Groundwater Dependent Vegetation Assessment

Talison Lithium - New Water Storage

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1.0 INTRODUCTION

1.1 Preamble

The Greenbushes Mine is a large mining operation located in south-west Western Australia (Figure 1) extracting lithium and tantalum products from a pegmatite orebody. It is the longest continuously operated mine in Western Australia, and one of the largest known spodumene pegmatite resources in the world. Talison Lithium Australia Pty Ltd (Talison) holds a 100% interest in 10,067 hectares (ha) of mineral tenements which cover the Greenbushes Mine and surrounding exploration areas.

Owing to increased world-wide demand for lithium driven by the battery electric vehicle market, Talison is continuing to expand the current mining operations. This will involve an increase in the area of in-pit mining and associated processing infrastructure. The requirement for in-pit dewatering to allow excavation in dry and stable conditions below the natural groundwater level will likely result in a cone of drawdown (CoD) extending around the pit.

Onshore Environmental Consultants Pty Ltd (Onshore Environmental) was commissioned by Talison to provide advice on groundwater dependency of native vegetation at the Greenbushes mining operation. The review was informed by numerous baseline flora and vegetation surveys and associated fine scale vegetation type mapping completed by Onshore Environmental between 2012 and 2024 (Onshore Environmental 2012, 2018, 2019a, 2019b, 2020, 2021, 2022a-2022e, 2023a-2023d, 2024), combined with hydrogeological models provided by GHD (2024).

1.2 Objective

The broad objective was to undertake an assessment of groundwater dependent vegetation within the footprint supporting the proposed new water dam and downstream areas of Salt Water Gully, to provide an understanding of the *in situ* presence, distribution and relative groundwater reliance of vegetation, and potential implication of change in water availability.

The groundwater dependent vegetation assessment addressed the following items:

1. Undertake a review of the available flora and vegetation data across the study area and surrounds to determine to presence of groundwater dependent vegetation based on a risk ranking linked to groundwater dependence for keystone indicator species; and
2. Undertake an assessment of the potential impacts on groundwater dependent vegetation (based on fine-scale vegetation type mapping) based on any hydrological modelling made available.

2.0 BACKGROUND

2.1 Climate

The Greenbushes region has a Mediterranean climate experiencing warm dry summers and cool wet winters. The long term average annual rainfall is 923 mm (range 472 mm to 1,306 mm), with the highest monthly totals recorded from May to August (BOM 2024). The last 30 years have seen an increasingly dry climate, with the annual averages reducing to 845 mm for the 30-year period between 1988 to 2017. The last ten years' average (756 mm) is approximately 18% less than the long-term average.

2.2 Surface Water

The Greenbushes Mine is located within the Middle Blackwood Surface Water Area, which has the largest catchment in southwest Western Australia approximately 22,000 square kilometres (km^2) (Centre of Excellence in Natural Resource Management 2004). All surface drainage within the mining leases is connected to the Blackwood River, which occurs 3.8 km south of the Mine Development Envelope (MDE) at its closest point. The Blackwood River is registered as a significant Aboriginal site that is protected under the *State Aboriginal Heritage Act 1972.*

The active mining area lies along a topographic ridge which hosts the mineralised pegmatite zone. The ridge diverts surface water west into the Norilup Brook sub-catchment (Cowan Brook) and east into the Hester Brook sub-catchment. Surface drainage follows a general north-to-south direction with the east and west sub-catchments joining south of the mine and flowing into the Blackwood River.

The mine relies on catchment of this surface water within a number of large dams in the western catchment to sustain mining activities; the Clean Water Dam, Austin's Dam, Southampton Dam and Cowen Brook Dam. Water discharges from dams that form part of the mine water circuit, including Cowen Brook Dam and Southampton Dam, are not permitted. The mine infrastructure, processing plants, and tailings storage facilities (TSFs) are also located within the western catchment. Schwenke's Dam and Norilup Dam are outside of the MDE.

The eastern catchment contains Floyd's Waste Rock Landform (WRL) which impacts on natural surface water flows. Discharges are permitted from Floyds Gully (situated to the east and below Floyd's WRL) to Salt Water Gully which flows to Hester Brook and into the Blackwood River. The Hester Brook watercourse has elevated salinity (1,000 to 5,000 µS/cm) (Talison 2020).

Downstream surface water users include privately owned farmland and State Forest 20.

2.3 Groundwater

The Greenbushes Mine is underlain by a lateritic weathered basement of clays ranging between 20 m and 50 m in thickness that has low permeability and supports negligible groundwater flow. The underlying Archean basement rocks are also considered to have low permeability with the exception of secondary permeability within fractured zones. The low permeability is supported by relatively low rates of groundwater ingress into the Cornwall Pit and underground workings (GHD 2019a). As such, groundwater is not available or not utilised extensively in the Greenbushes area.

Paleochannels comprising sand between 2 m and 30 m thickness are incised into the basement rock within the MDE and historically targeted for dredging during alluvial tin mining. The mine process water dams and local wetlands occur along these paleochannels, with a high degree of hydraulic connectivity between surface water and the underlying alluvial material (GHD 2019a). The paleochannels extend beneath the unlined TSFs at the southern extent of the MDE (GHD 2019b).

Given that the mine is located at the highest topographic point in the local landscape, groundwater radiates outwards from the ridge within the weathered and fractured rock where a portion is discharged as baseflow into creek lines.

Groundwater quality is variable across the MDE, influenced predominantly by groundwater recharge from surface water and mineralisation, and potentially influenced by seepage originating from historic dredge mining (GHD 2019a).

2.4 Flora and Vegetation

The results from previous flora and vegetation surveys completed at the Greenbushes Mine are presented in Table 1 and summarised below. The 16 surveys have recorded one Threatened Flora taxon and five Priority flora taxa within a 10 km radius of the study area:

- *Caladenia harringtoniae* (Threatened, Vulnerable);
- *Eucalyptus relicta* (Priority 2);
- *Dillwynia* sp. Capel (P.A. Jurjevich 1771) (Priority 3);
- *Melaleuca viminalis* (Priority 2)[1];
- *Tetratheca parvifolia* (Priority 3); and
- *Acacia semitrullata* (Priority 4).

Two species have been identified as occurring outside of their known distribution (i.e. range extensions):

- **Cyperus involucratus* (80 km southeast of nearest known population); and
- *Hybanthus epacroides* (180 km west of nearest known population).

Vegetation types recorded during the previous surveys are not aligned with any Commonwealth or State listed TECs or DBCA listed PECs, and are regarded as well represented and adequately reserved at the state-wide level.

The previous surveys have typically recorded a high representation of introduced species within the total flora reflecting historical mining activities, heavy logging of hardwood timber and related disturbance of the State Forest precinct around Greenbushes.

2.5 Groundwater Dependency of Vegetation

Previous studies into the dependence of phreatophytic terrestrial, riparian and fringing tree species on various groundwater regimes on the Swan Coastal Plain (Froend and Loomes 2004; Froend, Loomes *et al.* 2004; Froend, Loomes and Zencich 2002; Froend and Zencich 2001), have resulted in the definition of four categories of groundwater depth that support phreatophytic plant species: 0-3 m, 3-6 m, 6-10 m and

[1] Likely introduced through revegetation around the Greenbushes Swimming Pool.

>10 m. For these four categories, the greater the depth to groundwater, the lower the requirement for groundwater and the more tolerant vegetation is to water table decline due to the corresponding increase in alternative water sources (Froend and Zencich 2001). The primary alternative water source is the larger volume of unsaturated zone (with increasing depth) exploitable by the plant's root system. There is a significant reduction in the importance of groundwater to terrestrial vegetation where depth to groundwater exceeds 10 m, with groundwater use thought to be negligible in terms of total plant water use (Froend and Zencich 2001; Department of Water 2008).

Where depth to groundwater is less than 10 m, plant species are assumed to be phreatophytic and to derive at least some water from groundwater throughout the year. As the depth to groundwater decreases, the dependence on groundwater increases, influenced by factors including proximity to groundwater, root system (distribution and depth), and groundwater quality (Zencich *et al.* 2002).

Table 1 Results from flora and vegetation surveys previously completed at the Greenbushes Mine.

