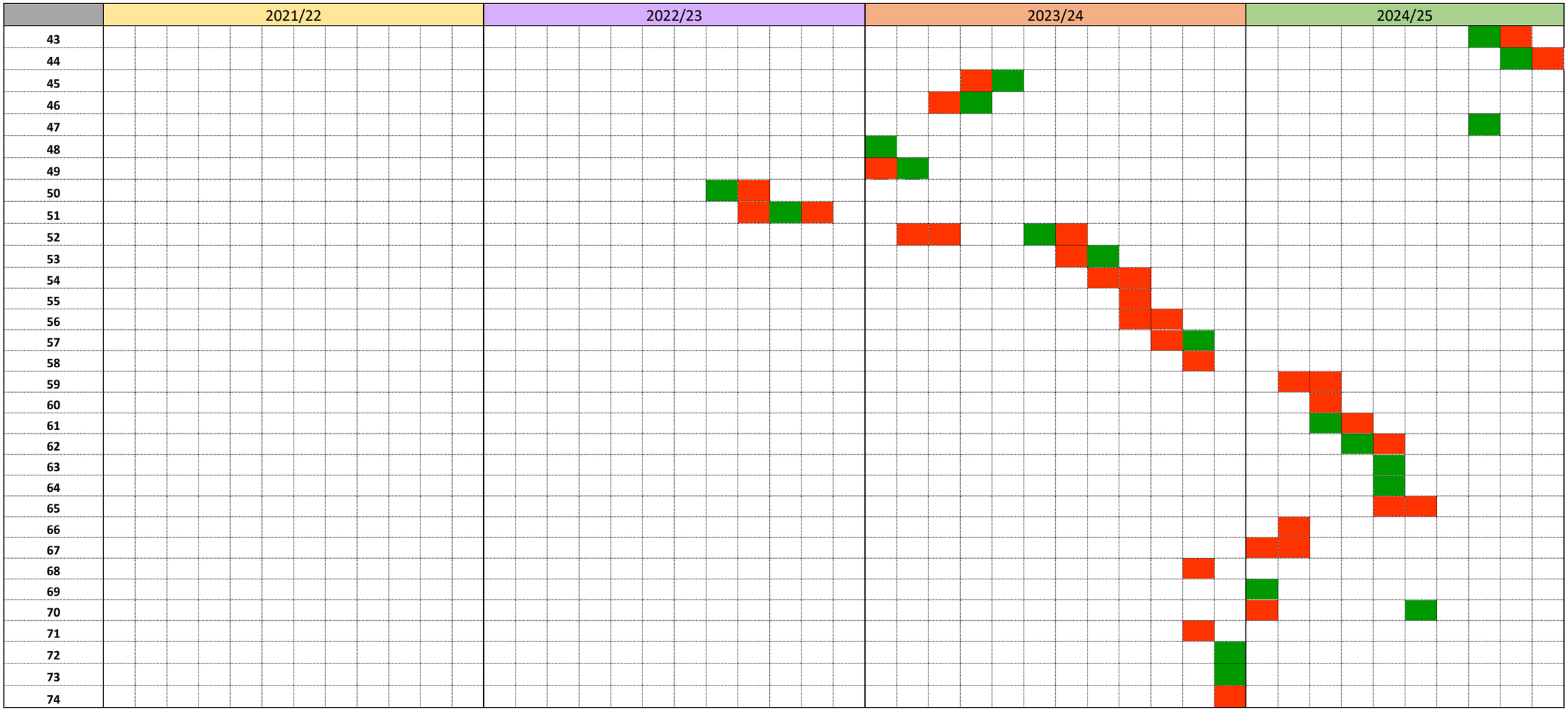


Legend

- Construction
- Overburden
- Ore & Overburden
- Ore

ORE PROCESSING

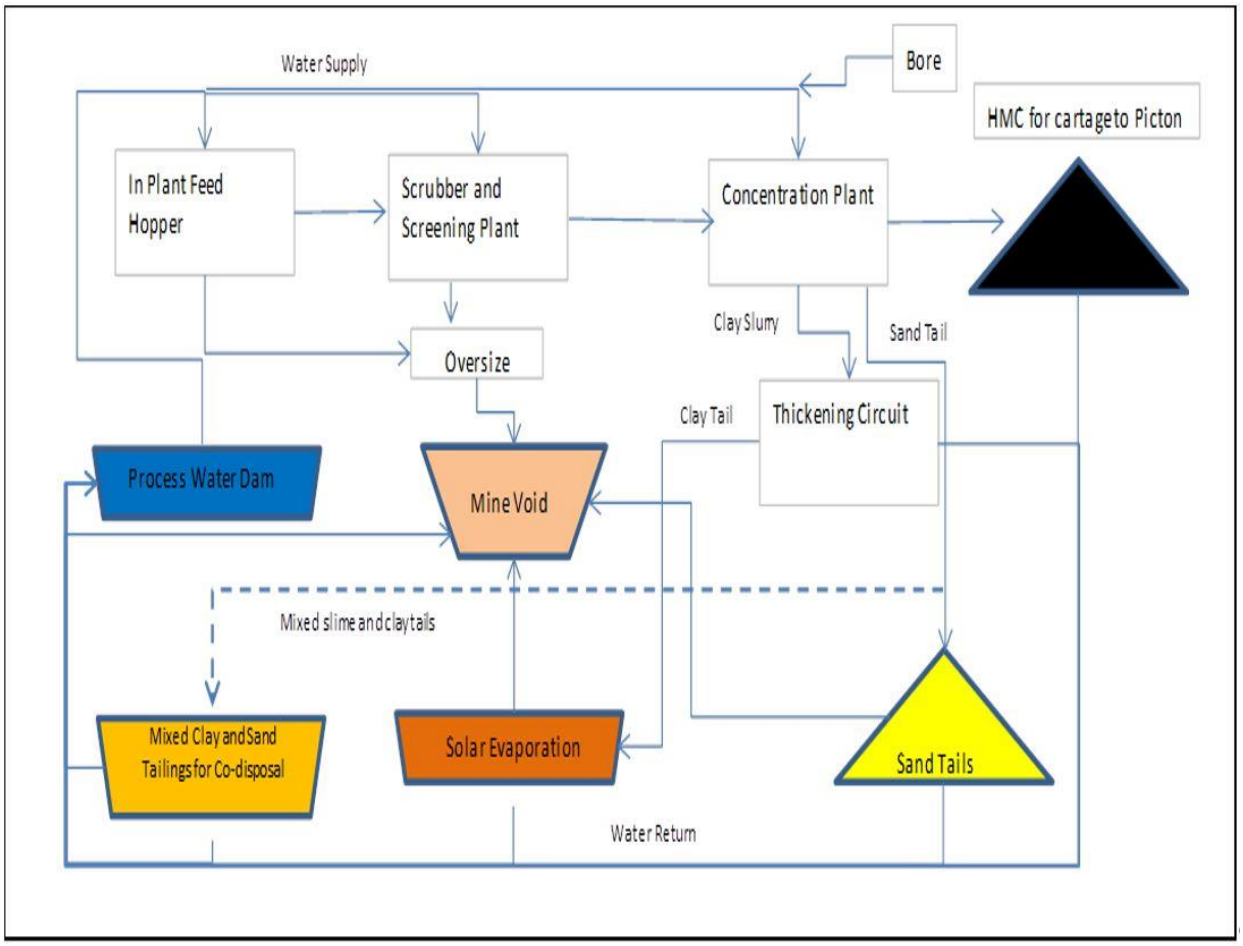
Two methods of ore extraction will be undertaken at the Yalyalup Project. The shallow 1-4m 'windblown ore' reserves will be mined using a Front End Loader, and fed into the mobile in-pit hopper. The ore will be screened and slurried using a mobile in-pit screening unit and pumped to the trommel at the Feed prep plant for removal of material greater than 3 mm. For the deeper strand ore areas, these will be mined using a traditional excavator and truck combinations (dayshift only) and trucked to a central stockpile at the Feed Prep plant and processed in campaigns as required and during the evening and night periods.

From the feed preparation plant, the ore will be transported via pumps and pipelines to the wet concentration plant where the process requires all particles >2.4 mm to be removed from the ore. The feed preparation plant will also be able to operate from an ore stockpile (ROM) to maintain ore feed during night time activities. It is anticipated the wet Concentrator plant will operate at a nominal throughput rate of 400TPH to produce ~380,000 tonnes of HMC over the life of mining the Yalyalup Mineral Sands Deposit. Processing of ore results in three streams of material, HMC, clay fines and sand tails. The three streams are then dealt with in the following manner:

- HMC are stockpiled on limestone pad(s) and stored on-site until transport to Doral's Picton dry processing plant for further processing;
- Sand tails are hydraulically returned into pit voids (including as co-disposal);
- Clay fines are directed to the thickening circuit, where flocculent agglomerates clay fines, producing clay tails. The clay tails are either hydraulically co-disposed with sand tails into pit voids or directed to SEPs to allow settlement and drying for future disposal into mine voids. The majority of water will be decanted from the SEPs/tails areas and pumped or gravity fed back to the PWD for use as process water.

A flow chart of mining operations is provided in Plate 2-2.

PLATE 2-2: FLOW CHART OF MINING OPERATIONS



2.4.4. ANCILLARY INFRASTRUCTURE

Infrastructure

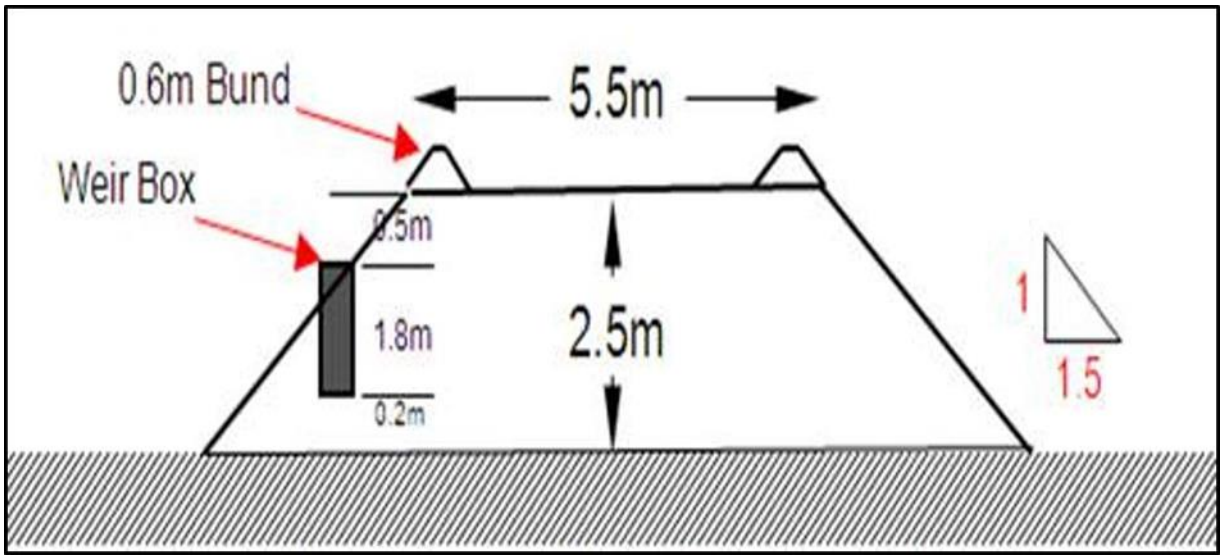
Infrastructure to support mining will include:

- Mobile in-pit screening plant, comprising feed hopper and screens and conveyors;
- Feed preparation plant, comprising a screen, rotary trommel and scrubber unit to remove rock and clay from the ore;
- Wet concentration plant, comprising gravity separation spirals for heavy mineral separation, a thickening unit and other ancillary equipment;
- Mine offices, workshops and associated hardstand area;
- Internal roads and access roads;
- Power supply – Western Power and Doral owned transmission lines.

Solar Evaporation Ponds (SEPs)

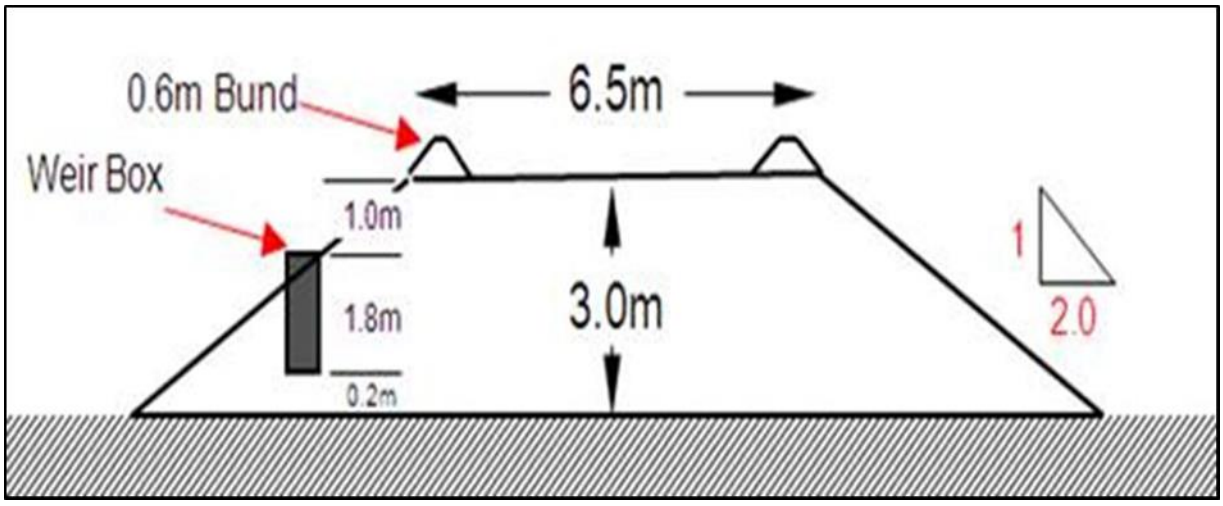
Doral proposes to construct Solar Evaporation Ponds (SEPs) as shown on Figure 1-2, to receive and dry clay fines during mining. SEPs will be constructed in accordance with *Tailings storage facilities in Western Australia – code of practice* (DMP, 2013) as shown in Plates 2-3 and 2-4.

PLATE 2-3: SOLAR EVAPORATION POND DESIGN CLAY AND OVERBURDEN STRUCTURES



Note: not to scale

PLATE 2-4: SOLAR EVAPORATION POND DESIGN TAILINGS SAND STRUCTURES



Note: not to scale

The following standard design and operating practices for the management of SEPs will be implemented over the life of the mine in order to maintain the structural integrity of the embankment walls and to prevent over topping:

- All SEP floors are constructed to design slope using GPS control prior to pouring. The SEP floors are designed with a slope of 1:300 to 1:400 to assist with even and homogenous fills and the prevention of free water pools unable to flow to the weir box;
- SEP wall height must be at least 2.5 m above the floor for clay and overburden structures and at least 3.0 m above the floor for tailing sand structures;
- SEPs constructed with dry clay material or overburden is track rolled using a D7 bulldozer. The angle of repose for the outer pond wall is 1.0 vertical: 1.5 horizontal;

- Only light vehicles have access to standard pond walls following construction. If SEP walls are to be modified as haul roads the running width must be at least 6.5 m for one-way traffic and 14 m for two-way traffic.

Process Water Dam and Drop Out Dam

A process water dam and drop out dam (PWD/DOD) will be constructed in mine voids created from the removal of overburden and ore. The PWD will be unlined and will supply water to the plant for processing of ore.

The drop out dam will be constructed adjacent to the PWD. The purpose of this pond is to receive all return water from the site and act as a settling pond to settle out suspended solids from water prior to it entering the PWD.

2.4.5. WATER SUPPLY

Water required for the wet Concentrator plant process will be sourced entirely from the PWD. Water for the PWD will be sourced from mine dewater, return water from the SEPs, rainfall runoff and supplemented with a production bore(s) screened within the Yarragadee aquifer. Doral will make every effort to maximise water recycling and to minimise water use. Process water will, in the first instance be sourced from recycled water and dewatering of the pits. Additional process water sourced from the Yarragadee aquifer bore will be used only after other resources have been fully utilised.

A summary of the main inputs of water to the PWD include:

- Recycled process water;
- Groundwater inflows pumped from the active mining cells (i.e. pit dewatering);
- Site runoff from impervious disturbance areas, including access road, building/structures and hardstands;
- Direct rain that falls over the surface of the PWD;
- Abstraction from production bore screened in the Yarragadee aquifer.

The outputs from the PWD are:

- Use of water in the wet concentration plant process;
- Evaporation;
- Emergency discharge.

A conceptual site water balance for the Proposal using GoldSim was conducted by (AQ2, 2020b), which returned the following results:

- A 1.6GL annual abstraction licence from the Yarragadee aquifer should be sufficient to provide a reliable water supply system, with the predicted peak annual demand of 1.3GL. The highest demand for groundwater is expected to be in the first year of operation.
- An annual discharge licence in the order of 100,000m^3 (100ML) would allow the site to discharge from the PWD/DOD during wet conditions without impacting operations. The largest annual discharge volume was predicted to be 82,000m^3 during the Q2 2023 mining period, across the 100 model iterations. Some buffer storage capacity within the open pit is assumed within this estimation.

- Although an annual discharge licence in the order of 100,000m^3 is suggested, the licence is to cover the risk of a wet period occurring during the 2023 winter (greater than 50% likelihood). Outside this period, the model doesn't predict there to be a requirement to discharge surplus water. Note that a separate assessment has been documented to estimate runoff from a 100-yr event across the site (with different assumptions to this assessment), refer to (AQ2, 2019b).

Doral propose to secure water for the Proposal through the legislative instruments of the RIWI Act via either a Yarragadee allocation acquisition or trade.

2.4.6. POWER SUPPLY

Power requirements will be sourced from the Western Power grid via a 22kV power line. Consultation with Western Power has indicated that Western Power will utilise existing infrastructure and upgrade where required to provide a three-phase power supply at an estimated load of 3MVA. Internal high voltage reticulation will distribute the power to the various processing plant locations. The power demands of the proposal are estimated at 2,750kW, with the major consumption areas being:

- 750kW: Feed Preparation Plant;
- 1250kW: Wet Concentration Plant;
- 450kW: Tailings disposal system;
- 300kW: Mine Services.

2.4.7. TRANSPORT ROUTE

Trucks will transport HMC to Picton Dry Separation Plant by road, travelling east from the mine to Ludlow-Hithergreen Rd (within Lots 1609 and 820 which are both owned by Doral), north along Ludlow-Hithergreen Rd to Bussell Highway, north along Bussell Highway, east on Robertson Dr, east on South-Western Highway, south-east onto Boyanup Picton Rd and then east onto Harris Rd to the Picton Dry Separation Plant (Figure 2-1). There will be approximately ten round trips per day (assumed ~200 days per year) using Class 10 or 11 vehicles.

2.4.8. WORKFORCE

Workforce requirements will fluctuate between summer months when clay tails are removed from SEPs and winter where the workforce will generally be focused on mining activities.

The permanent workforce levels are expected to be:

- Summer - 32 people;
- Winter - 25 people.

This includes:

- A Mine Coordinator;
- Mine Engineer;
- Surveyor;
- Environmental Officer;
- Operators;

- Maintenance staff.

Sub–contractors will be utilised for specific task as required. Specific workforce induction and training commitments will be implemented for the Proposal as outlined in the Environmental Management System and Safety Manual. Mining of this mineral resource will provide direct and indirect employment opportunities for the local community.

2.4.9. MINE CLOSURE PHASE

Full details of the mine closure phase for the Proposal is detailed in the Mine Closure Plan, provided as Appendix 3. A summary of the treatments that will be undertaken for the Site is provided as follows.

Mine pits will be progressively backfilled via co-disposal of sand tailings, dried clay tailings, oversize and overburden. A depth of ~350mm subsoil (in strand ore areas only) and then a depth of ~100-150mm of topsoil will then be replaced in order to promote the establishment of pasture grasses. Following replacement of topsoil, the surface will be contoured to provide drainage and then ripped to 300mm.

In areas identified for revegetation, prior to planting, rip lines will be furrowed along contours to collect water, directing it to the root-zone and also assist to remove hydrophobic soils, if present. Furrow spoil will be hilled on the down-slope side to better trap and retain water and to minimise erosion.

2.5. LOCAL AND REGIONAL CONTEXT

2.5.1. REGIONAL SETTING

The Proposal is located on the Swan Coastal Plain, approximately 10km east-southeast from the town of Busselton and the coast at Geographe Bay (Figure 1-1). The Swan Coastal Plain in this area slopes gently to the northwest from maximum elevations of approximately 50mAHD at the base of the Whicher Scarp, to the Vasse-Wonnerup wetlands system and the coastline.

The Proposal slopes gently northwest from elevations of approximately 30mAHD in the south-eastern corner to around 22 mAHD in the northwest. It is generally comprised of farmland and contains three continuous farm drains running southeast/northwest through the area.

The Abba River crosses the northeast corner of the Development Envelope and the Sabina River lies approximately 900m beyond the southwest corner. These rivers drain to the Vasse-Wonnerup wetlands to the northwest of the Development envelope. The wetlands are listed as a wetland of International importance under the Ramsar Convention and DWER Conservation Category Wetlands.

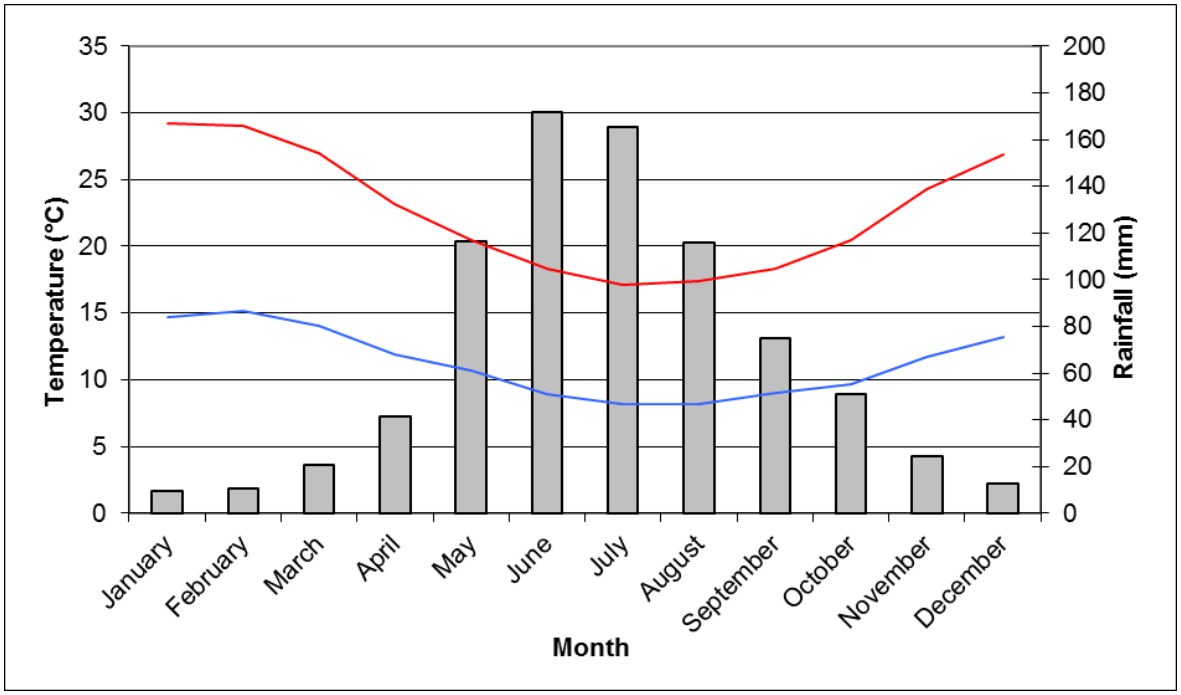
2.5.2. CLIMATE

The Geographe-Naturaliste coastline experiences a Mediterranean climate with warm to hot dry summers, and mild wet winters. High pressure cells dominate climatic patterns during summer and the passage of cold fronts and associated low pressure cells dominate during winter. Strong sea breezes occur from late November to early March.

The annual rainfall generally falls within the 800mm and 1000mm range, peaking in June and July, as shown in Plate 2-5, with minimal rainfall (<25mm) in the summer months. Annual mean rainfall for the period 2007-2017 is ~680mm, which is substantially lower than the long-term average for Busselton of 811mm. Potential average annual evapotranspiration in the region is approximately 1200mm, which therefore is likely to exceed precipitation during summer months.

In summer the average maximum temperature is 29°C with an average minimum temperature of 14°C. In winter the average maximum temperature is 17°C with an average minimum temperature of 7°C (Bureau of Meteorology, 2019).

PLATE 2-5: ANNUAL AVERAGE CLIMATE DATA



Source: Bureau of Meteorology Busselton Weather Station (Weather Station 009515)

2.5.3. RAINFALL AND FLOODING

Baseline information of rainfall depth for durations, exceedance per year (EY), and the annual exceedance probabilities (AEP) for Yalyalup are provided in Table 2-5. This information has been sourced using the Bureau of Meteorology's (BOM) 2016 Intensity Frequency Duration (IFD) design rainfall estimates which is part of the revision of the Engineers Australia design handbook *Australia Rainfall and Runoff: A Guide to Flood Estimation* (Ball, et al., 2019). The new IFD's are estimated using a more extensive dataset of rainfall data from BOM sites as well as other organisations, which have provided nearly 30 years' additional rainfall data. The IFD's provide more accurate design rainfall estimates by combining contemporary statistical analysis and techniques with the expanded rainfall dataset. A Surface Water Discharge Assessment (AQ2, 2019b) has been prepared to assist with assessment of impacts from flooding and is discussed in Section 4.4 Hydrological Processes.

TABLE 2-5: RAINFALL DEPTH FOR DURATIONS, EXCEEDANCE PER YEAR (EY), AND THE ANNUAL EXCEEDANCE PROBABILITIES (AEP)

	Annual Exceedance Probability (AEP)						
Duration	63.2%	50%	20%	10%	5%	2%	1%
1 min	2.14	2.37	3.10	3.62	4.14	4.86	5.43
2 min	3.67	4.03	5.19	6.03	6.88	8.05	8.98
3 min	4.91	5.39	6.98	8.11	9.26	10.8	12.1
4 min	5.93	6.53	8.49	9.88	11.3	13.2	14.7
5 min	6.79	7.50	9.77	11.4	13.0	15.3	17.0
10 min	9.83	10.9	14.3	16.7	19.1	22.4	25.0
15 min	11.8	13.1	17.2	20.1	23.0	27.0	30.2
20 min	13.3	14.7	19.3	22.5	25.8	30.3	33.9
25 min	14.5	16.0	21.0	24.5	28.1	33.0	36.9
30 min	15.5	17.1	22.4	26.2	30.0	35.3	39.5
45 min	17.9	19.8	25.8	30.1	34.5	40.5	45.4
1 hour	19.8	21.8	28.4	33.1	37.9	44.6	50.0
1.5 hour	22.7	25.0	32.4	37.8	43.4	51.0	57.2
2 hour	25.0	27.5	35.7	41.6	47.7	56.2	63.1
3 hour	28.6	31.4	40.8	47.7	54.7	64.5	72.4
4.5 hour	32.7	36.0	46.8	54.7	62.9	74.2	83.4
6 hour	35.9	39.5	51.6	60.3	69.3	81.9	92.1
9 hour	40.9	45.1	59.0	69.0	79.2	93.7	105
12 hour	44.7	49.4	64.6	75.5	86.7	103	115

	Annual Exceedance Probability (AEP)						
Duration	63.2%	50%	20%	10%	5%	2%	1%
18 hour	50.5	55.7	72.8	85.0	97.4	115	129
24 hour	54.8	60.5	78.7	91.7	105	124	139
30 hour	58.3	64.2	83.3	96.7	110	130	146
36 hour	61.3	67.4	87.0	101	114	134	151
48 hour	66.2	72.5	92.8	107	121	141	157
72 hour	73.9	80.6	101	115	129	149	165
96 hour	80.4	87.4	109	122	135	155	170
120 hour	86.6	93.8	115	129	141	160	174
144 hour	92.6	100	122	135	147	165	178
168 hour	98.8	107	129	143	154	171	183

2.5.4. BIOGEOGRAPHIC REGION

The Proposal is situated within the Perth Coastal Plain 2 (SWA2) sub-region of the Swan Coastal Plain biogeographic region, as defined in the Interim Biogeographical Regionalisation for Australia (IBRA) (Australian Government, 2013). The Swan Coastal Plain in this area slopes gently to the northwest from maximum elevations of approximately 50mAHD at the base of the Whicher Scarp, to the Vasse-Wonnerup wetlands system and the coastline.

The Swan Coastal plain is a low lying coastal plain, mainly covered with woodlands (Mitchell, et al., 2002). It is dominated by Banksia or Tuart on sandy soils, *Casuarina obesa* on outwash plains and paperbark in swampy areas. In the east, the plain rises to duricrusted Mesozoic sediments dominated by Jarrah woodland. Three phases of marine sand dune development provide relief. The outwash plains, once dominated by *C. obesa*-marri woodlands and *Melaluca* shrublands are extensive only in the south (Mitchell, et al., 2002).

The Perth sub-region is composed of colluvial and aeolian sands, alluvial river flats, coastal limestone. Heath and/or Tuart woodlands on limestone, *Banksia* and Jarrah-*Banksia* on woodlands on Quarternary marine dunes of various ages, Marri on colluvial and alluvials (Mitchell, et al., 2002). The sub-region is 1,333,901ha (Mitchell, et al., 2002).

2.5.5. LANDUSES

The City of Busselton's Local Planning Scheme (LPS) No. 21 (TPS 21) shows the Proposal and surrounding properties are zoned as 'Agriculture', and primarily used for beef cattle, dairy cattle, pasture and horticulture. Other nearby landuses include mineral sands mining and the Busselton Margaret River Airport.

2.5.6. GEOLOGY

The Proposal is located within the southern part of the Perth Basin, an elongate north–south rift trough with a series of sub-basins, shelves, troughs and ridges (AQ2, 2020a). The Proposal is wholly contained within the Bunbury Trough, a sub-basin containing a Permian–Cretaceous succession up to 11 km thick. The sub-basin is wedged between the Vasse Shelf and the Yilgarn Craton, bounded to the east by the Darling Fault and to the west by the Busselton Fault. The Proposal is included on the published 1:50,000 Environmental Geology Series map for Busselton (Belford, 1987) (Figure 2-2).

A summary of the stratigraphy and hydrogeology within the upper 900m of the Perth Basin at the Proposal is summarised in Table 2-6.

TABLE 2-6: SUMMARY OF STRATIGRAPHY AND HYDROGEOLOGY

AGE	FORMATION	STRATIGRAPHY	THICKNESS (m)	LITHOLOGY	HYDROGEOLOGY
Quaternary - late Tertiary	Superficial	Bassendean Sand	0.5-3	Fine to medium sub-rounded quartz sand	Superficial aquifer
		Guildford Formation	2-5	Clay and sandy clay with occasional discontinuous sand lenses	Local aquiclude
		Yoganup Formation	2-5	Leached and ferruginized beach sand conglomerate and clay. Local laterite.	Superficial aquifer
UNCONFORMITY					
Cretaceous	Leederville	Mowen Member	1-10	Clay and silty clay, with thin interbedded silt, clayey sand and fine grained sand	Regional aquitard; local Leederville aquifer (when significant sand is present)
		Vasse Member	50-100	Fine to medium grained quartz sandstone and interbedded shale.	Leederville aquifer
UNCONFORMITY					
Mid-late Jurassic	Yarragadee	Unit 1	0-50	Medium to coarse grained, weakly consolidated sandstone, minor siltstone and shales	Yarragadee aquifer
		Unit 2	0-250		
		Unit 3	200-500		
		Unit 4	0-100		

AQ2 (2020a) provides the following description of geology for the Proposal.

The upper geology sequence comprises the Quaternary-late Tertiary aged Superficial Formation, which are represented at the Site by the Bassendean Sand towards the top, the Guildford Formation and the Yoganup Formation towards the base. The Bassendean Sand forms a thin bed of fine to medium grained aeolian sand. The Guildford Formation consists predominantly of silty to sandy clay of fluvial origin. The Yoganup Formation comprises leached and ferruginous coarse-grained beach sand, with localised concentrations of heavy minerals and some sandy silt and clay layers. The superficial deposits commonly contain ironstone caprock, colloquially known as Coffee Rock, in the zone of water table fluctuation. At the Site, the Coffee

Rock is generally 2-3m thick and is exposed at the surface in the eastern side of the Site, near and along the McGibbon Track. The thickness of the Superficial Formation is irregular, reaching a maximum of ~12m at the Site, but generally 7-8 m thick.

Outside of the Development Envelope closer to the coast, the Bassendean Sand is interfingered by Tamala Limestone (i.e. limestone, calcarenite and sand), which can be up to 15m thick. Tamala Limestone is overlain by Estuarine and swamp deposits at the Vasse-Wonnerup Wetland, consisting of fine sand, silt and clay and by Safety Bay Sand at the coast area. Thin layer of the Guildford Formation underlain Tamala Limestone, with the basal sand of the Guildford Formation being equivalent to the Yoganup Formation.

The Superficial Formation is unconformably underlain by Cretaceous age, riverine and deltaic sediments of the Leederville Formation, comprising discontinuous interbedded weakly consolidated sandstone, clayey sand, silt and shale. Three member units of the Leederville Formation are identified: Vasse Member, Mowen Member, and Quindalup Member, with only Vasse and Mowen Members, present in the Yalyalup area. The lower Vasse Member is highly stratified, containing sand beds interbedded with clay aquitards. Sand beds are generally up to 10m thick with overall unit thickness of 100m at the project site. The upper Mowen Member is dominated by clay and silt with some thin interbedded silty to medium grained sand, with a thickness of up to 10m. The Mowen Member is likely to be very thin or has a greater sand content, especially on the eastern side of the project area.

The Yarragadee Formation (the aquifer being targeted for the mine water supply) underlies the Leederville Formation, comprising predominantly weakly consolidated, medium to very coarse-grained quartz sandstone, with minor siltstone and shale beds. Based on lithology and age, this formation has been divided into four sub-units (sequentially, Unit 1 to Unit 4; Baddock et. al., 2005). Unit 1 occurs at the top of the formation and Unit 4 at the base, with all units likely to be present in the project area (a total thickness of approximately 900 m).

The Bunbury Basalt occurs discontinuously between the Yarragadee and Leederville Formations and the top of the basalt is typically highly weathered. The Bunbury Basalt is unlikely to be present at the Site, based on the literature (i.e. DWER drilling information records (DWER, 2019) and the Water Corporation Magnetic data survey (Baddock, et al., 2005).

2.5.7. WATER MANAGEMENT AREAS

The Proposal is wholly located within the Busselton-Capel Groundwater Area (BCGA) (Figure 2-3). The Busselton-Capel sub-area covers 757.3km^2 and is predominantly used by the service sector, mining and industry, and horticulture. Currently the Superficial and Leederville aquifers in the subarea are fully allocated (DoW, 2009).

The Proposal is also within the Busselton-Yarragadee Groundwater Area (Yarragadee aquifer). The Busselton-Yarragadee subarea covers 2,021.4km^2 (Figure 2-3) and is fully allocated. The predominant use of this aquifer is for public water supply, mining and industry (DoW, 2009).

2.5.8. HYDROGEOLOGY

Groundwater is present in the area within a multi-layered aquifer system. Three major aquifers have been identified within the Proposal area (ordered from shallow to deep), namely:

- Superficial;
- Leederville;

- Yarragadee.

A conceptual hydrogeological cross section in the proposal area is provided as Figure 2-4 and a detailed description of the three aquifers (from AQ2, 2020a) is provided below.

Superficial Aquifer

The Bassendean Sand, Guildford Formation and Yoganup Formation form an unconfined Superficial aquifer, with a maximum saturated aquifer thickness of ~9m at the Site. The Guildford Formation is present between the Bassendean Sand and Yoganup aquifers and is of low permeability, owing to its more clayey nature. The permeability of the superficial aquifer is variable and depends on sediment type, with saturated sands having higher permeability than clays. At the site, the Yoganup Formation forms the main portion of the aquifer, while the Bassendean Sand is generally only saturated in the wet season.

Leederville Aquifer

The Leederville Formation forms a multi-layered confined aquifer system, comprising discontinuous interbedded sequences of sand, clayey sand, silt and shale. It underlies the Superficial deposits across the Proposal area, coming to surface approximately ~5-10km to the south-east of the Site, where it forms outcrops in the Whicher Scarp/Blackwood Plateu.

At the Site, the Leederville aquifer generally comprises the Mowen Member of the Leederville Formation. The Mowen Member of the Leederville Formation, which overlies the Vasse Member is commonly considered as an aquitard due to its clayey nature. At the eastern portion of the modelled study area by AQ2 (2019a), the Mowen Member is likely to be very thin or has a greater sand content, resulting in the Leedeville aquifer directly underlying the Superficial aquifer.

Yarragadee Aquifer

The Yarragadee Formation forms a confined Yarragadee aquifer below the Leederville aquifer. There are four sub-units within the Yarragadee Formation with distinct lithological properties. The Yarragadee aquifer is confined by the Leederville Formation. The Bunbury Basalt is discontinuously thin aquitard and it is believed not to be present at the modelled study area (AQ2, 2020a).

Additional details for each aquifer is provided in Section 4.4.3 and in AQ2 (2020a).

2.5.9. HYDROLOGY

Local Rivers

The Proposal is within the Wonnerup (Busselton Coast) Surface Water Management subarea (Figure 2-3) and the Lower Sabina River sub-catchment. The Proposal is not within a proclaimed area for surface water management (DoW, 2009).

The Abba River crosses the northeast corner of the Development Envelope and the lower Sabina River lies ~900m beyond the southwest corner, both generally flowing in a northwesterly direction. The Lower Sabina River flows from below the Sabina Diversion Weir to the Ramsar listed Vasse-Wonnerup Wetlands. The Lower Sabina, Lower Vasse, Abba and Ludlow rivers drain into the Vasse-Wonnerup Wetlands, before discharging through the Wonnerup Inlet into Geographe Bay.

The Sabina Diversion Weir was constructed to allow overflow during extreme rainfall events from the Upper Sabina to the Lower Sabina, with regular flows through the Sabina Diversion Drain. The weir was over designed and the Upper Sabina catchment (78 km^2) no longer contributes any flow directly to the Lower

Sabina river, although some minor sub-drains in the upper catchment may spill in large events (Marillier, 2018). The flow upgradient of the Sabina diversion weir is directed through the Sabina Diversion Drain to the Vasse Diversion Drain system and out to the Geographe Bay, rather than to Vasse-Wonnerup Wetlands.

The Vasse-Wonnerup Wetlands catchment area is 473 km^2, excluding the diverted sub-catchments (DWER, 2019). The Lower Sabina River catchment area of 45.5 km^2 is less than 10% of the Vasse-Wonnerup Wetland Catchment. The Abba River is one of the other major tributaries to the Vasse-Wonnerup Wetland and has a catchment area of 137km^2 which is 29% of the Vasse-Wonnerup Wetlands catchment.

Other regional drainage features outside of the Vasse-Wonnerup Wetlands include the Vasse Diversion Drain, which has a catchment area of 303 km^2 and receives inflows from the diverted Upper Sabina (78 km^2) and Upper Vasse (catchment 180 km^2) rivers (Marillier, 2018).

There are no stream gauges in the Lower Sabina catchment. The closest stream gauges are on the Upper Sabina at the Sabina Diversion (site 610025), and on the Abba River (site 610062). Marillier (2018) analysed gauge information and estimated average annual flows (2001–14) in the major ungauged rivers flowing to the Vasse Estuary Wetland. Marillier (2018) estimated the Lower Sabina discharge as 5.7 GL/year, less than half the Abba River volumes (12.5 GL/yr). In contrast, 4 GL/year is diverted away from Vasse-Wonnerup Wetlands along the Sabina Diversion Drain, and 24 GL/yr is diverted via the Vasse Diversion Drain (Marillier, 2018). The Ludlow River discharges the second highest volumes to the Vasse-Wonnerup Wetlands, an annual average of 11.4 GL/yr based on DWER gauging station summary statistics (DWER, 2019).

On-Site Drainage

Several roads and man-made drains installed in the 20th century have modified the natural drainage pattern within the Development Envelope. These include the Princefield Rd drain located near the northern boundary of the Development Envelope and two other first order drainage lines which contribute to a tributary (Woddidup Creek) of the Lower Sabina River (downstream of the Sabina Diversion Weir).

2.5.10. SOILS AND LANDFORMS

Soil Landscape System

The Proposal is situated on the Abba Plains soil-landscape system (213Ab). The Abba Plain is a level to gently undulating plain formed on alluvium. It is situated on the southern Swan Coastal Plain and extends for about 10km inland between the Ludlow Plain system to the north and the foot of the Blackwood Plateau system to the south. It lies approximately 10-40m above sea level and contains extensive areas of poor drainage (Tille & Lantzke, 1990). The total area of the Abba Plain soil-landscape system is 48,954ha.

Soil-landscape systems have been further divided into subsystems, and within these into soil phases or mapping units. Within the Abba Plains, the Proposal is situated on soils of the Abba and Jindong Subsystems.

Within the Abba Subsystem, Tille and Lantzke (1990) have identified eleven soil phases or mapping units. Six of these occur within the Development Envelope. Two of the four units mapped for the Jindong Subsystem are also present within the Development Envelope as described in Table 2-7 and shown on Figure 2-5.

TABLE 2-7: SOIL MAPPING UNITS

SOIL MAPPING UNIT	DESCRIPTION
213AbABw	Winter wet flats and slight depressions with sandy grey brown duplex (Abba) and gradational (Busselton) soils.

SOIL MAPPING UNIT	DESCRIPTION
213AbABvw	Small narrow swampy depressions along drainage lines. Alluvial soils.
213AbAB1	Flats and low rises with sandy grey brown duplex (Abba) and gradational (Busselton) soils.
213AbABd	Gently sloping low dunes and rises (0-5% gradients) with deep bleached sands.
213AbABwi	Winter wet flats and slight depressions with shallow red brown sands and loams over ironstone (i.e. bog iron ore soils).
213AbABwy	Poorly drained depressions with some areas which become saline In summer. Shallow sands over clay subsoils (i.e. Abba Clays).
213AbJD1	Well drained flats with sandy gradational grey brown (Busselton) soils, some red brown sands and loams (Marybrook Soils).
213AbJDf	Well drained flats with deep red brown sands, loams and light clays (i.e. Marybrook soils).

Acid Sulfate Soils

The Proposal occurs in an area depicted on DWER's online ASS risk map as Class II 'moderate to low risk of ASS occurring within 3m of natural soil surface' (www2.landgate.wa.gov.au)

2.5.11. VEGETATION

Utilising the recent extension of the vegetation complex mapping within the Swan Coastal Plain (Webb, et al., 2016) remnant vegetation within the Development Envelope (37.81ha) is mapped as Abba vegetation complex as described in Table 2-8 and shown on Figure 2-6.

TABLE 2-8: VEGETATION COMPLEXES

VEGETATION COMPLEX	SYSTEM 6 CODE	DESCRIPTION	CURRENT AREA REMAINING (HA)	REGIONAL PERCENTAGE OF COMPLEX REMAINING (%)	AREA OF VEGETATION MAPPED WITHIN DEVELOPMENT ENVELOPE (HA)
Abba	30	A mixture of open forest of *Corymbia calophylla* (Marri) - *Eucalyptus marginata* (Jarrah) - Banksia species and woodland of *Corymbia calophylla* (Marri) with minor occurrences of *Corymbia haematoxylon* (Mountain Marri). Woodland of *Eucalyptus rudis* (Flooded Gum) - Melaleuca species along creeks and on flood plains.	3,359	6.6%	37.81

2.5.12. WETLANDS

Approximately 90% of the Development Envelope is mapped as a wetland in the Geomorphic Wetlands of the Swan Coastal Plain dataset (DEC, 2008a), all of which has been assessed as being in the 'Multiple Use' management category, which is described as wetlands with few ecological attributes and functions remaining. The majority of the wetland area within the Development Envelope (~77%) is mapped as Palusplain (seasonally waterlogged flat), with small areas of Sumpland (seasonally inundated basin, ~3%) and floodplain (seasonally inundated flats, ~17%). No wetlands of environmental significance are present within the Development Envelope (Figure 2-7).

The Vasse-Wonnerup wetland, located approximately 4.6km to the northwest of the Site (Figure 1-1). This wetland is listed under the Ramsar convention as a wetland of international significance and is an extensive, shallow, nutrient-enriched, wetland system with widely varying salinities. Water levels in it have two principal components, the Vasse and Wonnerup lagoons (former estuaries), are managed through the use of weirs (flood gates) with the aim of minimising flooding of adjoining lands and of keeping sea water out. When the water level in the estuaries rises above sea level, hydrostatic pressure opens the floodgates and allows water to flow out to Wonnerup Inlet and the sea. When the level drops, the gates close, thereby preventing ingress of sea water (HydroSolutions, 2017).

Three reserve areas in the Busselton-Capel groundwater subarea are under ecological monitoring due to the presence of high sensitivity GDE's (DWER, 2009, Figure 1). These GDE's have management triggers and responses attached to them by DWER (Del Borello, 2008). These are labelled 'conservation' Sumpland and Floodplain, but are located approximately 6km the northeast and southwest of the Proposal.

2.5.13. SURROUNDING DEVELOPMENTS AND ENVIRONMENTAL ASSETS

Other Developments

The Proposal is located nearby to the following developments, as shown on Figure 2-8:

- Cristal Wonnerup Mineral Sands Mine - located ~2.7km north-northwest;
- Cristal Wonnerup South Mineral Sands Mine – located ~2.6km northwest;
- Cristal Wonnerup North Mineral Sands Mine – located ~3.5km north;
- Iluka Resources Ltd Tutunup South Mineral Sands Mine - located ~3km southeast;
- Doral's Yoongarillup Mineral Sands Mine - located ~6.6km southwest;
- Avocado Farm – located ~4.5km north;
- Avocado Fram – located ~3.7km southwest;
- Turf Farm – located ~2.4km north;
- Busselton Airport – located 5.1km.

Environmental Assets

The Proposal is located nearby to the following Environmental Asset, as shown on Figure 2-8:

- Ramsar listed Vasse-Wonnerup System Wetland – located ~4.6km north-northwest.

3. STAKEHOLDER ENGAGEMENT

3.1. KEY STAKEHOLDERS

Doral is committed to undertaking a proactive engagement program with its stakeholders, government and the broader community as part of its community engagement program for the Proposal. Key stakeholders for the Proposal have been identified as having an influence and/or interest throughout the life of the Project and who are impacted by the Proposal's operations.

Doral has proactively engaged with its stakeholders commencing in 2012 with the commencement of the exploration program and stakeholders further defined as the Proposal progressed through to the environmental approvals phase. A dedicated Community Relations Officer was appointed in 2019 to enhance the engagement function and will continue to manage all stakeholder interactions.

The key stakeholders for the Proposal identified to date include the following as identified in Table 3-1.

TABLE 3-1: KEY STAKEHOLDERS

KEY STAKEHOLDER GROUP	
Landowners	• Landowners within the development envelope • Near neighbours
Local Government Authorities	• City of Busselton
State Government Departments and Agencies	• Department of Mines, Industry regulation and Safety (DMIRS) • Department of Water and Environmental Regulation (DWER) • Department of Biodiversity, Conservation and Attractions (DBCA) • Main Roads of WA • South West Development Commission • Water Corporation
Members of Parliament	• Local member for Vasse, Libby Mettam MLA • Federal member for the South West (Forrest Division) Hon. Nola Marino MP
Non-Government Organisations, including special interest groups	• Chamber of Minerals and Energy of WA (CMEWA) • Ruabon Fire Brigade • Geocatch

3.2. STAKEHOLDER ENGAGEMENT PROCESS

The objective of Doral's stakeholder engagement program is to provide timely information to ensure key issues and concerns have been identified and can be managed effectively throughout the life of the project.

Doral's approach to implementing the engagement strategy and ongoing consultation includes:

- Identification of key stakeholders, documenting interests and concerns in relation to the project;
- Communicate clearly the purpose of the consultation and provide information in a timely manner;

- Implement communication tools to manage ongoing engagement activities over the life of the project, whilst allowing for meaningful input into the project design;
- Document and record stakeholder interactions through its Consultation Manager software program;
- Implement the Stakeholder Interaction Policy and Procedure to ensure stakeholder concerns or grievances are appropriately documented and managed.

The following table provides a summary of Doral's Stakeholder Engagement Process.

TABLE 3-2: STAKEHOLDER ENGAGEMENT PROCESS

KEY STAKEHOLDER GROUP	TIMING	ENGAGEMENT METHOD
Landowners	• Quarterly or as required	• One-On-One meetings • Correspondence /Project Updates • Newsletters /Fact Sheet
Local Government Authorities	• Annually	• Project briefing • Newsletter / Fact Sheet
State Government Departments and Agencies	• Ongoing / as required	• Meetings • Correspondence /Project Updates
Members of Parliament	• Annually	• Meetings • Project updates • Newsletter / Fact Sheet
Non-Government Organisations, including special interest groups	• Annually	• Meetings • Project updates • Newsletter / Fact Sheet

Ongoing Stakeholder Consultation

The implementation of Doral's Stakeholder Engagement Plan will ensure the delivery of timely and regular communication activities based around key milestone dates and events that is relevant to key stakeholders.

Ongoing consultation activities will include:

- One on one meetings with landholders;
- Community update letter to landholders and near neighbors;
- Project Newsletter to the broader community;
- Project fact sheets;
- Provision of 24-hour contact cards to nearest neighbors for any issue or concern;
- Briefings and presentations to local government, community groups and key stakeholders;
- Mine site tour for interested parties;

- Continued appointment of Community Relations Advisor.

3.3. STAKEHOLDER CONSULTATION

A summary of Stakeholder consultation undertaken to date is provided in the following table.

TABLE 3-3: STAKEHOLDER CONSULTATION UNDERTAKEN

STAKEHOLDER	DATE	ISSUES/TOPICS RAISED	PROPONENT RESPONSE/OUTCOME
DWER (OEPA)	19/10/17 26/10/17 03/01/18 07/04/18 29/08/18 05/03/19 21/03/19 29/05/19 30/05/19 04/10/19	Pre-referral meeting; R Sutherland, R Hughes. All relevant environmental factors discussed. Referral Document received. Referral Document accepted and nominated as PER. Draft ESD submitted to EPA. Yalyalup Site Visit – R Hughes and M Spence. ESD Submitted to EPA. Presentation of Yalyalup Project to EPA Board. Submission of Revised version of ESD to EPA. ESD acceptable by EPA services and published on website. Submission to EPA of S43A amendment to Proposal for the amendment of Development Envelope and disturbance areas to include creation of internal access road.	No significant issues noted at this stage
DMIRS	14/02/18	Pre-referral meeting to discuss project; R Hepworth, L Copeland. All relevant environmental factors discussed.	No issues noted
DBCA	24/05/19	A Webb - Post referral meeting to discuss project, flora studies to date and proposed GDE survey scope. Reference to historic mineral sands dewatering incident at Gwinninup mine and likelihood of direct offsets due to dewatering risks of McGibbon Track. Likely offsets requirement due to dewatering risk	Acknowledged

STAKEHOLDER	DATE	ISSUES/TOPICS RAISED	PROPONENT RESPONSE/OUTCOME
		of McGibbon Track. Several sites mentioned as possible Ironstone community for investigation by Doral.	
	03/12/19	Email to DBCA; A Webb of completed Yalyalup GDE report for discussion.	Proposed meeting to discuss in new year (2020).
DWER - Licencing	01/12/17	Pre-referral meeting - D Hartnup to inform of proposal and relevant environmental factors.	No issues noted.
DWER - DoW	22/11/17	Pre referral meeting to discuss project; A De Chaneet, R Gibbs. Potential for cumulative effects of dewatering with Avocado farm and Wonnerup North Mine.	Acknowledged.
DWER - Contaminated Sites Branch	13/11/17	Pre-referral meeting S Appleyard, S Jenkinson to discuss potential acid sulphate soils risk and intended management actions.	Acknowledged.
City of Busselton	09/08/19	Email correspondence to City; J Smith from Civil Engineering Consultant regarding City road categories and construction for intersection and road reserve crossings.	Ongoing.
	09/12/19	Scheduled meeting with City CEO to discuss Proposal.	
SWALSC	06/08/19	Consultation; P Nettleton and M Benson to review Heritage agreement contract and request nomination of consultants for Ethnographic studies.	Agreed.
DAWE (previously DoEE)	01/11/17	Submission of referral of Project.	
	09/11/17	Request for information; D Rothenfluh regarding Naturally Occurring Radioactive Materials.	Information supplied, not a nuclear action.
	12/02/18	DAWE (then DoEE) decision a declared action. Assessment by EPA under bilateral agreement.	Acknowledged.
Water Corporation	12/12/19	Construction of crossing over Abba River identified as a drain under the	The proposed construction of the bridge to cross the Abba River (drain) will not impede

STAKEHOLDER	DATE	ISSUES/TOPICS RAISED	PROPONENT RESPONSE/OUTCOME
		Water Services Act 2012 and will require approval by the Water Corporation.	upon the waterway. Doral will provide suitable engineering drawings of the "bridge" design to the Water Corporation to satisfy Water Corporation Policy requirements.
LANDOWNERS (require approvals and/or agreements)			
P & A Macleay Lot 843 Lot 748	23/05/2017 21/09/2017 23/02/2018 21/05/2019	Project overview and timelines discussed. Concerns raised with mine site proximity to residence, and impact on existing vegetation. Request visit to Dardanup rehabilitation site. Further discussion on timeline and environmental approvals process.	Potential impacts will be assessed in the noise, dust and groundwater modelling studies and presented in the ERD (refer Social Surroundings, Air Quality, Hydrological Processes and Inland Waters Environmental Quality). Groundwater monitoring results presented. Dardanup Mine rehabilitation site tour arranged.
K & J Hester Lot 103 Lot 104	23/05/2017 26/09/2017 2/03/2018 20/03/2019 8/05/2019 18/09/2019	Project overview and timelines discussed. Concerns with mining methods and impact on water access and quality for property. Other matters raised include impact on native fauna, light pollution, dust and noise. Ongoing engagement regarding environmental approvals process and timeline.	Potential impacts on groundwater and surface water assessed in the groundwater modelling studies and presented in the ERD (refer Hydrological Processes and Inland Waters Environmental Quality). Baseline water testing conducted and reported back to landholder. Potential impacts modelled and assessed in the ERD (refer Terrestrial Fauna, Air Quality, Social Surroundings). Agreed to land access for environmental studies. Follow up meeting to present mine layout and outcomes of surveys and studies. Potential impacts will be managed in accordance with ERD commitments.
Mark Conrau Lot 4551	21/06/2019	Project overview, approvals process and timeline were discussed. No concerns raised.	Follow up mine site tour to be arranged.
A & K Bashford Lot 1426 Lot 552	25/05/2017 12/10/2017 2/03/2018 20/03/2019	Subsequent meetings discussed approvals process, proposed timeline and results of environmental studies and surveys. No concerns raised.	Water monitoring results presented. Follow up meeting when mine plan complete and environmental study results available.

STAKEHOLDER	DATE	ISSUES/TOPICS RAISED	PROPONENT RESPONSE/OUTCOME
	28/11/2019		Potential impacts presented in the ERD (refer all factors). Follow up meeting to update on progress.
Boardman Lot 3773	27/05/2017 21/09/2017 30/03/2019	Project overview and next phase of preliminary work were discussed. Subsequent meetings provided information on mine plan and proposed timeline. No concerns raised.	Committed to ongoing engagement.
Slade & Parkin Lot 668 Lot 421	1/06/2017 29/03/2018 4/07/2019 29/11/2019	Project overview and next phase of preliminary work were discussed. Concerns raised regarding dust management, noise, traffic and rehabilitation. Committed to ongoing engagement.	Undertake dust sampling pre-mining and radiation survey. Incorporate in Dust Management Plan. Follow up meeting to present mine plan, location and survey results. Potential noise impacts incorporated in MP. Soil testing and revegetation incorporated in mine closure plan.
Gronya Swift Lot 200	1/06/2017 2/10/2017 2/03/2018 5/06/2019	Project overview and next phase of preliminary work were discussed. Concerns raised regarding water supply. raised at impacts on water supply. Preliminary mine plan and approvals process discussed. Committed to ongoing engagement.	Potential impacts on water supply assessed in the groundwater modelling studies and ERD (refer Hydrological Processes). Baseline water testing on pre-existing water quality and advised on options for improving quality. Follow up mine site tour to be arranged.
Mitchell & Anstey Lot 292	May 2019 20/11/2019	Telephone conversation provided overview of project and timeframe. Meeting update on mine plan, timeline, approvals. Concerns raised were dust, light, access to water and increased traffic.	Potential impacts assessed in ERD and will be incorporated into noise, dust and water management plans (refer Hydrological Processes and Social Surroundings). Committed to ongoing engagement.
Phillips Lot 229	May 2017 Phone call 27/09/2017	Project overview and next phase of preliminary work discussed. Project mine plan presented, and environmental approvals process discussed. No concerns raised.	Committed to ongoing engagement via Property Manager.

STAKEHOLDER	DATE	ISSUES/TOPICS RAISED	PROPONENT RESPONSE/OUTCOME
NEAR NEIGHBOURS			
McClean Lot 10	21/6/2019	Overview of project, timeline and approvals process. Concern raised regarding noise at residence.	Potential impacts assessed in modelling scenarios and presented in ERD (refer Social Surroundings).
Jamie Oates Lot 652	4/07/2019	Overview of project, timeline and approvals process. Concern raised at increased traffic on Ludlow Hithergreen Road and likelihood of road closures.	Advised of the proposed road access and haulage route as per mine plan.
Scott, Spragg, Hartnett Lot 1461	6/08/2019	Overview of project, timeline and approvals process. Concerns raised on impact on the broader environment.	Potential impacts assessed in the ERD and management measures will be incorporated into various Environmental Management Plans (refer all factors).
Van Kleef Lot 651	5/07/2019	Phone discussion providing project overview. Interested in site plan/ layout and proximity to residence including road haulage options.	Provide update when a more detailed mine site plan is available.
Peter Oates Lot 1370, Lot 3382, 1976	24/10/2019	Overview of project, mine plan and timeframe. Concerns at McGibbon track access and closure.	Potential impacts assessed in the Groundwater Dependent Ecosystems Study and the ERD (refer Flora and Vegetation and Hydrological Processes factors).
Copeland Lot 221	29/11/2019	Overview of project, mine plan, approvals process and timeframe.	No concerns.
A Franklin Lot 52	23/07/2019	Phone discussion on project overview, current work and timeframe.	No concerns. Provide update when new information becomes available.

Doral is committed to ensuring that all stakeholder feedback is documented and considered as part of the Proposal. Stakeholder engagement remains an ongoing activity for the Mine, which includes regular and timely information provided to all key stakeholders regarding the environmental approvals process and subsequent updates as the mine plan layout and timings progress.

4. ENVIRONMENTAL PRINCIPLES AND FACTORS

4.1. PRINCIPLES

The EP Act sets out five principles by which protection of the environment is to be achieved in Western Australia. These principles, and the manner in which Doral has sought to apply them in the design and planned implementation of the Proposal, are outlined in Table 4-1.

TABLE 4-1: EP ACT PRINCIPLES

PRINCIPLE	CONSIDERATION
1. Precautionary Principle Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, decisions should be guided by: • Careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; • An assessment of the risk weighted consequences of various options.	Doral have used existing environmental data and commissioned site-specific investigations and assessments to assess risk to relevant environmental values during the design of the Proposal. Environmental management plans and closure plans have been prepared to avoid or minimise impacts on identified environmental values. Doral have maintained engagement with relevant government agencies (see Table 3-3) to minimise any uncertainty surrounding the environmental impact of the Proposal.
2. Intergenerational Equity The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	Doral recognises the importance of intergenerational equity and throughout the management measures sections of this ERD, measures to appropriately manage potential impacts to ensure health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations are presented.
3. Conservation of biological diversity and ecological integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration.	Doral recognises the values of native vegetation present within the Development Envelope and have designed the Proposal to avoid clearing vegetation as far as practicable.
4. Improved valuation, pricing and incentives mechanisms i. Environmental factors should be included in the valuation of assets and services. ii. The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance or abatement.	Doral have factored in the costs of implementing environmental management measures into annual budgets for the Proposal. Costs of rehabilitation and decommissioning will be further considered and included in the Mine Closure Plan.

PRINCIPLE	CONSIDERATION
iii. The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any wastes. iv. Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentives structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solutions and responses to environmental problems.	
5. Waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge.	Doral's Environmental Management System (EMS) includes waste management plans, waste management procedures and incident reporting procedures which will be communicated to staff in inductions and regular meetings to ensure best practise management of wastes is implemented for the Proposal.

