CHAPTER 19
VEGETATION AND WEEDS

BIRD IN HAND GOLD PROJECT

MINING LEASE PROPOSAL

ABN | 66 122 765 708
Unit 7 / 202-208 Glen Osmond Road | Fullarton SA 5063

DISCLAIMER

A declaration has been made on behalf of Terramin Exploration Proprietary Limited and Terramin Australia Limited by its Chief Executive Officer that he has taken reasonable steps to review the information contained in this document and to ensure its accuracy as at 31st May 2019.

Subject to that declaration:

(a) in writing this document, Terramin Exploration Proprietary Limited and Terramin Australia Limited have relied on information provided by specialist consultants, government agencies, and other third parties. Terramin Exploration Proprietary Limited and Terramin Australia Limited have reviewed all information to the best of their ability but do not take responsibility for its accuracy or completeness; and

(b) this document has been prepared for information purposes only and, to the full extent permitted by law, Terramin Exploration Proprietary Limited and Terramin Australia Limited, in respect of all persons other than the relevant government departments, makes no representation and gives no warranty or undertaking, express or implied, in respect to the information contained herein, and does not accept responsibility and is not liable for any loss or liability whatsoever arising as a result of any person acting or refraining from acting on any information contained within it.

Document Control

This Document is a controlled document. The Document Controller holds the Master electronic copy.

Master Document Information			
Document Number	File Path	Format	Last Modified
BIHMLP_V2	O:\Technical\Bird In Hand\Regulatory\DSD\ML Application\BIHMLP_V2	PDF	18/6/2019

If you become aware of any changes or corrections that are required please photocopy this page and the relevant page(s) requiring changes, note the corrections, and email them to the Document Controller:

Document Controller:

Terramin Exploration Pty Ltd

Unit 7 / 202-208 Glen Osmond Road

Fullarton, South Australia 5063

Tel: 08 8213 1415

email: info@terramin.com.au

Distribution Electronic Copies (Body and Appendices)

Document Number	Issued To	Format	Date
BIHMLP_Draft_V1	DEM	Adobe	18/12/2017
BIHMLP_V2	DEM (45 copies)	PDF	21/6/2019
BIHMLP_V2	DEM (5 copies)	Hard Copy	21/6/2019

Contents

FIGURES

TABLES

All maps presented in this chapter are in GDA94 / MGA zone 54 (EPSG: 28354) unless otherwise stated.

19 VEGETATION, WEEDS AND PATHOGENS

As the Mining Lease (ML) is used for a number of different purposes, the vegetation associations differ quite dramatically over the area.

Table 19-1 details thesurveys, analysis and reports have been reviewed or undertaken in order to gain a holistic understanding of all vegetation and vegetation associations within the ML:

TABLE 19-1 LIST OF SURVEYS, ANALYSIS AND REPORTS

Report	Consultant	Year	Appendix
2014 Flora/Fauna field survey and report	Care of Our Environment Pty Ltd (COOE)	2014-2016	Appendix Q1
Inverbrackie Creek Macroinvertebrate and Water Quality Investigation (descriptions of riparian vegetation along Inverbrackie Creek),	AC Environmental	2017	Appendix I1
Bushland Condition Monitoring	Nature Conservation Society of SA	2016	Appendix R1
Landscape Function Analysis	COOE	2016	Appendix R2
EPBC act referral 2017/8075	Commonwealth Department of the Environment	2017	Pending (R3)
Heritage Agreement Vegetation Associations	DEWNR	2012	Appendix R4
Native Vegetation Heritage Assessment Groundwater Study	Golder Associates	2017	Appendix R5
2017 Commonwealth Protected Matters Search Tool (PMST) and the South Australian Department of Environment, Water and Natural Resources Biological Databases of South Australia (BDBSA) desktop study	Commonwealth Department of the Environment and DEWNR	2017	Appendix R7

Occupying approximately 195.9 hectares (ha) of predominantly freehold agricultural land, the ML falls primarily within the Adelaide and Mount Lofty Ranges (AMLR) Natural Resources Management (NRM) Region (approximately 164 ha, 84%) and is also partially intersected by the South Australian Murray-Darling Basin (SAMDB) NRM Region (approximately 31.9 ha, 16%).

19.1 APPLICABLE LEGISLATION AND STANDARDS

Threatened flora species and some vegetation communities within South Australia are protected (as indicated by legislatively established Conservation Status) both at the Commonwealth and State levels via the following legislation:

19.1.1 ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999 (EPBC ACT) (COMMONWEALTH)

This Act prescribes the Commonwealth's role in environmental assessment, biodiversity conservation and the management of protected areas. Under the environmental provisions of the EPBC Act, actions that are likely to have 'significant impact' on a matter of National Environmental Significance require assessment and approval by the Commonwealth Environment Minister. There are nine matters of national environmental significance identified under the EPBC Act.

Aspects of this Act that are relevant to vegetation include conservation listings for one Threatened Flora species. The category of threat is Endangered.

A referral of the proposed ML pursuant to Section 68 of the EPBC Act was made to the Commonwealth Department of the Environment and Energy on 20th October 2017. The proposed ML was declared to be not a controlled action on the 7th February by the Commonwealth. The EPBC letter from the Commonwealth of Australia is included in Appendix R3.

19.1.2 *NATIONAL PARKS AND WILDLIFE ACT 1972* (SCHEDULES 7, 8 AND 9 OF THE ACT) (NPW ACT) (SA)

This Act provides for the protection of flora habitat through the establishment of parks and reserves (both on land and in State waters) and provides for the use of vegetation through a system of permits allowing certain actions, i.e. keeping, selling, trading, harvesting, farming and the destruction of native species. This Act also assigns flora species to state conservation categories; located in Endangered (Schedule 7), Vulnerable (Schedule 8) and Rare (Schedule 9).

19.1.3 *NATURAL RESOURCE MANAGEMENT ACT 2004* (NRM ACT) (SA)

This Act is to assist in the achievement of ecologically sustainable development in the State by establishing an integrated scheme to promote the use and management of natural resources that recognise and protects the intrinsic value of natural resources, including native flora and fauna, soils, water resources and the coastal environment.

This Act also sets out the legal framework for management of pest plants and animals. Pest plants that are a significant threat to agriculture, native flora and fauna and public health and safety are called 'Declared' plants. Under this Act landowners have a legal responsibility to manage pest plants. In addition, the Act sets out a framework for banning the sale of Declared weeds, controlling the movement of Declared weeds, destroying or controlling infestations of Declared weeds and notifying authorities when an infestation is detected.

The BIHGP falls within the authority of the Adelaide and Mount Lofty Ranges Natural Resource Management (NRM) Board, which is the relevant authority administering the NRM Act.

19.1.4 *Native Vegetation Act 1991 (NV Act)* (SA) and *Native Vegetation Regulations 2003* (SA)

This Act controls the clearance of native vegetation and provides incentives and assistance to landowners and proponents in relation to the preservation and enhancement of native vegetation. Broad objectives of this Act include:

- The conservation, protection and enhancement of the native vegetation of the State and in particular, remnant native vegetation, in order to prevent further reduction of biological diversity and degradation of the land and its soil, loss of quantity and quality of state vegetation and loss of critical habitat.
- Provision of incentives and assistance to landowners for preservation and management of vegetation.
- Limitations on clearance of native vegetation.
- Encouragement of research into protection and management of vegetation.
- Encouragement of re-establishment of native vegetation in areas where vegetation has been cleared or is degraded.
- Sets out principals of clearance and if permitted, details conditions and requirements for a Significant Environmental Benefit (SEB) to be made to counter the loss of habitat and impacts to biodiversity.

The DPC currently has delegation for the administration of the NV Act for native vegetation clearance undertaken as part of mine developments.

Additionally, a Native Vegetation Heritage Agreement (NVHA) is a permanent, legally binding contract between a landholder and the Minister for Environment and Water placed on a property's title for the protection of an area of native vegetation, ensuring native plants and wildlife on the property are protected forever. It is legally recognised under the *Native Vegetation Act 1991* (SA).

19.1.5 Adelaide Hills Council Biodiversity Strategy

The Adelaide Hills Council district is located within the Mount Lofty Ranges, an Australian Government biodiversity hotspot, where a high variety of locally native flora and fauna species exist. Due to the vast changes to the Australian landscape brought about by development and agriculture post-settlement, approximately only 10% of the original native vegetation of the MLR remains.

Priority actions from the strategy that have been adopted for the project include:

- Identify and map areas which form linkages to connect and expand habitat within the district
- Develop a Woody Weed Control program to reduce fuel load while improving habitat quality
- Develop best practice bushfire management procedures in sites with remnant or listed vegetation
- Review and map sites to determine condition and prioritise weed treatment
- Seek input from local community in biodiversity and habitat planning through Strategy and implementation of site action or management plans.
- Liaise with DEWNR to identify areas of high conservation value for consideration of entering into Heritage Agreements
- Develop best-practice procedures for staff and contractors for works in environmentally sensitive areas in liaison with experienced groups and organisations
- Prepare a Strategy Action Plan that identifies resources necessary to undertake the high priority biodiversity activities.

- Investigate opportunities for additional resources for on-ground ongoing management of biodiversity
- Development of management/action plans

19.2 ASSESSMENT METHOD

19.2.1 DESKTOP

A desktop study of the ML and surrounds was undertaken by COOE Pty Ltd (COOE) to identify the nature and condition of the existing environment, including vegetation associations and habitat and to develop a list of flora and fauna species that may occur in the area, based on existing records. Literature reviews and database searches have been conducted, consisting of the following:

- The EPBC Act Protected Matters Search Tool (PMST) – to determine if matters of national environmental significance have the potential to occur within the proposed project area
- Species Profile and Threats Database – to gather information on the statutory, biological and ecological status of species protected under the EPBC Act
- Biological Databases of South Australia – to access spatial datasets, including records of previous survey efforts and species observed within the area
- NatureMaps and Data.SA (South Australian Government Data Directory) – Spatial datasets
- Accessible published and unpublished literature, including the AMLR NRM Plan, associated recovery plans and previous survey assessments.
- Aerial imagery and mapping.

The Commonwealth Department of the Environment's PMST was used to generate a Protected Matters Report (PMR), to help determine potential matters of national environmental significance (MNES) in the area of interest. The area nominated in the PMR was the aforementioned Bird-in-Hand Gold ML. The search was conducted based on the coordinates of the ML, with a ten kilometre buffer.

A search of a wider area utilising the Biological Databases of South Australia (hereafter referred to as, 'BDBSA' or 'BioData') was also undertaken to collate flora and fauna records from within the ML and surrounds. Upon request, BioData records are provided by the South Australian Department of Environment, Water and Natural Resources (DEWNR). The records were utilised to indicate the likelihood of occurrence (unlikely, possible, likely or confirmed) of species listed under the EPBC Act and the National Parks and Wildlife Act 1972 (SA) on the ML. The likelihood assessment was based on proximity of the ML to extant and historical records, habitat preferences and capacity for recruitment and increased distribution.

19.2.2 FIELD SURVEY

19.2.2.1 MINING LEASE

A preliminary field reconnaissance was undertaken on 15 September 2014 by COOE to gain familiarity with the site and record the location of some listed threatened flora species during peak detectability. The flora survey was subsequently undertaken on 8 October 2014 by COOE . The flora survey was undertaken to compile an annotated inventory of vegetation types, and vascular plant taxa, including listed threatened and introduced species. A review of existing information, assessing the ecological aspects of the ML, identified species and vegetation associations likely to occur. Results of the desktop study were utilised to validate and improve existing knowledge of:

- Vegetation associations present
- Flora and fauna species (including listed species) known or likely to occur in the area
- Key Threatening Processes that may require specific management, such as introduced flora and fauna
- Potential ecological constraints for the Project.

19.2.2.2 LISTED THREATENED SPECIES

The preliminary field reconnaissance assisted to record the location of listed threatened flora species during peak detectability, namely, *Diuris behrii* (Behr's Cowslip Orchid). During the reconnaissance, COOE obtained information from local landholders regarding their knowledge of species in the area, in particular the location of orchid species. The flora survey was subsequently targeted to confirm the presence and likelihood of occurrence of additional listed threatened species to better inform ecological constraints of the Project.

19.2.2.3 BROAD LEVEL VEGETATION ASSOCIATION MAPPING

The ML was traversed on-foot and by vehicle by two field surveyors (Botanist and Field Assistant), recording the vascular plant species of each of the defined the vegetation associations. A hand-held GPS was used to record the occurrence of visible changes in vegetation characteristics.