Survey	Consultant	Year	Field Survey Date	Flora Statistics	Significant Flora	Introduced (Weed) Taxa
A Flora and Vegetation Survey of Part of the Greenbushes Leases	Trudgen and Morgan	1991	13-14 April 1991	91 plant taxa 35 families 65 genera	None	9 introduced taxa including one Declared Plant listed under the BAM Act; **Rubus anglocandicans* (Blackberry)
Flora and Vegetation Survey Greenbushes Mine Site: Vegetation surrounding south east corner of the TSF	Onshore Environmental Consultants	2006	13th April 2006	135 plant taxa 37 families 97 genera	None	27 introduced taxa including one Declared Plant listed under the BAM Act; **Rubus anglocandicans* (Blackberry)
Flora and Vegetation Survey Greenbushes Mining Leases	Onshore Environmental Consultants	2012	13-21 October 2011	368 plant taxa 73 families 208 genera	*Caladenia harringtoniae* (T); *Tetratheca parvifolia* (P3)	86 introduced taxa including three Declared Plants listed under the BAM Act; **Asparagus asparagoides* (Bridal Creeper), **Galium aparine* (Goosegrass), **Rubus ulmifolius* (Blackberry)
Greenbushes Mining Operations Detailed Flora and Vegetation Survey	Onshore Environmental Consultants	2018	27 February - 2 March and 26 September, 4, 16-18 October 2018	365 plant taxa 63 families 200 genera	*Acacia semitrullata* (P4), **Cyperus involucratus* (range extension)	66 introduced taxa, including three Declared Plants listed under the BAM Act; **Asparagus asparagoides* (Bridal Creeper), **Rubus anglocandicans* (Blackberry) and **Rumex acetosella* (Sorrell)
Greenbushes Infrastructure Corridors Detailed Flora and Vegetation Survey	Onshore Environmental Consultants	2019a	30 July - 6 August and 26-27, 29-30 September, 3-4 and 18 October 2018	280 plant taxa 60 families 157 genera	*Acacia semitrullata* (P4), *Melaleuca viminalis* (P2), *Hybanthus epacroides* (range extension)	45 introduced taxa, including two Declared Plants listed under the BAM Act; **Asparagus asparagoides* (Bridal Creeper) and **Rubus anglocandicans* (Blackberry)
Targeted Flora Survey Greenbushes Lithium Mine	Onshore Environmental Consultants	2019b	19-20 September and 10 October 2019	Not assessed	*Acacia semitrullata* (P4)	Not assessed
Targeted Survey for *Eucalyptus relicta* Greenbushes Lithium Operations	Onshore Environmental Consultants	2020	20-24 July and 5-15 August 2020	Not assessed	*Eucalyptus relicta* (P2)	Not assessed

Survey	Consultant	Year	Field Survey Date	Flora Statistics	Significant Flora	Introduced (Weed) Taxa
Detailed Flora and Vegetation Survey Greenbushes Mine Expansion Area 2 and Area 4	Onshore Environmental Consultants	2021	26 -31 October 2021	272 plant taxa, 60 families and 162 genera	None	49 introduced taxa
Greenbushes Proposed Village - Reconnaissance Flora and Vegetation Survey	Onshore Environmental Consultants	2022a	20 September 2022	Not recorded	None	One Declared Plant listed under the BAM Act; **Rubus ulmifolius* (Blackberry)
Greenbushes Mine Access Road - Reconnaissance Flora and Vegetation Survey	Onshore Environmental Consultants	2022b	19-20 September 2022	Not recorded	None	Three plant taxa were listed as Declared Plants under the BAM Act; **Rubus ulmifolius* (Blackberry), **Asparagus asparagoides* (Bridal Creeper) and **Zantedeschia aethiopica* (Arum Lilly)
Greenbushes Rehabilitation Materials Stockpiles - Reconnaissance Flora and Vegetation Survey	Onshore Environmental Consultants	2022c	21 September 2022	Not recorded	None	One Declared Plant listed under the BAM Act; **Rubus ulmifolius* (Blackberry)
Detailed Flora and Vegetation Survey - New Water Storages	Onshore Environmental Consultants	2023a	1-5 October 2022	236 plant taxa, 55 families and 142 genera	None One species of interest: *Gonocarpus* sp. indet	Four plant taxa listed as Declared Plants under the BAM Act; **Rubus anglocandicans* (Blackberry), **Asparagus asparagoides* (Bridal Creeper), **Zantedeschia aethiopica* (Arum Lilly) and **Galium aparine* (Cleavers)
Detailed Flora and Vegetation Survey - Floyd's Waste Rock Landform Extension	Onshore Environmental Consultants	2023b	26-30 September 2022	132 plant taxa, 45 families and 102 genera	None	14 introduced species (none listed as Declared Plants under the BAM Act
Additional Areas at Water Storages Reconnaissance Flora and Vegetation Survey	Onshore Environmental Consultants	2023c	7-8 and 15-16 December 2022	Not recorded	*Acacia semitrullata* (P4)	Not recorded
Targeted Flora Survey New Zealand Gully	Onshore Environmental Consultants	2023d	5-9 September 2023	Not recorded	*Caladenia validinervia* (P1), *Dillwynia* sp. Capel (P.A. Jurjevich 1771) (P3).	Not recorded

Survey	Consultant	Year	Field Survey Date	Flora Statistics	Significant Flora	Introduced (Weed) Taxa
Detailed Flora and Vegetation Survey Additional Areas North	Onshore Environmental Consultants	2024	15-23 November 2023	330 plant taxa	Species of interest: *Lepidosperma* sp. ONS6731	75 introduced plant species (three species listed as Declared Pests under the Biosecurity and Agriculture Management Act 2007 (BAM Act): *Gomphocarpus fruticosus* (Narrowleaf Cottonbush), *Rubus anglocandicans* (Blackberry) and *Asparagus asparagoides* (Bridal Creeper).

3.0 METHODOLOGY

Fine scale vegetation type mapping has been completed across the MDE and adjacent proposed expansion areas of the mining operation at a scale of 1:10,000. Broader scale mapping of the wider mining lease area at the vegetation association level was completed in 2011 (Onshore Environmental 2012). Vegetation mapping incorporated not only the structural and floristic components but extended the conservative definition of mapping to incorporate relationships with underlying landform, soils and hydrology. This methodology provided a clear basis for interpreting susceptibility of the mapped vegetation types to change in the local hydrological conditions.

There have been over 350 plant taxa recorded within and surrounding the MDE at Greenbushes over a 12 year period. While detailed information on the biology does not exist for all of these species, there is increasing research being undertaken for keystone structural species present in southwest Western Australia. All available information was combined with field observations made by two Principal Botanists each with over 30 years' experience surveying local vegetation associations, and understanding environmental factors limiting individual species distribution. The cumulative database allowed informed assumptions on rooting depth and individual species ability to tolerate change in groundwater levels and soil moisture. The assessment of groundwater dependency focused on those species known to occur on soils with higher seasonal soil moisture levels.

Groundwater dependency of vegetation was also based on hydrological data supplied by GHD (2024), including *in situ* groundwater levels at 2023 and modelled changes at 2050 made on the basis of proposed mine expansion activities and associated dewatering within the mine pit. This data was provided at 3 m, 6 m and 9 m groundwater contours. The degree of groundwater dependence for each vegetation type within the study area was subsequently ranked using a three point scoring system: low, moderate and high (Table 2). For each of the 30 vegetation types previously mapped at Greenbushes, the ranking was based on:

a) position in the landscape;
b) depth to water table; and
c) floristic composition of each vegetation type (with a focus on the groundwater dependency of key structural species).

Table 2 Risk rating for all vegetation types recorded during flora and vegetation surveys at the Greenbushes Mine between 2012 and 2024.

