Department of Biodiversity, Conservation and Attractions

GOVERNMENT OF WESTERN AUSTRALIA

Nomination *(to be completed by nominator)*

Current conservation status	
Name of ecological community:	*Corymbia calophylla* woodlands on heavy soils of the southern Swan Coastal Plain (floristic community type 1b as originally described in Gibson *et al*. (1994))
Other names:	Swan Coastal Plain community 1b (SCP1b), floristic community type 1b (FCT1b) as described by Gibson *et al.* (1994).
Description:	The community is known from heavy fertile soils of the southern Swan Coastal Plain south of Dardanup. It consists largely of *Corymbia calophylla* (marri) forests and woodlands. *Eucalyptus marginata* (jarrah) is also common in the tree layer. Common understorey species include *Acacia extensa* (wiry wattle), *Gompholobium polymorphum, Billardiera variifolia*, *Hibbertia hypericoides* (yellow buttercups), *Hypocalymma angustifolium* (white myrtle) and *Xanthorrhoea preissii* (balga) over a rich herb layer including *Scaevola calliptera*, *Agrostocrinum scabrum* (blue grass lily), *Austrostipa semibarbata*, *Dampiera linearis* (common dampiera), *Mesomelaena tetragona* (semaphore sedge), *Morelotia octandra* and *Lomandra purpurea* (purple mat rush). The community is also known as "floristic community type 1b" as originally described in Gibson N., Keighery B.J., Keighery G.J., Burbidge A.H. and Lyons M.N. (1994) "A floristic survey of the southern Swan Coastal Plain" (unpublished report for the Australian Heritage Commission prepared by the Department of Conservation and Land Management and the Conservation Council of Western Australia (Inc.)).
Nomination for:	Listing under BC Act ☒ Change of status ☐ Delisting ☐

1. *Is the ecological community currently on any conservation list, either in a State or Territory, Australia or Internationally?* 2. *Is it present in an Australian jurisdiction, but not listed?*	*Provide details of the occurrence and listing status for each jurisdiction in the following table*

Jurisdiction	**List or Act name**	**Date listed or assessed (or N/A)**	**Listing category eg. critically endangered (or none)**	**Listing criteria eg. B1ab(iii)+2ab(iii) (or none)**
National	EPBC Act			
Western Australia	TEC list: WA Minister ESA list in policy	6/11/2001	Vulnerable	B) under previous ranking criteria developed in WA
	Priority list		1 ☐ 2 ☐	3 ☐ 4 ☐
Other State/Territory				

Nominated conservation status: category and criteria (include recommended status for deleted ecological communities)

Critically endangered (CR) ☒ Endangered (EN) ☐ Vulnerable (VU) ☐ Collapsed (CO) ☐

Priority 1 ☐ Priority 2 ☐ Priority 3 ☐ Priority 4 ☐ None ☐

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What criteria support the conservation status category for listing as a threatened ecological community or collapsed ecological community? *Refer to Section 32 of the Biodiversity Act 2016 for definition of 'Collapsed', and Appendix 3 table 'IUCN Red List Criteria for ecosystems version 2.2'.*	CR B1a(ii),(iii),b

Eligibility against the criteria

*Provide justification for the nominated conservation status; is the ecological community eligible or ineligible for listing against the five criteria. For **delisting**, provide details for why the ecological community no longer meets the requirements of the current conservation status.*

A.	Reduction in geographic distribution *(evidence of decline)*	☐ **A1** ☐ **A2a** ☐ **A2b** ☒ **A3**
	Justification of assessment under Criterion A.	For criteria A and B, the community is assumed to collapse when the mapped distribution declines to zero. • The reduction in extent of native vegetation on the vegetation complexes that support the community is assumed to be indicative of the level of clearing of the community. • The following vegetation complexes support the community, with the proportion cleared in brackets: Swan (86%), Southern River (82%) and Abba (93%) (Government of Western Australia 2019). • Based on available evidence, the community plausibly meets criteria for EN to CR under criterion A3. As the timing of clearing is unknown, the clearing is assumed to have occurred since 1750. The distribution is inferred to have declined between 82%-93% (threshold for CR is ≥ 90%, and EN is ≥70%) since 1750 under A3. • Plausibly meets criteria for Critically Endangered or Endangered under A3 • **EN under A3** is more conservative and defensible as the community occurs over a range of vegetation complexes with a range of levels of clearing.
B.	Restricted geographic distribution *(EOO and AOO, number of locations and evidence of decline)*	☒ **B1** (specify at least one of the following): ☐ **a)(i)** ☒ **a)(ii)** ☒ **a)(iii)** ☒ **b)** ☐ **c);** ☐ **B2** (specify at least one of the following): ☐ **a)(i)** ☐ **a)(ii)** ☐ **a)(iii)** ☐ **b)** ☐ **c);** ☐ **B3 (only for Vulnerable Listing)**
	Justification of assessment under Criterion B.	• B1: EOO is 674.7km^2

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		The community's EEO is less that the 2,000km^2 threshold for rank CR. Community meets threshold for rank CR under criterion part B1. • B1,2 a(ii): Bore data support an inference of continued decline in a measure of disruption to environmental quality to support ranking under B1a(ii) and B2a(ii). There is an observed and inferred continuing decline in groundwater levels in some occurrences (see Appendix 1 for details) with inference of continuing decline in environmental quality over next 20 years. • B1,2 a(iii): Dieback data supports an inference of continued decline over next 20 years, representing a measure of disruption to biotic interactions appropriate to the characteristic biota of the ecosystem (see Appendix 1 for details). There is also an observed and inferred continuing decline of native taxa in the occurrences at Ambergate Reserve (increasing weeds). • B1, B2 b): Continuing decline observed from the impacts of; land clearing, hydrological change, weed invasion, grazing by introduced fauna, altered fire regimes, disease and a drying climate (see Appendix 1 for details of threats). • B1, B2 c) Community is considered to occur at 8 threat defined locations, based on the identification of 8 clusters that may be subject to similar threats such as those that affect a particular aquifer, or bushland location. The community meets VU under B1c), B2c as the threshold for EN is ≤5 and for VU is ≤10 threat-defined locations. • B2: AOO. Community covers 8 grid cells. The community meets EN under criterion part B2 for which the AOO threshold is ≤20 grid cells (threshold for CR ≤2 grid cells) (b and c of B1 are the same for B2). • B3: community is considered to consist of 8 threat defined locations. Does not meet VU under criterion B3, as community occurs at >5 threat defined locations. • **Meets criteria for Critically Endangered B1a(ii),(iii),b. Meets criteria for EN under B2a(ii),(iii),b. Meets VU under B1c; B2c.**
C.	Environmental degradation of abiotic variable *(Evidence of decline over 50-year period)*	☐ **C1** ☒ **C2** ☐ **C3**
	Justification of assessment under Criterion C.	Altered hydrology in the form of declining groundwater is a significant abiotic variable affecting the community.

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		• For criterion C, the assessment of decline in abiotic processes focussed on hydrological change using data on the depth of the water tables. It was assumed conservatively that the community would collapse if the water table depth fell to about 10m below ground surface based on the maximum water depth accessed by deep rooted phreatophytic taxa in nearby areas (Froend and Loomes 2006), and observations that the vigour of canopies declined in groundwater dependent trees in association with declining water table levels (Froend *et al*. 2004). • Bore data were available for the vicinity of 16 occurrences of the community. The steady water table decline at the Ambergate reserve, where occurrences AMBR01, AMBR04, myAMBR03, AMBR06, myAMBR07 AND myAMBR09 occur (representative of 36% of the community), is likely due to a drying climate and therefore less recharge to the aquifer, or water abstraction. Based on current and future forecasted groundwater levels at the Ambergate reserve, it is predicted that within the next 50 years there will be a 41% severity in relation to total collapse assuming groundwater levels decline at the current calculated rate (y=-0.0046x + 21.023) (Figure 2 in Appendix 1). This can therefore be quantified as a predicted 41% severity over 36% of the extent of the community. • The rapid water table decline at occurrences CARB01 and CARB02 in Reserve 38582 (representative of 25% of the community), is potentially associated with drainage and groundwater abstraction from road development (Bussell Hwy). Based on current and future forecasted groundwater levels in the area, it is predicted that within the next 50 years there will be a 100% severity in relation to total collapse assuming groundwater levels decline at the current calculated rate (y=-0.0087x + 18.291). • This can therefore be quantified as a predicted 100% severity over 25% of the extent of the community. • There is a steady water table decline at occurrence coolilup01 (9) within Reserve 38582 (representative of 4% of the community). Based on current and future forecasted groundwater levels in the area, it is predicted that within the next 50 years there will be an 8% severity in relation to total collapse assuming groundwater levels decline at the current calculated rate (y=-0.0008x + 18.787). This can therefore be quantified as a predicted 8% severity over 4% of the extent of the community. • There is a steady water table decline at occurrence R116703 (8) (representative of 1% of the community). Based on current and future forecasted groundwater