Once the field survey was complete, the list of vegetation associations present was finalised and a list of all vascular plant species compiled. The associations were mapped using spatial GIS data and satellite imagery. The distribution and extent of the broad vegetation associations within the ML were finalised with reference to the results of the desktop study.

19.2.2.4 SCATTERED TREE ASSESSMENT

Scattered trees were assessed using the Scattered Tree Clearance Assessment in South Australia – Streamlining, Guidelines for Assessment and Rural Industry Extension (Cutten and Hodder 2002). Trees were assessed individually, or as a group. When trees were assessed as a group, an average measurement of all trees was taken for each attribute (height, trunk circumference, canopy radius, hollows, nests, beehives and dieback). The data collected identifies the habitat value of scattered trees and aligns with the aforementioned method, should calculations to determine Significant Environmental Benefit requirements be required in future.

19.2.2.5 INVERBRACKIE CREEK

Habitat assessments were obtained from 6 sites along two transects along the Inverbrackie Creek (labelled Polo Bridge and Wicks) and one dam located within a drainage line south of the orebody. This drainage line ultimately reports to the Inverbrackie Creek between the two transects described above, as can be seen in Figure 19-1.

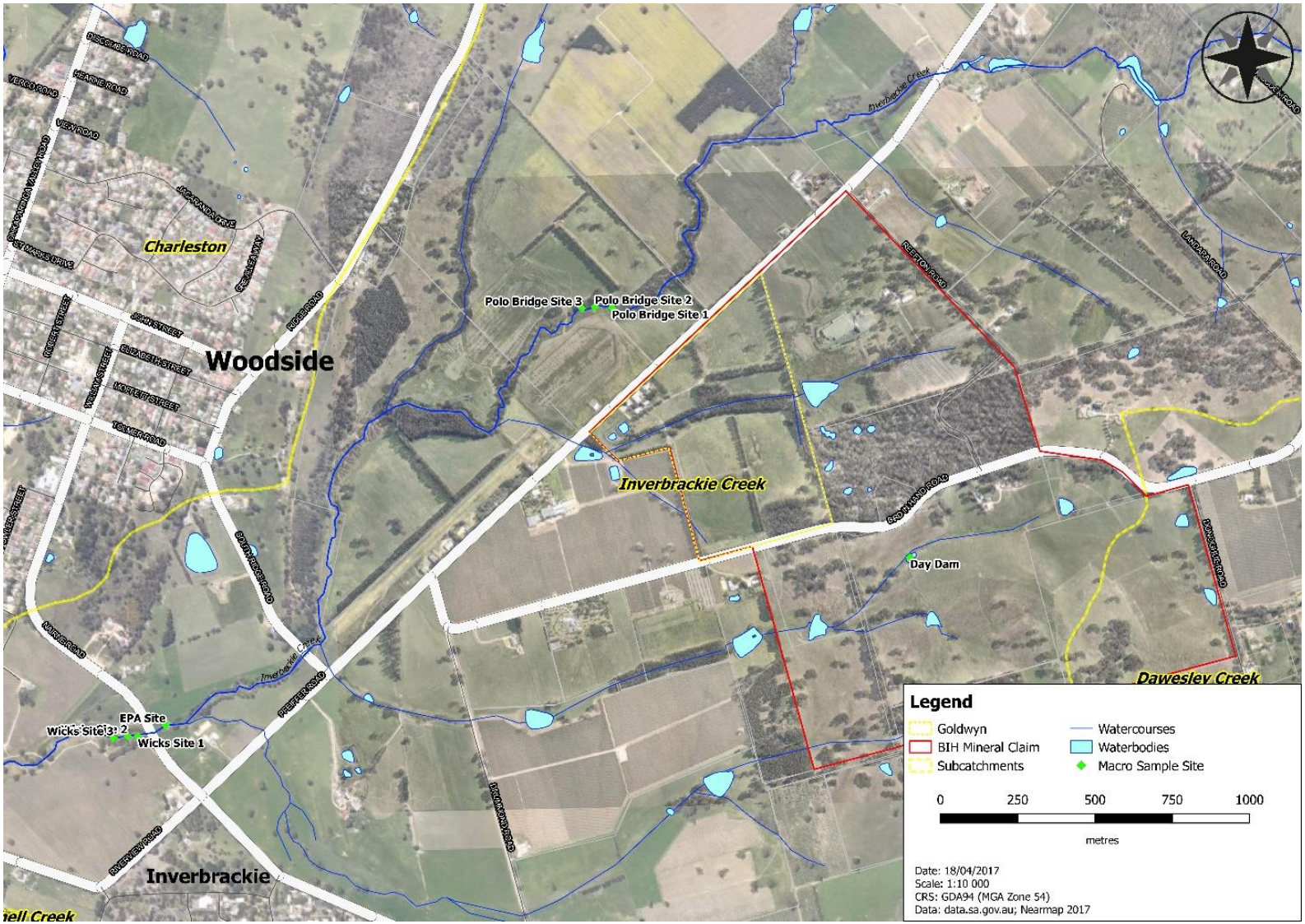

FIGURE 19-1 | MACROINVERTEBRATE SAMPLING LOCATIONS

19.3 EXISTING ENVIRONMENT

Characterising the historical and existing environment within the ML is a key milestone in the development of a mining project and flora and fauna studies are a component of this characterisation. Terramin undertook a study, conducted in October 2014, which has provided the first year of baseline data.

The study assisted in validating and improving existing knowledge of the key ecological attributes of the ML area, through acquisition of more recent and spatially targeted flora and fauna data. The ML was assessed for the presence of vegetation associations, flora and fauna species (including listed species) and key threatening processes (such as introduced plants and animals). Ultimately, the information presented in the flora/fauna reports will contribute to the assessment of potential environmental constraints relating to the BIH Project.

The proposed area of disturbance for the BIH Project is contained with the Property Goldwyn. This property has been cleared extensively over the preceding century, and has been used for mining, potato farming, as a dairy, and in the preceding couple of decades, as a cattle grazing property – shown in Figure 19-2.

FIGURE 19-2 | PREVIOUSLY DISTURBED LAND

The ML falls primarily within the Adelaide and Mount Lofty Ranges (AMLR) Natural Resources Management (NRM) Region (approximately 164 ha, 84%) and is also partially intersected by the South Australian Murray-Darling Basin (SAMDB) NRM Region (approximately 31.9 ha, 16%).

Broad-scale clearance has removed a large proportion of native vegetation within the AMLR Region, with approximately 14% of the pre-European native vegetation cover remaining (AMLR NRMB 2008). Isolated areas of remnant native vegetation are predominantly surrounded by agricultural land

(AMLR NRMB 2008). Table 19-2 describes land use within the 195.9 ha ML, including approximate hectare and percentage values. Land use of the ML and the surrounding region is shown in Figure 19-3.

TABLE 19-2 | LAND USE WITHIN THE BIRD-IN-HAND GOLD ML (DEWNR 2013).

No.	Land Use Description (Tertiary)	Land Use Description (Primary)	Area (ha)	Area (%)
1.	Grazing modified pastures	Production from dryland and irrigated agriculture and plantations	117.03	59.74
2.	Irrigated sown grasses	Production from dryland and irrigated agriculture and plantations	39.12	19.97
3.	Residual native cover	Conservation and Natural Environments	29.87	15.25
4.	Irrigated perennial vine fruits	Production from dryland and irrigated agriculture and plantations	5.17	2.64
5.	Roads	Intensive uses	3.65	1.86
6.	Water storage – intensive use/farm dams	Water	0.79	0.4
7.	Urban residential	Intensive uses	0.27	0.14
		TOTAL	195.9	100

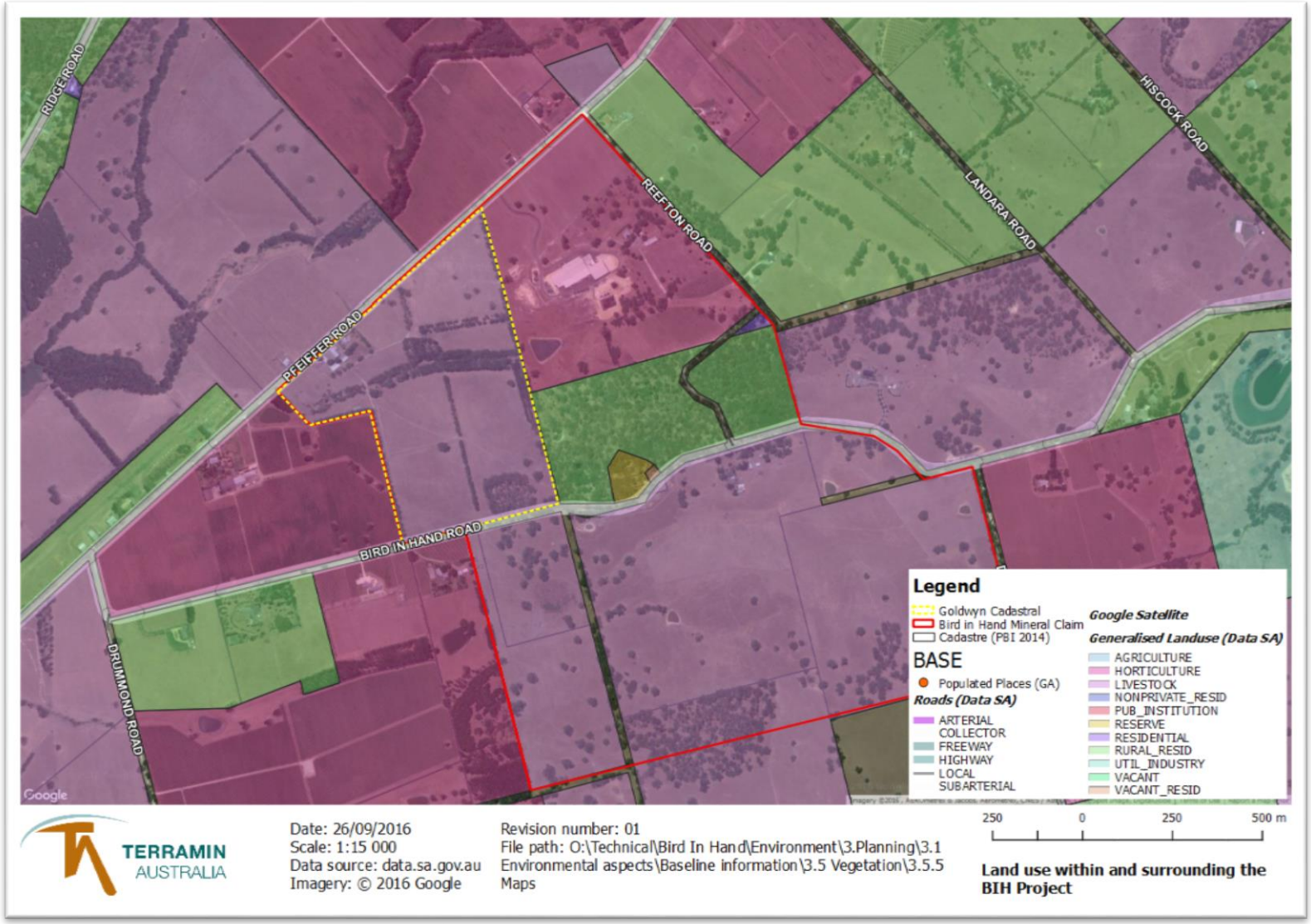

FIGURE 19-3 | LANDUSE SURROUNDING AND WITHIN THE ML

The Interim Biogeographic Regionalisation of Australia (IBRA) establishes a hierarchy of ecosystem classification for which physical, climatic and biological characteristics are described (Department for Environment and Heritage 2009). The ML falls within the Kanmantoo IBRA Bioregion, Fleurieu IBRA Sub-region and Eden Valley IBRA Association (Table 19-3). Please see Figure 19-4 for delineation of the bioregions within and surrounding the ML site.

TABLE 19-3 | IBRA ASSOCIATIONS 7.0 DESCRIPTION FOR THE BIRD-IN-HAND GOLD ML (DEWNR 2015).