Consolidated Vegetation Code	Vegetation Type	Plant Taxa Susceptible to Groundwater Drawdown	GDV Risk Rating	Vegetation Condition
HC EmCcAf AfBgPl BoLc	Forest of Eucalyptus marginata subsp. marginata, Corymbia calophylla and Allocasuarina fraseriana over Low Forest A of Allocasuarina fraseriana, Banksia grandis and Persoonia longifolia over Open Dwarf Scrub D of Bossiaea ornata and Leucopogon capitellatus on brown loamy sand on hill crests and upper hill slopes with outcropping laterite	None	Low	Very Good
HC EmCc BgPl PeMr(Bl) BoLc	Forest of Corymbia calophylla and Eucalyptus marginata subsp. marginata over Low Woodland A of Banksia grandis and Persoonia longifolia over Open Low Scrub A/B of Pteridium esculentum and Macrozamia riedlei (Bossiaea linophylla) over Dwarf Scrub D of Bossiaea ornata and/or Leucopogon capitellatus on brown loamy sand on hill crests and upper hill slopes	None	Low	Very Good to Good
HS CcEm Bl Pe(XpMr) LcBoHam	Forest of Corymbia calophylla and Eucalyptus marginata subsp. marginata over Scrub of Bossiaea linophylla over Low Scrub B of Pteridium esculentum (Xanthorrhoea preissii, Macrozamia rieldei) over Open Dwarf Scrub D of Leucopogon capitellatus, Bossiaea ornata and Hibbertia amplexicaulis on brown sandy loam on lateritic hill slopes	None	Low	Good to Degraded
HS EmCc BoLc	Forest of Eucalyptus marginata subsp. marginata and Corymbia calophylla over Low Heath D of Bossiaea ornata and Leucopogon capitellatus on grey/brown sandy loam on hill crests and upper hill slopes	None	Low	Very Good to Degraded
HS EmCc PeMr LcBo	Forest of Eucalyptus marginata subsp. marginata and Corymbia calophylla over Low Scrub A of Pteridium esculentum and Macrozamia riedlei over Low Heath D of Leucopogon capitellatus and Bossiaea ornata on brown loamy sand on lateritic hill slopes	None	Low	Very Good to Degraded
LS CcEm Xp PcBdHa	Forest of Corymbia calophylla and Eucalyptus marginata subsp. marginata over Scrub of Xanthorrhoea preissii over Dwarf Scrub C of Lysiandra calycina, Banksia dallanneyi subsp. sylvestris and Hypocalymma angustifolium on brown sandy loam on lower hill slopes	None	Low	Very Good to Degraded
LS EmCc BlTp SpMr HaBdPo Ll	Forest of Eucalyptus marginata subsp. marginata and Corymbia calophylla over Heath A of Bossiaea linophylla and Taxandria parviceps over Open Dwarf Scrub C of Styphelia propinqua and Macrozamia riedlei over Dwarf Scrub D of Hypocalymma angustifolium, Banksia dallaneyi subsp. sylvestris and Patersonia occidentalis var. occidentalis over Very Open Low Sedges of Lepidosperma leptostachyum on lower hill slopes	None	Low	Very Good to Degraded
LS EmCc TpBl Pd(Po) DbAoSe	Forest (to Woodland) of Eucalyptus marginata subsp. marginata and Corymbia calophylla over Scrub of Taxandria parviceps (Bossiaea linophylla) over Heath A of Podocarpus drouynianus (Pultenaea ocheata) over Dwarf Scrub D of Dasypogon bromeliifolius, Adenanthos obovatus and Styphelia erubescens on grey sand on lower hill slopes and footslopes	None	Low	Good
LS CcEpEm BlXp Pe(XpLvMr) LcCcSp	Forest of Corymbia calophylla, Eucalyptus patens and Eucalyptus marginata subsp. marginata over Scrub of Bossiaea linophylla and Xanthorrhoea preissii over Low Scrub B of Pteridium esculentum (Xanthorrhoea preissii, Leucopogon verticillatus, Macrozamia riedlei) over Open Dwarf Scrub D of Leucopogon capitellatus, Chorizema cordatum and Styphelia propinqua on brown loam on lower hill slopes and footslopes	None	Low	Good to Degraded
LS CcEpEm Hp Xp HaBdLc NjLlDf	Forest of Corymbia calophylla, Eucalyptus marginata subsp. marginata and Eucalyptus patens over Open Scrub of Hakea prostrata over Open Low Scrub A of Xanthorrhoea preissii over Dwarf Scrub D of Hypocalymma angustifolium, Banksia dallanneyi subsp. sylvestris and Lysiandra calycina over Open Low Sedges of Netrostylis sp. Jarrah Forest (R. Davis 7391), Lepidosperma leptostachyum and Desmocladus fasciculatus on red brown loam on lower valley slopes	None	Low	Good to Degraded
GR CcEp XpApHs Hi HaHcSg	Low Woodland A of Corymbia calophylla and Eucalyptus patens over Open Low Scrub A of Xanthorrhoea preissii, Acacia pulchella and Hakea lissocarpha over Low Scrub B of Hemigenia incana over Dwarf Scrub D of Hypocalymma angustifolium, Hibbertia commutata and Stypandra glauca on brown sandy and silty loam on granitic slopes	None	Low	Degraded
GR Le LeBaAh HaBcTc	Scrub of Leptospermum erubescens over Heath A of Leptospermum erubescens, Bossiaea aquifolium and Allocasuarina humilis over Low Heath C of Hypocalymma angustifolium, Babingtonia camphorosmae and Thomasia foliosa on brown loamy sand on granite outcrops and sheets	None	Low	Very Good
HS CcEmEp Ed GsXpAp (DgLe) HiCaTl HaBcBd(Sp)	Open Low Woodland A of Corymbia calophylla, Eucalyptus marginata subsp. marginata and Eucalyptus patens over Very Open Tree Mallee of Eucalyptus drummondii over Open Low Scrub B of Gastrolobium spinosum, Xanthorrhoea preissii and Acacia pulchella (Diplolaena graniticola, Leptospermum erubescens) over Dwarf Scrub C of Hemigenia incana, Cryptandra arbutiflora var. tubulosa and Trymalium ledifolium var. rosmarinifolium over Dwarf Scrub D of Hypocalymma angustifolium, Babingtonia camphorosmae and Banksia dallaneyi subsp. sylvestris (Styphelia pallida) on hill slopes with dolerite outcropping	None	Low	Very Good
HS CcEm Gb Dg CcApTl MoLl	Forest of Corymbia calophylla and Eucalyptus marginata subsp. marginata over Open Scrub of Gastrolobium bilobum over Heath A of Diplolaena graniticola over Low Scrub B of Chorizema cordatum, Acacia pulchella and Trymalium ledifolium var. rosmarinifolium over Very Open Low Sedges of Morelotia octandra and Lepidosperma leptostachyum on steep valley slopes below granite outcrops	None	Low	Good to Degraded
LS Ew(Cc) Xp(Ac) HaBcBd(XgBo)	Low Woodland A of Eucalyptus wandoo (Corymbia calophylla) over Open Low Scrub B of Xanthorrhoea preissii (Acacia celastrifolia) over Low Heath C of Hypocalymma angustifolium, Babingtonia camphorosmae and Banksia dallanneyi subsp. sylvestris (Xanthorrhoea gracilis and Bossiaea ornata) on grey clay loam soil on lower hill slopes	None	Low	Good
DF EpCc TlBlHp Ha CaNjDb	Forest of Eucalyptus patens and Corymbia calophylla (Eucalyptus marginata subsp. marginata) over Scrub of Taxandria linearifolia, Bossiaea linophylla and Hakea prostrata over Open Dwarf Scrub D of Hypocalymma angustifolium over Very Open Low Sedges of Cyanochaeta avenacea, Lepidosperma leptostachyum and Netrostylis sp. Jarrah Forest (R. Davis 7391) brown sandy clay loam on drainage flats	Eucalyptus patens Taxandria linearifolia Hypocalymma angustifolium Cyanochaeta avenacea Lepidosperma leptostachyum	Moderate	Very Good to Degraded
DF MpEp AsTl AgPe IcJp	Forest of Melaleuca preissiana and Eucalyptus patens over Scrub of Astartea scoparia and Taxandria linearifolia over Low Scrub B of Aotus gracillima and Pteridium esculentum over Very Open Low Sedges of Isolepis cyperoides and Juncus pallidus on black sandy clay loam on seasonally wet drainage flats	Melaleuca preissiana Eucalyptus patens Astartea scoparia Taxandria linearifolia	Moderate	Degraded to Good
DF Mp As LdMr	Open Low Woodland B of Melaleuca preissiana over Low Scrub A of Astartea scoparia over Tall Sedges of Leptocarpus depilatus over Very Open Low Sedges of Machaerina rubiginosa on wetland flats and lake edges	Melaleuca preissiana Astartea scoparia Leptocarpus depilatus Machaerina rubiginosa	Moderate	Degraded
DF ErEpCc GbGs Ha	Forest of Eucalyptus rudis subsp. rudis, Eucalyptus patens and Corymbia calophylla (+/- *Eucalyptus resinifera) over Scrub of Gastrolobium bilobum, Gastrolobium spinosum and Acacia celastrifolia over Low Scrub A of Acacia pulchella, Acacia latericola and Billardiera fusiformis over Dwarf Scrub C of Hypocalymma angustifolium over Very Open Low Sedges of Netrostylis sp. Jarrah Forest (R. Davis) over Very Open Herbs of Dampiera alata and Stylidium spathulatum on brown loamy sands on drainage area/ floodplains	Eucalyptus rudis subsp. rudis Eucalyptus patens Hypocalymma angustifolium	Moderate	Degraded