4.2. KEY ENVIRONMENTAL FACTOR 1 - FLORA AND VEGETATION

For the purposes of EIA, flora is defined as native vascular plants and vegetation is defined as groupings of different flora patterns across the landscape that occur in response to environmental conditions.

4.2.1. EPA OBJECTIVE

The EPA objective for Flora and Vegetation is:

To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

4.2.2. POLICY AND GUIDANCE

Guidance relevant to flora and vegetation are documented in the following documents:

EPA Policy and Guidance

- *Statement of Environmental principles, Factors and Objectives* (EPA, 2018b).
- *Environmental Factor Guideline – Flora and Vegetation* (EPA, 2016c).
- *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA, 2016d).
- *Instructions on how to Prepare Environmental Protection Act 1986 Part IV Environmental Management Plans* (EPA, 2016e).
- *Environmental Offsets Policy, Perth, Western Australia (Government of Western Australia, 2011).*
- *Environmental Offsets Guidelines, Perth, Western Australia (Government of Western Australia, 2014).*

Other Policy and Guidance

- Matters of National Environmental Significance. Significant Impact Guidelines 1.1. *Environmental Protection and Biodiversity Conservation Act 1999* (DoE, 2013).
- *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPaC, 2012a).
- *Guidelines for Preparing Mine Closure Plans* (DMP and EPA, 2015).
- *Conservation Advice Banksia squarrosa subsp. argillacea Whicher Range banksia, Whicher Range dryandra. Canberra: Department of the Environment* (Threatened Species Scientific Committee, 2015).
- *Approved Conservation Advice for Verticordia plumosa 3 var. vassensis (Vasse Featherflower). Canberra: Department of the Environment, Water, Heritage and the Arts* (DEWHA, 2008a).
- *Shrubland Association on Southern Swan Coastal Plain Ironstone (Busselton area) (Southern Ironstone Association) Recovery Plan. Interim recovery plan no. 215. Department of Environment and Conservation* (Meissner & English, 2005).
- *Threat abatement plan for disease in natural ecosystems caused by Phytophthora cinnamomi. Canberra, ACT: Commonwealth of Australia (DoE, 2014).*

4.2.3. RECEIVING ENVIRONMENT

SURVEYS COMPLETED

Ecoedge Environmental undertook the following Level 1 Flora and Vegetation Surveys of remnant vegetation within and immediately surrounding the Development Envelope (Appendix 4).

Appendix 4A: *Report of a Level 1 Flora and Vegetation. February 2016. Revised May 2019*. (Ecoedge, 2020a).

Appendix 4B: *Report of a Supplementary Level 1 Flora and Vegetation. November 2017.* (Ecoedge, 2017).

Appendix 4C: Supplementary Reconnaissance and Targeted Flora and Vegetation Survey. November 2019 (Ecoedge, 2020b).

The field assessment (Ecoedge, 2020a) was carried out on 16 September and 13-14 October 2015 and 18 February 2016 in accordance with *EPA Guidance Statement 51 – Terrestrial Flora and Vegetation Surveys for environmental Impact Assessment in Western Australia* (EPA, 2004a), and on 9 and 11 October 2017 (Ecoedge, 2017) and 30 May, 6 and 23 September 2019 (Ecoedge, 2020b) in accordance with *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA, 2016d).

All areas of remnant native vegetation within the survey area were visited on foot or by vehicle and data on plant species composition and vegetation was collected at 105 sites. It should be noted that the initial survey was undertaken prior to Doral defining the Development Envelope and disturbance areas, which are smaller in area than that surveyed. As such, some flora species and vegetation units identified and are now located outside of the Development Envelope.

SOIL-LANDSCAPE SYSTEM

The Proposal is situated on the Abba Plains soil-landscape system (213Ab). The Abba Plain is a level to gently undulating plain formed on alluvium. It is situated on the southern Swan Coastal Plain and extends for about

10km inland between the Ludlow Plain system to the north and the foot of the Blackwood Plateau system to the south. It lies approximately 10-40m above sea level and contains extensive areas of poor drainage (Tille & Lantzke, 1990). The total area of the Abba Plain soil-landscape system is 48,954ha.

Soil-landscape systems have been further divided into subsystems, and within these into soil phases or mapping units. Within the Abba Plains, the Development Envelope is situated on soils of the Abba and Jindong Subsystems.

Within the Abba Subsystem, Tille and Lantzke (1990) have identified eleven soil phases or mapping units. Six of these occur within the Development Envelope. Two of the four units mapped for the Jindong Subsystem are also present within the Development Envelope as described in Table 4-2 and shown on Figure 2-5.

TABLE 4-2: SOIL MAPPING UNITS OCCURRING WITHIN THE DEVELOPMENT ENVELOPE

SOIL MAPPING UNIT	DESCRIPTION
213AbABw	Winter wet flats and slight depressions with sandy grey brown duplex (Abba) and gradational (Busselton) soils.
213AbABvw	Small narrow swampy depressions along drainage lines. Alluvial soils.
213AbAB1	Flats and low rises with sandy grey brown duplex (Abba) and gradational (Busselton) soils.
213AbABd	Gently sloping low dunes and rises (0-5% gradients) with deep bleached sands.
213AbABwi	Winter wet flats and slight depressions with shallow red brown sands and loams over ironstone (i.e. bog iron ore soils).
213AbABwy	Poorly drained depressions with some areas which become saline in summer. Shallow sands over clay subsoils (i.e. Abba Clays).
213AbJD1	Well drained flats with sandy gradational grey brown (Busselton) soils, some red brown sands and loams (Marybrook Soils).
213AbJDf	Well drained flats with deep red brown sands, loams and light clays (i.e. Marybrook soils).

VEGETATION COMPLEXES

Utilising the recent extension of the vegetation complex mapping within the Swan Coastal Plain (Webb, et al., 2016) remnant vegetation within the Development Envelope (37.81ha) is mapped as Abba vegetation complex as described in Table 4-3 and shown on Figure 2-6.

TABLE 4-3: VEGETATION COMPLEXES WITHIN THE DEVELOPMENT ENVELOPE

VEGETATION COMPLEX	SYSTEM 6 CODE	DESCRIPTION	CURRENT AREA REMAINING (HA)	PERCENTAGE OF COMPLEX REMAINING (%)	AREA OF VEGETATION MAPPED WITHIN DEVELOPMENT ENVELOPE (HA)
Abba	30	A mixture of open forest of Corymbia calophylla (Marri) - Eucalyptus marginata (Jarrah) - Banksia species and woodland of Corymbia calophylla (Marri) with minor occurrences of Corymbia haematoxylon (Mountain Marri). Woodland of Eucalyptus rudis (Flooded Gum) - Melaleuca species along creeks and on flood plains.	3,359	6.6%	37.81

DESKTOP ASSESSMENT THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

Ecoedge (2020a) undertook a DPaW (now DBCA) database search for threatened or priority ecological communities known to occur within a 5km radius of the Development Envelope (DPaW 2015a and 2015b, cited in Ecoedge 2020a).

Ecological communities are defined by Western Australia's DBCA (previously DPaW and the Department of Environment and Conservation (DEC) as "...naturally occurring biological assemblages that occur in a particular type of habitat. They are the sum of species within an ecosystem and, as a whole, they provide many of the processes which support specific ecosystems and provide ecological services." (DEC, 2013).

Under Section 27 of the *Biodiversity Conservation Act 2016* (BC Act) the Western Australian Minister for Environment may list communities that are considered to be under significant threat as a Threatened Ecological Communities (TEC). These TECs can be listed under one of three conservation categories; critically endangered (CE), endangered (EN), vulnerable (V). The BC Act also provides for listing communities as collapsed ecological communities.

Possible TECs that do not meet survey criteria are added to the DBCA's Priority Ecological Community (PEC) lists under Priorities 1, 2 or 3 (referred to as P1, P2, P3). Ecological communities that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4 (P4). These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5 (P5) (DEC, 2013).

The current listing of Threatened and Priority Ecological Communities is specified in Ecoedge (2020a) (refer to DPaW,2015a and 2015b).

A Protected Matters Search Tool query was also undertaken for communities listed under the EPBC Act occurring within a 5km radius of the Development Envelope (DoEE, 2015b, cited in Ecoedge, 2020a). There are three categories of TEC under the EPBC Act: Critically Endangered (CE), Endangered (E) and Vulnerable (V). Results of these searches are provided in Table 4-4.

TABLE 4-4: THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES DATABASE SEARCH RESULTS

COMMUNITY NAME	DESCRIPTION	CONSERVATION STATUS (BC ACT)	CONSERVATION STATUS (EPBC ACT)
Claypans of the Swan Coastal Plain	Includes the following Western Australian listed Threatened Ecological Communities (TECs): • Herb rich saline shrublands in clay pans (SWAFCT07); • Herb rich shrublands in clay pans (SWAFCT08); • Dense shrublands on clay flats (SWAFCT09); • Shrublands on dry clay flats. (SWAFCT10a). and the following Priority Ecological Community (PEC): • Clay pans with shrubs over herbs.	-	CR
SWAFCT10b - Shrublands on southern Swan Coastal Plain Ironstones (Busselton area)	Species rich plant community located on seasonal wetlands on ironstone and heavy clay soils on the Swan Coastal Plain near Busselton. Much of the high species diversity comes from annuals and geophytes.	CR	EN
SWAFCT01b – Southern *Corymbia calophylla* woodlands on heavy soils	Dominated by *C. calophylla* and *Eucalyptus marginata. Acacia extensa, Hypocalymma angustifolium* and *Xanthorrhoea preissii* are important shrubs. Mainly occurs south of Capel.	VU	-
SWAFCT21b - Southern *Banksia attenuata* woodlands	Structurally, this community type is normally *Banksia attenuata* or *Eucalyptus marginata – B. attenuata* woodland. Common taxa include *Acacia extensa, Jacksonia* sp. *Busselton, Laxmannia sessiliflora, Lysinema ciliatum* and *Johnsonia acaulis.*	P3	-

VEGETATION UNITS

Ecoedge (2020a) identified and mapped eight vegetation units within the survey area (Figure 4-1a), totaling 37.81ha. Most areas of remnant vegetation are in Degraded or Completely Degraded condition (~88%) and consequently had low species diversity. As such, it was generally only possible to separate vegetation types based on overstorey composition and to a lesser extent soil type (Ecoedge, 2020a). Vegetation units are described in Table 4-5 and includes comments on their conservation status.

TABLE 4-5: VEGETATION UNITS WITHIN DEVELOPMENT ENVELOPE

VEGETATION UNIT	DESCRIPTION	COMMENTS AND CONSERVATION STATUS	AREA WITHIN DEVELOPMENT ENVELOPE (HA)
A1	Woodland of *Corymbia calophylla* and *Eucalyptus marginata*, with scattered *Agonis flexuosa*, *Banksia attenuata*, *B. grandis*, *Melaleuca preissiana*, *Nuytsia floribunda*, *Persoonia longifolia* or *Xylomelum occidentale* over *Xanthorrhoea preissii* over weeds on grey-brown or grey loamy sand or sand (on farmland usually only *C. calophylla* and *E. marginata* are present).	Degraded form of SWAFCT01b - Southern *Corymbia calophylla* woodlands on heavy soils (Gibson, et al., 2000) which is listed as a Threatened Ecological Community (TEC), with threat status of "Vulnerable" by DBCA. Mostly in Degraded or Completely Degraded Condition. Only area of Unit A1 of sufficient size and in good enough condition to be inferred as an occurrence of TEC SWAFCT01b is on McGibbon Track.	10.86 (of which 1.18 is FCT01b)
A2	Woodland of *Corymbia calophylla* (sometimes with *Eucalyptus marginata* or *E. rudis*) with scattered *Melaleuca preissiana* or *Banksia littoralis* over open shrubland that may include *Acacia extensa*, *A. saligna*, *Hakea ceratophylla*, *H. lissocarpha*, *H. prostrata*, *H. varia*, *Kingia australis*, *Melaleuca viminea* and *Xanthorrhoea preissii* over weeds on seasonally wet grey loamy sand.	Similar to both SWAFCT01b and SWAFCT02 - Southern wet shrublands, however the predominance of wetland-adapted species characteristics makes it floristically much closer to SWAFCT02. SWAFCT02 is listed as a TEC, with threat status of "Endangered" by DBCA. The occurrence of Unit A2 at the northern end of McGibbon Track in good condition is inferred to be an occurrence of TEC SWAFCT02.	4.03 (of which 3.42 is FCT02)
B1	Tall shrubland of *Acacia saligna*, *Banksia squarrosa* subsp. *argillacea*, *Calothamnus quadrifidus* subsp. *teretifolius*, *Hakea oldfieldii* and *Kunzea micrantha* (with scattered emergent *Eucalyptus rudis*) over scattered native herbs including *Drosera glanduligera* and *Sowerbaea laxiflora*, the sedge *Loxocarya magna*, and weeds on shallow red sandy clay on massive ironstone.	Vegetation Unit B1 is recognised as the TEC SWAFCT10b - Shrublands on southern Swan Coastal Plain Ironstones (Busselton area)" (Gibson, et al., 2000); (Meissner & English, 2005). This TEC has a threat status of "Critically Endangered" by DBCA and Endangered under the EPBC Act. The largest occurrence of B1, that on the McGibbon Track (0.34ha) is recognised as an occurrence of Busselton Ironstones community (Webb, 2004) but unaccountably is yet to be added to the DBCA threatened communities' database (A, Webb, DBCA Bunbury, pers. Comm. 22/02/2016, cited in Ecoedge, 2020a).	0.50 (of which 0.45 is FCT10b)

VEGETATION UNIT	DESCRIPTION	COMMENTS AND CONSERVATION STATUS	AREA WITHIN DEVELOPMENT ENVELOPE (HA)
		Except on McGibbon Track where it is classed as Good condition the small fragments of this unit elsewhere are completely degraded and are not considered to be occurrences of the TEC SWAFCT10b.	
B2	Woodland of *Eucalyptus rudis* and (in some areas) *Melaleuca rhaphiophylla* over weeds on massive ironstone.	Severely degraded form of SWAFCT10b - Shrublands on southern Swan Coastal Plain Ironstones (Busselton area) recognisable only by the presence of massive ironstone and lateritic boulders at or near surface. Completely degraded with only the overstorey remaining, does not represent the TEC SWAFCT10b	2.79
C1	Woodland of *Eucalyptus rudis* (and sometimes *Corymbia calophylla*) over scattered *Agonis flexuosa* and *Melaleuca rhaphiophylla* over weeds on grey-brown clayey loams in drainage lines.	Riverine Jindong Plant Communities (Webb, et al., 2009). All in Completely Degraded condition.	19.08
C3	Tall Open Shrubland that may include *Acacia saligna*, *Jacksonia furcellata*, *Kingia australis*, *Melaleuca osullivanii*, *M. preissiana*, *M. viminea* and *Xanthorrhoea preissii* on seasonally wet grey-brown sandy loam.	Similarities to the TEC SWAFCT09 - Dense shrublands on clay flats (TEC). However, the occurrence is considered to be too small and badly degraded to be inferred as an example of this TEC. A small area in Degraded/Good or Good condition on the verge of Princefield Road.	0.55
PL	Planted Species	Planted non-endemic and exotic trees	6.87
CL	Cleared Pasture	Existing cleared/highly degraded areas (e.g. paddocks/road verges) with scattered trees/shrubs. Some areas seasonally inundated/waterlogged	880.17
TOTAL			**924.84**

As the majority of the vegetation units mapped within the Development Envelope are in either degraded or completely degraded condition, publicly available local and regional distribution mapping is not available for these vegetation units. Ecoedge (2020a) note that there is no readily available information on the conservation significance of the TECs (SWAFCT01b, SWAFCT02, SWAFCT09 and SWAFCT10b) present within the Development Envelope at a local or regional level. These records are held by the DBCA and are not publicly available. However, SWAFCT01b, SWAFCT02 and SWAFCT10b are only found on the Swan Coastal Plain south of Capel so their local threat status and conservation significance would be the same as their State-wide level. Figure 4-1b shows the known regional distribution of the conservation significant vegetation units present within the Development Envelope.

These TECs are discussed below under Conservation Significant Vegetation including local and known regional distribution.

VEGETATION CONDITION

Vegetation condition was assessed against the method detailed in (Keighery, 1994). Most remnant native vegetation within the survey area, and all mapped remnant vegetation on farmland, is in "Completely Degraded" condition (~84%). The only vegetation deemed to be in "Good" condition is at the northern end of McGibbon Track and a small area on Princefield Road. A few other small areas were rated by Ecoedge (2020a) as "Degraded/Good" condition on McGibbon Track, Princefield Road and Yalyalup Road (Figure 4-2). Vegetation condition is summarised in Table 4-6.

TABLE 4-6: VEGETATION CONDITION

CONDITION SCORE	MAPPED AREA (HA)	PERCENTAGE (%)
Good	2.31	6.11
Degraded/Good	2.43	6.43
Degraded	1.31	3.47
Completely Degraded	31.77	84.03
TOTAL	37.81	100.00

The main reasons for the generally poor condition of remnant native vegetation in the survey area are the small size of the remnants that are not on farmland, and the fact that all of the remnants on farmland have been grazed for many years.

Small fragments remaining after land clearing are subject to new disturbance regimes, invasive species, disease, increased nutrient loads, and changes in physical edge effects, including changes in wind, temperature, light and humidity (Lindenmayer, 2001). In this altered environment native species, particularly herbaceous taxa, are usually out-competed by agricultural weeds. Long-term grazing of native vegetation by livestock has been shown to cause eventual replacement of the native shrub and herbaceous components by exotic annual grasses and forbs (Pettit, et al., 1998).

CONSERVATION SIGNIFICANT VEGETATION

Baseline information on conservation signification vegetation mapped within the Development Envelope by Ecoedge (2020a), with potential to be impacted directly or indirectly by the proposal is provided as follows and shown in Figure 4-3:

- SWAFCT01b - Southern *Corymbia calophylla* woodlands on heavy soils

SWAFCT01b - Southern *Corymbia calophylla* woodlands on heavy soils (Gibson, et al., 2000) is listed as a TEC, with threat status of "Vulnerable" by DBCA. The only occurrence of TEC SWAFCT01b is on McGibbon Track (vegetation unit A1 in degraded/good and good condition), totalling 1.18ha. This community is known from the following quadrats and Busselton Plain reference areas; ACTN01, AMBR-1, AMBR-4, AMBR-6, AMBR-9, AMBRAL-1, CAPEL-5, CARB-1, CARB-2, CARB-4, WONN-2, YALLIN-1 and YOON-1 (Webb, et al., 2009) (Figure 4-1b). Average species richness for this community is 65.0 (Webb, et al., 2009).

- SWAFCT02 - Southern wet shrublands

SWAFCT02 is listed as a TEC, with threat status of "Endangered" by DBCA. The only occurrence of TEC SWAFCT02 is on McGibbon Track (vegetation unit A2 in degraded/good and good condition), totalling 3.42ha. This community is known from the following quadrats and Busselton Plain reference areas; AMBR-2, AMBR-5, AMBR-7, FISH-5, SF1201 and YOON-2 (Webb, et al., 2009) (Figure 4-1b).

- SWAFCT10b - Shrublands on southern Swan Coastal Plain Ironstones (Busselton area)

SWAFCT10b - Shrublands on southern Swan Coastal Plain Ironstones (Busselton area)" (Gibson, et al., 2000); (Meissner & English, 2005) is listed as a TEC with threat status of "Critically Endangered" by DBCA and Endangered under the EPBC Act. The only occurrence of TEC SWAFCT10b is on McGibbon Track (vegetation unit B1 in good condition), totalling 0.45ha.

This community typically occurs on a soil type that is restricted to the eastern side of the Swan Coastal Plain along the base of the Whicher Scarp near Busselton (Meissner & English, 2005). This area contains heavy soils that are particularly useful for agricultural purposes and are around 97% cleared (CALM, 1990) (Keighery & Trudgen, 1992). Tille and Lantzke (1990) mapped the original extent of the southern ironstone soils in the Busselton area, totalling ~1,200ha, of which ~139ha remains uncleared. This equates to a 90% loss of the area of the plant community that was originally highly restricted in distribution.

The ironstone soils near Busselton are associated with shallow seasonal inundation with fresh water (Meissner & English, 2005). This inundation may occur due to ponding of rainfall as a consequence of the impermeable nature of the surface outcrops of ironstone and the associated heavy soils (Meissner & English, 2005). Tille and Lantzke (1990) also note that groundwater levels in the community come very close to or may reach the surface in the wetter months.

Typical and common native species in the community are the shrubs *Kunzea* aff. *micrantha, Pericalymma ellipticum, Hakea oldfieldii, Hemiandra pungens* and *Viminaria juncea,* and the herbs *Alphelia cyperiodes*, *Centrolepis aristate* and the introduced species *Hypochaeris glabra* within the community (Gibson, et al., 1994). The community type contains a number of taxa that are listed as Threatened or Priority Flora and are either totally confined or largely confined to it, or may be shared with the ironstone of the Scott Coastal Plain (Gibson, et al., 2000).

The extent and location of occurrences of SWAFCT10b as documented in (Meissner & English, 2005) is reproduced in the following table and shown on Figure 4-1b.

TABLE 4-7: EXTENT AND OCCURRENCES OF SWAFCT10b

OCCURRENCE NO.	LOCATION	LAND TENURE	ESTIMATED AREA (Ha)
1 and 2	Ruabon-Tutunup Rd 2 (WONN03, 04)	Rail and road reserves, Nature Reserve and adjacent private land	65.9
3	Ruabon-Tutunup Rd 3 (WONNEW1)	Rail and road reserves	1.4
4	Ruabon-Tutunup Rd 4 (WONN06)	Rail and road reserves	3.8
5	Ruabon-Tutunup Rd 5 (WONN05)	Rail and road reserves	0.1
6	Oates Road verge (OATESIRON)	Rail and road reserves	0.2
7	Williamson Road east (WIL01)	State Forest – Abba block	4.2
8	Williamson Road west (WIL03)	State Forest – Abba block	4.2
9	Smith Road (SMITH01)	State Forest – Treeton block	9.4
10	Jacka Road (JACKA01)	State Forest – Treeton block and adjacent private land	7.8
11	Kolhagen Road (SMITH04)	State Forest – Treeton block, road reserve	0.3
12	Ironstone Gully (IRON01, 02)	State Forest – Treeton block	7.0
13	Sussex Location 5114 (YIRON) Corner of Jindong-Treeten and Gale Roads	Nature Reserve	12.5
14	Sussex Location 2561 Payne Road (PAYNE02, 03, 04)	Nature Reserve and adjacent private land	14.2
15	Lot 5 Chambers Road	Private land	7.7

DESKTOP ASSESSMENT THREATENED AND PRIORITY FLORA

Species of flora and fauna are defined as having a Threatened or Priority conservation status where their extant populations are restricted geographically and or under threat of possible extinction. DBCA recognises these threats and consequently applies regulations towards population and species protection.

Threatened flora species are listed under Section 19 of the BC Act and are ranked according to their level of threat using the International Union for Conservation of Nature (IUCN) Red List categories and criteria of; critically endangered (CE), endangered (EN), vulnerable (VU). It is an offence to "take" or damage threatened flora without Ministerial approval. Section 5 of the BC Act defines "to take" as "… to gather, pluck, cut, pull up, destroy, dig up, remove, harvest or damage flora by any means".

Priority flora are under consideration for future declaration as "Threatened flora", dependent on more information. Species classified as Priority One to Three (referred to as P1, P2 and P3) are in need of further survey to determine their status, while Priority Four (P4) species are adequately known rare or threatened species that require regular monitoring.

Threatened flora lists are formally reviewed on an annual basis, whilst the priority flora list is subject to a less formal ongoing review. The current listing of Threatened and Priority flora was updated on the 5 December 2018. Categories of Threatened and Priority flora under the BC Act and Threatened species under the EPBC Act are provided in Ecoedge (2020a).

Ecoedge (2020a) conducted a Naturemap data search for Threatened and Priority flora occurring within 10km of the Development Envelope (DPaW, 2014c, cited in Ecoedge, 2020a) and a Protected Matters Search Tool query (DoEE, 2014b) for flora listed as Threatened pursuant to Schedule 1 of the EPBC Act occurring within 5km of the Development Envelope (DoEE, 2015b, cited in Ecoedge, 2020a). Results of the searches are provided in Table 4-8.

TABLE 4-8: THREATENED AND PRIORITY FLORA POTENTIALLY OCCURRING WITHIN DEVELOPMENT ENVELOPE

SPECIES	CONSERVATION STATUS		FLOWERING	DESCRIPTION/HABITAT	LIKELIHOOD OF OCCURRENCE
	BC ACT	EPBC ACT			
Brachyscias verecundus	T	CE		Annual (or ephemeral), herb, 0.012-0.022 m high, entirely glabrous. Fl. white/cream. In a moss sward. On a granite outcrop.	Low
Caladenia procera	T	CE	Sep-Oct	Tuberous, perennial, herb, 0.35-0.9 m high. Fl. yellow. Rich clay loam. Alluvial loamy flats, jarrah/marri/peppermint woodland, dense heath, sedges.	Low
Andersonia gracilis	T	E	Sep to Nov	Slender erect or open straggly shrub, 0.1-0.5(-1) m high. Fl. white-pink-purple. White/grey sand, sandy clay, gravelly loam. Winter-wet areas, near swamps.	Moderate
Banksia nivea subsp. *uliginosa*	T	E	Aug-Sep	Dense, erect, non-lignotuberous shrub, 0.2–1.5 m high. Fl. yellow, brown. Sandy clay, gravel.	Moderate
Caladenia huegelii	T	E	Sep-Oct	Tuberous, perennial, herb, 0.25-0.6 m high. Fl. green, cream, red. Grey or brown sand, clay loam.	Low
Centrolepis caespitosa	T	E	Oct - Dec	Tufted annual, herb (forming a rounded cushion up to 25 mm across). White sand, clay. Salt flats, wet areas.	Moderate
Darwinia whicherensis	T	E	Oct - Nov	Erect low shrub to 30 cm, flowers green, outer red. Winter-wet area of shrubland over shallow red clay over ironstone.	Moderate
Drakaea elastica	T	E	Oct-Nov	Tuberous, perennial, herb, 0.12-0.3 m high. Fl. red, green, yellow. White or grey sand. Low-lying situations adjoining winter-wet swamps.	Low
Gastrolobium papilio	T	E	Oct-Dec	Tangled, clumped shrub, to 1.5 m high. Fl. cream-red. Sandy clay over ironstone and laterite. Flat plains.	Low
Grevillea maccutcheonii	T	E	Mar/May or Dec	Densely branched shrub, to 2 m high. Fl. green & red. Shallow soils over laterite, clay. Seasonally inundated sites.	Moderate

SPECIES	CONSERVATION STATUS		FLOWERING	DESCRIPTION/HABITAT	LIKELIHOOD OF OCCURRENCE
	BC ACT	EPBC ACT			
Lambertia echinata subsp. *occidentalis*	T	E	Feb/May-Jun/Oct	Prickly, much-branched, non-lignotuberous shrub, to 3 m high. Fl. Yellow. White sandy soils over laterite, orange/brown-red clay over ironstone.	Low
Petrophile latericola	T	E	Nov	Multi-stemmed shrub, 0.4-1.5 m high. Fl. yellow. Red lateritic clay. Winter-wet flats.	Moderate
Synaphea stenoloba	T	E	Aug-Oct	Caespitose shrub, 0.3–0.45 m high. Fl. yellow. Sandy or sandy clay soils. Winter-wet flats, granite. Shrublands and woodlands on loamy soils.	Low
Verticordia plumosa var. *vassensis*	T	E	Sep-Feb	Shrub, 0.3–1 m high. Fl. pink, Sep–Feb. White/grey sand. Winter-wet flats	Moderate
Banksia squarrosa subsp. *argillacea*	T	V	Jun-Nov	Erect, open, non-lignotuberous shrub, 1.2–4 m high. Fl. yellow. White/grey sand, gravelly clay or loam. Winter-wet flats, clay flats.	High
Chamelaucium sp. S Coastal Plain (R.D.Royce 4872)	T	V	Aug-Oct	Winter-wet areas, loams and ironstone.	Moderate
Diuris micrantha	T	V	Sep-Oct	Tuberous, perennial, herb, 0.3–0.6 m high. Fl. yellow, brown. Brown loamy clay. Winter-wet swamps, in shallow water.	Moderate
Drakaea micrantha	T	V	Sep-Oct	Tuberous, perennial, herb, 0.15–0.3 m high. Fl. red, yellow. White-grey sand.	Low
Grevillea elongata	T	V	Oct	Shrub, 1.5-2 m high. Fl. white-cream. Gravelly clay, sandy clay, sand. Road verges, swamps, creek banks	Moderate
Hemigenia ramosissima	T		Nov–Dec or Jan	Slender shrub, to 0.5 m high. Fl. blue-purple. Lateritic soils, clay. Granite outcrops.	Low
Verticordia plumosa var. *ananeotes*	T		Nov-Dec	Erect, sparsely branched shrub, 0.3-0.5 m high. Fl. pink-purple/white. Sandy loam. Seasonally inundated plains.	Moderate

SPECIES	CONSERVATION STATUS		FLOWERING	DESCRIPTION/HABITAT	LIKELIHOOD OF OCCURRENCE
	BC ACT	EPBC ACT			
Gastrolobium sp. Yoongarillup (S.Dilkes s.n. 1/9/1969)	P1		Aug-Oct	Erect, perennial shrub; 0.5 m high, 1.0 m wide; flowers yellow/orange. Jarrah-Marri forest, white sand, gravel	Low
Andersonia ferricola	P1		Oct	Shrub, 0.2-0.5 m high. Fl. purple. White sand or red-brown loam over ironstone. Seasonally wet flats	Moderate
Loxocarya striata subsp. *implexa*	P1		Jul-Dec	Winter-wet flats	Moderate
Stylidium ferricola	P1		…	Caespitose perennial, herb, 0.09-0.15 m high. Shallow red-brown clay loam over ironstone. Seasonally wet poorly-drained slopes.	Moderate
Actinotus whicheranus	P2		Dec or Jan-Mar	Erect, slender perennial, herb, with flowering branches to 0.4 m high. Fl. white. White sand pockets over laterite.	Moderate
Amperea micrantha	P2		Oct-Nov	Low, spreading, bushy perennial, herb, 0.1–0.3 m high. Fl. brown. Sandy soils	Low
Calytrix sp. Tutunup (G.J. Keighery & N. Gibson 2953)	P2		Oct	Slender, spreading shrub, to 3 m high. Fl. white. Yellow-grey clayey loam, red clayey loam, laterite, ironstone. Slopes and flats, winter-wet areas, grazed paddocks.	Moderate
Gratiola pedunculata	P2		Sep-Nov	Erect to decumbent perennial herb 13–50 cm high. Damp areas.	Low
Leucopogon sp. Busselton (D. Cooper 243)	P2		Aug-Sep	Slender, erect shrub to 70 cm; flowers white. *Pericalymma ellipticum* wet shrubland, Marri-Jarrah woodland.	Low
Blennospora doliiformis	P3		Oct-Nov	Erect annual, herb, to 0.15 m high. Fl. yellow. Grey or red clay soils over ironstone. Seasonally-wet flats.	Moderate
Boronia capitata subsp. *gracilis*	P3		Jun-Nov	Slender shrub, 0.3-0.6(-3) m high, branches pilose. Fl. pink. White/grey or black sand. Winter-wet swamps,	Moderate

SPECIES	CONSERVATION STATUS		FLOWERING	DESCRIPTION/HABITAT	LIKELIHOOD OF OCCURRENCE
	BC ACT	EPBC ACT			
Boronia tetragona	P3		Oct-Dec	Perennial, herb, 0.3–0.7 m high, leaves sessile, entire, with papillate margins, branches quadrangular, sepals ciliate. Fl. pink, red. Black/white sand, laterite, brown sandy loam. Winter-wet flats, swamps, open woodland.	Moderate
Chordifex gracilior	P3		Sep-Dec	Rhizomatous, erect perennial, herb, 0.3-0.5 m high. Fl. brown, Sep to Dec. Peaty sand. Swamps.	Moderate
Conospermum paniculatum	P3		Jul-Nov	Spreading, open shrub, 0.3-1.25 m high. Fl. blue, white. Sandy or clayey soils. Swampy areas, plains, slopes.	Low
Grevillea brachystylis subsp. *brachystylis*	P3		Aug-Nov	Much-branched, prostrate or decumbent, non-lignotuberous shrub, 0.2-0.5 m high, to 3 m wide. Fl. red. Black sand, sandy clay. Swampy situations.	Moderate
Grevillea bronwenae	P3		Jun-Dec	Slender, erect shrub, 0.5–1.6 m high. Fl. red. Grey sand over laterite, lateritic loam. Hillslopes.	Moderate
Hakea oldfieldii	P3		Aug-Oct	Open, straggling shrub, up to 2.5 m high. Fl. white, cream, yellow. Red clay or sand over laterite. Seasonally wet flats.	High
Isopogon formosus subsp. *dasylepis*	P3		Jun-Dec	Low, bushy or slender, upright, non-lignotuberous shrub, 0.2–2 m high. Fl. pink, purple, red. Sand, sandy clay, gravelly sandy soils over laterite. Often swampy areas.	High
Lasiopetalum laxiflorum	P3		Sep-Oct	Jarrah forest, lateritic soils	Low
Loxocarya magna	P3		Sep or Nov	Rhizomatous, perennial, herb (sedge-like), 0.5-1.5 m high. Sand, loam, clay, ironstone. Seasonally inundated or damp habitats.	High
Pithocarpa corymbulosa	P3		Jan-Apr	Erect to scrambling perennial, herb, 0.5-1 m high. Fl. white. Gravelly or sandy loam. Amongst granite outcrops.	Low

SPECIES	CONSERVATION STATUS		FLOWERING	DESCRIPTION/HABITAT	LIKELIHOOD OF OCCURRENCE
	BC ACT	EPBC ACT			
Schoenus pennisetis	P3		Aug-Sep	Tufted annual, grass-like or herb (sedge), 0.05-0.15 m high. Fl. purple-black. Grey or peaty sand, sandy clay. Swamps, winter-wet depressions.	Moderate
Stylidium longitubum	P3		Oct-Dec	Erect annual (ephemeral), herb, 0.05-0.12 m high. Fl. Pink. Sandy clay, clay. Seasonal wetlands.	Moderate
Verticordia attenuata	P3		Dec-May	Shrub, 0.4–1 m high. Fl. pink. White or grey sand. Winter-wet depressions	Moderate
Acacia flagelliformis	P4		May-Sep	Rush-like, erect or sprawling shrub, 0.3-0.75(-1.6) m high. Fl. yellow. Sandy soils. Winter-wet areas.	Moderate
Acacia semitrullata	P4		May-Oct	Slender, erect, pungent shrub, (0.1-)0.2-0.7(-1.5) m high. Fl. cream, white. White/grey sand, sometimes over laterite, clay. Sandplains, swampy areas.	Moderate
Banksia meisneri subsp. *ascendens*	P4		Apr-Sep	Shrub, 0.5-2 m high, leaves ascending, 8-15 mm long. Fl. yellow-orange-brown. White or grey sand. Swampy flats.	Moderate
Calothamnus quadrifidus subsp. *teretifolius*	P4		Nov-Dec	Erect, compact, perennial shrub 1.7 m high x 1 m wide. Fl. Red. Seeds held. Fruit exposed.	High
Chamelaucium sp. Yoongarillup (G.J. Keighery 3635)	P4		Jul-Oct	Non-lignotuberous shrub, to 2.5 m high. Fl. cream, yellow. Jarrah-marri forest. Loams, sandy clays. Riverbanks, lower slopes, below laterite breakaways.	Low
Franklandia triaristata	P4		Aug-Oct	Erect, lignotuberous shrub, 0.2-1 m high. Fl. white, cream, yellow, brown, purple. White or grey sand.	Low
Ornduffia submersa	P4		Sep-Oct	Tuberous emergent aquatic perennial dwarf shrub, height to 35 cm; flowers white; leaves floating on surface of water. Clay-based ponds and swamps (semi-aquatic)	Moderate

SPECIES	CONSERVATION STATUS		FLOWERING	DESCRIPTION/HABITAT	LIKELIHOOD OF OCCURRENCE
	BC ACT	EPBC ACT			
Pultenaea skinneri	P4		Jul-Sep	Slender shrub, 1-2 m high. Fl. yellow, orange, red. Sandy or clayey soils. Winter-wet depressions.	Low

FLORA

One hundred and forty-nine taxa of vascular plants were identified during the surveys (Ecoedge, 2020a, 2017 and 2020b), of which 57 taxa (38%) were introduced species. The relatively low number of native species found within the ~78 ha of native vegetation in the wider survey area is a result of many years of degradation of the small fragments of native bush. The largest single area of native vegetation is only 6.5ha in size and has been subject to many years of livestock grazing. As a consequence, all native species have been removed from the understorey.

The dominant genera were the Fabaceae with 23 taxa (including 10 introduced species), Proteaceae with 16 taxa, Myrtaceae with 16 taxa (2 introduced species) and Poaceae with 15 taxa (14 introduced species).

FLORA OF CONSERVATION SIGNIFICANCE

Two Threatened (T) Flora species, *Banksia squarrosa* subsp. *Argillacea* (Whicher Range banksia) and *Verticordia plumosa* var. *vassensis* (Vasse Featherflower), were recorded within the survey area. Both of these species are listed as Threatened pursuant to Section 19 of the BC Act and Endangered pursuant to section 179 of the EPBC Act. Four Priority listed species listed by DBCA, *Loxocarya magna* (P3), *Calothamnus quadrifidus* subsp. *teretifolius* (P4), *Grevillea brachystylis subsp. Brachystylis* (P3) and *Acacia flagelliformis* (P4) were also recorded within the survey area.

Local and regional perspective of these flora species are discussed below from publicly available information.

Banksia squarrosa subsp. *Argillacea* (Whicher Range banksia) T(E)

The population of *B. squarrosa* subsp. *argillacea* within the Development Envelope occurs on McGibbon Track within a small occurrence of Vegetation Unit B1 which is recognised as the TEC SWAFCT10b - Shrublands on southern Swan Coastal Plain Ironstones (Busselton area)" (Gibson, et al., 2000) (Meissner & English, 2005). A total of nine individuals were identified during the survey which is a decline in population since 2003 by five individuals. Weeds, dieback, track maintenance and mining were given as the principle threats to the population (Ecoedge, 2020a). Track maintenance remains a threat, as Ecoedge (2020a) noted the track was graded in February 2016 with some resulting damage to the ironstone shrubland vegetation.

B. squarrosa subsp. *Argillacea* occurs on the coastal plain close to the western base of the Whicher Range, east of Busselton, in WA (Department of the Environment, 2015). It is known from 11 subpopulations, has an abundance of 2,876 mature plants and an area of occupancy of 0.38km^2 (Department of the Environment, 2015). Ecoedge (2020a) reported that there are 63 records for this species in the DBCA database, most of which relate to occurrences in "Busselton Ironstone" vegetation on the Swan Coastal Plain south of Busselton, however there are several known populations in State Forest on the Blackwood Plateau.

Verticordia plumosa var. vassensis (Vasse Featherflower) T(E)

The population of *V. plumosa* var. *vassensis* is located outside of the Development Envelope and is situated on the verge of Princefield Road, 2.1km west of Ludlow-Hithergreen Road. The population size was estimated at 200+ plants in 1996, and 100+ in 2006 (Williams, et al., 2001) (DoEE, 2016f, cited in Ecoedge, 2020a). The population size was difficult to estimate during the Ecoedge (2020a and 2020b) surveys as the plants are situated within an area of thick wet shrubland, however approximately 20 individuals were recorded.

V. plumosa var. *vassensis* is known from 13 populations near Busselton (DEC, 2007). This species' distribution is severely fragmented and very restricted, with known subpopulations occurring over a large geographic range in isolated pockets of remnant vegetation (DEC, 2007). Most populations are located within road, rail and recreational reserves or on private property, with only one part of a population occurring within a nature

reserve. The total population of *V. plumosa* var. *vassensis* has been estimated at 3,200 mature plants, although this estimate relies on 10-year-old survey counts and may not be accurate (DEC, 2007). Ecoedge (2020a) reported that there are 97 records for this species in the DBCA database, most of which relate to locations on the Swan Coastal Plain south of Busselton, with an east-west range of 30km *V. plumosa* var. *vassensis* grows on a variety of sands and swampy clay soils in mostly winter-wet flats and depressions. It grows with sedges and rushes or in low heath and is often found on degraded, grassy-weed infested road verges (Brown, et al., 1998) (Williams, et al., 2001). This species occurs in the South West (Western Australia) Natural Resource Management region. The distribution of this species overlaps with *SWAFCT10b - Shrublands on southern Swan Coastal Plain Ironstones (Busselton area)" (Gibson, et al., 2000);* (Meissner & English, 2005) which is listed as a TEC with threat status of "Critically Endangered" by DBCA and Endangered under the EPBC Act. This species is currently known from Ambergate Reserve and Ruabon and Ruabon-Tutunup Road Bushland areas in the Busselton and Capel Shires and from the Scott Coastal Plain (Webb, et al., 2009).

Loxocarya magna (P3)

L. *magna* (P3) is confined to, and dominant in, ironstone communities of the Scott River and Busselton Plains (Webb, et al., 2009) and is represented by 70 records in the DBCA databases. Within the survey area, this species was present in the area of Busselton Ironstone on the McGibbon Track and also near the junction of Coopers Road and Princefield Road. The most northern locality of this species is in the Busselton Ironstones-Tutunup Road (Webb, et al., 2009).

Calothamnus quadrifidus subsp. Teretifolius (P4)

Calothamnus quadrifidus subsp. *Teretifolius* (P4) is mostly confined to fragmented remnants of Busselton Ironstone plant community on the Swan Coastal Plain south of Busselton (Ecoedge, 2020a). This species is represented by 69 records in the DBCA databases. This species was found during the survey in the small area of Busselton Ironstone at the Junction of Coopers Road and Princefield Road, and on McGibbon Track. All populations contain mainly old plants and many of those at the junction of Coopers Road and Princefield Road have recently been severely pruned back by cattle grazing (Ecoedge, 2020a).

Grevillea brachystylis subsp. Brachystylis (P3)

Located outside of the Development Envelope and potential areas of impact on Princefield Road.

Acacia flagelliformis (P4)

Located outside of the Development Envelope and potential areas of impact on Princefield Road.

Locations of conservation significant flora relevant to the Proposal (Ecoedge, 2020b) are shown on Figure 4-3 and summarised in Table 4-9.

TABLE 4-9: LOCATIONS AND NUMBERS OF THREATENED AND PRIORITY FLORA

TAXON	STATUS BC ACT	STATUS EPBC ACT	NUMBER	LOCATION
Banksia squarrosa subsp. *Argillacea*	T	E	9	McGibbon Track
Verticordia plumosa var. *vassensis*	T	E	c.30	Princefield Road
Loxocarya magna	P3		(1) c.42	McGibbon Track

TAXON	STATUS BC ACT	STATUS EPBC ACT	NUMBER	LOCATION
			(2) 1 (3) 3	Cooper's Road Drain Reserve Princefield Road
Calothamnus quadrifidus subsp. *teretifolius*	P4		(1) 62 (2) 12	McGibbon Track Cooper's Road Drain Reserve
Grevillea brachystylis subsp. brachystylis	P3		2	Princefield Rd
Acacia flagelliformis	P4		(1) 13 (2) 9	Princefield Rd McGibbon Track

Several other Threatened and Priority flora species previously known to occur in the area (or mapped on the DBCA database) were not able to be located during the initial survey (Ecoedge, 2020a) or follow up site visits (Ecoedge, 2020b) and are considered to have been lost. These include:

- *Chamelaucium roycei* (T) (40+ plants in 1997) previously occurred within a small area of ironstone vegetation near the junction of Princefield Road and Coopers Road but this population is now possibly extinct due to burning and grazing of the small remnant (which is situated on a road and drainage reserve);
- *Banksia nivea* subsp. *uliginosa* (T) (6 plants in 2003) previously occurred on the verge of Princefield Road 875m west of Coopers Road (Williams, et al., 2001), but this also no longer extant. The road verge shows signs of having been mowed and/or grazed by livestock being herded along this area by farmers;
- One plant of *Verticordia plumosa* var. *vassensis* (T) on the verge of Princefield Road 4.3km west of Ludlow-Hithergreen Road in 1996. This plant was not able to be found during the surveys;
- *Isopogon formosus* subsp. *dasylepis* (P3) had previously been known from 200m north along McGibbon Track from Yalyalup Road. This plant was not able to be found during the present survey;
- *Calothamnus* sp. Whicher (B. J. Keighery & N. Gibson 230) pn – mapped on DBCA database as occurring on McGibbon track within vegetation unit B1 (SWAFCT10b) and on Princefield Rd outside of the Development Envelope;
- *Chamelaucium roycei ms* – mapped on DBCA database as occurring on Princefield Rd outside of the Development Envelope;
- *Drakaea elastica* – mapped on DBCA database within paddock south of Princefield Rd outside of the Development Envelope;
- *Dryandra nivea* subsp. *uliginosa* – mapped on DBCA database on Princefield Rd, just outside of Development Envelope;
- *Dryandra squarrosa* subsp. *Argillacea* – mapped on DBCA database as occurring on McGibbon track within vegetation unit B1 (SWAFCT10b).

DECLARED PLANTS

Two weeds were found within the Development Envelope, *Asparagus asparagoides* and *Zantedeschia aethiopica*. Both are listed as Pest Plants by the Department of Agriculture and Food (DAF, 2014) and are in the C3 (management) category for the whole of the State. *A. asparagoides* (Bridal Creeper) was only found in four locations, but *Z. aethiopica* (Arum Lily) is widespread within the Development Envelope, particularly along creeklines (Figure 4-4).

DIEBACK

A *Phtophthora* Dieback Assessment for the Proposal was undertaken by (BARK Environmental, 2019) using DBCA methodology described in *Forest and Ecosystem Management Division 2015, Phtophthora Dieback Interpreters manual for lands managed by the Department, DPaW, Perth, WA* (DPaW, 2015). Results of the assessment (Appendix 4) identified only 0.3ha of the Development Envelope as being "infested" with *Phtophthora* dieback, in the road reserve along Princefield Rd (Figure 4-5). The remaining 924.7ha of the Development Envelopment was assessed as "excluded" which was applied to all remaining areas comprising fragmented remnant vegetation, isolated paddock trees, planted trees and degraded/completely degraded vegetation/land. The area identified as infested is outside of the disturbance area and will not be impacted by the Proposal.

WETLANDS

Approximately 90% of the Development Envelope is mapped as a wetland in the Geomorphic Wetlands of the Swan Coastal Plain dataset (DEC, 2008a), all of which has been assessed as being in the 'Multiple Use' management category, which is described as wetlands with few ecological attributes and functions remaining. The majority of the wetland area within the Development Envelope (~77%) is mapped as Palusplain (seasonally waterlogged flat), with small areas of Sumpland (seasonally inundated basin, ~3%) and floodplain (seasonally inundated flats, ~17%). No wetlands of environmental significance are present within the Development Envelope (Figure 2-8).

The Vasse-Wonnerup wetland is located approximately 4.6km to the northwest of the Site (Figure 2-8). This wetland is listed under the Ramsar convention as a wetland of international significance and is an extensive, shallow, nutrient-enriched, wetland system with widely varying salinities. Water levels in it have two principal components, the Vasse and Wonnerup lagoons (former estuaries), are managed through the use of weirs (flood gates) with the aim of minimising flooding of adjoining lands and of keeping sea water out. When the water level in the estuaries rises above sea level, hydrostatic pressure opens the floodgates and allows water to flow out to Wonnerup Inlet and the sea. When the level drops, the gates close, thereby preventing ingress of sea water (HydroSolutions, 2017).

GROUNDWATER DEPENDENT ECOSYSTEMS

Definition

Groundwater-dependent ecosystems (GDEs) may be defined as ecosystems that require access to groundwater to meet all or some of their water requirements so as to maintain the communities of plants and animals, ecological processes they support, and ecosystem services they provide (Richardson, et al., 2011).

For the purposes of defining ecosystem dependence on groundwater, groundwater is defined as "*…that water which has been below ground and would be unavailable to plants and animals were it to be extracted by pumping*" (Hatton & Evans, 1998).

Types of groundwater dependent ecosystems may include (Richardson, et al., 2011):

1. Aquifer and cave ecosystems including stygofauna (fauna that live in groundwater) in fractured rock aquifers;
2. Ecosystems dependent on surface expression of groundwater including base flow (e.g. fish in remnant aquatic pools), wetlands, mound springs and sea grass beds;
3. Ecosystems dependent on subsurface presence of groundwater where roots tap into the groundwater system (via the capillary fringe). They include terrestrial vegetation that depends on groundwater fully or on a seasonal or episodic basis in order to prevent water stress and generally avoid adverse impacts to their condition. In these cases, and unlike the situation with Type 2 systems (above), groundwater is not visible from the earth surface. These types of ecosystem can exist wherever the water table is within the root zone of the plants, either permanently or episodically.

Type 3 GDE's may be difficult to identify in the field and their identification may require a detailed knowledge of local hydrogeology, ecosystems dynamics and plant physiology. Dependence on groundwater can be variable, ranging from partial and infrequent dependence, i.e. seasonal or episodic, to total (entire or obligate), continual dependence. It is often difficult, however, to determine the nature of this dependence (Serov *et al*., 2012).

Potential GDEs

To assist with identification of Type 3 GDE's within the area predicted to be impacted by dewatering for the proposal, a detailed review of soil information, depths to groundwater, proposed dewatering extents and specific water dependency of flora species/ecosystems was undertaken by (Ecoedge, 2020c) (Appendix 4D).

Vegetation units within the Development Envelope were described by (Ecoedge, 2020a) and described previously in Table 4-5 and shown on Figure 4-1a. Three of these vegetation units are considered to be GDEs (Unit A2, Unit B1, and Unit C3), and another unit, A1, while probably not a GDE, has groundwater-dependant trees within it. Three no longer intact communities[1] (Unit B2, Unit C1 and Unit C2), are dominated by phreatophytic species. Two of the GDEs (A2, SWAFCT02 and B1, SWAFCT10b) and unit A1 (SWAFCT01b) are listed as TECs under the BC Act. Unit B1 (SWAFCT10b), is also listed as Threatened under the EPBC Act. The occurrence of the unit C3 however is considered to be too small and badly degraded to be inferred as an example of the TEC, SWAFCT09 (Ecoedge, 2020a).

Locations of GDE's within the Development Envelope are shown in Figure 4-6 and denoted by Areas A, B, and C[2] and are described as follows.

Southern wet shrublands (SWAFCT02) Vegetation Unit A2

Southern wet shrublands (SWAFCT02) (which are listed as "Endangered" under BC Act), are shrublands or open woodlands occurring on seasonally inundated sandy-clay soils. Because their subsoil has higher permeability than claypan communities they are more typically a GDE. There appears to have been no research conducted into the hydrology of this community. However, the response of the dominant small trees such as *Melaleuca preissiana* and *Banksia littoralis* in this community is probably similar to that of the same species occurring in the sandier wetlands of the Gnangara Mound near Perth (Groom, et al., 2001). In

[1] These vegetation units are classed as "Completely Degraded" and while having one or more of the original overstorey species, are devoid of native species in the understorey.
[2] These GDE Area codes do not relate to the vegetation unit codes.

the study both taxa were shown to be dependent on groundwater, and *B. littoralis* in particular had showed a decline in distribution resulting from declining rainfall and increased water abstraction.

The geological bore log for groundwater monitoring well, MB08S (AQ2, 2020a) which is adjacent to the *Southern wet shrublands* (SWAFCT02) at the northern end of McGibbon Track, records grey sand to 1m and then a relatively impervious layer of clayey-sand over sandy clay (with ironstone gravel) to 3m.

Shrublands on Southern Swan Coastal Plain Ironstones (SWAFCT10b) Vegetation Unit B1

The ironstone soils near Busselton are associated with shallow seasonal inundation with fresh water. This inundation may occur due to ponding of rainfall as a consequence of the impermeable nature of the surface outcrops of ironstone and the associated heavy soils. In addition, groundwater levels in the community come very close to or may reach the surface in the wetter months (Tille & Lantzke, 1990) (Smith, 1994).

The geological bore log for groundwater monitoring well MB03S (AQ2, 2020a), which was drilled into an ironstone outcrop on Princefield Road within the Development Envelope, recorded ~4m of massive ironstone over sandy-clay at 5m and clay at 6 m. The geological bore log for groundwater monitoring well MB11S (AQ2, 2020a) provides another glimpse of the geology of the ironstone formation in the Development Envelope. At this location, the bore log notes 0.7 m of grey sand overlies 2.1m of massive ironstone, overlying ~3 m of clayey sand.

The specialised root-growth adaptations of several ironstone endemic shrubs have been the subject of research in recent years (Williams, 2007), (Poot & Lambers, 2008) and (Poot, et al., 2008). Seedlings of ironstone endemics were shown to direct much more of their growth into their root systems than more widespread congeners. Ironstone endemics also favoured root growth in deeper layers of the substrate which appears to be related to their need to produce roots capable of penetrating vertical cracks or fissures in the laterite to access water at deeper levels as the water-table retreats during the summer drought.

Vegetation unit B1 on McGibbon Track (SWAFCT10b) contains the threatened species *Banksia squarrosa* subsp. *argillacea* plus several other ironstone endemics that are classified as priority species.

Vegetation Unit C3

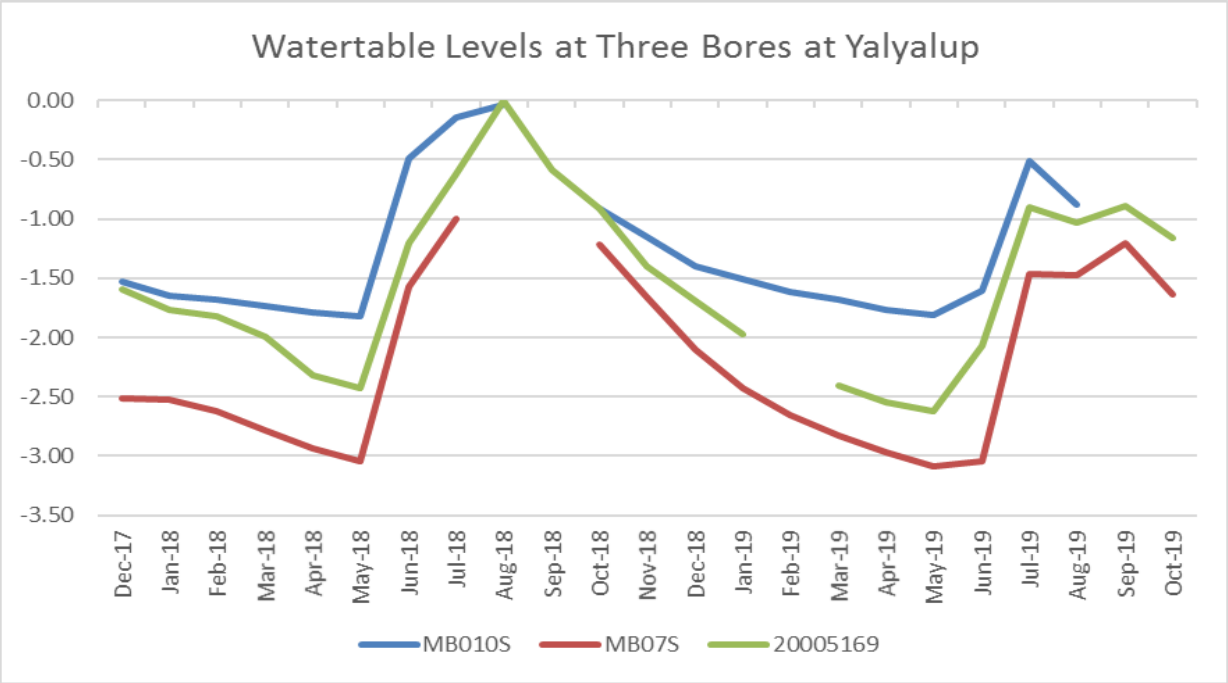
Hydrology studies of the Brixton Street wetlands (which include claypan GDEs) has recently been summarised (Bourke, 2017). There is some evidence that there is limited or no hydrological connection between claypan vegetation and groundwater in claypan wetlands and that the vegetation relies primarily on rainfall (V & C Semenuik, 2001[3]) (Chow, et al., 2010). However, widespread historical clearing, that has occurred within the Development Envelope combined with the fact that most of the native vegetation occurs as narrow remnants would, no doubt, have led to substantial changes in local hydrology. The replacement of native vegetation by agricultural crops and pastures has disturbed the water cycle that existed prior to European settlement and greatly increased the amount of water leaking beyond the root zone of introduced species and contributing to groundwater systems (Eberbach, 2003).

Superficial Groundwater Levels Within GDEs

Superficial groundwater levels for monitoring bores MB07S, MB10S and 20005169 (Figure 4-6), located in proximity to the identified GDEs, have been monitored by Doral as part of the baseline groundwater monitoring program (refer Section 4.5.3). A summary of the seasonal fluctuations for water depths is provided in Plate 4-1.

[3] Cited in DPaW, 2015

PLATE 4-1: WATERTABLE FLUCTUATIONS NEAR GDEs



- Highest water level elevations were recorded in August or September and lowest in May or June;
- The seasonal water level variations for these bores were between 1.7 and 2.5 m;
- Variations in water levels are generally correlated with the seasonal rainfall pattern.

Other GDEs

Three reserve areas in the Busselton-Capel groundwater subarea are also under ecological monitoring due to the presence of high sensitivity GDE's (DWER, 2009, Figure 1). These GDE's have management triggers and responses attached to them by DWER (Del Borello, 2008). These are labelled 'conservation' Sumpland and Floodplain, but are located approximately 6km the northeast and southwest of the Proposal and more than 5km outside the proposed dewatering extent.

4.2.4. POTENTIAL IMPACTS

The following aspects of the Proposal may affect flora and vegetation values:

Direct Impacts

- Clearing of ~3.5ha of native vegetation will reduce the extent of soil-landscape systems, vegetation complexes, vegetation units and occurrences of TECs.

Indirect Impacts

- Dewatering activities may indirectly affect groundwater-dependent vegetation by lowering local groundwater levels;
- Clearing native vegetation may result in fragmentation of vegetation;
- Altered fire regime due to operation of mine;
- Mining activities and vehicle movement have the potential to spread weeds within and adjacent to the Development Envelope;

- Mining activities and vehicle movement has the potential to deposit dust on vegetation within and adjacent to the Development envelope.

4.2.5. ASSESSMENT OF IMPACTS

DIRECT IMPACTS

CLEARING AND FRAGMENTATION OF NATIVE VEGETATION

The Proposal has been designed to avoid clearing native vegetation as far as practicable in order to reduce direct impacts to flora and vegetation values. The Proposal however will require clearing of ~3.5ha of native vegetation to facilitate the development of mine areas and associated infrastructure. This will reduce the regional and local extent of soil-landscape systems, vegetation complexes, vegetation units and TECs. No Threatened or Priority flora species will be directly impacted (cleared) for the Proposal.

Soil Landscape Mapping

The Proposal will require clearing of ~3.5ha of native vegetation and disturbance of 449.84ha of cleared pasture and planted species, that occurs within the Abba Plains soil-landscape system (213Ab). Table 4-10 shows the potential impact to the Abba Plains soil-landscape system and soil mapping units (subsystems of the Abba Plains soil-landscape system) that occur within the Development Envelope.

TABLE 4-10: DIRECT IMPACTS TO SOIL-LANDSCAPE SYSTEMS AND MAPPING UNITS

SOIL MAPPING UNIT	TOTAL EXTENT OF SOIL MAPPING UNIT (HA)	AREA OF SOIL MAPPING UNIT AFFECTED BY PROPOSAL (HA)	PERCENTAGE OF SOIL MAPPING UNIT AFFECTED BY PROPOSAL (%)
TOTAL ABBA PLAINS SOIL-LANDSCAPE SYSTEM	**48,954**	**453.34**	**0.93**
213AbABw	3320	166.03	5.00
213AbABvw	1026	0	0
213AbAB1	2127	219.15	10.30
213AbABd	1495	0	0
213AbABwi	154	59.93	38.92
213AbABwy	871	2.68	0.31
213AbJD1	162	5.58	3.44
213AbJDf	1817	0	0

VEGETATION COMPLEXES

Utilising the recent extension of the vegetation complex mapping within the Swan Coastal Plain (Webb, et al., 2016), clearing of native vegetation for the Proposal will only occur in the Abba vegetation complex. As shown in Table 4-11, the area of native vegetation to be cleared represents only 0.05% of the remaining area of the Abba vegetation complex and therefore does not significantly reduce the extent of this vegetation complex.