IBRA Association: Eden Valley		
IBRA Aspect	**IBRA Region: Kanmantoo**	**IBRA Sub-region: Fleurieu**
Landtype	Erosional, depositional or volcanic	Erosional/Depositional
Landscape	Low hills	Low hills
Landform	Central Island; dissected tableland with moderate to very steep slopes. Coastal fringe and eastern area; coastal dune formations with small plains, swamps, lagoons, lunettes. Undulating old dune formations largely stripped of sands exposing dune limestone.	Undulating upland plain with broad interfluves and occasional higher hills. Hills and valleys; alternating subparallel hilly ridges and valleys with a general N-S trend in north. In south, hilly dissected tableland.
Geology	Small areas of sandy acidic yellow soils, with a laterite layer on the tableland remnants. Ironstone gravels on tableland. Commercial gypsum mining.	Metasediments and alluvium. Dissected lateritized surface in south.
Soil	Calcareous sand soil of minimal development, coherent sandy soils, sand-soils with mottled yellow clayey subsoils, cracking clays.	Hard pedal mottled-yellow duplex soils, bleached sands and reddish weakly structured sandy soils. Hard setting loams with red clayey subsoils, highly calcareous loamy earths, hard setting loams with mottled yellow clayey subsoil, coherent sandy soils, cracking clays.
Vegetation	Mallee Woodland and Shrubland	Eucalyptus woodlands with a shrubby understorey. Woodlands of SA Blue Gum and woodlands of River Red Gum.
Climate	Classic, 'Mediterranean' climate with peak of growth in autumn and spring and moderate growth in winter.	Classic, 'Mediterranean' climate with peak of growth in autumn and spring and moderate growth in winter.

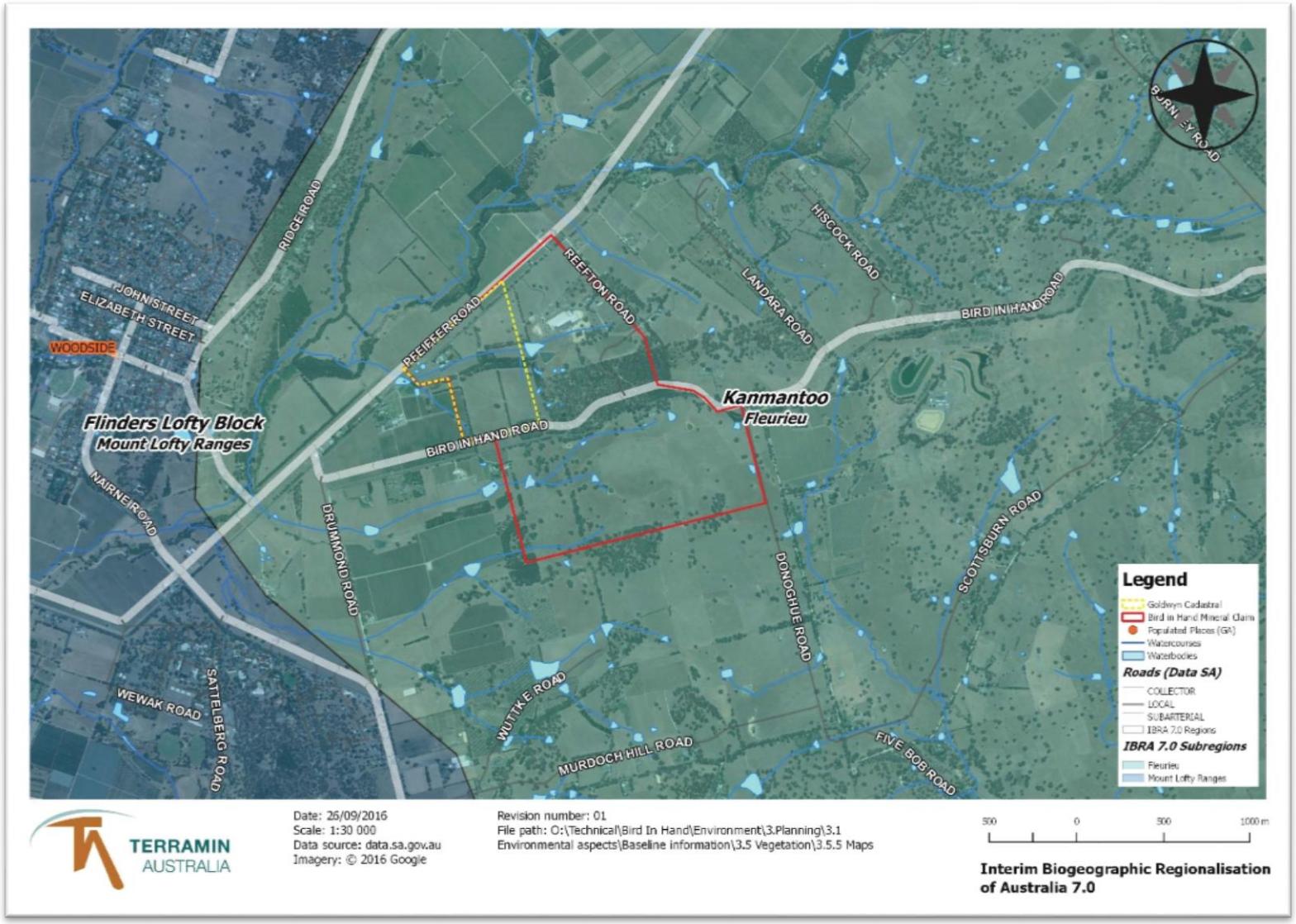

FIGURE 19-4 | IBRA ASSOCIATIONS AND THE ML BOUNDARY

The Eden Valley IBRA Association (Eden Valley) comprises 68 708 ha, with approximately 3 964 ha (6%) mapped as remnant native vegetation. Areas of this remnant vegetation comprising 128 ha (3%) have undergone formal protection. One *National Parks and Wildlife Act 1972* (SA) (NPW Act) reserve occurs within the Eden Valley Association, namely the Charleston Conservation Park (Park), located approximately 6 km north-east of the ML.

In addition to the six existing Heritage Agreements that occur, a Vegetation Heritage Agreement covers 13.8 ha of native vegetation contained within the ML, described in more detail below, see Figure 19-5.

19.3.1 Native Vegetation Heritage Agreement Area

The most significant vegetation area within the ML includes a Native Heritage Agreement Vegetation Associations (application no: 2011/1019/473), which covers approximately 13.8 ha, in the centre of the ML, shown in Figure 19-6. The application resulted in a site survey by the Native Vegetation Council (NVC) in 2012, which included a Biodiversity Assessment following the BushRAT Rapid Assessment Technique.

In summary, the application area includes a diversity of habitats and vegetation types, including rocky outcrops and dense sclerophyll shrubs (Association 1) grading through to Red Gum grassy woodland (Association 3). This block was identified as significant for conservation owing to the intact native understory present within the Red Gum grassy woodlands and specifically two species of orchid with national and/or State ratings (Stiff White Spider Orchid *(Caladenia rigida)* listed as endangered under the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) and Behr's Cowslip Orchid (*Diuris behrii*), listed as vulnerable under the National Parks and Wildlife Act 1972 (SA) (NPW Act). The woodlands dominated by Blue Gum *(Eucalyptus leucoxylon ssp. leucoxylon)* and Red Gum *(Eucalyptus camaldulensis ssp.)* provides suitable habitat for bird species considered to be declining in the Mount Lofty Ranges region, including the Crested Shriketit (*Falcunculus frontatus)* and the Diamond Firetail *(Stagonopleura guttata)*. 53 native species were recorded during the NVC early winter field inspection and a further 6 species were identified through historic records as part of the application.

The Native Vegetation Heritage Agreement area is also defined as a Eucalyptus leucoxylon ssp. woodland having a low potential as being a groundwater dependent ecosystem, as defined by the Groundwater Dependent Ecosystems Atlas (Australian Government: Bureau of Meteorology, 2017).

The Heritage Agreement Vegetation Associations (application no: 2011/1019/473) is located in Appendix R4.

FIGURE 19-5 | LOCATION OF NATIVE VEGETATION HERITAGE AGREEMENT AREA WITHIN THE PROPOSED MINING LEASE

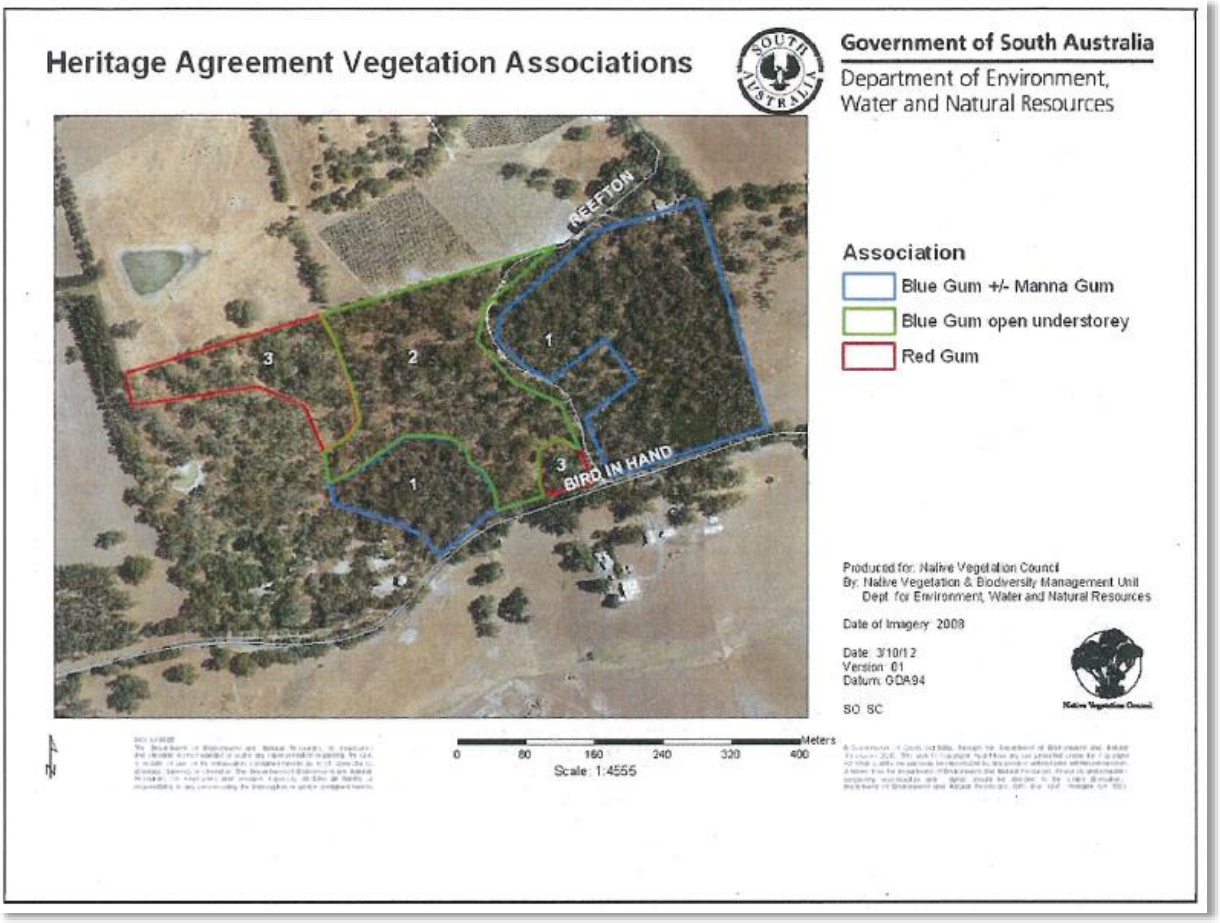

FIGURE 19-6 | VEGETATION HERITAGE AGREEMENT VEGETATION ASSOCIATIONS

19.3.2 DESKTOP STUDY

19.3.2.1 MINING LEASE

The Commonwealth PMST and the South Australian Department of Environment, Water and Natural Resources BDBSA identified 15 Commonwealth-listed and 57 SA-listed threatened flora species as potentially occurring within or surrounding the BIH ML. The Stiff White Spider-orchid (*Caladenia rigida*), listed as endangered under the EPBC Act and Behr's Cowslip Orchid (*Diuris behrii*), listed as vulnerable under the NPW Act were previously recorded (in 2009) within the ML.

The Desktop Study is included in section 5.1 of Appendix Q1.

19.3.2.2 INVERBRACKIE CREEK

The SA EPA have undertaken aquatic ecosystem assessments within the Inverbrackie Creek in 2008, 2011, 2013 and 2016, downstream of the proposed Project (see Appendix I2).