Consolidated Vegetation Code	Vegetation Type	Plant Taxa Susceptible to Groundwater Drawdown	GDV Risk Rating	Vegetation Condition
ME EpCc(BsBli) ToTp PeAp LeLt	Woodland (to Forest) of Eucalyptus patens and Corymbia calophylla (Banksia seminuda, Banksia littoralis) over Scrub of Trymalium odoratissimum subsp. trifidum and/or Taxandria parviceps over Low Scrub B of Pteridium esculentum and Acacia pulchella over Open Tall Sedges of Lepidosperma effusum and Lepidosperma tetraquetrum on medium drainage lines along riverine valleys	Eucalyptus patens Banksia seminuda Banksia littoralis Trymalium odoratissimum subsp. trifidum Taxandria parviceps Lepidosperma effusum Lepidosperma tetraquetrum	High	Very Good to Degraded
MI Er(Cc) ToTlHp Lt	Forest of Eucalyptus rudis subsp. rudis (Corymbia calophylla) over Scrub of Trymalium odoratissimum subsp. trifidum, Taxandria linearifolia and/or Hakea prostrata over Open Tall Sedges of Lepidosperma tetraquetrum on brown sandy clay loam on minor drainage lines	Eucalyptus rudis subsp. rudis Trymalium odoratissimum subsp. trifidum Taxandria linearifolia Hakea prostrata Lepidosperma tetraquetrum	High	Degraded
ME ErCc Bs ToBlTl PeCcBf	Forest of Eucalyptus rudis subsp. rudis, Corymbia calophylla and Eucalyptus marginata subsp. marginata over Open Low Woodland A of Banksia seminuda over Thicket of Trymalium odoratissimum subsp. trifidum, Bossiaea linophylla and Taxandria linearifolia over Low Scrub B of Pteridium esculentum, Chorizema cordatum and Billardiera fusiformis on wet valley slopes with areas of permanent surface water along medium drainage lines	Eucalyptus rudis subsp. rudis Banksia seminuda Trymalium odoratissimum subsp. trifidum Taxandria linearifolia	High	Good
ME Er(CcEp) BliClAs(Mr) TlPe LeJp	Forest of Eucalyptus rudis subsp. rudis (Corymbia calophylla, Eucalyptus patens) over Low Woodland A of Banksia littoralis, Callistachys lanceolata and Acacia saligna (Melaleuca rhaphiophylla) over Low Scrub A of Taxandria linearifolia and Pteridium esculentum over Very Open Tall Sedges of Lepidosperma effusum and Juncus pallidus on brown loam on medium drainage lines and floodplains	Eucalyptus rudis subsp. rudis Eucalyptus patens Banksia littoralis Callistachys lanceolata Melaleuca rhaphiophylla Taxandria linearifolia Lepidosperma effusum	High	Degraded
MI ErCc(Ep) TlAsCl Mr	Open Woodland of Eucalyptus rudis subsp. rudis and Corymbia calophylla (Eucalyptus patens) over Scrub of Taxandria linearifolia, Astartea scoparia and Callistachys lanceolata (Pteridium esculentum) over Open Tall Sedges of Machaerina rubiginosa on brown sandy clay loam on minor drainage lines and artificial wetlands	Eucalyptus rudis subsp. rudis Eucalyptus patens Taxandria linearifolia Astartea scoparia Callistachys lanceolata Machaerina rubiginosa	High	Good to Completely Degraded
DF Pe	Dense Heath B of Pteridium esculentum on grey sand on seasonally wet drainage flats	Pteridium esculentum	Moderate	Degraded
DF MpBli(ClCc) TlHp Ld	Low Woodland A of Melaleuca preissiana and Banksia littoralis (Callistachys lanceolata, Corymbia callophylla) over Thicket of Taxandria linearifolia and Hakea prostrata over Open Tall Sedges of Leptocarpus depilatus on brown sandy clay loam on drainage flats	Melaleuca preissiana Banksia littoralis Callistachys lanceolata Taxandria linearifolia Hakea prostrata Leptocarpus depilatus	Moderate	Very Good to Completely Degraded
WE TlTpAs MrMj	Low Open Scrub A of Taxandria linearifolia, Taxandria parviceps and Astartea scoparia over Dense Tall Sedges of Machaerina rubiginosa and Machaerina juncea on brown sandy clay on wetlands	Taxandria linearifolia Taxandria parviceps Astartea scoparia Machaerina rubiginosa Machaerina juncea	High	Good to-Degraded
DF Mr Jp	Tall Sedges of Machaerina rubiginosa over Very Open Low Sedges of Juncus pallidus on brown light medium clay on drainage zone amongst annual pasture	Machaerina rubiginosa	Moderate	Degraded
WE Tor	Dense Tall Sedges of *Typha orientalis on brown light clay in seasonal and permanent wetlands	Typha orientalis	High	Degraded to Completely Degraded
HS CcEm	Forest (to Open Woodland) of Corymbia calophylla and Eucalyptus marginata over parkland cleared understorey		Low	Completely Degraded
CF	Farmland (Annual Pasture)		Low	Completely Degraded
CL	Cleared		Low	Completely Degraded
MR	Mine Rehabilitation		Low	Good to Degraded
PL	Plantation		Low	Completely Degraded
RT	Roads, tracks and infrastructure corridors		Low	Completely Degraded
TS	Townsite		Low	Completely Degraded
WB	Water Bodies / Dams		High	

4.0 RESULTS

4.1 Potential for Groundwater Drawdown

4.1.1 Norilup Brook Sub-catchment

Depth to groundwater data in 2023 versus modelled data for 2050 (GHD 2024) showed no significant change (>3 m drawdown) evident across the majority of the Norilup Brook sub-catchment, situated on the west side of the topographic ridge hosting the mineralised zone.

There were five receptors investigated more closely where minor drawdown over the 27 year period was evident (Figure 2):

- The *Caladenia harringtoniae* (Threatened Flora) population approximately 1.5 km west southwest of the Tailings Retreatment Plant (Figure 3);
- Explosives Compound (between the Southampton and Cowan process water dams, see Figure 4);
- Spring Gully Road (Southampton and Austin's process water dams north across Spring Gully Road, see Figure 5);
- Maranup Ford Road (west of the Greenbushes Mine administration building and TSF2 cell, see Figure 6); and
- Greenbushes townsite (western divide draining towards process water dams, see Figure 7).

The western divide of the Greenbushes townsite was the only receptor where groundwater drawdown was modelled to occur at >3 m (Figure 7). However, *in situ* groundwater levels were >10 m bgl within this area and vegetation was not determined to be groundwater dependent (mapped as the most widespread Jarrah-Marri forest on lateritic hill slopes vegetation type, HS EmCc BoLc) (Table 2).

4.1.2 Hester Brook Sub-catchment

Depth to groundwater data in 2023 versus modelled data for 2050 (GHD 2024) showed no significant change (>3 m drawdown) evident across the majority of the Hester Brook sub-catchment, situated on the east side of the topographic ridge hosting the mineralised zone.

There were three receptors investigated more closely where minor drawdown over the 27 year period was evident:

- Catterick Road (Figure 8);
- Salt Water Gully (Figure 9); and
- Greenbushes townsite (eastern divide between town and the Mine Services Area, see Figure 7).

As was the case for the Norilup Brook Sub-catchment, the eastern divide of the Greenbushes townsite was the only receptor where groundwater drawdown was modelled to occur at >3m (Figure 7). The *in situ* groundwater levels in this area were >20 m bgl and vegetation was not determined to be groundwater dependent (mapped as the most widespread Jarrah-Marri forest on lateritic hill slopes vegetation type, HS EmCc BoLc).

4.2 Groundwater Dependency of Vegetation

There have been a total of 30 vegetation types described and mapped across 14 baseline flora and vegetation surveys completed at the Greenbushes Mine between 2012 and 2024. The majority of the vegetation types (16 in total) were ranked as being at low risk from groundwater drawdown (Table 2, Figure 2). These vegetation types occurred on undulating lateritic hills where the flora assemblages were not groundwater dependent, but rather comprised a suite of xerophytic plant species. Upland topographic areas represented by undulating lateritic hill crests and hill slopes supported groundwater at depths typically >10 m bgl. While groundwater may be accessible to vegetation at depths >10 m bgl within these areas, the utilisation by plants at this depth is predicted to be negligible in terms of total water use (Department of Water 2008). The vegetation types in these areas were broadly characterised as *Eucalyptus marginata* (Jarrah) - *Corymbia calophylla* (Marri) forest.

There were seven vegetation types mapped across the Greenbushes mining leases that were ranked as being at moderate risk from groundwater drawdown (Table 2, Figure 2). These vegetation types occurred on lower valley slopes and adjacent drainage flats where groundwater was <3 m bgl. Vegetation was characterised by the presence of the tree *Eucalyptus patens* (Yarri), tall shrub *Melaleuca preissiana,* and low sedge *Cyathochaeta avanacea* which are likely to be partially reliant on groundwater use.

Seven vegetation types mapped across the Greenbushes mining leases were determined to be at high risk from groundwater drawdown (Table 2, Figure 2). The high risk vegetation types occurred at the lowest point in the local landscape which included drainage channels, scattered permanent pools and dams along local tributaries, and fringing drainage flats (Figure 2). Groundwater was <1.0 m bgl and in some areas expressing at surface. Vegetation supported indicator species that were key structural components and had a moderate to high reliance on groundwater use for survival. These taxa included the tall tree *Eucalyptus rudis* subsp. *rudis* (Flooded Gum), low trees / tall shrubs *Banksia seminuda, Banksia littoralis, Callistachys lanceolata, Melaleuca rhaphiophylla* and *Taxandria linearifolia,* and sedges *Lepidosperma effusum, Lepidosperma tetraquetrum, Leptocarpus roycei* and *Machaerina rubiginosa.*

It is noted that the high risk vegetation type ME Er(CcEp) BliClAs(Mr) TlPe LeJp occurred along the medium drainage line of Salt Water Gully, however associated vegetation condition was rated at degraded. The drainage line included a series of dams constructed following historical alluvial tin mining (mapped as ‘water bodies’) which supported scattered native trees and shrubs and a heavy weed loading along the shoreline. The relatively large area of standing water in man-made dams and degraded condition of the groundwater dependent vegetation type reduces any potential impact on vegetation from drawdown.

5.0 SUMMARY

Groundwater levels in 2023 at Greenbushes show that depth to groundwater is shallowest along the larger tributaries including Saltwater Gully, Hester Brook and Cascade Gully (<1.0 m bgl), with standing water present in dams along the main drainage channels. Groundwater depth remains <3 m bgl on drainage flats fringing these tributaries. The groundwater depth increases with elevation as the topography rises on undulating hill slopes, but typically remains <10 m bgl within a radius of 20 m either side of the larger tributaries. The area north of the Greenbushes townsite supports a more extensive area where groundwater remains <10 m bgl owing to the more subdued and less undulating landscape.