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		levels in the area, it is predicted that within the next 50 years there will be a 37% severity in relation to total collapse assuming groundwater levels decline at the current calculated rate (y=-0.004x + 22.595). This can therefore be quantified as a predicted 37% severity over 1% of the extent of the community. • The relatively stable water table at occurrences YALLIN01 and PAYNE01, 07, 08, 09 and 10, indicate they are not threatened by hydrological changes currently. It can be inferred that future forecasted groundwater levels within the vicinity of these occurrences are likely to not exceed the total collapse threshold in the next 50 years. • Based on current and future forecasts of groundwater levels across the community, 66% of the extent of the community has a quantified severity ranging from 8%-100% over 50 years. With a calculated extent of 66% of the extent, the range in severity plausibly falls within the boundaries of VU (>50%) and EN (>80%), or 'does not meet' under C2. • **Available data indicates VU to EN, or does not meet are plausible under C2.**
D.	Disruption of biotic processes or interactions *(Evidence of decline over 50-year period)*	☐ **D1** ☐ **D2** ☐ **D3**
	Justification of assessment under Criterion D.	• Weed invasion and infestation by dieback are considered to be the most significant biotic threats to the community. • The severity of weed invasion associated with collapse is uncertain, but it is assumed conservatively that the community reaches a collapsed state when only 10% (plausible range 0–20%) of its plant species are native. The severity of dieback associated with collapse is assumed to be when 100% of all flora that are susceptible to the disease are lost. • Currently, there are inadequate systematically collected quantitative data about weed levels to support assessment of the community against criterion D. • Currently, there is insufficient evidence to determine the total loss of susceptible native flora lost through dieback infestation, to support assessment of the community against criterion D. • **Insufficient evidence to indicate if the community meets criterion D.**
E.	Quantitative analysis	• No quantitative estimates of the risk of ecosystem collapse have been completed

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	(statistical probability of ecosystem collapse)	• **Not evaluated under criterion E**

Reasons for change of status

Genuine change ☐ New knowledge ☐ Previous mistake ☐ Review/Other ☒ Listing under BC Act

Provide details: The community was initially ranked as Vulnerable using ranking criteria developed in WA that differ from those in the IUCN Red List Criteria for Ecosystems (version 2.2).

Summary of assessment information *(provide detailed information in the relevant sections of the nomination form)*

EOO	674.7km^2	AOO	800km^2 (8 10x10km grid method).
No. occurrences	18	Severely fragmented (justification below)	Yes ☒ No ☐ Unknown
Justification of whether fragmented	Has a naturally narrow endemic range and the Swan Coastal Plain has been subject to extensive clearing. The community occurs as isolated small remnants in a matrix of land that is largely cleared.		
Current known area			110ha
Pre-industrialisation extent or its former known extent (if known)			Community occurs on the Swan, Southern River and Abba vegetation complexes for which 14%, 18% and 7%, respectively remains uncleared; indicative of estimated pre-1750 extent of ~611ha to ~1571ha.
Estimated percentage decline			The extent of decline since 1750 based on vegetation complexes that support community estimated at 82% to 93% (Government of Western Australia 2019).

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Summary assessment against IUCN RLE Criteria

Criterion	Rank indicated	Overall conclusion
A1	-	• Available data do not indicate community meets criterion
A2a	-	• Available data do not indicate community meets criterion
A2b	-	• Available data do not indicate community meets criterion
A3	EN-CR	• Based on available evidence, community plausibly meets criterion EN to CR • EN is most conservative and defensible
B1a	CR	• EOO is <2,000km^2 • Groundwater level and dieback data provide a measure of continuing decline in environmental quality and biotic interactions over next 20 years. • Meets criterion for CR under B1a(ii),(iii)
B1b	CR	• EOO is <2,000km^2 • Observed and inferred continuing decline from land clearing, hydrological change, weed invasion, grazing by introduced fauna, altered fire regimes, disease and a drying climate • Meets criterion for CR
B1c	VU	• EOO is <2,000km^2 • Ecosystem exists at 8 threat defined locations • Meets criterion for VU
B2a	EN	• AOO is 8 grid cells • Groundwater level and dieback data provide a measure of continuing decline in environmental quality and biotic interactions over next 20 years. • Meets criterion for EN under B2a(ii),(iii)
B2b	EN	• AOO is 8 grid cells • Observed continuing decline from land clearing, hydrological change, weed invasion, grazing by introduced fauna, altered fire regimes, disease and a drying climate • Meets criterion for EN
B2c	VU	• AOO is 8 grid cells • Ecosystem exists at 8 threat defined locations • Meets criterion for VU
B3	-	• Known from 8 threat-defined locations • Does not meet
C1	-	• Inadequate evidence to indicate if community meets the minimum thresholds for proportion of the extent (30%) or proportional severity of degradation (30%) over the past 50 years to meet VU.
C2	VU to EN, or does not meet	• 66% of the extent of the community has a quantified severity ranging from 8%-100% over 50 years • Plausibly meets VU to EN, or does not meet
C3	-	• Inadequate data to indicate if community meets minimum thresholds for proportion of the extent (50%) or proportional severity of disruption of abiotic processes (50%) since ~1750 to meet VU.
D1	-	• Inadequate evidence to indicate if community meets the minimum thresholds for proportion of the extent (30%) or proportional severity of disruption of biotic processes (30%) over past 50 years to meet VU.
D2	-	• Inadequate evidence to indicate if community meets the minimum thresholds for proportion of the extent (30%) or proportional severity of disruption of biotic processes (30%) over any 50-year period to meet VU.

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D3	-	• Inadequate evidence to indicate if community meets minimum thresholds for proportion of the extent (50%) or proportional severity of disruption of biotic processes (50%) since ~1750 to meet VU.
E	NA	• No quantitative estimates of the risk of ecosystem collapse.
		Plausibly meets EN under A3. Meets CR under B1a(ii)(iii),b. Meets EN under B2a(ii),(iii),b. Meets VU under B1c, B2c. Plausible rank VU to EN or 'does not meet' under C2. Plausible range of ranks: VU to CR. *'The highest risk category obtained by any of the assessed criteria will be the overall risk status of the ecosystem'* (IUCN RLE Guidelines V1.1 page 42). **Meets CR under B1a(ii)(iii),b.**

Summary of location (occurrence) information *(provide detailed information in the relevant sections of the nomination form)*						
Occurrence	Land tenure	Survey information: date of survey	Condition	Area of occurrence (ha)	Threats *(note if past, present or future)*	Specific management actions
YOON01 (1)	Shire of Busselton (Reserve 1459) Private Public road	1995	70% Excellent 30% Very good	2.6	Clearing, weed invasion and too frequent fire *(past, present, future)*	Fencing, weed control, appropriate fire regime
AMBR01 (2)	Shire of Busselton Public road	1995, 2002, 2012, 2014 (condition survey) and 2015	60% Excellent 25% Very good 15% Good	10.8	Clearing, weed invasion and too frequent fire and disease *(past, present, future)*	Fencing, weed control, apply appropriate fire regime and hygiene procedures
CARB01 (3)	Shire of Busselton (Reserve 38582) Public road	1995	90% Excellent 10% Good	9.8	Clearing, recreational activities and too frequent fire *(past, present, future)*	Fencing, weed control and appropriate fire regime
YALLIN01 (4)	Shire of Busselton (Reserve 36717) Public road	1995	90% Excellent 10% Good	14.5	Clearing, weed invasion and too frequent fire *(past, present, future)*	Fencing, weed control, and appropriate fire regime
CAPEL05 (5)	DBCA (Nature reserve 16144)	1995	90% Excellent 10% Very good	4.3	Clearing (past), too frequent fire and grazing by native or introduced species *(past, present, future)*	Maintenance of fencing around the Capel Nature Reserve, weed control and feral animal control
CARB02 (7)	Shire of Busselton (Reserve 38582) Public road	1995	90% Excellent 10% Good	17.4	Clearing, recreational activities and too frequent fire *(past, present, future)*	Fencing, weed control, appropriate fire regime

