Great Northern Highway

MAIN ROADS WESTERN AUSTRALIA

Bindoon Bypass
Environmental Review Document | Response to Submissions

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Issue summary

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9	31-05-22	Revised with further EPA comments	Peta Hayward (EPA Services); John Braid (Main Roads)

Contents

Tables

Figures

Appendices

Glossary

Abbreviation	Description
AHMP	Artificial Hollow Management Plan
CEMP	Construction Environmental Management Plan
DWER	Department of Water and Environmental Regulation
DAWE	Department of Agriculture water and the Environment
DBCA	Department of Biodiversity, Conservation and Attractions
DoW	Department of Water (now DWER)
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA	Environmental Protection Authority
EP Act	*Environmental Protection Act 1986*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ERD	Environmental Review Document
ESD	Environmental Scoping Document
FCT	Floristic Community Type
GHG	Greenhouse Gas
GNH	Great Northern Highway
ha	Hectare
km	Kilometre
m	Metre
Main Roads	Main Roads Western Australia
MNES	Matters of National Environmental Significance
mm	Millimetre
PEC	Priority Ecological Community
RIWI	Rights in Water and Irrigation (Act)
t	Metric tonne
tCO_2e	Tonnes Carbon Dioxide equivalent
TEC	Threatened Ecological Community
WA	Western Australia
BC Act	Biodiversity Conservation (Act)

1. Introduction

1.1 Purpose and Structure of this Document

The purpose of this document is to provide responses to issues in submissions provided to Main Roads WA (Main Roads) between 25 May 2020 to 6 July 2020 that relate to content of the Bindoon Bypass Environmental Review Document (ERD). The key points from issues raised within submissions are summarised in this document. Submissions are classified according to the Key Environmental Factors of the Proposal. Where a submission raises points across a number of Environmental Factors, these points are addressed separately under each Environmental Factor.

This document provides Main Roads with an opportunity to:

- Address any errors and/or omissions identified in the ERD document
- Present additional information from investigations undertaken since the ERD document was submitted
- Modify aspects of the Proposal in response to submissions received
- Amend environmental commitments and/or include additional environmental commitments in response to submissions received

On 8 February 2021, the Department of Water and the Environment's (DWER) EPA Services provided comment and advice on the draft responses to the submissions received. Further comments on the responses to the submission from the Department of Biodiversity, Conservation and Attractions (DBCA) were provided on 19 February 2021. Additional comments and queries were provided by DWER EPA Services on 23 July 2021 and 3 September 2021. This document also provides responses to those comments and advice.

1.2 Description of the Proposal

Main Roads proposes to construct a bypass around Bindoon town and Bindoon Hill (hereafter referred to as the Bindoon Bypass, or the Proposal), located within the Shire of Chittering approximately 70 km north east of Perth and approximately 13 km north of Muchea. The Bindoon Bypass will divert from the existing Great Northern Highway (GNH) at the Chittering Roadhouse, running to the west of Bindoon and re-joining the GNH north of Calingiri Road. This will involve the construction of 47 km of new highway, including a bridge over the Brockman River.

The Bindoon Bypass will be constructed in stages based on the expected traffic volumes. The initial stage (Interim Stage) will consist of a single carriageway (two lanes) with a number of overtaking lanes for both north-bound and south-bound traffic, as well as stopping facilities. The second stage (Ultimate Stage) will build on the work done in the Interim Stage to accommodate higher numbers of road users and comprises an upgrade to a dual carriageway (four lanes) between Chittering Roadhouse and Bindoon-Moora Road. Upgrades to local roads, rail crossings and intersections may also be required, as well as relocation of services, fencing of the road reserve and construction of driveway accesses for landowners.

1.3 Environmental Assessment Process

The Bindoon Bypass was referred to the EPA under section 38 of the WA *Environmental Protection Act 1986* (EP Act) on 1 September 2017. The referral was advertised by the EPA for a seven-day public comment period from 15 September 2017 to 21 September 2017. Two comments on the referral were received by the EPA during this period.

On 2 October 2017, the Chairman of the EPA determined the Proposal required further assessment at the level of public environmental review. The public review period was set at six weeks and the Environmental Scoping Document (ESD) for the environmental review would be prepared by the EPA.

The ESD for the Proposal identified the following five Key Environmental Factors:

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

The ERD for the Proposal was published on 25 May 2020 for a public review period of six weeks, ending on 6 July 2020. A total of ten submissions were received during the public review period.

The Proposal (EPBC 2017/8035) has also been determined to be a controlled action under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and will be assessed via Preliminary Documentation. The controlling provision under Part 3 of the EPBC Act is:

- Listed threatened species and communities (Sections 18 and 18A)

2. Submissions Received and Main Roads Responses

2.1 Flora and Vegetation

The submission from the Department of Biodiversity, Conservation and Attractions (DBCA) raised concerns related to impacts to flora and vegetation including technical queries in regards to the definition of vegetation types and community boundaries, impacts to Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community (Banksia Woodlands TEC) and the completeness of the surveys. The submissions relevant to this environmental factor and Main Roads responses to these are provided in **Table 2-1**.

Table 2-1: Responses to Submissions Received in Relation to the Flora and Vegetation Environmental Factor

No.	Submitter	Submission and/or Issue	Response to Comment
1.	Department of Biodiversity, Conservation and Attractions (DBCA)	Concerns in relation to the consolidation of vegetation quadrat data and resultant determination of Floristic Community Type (FCTs). To enable assessment of impacts of significant FCTs, section 6.2.3 should be revised in addition to the provision of amended dendrograms, raw quadrat data and spatial data displaying quadrat locations and potential FCT extents.	Only a portion of the study area (i.e. that within the Swan Coastal Plain Bioregion) is relevant to the FCT studies of Gibson *et al* and Keighery. Therefore, it isn't possible to analyse all the quadrat data for the project in comparison to these sources. When work was originally commenced in 2016, DBCA suggested that the Shepherd regional vegetation be used to analyse regional representation of the vegetation since previous surveys conducted by Phoenix had used this reference, and this would allow local comparisons. Therefore, the Shepherd vegetation associations were used for the analysis of regional context (representation). The only TECs and PECs relevant to the region of the study area at the time of the assessment were the Banksia woodlands at various State and Commonwealth classifications. The later analysis of vegetation data conducted as part of a targeted Banksia woodland TEC/PEC study used only quadrat data from sites that were found to support Banksia woodland. Each quadrat containing Banksia woodland was compared to the Gibson *et al* /Keighery dataset, in an attempt to infer FCTs and to determine representation of the significant ecological communities within the study area. The following data analysis approach was taken:

No.	Submitter	Submission and/or Issue	Response to Comment
			• Compare all quadrat data with each other to identify clusters of similar vegetation units, which then allowed grouping of study sites for vegetation mapping purposes with associated vegetation descriptions prepared • Compare the qualitative descriptions of the groupings of quadrats (and the descriptions prepared) with Shepherd vegetation associations, to align Shepherd associations to each, which was then used to determine regional representation and therefore significance • Analyse quadrat data from Banksia woodlands with the Gibson *et al* / Keighery dataset to infer and assign FCT. The extent of all vegetation types throughout the study area was determined through multiple surveys across various seasons, including three spring survey events and a high density of quadrats sampled in Banksia woodland, in order to appropriately target the significant ecological community. Reanalysis of all quadrat data in comparison to the Gibson/Keighery dataset for those quadrats on the Swan Coastal Plain has been undertaken. Refer to the responses provided in **Table 3-2** for full details of the reanalysis.
2.	DBCA	Clarification on how vegetation was determined to correspond to the Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community (TEC). Based on the methodology provided in section 6.3 (page 86), it appears that the combined PATN analysis used in the determination of the extent of this TEC is not in accordance with the 'Approved Conservation Advice for the Banksia Woodlands of the Swan Coastal Plain ecological community' (Threatened Species Scientific Committee, 2016). Quadrat data can provide a general description for a vegetation unit, however the mapping of areas 'likely to be Banksia Woodlands of the Swan Coastal Plain TEC',	The assessment of Banksia Woodlands of the Swan Coastal Plain TEC consisted of an on-ground assessment in accordance with the Approved Conservation Advice to determine if the TEC occurs. Each quadrat was analysed against the diagnostic criteria described in the approved Conservation Advice for the Banksia Woodlands Community. Based on the key diagnostic characteristics of the TEC, a simple checklist was developed in order to determine whether each quadrat is representative of the TEC. PATN analysis was also conducted to infer the FCTs relevant to each quadrat for vegetation supporting Banksia woodland. Determination of the areas of Banksia woodland that are eligible for inclusion as the TEC was then carried out, based on the size and condition of each individual patch (contiguous area, not separated by more than 30 m) of Banksia woodland. This analysis and assessment determined which areas and vegetation units of the study area are considered to be representative of the Banksia Woodland TEC and

No.	Submitter	Submission and/or Issue	Response to Comment
		require an on-ground assessment against the description, condition and area thresholds in the Approved Conservation Advice to determine if the TEC occurs. Please confirm if this has occurred?	the extent of patches, including as connected to Banksia woodland outside the study area (regional patches).
3.	DBCA	It is noted in section 7.2.1 (page 109) of the Flora and Vegetation Assessments report that 89.05 hectares of the study area was not accessible and therefore not included in the 2018 survey. If project works are proposed to occur within this area, an assessment of conservation values is required to enable identification and management of environmental impacts.	The 89.05-hectare portion of the Development Envelope that was not surveyed is to the west of the railway and Cullalla Road and is largely private property that will not be acquired for the Proposal. This area consists of cleared paddocks, pine plantation and some native vegetation, likely to be Banksia woodland. The disturbance footprint for the proposal does not extend into this unmapped area. Native vegetation present will be marked as a "Native Vegetation Retention Area" and no clearing will occur in this area (**Figure 2**).

2.2 Terrestrial Fauna

Four submissions were received regarding the EPA's Terrestrial Fauna factor. The submissions raised concerns related to habitat fragmentation, design of fauna underpasses, impacts to black cockatoos and potential presence of the Julimar Shield-backed Trapdoor Spider. The submissions relevant to this environmental factor and Main Roads responses to these are provided in **Table 2-2**.

Table 2-2: Responses to Submissions Received in Relation to the Terrestrial Fauna Environmental Factor

No.	Submitter	Submission and/or Issue	Response to Comment
4.	ANON-8KZR-56UW-6	The Proposal does not appear to consider Short-Range Endemics, such as the trap-door spider, nor provide information on avoidance or mitigation.	Targeted searches for the Julimar Shield Backed Trapdoor Spider (*Idiosoma mcclementsorum*) were undertaken in areas of appropriate habitat in August 2018. Two burrows were located but are outside of the disturbance footprint (**Figure 1**). For full details, refer to the fauna survey report titled "*Great Northern Highway Bindoon Bypass Project: Revised Fauna Assessment (June 2019)*" provided as Appendix E to the ERD.
5.	• ANON-8KZR-56U6-5 • ANON-8KZR-56US-2	Scale of clearing of Black Cockatoo foraging habitat and the need to revegetate foraging habitat within the range of the affected flocks.	Observations of both Carnaby's Black Cockatoo and the Forest Red-tailed Black Cockatoo were recorded across the Development Envelope during the surveys undertaken for the Proposal. While much of the Development Envelope was mapped as potential foraging habitat, the value of this varied, depending on the condition and type of the vegetation. For example, scattered trees in otherwise cleared paddocks were considered Low value habitat. It should also be noted that the Forest Red-tailed Black Cockatoo does not commonly forage on Banksia. As such, those areas of the property that are dominated by Banksia woodland are considered to represent low value foraging habitat for the Forest Red-tailed Black Cockatoo. Revegetation of the roadsides and road reserve following construction of the Proposal will include species that provide both foraging and breeding habitat for Black Cockatoos. In addition, the offsets package for the Proposal may include revegetation of degraded land in combination with acquisition of land with good quality vegetation that provides foraging habitat for Black Cockatoos. Main Roads is liaising with DBCA to identify appropriate land parcels to acquire. The advice from the submitter that revegetation should occur within the range of the affected flocks and will be taken into consideration during these ongoing discussions with DBCA.

No.	Submitter	Submission and/or Issue	Response to Comment
			The Carnaby's Cockatoo (*Calyptorhynchus latirostris*) Recovery Plan sets out the actions and priority areas required to stop further decline in the distribution and abundance of the species. There are several recovery projects underway, details of which can be found on DBCA's website (https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-animals/black-cockatoos) Management actions presented in the ERD for Carnaby's Black Cockatoo along with the offset package have been and will continue to be guided by the objectives and priorities identified in the Recovery Plan.
6.	• ANON-8KZR-56U6-5 • ANON-8KZR-56UW-6	The need to retain and protect current and future Black Cockatoo breeding habitat, including the role of offsets such as installation of artificial hollows, to achieve this.	Main Roads is committed to minimising impacts to Black Cockatoo, through avoidance where possible, mitigation through the revegetation of roadsides and offsets including the installation of artificial hollows. During the route selection and alignment design process, the Proposal has sought to avoid Black Cockatoo habitat where practicable. The alignment has been preferentially located in areas of cleared paddock or low value habitat for Black Cockatoos. Specific effort has been undertaken to minimize the number of trees with hollows showing evidence of use that cannot be avoided. This included an assessment of the implications of avoiding these trees on other areas further along the alignment. The assessment found that further avoidance was not possible and that avoiding any of the remaining trees would in fact increase the number of trees with hollows (showing evidence of use) that would be cleared. Surveys undertaken by Bamford Consulting Ecologists (BCE – 2019) identified 12,936 potential breeding trees (not including those with hollow suitable for black cockatoos) within the study area. Of these 1,465 are within the disturbance footprint. The clearing of 1,465 potential breeding trees (without suitable hollows) equates to 11% of those recorded by BCE (2019). BCE (2017) assessed the density of potential breeding trees within habitats considered suitable for Black Cockatoos as follows: • VSA 3 Marri – Jarrah Woodland: 10.06 trees/ha (± 1.34) • VSA 4 Marri – Jarrah Woodland with little understorey: 13.22 trees/ha (± 0.73) • VSA 5 Wandoo Woodland: 25.41 trees/ha (± 1.54)

No.	Submitter	Submission and/or Issue	Response to Comment
			• VSA 8 Paddocks with Large Remnant Trees: 4.9 trees/ha (± 2.59) It is reasonably expected that these densities are applicable to the habitats adjacent to the survey study area. There is approximately 93,004 ha of potentially suitable habitat within 15 km of the Development Envelope. Based on the vegetation complex mapping undertaken by Heddle et al. (1980) and Mattiske and Havel (1998) there is approximately 23,996 ha of vegetation that can be considered to correspond to VSA 3, 21,692 ha corresponding to VSA 4 and 28,767 ha corresponding to VSA 5. It is therefore reasonable to assume that there are over 1.2 million potential breeding trees within this area. The removal of 1,465 (0.12%) of these to allow for implementation of the Proposal is considered unlikely to have a significant impact on the recruitment of future nest hollows in the area. Revegetation of roadsides and the road reserve for the Proposal will include species that provide both foraging and breeding habitat for Black Cockatoos. This will assist in providing replacement habitat and breeding tree succession within the range of the affected flocks. In addition, the offsets package for the Proposal may also include revegetation of degraded land with species that provide breeding habitat. Where artificial hollows are installed, they will be managed in accordance with an Artificial Hollow Management Plan (in prep.) which will include regular inspections to identify maintenance needs. It is anticipated that these hollows will be installed within the range of the affected flocks and will be used to enhance breeding habitat. Main Roads is liaising with DBCA to identify appropriate offsets for the Proposal, including the identification of land parcels that may be acquired. Offsets will be used to retain and protect current habitat for Black Cockatoos.
7.	ANON-8KZR-56U6-5	The need to consider cumulative impacts in relation to Black Cockatoos.	Cumulative impacts were considered in Section 4.3.5.4 of the ERD. Part 9 of the ERD was provided to the EPA but was not uploaded to the EPA's website. Submitters were not able to review this information.
8.	• DBCA • ANON-8KZR-56UW-6	Further information on post-construction mitigation measures for fauna, such as the design of fauna underpasses and details of revegetation.	The ERD includes the following management measures that will continue into the operations phase:

No.	Submitter	Submission and/or Issue	Response to Comment
			• No plant species which provides habitat for Black Cockatoos will be planted within 10 m of the edge of the road seal. • Fauna warning signs installed in areas where native vegetation occurs next to the roadside. Indicative locations for up to seven fauna underpasses are provided in the ERD. These locations will be confirmed during detailed design. Fauna underpasses will be designed in accordance with Main Roads guideline "*Design of Fauna Underpasses*" available online at *https://www.mainroads.wa.gov.au/technical-commercial/technical-library/road-traffic-engineering/roadside-items/design-of-fauna-underpasses/* and includes fencing and landscaping to channel fauna to the underpass. The Main Roads guideline has been developed with reference to the following documents in order to identify preferred design and construction practices that take into consideration target fauna species and result in effective fauna underpasses: • Fauna Sensitive Road Design: Past and Existing Practices. Queensland Department of Main Roads (2000) • Roads versus animals: how can we maximise the effectiveness of fauna underpasses and minimise road kills? West, Paul and Bencini, Roberta and Della Bona, Jeanette (2007) • Evaluation of the Use and Effectiveness of Wildlife Crossings – NCHRP Report 615. Transportation Research Board (2008) Main Roads acknowledges that fauna underpasses can attract introduced predators such as cats and foxes. Proper design of these underpasses in line with Main Roads guidelines and best practice, including the use of landscaping to provide shelter, will minimise the risk of predation at these locations.
9.	ANON-8KZR-56US-2	Presence of the road severing fauna corridors and fauna mortality due to vehicle collisions (roadkill).	Section 4.3.5.1 of the ERD notes that the clearing required for the proposal may increase habitat fragmentation within the broader area, however it was considered unlikely that the clearing required would result in a barrier to the movement of bird species. The provision of fauna underpasses will assist in mitigating impacts to habitat connectivity for ground dwelling fauna. The fauna underpasses will be

No.	Submitter	Submission and/or Issue	Response to Comment
			designed in accordance with Main Roads guideline "Design of Fauna Underpasses" available online at *https://www.mainroads.wa.gov.au/technical-commercial/technical-library/road-traffic-engineering/roadside-items/design-of-fauna-underpasses/* The following management and mitigation measures have been included in the ERD to reduce the risk of these impacts to terrestrial fauna: • Installation of fauna underpasses to provide fauna with safe passage under the road. Fauna underpass design includes fencing and landscaping to channel fauna to the underpass • Installation of lighting at intersections only. Full (V3) lighting will only be installed at major intersections. Other intersections will have 'flag' lighting installed, the purpose of which is to indicate to drivers the location of an intersection, rather than providing full lighting of the road surface. • Lighting design and luminaries will be selected such that light spill is minimised.

2.3 Inland Waters

Four submissions were received regarding the EPA's Inland Waters factor. The submissions raised concerns related to impacts to wetlands and availability of water for existing users drawing from the superficial aquifer. The submissions relevant to this environmental factor and Main Roads responses to these are provided in **Table 2-3**.

Table 2-3: Responses to Submissions Received in Relation to the Inlands Waters Environmental Factor

No.	Submitter	Submission and/or Issue	Response to Comment
10.	• ANON-8KZR-56US-2 • Private Landowner - Cullalla Road Submission not provided through Consultation Hub • Private Landowner - Kinkella Road Submission not provided through Consultation Hub	• Concerns about disruption to groundwater flows, particularly in the surficial aquifer, and a reduction in groundwater available to existing users as a result of the Proposal. • Concerns about disruption to groundwater flows and indirect impacts to wetlands including Lake Nangar.	The location of groundwater bores for construction and their rates of abstraction will be considered further closer to construction commencing. The impact on existing bores and local users will be considered by Main Roads during this process. All efforts will be made to avoid impacts on local abstraction bores during construction. It is possible that construction water may be sourced from existing licenced bores upon agreement with the licensee. Abstraction for construction water will be managed to avoid impacts to downstream users and the environment. Construction water is typically sourced from deeper aquifers, such as the Leederville aquifer, which are separated from the superficial aquifer in this location by a clay aquitard. Where downstream users experience a reduction in available water that is attributable to construction water abstraction, Main Roads will consult with the impacted users to identify an appropriate solution, which may include cessation of abstraction at that location. During road operation, Main Roads will not be abstracting groundwater and there will be no impact on local bore users. The existing hydrological regime, both surface and ground water, will be maintained post-construction. There may be localised minor disruptions to surface water due to drainage structures. The presence of the road, once constructed, is unlikely to significantly reduce infiltration to the underlying aquifers. Some excavation (cut) will be required for construction of the road in order to achieve the required road levels and reduce the steepness of uphill/downhill sections. These excavations are not expected to intersect the superficial groundwater aquifer. Any seepage that may occur in these areas will be captured by the drainage system and allowed to infiltrate into the ground and back into the superficial aquifer. The existing groundwater regime is therefore expected to be

No.	Submitter	Submission and/or Issue	Response to Comment
			maintained and indirect impacts to wetlands, including Lake Nangar, are not expected. In the area of Barn Road/Cullalla Road, the Bindoon Bypass is at grade with the natural land surface. That is, there is no cut proposed in this area. As no deep excavation is required the construction and ongoing presence of the road itself will not result in changed groundwater pathways in this location and the groundwater connection to the dams downstream of this area will be maintained. In addition, Main Roads has made the following commitments in relation to groundwater management: • Road sub-surface will be constructed above the high (wet) groundwater table • Where groundwater is intersected, seepage water will be collected for construction purposes, or drained to an infiltration basin based on drainage management strategy • Implementation of a drainage management strategy including the location of culverts to maintain flow connectivity Effective, site-relevant stormwater treatment measures such as swales and infiltration basins will be implemented to promote infiltration as close to the source as possible, as well as promote controlled sedimentation prior to stormwater discharging to the wetland and waterways.
11.	DBCA	Confirmation that calculation of significant impacts to wetlands considered the full extent of areas mapped as “Conservation”. The ERD identifies 0.4 ha of impacts to wetlands that are considered significant and proposed to be offset. In accordance with ‘A methodology for the evaluation of Wetlands of the Swan Coastal Plain, Western Australia’ (DBCA 2017) a wetland evaluation to determine the conservation significance should consider a suite of wetland attributes, functions, and values. In the absence of a formal request to modify the	Section 4.4.4.2 of the ERD sets out the amount of disturbance required within the mapped boundaries of CCWs and REWs. A total of 2.7 ha within the mapped boundaries of CCWs while 0.43 ha within the mapped boundaries of REWs will be impacted by the proposal. Main Roads will offset the 2.7 ha of disturbance required within the CCWs. It is expected that this will be in the form of acquisition of land that that includes 7.35 ha of vegetation associated with CCWs. In line with the recommendation in the Wetland Assessment Report, an application to amend the current GWSCP mapping within and adjacent the development envelope has not been made.

No.	Submitter	Submission and/or Issue	Response to Comment
		Geomorphic Wetlands of the Swan Coastal Plain (GWSCP), undertaken, in accordance with the current DBCA methodology, the existing GWSCP mapping should be utilised to calculate the direct and indirect impacts to the CCW and REWs.	
12.	DBCA	Maintenance of the hydrological function of mapped wetlands should be addressed during construction within the proposed Construction Environmental Management Plan and post-construction through the implementation of proposed site-relevant stormwater treatment measures developed in accordance with the Stormwater Management Manual for WA (DWER 2017). These measures in addition to the proposed offsets for residual wetland impacts, should assist in mitigating and offsetting direct and indirect impact to wetlands with the development envelope.	The CEMP for the Proposal will include the management measures outlined in the ERD and consider the relevant provisions of the Stormwater Management Manual for Western Australia' (DoW 2004-2007) and the 'Decision process for stormwater management in WA' (DWER 2017).

2.4 Social Surroundings

Four submissions were received regarding the EPA's Social Surroundings factor. The submissions raised concerns related to light pollution, headlight glare, impacts on amenity from noise and odour, and visual amenity impacts. The submissions relevant to this environmental factor and Main Roads responses to these are provided in **Table 2-4**.

Table 2-4: Responses to Submissions Received in Relation to the Social Surroundings Environmental Factor

No.	Submitter	Submission and/or Issue	Response to Comment
13.	ANON-8KZR-56U9-8 (Astrotourism Western Australia)	The impact of lighting design on the night-time (dark night sky) environment. To maintain and preserve the dark night sky environment for Astrotourism activities the choice of street lighting on regional road infrastructure will help protect the dark night sky environment. The submitter has provided a guide "The promise and challenge of LED Lighting: A Practical Guide" and other reference documents. Advise whether these documents are relevant and would be used in the design of road lighting for the Bindoon Bypass.	Lighting of the Bindoon Bypass will be limited to intersections/interchanges. Full (V3) lighting will only be installed at major intersections/interchanges. Other intersections will have 'flag' lighting installed, the purpose of which is to indicate to drivers the location of an intersection, rather than providing full lighting of the road surface. Main Roads met with Astrotourism WA on 24 February 2021 to further understand their concerns and the potential for the Proposal to impact Astrotourism activities in the region. Astrotourism activities including astrophotography and stargazing (with or without telescopes/binoculars) at sites in the vicinity of the Proposal including Spoonbill Lake and the Brockman Centre. Construction of the Proposal will have the effect of moving a significant portion of the current road traffic to the east and further away from these sites. The Brockman Centre is adjacent to the existing GNH while Spoonbill Lake is 700 m from the existing GNH. The proposed Bindoon Bypass will be located 4.5 km and 3.2 km from these sites respectively. The greater separation distance will reduce the impact of vehicle lights on Astrotourism activities at these locations. Main Roads will seek to control glare and upward waste light associated with road lighting in accordance with AS/NZS 1158 section 3.7 and AS/NZS 4282.
14.	ANON-8KZR-56U4-3 (Parkwood Properties Pty Ltd)	The potential for head light glare to intrude on private residences.	Vehicles travelling along the Bindoon Bypass adjacent to the subdivision north of Teatree Road (Parkwood Springs Estate) are unlikely to cause headlight glare impacts as vehicles are travelling parallel to the property boundary, not at an angle towards it. Vehicles turning onto Teatree Road from the Bindoon Bypass could have headlight glare impacts on future dwellings, however landscaping of the road reserve with a tree and shrub layer will reduce the potential for headlight glare to penetrate beyond the road reserve.

No.	Submitter	Submission and/or Issue	Response to Comment
15.	• Private Landowner - Cullalla Road Submission not provided through Consultation Hub • ANON-8KZR-56US-2	Impacts on amenity (noise, vibration, light, odour and visual impacts) from truck bays / stopping areas. A submitter has raised that a truck bay is approximately 600 metres from their residence. It is believed that the location, scale, and activities associated with this truck stop have changed. Confirm the scale and activities associated with this truck stop and whether they have changed from what was first proposed. If so, this may warrant a change to the proposal.	The stopping area highlighted by the submitter is only intended to provide travellers, including trucks, a place to temporarily stop and take a break from driving. The stopping area also provides a safe location off the highway for truck drivers to manage fatigue. No ablutions will be provided. The location, scale and activities associated with the stopping area has not changed from that originally proposed in the referral. Not every vehicle passing by this stopping bay will choose to stop. With the close proximity to Perth, it is expected that southbound trucks would be more likely to take advantage of this stopping area, particularly if they would reach Perth after the transport depots close. Additionally, the road train assembly area at Muchea is only 30 km further south. The facility is not intended for use as a breakdown area or for long term parking of trucks or trailers. The road train assembly area at Muchea is the designated location for these activities. Noise modelling was undertaken using SoundPLAN Version 8.0, industry standard modelling software that is commonly used for traffic noise modelling. The modelling and assessment were undertaken in accordance with the requirements of State Planning Policy 5.4 (Road and Rail Noise). Noise contours for areas of the road that are most likely to impact residents have been shown on the mapping. Given the intermittent use of the stopping area and distance from the residences, it is unlikely that noise emissions will be higher than those from the section of road directly east of the residence. Given the use of the stopping area is expected to be intermittent and of a short duration for any particular vehicle any odours from, for example, livestock trucks will similarly be temporary and will rapidly disperse once the vehicle leaves the stopping area. Odours are unlikely to build up over time as would be the case for facilities such as feedlots.
16.	ANON-8KZR-56US-2	Security concerns related to the location of truck bays / stopping areas.	South of Barn Road, there is no direct access from the Bindoon Bypass to private properties. Access will remain via existing driveways that are located off other local roads. The stopping area will be fenced along the road reserve boundary, which will assist in deterring people from accessing adjacent private property. Main Roads will

No.	Submitter	Submission and/or Issue	Response to Comment
			consult with landowners adjacent to stopping areas to understand their concerns and identify feasible solutions.
17.	ANON-8KZR-56U4-3 (Parkwood Properties Pty Ltd)	Effects of noise and vibration as well as visual impacts on the amenity of future subdivisions adjacent to the alignment. The submitter considers that the proposed road is inconsistent with approved rural residential subdivisions relating to lots 519,549 and 9503. Confirm if the consideration of these subdivisions is consistent with 'Road and Rail Noise Guidelines' September 2019.	Main Roads acknowledges the Parkwood Springs Estate Plan was approved by the Shire of Chittering in 2007 and that a subsequent subdivision plan was lodged in October 2019, after consultation commenced on the Bindoon Bypass corridor selection process. It should be noted that the Bindoon Bypass corridor was endorsed by the Minister for Transport in January 2017. Main Roads intends to prepare a Noise Management Plan for the Proposal prior to commencement of construction. This Plan will take into consideration mitigation of noise impacts for all residences that have been identified by the modelling as above the noise target, including the Parkwood Springs Estate subdivision. In accordance with State Planning Policy 5.4, it is expected that noise mitigation will be a shared responsibility between Main Roads and the developer. The visual impact assessment prepared for the Proposal and provided as Appendix I to the ERD assessed changes to views from the existing subdivision along Windemere Way. This assessment noted the value of the exiting rural outlook to residents and identified the road reserve adjacent to the future subdivision as requiring sensitive view mitigation. This may consist of visual screening using canopy, shrubs and groundcover within the road corridor to screen views of the Bindoon Bypass from the subdivision. As the 96 lots (as per WAPC Ref: 158574) have not been created on Lots 9503 Woodbridge Road and 9504 Tea Tree Road Bindoon at this time and the likely locations of dwellings is unknown, specific impact assessment in relation to light emissions cannot be undertaken with confidence. However it is unlikely that there will be any significant impact from headlight glare due to the separation of these potential dwellings from the road (in line with the notification on title requirements), the lack of any bend in the road to direct headlights into dwellings and the likely construction of a noise or screen wall between any dwellings and the road. The use of lighting that complies with the requirements of AS/NZS 1158 section 3.7 and AS/NZS 4282 will reduce light spill from road lighting and therefore minimise potential impacts to these lots.

2.5 Greenhouse Gas Emissions

As part of the summary of public submissions, the EPA requested information on the greenhouse gas emissions of the Proposal. The information requested is provided in **Table 2-5**.

Table 2-5: Responses to Submissions Received in Relation to the Greenhouse Gas Emissions Environmental Factor

No.	Submitter	Submission and/or Issue	Response to Comment

18.	EPA Services	The Environmental Protection Authority finalised its Environmental Factor Guideline- Greenhouse Gas emissions in April 2020. Please provide an estimate of Greenhouse Gas Emissions relating to the clearing, construction and operation of the Bindoon Bypass proposal.	Greenhouse gas (GHG) emissions have been calculated as follows:
			• Land Clearing (Scope 1): 66,220 tCO_2e
			• Construction:
			  ▸ Scope 1 emissions: 128,383 tCO_2e
			  ▸ Scope 3 emissions: 23,138 tCO_2e
			  ▸ Total: 217,741 tCO_2e
			• Operation (Scope 3):
			  ▸ 50-year operational life: 2,575,561 tCO_2e
			  ▸ Annual Average: 51,086 tCO_2e
			Over the 42-month construction period, Scope 1 GHG emissions are estimated to be 55,601 tCO_2e/annum. This is below the 100,000 tCO_2e/annum Scope 1 emissions threshold within the EPA Environmental Factor Guideline – Greenhouse Gas Emissions.
			A technical memorandum outlining the method and inputs used to develop the GHG emissions estimates along with a further breakdown of GHG emissions is provided in **Appendix A**.

2.6 Offsets

Two submissions made comment on the environmental offsets related to the Proposal. The submissions relevant to this environmental factor and Main Roads responses to these are provided in **Table 2-6**.