In 2001, the Commonwealth of Australia stated National Targets and Objectives for Biodiversity Conservation, which recognised that the retention of 30% or more, of the pre-European vegetation of each ecological community was necessary if Australia's biological diversity were to be protected (Environment Australia, 2001). This level of recognition is in keeping with the targets set in the EPA's Position Statement No. 2 (EPA, 2000), with particular reference to the agricultural area. With regard to conservation status, the EPA has set a target of 15% of pre-European extent for each community to be protected in a comprehensive, adequate and representative reserve system (EPA, 2006).

Currently 6.6% of the pre-European extent of the Abba vegetation complex is remaining, which is below the Commonwealth's 30% target and the EPA's 15% target. Only 1.67% of the Abba vegetation complex is in DBCA managed lands.

TABLE 4-11: DIRECT IMPACTS TO VEGETATION COMPLEXES

VEGETATION COMPLEX	SYSTEM 6 CODE	CURRENT AREA OF VEGETATION COMPLEX REMAINING (HA)	PERCENTAGE OF VEGETATION COMPLEX REMAINING (%)	PERCENTAGE OF VEGETATION COMPLEX IN DBCA MANAGED LANDS (%)	AREA OF VEGETATION COMPLEX TO BE CLEARED (HA)	PERCENTAGE OF VEGETATION COMPLEX AFFECTED BY PROPOSAL %
Abba	30	3,359.08	6.60	1.59	3.5	0.10

VEGETATION UNITS

Clearing for the Proposal will affect the following vegetation units:

- Vegetation Unit A1;
- Vegetation Unit A2;
- Vegetation Unit B2;
- Vegetation Unit C1.

The majority of native vegetation to be cleared for the Proposal is within vegetation unit A1 (2.06ha). Almost all of vegetation unit A1 to be cleared (1.89ha) is a degraded form of the DBCA listed TEC (vulnerable), SWAFCT01b - Southern *Corymbia calophylla* woodlands on heavy soils (Gibson, et al., 2000) due to its completely degraded condition. Only a small area (0.17ha) of sufficient size and in good enough condition to be inferred as an occurrence of TEC SWAFCT01b will be cleared for the Proposal. Impacts to conservation significant vegetation is discussed in the following section.

Approximately 0.63ha of vegetation unit A2 will be cleared for the Proposal. This vegetation unit only occurs on the McGibbon Track and has characteristics of both SWAFCT01b (because of the overstorey of *C. calophylla*) and SWAFCT02 - Southern wet shrublands, however the predominance of wetland-adapted species characteristics such as *Acacia saligna, Banksia littoralis, Melaleuca rhaphiophylla* and *Hakea ceratophylla* makes it floristically much closer to SWAFCT02 which is listed as a TEC by DBCA (endangered). The total area of unit A2 to be cleared for the Proposal is considered to be an occurrence of the TEC SWAFCT02, due to its degraded/good or good condition. Impacts to conservation significant vegetation is discussed in the following section.

Approximately 0.3ha of vegetation unit B2 will be cleared for the Proposal. This unit is a severely degraded form of SWAFCT10b - Shrublands on southern Swan Coastal Plain Ironstones (Busselton area) (vegetation unit B1), recognisable only by the presence of massive ironstone and lateritic boulders at or near surface. Generally, the only native species still present are the trees *Eucalyptus rudis* which is also present within unit B1 on the McGibbon Track, and sometimes *Melaleuca rhaphiophylla.* Unit B2 does not represent an occurrence of SWAFCT10b - Shrublands on southern Swan Coastal Plain Ironstones (Busselton area) based on its completely degraded condition.

The final vegetation unit to be directly impacted by clearing for the Proposal is vegetation unit C1, of which 0.51ha will be cleared. Vegetation unit C1 appears to belong to the "Riverine Jindong Plant Communities" as discussed in (Webb, et al., 2009) and is associated with winter streams that flow northwards in the western portion of the Development Envelope towards the Sabina River. All of vegetation unit C1 to be cleared is in Completely Degraded condition.

The remainder of the disturbance area will occur in cleared pasture (446.95ha), and planted/non-native vegetation (2.88ha).

Table 4-12 details the area, condition and local percentage of vegetation units to be directly impacted by the Proposal.

TABLE 4-12: DIRECT IMPACTS TO VEGETATION UNITS

VEGETATION UNIT	AREA WITHIN DEVELOPMENT ENVELOPE (HA)	AREA TO BE CLEARED (HA)	MAPPED CONDITION OF VEGETATION TO BE CLEARED	CLEARING AS A PERCENTAGE OF TOTAL VEGETATION UNIT WITHIN DEVELOPMENT ENVELOPE (%)
A1	9.68	1.89	Completely Degraded	19.53
A1 (SWAFCT01b)*	1.18	0.17	Degraded/good and good	14.41
A2	0.61	0.0	Degraded/Completely degraded	0.00
A2 (SWAFCT02)*	3.42	0.63	Degraded/good and good	18.42
B1	0.05	0.0	n/a	0.00
B1 (SWAFCT10b)*	0.45	0.0	n/a	0.00
B2	2.79	0.30	Completely degraded	10.75
C1	19.08	0.51	Degraded/good to completely degraded	2.67
C3	0.55	0.0	n/a	0.0
Planted/non-native (PL)	6.87	2.88	n/a	41.92
Cleared Pasture (CL)	880.17	446.95	Completely degraded	50.78

VEGETATION UNIT	AREA WITHIN DEVELOPMENT ENVELOPE (HA)	AREA TO BE CLEARED (HA)	MAPPED CONDITION OF VEGETATION TO BE CLEARED	CLEARING AS A PERCENTAGE OF TOTAL VEGETATION UNIT WITHIN DEVELOPMENT ENVELOPE (%)
*Area of vegetation units A1, A2 and B1 in degraded/good and good condition represent occurrences of TECs.				

CONSERVATION SIGNIFICANT VEGETATION

Table 4-13 shows the areas and percentages of the conservation significant vegetation that will be directly impacted by clearing for the Proposal. Limited information is available on the current remaining extents of both SWAFCT01b and SWAFCT02, however Figure 4-1b shows the regional distribution of known quadrats mapped as these TECs.

TABLE 4-13: DIRECT IMPACTS TO CONSERVATION SIGNIFICANT VEGETATION

TEC	TOTAL AREA OF TEC WITHIN DEVELOPMENT ENVELOPE (ha)	APPROX. KNOWN MAPPED EXTENT OF TEC (ha)	TOTAL AREA OF CLEARING WITHIN THE DEVELOPMENT ENVELOPE (ha)	CLEARING AS A PERCENTAGE OF TEC WITHIN THE DEVELOPMENT ENVELOPE (%)	CLEARING AS A PERCENTAGE OF KNOWN MAPPED EXTENT OF TEC (%)
SWAFCT01b	1.18	Known from 13 quadrats outside Proposal	0.17	14.41	unknown
SWAFCT02	3.42	Known from 6 quadrats outside Proposal	0.63	18.42	unknown

CONSERVATION SIGNIFICANT FLORA

All conservation significant flora species within the Development Envelope (identified by Ecoedge, 2020a) are located within McGibbon Track. As Doral have designed the Proposal to avoid clearing of the McGibbon Track as far as practicable, no conservation significant flora species will be directly impacted by the proposal.

INDIRECT IMPACTS

GROUNDWATER DRAWDOWN ON GDEs

A groundwater model was developed by AQ2 (2019a) (Appendix 7) for the Proposal to assist with assessment of hydrological impacts within the surrounding groundwater catchment including indirect impacts from lowering of the water table on GDEs within the Development Envelope. As part of the modelling a series of predicted water level drawdown contours were produced for both wet and dry climatic conditions within the superficial aquifer. These figures are provided as Figure 4-24a-24n (dry) and Figures 4-25a-25n (wet). Detailed discussion on the groundwater modelling is provided in Section 4.4 Hydrological processes.

The following discussion however, focuses on those periods when the “dry climatic conditions” (late autumn) predicted drawdown will be at its maximum for the GDEs shown in Figure 4-6.

Figure 4-24h shows the projected drawdowns for Q2 (Apr-Jun) 2023 under dry climatic conditions. Under this scenario drawdown of 1m would occur within 30m of GDE Area A (and between 0.1m and 0.25m within the road verge vegetation), and of 7m within 40m of the northern part of GDE Area B. Within the vegetation on McGibbon Track in the northern part of Area B, drawdowns of between 3m and 5m are projected.

During Q3 2023 (Figure 4-24i), the contours of projected drawdown move further south and the central part of GDE Area B has 7m projected drawdowns within 40m of its boundary and 4-5m within the vegetation on McGibbon Track. In this quarter, however, the projected drawdowns of vegetation unit B1 (SWAFCT10b) within GDE Area B are only 0.1 – 0.25m. Predicted drawdowns in the central part of GDE Area B reduce to 1-2m by Q4 2023 (Figure 4-24j).

Mining moves to the east side of McGibbon Track in 2024 and in Q3, 2024 (Figure 4-24m) drawdowns within vegetation unit A2 (SWAFCT02) within GDE Area B on McGibbon Track are predicted to be 3-4m, and within 20m of the edge of the road reserve they are predicted to be 5m (Q3, 2024, Figure 4-24m). Water level drawdown within vegetation unit A2 (SWAFCT02) is projected to be between 0.25-1.5m in Q3, 2024. In Q4, 2024 (Figure 4-24n), water level drawdowns will remain between 0.5m and 2m within the central part of GDE Area B, which includes vegetation unit B1 (SWAFCT10b). Predicted drawdowns within the central part of GDE Area B are similar whether the "wet climate" or "dry climate" is chosen.

The predicted water level drawdowns under the dry climate scenario are no greater than 0.25 m for GDE Area C.

Based on what is known about the hydrogeology and groundwater dependence of vegetation for the Proposal, it is likely that the predicted water drawdowns for the central and northern part of GDE Area B will be moderate to severe (Ecoedge, 2020c) (Figure 4-7). The Wet Shrublands (SWAFCT02), unit A2, with predicted drawdowns of up to 5m, and drawdowns of more than 2m lasting for 3-6 months in 2023, is likely to be severely impacted. Small trees and medium- deep-rooted shrubs within this groundwater-dependent community, such as *Banksia littoralis*, *Melaleuca preissiana*, *Hakea ceratophylla* and *Xanthorrhoea preissii* are likely to suffer moderate-severe desiccation and possible death. *Banksia littoralis*, which is an important part of the overstorey, has a high likelihood of significant mortality, especially if 2023/2024 is a dry year with less than average rainfall (Ecoedge, 2020c). The area of this vegetation unit likely to be severely impacted by the projected water drawdowns is 1.81 ha.

Impact on the Ironstone Shrubland (SWAFCT10b), unit B1, is low-moderate, with the impact likely to be higher at the northern end. Maximum predicted drawdowns in the ironstone shrubland are predicted to be 1-1.5m in Q3 and Q4, 2024 (Figures 4-24m and 4-24n). Most of the shrubs growing in this ironstone community are relatively large and old, including the Endangered *Banksia squarrosa* subsp. *argillacea*. As such they are likely to have roots that have found their way through fractures in the ironstone to access groundwater as it retreats in late summer and autumn. There is a previous case of nearby mineral sands adversely impacting an ironstone community (at Tutunup; (Meissner & English, 2005), although in this case the pit was closer to the community than will be the case for the Proposal. There is a moderate probability that stress within shrubs growing in the ironstone vegetation will increase, and potentially some deaths will occur if drawdowns are greater than 1m. The area of this vegetation unit likely to be moderately impacted is 0.34ha.

Effects on the GDE vegetation within Areas A and C are likely to be minimal based on the predicted drawdowns. However, it is likely that there will be increased stress and potentially mortality in individual trees in degraded vegetation that has not been mapped as a GDE, such as in the stand of *Eucalyptus rudis*

on private property (Lot 3752) immediately east of vegetation unit B1, the ironstone shrubland, on McGibbon Track.

TABLE 4-14: POTENTIAL INDIRECT IMPACTS TO GROUNDWATER DEPENDENT VEGETATION

GDE	AREA OF GDE WITHIN DEVELOPMENT ENVELOPE (HA)	AREA AND PREDICTED SEVERITY OF POTENTIAL IMPACTS (HA)		
		LOW	MODERATE	SEVERE
A2 (SWAFCT02)	3.42	1.01		1.81
B1 (SWAFCT10b)	0.45	0.34		0

FRAGMENTATION OF VEGETATION

Native vegetation within the Development Envelope generally comprises fragmented isolated patches of vegetation in completely degraded condition, likely due to past and current farming activity. The only continuous patches of vegetation within the Development Envelope occur either along the McGibbon Track or Woddidup Drain. Vegetation along the Woddidup Drain (C1) was classified by Ecoedge (2020a) based on the *South West Regional Ecological Linkages (SWREL) Project* (Molloy, et al., 2009), as "*3b: an edge touching or <1,000m from a natural area selected as 3a*", based on the presence of a regional ecological linkage axis located to the west of the Development Environment, along the Sabina River. Given this area of vegetation will not be directly impacted by the Proposal, fragmentation is unlikely to occur as a result of implementing the Proposal.

Clearing for the Proposal is predominantly limited to isolated small patches of fragmented vegetation on farmland or along edges of road reserves. The majority of these areas are in completely degraded condition and generally only comprises *C. calophylla* and *E. marginate,* with no other native species or understorey present. The remainder of clearing is confined to isolated and scattered paddock trees located on cleared farmland.

ALTERED FIRE REGIME

The Development Envelope has been identified as a designated bushfire prone area by the Fire and Emergency Services Commissioner as being subject, or likely to be subject, to bushfire attack.

Alteration of the natural fire regime may occur as a result of implementing the Proposal due to improved access and increased human activity associated primarily with flammable liquids, combustible materials and hot machinery. The risk of causing fire during the operations has the potential to increase the frequency of fires in the project location. However, large areas of bare earth may act as firebreaks in the event of a blaze from adjacent farming or mining areas.

The potential consequences of an altered fire regime have the potential to affect 37.81ha of vegetation within the Development Envelope, including TECs, Threatened and Priority species. Fire risk will be managed through the implementation of a Fire Management Plan which will include a fire response procedure.

DUST DEPOSITION

Mining activities and vehicle movement have the potential to generate dust which may indirectly affect vegetation within and adjacent to the Development Envelope through deposition of dust on the plants. Impacts to flora and vegetation at the site resulting from dust disturbing activities are expected to be localised. The extent of the dust generated will be determined by the specific activity and the direction of

the prevailing wind conditions. The main activities likely to create suspended dust particles in the air at the site are associated with mining activities such as vegetation removal, topsoil and subsoil stripping, excavation of overburden and ore, backfilling, truck movements and processing.

Dust is more likely to be a concern close to the mine (i.e. less than 1,000m), with the risk decreasing further away from the mine site. However, under adverse weather conditions dust can travel considerable distances. Dust can stress vegetation as it accumulates on leaf surfaces and reduce essential processes including photosynthesis, respiration and transpiration. Dust can also produce physical effects on plants such as blockage and damage to stomata, shading, and abrasion of leaf surface or cuticle. This can result in cumulative effects such as drought stress on already stressed species or lead to decreased plant health and even death in extreme circumstances. Decreased growth and vigour of plants may mean that they are more susceptible to pathogens and other disturbance, and these plants are more likely to be subject to increased mortality. Such impacts to individual plants generally result in decreased productivity and can result in changes in vegetation and community structure (Farmer, 1993).

Although the generation of dust from mining activities is unavoidable, with the implementation of appropriate dust management techniques already employed by Doral at its other mine sites, the impacts of dust to flora and vegetation values are considered low.

SPREAD OF WEEDS AND DIEBACK

Mining activities and vehicle movements have the potential to result in the spread of weeds within and adjacent to the Development Envelope. Environmental weeds are described by (DEC, 1999) as 'plants that establish themselves in natural ecosystems and proceed to modify natural processes, usually adversely, resulting in the decline of communities they invade'. Environments affected by mining activities are highly susceptible to invasion by weeds, as disturbances to soils caused by mining operations (i.e. creating bare ground) provide an ideal habitat where weeds can readily colonise and quickly become the dominant vegetation. Weeds pose a key risk, not only during operational phases of mining, but also during rehabilitation or care and maintenance phases. Weed infestations can compete directly (as well as indirectly) with native or selected revegetation species and also increase the risk of fires (and fire intensity) that may damage revegetated areas. Weeds have the potential to substantially change the dynamics of natural ecosystems by:

- Competing with or displacing native plant species;
- Affecting natural processes such as fire intensity, stream flows and water quality;
- Changing habitats and therefore impacting on ecosystem health;
- Diminishing natural aesthetic values.

Strict weed hygiene measures will be implemented during implementation of the Proposal to reduce the risk of weed introduction and spread into areas of native vegetation, which are largely weed free. Measures will be implemented to target the control of the Declared Plants *Asparagus asparagoides* and *Zantedeschia aethiopica*. Weed management will be implemented as per Doral's Flora and Vegetation Management Plan.

No areas identified as 'infested' with *Phytophthora* dieback are present within the proposed disturbance area. The only infested area (0.3ha) within the Development Envelope is located within the road reserve of Princefield Road, which has been excluded from any disturbance. This area will be segregated and avoided for the duration of the proposal.

MODIFICATION OF ECOSYSTEM FROM ACID SULFATE SOILS

When ASS materials are exposed to the atmosphere, the sulfide minerals oxidise and generate sulfidic acidity, resulting in the release of metals, nutrients and acidity into the soil and groundwater system. The release of contaminants such as acid, nutrients, iron, aluminum, arsenic and other heavy metals may adversely affect the natural environment and modify ecosystems such as GDE and wetlands.

Doral has undertaken a detailed ASS investigation in accordance with DWER guidelines (DER, 2015a), which indicates that potential unoxidised sulfidic acidity is present in Site soils. As excavation and dewatering is likely to occur to a depth of ~10.5m along the deeper strand material in close proximity to the McGibbon Track, oxidation of sulfide minerals may potentially occur, which has the potential to modify GDE's in this area.

Groundwater modelling by (AQ2, 2020a) predicted the following drawdown extents to the Superficial Aquifer:

- The maximum drawdown extent of 0.1m extends outside of the perimeter of the mine disturbance area is 700m to the north, 250m to the south, 300m to the east and 450m to the west, at various times during the mine life for the dry climate scenario.
- The maximum drawdown extent of 0.1m extends outside of the perimeter of mine disturbance area is 600m to the north, 200m to the south, 300m to the east and 400m to the west, at various times during the mine life for the wet climate scenario.

Groundwater modelling by (AQ2, 2020a) also predicted the following drawdown extents to the Leederville Aquifer:

- The extent of predicted drawdown of 0.1 m is generally limited to the mine disturbance areas. The maximum distance that drawdown of 0.1 m extends outside of the perimeter of the mine disturbance area is 700m to the north, 50m to the south, 300m to the east and 300m to the west for both wet and dry scenarios (i.e. Q3 of 2023).

Based on the dewatering extents, potential oxidation of ASS will not affect the Vasse-Wonnerup Ramsar wetland or the Lower Sabina River, as they are located outside of any potential groundwater drawdown.

4.2.6. MITIGATION

In order to protect flora and vegetation values so that biological diversity and ecological integrity are maintained during the implementation of the Proposal, Doral has applied the mitigation hierarchy to avoid, mitigate and rehabilitate potential impacts to flora and vegetation values.

AVOID

Doral's primary mitigation strategy to protect flora and vegetation values so that biological diversity and ecological integrity are maintained, is to design the Proposal to avoid clearing of native vegetation, as far as practicable and maximise the use of existing cleared areas. This has resulted in all but <1% of the disturbance area being located on cleared pasture.

A total of 37.81ha of native vegetation is present within the Development Envelope, with the majority of conservation significant vegetation and flora species confined to ~5.1ha of vegetation along the McGibbon Track. Doral has successfully designed the Site to avoid all but 3.5ha of predominantly degraded native vegetation, which avoids the majority of conservation significant vegetation along the McGibbon Track. The design of the Proposal has successfully avoided clearing the DBCA/EPBC listed TEC, *SWAFCT10b* –

"Shrublands on southern Swan Coastal Plain Ironstones (Busselton area) as well as all Threatened and priority flora species.

MINIMISE

Doral has an existing Environmental Management System (EMS) which it implements at its Yoongarillup and previous Dardanup Mines. The EMS will be updated to include the Yalyalup Mineral Sands Project, which will include the following management plans and procedures detailed below, to mitigate potential impacts to flora and vegetation values.

FLORA AND VEGETATION MANAGEMENT PLAN

Doral will prepare a Flora and Vegetation Management Plan to minimise impacts to flora and vegetation values. The Flora and Vegetation Management Plan will include the following key management and monitoring actions:

- Development and implementation of specific clearing procedures to minimise impacts to flora and vegetation. This will include demarcation of vegetation/trees to be cleared and authorisation requirements;
- Establishment of specific stockpile management procedures to store and manage crushed vegetation, topsoil and subsoil;
- Access to McGibbon Track will be excluded in order to avoid any inadvertent impacts to conservation significant vegetation and flora;
- Declared Plants *Asparagus asparagoides and Zantedeschia aethiopica ragoides* will be managed in accordance with the Biosecurity and Agricultural Management Act 2007;
- Infested area of dieback (0.3ha) within the Princfield Road reserve will be demarcated and avoided from any disturbance for the duration of the Proposal.
- Weed and dust management measures will be incorporated into the ongoing management of flora and vegetation for the Proposal.
- Comply with any necessary approvals, permits and licences required under the BC Act.

GDE MANAGEMENT PLAN

A GDE Management Plan (Appendix 4E) has been prepared by AQ2 (2020d) to minimise impacts to flora and vegetation values from indirect impacts associated with groundwater drawdowns. As detailed in the Plan, monitoring will comprise a combination of hydrological parameters and quantitative and qualitative vegetation measurements, ecophysiological measurements and health assessments using qualitative criteria. This will comprise:

- Groundwater level monitoring in a network of six monitoring wells proximal to the GDEs;
- Leaf Water Potential (LWP) monitoring of targeted species in each GDE communities (i.e. SWAFCT02 and SWAFCT10b);
- The species selected for LWP monitoring will also be assessed for health monitoring using visual inspection and assessed using a scale based on that used by Lay and Meissner (1985).

The following management response triggers and contingency measures will apply:

- Leading indicators of risk such that management intervention can pre-empt the development of vegetation water stress:
    - Hydrological triggers provide warning of the onset of a water regime that may cause water tress to develop;
    - Ecophysiological triggers within the vegetation community provide a direct measure of current water status.
- Lagging indicators designed to provide redundancy in risk identification and allow verification of success of management interventions.

Triggers have been designed around parameters that may be affected by mining-induced changes to the water regime (i.e. groundwater levels and associated plant hydration status). Soil moisture is not included as a monitoring parameter because it is influenced by infiltrating rainfall and this will not be affected by mining.

For all trigger exceedances the management response will be that water supplementation is required. Final design for the supplementation scheme will be completed during implementation of this GDE Management Plan. Supplementation will be based on a combination of:

- Surface irrigation;
- Subsurface irrigation in proximity to the groundwater table through either trenches or shallow spear-points.

The supplementation scheme will have the following design criteria:

- To supply enough water to offset declines in groundwater levels (i.e. to maintain levels within the natural range under the GDEs along McGibbon track. This will be determined using the existing groundwater model;
- To prevent sustained periods of excessive inundation of the vadose zone that may result in water logging or reconfiguration of the root systems within the GDEs. This will be achieved by the use of sub-surface supplementation;
- To be operationally effective and not subject to excessive clogging that may limit infiltration capacity. This will be assessed during engineering design of the scheme based on aquifer parameters derived during previous groundwater investigations;
- To incorporate a monitoring programme that can be used to confirm the efficacy of the supplementation system. This will be achieved by the monitoring programme outlined in this Plan;
- To utilise water of sufficient quality so as not to result in acidification or dieback within the GDEs along McGibbon track. In this regard, supplementation water will be sourced from the Yarragadee aquifer only.

DUST MANAGEMENT PLAN

Doral will develop and implement a Dust Management Plan as detailed in Section 5.6.

FIRE MANAGEMENT PLAN

A Fire Management Plan will be prepared to manage the risk of unplanned fires and provide contingency measures to minimise any associated impacts. The plan will include a fire response procedure in the event of any bushfires that commence as a result of the works on site.

GROUNDWATER OPERATING STRATEGY

The groundwater system will need to be carefully managed at the Site in order to avoid or minimise impacts to GDEs due to mining operations. A draft Groundwater Operating Strategy (GWOS) (Appendix 7E) has been developed and a final version will be submitted to DWER when applying for the 5C groundwater licences, both for the groundwater abstraction from the Superficial aquifer (during mine dewatering) and the Yarragadee aquifer (for water supply). The GWOS includes a groundwater and surface water monitoring program (i.e. abstraction, discharge, water levels and water quality) and has been designed to assess aquifer performance, the potential impacts of groundwater abstraction proposed upon commencement of mining operations and specify operational requirements. Trigger levels and contingency actions have been developed to mitigate potential impacts caused by the mining operations and also to ensure the actual impacts are not greater than predicted. The GWOS has been prepared in accordance with *Operational policy 5.08 - Use of operating strategies in the water licensing process* (DoW, 2011) and the DWER guidelines for the preparation of Operating Strategies for mineral sand mine dewatering licences in the South West Region (DWER, 2015).

ACID SULFATE SOIL MANAGEMENT PLAN

The key mitigation measure to reduce impacts associated with ASS to surrounding ecosystems is to implement an ASSMP in consultation with DWER guidance. The ASSMP, provided as Appendix 5, includes specific treatment strategies designed to manage impacts to soil, groundwater and surface water receptors. A summary of the key management measures documented in the ASSMP is provided as follows:

- Mining activities will be scheduled to be undertaken on a campaign basis, with a portion of the ore body being mined and processed in a discrete time period to assist in minimising the area of groundwater drawdown at any one time;
- Topsoil/subsoil will be stripped to a depth of ~100mm, stockpiled for rehabilitation and neutralised if pH is <4.0pH;
- Overburden identified as ASS (i.e. NA>0.03%S) will be removed via excavator and trucks or dozers and then immediately transported to an open pit void and backfilled simultaneously with a suitable alkaline material at an appropriate rate to account for the acidity. The backfilling process will aim to mix the neutralising material with the overburden as far as practical. A guard layer of alkaline material will initially be added to the base and walls (where practical) of the mine void to limit potential for oxidation;
- Excavated ore identified as ASS will be processed through the wet concentration plant as soon as possible. As this material is maintained in the form of a wet slurry (i.e. saturated), the risk of sulfide oxidation is greatly reduced. The process slurry is maintained at or above pH5.5 to assist with the mineral separation process. As such, alkaline (lime sand) material will be added into the in-pit hopper during the excavation of ore to maintain pH5.5 and increase buffering capacity within the wet concentration process;

- Processing of ore results in three streams of material, HMC, clay fines and sand tails. These will be managed as follows:
    - HMC will be stockpiled and stored on a bunded alkaline pad. Leachate emanating from the stockpiled HMC will be captured and returned to the ore processing circuit, which is maintained at pH5.5;
    - Sand tails will be hydraulically returned to pit voids as a single waste stream and/or co-disposed with clay fines into pit voids. This material will have been maintained in a saturated state and with conditions maintained at pH5.5 throughout the process. Furthermore, the unused (unreacted) lime sand that was added to the process at commencement of the ore processing sequence (i.e. at the in-pit hopper) will form part of this process stream, resulting in the addition of buffering capacity to the locations where this material is hydraulically returned. Sand tails will be regularly assayed for Total Sulfur to ensure concentrations are below 0.03%S. If necessary, additional lime sand will be incorporated during hydraulic disposal. If necessary, additional lime sands will be incorporated during hydraulic disposal;
    - Clay fines will be managed by either:
        - Immediate co-disposal with sand tails by hydraulic return in existing mine voids; or
        - Directed to a SEP for storage and future use as void backfill.
    - Clay fines that are immediately co-disposed with sand tails will be maintained in a saturated state prior to disposal and will include additional buffering capacity provided by the unused (unreacted) lime sands within the sand tails material. This material will be regularly assayed for Total Sulfur to ensure concentrations are below 0.03%S;
    - Clay fines material that are directed to the SEPs will also be regularly assayed for Total Sulfur to ensure concentrations are below 0.03%S. If insufficient buffering capacity is identified, additional neutralising material (lime sand) will be added prior to being discharged into a SEP. In addition to regular testing during discharge, this material will be re-tested following consolidation and drying within the SEP, prior to final disposal.
- Overburden and non-processed material identified as ASS, that will be used for site construction purposes (i.e. roads, pads, bunds etc) will either be:
    - Neutralised for re-use within 70 hours of excavation; or
    - Stockpiled on a treatment pad for up to 21 days prior to neutralisation and re-use.
- Water quality of the process water dam will be monitored (three times per week for field measurements) and maintained by the addition of a suitable alkaline material to the in-pit hopper at the commencement of the ore processing sequence (where required) to ensure:
    - Field pH >5.5; or
    - TTA <40 mg$CaCO_3$/L; and
    - TAlk >30 mg$CaCO_3$/L.
- Groundwater monitoring will be conducted during dewatering for a network of monitoring wells. The program will include:

- Monthly monitoring of groundwater levels;
- Monthly field testing for pH, EC, TTA and Talk;
- Monthly laboratory analysis for pH, EC, total acidity, total alkalinity, chloride, sulfate, dissolved aluminium, dissolved iron and dissolved manganese. (If Al >1 mg/L then the sample will also be analysed for As, Cd, Cr, Cu, Pb, Hb, Ni, Se, Zn);
- Comparison of results to site-specific groundwater assessment criteria.

REHABILITATE

MINE CLOSURE PLAN

Doral has prepared a Mine Closure Plan (Appendix 3) which describes how the Yalyalup Mine will be decommissioned and rehabilitated to meet the agreed end landuses. This will include revegetating an area of 4.7ha to counterbalance clearing of 3.5ha of predominantly completely degraded vegetation with local native species.

4.2.7. PREDICTED OUTCOME

After the application of the mitigation hierarchy described above, the Proposal will result in the following outcomes in relation to flora and vegetation values:

- The Proposal will clear ~3.5ha of a total 37.81ha of native vegetation within the Development Envelope, of which 2.7ha is in Degraded or Completely Degraded condition, with the remaining 0.8ha in Degraded/Good and Good condition.
- Clearing for the Proposal represents disturbance to 0.93% of the area remaining of the Abba Plains soil-landscape system (48,954ha) and does not significantly reduce the regional extent of this soil-landscape system.
- Clearing for the Proposal represents disturbance to 0.10% of the area remaining for the Abba vegetation complex and does not significantly reduce the regional extent of this vegetation complex (i.e. 3.5ha of the remaining 3,359.08ha). However only 6.6% of the Abba vegetation complex is remaining which is below the Commonwealth's 30% target and the EPA's 15% target.
- Clearing for the Proposal will directly reduce the extent of the following TECs within the Development Envelope:
  - SWAFCT01b will be reduced by 0.17ha (14.41%);
  - SWAFCT02 will be reduced by 0.63ha (18.42%).
- Populations of Threatened and Priority listed flora species located within the Development Envelope will not be directly impacted by the Proposal.
- Approximately 1.81ha of the Wet Shrublands (SWAFCT02) GDE is likely to be severely impacted, with predicted drawdowns of up to 5m, and drawdowns of more than 2m lasting for 3-6 months in 2023.
- Drawdown impacts on the Ironstone Shrubland (SWAFCT10b), are predicted to be low-moderate and may potentially affect 0.34ha. Maximum predicted drawdowns are predicted to be 1-1.5m in Q3 and Q4, 2024.

- Drawdown impacts in the Ironstone Shrubland (SWAFCT10b), although predicted to be low-moderate, have the potential to affect the population of nine *Banksia squarrosa* subsp. *Argillacea,* listed as Threatened under the BC Act and Endangered under the EPBC Act.

Doral recognises that floristically the most important area of the Development Envelope is the ~5.1ha of native vegetation located along the McGibbon Track, which has 50% of the total number of native species (Ecoedge, 2020a). As such, in accordance with the mitigation hierarchy, the Proposal has been designed, as far as practicable to avoid direct disturbance to vegetation and flora along the McGibbon Track, and also within the Development Envelope. In total, only 3.5ha of predominantly "completely degraded" native vegetation will be cleared for the Proposal.

Regionally, clearing will not significantly reduce the remaining area of the Abba Plains soil-landscape system (0.93%) or the Abba vegetation complex (0.10%), however this vegetation complex is already below the Commonwealth and EPA targets of 30% and 15%, respectively. The remaining extent of the Abba vegetation complex after implementation of the Proposal is 6.5%.

Locally (i.e. within the Development Envelope) clearing will reduce the extent of two inferred occurrences of DBCA listed TEC's (Unit A1 - SWAFCT01b and Unit A2 - SWAFCT02) by 0.17ha and 0.63ha (i.e. ~14% and ~18%), respectively. Limited information about the regional extent of these TECs is available, however they are known from 13 and 6 quadrats, outside of the Development Envelope (Webb, et al., 2009) (Figure 4-1b).

Clearing will not impact any Threatened or Priority listed flora species within the Development Envelope.

Indirect impacts to groundwater dependent vegetation along McGibbon Track may occur as a result of groundwater drawdowns in 2023-2024 to facilitate mining. This has the potential to indirectly reduce water availability to the GDEs SWAFCT02 and SWAFCT10b, by 1.81ha and 0.34ha, respectively and also affect the population of nine *Banksia squarrosa* subsp. *Argillacea,* listed as Endangered under the EPBC Act and Threatened under the BC Act. The Ironstone Shrubland TEC (SWAFCT10b) is known regionally from 15 locations, totally 138.7ha.

Doral will implement various management plans, including a Flora and Vegetation Management Plan, GDE Management Plan and GWOS to monitor groundwater levels and vegetation health during periods of drawdown, and also provide supplementary water to affected GDE's, as detailed in the GDE Management Plan.

Revegetation of 4.7ha of native vegetation using local provenance species, will be provided to counterbalance clearing of 3.5ha of predominantly completely degraded vegetation.

After the application of mitigation measures , the Proposal will result in a residual impact to 3.5ha of native vegetation, which includes a residual impact to 0.8ha of degraded/good and good condition DBCA listed TEC's (0.17ha-SWAFCT01b and 0.63ha-SWAFCT02) and a residual impact of 2.15ha to groundwater dependent vegetation (1.81ha-SWAFCT02 and 0.34ha-SWAFCT10b). In addition, a residual impact to the population of nine *Banksia squarrosa* subsp. *Argillacea* may also occur as a result of dewatering. An assessment of significance for the residual impacts has been undertaken in accordance with the WA Environmental Offset Guidelines (Government of Western Australia, 2014) and is provided in Section 6 Offsets.

As detailed further in Section 6 – Offsets, Doral is committed to providing a suitable offset (land acquisition) to secure a positive environmental outcome for the Proposal on a 'like for like' principle (or as near to as practical). Doral considers that with the implementation of the proposed management listed above, and the

acquisition of land via an offsets package, the EPA's objective to protect flora and vegetation so that biological diversity and ecological integrity are maintained, can be achieved. Section 6 describes further the offset strategy that Doral will implement for this Proposal.

4.3. KEY ENVIRONMENTAL FACTOR 2 – TERRESTRIAL FAUNA

For the purposes of EIA, the EPA defines Terrestrial Fauna as animals living on land or using the land (including aquatic systems) for all or part of their lives. Terrestrial fauna includes vertebrate (birds, mammals including bats, reptiles, amphibians and freshwater fish) and invertebrate (arachnids, crustaceans, insects, molluscs and worms) groups.

The EPA defines fauna habitat as the natural environment of an animal or assemblage of animals, including biotic and the abiotic elements, that provides a suitable place for them to live (e.g. breed, forage, roost or seek refuge).

4.3.1. EPA OBJECTIVE

The EPA objective for Terrestrial Fauna is:

To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.

4.3.2. POLICY AND GUIDANCE

Guidance relevant to Terrestrial Fauna that have been considered during the EIA process are documented in the following documents:

EPA Policy and Guidance

- *Statement of Environmental principles, Factors and Objectives* (EPA, 2018b)
- *Environmental Factor Guideline – Terrestrial Fauna* (EPA, 2016f).
- *Technical Guidance – Terrestrial Fauna Surveys* (EPA, 2016g).
- *Technical Guidance – Sampling Methods for Terrestrial Vertebrate Fauna* (EPA, 2016h).
- *Instructions on how to Prepare Environmental Protection Act 1986 Part IV Environmental Management Plans* (EPA, 2016e)
- *Guidelines for Preparing Mine Closure Plans (DMP and EPA, 2015).*
- *Environmental Offsets Policy, Perth, Western Australia (Government of Western Australia, 2011).*
- *Environmental Offsets Guidelines, Perth, Western Australia (Government of Western Australia, 2014).*

Other Policy and Guidance

- Matters of National Environmental Significance. Significant Impact Guidelines 1.1. *Environmental Protection and Biodiversity Conservation Act 1999* (DoE, 2013).
- Significant impact guidelines for the vulnerable western ringtail possum (*Pseudocheirus occidentalis*) in the southern Swan Coastal Plain, Western Australia. Nationally threatened species and ecological communities. EPBC Act policy statement 3.10. (DEWHA, 2009).
- *Survey guidelines for Australia's threatened mammals. EPBC Act survey guidelines 6.5.* (DSEWPaC, 2011).

- *Survey guidelines for Australia's threatened birds. Guidelines for detecting birds listed as threatened under the EPBC Act*. (DEWHA, 2010).
- *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy October 2012*. (DSEWPaC, 2012a).
- *EPBC Act Referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo (endangered) Calyptorhynchus latirostris, Baudin's cockatoo (vulnerable) Calyptorhynchus baudinii, Forest red-tailed black cockatoo (vulnerable) Calyptorhynchus banksii naso* (DSEWPaC, 2012b)
- *Conservation Advice Pseudocheirus occidentalis Western ringtail possum. Canberra: Department of the Environment and Energy* (Threatened Species Scientific Committee, 2018a)
- *Conservation Advice Calyptorhynchus baudinii* Baudin's Cockatoo*. Canberra: Department of the Environment and Energy* (Threatened Species Scientific Committee, 2018b).
- *Western Ringtail Possum (Pseudocheirus occidentalis) Recovery Plan. Wildlife Management Program No. 58. Department of Parks and Wildlife, Perth, WA* (DPaW, 2017).
- *Approved Conservation Advice for Calyptorhynchus banksii naso (Forest Red-tailed Black Cockatoo). Canberra: Department of the Environment, Water, Heritage and the Arts* (DEWHA, 2009).
- *Forest Black Cockatoo (Baudin's Cockatoo Calyptorhynchus baudinii and Forest Redtailed Black Cockatoo Calyptorhynchus banksii naso) Recovery Plan. Department of Environment and Conservation, Western Australia* (Chapman, 2008).
- *Carnaby's Cockatoo (Calyptorhynchus latirostris) Recovery Plan. Department of Parks and Wildlife, Perth, Western Australia* (DPaW, 2013).
- *Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia* (DoE, 2015a).
- *Threat abatement plan for predation by the European red fox. DEWHA, Canberra* (DEWHA, 2008b).
- *Wildlife Conservation Plan for Migratory Shorebirds. Canberra, ACT: Department of the Environment* (Commonwealth of Australia, 2015).
- *EPBC Act Policy Statement 3.21 - Industry Guidelines for avoiding, assessing and mitigating impacts on EBBC Act listed migratory shorebird species* (DoE, 2015b).

4.3.3. RECEIVING ENVIRONMENT

SURVEYS COMPLETED

Harewood (2020a) (Appendix 6A) conducted a desktop study and Level 1 Fauna Survey of the Development Envelope in accordance with *Technical Guidance – Terrestrial Fauna Surveys* (EPA, 2016g) and *Technical Guidance – Sampling Methods for Terrestrial Vertebrate Fauna* (EPA, 2016h). In addition, as the general area is known to be utilised by Western Ringtail Possums *Pseudocheirus occidentalis* (WRP) and three species of Black Cockatoos (*Calyptorhynchus latirostris, Calyptorhynchus banksii naso* and *Calyptorhynchus baudinii)*, the scope of work was expanded to include targeted assessments of WRP's and Black Cockatoo's in areas containing suitable habitat within the Development Envelope. The targeted surveys were undertaken in accordance with EPA and Commonwealth guidance in 2017 and 2019.

The fauna assessment (Harewood, 2020a) included:

- Level 1 Fauna Assessment in accordance with (EPA, 2016f) including review of:
    - Database searches (DBCA's NatureMap and Protected Matters Search Tool);
    - Previous fauna surveys in the area;
    - Existing publications to identify and refine potential fauna species list for the subject Site;
    - Fauna of conservation significance using data sourced from the:
        - EPBC Act 1999;
        - BC Act 2018;
        - IUCN Red List;
        - DBCA priority Fauna list
    - Migratory species recognised under international treaties including:
        - Japan Australia Migratory Bird Agreement 1981 (JAMBA);
        - China Australia Migratory Bird Agreement 1988 (CAMBA);
        - Republic of Korea-Australia Migratory Bird Agreement 2007 (ROKAMBA);
        - Bonn Convention 1979 (The Convention on the Conservation of migratory Species of Wild Animals).
    - Bush Forever Decreaser Species using the following three categories
        - Habitat specialists with reduced distribution on the Swan Coastal Plain (code Bh);
        - Wide ranging Species with reduced populations on the Swan Coastal Plain (code Bp);
        - Extinct in the Perth region (Code Be).
- WRP surveys in areas containing suitable habitat (i.e. foraging, refuge and dispersal habitat and individuals);
- Black Cockatoo assessment in areas containing suitable habitat (i.e. opportunistic observations on potential habitat trees, foraging and roosting habitat);
- Identify and discuss any other potentially occurring significant fauna species and their habitat;
- Report summarising results, methods and conclusions.

At the time of the Fauna Survey, access to one of the private properties (Lot 292, "Mitchells Block") which is not subject to any proposed clearing activities was restricted. The vast majority of native vegetation within the subject site is however located in road reserves and therefore this was not, for the purpose of the assessment, seen as a major limitation (Harewood, 2020a, Appendix 6A).

In recognition of survey limitations, a precautionary approach has been adopted for the Fauna Assessment (Harewood, 2020a). Any fauna species that would possibly occur within the subject site (or immediately adjacent) as identified through ecological databases, publications, discussions with local experts/residents and the habitat knowledge of the author, has been assumed to potentially occur in the subject site.

FAUNA HABITATS

Approximately 95% of the Development Envelope has been totally cleared or almost totally cleared of native vegetation for livestock grazing, with only pasture grasses and the occasional widely spaced, scattered trees remaining. Parts of the Development Envelope have been planted with non-endemic/exotic tree species to act as wind breaks. Native remnant vegetation is mostly confined to road verges and along two small, seasonally inundated creek lines, one being a minor tributary of the Sabina River (Woddidup Creek/drain) and the other the Abba River. Most of this vegetation is dominated by woodlands containing various densities of marri, jarrah and/or flooded gum with or without midstorey species such as peppermint, paperbark or banksia. Almost all native vegetation present within the Development Envelope is in a Completely Degraded condition (Ecoedge, 2020a).

Descriptions of the main fauna habitats/dominant vegetation present within the Development Envelope is provided in Table 4-15 (based on mapping by Ecoedge, 2020a) and shown on Figure 4-8.

TABLE 4-15: FAUNA HABITAT TYPES

UNIT	BROAD FAUNA HABITAT TYPE	FAUNA HABITAT DESCRIPTION	AREA (HA)	PHOTOGRAPHS
A1	Woodland	Woodland of *Corymbia calophylla* and *Eucalyptus marginata*, with scattered *Agonis flexuosa*, *Banksia attenuata*, *B. grandis*, *Melaleuca preissiana*, *Nuytsia floribunda*, *Persoonia longifolia* or *Xylomelum occidentale* over *Xanthorrhoea preissii* over weeds on grey-brown or grey loamy sand or sand (on farmland usually only *C. calophylla* and *E. marginata* are present).	~10.86 (1.17%)	
A2	Woodland	Woodland of *Corymbia calophylla* (sometimes with *Eucalyptus marginata* or *E. rudis*) with scattered *Melaleuca preissiana* or *Banksia littoralis* over open shrubland that may include *Acacia extensa*, *A. saligna*, *Hakea ceratophylla*, *H. lissocarpha*, *H. prostrata*, *H. varia*, *Kingia australis*, *Melaleuca viminea* and *Xanthorrhoea preissii* over weeds on seasonally wet grey loamy sand.	~4.03 (0.44%)	

UNIT	BROAD FAUNA HABITAT TYPE	FAUNA HABITAT DESCRIPTION	AREA (HA)	PHOTOGRAPHS
B1	Shrubland	Tall shrubland of *Acacia saligna*, *Banksia squarrosa* subsp. *argillacea*, *Calothamnus quadrifidus* subsp. *teretifolius*, *Hakea oldfieldii* and *Kunzea micrantha* (with scattered emergent *Eucalyptus rudis*) over scattered native herbs including *Drosera glanduligera* and *Sowerbaea laxiflora*, the sedge *Loxocarya magna*, and weeds on shallow red sandy clay on massive ironstone.	0.50 (0.12%)	
B2	Woodland	Woodland of *Eucalyptus rudis* and (in some areas) *Melaleuca rhaphiophylla* over weeds on massive ironstone.	2.79 (0.30%)	
C1	Woodland	Woodland of *Eucalyptus rudis* (and sometimes *Corymbia calophylla*) over scattered *Agonis flexuosa* and *Melaleuca rhaphiophylla* over weeds on grey-brown clayey loams in drainage lines.	19.08 (2.06%)	
C3	Open Shrubland	Tall Open Shrubland that may include *Acacia saligna*, *Jacksonia furcellata*, *Kingia australis*, *Melaleuca osullivanii*, *M. preissiana*, *M. viminea* and *Xanthorrhoea preissii* on seasonally wet grey-brown sandy loam.	0.55 (0.06%)	

UNIT	BROAD FAUNA HABITAT TYPE	FAUNA HABITAT DESCRIPTION	AREA (HA)	PHOTOGRAPHS
PL	Planted species	Planted non-endemic and exotic trees	6.87 (0.74%)	
CL	Cleared pasture	Existing cleared/highly degraded areas (e.g. paddocks/road verges) with scattered trees/shrubs. Some areas seasonally inundated/waterlogged.	880.17 (95.12%)	
N/A	n/a	Seasonal creeks and drains (minor tributaries of the Sabina River and a section of the Abba River)	-	

Overall fauna habitat values within the Development Envelope have been severely compromised by the almost total removal of native vegetation. Most areas lack any natural attributes and are now only likely to be utilised by generally common and widespread fauna species with non-specific requirements which allow them to persist in highly disturbed habitats.

As a consequence, the fauna biodiversity of the Development Envelope is well below levels present prior to historical disturbance having occurred and can therefore be regarded as highly depauperate (Harewood, 2020a). The overall fauna assemblage can therefore be regarded as highly unlikely to be of local or regional significance (Harewood, 2020a).

The two seasonal creek systems which pass through the Development Envelope also have very low fauna values given their long history of disturbance. This is primarily a consequence of total or partial clearing of vegetation from their banks, modification of the creek line path in some sections and the fact they have been

or are open to ongoing access by livestock which has further degraded the habitat and water quality compared to that originally present.

Despite this, some of the vegetation remaining within the Development Envelope still represents suitable habitat for some species of conservation significance in particular a small population of western ringtail possums. The sites overall value to conservation significant species can however be regarded as being low given the extent of native vegetation is limited. It should be noted that the majority of native vegetation is not located with the proposed disturbance area and will therefore not be directly impacted by the proposal.

OCCURRENCES VERTEBRATE FAUNA SPECIES

A summary of potential vertebrate fauna species potentially occurring within or utilising at times the Development Envelope, based on results from the literature review and observations made during the field assessment are provided in Table 4-16. A complete list of vertebrate fauna possibly inhabiting or frequenting the Development Envelope is provided in Appendix B of Harewood (2020a) (Appendix 6A). Harewood (2020) notes that despite the omission of some species, the list provided is still very likely an over estimation of the fauna species utilising the Development Envelope (either on a regular or infrequent basis) as a result of the precautionary approach adopted for the assessment. At any one time only a subset of the listed potential species is likely to be present within the bounds of the Development Envelope

TABLE 4-16: SUMMARY OF POTENTIAL VERTEBRATE SPECIES

GROUP	TOTAL NO. OF POTENTIAL SPECIES	POTENTIAL NO. OF SPECIALLY PROTECTED SPECIES	POTENTIAL NO. OF MIGRATORY SPECIES	POTENTIAL NO. OF PRIORITY SPECIES	NO. OF SPECIES RECORDED DURING FIELD ASSESSMENT
Amphibians	8	0	0	0	2
Reptiles	13	0	0	0	1
Birds	78^{1}	4	0	0	39^{1}
Non-Volant mammals	11^{8}	1	0	0	7^{4}
Volant Mammals (Bats)	8	0	0	0	0
TOTAL	**118^{9}**	**5**	**0**	**0**	**49^{5}**

Subscript = no. of introduced species included in total

CONSERVATION SIGNIFICANT VERTEBRATE FAUNA SPECIES

A review of the EPBC Act threatened fauna list, DBCA's threatened fauna database and priority list, unpublished reports and scientific publications by Harewood (2019) identified a number of specially protected, priority or migratory vertebrate fauna species as potentially occurring in the general vicinity of the Development Envelope. Harewood (2020a) notes that of these species, those that have no potential whatsoever to utilise the Development Envelopment for any purpose have been omitted from the potential list (Appendix B of Harewood, 2020a), principally due to lack of suitable habitat (including extent and/or quality) or known local extinction.

In summary, four vertebrate fauna species of conservation significance were positively identified as utilising the Development Envelope for some purpose during the survey period. These are:

- Carnaby`s Black-Cockatoo *Calyptorhynchus latirostris* – S2 (*BC Act*), Endangered (*EPBC Act*). Small areas of favoured foraging habitat (i.e. marri, jarrah and banksia) present. Evidence of foraging observed in the form of chewed marri fruits and pine cones. Larger trees (>50cm DBH) can be considered potential breeding habitat. No roosting sites identified within the Development Envelope;
- Baudin's Black-Cockatoo *Calyptorhynchus baudinii* – S3 (*BC Act*), Vulnerable (*EPBC Act*). Small areas of favoured foraging habitat (i.e. marri, banksia and pines) present. Evidence of foraging observed in the form of chewed marri fruits. Larger trees (>50cm DBH) can be considered potential breeding habitat. No roosting sites identified within the Development Envelope.
- Forest Red-tailed Black-Cockatoo *Calyptorhynchus banksii naso* – S3 (*BC Act*), Vulnerable (*EPBC Act*). Small areas of favoured foraging habitat (i.e. marri and jarrah) present. Evidence of foraging attributed to this species observed in the form of chewed marri fruits. Larger trees (>50cm DBH) can be considered potential breeding habitat. No roosting sites identified within the Development Envelope.
- Western Ringtail Possum *Pseudocheirus occidentalis* - S1 (*BC Act*), Critically Endangered (*EPBC Act*). This species seems to be persisting in the northern section of the McGibbon Track in low numbers. Appears to be absent from other sections of the Development Envelope.

Based on the habitats present and current documented distributions it is considered possible that the following additional species of conservation significance may use the Development Envelope for some purpose at times, though, as no evidence of its presence was recorded at the time of the field surveys was found, its current status in the area remains uncertain.

This species is:

- Peregrine Falcon *Falco peregrinus* – S7 (*BC Act*). This species potentially utilises some sections of the Development Envelope as part of a much larger home range. No evidence of nesting seen and the probability of this species breeding within the Development Envelope can be considered to be very low;

As indicated for some species, habitat within the Development Envelope, while considered possibly suitable, may be marginal in extent/quality and species listed may only visit the area for short periods, or as rare/uncommon vagrants/transients.

A number of other species of conservation significance, while possibly present in the wider area (e.g. Whicher Range), are not listed as potential species due to known localised extinction (and no subsequent recruitment from adjoining areas), lack of suitable habitat and/or the presence of feral predators. Details on conservation significant species and reasons for the omission of some from the potential listing are provided in Appendix E of Harewood (2020a) and Table 4-17.

INVERTEBRATE FAUNA OF CONSERVATION SIGNIFICANCE

Two conservation significant invertebrate species appear in the DBCA NatureMap database searches (DBCA, 2019 in Harewood, 2020a), the Swan Coastal Plain shield-backed trapdoor spider and Carter's freshwater mussel. Neither species are however considered likely to frequent the Development Envelope primarily due

to lack of suitable (type, quality and/or extent) habitat (Harewood, 2020a). Details on conservation significant species and reasons for the omission of some from the potential listing are provided in Appendix E of Harewood (2020a) and Table 4-17.

A targeted SRE survey was not undertaken as it was considered unwarranted for the following reasons as detailed in Harewood (2020a):

- The Swan Coastal Plain as a whole has limited occurrence of species considered to be short range endemic (Invertebrate Solutions , 2018);
- The area of proposed ground disturbance is almost totally cleared of native vegetation and unlikely to represent habitat suitable for SREs;
- The small areas of remnant vegetation/habitat in adjoining areas would have once been widespread/continuous and there are no apparent geomorphological boundaries or subdivisions that would have represented species isolators prior to clearing;
- Invertebrate species utilising these areas would therefore be unlikely to have distributions totally restricted to the Development Envelope;
- Targeted surveys for SREs have not been undertaken at any of the nearby mineral sand mines on the southern Swan Coastal Plain in the past (e.g, Yoongarillup, Wonnerup, Wonnerup South, Wonnerup North, Yoganup, Yoganup Extended, Yoganup 215, Tutunup South, Tutunup, Happy Valley, Gwindinup and Ludlow). Where invertebrates have been collected during general fauna surveys at these sites as bycatch none have been identified as being SREs (Harewood, 2012, Biota 2007a, Biota 2007b and Biota 2009).

TABLE 4-17: LIKELIHOOD OF OCCURRENCE– FAUNA SPECIES OF CONSERVATION SIGNIFICANCE

COMMON NAME	GENUS & SPECIES	CONSERVATION STATUS	HABITAT PRESENT	LIKELIHOOD OF OCCURRENCE
Swan Coastal Plain Shield-backed Trapdoor Spider	*Idiosoma sigillatum*	P3	No/Marginal	Unlikely to Occur
Carter's Freshwater Mussel	*Westralunio carteri*	S3	No	Would Not Occur
Pouched Lamprey	*Geotria australis*	P1	No/Very Marginal	Would Not Occur
Balston's Pygmy Perch	*Nannatherina balstoni*	S3, VU	No	Would Not Occur
Coastal Plains Skink	*Ctenotus ora*	P3	No/Marginal	Unlikely to Occur
Australasian Bittern	*Botaurus poiciloptilus*	S2, EN	No	Would Not Occur
Blue-billed Duck	*Oxyura australis*	P4	No/Very Marginal	Would Not Occur

COMMON NAME	GENUS & SPECIES	CONSERVATION STATUS	HABITAT PRESENT	LIKELIHOOD OF OCCURRENCE
Glossy Ibis	*Plegadis falcinellus*	S3	Yes/Marginal	Unlikely to Occur
Migratory Shorebirds/Wetland Species/Marine Vertebrates*	Various	Mig, Various	No	Would Not Occur
Eastern Osprey	*Pandion haliaetus*	S5, Mig	No	Would Not Occur
Peregrine Falcon	*Falco peregrinus*	S6	Yes	Possibly Occurs but only rarely.
Masked Owl	*Tyto novaehollandae novaehollandae*	P3	Yes/Marginal	Unlikely to Occur
Fork-tailed Swift	*Apus pacificus*	S5, Mig	Yes	Unlikely to Occur, Flyover only on very rare occasions.
Grey Wagtail	*Motacilla cinerea*	S5, Mig	No	Would Not Occur
Carnaby`s Black Cockatoo	*Calyptorhynchus latirostris*	S2, EN	Yes	Known to Occur
Baudin`s Black Cockatoo	*Calyptorhynchus baudinii*	S3, VU	Yes	Known to Occur
Forest Red-tailed Black Cockatoo	*Calyptorhynchus banksii naso*	S3, VU	Yes	Possibly Occurs
Chuditch	*Dasyurus geoffroii*	S3, VU	No	Would Not Occur
South-western Brush-tailed Phascogale	*Phascogale tapoatafa wambenger*	S6	No	Unlikely to Occur
Quenda	*Isoodon fusciventer*	P4	No	Unlikely to Occur
Western Ringtail Possum	*Pseudocheirus occidentalis*	S1, CR	Yes	Known to Occur
Quokka	*Setonix brachyurus*	S3, VU	No	Would Not Occur
Western Brush Wallaby	*Macropus irma*	P4	No	Would Not Occur
Woylie	*Bettongia penicillata ogibyi*	S1	No	Would Not Occur

COMMON NAME	GENUS & SPECIES	CONSERVATION STATUS	HABITAT PRESENT	LIKELIHOOD OF OCCURRENCE
Western False Pipistrelle	*Falsistrellus mackenziei*	P4	No/Marginal	Unlikely to Occur
Water Rat	*Hydromys chrysogaster*	P4	No/Marginal	Unlikely to Occur

*Includes the following MNES identified by DAWE: Wood sandpiper (*Tringa glareola*), Sharp-tailed sandpiper (*Calidris acuminate*) and Long-toed stint (*Calidris subminuta*).

WESTERN RINGTAIL POSSUM ASSESSMENT

Harewood (2020a) undertook a survey for Western Ringtail Possums (WRP) following as a minimum the survey guidelines for the species as recommended in *Survey guidelines for Australia's threatened mammals* (DSEWPaC, 2011). The surveys included day and nocturnal surveys and assessment of habitat.

The day time surveys to locate and record dreys, obvious tree hollows, scats and individual WRPs were carried out concurrent with the general fauna assessment and Black Cockatoo habitat assessment and involved the examination of all vegetation where access was available within the Development Envelope.

The assessment included the examination of almost every tree and areas containing large shrubs within the Development Envelope. In total ~28km of transects were completed over several days. In total six WRP dreys were observed during the day survey in 2017 and three in 2019. All dreys were recorded in a short section of habitat at the northern end of McGibbon Track (Figure 4-9 and 4-9A).

Tree hollows, forks in tree branches, subtle cavities in tree trunks, fallen hollow logs, rabbit burrows and dense ground cover are also used (to varying degrees) by WRP's for daytime refuge and therefore observations of dreys only provide a guide to WRP habitat use/quality as other opportunities for daytime refuge may exist (Harewood, 2020a). A small number of WRPs scats were also observed during both surveys in close proximity to some dreys.

Nocturnal surveys were carried out to provide an estimate of the distribution and abundance of WRPs in areas of potential habitat identified during the day time survey. Survey work was carried out on foot using a LED head torch. In total ~12km of transects were completed over several nights. During the nocturnal surveys, five WRPs and six common brushtail possums were recorded in 2017, in contrast to one WRP and two common brushtail possums during the 2019 survey. As with the day surveys, all observations were made along the northern section of McGibbon Track. A common brushtail possum was also recorded during the 2019 survey along the Woddinup Creek/drainage line in the western portion of the Development Envelope.

WRP observations made during both survey periods were all recorded within vegetation bordering the McGibbon Track. This area is characterised by having good midstorey canopy connectivity and a range of plant species known to be fed upon by WRPs (e.g. jarrah, marri, peppermint, Christmas tree, *Acacia saligna*).

The vegetation along the northern section of the creek line in the west of the Development Envelope also appears to represent potential WRPs habitat given the prevalence of peppermint in this area, though no evidence of the species presence was found during the day or night surveys.

Some sections of other road reserve vegetation, in particular those areas which contain some midstorey vegetation (mainly in the vicinity of the creek crossings), also appears to be potentially suitable habitat for WRPs despite no evidence of their presence in these areas was found.

Other areas of vegetation which lack a strong midstorey component, including areas of planted non-endemic/exotic species can be regarded as being marginal/unsuitable for use by WRPs on a permanent basis, though some sections would represent dispersal habitat, albeit of a generally poor quality.

Important areas for the WRP have been mapped as part of the *Significant Impact Guidelines for the Vulnerable Western Ringtail Possum in the Southern Swan Coastal Plain, Western Australia* (DEWHA, 2009) Fauna habitat present within the Development Envelope is outside of core habitat, primary corridors and supporting habitat (DEWHA, 2009). The nearest core habitat to the Site occurs in Tuart Forest National Park (DEWHA, 2009).