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R116703 (8)	Shire of Capel Public road UCL	2002	100% Excellent	1.6	Weed invasion, too frequent fire, disease and rubbish dumping *(past, present, future)*	Fencing, weed control, appropriate fire regime and hygiene procedures
Coolilup01 (9)	Public road DBCA Private	2002	95% Excellent 5% Good	4.2	Weed invasion, too frequent fire, disease and rubbish dumping *(past, present, future)*	Fencing, weed control, appropriate fire regime and hygiene procedures
AMBR04 (10)	Shire of Busselton (Reserve 22614) Public road	2002 (condition survey) and 2012	95% Excellent 5% Good	15.1	Clearing, weed invasion, too frequent fire, disease and grazing by native or introduced species *(past, present, future)*	Maintenance of fencing, weed control, appropriate fire regime, feral animal control and hygiene procedures
myAMBR03 (11)	Shire of Busselton (Reserve 22614)	2002 (condition survey) and 2012	100% Excellent	0.7	Weed invasion, too frequent fire, disease and grazing by native or introduced species *(past, present, future)*	Fencing, weed control, appropriate fire regime, feral animal control and hygiene procedures
AMBR06 (12)	Shire of Busselton (Reserve 22614)	2002 (condition survey) and 2012	100% Excellent	1.6	Weed invasion, too frequent fire, disease and grazing by native or introduced species *(past, present, future)*	Fencing, weed control, appropriate fire regime, feral animal control and hygiene procedures
myAMBR07 (13)	Shire of Busselton (Reserve 22614) Public road	2002 (condition survey) and 2012	80% Excellent 20% Good	4.7	Weed invasion, too frequent fire, disease and grazing by native or introduced species *(past, present, future)*	Fencing, weed control, appropriate fire regime, feral animal control and hygiene procedures
PAYNE01 (14)	DBCA	2003 and 2005	100% Good	6.1	Weed invasion and disease *(past, present, future)*	Maintenance of fencing, weed control,

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						appropriate fire regime and hygiene procedures
myAMBR09 (15)	Shire of Busselton (Reserve 22614) Public road	2003 (condition survey) and 2012	95% Excellent 5% Good	7.2	Weed invasion, too frequent fire, disease and grazing by native or introduced species *(past, present, future)*	Fencing, weed control, appropriate fire regime, feral animal control and hygiene procedures
PAYNE07 (16)	DBCA	2005 and 2011	100% Excellent	1.8	Weed invasion, too frequent fire, disease and grazing by native or introduced species *(past, present, future)*	Fencing, weed control, appropriate fire regime, feral animal control and hygiene procedures
PAYNE08 (17)	DBCA	2011	100% Excellent	2.0	Weed invasion, too frequent fire, disease and grazing by native or introduced species *(past, present, future)*	Fencing, weed control, appropriate fire regime, feral animal control and hygiene procedures
PAYNE09 (18)	DBCA	2005	100% Excellent	1.3	Weed invasion, too frequent fire, disease and grazing by native or introduced species *(past, present, future)*	Fencing, weed control, appropriate fire regime, feral animal control and hygiene procedures
PAYNE10 (19)	Shire of Busselton (Reserve 37348) Public road	2005	100% Excellent	4.0	Clearing (used as sandpit), weed invasion, too frequent fire, disease and grazing by native or introduced species *(past, present, future)*	Fencing, weed control, appropriate fire regime, feral animal control and hygiene procedures

*Condition categories from (Keighery 1994 Vegetation Condition Scale in Government of WA (2000)) are defined below:

Good ('Pristine', 'Excellent', 'Very Good' using Bush Forever (2000) scale): This includes vegetation ranging from 'Pristine' - with no obvious signs of disturbance, to 'Excellent' - Vegetation structure intact, with disturbance only affecting individual species, weeds are non-aggressive species and 'Very Good' - Vegetation structure altered, obvious signs of disturbance eg: from repeated fires, dieback, logging, grazing.

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Medium ('Good' using Bush Forever (2000) scale): This includes vegetation categorised as 'Good' - Vegetation structure altered but retains basic vegetation structure or ability to regenerate it, obvious signs of disturbance are present, from activities including partial clearing, dieback and grazing.

Poor ('Degraded' using Bush Forever (2000) scale): Basic vegetation structure severely impacted by disturbance such as partial clearing, dieback, logging and grazing. Scope for regeneration but not to a state approaching good condition without intensive management.

Beyond recovery ('Completely degraded' using Bush Forever (2000) scale): Vegetation structure is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native shrubs and trees.

Table 1. Vegetation condition of occurrences of the '*Corymbia calophylla* woodlands on heavy soils of the southern Swan Coastal Plain (floristic community type 1b as originally described in Gibson *et al.* (1994))'

IUCN Criteria condition ranking	**Hectares**
Good	80.8
Medium	13.8
Poor	0
Total	94.6

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APPENDIX 1 THREATS

Clearing

The southern Swan Coastal Plain was historically highly cleared for agriculture, rural and urban uses. This community now occurs as highly fragmented small remnants within a highly cleared matrix.

The vegetation complexes that support the community are highly cleared, and this is presumed to be indicative of the level of clearing of this community.

Recent road and bridge construction resulted in clearing of marri and peppermint trees and degraded understorey in an occurrence of the community.

Weed invasion

Weeds change the natural diversity and balance of ecological communities and if not managed can develop into a major threat to this community. Weeds displace native plants, particularly following disturbances such as too frequent fire, grazing or partial clearing, and compete with them for light, nutrients and water. They can also prevent recruitment, cause changes to soil nutrients, and affect abundance of native fauna. They can also impact on other conservation values by harbouring pests and diseases and increasing the fire risk. Sources of weed invasion include adjoining areas of agricultural and urban use, drains, and tracks within the occurrences of this community.

Grazing

Grazing of native vegetation causes alterations to species composition through selective removal of edible species, the introduction and enhancement of weeds by the addition of dung, and through trampling and general disturbance. The presence of feral animals such as rabbits (*Oryctolagus cuniculus)* is a concern as they disturb the vegetation by grazing and burrowing. Rabbit tracks have been recorded at occurrence CAPEL05 (5). Within Ambergate Reserve, high level kangaroo grazing is causing alterations to vegetation. Foxes have also been recorded. This situation is exacerbated due to the lack of intact natural vegetation surrounding the community.

Disease

A combination of factors including temperature and rainfall need to be optimal for the spread of dieback disease caused by *Phytophthora* species to take hold within the occurrences. Taxa that commonly occur in this community, such as *Eucalyptus marginata* (Jarrah) and *Xanthorrhoea preissii* indicate a susceptibility to the disease.

In 2012, full *Phytophthora* dieback interpretation was completed on the 75-hectare Ambergate Reserve in the City of Busselton by Dieback Treatment Services (Dieback Treatment Services 2012). Figure 1 indicates that two small areas located in the centre and north-west of the reserve were determined to be infected by Dieback. The two infected portions of the reserve overlap with occurrences AMBR04 and myAMBR09. There is some evidence of dieback in a small path of occurrence Coolilup01 (9). Dieback disease may potentially be present in more occurrences as not all locations of the community have been surveyed for this pathogen.

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Figure 1. Dieback infectation in Ambergate Reserve (occurrences AMBR02, myAMBR06 and myAMBR08). Red = areas infected; purple = uninterpretable; green = un-infested (Dieback Treatment Services 2012).

Marri canker, caused by a native fungus, *Quambalaria coyrecup*, which appears to attack the stem, is also a threat to the survival of the marri. The disease incidence is greater in disturbed areas such as along roads, in parks, in remnant bushland on farms and on small rural blocks, and appears to be non-recoverable with attempts to contain the pathogen by callus production ultimately circumvented by the pathogen (Lamond 2009; Paap *et al*. 2017).

Hydrology

Altered hydrology due to anthropogenic causes is likely to be an increasing threat to the woodlands of the south-west. Drainage causing decline in water tables, clearing resulting in a decline in evapotranspiration and increased surface runoff, and water quality declines are likely to increasingly impact the hydrologic regimes in the community.