Table 2-6: Responses to Submissions Received in Relation to Environmental Offsets

No.	Submitter	Submission and/or Issue	Response to Comment
19.	DBCA	Consultation with DBCA to identify appropriate offset sites.	Main Roads is currently liaising with DBCA to identify appropriate offsets. We note the Department's advice that the time required to complete any land acquisition process and achieve protection as conservation estate is likely to take longer than the time remaining before Main Roads wishes to commence construction of the Proposal. Main Roads will continue to liaise with DBCA and other organisations to refine the offset strategy for the Proposal and provide confidence to regulators, stakeholders and the general public that an appropriate and effective offset package will be established for the Proposal.
20.	ANON-8KZR-56U6-5	Offsets need to consider current and future breeding habitat for Black Cockatoos.	Main Roads is liaising with DBCA to identify appropriate offsets for the Proposal, including the identification of land parcels that may be acquired. Offsets will be used to retain and protect current habitat for Black Cockatoos and are anticipated to include potential breeding trees which will become breeding habitat in the future. Where artificial hollows are installed, they will be managed in accordance with the Artificial Hollow Management Plan (**Appendix B)** which includes regular inspections to identify maintenance needs. It is anticipated that these hollows will be installed within the range of the affected flocks and will be used to enhance breeding habitat.
21.	ANON-8KZR-56U6-5	Offsets for Black Cockatoos need to be within the range/s of impacted flocks.	Main Roads is liaising with DBCA to identify appropriate land parcels to acquire. The advice from the submitter that offset properties should be within the range of the affected flocks will be taken into consideration during these ongoing discussions with DBCA.
22.	DBCA	The Offset Table may require revision depending on the outcome of matters raised above related to CCWs and TECs.	Main Roads proposes the following changes to the offsets required for the Proposal:

No.	Submitter	Submission and/or Issue	Response to Comment
			• Offsetting of 2.7 ha of disturbance required within the CCWs through acquisition of land that that includes 7.35 ha of vegetation associated with CCWs. • No changes to offsets required for the Banksia Woodlands TEC are anticipated. Main Roads recognises the recent changes to the DBCA Banksia Woodlands PEC listing. The offset proposed for the Banksia Woodlands TEC will also cover the DBCA listed Banksia Woodlands PEC.

2.7 Other

Seven submissions were received that commented on matters not covered by the environmental factors addressed above. The submissions and Main Roads responses to these are provided in **Table 2-7**.

Table 2-7: Responses to Submissions Received in Relation to Other Concerns not Addressed Previously

No.	Submitter	Submission and/or Issue	Response to Comment
23.	ANON-8KZR-56UJ-S	Will the existing GNH that will still be in service get an upgrade?	The existing bypassed section of GNH will remain a Main Roads asset (or will become a local government road). The maintenance of this section of GNH will continue in accordance with safety requirements. No specific upgrade is proposed.
24.	ANON-8KZR-56UW-6	Justification for the Proposal in relation to improving safety at Bindoon townsite and the route selected	Due to the increase in demand for mineral resources, such as iron ore, and the exploration and development of oil and gas, the population and industry in the northwest of Australia has grown significantly. With GNH being the primary highway connecting Perth to the Pilbara and WA's north west, this has resulted in a growing number of heavy vehicles, including road trains and Over Size Over Mass vehicles, on the highway. This increase has put a strain on existing road infrastructure, as well as causing traffic congestion and a significant amount of freight vehicles in Bindoon town. There are a number of locations within Bindoon where local traffic and heavy vehicles may come into conflict and which increases risks related to road safety. This includes local vehicles entering and exiting the highway from shopping areas, the local primary school and side roads or private driveways. As the town sits on either

No.	Submitter	Submission and/or Issue	Response to Comment
			side of the highway, there are also safety concerns related to pedestrians crossing the highway. A bypass of Bindoon has been under consideration since the mis-1990's in order to remove heavy vehicles from the town and improve road safety for local residents. Section 2.4 the ERD outlines the process that was followed to identify the preferred route and the aspects that were considered.
25.	Private Landowner - Cullalla Road Submission not provided through Consultation Hub	Why the alignment presented in the ERD was selected when previous planning studies did not recommend alignments to the west of Bindoon townsite. It was suggested that the type of contract may have influenced the decision.	Since the previous planning study undertaken in 2010, the objectives for the Great Northern Highway between Muchea and Wubin have changed significantly. One of the key differences is the need to enable the safe use of the highway by 53.5 m road trains. Currently the maximum road train length allowed on this section of the GNH is 36.5 m. A review of the road grades north of Bindoon, and particularly those associated with the Bindoon Hill identified that the existing road would be too steep for 53.5 m road trains to traverse safely. In order to achieve road grades that would be suitable, a significant cutting through Bindoon Hill would be required, which would have significant impacts, including on fauna habitat, native vegetation and visual amenity. A new planning study was then commenced to identify an appropriate corridor that would meet the current project objectives, including to enhance the environment. A detailed multi-criteria assessment was undertaken to review all available options as part of the corridor selection process for Bindoon Bypass. This process has been described in detail in Section 2.4 the ERD.
26.	• Private Landowner - Cullalla Road Submission not provided through Consultation Hub • ANON-8KZR-56US-2	Concerns that the alignment had not been confirmed and could change, requiring additional land acquisition, as recent communications from Main Roads suggests feasibility studies are still ongoing. Related to this was the concern that land may be acquired to secure access to construction materials such as sand and water.	The alignment of the Bindoon Bypass has been confirmed, however the detailed design is yet to be completed and there may be some minor changes to the design. It is unlikely that any further land acquisition will be required as a result of these minor changes. The road alignment was determined based on the best result for safety and freight movement. The existence or otherwise of basic raw materials was not considered in determining the road alignment. The multi-criteria analysis undertaken to inform the preferred corridor selection processes did not consider property specific materials such as sand or water. Nor did

No.	Submitter	Submission and/or Issue	Response to Comment
			the multi-criteria analysis consider potential vegetation clearing offsets or zoning considerations. The Notice of Authority to Enter letter was recently re-sent to all Bindoon Bypass properties to allow future access to private properties and enable feasibility investigations to occur if required. Government environmental agencies often request environmental data outside the expected disturbance areas to ensure a good understanding of potential local and regional impacts, and sometime request further investigations as part of the outcomes from environmental approval processes.
27.	Private Landowner - Cullalla Road Submission not provided through Consultation Hub	Suggestion that the bypass north of Mooliabeenee Road should be a toll road.	There are no current plans to levy a toll on road users for the Bindoon Bypass.
28.	• Private Landowner - Cullalla Road Submission not provided through Consultation Hub • ANON-8KZR-56US-2	Land acquisition splitting properties into two portions and the effect of this on the landowner's ability to access all areas of the property safely and efficiently. Additional concern that this would result in a part of some properties being re-zoned as "conservation".	Main Roads will liaise with landowners whose land is to be acquired as part of this project in order to identify workable solutions to the severance of property. This may include providing an individual access for stock; construction of access tracks or acquisition of an unviable severed portion of land.
29.	DBCA	Mitigation measures outlined in the ERD should be carried through to the Construction Environmental Management Plan for the project.	The CEMP will include, at a minimum, all management measures outlined in the ERD.
30.	• ANON-8KZR-56US-2 • ANON-8KZR-56UW-6 • ANON-8KZR-56U6-5	It was noted that Part 9 of the ERD was not provided on the EPA's website.	Following completion of the Public Review period Main Roads became aware that Part 9 of the ERD (Chapter 4.3.3.3 – 4.3.7) was not uploaded to the EPA's website. Part 9 includes the majority the receiving environment information for terrestrial fauna along with the assessment of the potential impacts, proposed mitigation and predicted outcome for terrestrial fauna. A description of the groundwater environment of the Proposal, potential impacts and proposed management measures was provided in Section 4.4.3 of the ERD.

No.	Submitter	Submission and/or Issue	Response to Comment
31.	ANON-8KZR-56UB-H (WA Limestone)	Support the Proposal.	Main Roads acknowledges and values the support of WA Limestone.

3. Additional Comments and Advice Received

On 8 February 2021, the DWER's EPA Services provided comment and advice on the draft responses to the submissions received. Further comments on the responses to the submission from DBCA were provided on 19 February 2021. Main Roads response to these comments is provided in **Table 3-1** and **Table 3-2** respectively.

Table 3-1: Comments Received on Draft Response to Submissions from EPA Services and Main Roads Responses

Comment	EPA Services Comment	Main Roads Response
Proposal		
Changes to a proposal during assessment - Section 43A	Section 43A of the Environmental Protection Act 1986 (EP Act) provides for the Environmental Protection Authority (EPA) to consent to a proponent making changes to a proposal during an assessment, without a revised proposal being submitted. This is provided that the EPA considers that the change/s is unlikely to significantly increase any impact that the proposal may have on the environment. Should the proposal differ from that published in the Environmental Review Document (ERD) please provide updated extent of impacts for all environmental factors as appropriate to reflect any changes to the proposal. EPA Services during the assessment has reviewed the proposal and notes the development envelope (DE) and disturbance footprint (DF) have changed throughout the assessment and are summarised below: • Referral (6/9/2017) – DE of 3,422 hectares (ha), DF of 650 ha • s. 43A (9/7/2018) – DE of 3,407 ha, DF of 625 ha • Public Environmental Review (PER) (May 2020) – DE of 2552.5 ha, DF of 503 ha A s. 43A application should be submitted for changes to the proposal during assessment in accordance with the EP Act. The s. 43A application should demonstrate that the change/s to the proposal are unlikely to significantly increase any impact the proposal may have on the environment. In this case, it is encouraging to note that the DF has decreased in extent. Any further reductions in impacts and DF to demonstrate the	A s 43A application has been prepared and submitted to the EPA.

Comment	EPA Services Comment	Main Roads Response
	application of avoid and minimisation principles should be included in the application. The s. 43A should include spatial data for the revised alignment in accordance with the EPA's spatial data requirements, this requirement is geo-referenced data and conforms to the following parameters: • Data type: closed polygons that represent the proposal boundary (development envelope) and the activity areas for all physical elements of the proposal (footprint). • Attribution: Name the development envelope and each activity area in the attribute table of the spatial data. • Format: ESRI geodatabase or shapefile. • Coordinate System: GDA94 (datum) and projected into the appropriate Map Grid of Australia (MGA) zone.	
Terrestrial Fauna		
Impacts to black cockatoo potential breeding habitat	EPA Services acknowledges the targeted survey work that has been undertaken for black cockatoos, particularly the identification of suitable hollows. The proposal is located within the known breeding range for Carnaby's cockatoos. In order to undertake an assessment of all the impacts to black cockatoo breeding habitat, which includes potential breeding trees, please provide the number of potential breeding trees located within the disturbance footprint that will be directly impacted from construction of the proposal. That is those trees of species known to support breeding which either have a suitable nest hollow or are of a suitable diameter at breast height to develop a nest hollow (Commonwealth of Australia 2012). Please be advised recent EPA assessments have identified potential breeding trees as important to ensure continual recruitment of future nest hollows. Main Roads should include potential breeding trees in their assessment and consider whether offsets are appropriate.	Surveys undertaken by Bamford Consulting Ecologists (BCE – 2019) identified 12,936 potential breeding trees (not including those with hollow suitable for black cockatoos) within the study area. Of these 1,465 are within the disturbance footprint. The clearing of 1,465 potential breeding trees (without suitable hollows) equates to 11% of those recorded by BCE (2019). BCE (2017) assessed the density of potential breeding trees within habitats considered suitable for Black Cockatoos as follows: • VSA 3 Marri – Jarrah Woodland: 10.06 trees/ha (± 1.34) • VSA 4 Marri – Jarrah Woodland with little understorey: 13.22 trees/ha (± 0.73) • VSA 5 Wandoo Woodland: 25.41 trees/ha (± 1.54) • VSA 8 Paddocks with Large Remnant Trees: 4.9 trees/ha (± 2.59)

Comment	EPA Services Comment	Main Roads Response
	Reference *Commonwealth of Australia 2012, EPBC Act referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo (endangered) Calyptorhynchus latirostris Baudin's cockatoo (vulnerable) Calyptorhynchus baudinii Forest red-tailed black cockatoo (vulnerable) Calyptorhynchus banksii naso, Commonwealth of Australia, Canberra, ACT.*	It is reasonably expected that these densities are applicable to the habitats adjacent to the survey study area. There is approximately 93,004 ha of potentially suitable habitat within 15 km of the Development Envelope. Based on the vegetation complex mapping undertaken by Heddle et al. (1980) and Mattiske and Havel (1998) there is approximately 23,996 ha of vegetation that can be considered to correspond to VSA 3, 21,692 ha corresponding to VSA 4 and 28,767 ha corresponding to VSA 5. It is therefore reasonable to assume that there are over 1.2 million potential breeding trees within this area. The removal of 1,465 (0.12%) of these to allow for implementation of the Proposal is considered unlikely to have a significant impact on the recruitment of future nest hollows in the area. This information has been added to the response to Submission 6 in the Response to submissions document.
Social Surroundings		
Aboriginal Heritage	Given the time since the Aboriginal Heritage surveys were undertaken and the continued refinement and design of the proposal. EPA Services is seeking up-to-date information on the status of consultation with the Yued Native Title Claim group, any new surveys undertaken of private properties, any new sites being identified and/or formally registered and any new impacts to Aboriginal Heritage which has come to light since the surveys were undertaken. Please advise if any further consultation has occurred with relevant Traditional Owners more recently (since 2018) and whether Main Roads has provided responses to the concerns raised in the Aboriginal Heritage survey report particularly in relation to the proposed Brockman River crossing and the crossing at an unnamed tributary and wetland, southwest of Bindoon-Moora Road and between Kangaroo Gully Road and Pines Road.	No further consultation with the Yued Traditional Owners has been undertaken to date. Additional consultation will occur during the detailed design phase of the Proposal. Main Roads has provided responses to concerns raised and updates on design progress at the Yued Working Group meetings as detailed in the ERD. The concerns in relation to the Brockman River crossing and the crossing of the unnamed tributary were raised prior to the realignment of the Proposal in that area and were taken into consideration during this process. Design of the Brockman River crossing and connection with Bindoon-Moora Road sought to avoid direct impact to the creek near Kangaroo Gully Road and minimise impacts to the Brockman River. There is an opportunity to improve the condition of the unnamed creek where it crosses under both Kangaroo Gully Road and Bindoon-Moora Road through installation of suitably sized culverts, improving the flow and reducing ponding and damming that currently occurs. The realignment has moved the Proposal away

Comment	EPA Services Comment	Main Roads Response
	Please provide a final list of how many registered sites will be directly disturbed and require a section 18 application approval under the Aboriginal Heritage Act 1972 (AH Act). In addition to the above, please advise if any Aboriginal Heritage sites that the proposal avoids (and hence does not require a section 18 of the AH Act approval to disturb); but are in the vicinity of the proposal. For these sites, information should be provided on whether any of these sites are likely to be subject to potential indirect impacts. For example, isolating or blocking off access to ritual/ceremonial sites and any downstream impacts to wetlands and creeks.	from the wetland in question (Site WP-04), which is now 600 m to the north west. Main Roads is committed to meaningful and ongoing Aboriginal participation and engagement throughout all project phases. The construction contractor for the Bindoon Bypass will be expected to meet specific targets in relation to Aboriginal participation and engagement, including direct employment and procurement of services through Aboriginal businesses. It is anticipated that a similar approach to that undertaken for recent upgrades to the Great Northern Highway between Muchea and Wubin will be applied to construction of the Bindoon Bypass. This approach involves an incentive scheme whereby higher levels of Aboriginal engagement and participation result in increasing financial rewards for the contractor. In relation to the Great Northern Highway upgrades, this approach has resulted in direct employment of Aboriginal persons of between 10% and 20% of total workforce hours, including a number of trainees, and over $10 million spend with Aboriginal businesses across four separate construction contacts. There has been no change to the status of the aboriginal heritage sites identified in the ERD and no new sites have been added to DPLH's register of sites. The sites that will be impacted by the Proposal and require a s18 application are detailed below. No additional sites are considered in close enough vicinity to the Proposal that indirect impacts would occur. As the Development Envelope is located on freehold land, the presence of the road after construction will not change the ability of Traditional Owners to access these sites.

Comment	EPA Services Comment	Main Roads Response

ID	Name	Known Extent (ha)	Direct Impact (ha)	% of Site Impacted
Registered Aboriginal Sites				
20008	Gingin Brook Waggyl Site	108 060.77	41.41	0.04
Other Heritage Places (Lodged and Awaiting Assessment)				
3528	Burroloo Well	51.32	0.00[1]	0.00
20650	Lennard Brook	175.82	2.31	1.31
22027	Udumung Brook Artefact 1	0.044	0.00[1]	0.00
Newly Identified Sites				
NA	Spring Valley Artefact Scatter	0.57	0.15	26.32

[1] *No impact is expected as archaeological surveys indicate the site is not located at the coordinates on file for this location.*

Downstream impacts to the Lennard Brook site will be avoided and mitigated through the management measures detailed in Section 4.4.6 (Inland Waters) of the ERD. This includes:

- Site-specific erosion and sediment control measures
- Maintain drainage across the site to as close to the pre-development condition as practicable
- No refuelling will be undertaken within 50 m of watercourses
- Construction areas near or within watercourses will be equipped with appropriately stocked and readily accessible spill kits

Comment	EPA Services Comment	Main Roads Response
Noise impacts to subdivision on Lots 9503 Woodbridge Road and 9504 Tea Tree Road Bindoon	With regard to the approved subdivision (Lots 9503 Woodbridge Road and 9504 Tea Tree Road Bindoon), please consider the likely impacts to this recently approved subdivision and determine how the properties fit with Table 2 Noise Exposure Forecast in Road and Rail Noise Guidelines (State of Western Australia 2019). From advice below a Notification has been placed on the Titles relating to land that may be required for construction and affected by noise (see below). Please provide evidence of any recent consultation with the applicant of the Parkwood Springs Estate subdivision regarding any cooperative arrangements to mitigate ongoing traffic noise impacts on residential developments. The following advice was subsequently received (below) and is provided for context. The Western Australian Planning Commission (WAPC) conditionally approved subdivision for Lots 9503 Woodbridge Street and Lot 9504 Teatree Road, Bindoon (the site) under WAPC Ref: 158574 on 14 January 2020, to allow for the creation of 96 rural residential lots. The site forms part of the Parkwood Springs Estate to which a structure plan, being the Parkwood Springs Estate Development Plan (PSDP), was endorsed by the WAPC in April 2008 and subdivision of the land has been approved on previous occasions dating back to 2008. The PSDP identifies 58 lots that are 4 hectares and greater in area on the basis that a reticulated water supply would not be provided. Following endorsement of the PSDP, 31 lots were developed in the eastern half of the estate through stages 1 to 3b (under WAPC Ref: 136418 and 145348). In November 2015, subdivision approval was granted for the remaining 27 lots (WAPC Ref: 152449). Following this approval, capacity was identified in the Water Corporation's Bindoon water supply scheme and long-term planning to service the area. As a result, the landowner sought to intensify development of the site through lodgement of another subdivision application for 96 lots which was approved by the WAPC in December 2016 (WAPC Ref: 154175). WAPC Ref: 158574 was a re-approval of the previous subdivision application (WAPC ref: 154175) with	All properties along the Bypass will have noise treatments to bring the noise experienced to below the limits specified by State Planning Policy 5.4. In relation to the Parkwood Springs Estate, the 96 lots as per WAPC Ref: 158574 have not been created at this time and the likely locations of dwellings is unknown. It is therefore not possible to assess potential road noise levels at these undescribed locations. Main Roads will develop a Traffic Noise Management Plan in accordance with the requirements of State Planning Policy 5.4 following the detailed design phase and prior to the commencement of road operations in order to mitigate traffic noise impacts along the alignment and in particular at 9503 Woodbridge Road and 9504 Tea Tree Road. The matter has been raised by Parkwood Properties in the course of the land acquisition process, but no specific resolution has been arrived at yet. Land acquisition discussions continue with Parkwood Properties.

Comment	EPA Services Comment	Main Roads Response
	the removal of water tank sites for bushfire mitigation due to the requirement to connect to a reticulated water supply. As you have noted, the proposed Bindoon Bypass alignment impacts the site. At the time the most recent subdivision proposal (WAPC Ref: 158574) was being considered, the alignment had not been formally reserved or acquired. Furthermore, as the site had been zoned for Rural Residential purposes since 2004 and the PSDP and subdivision proposals had been in place over the site since 2008, the WAPC determined that there were no planning grounds relating to the Bindoon Bypass to withhold subdivision approval. As such, the following conditions relating to the Bindoon Bypass were applied to the approval: **Condition 27** A notification, pursuant to Section 70A of the Transfer of Land Act 1893 is to be placed on the certificates of title of proposed lots 31 to 53. Notice of this notification is to be included on the diagram or plan of survey (deposited plan). The notification is to state as follows: "This lot is affected by the proposed alignment of the Great Northern Highway western bypass corridor. Land may be required in the future for the construction of the corridor and the lot may be affected by transport noise." **Condition 28** A notification, pursuant to Section 70A of the Transfer of Land Act 1893 is to be placed on the certificates of title of proposed lots 1 to 30 and 54 to 96, including any lot modified by Condition 1. Notice of this notification is to be included on the diagram or plan of survey (deposited plan). The notification is to state as follows: "This lot is situated in the vicinity of the proposed Great Northern Highway western bypass corridor and may in the future be affected by transport noise." *Reference*	

Comment	EPA Services Comment	Main Roads Response
	State of Western Australia 2019, Road and Rail Noise Guidelines, Department of Planning, Lands and Heritage, Perth, WA.	
Light emission impacts	It is not clear from Main Roads ERD or response to submissions whether the proposal is likely to impact on Astrotourism activities. Main Roads advises that lighting will be limited to intersections/interchanges. Further information is required as follows: • What is the proximity of intersections/interchanges to the Astrotourism activities? • How do the new intersections/interchanges relate to existing infrastructure in proximity to Astrotourism activities? • The likelihood of light emissions from the proposal impacting on Astrotourism activities and if appropriate proposed mitigation and management measures to reduce impacts on Astrotourism activities. Will meeting the Australian Standards Lighting for Roads and public spaces be sufficient to mitigate light emissions on Astrotourism? It is recommended that consultation with Astrotourism is undertaken.	Main Roads met with Astrotourism WA on 24 February 2021 to further understand their concerns and the potential for the Proposal to impact Astrotourism activities in the region. Astrotourism activities including astrophotography and stargazing (with or without telescopes/binoculars) at sites in the vicinity of the Proposal including Spoonbill Lake and the Brockman Centre. Construction of the Proposal will have the effect of moving a significant portion of the current road traffic to the east and further away from these sites. The Brockman Centre is adjacent to the existing GNH while Spoonbill Lake is 700 m from the existing GNH. The proposed Bindoon Bypass will be located 4.5 km and 3.2 km from these sites respectively. The greater separation distance will reduce the impact of vehicle lights on Astrotourism activities at these locations. Main Roads will seek to control glare and upward waste light associated with road lighting in accordance with AS/NZS 1158 section 3.7 and AS/NZS 4282. This information has been included in the response to Submission 13 in the Response to Submissions document.
	Furthermore, the impact assessment in the ERD for light emissions does not take into consideration the approved subdivision on Lots 9503 Woodbridge Road and 9504 Tea Tree Road Bindoon. Please provide information on the likely impacts from light emissions and any proposed mitigation and management measures to minimise these impacts.	As the 96 lots (as per WAPC Ref: 158574) have not been created on Lots 9503 Woodbridge Road and 9504 Tea Tree Road Bindoon at this time and the likely locations of dwellings is unknown, specific impact assessment in relation to light emissions cannot be undertaken with confidence. However it is unlikely that there will be any significant impact from headlight glare due to the separation of these potential dwellings from the road (in line with the notification on title requirements), the lack of any bend in the road to direct headlights into dwellings and the likely construction of a noise or screen wall between any dwellings and the road.

Comment	EPA Services Comment	Main Roads Response
		The use of lighting that complies with the requirements of AS/NZS 1158 section 3.7 and AS/NZS 4282 will reduce light spill from road lighting and therefore minimise potential impacts to these lots. The above information has been added to the response to Submission 17 of the Response to Submissions document. Generally, headlight glare from vehicles is the more disruptive of potential light impacts due to their intermittent and erratic nature. This has been addressed in the response to Submission 14 in the Response to Submissions document.
Flora and Vegetation		
Impacts to Department of Biodiversity, Conservation and Attractions (DBCA) Threatened Ecological Communities (TEC) and Priority Ecological Communities (PEC)	EPA Services notes that Figure 8 in the Focused Vision Consulting Flora and Vegetation Assessment (October 2020) depicts the locations of the State TEC and two PECs in relation to the proposal and includes occurrences of Banksia woodlands of the Gingin area. It is noted that the DBCA description of the Banksia woodlands of the Gingin area indicates that the community appears restricted to the western Dandaragan Plateau. It is further noted that a portion of the alignment intersects the southern Dandaragan Plateau where it is relatively narrow east to west. Further evidence may be required to ascertain whether the Banksia woodlands of the Gingin area community does not in fact occur within the development envelope. This evidence may include a consideration of soil type in the identified areas. Further consultation with DBCA should be sought to rule out the potential for this community to occur within the proposal area.	The field survey results and floristic analysis undertaken did not identify the Banksia Woodlands of the Gingin Area PEC in these locations. Additionally, soils at these locations were not the typical yellow to orange sand which dominate the soils found in association with this PEC. Most quadrats were recorded to have pale grey or brown soils with some white soils present (FVC 2017,2018, 2020). The mapped presence of the PEC *Banksia woodland of the Gingin area restricted to soils dominated by yellow to orange sands* was discussed with DBCA at a meeting on 15 March 2021. DBCA confirmed the mapping was in error and the occurrences mapped adjacent to Teetree Road and north of Mooliabeenee Road are not the Banksia woodland of the Gingin area PEC (Val English pers. comm.).
	For the purposes of the assessment under the EP Act, it will be necessary to assess the impact to the floristic community types (FCT) that make up the EPBC Banksia woodlands of the Swan Coastal Plain (SCP) TEC within the development envelope. Please assess the impacts of the proposal in relation to inferred FCT (for example FCT SCP 28 and FCT SCP 23a) or other Banksia communities (Banksia woodlands of the Gingin area and/or Banksia woodlands of the SCP (P3 PEC)) for the purposes of the EP Act assessment.	The reanalysis of the floristic data undertaken by FVC (see **Appendix C**) concluded that the Banksia Woodland vegetation within the Development Envelope is representative of common FCTs, with vegetation showing most affinity to FCT 28, FCT S09 or FCT 23a. While the analysis indicated some affinity to FCTs that represent State listed TECs or PECs (other than the P3 Banksia Woodlands of the Swan Coastal Plain), this affinity was not as strong as the affinity for more common FCTs. Banksia Woodland vegetation across the

<table>
<tr><th>Comment</th><th>EPA Services Comment</th><th>Main Roads Response</th></tr>
<tr><td></td><td></td><td>Development Envelope is therefore of the same significance with no quadrats identified as supporting Banksia Woodland vegetation of greater significance than any other quadrat.</td></tr>
<tr><td>Wetland and riparian vegetation</td><td>Please confirm the extent of vegetation representative of riparian and wetland vegetation that occurs within the development envelope and development footprint. The extent should represent any changes to the proposal (refer to item 1).</td><td>The Proposal is located mainly within the upland areas of the catchments of the nearby watercourses, with the exception of the crossing of the Brockman River.
Three vegetation associations were mapped by FVC (2020) that represent wetland or riparian vegetation (Figure 3). These are:
MvJspLs (Melaleuca viminea shrubland) – Brockman River crossing, Lake Nangar.
ErXpBm (Eucalyptus rudis and Melaleuca preissiana sparse woodland) - Brockman River crossing, north of Cook Road, north of Barn Road, near Gray Road, and Teatree Road.
EwBeNa (Eucalyptus wandoo and Casuarina obesa sparse woodland – Hay Road, near Udumung Nature Reserve.
Additionally, vegetation association BmKgHg (Kunzea glabrescens shrubland) was found to be restricted to two locations associated with Lake Nangar (FVC, 2020). The extents of these vegetation associations within the Development Envelope and the disturbance footprint are shown below.<table><tr><th>Vegetation Association</th><th>Extent within Development Envelope (ha)</th><th>Extent within footprint (ha)</th></tr><tr><td>MvJspLs</td><td>0.1</td><td>0.0</td></tr><tr><td>ErXpBm</td><td>35.8</td><td>12.5</td></tr><tr><td>EwBeNa</td><td>4.5</td><td>1.0</td></tr><tr><td>BmKgHg</td><td>8.6</td><td>0.1</td></tr></table></td></tr>
<tr><td>Unsurveyed area</td><td>The October 2020 biological survey report still refers to a “significant sized area, comprising 89.05 ha…was not accessible for the detailed</td><td>The portion of the Development Envelope that was not surveyed is to the west of the railway and Cullalla Road and is largely private</td></tr>
</table>

Comment	EPA Services Comment	Main Roads Response
	survey…and vegetation could not be confirmed" The Response to Submissions states that this area was surveyed in 2018 with the results reported in the 2019 survey report. The Response to Submissions further states that all areas of the development envelope have been surveyed and that no works associated with this proposal are in the areas outside of the extent of the surveys. It is noted that all of the flora and vegetation survey reports include an area of vegetation that was not mapped, a portion of which appears to be within the proposed development envelope. It is understood that there have been further changes to the proposal during assessment that have yet to be approved under s. 43A of the EP Act (refer to item 1). Once the changes to the proposal have been finalised, and if approved, please update the extent of impact of the proposal to flora and vegetation values and confirm whether flora and vegetation surveys have been undertaken across the full extent of the development envelope. If areas of the development envelope remain unsurveyed, an assessment should be undertaken of the likely occurrence of significant flora and vegetation within the unsurveyed area.	property that will not be acquired for the Proposal. This area consists of cleared paddocks, pine plantation and some native vegetation, likely to be Banksia woodland. The disturbance footprint for the proposal does not extend into this unmapped area. Native vegetation present will be marked as a "Native Vegetation Retention Area" and no clearing will occur in this area. The response to submission 3 has been updated as above.
Offsets		
	Further information is required on proposed offsets to determine their suitability. At this stage, the proposed offsets do not provide adequate assurance that they will meet the offsets principles in the WA Offsets Policy and WA Offsets Guidelines. The assessment of offsets should provide confidence that genuine offsets are available, achievable and will counterbalance the significant residual impact delivering an environmental benefit. <u>Land Acquisition</u> Information should be provided on proposed parcels of land to be acquired. Information should be provided to demonstrate that the proposed parcels of land to be acquired have the same environmental values as the significant residual impacts of the proposal. Please provide	**Land Acquisition** Main Roads is undertaking extensive consultation with DBCA to identify appropriate land parcels for acquisition that will meet the offset requirements for the Proposal. This consultation is ongoing. Currently 43 properties have been identified for further investigation to confirm their suitability for offsets in relation to this proposal. The properties under consideration range in size from 2.8 ha to 2,130 ha and are located within the area between Mimegarra in the north west, New Norcia in the north east and Muchea in the south. All properties are expected to contain the following environmental values, though this requires confirmation through site investigations and surveys: • Vegetation corresponding to the Banksia woodlands TEC;

Comment	EPA Services Comment	Main Roads Response
	evidence of consultation and information regarding the condition and values of the proposed offset properties. The ERD states that restoration/revegetation will form part of the offsets package but provides no further information or details. The extent and scope of works proposed is unclear as is what environmental values will be counterbalanced through restoration/revegetation. Restoration and revegetation result in very different environmental outcomes therefore, the proposed offset should be explicit in what environmental outcome is being achieved and how that counterbalances the impacts of this proposal. The EPA understands the acquisition of properties may be sensitive and confidential. However, this should not be a reason for not supplying this information to the EPA. Offset sites can be identified by their size, environmental values and general location, with Lot identifiers remaining confidential. <u>Tree hollow offset</u> Further information is also required for the proposed black cockatoo artificial hollows offset to provide confidence to the EPA that the impacts to tree hollows will counterbalance the impact of the proposal. Information on who will be responsible for the maintenance, replacement and monitoring of the artificial hollows. An adaptive management approach should also be provided in the event the artificial hollows are not successful to ensure an offset is achieved to counterbalance the impacts of the proposal. <u>Research Offset</u> The proposed indirect offset in the ERD of providing funding to Murdoch University for research into Carnaby's Cockatoos focuses on expending a certain amount of money rather than achieving an outcome. To meet the offset principles in the WA Offsets Policy and WA Offsets Guidelines further information is required explaining what the research is, how it would result in a positive conservation outcome and counterbalance the impact from the proposal.	• Black Cockatoo habitat (foraging and breeding); and • Vegetation in Good or better condition. The ultimately selected offset properties will also include vegetation associated with conservation category wetlands and vegetation corresponding to the Nooning vegetation complex. Due to the stage at which this identification and verification process is at, the there are no specific details of these a particular property or properties is confidential that will form part of the offset. Restoration/revegetation of degraded land was included as an option for land acquisition offsets due to the uncertainty associated with acquiring vegetated land of a suitable quality at the time of writing the ERD. Areas of revegetation will focus primarily on providing ecosystem services for fauna, such as foraging habitat for Black Cockatoos, rather than restoring pre-existing vegetation communities. Conversations are progressing with a number of landowners and managers in relation to suitable sites for revegetation and how these could be included in the overall offset strategy for the Bindoon Bypass. Main Roads is anticipating that offsets will be conditioned within the Ministerial Statement and that the final offsets package will be signed off by DWER/EPA post-approval. **Artificial Hollow Offset** An Artificial Hollow Management Plan (AHMP) has been prepared for the Proposal and is provided as **Appendix B** to the Response to Submissions. The AHMP provides guidance on the installation of artificial hollows for Black Cockatoos, details management targets to determine success of the artificial hollows, outlines monitoring and maintenance requirements, recommends adaptive management approaches should targets be at risk of not being met, and describes the record keeping, review and reporting requirements for this plan.