Overall, the SA EPA concluded that the Inverbrackie Creek returned a rating of poor, which was expected, due to the site sampled "showed evidence of major changes in ecosystem structure and moderate changes to the way the ecosystem functions. There was clear evidence of human disturbance at the site due to nutrient enrichment, the mobilisation of fine sediment, and the extent of weeds in the riparian zone".

A large amount of phytoplankton was present in spring (chlorophyll *a* ranged from 1.27-6.58 g/L). Filamentous algae (*Cladophora*) covered over 10% of the channel in both seasons. The same area of the creek was also covered by a range of aquatic plants, which included floating (*Azolla*), submerged (*Callitriche* and *Crassula*) and emergent macrophytes (*Typha, Persicaria, Juncus, Phragmites, Mimulus, Isolepis* and the introduced *Rorippa* and *Rumex*). The riparian zone generally lacked any trees and consisted mainly of weedy shrubs and introduced grasses. The surrounding vegetation comprised grazing paddocks.

The EPA do not recognise any significant environmental values of the creek existing in 2016.

The EPA Aquatic Ecosystem reports have been included in Appendix I2.

19.3.3 Field Survey

19.3.3.1 MINING LEASE

During the COOE (2014) survey, four SA-listed flora species were recorded, namely the vulnerable Behr's Cowslip Orchid *Diuris behrii*, Pale Wood-rush (*Luzula flaccida*) and Blue Star Sun-orchid (*Thelymitra latifolia*) and the rare Pink Gum (*Eucalyptus fasciculosa*). An additional eight recorded flora species are regionally-listed (AMLR) as rare and one species is listed as Endangered. Following the October 2014 study, Terramin personnel have captured flora and fauna species records opportunistically (and during active inspections within peak detectability periods), whilst onsite. In conducting an active inspection in September 2015, *C. rigida* was recorded onsite by Terramin personnel - listed as endangered under the (EPBC Act. The Maroon-hood (*Pterostylis viriosa*), regionally-listed as vulnerable was also observed.

A total of nine broad vegetation associations were identified across the ML, predominantly comprising minor variations in *Eucalyptus leucoxylon ssp. leucoxylon* and *E. camaldulensis ssp*. woodland. The ML is considered to contain areas of high conservation value, with suitable habitat for listed flora and fauna species. In particular, listed flora and fauna species were recorded throughout the central parcel of native vegetation within the ML site (comprising five vegetation associations. A total of 166 flora species have been recorded within the ML, including 38 introduced species, five of which are declared under the NRM Act. An additional 10 native flora species (all from the Orchidaceae family) not recorded during the October 2014 have been identified as known to occur within the ML. Figure 19-7 shows the native vegetation cover present within the ML and surrounding area.

Significant trees exist within Goldwyn and are located in Figure 19-8.

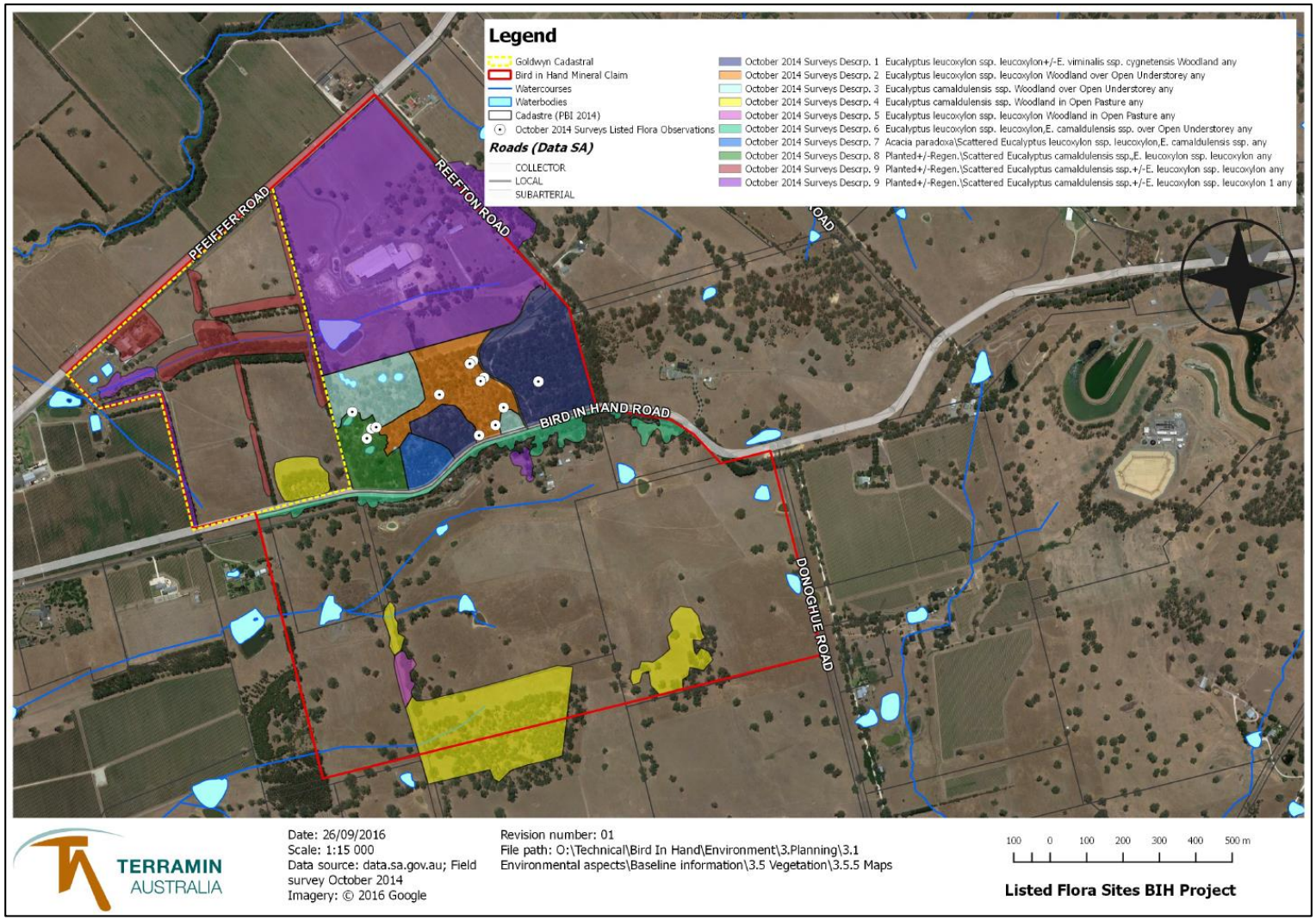

FIGURE 19-7 | LISTED FLORA SITES AND VEGETATION ASSOCIATIONS FROM 2014 FLORA SURVEY

FIGURE 19-8 | SIGNIFICANT TREES LOCATED WITHIN GOLDWYN

19.3.3.2 INVERBRACKIE CREEK

Inverbrackie Creek and its tributaries are located within the Onkaparinga River Catchment. The subcatchment is dominated by intensive agriculture, largely focussed on cattle and horticulture,

including vineyards and orchards. Irrigation in the catchment is predominantly for horticulture and viticulture while less intensive irrigation is associated with pasture farming and grazing. Irrigation for orchards, grapevines and pasture increased substantially in the Central Hills region between 2000 and 2011, with harvest increasing by 62% in this timeframe and land use increasing by 44% (AMLR NRM, 2013). There are currently approximately 180 dams within the subcatchment (Naturemaps, 2017). These dams contribute to lower stream flows throughout the subcatchment. Historically Inverbrackie creek water volumes were such that it was possible to canoe upstream (D. Kerber 2016 (Local landowner, Pers. comm.)).

Riparian vegetation along the watercourse commonly includes River Red Gums (*Eucalyptus camaldulensis)*, Blue Gums (*Euc. leucoxylon)*, Sheoak (Causuriana sp.), Blackwood (*Acacia melanoxylon),* Weeping Willows (*Salix babylonica*), Desert Ash trees (*Fraxinus angustifolia* ssp), Poplars (*Populus alba*) and is frequently dominated by Blackberries (*Rubus fruticosus*), Gorse (*Ulex europaeus*), Montpellier Broom (*Genista monspessulana*), Phalaris (*Phalaris sp*), Rye (*Lolium rigidum*) and Barley grass (*Hordeum sp*). Small occurrences of native emergent macrophytes including sedges and rushes (inc. *Juncus* sp., *Phragmites*) are scattered along the watercourse, with limited occurrence of submerged or floating macrophytes. Downstream of the site "Airstrip South", *Azolla* is commonly observed.

Inverbrackie creek was the focus of a substantial Landcare program in the early 1990s with the majority of riparian woody weeds being removed, dairy effluent treatment systems being constructed and revegetation of fence lines and riparian zones with native agro forestry trees or endemic vegetation, this work was undertaken by landowners at the time (D. Kerber 2016 (Local landowner, Pers. comm.)).

Currently a large majority of the Inverbrackie Creek and associated tributaries and drainage lines within the subcatchment are accessible to grazing animals for their water source, resulting in increased nutrient and sediment loads throughout the catchment, reduced riparian vegetation, increased erosion, and therefore increased contaminants entering the catchment.

The Inverbrackie Creek Macroinvertebrate and Water Quality Investigation is located in Appendix I1.

Other sensitive areas within the ML include surface drainage lines, which ultimately report east and join the Inverbrackie Creek. Drainage lines within the Goldwyn property are infested with introduced pasture grasses, thistles, blackberry and various other weeds as described in Table 19-4. Drainage lines on the southern side of Bird in Hand Road contain introduced pasture grasses and sporadic instances of *Juncus palladus* (Appendix I1).

TABLE 19-4 | WEEDS PRESENT ON GOLDWYN PROPERTY

Common Name	Species	Declared	WoNS	Alert Weed
African Box Thorn	*Lycium ferocissimum*	Y	Y	
Aleppo Pine	*Pinus halepensis*	Y		
Artichoke Thistle	*Cynara cardunculus L.*	Y		
Barley Grass	*Hordeum glaucum and H. leporinum*			
Black Nightshade	*Solanum nigrum*			
Blackberry	*Rubus fruticosus L. agg*	Y	Y	
Bone seed	*Chrysanthemoides monilifera ssp. monilifera*	Y	Y	
Bridal creeper	*Asparagus asparagoides*	Y	Y	
Caltrop	*Tribulus terrestris*	Y		
Cape Weed	*Arctotheca calendula*			
Common Heliotrope	*Heliotropium europaeum*			
Common Sow-thistle	*Sonchus oleraceus*			
Common Vetch	*Vicia sativa*			
English Broom	*Cytisus scoparius*	Y	Y	
Gazania	*Gazania linearis*	Y		
Gorse	*Ulex europaeus L*	Y	Y	
Hop Clover	*Trifolium campestre*			
Horehound	*Marrubium vulgare*	Y		
Marguerite Daisy	*Argyranthemum frutescens*			
Marshmallow	*Malva parviflora*			
Montpellier broom	*Genista monspessulana*	Y		
Musky Herons-bill	*Erodium moschatum*			
Olive	*Olea europaea.*	Y		
Onion Weed	*Nothoscordum inodorum*			
Paterson's curse / salvation jane	*Echium plantagineum*	Y		
Perennial Thistle	*Cirsium arvense*	Y		
Phalaris	*Phalaris aquatica*			
Rough Cat's Ear	*Hypochaeris radicata*			
Scotch Thistle	*Onopordum acanthium L*			
Silver-leaf Nightshade	*Solanum elaeagnifolium*	Y	Y	
Soursob	*Oxalis pes-capre*	Y		
South African Weed Orchid	*Disa bracteata*			
Sparaxis	*syn Ixia bulbifera*			
Spear Thistle	*Cirsium vulgare*	Y		
Turnip Weed	*Rapistrum rugosum*			
Variegated Thistle	*Silybum marianum*	Y		
White-flower Fumitory	*Fumaria capreolata*			

The remainder of the ML comprises largely of pastoral grazing paddocks, dotted with paddock trees, River Red Gums *(Eucalyptus camaldulensis ssp.)*, which are generally located along drainage lines. The fencelines within the ML are mostly planted with introduced, non endemic Eucalypts through a 1990s Landcare agroforestry initiative (David Kerber, pers. Comm. 2016). The Petaluma property has approximately 10 Ha of vineyards. The Petaluma Property is also dotted with River Red Gums *(Eucalyptus camaldulensis ssp.)*.