Monitoring bore BN32S (site ref: 61030097), located at the centre of occurrences AMBR01, AMBR04, myAMBR03, AMBR06, myAMBR07 and myAMBR09 within Ambergate Reserve, shows an approximate 1.5m groundwater decline between 1987 and 2018 (Figure 2). The steady water level decline of this area is likely due to a drying climate and therefore less recharge to the aquifer. The decline may also be due to leakage into the underlying aquifer (Leederville aquifer) as licences for water abstraction from the Leederville aquifer surround the Amerbgate reserve. The Ambergate reserve has a specified Ecological Water Requirement (EWR) of 16.85 mAHD (using bore BN32S) reported in the 'South West groundwater areas allocation plan' (Department of Water and Environmental Protection - DWER 2009). As shown in figure 2, water levels do not fall below the EWR threshold currently. Figure 3 is indicative of a prediction that water levels will fall below this threshold in the next 50 years if water continues to decline at the

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current rate (y=-0.0119x + 14.693). This rate will increase if increased drainage and water abstraction occurs. Falling below this threshold would trigger a close monitoring response in this occurrence of the community. It was assumed conservatively that the community would collapse if the water table depth fell to about 10m below ground surface based on the maximum water depth accessed by deep rooted phreatophytic taxa in nearby areas (Froend & Loomes 2006), and observations that the vigour of canopies declined in groundwater dependent trees in association with declining watertable levels (Froend *et al*. 2004). As seen in Figure 3, water table levels at this occurrence do not drop below this threshold of collapse currently, or in the next 50 years.

Monitoring bores within the vicinity of CARB01 and CARB02 (site ref: 61030071), shows an approximate 3.25m groundwater decline between 1987 and 2018 (Figure 6). As shown in figure 6, water levels do not fall below the collapse rate of 10m depth, however, figure 7 shows water levels will fall below this threshold in the next 50 years if water continues to decline at the current rate (y=-0.0087x + 18.291).

Monitoring bores within the vicinity of coolilup01, R116703, YALLIN01 and PAYNE01, 07, 08, 09 and 10, show relatively stable or slow declining levels of groundwater between 1987 and 2018 (Figure 4, 8, 10 and 11). They indicate no signs of hydrological changes currently, and so it is inferred they will not exceed the total collapse threshold of 10m in the next 50 years.

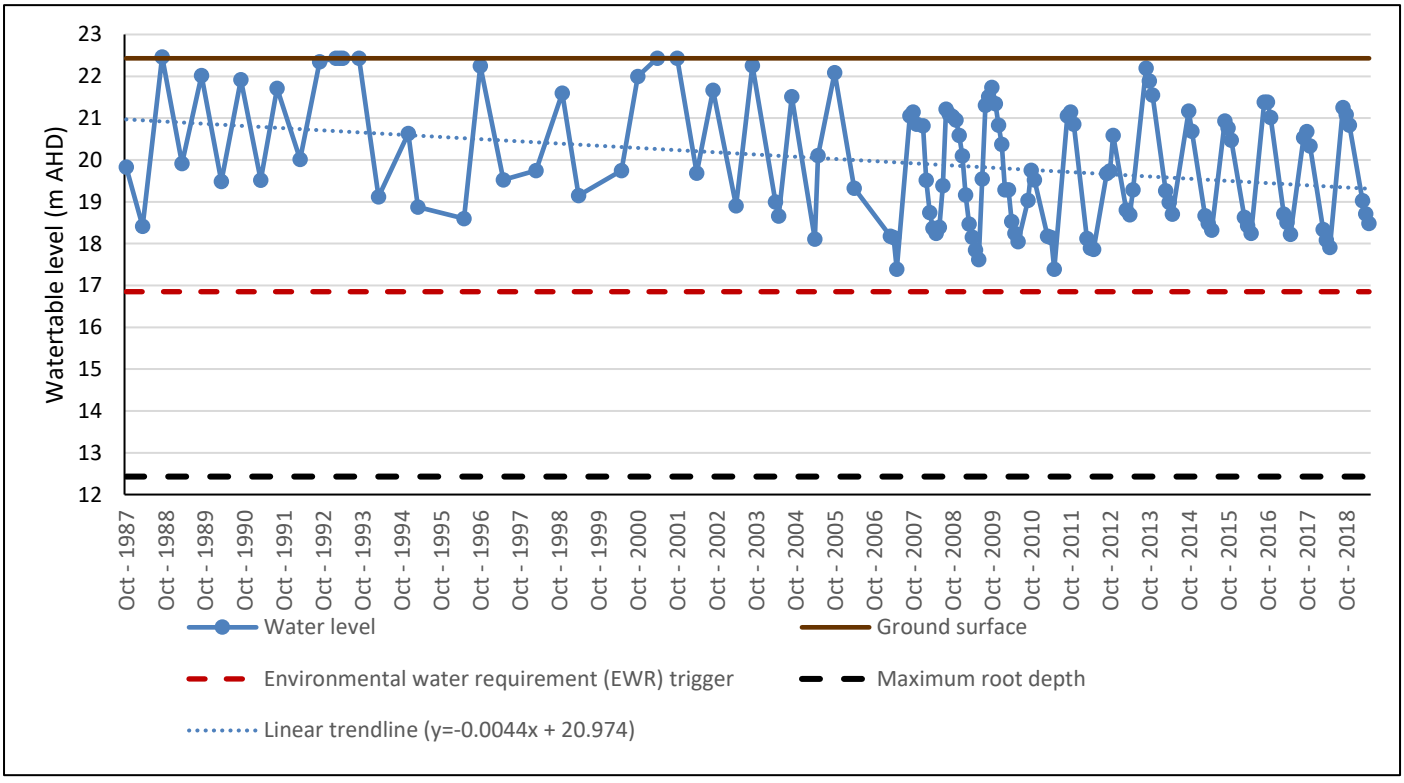

Figure 2. Hydrograph of bore located at the centre of occurrences AMBR01, AMBR04, myAMBR03, AMBR06, myAMBR07 and myAMBR09 within Reserve 22614 of Ambergate (site ref: 61030096). Bore data produced by sampling the Superficial Swan aquifer.

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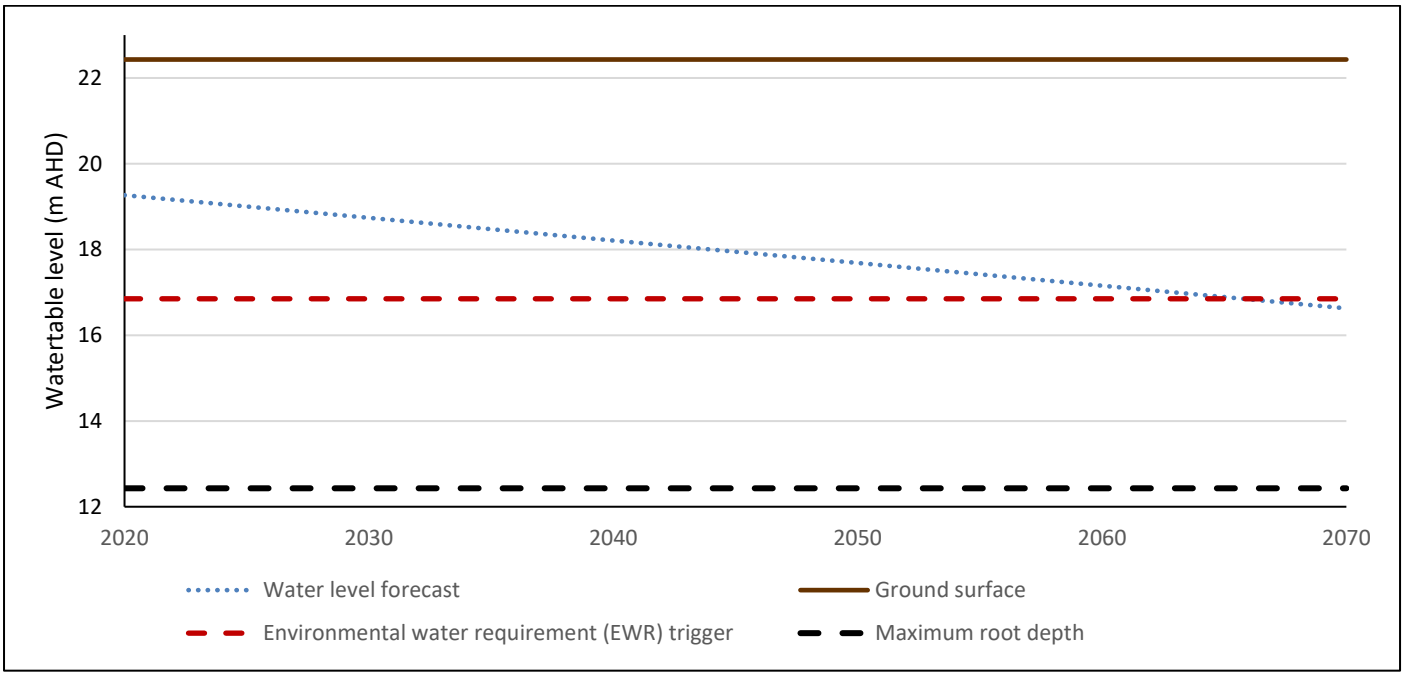

Figure 3. A 50-year forecast of groundwater level decline at the centre of occurrences AMBR01, AMBR04, myAMBR03, AMBR06, myAMBR07 and myAMBR09 within Reserve 22614 (site ref: 61030096), calculated using the trendline (y=-0.0044x + 20.974).