BLACK COCKATOO HABITAT ASSESSMENT

The following methods were employed by Harewood (2020a) during the Black Cockatoo habitat assessment based on guidelines published by Department of Agriculture, Water and the Environment (DAWE) (DSEWPaC, 2012b), which states that surveys for Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo habitat should:

- Be done by a suitably qualified person with experience in vegetation or cockatoo surveys, depending on the type of survey being undertaken;
- Maximise the chance of detecting the species' habitat and/or signs of use;
- Determine the context of the Site within the broader landscape (e.g. the amount and quality of habitat nearby and in the local region i.e. within 10km);
- Account for uncertainty and error (false presence and absences);
- Include collation of existing data on known locations of breeding and feeding birds and night roost locations.

Habitat used by Black-Cockatoos have been placed into three categories by the DAWE (DSEWPaC, 2012b), these being:

- Breeding habitat;
- Foraging habitat;
- Night roosting habitat.

These are discussed as follows.

BLACK COCKATOO BREEDING HABITAT TREE ASSESSMENT

The Black Cockatoo breeding habitat assessment identified all suitable breeding tree species within the Development Envelope that had a Diameter at Breast Height (DBH) $\geq$50cm ($\geq$30cm for wandoo) (DSEWPaC, 2012b). The DBH was estimated using a pre-cut 50cm (30cm for wandoo) caliper.

Trees considered potentially suitable for Black Cockatoos to use as nesting habitat (subject to a suitable hollow being present or forming and a range of other factors) which were found within the Development Envelope comprised the following species:

- Marri – *Corymbia calophylla.*
- Jarrah - *Eucalyptus marginata.*
- Flooded Gum – *Eucalyptus rudis.*
- Tuart - *Eucalyptus gomphocephala* (small number of planted specimens only).
- Wandoo – *Eucalyptus wandoo* (very small number of planted specimens only)
- Planted non endemic eucalypts (at least two species).
- Dead unidentified species (most likely marri or jarrah).

The location of each tree identified over the DBH threshold was recorded with GPS and details of tree species, number and size of hollows (if any) were noted. Trees observed to contain hollows (of any size/type) were marked with an H using spray paint.

Potential hollows were placed into one of four categories, based on the size of the apparent hollow entrance. These include:

- Small = <5cm diameter (i.e. entrance too small for a Black Cockatoo);
- Medium = ~5-10cm diameter (i.e. entrance too small for a Black Cockatoo);
- Large = ~ >10cm diameter (entrance large enough for a Black Cockatoo but hollow appears unsuitable for nesting i.e. wrong orientation, appears too small, too low or too shallow); or
- Large (cockatoo) = ~ >10cm diameter (entrance appears big enough for a Black Cockatoo to use for nesting).

Based on this assessment, trees present with thin the Development Envelope were placed into one of four categories:

- Tree <50cm DBH or an unsuitable species (these were not assess/recorded);
- Tree ≥50cm DBH, no hollows seen;
- Tree ≥50cm DBH, one or more hollows seen, none of which were considered suitable for Black Cockatoos to use for nesting: or
- Tree ≥ 50cm DBH, one or more hollows seen, with at least one considered suitable for Black Cockatoos to use for nesting.

A summary of the potential Black Cockatoo breeding trees observed within the Development Envelope is provided in Table 4-18 below and their locations shown in Figures 4-10, 4-10A, 4-10B, 4-10C and 4-10D.

TABLE 4-18: SUMMARY OF POTENTIAL BLACK COCKATOO BREEDING HABITAT TREES (DBH ≥50cm and ≥30cm for Wandoo)

TOTAL NO. OF HABITAT TREES	NO. OF TREES WITH NO HOLLOWS OBSERVED	NO. OF TREES WITH HOLLOWS CONSIDERED UNSUITABLE FOR NESTING	NO. OF TREES WITH HOLLOWS CONSIDERED POSSIBLY SUITABLE FOR NESTING	TREE SPECIES					
				Marri	Flooded Gum	Non-Endemic Euc.	Dead Unknown	Tuart	Wandoo
1,053	893	106	54	489	304	171	44	13	2

The assessment identified a total of 1,053 trees with a DBH ≥50cm (or DBH ≥30cm for wandoo) within the Development Envelope. Of these trees, 106 were considered unsuitable for Black Cockatoo nesting and only 54 were considered possibly suitable for nesting. It should be noted that the majority of the currently identified habitat trees are not inside the proposed disturbance area and will therefore not be affected. Isolated scattered paddock trees present within the 'Other Supporting Infrastructure' disturbance category will also be avoided. It is also not known if some of the unknown eucalypt species (i.e. mapped as planted species) actually represent trees that would ultimately develop hollows for Black Cockatoos. Additional details on each habitat tree observed can be found in Appendix D of Harewood (2020a) (Appendix 6A).

A subsequent detailed Black Cockatoo Habitat Tree Assessment was conducted by Harewood (2020b) (Appendix 6B) to reinspect trees containing hollows possibly suitable for use by a Black Cockatoo from within the disturbance area. Results of this assessment indicated that of the 16 trees to be directly or indirectly impacted, only 5 contain suitable hollows and one tree had fallen over since the original survey. As a result, only 5 trees containing possibly suitable hollows will be impacted (directly) by the Proposal.

The Development Envelope falls within the mapped breeding range of Carnaby's cockatoo as depicted in the most current recovery plan produced by DBCA in Figure 2 of (DPaW, 2013). The DBCA recovery plan for Baudin's Cockatoo and the Forest Red-Tailed Black Cockatoo (DEC, 2008b) does not specifically define any known breeding areas for either species. Johnstone and Kirkby (2011) also do not specifically mention breeding areas of either species of Black Cockatoo within the area though both are noted as utilising marri trees (and other tree species) for breeding in the south west.

While there appears to be a paucity of breeding data for the general area this could simply be a consequence of a lack of survey work or a lack of publicly available data. The author of the current fauna survey (Greg Harewood) is aware of a documented Forest Red-Tailed Black Cockatoo breeding event on farmland in Elgin about 25km north east of the Development Envelope. A review of other available data revealed several Carnaby's Black Cockatoo breeding records in Dalyellup and Gelorup, about 35km distance from the Development Envelope. Bamford (2004) also reports a breeding attempt by Carnaby's Black Cockatoo in the Ludlow Tuart Forest in 2003 at a point about 10km north of the Development Envelope.

Based on available vegetation mapping it is estimated that there is approximately 13,300ha of native vegetation within 10km of the Development Envelope and there is therefore significant potential for breeding to take place in the wider area (assuming the presence of suitable trees).

BLACK COCKATOO FORAGING HABITAT ASSESSMENT

The location and nature of Black Cockatoo foraging evidence (e.g. chewed fruits around base of trees) was observed during the assessment and recorded. The nature and extent of potential foraging habitat present was also documented by Harewood (2020a) irrespective of the presence of any actual foraging evidence. A review of available literature was also undertaken to determine the location/extent of any known/likely Black Cockatoo foraging habitat areas in the vicinity of the Development Envelope.

The following represents a list of plant species recorded within the subject site by Ecoedge (2020a) which are known (or highly likely) to be used by one or more of the Black Cockatoo species as a food source (i.e. foraging habitat).

TABLE 4-19: DOCUMENTED BLACK COCKATOO FORAGING SPECIES RECORDED WITHIN DEVELOPMENT ENVELOPE

COMMON NAME	SPECIES
Orange Wattle	*Acacia saligna*
Peppermint	*Agonis flexuosa*
Slender Banksia	*Banksia attenuata*
Couch Honeypot Dryandra	*Banksia dallanneyi*
Bull Banksia	*Banksia grandis*
Swamp Banksia	*Banksia littoralis*
Pingle	*Banksia squarrosa*
Pie or Afghan Melon	*Citrullus lanatus (introduced)*
Marri	*Corymbia calophylla*
Corkscrew Grass or Storksbill	*Erodium botrys (introduced)*
Tuart	*Eucalyptus gomphocephala*
Jarrah	*Eucalyptus marginata*
Flooded Gum	*Eucalyptus rudis*
Rye	*Hakea lasianthoides*
Honeybush	*Hakea lissocarpha*
Harsh Hakea	*Hakea prostrata*
Candle Hakea	*Hakea ruscifolia*
Variable-leaved Hakea	*Hakea varia*
Grey Stinkwood	*Jacksonia furcellata*
Kingia	*Kingia australis*

COMMON NAME	SPECIES
Snottygobble	*Persoonia longifolia*
Guildford or Onion Grass	*Romulea rosea (introduced)*
Grass tree	*Xanthorrhoea preissii*
Woody Pear	*Xylomelum occidentale*

It should be noted that the degree to which the various plant species are utilised varies considerably. For example, marri is documented as being the primary food source for all three species, though jarrah and *banksia* make up a high proportion of some Black Cockatoo species in other areas where they proliferate. Plants such as flooded gum, woody pear and peppermint (for example) are only foraged upon rarely.

Evidence of Black Cockatoos foraging was observed during the field survey in the form of chewed marri fruits and pine cones. This evidence was attributed to Carnaby's or Baudin's Black Cockatoo depending on the plant species involved and the characteristics of the foraging activity (i.e. bite marks).

The extent of quality foraging habitat within the Development Envelope can be regarded as those areas containing marri, jarrah, banksia and to a lesser extent flooded gum. This area totals ~38ha. Most of this vegetation does not fall within the disturbance area and will not be affected by the Proposal.

Based on available vegetation mapping it is estimated that there is approximately 13,300ha of native vegetation within 10km of the Development Envelope, much of which is very likely to represent potential Black Cockatoo foraging habitat of some type.

BLACK COCKATOO ROOSTING HABITAT ASSESSMENT

Direct and indirect evidence of Black Cockatoos roosting within trees within the Development Envelope were noted if observed (e.g. branch clippings, droppings or louted feathers). No evidence of Black Cockatoo roosting within trees located within the Development Envelope was observed during the field survey.

Harewood (2020a) noted that it was difficult to determine if trees or groves of trees within the Development Envelope represent potential roosting habitat as a range of factors, not all of which can be observed, determine suitability. Some of the larger trees may be suitable but as indicated no actual evidence of use was seen. A review of the 2018 Great Cocky Count database shows no documented, active roost sites within 10km of the subject site survey area (Peck, et al., 2018).

Based on available vegetation mapping it is estimated that there is approximately 13,300ha of native vegetation within 10km the survey area and therefore there is significant potential for roosting habitat to be present in the wider area (assuming the presence of suitable trees).

4.3.4. POTENTIAL IMPACTS

The Proposal may result in the following impacts to fauna and fauna habitats:

- Direct clearing of fauna habitat resulting in the loss or fragmentation of fauna habitat;
- Death, injury and/or displacement of fauna species, as a result of clearing and construction activities;
- Dewatering activities may affect GDE's and the ecological character of the Vasse-Wonnerup Ramsar wetland which may reduce the value of fauna habitat resulting in displacement of fauna and migratory species;

- Vehicle movements during construction and operation may result in the loss of individual fauna, especially less-mobile species, from vehicle strikes;
- Presence of artificial water bodies may result in the loss/injury of individual fauna;
- Increase in the number of predatory introduced species;
- Light, noise and dust emissions could disrupt fauna behaviour or reduce the value of fauna habitat;
- Introduction and/or spread of *Phytophthora* dieback which may reduce the value of fauna habitat;
- Altered fire regime which may reduce available fauna habitat.

4.3.5. ASSESSMENT OF IMPACTS

FAUNA HABITAT CLEARING AND FRAGMENTATION

It is difficult to determine the regional impacts to fauna habitats as most fauna would not be confined to a certain vegetation complex or soil-landscape system. However, in order to provide some regional context on the significance of habitat clearing, impacts to the Abba vegetation complex have been assessed. The area proposed to be cleared to facilitate the Proposal represents only 0.10% (i.e. 3.5ha of 3,359.08ha) of the current area remaining which does not significantly reduce its extent.

Almost all native fauna rely on native vegetation to provide food, shelter and breeding sites. Clearing of native vegetation may reduce the capacity of the habitat to support fauna potentially resulting in the displacement of fauna. Fauna habitat areas within the Development Envelope to be directly impacted by clearing are outlined in Table 4-20. As most fauna would not be confined to a specific vegetation complex, all native vegetation types (i.e. woodlands, shrublands etc) within the Development Envelope have been grouped for these calculations. This total is the total native vegetation present within the Development Envelope.

TABLE 4-20: DIRECT IMPACTS TO FAUNA HABITAT

HABITAT TYPE	TOTAL AREA WITHIN DEVELOPMENT ENVELOPE (ha)	AREA TO BE CLEARED FOR THE PROPOSAL (ha)	PERCENTAGE OF TOTAL HABITAT TO BE CLEARED (%)
Woodlands and shrublands	37.81	3.50	9.26
Planted non-endemic and exotic	6.87	2.88	41.92
Cleared Pasture	880.17	446.95	50.78

The conservation significance of vegetation (for fauna) within the Development Envelope has been determined by applying site specific criteria such as:

- Fauna species and/or habitat present that is poorly represented in the general vicinity (<10km) of the subject site;
- Fauna habitat in better condition than other similar locations in the general vicinity (<10km) of the subject site;
- Fauna habitat within the subject site supporting species of conservation or other significance.

Natural areas within the south west of Western Australia have been significantly altered since European settlement in the 1830's and a variety of environmental factors, in particular habitat fragmentation and fire, will continue to threaten many species of fauna with local extinction. As the local development of land progresses the significance of any remnant vegetation increases.

The extent of natural fauna habitat within the Development Envelope is relatively small and the remnants present are generally highly degraded and fragmented. As such, the overall value to fauna can be regarded as low when compared to other nearby areas such as the Whicher Range and Ludlow Tuart Forest. The vegetation does however have some value to at least one conservation significant fauna species, the WRP, which is persisting in the area despite the large degree of historical clearing/fragmentation (Harewood, 2020a).

Disturbance for the Proposal will primarily be confined to completely degraded vegetation and isolated scattered paddock trees and therefore the clearing required will only involve the removal of a very small area of the native vegetation (~9%) present within the Development Envelope, predominantly as isolated paddock trees and/or overstory species (woodland species). These areas would only be utilised by a very small percentage of the predicted/known species given their very low habitat values and does not therefore comprise areas of high biological diversity. Given the existing value of habitat to fauna is low, along with the location and extent of the Proposal, clearing of 3.5ha of native vegetation (as woodland habitat) (of which 2.7ha is in Completely Degraded or Degraded condition) and isolated scattered paddock trees is extremely unlikely to affect any area of habitat considered to be of high biological diversity.

Native vegetation within the Development Envelope generally comprises fragmented isolated patches of vegetation in completely degraded condition, likely due to past and current farming activity. The only continuous patches of vegetation within the Development Envelope occur either along the McGibbon Track or Woddidup Drain. Vegetation along the Woddidup Drain (C1) in the west of the Development Envelope was classified by Ecoedge (2019a) based on the *South West Regional Ecological Linkages (SWREL) Project* (Molloy, et al., 2009), as "*3b: an edge touching or <1,000m from a natural area selected as 3a*", based on the presence of a regional ecological linkage axis located to the west of the Development Environment, along the Sabina River. Given these corridors of vegetation will not be directly impacted by the Proposal, fragmentation is unlikely to occur as a result of implementing the Proposal.

DIRECT IMPACTS TO FAUNA OF CONSERVATION SIGNIFICANCE

The potential direct impacts to fauna of conservation significance and their associated habitats 'known to occur' or considered to 'possibly occur' within the Development Envelope are outlined in Table 4-21 and shown on Figure 4-9 and 4-9A (for WRP) and 4-10, 4-10A, 4-10B, 4-10C and 4-10D (for Black Cockatoos).

TABLE 4-21: DIRECT IMPACTS ON CONSERVATION SIGNIFICANT FAUNA AND HABITAT

SPECIES	HABITAT TO BE DISTURBED	GOOD/DEGRADED OR GOOD QUALITY HABITAT TO BE DISTURBED (HA)	POSSIBLE IMPACT/ SIGNIFICANCE OF POSSIBLE IMPACT
Western Ringtail Possum *Pseudocheirus occidentalis*	Potential foraging	0.8ha	Loss of a very small area of habitat. The small area of good quality vegetation to be cleared for the Proposal (0.8ha) is confined to a very small area on the edge of McGibbon Track and will not affect any of the identified dreys or individuals observed within vegetation along McGibbon Track. Fauna habitat present within the Development Envelope is outside of Area 1 - Core Habitat, Area 2 - Primary Corridors and Area 3 - Supporting Habitat as documented in the *Significant Impact Guidelines for the Vulnerable Western Ringtail Possum in the Southern Swan Coastal Plain, Western Australia* (DEWHA, 2009). As such clearing of 0.8ha does not trigger any of the Significant Impact Assessment criteria detailed on page 7 of (DEWHA, 2009). Notwithstanding, as this vegetation is in close proximity to more suitable vegetation known to contain dreys and individuals, a residual impact of 0.8ha of WRP habitat will remain after implementation of the Proposal. The nearest core habitat to the Site occurs in Tuart Forest National Park (DEWHA, 2009).
Three species of Black-Cockatoos: • Carnaby`s Black-Cockatoo (*Calyptorhynchus latirostris*) • Baudin's Black-Cockatoo	Potential breeding habitat	A total of 102 potential breeding habitat trees (i.e. DBH>50cm or >30cm for wandoo) will be cleared for the Proposal. Of these trees, 14 have hollows possibly suitable for nesting, but evidence of use.	Loss of 102 isolated scattered paddock trees, mapped as potential breeding habitat (i.e. DBH ≥50cm or DBH ≥30cm for wandoo). Based on the total area of ground disturbance of 453.35ha, clearing of 102 trees equates to approximately 1 tree per 4ha. No evidence of Black Cockatoo roosting within any tree located within the Development Envelope was observed by Harewood (2020a and 2020b). A review of the 2018 Great Cocky Count database shows no documented, active roost sites within 10km of the subject site survey area (Peck, et al., 2018).

SPECIES	HABITAT TO BE DISTURBED	GOOD/DEGRADED OR GOOD QUALITY HABITAT TO BE DISTURBED (HA)	POSSIBLE IMPACT/ SIGNIFICANCE OF POSSIBLE IMPACT
(*Calyptorhynchus baudinii*) • Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*)			Evidence of Black Cockatoos foraging was observed during the field survey in the form of chewed marri fruits and pine cones. This evidence was attributed to Carnaby's or Baudin's Black Cockatoo depending on the plant species involved and the characteristics of the foraging activity (i.e. bite marks). The extent of quality foraging habitat within the Development Envelope can be regarded as those areas containing marri, jarrah, banksia and to a lesser extent flooded gum. This area totals ~38ha. Most of this vegetation does not fall within the disturbance area and will not be affected by the Proposal. Of the total 1053 potential breeding habitat trees (i.e. DBH ≥50cm or DBH ≥30cm for wandoo) present within the Development Envelope, 102 trees (~10%) will require removal to facilitate mining. The trees to be removed comprise the following as shown on Figures 4-10, 4-10A, 4-10B, 4-10C and 4-10D: • 81 Habitat trees – no suitable hollows seen; • 16 Habitat trees – One or more possible small/medium hollows; • 5 habitat trees – One or more large hollows possibly suitable for a Black Cockatoo. The trees to be removed containing possibly suitable hollows (5 in total) were subject to an additional assessment by (Harewood, 2020b) (Appendix 6B) to determine suitability and to aid in identifying any signs of current or previous use by Black Cockatoos. None of the hollows showed any conclusive evidence of actual use by nesting Black Cockatoos. Based on available vegetation mapping it is estimated that there is approximately 13,300ha of native vegetation within 10km the Development

SPECIES	HABITAT TO BE DISTURBED	GOOD/DEGRADED OR GOOD QUALITY HABITAT TO BE DISTURBED (HA)	POSSIBLE IMPACT/ SIGNIFICANCE OF POSSIBLE IMPACT
			Envelope, much of which is very likely to represent potential Black Cockatoo foraging and breeding habitat of some type. Direct impacts to Black Cockatoo potential breeding habitat will result in a residual impact to 102 isolated paddock trees, which includes 5 trees containing possibly suitable hollows.
Peregrine Falcon *Falco peregrinus*	Potential foraging / breeding	0ha	No impact/Negligible. This species potentially utilises some sections of the Site as part of a much larger home range. No evidence of nesting seen and the probability of this species breeding within the Site can be considered to be very low.

Based on available information no substantial impacts on any fauna species or overall biodiversity values are anticipated as a consequence of implementing the Proposal. In cases where some impact is anticipated, the degree of the impact is only expected to be very low and relates to the loss of very small areas of habitat, primarily in the form of a small number of scattered, isolated paddock trees.

This loss of fauna habitat however will result in a residual impact of 0.8ha of good quality vegetation, considered to represent suitable WRP habitat and a total of 102 Black Cockatoo potential breeding habitat trees (i.e. DBH ≥50cm or DBH ≥30cm for wandoo). Of these trees, 5 contain hollows possibly suitable for nesting by a Black Cockatoo, however additional assessment of these trees, showed no conclusive evidence of actual use by a Black Cockatoo (Harewood, 2020b). Based on the total area of ground disturbance of 453.35ha, clearing of 102 trees equates to approximately 1 tree per 4ha.

Based on available vegetation mapping it is estimated that there is approximately 13,300ha of native vegetation within 10km of the Development Envelope. This coupled with the fact that most of the species known to or likely to occur are common and widespread, no overall change in their conservation status is anticipated, despite a possible, very localised/small reduction in habitat extent.

DEATH, INJURY AND DISPLACEMENT OF FAUNA FROM CLEARING AND VEHICLE MOVEMENTS

Clearing of native vegetation by machinery prior to mining has the potential to result in death, injury or displacement to resident fauna, particularly on less mobile species. The construction and operation of the Proposal will also result in an increase in vehicle movement to and from the site. Vehicle movements may result in the loss of individual fauna, especially less-mobile species, from vehicle strikes.

Some loss of fauna may occur as a result of these activities, however mitigation measures will be implemented to ensure that impacts to fauna are minimised as far as practicable. Isolated deaths of individual fauna are not expected to affect the distribution or conservation status of any fauna species.

Mitigation measures will include:

- Pre-clearing Surveys;
- Restricted speed limits on access roads;
- Education of staff during inductions and regular toolbox meetings.

GROUNDWATER DRAWDOWN ON GDE/FAUNA HABITAT

Groundwater drawdown of GDE's mapped within the Development Envelope (Ecoedge, 2020c) has the potential to indirectly reduce the quality of fauna habitat. Specially, Vegetation Unit A2 (SWAFCT02 - Wet Shrublands), an identified GDE (Ecoedge, 2020c) within the northern portion of McGibbon Track, is known to contain conservation significant WRP habitat and Black Cockatoo potential breeding habitat trees (i.e. DBH ≥50cm or DBH ≥30cm for wandoo). This GDE is identified as Area B by (Ecoedge, 2020c) as shown on Figure 4-6 and 4-7. WRP habitat and Black Cockatoo potential breeding habitat trees are shown on Figures 4-9A and 4-10B relevant to this GDE.

An assessment of drawdown impacts on GDEs was undertaken by Ecoedge (2020c) using groundwater modelling data prepared by AQ2 (2020a). Based on what is known about the hydrogeology and groundwater dependence of vegetation for the Proposal, it is likely that the predicted water drawdowns for the central and northern part of GDE Area B, containing WRP habitat and Black Cockatoo potential breeding habitat trees, will be moderate to severe (Ecoedge, 2020c) (Figure 4-7), with predicted drawdowns of up to 5m, and drawdowns of more than 2m lasting for 3-6 months in 2023.

Small trees and medium-deep-rooted shrubs within this groundwater-dependent community, such as *Banksia littoralis*, *Melaleuca preissiana*, *Hakea ceratophylla* and *Xanthorrhoea preissii* are likely to suffer moderate-severe desiccation and possible death. *Banksia littoralis*, which is an important part of the overstorey, has a high likelihood of significant mortality, especially if 2023/2024 is a dry year with less than average rainfall (Ecoedge, 2020c).

The WRP habitat present as a GDE predicted to be indirectly impacted by groundwater drawdowns, is outside of core habitat, primary corridors and supporting habitat as documented in the *Significant Impact Guidelines for the Vulnerable Western Ringtail Possum in the Southern Swan Coastal Plain, Western Australia* (DEWHA, 2009). The nearest core habitat to the Site occurs in Tuart Forest National Park (DEWHA, 2009). No overall change in conservation status for this species is anticipated, despite a possible, very localised/small reduction in habitat extent.

Based on available vegetation mapping it is estimated that there is approximately 13,300ha of native vegetation within 10km the Development Envelope, much of which is very likely to represent potential Black Cockatoo foraging and breeding habitat of some type.

The fauna habitat likely to be impacted by the projected water drawdowns, however, will result in a potential residual impact of 1.81ha of WRP habitat, also containing 32 Black Cockatoo potential breeding habitat trees. Two of these trees are dead and will not be affected by drawdown and none of the remaining 30 trees contain hollows suitable for a Black Cockatoo to use. All other scattered isolated paddock trees, mapped as Black Cockatoo potential breeding habitat trees are not groundwater dependent (not mapped within a GDE) and no impacts are predicted.

Drawdown modelling conducted by (AQ2, 2020a) also shows that the drawdown from dewatering of mine pits does not extend to the Lower Sabina River (~1.6 km to the west), Abba River (~1 km to the east) or the Ramsar listed Vasse-Wonnerup wetland (~4.6km to the north west) during the life of the mine and as such will not affect the ecological character of the Vasse-Wonnerup Ramsar wetland or the associated migratory bird habitat.

PRESENCE OF ARTIFICIAL WATERBODIES

The presence of drains and other artificial water bodies for the Proposal (i.e. SEPs, DOD/PWD and open cut drains) may attract native fauna, entrapping animals, possibly resulting in death as a result of drowning. Artificial water bodies may also attract introduced fauna that rely on artificial water bodies for drinking.

As there are existing nearby water sources in the vicinity of the Proposal, such as the Sabina River, Abba River and several onsite drains, some of the above impacts may already be occurring. The provision of additional artificial water bodies may increase these impacts.

INCREASED PREDATION

Some fauna species (particularly smaller mammals) are sensitive to predation by foxes and feral cats. Foxes and feral cats may increase in abundance around the proposed minesite from an increase in the abundance of rodents, access to waste/scraps and/or from feeding by personnel. Waste management procedures will be implemented by Doral to ensure that fauna have no access to scraps or rubbish.

LIGHT, NOISE AND DUST EMISSIONS

Light, noise and dust emissions are all likely to increase as a result of construction and mining activities. The impacts of these emissions on fauna are difficult to predict and therefore a precautionary approach will be adopted and emissions will be reduced as far as practicable. Lighting will be directed onto construction and

operational areas and will be in accordance with Australian Standard *AS4282-1997 Control of the obtrusive effects of outdoor lighting*. A Noise Management Plan will be developed and implemented to minimise noise emissions and impacts. A Dust Management Plan will be prepared and implemented to mitigate the generation of dust as far as practicable.

INTRODUCTION AND SPREAD OF WEEDS AND DIEBACK

Mining activities and vehicle movements have the potential to result in the spread of weeds within and adjacent to the Development Envelope. Environmental weeds are described by (DEC, 1999) as 'plants that establish themselves in natural ecosystems and proceed to modify natural processes, usually adversely, resulting in the decline of communities they invade'. Environments affected by mining activities are highly susceptible to invasion by weeds, as disturbances to soils caused by mining operations (i.e. creating bare ground) provide an ideal habitat where weeds can readily colonise and quickly become the dominant vegetation. Weeds pose a key risk, not only during operational phases of mining, but also during rehabilitation or care and maintenance phases. Weed infestations can compete directly (as well as indirectly) with native or selected revegetation species and also increase the risk of fires (and fire intensity) that may damage revegetated areas. Weeds have the potential to substantially change the dynamics of natural ecosystems by:

- Competing with or displacing native plant species;
- Affecting natural processes such as fire intensity, stream flows and water quality;
- Changing habitats and therefore impacting on ecosystem health;
- Diminishing natural aesthetic values.

Strict weed hygiene measures will be implemented during implementation of the Proposal to reduce the risk of weed introduction and spread into areas of native vegetation, which are largely weed free. Measures will be implemented to target the control of the Declared Plants *Asparagus asparagoides* and *Zantedeschia aethiopica*. Weed management will be implemented as per Doral's Flora and Vegetation Management Plan.

No areas identified as 'infested' with *Phytophthora* dieback are present within the proposed disturbance area. The only infested area (0.3ha) within the Development Envelope is located within the road reserve of Princefield Road, which has been excluded from any disturbance. This area will be segregated and avoided for the duration of the proposal.

ALTERED FIRE REGIME

The Development Envelope has been identified as a designated bushfire prone area by the Fire and Emergency Services Commissioner as being subject, or likely to be subject, to bushfire attack.

Alteration of the natural fire regime may occur as a result of implementing the Proposal due to improved access and increased human activity associated primarily with flammable liquids, combustible materials and hot machinery. The risk of causing fire during the operations has the potential to increase the frequency of fires in the project location. However large areas of bare earth may act as firebreaks in the event of a blaze from adjacent farming or mining areas.

The potential consequences of an altered fire regime have the potential to affect 33.36ha of vegetation used as fauna habitat within the Development Envelope. Fire risk will be managed through the implementation of a Fire Management Plan which will include a fire response procedure.

4.3.6. MITIGATION

In order to protect terrestrial fauna values so that biological diversity and ecological integrity are maintained during the implementation of the Proposal, Doral has applied the mitigation hierarchy to avoid, mitigate and rehabilitate potential impacts to fauna and fauna habitat.

AVOIDANCE

Doral's primary mitigation strategy to protect fauna values, is to design the Proposal to avoid and minimise native vegetation clearing and land disturbance, as far as practicable. The extent of natural fauna habitat within the Development Envelope is relatively small and the remnants present are generally highly degraded and fragmented. A total of 37.81ha of native vegetation is present within the Development Envelope, with the majority confined to vegetation along the McGibbon Track and the Woddidup Creek/drainage line. Doral has successfully designed the Site to avoid all but 3.5ha of fauna habitat within the Development Envelope, which includes avoidance of the majority of conservation significant vegetation on McGibbon Track. No WRP dreys will be cleared for the Proposal and of the 1,053 Black Cockatoo potential breeding habitat trees present within the Development Envelope, 951 will be avoided (~90%). Of the total 54 potential breeding habitat trees possibly suitable for nesting by a Black Cockatoo within the Development Envelope, only 5 are located within the disturbance area and require removal. None of these 5 trees showed any conclusive evidence of actual use by nesting by a Black Cockatoos. No nesting trees are present within the Development Envelope. All isolated scattered paddock trees mapped as Black Cockatoo potential breeding habitat located in the 'Other Supporting Infrastructure' disturbance category (i.e. not within a mine pit or location of key infrastructure) will be avoided as shown on Figure 4-10, 4-10A, 4-10B, 4-10C and 4-10D.

MINIMISE

PRE-CLEARING SURVEYS

Pre-clearing surveys will be conducted, where necessary, prior to any vegetation being cleared. Fauna present in the clearing area will be encouraged to move to nearby vegetation, or captured and relocated in adjacent vegetation nearby to the Site (such as Woddidup Creek/drainage line, Lower Sabina River or Abba River). The capture/relocation will be undertaken by a qualified fauna handler with the appropriate licences in place.

For Black Cockatoos, a pre-clearing survey using the "Great Cocky Count" methods (Peck, et al., 2018) will be undertaken prior to clearing any Black Cockatoo potential breeding habitat tree containing a possibly suitable hollow.

FAUNA MANAGEMENT PLAN

Doral will develop and implement a Fauna Management Plan to address potential impacts to fauna of conservation significance and their associated habitat. The Fauna Management Plan will include the following key management actions:

- Development and implementation of specific clearing procedures to minimise impacts to fauna and fauna habitats. This will include demarcation of cleared areas, pre-clearing surveys and authorisation requirements;
- Pre-clearing survey using the "Great Cocky Count" methods (Peck, et al., 2018) will be undertaken prior to clearing any Black Cockatoo potential breeding habitat tree possibly containing a hollow;

- Vehicle speeds on site will be restricted. All collisions with fauna are to be reported and recorded through Doral's Hazard and Incident Management System (DHIMS);
- Native fauna injured during clearing or normal site operations should be taken to a designated veterinary clinic or a nominated wildlife carer;
- No dead, standing or fallen timber will be removed from site unnecessarily;
- To minimise the potential impacts of artificial water bodies and drains on fauna Doral will:
    - Design the site as to reduce accessibility to most artificial water sources and drains;
    - If artificial ponds or drains are directly adjacent to native vegetation then use fencing to exclude larger animals;
    - Prevent overflow of artificial waterbodies and drains in dry conditions;
    - Use fauna deterrent devices such as high visibility material flapping over water bodies;
    - Non-slippery sides to ponds/drains and/or egress points so that any animals that enter the artificial waterbody may escape;
    - Any trenching required for services or drains should be kept open only for as long as necessary and suitable escape ramps provided.
- All staff working on site will be educated with regards to protected fauna;
- Weapons and pets will not be permitted on site;
- Wastes will be managed appropriately to ensure that fauna have no access to scraps or rubbish
- Contribute to feral species removal such as fox/cat;
- Lights at night will be directed towards construction and operation activities and will be in accordance with *AS4282-1997 Control of the obtrusive effects of outdoor lighting.*

Environmental targets and performance indicators will be developed to ensure fauna management can be monitored and audited.

GDE MANAGEMENT PLAN

A GDE Management Plan (Appendix 4E) has been prepared by AQ2 (2020d) to minimise impacts to flora and vegetation values from indirect impacts associated with groundwater drawdowns. As detailed in the Plan, monitoring will comprise a combination of hydrological parameters and quantitative and qualitative vegetation measurements, ecophysiological measurements and health assessments using qualitative criteria. This will comprise:

- Groundwater level monitoring in a network of six monitoring wells proximal to the GDEs;
- Leaf Water Potential (LWP) monitoring of targeted species in each GDE communities (i.e. SWAFCT02 and SWAFCT10b);
- The species selected for LWP monitoring will also be assessed for health monitoring using visual inspection and assessed using a scale based on that used by Lay and Meissner (1985).

The following management response triggers and contingency measures will apply:

- Leading indicators of risk such that management intervention can pre-empt the development of vegetation water stress:
    - Hydrological triggers provide warning of the onset of a water regime that may cause water tress to develop;
    - Ecophysiological triggers within the vegetation community provide a direct measure of current water status.
- Lagging indicators designed to provide redundancy in risk identification and allow verification of success of management interventions.

Triggers have been designed around parameters that may be affected by mining-induced changes to the water regime (i.e. groundwater levels and associated plant hydration status). Soil moisture is not included as a monitoring parameter because it is influenced by infiltrating rainfall and this will not be affected by mining.

For all trigger exceedances the management response will be that water supplementation is required. Final design for the supplementation scheme will be completed during implementation of this GDE Management Plan. Supplementation will be based on a combination of:

- Surface irrigation;
- Subsurface irrigation in proximity to the groundwater table through either trenches or shallow spear-points.

The supplementation scheme will have the following design criteria:

- To supply enough water to offset declines in groundwater levels (i.e. to maintain levels within the natural range under the GDEs along McGibbon track. This will be determined using the existing groundwater model;
- To prevent sustained periods of excessive inundation of the vadose zone that may result in water logging or reconfiguration of the root systems within the GDEs. This will be achieved by the use of sub-surface supplementation;
- To be operationally effective and not subject to excessive clogging that may limit infiltration capacity. This will be assessed during engineering design of the scheme based on aquifer parameters derived during previous groundwater investigations;
- To incorporate a monitoring programme that can be used to confirm the efficacy of the supplementation system. This will be achieved by the monitoring programme outlined in this Plan;
- To utilise water of sufficient quality so as not to result in acidification or dieback within the GDEs along McGibbon track. In this regard, supplementation water will be sourced from the Yarragadee aquifer only.

FLORA AND VEGETATION MANAGEMENT PLAN

Doral will implement a Flora and Vegetation Management Plan, as described in Section 4.2.6, which will include the following:

- Development and implementation of specific clearing procedures to minimise impacts to flora and vegetation. This will include demarcation of vegetation/trees to be cleared and authorisation requirements;
- Establishment of specific stockpile management procedures to store and manage crushed vegetation, topsoil and subsoil;
- Access to McGibbon Track will be excluded in order to avoid any inadvertent impacts to conservation significant vegetation and flora;
- Declared Plants *Asparagus asparagoides and Zantedeschia aethiopica ragoides* will be managed in accordance with the Biosecurity and Agricultural Management Act 2007;
- Infested area of dieback (0.3ha) within the Princfield Road reserve will be demarcated and avoided from any disturbance for the duration of the Proposal.
- Weed and dust management measures will be incorporated into the ongoing management of flora and vegetation for the Proposal.
- Comply with any necessary approvals, permits and licences required under the BC Act.

GROUNDWATER OPERATING STRATEGY

The groundwater system will need to be carefully managed at the Site in order to avoid or minimise impacts to GDEs due to mining operations. A draft Groundwater Operating Strategy (GWOS) (Appendix 7E) has been developed and a final version will be submitted to DWER when applying for the 5C groundwater licences, both for the groundwater abstraction from the Superficial aquifer (during mine dewatering) and the Yarragadee aquifer (for water supply). The GWOS includes a groundwater and surface water monitoring program (i.e. abstraction, discharge, water levels and water quality) and has been designed to assess aquifer performance, the potential impacts of groundwater abstraction proposed upon commencement of mining operations and specify operational requirements. Trigger levels and contingency actions have been developed to mitigate potential impacts caused by the mining operations and also to ensure the actual impacts are not greater than predicted. The GWOS has been prepared in accordance with *Operational policy 5.08 - Use of operating strategies in the water licensing process* (DoW, 2011) and the DWER guidelines for the preparation of Operating Strategies for mineral sand mine dewatering licences in the South West Region (DWER, 2015).

FIRE MANAGEMENT PLAN

A Fire Management Plan will be prepared to manage the risk of unplanned fires and provide contingency measures to minimise any associated impacts. The plan will include a fire response procedure in the event of any bushfires that commence as a result of the works on site.

REHABILITATE

MINE CLOSURE PLAN

Doral has prepared a Mine Closure Plan (Appendix 3) which describes how the Yalyalup Mine will be decommissioned and rehabilitated to meet the agreed end landuses. This will include revegetating 4.7ha of native vegetation along and adjacent to McGibbon Track, with local native species including species suitable for WRP and Black Cockatoos to counterbalance impacts from clearing of fauna habitat.

4.3.7. PREDICTED OUTCOME

After the application of the mitigation hierarchy described above, no substantial impacts on any fauna species or overall biodiversity values are anticipated as a consequence of clearing for the Proposal. In cases where some impacts are anticipated, the degree of the impact is only expected to be very low and relates to the loss of very small areas of suitable habitat, primarily in the form of a small number of scattered, isolated paddock trees and/or overstory species. This coupled with the fact that most of the species known to or likely to occur are common and widespread, no overall change in their conservation status is anticipated, despite a possible, very localised/small reduction in habitat extent.

A residual impact of 0.8ha of good quality vegetation, considered to represent suitable WRP habitat will however remain after mitigation measures have been applied. In addition, a residual impact of 102 Black Cockatoo potential breeding habitat trees will remain after implementation of the Proposal, as these trees require removal to facilitate mining. Of these trees, 5 of the 54 mapped as containing one or more hollows possibly suitable for a Black Cockatoo will require removal to facilitate mining. These trees are present as scattered, isolated paddock trees and an assessment by Harewood (2020b) indicates that none of these trees show current signs of use for nesting by a Black Cockatoo.

Potential indirect impacts from projected water drawdowns within the Wet Shrublands (SWAFCT02) GDE, will also result in a residual impact to ~1.81ha of WRP habitat and 30 Black Cockatoo potential breeding habitat trees, with predicted drawdowns of up to 5m, and drawdowns of more than 2m lasting for 3-6 months in 2023. This vegetation is considered to represent suitable habitat for WRP, given the known presence of WRP dreys and individuals observed within this location. Of the 30 Black Cockatoo trees, none contain hollows suitable for use by a Black Cockatoo.

All other scattered isolated paddock trees within the Development Envelope, mapped as Black Cockatoo potential breeding habitat, are not groundwater dependent as they do not occur within a mapped GDE and no indirect impacts from dewatering are predicted.

The residual impacts to WRP habitat (direct and indirect) is outside of Area 1 - Core Habitat, Area 2 - Primary Corridors and Area 3 - Supporting Habitat as documented in the *Significant Impact Guidelines for the Vulnerable Western Ringtail Possum in the Southern Swan Coastal Plain, Western Australia* (DEWHA, 2009). As such residual impacts from clearing and potentially dewatering does not trigger any of the Significant Impact Assessment criteria detailed on page 7 of (DEWHA, 2009). The nearest core habitat to the Site occurs in Tuart Forest National Park (DEWHA, 2009).

Based on available vegetation mapping it is estimated that there is approximately 13,300ha of native vegetation within 10km the Development Envelope, much of which is very likely to represent potential Black Cockatoo foraging and breeding habitat of some type.

Species of migratory birds identified as Matters of NES by DAWE are not likely to utilise the Proposal area and indirect impacts to these species and habitat (i.e. Vasse-Wonnerup Ramsar wetland) from dewatering activities will not occur, as it is well outside the maximum extent of groundwater drawdown (~3.5km). As such no effect to the ecological character of the Vasse-Wonnerup Ramsar wetlands and migratory species will occur as a result of the Proposal.

Doral will implement various management plans, including a Fauna Management Plan, GDE Management Plan and GWOS to monitor vegetation health, soil moisture content and groundwater levels during periods of drawdown, as well as conduct pre-clearing surveys of Black Cockatoo potential breeding habitat trees

containing possibly suitable hollows in accordance with the "Great Cocky Count" methods (Peck, et al., 2018).

Revegetation of 4.7ha of native vegetation using local provenance species including habitat suitable for WRP and Black Cockatoos, will be provided to counterbalance clearing of 3.5ha of predominantly completely degraded vegetation.

An assessment of significance in accordance with the *WA Environmental Offset Guidelines* (Government of Western Australia, 2014) is provided in Section 6 Offsets for the residual impacts to conservation significant fauna habitat.

Doral considers that with the implementation of the above listed key mitigation measures and provision of a suitable offset in consultation with DBCA and DAWE to offset residual impacts to conservation significant fauna habitat determined to be significant (refer to Section 6), the EPA's objective to protect terrestrial fauna so that biological diversity and ecological integrity are maintained. Section 6 describes further the offset strategy that Doral will implement for this Proposal.

4.4. KEY ENVIRONMENTAL FACTOR 3 - INLAND WATERS

The Environmental Factors "Hydrological Processes" and "Inland Waters Environmental Quality", identified in the ESD (Doral, 2019) have been combined and addressed as "Inland Waters" as per *Statement of Environmental Principles, Factors and Objectives* (EPA, 2018b).

For the purposes of EIA, the EPA defines the factor Inland Waters as:

> *The occurrence, distribution, connectivity, movement and quantity (hydrological regimes) of inland water including its chemical, physical, biological and aesthetic characteristics (quality).*

4.4.1. EPA OBJECTIVE

The EPA objective for Inland Waters is:

> *To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.*

4.4.2. POLICY AND GUIDANCE

EPA Policy and Guidance

- *Environmental Factor Guideline – Inland Waters* (EPA, 2016i).

Other Policy and Guidance

- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ, 2000).
- *Western Australian Water in Mining Guideline. Water licensing delivery report series. Report No. 12* (DoW, 2013).
- *Hydrogeological Reporting Associated with a Groundwater Well Licence. Operational Policy 5.12.* (DoW, 2009).
- *Identification and investigation of acid sulfate soils and acidic landscapes* (DER, 2015a).
- *Treatment and management of soil and water in acid sulfate soil landscapes* (DER, 2015b).
- *Information Sheet on Ramsar Wetlands (RIS) – 2009-2014 version.*

- *Ecological Character Description for the VasseWonnerup Wetlands Ramsar Site in South-west Western Australia. Unpublished report to the Department of Environment and Conservation and Geographe Catchment Council Inc. by Wetland Research & Management. September 2007* (WRM, 2007).
- *Swan Coastal Plain South Management Plan 2016. Management plan number 85. Department of Parks and Wildlife, Perth* (DPaW, 2016).

4.4.3. RECEIVING ENVIRONMENT

INVESTIGATIONS UNDERTAKEN

The following hydrogeological and hydrology assessments were undertaken by AQ2 and provided in Appendix 7:

Appendix 7A Groundwater Modelling Assessment (AQ2, 2020a);

Appendix 7B Surface Water Assessment (AQ2, 2019a);

Appendix 7C Site Water Balance (AQ2, 2020b);

Appendix 7D Surface Water Discharge Assessment (AQ2, 2019b).

Information provided in these reports have been used to provide background information and assessment of potential impacts in the following sections.

ENVIRONMENTAL VALUE AND BENEFICIAL USES

Environmental value is defined under the EP Act as a beneficial use or an ecosystem health condition and is described in (EPA, 2016i). Environmental values and beneficial uses of water considered relevant to the Proposal are limited to the following:

- Ramsar listed Vasse-Wonnerup wetlands;
- Lower Sabina River;
- Groundwater which may be abstracted for livestock and non-potable uses.

A description of the receiving environment relevant to Inland Waters is provided in the following sections.

CLIMATE AND RAINFALL

The Geographe-Naturaliste coastline experiences a Mediterranean climate with warm to hot dry summers, and mild wet winters. High pressure cells dominate climatic patterns during summer and the passage of cold fronts and associated low pressure cells dominate during winter. Strong sea breezes occur from late November to early March. table

The annual rainfall generally falls within the 800mm and 1000mm range, peaking in June and July, as shown in Plate 2-5, with minimal rainfall (<25mm) in the summer months. Annual mean rainfall for the period 2007-2017 is ~680mm, which is substantially lower than the long-term average for Busselton of 811mm. Potential average annual evapotranspiration in the region is approximately 1200mm, which therefore is likely to exceed precipitation during summer months.

In summer the average maximum temperature is 29°C with an average minimum temperature of 14°C. In winter the average maximum temperature is 17°C with an average minimum temperature of 7°C (Bureau of Meteorology, 2019).

GROUNDWATER MANAGEMENT AREA

The Development Envelope is wholly within the Busselton-Capel Groundwater Area (BCGA) (Figure 2-3). The Busselton-Capel sub-area covers 757.3km^2 and is predominantly used by the service sector, mining and industry, and horticulture. Currently the Superficial and Leederville aquifers in the subarea are fully allocated (DoW, 2009).

The Development Envelope is also within the Busselton-Yarragadee Groundwater Area (Yarragadee aquifer). The Busselton-Yarragadee subarea covers 2,021.4km^2 (Figure 2-3) and is fully allocated. The predominant use of this aquifer is for public water supply, mining and industry (DoW, 2009).

GEOLOGY

The Proposal is located within the southern part of the Perth Basin, an elongate north–south rift trough with a series of sub-basins, shelves, troughs and ridges (AQ2, 2020a). The Proposal is wholly contained within the Bunbury Trough, a sub-basin containing a Permian–Cretaceous succession up to 11 km thick. The sub-basin is wedged between the Vasse Shelf and the Yilgarn Craton, bounded to the east by the Darling Fault and to the west by the Busselton Fault. The Proposal is included on the published 1:50,000 Environmental Geology Series map for Busselton (Belford, 1987) (Figure 2-2).

A summary of the stratigraphy and hydrogeology within the upper 900m of the Perth Basin at the Proposal is summarised in Table 4-22.

TABLE 4-22: SUMMARY OF STRATIGRAPHY AND HYDROGEOLOGY

AGE	FORMATION	STRATIGRAPHY	THICKNESS (m)	LITHOLOGY	HYDROGEOLOGY
Quaternary - late Tertiary	Superficial	Bassendean Sand	0.5-3	Fine to medium sub-rounded quartz sand	Superficial aquifer
		Guildford Formation	2-5	Clay and sandy clay with occasional discontinuous sand lenses	Local aquiclude
		Yoganup Formation	2-5	Leached and ferruginized beach sand conglomerate and clay. Local laterite.	Superficial aquifer
UNCONFORMITY					
Cretaceous	Leederville	Mowen Member	1-10	Clay and silty clay, with thin interbedded silt, clayey sand and fine grained sand	Regional aquitard; local Leederville aquifer (when significant sand is present)
		Vasse Member	50-100	Fine to medium grained quartz sandstone and interbedded shale.	Leederville aquifer
UNCONFORMITY					

AGE	FORMATION	STRATIGRAPHY	THICKNESS (m)	LITHOLOGY	HYDROGEOLOGY
Mid-late Jurassic	Yarragadee	Unit 1	0-50	Medium to coarse grained, weakly consolidated sandstone, minor siltstone and shales	Yarragadee aquifer
		Unit 2	0-250		
		Unit 3	200-500		
		Unit 4	0-100		

AQ2 (2020a) provides the following description of geology for the Proposal.

The upper geology sequence comprises the Quaternary-late Tertiary aged Superficial Formation, which are represented at the Site by the Bassendean Sand towards the top, the Guildford Formation and the Yoganup Formation towards the base. The Bassendean Sand forms a thin bed of fine to medium grained aeolian sand. The Guildford Formation consists predominantly of silty to sandy clay of fluvial origin. The Yoganup Formation comprises leached and ferruginous coarse grained beach sand, with localised concentrations of heavy minerals and some sandy silt and clay layers. The superficial deposits commonly contain ironstone caprock, colloquially known as Coffee Rock, in the zone of water table fluctuation. At the Site, the Coffee Rock is generally 2-3m thick and is exposed at the surface in the eastern side of the Site, near and along the McGibbon Track. The thickness of the Superficial Formation is irregular, reaching a maximum of 12m at the site, but generally 7-8 m thick.

Outside of the Development Envelope closer to the coast, the Bassendean Sand is interfingered by Tamala Limestone (i.e. limestone, calcarenite and sand), which can be up to 15m thick. Tamala Limestone is overlain by Estuarine and swamp deposits at the Vasse-Wonnerup Wetland, consisting of fine sand, silt and clay and by Safety Bay Sand at the coast area. Thin layer of the Guildford Formation underlain Tamala Limestone, with the basal sand of the Guildford Formation being equivalent to the Yoganup Formation.

The Superficial Formation is unconformably underlain by Cretaceous age, riverine and deltaic sediments of the Leederville Formation, comprising discontinuous interbedded weakly consolidated sandstone, clayey sand, silt and shale. Three member units of the Leederville Formation are identified: Vasse Member, Mowen Member, and Quindalup Member, with only Vasse and Mowen Members, present in the Yalyalup area. The lower Vasse Member is highly stratified, containing sand beds interbedded with clay aquitards. Sand beds are generally up to 10m thick with overall unit thickness of 100m at the project site. The upper Mowen Member is dominated by clay and silt with some thin interbedded silty to medium grained sand, with a thickness of up to 10m. The Mowen Member is likely to be very thin or has a greater sand content, especially on the eastern side of the project area.

The Yarragadee Formation (the aquifer being targeted for the mine water supply) underlies the Leederville Formation, comprising predominantly weakly consolidated, medium to very coarse grained quartz sandstone, with minor siltstone and shale beds. Based on lithology and age, this formation has been divided into four sub-units (sequentially, Unit 1 to Unit 4; Baddock et. al., 2005). Unit 1 occurs at the top of the formation and Unit 4 at the base, with all units likely to be present in the project area (a total thickness of approximately 900 m).

The Bunbury Basalt occurs discontinuously between the Yarragadee and Leederville Formations and the top of the basalt is typically highly weathered. The Bunbury Basalt is unlikely to be present at the Site, based on

the literature (i.e. DWER drilling information records (DWER, 2019) and the Water Corporation Magnetic data survey (Baddock, et al., 2005)).

HYDROGEOLOGY

Groundwater is present in the area within a multi-layered aquifer system. Three major aquifers have been identified within the Proposal area (ordered from shallow to deep), namely:

- Superficial;
- Leederville;
- Yarragadee.

A conceptual hydrogeological cross section in the Proposal area is provided as Figure 2-4 and a detailed description of the three aquifers and their key properties (from AQ2, 2020a) is provided below.

Superficial Aquifer

The Bassendean Sand, Guildford Formation and Yoganup Formation form an unconfined Superficial aquifer, with a maximum saturated aquifer thickness of ~9m at the Site. The Guildford Formation is present between the Bassendean Sand and Yoganup aquifers and is of low permeability, owing to its more clayey nature. The permeability of the superficial aquifer is variable and depends on sediment type, with saturated sands having higher permeability than clays. At the site, the Yoganup Formation forms the main portion of the aquifer, while the Basendean Sand is generally only saturated in the wet season.

Outside of the proposed mine area, within the modelling study area by AQ2 (2020a) and closer to the coast, the Bassendean Sands are interfingered by Tamala Limestone and Safety Bay Sand, which form a significant aquifer zone along the coastal margin. The basal sand of the Guildford Formation close to the coast also forms local aquifer, which may be equivalent to the Yoganup Formation, that is likely to be absent at this location. The estuarine and swamp deposits at the Vasse-Wonnerup Wetland act as a low permeability aquiclude, owing to its clayey nature.

Recharge

Recharge of groundwater to the Superficial aquifer is mostly from direct infiltration of rainfall, with some recharge occurring by upward leakage from the underlying Leederville aquifer mostly across the seaward section and from down-slope surface drainage from the Whicher Scarp (Hirschberg, 1989). In the climate of South West of WA, most of the rain that falls is lost again through various forms of evapotranspiration. Any precipitation in excess of soil moisture deficit and evapotranspiration will become runoff or infiltrate downward to the water table. The downward flow of water may or may not reach the water table depending on the soil properties in the soil profile. The rate of groundwater recharge is controlled by climate, land use, vegetation type and density, soil hydraulic properties, geology and topography; and is in a range between 5 and 40% of the rainfall, averaging 10%. Much of the Swan Coastal Plain is cleared of native vegetation for pasture, which results in relatively high recharge rates even up to 50% of the rainfall (Baddock, et al., 2005).

Discharge

Groundwater is discharged from the Superficial aquifer to the ocean and the coastal swamps, to surface drainage including rivers, streams and an extensive network of constructed drains. It is also discharged via direct evaporation from swamps and evapotranspiration from vegetation where the water table is shallow. There is also discharge of groundwater downward into the Leederville and Yarragadee aquifers where the hydraulic head gradient is downward, especially where the superficial lithology is sandy (Baddock, et al.,

2005). Owing to the very shallow water table, the loss of groundwater to the atmosphere through evapotranspiration is likely to be high (Hirschberg, 1989).

Groundwater Levels and Flow

The water table elevation slopes gently from the Whicher Scarp (i.e. ~40 mAHD) to the coast (i.e. 0 mAHD), closely parallels to the topography in a north-western direction under a low hydraulic gradient (AQ2, 2020a). Groundwater levels, as measured in the Superficial monitoring bores (both Doral's monitoring bores, other private users and DWER monitoring bores), are close to surface, at depths of 0 to 4.7mbtoc (i.e. 15.6 and 34.8 mAHD). Within the Site, low-lying areas are often waterlogged during winter period (i.e. with the water table rising to ground surface). The seasonal water table fluctuation is less than 0.4m close to the coast, approximately 1 to 2m across the central part of the Swan Coastal Plain (including the Proposal area) and up to 2 to 4m close to the Whicher Scarp. Hydrographs for superficial deposits on the Coastal Plain show that variations in water level are usually correlated with variations in rainfall. Peaks in the groundwater hydrographs generally occur 1 to 3 months after peaks in the rainfall and the length of the time lag increases with increasing depth to the water (AQ2, 2020a). The average water table elevation contours in the Superficial aquifer across the Site are shown in Figure 4-11.

Water Quality

Groundwater at the Site is fresh (<500 mg/L TDS) to brackish (up to 3,000 mg/L TDS) with a general trend of increasing salinity toward the coast from the Whicher Scarp. High salinity groundwater occurs in areas of poorly drained clay soils and swampy areas, exceeding 2,000mg/L in some areas. Elevated groundwater salinity occurs near the coast resulting from coastal saline swamps and groundwater mixing with the sea-water interface (Baddock, et al., 2005). Groundwater chemistry within the Superficial aquifer is normally a sodium-chloride type.

Leederville Aquifer

The Leederville Formation forms a multi-layered confined aquifer system, comprising discontinuous interbedded sequences of sand, clayey sand, silt and shale. It underlies the Superficial deposits across the Proposal area, coming to surface only to the south-east of the Site, where it forms the Whicher Scarp.

At the Site, the Leederville aquifer generally comprises the Vasse Member of the Leederville Formation. The Mowen Member of the Leederville Formation, which overlies the Vasse Member is commonly considered as an aquitard due to its clayey nature. At the eastern portion of the modelled study area by AQ2 (2020a), the Mowen Member is likely to be very thin or has a greater sand content, resulting in the Leedeville aquifer directly underlying the Superficial aquifer.

Recharge

The Leederville aquifer is recharged mostly on the Blackwood Plateau by direct recharge where the aquifer is present at surface, with lower rates by downward leakage through the Mowen aquitard. Chloride mass balance calculations suggest that recharge rates are around 7% of rainfall and locally significantly higher, while leakage recharge through the Mowen aquitard may be equivalent to only 1 to 2% of rainfall (Baddock, et al., 2005).

Hirschberg (1989), reports that upward leakage occurs into the Superficial aquifer from the confined aquifers in the vicinity of the Site, although later studies suggest that downward flows have also been occurring since that time, potentially due to ongoing regional abstraction from the Leederville aquifer (Schafer, et al., 2008). Based on the measured groundwater levels for the two aquifers shown on Figure 4-12, there is generally a

1m or greater difference in equipotential heads between the Superficial and Leederville aquifers, with lower elevations recorded within the Leederville aquifer. However, water levels recorded in bores screened in the deeper section of the Leederville aquifer show the upward hydraulic heads (Figure 4-12). The potential for recharge on the coastal plains is restricted by the upward potentiometric head gradients or small downward gradients that exist between the Leederville and Superficial aquifers.

Discharge

Groundwater discharge from the Leederville aquifer into the underlying Yarragadee aquifer occur through the majority of the Site. However, clay layers within the Leederville Formation and shale layers of the upper unit of the Yarragadee Formation are believed to restrict vertical flow (AQ2, 2020a). Groundwater head gradients are upward in the north of the Site, where groundwater is discharged into the overlying Superficial Formation near the coast and offshore.

Groundwater Levels and Flow

Generally, the Leederville Formation receives recharge towards the Whicher Scarp and discharges towards the coast. Groundwater level elevations in the Leederville aquifer reduce from an average of approximately 35mAHD at the foot of the Whicher Scarp (61030067) to approximately 2mAHD close to the coast (61030028). The seasonal water level fluctuations are generally between 2 to 3m. Additionally, a gradual small declining trend associated with ongoing pumping activity in the area is evident since 2003, especially in the bores screened deeper in the Leederville aquifer. The average water table elevation contours in the Leederville aquifer across the modelled area are shown in Figure 4-13.

Water Quality

Groundwater at the Site is fresh to transitional, with the average salinity of between 300 and 400mg/L TDS. The areas of high salinity groundwater generally correspond to discharge areas of the Leederville aquifer where there is an upward potentiometric head gradient with the overlying Superficial aquifer or affected by downward leakage of higher salinity groundwater from the overlying Superficial aquifer (Baddock, et al., 2005).

Groundwater chemistry within the Leederville aquifer is normally a sodium-chloride type, but the elevated bicarbonate is evident around Busselton area likely associated with the infiltration from the Superficial aquifer containing Tamala Limestone. Locally the aquifer can contain high concentrations of iron (AQ2, 2020a).

Yarragadee Aquifer

The Yarragadee Formation forms a confined Yarragadee aquifer below the Leederville aquifer. There are four sub-units within the Yarragadee Formation with distinct lithological properties. The Yarragadee aquifer is confined by the Leederville Formation. The Bunbury Basalt is discontinuously thin aquitard and it is believed not to be present at the modelled study area (AQ2, 2020a).

Recharge

The Yarragadee aquifer receives recharge by downward leakage from the Leederville Formation (Hirschberg, 1989), especially in the inland areas around the Whicher Scarp where downward heads prevail. As well as downward leakage from the Leederville Aquifer, recharge to the aquifer is likely to occur mostly from the south and south east where the formation outcrops.

Discharge

A major of groundwater discharge from the Yarragadee aquifer is offshore adjacent to Bunbury, where the aquifer subcrops beneath the Superficial aquifer below the sea floor. Groundwater is also discharged to the overlying Superficial and Leederville Formations adjacent to the coast.

Groundwater Levels and Flow

Groundwater flow through the upper part of the Yarragadee aquifer is south to southwest toward the coast. Groundwater level elevations in the Yarragadee aquifer reduce from an average of approximately 25 to 35mAHD at the foot of the Whicher Scarp to approximately 5mAHD close to the coast.

There is generally 4 to 5m of the average seasonal water level fluctuation evident at the study area. The hydrograph for DWER's monitoring bore 61000125 (Figure 4-12) indicates, apart from seasonal fluctuations (peaks in March and lows in September), a gradual small declining trend associated with ongoing pumping activity in the area.