Within the disturbance area for the Project (Goldwyn), there remains River Red Gums *(Eucalyptus camaldulensis ssp.)*, as well as introduced Eucalypts and Casuarinas through a 1990s Landcare agroforestry initiative (David Kerber, pers. Comm. 2016) planted along the primary central drainage line and fence lines.

The results of the flora survey, as well as the methodology employed, can be found in Appendix Q1.

19.3.4 Weeds, Disease and Key Threatening Processes

There has been one recording of *Phytopthora cinnamomi* (Green Fruit Rot) confirmed in a soil test found in the BDBSA database to the north west of the ML in 1991 by SARDI (BSBSA, 2015).

Goldwyn, at the time of purchase in 2015, can be described as a highly degraded grazing and dairy property with extensive sheet erosion and scoured riparian zone infested with broadleaf, woody weeds and introduced pasture.

Table 19-4 outlines the weeds present within Goldwyn at the time of purchase, as well as their status under the Natural Resources Management Act 2004 (SA), and whether they are Weeds of National Significance (WoNS). Approximately 110 species are declared under the NRM Act, including weeds such as bridal creeper, salvation jane, wheel cactus, caltrop and African boxthorn (Biosecurity SA 2016). Landowners have the legal responsibility to control declared plants. The NRM Boards coordinate and enforce control programs for declared plants.

A total of 38 introduced flora species were recorded within the ML Boundary (Table 19-5). Of the 38 species, five are declared under the NRM Act. The Bulbil Watsonia (*Watsonia meriana var. bulbillifera*) was the most ubiquitous, recorded in four Associations (2, 3, 7 and 8), followed-by Gorse (*Ulex europaeus*) recorded in two Associations (3 and 7). Blackberry (*Rubus sp.*) and Variegated Thistle (*Silybum marianum*) were recorded in Association 9 and Artichoke Thistle (*Cynara cardunculus ssp. flavescens*) in Association 7.

Table 19-5 | Introduced flora species with the ML

Common Name	Species	Introduced	Declared
Silver Wattle	*Acacia dealbata ssp. dealbata*	Y	N
Golden Wreath Wattle	*Acacia saligna*	Y-Planted	N
Cape Weed	*Arctotheca calendula*	Y	N
Bearded Oat	*Avena barbata*	Y	N
Oat	*Avena sp.*	Y	N
Large Quaking-grass	*Briza maxima*	Y	N
Brome	*Bromus sp.*	Y	N
Common Water Starwort	*Callitriche stagnalis*	Y	N
River Sheoak	*Casuarina cunninghamiana*	Y-NSW	N
Chickweed	*Cerastium sp.*	Y	N
Artichoke Thistle	*Cynara cardunculus ssp. flavescens*	Y	Y
Cocksfoot	*Dactylis glomerata*	Y	N
Sugar Gum	*Eucalyptus cladocalyx ssp.*	Y-Lofty Region	N
Tasmanian Blue Gum	*Eucalyptus globulus*	Y	N
N/A*	*Eucalyptus spp.*	Y	N
Freesia	*Freesia sp.*	Y	N

Common Name	Species	Introduced	Declared
Rough Cat's Ear	*Hypochaeris radicata*	Y	N
Flag Iris	*Iris germanica*	Y	N
Tea-tree	*Leptospermum sp.*	Y-WA	N
Ryegrass	*Lolium sp.*	Y	N
Medic	*Medicago sp.*	Y	N
Tea-tree	*Melaleuca spp.*	Y-Planted	N
Thread Iris	*Moraea setifolia*	Y	N
Soursob	*Oxalis pes-caprae*	Y	N
One-o'clock	*Oxalis purpurea*	Y	N
	Pentaschistis sp.	Y	N
Pine	*Pinus sp.*	Y-Planted	N
Ribwort	*Plantago lanceolata var. lanceolata*	Y	N
Blackberry	*Rubus sp.*	Y	Y
African Daisy	*Senecio pterophorus*	Y	N
Variegated Thistle	*Silybum marianum*	Y	Y
Black Nightshade	*Solanum nigrum*	Y	N
Sparaxis	*Sparaxis sp.*	Y	N
Bulrush	*Typha sp.*	Y-Planted	N
Gorse	*Ulex europaeus*	Y	Y
Blue Periwinkle	*Vinca major*	Y	N
Fescue	*Vulpia sp.*	Y	N
Bulbil Watsonia	*Watsonia meriana var. bulbillifera*	Y	Y

19.4 SENSITIVE RECEPTORS

Potential sensitive receptors identified through the desktop and subsequent field surveys are included in Table 19-6.

TABLE 19-6 | IDENTIFIED SENSITIVE RECEPTOR SUMMARY

Sensitive Receptor	Summary	Impact ID
Vegetation Heritage Agreement Area	Identified in Figure 19-5	PIE_19_08
Native flora (conservation significant)	Includes state and federally listed species in Appendix B in Appendix Q1	PIE_19_16
Native flora (locally indigenous)	Includes AMLR listed species in Appendix B in Appendix Q1	PIE_19_17
Native vegetation	Vegetation which is listed as native by definition of the Native Vegetation Act 1991 (SA)	PIE_19_02 PIE_19_09 PIE_19_10 PIE_19_13 PIE_19_18
Potential ecological values	Loss of potential for additional ecological values – associated with failure of revegetation potential impact events	PIE_19_03 PIE_19_04 PIE_19_06 PIE_19_12 PIE_19_14 PIE_19_15
Post mining land use	As defined in Chapter 3: Closure	PIE_19_07 PIE_19_11

Sensitive Receptor	Summary	Impact ID
Native vegetation on and off mining lease	Vegetation which is listed as native by definition of the Native Vegetation Act 1991 (SA)	PIE_19_05
Vegetation, native fauna, stock	Biological vegetative receptors (bio uptake of metals)	PIE_19_01

19.5 POTENTIALLY IMPACTING EVENTS

Potentially impacting events for vegetation are largely regarding the potential for clearance of native vegetation, as well as the potential for contaminated soils and both water and wind erosion causing scouring and dust impacts, which has the potential to impact the native vegetation heritage agreement area and the Inverbrackie Creek, see Table 19-7.

TABLE 19-7 | POTENTIAL IMPACT EVENTS: VEGETATION, WEEDS AND PLANT PATHOGENS

Potentially Impacting Events	Mine Life Phase	Source	Potential Pathway	Sensitive Receptors	Confirmation of S-P-R	Impact ID
Bio-uptake of disturbed metals/toxins (including asbestos, lead, etc.) by vegetation, crops, native fauna, stock impact health of environment	Construction, Operation, Closure, Post-closure	Metals/toxins from mine site	Ingestion or absorption of airborne emissions	Vegetation, native fauna, stock	No (not caused by project)	PIE_19_01
Dust deposition from mining activities negatively impacts on the health of native vegetation	Construction, Operation, Closure	Dust generating from construction, operation and closure activities	Deposition of airborne dust	Native vegetation	Yes	PIE_19_02
Poor stockpiling of topsoils has the potential to degrade soil quality and seedbanks, resulting in poor revegetation or regeneration success, impacting on potential ecological values	Operation, Closure, Post-closure	Stockpiling procedure	Physical and chemical changes that affect seed viability	Post mining land use	Yes	PIE_19_03

Potentially Impacting Events	Mine Life Phase	Source	Potential Pathway	Sensitive Receptors	Confirmation of S-P-R	Impact ID
Revegetation success on ML reduced as a result of inappropriate soils used to construct landscape and amenity bunds and IML	Construction, Operation, Closure, Post-closure	Particle size distribution of clays	Soil characteristics	Post mining land use	Yes	PIE_19_04
Earthworks and reshaping of natural surfaces has the potential to change surface water flow and impact on surrounding native vegetation	Construction, Operation, Closure, Post-closure	Earthworks and reshaping of natural surface	Alteration of surface water flows	Native vegetation on and off mining lease	No	PIE_19_05
Erosion (wind and water) of exposed topsoil reduces quality of land for revegetation and rehabilitation impacting potential ecological values	Construction, Operation, Closure	Erosion of exposed soils and stockpiles	Air and overland flow	Post mining land use	Yes	PIE_19_06
Mining activities (establishment of roads, foundations and hardstand areas) have the potential to compact soils reducing productivity and/or vegetation growth	Operation, Closure, Post-closure	Establishment of roads, foundations and hardstand areas	Soil compaction	Post mining land use	Yes	PIE_19_07
Mine water management (extraction) will reduce the groundwater level and has the potential to impact on Vegetation Heritage Area	Operation, Closure, Post-closure	Extraction of groundwater	Groundwater depression	Vegetation Heritage Agreement Area	Uncertain	PIE_19_08

Potentially Impacting Events	Mine Life Phase	Source	Potential Pathway	Sensitive Receptors	Confirmation of S-P-R	Impact ID
Mining operation activities have the potential to cause fires that result in loss of native vegetation within ML and Vegetation Heritage Agreement area	Construction, Operation, Closure	Fire caused by mining operations	Consumption of vegetation as fuel for uncontrolled fire	Native vegetation	Yes	PIE_19_09
Fuel and chemical spills/leaks have the potential to contaminate land onsite and impact native vegetation	Construction, Operation	Hydrocarbons and chemicals stored / used on Mining Lease	Uncontrolled releases (spills, leaks etc.)	Native vegetation	No	PIE_19_10
Land quality reduced on-lease as a consequence of microclimatic changes adjacent IML (wind, shade)	Operation, Closure, Post-closure	Integrated Mullock Landform	Microclimatic changes	Post mining land use	No	PIE_19_11
Landform design fails to provide adequate moisture retention impacting quality of revegetation and rehabilitation and potential ecological values	Operation, Closure, Post-closure	Low moisture retention due to landform cover design	Failure of revegetation	Post mining land use	No	PIE_19_12
Unauthorised off-road vehicle use has the potential to impact on native vegetation	Construction, Operation, Closure	Off-road vehicle use	Direct disturbance	Native vegetation	No	PIE_19_13
Poor species selection for revegetation or rehabilitation of ML causes loss of planted species and impacts potential for ecological values	Closure, post-closure	Poor species/community selection	Failure of revegetation	Post mining land use	No	PIE_19_14

Potentially Impacting Events	Mine Life Phase	Source	Potential Pathway	Sensitive Receptors	Confirmation of S-P-R	Impact ID
Seasonal climatic conditions (e.g. frosts, draughts, flooding, wind storms) have the potential to impact revegetation success on ML and potential ecological values	Operation, Closure, Post-closure	Seasonal climatic conditions	Environmental stress on vegetation development	Post mining land use	No	PIE_19_15
Clearance of vegetation results in loss of conservation significant flora species and communities	Construction	Vegetation clearance	Vegetation clearance	Native flora (conservation significant)	No	PIE_19_16
Clearance of vegetation results in loss of locally indigenous flora species and communities	Construction	Vegetation clearance	Vegetation clearance	Native flora (locally indigenous)	No	PIE_19_17
Introduction and establishment of new invasive species has the potential to impact on native vegetation	Construction, Operation, Closure	Invasive species	Introduced to site from offsite vehicle and human traffic movements	Native vegetation	Yes	PIE_19_18
Clearance of vegetation results in unauthorised clearance of significant trees	Construction	Vegetation clearance	Unauthorised clearance	Native vegetation (significant trees)	No	PIE_19_19

19.6 CONTROL MEASURES TO PROTECT VEGETATION

This section identified design measures and management strategies which will be implemented to mitigate the level of impact, likelihood or occurrence and thus the risk associated with native vegetation, such that is it considered as low as reasonably practical (ALARP).