Comment	EPA Services Comment	Main Roads Response
		Research Offset The research offset is no longer being considered by Main Roads as part of the offsets package for this Proposal.

Table 3-2: Comments Received on Draft Response to Submissions from DBCA and Main Roads Responses

DBCA Comment	Main Roads Response
DBCA considers further information is required on the analysis for determining the presence of specific Floristic Community Types (FCTs). This information on FCTs will enable the Environmental Protection Authority to identify and assess any potential impacts to state listed Threatened Ecological Communities (TEC) and Priority Ecological Communities (PEC) if present. The outcome of this analysis would also inform the development of any potential offset requirements. Please revise the Response to Submission document to incorporate the following comments and advice.	A meeting was held with DBCA on 15 March 2021 to discuss the analysis undertaken to date and additional requirements. The general method for the additional analysis was agreed via email (30 March 2021). The additional analysis is provided in **Appendix C**. Further information is provided in the responses below.
The Flora and Vegetation Assessments report (October 2020) states that the statistical analysis of Banksia woodland was undertaken against Gibson et al. (1994) and Keighery (2008) datasets. However, Keighery et al. (2008) is a floristic survey of the Whicher Scarp. It is not clear if this is an error and that Keighery et al. (2012) is the dataset used. Please confirm if this is the case. *Reference: Keighery, B., Keighery, G., Longman, V.M., and Clarke, K.A. (2012). Weed and native flora quadrat data compiled between 1990 - 1996 for the Southern Swan Coastal Plain. Data compiled for the Departments of Environmental Protection and Conservation and Land Management, Perth.*	The Keighery et al (2008) reference is an error and should be Keighery et al. (2012) [Keighery, B., Keighery, G., Longman, V.M., and Clarke, K.A. (2012). Weed and native flora quadrat data compiled between 1990 - 1996 for the Southern Swan Coastal Plain. Data compiled for the Departments of Environmental Protection and Conservation and Land Management, Perth.] A corrigendum page has been added to the FVC (2020) report, a copy of which is provided in **Appendix D**.
DBCA's recommended method for determining FCT is to assess each quadrat against the Gibson et al (1994) and/or Keighery et al. (2012), through single site insertions to minimise disruption of the original dataset. Figure 17 of Flora and Vegetation Assessments report (October 2020) indicates that over 80 quadrats established in the survey area were inserted into the dataset for analysis together. This results in a major disruption of the original dataset and may mask affinities of individual quadrats with particular FCTs. The recommended method is to insert new quadrat data as single site insertions and rerun the classification and examine with cluster or ordination techniques. Nearest neighbour distances of	Reanalysis of quadrat data has been undertaken. All of the FVC sampled quadrats that were identified to be representative or potentially representative of known TECs or PECs for the region, including the Banksia woodlands TEC (consolidated in FVC (2018c)) were analyzed using PATN™ (Belbin 2013) multivariate cluster analysis of species presence/absence. The proposed method for analysis was sent to DBCA for their review via email on 29 March 2021. DBCA provided some recommended amendments to this

DBCA Comment	Main Roads Response
the new quadrats to the Gibson et al. (1994) and/or Keighery et al. (2012) quadrat data can also be examined. Table 17 is a simple analysis of the floristic data against individual FCTs. This, and results of single site insertion analysis for each quadrat should be evaluated to determine the most logical conclusions regarding FCTs present in each individual quadrat. There is a high level of affinity of some quadrats for state TEC indicated in Table 17 including FCT20a, 20b and 20c. Quadrat B56 had a high affinity for FCT20a (Endangered in Western Australia (WA)), and with FCT20c (Critically Endangered in WA and Endangered under the Environment Protection and Biodiversity Conservation Act 1999). Quadrat C08 had the highest affinity with FCT20b, and a high affinity with FCT20a. In addition, a series of other quadrats have high or highest affinities to PECs. Quadrat B06, B10, and B10.2, for example, have greatest affinity to FCT23b (Priority 3), that is also an important subset of the Banksia woodlands of the Swan Coastal Plain TEC.	method via email on 29 March 2021 (**Appendix E**), resulting in the analysis method detailed below. The following information was assessed for each quadrat: • 'Batch' floristic analysis of quadrat data against Gibson et al (1994) and Keighery et al. (2008) datasets. • SSI for a selection of individual quadrats to confirm or disprove PATN results returned for the 'batch' analysis. • Where SSI results did not align with the 'batch' analysis results, SSI was conducted for all quadrats within that vegetation unit. • Further analysis of flora species presence-absence data, comparing the number of common species occurring within the recorded quadrat and the Gibson et al (1994) and Keighery et al. (2008) sampled sites. • Quadrat data was subsequently compared to other information relevant to each FCT; key dominant species, typical habitat, vegetation complexes and geographical distribution. • Final conclusions were made based on the consolidated results of all comparative analyses. Full details of the method used to re analyse the quadrat data is provided in **Appendix C**.
The assessment of significance of vegetation will need to be reassessed following further analysis of FCTs based on single site insertions into the classification, and other relevant data (including Table 17, habitat characteristics and combinations of key taxa). This may also influence the assessment of national significance, based on whether quadrats align with subtypes of the Banksia woodlands of the Swan Coastal Plain TEC that are State-listed PECs or TECs and therefore have higher significance.	Banksia woodland vegetation within the Development Envelope has been identified as being representative of the Priority 3 listed Banksia woodlands of the Swan Coastal Plain PEC (equivalent to the EPBC Act listed TEC of the same name). Floristic analysis of the surveyed quadrats has been undertaken with further reanalysis completed to identify the FCTs present on a quadrat by quadrat basis. The purpose of this analysis was to determine if portions of the mapped Banksia Woodland vegetation units were representative of other State listed

DBCA Comment	Main Roads Response
	TECs or PECs and would therefore have a higher significance compared to the surrounding vegetation. The reanalysis of the floristic data (see **Appendix C**) concluded that the Banksia Woodland vegetation within the Development Envelope is representative of common FCTs, with vegetation showing most affinity to FCT 28, FCT S09 or FCT 23a. While the analysis indicated some affinity to FCTs that represent State listed TECs or PECs (other than the P3 Banksia Woodlands of the Swan Coastal Plain), this affinity was not as strong as the affinity for the more common FCTs. Banksia Woodland vegetation across the Development Envelope is therefore of the same significance with no quadrats identified as supporting vegetation of greater significance than any other quadrat.

Table 3-3: Additional Comments Received from EPA Services – July 2021

EPA Comment	Main Roads Response
Request change to proposal during assessment (S43A)	
The approved changes to the proposal issued on the 7 September 2018 states *"Disturbance of no more than 625 ha which includes clearing of up to 144 ha of native vegetation and 362 ha of scattered trees over pasture within a 3,407 ha development envelope"* however, the "Current Proposal" calculations in the request to change proposal (s43A) dated 2 June 2021 state in Table 2, that the 'Disturbance Footprint' is 652 ha and the 'Scattered trees over pasture' is 392 ha. Please explain and confirm the above calculations.	The numbers provided in the request to change proposal (s43A) dated 2 June 2021 are in error. The correct numbers are those as stated in the approved changes issued on 7 September 2018 (that is, the indicative disturbance footprint is 625 ha and the 'Scattered trees over pasture' is 392 ha). The s43A request has been corrected.
Please be advised the definition for native vegetation does not discriminate between vegetation condition. The Environmental Review Document (ERD) states a total of 119.1 ha of native vegetation will be cleared while the s43A application states 107.9 ha. To ensure the actual impacts to native vegetation are accounted for, it is recommended the total clearing of all native vegetation irrespective of its condition be included.	The 507.7 ha indicative disturbance footprint incudes 498.7 ha of native vegetation consisting of: • 107.9 ha of native vegetation in Good or better condition.

<table>
<tr><th>EPA Comment</th><th>Main Roads Response</th></tr>
<tr><td></td><td>

208 ha of native trees over pasture. Only the overstorey remains in these areas with all mid- and understorey vegetation removed. These areas have been mapped as Degraded to Completely Degraded.
182.8 ha of paddocks with scattered native trees. These areas are mapped as Completely Degraded. The distance between individual trees is generally greater than 50 m.

The remaining 9 ha is completely cleared land with no native vegetation, for example roads.
The s43A request has been updated to reflect this.
</td></tr>
<tr><td>Tables 2 and 3 detail the proposed impacts to Conservation Category Wetlands (CCW) as 2.7 ha, however in the RtS document Item No. 11 and 22 and the ERD, the total proposed impact to CCWs is 2.45 ha. Please confirm the correct figure and update accordingly, including offsets proposed, where relevant.</td><td>Main Roads can confirm that 2.7 ha within the mapped boundaries of CC wetlands is proposed to be cleared. Table 2-2 and Table 4-20 of the ERD correctly state disturbance of 2.7 ha of CC wetlands. Table 4-40 is incorrect. The correct values are provided below.
Items 11 and 22 in this RtS document have been updated to reflect the correct area of disturbance.
<table>
<tr><th>Wetland UFI</th><th>Wetland Category</th><th>Total Wetland Area (ha)</th><th>Area within Disturbance Footprint (ha)</th></tr>
<tr><td>12779</td><td>CC Wetland (Teatree Road)</td><td>5.2</td><td>0.4</td></tr>
<tr><td>15154</td><td>CC Wetland (Teatree Road)</td><td>30.3</td><td>0.3</td></tr>
<tr><td>12840</td><td>CC Wetland (Brockman River)</td><td>56.0</td><td>2.0</td></tr>
</table>
</td></tr>
<tr><td>Main Roads has proposed that the disturbance footprint is calculated at 503 ha however, an analysis of the spatial data provided has measured the disturbance footprint at 507.7 ha. Please confirm the correct figure and update relevant documentation accordingly.</td><td>The correct figure for the disturbance footprint is 507.7 ha. The s43A document has been updated accordingly.</td></tr>
</table>

EPA Comment	Main Roads Response
Response to Submissions	
Based on advice from DBCA additional analyses was undertaken to assist in confirming the floristic community type (FCT) present in the proposal area. It is understood that the most reliable and dependable methods of assigning FCTs in new quadrats on the southern Swan Coastal Plain is to repeat methods as applied in the Gibson et al. (1994). DBCA advises that unless there is justification to question the logic of the assignment of FCTs based on statistical analyses and that are also consistent with broad habitat characteristics, the results of the statistical analysis are considered to provide the most reliable and defendable outcomes. It appears that comparisons of proportions of species present with specified FCTs and percent dominant species from a particular FCT to assign FCTs has been relied on. Furthermore, the Darling Plateau habitat is inappropriate for Swan Coastal Plain FCTs that are weakly indicated in some of the statistical analyses shown in Table 3.1 of the Bindoon Bypass – Revised FCT Analysis (Focused Vision Consulting 2021). It is therefore considered that the information provided is not adequate to determine impacts and potentially offsets to State listed Threatened Ecological Communities (TEC) and Priority Ecological Communities (PEC). On review of the revised FCT analysis DBCA have identified a number of quadrats that, based on statistical analyses should logically be assigned FCTs that are State listed TECs or PECs. DBCA have reviewed species lists and photos, and are of the view that the occurrences of FCT3b and FCT20a are likely to represent northern expressions of those communities. To ensure that the State listed TECs and PECs are correctly recognised, it is recommended that:	
• The results for all quadrats that should be assigned to FCTs that are listed as TECs or PECs should be tabulated separately in a summary table.	Table 5 in the memorandum entitled *Bindoon Bypass – Revised FCT Analysis* (**Appendix F**) provides a summary of the quadrats that were inferred to be State listed PECs or TECs. The FCT analysis identified the following TECs and PECs: • FCT20a – *Banksia attenuata* woodlands over species rich dense shrublands (Endangered TEC) • FCT23b – Northern *Banksia attenuata* - *Banksia menziesii* woodlands (Priority 3) • FCT3b - *Corymbia calophylla* – *Eucalyptus marginata* woodland on sandy clay soils (Vulnerable TEC). The occurrence of this FCT within the survey area is noted as being a northern expression of the TEC (FVC 2022). The extent of each of the above TEC/PECs has been mapped by FVC (refer to the Figure 1 series in **Appendix F**). The table below presents the area of each TEC/PEC mapped by FVC along with the extent within the Development Envelope and the extent within the indicative disturbance footprint that will be cleared.

<table>
<tr><th>EPA Comment</th><th>Main Roads Response</th></tr>
<tr><td></td><td>
<table>
<tr><th>FCT</th><th>Status</th><th>Mapped Area (ha)</th><th>Development Envelope (ha)</th><th>Indicative Footprint (ha)</th></tr>
<tr><td>20a</td><td>Endangered</td><td>7.9</td><td>2.9</td><td>2.0</td></tr>
<tr><td>23b</td><td>Priority 3</td><td>26.6</td><td>10.2</td><td>4.5</td></tr>
<tr><td>3b</td><td>Vulnerable</td><td>25.4</td><td>5.2</td><td>3.0</td></tr>
</table>

The extent of the TEC/PEC that will be cleared represents a significant residual impact, as this clearing will be permanent, and will be offset as part of the overall offset package for the Proposal as follows:
• 13 ha of FCT20a
• 28.5 ha of FCT23b
• 19 ha of a northern expression of FCT3b
</td></tr>
<tr><td>• FCT boundaries be mapped based on FCTs that have been primarily assigned from the results of statistical analyses and the logic of the FCT occurring in the broader habitat (eg Swan Coastal Plain FCTs will not occur on Darling Plateau but may occur in transitional zones), and general logic of the floristics of the FCT.</td><td>Figure 1 in Bindoon Bypass – Revised FCT Analysis (Appendix F) shows the mapped extent of FCT20a, FCT23b, and FCT3b.</td></tr>
</table>

EPA Comment	Main Roads Response
• The mapped vegetation units presented often include more than one FCT. Boundaries of FCTs that are TECs and PECs need to be mapped separately from vegetation mapping based on structure or other characteristics such as the broad similarity of quadrats to each other. Mapping of the boundaries of FCTs is essential to determine offset requirements as the current vegetation mapping does not equate to FCT mapping for the area.	Figure 1 in *Bindoon Bypass – Revised FCT Analysis* (**Appendix F**) shows the mapped extent of FCT20a, FCT23b, and FCT3b. Spatial data is provided in the file titled ASJ17001_State_PEC_TEC_FCT.shp. Only the FCT boundaries of TECs and PECs have been mapped. Vegetation mapping as per EPA guidance (EPA, 2016) does not require mapping of all FCTs but rather those identified as "significant vegetation".
• Similarity indices from the statistical analyses, which indicate the most similar quadrats to those in the proposal area, were not provided and may also assist in guiding conclusions about FCTs present.	Similarity of the Bindoon Bypass quadrats to the Gibson *et al.* (1994) and Keighery *et al.* (2012) datasets was undertaken using the Bray-Curtis dissimilarity Index in PATN. For full details of the method and results please refer to *Bindoon Bypass – Revised FCT Analysis* in **Appendix F**
Please provide spatial data for the following environmental values that are located within the development envelope: • potential black cockatoo breeding trees • trees with suitable hollows for black cockatoo • trees with hollows showing evidence of use by black cockatoos • trees recorded as actively being used by black cockatoos at the time of survey • Native Vegetation Retention Areas	The requested shapefiles have been provided with this response as follows: • BC_Potential-breeding-trees.shp • BC_Hollows_Suitable.shp • BC_Hollows_Evidence.shp • BC_Hollows_Active.shp • NV_Retention_Areas.shp
Item No. 17 and Main Road's response in Section 3 (Social Surroundings) states that the construction of a noise or screen wall between dwellings on the Parkwood Springs Estate and the road is likely. Furthermore, the ERD in Figures 4-32 indicates the location of a noise protection wall between the Estate and the road.	There are no existing dwellings within 500 m of the proposed road at Parkwood Springs Estate and no indication as to where dwellings are likely to be located in the future. This makes it difficult to assess the impact of operational road noise in line with the requirements of SPP 5.4 and determine appropriate design criteria for any noise wall in this location at this time.

EPA Comment	Main Roads Response
Please confirm whether a noise wall is proposed, and the indicative dimensions, as a mitigation measure for this proposal.	Main Roads is committed to minimising operational noise impacts on noise sensitive receptors, as far as practicable. To address the potential for noise impacts on future dwellings at Parkwood Springs Estate, Main Roads intends to prepare a Traffic Noise Management Plan at least six months prior to operation of the Bindoon Bypass. The Plan will include: • Outdoor noise management targets. • Indoor noise management targets to apply to noise sensitive receptors where the construction of noise walls is not feasible or practicable. • The noise management actions to ensure the noise management targets are met during the operation of the proposal. • Where noise walls will be constructed, the location, height and timing of construction of the walls. • Where acoustic treatment of houses will be implemented, the standard of treatments, timing and evidence of consultation with affected stakeholders. • Road design measures to minimise noise emissions where relevant and appropriate, including low noise road surfaces and selection of appropriate bridge expansion joints. • Post-construction noise monitoring to demonstrate that noise management actions meet the relevant outdoor noise management targets. • Contingency actions in the event relevant noise management targets are not met.
Section 3 'Offsets' [Table 3-1] advises that it is unlikely that restoration/revegetation will form part of the offsets package, however in Items 5 and 6 it states that revegetation of degraded land may form part of the offsets package. Main Roads may wish to clarify its commitment on whether revegetation of degraded land would form part of the offsets package.	Main Roads has reviewed the potential composition of offsets for this proposal, considering availability of suitable parcels of land and experience with recent offsets for other Main Roads projects. The offsets package will include an element of revegetation. Areas of revegetation will focus on providing ecosystem services for fauna, such as foraging habitat for Black Cockatoos and ecological linkages. Main Roads are currently acquiring a 100 to130 m wide road reserve for this Proposal. As the road design progresses, it is expected that some of this reserve not required for the road may be able to be revegetated to provide habitat and fauna linkages.

EPA Comment	Main Roads Response
	Opportunities for revegetation and rehabilitation within the existing DBCA estate are limited on the northern Swan Coastal Plain, especially when compared to the Bunbury Outer Ring Road Proposal (EPA Report 1714). Most of the DBCA reserves in close proximity to this Proposal are intact remnants of vegetation that have not been subject to historic logging. As the location/s and activities required for revegetation sites have not yet been determined, calculations for offsets have assumed vegetated land will be purchased. The final offsets package will contain a revegetation component within the road reserve and potentially in areas outside of the road reserve. A Revegetation Offset Plan will be prepared prior to the commencement of construction for the approval of the EPA, if this Proposal is approved.

Table 3-4: Additional Comments Received from EPA Services – September 2021

EPA Services Comment	Main Roads Response
EPA Services recommends Main Roads prepares a revised Residual Impact Significance Model (refer Attachment 1) to clarify the final significant residual impacts from the proposal, incorporating where relevant, outcomes from the floristic community type analysis interpretation, the comments below and any amendments requested under the Request to Change Proposal During Assessment.	Refer to **Appendix G** for the revised Residual Impact Significance Model.
On completion of the revised Residual Impact Significance Model, if required, please provide details on the revised offset package.	Land acquired as part of the offset package for the Bindoon Bypass will include occurrence(s) of the P3 PEC Northern *Banksia attenuata - Banksia menziesii* woodlands (FCT23b), Endangered TEC *Banksia attenuata* woodlands over species rich dense shrublands (FTC20a) and northern expressions of the Vulnerable TEC *Corymbia calophylla – Eucalyptus marginata* woodland on sandy clay soils (FCT3b). Using the WA Offsets calculator, and the same general inputs as used previously with the EPBC Act Offsets calculator, the clearing of up to 4.5 ha of FCT23b will be compensated with the acquisition of 23.03 ha of land containing this PEC. Clearing of up to 2.0 ha of FCT20a will be compensated with the acquisition of 10.35 ha of land containing this TEC. Clearing of up to 3.0 ha of FCT3b will be compensated with the acquisition of 15.37 ha of land containing this northern expression of the TEC.

EPA Services Comment	Main Roads Response
	Main Roads acknowledges that the Marri-Jarrah woodlands habitat is considered habitat critical for the survival of the Chuditch and that clearing of this habitat may be considered a significant residual impact. To compensate for the loss of 54.4 ha of Chuditch habitat, Main Roads proposes to include at least 277 ha of habitat suitable for Chuditch as part of the offsets package for the Bindoon Bypass. This calculation will be refined once the offset property is determined.
Further information is required to demonstrate how the proposed offsets counterbalance significant residual impacts and provide tangible improvement and additionality providing conservation benefits to environmental values in an offset area. The current proposed offset package includes land acquisition (with vegetation likely to be in good or better condition), and the potential use of artificial hollows for black cockatoos.	Main Roads' proposed offsets are in line with the current WA Offsets Policy and the WA Environmental Offsets Guidelines. Land acquisition offsets provide mitigation by protection of existing values through security of tenure. On-ground offsets (as opposed to land acquisition offsets) are required to provide a tangible benefit and management actions within existing conservation land need to demonstrate additionality to business as usual management to be considered as offsets. The WA Environmental Offsets Guidelines describe land acquisition offsets as involving "the protection of environmental values through improved security of tenure or restricting the use of the land". Main Roads is proposing acquisition and protection in secure conservation tenure as the primary method of counterbalancing the significant residual impacts of this Proposal, in accordance with the guidelines. Where on-ground management is proposed (such as revegetation of degraded area within the road reserve) a tangible benefit will be demonstrated through the creation of habitat. As per the WA Offsets Guidelines, the objective of on-ground management actions is a tangible improvement to the environmental values of the offset. Currently there are no proposed offsets within existing conservation areas. The WA Offsets Guidelines only discusses "additionality" in association with works within existing conservation areas, not a land acquisition offset area. Acquisition of Good quality, privately owned land and transfer of this to DBCA for ongoing management will protect the environmental values present from future degradation by providing secure conservation tenure. Land outside of secure conservation tenure is likely to degrade due to land management practices that are incompatible with conservation such as subdivision for housing, inappropriate prescribed burning practices (e.g. periods between burning is too short), weed invasion from adjacent cleared areas, or spread of dieback due to unmanaged access

EPA Services Comment	Main Roads Response
	and lack of hygiene protocols. Transfer of the land to DBCA will allow for coordinated management of all DBCA owned and managed lands with similar environmental values while consultation and collaboration with DBCA during the land acquisition process will allow Main Roads to identify land parcels that either have strategic importance for conservation or can be amalgamated into existing conservation areas, thereby avoiding the acquisition of small, disconnected land parcels that are difficult to manage and ultimately not of value to DBCA. Revegetation (focusing on ecosystem services for Black Cockatoo or other fauna) and installation of artificial hollows will provide additional habitat for the species. As a larger number of artificial hollows will be installed than the number of breeding hollows (hollows with evidence of use) proposed to be removed, this will ultimately increase the number of hollows available for Black Cockatoos in the area for at least the 20-year maintenance period proposed.
Please provide justification for the proposed ratio of 3:1 for offsetting hollows with evidence of use by black cockatoos.	A 3:1 ratio was agreed with DAWE as an appropriate offset for Black Cockatoo hollows for the Muchea North project. Muchea North is located directly south of and adjoins the Bindoon Bypass Development Envelope. The same ratio was proposed and accepted by DAWE in the Artificial Hollow Management Plan conditioned in EPBC 2017/8035. Using the WA Offset calculator, the required offset for these hollows is 12.65, a ratio of 1.265:1 (**Appendix H)**. The installation of artificial hollows will result in a nett increase in suitable breeding hollows available for Black Cockatoos.
A review of recent Native Vegetation Clearing Permits and Ministerial environmental approvals require offsets for the direct impact to trees with hollows suitable for black cockatoos with no evidence of use and trees with suitable diameter breast height (50 centimetres or greater or 30 centimetres or greater for salmon gums and wandoo species). The EPA is likely to require an offset for the above-mentioned trees, therefore EPA Services recommends that direct impacts to these trees are included as a significant residual impact and subsequently offset.	The Residual Impact Significance Model has been updated to include loss of trees with suitable hollows and potential breeding trees (those trees with suitable diameter breast height). As discussed in Section 7.1 of the ERD, land acquired as part of the offsets package for the Proposal will include 351 trees with hollows suitable for Black Cockatoo in order to offset the clearing of 117 trees with suitable hollows. This is greater than the offset calculated using the WA Environmental Offsets Calculator of 148 trees with suitable hollows (**Appendix H).**

EPA Services Comment	Main Roads Response
	1,358 potential breeding trees are within the indicative footprint for the Proposal. This is 13% of the 10,337 potential breeding trees recorded during field surveys for the Proposal. To offset for this loss, and given the number of potential breeding trees to be cleared, land acquired for offsetting of Black Cockatoo breeding habitat will have an estimated density of at least 6 potential breeding trees per hectare. The overall density of potential breeding trees within the indicative footprint is 2.67 trees/ha. Density across the indicative footprint varies from less than 1 tree/ha in paddock areas to 12.5 trees/ha. As 300 ha of potential breeding habitat for Carnaby's Black Cockatoo and 226 ha of potential breeding habitat for the Forest Red-tailed Black Cockatoo is proposed to be acquired as part of the offsets package for the Proposal, an estimated 1,800 to 3,156 potential breeding trees will be included in the acquired land package, depending on how much overlap there is between breeding habitat for each species. This is greater than the calculated offset of 1,718 trees calculated using the WA Environmental Offsets Calculator (**Appendix H**).
EPA Services notes that Main Roads has concluded that residual impacts to 54.4 ha of habitat for Chuditch (*Dasyurus geoffroii*) are not significant. However, the proposal is partially located within the Jarrah Forest IBRA region, which is listed as habitat critical for survival of the Chuditch in the National Recovery Plan. Chuditch are wide-ranging and it is likely they will use east-west vegetated linkages to facilitate movement, in addition to providing potential feeding habitat and shelter. EPA Services recommends that Main Roads reanalyses the impacts to Chuditch habitat including any potential denning habitat and impacts from fragmentation. If Main Roads determines that residual impacts are not considered significant, clear reasoning must be provided. EPA Services requests Main Roads provide any evidence if available that Chuditch have used fauna underpasses.	Main Roads acknowledges that the Marri-Jarrah woodlands habitat is considered habitat critical for the survival of the Chuditch and that clearing of this habitat may be considered a significant residual impact. To compensate for the loss of 54.4 ha of Chuditch habitat, Main Roads proposes to include at least 277 ha of habitat suitable for Chuditch as part of the offsets package for the Bindoon Bypass. Main Roads is not aware of any research that has been specifically conducted into Chuditch use of underpasses, however recent research into the Northern Quoll, a related species, has shown that this species does make use of underpasses, particularly those constructed using box culverts (Harewood, 2020 - Appendix I). Other recent studies into the use of underpasses in Western Australia have shown that Woylies (Bateman *et al.,* 2017) and Quenda (Harris *et al.*, 2010) also make use of underpasses to safely cross beneath roads. Chuditch have been observed in proximity to underpasses in the Muchea area. This together with research into similar sized and related mammals supports the hypothesis that the Chuditch will make use of underpasses to move between areas of habitat on either side of the road.

EPA Services Comment	Main Roads Response
EPA Services understands that Main Roads has installed black cockatoo artificial nest hollows in areas along the Great Northern Highway. Please provide any report(s) or monitoring data available that details the use of the artificial nest hollows by black cockatoos including, but not limited to, how many artificial nest hollows were installed, how many were used by black cockatoos and the history of use over the years.	Artificial hollows have been installed as part of the Muchea North upgrade. 39 artificial hollows were installed in September 2018 and have been monitored annually since. The monitoring reports are provided in **Appendix J**. Monitoring results for the three breeding seasons between 2018 and 2021 show that use of artificial hollows has increased over the period with breeding identified in 12 artificial hollows during the 2020/21 season, though not all of these resulted in live, fledged chicks. A summary of the results is provided below. **2018/19:** • Confirmed breeding in Nest Box (NB) 2, though unknown if the breeding event was successful. • Confirmed nesting in NB66 but no breeding. • Confirmed nesting in NB64 but no breeding. **2019/20:** • Confirmed nesting in NB01 but no breeding. • Confirmed nesting in NB04 but no breeding. • Confirmed nesting in NB10 but no breeding. • Confirmed breeding in NB38. • Confirmed breeding in NB41. • Confirmed nesting in NB58 but no breeding. • Confirmed nesting in NB60 but no breeding. • Confirmed breeding in NB63. • Confirmed nesting in NB65 but no breeding. • Confirmed nesting in NB68 but no breeding.

EPA Services Comment	Main Roads Response
	• Confirmed nesting in NB76 but no breeding. • Confirmed nesting in NB77 but no breeding. **2020/21:** • Confirmed breeding in NB01. • Confirmed breeding in NB03. • Confirmed nesting in NB04 but no breeding. • Confirmed nesting in NB06 but no breeding. • Confirmed breeding in NB10, though unknown if the breeding event was successful. • Confirmed breeding in NB12, though breeding event was unsuccessful. • Confirmed breeding in NB32. • Confirmed breeding in NB34. • Confirmed breeding in NB41. • Confirmed nesting in NB42 but no breeding • Confirmed breeding in NB62 • Confirmed breeding in NB63, though breeding event was unsuccessful. • Confirmed nesting in NB64 but no breeding (successful breeding in natural hollow in same tree) • Confirmed breeding in NB71. • Confirmed nesting in NB76 but no breeding • Confirmed nesting in NB77 but no breeding • Confirmed breeding in NB78.

EPA Services Comment	Main Roads Response
	• Confirmed nesting in NB79 but no breeding • Confirmed breeding in NB99, though breeding event was unsuccessful.
The Artificial Hollow Management Plan does not clearly outline the length of time the artificial nest hollows will receive ongoing maintenance. For example, will maintenance of the artificial nest hollows extend beyond the completion/success criteria being met? Noting that without regular maintenance, artificial nest hollows may not support breeding black cockatoos. In accordance with the Offset Guidelines permanent impacts must ensure a long-lasting environmental benefit. Please revise the Artificial Hollow Management Plan clearly outlining the duration for which artificial nest hollows will be maintained.	Maintenance of artificial hollows will continue for a period of 20 years. During this time, it is anticipated that natural hollows will form to replace artificial hollows as they degrade and no longer become usable. This reflects natural processes, whereby hollows form, are be used by a variety of fauna for a period and then are abandoned as the hollows degrade or are lost due to loss of tree limbs or the entire tree (such as during storms).
EPA Board members on the site visit questioned the impacts to Aboriginal Heritage sites/places. It is unclear from the environmental review document or the response to submissions whether the Yued people support the proposal. Please provide further information on the outcome of discussions and responses provided to the Yued Working Group at meetings mentioned in the environmental review document.	The Yued people have indicated support for the Proposal, provided consideration of a number of concerns could be demonstrated. These concerns and Main Roads response to them were: • Engagement of Yued monitors for initial ground disturbing works associated with Site ID 20008 Gingin Brook Waggyl and Place ID 20650 Lennard Brook. • Engagement of Yued monitors for initial ground disturbing works associated with all watercourse crossings. Engagement of Yued monitors will be considered during detailed design and as the Proposal moves into construction. Further conversation with the Yued will occur prior to construction commencing. • Avoid impacting upon an unnamed tributary and the wetland southwest of Bindoon Moora Road between Kangaroo Gully and Pines Road. The design of the main alignment avoids this tributary and wetland. Changes to the alignment of Bindoon-Moora Road will be required to accommodate the intersection/interchange with the Bindoon Bypass, however this presents an opportunity to improve the flow of the creek and avoid the damming and flooding that currently occurs by increasing the size of the culverts.