Water Quality

Groundwater at the Site is fresh with the average salinity of groundwater within Yarragadee units 1 to 3, 360 mg/L TDS, while in unit 4 it is 440 mg/L TDS. Groundwater salinity is lowest within the main recharge areas to the aquifer, where the salinity is mostly less than 200 mg/L TDS. Higher groundwater salinity within the Yarragadee aquifer beneath the Swan Coastal Plain in the area of Busselton correspond to elevated groundwater salinity within the overlying Leederville and Superficial aquifers (Baddock, et al., 2005).

Groundwater chemistry within the Yarragadee aquifer is normally a sodium-chloride type, but becomes sodium-bicarbonate type in the deeper portions of the aquifer. An increased proportion of sodium and bicarbonate generally distinguishes older groundwater in the Yarragadee aquifer, possibly as the result of weathering of feldspars (Baddock, et al., 2005). The relative proportions of major ions are similar to those in the Leederville Formation, suggesting a close relationship between the two aquifers at the Site.

GROUNDWATER USERS

According to the DWER Water Register Database , there are currently 23 licenced groundwater users within the vicinity of the Site (i.e. within a 2km radius), of which two abstract from the Superficial aquifer, 21 from the Leederville aquifer and none from the Yarragadee aquifer (AQ2, 2020a).

A total of 503 licenced groundwater users are currently abstracting water within the groundwater modelled area (refer to Section 9.44 of AQ2, 2019a); 43 of them are abstracting from the Superficial aquifer (a total of 4.1 GL/year), 435 from the Leederville aquifer (a total of 6.8 GL/year), and 25 from the Yarragadee aquifer (a total of 32.3 GL/year).

Current drawpoints and licenced groundwater users in the vicinity of the Site are shown in Figures 4-14 and 4-15.

The majority of groundwater abstracted from the Superficial aquifer is stated to be used for livestock and domestic/household purposes, although there are two major, high volume abstraction licenses. These abstractions are located to the north and down gradient of the Yalyalup site, are owned by the Cable Sands (WA) Pty Ltd (GWL173523 0.6 GL/year and GWL202089 1.4 GL/year) and are associated with the Wonnerup mine (existing mine) and Wonnerup North (proposed mine), respectively. Iluka's Tutunup South mine site,

located 2.5 km south east and up gradient of the Yalyalup site, used to abstract 1.04 GL/year (GWL167315), however this mine was closed in 2018.

There are two licences that abstract water from the Superficial aquifer in close proximity to the Site; GWL 180363 owned by J Stefani is allowed to abstract 50,000 kL/year, while GWL182032 owed by T O'Neill is allowed to abstract 30,000 kL/year.

All identified groundwater licences within the Development Envelope abstract from the Leederville Aquifer (5 licenses). The licenced abstraction volumes are minor, ranging between 1,500 to 14,500 kL/year and are used for livestock and domestic/household purposes. There is one Leederville licence (GWL180362), located immediately south west of the Development Envelope, that is allowed to abstract 100,000 kL/year. Details of these licences are summarised in Table 4-23.

The closest licenced Yarragadee abstraction bore to Doral's proposed Yarragadee production bore (YA_PB01) is bore under GWL156423 (Turf Farm), located approximately 3.7 km away. Additionally, there are three major, high volume abstraction Yarragadee aquifer licences within the groundwater modelled area: Cable Sands (WA) Pty Ltd (GWL16184 - 3.9 GL/year), Doral Mineral Sands Pty ltd (AGR18381291) under GWL6658815 -1.6 GL/year) and The Trust Company Ltd (GWL151407-6,66 GL/year). Cable Sands and Doral licences are associated with the Wonnerup North mine and Yoongarillup mine, respectively. Two avocado farms are covered under one GWL151407, with first farm being located north of the Wonnerup North mine and second farm to the northeast of the Yoongarillup mine.

In addition to the DWER Water Register Database, DWER Water Information Reporting (WIR) database provides information regarding the bores drilled (including licenced and unlicenced bores) and shows that there are also 26 current and legacy landholder bores within the Development Envelope which are screened within the Superficial Aquifer, but not licenced. Licencing of Superficial Aquifer abstractions are not always mandated by DWER. These bores are listed in Appendix C and shown in Figure 29 of AQ2 (2020a) (Appendix 7A).

DWER WIR Database also shows that there are several DWER bores within the modelled project area that are screened in the Superficial, Leederville and Yarragadee aquifers and are used as regional monitoring bores. All DWER monitoring bores are also listed in Appendix C and shown in Figure 29 of AQ2 (2020a) (Appendix 7A).

TABLE 4-23: ACTIVE SUPERFICIAL AND LEEDERVILLE AQUIFER GROUNDWATER LICENSEES WITHIN 2KM FROM THE SITE

WRI LICENCE NUMBER	ISSUE DATE	EXPIRY DATE	LICENCE ALLOCATION (KL/YEAR)	LICENCE HOLDER	AQUIFER
180363	24/03/2016	31/03/2026	50,000	Stefani, Jeremy	Superficial
182032	11/12/2015	10/12/2025	30,000	O'Neill, Timothy John	
107623	30/04/2012	13/03/2022	2,850	Brand, Adrian Ralph, Brand, Evelyn Anne	Leederville
110289	24/02/2017	23/02/2027	1,500	Hodge, Robert, Lisa Hodge	

WRI LICENCE NUMBER	ISSUE DATE	EXPIRY DATE	LICENCE ALLOCATION (KL/YEAR)	LICENCE HOLDER	AQUIFER
156606	19/03/2015	18/03/2025	2,220	Shorelands Pastoral Co Pty Ltd	
165828	20/11/2009	9/11/2019	10,000	Avery, Norman Lindsay	
168831	30/05/2017	31/05/2027	63,700	Rival Pty Ltd	
169309	19/06/2019	18/06/2029	32,000	Oates, Jamie Allan	
174021	4/08/2011	4/08/2021	1,000	Slee, Ian Sydney	
174905	6/01/2012	6/01/2022	1,800	Slade Parkin Pty Ltd	
175045	21/02/2012	20/02/2022	1,500	Iluka Resources Limited	
177828	16/01/2019	11/01/2026	10,500	Boardman, Terry Stephen, Boardman, Darryl Fredric	
178017	2/09/2013	1/09/2023	1,500	Macleay, Peter Hervey	
179889	16/09/2014	15/09/2024	1,500	Buchan, Alice, Buchan, John	
180362	1/06/2017	31/05/2027	100,000	Stefani, Jeremy	
181194	17/08/2015	18/08/2025	18,400	Kimbolton Greyman Pty Ltd	
183817	10/01/2017	10/01/2027	60,000	OATES, Peter James	
202488	22/02/2019	21/02/2029	1,500	Ian Alastair Taylor	
49902	19/06/2019	18/06/2029	27,000	OATES, Peter James	
50966	15/06/2015	14/06/2025	14,500	Paperbark Farm Pty Ltd	
58886	19/02/2013	19/02/2023	2,500	Avery, Julia Anne, Avery, Trevor William	
67672	1/05/2015	30/04/2025	9,500	Macleay, Anna Maree, Macleay, Peter Hervey	
95377	23/05/2012	30/06/2022	3,000	Copeland, Anthony Hedley, Copeland, Elizabeth Margaret	

GROUNDWATER DEPENDANT ECOSYSTEMS

Approximately 90% of the Development Envelope is mapped as a wetland in the Geomorphic Wetlands of the Swan Coastal Plain dataset (DEC, 2008a), all of which has been assessed as being in the 'Multiple Use' management category, which is described as wetlands with few ecological attributes and functions

remaining. The majority of the wetland area within the Development Envelope (~77%) is mapped as Palusplain (seasonally waterlogged flat), with small areas of Sumpland (seasonally inundated basin, ~3%) and floodplain (seasonally inundated flats, ~17%). No wetlands of environmental significance are present within the Development Envelope (Figure 2-8).

Three reserve areas in the Busselton-Capel groundwater subarea are under ecological monitoring due to the presence of high sensitivity GDE's (DWER, 2009, Figure 1). These GDE's have management triggers and responses attached to them by DWER (Del Borello, 2008). These are labelled 'conservation' Sumpland and Floodplain, but are located approximately 6km the northeast and southwest of the Proposal.

To assist with identification of Type 3 GDE's within the area predicted to be impacted by dewatering for the Proposal, a detailed review of soil information, depths to groundwater, proposed dewatering extents and specific water dependency of flora species/ecosystems was undertaken by (Ecoedge, 2020c).

Vegetation units within the Development Envelope were described by (Ecoedge, 2020a) and described previously in Table 4-5 and shown on Figure 4-1. Three of these vegetation units are considered to be GDEs (A2, B1, and C3), and another unit, A1, while probably not a GDE, has groundwater-dependant trees within it. Three no longer intact communities[4] (B2, C1, C2), are dominated by phreatophytic species. Two of the GDEs (A2, SWAFCT02 and B1, SWAFCT10b) and unit A1 (SWAFCT01b) are listed as TECs under the BC Act. Unit B1 (SWAFCT10b), is also listed as Threatened under the EPBC Act. The occurrence of the unit C3 however is considered to be too small and badly degraded to be inferred as an example of the TEC, SWAFCT09 (Ecoedge, 2020a).

Locations of GDE's within the Development Envelope are shown in Figure 4-6 and denoted by Areas A, B, and C[5] and are described in detail in Section 4.2.3.

VASSE – WONNERUP RAMSAR WETLAND

The Ramsar listed Vasse-Wonnerup wetland is located ~4.6km to the northwest of the Site (Figure 2-8 and Figure 4-16). The Vasse-Wonnerup Wetlands catchment area is 473 km^2, excluding the diverted sub-catchments (DWER, 2019) (Figure 4-16). The Lower Sabina River catchment area of 45.5 km^2 is less than 10% of the Vasse-Wonnerup Wetland Catchment. The Abba River is one of the other major tributaries to the Vasse-Wonnerup Wetland and has a catchment area of 137km^2 which is 29% of the Vasse-Wonnerup Wetlands catchment.

The Vasse-Wonnerup system is already highly hydrologically and chemically altered due to extensive clearing, agricultural practices occurring over most of the Geographe catchment, and other commercial and residential developments in the area. Clearing and agricultural practices contribute to altered water regimes and increases in nutrients, sedimentation and pollution (DoW, 2010). The system is highly modified, with diversion of flow from several of the rivers into the ocean that historically flowed into the Vasse and Wonnerup estuaries, which has accounted for a significant decrease in water entering the system. The floodgates were installed in the early 1900s to mitigate flooding of adjoining agricultural land during high river flows in winter and to prevent seawater inundation caused by storm surges. The gates effectively transformed the estuaries in to shallow, winter fresh/ summer saline lagoons, unique in Western Australia

[4] These vegetation units are classed as "Completely Degraded" and while having one or more of the original overstorey species, are devoid of native species in the understorey.
[5] These GDE Area codes do not relate to the vegetation unit codes.

(Department of Environment, 2007). DWER estimated a 60% decrease in flow from the Sabina River and a 90% decrease from the Vasse River into the Wonnerup estuary as a result of these diversions (DoW, 2010).

The wetlands are listed as a wetland of International importance under the Ramsar Convention. The high ecological values of the wetlands are coupled with extremely poor water quality in late summer that lead to fish kills and declines in visual amenity. The wetlands are managed for multiple purposes including water bird habitat, flood and storm surge mitigation, visual amenity and the prevention of fish kills.

Department of Environment (2007) reported that the wetlands are subject to poor water quality issues, with the floodgates acting to reduce flushing flows that may otherwise help to ameliorate high nutrient concentrations from catchment runoff, while excessive algal blooms, blooms of potentially toxic cyanobacteria and fish deaths are not uncommon (and) increased salinisation of adjoining pastoral lands and death of colonising native vegetation.

ACID SULFATE SOILS

Doral undertook a targeted ASS investigation (Appendix 5) in conjunction with resource definition drilling at the Site in 2014 and 2017 to assist in determining the presence and distribution of ASS at the Site and also to characterise the various geological/geomorphological units.

The Site occurs in an area depicted on an ASS risk map as Class II 'moderate to low risk of ASS occurring within 3m of natural soil surface' and is shown as being underlain by Pliocene to Quarternary sands and silts, which comprise the Superficial Formations. Identified units within the Superficial formations include Bassendean Sand (aeolian quartz sand), the Guildford Formation (dominated by interbedded sandy silt in the area) and the Yoganup Formation (fine to medium quartz sand). The total depth of the superficial formations at the Site is approximately 12-15m.

Field results of the ASS investigation indicate that Site soils are generally slightly acidic to neutral as a large proportion of pH_F results are within the pH6.0 to pH7.0 range. This indicates that there is very little actual acidity present in the soil profile, which is confirmed by the laboratory results, which show very little acidity is present as s-TAA (i.e. actual acidity). However, field results also show a high proportion of samples with $pH_{FOX} \leq 3$ and a ΔpH above 3.0pH units, indicating that there is additional potential acidity within the soil profile. This is also confirmed by the laboratory chromium reducible sulfur (CRS) results which show 75 of the 118 samples analysed (15 out of 17 drill holes), contain net acidity (NA) as S_{CR} above the DWER action criterion (0.03%S).

Groundwater results from initial groundwater monitoring undertaken by Doral, indicate that Superficial groundwater quality beneath the Site is slightly acidic due to pH levels generally <6.0 (although above the ASS indicator value of pH5.0), elevated total acidity concentrations of up to 170mg$CaCO_3$/L and moderate total alkalinity concentrations, generally below 70mg$CaCO_3$/L. The alkalinity/sulfate ratio indicates that groundwater is being affected by, or has already been affected by, the oxidation of sulfides. Moderate alkalinity concentrations coupled with a pH of <6.0 indicates groundwater is generally inadequate to maintain a stable pH in areas vulnerable to acidification. It is also noted that the alkalinity concentrations are approximately equal to the total acidity concentrations, indicating that some buffering capacity is present within the system to offset some of the acidity.

Groundwater quality in the Leederville Aquifer is also considered to be acidic as evidenced by the high total acidity concentrations (up to 200mg$CaCO_3$/L) and pH generally between 5.6 and 6.2. Alkalinity concentrations are in the low to moderate range (20-90 mg$CaCO_3$/L) indicating that groundwater is

inadequate to maintain a stable, acceptable pH level. The alkalinity/sulfate ratio also indicates that groundwater is being affected by, or has already been affected by, the oxidation of sulfides.

SURFACE WATER

Local Rivers

The Proposal is within the Wonnerup (Busselton Coast) Surface Water Management subarea (Figure 2-3) and the Lower Sabina River sub-catchment (Figure 4-16). The Proposal is not within a proclaimed area for surface water management (DoW, 2009).

The Lower Sabina and Abba Rivers are located within ~1km of the Site to the southwest and northeast, respectively, generally flowing in a northwesterly direction. The Lower Sabina River flows from below the Sabina Diversion Weir to the Ramsar listed Vasse-Wonnerup Wetlands. The Lower Sabina, Lower Vasse, Abba and Ludlow rivers drain into the Vasse-Wonnerup Wetlands, before discharging through the Wonnerup Inlet into Geographe Bay.

The Sabina Diversion Weir (Figure 4-16) was constructed to allow overflow during extreme rainfall events from the Upper Sabina to the Lower Sabina, with regular flows through the Sabina Diversion Drain. The weir was over designed and the Upper Sabina catchment (78 km^2) no longer contributes any flow directly to the Lower Sabina river, although some minor sub-drains in the upper catchment may spill in large events (Marillier, 2018). The flow upgradient of the Sabina diversion weir is directed through the Sabina Diversion Drain to the Vasse Diversion Drain system and out to the Geographe Bay, rather than to Vasse-Wonnerup Wetlands.

The Vasse-Wonnerup Wetlands catchment area is 473 km^2, excluding the diverted sub-catchments (DWER, 2019) (Figure 4-16). The Lower Sabina River catchment area of 45.5 km^2 is less than 10% of the Vasse-Wonnerup Wetland Catchment. The Abba River is one of the other major tributaries to the Vasse-Wonnerup Wetland and has a catchment area of 137km^2 which is 29% of the Vasse-Wonnerup Wetlands catchment.

Other regional drainage features outside of the Vasse-Wonnerup Wetlands include the Vasse Diversion Drain, which has a catchment area of 303 km^2 and receives inflows from the diverted Upper Sabina (78 km^2) and Upper Vasse (catchment 180 km^2) rivers (Marillier, 2018).

There are no stream gauges in the Lower Sabina catchment. The closest stream gauges are on the Upper Sabina at the Sabina Diversion (site 610025), and on the Abba River (site 610062). Marillier (2018) analysed gauge information and estimated average annual flows (2001–14) in the major ungauged rivers flowing to the Vasse Estuary Wetland. Marillier (2018) estimated the Lower Sabina discharge as 5.7 GL/year, less than half the Abba River volumes (12.5 GL/yr). In contrast, 4 GL/year is diverted away from Vasse-Wonnerup Wetlands along the Sabina Diversion Drain, and 24 GL/yr is diverted via the Vasse Diversion Drain (Marillier, 2018). The Ludlow River discharges the second highest volumes to the Vasse-Wonnerup Wetlands an annual average of 11.4 GL/yr based on DWER gauging station summary statistics (DWER, 2019).

The Whicher Area Surface Water Management Plan (DoW, 2009) does not list the Sabina or Abba Rivers as connected to the groundwater system. However, the shallow depth of unconfined groundwater at the Site could suggest the possibility of groundwater discharge occurring as baseflow in these rivers. Notwithstanding, hydrographs for both rivers (Figure 4-17) clearly indicate a cessation of the river flow during summer periods, with limited rainfall recharge. Therefore, there is limited or no groundwater connection with the surface water, resulting in minimal or no groundwater contribution to the river's

baseflow. The surface water flow regime is therefore likely to be dominated by high-rainfall periods generating surface water runoff, rather than any substantial groundwater flow component.

On-Site Drainage

Several roads and man-made drains installed in the 20th century have modified the natural drainage pattern within the Development Envelope. These include the Princefield Rd drain located across the northern boundary of the Development Envelope and two other first order drainage lines which contribute to a tributary (Woddidup Creek) of the Lower Sabina River (downstream of the Sabina Diversion Weir). The local drains and waterways in the vicinity of the Proposal are shown on Figure 4-18.

SITE WATER BALANCE

AQ2 (2020b) prepared a conceptual site water balance for the Proposal using GoldSim. The objectives of the water balance, as documented in the ESD (Doral, 2019), include:

- Prepare a conceptual water balance to determine the site water demands over the life of the project. This will include:
    - All fluxes (and their seasonal variations);
    - Discussion of capacity to reuse surplus mine dewater;
    - Requirements for supplementary process water to be sourced from the Yarragadee aquifer.

The GoldSim water balance model was set to run on a daily timestep for 100 model iterations for the 3.5-year mine life. Input data/parameters to the model were set as either a constant value, time-series or probability distribution.

The model operation can be summarised as follows:

- At each time step, open pit areas have been assumed as per the mining schedule;
- Each open pit area has an external surface water catchment area which, reports to the pit during the period over which the pit is open;
- The Process Water Dam (PWD) and Drop-Out Dam (DOD) collect local runoff from the adjacent plant, admin and impervious areas, plus receive pumped water being removed from the open pits (dewatering plus stormwater).;
- At each model timestep (daily), rainfall is included within the model, with runoff collected in the base of the operating pit, and within the PWD and DOD;
- Dewatering inflow rates over the mine life, obtained from groundwater modelling studies AQ2 2020a), have been used as an inflow to the active pit area;
- Water collected within the active pit area is pumped to the PWD/DOD at an assumed transfer rate (nominally 75L/s);
- Process water demand is sourced from the PWD/DOD;
- The model tracks water which exceeds the PWD/DOD capacity (i.e. potentially requires discharge), plus water shortfall from the PWD/DOD (i.e. needs to be supplemented by pumping from the Yarragadee aquifer).

The model was run for two dewatering scenarios resulting from different rainfall patterns being applied to the groundwater model – a wet rainfall sequence ("Wet Dewatering" scenario) and a dry rainfall sequence ("Dry Dewatering" scenario).

Based on the water balance model predictions, the following results have been concluded by AQ2 (2020b):

- A 1.6GL annual abstraction licence from the Yarragadee aquifer should be sufficient to provide a reliable water supply system, with the predicted peak annual demand of 1.3GL. The highest demand for groundwater is expected to be in the first year of operation.
- An annual discharge licence in the order of 100,000m^3 (100ML) would allow the site to discharge from the PWD/DOD during wet conditions without impacting operations. The largest annual discharge volume was predicted to be 82,000m^3 during the Q2 2023 mining period, across the 100 model iterations. Some buffer storage capacity within the open pit is assumed within this estimation.
- Although an annual discharge licence in the order of 100,000m^3 is suggested, the licence is to cover the risk of a wet period occurring during the 2023 winter (greater than 50% likelihood). Outside this period, the model doesn't predict there to be a requirement to discharge surplus water. Note that a separate assessment has been documented to estimate runoff from a 100-yr event across the site (with different assumptions to this assessment), refer to (AQ2, 2019b).

BASELINE GROUNDWATER LEVELS AND QUALITY

Doral recognise the importance of the collection of background or 'pre-mine' water quality data given the wider Busselton area has previously been modified by agricultural uses since the 1830s (DoW, 2010) and has the potential to be further impacted by mining. Background groundwater quality data will be used for comparison with data collected during mining and post-mining to monitor and identify any impacts.

Doral has undertaken site-specific groundwater monitoring for the Proposal since 2017, which involved the collection of background groundwater data relating to water level and water quality of the Superficial and Leederville aquifers from six monitoring bores installed by Doral (YA_MB01S, YA_MB02S, YA_MB04S, YA_MB07S, YA_MB09S and YA_MB10S) and also from several private landowners bores on a monthly basis. Bores (YA_MB03S, YA_MB05S, YA_MB06S, YA_MB08S, YA_MB11S and YA_M12S) were constructed in June 2019 and commenced monitoring following improved accessibility to the site in October.

Locations of bores selected for the baseline groundwater monitoring of the Superficial aquifer and contours for winter and summer periods are shown in Figures 4-19 and 4-20.

Locations of bores selected for the baseline groundwater monitoring of the Leederville aquifer and contours for winter and summer periods are shown in Figures 4-21 and 4-22. Details of Doral's monitoring bores and private landowners' bores are provided in Table 4 and Appendix C of (AQ2, 2020a).

Water Levels

The results from monthly water level monitoring in the Superficial aquifer indicates the following:

- Pre-mining groundwater levels in the Superficial aquifer across the proposed mining area ranged between 15.6 and 34.8 mAHD (i.e. 0 to 4.7mbtoc);
- Highest water level elevations were recorded in August or September and lowest in May or June;

- Seasonal cycles of water table variations associated with the winter-dominated rainfall recharge to the Superficial aquifer are evident. The seasonal water level variations for these bores were between 1.7 and 2.6 m, averaging of 2 m;
- The site's Superficial groundwater flow direction is towards the north-west under a low hydraulic gradient, closely following the Site topography and consistent with the regional flow direction.

The results from monthly water level monitoring in the Leederville aquifer indicates the following:

- Long-term groundwater elevations (since 2000) recorded in the DWER monitoring bores, 61030085 (BN28I) and 61030088 (BN29I), located nearby to the Site, ranged between 18.2 to 20.3mAHD and 33 to 35.8mAHD, respectively, with the seasonal water level fluctuations of between 2 to 2.5m;
- Bores Lot668_Bore2 and 23073124 recorded water level variation of up to 6m as a response to pumping in these bores;
- Groundwater levels (m below surface) in the Leederville aquifer tend to decrease towards the north-west, which is consistent with the regional groundwater flow direction generally towards the coast.

Groundwater Quality

Field groundwater quality measurements (i.e. pH, EC and TDS) were also taken from selected bores screened in the Superficial and Leederville aquifers on a monthly basis since December 2017.

The baseline groundwater quality from the Superficial aquifer is summarized below (AQ2, 2020a):

- Field pH is in the range of 5.2 (YA_MB07S) to 6.5 (20005166); acidic to slightly acidic, but generally pH was between 5.4 and 6. Lower values of pH were normally recorded in summer periods and higher values in winter periods;
- Field TDS concentrations ranged between 190mg/L (YA_MB07S) and 1,900mg/L (SCPD28A), generally below 1,200mg/L, indicating water being generally fresh to marginal. The only exception is SCPD28A, where TDS concentrations range from 1,400 and 1,900mg/L (i.e. brackish);
- Total Acidity (as $CaCO_3$) ranged from 14 to 170mg/L, relatively consistent;
- Total Alkalinity (as $CaCO_3$) ranged from 11 to 130mg/L, generally below 70mg/L, relatively consistent;
- Sulphate concentrations ranged between 24 to 230mg/L, generally below 150mg/L;
- Concentrations of dissolved metals are mostly below or just above the limit of reporting, except for the iron concentrations that are slightly elevated (between 0.4 to 23mg/L) in all Doral monitoring bores.

The baseline groundwater quality from the Leederville aquifer is summarised below (AQ2, 2020a):

- Field pH was in the range of 5.2 (20005356) to 6.6 (Lot758_Bore); acidic to slightly acidic, but generally pH was between 5.6 and 6.2;
- Field TDS concentrations ranged between 350mg/L (Lot552_Bore) and 1,050mg/L (20005356), generally below 800mg/L, indicating water being fresh to marginal;
- Total Acidity (as $CaCO_3$) ranged from 50 to 200mg/L, relatively consistent;
- Total Alkalinity (as $CaCO_3$) ranged from 20 to 90mg/L, relatively consistent;

- Sulphate concentrations are generally below 40mg/L, except for 20005356 (60 to 140mg/L);
- Concentrations of dissolved metals were generally low, except for the iron concentrations that were recorded to be elevated (between 20 and 35mg/L);
- In general, groundwater samples collected from the Leederville monitoring bores during summer and winter periods have a similar chemical composition and are dominated by sodium and chloride.

Further details on water level and water quality data can be found in (AQ2, 2020a). Doral will continue to assess groundwater quality from both the Superficial and Leederville aquifers.

BASELINE SURFACE WATER QUALITY

A network of 14 surface water monitoring sites (YALSW01 to YALSW14) have been identified and monitored on the near surrounds of the Site since July 2017. These locations are shown on Figure 4-23 with details of each location provided in Table 4-24 Monitoring of surface water level and quality allows recording of any unseasonal increases in water level, seasonal fluctuations and any changes in basic water chemistry pre-mining and during the period of the mine operations.

TABLE 4-24: DETAILS OF SURFACE WATER MONITORING SITES

Site Name	Approximate Location (GPS surveyed)			Reason for Sampling
	Eastings (MGA94)	Northings (MGA94)	Elevation (m)	
YALSW01	355307	6269882	23	Original Sabina River channel. Limited area surface flows ~1km downstream from Sabina Diversion weir.
YALSW02	356614	6269990	24	Artificial drainage flows from paddocks within Lot 421
YALSW03	357034	6270001	26	Woddidup Creek flows, semi regional, ~3.0km x 2.0km catchment
YALSW04	357848	6270038	23	Ag dam Lot 758. Seepage from Bassendean Sands in close proximity to proposed mining
YALSW05	359214	6270070	29	Un-named Creek, catchment estimated 2.0km x 2.0km
YALSW06	356099	6270231	21	Optional, alternate site if YALSW02 access is poor
YALSW07	356887	6270304	20	Farm dam
YALSW08	356081	6270852	20	Optional, alternate site if YALSW02+06 access is poor
YALSW09	357805	6270840	22	Un-named Creek/Artificial drains in centre of project
YALSW10	355520	6271611	18	Downslope sampling site for western margins of project.
YALSW11	356540	6271665	18	Woddidup Creek flows, downslope flows from central west of project area. No Mixing with Princefield Drain.
YALSW12	356866	6271676	18	Un-named Creek/Artificial drains in centre of project. No Mixing with Princefield Drain.

Site Name	Approximate Location (GPS surveyed)			Reason for Sampling
	Eastings (MGA94)	Northings (MGA94)	Elevation (m)	
YALSW13	356997	6271686	18	Roadside drain downslope flows from north east of project area.
YALSW14	358604	6271766	21	Roadside drain downslope flows from north east of project area

Since monitoring commenced in July 2017, data for all surface monitoring sites has been collected on a monthly basis, except for the site YALSW09, due to access limitations (i.e. landowner access approval).

A summary of the monitoring results (AQ2, 2020a) indicates that:

- The surface water flows on site are limited to winter and spring seasons;
- Field pH was in the range of 6 (YALSW03) to 8.5 (YALSW07); slightly acidic to slightly alkaline, but generally neutral (i.e. pH between 6.5 and 7);
- Field EC was generally between 100 and 3,000µS/cm for all surface water sites, except for site YALSW07, where higher EC readings were recorded (between 3,600 and 5,300µS/cm). These increased EC values could be related to this dam having limited seepage connection with the groundwater, possibly due to clayey layers surrounding the wall of this dam, causing increase in EC concentrations owing to evaporation. Additionally, at this site EC concentrations are the lowest during wet season where rainfall peaks and the highest during dry seasons where rainfall is low;
- Field TDS concentrations ranged between 40 and 1,500 mg/L for all surface water sites, indicating water being fresh becoming slightly brackish. The only exception is site YALSW07 where TDS concentrations range from 1,800 to 2,600 mg/L, being brackish, likely due to this dam having limited seepage and high evaporation;
- TSS values were mostly below 10 mg/L for the majority of surface water sites, except for July 2018 sampling event, where high TSS concentrations were recorded at all sites;
- Sulphate concentrations were generally below 150mg/L, except for YALSW07 (i.e. 250 to 490mg/L);
- Total Acidity (as $CaCO_3$) was below 15mg/L in all monitoring sites;
- There have been seasonal increasing trends of EC, TDS and sulphate in all surface water sites (except for YALSW07). These rising trends generally commence in June/July (i.e. at the start of the surface water flow) to October/November (i.e. when the flows diminish) and are likely related to sulphate leaching out from free draining soils up-slope of the Lower Sabina catchment during high rainfall or irrigation periods.

4.4.4. POTENTIAL IMPACTS

Potential impacts from the Proposal on Inland Waters are:

- Short-term dewatering of mine pits and associated drawdown of the water table, which may affect:
  - Water availability at surrounding groundwater users;
  - Potential GDE's;

  - Acid Sulfate Soils.
- Hydrological impacts on the Lower Vasse River Catchment and Vasse-Wonnerup Ramsar wetlands including:
  - Groundwater drawdown on surface water courses;
  - Reduction in surface water yields;
  - Discharge of surplus water.
- Short-term abstraction of water from the Yarragadee aquifer, which may affect other users of the Yarragadee aquifer and the overlying Leederville Aquifer;
- Reduction in groundwater quality to the Superficial and Leederville aquifers as a result of dewatering potential ASS potentially affecting beneficial users of water for non-potable uses;
- Reduction in surface water quality as a result of discharge of water in emergency situations, which may have a localised adverse effect on the receiving environment, such as the Lower Sabina River and the Vasse-Wonnerup Ramsar wetlands.

4.4.5. ASSESSMENT OF IMPACTS

A groundwater model was developed by AQ2 (2020a) (Appendix 7A) for the Proposal to assist with assessment of hydrological impacts within the surrounding groundwater catchment and predict the following:

- Dewatering requirements for the proposed Yalyalup mining operation;
- Drawdown impacts across the modelled catchment of mine dewatering at the Site and water supply pumping from the Yarragadee aquifer during mining and after mine closure;
- Drawdown impacts of Doral's proposed groundwater abstraction on:
  - Other groundwater users in the modelled catchment;
  - The Vasse-Wonnerup Ramsar Wetland system;
  - Other potentially sensitive areas in the catchment (GDE's).
- The impact of groundwater pumping on the modelled catchment water balance.

The modelling study was completed consistent with the *Australian Groundwater Modelling Guidelines* (Barnett, et al., 2012). Key features of the groundwater model are summarised below:

- The Superficial Formation and the underlying Leederville and Yarragadee aquifers;
- Recharge to the aquifer system from rainfall recharge;
- Groundwater inflow from upstream and groundwater outflow to downstream;
- Dewatering of the proposed Yalyalup mine area and dewatering at Cristal's nearby operational mine;
- Water supply pumping from the Superficial, Leederville and Yarragadee aquifers;
- Evapotranspiration from the shallow water table across the modelled catchment and the areas of the Vasse-Wonnerup Ramsar Wetlands System that lie within the model domain, north west of the Proposal.

DEWATERING MINE PITS AND DRAWDOWN OF WATER TABLE

Dewatering of mine pits and localised drawdown of the water table will occur in a staged approach, with mine pits being dewatered as per the mining schedule (Table 2-4). Dewatering involves lowering the hydraulic head of the aquifer to the base of the open-cut mine pit, to allow dry mining techniques to be carried out within the pit.

Dewatering of mining areas occurs through the construction of a sump at the deepest point of the pit. The rest of the pit is then open drained to this sump with water is pumped from the sump to the drop out dam (either directly or via an open drain and then gravity fed). Water then flows from the drop out dam to the process water dam, where it is utilised in processing operations.

Groundwater drawdowns (i.e. decrease in water levels) in the Superficial aquifer and the underlying Leederville aquifer due to the open pit dewatering have been predicted by the numerical model. These drawdowns are the difference between the water levels predicted at each selected time interval for the *Yalyalup Dewatering* Scenario and the corresponding *No Yalyalup Development* Scenario. The *Yalyalup No Development* Scenario contained the same conditions as the *Yalyalup Dewatering* Scenario, except that proposed dewatering for the Proposal was excluded.

Contours of predicted Superficial aquifer water table drawdown at quarterly intervals, over the mine life, for the *Yalyalup Dewatering* Scenarios are shown in Figures 4-24a to 4-24n) for the dry climatic conditions, and Figures 4-25a to 4-25n for the wet climatic conditions.

In summary, water level drawdowns in the Superficial aquifer are predicted to be localised in the immediate area of the active mining pits, temporary in duration and relatively small, with a maximum drawdown of 10.5m predicted at the end of mining in Q2 of 2023. The cone of depression of 0.1m generally lies within the proposed mining disturbance areas and only marginally extends past this area (up to 700m for the dry scenario and 600m for the wet scenario).

The following general observations can also be made regarding predicted drawdown:

- As would be expected, maximum drawdown is predicted in the immediate mine area. The total maximum drawdown predicted over the life of the mine varies with mining depth;
- Maximum drawdown is predicted in the immediate mining area and is similar for both climatic cases;
- The extent of predicted drawdown shown (0.1m contour) is generally limited to the disturbance areas within the Development Envelope.
- The maximum distance that drawdown of 0.1m extends outside of the perimeter of the mine disturbance area is 700m to the north, 250m to the south, 300m to the east and 450m to the west, at various times during the mine life for the dry climate scenario.
- For the wet climate scenario, the maximum distance that drawdown of 0.1m extends outside of the perimeter of mine disturbance area is 600m to the north, 200m to the south, 300m to the east and 400m to the west, at various times during the mine life for the wet climate scenario.

Contours of maximum predicted drawdown in the Leederville aquifer from dewatering of the Yalyalup mine (*Yalyalup Dewatering* Scenario) are shown in Figures 4-26 and 4-27 for dry and wet climatic conditions. This maximum drawdown is predicted in September 2023 and is calculated by subtracting predicted water levels for the Leederville aquifer for the *Yalyalup Dewatering* Scenario from the *No Yalyalup Development* Scenario. A similar drawdown profile is predicted for the dry and wet climate scenarios. The extent of predicted

drawdown in the Leederville Aquifer shown (0.1 m) is generally limited to the disturbance areas within the Development Envelope. The maximum distance that drawdown of 0.1 m extends outside of the perimeter of the mine disturbance area is 700m to the north, 50m to the south, 300m to the east and 300m to the west for both wet and dry scenarios (i.e. Q3 of 2023).

Additionally, some small drawdowns (up to 0.4m) are predicted in the Leederville aquifer due to dewatering of the overlying Superficial aquifer. The Mowen Member of the Leederville Formation is generally considered as an aquitard, however at the Site the Mowen Member is thin resulting in small indirect upward leakage of water from the Leederville aquifer from below the pit floor. Based on the results of groundwater modelling, the drawdowns in the Leederville aquifer are predicted to be local and likely to extend laterally, but not vertically (owing to clayey layers within the sand).

Long-term post mining effects on water levels are expected to be minimal. The recovery of water levels will commence immediately once mining of each active mine pit is completed, owing to backfilling of mined-out pits. Groundwater inflows to the mined-out pits are driven by water level gradients between the mine voids and the surrounding areas. It should be noted that during the mining phase, water recovery in mined-out areas may be interfered with by dewatering of subsequent mining areas, thus the rate of water level recovery can be slow. Once all mining areas are completed, dewatering will cease, and water levels will continue to rise until a steady state or equilibrium water level is resumed. The numerical model shows that water levels are predicted to return to pre-mining levels within 18 months of mine closure (i.e. by July 2026).

Therefore, it is unlikely that short-term dewatering at the proposed Site will have any adverse impacts on the water supply potentials of the Superficial and Leederville aquifer systems.

DRAWDOWN ON GROUNDWATER USERS

Two bores under one licence, (GWL180363) that abstract water from the Superficial aquifer, are located within the modelled drawdown extent of between 0.1 to 0.25m contour due to dewatering (occurring during Q4 of 2021 and Q3 of 2022 for the wet scenario and from Q4 of 2021 to Q1 of 2023 for the dry scenario). The maximum drawdown of 0.3m is predicted to occur during Q2 of 2022 (Figure 4-28). The remaining Superficial aquifer licenced bores are located outside of the predicted 0.1 m drawdown contour and are unlikely to be impacted by the dewatering operations.

Additionally, there are several unlicenced bores which are screened in the Superficial aquifer that are within the modelled extent of the 0.1 to 0.25m drawdown contours. Most of them have either been decommissioned or used by DWER for monitoring purposes. There are only five unlicenced bores (20005101, 20005166, 20005168, 20005169 and Lot421_Bore2) that have been reported by Doral being in use and three of them (20005101, 20005166 and 20005169) may experience short-term minor water level reductions (i.e. drawdowns of between 0.1 to 0.25 m) due to mining dewatering – this limit drop in water level is unlikely to influence their supply potential. It is also noted that bores 20005101 and 20005169 are only used for water level monitoring (no abstraction).

The numerical model also indicated that small drawdowns (up to 0.4m) are predicted in the Leederville aquifer due to dewatering of the overlying Superficial aquifer. There are three Leederville aquifer licences (GWL67672, GWL94291 and GWL178017) that have bores located within the drawdown extent of between 0.1 to 0.25 m and could be affected by mining related dewatering (Figure 4-29). However, these drawdowns are predicted to be temporary in duration and relatively minor.

It is therefore unlikely that short-term dewatering at the proposed Yalyalup mine will have any long-term adverse impacts on the water supply potentials of other users in the Superficial and Leederville aquifers.

Regular monitoring of groundwater levels in the Superficial and Leederville bores and the clear communication with the nearby groundwater users during the mining operation, will provide information on the actual induced drawdowns and impacts on the other users. If any of the Superficial and Leederville bores are affected by Doral's mining operations, then Doral will implement the mitigation measures.

DRAWDOWN OF POTENTIAL GDE'S

Ecoedge (2020c) conducted an assessment of potential impacts to GDEs from groundwater drawdown, using groundwater modelling information (AQ2, 2020a) and a review into water dependency of vegetation communities present within the Development Envelope.

Figure 4-24h shows the projected drawdowns for Q2 (Apr-Jun) 2023 under dry climatic conditions. Under this scenario drawdown of 1m would occur within 30m of GDE Area A (and between 0.1m and 0.25m within the road verge vegetation), and of 7m within 40m of the northern part of GDE Area B. Within the vegetation on McGibbon Track in the northern part of Area B, drawdowns of between 3m and 5m are projected.

During Q3 2023 (Figure 4-24i), the contours of projected drawdown move further south and the central part of GDE Area B has 7m projected drawdowns within 40m of its boundary and 4-5m within the vegetation on McGibbon Track. In this quarter, however, the projected drawdowns of vegetation unit B1 (SWAFCT10b) within GDE Area B are only 0.1 – 0.25m. Predicted drawdowns in the central part of GDE Area B reduce to 1-2m by Q4 2023 (Figure 4-24j).

Mining moves to the east side of McGibbon Track in 2024 and in Q3, 2024 (Figure 4-24m) drawdowns within vegetation unit A2 (SWAFCT02) within GDE Area B on McGibbon Track are predicted to be 3-4 m, and within 20m of the edge of the road reserve they are predicted to be 5m (Q3, 2024, Figure 4-24m). Water level drawdown within vegetation unit A2 (SWAFCT02) is projected to be between 0.25-1.5m in Q3, 2024. In Q4, 2024 (Figure 4-24n), water level drawdowns will remain between 0.5m and 2m within the central part of GDE Area B, which includes vegetation unit B1 (SWAFCT10b). Predicted drawdowns within the central part of GDE Area B are similar whether the "wet climate" or "dry climate" is chosen.

The predicted water level drawdowns under the dry climate scenario are no greater than 0.25m for GDE Area C.

Based on what is known about the hydrogeology and groundwater dependence of vegetation for the Proposal, it is likely that the predicted water drawdowns for the central and northern part of GDE Area B will be moderate to severe (Ecoedge, 2020c) (Figure 4-7). The Wet Shrublands (SWAFCT02), unit A2, with predicted drawdowns of up to 5m, and drawdowns of more than 2m lasting for 3-6 months in 2023, is likely to be moderately to severely impacted. Small trees and medium- deep-rooted shrubs within this groundwater-dependent community, such as *Banksia littoralis*, *Melaleuca preissiana*, *Hakea ceratophylla* and *Xanthorrhoea preissii* are likely to suffer moderate-severe desiccation and possible death. *Banksia littoralis*, which is an important part of the overstorey, has a high likelihood of significant mortality, especially if 2023/2024 is a dry year with less than average rainfall (Ecoedge, 2020c). The area of this vegetation unit likely to be severely impacted by the projected water drawdowns is 1.81ha.

Impact on the Ironstone Shrubland (SWAFCT10b), unit B1, is predicted to be low-moderate, with the impact likely to be higher at the northern end (Ecoedge, 2020c). Maximum predicted drawdowns in the ironstone shrubland are predicted to be 1-1.5m in Q3 and Q4, 2024 (Figures 4-24m and 4-24n). Most of the shrubs growing in this ironstone community are relatively large and old, including the Endangered *Banksia squarrosa* subsp. *argillacea*. As such they are likely to have roots that have found their way through fractures in the ironstone to access groundwater as it retreats in late summer and autumn. There is a previous case

of nearby mineral sands adversely impacting an ironstone community at Tutunup (Meissner & English, 2005), although in this case the pit was closer to the community than will be the case for the Proposal. There is a moderate probability that stress within shrubs growing in the ironstone vegetation will increase, and potentially some deaths will occur if drawdowns are greater than 1m. The area of this vegetation unit likely to be moderately impacted is 0.34ha.

Effects on the GDE vegetation within Areas A and C are likely to be minimal based on the predicted drawdowns. However, it is likely that there will be increased stress and potentially mortality in individual trees in degraded vegetation that has not been mapped as a GDE, such as in the stand of *Eucalyptus rudis* on private property (Lot 3752) immediately east of vegetation unit B1 on McGibbon Track.

TABLE 4-25: POTENTIAL INDIRECT IMPACTS TO GROUNDWATER DEPENDENT VEGETATION

GDE	AREA OF GDE WITHIN DEVELOPMENT ENVELOPE (HA)	AREA AND PREDICTED SEVERITY OF POTENTIAL IMPACTS (HA)		
		LOW	MODERATE	SEVERE
A2 (SWAFCT02)	3.42	1.01	0	1.81
B1 (SWAFCT10b)	0.45	0	0.34	0

DRAWDOWN ON POTENTIAL ASS

Results of Doral's ASS investigation (Appendix 5) indicate that potential unoxidised sulfidic acidity is present in Site soils throughout the soil profile. If exposed to the atmosphere, the sulfide minerals will oxidise and generate sulfidic acidity. Oxidation of sulfide minerals may potentially occur during extraction of soils containing potential ASS and/or as a result of dewatering activities.

The strandline deposit ore will be mined progressively via a series of open-cut pits using dry mining techniques. Once the topsoil and available subsoil are stripped and stockpiled, overburden will be removed via excavators and trucks and dozers. Overburden that has been identified as ASS will be immediately transported to an open pit void and backfilled simultaneously with a suitable alkaline material at an appropriate rate to account for the acidity.

Dewatering to the required depth of excavation (maximum of ~10.5mBGL) will occur passively as groundwater enters the mining excavation. The water will be pumped out using a suction pump set at a level to maintain a 0.5m saturated pit floor and sent through to a sump prior to reaching the unlined process water dam where it mixes with other water from other mine processes. This lowering of the water table (although passive) may therefore expose sulfide minerals to oxygen, resulting in oxidation of *in situ* soils within the predicted dewatering drawdown extent. If the oxidation of *in situ* ASS generates sulfidic acidity then groundwater is the initial pathway by which impacts may migrate. Acidity could therefore be mobilised downwards by leachate, upwards with groundwater rebound, or laterally by groundwater migration. If acidic groundwater mobilises heavy metals they will migrate along the same pathways.

The extent of groundwater drawdown however is reduced by recharge of water, resulting from the hydraulic backfill of the pit voids with sand tails and clay fines. The pit backfilling acts to recharge groundwater levels rapidly, compared to unassisted rebound by aquifer hydraulic head pressures only. The expedited recharge, thereby reduces the extent of dewatering influence and returns the soil profile to anoxic conditions. Unreacted lime sand that is added to the ore slurry at the in-pit hopper (to ensure the process stream pH is

maintained at pH5.5) also ends up in the sand tails waste stream, assisting to buffer the pH of the groundwater system as rebound occurs.

The maximum distance that drawdown of 0.1m extends outside of the perimeter of the mine disturbance area, which may oxidise *in situ* soils, is 700m to the north, 250m to the south, 300m to the east and 450m to the west, at various times during the mine life for the dry climate scenario, which is considered to represent worst case scenario.

HYDROLOGICAL IMPACTS TO LOWER SABINA RIVER AND VASSE WONNERUP WETLANDS

GROUNDWATER DRAWDOWN ON SURFACE WATER COURSES

Drawdown modelling conducted by AQ2 2020a shows that the drawdown from dewatering of mine pits does not extend to the Lower Sabina River (~1.6 km to the west), Abba River (~1 km to the east) or the Ramsar listed Vasse-Wonnerup wetland (~4.6km to the north west) during the life of the mine.

In addition, as identified in Section 4.4.3 (Surface Water), there is limited or no groundwater connection with these surface water bodies, resulting in minimal or no groundwater contribution to the river's baseflow. Therefore, the existing surface water flow regime is unlikely to be impacted by the dewatering operations during the implementation and operation of the Proposal, as it is likely to be dominated by high-rainfall periods generating surface water runoff, rather than any substantial groundwater flow component.

Additionally, flows in the local surface water drains around the mining area are similar to the Lower Sabina or Abba Rivers and rely mainly on surface water runoff after heavy rainfall events, with no or limited groundwater contribution to surface water flow in these local drains.

As such, no predicted impacts to surface water courses from groundwater drawdown are predicted.

REDUCTION IN SURFACE WATER YIELDS

A surface water assessment was prepared by AQ2 (2019a) to estimate how the proposed mine pits will reduce surface water runoff to the downstream water courses and minimise potential impacts.

Figure 4-16 shows the mine pits and other disturbance areas within the broader catchment areas for the Proposal. Not all areas will be disturbed at one time as the mine pits will be mined sequentially in accordance with the Mining Schedule (Table 2-4) and rehabilitation will occur progressively for completed areas. However, for the purposes of assessing reductions in surface water yield, conservatively the entire mine disturbance area of ~3.6km^2 has been used as the basis for calculations (Table 4-26 and 4-27).

Several local catchments labeled A to D on Figure 4-18 drain towards the disturbance area, with areas of each sub catchment provided in Table 4-26.

TABLE 4-26: DIVERTED UPSTREAM CATCHMENT AREAS

	TOTAL AREA (km^2)	SUB CATCHMENT AREA (km^2)			
		A	B	C	D
Upstream sub catchment area (diverted around disturbance area)	4.7	1.08	2.59	1.05	0.017

To minimise changes to downstream flows, diversion of the intercepted upstream catchments around the disturbance areas is proposed, in order to convey only clean upgradient flows and not intercept site runoff from disturbed areas. Proposed diversions are shown in Figure 4-18.

Water from the disturbed areas within at the Site will generally be captured and reused within the mining process. An emergency overflow spillway and licensed discharge point to a road-side drain along Princefield Road is also proposed as shown on Figure 1-2.

The impact to the potential contributing surface water catchments (i.e. Lower Sabina and Vasse-Wonnerup Wetlands) during mining is shown in Table 4-27.

TABLE 4-27: SURFACE WATER CONTRIBUTION AREA

	LOWER SABINA RIVER	VASSE-WONNERUP WETLANDS	SABINA PRIOR TO HISTORICAL DIVERSION
Catchment Area (km^2)	45	473	123
Mine/ Infrastructure Disturbance Area (km^2)	3.6	3.6	3.6
Catchment Area excluding Disturbance Area (km^2)	41.4	469.4	119.4
Contribution area remaining during mining (%)	92%	99%	97%

The impact to the potential contributing surface water catchment during mining is a maximum 1% reduction to the Vasse-Wonnerup Ramsar wetland, based on a catchment area of 473km^2 (DWER, 2019) and a total mine pit disturbance area of ~3.6km^2, a relatively minor change for the large wetland system, which is the key downstream environmental receptor.

The Lower Sabina River is not considered a key receptor given its heavily modified catchment area as a result of the construction of the Upper Sabina Diversion and other modifications for agricultural uses. Based on a catchment area of 45.5km^2 for the Lower Sabina River (DWER, 2019) and a total mine pit disturbance area of ~3.6km^2, the maximum reduction to the Lower Sabina River catchment is calculated to be ~8%.

However, it should be noted that as mining is staged and not all mine pits will be open at once to capture rainfall/runoff, the actual reduction to these catchment areas will be less than ~1% and ~8%, to the respective catchments. Furthermore, given the Lower Sabina River has an average annual discharge of approximately 5.7GL, disturbance of up to ~8% of the catchment area would only reduce the annual discharge by 0.46GL. In addition, during operations, runoff from undisturbed and progressively rehabilitated areas from within the Site will be allowed to drain offsite and reduce the aforementioned conservative estimates.

DISCHARGE OF SURPLUS WATER

The Site Water Balance (AQ2, 2020b) indicates that during wet climate sequences water pumped to the PWD/DOD from the mine pits (collected groundwater and stormwater) exceeds the mine water demand for a sufficiently sustained period such that the PWD/DOD will overtop. The required period where surplus water would be generated is confined to the Q2 2023 mining period (i.e. winter 2023 period). The annual surplus (discharge) water estimates from the GoldSim Model (Figure 6 of AQ2, 2020b) show the following:

- The PWD/DOD is predicted to overtop in 55% of the model runs;
- There is a 25% chance that the predicted discharge volume will exceed 23,000m^3 (23ML);
- The maximum total volume of water predicted to overtop the PWD/DOD in any of the model iterations is 82,000m^3 (0.082GL).

The impact from the modelled maximum volume of water to be discharged from the site during the winter 2023 period to the annual flows of the Lower Sabina River and the Vasse Wonnerup Wetlands is presented in Table 4-28.

TABLE 4-28: IMPACTS FROM DISCHARGE OF EXCESS WATER TO SURFACE WATER RECEPTORS

SURFACE WATER RECEPTOR	ANNUAL FLOW (GL)	MAXIMUM DISCHARGE VOLUME (GL)	PERCENTAGE OF INCREASED DISCHARGE (%)
Lower Sabina River	5.7	0.082	1.44
Vasse-Wonnerup Wetlands*	29.6	0.082	0.28

*Combined flows from the Lower Sabina, Abba and Ludlow Rivers

The impact to the potential contributing surface water catchment during mining is a maximum 1.44% increase to the Lower Sabina River annual flows and only 0.28% increase to the Vasse-Wonnerup Ramsar wetland flow, based on the maximum modelled volume of water to be discharged (82,000m^3). The increase to the annual surface water flows to both systems is considered minor. Potential impacts associated with a reduction in water quality is discussed later in this section.

A Surface Water Discharge Assessment was completed by (AQ2, 2019b) to determine the runoff volume that may be required to be discharged from the PWD/DOD following a 100-yr, 72hr rainfall event. AQ2 (2019b) notes that the likelihood of such an event of this size occurring during the ~3.5yr mining operation is 3.5%. Total runoff volume was determined by calculating the total runoff volume generated over the entire disturbance area (3.6km^2) for the design rainfall event depth (168mm) and a runoff coefficient of 0.75, corresponding to a proportionate loss rate of 25% for a 100-yr event in loam soils with 100% clearing (as per Rainfall and Runoff Volume 1, 1998).

In addition, the following conservative assumptions were made in the calculations by AQ2 (2019b):

- Water generated from the full mine area within the site boundary flood bund, reports to the PWD/DOD;
- All storage capacities at the Site including mine voids and storage ponds, are full and unable to store or attenuate the required runoff rates;
- Other site water inputs (such as dewatering) will meet the mine water demands during the rainfall event, such that no runoff from the rainfall event will be consumed by the mine process.

Results of the modelling indicate that a total runoff volume that may require discharge under emergency situations following a 100-yr event is ~450ML. This estimated volume accounts only for rainfall runoff within the mine area and does not include inflows from upstream catchments, all of which are assumed to be diverted around the disturbance footprint and released downstream (as per Surface Water Assessment, AQ2, 2019a).

AQ2 (2019b) notes that this assessment is highly conservative due to the following:

- The likelihood of a 100-yr rainfall event occurring within the 3.5yr mine life is 3.5%;
- The full disturbance footprint has been assumed to contribute to the discharge volume, whereas in practice, at any one time there will only be a single mine void open, plus previously mined areas in

various stages of backfill and rehabilitation. Undisturbed areas will not be required to pass through the PWD/DOD;

- The Site is dissected by a diversion channel which will pass flow from upstream of the mining area to downstream.

The impact from the modelled total runoff volume to be discharged from the Site during a 100-yr 72-hr rainfall event, to the annual flows of the Lower Sabina River and the Vasse Wonnerup Wetlands is presented in Table 4-29.

TABLE 4-29: IMPACTS FROM DISCHARGE OF 100-YR RAINFALL EVENT TO SURFACE WATER RECEPTORS

SURFACE WATER RECEPTOR	ANNUAL FLOW (GL)	MAXIMUM DISCHARGE VOLUME (GL)	PERCENTAGE OF INCREASED DISCHARGE (%)
Lower Sabina River	5.7	0.45	7.95
Vasse-Wonnerup Wetlands*	29.6	0.45	1.52

*Combined flows from the Lower Sabina, Abba and Ludlow Rivers

The modelled runoff volume which would be required to be discharged from the Site following a large, rare rainfall event will be returned to the same catchment it would have discharged through prior to mining activities. As such, there is not expected to be any hydrological impacts of discharging this water to the downstream environments of Lower Sabina River and Vasse-Wonnerup Ramsar wetland. Potential impacts associated with a reduction in water quality is discussed later in this section. Doral will however monitor the quality of runoff prior to discharge to ensure it meets any discharge water quality requirements.

Doral will make every effort to maximise water recycling and to minimise water use. Process water will, in the first instance be sourced from recycled water and dewatering of the pits. Additional process water sourced from the Yarragadee aquifer bore will be used only after other resources have been fully utilised. Water will be discharged offsite when the storages at PWD/DOD are at their full capacity (overtop) in the event of sufficiently sustained period of high rainfall events resulting in site runoff exceeding the mine water dam.

SHORT-TERM ABSTRACTION OF WATER FROM THE YARRAGADEE AQUIFER POTENTIALLY AFFECTING OTHER USERS OF THE YARRAGADEE AQUIFER

The proposed extraction of 1.6 GL/year from the Yarragadee aquifer for the Proposal is unlikely to have any adverse impacts on the water supply potentials of the aquifer systems, as the extraction will result in a piezometric level reduction in this aquifer on the local scale only (AQ2, 2020a). A maximum drawdown of 3.8m is predicted adjacent to the production bore after 3.5 years of pumping, with the 1m drawdown contour extending up to 1.2km from the production bore. Generally, the 1m drawdown lies within the proposed mining disturbance area.

At the Site, the Yarragadee aquifer is a confined aquifer with limited downward leakage from overlying aquifers, due to the presence of low permeable confining layers within the aquifers. However, there may be some small drawdowns recorded in the Leederville aquifer (Vasse Member) during the 3.5 years of pumping from YA_PB01 and the drawdown may extend in the vicinity of YA_PB01 (i.e. a maximum drawdown of 0.6 m with the 0.5m drawdown estimated to extend no more than 1.3 km from the production bore) (Figure 4-30). It is noted that these predicted drawdowns are not water table drawdowns, but pressure changes (AQ2, 2020a).

It should be noted that Doral plans to pump from YA_PB01 only when required (i.e. when there is a shortage of water from rainfall runoff and pit dewatering), therefore the actual drawdowns in the Yarragadee and Leederville aquifers will be smaller than predicted, due to the recovery periods between the extractions.

Regular monitoring of groundwater levels in the all aquifers during the mining operation will provide information on the actual induced drawdowns and impacts on these aquifers.

There are no known bores that abstract water from the Yarragadee aquifer that are located within the extent of the 0.5m and 1m drawdown contours developed around the production bore (i.e. within 1.2 and 3.7km from the YA_PB01, respectively). The closest Yarragadee aquifer production bore is located at 4.5km from the site (i.e. GWL156423, Turf Farm) and small drawdowns (between 0.25m and 0.5m) are predicted at this location due to extraction from YA_PB01 (Figure 4-31).

There are four licenced bores that abstract water from the Leederville aquifer that are located within the modelled extent of the 0.5 m drawdown cone in the Leederville aquifer (i.e. 1.3km from the production bore YA_PB01) at the end of mining (Figure 4-30).

However, given the short term of the abstraction from YA_PB01, the impacts to other Yarragadee and Leederville aquifer users is not expected to be significant. It should be noted that continuously pumping from YA_PB01 has been modelled, while it is planned that YA_PB01 will be used only when required, most likely during summer periods when there is a shortfall of water supplied from rainfall runoff and pit dewatering. Therefore, during the winter periods when minimal to no pumping from YA_PB01 occurs, the actual drawdowns in the Yarragadee and Leederville aquifers will be smaller than predicted, owing to the recovery periods between the extractions.

Regular monitoring of groundwater levels in the Yarragadee and deep Vasse Member of the Leederville bores and the clear communication with the nearby groundwater users during the mining operation will provide information on the actual induced drawdowns and impacts on the other users.

REDUCTION IN GROUNDWATER QUALITY

Based on the results of Doral's ASS investigation (Appendix 5), lowering of the water table (although passive) may potentially expose sulfide minerals to oxygen, resulting in some oxidation of *in situ* soils within the predicted dewatering drawdown extent. If the oxidation of *in situ* ASS generates sulfidic acidity then groundwater is the initial pathway by which impacts may migrate. Acidity could therefore be mobilised downwards by leachate, upwards with groundwater rebound, or laterally by groundwater migration. If acidic groundwater mobilises heavy metals they will migrate along the same pathways and have the potential to reduce the quality of groundwater in bores screened within the 0.1m contours for both the Superficial and Leederville aquifers.

Two licenced bores (under GWL180363) and three unlicenced bores (20005101, 20005166 and 20005169) located within the modelled 0.1 to 0.25m drawdown extent (occurring during Q4 of 2021 and Q3 of 2022 for the wet scenario and Q4 of 2021 to Q1 of 2023 for the dry scenario) abstract water from the Superficial aquifer (Figure 4-23). These bores therefore have the potential to be affected by reduced water quality should acidification of groundwater occur. All of these bores are used for either stock water or domestic non-potable purposes (not for drinking water).

Small drawdowns of up to 0.4m during Q3 of 2023 are predicted in the Leederville aquifer due to dewatering of the overlying Superficial aquifer (AQ2, 2020a). These drawdowns however are predicted to be temporary in duration, local, and likely to extend laterally, but not vertically (owing to clayey layers within the sand)

(AQ2, 2020a). There are three Leederville aquifer licences (GWL67672, GWL94291 and GWL178017) that have bores located within the 0.1 to 0.25m drawdown extent that have the potential to be affected by reduced water quality should acidification of groundwater occur (Figure 4-24). It is understood a bore associated with GWL67672 was used to service a former dairy, however this dairy is no longer in use, the bore has no pump connected to it and no abstraction has occurred since Doral commenced baseline groundwater monitoring in May 2017. GWL94291 has a small total allocation limit of 3,100KL/year and in combination with the known drawpoints, is considered to only be used for stock water purposes. The remaining licence, GWL178017, has a total allocation of 1,500KL/year and Doral have not been able to identify existing bores within the GWL area. A drawpoint from DWER however suggests there is a bore located next to the household, and is considered most likely to be used for stock water/non-potable purposes.