19.6.1 DESIGN MEASURES

The primary design measures to reduce the impact associated with native vegetation, and minimise the direct and indirect consequences to native vegetation as a result of the Project activities through construction, operation and closure include:

- As small as reasonably practical operating footprint

    - No processing facility or tailings facility located onsite
    - Integrated Mullock Landform reduced considerably due to proposed location and shape (cut into hillside landform)
    - Operating area requires no clearance of native vegetation owing to previous agricultural clearance
    - No clearance of significant trees (Figure 19-9)
    - Limited clearance of agroforestry trees (0.24 Ha of the 5.43 Ha planted) (Figure 19-9)
- Site design includes revegetation 30m buffer zones around the existing remnant vegetation, of which a portion is protected under a Native Vegetation Heritage Agreement area (Figure 19-9)
- Stormwater design does not alter surface water flow volumes entering the subcatchment, thus not altering the water available for downstream riparian vegetation
- Groundwater management system in place including Managed Aquifer Recharge system to limit groundwater drawdown around Native Vegetation Heritage Agreement area, this ensures existing over story trees continue to have access to a water source
- Topsoil placement included in design of landscape and amenity bunding, and then in during rehabilitation, as well as irrigation and hare fencing to reduce potential for revegetation failure
- Species selection has been entirely chosen based on local endemic species to maximise vegetation success on local soil and climatic conditions
- Dust design measures as per Chapter 15 to minimise potential impacts to vegetation habitat (dust impacts)
- MAR bores indicatively located in cleared areas
- MAR pipelines indicatively located along fence lines, in cleared areas, in consultation with landholders.

Key design measures that are proposed for this Project are included in Table 19-8 below.

FIGURE 19-9 | LOCATION OF AGROFORESTRY TREES AND PROPOSED HARVEST (LEFT) AND BUFFER ZONES

TABLE 19-8 | DESIGN MEASURES: VEGETATION, WEEDS AND PLANT PATHOGENS

Design Measures	Impact ID
Site design includes buffer zones of endemic native vegetation of 30m around remnant vegetation located in Figure 19-5 (Vegetation Heritage Agreement Area)	PIE_19_02
Site design includes buffer zones of endemic native vegetation of 30m around riparian zones (excluding constructed culvert over drainage line)	PIE_19_02 PIE_19_10
No clearance of native vegetation including significant trees	PIE_19_16 PIE_19_17 PIE_19_19
Limited clearance of agroforestry trees	PIE_19_16 PIE_19_17 PIE_19_19
Fire access tracks and fire breaks incorporated into site design	PIE_19_09
Topsoil to be used on landscape and amenity bunding prior to revegetation	PIE_19_03 PIE_19_04
Topsoil to be used on rehabilitated landforms through the closure earthworks phase	PIE_19_03 PIE_19_04
Bunding and storage of hazardous chemicals as per AS standards	PIE_19_10
Stormwater management and water treatment limits or removes potential for contaminated surface water to leave site – EP Act (Water Quality) Policy	PIE_19_10
Erosion control strategies (erosion slope modelling for constructed landforms excl. IML)	PIE_19_06
Topsoil stockpile height designed to limit compaction	PIE_19_03 PIE_19_04
Managed Aquifer Recharge system – maintain water levels in NVHA	PIE_19_08
Pre-Excavation Grouting – maintain water levels in NVHA	PIE_19_08
Endemic vegetation chosen which will grow in local soil types	PIE_19_04 PIE_19_14 PIE_19_15
Irrigation system on landscape bunding to establish vegetation if required	PIE_19_04 PIE_19_14 PIE_19_15
Revegetation area fenced to guard against grazing pressure	PIE_19_04 PIE_19_14 PIE_19_15

19.6.2 MANAGEMENT STRATEGIES

In order to minimise and mitigate impacts to native vegetation, and decrease the potential of both the abundance and spread of weeds and plant pathogens during construction, operation and closure, the following management strategies would be incorporated into the PEPR and implemented at the appropriate Project junctures. Key management strategies are included in Table 19-9.

Management strategies are grouped thematically around aspects including fire, soil, air quality, and weeds and plant pathogens, however, overarchingly, Landscape Function Analysis (LFA) will enable active, adaptive land management based upon the prior year's results. LFA uses simple indictors to assess how well an ecosystem works as a biochemical system, and is able to identify deficiencies in revegetation, including erosion features, to allow alternative management practices to be implemented.

A Phytopthora and Phylloxera Management Plan has been implemented as a precaution due to the sensitive location of the Project and the community expectation that Terramin will not contribute to a

viticultural industry problem, as well as the detriment both of these pathogens have the potential to cause to the Native Vegetation Heritage Agreement area, which is the location of all identified listed species.

An incident register of any new declared weeds or pests identified by site personnel and also an additional incident register is to be maintained of any unauthorised vegetation clearances on site. The registers will be reviewed monthly and results will be presented in monthly site management reports prepared by the Mine Manager. The review will include the identification of any procedural changes required.

Annual review of safety systems and maintenance of fire breaks will be undertaken to show that these were maintained and demonstrates that Terramin did not cause, or could not have reasonably prevented, the deaths or injuries occurring.

All air quality management strategies are included in Chapter 15.

TABLE 19-9 | CONTROL AND MANAGEMENT STRATEGIES: VEGETATION, WEEDS AND PLANT PATHOGENS

Management Strategies	Impact ID
Landscape Function Analysis allows active adaptive management of vegetation	PIE_19_01-19
Bushland Condition Monitoring on control sites to track vegetation health	
Biodiversity Management Plan (includes orchid propagation option)	
Native Vegetation Heritage application for remnant vegetation implemented post-closure	PIE_19_01 PIE_19_03 PIE_19_04 PIE_19_05 PIE_19_07 PIE_19_08 PIE_19_11 PIE_19_12 PIE_19_14 PIE_19_15
Fire	
Equipment maintenance schedule to reduce fire risk associated with equipment	PIE_19_09
Fire suppression equipment located within all LVs and HVs and at points onsite	PIE_19_09
Fire hydrants and tanks located onsite	PIE_19_09
Dig/land disturbance permits to be signed off by Environment Superintendent	PIE_19_09
Hot Work Permits to reduce bushfire risk	PIE_19_09
Fuel reduction strategies included in the Biodiversity Management Plan	PIE_19_09
Site based water truck for rapid response	PIE_19_09
Training of personnel for emergency situations including bushfire	PIE_19_09
Emergency Response Plan	PIE_19_09
Soil	
Spray seeding of landscape and amenity bunds with native grass to reduce dust and erosion	PIE_19_03 PIE_19_04
Implementation of Soil Contamination Management Plan	
Erosion control strategies (erosion logs and silt fencing through construction, establishment of WSUD swales through natural drainage lines)	PIE_19_06
Topsoil management plan to control topsoil placement and avoid compaction through operations. Includes annual testwork for anions and cations.	PIE_19_03 PIE_19_04
Seeding of stockpiles to reduce erosion and dust potential	PIE_19_06

Management Strategies	Impact ID
Waste management plans including spill response plans, clean up kits, etc.	PIE_19_10
Deep ripping of soil prior to revegetation/rehabilitation	PIE_19_04 PIE_19_14
Air quality (dust)	
Air quality Management Plan (dust control) and TARP	PIE_19_02
Weeds and plant pathogens	
Weed and Pest Management Plan – prevent spread and/or increase of weeds and pests within the operational area of the ML (Goldwyn), based on active adaptive management of weeds and pests	PIE_19_18
Phytophthora and Phylloxera Management Plan, including hygiene SWP's for all vehicles	PIE_19_18

19.7 POTENTIAL BENEFITS

19.7.1 VOLUNTARY, NON-CORE ENVIRONMENTAL BENEFITS ASSOCIATED WITH THE PROPOSAL

Improvements in environmental condition of local existing agricultural land located within Goldwyn are planned. Terramin purchased this property in 2015, at that time it had poor productivity, being extensively overgrazed and experiencing obvious soil loss through sheet and gully water erosion. Grazing pressure has subsequently been reduced across the property and gully erosion remediation is included in the land management planning, which includes installing bunds, contour lines, rip-rap rockwork and where required sediment traps. Trials of regenerating the property with perennial native grass, to increase soil surface basal cover will reduced soil loss by erosion over time. A benefit of native grass providing a seed source that may colonise and spread throughout the sub-catchment.

Land management actions that benefit riparian zones – it is expected ecological health improvements will occur by implementing modern land management practices, e.g. excluding grazing animals from creek, weed control, erosion remediation, and revegetation with endemic riparian plants. Riparian zones have been fenced from feral herbivores (hares, rabbits), revegetated with native wetland plants and a program of erosion gully remediation is planned. Local water quality improvements are expected to occur from this work and this means that some downstream improvements to the Inverbrackie creek water quality may occur in time. Paddock soil health and increased basal cover from the reduced cattle grazing pressure and native grass introduction will result in reduced surface water turbidity inputs to the riparian zone from the paddock areas.

Biodiversity resilience for the region – the long term viability of many species in the Mount Lofty Ranges is under threat (Szabo, 2011), this is particularly true for woodland birds and flora species, particularly populations isolated in remnant patches, like those in the Native Vegetation Heritage Agreement area near Reefton road within the proposed Mining lease area. The ongoing voluntary revegetation program at Goldwyn will expand the native vegetation patch by 10.5 Ha, to approximately 22 Ha with endemic native species. Benefits include connecting heritage paddock trees and remnant vegetation with vegetation corridors and creating further linking vegetation corridors to neighbouring properties. Vegetation buffer zones installed around the government mapped riparian zones on the property will also lead to benefits in riparian habitat health, as opposed to previous practices of grazing riparian areas resulting in soil compaction, low vegetation coverage and erosion. Carbon sequestration by the revegetation undertaken by Terramin will occur.

Native fauna habitat, such as tree hollows can take 100 years to evolve in vegetation plantings, therefore to increase the biodiversity value it is useful to install nest boxes targeting certain species.

Terramin has installed over 50 nestboxes amongst the revegetated areas to increase harbor for woodland birds and mammals.

The mining proposal has increased attention on rare orchid populations and this attention has influenced government bodies to increase partnership networks leading to positive outcomes. Perennial native grasses have been reintroduced at Goldwyn, which both reduces bushfire fuel loads and increases food diversity/availability for woodland birds. Increases in woodland habitat will benefit (lower) the local long term extinction probability rates.

Part of the economic assessment of the region and the projects impact assessment includes incorporating feedback from community members. Some of the feedback revolves around how the community is currently changing, with land holdings being subdivided and land values increasing. It can be seen that property sale prices are not able to be paid back using agricultural methods (the % of profitable annual payback per Ha) such as cattle grazing; hence property in the region, if brought at market value and environmental values are to be maintained, is only suitable as a lifestyle, high value boutique business, or industrial property. This means if one is seeking to purchase land at market value and pay off using traditional agriculture business methods there is a risk of impacting environmental values by overutilization in the hope of maximising incomes. This is what appears to have occurred at Goldwyn prior to 2015 and the property is now an example of changing landuse resulting in environmental benefits. At the paddock scale the use of Goldwyn as a basis of an underground mine will, and has already, resulted in improved biodiversity values (due to changed grazing practices and revegetation) as there is no pressure to use traditional agriculture to pay off the capital cost of purchase. Surface water and ecosystem health values are expected to increase over time as a result and these values will be monitored.

19.7.1.1 ACQUISITION OF NEW BASELINE DATA

Groundwater levels and quality in the bores in the catchment, surface water quality and flow data, air quality, native vegetation health, recording of observed existing impact activities in the catchment, e.g. landfill solute, winery effluent, stock waste, lead, copper, arsenic and other metals occurring in water, analytes in dust and localized soil contamination, etc. have been documented since early 2014.

19.7.1.2 ENVIRONMENTAL BENEFITS OVER AND ABOVE REHABILITATION ACTIVITIES TO BE PAID OR MADE IN ASSOCIATION WITH NATIVE VEGETATION CLEARANCE

No Significant Environmental Benefit (SEB) payment is to be made in accordance with the Native Vegetation Regulations 2017 as no native vegetation as defined by the *Native Vegetation Act 1991* is to be cleared.

19.8 IMPACT ASSESSMENT

Owing to the selected site design, potential vegetation impacts are largely limited to the potential for native vegetation clearance and limited by the buffer zones installed around both the remnant vegetation block (which hosts the Native Vegetation Heritage Agreement Area) and the riparian zone around the drainage line which runs through the property, excluding the culvert which needs to be constructed to gain access to the operational area.

Overall, Terramin do not expect any perceptible impact to the native vegetation heritage agreement area, largely due to the location of the vent rise, the landscaped amenity bunds, the air quality, weed and pest and phytopthora and phylloxera management plans and the 30m vegetation and riparian buffer zones which bound the eastern side of the operational area of Goldwyn.

Terramin will continue to implement and report on Landscape Function Analysis as the primary means of monitoring vegetation health within the native vegetation heritage agreement area, and also within Terramin's revegetated areas within Goldwyn, as well as document and report records of vegetation clearance and annual photo monitoring to demonstrate no unauthorised clearance has occurred.