EPA Services Comment	Main Roads Response
	• The Udumung Brook crossing incorporates a bridge span design rather than culverts to reduce the amount of clearing, excavation and disruption to the underground stream at this location and that the Yued are given the opportunity to relocate turtles to the Wannamal Wetlands prior to the works occurring at the Udumung Brook. This will be considered during detailed design. Further consultation with the Yued will be undertaken in relation to the design of the Udumung Brook crossing. The Yued will be provided opportunity to relocate turtles from Udumung Brook to the Wannamal Wetlands prior to construction of the crossing commencing. • The 'Emu Spring' is not impacted upon by the road alignment and that the proposed culvert is adequate to maintain the waters flow. Appropriate sizing of culverts to provide ongoing connection between Emu Springs (located on Lot 21 Cook Road) and the creek will be undertaken during detailed design. Consultation with the Yued will be undertaken to provide updates on the design of the culverts. • A large Moodjar tree (*Nuytsia floribunda*) identified during the survey north of Cook Road is marked on contractor's plans and that where possible all Moodjar trees are not affected during the proposed works. The large Moodjar tree is not within the indicative footprint and can be avoided. It will be marked on contractor's plans. • If any work is to occur within the reported 'Mooliabeenie Road Rail Crossing Camp' area within Lot M2106 and Lot 101 Mooliabeenie Road, that Ms June Headland and Ms Ruby Ryder are consulted and that Yued monitors are engaged to supervise any excavations. No works will occur within these properties. Main Roads will undertake heritage surveys with the Yued in 2022 in order to update the surveys undertaken in 2017. This will include a survey of the revised alignment for

EPA Services Comment	Main Roads Response
	Bindoon Bypass, as the alignment has changed at the southern end since the original consultation. Additional consultation will be undertaken with the Yued during the detailed design phase in order to understand and consider their concerns, including areas of significance to the Yeud, and further develop a respectful and beneficial relationship for both the Yued and Main Roads (including their partners and contractors).

Table 3-5: Additional Comments Received from DBCA and EPA Services – February 2022

DBCA Comment on RtS	EPA Services Comment	Main Roads Response
Flora and Vegetation		
1. DBCA previously noted that it would be useful to apply statistical analyses against Gibson et al (1994) data for a few key quadrats to check results. If statistical analyses have been completed against the Gibson et al. (1994) dataset, this should be indicated in the report, or provided.	• Revise the report to clarify whether the statistical analysis against Gibson et al (1994) has been completed.	The memorandum entitled *Bindoon Bypass – Revised FCT Analysis* (**Appendix F**) has been updated to confirm that statistical analysis against Gibson et al (1994) has been completed (refer to Section 2 of the memorandum).
2. It is DBCA's conclusion that quadrats within the footprint align with TECs as per advice in Attachment 2 ie: "Key data including species lists and photos from the proposal area were discussed with the Chair of the TEC Scientific Committee. It was concluded that the composition and structure of specific quadrats was consistent with northern expressions of specific FCTs. This includes quadrats B2.31, B2.33, C03, C09, B2.12, B2.45 (all FCT 3b). The SSI cluster and dissimilarity indices for these quadrats are also consistent with FCT 3b.	• DBCA have advised that the statistical analysis which was run following the ERD's public review period, does not require re-running and is considered satisfactory. However, Main Roads consultant has concluded that only FCT23b occurs within the development envelope, and DBCA considers that FCT3b and FCT20a are also present. DBCA does not agree with the consultant's justifications provided in Appendix F, Table 2 and 3.	• The memorandum entitled *Bindoon Bypass – Revised FCT Analysis* (**Appendix F**) has been updated to reflect DBCA's advice that FCT3b and FCT20a are present, based on the outcomes of the statistical analysis. • Maps of FCTs that are State listed TECs or PECs within the flora and vegetation survey area are provided as Figure 1a – Figure 1d of the memorandum.

DBCA Comment on RtS	EPA Services Comment	Main Roads Response
The affinity of B16R with FCT 20a is less clear as the outcomes of cluster and dissimilarity indices do not align. This quadrat clustered most closely with a group of quadrats of FCT20a and the quadrat clearly has similarities to FCT 20a." The consultants also sought to assign their pre-determined vegetation units to a single Floristic Community Type (FCT). DBCA's recommended methods are to assign quadrats to an FCT prior to mapping boundaries of vegetation units purported to reflect FCT boundaries. Vegetation units can otherwise contain one or many FCTs.	• Given DBCA's advice, reconsider the interpretation of results and conclusions in Appendix F about the likely presence of FCT3b and FCT20a. Update RtS and Appendix F where relevant. • Provide a map of all FCTs that are State listed TECs or PECs. ▸ If there are any changes to FCTs that are TECs or PECs, resubmit the associated spatial data to confirm extents of significant values.	• Revised spatial data is provided with this response in the file titled *ASJ17001_State_PEC_TEC_FCT.shp*.
3. n/a	• Confirm whether Main Roads considers there are any changes to the significant residual impacts from the proposal, and/or environmental outcomes as a result of addressing DBCA's comments in point 2. above? Update the RtS where relevant.	Following reanalysis of the FCTs, the proposal will result in the following significant residual impacts: • Clearing of up to 2.0 ha of FCT20a • Clearing of up to 4.5 ha of FCT23b • Clearing of up to 3.0 ha of FCT3b (northern expression). These residual impacts and associated environmental outcomes will be included in the updated S43A application. The RtS has been updated with the results of the revised analysis as follows: • Table 3.3 has been updated to reflect the revised analysis

DBCA Comment on RtS	EPA Services Comment	Main Roads Response
		• The Residual Impact Significance Model in **Appendix G** has been updated to include FCT20a, FCT23b and FCT 3b • Offsets have been proposed for the significant residual impacts to FCT20a, FCT23b and FCT 3b and the WA Environmental Offsets Calculator completed for each (**Table 3-4** and **Appendix H**)
4. It is noted in section 7.2.1 (page 109) of the Flora and Vegetation Assessments report that 89.05 hectares of the study area was not accessible and therefore not included in the 2018 survey. If project works are proposed to occur within this area, an assessment of conservation values is required to enable identification and management of environmental impacts.	• EPA Services notes MRWA's response to this comment ie: to delineate this 89 ha area as a "Native Vegetation Retention Area" and submit the corresponding shapefile. However, given this area is on private property that has not been surveyed and is no longer required for the proposal, it is recommended that it is instead removed from the development envelope as part of the pending section 43A application.	Main Roads has substantially reduced the Development Envelope for the Proposal, including removal of the unsurveyed area. The Section 43A application has been updated accordingly.

4. References

Bateman, A., Chambers, B., Pacioni, C., Rafferty, C., Jones, K and Bencini, R. (2017). Application of underpasses to expand nature reserves: responses of a critically endangered marsupial, the woylie, Bettongia penicillata. Hystrix.

Environmental Protection Authority (2016) Technical Guidance. Flora and Vegetation Surveys for Environmental Impact Assessment. Available from https://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/EPA%20Technical%20Guidance%20-%20Flora%20and%20Vegetation%20survey_Dec13.pdf

Harewood, G. (2020) Northern Quoll camera trap monitoring program (2020) - Marble Bar Road Coongan Gorge realignment. Unpublished report prepared for Main Roads Western Australia.

Harris, I., Mills, H. and Bencini, R. (2010). Multiple individual southern brown bandicoots (Isoodon obesulus fusciventer) and foxes (Vulpes vulpes) use underpasses installed at a new highway in Perth, Western Australia. CSIRO Wildlife Research. 37. 127-133. 10.1071/WR09040.

Figures

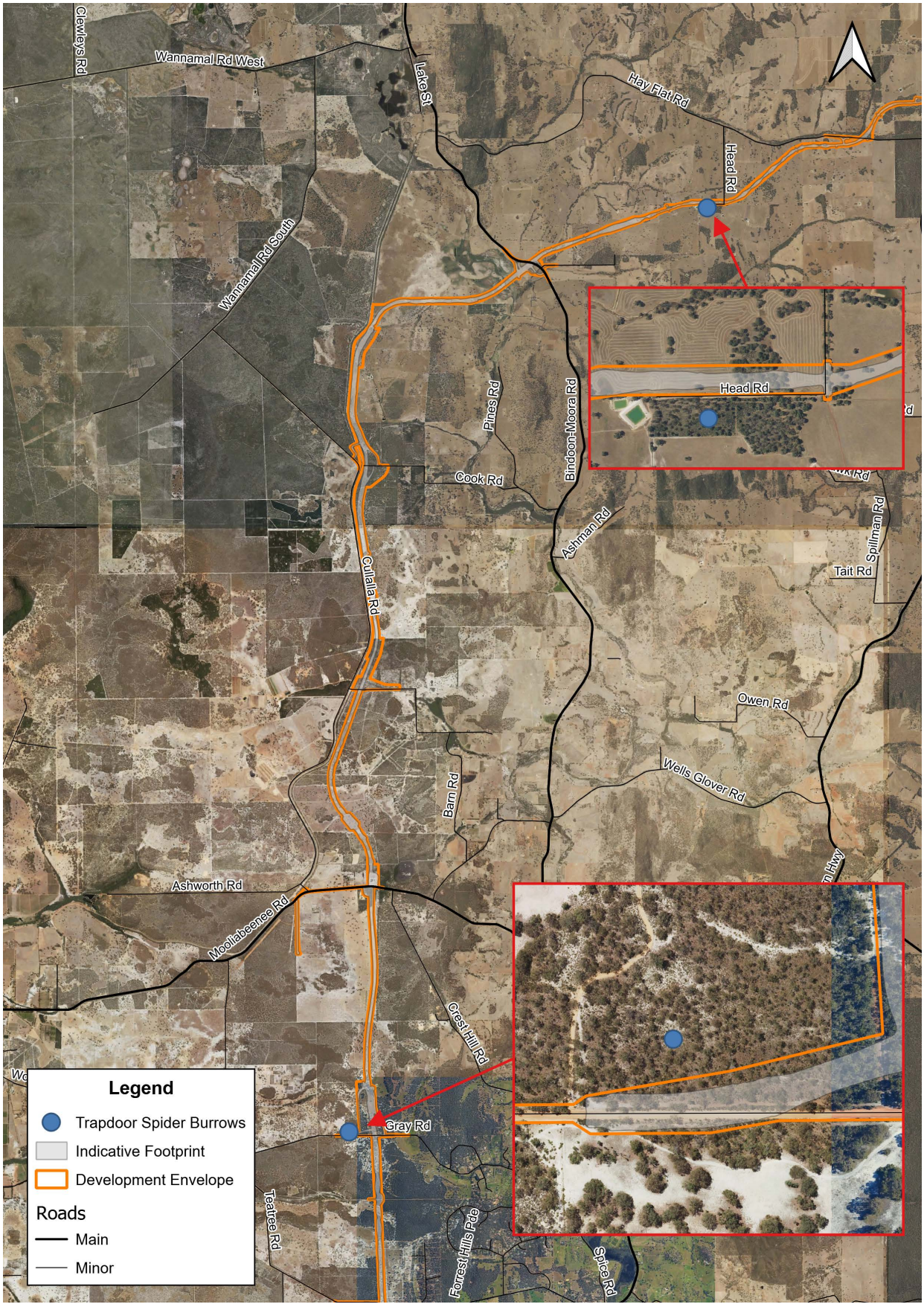

Figure 1: *Idiosoma mcclementsorum* Burrows

Figure 2: Vegetation Retention Area - Not required due to change to Development Envelope

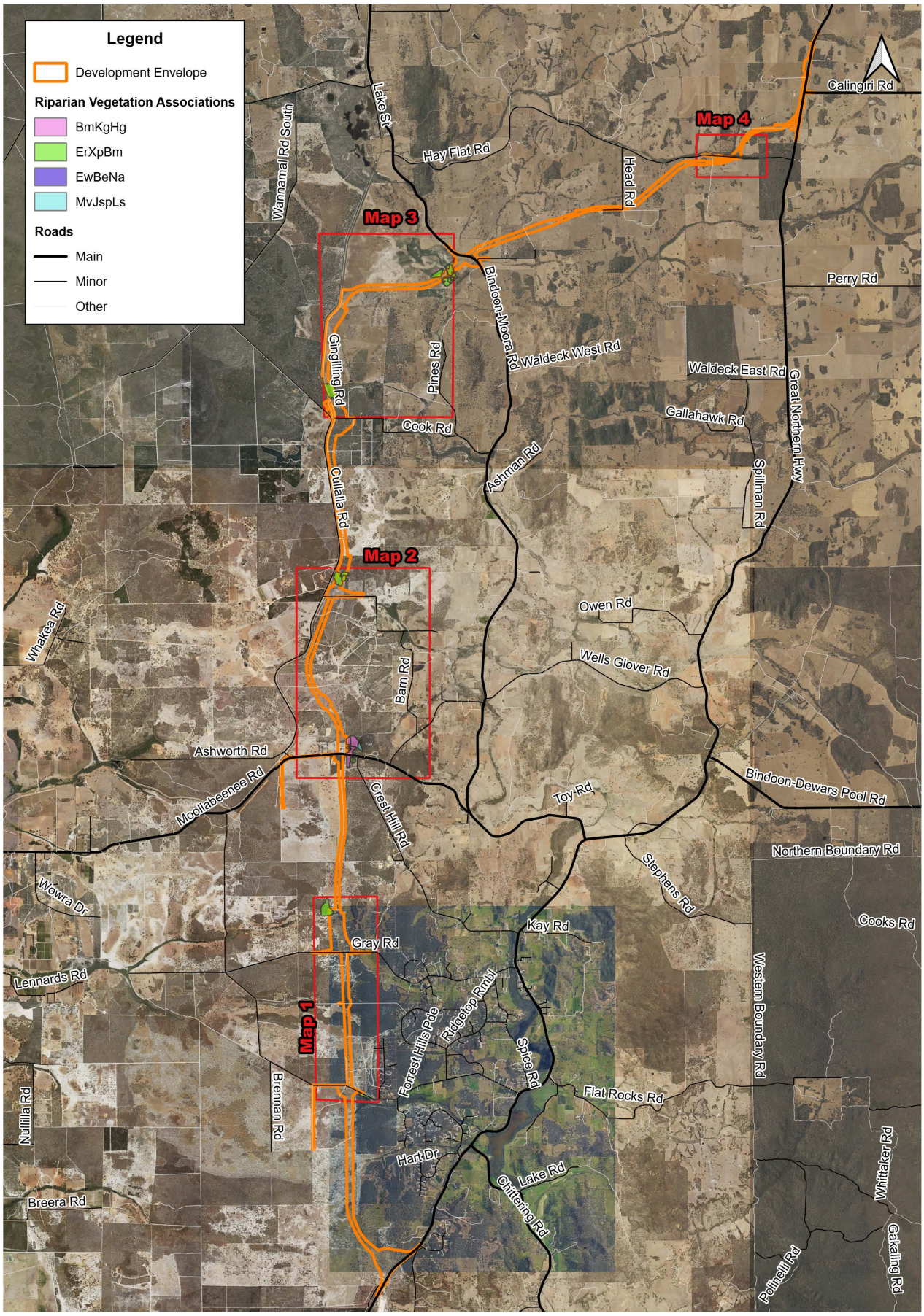

Figure 3: Riparian Vegetation Types

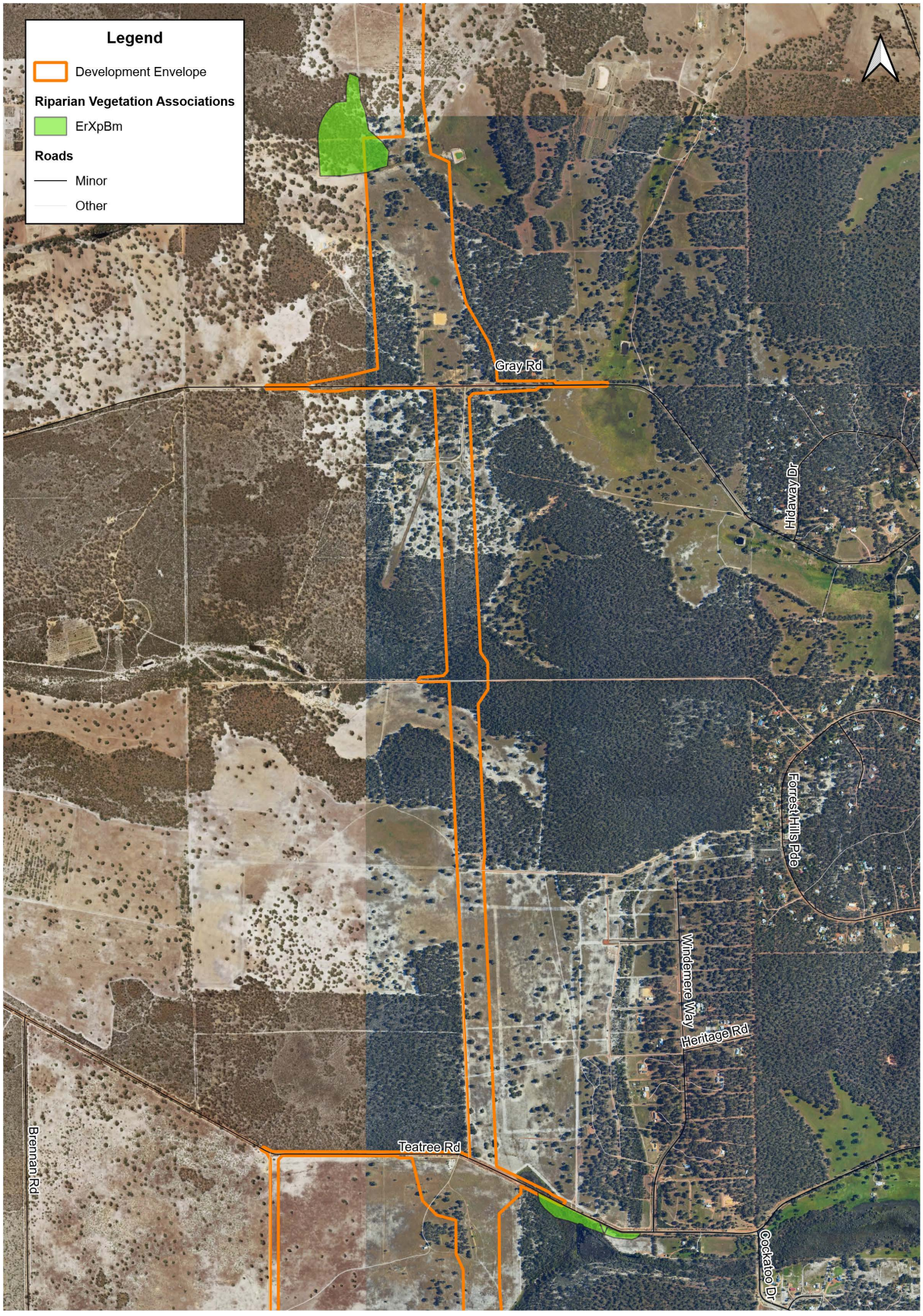

Figure 3: Riparian Vegetation Types – Map 1 of 4

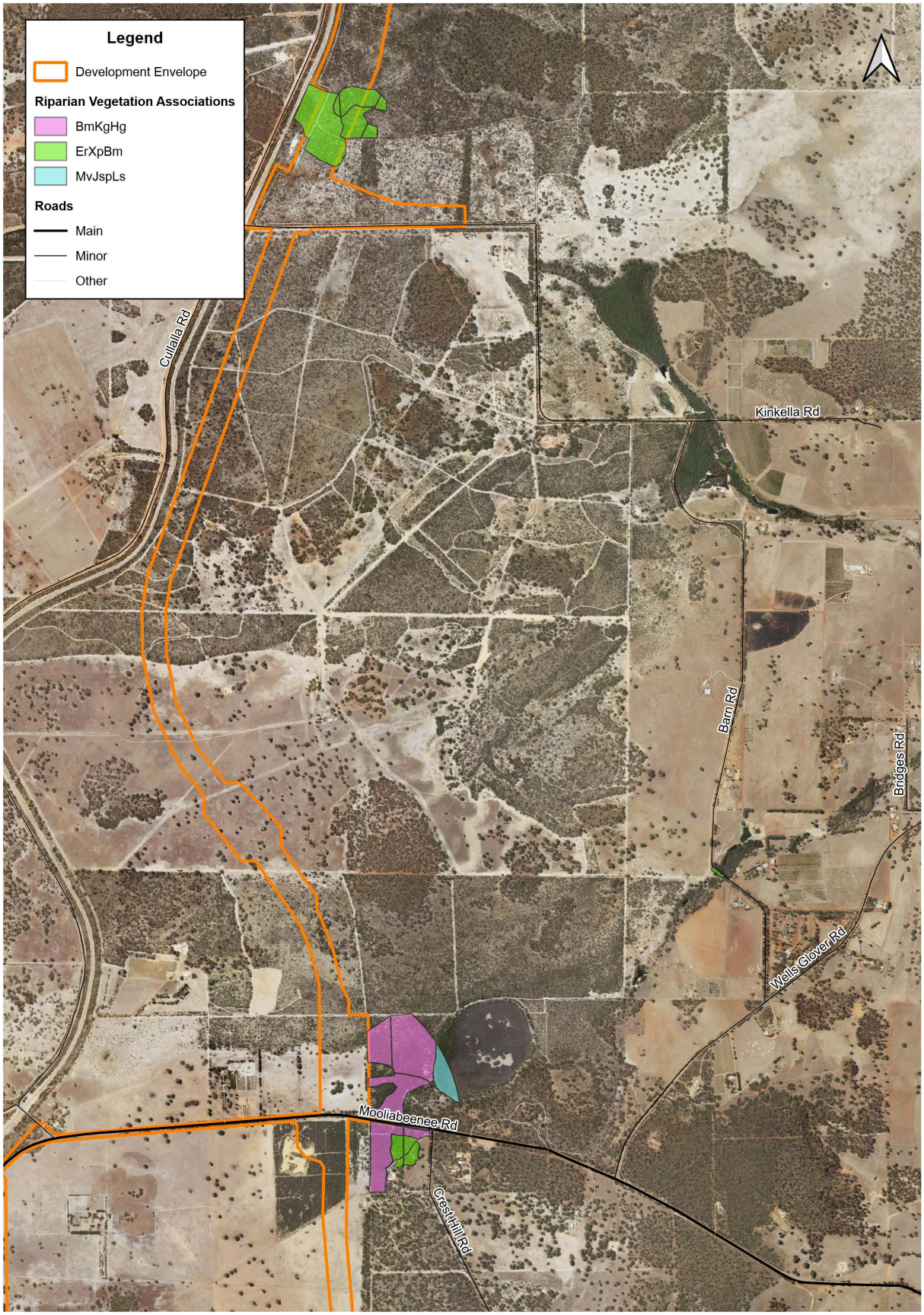

Figure 3: Riparian Vegetation Types – Map 2 of 4

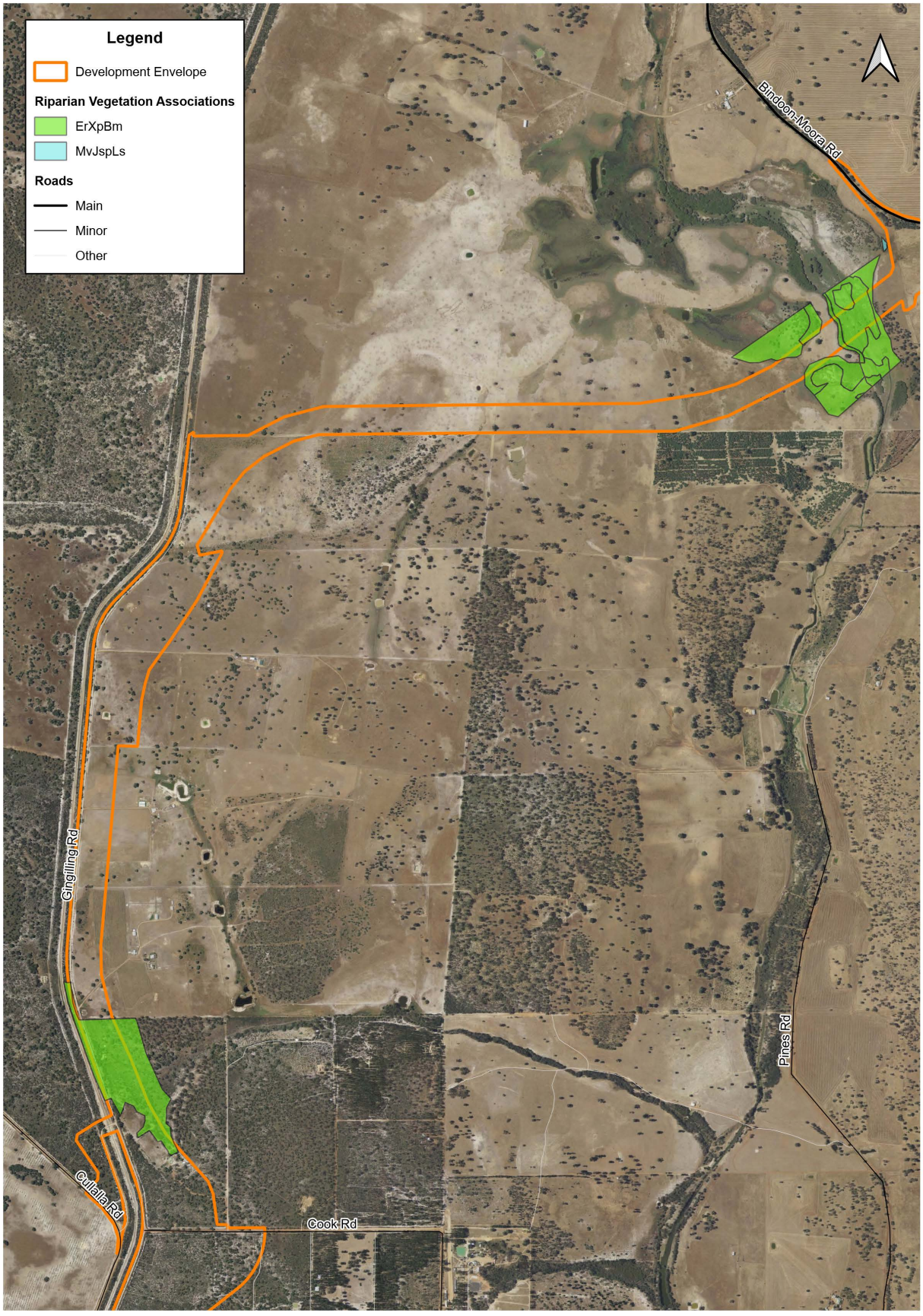

Figure 3: Riparian Vegetation Types – Map 3 of 4

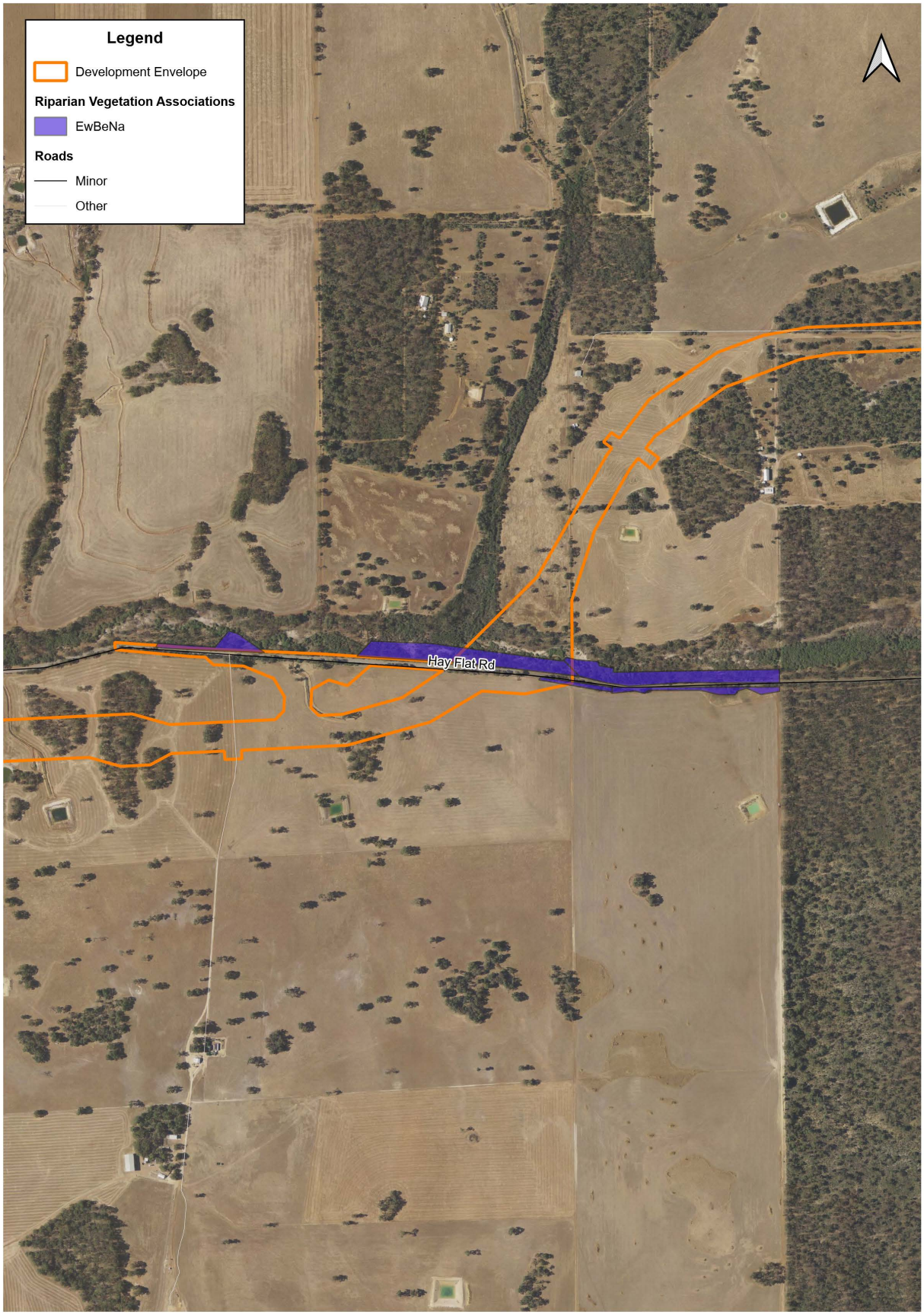

Figure 3: Riparian Vegetation Types – Map 4 of 4

Appendix A. GHG Emissions – Technical Memorandum

Jacobs

Memorandum

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Subject	**Bindoon Bypass Greenhouse Gas Estimate**	**Project Name**	Bindoon Bypass
Attention	Lisa Boulden	**Project No.**	IW056014
From	James Wilkinson		
Date	9 September 2020		
Copies to	**Dana Jump**		

Bindoon Bypass – Response to EPA Request for Greenhouse Gas Emissions Estimate

1. Summary

The Bindoon Bypass is expected to have the Greenhouse Gas Emissions as detailed below.

Period	Emissions Type	Total (tCO2e)	Annual (tCO2e)
Construction (42 months)	Scope 1	194,603	55,601
	Scope 2	0	0
	Scope 3	23,138	6,611
Operations (50 years)	Scope 1	21,279	426
	Scope 2	0	0
	Scope 3	2,554,282	51,086

The methodology and a breakdown of how this calculation has been made is provided below.

2. Introduction

In April 2020, the Western Australian Environmental Protection Authority (EPA) released its Environmental Factor Guideline – Greenhouse Gas Emissions. As the construction of the Bindoon Bypass project is an infrastructure development and a development that clears vegetation, it is an activity that may be considered under the Greenhouse Gas Emissions Factor. As a result of this, the Bindoon Bypass has been requested to provide an estimate of Greenhouse Gas (GHG) emissions as a result of the clearing, construction and operation of the project.

3. Methodology

3.1 Boundary and Emissions Sources

The Jacobs team has undertaken a high-level estimate of the project's GHG footprint, covering the most significant contributions. The assessment boundary is presented in Table 3-1.

Table 3-1: GHG Assessment Boundary

Source of GHG emission (construction)	Activity	Included in inventory?	Direct	Indirect	
			Scope 1	Scope 2	Scope 3
Stationary fuel	Fuel consumed by generators for operation of site offices	✓	●		●
Transport fuel	Fuel consumed for use in site management vehicles (utility vehicles)	✓	●		●
Stationary Fuel	Fuel consumed by construction plant / equipment, as well as for maintenance plant.	✓	●		●
Transport fuel	Fuel consumed for construction materials delivery and spoil/rock removal and haulage.	✓			●
Carbon sinks	Land clearing / soil disturbance	✓	●		
Construction materials	Embodied emissions of materials used in construction and maintenance.	✓			●
Road use during operation	Fuel consumed for users of the road throughout its life following construction	✓			●
Landfill	Construction waste disposed at landfill.	✘			●
Transport fuel	Employee / business commute (vehicles) and air travel.	✘			●

Due to the greenfield nature of the project, construction waste is expected to be limited to small quantities of office waste, as well as offcuts, breakages or similar minor quantities of inert materials with little organics content. These are not considered to be greater than one per cent of the total emissions for the project and hence have not been included, however spoil management for cut, fill and export is included.