Any potential reduction in groundwater quality, from dewatering of ASS, will unlikely affect nearby surface water receptors as the extent of groundwater drawdown from dewatering of mine pits does not extend to the Lower Sabina River (~1.6 km to the west), Abba River (~1 km to the east) or the Ramsar listed Vasse-Wonnerup wetland (~4.6km to the north west) during the life of the mine. Furthermore, as there is limited or no groundwater connection with these surface water bodies (AQ2, 2020a), resulting in minimal or no groundwater contribution to the river's baseflow, existing surface water receptors are unlikely to be impacted by reduced water quality, should acidification of groundwater occur, during the dewatering operations.

The numerical groundwater model also shows that water levels are predicted to return to pre-mining levels within 18 months of mine closure (i.e. by July 2026).

REDUCTION IN SURFACE WATER QUALITY FROM EMERGENCY DISCHARGE OF WATER

Discharging water offsite may lead to a reduction in surface water quality with the receiving environment (i.e. Lower Sabina River and Vasse-Wonnerup Ramsar wetland). The Site Water Balance (AQ2, 2020b) indicates that during wet climate sequences water pumped to the PWD/DOD from the mine pits (collected groundwater and stormwater) exceeds the mine water demand for a sufficiently sustained period such that the PWD/DOD will overtop. The required period where surplus water would be generated, estimated to be a maximum of 82,000m^3, is confined to the Q2 2023 mining period (i.e. winter 2023 period). In this instance, Doral will undertake a controlled discharge of water rather than have the PWD/DOD overflow in an uncontrolled manner, via a "Licensed Discharge Point" located at the eastern end of Lot 1293/3752 on Princefield Road within the Development Envelope (Figure 1-2).

Once discharged, water will move through the on-site drainage network into the Princefield Road drain flowing west into Woddidup Creek/drain before reaching the Lower Sabina River northwest of the mine where it will ultimately discharge into the Vasse-Wonnerup Ramsar wetlands. The discharged water will mix with other water in the Lower Sabina River catchment and given that water will only be discharged from the mine site during periods of heavy rainfall when all water storages are full (i.e. emergency situations only), discharge will coincide with seasonal higher flows of the Lower Sabina River catchment, as shown in the Lower Sabina River hydrographs (Figure 4-17). Any discharge from the Site is likely to be only a very small percentage of the total annual flows of the Lower Sabina River (~1.44%) and Vasse-Wonnerup Ramsar wetland (0.28%) as calculated in Table 4-28. Discharge of water into the Lower Sabina River is unlikely to occur when seasonal flows are at their lowest or ceased (i.e. summer), as sufficient storage capacity will be available during these times due to low seasonal low periods of rainfall. Discharge of water will occur in

accordance with DWER licence conditions. V-notch flow gauges will be installed at the proposed Licence Discharge Point.

In addition, modelling results of the Surface Water Discharge Assessment (AQ2, 2019b), conservatively indicates that a total runoff volume that may require discharge under emergency situations following a 100-yr event is ~450ML. This excess water would be discharged via either the "Licensed Discharge Point" and/or "Emergency Discharge Point" located at the north-west corner of Lot 1293 on Princefield Road within the Development Envelope (Figure 1-2). Once discharged, water will enter the Princefield Road drain/Woddidup Creek before reaching the Lower Sabina River northwest of the mine where it will ultimately discharge into the Vasse-Wonnerup Ramsar wetlands. The runoff from the Site which would be required to be discharged following a large, rare rainfall event will be returned to the same catchment it would have discharged through prior to mining activities and is therefore unlikely to result in adverse impacts to downstream water quality.

4.4.6. MITIGATION

AVOIDANCE

Doral will avoid groundwater drawdown impacts to key ecological receptors (the Lower Sabina River, Abba River and the Vasse-Wonnerup Ramsar wetland) and avoid exposing large areas of potential acidity at any one time. This will be achieved by mining/dewatering mine pits in a staged approach, as per the mining schedule. Pits will be mined on a slight incline from the deepest point and then mined moving up gradient in order to retain pit water within a sump at the deepest point on the pit floor. This form of dewatering is known as 'passive' as no dewatering apparatus (e.g. spears) are used to actively abstract water and groundwater drawdown below the base of the pit (i.e. 10.5m) is highly unlikely to occur. Only suction pumps (no submersible pumps) are used for dewatering and the suction pumps are set up at a level to maintain a 0.5m saturated pit floor, thus avoiding exposure of the pit floor to significant atmospheric oxygen and potential for acidification of sulfide minerals, whilst also minimising the drawdown extents.

Doral will avoid mining, groundwater drawdowns and exposure of potential acidity to the Leederville aquifer/formations using the above dewatering methodology (i.e. no excavation of and/or no dewatering equipment within Leederville formation).

Doral's production bore will be screened only within the confined Yarragadee aquifer.

Doral will avoid collection of surface water runoff from intercepted upstream catchments by constructing diversions around the disturbance areas. This will allow clean upgradient flows to go around the disturbance areas and into their intended catchment (Lower Sabina) without intercepted site runoff from disturbed areas.

MINIMISE

GROUNDWATER OPERATING STRATEGY

The groundwater system will need to be carefully managed at the Site in order to avoid or minimise impacts to GDEs due to mining operations. A draft Groundwater Operating Strategy (GWOS) (Appendix 7E) has been developed by (AQ2, 2020c) and a final version will be submitted to DWER when applying for the 5C groundwater licences, both for the groundwater abstraction from the Superficial aquifer (during mine dewatering) and the Yarragadee aquifer (for water supply). The GWOS includes a groundwater and surface water monitoring program (i.e. abstraction, discharge, water levels and water quality) and has been designed to assess aquifer performance, the potential impacts of groundwater abstraction proposed upon

commencement of mining operations and specify operational requirements. Trigger levels and contingency actions have been developed to mitigate potential impacts caused by the mining operations and also to ensure the actual impacts are not greater than predicted. The GWOS has been prepared in accordance with *Operational policy 5.08 - Use of operating strategies in the water licensing process* (DoW, 2011) and the DWER guidelines for the preparation of Operating Strategies for mineral sand mine dewatering licences in the South West Region (DWER, 2015).

ACID SULFATE SOIL MANAGEMENT PLAN

The key mitigation measure to reduce potential impacts associated with ASS is to implement an ASSMP in consultation with DWER guidance. The ASSMP, provided as Appendix 5, includes specific treatment strategies designed to manage impacts to soil, groundwater and surface water receptors. A summary of the key management measures documented in the ASSMP is provided as follows:

- Mining activities will be scheduled to be undertaken on a campaign basis, with a portion of the ore body being mined and processed in a discrete time period to assist in minimising the area of groundwater drawdown at any one time;
- Topsoil/subsoil will be stripped to a depth of ~100mm, stockpiled for rehabilitation and neutralised if pH is <4.0pH;
- Overburden identified as ASS (i.e. NA>0.03%S) will be removed via excavator and trucks or dozers and then immediately transported to an open pit void and backfilled simultaneously with a suitable alkaline material at an appropriate rate to account for the acidity. The backfilling process will aim to mix the neutralising material with the overburden as far as practical. A guard layer of alkaline material will initially be added to the base and walls (where practical) of the mine void to limit potential for oxidation;
- Excavated ore identified as ASS will be processed through the wet concentration plant as soon as possible. As this material is maintained in the form of a wet slurry (i.e. saturated), the risk of sulfide oxidation is greatly reduced. The process slurry is maintained at pH5.5 to assist with the mineral separation process. As such, alkaline (lime sand) material will be added into the in-pit hopper during the excavation of ore to maintain pH5.5 and increase buffering capacity within the wet concentration process;
- Processing of ore results in three streams of material, HMC, clay fines and sand tails. These will be managed as follows:
    - HMC will be stockpiled and stored on a bunded alkaline pad. Leachate emanating from the stockpiled HMC will be captured and returned to the ore processing circuit, which is maintained at pH5.5;
    - Sand tails will be hydraulically returned to pit voids as a single waste stream and/or co-disposed with clay fines into pit voids. This material will have been maintained in a saturated state and with conditions maintained at pH5.5 throughout the process. Furthermore, the unused (unreacted) lime sand that was added to the process at commencement of the ore processing sequence (i.e. at the in-pit hopper) will form part of this process stream, resulting in the addition of buffering capacity to the locations where this material is hydraulically returned. Sand tails will be regularly assayed for Total Sulfur to ensure concentrations are

below 0.03%S. If necessary, additional lime sand will be incorporated during hydraulic disposal. If necessary, additional lime sands will be incorporated during hydraulic disposal;

- Clay fines will be managed by either:
  - Immediate co-disposal with sand tails by hydraulic return in existing mine voids; or
  - Directed to a SEP for storage and future use as void backfill.
- Clay fines that are immediately co-disposed with sand tails will be maintained in a saturated state prior to disposal and will include additional buffering capacity provided by the unused (unreacted) lime sands within the sand tails material. This material will be regularly assayed for Total Sulfur to ensure concentrations are below 0.03%S;
- Clay fines material that are directed to the SEPs will also be regularly assayed for Total Sulfur to ensure concentrations are below 0.03%S. If insufficient buffering capacity is identified, additional neutralising material (lime sand) will be added prior to being discharged into a SEP. In addition to regular testing during discharge, this material will be re-tested following consolidation and drying within the SEP, prior to final disposal.

- Overburden and non-processed material identified as ASS, that will be used for site construction purposes (i.e. roads, pads, bunds etc) will either be:
  - Neutralised for re-use within 70 hours of excavation; or
  - Stockpiled on a treatment pad for up to 21 days prior to neutralisation and re-use.
- Water quality of the process water dam will be monitored (three times per week for field measurements) and maintained by the addition of a suitable alkaline material to the in-pit hopper at the commencement of the ore processing sequence (where required) or directly into the process water dam to ensure:
  - Field pH >5.5; or
  - TTA <40 mg$CaCO_3$/L; and
  - TAlk >30 mg$CaCO_3$/L.
- Groundwater monitoring will be conducted during dewatering for a network of monitoring wells. The program will include:
  - Monthly monitoring of groundwater levels;
  - Monthly field testing for pH, EC, TTA and Talk;
  - Monthly laboratory analysis for pH, EC, total acidity, total alkalinity, chloride, sulfate, dissolved aluminium, dissolved iron and dissolved manganese. (If Al >1 mg/L then the sample will also be analysed for As, Cd, Cr, Cu, Pb, Hb, Ni, Se, Zn);
  - Comparison of results to site-specific groundwater assessment criteria.

GDE MANAGEMENT PLAN

A GDE Management Plan (Appendix 4E) has been prepared by (AQ2, 2020d) to minimise impacts to flora and vegetation values from indirect impacts associated with groundwater drawdowns. As detailed in the Plan, monitoring will comprise a combination of hydrological parameters and quantitative and qualitative

vegetation measurements, ecophysiological measurements and health assessments using qualitative criteria. This will comprise:

- Groundwater level monitoring in a network of six monitoring wells proximal to the GDEs;
- Leaf Water Potential (LWP) monitoring of targeted species in each GDE communities (i.e. SWAFCT02 and SWAFCT10b);
- The species selected for LWP monitoring will also be assessed for health monitoring using visual inspection and assessed using a scale based on that used by Lay and Meissner (1985).

The following management response triggers and contingency measures will apply:

- Leading indicators of risk such that management intervention can pre-empt the development of vegetation water stress:
    - Hydrological triggers provide warning of the onset of a water regime that may cause water tress to develop;
    - Ecophysiological triggers within the vegetation community provide a direct measure of current water status.
- Lagging indicators designed to provide redundancy in risk identification and allow verification of success of management interventions.

Triggers have been designed around parameters that may be affected by mining-induced changes to the water regime (i.e. groundwater levels and associated plant hydration status). Soil moisture is not included as a monitoring parameter because it is influenced by infiltrating rainfall and this will not be affected by mining.

For all trigger exceedances the management response will be that water supplementation is required. Final design for the supplementation scheme will be completed during implementation of this GDE Management Plan. Supplementation will be based on a combination of:

- Surface irrigation;
- Subsurface irrigation in proximity to the groundwater table through either trenches or shallow spear-points.

The supplementation scheme will have the following design criteria:

- To supply enough water to offset declines in groundwater levels (i.e. to maintain levels within the natural range under the GDEs along McGibbon track. This will be determined using the existing groundwater model;
- To prevent sustained periods of excessive inundation of the vadose zone that may result in water logging or reconfiguration of the root systems within the GDEs. This will be achieved by the use of sub-surface supplementation;
- To be operationally effective and not subject to excessive clogging that may limit infiltration capacity. This will be assessed during engineering design of the scheme based on aquifer parameters derived during previous groundwater investigations;
- To incorporate a monitoring program that can be used to confirm the efficacy of the supplementation system. This will be achieved by the monitoring program outlined in this Plan;

- To utilise water of sufficient quality so as not to result in acidification or dieback within the GDEs along McGibbon track. In this regard, supplementation water will be sourced from the Yarragadee aquifer only.

In addition to the key Management Plans detailed above, the following key mitigation measures to minimise impacts to Inland Waters are:

- Installation of a drop out dam to reduce suspended solids entering the process water dam, where excess water will be discharged from;
- Preparation and implementation of plans and procedures relevant to the management of surface water (including monitoring programs, trigger criteria, management responses and contingencies). This will include:
    - Surface Water Management Plan;
    - Emergency Discharge – Pre-release of Discharge Procedure;
    - Emergency Discharge – Discharge Monitoring Procedure.
- Supply affected bore owners (including unlicensed bores and farm soaks, dams) with supplementary water (where required);
- Pits will be backfilled as soon as possible following cessation of mining to assist in recovery of groundwater levels as soon as possible;
- Placement of production bores has been selected to avoid impacts to other Yarragadee aquifer users as far as practicable;
- Volumes of water abstracted from the Yarragadee aquifer will be recorded monthly;
- Volumes and quality of water discharged from the mine site will be recorded during emergency discharge events and managed in accordance with the Site's DWER Licence;
- Prevention/minimisation of erosion at the discharge points from Site;
- Reporting in accordance with conditions of the approval documents (Ministerial Statement, RIWI Act licences, DWER Licence to Operate etc.).

Doral will make every effort to maximise water recycling and to minimise water use. Process water will, in the first instance be sourced from recycled water and dewatering of the pits. Additional process water sourced from the Yarragadee aquifer bore will be sued only after other resources have been fully utilised. Water will not be intentionally discharged offsite when it cannot be used for any other purpose. Water will be discharged offsite when the storages at PWD/DOD are at their full capacity (overtop) in the event of sufficiently sustained period of high rainfall events resulting in site runoff exceeding the mine water dam.

REHABILITATE

Sand tails resulting from ore processing will be hydraulically returned to pit voids as a single waste stream and/or co-disposed with clay fines into pit voids, as soon as possible in order to return groundwater levels. This material will have been maintained in a saturated state, with conditions maintained at pH5.5 throughout the process. Furthermore, the unused (unreacted) lime sand that was added to the process at commencement of the ore processing sequence (i.e. at the in-pit hopper) will form part of this process

stream, resulting in the addition of buffering capacity to the locations where this material is hydraulically returned.

The numerical groundwater model (AQ2, 2020a) shows that water levels are predicted to return to pre-mining levels within 18 months of mine closure (i.e. by July 2026).

4.4.7. PREDICTED OUTCOME

The predicted outcomes after the application of the mitigation measures are:

- Maximum drawdown of 10.5m is predicted in the immediate mining area and is similar for both climatic cases (dry and wet);
- The extent of predicted drawdown in the Superficial Aquifer (0.1m contour) is generally limited to the disturbance areas within the Development Envelope, with the following extents:
    - The maximum distance that drawdown of 0.1m extends outside of the perimeter of the mine disturbance area is 700m to the north, 250m to the south, 300m to the east and 450m to the west, at various times during the mine life for the dry climate scenario.
    - The maximum distance that drawdown of 0.1m extends outside of the perimeter of mine disturbance area is 600m to the north, 200m to the south, 300m to the east and 400m to the west, at various times during the mine life for the wet climate scenario.
- The maximum distance that drawdown of 0.1m extends outside of the perimeter of the mine disturbance area is 700m to the north, 50m to the south, 300m to the east and 300m to the west for both wet and dry scenarios (i.e. Q3 of 2023).
- Two bores under licence (GWL180363) that abstract water from the Superficial aquifer, are located within the modelled drawdown extent of between 0.1 to 0.25m contour due to dewatering (occurring during Q4 of 2021 and Q3 of 2022 for the wet scenario and from Q4 of 2021 to Q1 of 2023 for the dry scenario). The maximum drawdown of 0.3m is predicted to occur during Q2 of 2022
- Three unlicenced bores (20005101, 20005166, and 20005169) within the Superficial aquifer may experience short-term minor water level reductions (i.e. drawdowns of between 0.1 to 0.25m) due to mining dewatering – this limit drop in water level is unlikely to influence their supply potential. Bores 20005101 and 20005169 are reported as only being used for water level measurements (no abstraction).
- Some small drawdowns (up to 0.4m) are predicted in the Leederville aquifer due to dewatering of the overlying Superficial aquifer. These drawdowns are predicted to be local and likely to extend laterally, but not vertically (owing to clayey layers within the sand).
- Three Leederville aquifer licences (GWL67672, GWL94291 and GWL178017) have bores located within the drawdown extent of between 0.1 to 0.25m and could be affected by mining related dewatering. These drawdowns are however predicted to be temporary in duration and relatively minor.
- Approximately 1.81ha of the Wet Shrublands (SWAFCT02) GDE is likely to be severely impacted, with predicted drawdowns of up to 5m, and drawdowns of more than 2m lasting for 3-6 months in 2023.

- Drawdown impacts on the Ironstone Shrubland (SWAFCT10b), are predicted to be low-moderate and may potentially affect 0.34ha. Maximum predicted drawdowns are predicted to be 1-1.5m in Q3 and Q4, 2024.
- Drawdown impacts in the Ironstone Shrubland (SWAFCT10b), although predicted to be low-moderate, have the potential to affect the population of nine *Banksia squarrosa* subsp. *Argillacea,* listed as Threatened under the BC Act and Endangered under the EPBC Act.
- The numerical model shows that water levels are predicted to return to pre-mining levels within 18 months of mine closure (i.e. by July 2026).
- No adverse impacts to the Lower Sabina River, Abba River or Vasse-Wonnerup wetland area are predicted from groundwater drawdowns given they are located outside of the maximum groundwater drawdown extents.
- Minimal reduction to surface water yields in the Lower Sabina River (~8%) and the Vasse-Wonnerup Ramsar wetland catchments (~1%) will occur as a result of the Proposal. However, as mining is staged and not all mine pits will be open at once to capture rainfall/runoff, the actual reduction to these catchment areas will be even less.
- Impacts from the modelled maximum volume of water to be discharged from Site (0.082GL) during the winter 2023 period, will increase the annual flows of the Lower Sabina River and the Vasse Wonnerup Wetland catchments by 1.44% and 0.28%, respectively. However, no reduction in water quality will occur due to strict water quality criteria being met as per the DWER licence conditions. Modelling (AQ2, 2020a) indicates that no other period during the mine life will require discharge of excess water.
- Modelling (AQ2, 2020a) indicates that a total runoff volume that may require discharge under emergency situations following a large, rare, 100-yr rainfall event is ~0.45GL. This would increase annual flows to the Lower Sabina River and Vasse-Wonnerup Ramsar wetland catchments by 7.95% and 1.52%, respectively. However, it is unlikely to result in adverse impacts to downstream water quality as the water will be returned to the same catchment it would have discharged through prior to mining activities.
- Proposed extraction of 1.6 GL/year from the Yarragadee aquifer is unlikely to have any adverse impacts on the water supply potentials of the aquifer systems, with a maximum drawdown of 0.6m. The 0.5m drawdown is estimated to extend no more than 1.3km from the production bore.
- There are no known bores that abstract water from the Yarragadee aquifer that are located within the extent of the 0.5m and 1m drawdown contours developed around the production bore (i.e. within 1.2 and 3.7km from the YA_PB01, respectively).
- The closest Yarragadee aquifer production bore is located 4.5km from the Site (i.e. GWL156423, Turf Farm) and small drawdowns (between 0.25 and 0.5m) are predicted at this location due to extraction from YA_PB01.
- With the implementation of the ASSMP no adverse impacts to groundwater quality are expected to occur to the following beneficial users /environmental values:
    - Superficial and Leederville aquifer users within the 0.1m drawdown contours;

- Lower Sabina River, Abba River or Vasse-Wonnerup Ramsar wetland as they are located outside of the maximum groundwater drawdown extents and no connectivity of these surface water receptors and groundwater is evident (AQ2, 2020a).

Doral expects that with the implementation of the mitigation measures described above, the EPA's objective to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values and beneficial uses are protected, can be achieved.

4.5. KEY ENVIRONMENTAL FACTOR 4 - SOCIAL SURROUNDS

This factor assesses potential impacts and mitigation measures associated with Noise and Heritage. Impacts associated with generation of dust for construction, mining and processes activities are discussed in Section 5 – Air Quality.

4.5.1. EPA OBJECTIVE

The EPA objective for Social Surroundings is:

To protect social surroundings from significant harm.

The objective recognises the importance of ensuring that social surroundings are not significantly affected as a result of implementation of a proposal or scheme.

4.5.2. POLICY AND GUIDANCE

Guidance relevant to Social Surroundings that have been considered during the EIA process are documented in the following document:

- *Environmental Factor Guideline – Social Surroundings* (EPA, 2016j)*;*
- *Environmental Protection (Noise) Regulations 1997;*
- *Aboriginal Heritage Act 1972.*

4.5.3. NOISE - RECEIVING ENVIRONMENT

The Proposal is located within a rural farming land set ~11km southeast of Busselton, in a generally flat to slightly undulating landscape. Wind data from the nearest Bureau of Meteorology (BOM) weather station, Busselton Area (Site No. 006603) indicates the prevailing morning winds (9am) for most of the year are from the east. Mid-afternoon (3pm) winds tend to vary in direction, without a predominant vector, but are most commonly between 10-20km/hr from various directions, frequently from the northwest (~20%) or south (~18%), although also from the north, southwest or south (~15% each). In the winter months, regional weather systems can result in strong westerly and north-westerly winds.

Eleven residences are scattered around the local area less than 1km from the disturbance boundary and a further seventeen residences are present between 1-2kms from the mine disturbance boundary (Figure 4-32).

Noise Regulations

Environmental noise is regulated by the EP Act, through the implementation of the *Environmental Protection (Noise) Regulations 1997*. The Regulations set noise limits which are the highest noise levels that can be received at noise-sensitive (residential), commercial and industrial premises. These noise limits are defined as 'assigned noise levels' at receiver locations. Regulation 7 requires that "*noise emitted from any premises*

or public place when received at other premises must not cause, or significantly contribute to, a level of noise which exceeds the assigned level in respect of noise received at premises of that kind".

No noise limits apply for the construction period, as per Regulation 13(2), as long as construction work is carried out between 0700 hours and 1900 hours on any day which is not a Sunday or public holiday if the occupier of the premises, shows that:

a) The construction work was carried out in accordance with control of environmental noise practices set out in Section 4 of AS 2436: 2010 Guide to Noise and Vibration Control on Construction, Maintenance and Demolition sites;

b) The equipment used on the premises was the quietest reasonably available.

Assigned Noise Levels

The assigned noise limits for mining on residences (noise sensitive premises) are listed in Table 4-30 as assigned by *Environmental Protection (Noise) Regulations 1997*, Part 2 Division 1 Regulation 8 (3) Table 1. The L_{A10} noise limit is the most significant for the Proposal since this is representative of continuous noise emissions from the mining activities.

TABLE 4-30: ASSIGNED NOISE LEVELS AT RECEIVING LOCATIONS

TYPE OF RECEIVING NOISE	TIME OF DAY	ASSIGNED NOISE LEVELS - dB(A)		
		L_{A10}	L_{A1}	L_{AMAX}
Noise sensitive premises: highly sensitive area	0700 to 1900 hrs Monday to Saturday	45 + Influencing factor	55 + Influencing factor	65 + Influencing factor
	0900 to 1900 hrs Sunday and public holidays	40 + Influencing factor	50 + Influencing factor	65 + Influencing factor
	1900 to 2200 hrs All days	40 + Influencing factor	50 + Influencing factor	55 + Influencing factor
	2200 hrs on any day to 0700 hrs Monday to Saturday and 0900 hrs Sunday and public holidays	35 + Influencing factor	45 + Influencing factor	55 + Influencing factor
Noise sensitive premises: any area other than highly sensitive area	All hrs	60	75	80
Commercial premises	All hrs	60	75	80
Industrial and utility premises other than those in the Kwinana Industrial Area	All hrs	65	80	90

TYPE OF RECEIVING NOISE	TIME OF DAY	ASSIGNED NOISE LEVELS - dB(A)		
		L_{A10}	L_{A1}	L_{AMAX}
Industrial and utility premises in the Kwinana Industrial Area	All hrs	75	85	90

Findings of Noise Assessment

Acoustic Engineering Solutions (AES) was commissioned by Doral to carry out a noise impact assessment for the Proposal (Acoustic Engineering Solutions, 2019) (Appendix 8). The acoustic model was developed to generate noise contours for the area surrounding the Site and also to predict noise levels at 18 noise sensitive (residential) receivers (Figure 4-32) under a range of day and night-time meteorological conditions including calm conditions and worst-case winds in 8 cardinal directions. It is proposed that the Proposal will operate on a continuous 24/7 roster.

The assessment was based on the proposed location of fixed plant and mobile equipment according to the proposed mine schedule, sound power levels of the fixed plant and mobile equipment as measured when operational at the Yoongarillup Mine, and with consideration of likely wind conditions (Acoustic Engineering Solutions, 2019). Noise emissions from any source other than proposed mining was excluded (e.g. road traffic, aircrafts, animals, domestic sources etc.).

Most of the 18 residences are located more than 450m away from any mining pits or SEPs except R4, R13 to R15 and R17. Schedule 3 Clause 3 of the Regulations classifies mining as Type A land (industrial and utility premises). Due to the presence of the mining Site, the calculated influencing factor ranges from 0.7dB to 3.9dB, which are rounded to 1dB to 4dB according to the Regulations. Table 4-31 presents the calculated assigned noise levels for the 18 selected residential locations.

TABLE 4-31: CALCULATED ASSIGNED NOISE LEVELS (L_{A10}) FOR THE PROPOSAL

CLOSEST RESIDENCE	INFLUENCING FACTOR in dB	ASSIGNED NOISE LEVELS (L_{A10}) in dB(A)		
		Day[1] Monday to Saturday	Evening[2] Day[3] for Sunday and Public Holiday	Night[4]
R4 and R13	4	49	44	39
R14 and R15	2	47	42	37
R17	1	46	41	36
Others	0	45	40	35

Notes:

1. 0700 to 1900 hrs for Monday to Saturday

2. 1900 to 2200 hrs for all days.

3. 0900 to 1900 hrs for Sunday and public holidays

4. 2200 hrs on any day to 0700 hrs Monday to Saturday and 0900hrs Sunday to public holidays.

The following mining activities were provided to assist with the Noise Assessment (Acoustic Engineering Solutions, 2019):

- Construction activities in the mine start before any mining activities. Multiple topsoil stockpiles are built during the construction phase, including a U-shape stockpile at the Feed Prep, at multi-locations between the mining pits and some of the closest residences. These stockpiles are designed to reduce mining noise impact on the closest residences;
- The mine is proposed to operate 24 hours a day and 7 days a week. During evening and night periods (7pm to 7am), all earthworks and mining activities at pits shall cease, and only the Concentrator, Feed Prep and associated process water pumps are in operation;
- At the Feed Prep, a D7 dozer operates during the day-time period (7am to 7pm) to manage the stockpile while a single silenced CAT980K Loader operates to feed the feed prep ore hopper during the evening and night periods (7pm to 7am);
- Pits 25 and 15 to 17 will be mined during Q3 2021;
- Pits 19 and 30 will be mined during Q2 2022;
- Pits 9 and 50 will be mined during Q1 2023;
- Pits 55, 56 and 72 will be mined during Q2 2024;
- Pits 46 and 65 will be mined during Q4 2024;
- During the day-time period between 7am and 7pm, mining activities occur simultaneously at two different pits;
    - A CAT980K loader operates in one pit to feed the fixed plant of the McCloskey R230, a vibration screen, a feed pump and a pit generator;
    - A CAT390 excavator loads ore at another pit to AH500 trucks;
- Hitachi AH500 trucks will transport ore from a mining pit to the Feed Prep ore stockpile. Three AH500 trucks operate during Q2 2022 and Q1 2023, while four AH500 trucks operate for the other mining periods (Q3 2022, Q2 and Q4 2024);
- One watercart will operate for all scenarios;
- The following noise controls will be implemented:
    - Operate quietest mobile equipment as possible;
    - Construct a 6m U-shaped bund (open in north) and a 6m ore stockpile at the Feed Prep;
    - Lower the Feed Prep floor 2m below natural ground surface;
    - Modify the McCloskey including the change from diesel powered to electric (run by a silenced generator) plus a silencer on the exhaust outlet;
    - Acoustically insulate or partly enclose the apron feeder, scalping and double-deck screens;
    - Locate the Feed Prep and Concentrator as far as possible to any of the most affected residences;
    - Install drapes on the ground level of the Concentrator;

- Build 1.8m U-shaped noise bunds close to the roadside booster pumps between the Feed Prep and the Concentrator. The opening of the U-shaped bunds is either east or west.

Based on the above mining activities, the following seven operational scenarios were modelled to represent the worst-case construction and mining activities:

Scenario 1: Construction Phase

Scenario 2: Day-time mining activities in pits 25 and 15 to 17 during Q3 2021.

Scenario 3: Day-time mining activities in pits 19 and 30 during Q2 2022.

Scenario 4: Day-time mining activities in pits 9 and 50 during Q1 2023.

Scenario 5: Day-time mining activities in pits 55, 56 and 72 during Q2 2024.

Scenario 6: Day-time mining activities in pits 46 and 65 during Q4 2024.

Scenario 7: Evening and night-time (7pm to 7am) operations where only Concentrator and feed prep operate with the process water pumps and roadside booster pumps.

Figures 3 to 9 in Appendix B of (Acoustic Engineering Solutions, 2019) shows the assumed operating locations of the fixed plant and mobile equipment for the above scenarios.

A compliance assessment for the Proposal is discussed in Section 4.6.5 below.

4.5.4. NOISE - POTENTIAL IMPACTS

The potential impacts from the Proposal to Social Surroundings (noise) include:

- Numerous rural-residential premises located within 1km of the Proposal may potentially be impacted by noise from construction, mining and processing operations.

4.5.5. NOISE - ASSESSMENT OF IMPACTS

GENERATION OF NOISE FROM CONSTRUCTION, MINING AND PROCESSING ACTIVITIES

Potential noise generating sources during construction and mining activities for the Proposal include:

- Fixed plant: feed hopper and associated parts, mining unit, Concentrator, tails booster pump, feed booster pumps, process water pumps, pit feed pump, dewatering pumps;
- Mobile plant; dozers, McCloskey, grader, water cart, excavator, roller, front end loader, trucks.

Noise levels will vary depending on the type of activities and prevailing wind conditions. During pre-mine establishment construction activities will be limited to daytime only. Operational mining will involve mobile machinery and in-pit ore screening during the day and processing of ore at the fixed plants on a continuous basis.

A summary of the worst-case noise levels in dB(A) at each residence under the seven scenarios described in Section 4.6.3 is presented in Table 4-32. Adjusted values for tonality are expressed as **bold**.

The highest noise level is predicted at R13 for Scenarios 1 and 2, at Scenario 3, and at R4 for Scenarios 4 to 7. The worst-case night-time noise levels are predicted of below 37.1 dB(A).

The full point prediction results for different wind conditions are presented in Table C1 to Table C7 in Appendix C of (Acoustic Engineering Solutions, 2019). These tables indicate that wind direction has a big

impact on the noise levels received at the closest residential locations. Noise Contours for worst-case conditions for each Scenario are provided as Appendix D of (Acoustic Engineering Solutions, 2019).

TABLE 4-32: ADJUSTED WORSE-CASE NOISE LEVELS

CLOSEST RESIDENCE	ADJUSTED WORST-CASE NOISE LEVELS in dB(A)						
	S1	S2	S3	S4	S5	S6	S7
R1	26.4	24.6	25.4	26.6	25.5	26.4	21.4
R2	27.7	25.8	26.5	27.7	26.7	27.7	22.6
R3	34.2	30.2	30.7	31.6	32.9	34.4	28.2
R4	41.5	39.6	39.4	40.5	**54.9**	43.4	37.1
R5	28.2	27.2	24.6	24.5	27.7	24.9	22.3
R6	26.7	28.3	25.4	23.4	24.0	23.2	19.3
R7	29.5	31.4	28.1	25.9	26.5	25.7	21.7
R8	33.5	35.2	30.5	28.2	29.3	27.7	24.9
R9	34.0	36.2	31.3	28.7	29.9	28.3	25.1
R10	**40.3**	37.7	32.3	29.7	30.8	29.2	26.1
R11	**41.1**	38.8	33.0	30.3	31.4	29.9	26.7
R12	32.1	34.4	31.6	29.1	29.5	29.1	25.0
R13	42.6	47.9	40.4	36.6	37.1	36.4	33.2
R14	41.2	45.6	39.8	36.2	36.6	36.2	32.5
R15	42.5	44.4	45.8	39.7	39.5	39.5	35.8
R16	39.0	40.9	40.6	36.7	36.3	36.3	32.3
R17	37.8	39.2	41.0	37.7	36.4	36.8	32.5
R18	22.6	22.4	22.9	23.2	21.8	22.7	17.5

Note: **BOLD** represents adjusted values for tonality

A summary of the compliance assessment is provided as follows.

In accordance with Regulation 13, no assigned noise levels apply for the construction phase (Scenario 1).

Monday to Saturdays

Table 4-33 presents the compliance assessment for the worst-case day-time operations on Monday to Saturday.

TABLE 4-33: COMPLIANCE ASSESSMENT FOR DAY-TIME OPERATIONS MONDAY TO SATURDAY

CLOSEST RESIDENCES	ASSIGNED NOISE LEVELS in dB(A)	NOISE LEVEL EXCEEDANCE AND NON-COMPLIANT WIND DIRECTIONS				
		Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
R4	49				0.5 – 5.9 (calm, SE–NW)	
R13	49					
R14 and R15	47					
R17	46					
Others	45					

Compliance is achieved for Scenarios 2, 3, 4 and 6 but an exceedance is predicted at R4 under:

- Calm, south-easterly to north-westerly winds for Scenario 5;

Sundays and Public Holidays

Table 4-34 presents the compliance assessment for the worst-case day-time operations on Sundays and public holidays.

TABLE 4-34: COMPLIANCE ASSESSMENT FOR DAY-TIME OPERATIONS ON SUNDAYS AND PUBLIC HOLIDAYS

CLOSEST RESIDENCES	ASSIGNED NOISE LEVELS IN dB(A)	NOISE LEVEL EXCEEDANCE AND NON-COMPLIANT WIND DIRECTIONS				
		Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
R4	44				1.9 – 10.9 All winds	
R13	44	2.3 – 3.9 (NW – E)				
R14	42	1.9 – 3.6 (NW – E)				
R15	42	1.6 – 2.4 (W – N)	1.9 – 3.8 (NW – E)			
R16	40	0.9 (NW – N)	0.4 – 0.6 (NW – NE)			
R17	41					
Others	41					

Compliance is achieved for Scenario 4 and 6, but exceedance is predicted at:

- R13 to R16 under westerly to easterly winds for Scenario 2;
- R15 and R16 under north-westerly to easterly winds for Scenario 3;
- R4 for all wind conditions for Scenario 5;

Nights

The adjusted night-time noise levels for Scenario 7, presented in Table 4-32, are below the night-time assigned noise levels, shown in Table 4-31, at all of the receivers. This indicates that full compliance is achieved for the proposed night-time mining operations.

In summary, results of the compliance assessment for the Proposal concludes the following:

- Full compliance is achieved for Scenarios 4, 6 and 7;
- For Scenarios 2 and 3, compliance is achieved on Monday to Saturday, but exceedance is predicted on Sunday and public holidays;
- For Scenario 5, non-compliance is predicted at R4. The non-compliance for Monday to Saturday mainly results from the 5dB tonality adjustment.

Results of the compliance assessment conducted by (Acoustic Engineering Solutions, 2019) indicates that exceedance could occur at R4, R13 to R16 for the proposed day-time mining operations. Appendix E of the Environmental Noise Assessment (Acoustic Engineering Solutions, 2019) shows that the significant contributors to exceedance are the McCloskey, Screens, AH500 Trucks, Dozer, Watercart and Scrubber.

4.5.6. NOISE - MITIGATION MEASURES

AVOIDANCE

A Noise Management Plan will be prepared and implemented for the Proposal. The primary objective of the Noise Management Plan will be to maintain the amenity of neighboring residences during mining operations. The Noise Management Plan will include noise management strategies and control measures to reduce noise emissions and as a minimum maintain compliance with the Noise Regulations and include the following strategies:

- No night time mining or mobile machinery operation with the exception of the single 980K loader operating at the Feed Prep;
- Location of fixed plant (Feed Prep and Concentrator) central to the Project and at furthest reasonable distance from surrounding residences;
- Avoidance of Scenarios 2 and 3 (as modelled) on Sundays and Public holidays as determined by weather conditions and real time noise monitoring data at potentially affected residents;
- Avoidance of Scenario 5 (as modelled) unless a land access/amenity agreement is in place with the affected residence.

MINIMISATION

The key mitigation measures to reduce impacts associated with Social Surroundings (noise) is to implement a Noise Management Plan. Noise management minimisation strategies incorporated into the Noise Management Plan will include, but not limited to the following:

- Select quietest equipment available and install silencers to reduce exhaust noise where possible;
- Install acoustic insulation and barriers strategically to fixed plant (Feed Prep and Concentrator) to reduce noise emissions;
- Modify existing Yoongarillup McCloskey in-pit screen from diesel to electricity driven and run by a silenced generator;
- Create strategically designed noise bunding around plant and mining areas to reduce noise emission;
- Utilise real time monitoring equipment to manage mining activities under Scenarios 2, 3 and 5 on Monday to Saturdays, and Scenario 4 on Sunday and public holidays;
- Ensure that no overburden fleet or ore fleet will operate simultaneously in the same mining block at any one time;
- Restrict the operation of machinery relative to worst case weather conditions to minimise potential noise impacts;
- Restrict the operation of ancillary machinery (water cart and grader) to operate during daytime only;
- Establish preventative maintenance schedules for all vehicles, fixed plant and mobile equipment;
- Educate employees and contractors on the importance and requirements for noise management prior to commencing work on the mine, as part of the site induction process;
- Doral will actively seek amenity agreements with adjacent landowners;
- Maintain ongoing effective dialogue with nearby residents to ensure noise impacts are communicated to Doral to allow for rapid resolution;
- Regular monitoring of noise emissions at or near to the nearest residences to measure performance of the noise control measures and ensure compliance;
- Continue to implement an effective public comment and complaint communication system to ensure all concerns are received, recorded and acted upon.

If noise limits are exceeded after the above management strategies are implemented, the following contingency actions will be implemented:

- Attenuation of machinery where practicable;
- Temporary shutdown of relevant (noise generating) operations to ensure compliance during persistent wind conditions;
- Investigate and implement methods to reduce noise emissions in accordance with best practice;
- Temporary relocation of the mining fleet to alternate mining pit to ensure compliance with respect to worst case scenario wind conditions.

REHABILITATE

MINE CLOSURE PLAN

Doral has prepared a Mine Closure Plan (Appendix 3) which describes how the Yalyalup Mine will be decommissioned and rehabilitated to meet the agreed end landuses. Once rehabilitated, the amenity of the area will be returned to pre-mine values.

4.5.7. HERITAGE - RECEIVING ENVIRONMENT

The Proposal is within the South West Boojarah #2 (WC06/4) (SWB) native title claim, which is represented by the South West Aboriginal Land and Sea Council (SWALSC).

INVESTIGATIONS UNDERTAKEN

The following investigations have been undertaken to assist in the assessment of impacts to Social Surroundings (Heritage):

- Ethnographic Survey (Ethnosciences, 2020) (Appendix 9A);
- Archaeological Heritage Assessment (Snappy Gum Heritage, 2019) (Appendix 9B).

An Ethnographic Survey of the Development Envelope was undertaken by (Ethnosciences, 2020) to identify any known Aboriginal heritage issues that may affect the Proposal and provide recommendations for any further research and/or consultation that may be required to meet the requirements of the *Aboriginal Heritage Act 1972* (AH Act). The Development Envelope is located wholly within the South West Boojarah #2 (WC06/4) native title claim, which is represented by the South West Aboriginal Land and Sea Council (SWALSC).

The desktop research involved the following:

- Examination of the Register of Aboriginal Sites using the online Aboriginal Heritage Inquiry System (AHIS) maintained by the Department of Planning, Lands and Heritage (DPLH);
- Review of previously published and unpublished ethnohistorical and ethnographic material, including previous heritage reports.

Results of the desktop research indicate that one Registered Aboriginal Site, Abba River (DPLH 17354) is currently listed within the Development Envelope. The Abba River (DPLH 17354) which crosses a small portion of the Development Envelope in the east (Figure 1-2) is a registered mythological site with historical values (Cuthbert & Hovingh, 1998). (Bates, n.d.) reports that a major camp (*Joorgadup/joork guttuk*) was located on the Abba River, however, it has not been possible to positively identify its location. During a previous survey for the Wonnerup Mineral Sands Project, Aboriginal consultants reported that the river, in common with all rivers, was created by the *Waugul* and that people camped all along it in the past (McDonald, 2014).

A number of ethnographic sites surrounding the Development Envelope were identified including:

- Woddidup Mission/Mulgarnup Mission (DPLH 4401);
- Hithergreen Farm (DPLH 15999);
- Sabina River Camp Ground (DPLH 17350);
- Sabina River (DPLH 17353);
- Uligugillup Mission (DPLH 17355);
- Hills Campsite (DPLH 18985);
- Vasse Highway Camp (DPLH 21571);

A number of archaeological sites surrounding the Development Envelope were also identified including:

- Sabina River Artefact Scatter (DPLH 16609);

- Tutunup Mine Artefact Cluster 01 (DPLH 19362);
- Tutunup South Modified Tree (DPLH 22883);
- Tutunup South Artefact Cluster (DPLH 22884);
- TUT 07-01 (DPLH 24568).

Following the desktop assessment, Doral entered into a Noongar Standard Heritage Agreement with SWALSC, on behalf of the SWB claimants. Ethnosciences (2020) then conducted an ethnographic field survey of the Development Envelope on 28 November 2019 with seven SWB consultants comprising the ethnographic survey team (EST). With the exception of the Abba River (DPLH 17354) no other ethnographic sites were reported by the EST during the survey.

An archaeological survey was also conducted by (Snappy Gum Heritage, 2019) between 18-21 November 2019. The archaeological survey did not discover any new Aboriginal archaeological sites within the Development Envelope. Thirty-three (33) isolated artefacts however, were recorded, with the vast majority being quartz flakes, core fragments or debris, with a few fossiliferous chert flakes also identified. The isolated artefacts were found on top of fine white sands in small areas were vegetation was entirely absent and primarily in pushed-up earth around dams and deflations in the vicinity of the Abba River (Snappy Gum Heritage, 2019).

4.5.8. HERITAGE - POTENTIAL IMPACTS

The potential impacts from the Proposal to Social Surroundings (Heritage) include:

- Disturbance to Registered Aboriginal Sites.

4.5.9. HERITAGE – ASSESSMENT OF IMPACTS

DISTURBANCE TO REGISTERED ABORIGINAL SITES

In order to access the main haulage route (Ludlow-Hithergreen Rd) from the on-site processing plant, construction of a creek crossing over the Abba River is required (Figure 2-1). The selected crossing point of the Abba River has been selected to avoid the need for native vegetation clearing.

As the Abba River (DPLH 17354) is a registered Aboriginal Site, a Section 18 Notice under the AH Act to the Aboriginal Cultural Material Committee (ACMC) for Ministerial consent to use the land, upon which the Site is located, will be required for the construction of the creek crossing. S18 of the AH Act provides a mechanism for landowners to seek consent from the Minister of Aboriginal Affairs to use land that might contain an Aboriginal Site(s) (i.e. a place to which the AH Act applies) and in effect to disturb those sites, and thereby protect themselves from potential prosecutions under s.17 of the AH Act.

This process has been commenced withthe ethnographic and archaeology surveys and consultation with members of the SWB native title claim group.

No other registered Aboriginal Sites, ethnographic sites or archaeological sites will be disturbed by the Proposal.

4.5.10. HERITAGE – MITIGATION MEASURES

AVOID

Doral will avoid construction of the creek crossing over the Abba River until a Section 18 consent under the AH Act has been approved by the Minister for Aboriginal Affairs.

MINIMISATION

As the Abba River (DPLH 17354) is a registered Aboriginal Site, a Section 18 Notice under the AH Act to the Aboriginal Cultural Material Committee (ACMC) for Ministerial consent to use the land, upon which the Site is located, will be required for the construction of the internal road and river crossing.

REHABILITATION

MINE CLOSURE PLAN

Doral has prepared a Mine Closure Plan (Appendix 3) which describes how the Yalyalup Mine will be decommissioned and rehabilitated to meet the agreed end landuses. Once rehabilitated, the amenity of the Proposal will be returned to pre-mine values.

4.5.11. PREDICTED OUTCOME

Doral are experienced at managing noise impacts associated with mineral sands mine sites. Noise levels associated with mining will be controlled as described above. Effective implementation of these noise management strategies, including the use of avoidance strategies, engineering controls and administrative controls for mine scheduling (including Amenity Agreements), will ensure noise emissions from the operations comply with the Noise Regulations.

With consent of a S18 Notice by the Minister of Aboriginal Affairs to construct a crossing across the Abba River (DPLH 17354) Doral is confident that impacts to registered Aboriginal Sites will be minimised.

With the above mitigation measures, Doral is confident the EPA objective to protect social surroundings from significant harm can be achieved.

5. OTHER ENVIRONMENTAL FACTORS – AIR QUALITY

The EPA has identified Air Quality as an 'Other Environmental Factor' or matter relevant to the Proposal Terrestrial Fauna.

5.1. EPA OBJECTIVE

To maintain air quality and minimise emissions so that environmental values are protected.

5.2. POLICY AND GUIDANCE

EPA Policy and Guidance

- *Environmental Factor Guideline – Air Quality* (EPA, 2016k).

Other Policy and Guidance

- *A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities* (DEC, 2011)*;*
- *National Environment Protection (Ambient Air Quality) Measure* (AAQ NEPM);
- *National Greenhouse and Energy Reporting Act 2007 (NGER Act).*

5.3. RECEIVING ENVIRONMENT

The Proposal is located within a rural farming land set ~11km southeast of Busselton, in a generally flat to slightly undulating landscape. Eleven residence are scattered around the local area less than 1km from the disturbance boundary and a further seventeen residence are present between 1-2kms from the mine disturbance boundary (Figure 4-32). Wind data from the nearest Bureau of Meteorology (BOM) weather station, Busselton Area (Site No. 006603) indicates the prevailing morning winds (9am) for most of the year are from the east. Mid-afternoon (3pm) winds tend to vary in direction, without a predominant vector, but are most commonly between 10-20km/hr from various directions, frequently from the northwest (~20%) or south (~18%), although also from the north, southwest or south (~15% each). In the winter months, regional weather systems can result in strong westerly and north-westerly winds.

Air quality in the Busselton region is monitored and assessed by DWER as a part of the signatory commitments to the *National Environment Protection Measure (Ambient Air Quality) Measure* (AAQ NEPM). Monitoring in 2017 was only conducted for PM2.5 and the 2017 WA air monitoring report (DWER, 2018) noted that:

- The NEPM standard of 25µg/m^3 24-hour average was met in Busselton, with one allowable exceedance that was attributed to a prescribed burn;
- The NEPM standard for particles as PM2.5, 8µg/m^3 one-year average was exceeded in 2017 (with an annual average of 8.2µg/m^3. This was similar to six other years since monitoring commenced in 2008.

The key energy demands for the Proposal, contributing the most significant proportion of Scope 1 greenhouse gas emissions, are emissions due to combustion of diesel and emissions due to generation of electricity.

5.4. POTENTIAL IMPACTS

Potential impacts from the Proposal on Air Quality are:

- Particulate emissions associate with construction, mining, handling and processing may be generated during construction and operation phases of the Proposal;
- Greenhouse gas emissions associated with the combustion of diesel fuel from construction, mining, handling and processing may be generated and released into the atmosphere.

5.5. ASSESSMENT OF IMPACTS

GENERATION OF PARTICULATE EMISSIONS

Dry mining has the potential to generate dust from the stripping of topsoil and overburden, by vehicular movement and surface lift-off from exposed surfaces (e.g. stockpiles, mine pits) during dry and windy ambient conditions. Dust may also be generated from rehabilitation activities, and areas recently rehabilitated prior to the establishment of pasture and/or vegetation. Dust generation can result in adverse impacts on surrounding vegetation and create nuisance to landowners in the vicinity of the mine disturbance areas.

Particulate emissions in the context of the Proposal are defined as:

- Airborne particles (aerosols) or particulate matter (PM) released during the Proposal activities.
- Airborne particles can be defined as comprising dust, fumes, smoke or mist (DEC, 2011);
- The only emission being generated by the Proposal will be dusts, which is defined as an aerosol formed by mechanical subdivision of bulk materials into airborne fibres having the same chemical composition, and being generally greater than one micrometre (DEC, 2011).

Table 5-1 lists the most susceptible residences to dust each month, based on the historical prevailing wind directions. Residences are shown on Figure 5-1.

TABLE 5-1: PREDICTED PREVAILING WIND DIRECTION IN RELATION TO RESIDENCE LOCATIONS

TIME OF DAY	0900 HOURS			1500 HOURS		
MONTH	PREDICTED PREVAILING WIND DIRECTION*	RESIDENCE(S) MOST SUSCEPTIBLE TO PREDICTED PREVAILING WIND DIRECTION	APPROXIMATE DISTANCE TO MINE (m)	PREDICTED PREVAILING WIND DIRECTION*	RESIDENCE(S) MOST SUSCEPTIBLE TO PREDICTED PREVAILING WIND DIRECTION	APPROXIMATE DISTANCE TO MINE (m)
Jan	SE	R4	~100m	S	R4	~100m
Feb	E	R4, R13, R14, R15	~100-250m	S	R4	~100m
Mar	E	R4, R13, R14, R15	~100-250m	S	R4	~100m
Apr	E	R4, R13, R14, R15	~100-250m	NW	R4, R13, R14, R15, R16, R17	~100-500m

TIME OF DAY	0900 HOURS			1500 HOURS		
MONTH	PREDICTED PREVAILING WIND DIRECTION*	RESIDENCE(S) MOST SUSCEPTIBLE TO PREDICTED PREVAILING WIND DIRECTION	APPROXIMATE DISTANCE TO MINE (m)	PREDICTED PREVAILING WIND DIRECTION*	RESIDENCE(S) MOST SUSCEPTIBLE TO PREDICTED PREVAILING WIND DIRECTION	APPROXIMATE DISTANCE TO MINE (m)
May	E	R4, R13, R14, R15	~100-250m	N	R4, R13, R14, R15, R16, R17	~100-500m
Jun	E	R4, R13, R14, R15	~100-250m	N	R4, R13, R14, R15, R16, R17	~100-500m
Jul	E	R4, R13, R14, R15	~100-250m	N	R4, R13, R14, R15, R16, R17	~100-500m
Aug	E	R4, R13, R14, R15	~100-250m	NW	R4, R13, R14, R15, R16, R17	~100-500m
Sep	W	R2	~1,500m	NW	R4, R13, R14, R15, R16, R17	~100-500m
Oct	E	R4, R13, R14, R15	~100-250m	NW	R4, R13, R14, R15, R16, R17	~100-500m
Nov	E	R4, R13, R14, R15	~100-250m	S	R4	~100m
Dec	SE	R4	~100m	S	R4	~100m

*Prevailing wind direction taken from Bureau of Meteorology data (for Busselton Aero 009603) collated from 1997 – 2010

During dry and windy ambient conditions five residences that are present within 500m from the disturbance area boundary may be potentially impacted by nuisance-dust during construction activities, mining of mine pits and other associated dust generating activities from soil disturbance:

- Residence R4, located ~100m from the northern boundary of the Site is most susceptible to dust from winds with a southerly vector. In addition, being on the northern site boundary, R4 may potentially be susceptible to works that occur near the northern boundary during either westerly or easterly winds. Given the proximity of this residence to the disturbance area, dust measures will be implemented to minimise dust emissions leaving the northern boundary, and real time dust monitoring will be employed, in the vicinity of R4;
- Residence R13, R14, R15, R16 and R17 are located between 100m-500m from the southern boundary and therefore susceptible to dust from winds with a northern vector. In addition, being on the southern site boundary, R13 and R15 (in particular) may potentially be susceptible to works that occur near the southern boundary during either westerly or easterly winds. Given the proximity of this residence to the disturbance area, dust measures will be implemented to minimise dust emissions leaving the northern boundary, and real time dust monitoring will be employed, in the vicinity of these residences.

The risk of significant off-site impacts to any residence is considered low due to the proven performance of the dust management strategies at Doral's Dardanup and Yoongarillup Mines, which will be implemented for the Proposal.

Surrounding vegetation could potentially be affected by dust deposition arising from mining activities. Dust interferes with physiological processes of plants (e.g. transpiration). In extreme cases dust can smother the leaves of vegetation, resulting in adverse health of the plant and/or death. Generally significant dust is not generated from within the mining pits, but from stockpiles and unsealed road surfaces. Management measures (outlined below) will be implemented to reduce dust generation. The risk of death of vegetation from dust impacts is considered to be low, given the small area of vegetation within the disturbance area.

GENERATION OF GREENHOUSE GAS

The Proposal will contribute Scope 1 greenhouse emissions of up to approximately 12,000 tonnes CO_2 equiv. per year (Appendix 10). The key energy demands are from the combustion of diesel for operation of vehicles and mining fleet and emissions due to the generation of electricity from diesel generators. The Scope 1 greenhouse gas emissions for the Proposal are not considered to be significantly different to those generated by the existing Yoongarillup Mine. As the Proposal will not commence until approximately 12months after the closure of the Yoongarillup Mine, the Scope 1 greenhouse gas emissions from this Proposal are not considered to significantly increase Doral's current overall greenhouse gas emissions, as the new emissions would effectively replace the current emissions.

5.6. MITIGATION MEASURES

PARTICULATE EMISSIONS

Doral are experienced with dust management due to its previous experience at managing this aspect at its Dardanup and Yoongarillup Mine.

It is expected that air quality parameter limits will be incorporated into in the environmental Licence requirements issued under Part V of the EP Act for prescribed premises. Doral will employ mobile real time dust monitoring to regularly monitor TSP and PM_{10} concentrations in accordance with the Dust Management Plan which will be prepared and implemented for the Proposal. Doral will adhere to the limits set for dust within the licence, with a focus on minimising the concentration of TSP and PM_{10} leaving the mine site and potentially impacting neighbours.

During the pre-mine establishment phase management may include employing up to three water carts for dust suppression on unsealed roads and in new areas of ground disturbance.

A range of control techniques will continue to be implemented to eliminate, minimise and control dust generation activities for the Proposal which include:

- Restrictions on the areas open at any one time to ensure safe and efficient operations;
- Scheduling topsoil stripping as such to avoid periods of high winds;
- Inform all employees and contractors of the importance of reducing the creation of dust generating activities;
- When necessary, stripping operations are to be suspended under particularly high wind conditions;

- Watering all high traffic and haulage areas on a routine basis for dust suppression ensuring that there is no runoff into vegetated areas. Up to three water carts will be available for use at any one time;
- Spreading stockpiles, noise control bunds and pond embankments with fine clay solution or PVA sealant such that dust control and soil erosion measures are achieved;
- Minimising the number and size of stockpiles. This involves the direct use of overburden as backfill and the direct replacement of topsoil, wherever possible;
- Encouraging vegetative cover on stockpiles, especially the topsoil stockpiles. Many of these vegetative species generate from stored seed to minimise dust generation;
- The management and monitoring of ore loading and unloading operations such that dust generation is minimised and controlled;
- Spraying HMC stockpiles at the mine with water if they dry to the extent dust generation occurs. HMC stockpiles generally have a moisture content of between 5-9% and are not vulnerable to the adverse effects of strong winds causing dust;
- The co-disposal of sand tails and clay tails into pit backfill areas. This homogenous mixing increases the average particle size and reduces the potential for dust generation;
- When and where necessary, spraying with water or other dust suppression measures (e.g. emulsion spray, erection of wind barriers) is employed;
- Employ routine maintenance and housekeeping practices to ensure that waste materials in and around the mine voids and infrastructure do not accumulate and lead to the generation on unacceptable airborne particulates.

GREENHOUSE GAS

Doral will manage greenhouse gas emissions in accordance with the *National Greenhouse and Energy Reporting Act 2007* and report the following annually:

- Energy production;
- Energy consumption;
- Emissions.

Doral is committed to an ongoing program of review to identify opportunities to further reduce energy consumption and reduce greenhouse gas emissions.

5.7. PREDICTED OUTCOME

Doral considers that with the implementation of the above management measures, the EPA's objective to maintain air quality and minimise emissions so that environmental values are protected will be achieved.

6. OFFSETS

Environmental offsets are actions that provide environmental benefits which counterbalance the Significant Residual Environmental Impacts or risks of a Proposal. In accordance with *WA Environmental Offsets Policy, September 2011* (Government of Western Australia, 2011)*, WA Environmental Offsets Guidelines (Government of Western Australia, 2014)* and the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy Oct 2012 (DSEWPaC, 2012a),* offsets may only be applied after other mitigation measures have been considered, as per the following hierarchy:

- Avoid;
- Minimise;
- Rehabilitate;
- Offset.

As noted in the *WA Environmental Offsets Guidelines (Government of Western Australia, 2014)*, environmental offsets address significant environmental impacts that remain after on-site avoidance and mitigation measures have been undertaken. Environmental offsets will only be considered after strategies to avoid and mitigate significant environmental impacts have been applied. In general, significant residual impacts include those that:

- Affect rare and endangered plants and animals (such as declared rare flora and threatened species that are protected by statute);
- Areas within formal conservation reserve system;
- Important environmental systems and species that are protected under international agreements (such as Ramsar listed wetlands);
- Areas that are already defined as being critically impacted in a cumulative context.

The residual impact significance model detailed in the *WA Environmental Offsets Guidelines (Government of Western Australia, 2014)* identifies four levels of significance for residual impacts:

- Unacceptable impacts – impacts which are environmentally unacceptable or where no offset can be applied to reduce the impact.
- Significant impacts requiring an offset – any significant residual impact of this nature will require an offset. These generally relate to any impacts to species, ecosystems, or reserve areas protected by statute or where the cumulative impact is already determined to be at critical level.
- Potentially significant impact which may require an offset – the residual impact may be significant depending on the context and extent of the impact. These relate to impacts that are likely to result in a species or ecosystems requiring protection under statute or increasing the cumulative impact to a critical level. Whether these impacts require an offset will be determined by the decision-maker based on information provided by the proponent or applicant and expert judgement.
- Impacts which are not significant – impacts which do not trigger the above categories are not expected to have a significant impact on the environment and therefore do not require an offset.

Doral has considered all of these potential residual impacts and risks in the context of both State and Commonwealth values in defining offsets.

6.1. POLICY AND GUIDANCE

The relevant policy and guidelines which provide a framework for offsets for both State and Commonwealth governments are described in Table 6-1 and 6-2.

TABLE 6-1: STATE GOVERNMENT OFFSETS

POLICY/GUIDELINE	OVERVIEW
WA Environmental Offsets Policy, September 2011 (Government of Western Australia, 2011)	This Policy seeks to ensure that environmental offsets are applied in specified circumstances in a transparent manner to engender certainty and predictability, while acknowledging that there are some environmental values that are not readily replaceable. It serves as an overarching framework to underpin environmental offset assessment and decision-making in Western Australia.
WA Environmental Offsets Guidelines (Government of Western Australia, 2014)	These guidelines complement the *Western Australian Environmental Offsets Policy, September 2011* (Government of Western Australia, 2011) (above) by clarifying the determination and application of environmental offsets in WA. Application of these guidelines will ensure that decisions made on environmental offsets are consistent and accountable under the EP Act.