19.8.1 Groundwater levels (replicated in Chapter 10 Groundwater)

Golder Associates was engaged by Terramin to assess if the groundwater impacts of the proposed BIHGP had the potential to pose an adverse risk to nearby native vegetation and associated biodiversity values. This report is included in Appendix R5.

A key element of this assessment was to establish whether the NVHA represent a groundwater dependant ecosystem (that requires access to groundwater) and whether the structure and function this ecosystem could change if groundwater levels were lowered as a result of groundwater inflows to the proposed underground mine.

To mitigate against the groundwater related impacts, the Project proposes to grout ahead of mine development to limit groundwater inflows, followed by the reinjection of any groundwater inflows back into the aquifer via Managed Aquifer Recharge (MAR). This technique would maintain groundwater levels around the proposed mining area and ensure a 'no net groundwater abstraction' approach.

The work undertaken represents an extension to the Groundwater Assessment discussed in Chapter 10 and included in Appendix H1.

The objectives of the groundwater NVHA assessment were to:

- Document the existing groundwater environment specific to the NVHA area and in particular establish the groundwater elevation beneath the NVHA area;
- Based on expected root depth of the identified species in the NVHA area and depth to groundwater, establish whether the NVHA is likely to access groundwater (i.e. whether the aquifer is beyond the reach of root system);
- Using the existing numerical groundwater model, present predictive simulations of groundwater level response to mining operations beneath the NVHA area; and
- Based on the above, determine whether the Project poses a risk to the health of the NVHA area by changing groundwater levels.

The drilling logs of investigation bores near the southern border of NVHA (detailed within AGT, 2017) revealed that the first groundwater cut in the Fractured Rock Aquifer (FRA) was typically encountered at depths of around 120 m bgl (325 m AHD), with moisture noted at 55 m bgl (390 m AHD) in one investigation bore. Above this depth, the overlying strata (fine grained Tarcowie Siltstone) was very 'tight' and exhibited very low primary and secondary porosity.

At all investigation bores, the groundwater elevation (piezometric head) was higher than the first water cut and was reported at an elevation of 410 m AHD or 40 m bgl (AGT, 2017).

Contours showing current/pre-mining depth to groundwater are presented in Figure 5. This was produced by subtracting the groundwater elevation (410 m AHD) from ground surface elevation.

Figure 4 shows that approximately 90% of the NVHA area has a depth to water of 20 to 60 m bgl, and the remaining 10% of the area has a depth to water of about 15 m bgl. The area of shallowest depth to water (15 m bgl) is associated with a gully in the north-west corner of the NVHA area. A deep weathered (clay) zone underlies this area.

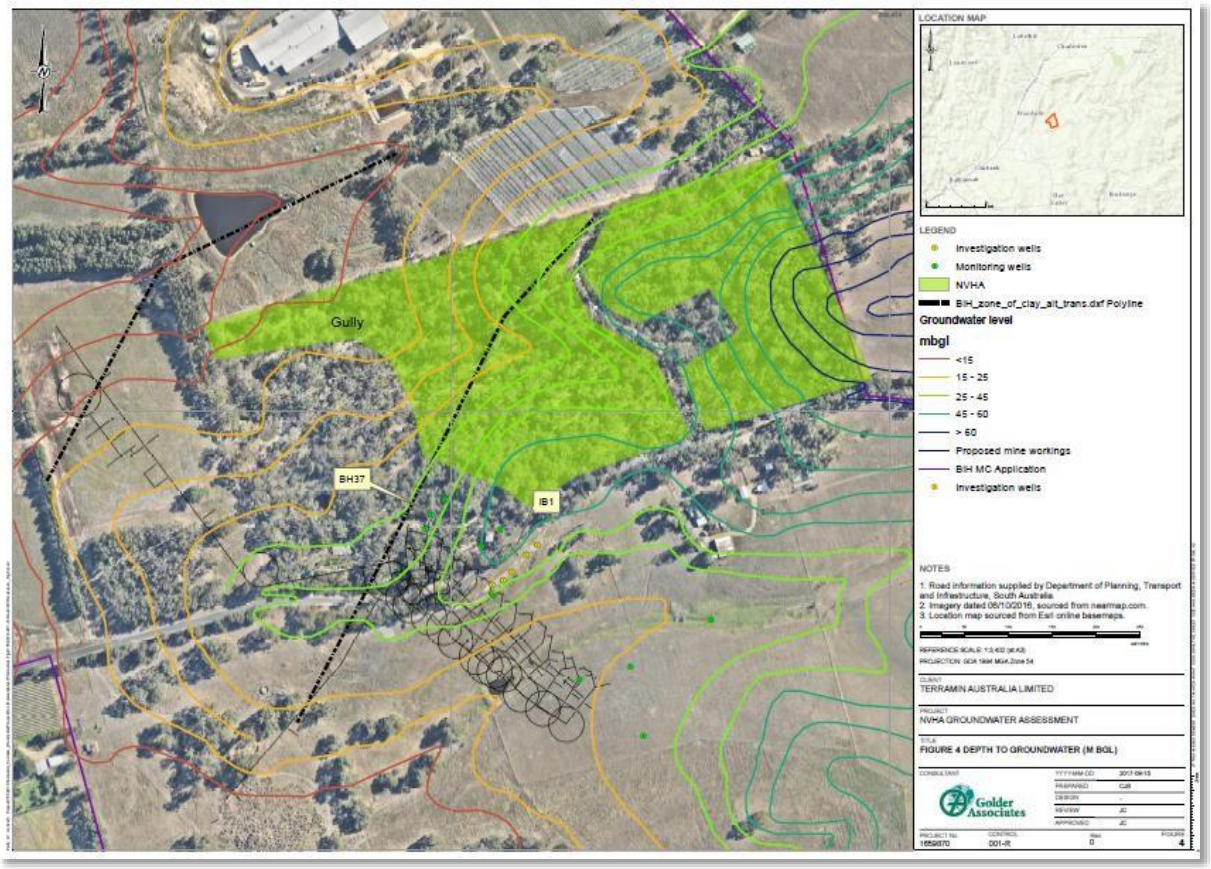

FIGURE 19-10 | GROUNDWATER ELEVATION - METRES BELOW GROUND LEVEL (GOLDER ASSOCIATES, APPENDIX R5)

Based on the depth to groundwater (15 to 60 m bgl), there is a low probability that vegetation within in the NVHA area can access or rely on groundwater supplies. One exploration hole revealed evidence of tree roots to a depth of 6 m (E. Whittaker, pers comm 2017). It is possible some of the trees on site may have deeper root systems or taproots, however this is an exception rather than the rule when it comes to tree root development (Australian Standard 4970-2009). A limiting factor for the growth of roots is gas exchange and therefore most plants are shallow rooted with the majority of roots occurring within the top 600 mm of the soil profile. Tree root systems are classed into three different parts: structural woody roots, second order roots and non-woody roots. Studies show that Blue gums (*E. leucoxylon*) are unlikely to access groundwater, particularly if clay layers are present (CSIRO, 2005). It is the non-woody roots that absorb water from the environment for plant function, and there is a low probability that these roots will occur at the depths required to access groundwater at the site because the depth to groundwater is greater than 15 m. Therefore any change in groundwater levels is unlikely to have a significant impact on the condition of vegetation and associated biodiversity values such as listed flora, including orchids, and avifauna in the project area. This is supported by the continued survival of the suite of sensitive flora and fauna despite the timber harvesting, grazing, development of a small settlement (Reefton Heights), quarrying, mining and dewatering practices that have taken place over the preceding 137 years (See attachment B in Appendix R5 for pictorial records from the SA Department of Mines).

Groundwater on site is shallowest within the ephemeral riparian gully, occurring 15 m below the natural ground level. If vegetation were able to access the groundwater, it is more likely to be in these areas. River Red Gum *(E. camaldulensis)* vegetation communities are commonly associated with watercourses, drainage lines or gullies across southern Australia, so is likely to be the main vegetation association in the lower lying parts of the gully on site, surveying confirms this (Native Vegetation Council, 2011). River Red Gum *(E. camaldulensis)* communities are adapted for riparian environments, known for having a varying water supply and are tolerant to seasonal and drought related changes in water accessibility.

A new monitoring bore installed during 2018 as part of the MAR trial (stage 1 and 2 completed prior to the submission of this MLA) confirmed the groundwater level in the eastern section of the native vegetation to be 81 m below ground level and of very low permeability (that is, less than 1.6 L/s). This confirms the hypothesis from Golder Associates (Appendix R5) that the vegetation is unlikely to be accessing groundwater due to both depth to water and permeability and any change in groundwater levels is unlikely to have impact on the vegetation and associated biodiversity values.

More information on the stage 1 and 2 of the MAR trial, including monitoring bore construction details is included in Appendix H8.

19.8.1.1 GROUNDWATER MODELLING

The process of mining reduces groundwater levels in the surrounding FRA. In FRA this is referred to as the zone of depressurisation (or drawdown) and the level of impact reduces with distance from the underground mine. Terramin propose to grout mine workings in order to reduce groundwater inflow and reinject remaining groundwater inflows back into the FRA in a radial pattern around the mine to constrain the extent of depressurisation.

Numerical groundwater modelling was undertaken by AGT (2017) to simulate the effects of the proposed underground mining operation on groundwater levels. Minor updates were made to the existing model in the area of the NVHA and an addition model simulation was undertaken by Golder Associates (2017) to predict groundwater level response to mining beneath the NVHA area. Model updates included refinement of the extent of weathering beneath the NVHA, which was encountered during the latest geotechnical drilling program undertaken in 2016 by Terramin (see dashed lines on Figure 2).

The results of the model simulation are presented in Figure 19-11 (cone of drawdown at the end of the proposed mine life) and Figure 19-12 (predictive hydrograph near the gully area). Modelling results showed:

- The extent of the cone of drawdown is constrained by the location of individual MAR bores and the zone of weathering. Groundwater drawdowns of 10 to 20 m may occur beneath the topographic high / eastern portion of the NVHA area where current groundwater levels are deeper than 45 m bgl.
- Groundwater levels beneath the gully area are expected to remain stable owing to the presence of a clay aquitard which underlies this area and MAR (Figure 19-11).

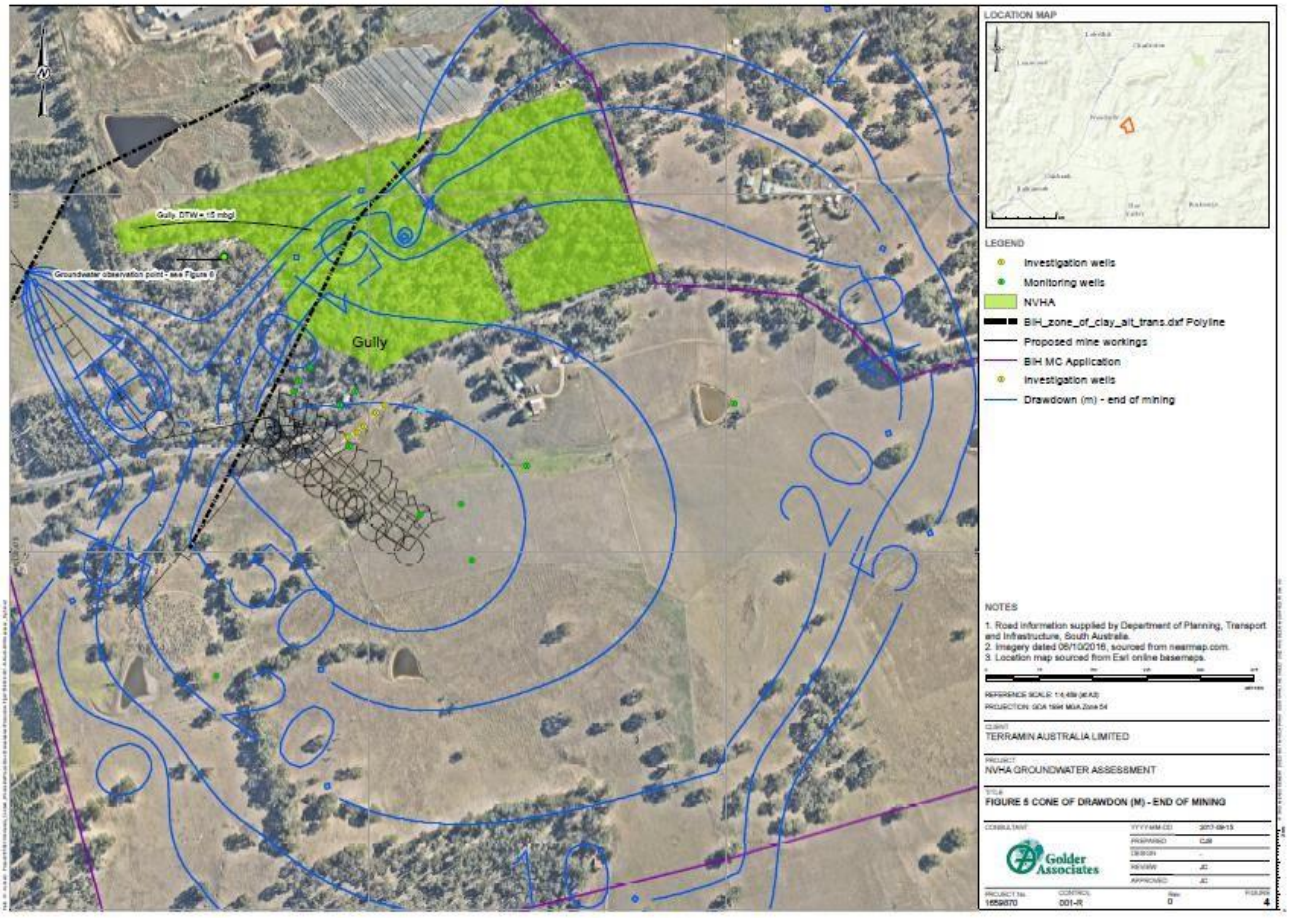

FIGURE 19-11 | GROUNDWATER DRAWDOWN (END OF MINE LIFE)