Fine-scale vegetation type mapping has defined changes in flora composition and vegetation structure which is strongly aligned to position in landscape, soil type and local hydrological conditions. It is predicted that flora and vegetation types at highest risk from groundwater drawdown will be those restricted to creek line habitats including minor and medium drainage lines, and associated dams and artificial wetlands.

Proposed expansion of mining operations at Greenbushes and the requirement to undertake dewatering during mining within the open pit has been modelled to determine depth to groundwater in 2050. The area to the north of current mining operations and surrounding the Greenbushes townsite is the only area identified where groundwater depth will decline by >3m between 2023 and 2025. However, native vegetation within this area comprises Jarrah-Marri forest on lateritic hill slopes and is not determined to be groundwater dependent. This is supported by the *in situ* groundwater levels which are >10 m bgl and typically >20 m bgl.

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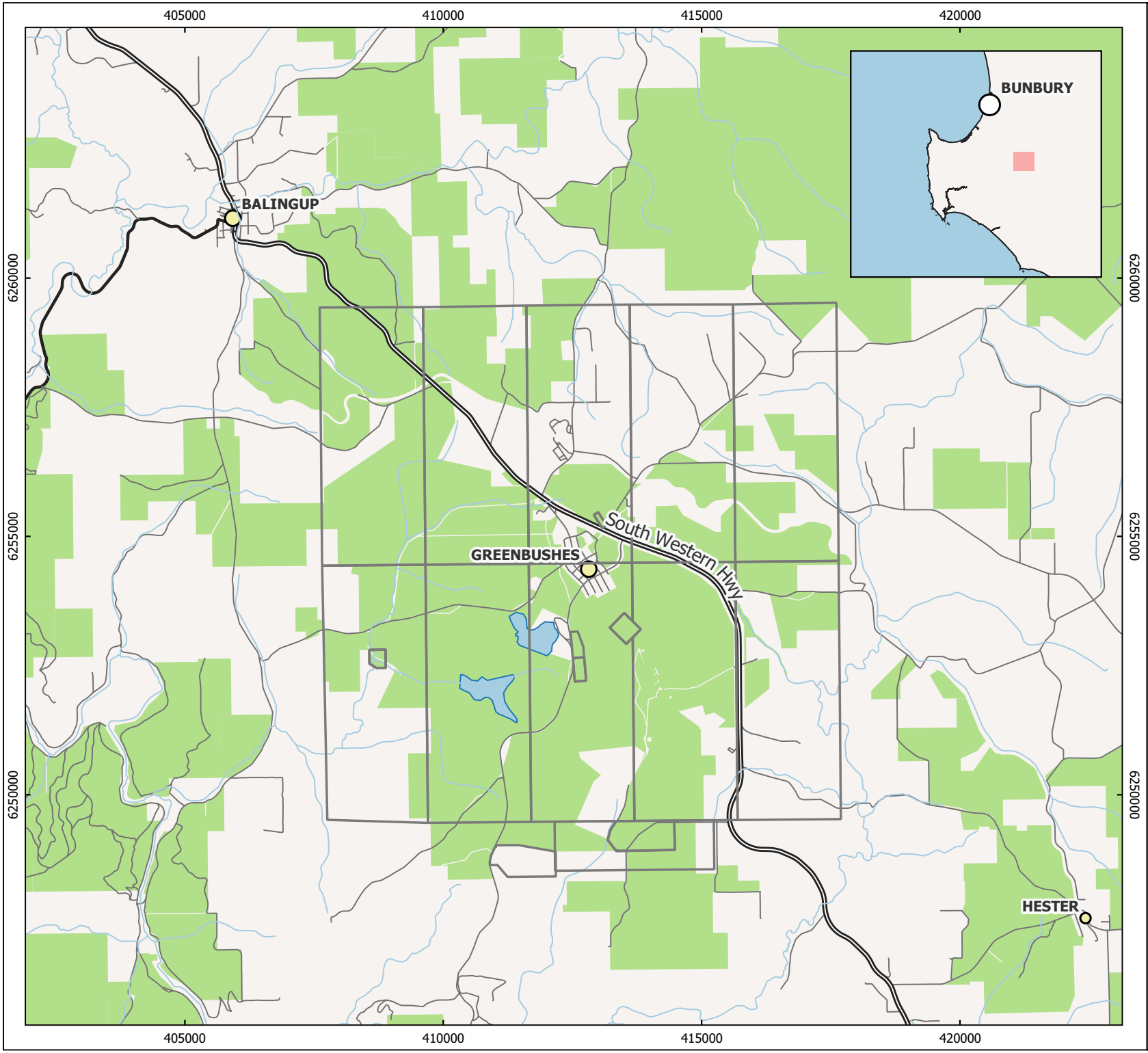

ONSHORE ENVIRONMENTAL

TALISON LITHIUM
Greenbushes Mine

Figure 1
Location of Study Area

Legend

- Talison Lithium Tenements
- State Forest

0 1 2 3 4 km

1:100,000

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Projection: MGA Zone 50

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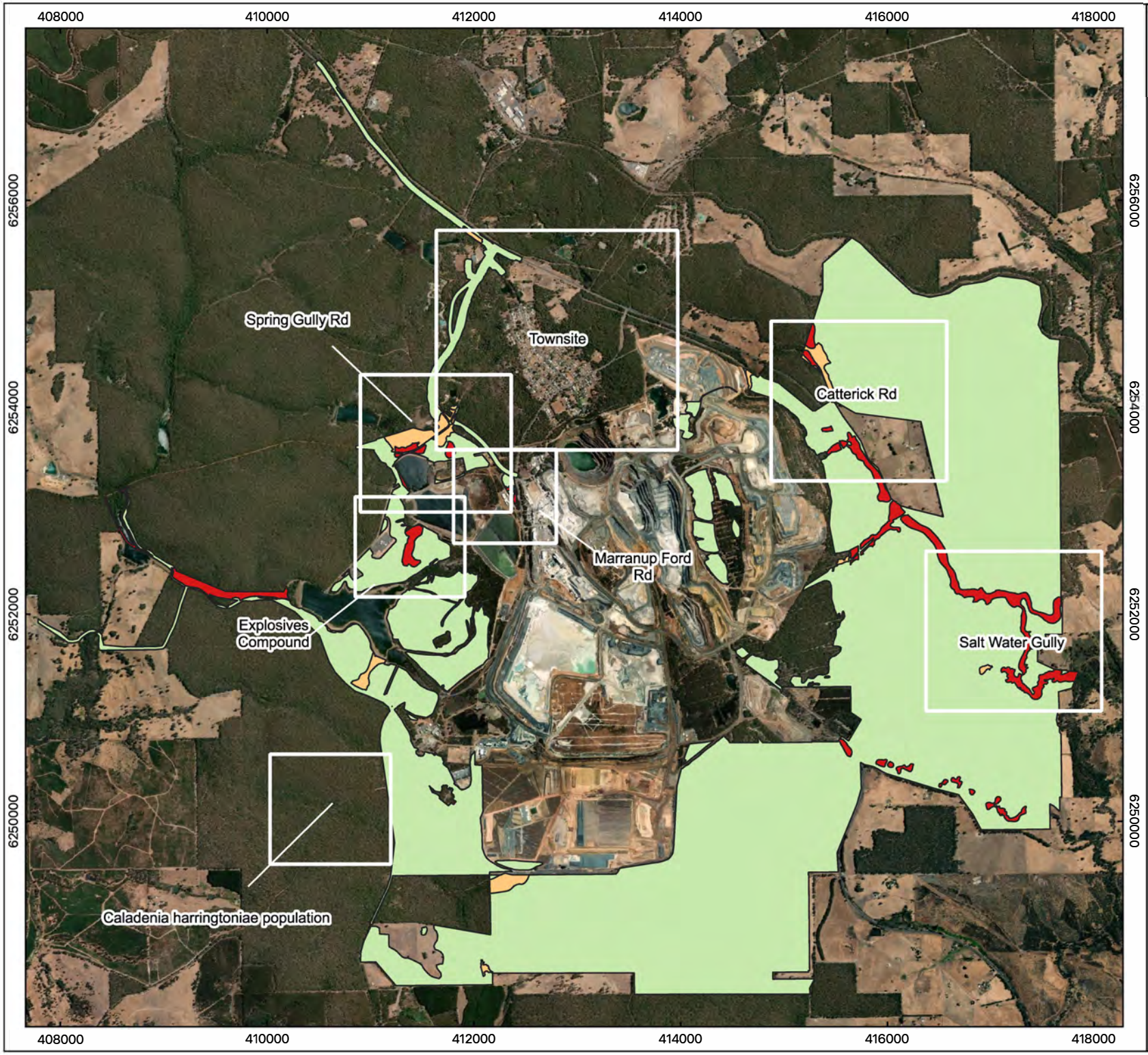