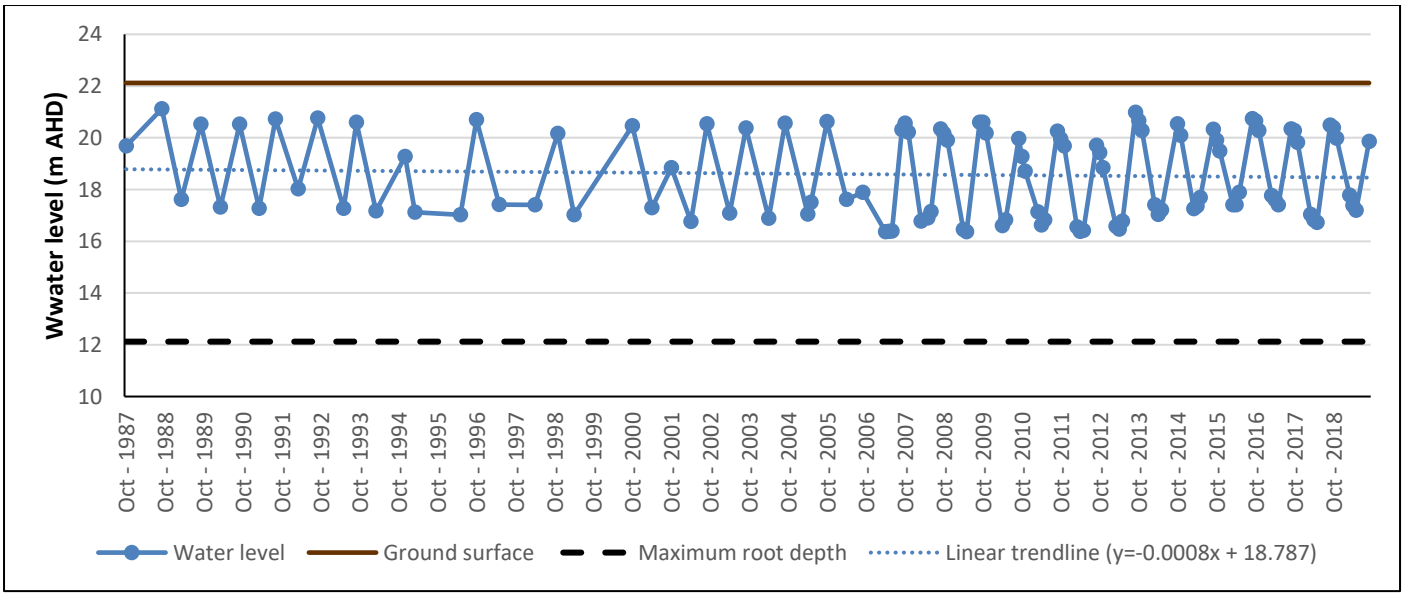

Figure 4. Hydrograph of bore located 94m south-east of occurrence coolilup01 (9) of Reserve 38582 (site ref: 61030033). Bore data produced by sampling the Superficial Swan aquifer.

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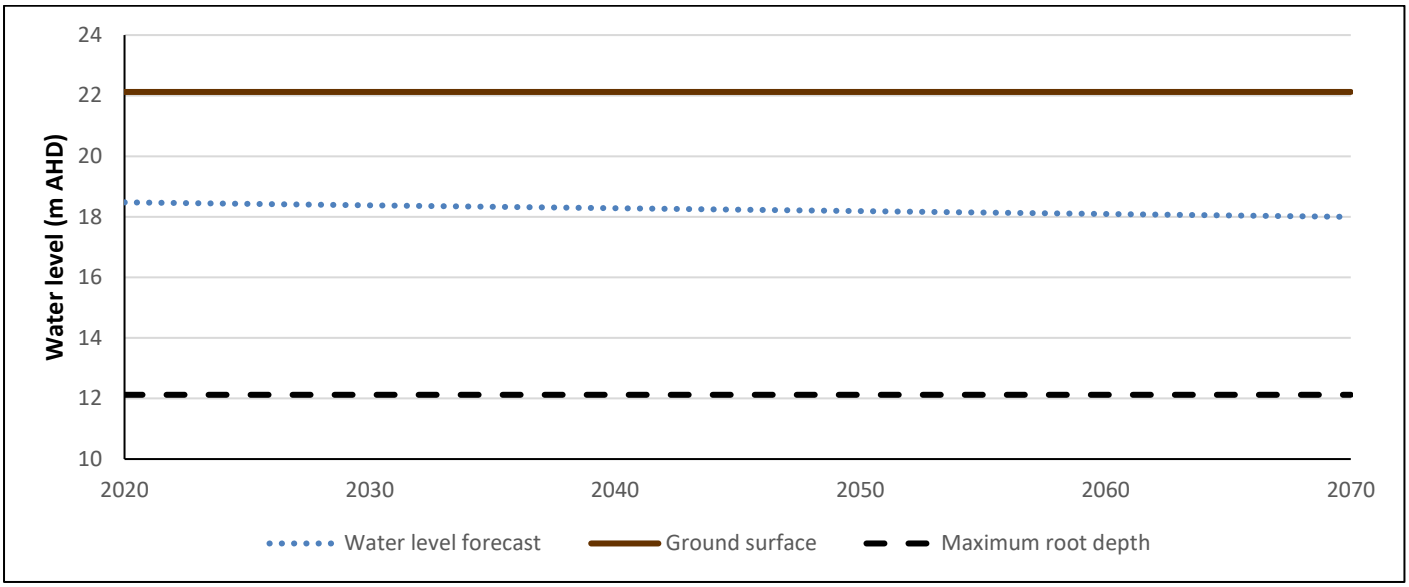

Figure 5. A 50-year forecast of groundwater level decline located 94m south-east of occurrence coolilup01 (9) of Reserve 38582 (site ref: 61030033), calculated using the trendline (y=-0.0008x + 18.787).

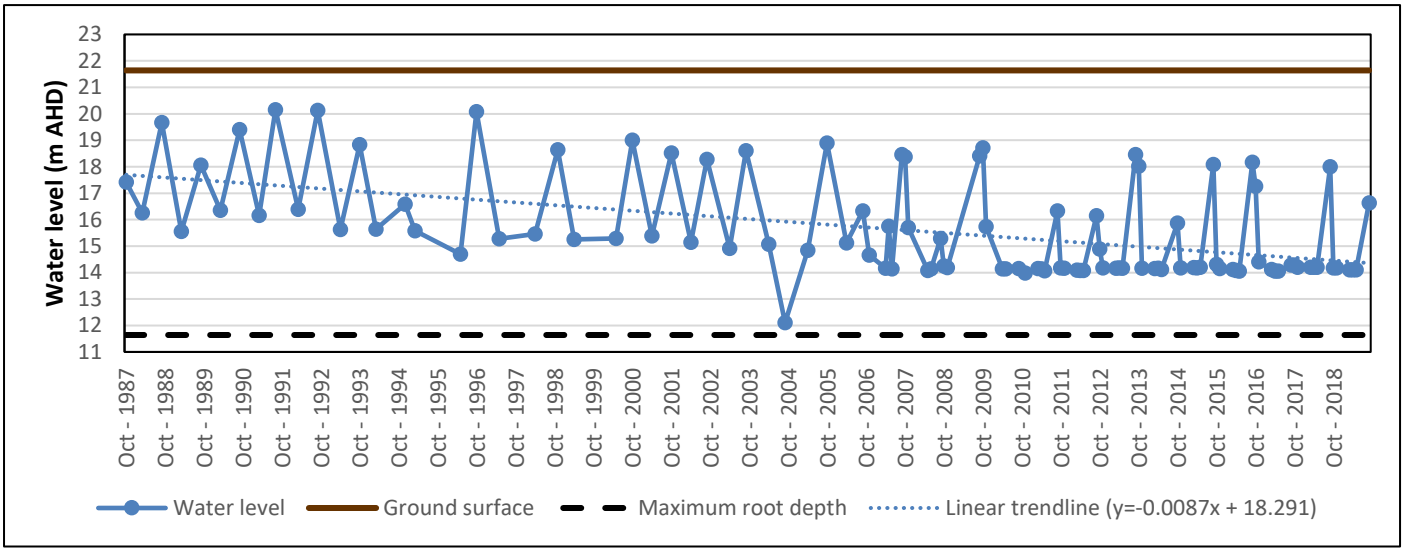

Figure 6. Hydrograph of bore located within occurrence CARB01 (3), and 50m east of occurrence CARB02 (7), in Reserve 38582 (site ref: 61030071). Bore data produced by sampling the Superficial Swan aquifer.