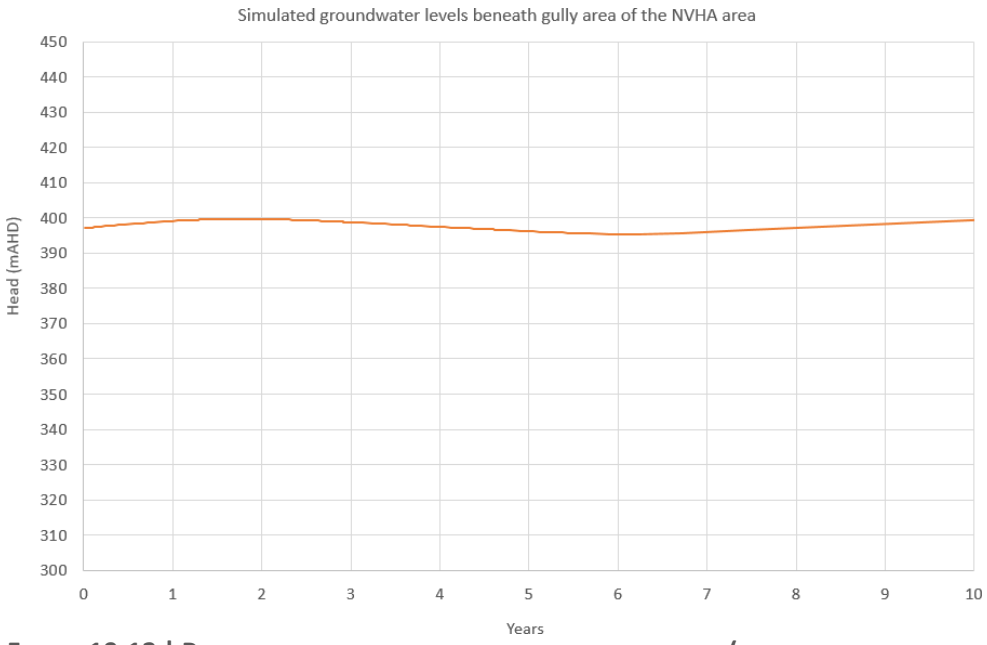

FIGURE 19-12 | PREDICTIVE HYDROGRAPH BENEATH THE GULLY AREA (MINE LIFE CORRESPONDS TO YEAR 0 TO 5.5. SEE FIGURE ABOVE FOR LOCATION

19.8.1.2 GROUNDWATER LEVELS CONCLUSION

Important conclusions of this assessment include:

- A regional fractured rock aquifer system underlies the NVHA area and surrounding catchment. The groundwater elevation beneath the NVHA area is at least 15 m bgl, with 90% of the NVHA area reporting groundwater levels of between 20 m and 60 m bgl. This hypothesis was confirmed in the drilling of a monitoring bore during 2018.
- Based on the expected root depth of identified species within the NVHA area (*E. leucoxylon* and *E. camaldulensis*), there is a **low probability** that vegetation within in the NVHA area accesses groundwater from the FRA system.
- Groundwater is shallowest within a gully, occurring 15 m below the natural ground level. This accounts for 10% of the total NVHA area. This area is most likely to be associated with River Red Gum vegetation communities are commonly associated with watercourses, drainage lines or gullies across southern Australia. River Red Gum communities are adapted to riparian environments, known for having a varying water supply and are hence tolerant to changes in water availability. Therefore any change in groundwater levels is unlikely to have a significant impact on the condition of the Red Gum (*E. camaldulensis*) community and have no impact on the Blue Gum communities (*E. leucoxylon*). The majority of the listed flora species appear to be found within the Blue gum communities (COOE, 2016). Given this, no impact to ecosystem health and habitat condition for the listed flora and fauna can be expected.
- Notwithstanding the above, current groundwater levels beneath the gully area are expected to be maintained during the mining operation, owing to MAR and the presence of a deep clay aquitard which behaves as a hydraulic barrier (limiting the cone of drawdown emanating from the proposed mine). This further reduces the risk of the NVHA area being impacted by the Project.
- The lowering of groundwater levels outside of the gully area is unlikely to pose an adverse risk to the vegetation within the NHVA area as current groundwater levels (20 to 60 m bgl) are several meters (tens of meters) beyond the reach of the root system.
- Any bores and infrastructure needed for MAR should be located along disturbed areas (existing roads and tracks).

Overall, Terramin expect the impact of groundwater levels below the NVHA to be either not a credible receptor or **negligible** based on the aforementioned information.

19.8.2 Fire

Owing to the potentially unpredictable nature of bushfire, the consequence of a bushfire which destroys the native vegetation heritage agreement area is considered major, however, the most credible worst case likelihood of the fire originating onsite (the operating area of the ML) is considered rare. Management strategies are imperative in preventing fire risk, however, design measures are in place for rapid response in the unlikely event of fire. These design measures include fire hydrants and extinguishers, the water truck onsite, and operational fire suppressant systems. The training of personnel for emergency response would also be implemented.

19.8.3 Soil and Air Quality

Impacts and management of soil and air quality have been discussed in their respective chapters (Chapter 15: Air Quality and Chapter 12: Land and Soil Quality).

The air quality management plan will ensure that the dust generation and any subsequent deposition into the NVHA area will not be above baseline conditions and hence plant community fecundity and photosynthesis processes will remain unchanged from baseline conditions.

The impact assessment also considers risks associated with hazardous chemicals and hydrocarbon spills. A waste management plan including spill response plans and clean up kits is currently in place onsite and will continue to be employed throughout the life of the Project.

No drainage lines from Goldwyn flow towards the native vegetation heritage agreement area, preventing a contaminated sedimentation impact from onsite.

19.8.4 Weeds and plant pathogens

Currently, there is a Land Management Plan in place onsite to reduce the risk of increased abundance and prevent spread and/or increase of weeds and pests within the operational area of the ML (Goldwyn), based on active adaptive management of weeds and pests

An extended weed and pest management plan would be developed through the PEPR stage which would include specific transects within the 30m vegetation buffer which exists between the operational area and the native vegetation, as well as control transects within the native vegetation heritage agreement area.

Whilst the potential for the introduction of phytophthora and/ phylloxera was limited, the likelihood has been reduced further with the implementation of the Phytophthora and Phylloxera Management Plan which is currently in place and will remain in place throughout the life of mine. Terramin propose that VineHealth Australia would review this Phytophthora and Phylloxera Management Plan through the PEPR development.

19.9 DRAFT OUTCOME(S) AND MEASUREMENT CRITERIA

In accordance with the methodology presented in Chapter 6, an outcome has been developed for vegetation and weed impact events with a confirmed link between a source, pathway and receptor (S-P-R linkage), see Table 19-10.

All outcomes are supported by draft measurement criteria which will be used to assess compliance against the draft outcomes during the relevant phases (construction, operation and closure), and where relevant proposed leading indicator criteria. These measurement criteria and leading indicators are indicative only and will be developed further through the PEPR.

Outcomes regarding air quality, surface water, soil and groundwater are included in their respective chapters.

All Outcomes for the entire project are presented in Appendix D1.

TABLE 19-10 | DRAFT OUTCOMES AND MEASUREMENT CRITERIA

Draft Outcome	Draft Measurement Criteria	Draft Leading Indicator Criteria
Designated rehabilitation sites are established self-sustaining systems.	Annual assessment until Lease surrender, or at a frequency as recommended by an independent and suitably qualified expert (to Chief Inspector of Mining's satisfaction) using Landscape Function Analysis (LFA), until LFA monitoring have achieved, or by trends, may be confidently predicted to reach and pass sustainability thresholds as defined by Landscape Function Analysis (Sustainability thresholds for each parameter are interpreted as the points of maximum curvature on the sigmoidal curve shape as per Tongway and Hindley (2005).	Evidence of establishment of native plant species on designated rehabilitation areas 12 months after progressive rehabilitation

Draft Outcome	Draft Measurement Criteria	Draft Leading Indicator Criteria
No permanent loss of abundance, condition or diversity of native vegetation (as defined by Native Vegetation Act 1991) on or off the lease caused by mining activities through; - Clearance - dust/contamination depositions - fire - reduction in water supply, or - other damage unless otherwise approved under Native Vegetation Act 1991 and Native Vegetation Regulations 2017 is obtained	Annual assessment until Lease surrender, or at a frequency as recommended by a suitably qualified and experienced independent party of native vegetation abundance, condition and diversity measured through standardised flora monitoring techniques (e.g. quadrats and/or transects such as Bushland Condition Monitoring) at permanent flora monitoring sites demonstrates no permanent loss of abundance or diversity of native flora species or communities due to mining operations, when compared to baseline flora surveys conducted prior to the commencement of operations. Annual assessment of native vegetation clearance, measured using a combination of GIS software, ground surveys and/or aerial surveys of the operational areas demonstrates that the total clearance area does not exceed the approved clearance. Records are to be kept of vegetation clearance approvals.	None proposed
	Monthly dust deposition and TSP monitoring using standardised monitoring techniques at nominated sites[1], demonstrates that annual average dust deposition including background dust deposition does not exceed 4 g/m^2/month and that annual average TSP concentration does not exceed 90 ug/m^3. If these levels are obtained for 12 months post-closure, monitoring will no long be required.	Monthly dust deposition from mining activities not to exceed 4 g/m^2/month onsite. TSP concentrations do not exceed 120 ug/m^3 (24 hour).
No introduction of new species of declared weeds, plant pathogens or pests (including feral animals), nor sustained increase in abundance of existing declared weed or pest species on the mining lease caused by mining activities	Survey demonstrates: - no new species of declared weeds or feral animals have become established on the lease - there has not been a statistically significant increase in abundance of existing weed or pest species in the Project area (Project site), compared to baseline studies and accounting for seasonal variation (regional trends).	

[1] Monitoring locations to be determined by the air quality model and by an independent suitably qualified and experienced expert through the PEPR development

19.10 FINDINGS AND CONCLUSIONS

Overall, with the proposed design measures and management strategies proposed, as well as the additional revegetation plantings, it is expected there will be negligible to no impact on the native vegetation present in the surrounding remnant native vegetation, including the NVHA area. Impacts are mitigated through the use of design measures which reduce the occurrence of dust and noise, and, however unlikely that the groundwater levels will impact the NVHA area, the proposed Managed Aquifer Recharge system is able to negate further the potential for groundwater level drawdown around the areas where sensitive receptors occur. Management measures regarding weeds and land management reduce the risk of the introduction of plant and soil borne disease, and are proposed to control the spread of weeds onsite which have the potential to impact the NVHA area. Overall, a combination of management and mitigation strategies works to reduce the risks associated with vegetation and weeds to as low as is reasonably practical and Terramin expect an overall negligible impact.