ONSHORE ENVIRONMENTAL

TALISON LITHIUM
Groundwater Dependent Vegetation Assessment

Figure 2
GDV risk rating for vegetation types based on consolidated mapping database, and location of receptors

Legend

GDV Risk

- High
- Low
- Moderate

0 1 2 km

1:50,000

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Projection: MGA Zone 50

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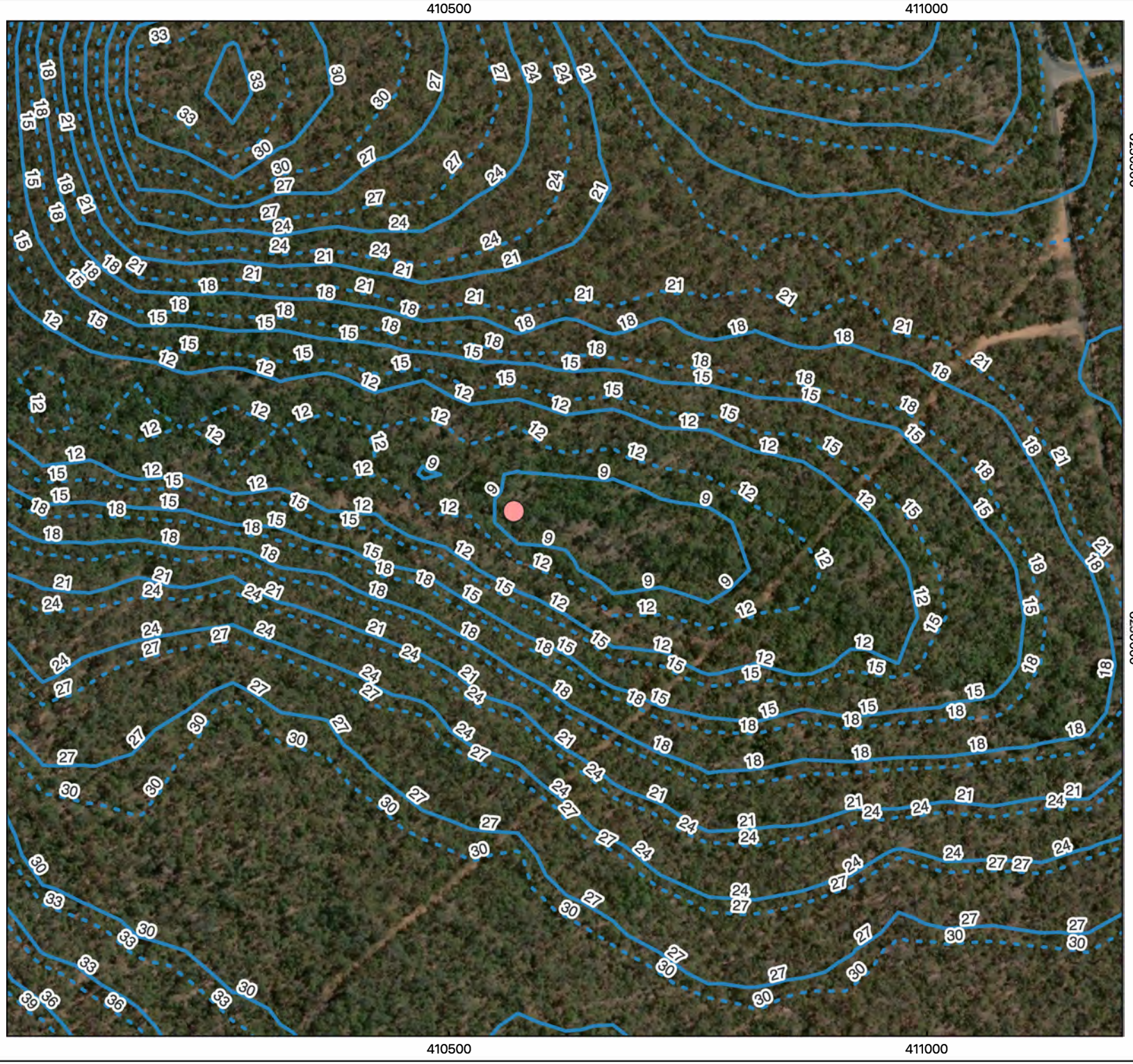

ONSHORE ENVIRONMENTAL

TALISON LITHIUM Groundwater Dependent Vegetation Assessment

Figure 3 Predicted groundwater drawdown 2023-2050 - *Caladenia harringtoniae* population

Legend

- 3m Groundwater Contours Baseline (2023)
- 3m Groundwater Contours Impact (2050)
- Caladenia harringtoniae

0 100 200 300 m

1:5,500

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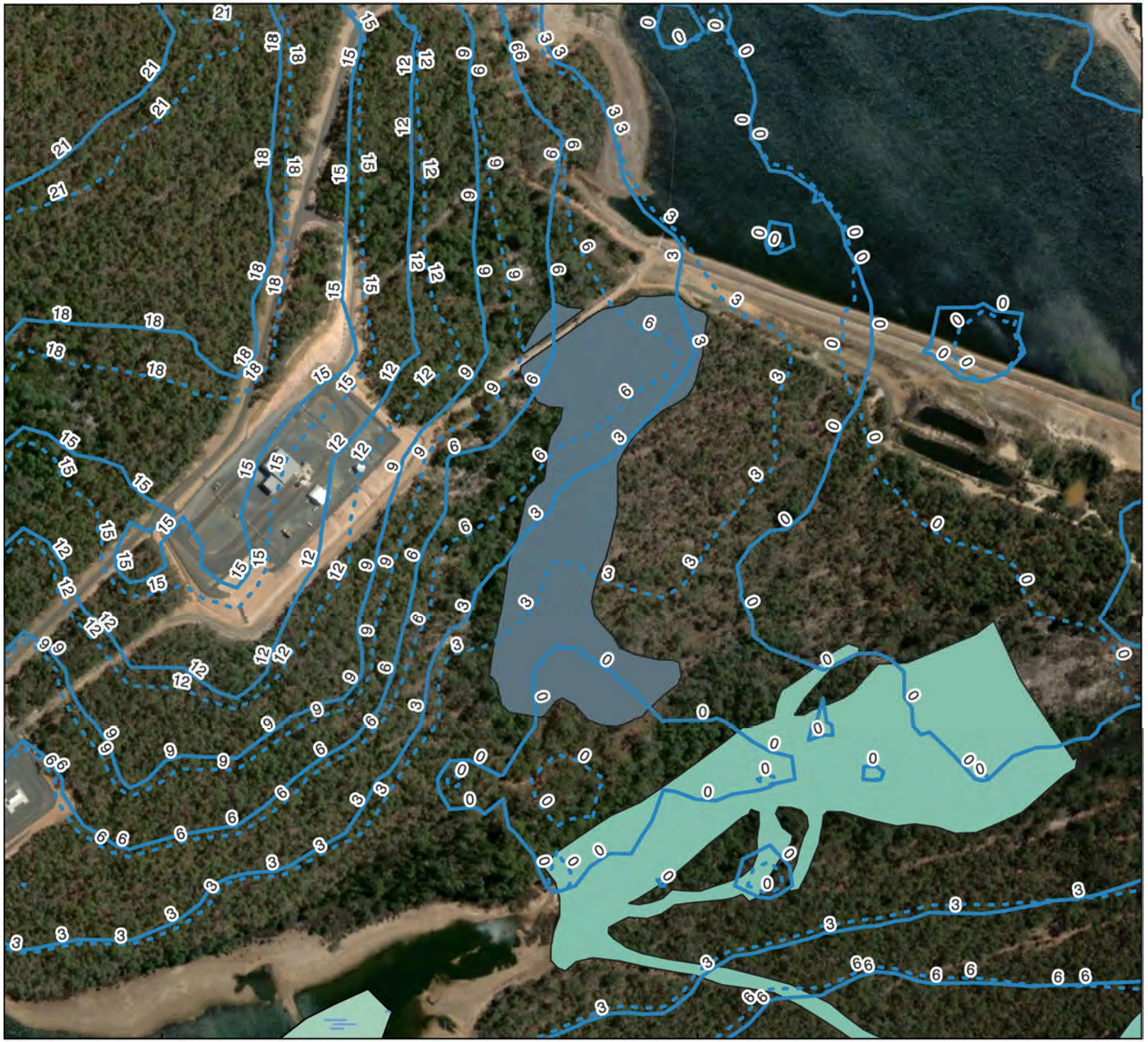

ONSHORE ENVIRONMENTAL

TALISON LITHIUM
Groundwater Dependent Vegetation Assessment

Figure 4
Predicted groundwater drawdown 2023-2050 Explosives Compound

Legend

- 3m Groundwater Contours Baseline (2023)
- 3m Groundwater Contours Impact (2050)