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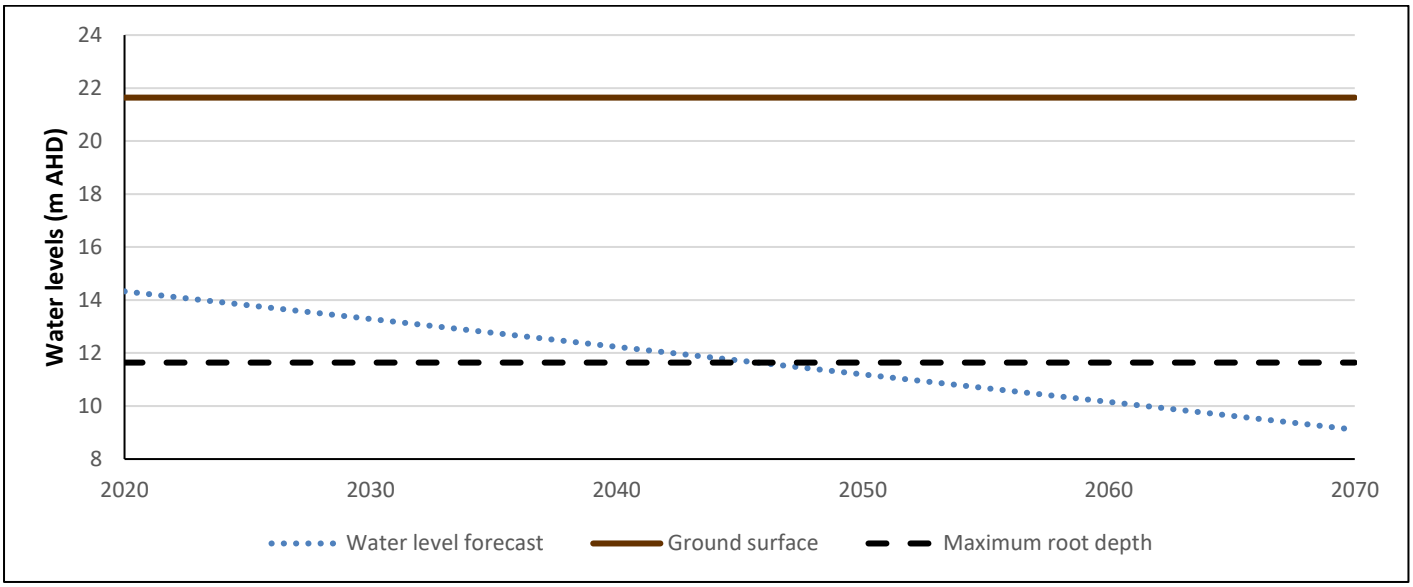

Figure 7. A 50-year forecast of groundwater level decline located within occurrence CARB01 (3), and 50m east of occurrence CARB02 (7), in Reserve 38582 (site ref: 61030071), calculated using the trendline (y=-0.0087x + 18.291).

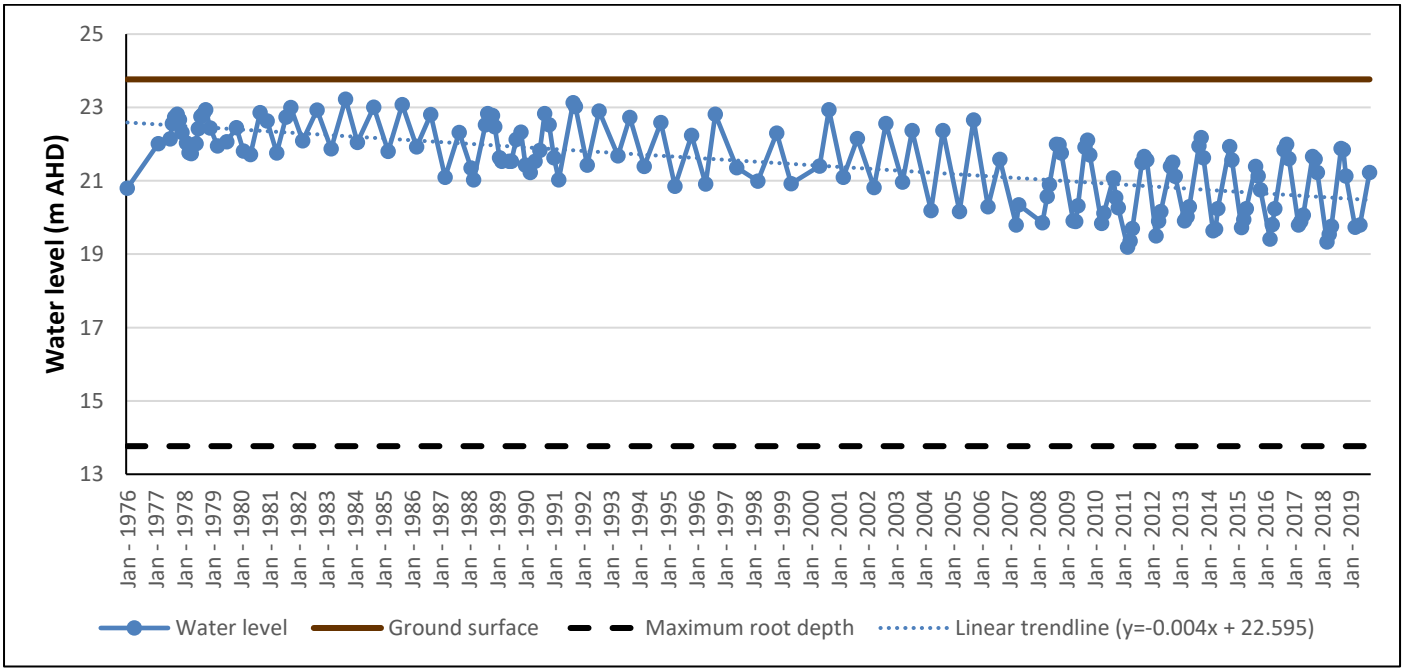

Figure 8. Hydrograph of bore located 11m south-west of occurrence R116703 (8) (site ref: 61118008). Bore data produced by sampling the Leederville aquifer.

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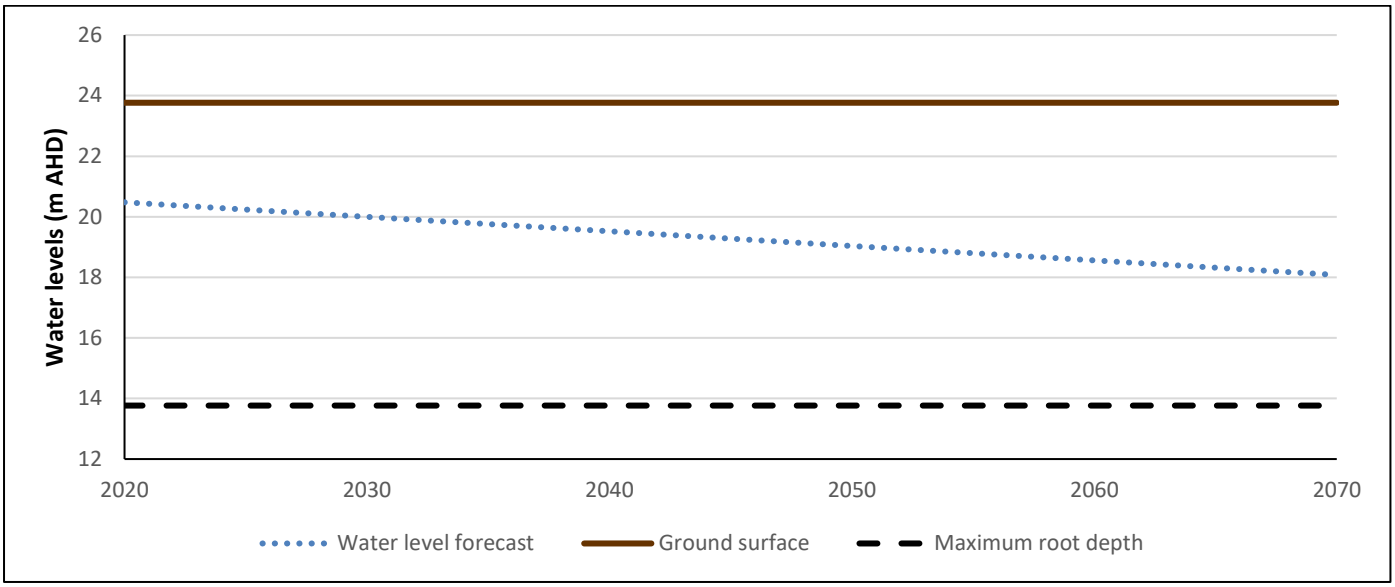