Employee commuting and air travel have been excluded as they are considered to be largely outside of the projects influence and are not considered to be greater than one per cent of the total emissions for the project.

No lighting, signalling or other notable operational electricity uses are present for the project and hence, this has not been included for the assessment.

3.2 Assumptions and Emissions Factors

Predictions of project quantities have been provided by the design team based on best available information at the time of design. These quantities have been used with the assessment methodology provided by the Transport Authorities Greenhouse Group (TAGG) Workbook (2013) and the associated Carbon Gauge Tool to prepare estimates of fuel use and construction materials, as well as land clearing emissions categories.

A breakdown of the land clearing allocations based on the TAGG Workbook (2013) classes is presented in Table 3-2, with all vegetation cleared being allocated as Biomass Class 2 (50-100 tonnes dry matter / hectare).

Table 3-2: Project land clearing breakdown

Vegetation Class	Emissions Factor (tCO_2e/ha)	Area Cleared (ha)
D	209	119.9
I	110	374.2
G	N/A*	0.1

* Vegetation class G, Biomass Class 2 does not have an emissions factor presented in the TAGG workbook methodology. The closest emissions factor for Class G Biomass Class 1 is 113 tCO_2e/ha, making this section of land clearing negligible (<<1%) and has thus been excluded from the assessment.

Operational fuel emissions associated with the use of the road over its lifetime (50 years) has been based on transport and traffic modelling undertaken for the Great Northern Highway (GNH) project with the traffic volume for the Bindoon Bypass section extracted. This traffic data has been used, along with state specific average fuel consumption data for various vehicle types sourced from the Australian Bureau of Statistics (2018), to generate annual fuel consumption data for vehicles using the road. Fuel consumption and traffic data has been assumed constant over the 50 year project life, with the emissions presented in Table 4-1 for the full 50 year period.

It is noted that the emissions associated with road users attributed to the project is based on the projected use of the Bindoon Bypass, but is not mutually exclusive from a scenario in which the project was not undertaken. i.e. these emissions may still have occurred through existing road corridors and no comparison has been made between road user emissions scenarios with and without the construction of the Bindoon Bypass.

Emissions factor sources are presented in Table 3-3.

Table 3-3: Emissions Factors Sources

Emissions Source	Emissions Factors Source
Fuel consumption (stationary and transport)	National Greenhouse Accounts Factors (2019)
Land Clearing	Transport Authorities Greenhouse Group (TAGG) Workbook (2013) Appendix E
Construction Materials	Infrastructure Sustainability Council of Australia (2018) Infrastructure Sustainability (IS) Materials Calculator v2.0

4. Emissions Footprint Results

The project is expected to result in the following emissions over the 50 year design life:

- Scope 1 = 215,882 tonnes CO_2e
- Scope 2 = 0 tCO_2e
- Scope 3 = 2,577,420 tCO_2e

The emissions source breakdowns are summarised in Table 4-1.

Table 4-1: Emissions breakdown from project activities

Source	Scope 1 Emissions (tCO_2e)	Scope 2 Emissions (tCO_2e)	Scope 3 Emissions (tCO_2e)	Total Emissions Proportion
Construction Fuel Consumption	128,383	0	6,632	4.8%
Maintenance (50-year life)	21,279	0	5,150	0.9%
Vegetation Clearance	66,220	0	0	2.4%
Construction Materials	0	0	12,167	0.4%
Haulage	0	0	4,339	0.2%
Road Users (50-year life)	0	0	2,549,132	91.3%
Total Emissions (tCO_2e)			2,793,302	

5. Conclusion

Based on an expected 42-month duration of construction, the annual Scope 1 emissions for the project's construction are 55,600 tCO_2e/annum. This is below the 100,000 tCO_2e/annum Scope 1 emissions threshold within the EPA Environmental Factor Guideline – Greenhouse Gas Emissions.

6. References

Australian Government Department of the Environment and Energy (2019), Australian National Greenhouse Accounts Factors

Environmental Protection Authority (2020), *Environmental Factor Guideline – Greenhouse Gas Emissions*. EPA, Western Australia

Infrastructure Sustainability Council of Australia (ISCA), (2018), Infrastructure Sustainability v2.0 Materials Calculator

Transport Authorities Greenhouse Group (TAGG), (2013) Greenhouse Gas Assessment Workbook for Road Projects

Appendix B. Black Cockatoo Artificial Hollow Management Plan

Great Northern Highway
Muchea to Wubin Upgrade - Stage 2

MAIN ROADS WESTERN AUSTRALIA

EPBC 2017/8035 Bindoon Bypass
Artificial Hollow Management Plan

Document Number :	GNH-CN12-EN01-MPL-0002
Revision :	2
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Date :	30 / 10 / 2020
Contract Number :	CN12-EN01
Client Contract Number :	10/13

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Document Control

Document description	
Project :	Great Northern Highway - Muchea to Wubin Upgrade - Stage 2
Document Title :	EPBC 2017/8035 Bindoon Bypass Artificial Hollow Management Plan
Document No. :	GNH-CN12-EN01-MPL-0002
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Client Contract Number :	10/13

Current Issue

Revision	Date
2	30 October 2020

Prepared by	Reviewed by	Reviewed by	Approved by
Document Owner	Contract Lead	Internal Technical Reviewer	Project Director
Maria Murphy	Lisa Boulden	N/A	Nigel Scott

Issue summary

Revision	Date	Issue description	Distribution
1	19-10-2020	Draft	Cross Discipline Review / Technical Review / PAG Review
2	30-10-2020	Final	Issued to DAWE

Contents

Tables

Diagrams

Figures

Glossary

Abbreviation	Description
AHMP	Artificial Hollow Management Plan
ASJV	Arup Jacobs Joint Venture
BCE	Bamford Consulting Ecologists
DAWE	Department of Agriculture, Water and the Environment
DBCA	Department of Biodiversity, Conservation and Attraction
DBH	Diameter at Breast Height
DPaW	Department of Parks and Wildlife
EP Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GNH	Great Northern Highway
GPS	Global Positioning System
ha	Hectare
km	Kilometre
Landcare SJ	Landcare Serpentine-Jarrahdale Inc.
mm	Millimetre
M2W	Muchea to Wubin
Main Roads	Main Roads Western Australia
PAG	Project Advisory Group
WA	Western Australia

1. Summary

Main Roads Western Australia (Main Roads) is proposing to construct a bypass around Bindoon town and Bindoon Hill (hereafter referred to as the Bindoon Bypass), deviating from the existing Great Northern Highway (GNH) at Chittering Roadhouse and re-joining the highway at Calingiri Road. This Artificial Hollow Management Plan (AHMP) has been prepared to:

- provide guidance to Main Roads and their contractors in relation to the requirement for, installation and management of artificial hollows for Black Cockatoos, specifically the Forest Red-tailed Black Cockatoo and Carnaby's Black Cockatoo.
- support the environmental assessment of the Bindoon Bypass under both the Commonwealth *Environment Protection and Biodiversity Act 1999* (EPBC Act) and Western Australian (WA) *Environmental Protection Act 1986* (EP Act).

Table 1-1 details the environmental management targets to measure achievement of the environmental objectives that must be met through implementation of this AHMP.

Table 1-1: Artificial Hollow Management Plan Summary

Item	Description
Project	Bindoon Bypass
Assessment Number	• EPBC 2017/8035 • Environmental Protection Authority (EPA) Assessment No. 2135
Proponent	Main Roads Western Australia
Purpose of the AHMP	Provide guidance to Main Roads and their contractors to manage, mitigate and offset potential impacts to Black Cockatoos resulting from the clearing of hollow bearing trees. Support the environmental assessment of the Bindoon Bypass
Environmental Objective	Minimise potential impacts to breeding success of Black Cockatoos as a result of clearing of natural hollows during construction of the Bindoon Bypass
Management Targets	• Three artificial hollows installed for each hollow showing evidence of use cleared • Artificial hollows installed prior to start of breeding season following clearing • Location/s for installation of artificial hollows verified by a suitably qualified person
Completion/Success Criteria	A minimum of ten artificial hollows have shown evidence of use by Black Cockatoos for three consecutive years

2. Scope, Context and Rationale

2.1 Description of the Action

The GNH is a critical freight link between the Perth metropolitan area, and the towns and mining centres of the Midwest and Pilbara regions of WA. The GNH forms part of Highway 1, a network of highways that connect all mainland state capitals. In order to improve freight efficiency and road safety, Main Roads is proposing to construct a bypass around Bindoon town and Bindoon Hill (hereafter referred to as the Bindoon Bypass or the Action), located within the Shire of Chittering approximately 70 km north east of Perth and approximately 13 km north of Muchea. The Bindoon Bypass will divert from the existing GNH at the Chittering Roadhouse, running to the west of Bindoon and re-joining the GNH north of Calingiri Road (**Figure 1**). This will involve the construction of approximately 47 km of new highway.

The Bindoon Bypass will be constructed in stages based on the expected traffic volumes. The initial stage (Interim Stage) will consist of single carriageway (two lanes) with a number of overtaking lanes for both north-bound and south-bound traffic, as well as stopping facilities. The second stage (Ultimate Stage) will build on the work done in the Interim Stage to accommodate higher numbers of road users, and comprises an upgrade to dual carriageway (four lanes) between Chittering Roadhouse and Bindoon-Moora Road. Upgrades to local roads, rail crossings and intersections may also be required, as well as relocation of services, fencing of the road reserve and construction of driveway accesses for landowners.

2.2 Purpose of this Management Plan

This AHMP has been prepared specifically in relation to the use of artificial hollows to manage, mitigate and offset potential impacts to Black Cockatoos resulting from construction of the Bindoon Bypass. This plan:

- provides guidance on the installation of artificial hollows for Black Cockatoos;
- details management targets to determine success of the artificial hollows;
- outlines monitoring and maintenance requirements;
- recommends adaptive management approaches should targets be at risk of not being met; and
- describes the record keeping, review and reporting requirements for this plan.

2.3 Black Cockatoo Values of the Bindoon Bypass

The Bindoon Bypass is within the mapped distribution of Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) and the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*). Fauna surveys across the Development Envelope for the Action and surrounds were undertaken by Bamford Consulting Ecologists (BCE) between October and December 2016, April and November 2017, February and November 2018, and March and May 2019. These surveys included targeted searches for Black Cockatoos.

The surveys undertaken by BCE (2017, 2018, 2019) identified 11,554 Black Cockatoo potential breeding trees, those trees with a diameter at breast height (DBH) greater than 500 mm. Of these, approximately 90% did not have hollows suitable for Black Cockatoos. A total of 1,352 tree hollows were recorded that are suitable for use by Black Cockatoos (BCE 2018), with a further 83 identified with evidence of chew marks around hollow entrances, indicating these are likely to be used for breeding (**Figure 2**). During the 2017 survey, three active nests were recorded outside of the Development Envelope.

Three roost sites for the Forest Red-tailed Black Cockatoo were identified by BCE (2018). None of these roosts are within the Development Envelope. No roost sites for Carnaby's Black Cockatoo were recorded (BCE 2018).

Foraging habitat for both Carnaby's Black Cockatoo and the Forest Red-tailed Black Cockatoo was recorded across the study area during the surveys by BCE (2017, 2018, 2019). The value of the foraging habitat ranged from Negligible to High for both species (**Table 2-1**). For the Forest Red-tailed Black Cockatoo, 68.5% of the survey area was determined to consist of habitat with Low or Negligible foraging value while for Carnaby's Black

Cockatoo 60% of the survey area was recorded as Low or Negligible (BCE 2018). Only 2.7% and 6.2% of the foraging habitat was recorded as High value for the Forest Red-tailed Black Cockatoo and Carnaby's Black Cockatoo, respectively. In general, the Development Envelope provides Moderate value foraging habitat for both species of Black Cockatoo (BCE 2019).

Table 2-1: Black Cockatoo Foraging Habitat Value within the Study Area

Habitat Value	Forest Red-tailed Black Cockatoo		Carnaby's Black Cockatoo	
	Area (ha)	%	Area (ha)	%
6: High	106.5	2.7	243.3	6.2
5: Moderate to High	202.1	5.2	383.7	9.8
4: Moderate	365.1	9.4	664.4	17.0
3: Low to Moderate	555.2	14.2	313.3	8.0
2: Low	1,362.0	34.9	1,452.0	37.1
1: Negligible	1,308.5	33.6	855.4	21.9
0: Nil	0.0	0.0	0.0	0.0

2.4 Potential Effects of the Action

Construction of the Bindoon Bypass will require clearing of Black Cockatoo habitat. Implementation of the Action will result in clearing of:

- 10 trees with hollows showing evidence of use by Black Cockatoos; and
- 117 trees with hollows suitable for use by Black Cockatoos.

3. Management Measures

3.1 Rationale for Choice of Management Measures

This AHMP has been informed by the results of baseline surveys, the recovery plans for each species (BCE 2017, 2018, 2019; Department of Parks and Wildlife 2013; Chapman 2008) and current scientific knowledge on the use and effectiveness of artificial hollows for Black Cockatoos (Johnstone R.E. 1997; BirdLife Australia 2017; Groom 2010; Johnstone *et al* 2010). The management approach has further been informed by current best practice and recent experience on similar road projects in WA.

The installation of artificial hollows has been selected as a key management and offset measure for the following reasons:

- Loss of breeding habitat and competition for nesting hollows have been identified as key threats to Black Cockatoos (Department of Parks and Wildlife 2013; Chapman 2008).
- Evidence of nesting by Black Cockatoos as recorded adjacent to the Development Envelope with evidence of potential nesting, in the form of chew marks at hollow entrances, also recorded within the Development Envelope (BCE 2017, 2018, 2019).

Throughout the planning and environmental assessment phase of the Bindoon Bypass, a hierarchical approach was taken to impact mitigation. The primary focus was on avoiding Black Cockatoo habitat and nesting trees through, for example, route selection and design refinement. Where avoidance was not possible, the use of artificial hollows is proposed to minimise the duration, intensity and/or extent of impacts on Black Cockatoos due to the clearing of potential nesting hollows.

3.2 Management Objectives, Actions and Targets

The objective of this AHMP is to minimise potential impacts to breeding success of Black Cockatoos as a result of clearing of natural hollows during construction of the Bindoon Bypass. Main Roads aims to achieve this objective through the installation of 30 artificial hollows to replace the 10 trees with hollows showing evidence of use that will be cleared for construction of the Bindoon Bypass. **Table 3-1** details the management actions required to meet the objective.

Table 3-1: Management Actions, Performance Targets and Timing

Management Actions	Performance Target	Timing
Location/s for installation of artificial hollows verified by a suitably qualified person with experience in Black Cockatoos	All artificial hollow locations signed off by a suitably qualified person	Prior to commencement of clearing
Artificial hollows installed prior to start of breeding season[1] following clearing	Required number of artificial hollows for each hollow showing evidence of use cleared installed prior to breeding season following clearing	Artificial hollows installed by 31 March
Three artificial hollows installed for each hollow showing evidence of use cleared	At least 30 artificial hollows installed	Completion of clearing activities and prior to 31 March

Notes: 1 Breeding season for Carnaby's Black Cockatoo is July to February with peak breeding occurring between September and December. Breeding season for the Forest Red-tailed Black Cockatoo is April to June and August to October.

3.3 Installation of Artificial Hollows

Artificial hollows will be installed prior to the breeding season that follows the clearing, in order to maximise the number of hollows available at the commencement of the breeding season. As no active nests will be cleared, this timing is considered appropriate to avoid any additional impacts on the species.

A suitably qualified person with experience in Black Cockatoos will be engaged to assist with the planning of artificial hollow installation, including location. Appropriate trees will be identified by taking into consideration the following parameters:

- trees should be within the road reserve, but not adjacent to the road, or within other Crown lands (e.g. DBCA-managed lands) to facilitate ease of access for monitoring and maintenance;
- located in proximity to impacted nesting hollow, or existing nesting hollow which will not be impacted;
- located within or adjacent to foraging habitat;
- located in proximity to water;
- trees should be mature and well shaded; and
- trees should be accessible with a cherry picker, without requiring additional disturbance, to allow installation of the artificial hollows.

Main Roads is intending to procure and install artificial hollows known as Cockatubes®. These are constructed by Landcare Serpentine-Jarrahdale Inc. (Landcare SJ), and the current design has been developed over a period of 10 years with the assistance of the Department of Biodiversity, Conservation and Attraction (DBCA) and the WA Museum. Cockatubes® have an expected lifespan of 50 years or more, provided they are regularly maintained (maintenance includes, for example, replacing the sacrificial wood chewing post as required). They are used extensively throughout the south west of WA, including a number of Cockatubes® that have been installed by Main Roads along the GNH in the Bindoon area. Recent monitoring of the artificial hollows show they have been used successfully for breeding (Johnstone *et al* 2010; Phoenix Environmental Sciences 2018).

3.4 Monitoring and Maintenance

3.4.1 Monitoring Surveys

Artificial hollows will be surveyed in September / October each year to coincide with the peak breeding season for both species. The first survey will occur during the breeding season following the installation of artificial hollows. Surveys will be undertaken by a suitably qualified person. Hollows should initially be inspected from the ground using binoculars to check for signs of use (chew marks or birds entering/exiting the hollow) or factors which may prohibit nesting by Carnaby's Black Cockatoo such as invasion of the hollow by feral bees. A drone or remotely operated camera on a pole of sufficient length may also be used to look directly into the hollow. Surveys will identify:

- if hollows are currently in use or show evidence of previous use;
- maintenance requirements for artificial hollows (such as replacement of the sacrificial wooden post or removal of feral bees); and
- if hollows are no longer able to be used by Carnaby's Black Cockatoo, for example they have been invaded by feral bees, the hollow has been damaged or the limb has fallen.

The results of monitoring surveys will be provided to DBCA in order to contribute to broader research into the species. This information will also be available to other research organisations and individuals upon request.

3.4.2 Artificial Hollow Maintenance

Maintenance of artificial hollows will be scheduled for March so as to occur outside of the breeding season. Maintenance may include:

- replacement of sacrificial chewing post;
- replacement/repair of attachment points;
- repairs to the base of hollows;
- repair of cracks in the artificial hollow. If crack form that are too large to be repaired the hollow may need to be replaced; and
- removal of pest species, such as feral bees.

Maintenance of artificial hollows will be undertaken for a period of 20 years from installation.

3.5 Completion/Success Criteria

The use of artificial hollows to achieve the stated environmental objective will be determined to be successful when a minimum of ten artificial hollows have shown evidence of use by Black Cockatoos for three consecutive years. As Black Cockatoos are known to have a roster of hollows from which they choose a nesting hollow for any given year (*pers com*. Ron Johnstone), the ten artificial hollows that show evidence of use do not need to be the same hollows over the three-year period.

4. Adaptive Management

To confirm that the installation of artificial hollows will meet the stated objective and completion criteria achieved, Main Roads will implement an adaptive management approach. The aim of adaptive management will be to maximise the likelihood, and eventually prove, that the artificial hollows are being used by Black Cockatoos in line with the pre-impact usage of natural hollows. The adaptive management approach is outlined in **Diagram 4-1** and **Table 4-1**. It is proposed that this adaptive management approach will be used until such a time that monitoring shows breeding by Black Cockatoo is at least equivalent to that recorded during pre-impact surveys.

The offset will be deemed to be effective and adaptive management will cease when at least 10 artificial hollows are in use for three consecutive years post-impact. Hollows identified as used do not need to be the same from year to year.

Table 4-1: Adaptive Management Actions

Management Actions / Monitoring Parameter	Adaptive Management Trigger	Corrective Actions
Location/s for installation of artificial hollows verified by a suitably qualified person with experience in Black Cockatoos	Artificial hollow locations have not been signed off by a suitably qualified person	Review of locations and installation by suitably qualified person to confirm acceptability
Artificial hollows will be installed prior to start of breeding season breeding season[1] following clearing	Artificial hollows not installed prior to breeding season following clearing	Undertake installation of artificial hollows as soon as practicable.
Three artificial hollows will be installed for each hollow showing evidence of use cleared	Less than 3 artificial hollows installed for each hollow showing evidence of use cleared	Undertake installation of additional artificial hollows as soon as practicable.
Installed artificial hollows are used by Black Cockatoos	• Monitoring shows artificial hollows are not in use • Trends from monitoring data suggest the completion criteria will not be achieved • Monitoring shows a drop in use of artificial hollows	• Review/modify location selection parameters. • Review artificial hollow location. • Move artificial hollow to new location in line with revised parameters. • Install additional artificial hollows to increase density. • Review regional cockatoo numbers and active breeding sites to determine if results are part of a larger trend.

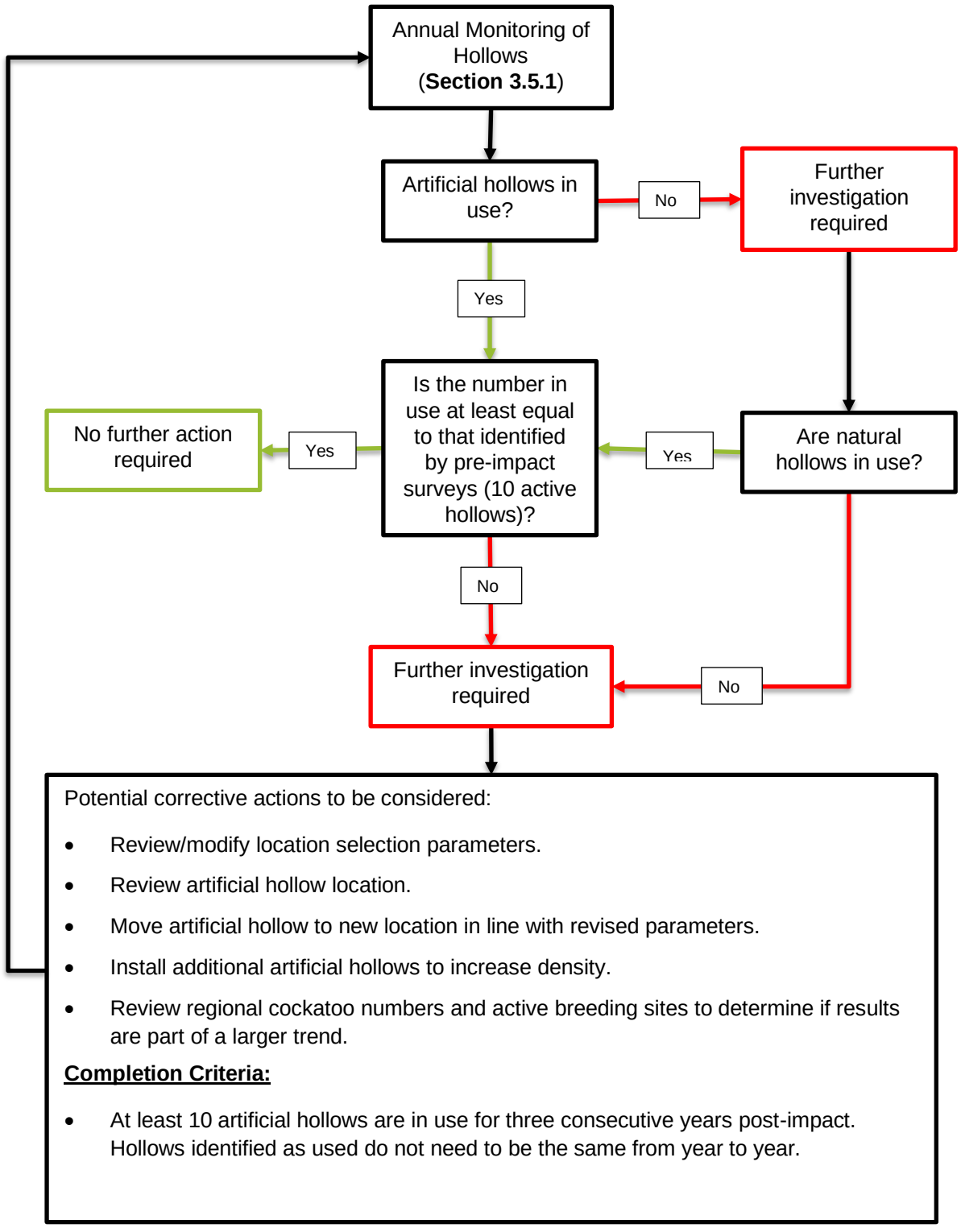

Diagram 4-1: Adaptive Management Decision Tree

5. Record Keeping, Reporting and Review

5.1 Record Keeping

The following information will be recorded and kept on file:

- each Cockatube® will be assigned a unique identifier;
- locations of installed Cockatubes® will be recorded using a GPS;
- date of installation for each Cockatube®;
- photographs of Cockatubes® following installation;
- results of annual monitoring including condition of the hollow, if the hollow is/has been in use and photographs;
- maintenance required and date undertaken; and
- outcomes of any investigations undertaken and additional actions put in place.

This information will be made available to other government organisations and third parties for research into the species.

5.2 Reporting

Compliance with this AHMP, results of monitoring and any investigations and/or corrective action undertaken will be reported to the Commonwealth Department of Agriculture, Water and the Environment (DAWE) in the annual compliance report for the action.

Results of monitoring will be provided to DBCA on an annual basis.

5.3 Management Plan Review

This AHMP shall be reviewed annually during construction. Once construction is complete, reviews shall be undertaken in line with Main Roads standard environmental management requirements. Out of cycle reviews of the plan may be undertaken for the following reasons:

- new or revised information relating to Black Cockatoos becoming available;
- the recovery plans for the species are revised;
- changes in the design and/or management of artificial hollows; or
- adaptive management (corrective) actions are triggered.

6. References

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Phoenix Environmental Sciences 2018, Muchea North Black Cockatoo breeding activity census, unpublished memorandum prepared for the GNH IPT, Phoenix Environmental Sciences Pty Ltd, Perth.

Figures

Figure 1: Location Plan

Legend

- Development Envelope
- Indicative Disturbance Footprint
- Highway
- Major Road
- Minor Road
- Cadastral Boundary

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0 1,400 2,800
Metres

Scale at A3 1:120,000

Coordinate System: GDA 1994 MGA Zone 50

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Client

Great Northern Highway
Bindoon Bypass
Artificial Hollow Management Plan
Project

Figure: 1 - Location Plan

Drawing No	Issue
GNH-CN12-EA-PER-00001 F2-1	1

Task	Drawing Status / Other
AHMP	Draft

Date	By	Chkd	Appd
30/05/2019	BG	LB	TJ

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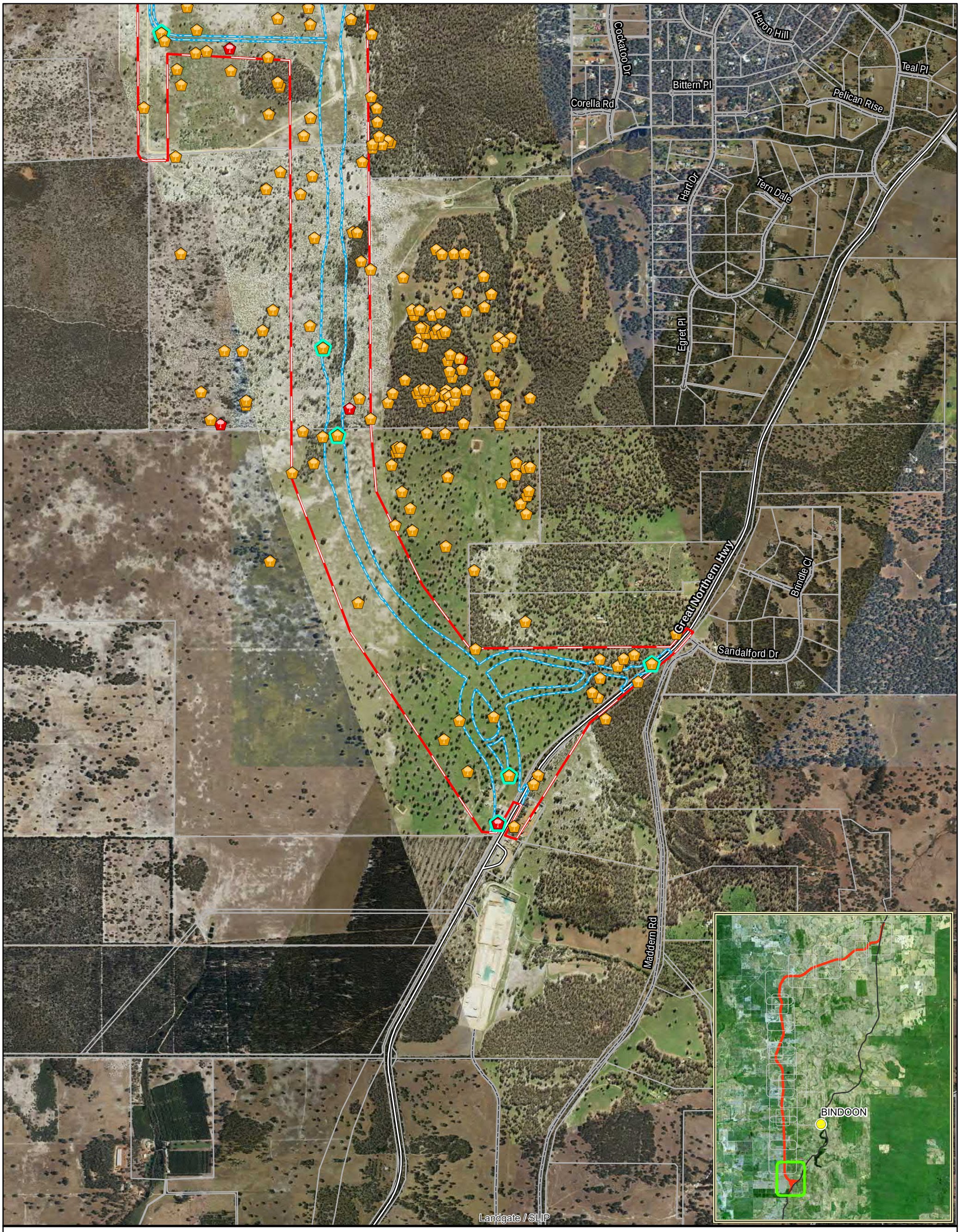
Figure 2: Hollows Suitable for or Used by Black Cockatoos



Black Cockatoo Trees (FVC) - Outside Development Footprint

- Hollow currently in Use
- Hollow with Evidence of Use (Previously Used Hollow)
- Suitable Hollow

Black Cockatoo Trees (FVC) - Within Development Footprint

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- Suitable Hollow

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Bindoon Bypass
Environmental Review Document

Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 2

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

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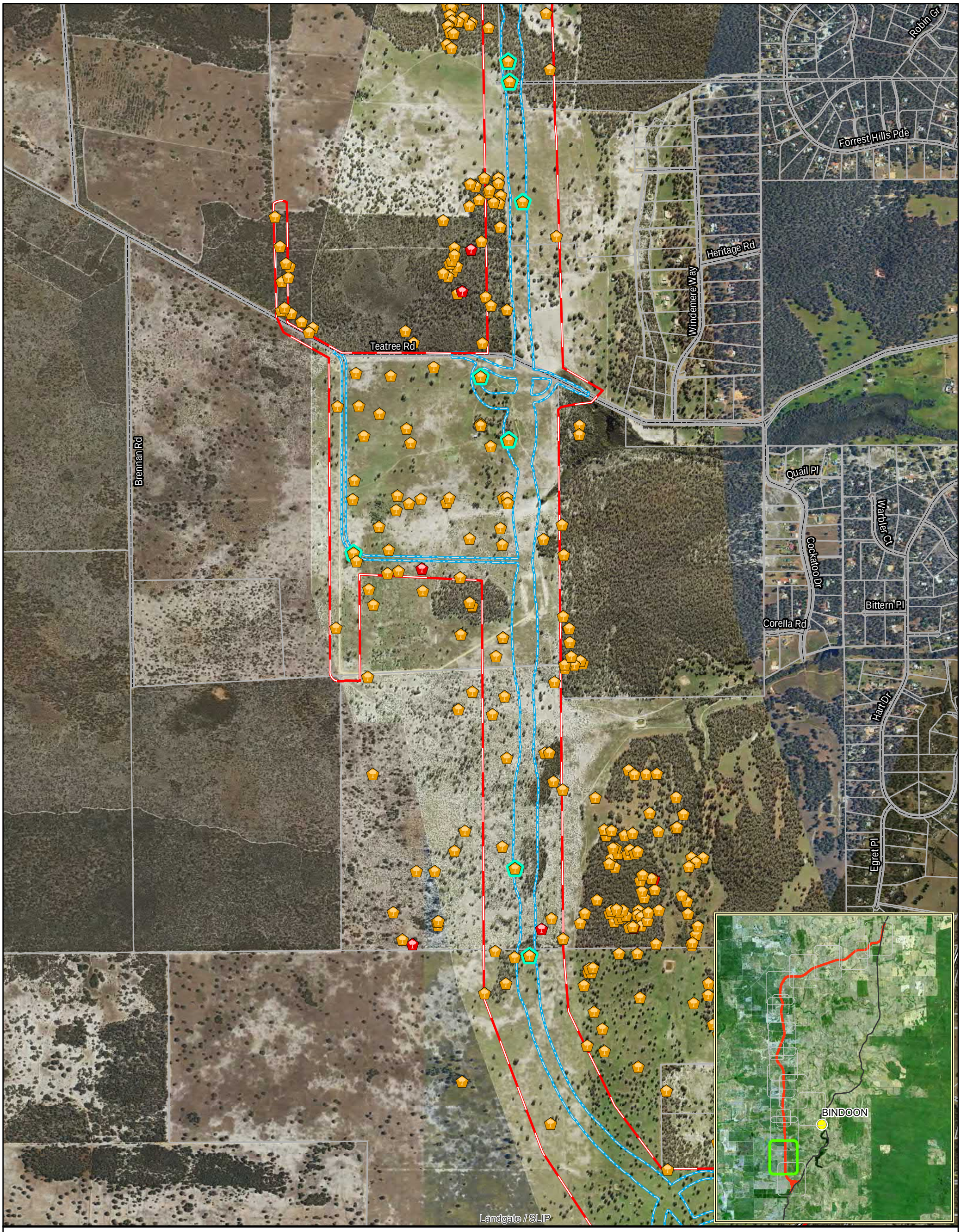

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Client: **Main Roads Western Australia**

Project: **Great Northern Highway Bindoon Bypass Environmental Review Document**

Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 2 Page 2 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

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Gray Rd
Crest Hill Rd
Hidaway Dr
Bonza Pl
Briar Lane
Evergreen Rise
Robin Gr
Forrest Hills Pde
Heritage Rd
Windemere Way
Teatree Rd
Brennan Rd
Landgate / SLIP
BINDOON

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Environmental Review Document
Project

Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 2 Page 3 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

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Date	By	Chkd	Appd
30/10/2020	JR	--	--

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Crest Hill Rd
Gray Rd
Teatree Rd
Landgate / SLIP
BINDOON

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Environmental Review Document
Project

Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 2 Page 4 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

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ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

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Cullalla Rd
Barn Rd
Ashworth Rd
Mooliabeenee Rd
Wells Glover Rd
Crest Hill Rd
BINDOON
Landgate / SLIP

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Metres

Scale at A3 1:20,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass
Environmental Review Document
Project

Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 2 Page 5 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-13a.mxd

Cullalla Rd
Barn Rd
Wells Glover Rd
Mooliabeenee Rd
Bindoon-Moora Rd
Crest Hill Rd
Atkinson Rd
BINDOON
Landgate / SLIP

Black Cockatoo Trees (FVC) - Outside Development Footprint

- Hollow currently in Use
- Hollow with Evidence of Use (Previously Used Hollow)
- Suitable Hollow

Black Cockatoo Trees (FVC) - Within Development Footprint

- Hollow with Evidence of Use (Previously Used Hollow)
- Suitable Hollow

- Development Envelope
- Indicative Disturbance Footprint
- Highway
- Major Road
- Minor Road
- Cadastral Boundary

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Figure: 2 Page 6 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

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MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-13a.mxd

Mooliabeenee Rd
Atkinson Rd
Bindoon-Moora Rd
Toy Rd
Settlement Rd
Crest Hill Rd
Kay Rd
Great Northern Hwy
Fishers Rd
Hidaway Dr
Cammeray Cl
Gray Rd
Clune Rd
Needoonga Pl
Ridgetop Rmbl
Pioneer Dr
Bonza Pl
Briar Lane
Forrest Hills Pde
Lakeside Gr
Evergreen Rise
Robin Gr
Kingfisher Ct
Orchard Rd
Landgate / SLIP
BINDOON

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Figure: 2 Page 7 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

MXD Location: \\Jacobs.com\PERProjects\PBII\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-13a.mxd

Kinkella Rd
Cullalla Rd
Barn Rd
Wells Glover Rd
Mooliabeenee Rd
Ashworth Rd
Crest Hill Rd
BINDOON
Landgate / SLIP

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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 2 Page 8 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
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MXD Location: \\Jacobs.com\PERProjects\PBI\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-13a.mxd

Cullalla Rd

Barn Rd

Kinkella Rd

Landgate / SLIP

BINDOON

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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 2 Page 9 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

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Gingilling Rd

Cullalla Rd

Cook Rd

BINDOON

Landgate / SLIP

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Project

Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 2 Page 10 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
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Main Roads Western Australia
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Great Northern Highway
Bindoon Bypass
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Project

Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 2 Page 11 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
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MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-13a.mxd

Hay Flat Rd

Kangaroo Gully Rd

Bindoon-Moora Rd

Pines Rd

Landgate / SLIP

BINDOON

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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 2 Page 12 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
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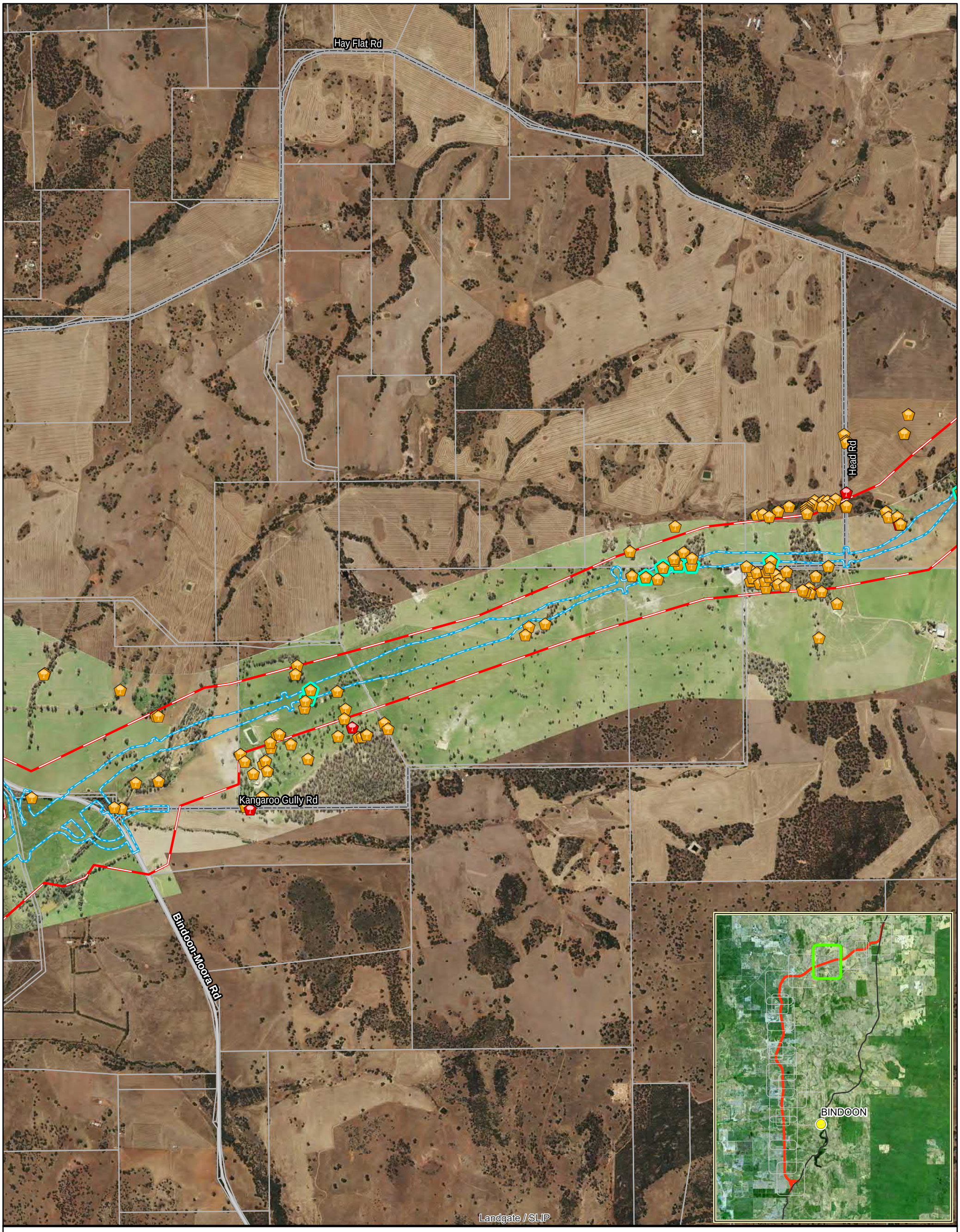

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Environmental Review Document

Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 2 Page 13 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

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Hay Flat Rd

Head Rd

BINDOON

Landgate / SLIP

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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 2 Page 14 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-13a.mxd

Hay Flat Rd

BINDOON

Landgate / SLIP

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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 2 Page 15 of 16

Drawing No	Issue
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Calingiri Rd

Great Northern Hwy

Hay Flat Rd

BINDOON

Landgate / SLIP

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Figure: 2 Page 16 of 16

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ERD	Final

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Appendix C. Quadrat Reanalysis

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MEMORANDUM

Date	27 May 2021	**Title**	Bindoon Bypass – Revised FCT Analysis
Ref	ASJV17001_MEM_Rev0	**Distribution**	Lisa Boulden Jacobs John Braid Main Roads Western Australia
Author	Lisa Chappell Senior Environmental Scientist/Botanist	**Review**	Kellie Bauer-Simpson Principal Ecologist/Environmental Manager

1. BACKGROUND

Main Roads Western Australia (Main Roads) is upgrading the 218 km section of the Great Northern Highway (GNH) between Muchea and Wubin. Jacobs and Arup together with Main Roads formed the Integrated Project Team (IPT) (formerly the Arup SKM Joint Venture (ASJV)) for the delivery of the upgrade project. As part of the GNH upgrades project, the IPT is also progressing work for a section of the GNH that will bypass the town of Bindoon (the Bindoon Bypass).

During 2016, Focused Vision Consulting Pty Ltd (FVC), supported by specialist sub-consultants, were engaged by the IPT to conduct initial spring flora, vegetation, fauna and habitat assessments of the proposed corridor for the Bindoon Bypass.

Multiple flora and vegetation assessments, commencing in spring 2016 were conducted by FVC within the study area during all seasons until spring 2018. The spring 2018 flora and vegetation assessment specifically focused on assessing and determining the presence of the Environment Protection and Biodiversity Conservation Act (EPBC) listed Endangered Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community (EPBC Banksia Woodlands TEC).

Following publication of the Environmental Review Document (ERD) for the public review period, the WA Department of Biodiversity, Conservation and Attractions (DBCA) requested additional information regarding the determination of Floristic Communities Types (FCTs) and quadrat statistical analysis. Liaison with DBCA during 2021 identified that further analysis of quadrat data may be appropriate to determine with increased certainty the likely presence of any Threatened or Priority Ecological Communities, with a particular focus on the EPBC Banksia Woodland TEC and/or FCTs which are considered to be representative of the EPBC Banksia Woodlands TEC, as well as other FCTs that may be of importance due to representing TECs, PECs or rarer floristic communities as relevant to the region (excluding other FCTs of conservation significance to geographically relevant such as FCTs 3a, 3b and 3c).

This memorandum presents the results of the additional data analysis and should be read conjunction with FVC (2018a, 2018b, 2018c).

Twenty-one FCTs described by Gibson *et al.* (1994), in Bush Forever (Government of Western Australia 2000), Keighery *et al.* (2008) and Urban Bushland Council (2011) best correspond to the EPBC Banksia woodlands TEC (Threatened Species Scientific Committee 2016) and these are summarised in **Table 1**.

Table 1 - Floristic Community Types Corresponding to the EPBC Banksia Woodlands TEC

FCT	FCT Name	WA TEC/PEC	EPBC TEC
Supergroup 3 – Uplands centred on Bassendean Dunes and Dandaragan Plateau			
20a	*Banksia attenuata* woodlands over species rich dense shrublands	Endangered	
20b	Eastern *Banksia attenuata* and/or *Eucalyptus marginata* woodlands	Endangered	
20c	Eastern shrublands and woodlands	Critically Endangered	Endangered
21a	Central *Banksia attenuata - Eucalyptus marginata* woodlands		
21b	Southern *Banksia attenuata* woodlands	P3	
21c	Low lying *Banksia attenuata* woodlands or shrublands	P3	
22	*Banksia ilicifolia* woodlands	P2	
23a	Central *Banksia attenuata - Banksia menziesii* woodlands		
23b	Northern *Banksia attenuata - Banksia menziesii* woodlands	P3	
23c	North-eastern *Banksia attenuata - Banksia menziesii* woodlands		
S09	*Banksia attenuata* woodlands over dense low shrublands		
Supergroup 4 – Uplands centred on Spearwood and Quindalup Dunes			
24	Northern Spearwood shrublands and woodlands	P3	
25	Southern *Eucalyptus gomphocephala – Agonis flexuosa* woodlands	P3	
28	Spearwood *Banksia attenuata* or *Banksia attenuata – Eucalyptus* woodlands		
Whicher Scarp FCTs (Keighery *et al.* 2008)			
A1	Central Whicher Scarp Mountain Marri Woodland WHSFCT_A1	P1	
A2	North Whicher Scarp Jarrah and Woody Pear woodland WHSFCT_A2		
A3	North Whicher Scarp *Banksia* and Woody Pear woodland WHSFCT_A3		
A4	Whicher Scarp *Banksia grandis*, Jarrah and Marri woodland WHSFCT_A4		
B1	Swan Coastal Plain /North Whicher Scarp *Banksia attenuata* woodland WHSFCT_B1		
B2	West Whicher Scarp *Banksia attenuata* woodland WHSFCT_B2		
C2	Whicher Scarp Jarrah woodland on deep coloured sands WHSFCT_C2		

The DBCA database search results for the study revealed the following State-listed TEC and two PECs as known to or potentially occurring in the local region:

- SCP 20a – *Banksia attenuata* woodlands over species rich dense shrublands (Endangered TEC)
- Banksia woodlands of the Gingin area restricted to soils dominated by yellow to orange sands (Priority 2 PEC)
- SCP 23b – Northern Swan Coastal Plain *Banksia attenuata – Banksia menziesii* woodlands (Priority 3 PEC).

All three of these ecological communities are also representative of the Commonwealth-listed TEC, EPBC Banksia woodlands TEC (Threatened Species Scientific Committee 2016). This was further supported by the search results from the Commonwealth Protected Matters Search Tool (PMST) for Matters of National Environmental Significance (MNES). Therefore, the further analysis in this memorandum is focused on quadrats within Banksia woodland.

2. METHODOLOGY

Further to the data processing and analysis presented in *Detailed Flora and Vegetation Assessment, Bindoon Bypass, Great Northern* (FVC 2018c), additional analysis of data was conducted utilising methodologies derived from consultation with the DBCA, with a focus on determining the presence of the EPBC Banksia Woodlands TEC and the FCTs represented in the study area (including FCTs that correspond to the EPBC Banksia Woodlands TEC).

All of the FVC sampled quadrats occurring within the current Development Envelope, that were identified to be representative or potentially representative of known TECs or PECs for the region, including the EPBC Banksia Woodlands TEC (consolidated in FVC (2018c)) were analysed utilising PATN™ (Belbin 2013) multivariate cluster analysis of species presence/absence.

For each of the FVC (2018c) recorded Banksia woodland vegetation units, a 'batch' of five to eight quadrats was analysed using PATN™ with in reference to the Gibson *et al.* (1994) and Keighery *et al.* (2012) datasets. The resulting dendrograms enabled representative FCTs to be preliminarily inferred for each quadrat. In order to confirm the inferred FCTs resulting from the 'batch' analysis, species data from single quadrats were then analysed against the Gibson *et al.* (1994) and Keighery *et al.* (2012) datasets using Single Site Insertion (SSI). Where the results of the 'batch' analysis and the SSI did not align/correspond, SSI was conducted individually for all quadrats for that vegetation type. The resulting dendrograms from the 'batch' and SSI analyses are presented in **Appendix A**, with the summary of results presented in **Table 2**.

FCT affinities were then further tested by carrying out an analysis of flora species presence-absence data, which compared recorded quadrat data with that of the Gibson *et al.* (1994) and Keighery *et al.* (2012) datasets. This simplified comparison provided numbers and percentages of species in common (between FVC (2018c) recorded data and the Gibson *et al.* (1994) and Keighery *et al.* (2012) datasets) as further justification of FCT inferences made for each sampled quadrat (**Table 3**).

Once FCTs had been inferred for each quadrat using PATN analysis/dendrogram results and the results if the simple species in common analysis, each was then assessed against the key dominant indicator species for each FCT (Gibson *et al.* 1994), habitat, vegetation complexes, the current known FCT distribution, the site-specific species data and geographical location (soil-landscape mapping for that location) in order to further verify the inferred FCT (**Table 4**).

In summary, the following information was assessed for each quadrat:

1. 'Batch' floristic analysis of quadrat data against Gibson *et al* (1994) and Keighery *et al.* (2012) datasets.
2. SSI for a selection of individual quadrats to confirm or disprove PATN results returned for the 'batch' analysis.
3. Where SSI results did not align with the 'batch' analysis results, SSI was conducted for all quadrats within that vegetation unit.
4. Further analysis of flora species presence-absence data, comparing the number of common species occurring within the recorded quadrat and the Gibson *et al* (1994) and Keighery *et al.* (2012) sampled sites.
5. Quadrat data was subsequently compared to other information relevant to each FCT; key dominant species, typical habitat, vegetation complexes and geographical distribution.
6. Final conclusions were made based on the consolidated results of all comparative analyses.

3. RESULTS

'Batch' and SSI analysis of the quadrat data using multivariate cluster analysis of species presence/absence in PATN™ was carried out for all potential TEC/PEC (Banksia woodland) quadrats within the Development Envelope. The initial 'Batch' analysis of all vegetation units did not align with Single Site Insertion results and therefore, SSI was conducted for all quadrats. The resulting dendrograms from the 'Batch' and SSI analysis are presented in **Appendix A**, with the summary of results presented in **Table 2**. The comparison for all analysed quadrats in comparison to the consolidated Gibson *et al* (1994) and Keighery (2012) dataset is presented in **Tables 3.1** and **3.2**. The assessment against the key dominant indicator species for each FCT, habitat, vegetation complexes and the current known FCT distribution and geographical location is summarised in **Table 4**.

The compiled summary of the PATN Analysis, FCT species comparison, FCT dominant species comparison, Vegetation Complexes and distribution is presented in **Table 5**.

Table 2 – Summary of Batch and Single Site Insertion PATN Analysis

*Nearest neighbour listed first

Vegetation Unit	Representative Quadrat	Batch Analysis Result*	Single Site Insertion (SSI) Result*	Preliminary Inferred FCT	Dendrogram No.
BaXpAn - *Banksia* spp. sparse woodland	B10, B10.2	21c, 20c, 28, 20b, 20a	23a, 23b, 28,	23a	1.2
	B11	21c, 20c, 28, 20b, 20a	28, 20b, 20a	28	1.3
	B2.25	21c, 20c, 28, 20b, 20a	6, 5, 4, 21c	6	1.4
	B2.30	21c, 20c, 28, 20b, 20a	SCP09, 23c	SCP09	1.5
	B2.32	21c, 20c, 28, 20b, 20a	28	28	1.6
	B49	21c, 20c, 28, 20b, 20a	SCP09, 23c	SCP09	2.2
	BW13	21c, 20c, 28, 20b, 20a	28	28	2.3
	BW14	21c, 20c, 28, 20b, 20a	SCP09, 23c	SCP09	2.4
	BW15	21c, 20c, 28, 20b, 20a	28	28	2.5
	BW16	21c, 20c, 28, 20b, 20a	28	28	2.6
	BW17	21c, 20c, 28, 20b, 20a	6, 21c	6	2.7
BaXpUa - *Banksia attenuata* sparse woodland	B2.48	28	28	28	3.2
	B2.49	28	28	28	3.1
	B2.50	28	28	28	3.1
	B55	SCP09, 22	SCP09, 22	SCP09	3.3
	BW03	23c	SCP09, 23c	SCP09	4.2
	BW04	23c	23c	23c	4.3
	BWC01	23c	SCP09, 23c	SCP09	4.4
	C04	23c	6, 21c, 4, 5	6	4.5
	C06	23c	6	6	4.6
EmBsHh - *Eucalyptus marginata* and *Banksia sessilis* sparse woodland	B08	21c, 20c, 28, 20b, 20a	23c, 21c, 20c, 28, 20b, 20a	23c	5.2
	B09, B09.2	21c, 20c, 28, 20b, 20a	1b, 1a	1b	5.3
	B15R	21c, 20c, 28, 20b, 20a	23c	23c	5.4
	B2.31	21c, 20c, 28, 20b, 20a	3b, 3a	3b	5.5

Vegetation Unit	Representative Quadrat	Batch Analysis Result*	Single Site Insertion (SSI) Result*	Preliminary Inferred FCT	Dendrogram No.
EmBsHh - *Eucalyptus marginata* and *Banksia sessilis* sparse woodland (cont.)	B2.33	3c, 3a, 3b, 1b, 1a	3b, 3a	3b	6.2
	B28, B28.2	3c, 3a, 3b, 1b, 1a	3b, 3a	3b	6.1
	C03	3c, 3a, 3b, 1b, 1a	3b, 3a	3b	6.1
	C09	3c, 3a, 3b, 1b, 1a	3b, 3a	3b	6.3
EmXpAn - *Eucalyptus marginata* sparse woodland	B07, B07.2	21c, 21a, 3a, 3b, 25, 21b,	23c	23c	7.2
	B2.19	21c, 21a, 3a, 3b, 25, 21b,	21a, 3a, 25, 3b	21a	7.3
	B2.51	21c, 21a, 3a, 3b, 25, 21b,	22, 23c	22	7.4
	B32, B32.2	21c, 21a, 3a, 3b, 25, 21b,	23c	23c	7.5
EmXpHh - *Eucalyptus marginata* sparse woodland	B2.12	3b, 3a, 3c	3b, 3a	3b	8.1
EtBeAn - *Eucalyptus todtiana* sparse woodland	B15	23c, 21c, 20c, 28, 20b, 20a	21c, 23c	21c	9.2
	B16R	23c, 21c, 20c, 28, 20b, 20a	20a	20a	9.3
	B17	23c, 21c, 20c, 28, 20b, 20a	28	28	9.4
	B18, B18.2	23c, 21c, 20c, 28, 20b, 20a	23c	23c	9.5
	B19, B19.2	23c, SCP09	23c	23c	10.2
	B51	23c, 21c, 20c, 28, 20b, 20a	SCP09	SCP09	9.6
	B54	23c, SCP09	SCP09, 23c	SCP09	10.3
	BW06	23c, SCP09	SCP09, 23c	SCP09	10.4
	BW07	23c, SCP09	SCP09, 23c	SCP09	10.5
	BW08	23c, SCP09	SCP09, 23c	SCP09	10.1
	BW09	SCP09, 23c	SCP09, 23c	SCP09	11.2
	BW18	SCP09, 23c	SCP09, 23c	SCP09	11.1
	BWC02	SCP09, 23c	SCP09, 23c	SCP09	11.1
	BWC03	SCP09, 23c	SCP09, 23c	SCP09	11.3
	C01	SCP09, 23c	SCP09, 23c	SCP09	11.1
	C02	SCP09, 23c	SCP09, 23c	SCP09	11.1
EtEpAn - *Eucalyptus todtiana* sparse woodland	B42	23c, SCP09	6	6	12.2
	B46, B46.2	23c, SCP09	SCP09, 22	SCP09	12.3
	B56	23c, SCP09	6, 23c	6	12.4
	BW10	23c, SCP09	21c	21c	12.5
	BW11	23c, SCP09	SCP09, 23c	SCP09	12.6

Vegetation Unit	Representative Quadrat	Batch Analysis Result*	Single Site Insertion (SSI) Result*	Preliminary Inferred FCT	Dendrogram No.
EtEpAn - *Eucalyptus todtiana* sparse woodland (cont.)	BW12	23c, SCP09	6	6	12.7
EwXpHh - *Eucalyptus wandoo* sparse woodland	B2.09	3a, 3c, 3b	18, 24, 19	18	13.2
	B2.45	3a, 3c, 3b	3b	3b	13.3
	B2.47	3a, 3c, 3b	3b	3b	13.4
EwXpHh - *Eucalyptus wandoo* sparse woodland (cont.)	B21	3a, 3c, 3b	6	6	13.5
	B22, B22.2	3c, 3a, 3b, 1b, 1a	3c, 3a, 3b	3c	14.2
	B23, B23.2	3c, 3a, 3b, 1b, 1a	3c, 3a, 3b	3c	14.3
	B24	3c, 3a, 3b, 1b, 1a	3c, 3a, 3b	3c	14.1

Table 3.1 – Summary of Potential Banksia Woodland Quadrat Species Comparison

					FCT 20a		FCT20b		FCT20c		FCT21a		FCT21b		FCT21c		FCT22		FCT23a		FCT23b		FCT23c	
Vegetation Unit and Description	Representative Quadrats	Single Site Insertion Result	Dendrogram Preliminary Inferred FCT	Dendrogram	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common
BaXpAn - *Banksia* spp. sparse woodland	B10	23a, 23b, 28,	23a	1.2	18	41.86	18	41.86	19	44.19	21	48.84	19	44.19	26	47.27	14	32.56	23	53.49	23	53.49	17	39.53
	B10.2	23a, 23b, 28,	23a	1.2	25	45.45	22	40.00	21	38.18	27	49.09	26	47.27	25	45.45	22	40.00	31	56.36	32	58.18	28	50.91
	B11	28, 20b, 20a	28	1.3	20	51.28	17	43.59	17	43.59	19	48.72	19	48.72	19	48.72	15	38.46	21	53.85	21	53.85	22	56.41
	B2.25	6, 5, 4, 21c	6	1.4	18	60.00	19	63.33	18	60.00	21	70.00	16	53.33	22	73.33	16	53.33	21	70.00	21	70.00	17	56.67
	B2.30	SCP09, 23c	SCP09	1.5	21	60.00	18	51.43	19	54.29	22	62.86	21	60.00	21	60.00	20	57.14	24	68.57	25	71.43	25	71.43
	B2.32	28	28	1.6	27	55.10	28	57.14	27	55.10	29	59.18	22	44.90	27	55.10	22	44.90	28	57.14	29	59.18	25	51.02
	B49	SCP09, 23c	SCP09	2.2	15	55.56	15	55.56	14	51.85	20	74.07	17	62.96	19	70.37	16	59.26	22	81.48	21	77.78	21	77.78
	BW13	28	28	2.3	21	46.67	19	42.22	19	42.22	22	48.89	20	44.44	20	44.44	17	37.78	23	51.11	23	51.11	21	46.67
	BW14	SCP09, 23c	SCP09	2.4	19	35.85	20	37.74	18	33.96	23	43.40	21	39.62	23	43.40	19	35.85	26	49.06	27	50.94	20	37.74
	BW15	28	28	2.5	22	43.14	25	49.02	18	35.29	25	49.02	21	41.18	22	43.14	20	39.22	26	50.98	24	47.06	18	35.29
	BW16	28	28	2.6	25	47.17	26	49.06	25	47.17	29	54.72	27	50.94	24	45.28	23	43.40	29	54.72	26	49.06	29	54.72
	BW17	6, 21c	6	2.7	17	32.69	15	28.85	16	30.77	15	28.85	13	25.00	18	34.62	13	25.00	19	36.54	18	34.62	17	32.69
BaXpUa - *Banksia attenuata* sparse woodland	B2.48	28	28	3.2	13	29.55	18	40.91	17	38.64	21	47.73	13	29.55	14	31.82	13	29.55	15	34.09	10	22.73	14	31.82
	B2.49	28	28	3.1	27	56.25	20	41.67	24	50.00	26	54.17	19	39.58	23	47.92	17	35.42	22	45.83	21	43.75	26	54.17
	B2.50	28	28	3.1	16	34.78	18	39.13	18	39.13	21	45.65	14	30.43	17	36.96	8	17.39	17	36.96	15	32.61	17	36.96
	B55	SCP09, 22	SCP09	3.3	10	58.82	8	47.06	11	64.71	9	52.94	9	52.94	13	76.47	10	58.82	12	70.59	12	70.59	10	58.82
	BW03	SCP09, 23c	SCP09	4.2	16	44.44	18	50.00	16	44.44	21	58.33	17	47.22	22	61.11	15	41.67	23	63.89	20	55.56	20	55.56
	BW04	23c	23c	4.3	14	43.75	12	37.50	13	40.63	17	53.13	16	50.00	19	59.38	12	37.50	19	59.38	17	53.13	16	50.00
	BWC01	SCP09, 23c	SCP09	4.4	19	46.34	19	46.34	21	51.22	21	51.22	18	43.90	24	58.54	14	34.15	23	56.10	23	56.10	19	46.34
	C04	6, 21c, 4, 5	6	4.5	16	61.54	14	53.85	16	61.54	18	69.23	16	61.54	15	57.69	8	30.77	15	57.69	13	50.00	15	57.69
	C06	6	6	4.6	13	37.14	15	42.86	13	37.14	15	42.86	12	34.29	18	51.43	9	25.71	18	51.43	17	48.57	17	48.57

Highest affinity

High affinity

					FCT 20a		FCT20b		FCT20c		FCT21a		FCT21b		FCT21c		FCT22		FCT23a		FCT23b		FCT23c	
Vegetation Unit and Description	Representative Quadrats	Single Site Insertion Result	Dendrogram Preliminary Inferred FCT	Dendrogram	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common
EmBsHh - *Eucalyptus marginata* and *Banksia sessilis* sparse woodland	B08	23c, 21c, 20c, 28, 20b, 20a	23c	5.2	18	46.15	18	46.15	18	46.15	20	51.28	18	46.15	20	51.28	16	41.03	19	48.72	16	41.03	15	38.46
	B09	1b, 1a	1b	5.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B09.2	1b, 1a	1b	5.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B15R	23c	23c	5.4	13	48.15	16	59.26	15	55.56	15	55.56	15	55.56	14	51.85	12	44.44	15	55.56	12	44.44	11	40.74
	B2.31	3b, 3a	3b	5.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B2.33	3b, 3a	3b	6.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B28	3b, 3a	3b	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B28.2	3b, 3a	3b	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	C03	3b, 3a	3b	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	C09	3b, 3a	3b	6.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EmXpAn - *Eucalyptus marginata* sparse woodland	B07	23c	23c	7.2	22	47.83	18	39.13	19	41.30	26	56.52	19	41.30	25	54.35	21	45.65	25	54.35	24	52.17	22	47.83
	B07.2	23c	23c	7.2	23	48.94	18	38.30	17	36.17	25	53.19	19	40.43	26	55.32	21	44.68	25	53.19	24	51.06	23	48.94
	B2.19	21a, 3a, 25, 3b	21a	7.3	21	53.85	18	46.15	19	48.72	25	64.10	20	51.28	21	53.85	16	41.03	22	56.41	22	56.41	21	53.85
	B2.51	22, 23c	22	7.4	15	53.57	11	39.29	13	46.43	15	53.57	10	35.71	16	57.14	14	50.00	17	60.71	15	53.57	14	50.00
	B32	22, 23c	23c	7.5	18	51.43	18	51.43	14	40.00	19	54.29	18	51.43	21	60	16	45.71	19	54.29	16	45.71	16	45.71
	B32.2	23c	23c	7.5	16	61.54	14	53.85	14	53.85	19	73.08	18	69.23	20	76.92	13	50.00	17	65.38	14	53.85	14	53.85
EmXpHh - *Eucalyptus marginata* sparse woodland	B2.12	3b, 3a	3b	8.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EtBeAn - *Eucalyptus todtiana* sparse woodland	B15	21c, 23c	21c	9.2	13	48.15	12	44.44	12	44.44	14	51.85	10	37.04	17	62.96	11	40.74	18	66.67	17	62.96	12	44.44
	B16R	20a	20a	9.3	24	48.00	17	34.00	20	40.00	21	42.00	17	34.00	19	38	22	44.00	25	50.00	28	56.00	26	52.00
	B17	28	28	9.4	11	37.93	13	44.83	12	41.38	13	44.83	9	31.03	12	41.38	9	31.03	12	41.38	12	41.38	12	41.38
	B18	23c	23c	9.5	15	35.71	18	42.86	18	42.86	21	50.00	15	35.71	18	42.86	13	30.95	21	50.00	19	45.24	19	45.24
	B18.2	23c	23c	9.5	21	45.65	22	47.83	22	47.83	23	50.00	19	41.30	22	47.83	16	34.78	25	54.35	24	52.17	25	54.35
	B19	23c	23c	10.2	20	41.67	16	33.33	19	39.58	22	45.83	18	37.50	20	41.67	19	39.58	24	50.00	24	50.00	24	50.00
	B19.2	23c	23c	10.2	18	52.94	16	47.06	17	50.00	19	55.88	15	44.12	20	58.82	18	52.94	22	64.71	21	61.76	19	55.88
	B51	SCP09	SCP09	9.6	19	51.35	18	48.65	19	51.35	17	45.95	15	40.54	20	54.05	16	43.24	22	59.46	21	56.76	21	56.76
	B54	SCP09, 23c	SCP09	10.3	21	70.00	16	53.33	17	56.67	22	73.33	16	53.33	19	63.33	18	60.00	23	76.67	24	80.00	21	70.00
	BW06	SCP09, 23c	SCP09	10.4	14	38.89	14	38.89	15	41.67	14	38.89	11	30.56	16	44.44	12	33.33	15	41.67	15	41.67	16	44.44