Consolidated Mapping

- ME EpCc(BsBli) ToTp PeAp LeLt
- Mine Rehabilitation
- Waterbodies

0 100 200 m

1:5,000

Datum: GDA 94
Projection: MGA Zone 50

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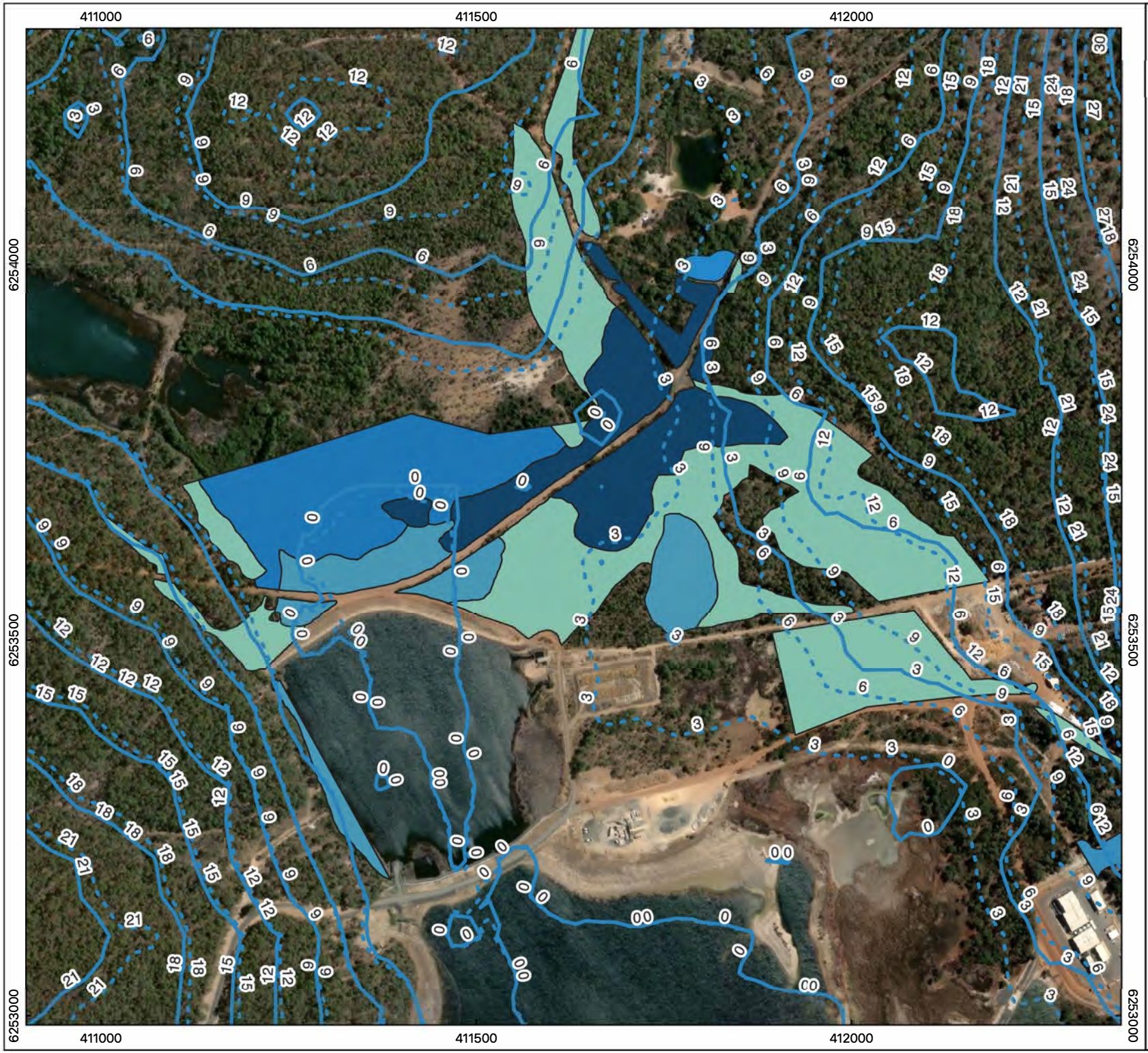

ONSHORE ENVIRONMENTAL

TALISON LITHIUM
Groundwater Dependent Vegetation Assessment

Figure 5
Predicted groundwater drawdown 2023-2050
Spring Gully Road

Legend

- 3m Groundwater Contours Baseline (2023)
- 3m Groundwater Contours Impact (2050)

Consolidated Mapping

- DF EpCc TlBlHp Ha CaNjDb
- DF MpBli(ClCc) TlHp Ld
- DF MpEp AsTl AgPe IcJp
- Mine Rehabilitation
- WE TlTpAs MrMj
- WE Tor

0 100 200 300 m

1:6,873

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ONSHORE ENVIRONMENTAL

TALISON LITHIUM
Groundwater Dependent Vegetation Assessment

Figure 6
Predicted groundwater drawdown 2023-2050 Maranup Ford Road

Legend

- 3m Groundwater Contours Baseline (2023)
- 3m Groundwater Contours Impact (2050)

Consolidated Mapping

- Mine Rehabilitation
- WE TITpAs MrMj
- WE Tor

0 100 200 m

1:4,683

Datum: GDA 94
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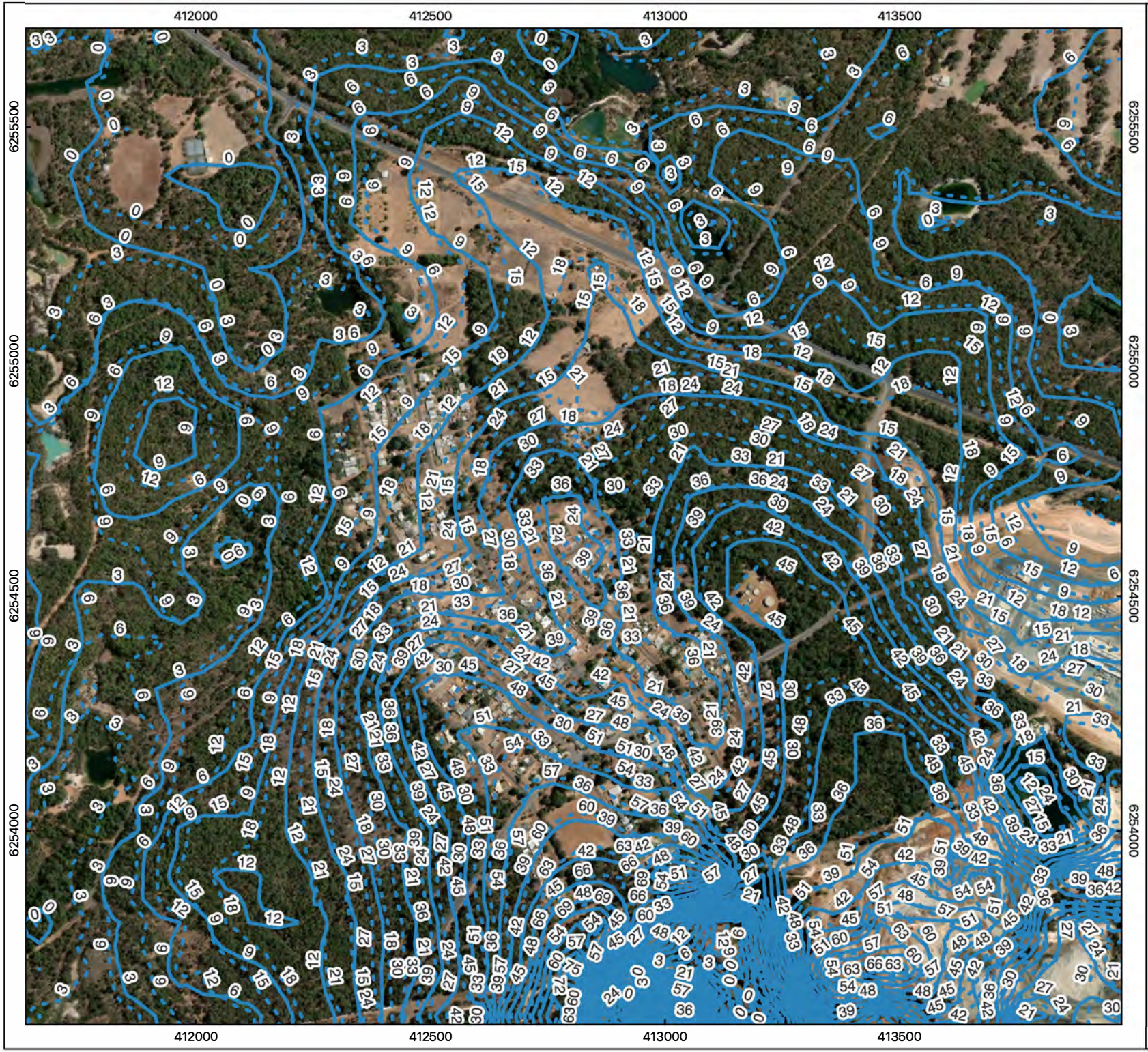

ONSHORE ENVIRONMENTAL

TALISON LITHIUM
Groundwater Dependent Vegetation Assessment

Figure 7
Predicted groundwater drawdown 2023-2050 Greenbushes Townsite

Legend

- 3m Groundwater Contours Baseline (2023)
- 3m Groundwater Contours Impact (2050)