Figure 9. A 50-year forecast of groundwater level decline located 11m south-west of occurrence R116703 (8) (site ref: 61118008, calculated using the trendline (y=-0.004x + 22.595).

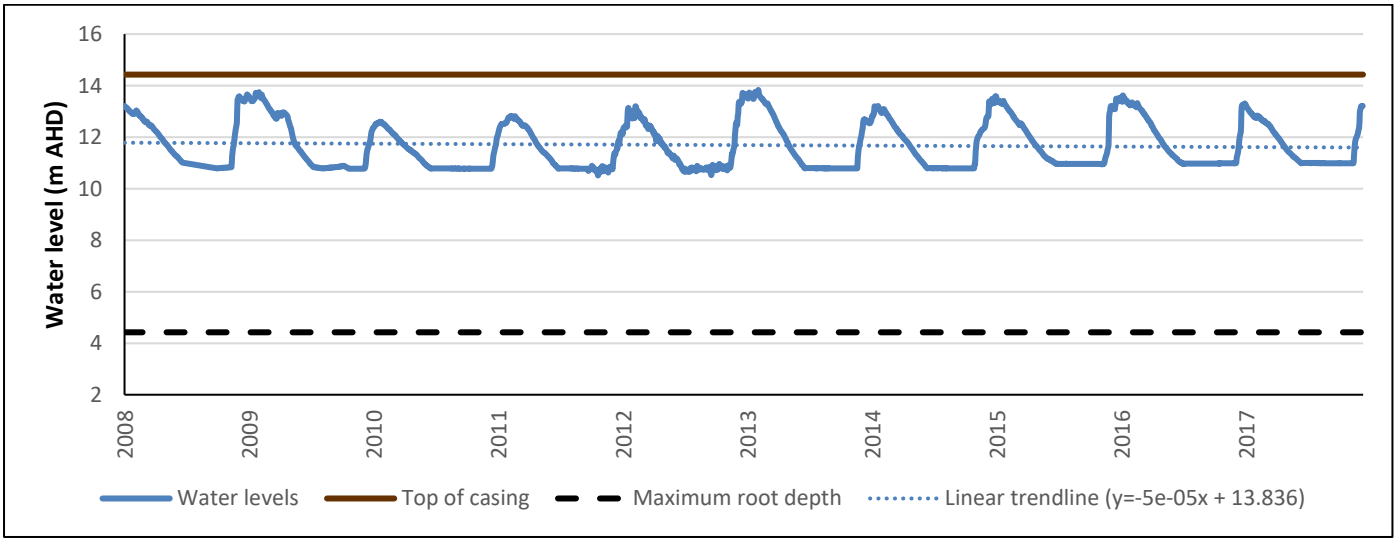

Figure 10. Hydrograph of bore located 2m north of occurrence YALLIN01 (4) (site ref: 61000021). No information on aquifer so assumed to be the Superficial Swan.

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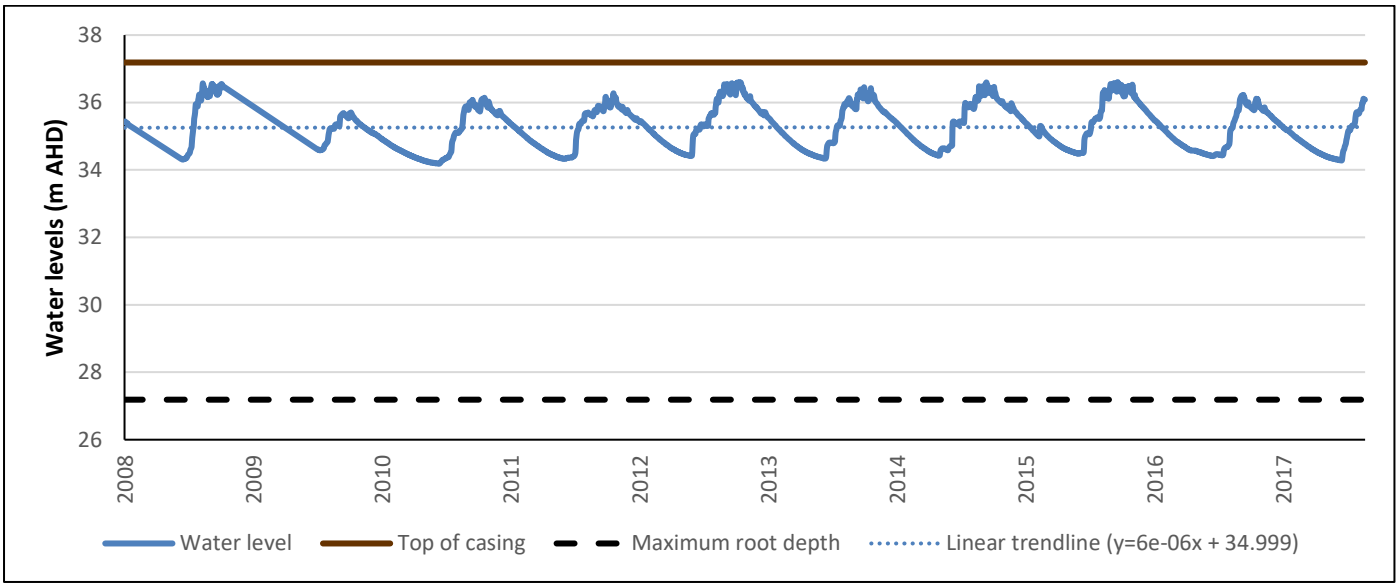

Figure 11. Hydrograph of bore located at the centre of PAYNE01, 07, 08, 09 and 10 occurrences (site ref: 61000022). No information on aquifer so assumed to be the Superficial Swan.

Too frequent fire

Mediterranean ecosystems are usually fire responsive and may require a particular fire regime to assist regeneration (Abbot and Burrows 2003). If an appropriate fire frequency is exceeded, however, species that are obligate seeders may not have sufficient time to flower and produce seed. If the time between fires is too long, obligate seeders may senesce and be unable to regenerate. Therefore, burns must occur at appropriate intervals, and possibly at the appropriate season and intensity, to sustain the integrity of plant communities.

Too frequent fire can increase the risk of invasive weeds establishing within small bushland remnants such as this community (Abbot and Burrows 2003). It is likely that the burning regime in the remnants containing the community has been modified to more frequent fires, especially hot burns, since European settlement.

The risk of fire can be exacerbated by surrounding land uses. The majority of occurrences, including Ambergate Reserve, Fish Road Nature Reserve and Spanish Settlers Reserve, Carbunup, Payne Road are surrounded by rural land where pasture and grassy weeds proliferate on the edges of occurrences and are often more flammable than many of the original native species in the herb layer. The risk of fire is generally increased by the presence of grassy weeds in the understorey, as they are likely to be more flammable than many of the original native species in the herb layer.

It is likely that reduced rainfall and changes in hydrology will cause diminishing growth rates, and plant maturation times will also therefore increase. Longer inter-fire intervals will therefore be desirable.

Climate drying

Drying climate may affect various components of the community type, as this community is reliant on rainfall and local hydrologic regimes. Reduced rainfall and altered hydrology may have a detrimental effect on the herbaceous assemblage. Altered periods or depths of ponding may impact the timing of growth of herbs in the understorey and may also affect the species composition of the community by favouring different plant species.