Highest affinity

High affinity

					FCT 20a		FCT20b		FCT20c		FCT21a		FCT21b		FCT21c		FCT22		FCT23a		FCT23b		FCT23c	
Vegetation Unit and Description	Representative Quadrats	Single Site Insertion Result	Dendrogram Preliminary Inferred FCT	Dendrogram	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common
EtBeAn - *Eucalyptus todtiana* sparse woodland (cont)	BW07	SCP09, 23c	SCP09	10.5	14	35.00	16	40.00	15	37.50	15	37.50	10	25.00	18	45	11	27.50	18	45.00	19	47.50	16	40.00
	BW08	SCP09, 23c	SCP09	10.1	17	39.53	21	48.84	19	44.19	21	48.84	13	30.23	20	46.51	19	44.19	25	58.14	23	53.49	21	48.84
	BW09	SCP09, 23c	SCP09	11.2	19	46.34	20	48.78	18	43.90	22	53.66	17	41.46	24	58.54	18	43.90	26	63.41	24	58.54	18	43.90
	BW18	SCP09, 23c	SCP09	11.1	27	51.92	32	61.54	27	51.92	33	63.46	27	51.92	24	46.15	26	50.00	30	57.69	32	61.54	30	57.69
	BWC02	SCP09, 23c	SCP09	11.1	16	50.00	17	53.13	17	53.13	18	56.25	15	46.88	18	56.25	15	46.88	20	62.50	19	59.38	18	56.25
	BWC03	SCP09, 23c	SCP09	11.3	21	58.33	22	61.11	20	55.56	21	58.33	19	52.78	21	58.33	19	52.78	26	72.22	24	66.67	22	61.11
	C01	SCP09, 23c	SCP09	11.1	22	61.11	22	61.11	23	63.89	22	61.11	22	61.11	22	61.11	20	55.56	26	72.22	27	75.00	26	72.22
	C02	SCP09, 23c	SCP09	11.1	25	62.50	26	65.00	23	57.50	25	62.50	21	52.50	22	55	23	57.50	27	67.50	28	70.00	27	67.50
EtEpAn - *Eucalyptus todtiana* sparse woodland	B42	6	6	12.2	15	57.69	13	50.00	12	46.15	16	61.54	13	50.00	16	61.54	12	46.15	15	57.69	13	50.00	14	53.85
	B46	SCP09, 22	SCP09	12.3	13	54.17	11	45.83	14	58.33	13	54.17	12	50.00	17	70.83	13	54.17	17	70.83	16	66.67	14	58.33
	B46.2	SCP09, 22	SCP09	12.3	15	57.69	12	46.15	15	57.69	14	53.85	14	53.85	19	73.08	16	61.54	20	76.92	19	73.08	15	57.69
	B56	6, 23c	6	12.4	9	60.00	8	53.33	9	60.00	9	60.00	7	46.67	9	60	7	46.67	10	66.67	9	60.00	9	60.00
	BW10	21c	21c	12.5	12	41.38	13	44.83	11	37.93	13	44.83	13	44.83	16	55.17	12	41.38	17	58.62	16	55.17	15	51.72
	BW11	SCP09, 23c	SCP09	12.6	17	47.22	17	47.22	15	41.67	18	50.00	17	47.22	18	50	16	44.44	22	61.11	20	55.56	18	50.00
	BW12	6	6	12.7	9	37.50	9	37.50	9	37.50	9	37.50	9	37.50	11	45.83	7	29.17	12	50.00	12	50.00	10	41.67
EwXpHh - *Eucalyptus wandoo* sparse woodland	B2.09	18, 24, 19	18	13.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B2.45	3b	3b	13.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B2.47	3b	3b	13.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B21	6	6	13.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B22	3c, 3a, 3b	3c	14.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B22.2	3c, 3a, 3b	3c	14.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B23	3c, 3a, 3b	3c	14.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Highest affinity

High affinity

					FCT 20a		FCT20b		FCT20c		FCT21a		FCT21b		FCT21c		FCT22		FCT23a		FCT23b		FCT23c	
Vegetation Unit and Description	Representative Quadrats	Single Site Insertion Result	Dendrogram Preliminary Inferred FCT	Dendrogram	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common
EwXpHh - *Eucalyptus wandoo* sparse woodland (cont.)	B23.2	3c, 3a, 3b	3c	14.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B24	3c, 3a, 3b	3c	14.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Highest affinity

High affinity

Table 3.2 - Summary of Potential Banksia Woodland Quadrat Species Comparison

Vegetation Unit and Description	Representative Quadrat	SSI Result	Dendrogram Preliminary Inferred FCT	Dendrogram	SCP09		FCT24		FCT25		FCT28		FCT 1a		FCT1b		FCT3a		FCT3b		FCT3c		FCT18	
					# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common
BaXpAn - *Banksia* spp. sparse woodland	B10	23a, 23b, 28,	23a	1.2	21	48.84	12	27.91	13	30.23	24	55.81	-	-	-	-	-	-	-	-	-	-	-	-
	B10.2	23a, 23b, 28,	23a	1.2	27	49.09	19	34.55	17	30.91	29	52.73	-	-	-	-	-	-	-	-	-	-	-	-
	B11	28, 20b, 20a	28	1.3	22	56.41	12	30.77	22	56.41	22	56.41	-	-	-	-	-	-	-	-	-	-	-	-
	B2.25	6, 5, 4, 21c	6	1.4	16	53.33	15	50.00	13	43.33	19	63.33	-	-	-	-	-	-	-	-	-	-	-	-
	B2.30	SCP09, 23c	SCP09	1.5	26	74.29	18	51.43	17	48.57	26	74.29	-	-	-	-	-	-	-	-	-	-	-	-
	B2.32	28	28	1.6	26	53.06	20	40.82	18	36.73	33	67.35	-	-	-	-	-	-	-	-	-	-	-	-
	B49	SCP09, 23c	SCP09	2.2	19	70.37	14	51.85	12	44.44	20	74.07	-	-	-	-	-	-	-	-	-	-	-	-
	BW13	28	28	2.3	24	53.33	18	40.00	17	37.78	27	60.00	-	-	-	-	-	-	-	-	-	-	-	-
	BW14	SCP09, 23c	SCP09	2.4	23	43.40	19	35.85	16	30.19	27	50.94	-	-	-	-	-	-	-	-	-	-	-	-
	BW15	28	28	2.5	22	43.14	20	39.22	19	37.25	29	56.86	-	-	-	-	-	-	-	-	-	-	-	-
	BW16	28	28	2.6	27	50.94	22	41.51	22	41.51	30	56.60	-	-	-	-	-	-	-	-	-	-	-	-
	BW17	6, 21c	6	2.7	17	32.69	13	25.00	10	19.23	19	36.54	-	-	-	-	-	-	-	-	-	-	-	-
BaXpUa - *Banksia attenuata* sparse woodland	B2.48	28	28	3.2	16	36.36	17	38.64	14	31.82	26	59.09	-	-	-	-	-	-	-	-	-	-	-	-
	B2.49	28	28	3.1	28	58.33	20	41.67	17	35.42	30	62.50	-	-	-	-	-	-	-	-	-	-	-	-
	B2.50	28	28	3.1	15	32.61	13	28.26	12	26.09	23	50.00	-	-	-	-	-	-	-	-	-	-	-	-
	B55	SCP09, 22	SCP09	3.3	12	70.59	6	35.29	5	29.41	12	70.59	-	-	-	-	-	-	-	-	-	-	-	-
	BW03	SCP09, 23c	SCP09	4.2	20	55.56	16	44.44	13	36.11	22	61.11	-	-	-	-	-	-	-	-	-	-	-	-
	BW04	23c	23c	4.3	16	50.00	16	50.00	11	34.38	19	59.38	-	-	-	-	-	-	-	-	-	-	-	-
	BWC01	SCP09, 23c	SCP09	4.4	19	46.34	18	43.90	13	31.71	25	60.98	-	-	-	-	-	-	-	-	-	-	-	-
	C04	6, 21c, 4, 5	6	4.5	18	69.23	12	46.15	11	42.31	18	69.23	-	-	-	-	-	-	-	-	-	-	-	-
	C06	6	6	4.6	13	37.14	11	31.43	10	28.57	17	48.57	-	-	-	-	-	-	-	-	-	-	-	-
EmBsHh - *Eucalyptus marginata* and *Banksia sessilis* sparse woodland	B08	23c, 21c, 20c, 28, 20b, 20a	23c	5.2	16	41.03	17	43.59	18	46.15	21	53.85	-	-	-	-	-	-	-	-	-	-	-	-
	B09	1b, 1a	1b	5.3	-	-	-	-	-	-	-	-	16	42.11	15	39.47	-	-	-	-	-	-	-	-
	B09.2	1b, 1a	1b	5.3	-	-	-	-	-	-	-	-	15	40.54	16	43.24	-	-	-	-	-	-	-	-
	B15R	23c	23c	5.4	13	48.15	11	40.74	13	48.15	18	66.67	-	-	-	-	-	-	-	-	-	-	-	-
	B2.31	3b, 3a	3b	5.5	-	-	-	-	-	-	-	-	-	-	-	-	9	29.03	20	64.52	13	41.93	-	-
	B2.33	3b, 3a	3b	6.2	-	-	-	-	-	-	-	-	-	-	-	-	5	31.25	13	81.25	5	31.25	-	-

Highest affinity

High affinity

Vegetation Unit and Description	Representative Quadrat	SSI Result	Dendrogram Preliminary Inferred FCT	Dendrogram	SCP09		FCT24		FCT25		FCT28		FCT 1a		FCT1b		FCT3a		FCT3b		FCT3c		FCT18	
					# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common
EmBsHh - *Eucalyptus marginata* and *Banksia sessilis* sparse woodland (cont.)	B28	3b, 3a	3b	6.1	-	-	-	-	-	-	-	-	-	-	-	-	9	22.50	16	40.00	13	32.50	-	-
	B28.2	3b, 3a	3b	6.1	-	-	-	-	-	-	-	-	-	-	-	-	8	25.53	16	47.06	13	38.24	-	-
	C03	3b, 3a	3b	6.1	-	-	-	-	-	-	-	-	-	-	-	-	13	44.83	19	65.52	13	44.83	-	-
	C09	3b, 3a	3b	6.3	-	-	-	-	-	-	-	-	-	-	-	-	18	41.86	24	55.81	20	46.51	-	-
EmXpAn - *Eucalyptus marginata* sparse woodland	B07	23c	23c	7.2	21	45.65	19	41.30	21	45.65	28	60.87	-	-	-	-	-	-	-	-	-	-	-	-
	B07.2	23c	23c	7.2	24	51.06	17	36.17	19	40.43	27	57.45	-	-	-	-	-	-	-	-	-	-	-	-
	B2.19	21a, 3a, 25, 3b	21a	7.3	21	53.85	13	33.33	14	35.90	23	58.97	-	-	-	-	-	-	-	-	-	-	-	-
	B2.51	22, 23c	22	7.4	14	50.00	12	42.86	12	42.86	16	57.14	-	-	-	-	-	-	-	-	-	-	-	-
	B32	22, 23c	23c	7.5	16	45.71	19	54.29	19	54.29	24	68.57	-	-	-	-	-	-	-	-	-	-	-	-
	B32.2	23c	23c	7.5	14	53.85	15	57.69	17	65.38	20	76.92	-	-	-	-	-	-	-	-	-	-	-	-
EmXpHh - *Eucalyptus marginata* sparse woodland	B2.12	3b, 3a	3b	8.1	-	-	-	-	-	-	-	-	-	-	-	-	12	27.27	24	54.54	12	27.27	-	-
EtBeAn - *Eucalyptus todtiana* sparse woodland	B15	21c, 23c	21c	9.2	13	48.15	15	55.56	10	37.04	18	66.67	-	-	-	-	-	-	-	-	-	-	-	-
	B16R	20a	20a	9.3	27	54.00	21	42.00	15	30.00	26	52.00	-	-	-	-	-	-	-	-	-	-	-	-
	B17	28	28	9.4	12	41.38	8	27.59	3	10.34	16	55.17	-	-	-	-	-	-	-	-	-	-	-	-
	B18	23c	23c	9.5	17	40.48	13	30.95	13	30.95	24	57.14	-	-	-	-	-	-	-	-	-	-	-	-
	B18.2	23c	23c	9.5	24	52.17	12	26.09	13	28.26	29	63.04	-	-	-	-	-	-	-	-	-	-	-	-
	B19	23c	23c	10.2	22	45.83	21	43.75	16	33.33	27	56.25	-	-	-	-	-	-	-	-	-	-	-	-
	B19.2	23c	23c	10.2	23	67.65	17	50.00	11	32.35	23	67.65	-	-	-	-	-	-	-	-	-	-	-	-
	B51	SCP09	SCP09	9.6	23	62.16	14	37.84	8	21.62	23	62.16	-	-	-	-	-	-	-	-	-	-	-	-
	B54	SCP09, 23c	SCP09	10.3	22	73.33	14	46.67	12	40.00	22	73.33	-	-	-	-	-	-	-	-	-	-	-	-
	BW06	SCP09, 23c	SCP09	10.4	18	50.00	13	36.11	9	25.00	19	52.78	-	-	-	-	-	-	-	-	-	-	-	-
	BW07	SCP09, 23c	SCP09	10.5	17	42.50	11	27.50	7	17.50	23	57.50	-	-	-	-	-	-	-	-	-	-	-	-
	BW08	SCP09, 23c	SCP09	NA	20	46.51	15	34.88	12	27.91	29	67.44	-	-	-	-	-	-	-	-	-	-	-	-
	BW09	SCP09, 23c	SCP09	11.2	18	43.90	18	43.90	13	31.71	22	53.66	-	-	-	-	-	-	-	-	-	-	-	-
	BW18	SCP09, 23c	SCP09	NA	26	50.00	21	40.38	21	40.38	37	71.15	-	-	-	-	-	-	-	-	-	-	-	-
	BWC02	SCP09, 23c	SCP09	11.1	17	53.13	14	43.75	9	28.13	21	65.63	-	-	-	-	-	-	-	-	-	-	-	-
	BWC03	SCP09, 23c	SCP09	11.3	25	69.44	18	50.00	14	38.89	26	72.22	-	-	-	-	-	-	-	-	-	-	-	-

Highest affinity

High affinity

Vegetation Unit and Description	Representative Quadrat	SSI Result	Dendrogram Preliminary Inferred FCT	Dendrogram	SCP09		FCT24		FCT25		FCT28		FCT 1a		FCT1b		FCT3a		FCT3b		FCT3c		FCT18	
					# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common
EtBeAn - *Eucalyptus todtiana* sparse woodland (cont.)	C01	SCP09, 23c	SCP09	NA	26	72.22	16	44.44	16	44.44	23	63.89	-	-	-	-	-	-	-	-	-	-	-	-
	C02	SCP09, 23c	SCP09	11.1	31	77.50	17	42.50	13	32.50	29	72.50	-	-	-	-	-	-	-	-	-	-	-	-
EtEpAn - *Eucalyptus todtiana* sparse woodland	B42	6	6	12.2	12	46.15	12	46.15	9	34.62	17	65.38	-	-	-	-	-	-	-	-	-	-	-	-
	B46	SCP09, 22	SCP09	12.3	16	66.67	11	45.83	8	33.33	17	70.83	-	-	-	-	-	-	-	-	-	-	-	-
	B46.2	SCP09, 22	SCP09	12.3	17	65.38	12	46.15	9	34.62	18	69.23	-	-	-	-	-	-	-	-	-	-	-	-
	B56	6, 23c	6	12.4	8	53.33	8	53.33	7	46.67	10	66.67	-	-	-	-	-	-	-	-	-	-	-	-
	BW10	21c	21c	12.5	16	55.17	14	48.28	10	34.48	17	58.62	-	-	-	-	-	-	-	-	-	-	-	-
	BW11	SCP09, 23c	SCP09	12.6	22	61.11	15	41.67	12	33.33	22	61.11	-	-	-	-	-	-	-	-	-	-	-	-
	BW12	6	6	12.7	13	54.17	8	33.33	7	29.17	13	54.17	-	-	-	-	-	-	-	-	-	-	-	-
EwXpHh - *Eucalyptus wandoo* sparse woodland	B2.09	18, 24, 19	18	13.2	-	-	-	-	-	-	-	-	-	-	-	-	5	29.41	6	35.29	5	29.41	6	35.29
	B2.45	3b	3b	13.3	-	-	-	-	-	-	-	-	-	-	-	-	12	27.27	24	54.54	17	38.64	-	-
	B2.47	3b	3b	13.4	-	-	-	-	-	-	-	-	-	-	-	-	10	23.81	22	52.38	13	30.95	-	-
	B21	6	6	13.5	-	-	-	-	-	-	-	-	-	-	-	-	12	27.27	20	45.45	21	47.73	-	-
	B22	3c, 3a, 3b	3c	14.2	-	-	-	-	-	-	-	-	9	25.00	8	22.22	5	13.89	13	36.11	12	33.33	-	-
	B22.2	3c, 3a, 3b	3c	14.2	-	-	-	-	-	-	-	-	12	27.27	12	27.27	12	27.27	21	47.73	19	43.18	-	-
	B23	3c, 3a, 3b	3c	14.2	-	-	-	-	-	-	-	-	13	37.14	15	42.86	10	28.57	18	51.43	17	48.57	-	-
	B23.2	3c, 3a, 3b	3c	14.3	-	-	-	-	-	-	-	-	9	33.33	10	37.04	5	18.52	12	44.44	13	48.15	-	-
	B24	3c, 3a, 3b	3c	14.1	-	-	-	-	-	-	-	-	12	28.57	9	21.43	12	28.57	16	38.10	15	35.71	-	-

Highest affinity

High affinity

Table 4 – Summary of FCT Dominant Species, Habitats and Distribution Comparison

Vegetation Unit	Quadrats	Inferred FCTs			Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species	FCT	No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
BaXpAn - *Banksia* spp. sparse woodland	B10	23a, 23b, 28	28, 23a, 23b	23a	21	55.81	46.67	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Moondah Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23b	16	37.21	45.71	Northern *Banksia attenuata - Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Calytrix flavescens, Eremaea pauciflora, Petrophile linearis* and *Philotheca spicata*	Dandaragan Plateau	Moondah Complex	Bassendean Complex North, Bassendean Complex - North- transition vegetation Complex, Cottesloe Complex - Central and South, Karrakatta Complex - North transition vegetation Complex
				28	11	25.58	40.74	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Moondah Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
	B10.2	23a, 23b, 28	23b, 23a, 28	23a	12	21.82	26.67	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Moondah Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23b	18	32.73	54.28	Northern *Banksia attenuata - Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Calytrix flavescens, Eremaea pauciflora, Petrophile linearis* and *Philotheca spicata*	Dandaragan Plateau	Moondah Complex	Bassendean Complex North, Bassendean Complex - North- transition vegetation Complex, Cottesloe Complex - Central and South, Karrakatta Complex - North transition vegetation Complex
		23a, 23b, 28	23b, 23a, 28	28	12	21.82	44.44	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Moondah Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
BaXpAn - *Banksia* spp. sparse woodland	B11	28, 20b, 20a	23c, SCP09, 25, 28	20a	14	35.90	29.79	*Banksia attenuata* (occasionally *Eucalyptus marginata*) over *Bossiaea eriocarpa, Conostephium pendulum, Hibbertia huegelii, Hibbertia hypericoides, Petrophile linearis, Scaevola repens, Stirlingia latifolia, Mesomelaena pseudostygia* and *Alexgeorgea nitens*	Dandaragan Plateau	Moondah Complex	Karrakatta Complex - Central and South, Southern River Complex
				20b	13	33.33	28.89	*Eastern Banksia attenuata and/or Eucalyptus marginata Woodlands over Grevillea pilifera, Babingtonia camphorosmae, Hibbertia vaginata, Mesomelaena pseudostygia, Tetraria octandra, Banksia lindleyana, Desmocladus fasciculatus and Chamaescilla corymbosa*	Dandaragan Plateau	Moondah Complex	Forrestfield Complex, Guildford Complex
				23c	11	28.20	45.83	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Moondah Complex	Bassendean Complexes
				25	3	7.70	9.68	Southern *Eucalyptus gomphocephala - Agonis flexuosa* Woodlands over *Hibbertia hypericoides, Macrozamia riedlei, Phyllanthus calycinus, Acacia willdenowiana, Hardenbergia comptoniana* and *Leucopogon propinquus*	Dandaragan Plateau	Moondah Complex	Bassendean Complex - Central and South, Cottesloe Complex - Central and South, Karrakatta Complex - Central and South, Vasse Complex
				28	8	20.51	29.63	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Moondah Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
		28, 20b, 20a	23c, SCP09, 25, 28	SCP09	8	20.51	47.06	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Moondah Complex	Mogumber Complex - South
	B2.25	6, 5, 4, 21c	21c, 23a, 23b	6	2	6.67	40.00	Weed dominated wetlands on heavy soils	Dandaragan Plateau	Cullula Complex	Guildford Complex, Yanga Complex
				5	3	10.00	23.08	Mixed Shrub Damplands	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition, Bassendean Complex North, Beermullah Complex, Herdsman Complex, Vasse Complex, Yoongarllup Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
BaXpAn - *Banksia* spp. sparse woodland (cont.)	B2.25 (cont.)	6, 5, 4, 21c	21c, 23a, 23b	4	4	13.33	28.57	*Melaleuca preissiana* Damplands	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation complex, Bassendean Complex North, Cannington Complex, Southern River Complex
				21c	9	30.00	42.86	Low lying Banksia attenuata Woodlands or shrublands over *Lyginia barbata, Trachymene pilosa, Patersonia occidentalis, Dasypogon bromeliifolius, Gompholobium tomentosum, Petrophile linearis, Drosera erythrorhiza, Xanthorrhoea preissii, Burchardia congesta, Lomandra caespitosa, Hibbertia subvaginata, Phlebocarya ciliata* and *Stylidium brunonianum.*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation complex, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Southern Complex, Yanga Complex
				23a	13	43.33	28.89	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23b	8	26.67	22.86	Northern *Banksia attenuata - Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Calytrix flavescens, Eremaea pauciflora, Petrophile linearis* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex North, Bassendean Complex - North- transition vegetation Complex, Cottesloe Complex - Central and South, Karrakatta Complex - North transition vegetation Complex
	B2.30	SCP09, 23c	SCP09, 28, 23b	SCP09	9	25.71	52.94	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullula Complex	Mogumber Complex - South
				23b	15	42.86	42.86	Northern *Banksia attenuata - Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Calytrix flavescens, Eremaea pauciflora, Petrophile linearis* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex North, Bassendean Complex - North- transition vegetation Complex, Cottesloe Complex - Central and South, Karrakatta Complex - North transition vegetation Complex
				23c	12	34.29	50.00	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullula Complex	Bassendean Complexes

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
BaXpAn - *Banksia* spp. sparse woodland (cont.)	B2.30 (cont.)	SCP09, 23c	SCP09, 28, 23b	28	14	40.00	51.85	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
	B2.32	28	28, 21a, 23b	21a	12	24.49	41.38	Central *Banksia attenuata - Eucalyptus marginata* Woodlands over *Hibbertia hypericoides, Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transitional vegetation Complex, Bassendean Complex North, Cannington Complex, Cottesloe Complex - Central and South, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Serpentine River Complex, Southern River Complex, Swan Complex, Yoongarillup Complex
				23b	14	28.57	31.11	Northern *Banksia attenuata - Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Calytrix flavescens, Eremaea pauciflora, Petrophile linearis* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex North, Bassendean Complex - North- transition vegetation Complex, Cottesloe Complex - Central and South, Karrakatta Complex - North transition vegetation Complex
				28	14	28.57	51.85	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
	B49	SCP09, 23c	23a, 23b, 23c	23a	11	40.74	24.44	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Moondah Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
BaXpAn - *Banksia* spp. sparse woodland (cont.)	B49 (cont.)	SCP09, 23c	23a, 23b, 23c	23b	13	48.15	37.14	Northern *Banksia attenuata - Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Calytrix flavescens, Eremaea pauciflora, Petrophile linearis* and *Philotheca spicata*	Dandaragan Plateau	Moondah Complex	Bassendean Complex North, Bassendean Complex - North- transition vegetation Complex, Cottesloe Complex - Central and South, Karrakatta Complex - North transition vegetation Complex
				23c	11	40.74	45.83	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Moondah Complex	Bassendean Complexes
				SCP09	8	29.63	47.06	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Moondah Complex	Mogumber Complex - South
	BW13	28	28, SCP09	28	13	0.28	48.15	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Yalanbee Complex in Low Rainfall	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
				SCP09	6	0.13	35.29	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Yalanbee Complex in Low Rainfall	Mogumber Complex - South
	BW14	SCP09, 23c	23b, 28, 23a	23a	19	35.85	42.22	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Moondah Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23b	16	30.19	45.71	Northern *Banksia attenuata - Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Calytrix flavescens, Eremaea pauciflora, Petrophile linearis* and *Philotheca spicata*	Dandaragan Plateau	Moondah Complex	Bassendean Complex North, Bassendean Complex - North- transition vegetation Complex, Cottesloe Complex - Central and South, Karrakatta Complex - North transition vegetation Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
BaXpAn - *Banksia* spp. sparse woodland (cont.)	BW14 (cont.)	SCP09, 23c	23b, 28, 23a	23c	14	26.42	58.33	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Moondah Complex	Bassendean Complexes
				28	14	26.42	51.85	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Moondah Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
				SCP09	7	13.21	41.18	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Moondah Complex	Mogumber Complex - South
	BW15	28	28, 23a	23a	16	31.37	35.56	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Moondah Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				28	13	25.49	48.15	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Moondah Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
BaXpAn - *Banksia* spp. sparse woodland (cont.)	BW16	28	28, 21a, 23a, 23c	21a	11	20.75	37.93	Central *Banksia attenuata - Eucalyptus marginata* Woodlands over *Hibbertia hypericoides, Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transitional vegetation Complex, Bassendean Complex North, Cannington Complex, Cottesloe Complex - Central and South, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Serpentine River Complex, Southern River Complex, Swan Complex, Yoongarillup Complex
				23a	17	32.08	37.78	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23c	13	24.53	54.17	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullula Complex	Bassendean Complexes
				28	14	26.42	51.85	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
	BW17	6, 21c	28, 23a, 21c, 23b	6	3	7.32	60.00	Weed dominated wetlands on heavy soils	Dandaragan Plateau	Cullula Complex	Guildford Complex, Yanga Complex
				21c	9	21.95	42.86	Low lying Banksia attenuata Woodlands or shrublands over *Lyginia barbata, Trachymene pilosa, Patersonia occidentalis, Dasypogon bromeliifolius, Gompholobium tomentosum, Petrophile linearis, Drosera erythrorhiza, Xanthorrhoea preissii, Burchardia congesta, Lomandra caespitosa, Hibbertia subvaginata, Phlebocarya ciliata* and *Stylidium brunonianum.*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation Complex, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Southern River Complex, Yanga Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
BaXpAn (cont.)	BW17 (cont.)	6, 21c	28, 23a, 21c, 23b	23a	12	29.27	26.67	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23b	10	24.39	28.57	Northern *Banksia attenuata - Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Calytrix flavescens, Eremaea pauciflora, Petrophile linearis* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex North, Bassendean Complex - North- transition vegetation Complex, Cottesloe Complex - Central and South, Karrakatta Complex - North transition vegetation Complex
				28	11	26.83	40.74	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
BaXpUa - *Banksia attenuata* sparse woodland	B2.48	28	28, 21a	21a	6	13.64	20.69	Central *Banksia attenuata - Eucalyptus marginata* Woodlands over *Hibbertia hypericoides, Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transitional vegetation Complex, Bassendean Complex North, Cannington Complex, Cottesloe Complex - Central and South, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Serpentine River Complex, Southern River Complex, Swan Complex, Yoongarillup Complex
				28	9	20.45	33.33	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
BaXpUa - *Banksia attenuata* sparse woodland (cont.)	B2.49	28	28, SCP09	28	14	29.17	51.85	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
				SCP09	9	18.75	52.94	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullula Complex	Mogumber Complex - South
	B2.50	28	28, 21a	21a	8	17.39	27.59	Central *Banksia attenuata - Eucalyptus marginata* Woodlands over *Hibbertia hypericoides, Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transitional vegetation Complex, Bassendean Complex North, Cannington Complex, Cottesloe Complex - Central and South, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Serpentine River Complex, Southern River Complex, Swan Complex, Yoongarillup Complex
				28	10	21.74	37.04	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
	B55	SCP09, 22	21c, 23a, 23b, SCP09, 28	21c	5	31.25	23.81	Low lying Banksia attenuata Woodlands or shrublands over *Lyginia barbata, Trachymene pilosa, Patersonia occidentalis, Dasypogon bromeliifolius, Gompholobium tomentosum, Petrophile linearis, Drosera erythrorhiza, Xanthorrhoea preissii, Burchardia congesta, Lomandra caespitosa, Hibbertia subvaginata, Phlebocarya ciliata* and *Stylidium brunonianum.*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation Complex, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Southern River Complex, Yanga Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
BaXpUa - *Banksia attenuata* sparse woodland (cont.)	B55 (cont.)	SCP09, 22	21c, 23a, 23b, SCP09, 28	22	4	25.00	36.36	*Banksia ilicifolia* and *Banksia attenuata* Woodlands over *Petrophile linearis, Dasypogon bromeliifolius, Patersonia occidentalis* and *Phlebocarya ciliata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation Complex, Bassendean Complex North, Cottesloe Complex - North
				23a	10	62.50	22.22	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23b	7	43.75	20.00	Northern *Banksia attenuata - Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Calytrix flavescens, Eremaea pauciflora, Petrophile linearis* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex North, Bassendean Complex - North- transition vegetation Complex, Cottesloe Complex - Central and South, Karrakatta Complex - North transition vegetation Complex
				28	6	37.50	22.22	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
				SCP09	4	25.00	23.53	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullula Complex	Mogumber Complex - South
	BW03	SCP09, 23c	23a, 21c, 28	21c	7	19.44	33.33	Low lying Banksia attenuata Woodlands or shrublands over *Lyginia barbata, Trachymene pilosa, Patersonia occidentalis, Dasypogon bromeliifolius, Gompholobium tomentosum, Petrophile linearis, Drosera erythrorhiza, Xanthorrhoea preissii, Burchardia congesta, Lomandra caespitosa, Hibbertia subvaginata, Phlebocarya ciliata* and *Stylidium brunonianum.*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation Complex, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Southern River Complex, Yanga Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
BaXpUa - *Banksia attenuata* sparse woodland (cont.)	BW03 (cont.)	SCP09, 23c	23a, 21c, 28	23a	11	30.56	24.44	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23c	12	33.33	50.00	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullula Complex	Bassendean Complexes
				28	9	25.00	33.33	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
				SCP09	7	19.44	41.18	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullula Complex	Mogumber Complex - South
	BW04	23c	21c, 23a, 28	21c	7	21.88	33.33	Low lying Banksia attenuata Woodlands or shrublands over *Lyginia barbata, Trachymene pilosa, Patersonia occidentalis, Dasypogon bromeliifolius, Gompholobium tomentosum, Petrophile linearis, Drosera erythrorhiza, Xanthorrhoea preissii, Burchardia congesta, Lomandra caespitosa, Hibbertia subvaginata, Phlebocarya ciliata* and *Stylidium brunonianum.*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation Complex, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Southern River Complex, Yanga Complex
				23a	9	28.13	20.00	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23c	6	18.75	25.00	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullula Complex	Bassendean Complexes