TABLE 6-2: COMMONWEALTH GOVERNMENT OFFSETS

POLICY/GUIDELINE	OVERVIEW
Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy Oct 2012 (DSEWPaC, 2012a).	This Policy Statement provides a description of the types of offsets that may be applied when impacts cannot be adequately reduced through avoidance and mitigation. Eight principles for environmental offsets are provided. Suitable offsets must: 1. Deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action. 2. Be built around direct offsets but may include other compensatory measures. 3. Be in proportion to the level of statutory protection that applies to the protected matter. 4. Be of a size and scale proportionate to the residual impacts on the protected matter. 5. Effectively account for and manage the risks of the offset not succeeding. 6. Be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of state or territory offsets that may be suitable as offsets under the EPBC Act for the same action).

POLICY/GUIDELINE	OVERVIEW
	7. Be efficient, effective, timely, transparent, scientifically robust and reasonable. 8. Have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.

6.2. SIGNIFICANT RESIDUAL IMPACTS

The Proposal has been designed to, as far as practicable, avoid clearing of native vegetation and associated loss of terrestrial fauna habitat. The design maximises the use of existing cleared areas which has resulted in all but <1% of the disturbance area being located on cleared pasture. Regionally, clearing will not significantly reduce the remaining area of the Abba Plains soil-landscape system (0.93%) or the Abba vegetation complex (0.10%), however this vegetation complex is already below the Commonwealth and EPA targets of 30% and 15%, respectively. The remaining extent of the Abba vegetation complex after implementation of the Proposal is 6.5% (currently 6.6%).

The assessment of Key Environmental Factors is presented in Sections 4.2, 4.3, 4.4 and 4.5 of this ERD and describes the residual impacts and risks of the Proposal that remain after on-site avoidance and mitigation measures (i.e. minimise and rehabilitate) have been applied. This assessment has determined that the Proposal has a potentially significant impact on flora and vegetation values and terrestrial fauna values.

The following provides an assessment of significance of the Proposal for these residual impacts, against applicable matters listed in Section 5 of *Statement of Environmental Principles, Factors and Objectives* (EPA, 2018b):

a) *Values, sensitivity and quality of the environmental which is likely to be impacted*

The Proposal will impact the following vegetation communities, flora species and fauna:

- SWAFCT01b - Southern *Corymbia calophylla* woodlands on heavy soils, is listed as a TEC, with threat status of "Vulnerable" by DBCA. Within the Development Envelope, this TEC is in degraded/good and good condition.
- SWAFCT02 - Southern wet shrublands, is listed as a TEC with threat status of "Endangered" by DBCA. Within the Development Envelope, this TEC is in degraded/good and good condition.
- SWAFCT10b - *Shrublands on southern Swan Coastal Plain Ironstones (Busselton area)* (Gibson, et al., 2000) is listed as a TEC with threat status of "Critically Endangered" by DBCA and "Endangered" under the EPBC Act. Within the Development Envelope, this TEC is in degraded/good and good condition.
- *Banksia squarrosa* subsp. *Argillacea*, listed as Threatened under the BC Act and Endangered under the EPBC Act. A population of nine are present within the Development Envelope.
- Western Ringtail Possum (WRP) *Pseudocheirus occidentalis* habitat – listed as *S1* under the *BC Act* and *Critically Endangered* under the *EPBC Act.* A total of three dreys are present within the Development Envelope (based on latest 2019 survey), with low numbers of individuals persisting in the northern portion of McGibbon Track, mapped as Woodlands, Unit A2 (i.e. SWAFCT02 - Southern wet shrublands and also a GDE).

- Black Cockatoo potential breeding habitat trees (i.e. DBH ≥50cm and DBH ≥30cm for wandoo) for the following three species:
    - Carnaby`s Black-Cockatoo *Calyptorhynchus latirostris* – listed as *S2* under the *BC Act* and *Endangered* under the *EPBC Act*.
    - Baudin's Black-Cockatoo *Calyptorhynchus baudinii* – listed as S3 under the *BC Act*, and *Vulnerable* under the *EPBC Act.*
    - Forest Red-tailed Black-Cockatoo *Calyptorhynchus banksii naso* – listed as S3 under the *BC Act*, and *Vulnerable* under the *EPBC Act.*

b) Extent (intensity, duration, magnitude and geographic footprint) of the likely impact

The Proposal will directly impact 0.17ha of SWAFCT01b - Southern *Corymbia calophylla* woodlands on heavy soils through clearing. Locally, this represents 14.41% of the TEC mapped within the Development Envelope, whilst regionally this TEC is known from 13 quadrats outside of the Proposal (as shown in Figure 4-1b). The Proposal will also directly impact 0.63ha of SWAFCT02 - Southern wet shrublands through clearing. Locally, direct impacts represent 18.42% of the TEC mapped within the Development Envelope, whilst regionally this TEC is known from 6 quadrats outside of the Development Envelope (as shown in Figure 4-1b).

Of the 3.5ha of clearing to facilitate the Proposal, only 0.8ha is mapped as good condition (i.e. SWAFCT01b and SWAFCT02 described above) and is considered suitable WRP habitat. The remaining 2.7ha of vegetation is in Degraded or Completely Degraded condition and is of little value to fauna.

Clearing will also require removal of 102 Black Cockatoo potential breeding habitat trees. Of these 102, 5 contain hollows considered possibly suitable for use by a Black Cockatoo. No evidence of current use of these trees by Black cockatoos has been observed (Harewood, 2020b). These trees are present within the disturbance area as isolated scattered paddock trees and based on the total area of ground disturbance of 453.35ha, clearing of 102 trees equates to approximately 1 tree per 4ha.

As part of Doral's mitigation measures, an area of 4.7ha is proposed to be rehabilitated with local native species, including WRP and Black Cockatoo habitat to counterbalance the total clearing area of the Proposal.

Indirectly, groundwater drawdown in the 2023-2024 period to facilitate mining, has the potential to reduce water availability to 1.81ha of SWAFCT02 - Southern wet shrublands (a GDE) which may also affect associated WRP habitat (including three dreys) and 30 co-located Black Cockatoo potential breeding habitat trees (none contain suitable hollows, Harewood, 2020b). Drawdowns of up to 5m are predicted in this GDE, with drawdowns of up to 2m lasting for 3-6 months in 2023. Locally, this may reduce the extent of SWAFCT02 by a maximum of 52%, whilst regionally this TEC is known from 6 quadrats outside of the Development Envelope (Figure 4-1b). Mitigation measures such as implementation of the GDE Management Plan (Appendix 4E), is expected to minimise the extent and severity of these potential impacts.

Indirect drawdown impacts to SWAFCT10b - *Shrublands on southern Swan Coastal Plain Ironstones (Busselton area)* is predicted to be low-moderate and may potentially affect up to 0.34ha. Maximum modelled groundwater drawdowns are predicted to be 1-1.5m in Q3 and Q4, 2024. Locally, this may reduce the extent of this TEC by 75%, whilst regionally the extent of impact is ~0.25% of the known area of this TEC (total area of 138.7ha from 15 quadrats) (Meissner & English, 2005). Indirect drawdown

impacts to SWAFCT10b, although predicted to be low-moderate, has the potential to affect the population of nine *Banksia squarrosa* subsp. *Argillacea.* This species is known from 11 subpopulations, has an abundance of 2,876 mature plants and an area of occupancy of 0.38km^2 (Department of the Environment, 2015). Ecoedge (2020a) reported that there are 63 records for this species in the DBCA database, most of which relate to occurrences in "Busselton Ironstone" vegetation on the Swan Coastal Plain south of Busselton, however there are several known populations in State Forest on the Blackwood Plateau. Indirect impacts to this species however has the potential to affect 100% of the local population, whilst regionally ~0.3% of the known population will be affected.

c) Consequences of the likely impacts (or change)

The extent of clearing within SWAFCT01b (0.17ha) and SWAFCT02 (0.63ha), although limited after the application of Doral's avoidance measures, will result in a local impact of 14.41% and 18.42% to these communities, respectively. As part of Doral's mitigation measures, an area of 4.7ha is proposed to be rehabilitated with local native species to counterbalance the total clearing area of the Proposal.

The maximum indirect impact to SWAFCT02 from predicted groundwater drawdowns has the potential to affect up to 52% of this community locally, however mitigation measures such as implementation of the GDE Management Plan (Appendix 4E), are expected to minimise the extent and severity of these potential impacts. Limited publicly available information about the regional extent of these two DBCA listed TECs is available, however they are known from 13 and 6 quadrats, outside of the Development Envelope (Webb, et al., 2009) in the southwest region.

The maximum indirect impact to SWAFCT10b from predicted groundwater drawdowns has the potential to affect up to 75% of this TEC locally, however mitigation measures such as implementation of the GDE Management Plan (Appendix 4E), are expected to minimise the potential impacts. Regionally the extent of impact is ~0.25% of the known area of this TEC (total area of 138.7ha from 15 quadrats). Drawdowns within this TEC also have the potential to affect up to 100% of the local population of nine *Banksia squarrosa* subsp. *Argillacea*, whilst only ~0.3% of the known regional population (2,876 mature plants) has the potential to be impacted. Mitigation measures such as implementation of the GDE Management Plan (Appendix 4E), are expected to minimise these potential impacts.

The small area of WRP habitat to be directly and indirectly impacted is located outside of the core habitat, primary corridors and supporting habitat as documented in *Significant Impact Guidelines for the Vulnerable Western Ringtail Possum in the Southern Swan Coastal Plain, Western Australia* (DEWHA, 2009). The nearest core habitat to the Site occurs in the Tuart Forest National Park. No overall change in the conservation status of this species is anticipated, despite a possible, very localised small reduction in habitat extent.

The Black Cockatoo potential breeding habitat trees to be directly (102 trees) and indirectly (30 trees) impacted are predominantly present as isolated scattered paddock trees. Only 5 of these trees contain hollows considered possibly suitable for a Black Cockatoo, and none are currently in use by a Black Cockatoo (Harewood, 2020b). A review of the 2018 Great Cocky Count database shows no documented, active roost sites within 10km of the subject site (Peck, et al., 2018).

Based on available mapping it is estimated that there is ~13,300ha of native vegetation within 10km of the Development Envelope and there is therefore significant potential for breeding to take place in the wider area. It is also noted that the design of the Proposal has resulted in all but <1% of the disturbance

area being located on cleared pasture. No overall change in the conservation status of this species is anticipated, despite a possible, very localised small reduction in habitat extent.

Mitigation measures such as implementation of the GDE Management Plan (Appendix 4E) are expected to minimise potential indirect impacts to flora, vegetation and fauna habitat. Furthermore, as part of Doral's mitigation measures, an area of 4.7ha is proposed to be rehabilitated with local native species including WRP and Black Cockatoo habitat.

d) Resilience of the environment to cope with the impact

Resilience is associated with the scale of impact to the local population. As previously stated, clearing and potential indirect impacts associated with implementing the Proposal will have varying levels of impacts and potential impacts to threatened vegetation communities, threatened flora and fauna habitat.

Doral has designed the Proposal as far as practicable to minimise impacts to conservation significant vegetation (SWAFCT01b, 0.17ha and SWAFCT02, 0.63ha) and as such 85.59% and 81.58% of these TECs will not be directly impacted. Clearing will also avoid all identified WRP dreys/individuals observed within this portion of vegetation, with only 0.8ha of good quality vegetation being cleared for the Proposal. Clearing has also avoided ~90% of all Black Cockatoo potential breeding habitat trees present within the Development Envelope, and no nesting tree will be impacted by the Proposal. The trees to be impacted are predominately present as isolated scattered paddock trees and Black Cockatoos can continue to utilise the remaining 951 potential breeding habitat trees within the Development Envelope.

Revegetation of 4.7ha with local native species, will counterbalance and provide additional fauna habitat, including WRP and Black Cockatoo's, in the immediate area, however revegetation will unlikely return species diversity of the TECs being directly impacted.

Based on what is known about the hydrogeology and groundwater dependence of local vegetation within the Development Envelope, indirect groundwater drawdowns are predicted to be moderate to severe in SWAFCT02, potentially impacting up to 52% of this TEC and associated WRP habitat (1.81ha) and Black Cockatoo potential breeding habitat trees (30 trees), without mitigation measures. Drawdown impacts to SWAFCT10b, are predicted to be low to moderate, with the impact likely to be higher at the northern end of this TEC (i.e. closer to greater drawdowns). These impacts have the potential to affect 100% of the local population of nine *Banksia squarrosa* subsp. *Argillacea*, however as these shrubs are relatively large and old, they are likely to have roots that have found their way through fractures in the ironstone to access groundwater as it retreats in summer and autumn. Implementation of the GDE Management Plan (Appendix 4E) is expected to minimise the extent and severity of potential impacts to vegetation from groundwater drawdowns.

e) Cumulative impact with other existing or reasonably foreseeable activities, developments and land uses connections and interactions between parts of the environment to inform a holistic view of impacts to the whole environment.

Limited information is publicly available for the regional extent of SWAFCT02 and SWAFCT01b, however both communities are known from 13 and 6 quadrats from outside of the Development Envelope (Figure 4-1b). Based on these quadrat locations, no known cumulative impacts from other existing or reasonably foreseeable activities, developments or land uses are known.

Cumulatively, the direct (0.8ha) and indirect (1.81ha) impacts to WRP habitat will not contribute to further loss of core habitat, primary corridors and supporting habitat as documented in *Significant Impact Guidelines for the Vulnerable Western Ringtail Possum in the Southern Swan Coastal Plain, Western Australia* (DEWHA, 2009) as the identified habitat is outside of these areas. In addition, direct (102 trees) and indirect (30 trees) impacts to Black Cockatoo potential breeding habitat trees are considered to represent ~130% of the potential breeding habitat trees within the Development Envelope. No known cumulative impacts from other existing or reasonably foreseeable activities, developments or land uses are known for WRP and Black Cockatoo potential breeding habitat trees. Furthermore, revegetation of 4.7ha with local native species, will counterbalance and provide additional WRP and Black Cockatoo habitat within the immediate area.

The extent of indirect impacts to SWAFCT10b is ~0.25%, based on the known area and location of this TEC (Meissner & English, 2005). From the 15 known quadrats and area (138.7ha), a significant portion is located within Nature Reserves and State Forests, as well as rail and road reserves. No known cumulative impacts from other existing or reasonably foreseeable activities, developments or land uses affected this community are known.

Indirect impacts to the population of nine *Banksia squarrosa* subsp. *Argillacea*, represents only ~0.3% of the known regional population (2,876 mature plants). Ecoedge (2020a) reported that there are 63 records of this species in the DBCA database, which mostly relate to "Busselton Ironstone" vegetation on the Swan Coastal Plain south of Busselton. No known cumulative impacts from other existing or reasonably foreseeable activities, developments or land uses are known for *Banksia squarrosa* subsp. *Argillacea*.

Holistically, cumulative impacts of the Proposal have the potential to affect up to 2.95ha of conservation significant vegetation, which includes 2.61ha of WRP habitat and 132 Black Cockatoo potential breeding habitat trees. These impacts will not significantly reduce the Abba vegetation complex (0.09%), however this vegetation complex is already below the Commonwealth and EPA targets of 30% and 15% respectively. The remaining extent of the Abba vegetation complex after implementation of the Proposal is ~6.5%.

f) Level of confidence in the prediction of impacts and the success of proposed mitigation

There is a high level of confidence around the direct impacts to SWAFCT01b, SWAFCT02, associated WRP habitat and Black Cockatoo potential breeding habitat and the associated mitigation measures (i.e. avoid, minimise and rehabilitate).

There is a high level of confidence in the groundwater model prepared by AQ2 (2020a), and moderate to high level of confidence that the proposed mitigation measures (i.e. GDE Management Plan) will minimise the extent and severity of indirect impacts. Uncertainty however exists around the actual extent of indirect impacts associated with groundwater drawdowns to SWAFCT02 (and associated WRP habitat and 30 Black Cockatoo potential breeding trees), SWAFCT10b and the *Banksia squarrosa* subsp. *Argillacea* due to the complex nature of the underlying strata, particularly to the "Busselton Ironstone" (SWAFCT10b).

An assessment of Significant Residual Impact from the Proposal using the Residual Impact Significance Model is provided in Table 6-3.

TABLE 6-3: RESIDUAL IMPACT SIGNIFICANCE MODEL

Part IV Environmental Factors	Vegetation and Flora						
				Terrestrial Fauna			
Part V Clearing Principles	Rare Flora	Threatened Ecological Communities	Remnant Vegetation	Wetlands & Waterways	Conservation Area	High Biological Diversity	Habitat for Fauna
Residual Impact that is environmentally unacceptable or cannot be offset							
Significant residual impacts that will require an offset- All significant residual impacts to species and ecosystems protected by statute or where the cumulative impact is already at a critical level	INDIRECT IMPACTS Indirect impacts from groundwater drawdown may impact up to nine individuals of *Banksia squarrosa* subsp. *Argillacea* which are protected by statute. These shrubs are relatively large and old, and are likely to have roots that have found their way through fractures in the ironstone to access groundwater as it retreats in summer and autumn. With the implementation of mitigation measures, such as the GDE Management Plan which includes irrigation triggers, contingencies etc. these impacts are expected to be minimised, however as uncertainty exists around the actual extent of indirect impacts from groundwater drawdown, the impacts are considered potentially significant and an offset is proposed.	DIRECT IMPACTS The Proposal will directly impact 0.17ha of SWAFCT01b - Southern *Corymbia calophylla* woodlands on heavy soils through clearing. Locally, this represents 14.41% of the TEC mapped within the Development Envelope, whilst regionally this TEC is known from 13 quadrats outside of the Proposal (as shown in Figure 4-1b). The Proposal will also directly impact 0.63ha of SWAFCT02 - Southern wet shrublands through clearing. Locally, direct impacts represent 18.42% of the TEC mapped within the Development Envelope, whilst regionally this TEC is known from 6 quadrats outside of the Development (as shown in Figure 4-1b). Doral's primary mitigation measure has been to design the Proposal to avoid clearing of native vegetation, as far as practicable, and maximise the use of existing cleared areas. This has resulted in all but <1% of the disturbance area being located on cleared pasture. Doral will also rehabilitate an area of 4.7ha of local native species to counterbalance direct impacts from clearing. As clearing will impact two DBCA listed TEC's protected by statute, the impacts are considered significant and an offset is proposed.					DIRECT IMPACTS The Proposal will clear ~0.8ha of WRP habitat predominantly as isolated paddock trees and/or overstory species (woodland species). Clearing will not affect any of the identified dreys/ individuals and the habitat to be impacted is outside of the core habitat, primary corridors and supporting habitat as described in *Significant Impact Guidelines for the Vulnerable Western Ringtail Possum in the Southern Swan Coastal Plain, Western Australia (DEWHA, 2009).* As clearing will impact habitat of a species protected by statute, the impacts are considered significant and an offset is proposed. The Proposal will require clearing of 102 Black Cockatoo potential breeding habitat trees, present as isolated scattered paddock trees, from the 1,053 mapped within the 924.8ha Development Envelope. Of these trees, only 5 contain one or more hollows possibly suitable for use by a Black Cockatoo, however no evidence of current use within any tree has been observed within the Development Envelope. Based on the total area of ground disturbance of 453.35ha, clearing of 102 trees equates to approximately 1 tree per 4ha. Based on available mapping it is estimated that there is ~13,300ha of

		INDIRECT IMPACTS Indirect impacts from groundwater drawdown may impact the following TECS which are protected by statute: • Up to 1.81ha of SWAFCT02 - Southern wet shrublands. • Up to 0.34ha of SWAFCT10b - *Shrublands on southern Swan Coastal Plain Ironstones (Busselton area)* (Gibson, et al., 2000) With the implementation of mitigation measures, such as the GDE Management Plan which includes irrigation triggers, contingencies etc. these impacts are expected to be minimised, however as uncertainty exists around the actual extent of indirect impacts from groundwater drawdown, the impacts are considered potentially significant and an offset is proposed.					native vegetation within 10km of the Development Envelope and there is therefore significant potential for Black Cockatoo breeding and/or foraging to take place in the wider area. A review of the 2018 Great Cocky Count database shows no documented, active roost sites within 10km of the subject site (Peck, et al., 2018). As clearing will impact habitat of a species protected by statute, the impacts are considered significant and an offset is proposed. **INDIRECT IMPACTS** Indirect impacts from groundwater drawdown may impact up to 1.81ha of WRP habitat including three dreys/individuals, as well as 30 co-located Black Cockatoo potential breeding habitat trees (none contain suitable hollows). The WRP habitat is outside of the core habitat, primary corridors and supporting habitat *(DEWHA, 2009).* Based on available mapping it is estimated that there is ~13,300ha of native vegetation within 10km of the Development Envelope and there is therefore significant potential for Black Cockatoo breeding and/or foraging to take place in the wider area. A review of the 2018 Great Cocky Count database shows no documented, active roost sites within 10km of the subject site (Peck, et al., 2018). With the implementation of mitigation measures, such as the GDE Management Plan and the revegetation of 4.7ha of WRP habitat, the extent and severity of impacts are expected to be minimised. However, as uncertainty exists around the actual extent of indirect impacts from groundwater drawdown, the impacts are considered significant as they have potential to affect species' protected by statute and an offset is proposed.

Significant residual impacts that may require an offset – **Any significant residual impact to potentially threatened species and ecosystems, areas of high environmental value or where the cumulative impact may reach critical levels if not managed.**							
Residual impacts that are not significant			The Proposal will clear ~3.5ha of a total 37.81ha of native vegetation within the Development Envelope, of which 2.7ha is in Degraded or Completely Degraded condition. Clearing represents disturbance to 0.10% of the area remaining for the Abba vegetation complex and does not significantly reduce the regional extent of this vegetation complex (i.e. 3.5ha of the remaining 3,359.08ha).	There are no conservation significant wetlands within or in proximity to the Development envelope that will be affected by the Proposal. The Vasse-Wonnerup Ramsar wetland is located ~4.6km to the north of the Development Envelope and will not be significantly affected by the Proposal.	There are no formal conservation reserves or conservation covenants within or in close proximity to the Development. Three 'conservation' Sumpland and Floodplain, are located ~6km the northeast and southwest of the Development Envelope.	The Proposal does not occur within an area of high biological diversity. Only ~37.8ha of remnant vegetation is present within the 924.8ha Development Envelope, with 87.5% in Degraded or completely Degraded condition. One hundred and forty-nine taxa of vascular plants were identified during the surveys (Ecoedge, 2019a, 20197 and 2019b), of which 57 taxa (38%) were introduced species.	The Proposal will clear ~3.5ha of fauna habitat within the Development Envelope, of which 2.7ha is in Degraded or Completely Degraded condition and is considered of little value to most fauna species.

As presented in Table 6-3, under the WA Environmental Offsets Guidelines (Government of Western Australia, 2014), Significant Residual Impacts have the potential to occur the following flora, vegetation and fauna habitat (WRP) as summarised in Table 6-4.

TABLE 6-4: SUMMARY OF SIGNIFICANT RESIDUAL IMPACTS

ENVIRONMENTAL FACTOR	EXTENT OF SIGNIFICANT RESIDUAL IMPACT (DIRECT IMPACTS)		EXTENT OF SIGNIFICANT RESIDUAL IMPACT (INDIRECT IMPACTS)	
Flora and Vegetation	SWAFCT01b - Southern *Corymbia calophylla* woodlands on heavy soils (TEC - vulnerable)	0.17ha	SWAFCT02 - Southern wet shrublands (TEC - endangered)	1.81ha
	SWAFCT02 - Southern wet shrublands (TEC - endangered)	0.63ha	SWAFCT10b - Shrublands on southern Swan Coastal Plain Ironstones (Busselton area) (TEC – critically endangered)	0.34ha
			Banksia squarrosa subsp. *Argillacea* (Whicher Range banksia) (Threatened)	9 individuals
Terrestrial Fauna	WRP habitat (comprising the above vegetation)	0.80ha	WRP habitat (comprising the Southern Wet Shrublands vegetation)	1.81ha
	Black Cockatoo potential breeding habitat trees	102 trees (5 contain possibly suitable hollows, but no evidence of use)	Black Cockatoo potential breeding habitat trees	30
TOTAL	Total significant impact (Direct)	0.80ha 102 x potential Black Cockatoo breeding trees	Total significant impact (Indirect)	2.15ha 9 x flora 30 x potential Black Cockatoo breeding trees

A completed WA Environmental Offsets Table is provided in Table 6-5, which describes the mitigation measures to be undertaken. The scale of impact however as discussed above in Table 6-4 (and listed in Table 6-5) is considered significant to flora, vegetation and fauna habitat.

TABLE 6-5: WA ENVIRONMENTAL OFFSETS TABLE

Project Name: YALYALUP MINERAL SANDS PROJECT									
Existing environment/ Impact	*Mitigation*			*Significant Residual Impact*	*Offset Calculation Methodology*				
	Avoid and minimise	*Rehabilitation Type*	*Likely Rehab Success*		*Type*	*Risk*	*Likely Offset Success*	*Time Log*	*Offset Quantification*
Disturbance of 453.34 hectares									
449.83 ha cleared pasture and planted non-endemic species	**Avoid** - The proposal has been designed as far as practicable to utilise existing cleared pasture rather than clearing native vegetation. **Minimise**- The following plans and strategy will be prepared and implemented to minimise impacts to flora and vegetation values: 1. A Flora and Vegetation Management Plan 2. GDE Management Plan 3. Dust Management Plan 4. Fire Management Plan 5.Acid Sulfate Soil Management Plan 6. Groundwater Operating Strategy	449.83 ha of cleared pasture and planted non-endemic species will be returned to pasture in accordance with Mine Closure Plan	High - Doral have significant experience with returning former mined/disturbed areas to pasture. Doral successfully rehabilitated 770ha of disturbed land at the Dardanup Mineral Sands Mine back to pasture, which is currently in the process of being relinquished by DMIRS.	No					
Clearing of 2.7ha of Degraded and Completely Degraded native vegetation	**Avoid** - The proposal has been designed as far as practicable to utilise existing cleared pasture rather than clearing native vegetation. **Minimise**- The following plans and strategy will be prepared and implemented to minimise impacts to flora and vegetation values: 1. A Flora and Vegetation Management Plan 2. GDE Management Plan	Doral will rehabilitate 4.7ha of native vegetation and WRP habitat using local species to counterbalance the clearing impacts. Specially, the revegetation will aim to establish Woodland of *Corymbia calophylla, Eucalyptus marginata* and *Agonis flexuosa* over shrubland.	High - Doral have successfully rehabilitated three Offset areas back to native vegetation in accordance with Department of Agriculture, Water and the Environment and DBCA/EPA conditions.	No					

Project Name: YALYALUP MINERAL SANDS PROJECT									
Existing environment/ Impact	*Mitigation*			*Significant Residual Impact*	*Offset Calculation Methodology*				
	Avoid and minimise	*Rehabilitation Type*	*Likely Rehab Success*		*Type*	*Risk*	*Likely Offset Success*	*Time Log*	*Offset Quantification*
	3. Dust Management Plan 4. Fire Management Plan 5.Acid Sulfate Soil Management Plan 6. Groundwater Operating Strategy								
The Proposal will clear 0.8ha of WRP habitat predominantly as isolated paddock trees and/or overstory species (woodland species). Clearing will not affect any of the identified dreys/ individuals and the habitat is outside of core habitat, primary corridors and supporting habitat as described in (DEWHA, 2009).	**Avoid** - The proposal has been designed as far as practicable to utilise existing cleared pasture rather than clearing native vegetation. This has resulted in the avoidance of all but 0.8ha of WRP habitat within the Development Envelope. **Minimise**- The following plans and strategy will be prepared and implemented to minimise impacts to flora and vegetation values: 1. A Flora and Vegetation Management Plan 2. GDE Management Plan 3.Fauna Management Plan 4. Dust Management Plan 5. Fire Management Plan 6.Acid Sulfate Soil Management Plan 7. Groundwater Operating Strategy	Doral will rehabilitate 4.7ha of native vegetation and WRP habitat using local species to counterbalance the clearing impacts. Specially, the revegetation will aim to establish Woodland of *Corymbia calophylla, Eucalyptus marginata* and *Agonis flexuosa* over shrubland.	<u>Can the environmental values be rehabilitated/Evidence?</u> Yes, WRP habitat can be established and be self-sustaining within a relatively short time frame (i.e.5-7years). <u>Operator experience in undertaking rehabilitation?</u> Yes, Doral have successfully rehabilitated three Offset areas back to native vegetation in accordance with Department of Agriculture, Water and the Environment and DBCA/EPA conditions. <u>What is the type of vegetation being rehabilitated?</u> Woodland of *Corymbia calophylla, Eucalyptus marginata* and *Agonis flexuosa* over shrubland. <u>Time lag?</u> 5-7 years for WRP habitat to be established and self-sustaining. <u>Credibility of the rehabilitation proposed (evidence of demonstrated success)</u> Doral have successfully rehabilitated three Offset areas as part of other mine operations. Doral are currently rehabilitating ~9ha of land back to State-Forest.	<u>Extent</u> 0.80ha <u>Quality</u> Vegetation has been mapped as Good condition. <u>Conservation Significance</u> WRP habitat <u>Land Tenure</u> Mining Tenements <u>Time Scale</u> The Proposal has an anticipated mine life of 4-5 years. According to the agreed significance framework, residual impact is considered significant as indirect impacts from groundwater drawdown, has the potential to affect a species protected by statute under the BC Act and EPBC Act.	Land acquisition	Low – Land to be secured and placed under Conservation Covenant by Doral or Doral to provide funding arrangement to DBCA for the purchase and management of a suitable the offset. It is expected that the offset will be a Ministerial Condition of the approval of the Proposal.	High – Land acquisition and management in the southwest is well understood and has been previously implemented by Doral and DBCA as an offset for the Yoongarillup Mine. <u>Can the values be defined and measured?</u> Yes - values of vegetation communities can be measured. <u>Operator experience/Evidence?</u> Doral/DBCA will manage the land. <u>What is the type of vegetation being revegetated?</u> Where possible, vegetation with same or similar characteristics to SWAFCT01b and SWAFCT02 or suitable WRP habitat. <u>Is there evidence the environmental values can be re-created (evidence of demonstrated success)?</u> Yes, Doral have successfully provided a Land Acquisition offset as part of its	Secures habitat upon agreement - no time delay	Area contained within Land Acquisition Offset to be provided. (refer to Appendix 11)

Project Name: YALYALUP MINERAL SANDS PROJECT									
Existing environment/ Impact	*Mitigation*			*Significant Residual Impact*	*Offset Calculation Methodology*				
	Avoid and minimise	*Rehabilitation Type*	*Likely Rehab Success*		*Type*	*Risk*	*Likely Offset Success*	*Time Log*	*Offset Quantification*
							Yoongarillup Mine Ministerial Conditions.		
Direct impact from clearing 102 Black Cockatoo potential habitat trees, present as isolated scattered paddock trees. In consultation with DAWE, the canopy area of Black Cockatoo potential breeding habitat has been calculated as 1.78ha to assist in determining suitable offsets.	**Avoid** - The proposal has been designed as far as practicable to utilise existing cleared pasture rather than clearing native vegetation. This has resulted in the avoidance of 951 of the total 1.053 Black Cockatoo potential breeding habitat trees within the Development Envelope. **Minimise**- The following plans and strategy will be prepared and implemented to minimise impacts to flora and vegetation values: 1. A Flora and Vegetation Management Plan 2. GDE Management Plan 3.Fauna Management Plan 4. Dust Management Plan 5. Fire Management Plan 6.Acid Sulfate Soil Management Plan 7. Groundwater Operating Strategy.	Doral will rehabilitate 4.7ha of native vegetation using local species to counterbalance the clearing impacts of the Proposal. Specially, the revegetation will aim to establish Woodland of *Corymbia calophylla, Eucalyptus marginata* and *Agonis flexuosa* over shrubland.	<u>Can the environmental values be rehabilitated/Evidence?</u> Yes, Black Cockatoo foraging habitat can be established and be self-sustaining within a relatively short time frame (i.e.5-7years). However, potential breeding trees may take up to 200 years to form a suitable hollow. <u>Operator experience in undertaking rehabilitation?</u> Yes, Doral have successfully rehabilitated three Offset areas back to native vegetation in accordance with Department of Agriculture, Water and Environment and DBCA/EPA conditions. <u>What is the type of vegetation being rehabilitated?</u> Woodland of *Corymbia calophylla, Eucalyptus marginata* and *Agonis flexuosa* over shrubland. <u>Time lag?</u> 5-7 years for foraging habitat to be established and self-sustaining, however 200 years for trees to form suitable hollows. <u>Credibility of the rehabilitation proposed (evidence of demonstrated success)</u> Doral have successfully rehabilitated three Offset areas as part of other mine	<u>Extent</u> 102 trees (equivalent to 1.78ha) <u>Quality</u> Isolated scattered paddock trees, with 14 trees containing hollows <u>possibly suitable</u> for a Black Cockatoo to use. No evidence of current or previous use. <u>Conservation Significance</u> Black Cockatoo potential breeding habitat trees, present as isolated scattered paddock trees. <u>Land Tenure</u> Mining Tenements <u>Time Scale</u> The Proposal has an anticipated mine life of 4-5 years. According to the agreed significance framework, residual impact is considered significant as clearing will affect a species protected by statute under the BC Act and EPBC Act.	Land acquisition	Low – Land to be secured and placed under Conservation Covenant by Doral or Doral to provide funding arrangement to DBCA for the purchase and management of a suitable offset. It is expected that the offset will be a Ministerial Condition of the approval of the Proposal.	High – Land acquisition and management in the southwest is well understood and has been previously implemented by Doral and DBCA as an offset for the Yoongarillup Mine. <u>Can the values be defined and measured?</u> Yes - values of vegetation communities can be measured. <u>Operator experience/Evidence?</u> Doral/DBCA will manage the land. <u>What is the type of vegetation being revegetated?</u> Vegetation suitable as Black Cockatoo potential breeding habitat. <u>Is there evidence the environmental values can be re-created (evidence of demonstrated success)?</u> Yes, Doral have successfully provided a Land Acquisition offset as part of its Yoongarillup Mine Ministerial Conditions.	Secures habitat upon agreement - no time delay	Area contained within Land Acquisition Offset, to be provided. (refer to Appendix 11)

Project Name: YALYALUP MINERAL SANDS PROJECT									
Existing environment/ Impact	*Mitigation*			*Significant Residual Impact*	*Offset Calculation Methodology*				
	Avoid and minimise	*Rehabilitation Type*	*Likely Rehab Success*		*Type*	*Risk*	*Likely Offset Success*	*Time Log*	*Offset Quantification*
			operations. Doral are currently rehabilitating ~9ha of land back to State-Forest.						
Clearing a total of 0.8ha of degraded/good and good quality native vegetation comprising: 0.17ha of FCT01b - Southern *Corymbia calophylla* woodlands on heavy soils in Degraded/Good or Good condition. 0.63ha of FCT02 - Southern wet shrublands, in Degraded/Good or Good condition.	**Avoid** - The proposal has been designed as far as practicable to utilise existing cleared pasture rather than clearing native vegetation. This has resulted in the avoidance of all Threatened and Priority flora species and the EPBC listed TEC, SWAFCT10b. **Minimise**- The following plans and strategy will be prepared and implemented to minimise impacts to flora and vegetation values: 1. A Flora and Vegetation Management Plan 2. GDE Management Plan 3. Dust Management Plan 4. Fire Management Plan 5.Acid Sulfate Soil Management Plan 6. Groundwater Operating Strategy	Rehabilitation back to the same community types (TECs) is unlikely. Doral will however rehabilitate 4.7ha of native vegetation and WRP habitat using local species, including those present in the impacted TECs and those suitable for WRPs. Specially, the revegetation will aim to establish Woodland of *Corymbia calophylla, Eucalyptus marginata* and *Agonis flexuosa* over shrubland.	<u>Can the environmental values be rehabilitated/Evidence?</u> Unlikely for the TECs, given the vegetation to be cleared has specific substrate requirements which will be disturbed during mining. The rehabilitation area is likely to have different substrate although it will not be disturbed by mining. <u>Operator experience in undertaking rehabilitation?</u> Doral have successfully rehabilitated three Offset areas back to native vegetation in accordance with Department of Agriculture, Water and the Environment and DBCA/EPA conditions. <u>What is the type of vegetation being rehabilitated?</u> Woodland of *Corymbia calophylla, Eucalyptus marginata* and *Agonis flexuosa* over shrubland. <u>Time lag?</u> 5-7 years for vegetation to be established and self-sustaining. <u>Credibility of the rehabilitation proposed (evidence of demonstrated success)</u> Doral have successfully rehabilitated three Offset areas as part of other mine operations. Doral are currently rehabilitating ~9ha of land back to State-Forest.	<u>Extent</u> 0.80ha <u>Quality</u> Vegetation has been mapped as Good condition. <u>Conservation Significance</u> FCT01b - Vulnerable by DBCA FCT02 - Endangered by DBCA <u>Land Tenure</u> Mining Tenements <u>Time Scale</u> The Proposal has an anticipated mine life of 4-5 years. According to the agreed significance framework, residual impact is considered to be significant because two DBCA listed TECs protected under the BC Act will be impacted.	Land acquisition	Low – Land to be secured and placed under Conservation Covenant by Doral or Doral to provide funding arrangement to DBCA for the purchase and management of a suitable offset. It is expected that the offset will be a Ministerial Condition of the approval of the Proposal.	High – Land acquisition and management in the southwest is well understood and has been previously implemented by Doral and DBCA as an offset for the Yoongarillup Mine. <u>Can the values be defined and measured?</u> Yes - values of vegetation communities can be measured. <u>Operator experience/Evidence?</u> Doral/DBCA will manage the land. <u>What is the type of vegetation being revegetated?</u> Vegetation with same or similar characteristics to SWAFCT01b and SWAFCT02 and include WRP habitat. <u>Is there evidence the environmental values can be re-created (evidence of demonstrated success)?</u> Yes, Doral have successfully provided a Land Acquisition offset as part of its Yoongarillup Mine Ministerial Conditions.	Secures habitat upon agreement - no time delay	Area contained within Land Acquisition Offset, to be provided. (refer to Appendix 11)

Project Name: YALYALUP MINERAL SANDS PROJECT									
Existing environment/ Impact	*Mitigation*			*Significant Residual Impact*	*Offset Calculation Methodology*				
	Avoid and minimise	*Rehabilitation Type*	*Likely Rehab Success*		*Type*	*Risk*	*Likely Offset Success*	*Time Log*	*Offset Quantification*
Indirect impacts from dewatering to the following GDEs and associated and flora: 1.81ha of SWAFCT02 - Southern wet shrublands 0.34ha of SWAFCT10b - Shrublands on southern Swan Coastal Plain Ironstones (Busselton area) Population of nine *Banksia squarrosa* subsp. *Argillacea* (Whicher Range banksia), present within SWAFCT10b.	Groundwater drawdown impacts will be avoided and/or minimised by implementing the following key actions: -Dewatering will be undertaken in a staged approach; -Passive dewatering with sump pump (i.e. no dewatering spears) will be used to minimise the extent of dewatering cone of depression; -Rapid hydraulic backfill of sand tails which will aid in returning groundwater levels will be conducted; -Provision of reticulation/irrigation to vegetation in accordance with: 1. GDE Management Plan 2. Groundwater Operating Strategy.	Rehabilitation back to the same community types (TECs) is unlikely. Doral will however rehabilitate 4.7ha of native vegetation and adjacent to the conservation significant McGibbon Track using local provence species, including those present in the impacted TECs. Specially, the revegetation will aim to establish Woodland of *Corymbia calophylla, Eucalyptus marginata* and *Agonis flexuosa* over shrubland.	<u>Can the environmental values be rehabilitated/Evidence?</u> Unlikely, given the vegetation to be potentially impacted by dewatering comprises specific substrate requirements. <u>Operator experience in undertaking rehabilitation?</u> Doral have successfully rehabilitated three Offsets areas back to native vegetation. <u>What is the type of vegetation being rehabilitated?</u> Woodland of *Corymbia calophylla* and *Eucalyptus marginata* over shrubland. <u>Time lag?</u> 5-7 for vegetation to be established and self-sustaining. <u>Credibility of the rehabilitation proposed (evidence of demonstrated success)</u> Doral have successfully rehabilitated three Offset areas as part of other mine operations. Doral are currently rehabilitating ~9ha of land back to State-Forest.	<u>Extent</u> 1.81ha of SWAFCT02 0.34ha of SWAFCT10b Population of nine *Banksia squarrosa* subsp. *Argillacea* (Whicher Range banksia) <u>Quality</u> Vegetation has been mapped as Degraded/Good and Good condition <u>Conservation Significance</u> SWAFCT02 - Endangered by DBCA SWAFCT10b - Critically Endangered by DBCA/Endangered under EPBC Act *Banksia squarrosa* subsp. Argillacea - Threatened (DBCA)/Endangered (EPBC) flora species <u>Land Tenure</u> Mining Tenement/Road reserve <u>Time Scale</u> N/A According to the agreed significance framework, residual impact is considered to be potentially significant as two TECs protected under the BC Act (inc. one under EPBC Act) have the potential to be impacted from dewatering. In addition, one flora species listed as Threatened by DBCA and Endangered under the EPBC Act, also has the potential to be impacted by dewatering.	Land acquisition	Low – Land to be secured and placed under Conservation Covenant by Doral or Doral to provide funding arrangement to DBCA for the purchase and management of a suitable offset. It is expected that the offset will be a Ministerial Condition of the approval of the Proposal.	<u>Can the values be defined and measured?</u> Yes - values of vegetation communities can be measured <u>Operator experience/Evidence?</u> Doral/DBCA will manage the land. <u>What is the type of vegetation being revegetated?</u> NA <u>Is there evidence the environmental values can be re-created (evidence of demonstrated success)?</u> Yes Doral have provided a Land Acquisition offset as part of its Yoongarillup Mine.	Secures habitat upon agreement - no time delay	Area contained within Land Acquisition Offset, to be provided. (refer to Appendix 11)
Indirect impacts from dewatering to 1.81ha of WRP habitat, present as the	Groundwater drawdown impacts will be avoided and/or minimised by	Doral will rehabilitate 4.7ha of native vegetation and WRP habitat using local species	<u>Can the environmental values be rehabilitated/Evidence?</u> Yes, WRP habitat can be established and be self-	<u>Extent</u> 1.81ha of WRP (mapped as SWAFCT02)	Land acquisition	Low – Land to be secured and placed under	<u>Can the values be defined and measured?</u> Yes - values of vegetation communities can be	Secures habitat upon agreement - no time delay	Area contained within Land Acquisition Offset, to be provided. (refer to Appendix 11)

Project Name: YALYALUP MINERAL SANDS PROJECT									
Existing environment/ Impact	*Mitigation*			*Significant Residual Impact*	*Offset Calculation Methodology*				
	Avoid and minimise	*Rehabilitation Type*	*Likely Rehab Success*		*Type*	*Risk*	*Likely Offset Success*	*Time Log*	*Offset Quantification*
GDE SWAFCT02, described above.	implementing the following key actions: -Dewatering will be undertaken in a staged approach; -Passive dewatering with sump pump (i.e. no dewatering spears) will be used to minimise the extent of dewatering cone of depression; -Rapid hydraulic backfill of sand tails which will aid in returning groundwater levels will be conducted; -Provision of reticulation/irrigation to vegetation in accordance with: 1. GDE Management Plan 2. Groundwater Operating Strategy.	to counterbalance the clearing impacts. Specially, the revegetation will aim to establish Woodland of *Corymbia calophylla, Eucalyptus marginata* and *Agonis flexuosa* over shrubland.	sustaining within a relatively short time frame (i.e.5-7years). Operator experience in undertaking rehabilitation? Doral have successfully rehabilitated three Offset areas back to native vegetation in accordance with Department of Agriculture, Water and the Environment and DBCA/EPA conditions. What is the type of vegetation being rehabilitated? Woodland of *Corymbia calophylla, Eucalyptus marginata* and *Agonis flexuosa* over shrubland. Time lag? 5-7 years for WRP habitat to be established and self-sustaining. Credibility of the rehabilitation proposed (evidence of demonstrated success) Doral have successfully rehabilitated three Offset areas as part of other mine operations. Doral are currently rehabilitating ~9ha of land back to State-Forest.	Quality Good condition Conservation Significance WRP habitat including 3 dreys Land Tenure Mining Tenement/Road reserve Time Scale N/A According to the agreed significance framework, residual impact is considered significant as clearing will impact habitat of a species protected by statute under the BC Act and EPBC Act.		Conservation Covenant by Doral or Doral to provide funding arrangement to DBCA for the purchase and management of a suitable offset. It is expected that the offset will be a Ministerial Condition of the approval of the Proposal.	measured Operator experience/Evidence? Doral/DBCA will manage the land. What is the type of vegetation being revegetated? NA Is there evidence the environmental values can be re-created (evidence of demonstrated success)? Yes Doral have provided a Land Acquisition offset as part of its Yoongarillup Mine.		
Indirect impacts from dewatering to 30 Black Cockatoo potential breeding habitat trees, co-located within the 1.81ha of WRP habitat, present as the GDE SWAFCT02.	Groundwater drawdown impacts will be avoided and/or minimised by implementing the following key actions: -Dewatering will be undertaken in a staged approach; -Passive dewatering with sump pump (i.e. no dewatering spears) will be	Doral will rehabilitate 4.7ha of native vegetation and WRP habitat using local species to counterbalance the clearing impacts. Specially, the revegetation will aim to establish Woodland of *Corymbia calophylla, Eucalyptus marginata*	Can the environmental values be rehabilitated/Evidence? Yes, Black Cockatoo foraging habitat can be established and be self-sustaining within a relatively short time frame (i.e..5-7years). However, potential breeding trees may take up to 200 years to form a suitable hollow.	Extent 30 Black Cockatoo potential breeding habitat trees (present within the WRP habitat/SWAFCT02, a GDE)) Quality 30 potential Black Cockatoo breeding trees. No evidence of current or previous use. Conservation Significance	Land acquisition	Low – Land to be secured and placed under Conservation Covenant by Doral or Doral to provide funding arrangement to DBCA for the purchase and	High – Land acquisition and management in the southwest is well understood and has been previously implemented by Doral and DBCA as an offset for the Yoongarillup Mine. Can the values be defined and measured?	Secures habitat upon agreement - no time delay	Area contained within Land Acquisition Offset, to be provided. (refer to Appendix 11)

Project Name: YALYALUP MINERAL SANDS PROJECT									
Existing environment/ Impact	*Mitigation*			*Significant Residual Impact*	*Offset Calculation Methodology*				
	Avoid and minimise	*Rehabilitation Type*	*Likely Rehab Success*		*Type*	*Risk*	*Likely Offset Success*	*Time Log*	*Offset Quantification*
	used to minimise the extent of dewatering cone of depression; -Rapid hydraulic backfill of sand tails which will aid in returning groundwater levels will be conducted; -Provision of reticulation/irrigation to vegetation in accordance with: 1. GDE Management Plan 2. Groundwater Operating Strategy.	and *Agonis flexuosa* over shrubland.	<u>Operator experience in undertaking rehabilitation?</u> Yes, Doral have successfully rehabilitated three Offset areas back to native vegetation in accordance with Department of Agriculture, Water and Environment and DBCA/EPA conditions. <u>What is the type of vegetation being rehabilitated?</u> Woodland of *Corymbia calophylla,* E*ucalyptus marginata* and *Agonis flexuosa* over shrubland. <u>Time lag?</u> 5-7 years for foraging habitat to be established and self-sustaining, however 200 years for trees to form suitable hollows. <u>Credibility of the rehabilitation proposed (evidence of demonstrated success)</u> Doral have successfully rehabilitated three Offset areas as part of other mine operations. Doral are currently rehabilitating ~9ha of land back to State-Forest.	Black Cockatoo potential breeding habitat trees, present as WRP in the GDE identified as SWAFCT02. <u>Land Tenure</u> Mining Tenements <u>Time Scale</u> The Proposal has an anticipated mine life of 4-5 years. According to the agreed significance framework, residual impact is considered significant as clearing will affect a species protected by statute under the BC Act and EPBC Act.		management of a suitable offset. It is expected that the offset will be a Ministerial Condition of the approval of the Proposal.	Yes - values of vegetation communities can be measured. <u>Operator experience/Evidence?</u> Doral/DBCA will manage the land. <u>What is the type of vegetation being revegetated?</u> Vegetation suitable as Black Cockatoo potential breeding habitat. <u>Is there evidence the environmental values can be re-created (evidence of demonstrated success)?</u> Yes, Doral have successfully provided a Land Acquisition offset as part of its Yoongarillup Mine Ministerial Conditions.		

6.3. OFFSET PROPOSAL

6.3.1. OBJECTIVES AND INTENDED OUTCOME

Doral is committed to delivering an offset strategy that addresses the requirements of both the State and Commonwealth Offset Policies with the objective of providing a net benefit to the environment.

Doral proposes to directly offset the significant residual impacts of the Proposal through undertaking a direct land acquisition offset within the southwest of WA, or other negotiated funding arrangement to secure like for like vegetation communities where possible. The experience of Doral to date in investigating land parcels for an offset package has identified that an adaptable process is required in consultation with DBCA to ensure that suitable land is acquired as and when it becomes available for purchase. This is due to the following factors:

- There is limited suitable land available that contains the values being impacted;
- Land acquisition requires the agreement of the freehold landowner to sell;
- There is potential of landowner agreement to not be forthcoming within the project timeframes;
- Linking a project approval with a particular property could increase the price for that acquisition;
- Potential for changes in circumstances for a particular property during the approval process (e.g. a change in land ownership, a change in vegetation condition due to fire or clearing or a change in the expected sale price).

6.3.2. OFFSET CALCULATION

The Department of Agriculture, Water and the Environment (DAWE) Offset calculator has been used to provide an offset assessment guide (parameters) associated with the impact of the Proposal and potential offset sites. To assist with quantifying an appropriate offset for both State and Federal significant residual impacts, the calculations rely on using the annual probability of extinction figures for MNES classifications (i.e. critically endangered, endangered, vulnerable), as per the *How to Use the Offsets Assessment Guide* and the associated *EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a).* This is intended to meet the requirements of the *EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a)* for the MNES, as well as providing a conservative estimate for quantifying an appropriate offset for State matters, given there are no published annual probability of extinction figures at State level.

Offset calculator values used for potential offsets of the following Ecological Communities and Fauna Habitat are summarised in Table 6-6, and the calculator spreadsheets included as Appendix 11.

- SWAFCT10b - *Shrublands on southern Swan Coastal Plain Ironstones (Busselton area)* (Gibson, et al., 2000), listed as a TEC with threat status of “Critically Endangered” by DBCA and “Endangered” under the *EPBC Act* and includes nine *Banksia squarrosa* subsp. *Argillacea*, listed as Threatened under the BC Act and Endangered under the EPBC Act. The area of habitat attribute (not number of individuals) has been selected as the most appropriate attribute to use for this protected matter.
- SWAFCT01b - Southern *Corymbia calophylla* woodlands on heavy soils, listed as a TEC with threat status of “Vulnerable” by DBCA.

- SWAFCT02 - Southern wet shrublands, listed as a TEC with threat status of "Endangered" by DBCA.
- Western Ringtail Possum (*Pseudocheirus occidentalis)* habitat, listed as S1 (BC Act) and Critically Endangered (EPBC Act).
- Black Cockatoo potential breeding habitat trees (i.e. DBH ≥50cm and DBH ≥30cm for wandoo) for the following three species:
    - Carnaby`s Black-Cockatoo *Calyptorhynchus latirostris* – listed as *S2* under the *BC Act* and *Endangered* under the *EPBC Act*.
    - Baudin's Black-Cockatoo *Calyptorhynchus baudinii* – listed as S3 under the *BC Act*, and *Vulnerable* under the *EPBC Act.*
    - Forest Red-tailed Black-Cockatoo *Calyptorhynchus banksii naso* – listed as S3 under the *BC Act*, and *Vulnerable* under the *EPBC Act.*

TABLE 6-6: ASSESSMENT OF ENVIRONMENTAL VALUES ASSOCIATED WITH POTENTIAL OFFSET SITES

Site	Offset Parameters	Values Used in Calculator					Justification of Value
		Ecological Communities (SWAFCT10b)	Ecological Communities (SWAFCT01b)	Ecological Communities (SWAFCT02)	Fauna Habitat (WRP)	Fauna Habitat (Black Cockatoo potential breeding habitat trees)	
Conservation Status		Endangered	Vulnerable	Endangered	Critically Endangered	Endangered	Annual probability of extinction figures derived from IUCN Redlist
Impact Site	Impact area (ha)	0.34	0.17	2.44	2.61 (includes 30 co-located Black Cockatoo potential breeding habitat trees)	1.78ha (102 trees)	Direct and indirect impacts from Proposal
	Quality (out of 10)	6	6	6	6	5	All TECs mapped as Good condition and are within McGibbon Track road reserve. The area of WRP habitat (comprising SWAFCT02), has good quality mid-storey vegetation and three dreys were mapped as being present during the most recent survey in 2019 as well as sightings of one indivual and observations of scats near dreys. The vegetation is subject to ongoing impacts from cattle movements and grazing, road maintenance/grading which have resulted in loss of flora species, and increased the presence of weeds. Majority of surrounding area is cleared pasture with all other vegetation within the Development Envelope mapped in Degraded or Completely Degraded condition. Black Cockatoo potential breeding habitat trees are present as isolated scattered paddock trees (1 tree per 4ha) and none of the 5 trees containing possibly suitable hollows shows evidence of use by Black Cockatoo for nesting purposes (Harewood, 2020b). No roosting sites are present according to the Great Cocky Count (Peck, et al., 2018). More favourable habitat (13,300ha) is present within 10om of the Site
Offset Site	Offset area (ha)	0.70	0.40	5	4.5	3.5 (~365 trees)	DAWE calculator.
	Start quality (out of 10)	6	6	6	6	5	The proposed offset site(s) would need to be of equal good quality vegetation that also represents WRP and Black Cockatoo habitat to provide like for like offset(s).
	Future quality without offset (out of 10)	3	3	3	3	3	Quality of the proposed offset site(s) may decline without any protection measures, from activities such as clearing, agriculture, horticulture, mining and/or other development, resulting in the reduction of vegetation quality or loss of vegetation.
	Future quality with offset (out of 10)	7	7	7	7	6	The quality of the potential offset site(s) would be improved through formal protection measures which would prevent activities likely to impact the vegetation. Weed management and other maintenance activities would lead to improved condition of vegetation in potential offset site(s).
	Time over which loss is averted (max. 20 years)	20	20	20	20	20	Potential offset sites(s) would be secured and placed under Conservation Covenant and managed by Doral/DBCA.

Site	Offset Parameters	Values Used in Calculator					Justification of Value
		Ecological Communities (SWAFCT10b)	Ecological Communities (SWAFCT01b)	Ecological Communities (SWAFCT02)	Fauna Habitat (WRP)	Fauna Habitat (Black Cockatoo potential breeding habitat trees)	
	Time until ecological benefit	1	1	1	1	1	Ecological benefit would be realised immediately as a direct offset would be provided.
	Risk of loss (%) without offset	20	20	20	20	20	There are likely to be no formal protection mechanisms or active conservation management measures at potential offset site(s). The vegetation communities are restricted to the southwest region of WA, are under pressure from development such as agriculture, horticulture and mining activities.
	Risk of loss (%) with offset	5	5	5	5	5	Potential offset sites(s) would be secured and placed under Conservation Covenant and managed by Doral/DBCA. Ongoing management will contribute to the protection and enhancement of the potential offset site(s)
	Confidence in result (%)	80	80	80	80	80	Protection mechanisms, once established, will provide a higher level of certainty that potential offset site(s) will be conserved
Summary	% of impact offset	110%	132%	109%	102%	109%	Greater than 100% direct offset as per DAWE calculator

6.3.3. OFFSET STRATEGY

Doral, shall seek the agreement of DBCA to propose an adaptive approach to land acquisition and management, which includes:

- A step-wise process for investigation, evaluation and purchase of one or more suitable land parcels to achieve the offset requirement;
- A contingency in the event that suitable land is not available for purchase within the Project timeframe;
- A clear funding agreement for land purchase and any revegetation and/or rehabilitation required;
- A clear definition of land acquisition and management completion for each case.

6.3.4. LAND IDENTIFICATION

Doral have been actively searching for suitable parcels of land for acquisition, however to date no available prospective land with the specific attributes required have been identified. Doral will work collaboratively with DBCA, and continue to identify other land parcels during the assessment process of the ERD.

Prospective parcels of land will be identified on the basis of the following criteria:

- Likely to contain seasonal wetland vegetation on ironstone or heavy clay soils, consistent with the TECs potentially being impacted;
- Expected to contain fauna habitat suitable for use by WRP and Black Cockatoos;
- Expected to include no more than 3ha of cleared land for revegetation;
- Preferably located on the Swan Coastal Plain;
- Preferably 10-14ha or more.

6.3.5. SUCCESS CRITERIA

A Land Offsets and Management Plan is intended to be prepared to the satisfaction of the CEO. This Plan shall outline the values provided by the proposed offset in comparison to the disturbed lands to ensure a net benefit is gained, and success criteria as set out in the Plan, is met.

6.3.6. GOVERNANCE AND OBLIGATIONS

Once prospective land parcel/s have been evaluated in consultation with DBCA as suitable, approval from the CEO shall be sought and land acquisition negotiations may commence. It is anticipated that Doral may seek assistance from DBCA during the land negotiation process to ensure a fair price is achieved, and once complete, the land shall be placed under conservation estate either by Doral or vested with the State for management and protection.

6.3.7. LAND PURCHASE

Once prospective land parcel/s have been evaluated as suitable, Doral will negotiate with the relevant land owner/s to determine if they are receptive to selling the parcel/s and the nominated purchase price.

If the land evaluation identified additional ground truthing as necessary, Doral will negotiate site access to undertake the additional ground truthing and confirm land parcel suitability.

If the land owner/s are not receptive, Doral will identify and evaluate further prospective land parcels.

If the land owner/s are receptive to selling the parcel/s, Doral will:

- Nominate a purchase price, and the expected revegetation and rehabilitation works for the land parcels;
- Confirm with DBCA and the CEO that the identified and negotiated land purchase is relevant and proportionate to counterbalance the significant residual impacts.

6.3.8. CONTINGENCY

Doral's experience with achieving suitable land acquisition packages, which contain a specific set of attributes (such as seasonal wetland vegetation on ironstone or heavy soils), is that a flexible approach is required due to the very localised vegetation communities, flora species and soil substrate, and the limited extent of forested lands that remain in freehold. Accordingly, Doral will incorporate a contingency process to facilitate suitable land acquisition securities while enabling Project timeframes.

In the event that, following a process of land identification, evaluation and negotiation, a suitable land parcel/s to a total of 14ha has not been acquired within a timeframe of three months prior to commencement of clearing/dewatering the area(s) of significant impact, Doral will negotiate with DBCA a provisional sum for land acquisition and management and arrange for a transfer of funds. The transfer of funds will occur prior to the commencement of clearing and/or dewatering activities.

7. MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

7.1. CONTROLLED ACTIONS PROVISIONS

The Proposal was referred to the Commonwealth DAWE (then DoEE) on 1 November 2017 for consideration under the EPBC Act. On 8 February 2018, DAWE determined that the Proposal is a Controlled Action and requires assessment and decision on approval under the EPBC Act (EPBC Reference: 2017/8094) (Appendix 2). The relevant Matters of NES for the Proposal are:

- Listed threatened species and communities (s18 and 18A)
    - Western Ringtail Possum *(Pseudocheirus occidentalis)* – Critically Endangered;
    - Whicher Range Dryandra *(Banksia squarrosa* subsp. *Argillacea)* – Vulnerable;
    - Vasse Featherflower *(Verticordia plumose* var. *vassensis)* – Endangered;
    - Shrublands on the southern Swan Coastal Plain Ironstones – Endangered.
- The ecological character of a declared Ramsar wetland (section 16 and 17B)
    - Vasse-Wonnerup Ramsar wetland system;
- Migratory species (section 20 and 20A)
    - Wood sandpiper *(Tringa glareola)* – Migratory;
    - Sharp-tailed sandpiper *(Calidris acuminate)* – Migratory;
    - Long-toed stint *(Calidris subminuta)* – Migratory.

7.2. LEGISLATION, POLICY AND GUIDANCE

Australian Government Protection

The Australian Government EPBC Act protects species listed under Schedule 1 of the EPBC Act. In 1974, Australia became a signatory to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). As a result, an official list of endangered species was prepared and is regularly updated. This listing is administrated through the EPBC Act. The current list differs from the various State lists however some species are common to both.

The EPBC Act aims to prevent significant impacts occurring to MNES, including threatened species, through assessment of proposed actions against the *Matters of National Environmental Significance: Impact Guidelines* (DSEWPaC, 2013).