Decreases in winter and spring (and annual) rainfall are projected with high confidence.

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According to data provided by the CSIRO, early in the century (2030) and under all emission scenarios, winter rainfall is projected to decrease by up to 15%. Late in the century, a decrease in winter rainfall of 30-45% is projected.

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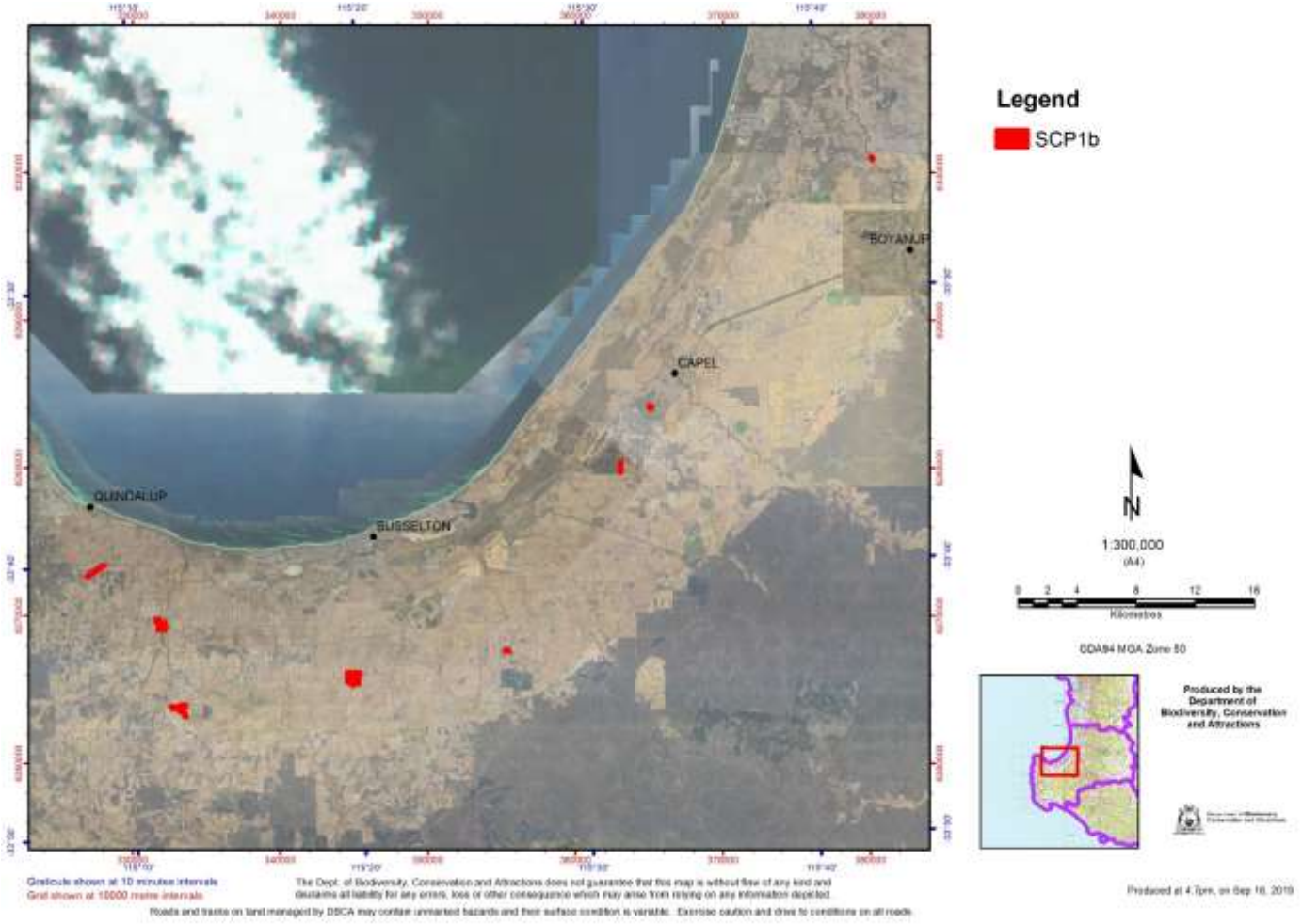
APPENDIX 2 '*Corymbia calophylla* woodlands on heavy soils of the southern Swan Coastal Plain (floristic community type 1b as originally described in Gibson *et al*. (1994))' distribution (red)



The map above was created using ArcGIS version 10.6.1 and shows the extent of distribution of the '*Corymbia calophylla* woodlands on heavy soils of the southern Swan Coastal Plain (floristic community type 1b as originally described in Gibson *et al*. (1994))'. This community has a range of 40km, from Quindalup to Boyanup.

The map was created from known mapped occurrences of the community contained on the Western Australian Threatened Ecological Community database (TECDB), as administered by the Department of Biodiversity and Conservation (DBCA).

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APPENDIX 3 IUCN Red List Criteria for ecosystems (version 2.2) (IUCN 2017)

A. Reduction in geographic distribution over ANY of the following time periods:				
		CR	EN	VU
A1	Present (over the past 50 years).	≥ 80%	≥ 50%	≥ 30%
A2a	Future (over the next 50 years).	≥ 80%	≥ 50%	≥ 30%
A2b	Future (over any 50 year period including the present and future).	≥ 80%	≥ 50%	≥ 30%
A3	Historic (since 1750).	≥ 90%	≥ 70%	≥ 50%
B. Restricted geographic distribution indicated by EITHER B1, B2 or B3:				
		CR	EN	VU
B1	Extent of a minimum convex polygon enclosing all occurrences (Extent of Occurrence)	≤ 2,000 km²	≤ 20,000 km²	≤ 50,000 km²
	AND at least one of the following (a-c):			
	(a) An observed or inferred continuing decline in **EITHER**:			
	i. a measure of spatial extent appropriate to the ecosystem; **OR**			
	ii. a measure of environmental quality appropriate to characteristic biota of the ecosystem; **OR**			
	iii. a measure of disruption to biotic interactions appropriate to the characteristic biota of the ecosystem.			
	(b) Observed or inferred threatening processes that are likely to cause continuing declines in geographic distribution, environmental quality or biotic interactions within the next 20 years.			
	(c) Ecosystem exists at …	1 location	≤ 5 locations	≤ 10 locations
B2	The number of 10 × 10 km grid cells occupied (Area of Occupancy)	≤ 2	≤ 20	≤ 50
	AND at least one of a-c above (same sub-criteria as for B1).			
B3	A very small number of locations (generally fewer than 5) **AND** prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and thus capable of collapse or becoming Critically Endangered within a very short time period (B3 can only lead to a listing as VU).			VU

C. Environmental degradation over ANY of the following time periods:

		Extent (%)	Relative severity (%) ≥ 80	≥ 50	≥ 30
C1	The past 50 years based on change in an abiotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table:	≥ 80	CR	EN	VU
		≥ 50	EN	VU	
		≥ 30	VU		
			≥ 80	≥ 50	≥ 30
C2	The next 50 years, or any 50-year period including the present and future, based on change in an abiotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table:	≥ 80	CR	EN	VU
		≥ 50	EN	VU	
		≥ 30	VU		
			≥ 90	≥ 70	≥ 50
C3	Since 1750 based on change in an abiotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table:	≥ 90	CR	EN	VU
		≥ 70	EN	VU	
		≥ 50	VU		

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D. Disruption of biotic processes or interactions over ANY of the following time periods:

		Extent (%)	Relative severity (%) ≥ 80	≥ 50	≥ 30
D1	The past 50 years based on change in a biotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table:	≥ 80	CR	EN	VU
		≥ 50	EN	VU	
		≥ 30	VU		
			≥ 80	≥ 50	≥ 30
D2	(D2a) The next 50 years, or (D2b) any 50-year period including the present and future, based on change in a biotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table: OR	≥ 80	CR	EN	VU
		≥ 50	EN	VU	
		≥ 30	VU		
			≥ 90	≥ 70	≥ 50
D3	Since 1750, based on a change in a biotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table:	≥ 90	CR	EN	VU
		≥ 70	EN	VU	
		≥ 50	VU		

E. Quantitative analysis

	CR	EN	VU
… that estimates the probability of ecosystem collapse to be:	≥ 50% within 50 years	≥ 20% within 50 years	≥ 10% within 100 years