0 100 200 m

1:11,000

Datum: GDA 94
Projection: MGA Zone 50

Date: 06/07/2024
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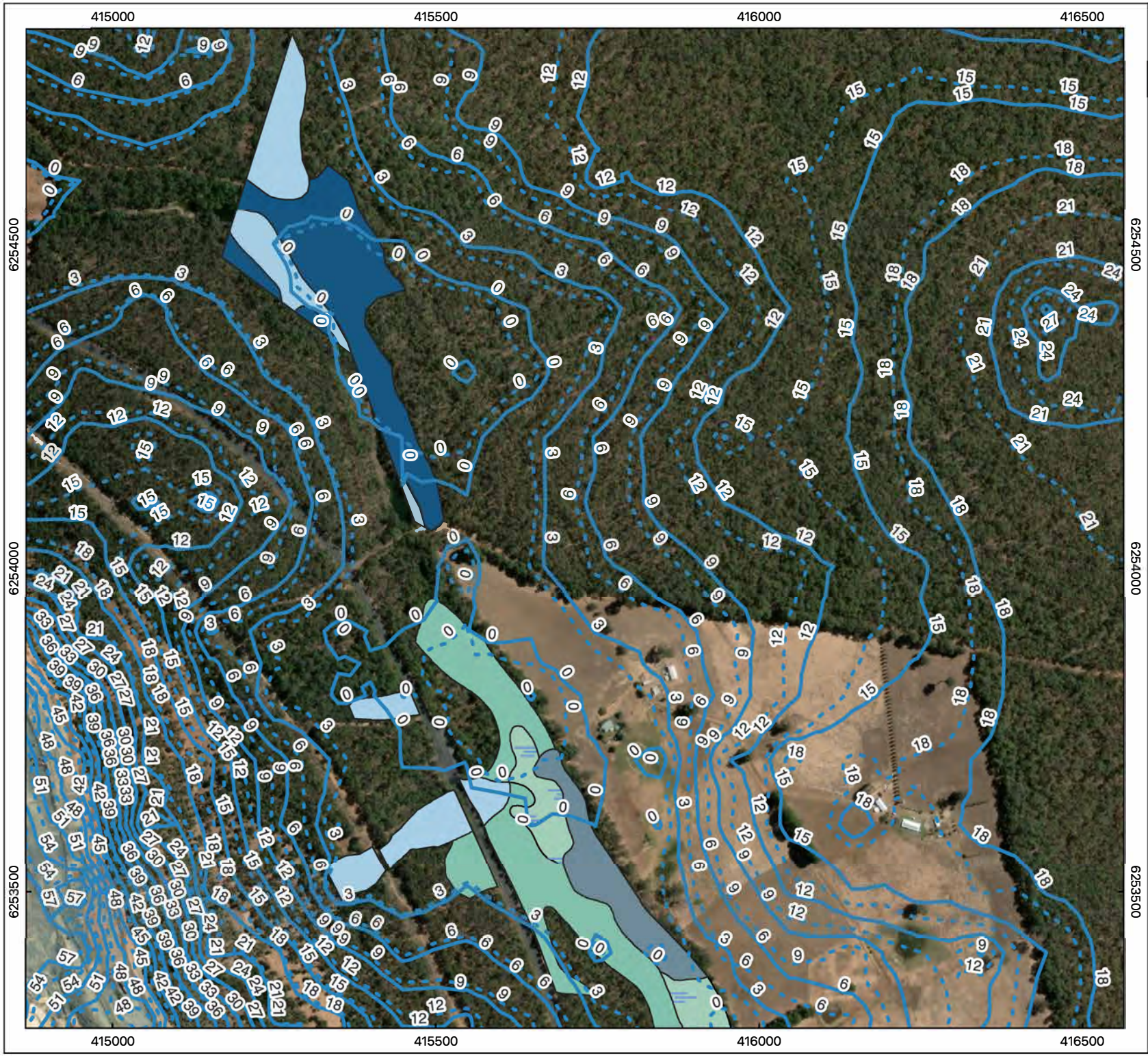

ONSHORE ENVIRONMENTAL

TALISON LITHIUM
Groundwater Dependent Vegetation Assessment

Figure 8
Predicted groundwater drawdown 2023-2050 Catterick Road

Legend

- 3m Groundwater Contours Baseline (2023)
- 3m Groundwater Contours Impact (2050)

Consolidated Mapping

- DF ErEpCc GbGs Ha
- ME Er(CcEp) BliClAs(Mr) TlPe LeJp
- MI ErCc(Ep) TlAsCl Mr
- Mine Rehabilitation
- Waterbodies

0 100 200 300 m

1:8,000

Datum: GDA 94
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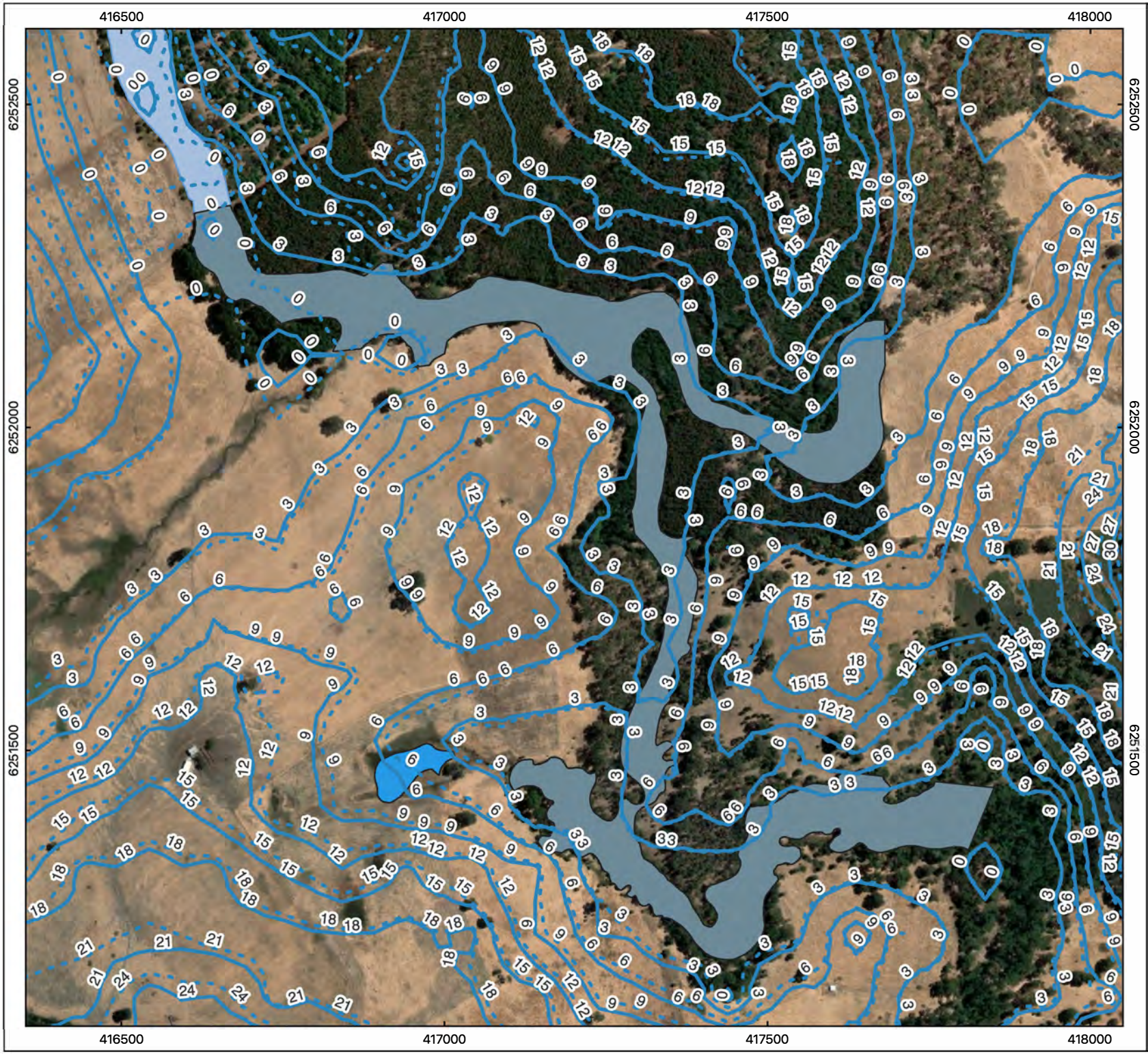

ONSHORE ENVIRONMENTAL

TALISON LITHIUM
Groundwater Dependent Vegetation Assessment

Figure 9
Predicted groundwater drawdown 2023-2050
Salt Water Gully

Legend

- 3m Groundwater Contours Baseline (2023)
- 3m Groundwater Contours Impact (2050)

Consolidated Mapping

- DF Mr Jp
- ME Er(CcEp) BliClAs(Mr) TlPe LeJp
- Waterbodies

0 100 200 300 m

1:8,000

Datum: GDA 94
Projection: MGA Zone 50

Date: 06/07/2024
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