The EPBC Act objectives are to:

- *Provide for the protection of the environment, especially Matters of National Environmental Significance.*
- *Promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources.*
- *Control the international movement of wildlife, wildlife specimens and products made or derived from wildlife.*

International Agreements

Australia is party to the Japan-Australia (JAMBA), China-Australia (CAMBA), Republic of Korea-Australia (ROKAMBA) Migratory Bird Agreements and the Convention on the Conservation of Migratory Species of Wild Animals. Most of the birds listed in these agreements are associated with saline wetlands of coastal shorelines, however some migratory birds not associated with water are also listed on these international treaties

EPBC Guidance

- Matters of National Environmental Significance. Significant Impact Guidelines 1.1. *Environmental Protection and Biodiversity Conservation Act 1999* (DoE, 2013).
- *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPaC, 2012a).
- Significant impact guidelines for the vulnerable western ringtail possum (*Pseudocheirus occidentalis*) in the southern Swan Coastal Plain, Western Australia. Nationally threatened species and ecological communities. EPBC Act policy statement 3.10. (DEWHA, 2009).
- *EPBC Act Referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo (endangered) Calyptorhynchus latirostris, Baudin's cockatoo (vulnerable) Calyptorhynchus baudinii, Forest red-tailed black cockatoo (vulnerable) Calyptorhynchus banksii naso* (DSEWPaC, 2012b).
- *Conservation Advice Pseudocheirus occidentalis Western ringtail possum. Canberra: Department of the Environment and Energy* (Threatened Species Scientific Committee, 2018a).
- *Conservation Advice Calyptorhynchus baudinii* Baudin's Cockatoo*. Canberra: Department of the Environment and Energy* (Threatened Species Scientific Committee, 2018b).
- *Western Ringtail Possum (Pseudocheirus occidentalis) Recovery Plan. Wildlife Management Program No. 58. Department of Parks and Wildlife, Perth, WA* (DPaW, 2017).
- *Approved Conservation Advice for Calyptorhynchus banksii naso (Forest Red-tailed Black Cockatoo). Canberra: Department of the Environment, Water, Heritage and the Arts* (DEWHA, 2009).
- *Forest Black Cockatoo (Baudin's Cockatoo Calyptorhynchus baudinii and Forest Redtailed Black Cockatoo Calyptorhynchus banksii naso) Recovery Plan. Department of Environment and Conservation, Western Australia* (Chapman, 2008).
- *Carnaby's Cockatoo (Calyptorhynchus latirostris) Recovery Plan. Department of Parks and Wildlife, Perth, Western Australia* (DPaW, 2013).
- *Wildlife Conservation Plan for Migratory Shorebirds. Canberra, ACT: Department of the Environment* (Commonwealth of Australia, 2015).
- *EPBC Act Policy Statement 3.21 - Industry Guidelines for avoiding, assessing and mitigating impacts on EBBC Act listed migratory shorebird species* (DoE, 2015b).
- *Conservation Advice Banksia squarrosa subsp. argillacea Whicher Range banksia, Whicher Range dryandra. Canberra: Department of the Environment* (Threatened Species Scientific Committee, 2015).

- *Approved Conservation Advice for Verticordia plumosa 3 var. vassensis (Vasse Featherflower). Canberra: Department of the Environment, Water, Heritage and the Arts* (DEWHA, 2008a).
- *Shrubland Association on Southern Swan Coastal Plain Ironstone (Busselton area) (Southern Ironstone Association) Recovery Plan. Interim recovery plan no. 215. Department of Environment and Conservation* (Meissner & English, 2005).

7.3. EXISTING ENVIRONMENT

7.3.1. LISTED THREATENED SPECIES AND COMMUNITIES (S18 AND 18A)

The status, distribution and habitat preferences, along with the results of targeted surveys and threats to the threatened species and communities listed as Controlled Actions and additional matters of NES identified within the Development Envelope (i.e. Black Cockatoos) are outlined below in Table 7-1 to 7-7.

TABLE 7-1: WESTERN RINGTAIL POSSUM *(Pseudocheirus occidentalis)*

Species	Western Ringtail Possum *(Pseudocheirus occidentalis)*
EPBC Status and distribution	Critically Endangered Once widely distributed across southern and south-western Australia, the WRP has a patchy distribution in forests and woodlands of south-western Australia from the Collie River near Bunbury to Two Peoples Bay near Albany (Jones, et al., 1994a). Coastal or near coastal forests in the southern Swan Coastal Plain support a dense and productive habitat, comprising peppermint (*Agonis flexuosa*) trees which supports the highest known populations of WRP. WRPs are distributed in both intact habitat patches and in vegetation remnants (DEWHA, 2009).
Habitat preference	WRPs are arboreal, spending most of their time in trees. They are typically located close to water courses, swamps, or on floodplains (Jones, et al., 1994a), with the highest density populations occurring in areas with higher canopy continuity. In the near coastal or coastal habitats of the southern Swan Coastal Plain, the WRP predominantly occurs in peppermint forest and woodland, and tuart (*Eucalyptus gomphocephala*) forest, usually with a peppermint understorey. Areas with an understory containing sword sedge and *Lepidosperma* spp. are also important habitat areas for the WRP in the southern Swan Coastal Plain (de Tores, 2008). Two habitat communities primarily used by WRPs in the southern Swan Coastal Plain are: • Coastal peppermint dominated communities; • Myrtaceous and other communities. An individual home range is usually less than five hectares, and in the high-density populations in the southern Swan Coastal Plain can be below one hectare. The WRP preferentially rests singly (or with young) in tree hollows and dreys (nests constructed from vegetation). In the southern Swan Coastal Plain WRPs breed once, and occasionally twice a year (Jones, et al., 1994b). Females give birth to one to three offsprings and most commonly occurs in autumn (April- June) (Jones, et al., 1994b). The young gain independence at six to seven months (Jones, et al., 1994b).
Survey results	Harewood (2020a) undertook a targeted assessment for WRP's including day/night surveys and assessment of habitat. In total six WRP dreys were observed during the day in 2017 and three in 2019. All dreys were recorded in a short section of habitat at the northern end of McGibbon Track.

Species	Western Ringtail Possum *(Pseudocheirus occidentalis)*
	During the nocturnal surveys, five WRPs and six common brushtail possums were recorded in 2017, in contrast to one WRP and two common brushtail possums during the 2019 survey. As with the day surveys, all observations were made along the northern section of McGibbon Track. A common brushtail possum was also recorded during the 2019 survey along the Woddidup Creek/drainage line in the western portion of the Development Envelope. WRP habitat present within the Development Envelope is outside of Area 1 -Core Habitat, Area 2 - Primary Corridors and Area 3 - Supporting Habitat as documented in the *Significant Impact Guidelines for the Vulnerable Western Ringtail Possum in the Southern Swan Coastal Plain, Western Australia* (DEWHA, 2009).
Mapping	Figure 4-9 and Figure 4-9A
Threats	The key threats to the WRP detailed in (DEWHA, 2009) include habitat loss through habitat degradation, fragmentation and clearing, predation by foxes and cats, altered fire regimes, competition with the common brushtail possum.
Reference	(Jones, et al., 1994a), (Jones, et al., 1994b), (de Tores, 2008), (DEWHA, 2009) and (Harewood, 2020a)

TABLE 7-2: WHICHER RANGE DRYANDRA *(Banksia squarrosa* subsp. *Argillacea)*

Species	Whicher Range Dryandra *(Banksia squarrosa* subsp. *Argillacea)*
EPBC Status and distribution	Vulnerable *B. squarrosa* subsp. *Argillacea* occurs on the coastal plain close to the western base of the Whicher Range, east of Busselton, in WA (Department of the Environment, 2015). It is known from 11 subpopulations, has an abundance of 2,876 mature plants and an area of occupancy of 0.38km^2 (Department of the Environment, 2015). Ecoedge (2020a) reported that there are 63 records for this species in the DBCA database, most of which relate to occurrences in "Busselton Ironstone" vegetation on the Swan Coastal Plain south of Busselton, however there are several known populations in State Forest on the Blackwood Plateau.
Habitat preference	*B. squarrosa* subsp. *Argillacea* occurs near Busselton on the Swan Coastal Plain, in winter-wet clay over ironstone, in open to tall shrubland. Some populations however, are found in lateric gravel pits. *B. squarrosa* subsp. *Argillacea* is typically associated with an Endangered ecological community, the 'Shrublands on southern Swan Coastal Plain Ironstone soils' (Busselton area) which are highly restricted in distribution (Luu & English, 2004).
Survey results	A population of nine individuals of *B. squarrosa* subsp. *argillacea* within the Development Envelope, occur on McGibbon Track within a small occurrence of Vegetation Unit B1 which is recognised as the TEC SWAFCT10b - Shrublands on southern Swan Coastal Plain Ironstones (Busselton area)" (Gibson, et al., 2000) (Meissner & English, 2005).
Mapping	Figure 4-3

Species	Whicher Range Dryandra *(Banksia squarrosa* subsp. *Argillacea)*
Threats	The key threats to the population are weeds, dieback, track maintenance, cattle droving, mining and habitat degradation.
Reference	(Ecoedge, 2020a), (Department of Environment, 2015), (Gibson, et al., 2000), (Meissner & English, 2005) and (Luu & English, 2004).

TABLE 7-3: VASSE FEATHERFLOWER *(Verticordia plumose* var. *vassensis)*

Species	Vasse Featherflower *(Verticordia plumose* var. *vassensis)*
EPBC Status and distribution	Endangered *V. plumosa* var. *vassensis* is endemic to the south-west Western Australia, where it is known from 13 populations near Busselton. This species' distribution is severely fragmented and very restricted, with known subpopulations occurring over a large geographic range in isolated pockets of remnant vegetation (DEC, 2007). Most populations are located within road, rail and recreational reserves or on private property, with only one part of a population occurring within a nature reserve. The total population of *V. plumosa* var. *vassensis* has been estimated at 3,200 mature plants, although this estimate relies on 10-year-old survey counts and may not be accurate (DEC, 2007). Ecoedge (2020a) reported that there are 97 records for this species in the DBCA database, most of which relate to locations on the Swan Coastal Plain south of Busselton, with an east-west range of 30km. This species occurs in the South West (Western Australia) Natural Resource Management region. The distribution of this species overlaps with *SWAFCT10b - Shrublands on southern Swan Coastal Plain Ironstones (Busselton area)" (Gibson, et al., 2000);* (Meissner & English, 2005). This species is currently known from Ambergate Reserve and Ruabon and Ruabon-Tutunup Road Bushland areas in the Busselton and Capel Shires and from the Scott Coastal Plain (Webb, et al., 2009).
Habitat preference	*V. plumosa* var. *vassensis* grows on a variety of sands and swampy clay soils in mostly winter-wet flats and depressions. It grows with sedges and rushes or in low heath and is often found on degraded, grassy-weed infested road verges (Brown, et al., 1998) (Williams, et al., 2001). *V. plumosa* var. *vassensis* flowers from October to February, occasionally continuing until April. It generates from seed following fire and soil disturbance.
Survey results	*V. plumosa* var. *vassensis* is located outside of the Development Envelope and is situated on the verge of Princefield Road, 2.1km west of Ludlow-Hithergreen Road. The population size was estimated at 200+ plants in 1996, and 100+ in 2006 (Williams, et al., 2001) (DoEE, 2016f, cited in Ecoedge, 2020a). The population size was difficult to estimate during the Ecoedge (2020a) survey as the plants are situated within an area of thick wet shrubland, however approximately 30 individuals were recorded.
Mapping	Figure 4-3
Threats	The keys threats to *V. plumosa* var. *vassensis* are habitat degradation due to horse riding (such as trampling), cattle droving and infrastructure maintenance (such as road, firebreak maintenance), invasive weeds, inappropriate fire regimes and dieback.

Species	Vasse Featherflower *(Verticordia plumose* var. *vassensis)*
Reference	(Brown, et al., 1998), (DEC, 2007), Ecoedge (2020a), *(Gibson, et al., 2000),* (Meissner & English, 2005), (Webb, et al., 2009) and (Williams, et al., 2001).

TABLE 7-4: SHRUBLANDS ON THE SOUTHERN SWAN COASTAL PLAIN IRONSTONES (SWAFCT10b)

Species	Shrublands on the southern Swan Coastal Plain Ironstones (SWAFCT10b)
EPBC Status and distribution	Endangered The Shrublands on the southern Swan Coastal Plain ironstones have a restricted distribution and mostly occur to the eastern side of the Swan Coastal Plain along the base of the Whicher Scarp near Busselton (Meissner & English, 2005). This area contains heavy soils that are particularly useful for agricultural purposes and are around 97% cleared (CALM, 1990) (Keighery & Trudgen, 1992). Tille and Lantzke (1990) mapped the original extent of the southern ironstone soils in the Busselton area, totalling ~1,200ha, of which ~139ha remains uncleared. This equates to a 90% loss of the area of the plant community which is at present day distributed in a total of thirteen isolated patches, much of it on private land or road and rail reserves. Of the remaining shrubland, approximately 114ha of the community remains on private land, road, rail and nature reserves including the largest known occurrence located in the Ruabon-Tutunup Bushland and around 25ha are in State Forest. Typical and common native species in the community are the shrubs *Kunzea* aff. *Micrantha* (Collection Bronwen Keighery and Neil Gibson 040), *Pericalymma ellipticum, Hakea oldfieldii, Hemiandra pungens* and *Viminaria juncia*, and the herbs *Aphelia cyperoides, Centrolepis aristate* and the introduced species *Hypochaeris glabra* (Gibson, et al., 1994).
Habitat preference	The species rich plant community is located on seasonal wetlands on ironstone and heavy clay soils on the Swan Coastal Plain near Busselton. The skeletal soils developed over massive ironstone have been historically associated with bogs and in the present day undergo seasonal inundation with fresh water.
Survey results	Vegetation Unit B1 is recognised as the TEC SWAFCT10b - Shrublands on southern Swan Coastal Plain Ironstones (Busselton area)" (Gibson, et al., 2000); (Meissner & English, 2005). The largest occurrence of B1 identified by Ecoedge (2020a), is on the McGibbon Track (0.34ha) and is recognised as an occurrence of Busselton Ironstones community (Webb, 2004) but unaccountably is yet to be added to the DBCA threatened communities' database (A, Webb, DBCA Bunbury, pers. comm. 22/02/2016, cited in Ecoedge, 2020a).
Mapping	Figure 4-1b and 4-3
Threats	The key threats to the community are frequent fire, weed invasion, track maintenance, accidental clearing and possibly salinization and waterlogging. In addition, many of the endemic, endangered and priority species of plants are dieback susceptible.
Reference	(Meissner & English, 2005), (Tille and Lantzke 1990c), (Gibson, et al., 1994), (Webb, 2004) and (Ecoedge, 2020a).

TABLE 7-5: CARNABY'S BLACK-COCKATOO (*Calyptorhynchus latirostris*)

Species	Carnaby's Black-Cockatoo *Calyptorhynchus latirostris*
EPBC Status and Distribution	Endangered. It is endemic to and widespread in the southwest of Western Australia. Occurring mostly in the Wheatbelt in areas that receive 300-750mm of rainfall annually, it is also found in wetter regions in the far southwest. Its range extends north to the lower Murchison River and east to Nabawa, Wilroy, Waddi Forest, Nugadong, Manmanning, Durokoppin, Noongar (Moorine Rock). Lake Cronin, Ravensthorpe Range, head of Oldfield River, 20km east-southeast of Condingup and Cape Arid. It has also occasionally been seen on Rottnest Island (Johnstone & Storr, 1998). The extent of occurrence is estimated at 32,000km² based on Birdlife International GIS. This estimate is considered to be of medium reliability (Garnett & Crowley, 2000). The range of Carnaby's Black-Cockatoo is said to have contracted by more than 30% since the late 1940s (Mawson, 1997) and the species is also said to have disappeared from more than a third of its former breeding range between 1968 and 1990 (Saunders & Ingram, 1998).
Habitat Preference	Carnaby's Black-Cockatoo prefers forest, woodlands, heathlands and farm environments where it feeds on Banksia, Hakea and Marri. This species has specific nesting site requirements - nests are mostly in smooth-barked Eucalypts with the nest hollows ranging from 2.5 to 12m above the ground, an entrance from 23-30cm diameter and a depth of 0.1-2.5m (Johnstone & Storr, 1998). Breeding occurs in winter/spring mainly in eastern forest and wheatbelt where they can find mature hollow bearing trees to nest in (Morcombe, 2004). Judging from records in the Storr-Johnstone Bird Data Bank, this species is currently expanding its breeding range westward and south into Jarrah-Marri forest of the Darling Scarp and into the Tuart forests of the SCP including the region between Mandurah and Bunbury. Carnaby's Black-Cockatoo has been known to breed close to the town of Mandurah, as well as Dawesville, Lake Clifton and Baldivis (Ron Johnstone, WA Museum, pers. comm.) and there are small resident populations on the southern SCP near Mandurah, Lake Clifton and near Bunbury. At each of these sites the birds forage in remnant vegetation and adjacent pine plantations (Johnstone, 2008). Carnaby's Black-Cockatoo lays eggs from July or August to October or November, with most clutches being laid in August and September (Saunders, 1986). Most of the breeding is in September through to December (Ron Johnstone pers comms). Birds in inland regions may begin laying up to three weeks earlier than those in coastal areas (Saunders, 1977). The female incubates the eggs over a period of 28-29 days. The young depart the nest 10-12 weeks after hatching (Smith & Saunders, 1986).
Results of Targeted Surveys	Small areas of favored foraging habitat (i.e. marri, jarrah, banksia and pines) present within Development Envelope. Evidence of foraging (such as chewed marri fruits and pine cones) observed during the Harewood (2020a) survey. Larger trees (i.e. 1,053 with DBH >50cm and >30cm wandoo) can be considered potential breeding habitat by DAWE (DSEWPaC, 2012b), with 54 trees containing one or more hollows possibly suitable for a Black Cockatoo, although no evidence of recent use observed (Harewood, 2020b). No roosting sites identified within the Development Envelope.
Mapping	Figures 4-10, 4-10A, 4-10B, 4-10C and 4-10D

Species	Carnaby's Black-Cockatoo *Calyptorhynchus latirostris*
Threats	The decline of Carnaby's Black-Cockatoo is due primarily to the loss and fragmentation of habitat. This has been caused by the clearing of native vegetation, mainly for agricultural purposes, since the middle of the 20th century (Cale, 2003) (Mawson & Johnstone, 1997) (Saunders, 1986). Carnaby's Black Cockatoo is a highly mobile species. They move sequentially through the landscape, utilising different habitat types at different times of the year, makes them especially vulnerable to the loss, fragmentation or degradation of any one component of the landscape. The long-term survival of Carnaby's Black-Cockatoo depends on the persistence of suitable breeding habitat (i.e. woodland), nest-sites (i.e. tree hollows) and foraging habitat (e.g. heathlands) capable of providing enough food to sustain the population. At present, the loss of foraging habitat is thought to pose the greatest risk to the species (Saunders & Ingram, 1998). The breeding habitat of Carnaby's Black-Cockatoo has also been extensively cleared (Garnett & Crowley, 2000). Hollow-bearing trees that are suitable for nesting are now located in remnant patches of woodland and at sites where selected trees have been retained in areas that have otherwise been cleared of native vegetation (Saunders & Ingram, 1998). The impact of clearing has also had other consequences for the remaining habitat. In some areas, the remnant native vegetation has become threatened by an increase in the salinity of soils (Mawson & Johnstone, 1997). Clearing also exposes remnant habitats to invasion by weeds and, potentially, other processes that will degrade the habitat. Other threats include Competition for nest hollows, Illegal trade predation by Wedge-tailed Eagles Aquila audax, collisions with cars, drowning and entrapment in tree hollows (Saunders, 1982). Carnaby's Black-Cockatoo is a long-lived species (Saunders & Ingram, 1998) that does not breed until four years of age (Saunders, 1982, 1986), has an estimated generation time of 15 years (Cale, 2003) (Garnett & Crowley, 2000) and has a low rate of productivity (i.e. most successful pairs fledge only one young per year) (Saunders, 1982). These characteristics limit the potential of the species to sustain numbers or to recover in the presence or aftermath of a threatening process.

TABLE 7-6: BAUDIN'S BLACK-COCKATOO (*Calyptorhynchus baudinii*)

Species	Baudin's Black-Cockatoo *Calyptorhynchus baudinii*
EPBC Status and Distribution	Vulnerable. The range of the species is confined to the southwest of Western Australia, north to Gidgegannup, east to Mount Helena, Wandering, Quindanning, Kojonup, Frankland and King River and west to the eastern strip of the Swan Coastal Plain including West Midland, Byford, Nth Dandalup, Yarloop, Wokalup and Bunbury (Johnstone & Storr, 1998). Breeding has been recorded in the far south of the range (Higgins, 1999) (Saunders, 1979b) (Storr, 1991) . The extent of occurrence is estimated at 40,000km² based on published maps, and this estimate is considered highly reliable (Garnett & Crowley, 2000). No specific information is

Species	Baudin's Black-Cockatoo *Calyptorhynchus baudinii*
	available on past changes in the extent of occurrence; however, it is likely to have declined due to the clearance of habitat (Blyth, 2005 pers. comm.).
Habitat Preference	The preferred habitat of Baudin's Black-Cockatoo is mainly Eucalypt forests where it feeds primarily on Marri seeds (Morcombe, 2004), *Banksia, Hakeas* and *Erodium* sp. They also strip bark from trees in search of Beetle larvae (Johnstone & Storr, 1998). Nests are built in large hollows in tall eucalypts, especially Karri, Marri and Wandoo (Johnstone & Storr, 1998) (Higgins, 1999) (Saunders, 1974) (Saunders, 1979b). As with other black cockatoos, Baudin's Black-Cockatoo nests in large vertical hollows of very long lived trees. Trees with hollows suitable for Baudin's Black-Cockatoo are likely to be >50cm DBH. As trees approaching this size are close to developing suitable hollows, trees below 50cm DBH are considered to have the potential to develop hollows and are therefore also important resources for Baudin's Black-Cockatoo. Preferred roosts are in areas with a dense canopy close to permanent sources of water, providing the birds with protection from weather conditions (Johnstone & Kirkby, 2008).
Results of Targeted Surveys	Small areas of favored foraging habitat (i.e. marri, banksia and pines) present within Development Envelope. Evidence of foraging (such as chewed marri fruits and pine cones) observed during the Harewood (2020a) survey. Larger trees (i.e. 1,053 with DBH >50cm and >30cm wandoo) can be considered potential breeding habitat by DAWE (DSEWPaC, 2012b), with 54 trees containing one or more hollows possibly suitable for a Black Cockatoo, although no evidence of recent use observed (Harewood, 2020b). No roosting sites identified within the Development Envelope.
Mapping	Figures 4-10, 4-10A, 4-10B, 4-10C and 4-10D
Threats	Loss of habitat was formerly the major threat to Baudin's Black-Cockatoo, however the threat has abated for several reasons: the clearing of forest for agricultural purposes has largely ceased; areas of forest that contain nest sites, or that are likely to contain nest sites, are protected from harvest or clearing; and logging practices are monitored (Blyth, 2005 pers. comm.). The major threats to the species at present appear to be illegal shooting and competition with introduced bees for nest hollows (Blyth 2005, pers. comm.). Baudin's Black-Cockatoo can feed on and do damage to cultivated fruit in orchards (Halse, 1986) (Long, 1985). To prevent such damage, the species was subject to shooting under an Open Season Notice from the 1950s until 1989, when the notice was revoked (Mawson & Johnstone, 1997). The species has been protected since 1996 (Mawson & Johnstone, 1997), but illegal shooting may still be occurring (Garnett & Crowley, 2000). Baudin's Black-Cockatoo has a low annual reproductive rate of 0.6 young per pair (Storr, 1991), which limits the potential of the species to recover in the presence or aftermath of a threatening process

TABLE 7-7: FOREST RED-TAILED BLACK-COCKATOO (*Calyptorhynchus banksii naso*)

Species	Forest Red-tailed Black-Cockatoo *Calyptorhynchus banksii naso*
EPBC Status and Distribution	Vulnerable. The Forest Red-tailed Black-Cockatoo is endemic to southwest WA from Gingin in the north and east to Mt Helena, Christmas Tree Well, West Dale, North Bannister, Mt Saddleback, Kojonup, Rocky Gully, upper King River and east to the Green Range (Johnstone and Storr, 1998). Small isolated breeding populations are on the Swan Coastal Plain and can be found during the fruiting season of Cape Lilac (*Melia azederach*) (CALM, 2006) (Stranger, 1997).
Habitat Preference	The Forest Red-tailed Black-Cockatoo prefers Eucalypt forests where it feeds on Marri, Jarrah, Blackbutt, Karri, Sheoak and Snottygobble and nests in the large hollows of Marri, Jarrah and Karri (Johnstone & Kirkby, 1999). In Marri the nest hollows of the Forest Red-tailed Black-Cockatoo range from 9-14m above ground, the entrance is 12-41cm in diameter and the depth is 1.5m (Johnstone & Storr, 1998). There are few records of breeding of the Forest Red-tailed Black-Cockatoo (Johnstone and Storr, 1998). Recent data however indicates that breeding in all months of the year occurs with peaks in spring and in autumn-winter (Ron Johnstone pers comms). Eggs are typically laid in October and November (Johnstone, 1997) (Johnstone & Storr, 1998) with an incubation period of 29-31 days. Young fledge at 8 to 9 weeks (Simpson & Day, 2004).
Results of Targeted Surveys	Small areas of favored foraging habitat (i.e. marri and jarrah) present within Development Envelope. Three individuals observed during the survey period in October 2019 and evidence of foraging observed in the form of chewed marri fruits. Larger trees (i.e. 1,053 with DBH >50cm and >30cm wandoo) can be considered potential breeding habitat by DAWE (DSEWPaC, 2012b), with 54 trees containing one or more hollows possibly suitable for a Black Cockatoo, although no evidence of recent use observed (Harewood, 2020b). No roosting sites identified within the Development Envelope.
Mapping	Figures 4-10, 4-10A, 4-10B, 4-10C and 4-10D
Threats	The main threats to the Forest Red-tailed Black-Cockatoo are habitat loss, nest hollow shortage, competition for available nest hollows from other species, injury or death from the European Honeybee (*Apis mellifera*), illegal shooting (Chapman, 2005) and fire (CALM, 2006).

7.3.2. ECOLOGICAL CHARACTER OF A DECLARED RAMSAR WETLAND (SECTION 16 AND 17B)

The Vasse-Wonnerup Ramsar wetland is located in the temperate, coastal south-west of Western Australia, within the Swan Coastal Plain biogeographic region and within the City of Busselton, ~4.6km to the northwest of the Site (Figures 1-1, and Figure 4-16). The Vasse-Wonnerup Ramsar wetlands are recognised as a Matter

of NES under the EPBC Act. The Site meets two of Ramsar's nominating criteria used to qualify sites as Wetlands of International Importance. These are:

- Criterion 5: regularly supports more than 20,000 waterbirds;
- Criterion 6: regularly supports at least 1% of the SE Asia-Australasia population of Black-winged Stilt *Himantopus himantopus*, Red-necked Avocet *Recurvirostra novaehollandiae*, Australian Shelduck *Tadorna tadornoides* and Australasian Shoveler *Anas rhynchotis*.

The Vasse-Wonnerup Wetlands catchment area is 473 km^2, excluding the diverted sub-catchments (DWER, 2019) (Figure 4-16). The Lower Sabina River catchment area of 45.5 km^2 is less than 10% of the Vasse-Wonnerup Wetland Catchment (Figure 4-16). The Abba River is one of the other major tributaries to the Vasse-Wonnerup Wetland and has a catchment area of 137km^2 which is 29% of the Vasse-Wonnerup Wetlands catchment.

The Vasse-Wonnerup system is already highly hydrologically and chemically altered due to extensive clearing, agricultural practices occurring over most of the Geographe catchment, and other commercial and residential developments in the area. Clearing and agricultural practices contribute to altered water regimes and increases in nutrients, sedimentation and pollution (DoW, 2010). The system is highly modified, with diversion of flow from several of the rivers into the ocean that historically flowed into the Vasse and Wonnerup estuaries, which has accounted for a significant decrease in water entering the system. The floodgates act as a partial barrier to upstream/downstream movement of fish and reduce flushing flows that may otherwise help ameliorate high nutrient concentrations from catchment runoff. Excessive algal blooms, blooms of potentially toxic cyanobacteria, anoxia and fish deaths are not uncommon. On several documented occasions, sudden, mass fish deaths have occurred in the lower reaches of Vasse-Wonnerup, principally in the channel immediately upstream of the Vasse estuary floodgates (Lane, et al., 2007). Though installation of the gates was not the cause of fish deaths, it has exacerbated the situation. In summer 1988, in an attempt to improve water quality, the (then) Water Authority of Western Australia manually opened the floodgates, allowing seawater to enter and fish to escape the adverse conditions that prevail throughout summer and autumn. However, the continued manual opening of the gates over summer-autumn in subsequent years (to 1997), is believed to have led to other problems such as increased salinisation of adjoining pastoral lands and death of colonising native vegetation that has encroached upon lower elevations since the floodgates were installed. The gates effectively transformed the estuaries in to shallow, winter fresh/ summer saline lagoons, unique in Western Australia (Department of Environment, 2007). DWER estimated a 60% decrease in flow from the Sabina River and a 90% decrease from the Vasse River into the Wonnerup estuary as a result of these diversions (DoW, 2010).

Other than for waterbirds, there is insufficient baseline and monitoring data to identify changes since Ramsar nomination in 1990. The most recent waterbird monitoring results (1998 - 2000) (Lane, et al., 2007) showed that despite on-going water quality problems, the Site continued to support waterbird abundance and species populations for which it was Ramsar listed in 1990. Abundances of a number of waterbird species recorded in the 1998 - 2000 surveys were less than previous estimates. For a few of these species, this was attributed to the fact that most, but not all habitats were included in post-1998 (and pre-1998) surveys (Lane, et al., 2007). For others, closer investigation of historic data is needed to determine if apparent declines are indeed actual and not just artefacts of differences in areas surveyed or sampling technique (Lane, et al., 2007). Species of local and/or regional concern include Blue-billed Duck, Great Cormorant, Great Egret, Curlew Sandpiper, Long-toed Stint and Wood Sandpiper.

7.3.3. MIGRATORY SPECIES (SECTION 20 AND 20A)

The status, distribution and habitat preferences, along with the results of targeted surveys and threats to the migratory species listed as Controlled Actions are outlined below in Table 7-5.

TABLE 7-5: Wood sandpiper (*Tringa glareola*), Sharp-tailed sandpiper (*Calidris acuminate),* Long-toed stint (*Calidris subminuta*)

Species	Wood sandpiper (*Tringa glareola*), Sharp-tailed sandpiper (*Calidris acuminate),* Long-toed stint (*Calidris subminuta*)
Status and distribution	Migratory, listed under international treaties JAMBA, CAMBA and/or CMS The wood sandpiper (*Tringa glareola*), sharp-tailed sandpiper (*Calidris acuminate)* and long-toed stint (*Calidris subminuta*) are three of the 17 migratory shorebird species that regularly undertake annual migrations along the East Asian-Australasian Flyway to spend their non-breeding season in Australia, where they then occupy a number of coastal and inland habitats including coastal wetlands, mudlands, estuaries and sandy beaches from August to May each year. These habitats, which allow the birds to build up energy reserves to support northward migration and subsequent breeding, include the Vasse-Wonnerup Ramsar wetlands, located ~4.6km to the northwest of the Development Envelope. Wood sandpiper distribution: N & C Europe through C Siberia to Anadyrland, Kamchatka and Commander Is, and NE China; occasionally Aleutian Is. Winters mainly in tropical and subtropical Africa and across S & SE Asia to S China, Philippines, Indonesia, New Guinea and Australia. Sharp-tailed sandpiper distribution: NC & NE Siberia from Lena Delta to R Kolyma. Winters from New Guinea through Melanesia to New Caledonia and Fiji, and S to Australia and New Zealand. Long-toed stint distribution: Disjunct populations from forest zone of SW Siberia to S tundra of Koryak Mts and NE Kamchatka; also Commander Is and N Kuril Is. Winters from E India, Sri Lanka and Indochina to Taiwan, and S through Philippines and Indonesia to W & SE Australia (del Hoyo, et al., 2019).
Habitat preference	The wood sandpiper (*Tringa glareola*), sharp-tailed sandpiper (*Calidris acuminate)* and long-toed stint (*Calidris subminuta*) have evolved to exploit a wide variety of habitat types for foraging purposes. They are transequatorial migratory birds, migrating southward to Australia, including the Vasse-Wonnerup Ramsar Wetlands during their non-breeding season to feed along shorelines, wet sandflats, mudflats, samphire and shallow waters. The seasonal shallow and partial drying of the wetlands attracts the migratory birds which feed on the exposed flats. The Vasse-Wonnerup wetland is considered of international importance since it meets two following Ramsar criteria, namely it regularly supports 1% of individuals in a population of species of waterbird, including the Flyway population and it supports a total abundance of at least 20,000 waterbirds.
Survey results	These three Migratory species were not identified as utilising the Development Envelope at any time (Harewood, 2020a).
Mapping	Habitat occurs within the Vasse-Wonnerup Ramsar wetland (Figure 4-16).
Threats	The key threats to the species include habitat loss, destruction and substantial modification by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles.
Reference	The above sections have been adapted from (Department of Environment, 2007), (Department of the Environment and Energy, 2017) and (del Hoyo, et al., 2019).

7.4. POTENTIAL IMPACTS

Activities or aspects of the Proposal that may potentially affect MNES, not considering mitigation efforts, include:

Direct Impacts

- Vegetation clearing for development of the Proposal could potentially impact listed Threatened species and communities.

Indirect Impacts

- Dewatering activities may potentially affect the condition of listed Threatened species and communities and affect the ecological character of the Vasse-Wonnerup Ramsar wetland and associated migratory species habitat;
- Emergency discharge of water from the site may potentially affect the ecological character of the Vasse-Wonnerup Ramsar wetland including migratory species habitat;
- Spread of dieback and weeds may negatively affect vegetation health and therefore the condition of listed Threatened species and communities;
- Changes to fire regime from introduced ignition sources may affect populations of listed Threatened species and communities;
- Vehicle strikes from vehicle movement during construction and operation may result in the loss of individual Threatened species (i.e. vehicle strikes is considered a threat to WRP).

7.5. ASSESSMENT OF POTENTIAL IMPACTS

DIRECT IMPACTS

CLEARING OF NATIVE VEGETATION

The Proposal has been designed to avoid clearing native vegetation as far as practicable in order to reduce direct impacts to the listed Threatened species and communities. As a result, no direct impacts will occur to the following listed Threatened species or communities:

- Whicher Range Dryandra *(Banksia squarrosa* subsp. *Argillacea)*.
    - No individuals will be cleared for the Proposal.
- Vasse Featherflower *(Verticordia plumose* var. *vassensis)*.
    - No individuals will be cleared for the Proposal.
- Shrublands on the southern Swan Coastal Plain Ironstones (SWAFCT10b).
    - No area of SWAFCT10b will be cleared for the Proposal.
- Migratory Species
    - No habitat for the listed Migratory species (Wood sandpiper *(Tringa glareola),* Sharp-tailed sandpiper *(Calidris acuminate)* and Long-toed stint *(Calidris subminuta)* occurs within the Development Envelope (Harewood, 2020a) and as such will not be directly impacted by the Proposal.

After the application of avoidance measures, clearing for the Proposal will only involve the removal of a very small area of the native vegetation (~9%) present within the Development Envelope, predominantly as isolated paddock trees and/or overstory species (woodland species). These areas would only be utilised by a very small percentage of the predicted/known species given their very low habitat values and does not comprise areas of high biological diversity. Given the existing value of habitat to fauna is low, clearing of 3.5ha of native vegetation (as woodland habitat) (of which 2.7ha is in Completely Degraded or Degraded condition) and isolated scattered paddock trees is extremely unlikely to affect any area of habitat considered to be of high biological diversity.

The Proposal will however require clearing of ~0.8ha of WRP habitat predominantly as isolated paddock trees and/or overstory species (woodland species). Clearing will not affect any of the identified dreys/ individuals recorded within vegetation along McGibbon Track and the habitat to be impacted is outside of the core habitat, primary corridors and supporting habitat as described in *Significant Impact Guidelines for the Vulnerable Western Ringtail Possum in the Southern Swan Coastal Plain, Western Australia (DEWHA, 2009).* The nearest core habitat to the Site occurs in Tuart Forest National Park (DEWHA, 2009). As such clearing of 0.8ha of WRP habitat does not trigger any of the Significant Impact Assessment criteria detailed on page 7 of (DEWHA, 2009). Notwithstanding, as this vegetation is in close proximity to more suitable vegetation known to contain dreys and WRPs, a residual impact of 0.8ha of WRP habitat will remain after implementation of the Proposal.

Clearing for the Proposal will also result in the loss of up 102 isolated paddock trees, (from 1,053 within the Development Envelope) mapped as Black Cockatoo potential breeding habitat (i.e. DBH ≥50cm and DBH ≥30cm for wandoo). Of these trees, 5 of the 54 mapped within Development Envelope as containing hollows possibly suitable for a Black Cockatoo will require removal to facilitate mining. These trees are present as scattered, isolated paddock trees and an assessment by Harewood (2020b) indicates that none of these trees show current signs of use for nesting.

The trees to be removed comprise the following as shown on Figures 4-10, 4-10A, 4-10B, 4-10C and 4-10D:

- 81 Habitat trees – no hollows seen;
- 16 Habitat trees – One or more possible small/medium hollows;
- 5 habitat trees – One or more large hollows possibly suitable for a Black Cockatoo.

Based on available vegetation mapping it is estimated that there is approximately 13,300ha of native vegetation within 10km the Development Envelope, much of which is very likely to represent potential Black Cockatoo foraging and breeding habitat of some type.

INDIRECT IMPACTS

DEWATERING ACTIVITIES

Water level drawdowns in the Superficial aquifer (as modelled by AQ2, 2020a) are predicted to be localised in the immediate area of the active mining pits, temporary in duration and relatively small, with a maximum drawdown of 10.5m predicted at the end of mining in Q2 of 2023. The cone of depression of 0.1m generally lies within the proposed mining disturbance areas and only marginally extends past this area (up to 700m for the dry scenario and 600m for the wet scenario).

The following general observations can also be made regarding predicted drawdown:

- As would be expected, maximum drawdown is predicted in the immediate mine area. The total maximum drawdown predicted over the life of the mine varies with mining depth;
- Maximum drawdown is predicted in the immediate mining area and is similar for both climatic cases;
- The extent of predicted drawdown shown (0.1m contour) is generally limited to the disturbance areas within the Development Envelope.
- The maximum distance that drawdown of 0.1m extends outside of the perimeter of the mine disturbance area is 700m to the north, 250m to the south, 300m to the east and 450m to the west, at various times during the mine life for the dry climate scenario.
- For the wet climate scenario, the maximum distance that drawdown of 0.1m extends outside of the perimeter of mine disturbance area is 600m to the north, 200m to the south, 300m to the east and 400m to the west, at various times during the mine life for the wet climate scenario.
- Drawdown from dewatering of mine pits does not extend to the Lower Sabina River (~1.6 km to the west), Abba River (~1 km to the east) or the Ramsar listed Vasse-Wonnerup wetland (~4.6km to the north west) during the life of the mine and will therefore not affect the ecological character of the Ramsar wetland or Migratory bird habitat.

Ecoedge (2020c) conducted an assessment of potential impacts to GDEs from groundwater drawdown, using groundwater modelling information (AQ2, 2020a) and a review into water dependency of vegetation communities present within the Development Envelope.

Indirect drawdown impacts to SWAFCT10b - *Shrublands on southern Swan Coastal Plain Ironstones (Busselton area)* are predicted to be low-moderate and may potentially affect up to 0.34ha. Maximum modelled groundwater drawdowns are predicted to be 1-1.5m in Q3 and Q4, 2024. Locally, this may reduce the extent of this TEC by 75%, whilst regionally the extent of impact is ~0.25% of the known area of this TEC (total area of 138.7ha from 15 quadrats) (Meissner & English, 2005).

Indirect drawdown impacts to SWAFCT10b, although predicted to be low-moderate, has the potential to affect the population of nine *Banksia squarrosa* subsp. *Argillacea.* This species is known from 11 subpopulations, has an abundance of 2,876 mature plants and an area of occupancy of 0.38km^2 (Department of the Environment, 2015). Ecoedge (2020a) reported that there are 63 records for this species in the DBCA database, most of which relate to occurrences in "Busselton Ironstone" vegetation on the Swan Coastal Plain south of Busselton, however there are several known populations in State Forest on the Blackwood Plateau. Indirect impacts to this species however has the potential to affect 100% of the local population, whilst regionally ~0.3% of the known population will be affected.

Groundwater drawdown of GDE's mapped within the Development Envelope (Ecoedge, 2020c) also has the potential to indirectly reduce the quality of fauna habitat. Specially, Vegetation Unit A2 (SWAFCT02 - Wet Shrublands), an identified GDE (Ecoedge, 2020c) and DBCA listed TEC located within the northern portion of McGibbon Track, is known to contain conservation significant WRP habitat and 32 potential Black Cockatoo potential breeding habitat trees (i.e. DBH >50cm or DBH >30cm for wandoo). Two of these trees contain hollows possibly suitable for a Black Cockatoo, however both are dead and will not be impacted by drawdown. This GDE is identified as Area B by (Ecoedge, 2020c) as shown on Figure 4-6 and 4-7. WRP habitat and Black Cockatoo potential breeding habitat trees are shown on Figures 4-9A and 4-10B relevant to this GDE.

Based on what is known about the hydrogeology and groundwater dependence of vegetation for the Proposal, it is likely that the predicted water drawdowns for the central and northern part of GDE Area B, containing WRP habitat and Black Cockatoo potential breeding habitat (Unit A2), will be moderate to severe (Ecoedge, 2020c) (Figure 4-7), with predicted drawdowns of up to 5m, and drawdowns of more than 2m lasting for 3-6 months in 2023.

Small trees and medium-deep-rooted shrubs within this groundwater-dependent community, such as *Banksia littoralis*, *Melaleuca preissiana*, *Hakea ceratophylla* and *Xanthorrhoea preissii* are likely to suffer moderate-severe desiccation and possible death. *Banksia littoralis*, which is an important part of the overstorey, has a high likelihood of significant mortality, especially if 2023/2024 is a dry year with less than average rainfall (Ecoedge, 2020c).

The WRP habitat predicted to be indirectly impacted by groundwater drawdowns, is outside of core habitat, primary corridors and supporting habitat as documented in the *Significant Impact Guidelines for the Vulnerable Western Ringtail Possum in the Southern Swan Coastal Plain, Western Australia* (DEWHA, 2009). The nearest core habitat to the Site occurs in Tuart Forest National Park (DEWHA, 2009). No overall change in conservation status for this species is anticipated, despite a possible, very localised/small reduction in habitat extent.

Based on available vegetation mapping it is estimated that there is approximately 13,300ha of native vegetation within 10km the Development Envelope, much of which is very likely to represent potential Black Cockatoo foraging and breeding habitat of some type.

TABLE 7-6: POTENTIAL INDIRECT IMPACTS TO THREATENED SPECIES AND COMMUNITIES

MNES	AREA/NUMBER WITHIN DEVELOPMENT ENVELOPE	AREA AND PREDICTED SEVERITY OF POTENTIAL IMPACTS		
		LOW	MODERATE	SEVERE
Vegetation Unit B1 (SWAFCT10b)	0.45ha	0.34ha		0
Banksia squarrosa subsp. *Argillacea*	9 individuals	9 individuals		0
WRP Habitat	1.81ha	0	1.81ha	
Black Cockatoo potential breeding habitat trees	1,053 trees	0	30 trees	

Long-term post mining effects on water levels are expected to be minimal. The recovery of water levels will commence immediately once mining of each active mine pit is completed, owing to backfilling of mined-out pits. Groundwater inflows to the mined-out pits are driven by water level gradients between the mine voids and the surrounding areas. It should be noted that during the mining phase, water recovery in mined-out areas may be interfered with by dewatering of subsequent mining areas, thus the rate of water level recovery can be slow. Once all mining areas are completed, dewatering will cease, and water levels will continue to rise until a steady state or equilibrium water level is resumed. The numerical model shows that water levels are predicted to return to pre-mining levels within 18 months of mine closure (i.e. by July 2026).

EMERGENCY DISCHARGE OF WATER

Discharging water offsite may lead to a reduction in surface water quality with the receiving environment (i.e. Lower Sabina River and Vasse-Wonnerup Ramsar wetland). The Site Water Balance (AQ2, 2020b) indicates that during wet climate sequences water pumped to the PWD/DOD from the mine pits (collected groundwater and stormwater) exceeds the mine water demand for a sufficiently sustained period such that the PWD/DOD will overtop. The required period where surplus water would be generated, estimated to be a maximum of 82,000m^3, is confined to the Q2 2023 mining period (i.e. winter 2023 period). In this instance, Doral will undertake a controlled discharge of water rather than have the PWD/DOD overflow in an uncontrolled controlled, via a "Licensed Discharge Point" located at the eastern end of Lot 1293/3752 on Princefield Road within the Development Envelope (Figure 1-2).

Once discharged, water will move through the on-site drainage network into the Princefield Road drain flowing west into Woddidup Creek before reaching the Lower Sabina River northwest of the mine where it will ultimately discharge into the Vasse-Wonnerup Ramsar wetlands. The discharged water will mix with other water in the Lower Sabina River catchment and given that water will only be discharged from the mine site during periods of heavy rainfall when all water storages are full (i.e. emergency situations only). Discharge will coincide with seasonal higher flows of the Lower Sabina River catchment, as shown in the Lower Sabina River hydrographs (Figure 4-17). Any discharge from the Site is likely to be only a very small percentage of the total annual flows of the Lower Sabina River (~1.44%) and Vasse-Wonnerup Ramsar wetland (0.28%) as calculated in Table 7-7.

TABLE 7-7: IMPACTS FROM DISCHARGE OF EXCESS WATER TO SURFACE WATER RECEPTORS

SURFACE WATER RECEPTOR	ANNUAL FLOW (GL)	MAXIMUM DISCHARGE VOLUME (GL)	PERCENTAGE OF INCREASED DISCHARGE (%)
Lower Sabina River	5.7	0.082	1.44
Vasse-Wonnerup Wetlands*	29.6	0.082	0.28

Discharge of water into the Lower Sabina River is unlikely to occur when seasonal flows are at their lowest or ceased (i.e. summer), as sufficient storage capacity will be available during these times due to low seasonal low periods of rainfall. Discharge of water will not occur until strict water quality criteria are met as per the DWER licence conditions. V-notch flow gauges will be installed at the proposed Licence Discharge Point.

In addition, modelling results of the Surface Water Discharge Assessment (AQ2, 2019b), conservatively indicates that a total runoff volume that may require discharge under emergency situations following a 100-yr event is ~450ML. This excess water would be discharged via either the "Licensed Discharge Point" and/or "Emergency Discharge Point" located at the north-west corner of Lot 1293 on Princefield Road within the Development Envelope (Figure 1-2). Once discharged, water will enter the Princefield Road drain/Woddidup Creek before reaching the Lower Sabina River northwest of the mine where it will ultimately discharge into the Vasse-Wonnerup Ramsar wetlands. The runoff from the Site which would be required to be discharged following a large, rare rainfall event will be returned to the same catchment it would have discharged through prior to mining activities and is therefore unlikely to result in adverse impacts to downstream water quality.

SPREAD OF DIEBACK AND WEEDS

Mining activities and vehicle movements have the potential to result in the spread of weeds within and adjacent to the Development Envelope. Environmental weeds are described by (DEC, 1999) as 'plants that establish themselves in natural ecosystems and proceed to modify natural processes, usually adversely, resulting in the decline of communities they invade'. Environments affected by mining activities are highly susceptible to invasion by weeds, as disturbances to soils caused by mining operations (i.e. creating bare ground) provide an ideal habitat where weeds can readily colonise and quickly become the dominant vegetation. Weeds pose a key risk, not only during operational phases of mining, but also during rehabilitation or care and maintenance phases. Weed infestations can compete directly (as well as indirectly) with native or selected revegetation species and also increase the risk of fires (and fire intensity) that may damage revegetated areas. Weeds have the potential to substantially change the dynamics of natural ecosystems by:

- Competing with or displacing native plant species;
- Affecting natural processes such as fire intensity, stream flows and water quality;
- Changing habitats and therefore impacting on ecosystem health;
- Diminishing natural aesthetic values.

Strict weed hygiene measures will be implemented during implementation of the Proposal to reduce the risk of weed introduction and spread into areas of native vegetation, which are largely weed free. Measures will be implemented to target the control of the Declared Plants *Asparagus asparagoides* and *Zantedeschia aethiopica*. Weed management will be implemented as per Doral's Flora and Vegetation Management Plan.

No areas identified as 'infested' with *Phytophthora* dieback are present within the proposed disturbance area. The only infested area (0.3ha) within the Development Envelope is located within the road reserve of Princefield Road, which has been excluded from any disturbance. This area will be segregated and avoided for the duration of the Proposal.

No impacts to listed Threatened species or communities are expected to occur.

CHANGES TO FIRE REGIME

The Development Envelope has been identified as a designated bushfire prone area by the Fire and Emergency Services Commissioner as being subject, or likely to be subject, to bushfire attack.

Alteration of the natural fire regime may occur as a result of implementing the Proposal due to improved access and increased human activity associated primarily with flammable liquids, combustible materials and hot machinery. The risk of causing fire during the operations has the potential to increase the frequency of fires in the project location. However, large areas of bare earth may act as firebreaks in the event of a blaze from adjacent farming or mining areas

The potential consequences of an altered fire regime has the potential to affect 37.81ha of native vegetation within the Development Envelope, including listed Threatened species and communities.

Fire risk will be managed through the implementation of a Fire Management Plan which will include a fire response procedure.

VEHICLE STRIKES

Clearing of native vegetation by machinery prior to mining has the potential to result in death, injury or displacement to resident fauna, particularly on less mobile species. The construction and operation of the Proposal will also result in an increase in vehicle movement to and from the site. Vehicle movements may result in the loss of individual fauna, especially less-mobile species, from vehicle strikes.

Some loss of fauna may occur as a result of these activities, however mitigation measures will be implemented to ensure that impacts to fauna are minimised as far as practicable. Isolated deaths of individual fauna are not expected to affect the distribution or conservation status of any fauna species.

Mitigation measures will include:

- Pre-clearing Surveys;
- Redistricted speed limits on access roads;
- Education of contractors during inductions and regular toolbox meetings.

7.6. MITIGATION

In order to protect Matters of NES for the Proposal, Doral has applied the mitigation hierarchy to avoid, mitigate and rehabilitate potential impacts as a result of implementing the Proposal.

AVOID

Doral's primary mitigation strategy to protect Matters of NES, is to design the Proposal to avoid and minimise native vegetation clearing containing Threatened species and communities, as far as practicable. As a result, Doral have successfully avoided direct impacts to the following:

- Western Ringtail Possum *(Pseudocheirus occidentalis)*
    - Dreys, individuals and core habitat, primary corridors and supporting habitat.
- Whicher Range Dryandra *(Banksia squarrosa* subsp. *Argillacea)*
    - 9 individuals.
- Vasse Featherflower *(Verticordia plumose* var. *vassensis)*
    - 30+ individuals
- SWAFCT10b - Shrublands on the southern Swan Coastal Plain Ironstones
    - All 0.45ha present within the Development Envelope.
- Black Cockatoo potential breeding habitat (i.e. DBH >50cm or DBH >30cm for wandoo).
    - 951 of the 1,053 trees present within the Development Envelope have been avoided.

MINIMISE

Doral has an existing Environmental Management System (EMS) which it implements at its Yoongarillup and Dardanup Mines. The EMS will be updated to include the Yalyalup Mineral Sands Project, which will include the following management plans and procedures detailed below, to mitigate potential impacts to Matters of NES.

Doral's overall principles for managing the impacts to matters of NES for the Proposal are to:

- Minimise native vegetation clearing and land disturbance;
- Meet the Commonwealth laws governing flora and fauna conservation as contained in the EPBC Act;
- Conduct pre-clearing surveys;
- Implementation of specific clearing procedures including the demarcation of cleared areas and authorisation requirements;
- Monitor vegetation health in areas contained Matters of NES (i.e. Threatened flora and vegetation communities present within McGibbon Track);
- Minimise the timeframe between disturbance and rehabilitation.

The potential impacts to Matters of NES will be managed through the development and implementation of several management plans and procedures. Those plans/procedures specific to the protection and management of Matters of NES include:

- Flora and Vegetation Management Plan (refer to Section 4.2.6);
- GDE Management Plan (refer to Section 4.2.6, Appendix 4E);
- A Fire Management Plan (refer to Section 4.2.6);
- A Fauna Management Plan (refer to Section 4.3.6);
- Groundwater Operating Strategy (refer to Section 4.4.6, Appendix 7E);
- Surface Water Management Plan;
- Emergency Discharge – Pre-release of Discharge Procedure;
- Emergency Discharge – Discharge Monitoring Procedure;
- Acid Sulfate Soil Management Plan (refer to Section 4.4.6; Appendix 5).

REHABILITATE

Doral has prepared a Mine Closure Plan (Appendix 3) which describes how the Yalyalup Mine will be decommissioned and rehabilitated to meet the agreed end landuses. This will include revegetating an area of 4.7ha to counterbalance clearing of 3.5ha of predominantly completely degraded vegetation with local native species, including WRP and Black Cockatoo habitat.

7.6.1. PREDICTED OUTCOME

The Proposal will result in the following residual impacts to Matters of NES, after the application of the above mitigation measures:

- Direct impact from clearing to 0.8ha of WRP habitat;
- Direct impact from clearing to 102 isolated/scattered Black Cockatoo potential breeding habitat trees;
- Indirect drawdown impact to 1.81ha of WRP habitat and associated (co-located) 30 Black Cockatoo potential breeding trees;

- Indirect drawdown impacts to 0.34ha of SWAFCT10b - *Shrublands on southern Swan Coastal Plain Ironstones (Busselton area)* and associated (co-located) population of nine *Banksia squarrosa* subsp. *Argillacea.*

An assessment of significance of these residual impacts and proposed offsets are provided in Section 6.

8. HOLISTIC IMPACT ASSESSMENT

Doral are proposing to mine the Yalyalup Mineral Sands Deposit, ~11km southeast of Busselton, WA, using open-cut dry mining techniques to extract and process ore to produce zircon, ilmenite and rutile. The Proposal presented in this ERD has demonstrated the preliminary key environmental factors, as outlined in the ESD, can meet EPA's objectives and can be managed to be environmentally acceptable.

The Proposal has been designed, as far as practicable, to avoid clearing of native vegetation and fauna habitat and maximise the use of existing cleared pasture, which accounts for ~99% of the proposed disturbance area. Of the 37.81ha of native vegetation present within the Development Envelope, only 3.5ha will be directly impacted. Of this area, 2.7ha is in degraded or completely degraded condition, with the remaining 0.8ha in degraded/good or good condition.

Regionally, clearing for the Proposal represents disturbance to 0.10% of the area remaining for the Abba vegetation complex and does not significantly reduce the regional extent of this vegetation complex (i.e. 3.5ha of the remaining 3,359.08ha). However only 6.6% of the Abba vegetation complex is remaining which is below the Commonwealth's 30% target and the EPA's 15% target.

Locally, no Threatened or Priority flora species will be directly impacted by the Proposal, however clearing will reduce the extent of the following DBCA listed TECs within the Development Envelope:

- SWAFCT01b - *Southern Corymbia calophylla woodlands on heavy soils* (Gibson, et al., 2000) will be reduced by 0.17ha (14.4%);
- SWAFCT02 - *Southern wet shrublands* will be reduced by 0.63ha (18.4%).

No substantial impacts on any fauna species or overall biodiversity values are anticipated as a consequence of implementing the Proposal. In cases where some impacts are anticipated, the degree of the impact is only expected to be very low and relates to the loss of very small areas of habitat, primarily in the form of a number of scattered, isolated paddock trees. This coupled with the fact that most of the species known to or likely to occur are common and widespread, no overall change in their conservation status is anticipated, despite a possible, very localised/small reduction in habitat extent.

The Proposal will however require clearing of ~0.8ha of WRP habitat predominantly as isolated paddock trees and/or overstory species (woodland species). Clearing will not affect any of the identified dreys/ individuals recorded within vegetation along McGibbon Track and the habitat to be impacted is outside of the core habitat, primary corridors and supporting habitat as described in *Significant Impact Guidelines for the Vulnerable Western Ringtail Possum in the Southern Swan Coastal Plain, Western Australia (DEWHA, 2009).* Clearing for the Proposal will also result in the loss of up to 102 isolated paddock trees, (from 1,053 within the Development Envelope) mapped as Black Cockatoo potential breeding habitat (i.e. DBH >50cm and DBH >30cm for wandoo). Of these trees, 5 contain hollows possibly suitable for a Black Cockatoo to use, however no evidence of use has been identified (Harewood, 2020b). No known nesting tree are present within the Development Envelope and will not be impacted by the Proposal.

Revegetation of 4.7ha of native vegetation using local provenance species, will be provided to counterbalance direct impacts from clearing and improve the overall quantity and quality of vegetation and fauna habitat, including WRP and Black Cockatoo, within the local area.

Dewatering of mine pits and localised drawdown of the water table will occur in a staged approach to allow dry mining techniques to be conducted. Groundwater drawdowns in the Superficial aquifer and the

underlying Leederville aquifer have been predicted by numerical modelling. The extent of predicted drawdown of the Superficial aquifer (0.1m contour) is generally limited to the disturbance areas within the Development Envelope. Drawdowns in the Leederville aquifer, due to upward leakage, are predicted to be local and likely to extend laterally, but not vertically (owing to clayey layers within the sand).

No drawdown impacts to the Lower Sabina River, Abba River or Vasse-Wonnerup wetland are predicted however potential impacts to groundwater dependent vegetation is predicted to occur to vegetation along the northern/central portion of McGibbon Track. This includes:

- 1.81ha of SWAFCT02 *Southern wet shrublands* (also considered present as WRP habitat containing 30 Black Cockatoo potential breeding habitat trees);
- 0.34ha of SWAFCT10b *Shrublands on Southern Swan Coastal Plain Ironstones* and co-located population of nine *Banksia squarrosa* subsp. *Argillacea*.

With the implementation of the proposed management measures and environmental management plans, including a Groundwater Operating Strategy, GDE Management Plan, Flora and Vegetation Management Plan and Fauna Management Plan potential impacts will be minimised as far as practical.

Soils proposed for excavation and dewatering have been identified to contain net acidity in excess of the DWER's action criterion (0.03%S) and will require management during the operation of the Proposal. With the implementation of soil, dewatering and groundwater management strategies detailed in the Acid Sulfate Soil Management Plan, no adverse impacts to groundwater quality are expected to occur.

Surface water discharge from Site (0.082GL) is only predicted to occur during the winter 2023 period and is considered to be minimal as annual flows of the Lower Sabina River and the Vasse Wonnerup Ramsar wetland catchments will only increase by 1.44% and 0.28%, respectively. No reduction in water quality from the discharge of excess water will occur due to strict water quality criteria being met to meet future DWER Part V licence conditions. Production water for mine processing will be required during dry conditions and will be sourced from the Yarragadee aquifer.

Doral are experienced at managing noise impacts associated with mineral sands mine sites. Effective implementation of noise management strategies and control measures will reduce noise emissions and as a minimum maintain compliance with the Noise Regulations.

With consent of a S18 Notice by the Minister of Aboriginal Affairs and approval by Water Corporation to construct a crossing over the Abba River (DPLH 17354), Doral is confident that impacts to registered Aboriginal Sites will be minimised. No other registered Aboriginal Sites will be impacted by the Proposal.

Doral will manage the rehabilitation and mine closure of the Proposal through the implementation of a Mine Closure Plan. This will include revegetation of 4.7ha of native vegetation to counterbalance clearing impacts. The remainder of the site will be returned to pasture which will allow for improvements to soil structure and drainage control and improve the overall quality of the land for is intended use.

Significant residual impacts to vegetation, flora and fauna habitat that remain after mitigation measures have been applied, are proposed to be offset through the acquisition of land, with similar values to the vegetation and fauna habitat proposed to be impacted. This will provide an overall net gain to the State and Commonwealth with long-term protection of conservation significant vegetation and fauna habitat.

Doral's stakeholder engagement process has provided timely information to its stakeholders in a planned and systematic manner to enable key issues and concerns to be identified and managed effectively

throughout the planning phase for the Proposal. Doral will continue its commitment to consult with relevant parties and Regulators throughout the progress of the Proposal.

Doral considers that with the implementation of EPA's mitigation hierarchy of avoid, minimise and rehabilitate, as well as providing a suitable offset for significant residual impacts to flora, vegetation and terrestrial fauna, that the Proposal presented in this ERD has demonstrated the preliminary key environmental factors, can meet EPA's objectives and can be managed to be environmentally acceptable.

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