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
BaXpUa - *Banksia attenuata* sparse woodland (cont.)	BW04 (cont.)	23c	21c, 23a, 28	28	10	31.25	37.04	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
	BWC01	SCP09, 23c	28, 23a, 23b	23a	14	34.15	31.11	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23b	13	31.71	37.14	Northern *Banksia attenuata - Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Calytrix flavescens, Eremaea pauciflora, Petrophile linearis* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex North, Bassendean Complex - North- transition vegetation Complex, Cottesloe Complex - Central and South, Karrakatta Complex - North transition vegetation Complex
				23c	12	29.27	50.00	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullula Complex	Bassendean Complexes
				28	12	29.27	44.44	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
				SCP09	10	24.39	58.82	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullula Complex	Mogumber Complex - South

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
BaXpUa - *Banksia attenuata* sparse woodland (cont.)	C04	6, 21c, 4, 5	21a, SCP09, 28	4	2	7.69	11.76	*Melaleuca preissiana* Damplands	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation complex vegetation complex, Bassendean Complex North, Cannington Complex, Southern River Complex
				5	2	7.69	15.38	Mixed Shrub Damplands	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition, Bassendean Complex North, Beermullah Complex, Herdsman Complex, Vasse Complex, Yoongarllup Complex
				6	2	7.69	20.00	Weed dominated wetlands on heavy soils	Dandaragan Plateau	Cullula Complex	Guildford Complex, Yanga Complex
				21a	8	30.77	27.59	Central *Banksia attenuata - Eucalyptus marginata* Woodlands over *Hibbertia hypericoides, Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transitional vegetation Complex, Bassendean Complex North, Cannington Complex, Cottesloe Complex - Central and South, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Serpentine River Complex, Southern River Complex, Swan Complex, Yoongarillup Complex
				21c	4	15.38	19.05	Low lying Banksia attenuata Woodlands or shrublands over *Lyginia barbata, Trachymene pilosa, Patersonia occidentalis, Dasypogon bromeliifolius, Gompholobium tomentosum, Petrophile linearis, Drosera erythrorhiza, Xanthorrhoea preissii, Burchardia congesta, Lomandra caespitosa, Hibbertia subvaginata, Phlebocarya ciliata* and *Stylidium brunonianum.*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation Complex, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Southern River Complex, Yanga Complex
				28	7	26.92	25.92	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
BaXpUa - *Banksia attenuata* sparse woodland (cont.)	C04 (cont.)	6, 21c, 4, 5	21a, SCP09, 28	SCP09	3	11.54	17.65	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullula Complex	Mogumber Complex - South
	C06	6	23b, 23c, 28	6	3	8.57	60.00	Weed dominated wetlands on heavy soils	Dandaragan Plateau	Cullula Complex	Guildford Complex, Yanga Complex
				23b	7	20.00	20.00	Northern *Banksia attenuata - Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Calytrix flavescens, Eremaea pauciflora, Petrophile linearis* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex North, Bassendean Complex - North- transition vegetation Complex, Cottesloe Complex - Central and South, Karrakatta Complex - North transition vegetation Complex
				23c	9	25.71	37.50	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullula Complex	Bassendean Complexes
				28	9	25.71	33.33	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
EmBsHh - *Eucalyptus marginata* and *Banksia sessilis* sparse	B08	23c, 21c, 20c, 28, 20b, 20a	28, 21a, 21c	20a	12	30.00	25.53	*Banksia attenuata* (occasionally *Eucalyptus marginata*) over *Bossiaea eriocarpa, Conostephium pendulum, Hibbertia huegelii, Hibbertia hypericoides, Petrophile linearis, Scaevola repens, Stirlingia latifolia, Mesomelaena pseudostygia* and *Alexgeorgea nitens*	Dandaragan Plateau	Moondah Complex	Karrakatta Complex - Central and South, Southern River Complex
				20b	14	35.00	31.11	*Eastern Banksia attenuata and/or Eucalyptus marginata Woodlands over Grevillea pilifera, Babingtonia camphorosmae, Hibbertia vaginata, C Mesomelaena pseudostygia, Tetraria octandra, Banksia lindleyana, Desmocladus fasciculatus and Chamaescilla corymbosa*	Dandaragan Plateau	Moondah Complex	Forrestfield Complex, Guildford Complex
				20c	10	25.00	29.41	Eastern Shrublands and Woodlands with *Allocasuarina humilis, Bossiaea eriocarpa, Hibbertia hypericoides* and *Stirlingia latifolia*	Dandaragan Plateau	Moondah Complex	Forrestfield Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EmBsHh - *Eucalyptus marginata* and *Banksia sessilis* sparse	B08 (cont.)	23c, 21c, 20c, 28, 20b, 20a	28, 21a, 21c	21a	11	27.50	37.93	Central *Banksia attenuata - Eucalyptus marginata* Woodlands over *Hibbertia hypericoides, Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum*	Dandaragan Plateau	Moondah Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transitional vegetation Complex, Bassendean Complex North, Cannington Complex, Cottesloe Complex - Central and South, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Serpentine River Complex, Southern River Complex, Swan Complex, Yoongarillup Complex
				21c	7	17.50	33.33	Low lying *Banksia attenuata* Woodlands or shrublands over *Lyginia barbata, Trachymene pilosa, Patersonia occidentalis, Dasypogon bromeliifolius, Gompholobium tomentosum, Petrophile linearis, Drosera erythrorhiza, Xanthorrhoea preissii, Burchardia congesta, Lomandra caespitosa, Hibbertia subvaginata, Phlebocarya ciliata* and *Stylidium brunonianum.*	Dandaragan Plateau	Moondah Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation Complex, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Southern River Complex, Yanga Complex
				23c	11	27.50	45.83	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Moondah Complex	Bassendean Complexes
				28	10	25.00	37.04	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Moondah Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
	B09	1b, 1a	1b, 1a	1a	9	23.68	25.71	*Corymbia haematoxylon* and *Eucalyptus marginata* Woodlands on Whicher foothills over *Banksia nivea, Gompholobium knightianum* and *Hibbertia hypericoides*	Dandaragan Plateau	Mogumber Complex - South	Cartis Complex, Kingia Complex, Mungardup Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EmBsHh - *Eucalyptus marginata* and *Banksia sessilis* sparse woodland (cont.)	B09 (cont.)	1b, 1a	1b, 1a	1b	8	21.05	20.51	Southern *Corymbia calophylla* and *Eucalyptus marginata* Woodlands on heavy soils	Dandaragan Plateau	Mogumber Complex - South	Abba Complex, Southern River Complex
	B09.2	1b, 1a	1b, 1a	1a	10	27.03	28.57	*Corymbia haematoxylon* and *Eucalyptus marginata* Woodlands on Whicher foothills over *Banksia nivea, Gompholobium knightianum* and *Hibbertia hypericoides*	Dandaragan Plateau	Mogumber Complex - South	Cartis Complex, Kingia Complex, Mungardup Complex
				1b	10	27.03	25.64	Southern *Corymbia calophylla* and *Eucalyptus marginata* Woodlands on heavy soils	Dandaragan Plateau	Mogumber Complex - South	Abba Complex, Southern River Complex
	B15R	23c	28, 20b	20b	10	37.04	22.22	*Eastern Banksia attenuata and/or Eucalyptus marginata Woodlands over Grevillea pilifera, Babingtonia camphorosmae, Hibbertia vaginata, Mesomelaena pseudostygia, Tetraria octandra, Banksia lindleyana, Desmocladus fasciculatus and Chamaescilla corymbosa*	Dandaragan Plateau	Cullula Complex	Forrestfield Complex, Guildford Complex
	B15R (cont.)	23c	28, 20b	23c	6	22.22	25.00	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullula Complex	Bassendean Complexes
				28	9	33.33	33.33	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
	B2.31	3b, 3a	3b, 3c	3a	5	16.13	19.23	*Corymbia calophylla - Kingia australis* Woodlands on heavy soils	Dandaragan Plateau	Cullula Complex	Forrestfield Complex, Guildford Complex
				3b	9	29.03	23.68	*Corymbia calophylla - Eucalyptus marginata* Woodlands on sandy clay soils	Dandaragan Plateau	Cullula Complex	Cannington Complex, Guildford Complex
			3b, 3c	3c	5	16.13	25.00	*Corymbia calophylla - Xanthorrhoea preissii* Woodlands and Shrublands	Dandaragan Plateau	Cullula Complex	Forrestfield Complex, Guildford Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EmBsHh - *Eucalyptus marginata* and *Banksia sessilis* sparse woodland (cont.)	B2.33	3b, 3a	3b	3a	6	18.18	23.08	*Corymbia calophylla - Kingia australis* Woodlands on heavy soils	Dandaragan Plateau	Cullula Complex	Forrestfield Complex, Guildford Complex
				3b	10	30.30	26.32	*Corymbia calophylla - Eucalyptus marginata* Woodlands on sandy clay soils	Dandaragan Plateau	Cullula Complex	Cannington Complex, Guildford Complex
	B28	3b, 3a	3b, 3c	3a	4	10.00	15.38	*Corymbia calophylla - Kingia australis* Woodlands on heavy soils	Darling Plateau	Coolakin Complex in Low Rainfall	Forrestfield Complex, Guildford Complex
				3b	7	17.50	18.42	*Corymbia calophylla - Eucalyptus marginata* Woodlands on sandy clay soils	Darling Plateau	Coolakin Complex in Low Rainfall	Cannington Complex, Guildford Complex
				3c	4	10.00	50.00	*Corymbia calophylla - Xanthorrhoea preissii* Woodlands and Shrublands	Darling Plateau	Coolakin Complex in Low Rainfall	Forrestfield Complex, Guildford Complex
	B28.2	3b, 3a	3b, 3c	3a	4	11.76	15.38	*Corymbia calophylla - Kingia australis* Woodlands on heavy soils	Darling Plateau	Coolakin Complex in Low Rainfall	Forrestfield Complex, Guildford Complex
				3b	8	23.53	21.05	*Corymbia calophylla - Eucalyptus marginata* Woodlands on sandy clay soils	Darling Plateau	Coolakin Complex in Low Rainfall	Cannington Complex, Guildford Complex
				3c	3	8.82	15.00	*Corymbia calophylla - Xanthorrhoea preissii* Woodlands and Shrublands	Darling Plateau	Coolakin Complex in Low Rainfall	Forrestfield Complex, Guildford Complex
	C03	3b, 3a	3b, 3c	3a	6	20.69	23.08	*Corymbia calophylla - Kingia australis* Woodlands on heavy soils	Dandaragan Plateau	Cullulla Complex	Forrestfield Complex, Guildford Complex
				3b	10	34.48	26.32	*Corymbia calophylla - Eucalyptus marginata* Woodlands on sandy clay soils	Dandaragan Plateau	Cullulla Complex	Cannington Complex, Guildford Complex
				3c	5	17.24	25.00	*Corymbia calophylla - Xanthorrhoea preissii* Woodlands and Shrublands	Dandaragan Plateau	Cullulla Complex	Forrestfield Complex, Guildford Complex
	C09	3b, 3a	3b, 3c	3a	5	11.63	19.23	*Corymbia calophylla - Kingia australis* Woodlands on heavy soils	Dandaragan Plateau	Cullulla Complex	Forrestfield Complex, Guildford Complex
				3b	15	34.88	39.47	*Corymbia calophylla - Eucalyptus marginata* Woodlands on sandy clay soils	Dandaragan Plateau	Cullulla Complex	Cannington Complex, Guildford Complex
				3c	6	13.95	30.00	*Corymbia calophylla - Xanthorrhoea preissii* Woodlands and Shrublands	Dandaragan Plateau	Cullulla Complex	Forrestfield Complex, Guildford Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EmXpAn - *Eucalyptus marginata* sparse woodland	B07	23c	28, 21a, 21c, 23a	21a	13	28.26	44.83	Central *Banksia attenuata - Eucalyptus marginata* Woodlands over *Hibbertia hypericoides, Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum*	Darling Plateau	Coolakin Complex in Low Rainfall	Bassendean Complex - Central and South, Bassendean Complex - Central and South transitional vegetation Complex, Bassendean Complex North, Cannington Complex, Cottesloe Complex - Central and South, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Serpentine River Complex, Southern River Complex, Swan Complex, Yoongarillup Complex
				21c	11	23.91	52.38	Low lying Banksia attenuata Woodlands or shrublands over *Lyginia barbata, Trachymene pilosa, Patersonia occidentalis, Dasypogon bromeliifolius, Gompholobium tomentosum, Petrophile linearis, Drosera erythrorhiza, Xanthorrhoea preissii, Burchardia congesta, Lomandra caespitosa, Hibbertia subvaginata, Phlebocarya ciliata* and *Stylidium brunonianum.*	Darling Plateau	Coolakin Complex in Low Rainfall	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation Complex, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Southern River Complex, Yanga Complex
				23a	17	36.96	37.78	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Darling Plateau	Coolakin Complex in Low Rainfall	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23c	12	26.09	50.00	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Darling Plateau	Coolakin Complex in Low Rainfall	Bassendean Complexes
				28	12	26.09	44.44	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Darling Plateau	Coolakin Complex in Low Rainfall	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EmXpAn - *Eucalyptus marginata* sparse woodland (cont.)	B07	23c	28, 21a, 21c, 23a	21a	11	23.40	37.93	Central *Banksia attenuata - Eucalyptus marginata* Woodlands over *Hibbertia hypericoides, Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum*	Darling Plateau	Coolakin Complex in Low Rainfall	Bassendean Complex - Central and South, Bassendean Complex - Central and South transitional vegetation Complex, Bassendean Complex North, Cannington Complex, Cottesloe Complex - Central and South, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Serpentine River Complex, Southern River Complex, Swan Complex, Yoongarillup Complex
				21c	9	19.15	42.86	Low lying Banksia attenuata Woodlands or shrublands over *Lyginia barbata, Trachymene pilosa, Patersonia occidentalis, Dasypogon bromeliifolius, Gompholobium tomentosum, Petrophile linearis, Drosera erythrorhiza, Xanthorrhoea preissii, Burchardia congesta, Lomandra caespitosa, Hibbertia subvaginata, Phlebocarya ciliata* and *Stylidium brunonianum.*	Darling Plateau	Coolakin Complex in Low Rainfall	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation Complex, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Southern River Complex, Yanga Complex
				23a	17	36.17	37.78	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Darling Plateau	Coolakin Complex in Low Rainfall	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23c	11	23.40	45.83	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Darling Plateau	Coolakin Complex in Low Rainfall	Bassendean Complexes
				28	12	25.53	44.44	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Darling Plateau	Coolakin Complex in Low Rainfall	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
	B2.19	21a, 3a, 25, 3b	21a, 23a, 23b, 28	3a	6	15.38	23.08	*Corymbia calophylla - Kingia australis* Woodlands on heavy soils	Dandaragan Plateau	Mogumber Complex - South	Forrestfield Complex, Guildford Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EmXpAn - *Eucalyptus marginata* sparse woodland (cont.)	B2.19 (cont)	21a, 3a, 25, 3b	21a, 23a, 23b, 28	3b	10	25.64	26.32	*Corymbia calophylla - Eucalyptus marginata* Woodlands on sandy clay soils	Dandaragan Plateau	Mogumber Complex - South	Cannington Complex, Guildford Complex
				21a	10	25.64	34.48	Central *Banksia attenuata - Eucalyptus marginata* Woodlands over *Hibbertia hypericoides, Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum*	Dandaragan Plateau	Mogumber Complex - South	Bassendean Complex - Central and South, Bassendean Complex - Central and South transitional vegetation Complex, Bassendean Complex North, Cannington Complex, Cottesloe Complex - Central and South, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Serpentine River Complex, Southern River Complex, Swan Complex, Yoongarillup Complex
				23a	14	35.90	31.11	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Mogumber Complex - South	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23b	11	28.21	31.43	Northern *Banksia attenuata - Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Calytrix flavescens, Eremaea pauciflora, Petrophile linearis* and *Philotheca spicata*	Dandaragan Plateau	Mogumber Complex - South	Bassendean Complex North, Bassendean Complex - North- transition vegetation Complex, Cottesloe Complex - Central and South, Karrakatta Complex - North transition vegetation Complex
				25	4	10.26	12.90	Southern *Eucalyptus gomphocephala - Agonis flexuosa* Woodlands over *Hibbertia hypericoides, Macrozamia riedlei, Phyllanthus calycinus, Acacia willdenowiana, Hardenbergia comptoniana* and *Leucopogon propinquus*	Dandaragan Plateau	Mogumber Complex - South	Bassendean Complex - Central and South, Cottesloe Complex - Central and South, Karrakatta Complex - Central and South, Vasse Complex
				28	9	23.08	33.33	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Mogumber Complex - South	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EmXpAn - *Eucalyptus marginata* sparse woodland (cont.)	B2.51	22, 23c	23a, 21c, 28	21c	6	21.43	28.57	Low lying Banksia attenuata Woodlands or shrublands over *Lyginia barbata, Trachymene pilosa, Patersonia occidentalis, Dasypogon bromeliifolius, Gompholobium tomentosum, Petrophile linearis, Drosera erythrorhiza, Xanthorrhoea preissii, Burchardia congesta, Lomandra caespitosa, Hibbertia subvaginata, Phlebocarya ciliata* and *Stylidium brunonianum.*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation Complex, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Southern River Complex, Yanga Complex
				22	2	7.14	18.18	*Banksia ilicifolia* and *Banksia attenuata* Woodlands over *Petrophile linearis, Dasypogon bromeliifolius, Patersonia occidentalis* and *Phlebocarya ciliata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation Complex, Bassendean Complex North, Cottesloe Complex - North
				23a	12	42.86	26.67	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23c	9	32.14	37.50	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullula Complex	Bassendean Complexes
				28	9	32.14	33.33	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
	B32	22, 23c	28, 21c	21c	9	25.71	42.86	Low lying Banksia attenuata Woodlands or shrublands over *Lyginia barbata, Trachymene pilosa, Patersonia occidentalis, Dasypogon bromeliifolius, Gompholobium tomentosum, Petrophile linearis, Drosera erythrorhiza, Xanthorrhoea preissii, Burchardia congesta, Lomandra caespitosa, Hibbertia subvaginata, Phlebocarya ciliata* and *Stylidium brunonianum.*	Darling Plateau	Coolakin Complex in Low Rainfall	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation Complex, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Southern River Complex, Yanga Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EmXpAn - *Eucalyptus marginata* sparse woodland (cont.)	B32 (cont.)	22, 23c	28, 21c	22	1	2.86	9.09	*Banksia ilicifolia* and *Banksia attenuata* Woodlands over *Petrophile linearis, Dasypogon bromeliifolius, Patersonia occidentalis* and *Phlebocarya ciliata*	Darling Plateau	Coolakin Complex in Low Rainfall	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation Complex, Bassendean Complex North, Cottesloe Complex - North
				23c	8	22.86	33.33	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Darling Plateau	Coolakin Complex in Low Rainfall	Bassendean Complexes
				28	10	28.57	37.04	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Darling Plateau	Coolakin Complex in Low Rainfall	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
	B32.2	23c	28, 21c	21c	4	15.38	19.05	Low lying Banksia attenuata Woodlands or shrublands over *Lyginia barbata, Trachymene pilosa, Patersonia occidentalis, Dasypogon bromeliifolius, Gompholobium tomentosum, Petrophile linearis, Drosera erythrorhiza, Xanthorrhoea preissii, Burchardia congesta, Lomandra caespitosa, Hibbertia subvaginata, Phlebocarya ciliata* and *Stylidium brunonianum.*	Darling Plateau	Coolakin Complex in Low Rainfall	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation Complex, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Southern River Complex, Yanga Complex
				23c	8	30.77	33.33	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Darling Plateau	Coolakin Complex in Low Rainfall	Bassendean Complexes
				28	7	26.92	25.93	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Darling Plateau	Coolakin Complex in Low Rainfall	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EmXpHh	B2.12	3b, 3a	3b	3a	7	15.91	26.92	*Corymbia calophylla - Kingia australis* Woodlands on heavy soils	Dandaragan Plateau	Cullula Complex	Forrestfield Complex, Guildford Complex
				3b	13	29.55	34.21	*Corymbia calophylla - Eucalyptus marginata* Woodlands on sandy clay soils	Dandaragan Plateau	Cullula Complex	Cannington Complex, Guildford Complex
EtBeAn - *Eucalyptus todtiana* woodland	B15	21c, 23c	23a, 28, 21c, 23b	21c	9	33.33	42.86	Low lying Banksia attenuata Woodlands or shrublands over *Lyginia barbata, Trachymene pilosa, Patersonia occidentalis, Dasypogon bromeliifolius, Gompholobium tomentosum, Petrophile linearis, Drosera erythrorhiza, Xanthorrhoea preissii, Burchardia congesta, Lomandra caespitosa, Hibbertia subvaginata, Phlebocarya ciliata* and *Stylidium brunonianum.*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation Complex, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Southern River Complex, Yanga Complex
				23a	11	40.74	24.44	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23b	8	29.63	22.86	Northern *Banksia attenuata - Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Calytrix flavescens, Eremaea pauciflora, Petrophile linearis* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex North, Bassendean Complex - North- transition vegetation Complex, Cottesloe Complex - Central and South, Karrakatta Complex - North transition vegetation Complex
				23c	7	25.93	29.17	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullula Complex	Bassendean Complexes
	B15R	21c, 23c	23a, 28, 21c, 23b	28	9	33.33	33.33	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EtBeAn - *Eucalyptus todtiana* woodland (cont.)	B16R	20a	23b, SCP09	20a	19	38.00	42.22	*Banksia attenuata* (occasionally *Eucalyptus marginata*) over *Bossiaea eriocarpa, Conostephium pendulum, Hibbertia huegelii, Hibbertia hypericoides, Petrophile linearis, Scaevola repens, Stirlingia latifolia, Mesomelaena pseudostygia* and *Alexgeorgea nitens*	Dandaragan Plateau	Cullula Complex	Karrakatta Complex - Central and South, Southern River Complex
				23b	15	30.00	42.86	Northern *Banksia attenuata - Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Calytrix flavescens, Eremaea pauciflora, Petrophile linearis* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex North, Bassendean Complex - North- transition vegetation Complex, Cottesloe Complex - Central and South, Karrakatta Complex - North transition vegetation Complex
				SCP09	8	16.00	47.06	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullula Complex	Mogumber Complex - South
	B17	28	28	28	6	20.69	22.22	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Mogumber Complex - South	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
	B18	23c	28, 21a, 23a	21a	6	14.29	20.69	Central *Banksia attenuata - Eucalyptus marginata* Woodlands over *Hibbertia hypericoides, Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transitional vegetation Complex, Bassendean Complex North, Cannington Complex, Cottesloe Complex - Central and South, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Serpentine River Complex, Southern River Complex, Swan Complex, Yoongarillup Complex
				23a	12	28.57	26.67	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EtBeAn - *Eucalyptus todtiana* woodland (cont.)	B18 (cont.)	23c	28, 21a, 23a	23c	12	28.57	50.00	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullula Complex	Bassendean Complexes
				28	8	19.05	29.63	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
	B18.2	23c	28, 23a, 23c	23a	13	28.26	28.89	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23c	12	26.09	50.00	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullula Complex	Bassendean Complexes
				28	7	15.22	25.92	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
	B19	23c	28, 23a, 23b, 23c	23a	14	29.17	31.11	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EtBeAn - *Eucalyptus todtiana* woodland (cont.)	B19 (cont.)	23c	28, 23a, 23b, 23c	23b	16	33.33	45.71	Northern *Banksia attenuata - Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Calytrix flavescens, Eremaea pauciflora, Petrophile linearis* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex North, Bassendean Complex - North- transition vegetation Complex, Cottesloe Complex - Central and South, Karrakatta Complex - North transition vegetation Complex
				23c	12	25.00	50.00	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullula Complex	Bassendean Complexes
				28	10	20.83	37.04	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
	B19.2	23c	SCP09, 28, 23a, 23b	23a	13	38.24	28.89	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23b	13	38.24	37.14	Northern *Banksia attenuata - Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Calytrix flavescens, Eremaea pauciflora, Petrophile linearis* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex North, Bassendean Complex - North- transition vegetation Complex, Cottesloe Complex - Central and South, Karrakatta Complex - North transition vegetation Complex
				23c	11	32.35	45.83	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullula Complex	Bassendean Complexes

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EtBeAn - *Eucalyptus todtiana* woodland (cont.)	B19.2 (cont.)	23c	SCP09, 28, 23a, 23b	28	9	26.47	33.33	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
				SCP09	9	26.47	52.94	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullula Complex	Mogumber Complex - South
	B51	SCP09	SCP09, 28, 23a	23a	13	35.14	28.89	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				28	7	18.92	25.93	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
				SCP09	8	21.62	47.06	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullula Complex	Mogumber Complex - South
	B54	SCP09, 23c	23b, 23a	23a	11	36.67	24.44	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EtBeAn - *Eucalyptus todtiana* woodland (cont.)	B54 (cont.)	SCP09, 23c	23b, 23a	23b	13	43.33	37.14	Northern *Banksia attenuata - Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Calytrix flavescens, Eremaea pauciflora, Petrophile linearis* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex North, Bassendean Complex - North- transition vegetation Complex, Cottesloe Complex - Central and South, Karrakatta Complex - North transition vegetation Complex
				23c	13	43.33	54.17	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullula Complex	Bassendean Complexes
				SCP09	10	33.33	58.82	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullula Complex	Mogumber Complex - South
	BW06	SCP09, 23c	28, SCP09	23c	10	27.78	41.67	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullula Complex	Bassendean Complexes
				28	9	25.00	33.33	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
				SCP09	8	22.22	47.06	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullula Complex	Mogumber Complex - South
	BW07	SCP09, 23c	28, 23b	23b	8	20.00	22.86	Northern *Banksia attenuata - Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Calytrix flavescens, Eremaea pauciflora, Petrophile linearis* and *Philotheca spicata*	Dandaragan Plateau	Mogumber Complex-South	Bassendean Complex North, Bassendean Complex - North- transition vegetation Complex, Cottesloe Complex - Central and South, Karrakatta Complex - North transition vegetation Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EtBeAn - *Eucalyptus todtiana* woodland (cont.)	BW07 (cont.)	SCP09, 23c	28, 23b	23c	10	25.00	41.67	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Mogumber Complex-South	Bassendean Complexes
				28	8	20.00	29.63	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Mogumber Complex-South	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
				SCP09	8	20.00	47.06	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Mogumber Complex-South	Mogumber Complex - South
	BW08	SCP09, 23c	28, 23a	23a	8	18.60	17.78	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23c	9	20.93	37.50	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullula Complex	Bassendean Complexes
				28	4	9.30	14.81	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
				SCP09	9	20.93	52.94	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullula Complex	Mogumber Complex - South

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EtBeAn - *Eucalyptus todtiana* woodland (cont.)	BW09	SCP09, 23c	23a	23a	14	34.15	31.11	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23c	11	26.83	45.83	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullula Complex	Bassendean Complexes
				SCP09	8	19.51	47.06	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullula Complex	Mogumber Complex - South
	BW18	SCP09, 23c	28, 21a	21a	10	19.23	34.48	Central *Banksia attenuata - Eucalyptus marginata* Woodlands over *Hibbertia hypericoides, Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transitional vegetation Complex, Bassendean Complex North, Cannington Complex, Cottesloe Complex - Central and South, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Serpentine River Complex, Southern River Complex, Swan Complex, Yoongarillup Complex
				23c	14	26.92	58.33	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullula Complex	Bassendean Complexes
				28	12	23.08	44.44	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EtBeAn - *Eucalyptus todtiana* woodland (cont.)	BW18 (cont.)	SCP09, 23c	28, 21a	SCP09	11	21.15	64.71	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullula Complex	Mogumber Complex - South
	BWC02	SCP09, 23c	28, 23a	23a	15	46.88	33.33	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23c	14	43.75	58.33	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullula Complex	Bassendean Complexes
				28	13	40.63	48.45	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
				SCP09	10	31.25	58.82	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullula Complex	Mogumber Complex - South
	BWC03	SCP09, 23c	23a, 28	23a	9	25.00	20.00	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullala Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23c	12	33.33	50.00	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullala Complex	Bassendean Complexes

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EtBeAn - *Eucalyptus todtiana* woodland (cont.)	BWC03 (cont)	SCP09, 23c	23a, 28	28	8	22.22	29.63	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullala Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
				SCP09	9	25.00	52.94	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullala Complex	Mogumber Complex - South
	C01	SCP09, 23c	23b, 23c, SCP09	23b	14	38.89	40.00	Northern *Banksia attenuata - Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Calytrix flavescens, Eremaea pauciflora, Petrophile linearis* and *Philotheca spicata*	Dandaragan Plateau	Cullala Complex	Bassendean Complex North, Bassendean Complex - North- transition vegetation Complex, Cottesloe Complex - Central and South, Karrakatta Complex - North transition vegetation Complex
				23c	12	33.33	50.00	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullala Complex	Bassendean Complexes
				SCP09	8	22.22	47.06	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullala Complex	Mogumber Complex - South
	C02	SCP09, 23c	SCP09, 28	23c	11	27.50	45.83	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullala Complex	Bassendean Complexes
				28	7	17.50	25.93	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullala Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EtEpAn - Eucalyptus todtiana (cont.)	C02	SCP09, 23c	SCP09, 28	SCP09	8	20.00	47.06	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullala Complex	Mogumber Complex - South
	B42	6	28, 21a, 21c	6	4	16.00	80.00	Weed dominated wetlands on heavy soils	Dandaragan Plateau	Cullula Complex	Guildford Complex, Yanga Complex
				21a	7	28.00	24.14	Central *Banksia attenuata - Eucalyptus marginata* Woodlands over *Hibbertia hypericoides, Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transitional vegetation Complex, Bassendean Complex North, Cannington Complex, Cottesloe Complex - Central and South, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Serpentine River Complex, Southern River Complex, Swan Complex, Yoongarillup Complex
				21c	5	20.00	23.81	Low lying Banksia attenuata Woodlands or shrublands over *Lyginia barbata, Trachymene pilosa, Patersonia occidentalis, Dasypogon bromeliifolius, Gompholobium tomentosum, Petrophile linearis, Drosera erythrorhiza, Xanthorrhoea preissii, Burchardia congesta, Lomandra caespitosa, Hibbertia subvaginata, Phlebocarya ciliata* and *Stylidium brunonianum.*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation Complex, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Southern River Complex, Yanga Complex
				28	5	20.00	18.50	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EtEpAn - Eucalyptus todtiana (cont.)	B46	SCP09, 22	21c, 23a, 28	21c	6	24.00	28.57	Low lying Banksia attenuata Woodlands or shrublands over *Lyginia barbata, Trachymene pilosa, Patersonia occidentalis, Dasypogon bromeliifolius, Gompholobium tomentosum, Petrophile linearis, Drosera erythrorhiza, Xanthorrhoea preissii, Burchardia congesta, Lomandra caespitosa, Hibbertia subvaginata, Phlebocarya ciliata* and *Stylidium brunonianum.*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation Complex, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Southern River Complex, Yanga Complex
				22	3	12.00	27.27	*Banksia ilicifolia* and *Banksia attenuata* Woodlands over *Petrophile linearis, Dasypogon bromeliifolius, Patersonia occidentalis* and *Phlebocarya ciliata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation Complex, Bassendean Complex North, Cottesloe Complex - North
				23a	14	56.00	31.11	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				28	8	32.00	29.63	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
				SCP09	6	24.00	35.29	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullula Complex	Mogumber Complex - South
	B46.2	SCP09, 22	23a, 21c, 23b	21c	7	26.92	33.33	Low lying Banksia attenuata Woodlands or shrublands over *Lyginia barbata, Trachymene pilosa, Patersonia occidentalis, Dasypogon bromeliifolius, Gompholobium tomentosum, Petrophile linearis, Drosera erythrorhiza, Xanthorrhoea preissii, Burchardia congesta, Lomandra caespitosa, Hibbertia subvaginata, Phlebocarya ciliata* and *Stylidium brunonianum.*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation Complex, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Southern River Complex, Yanga Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EtEpAn - Eucalyptus todtiana (cont.)	B46.2 (cont.)	SCP09, 22	23a, 21c, 23b	22	3	11.54	27.27	*Banksia ilicifolia* and *Banksia attenuata* Woodlands over *Petrophile linearis, Dasypogon bromeliifolius, Patersonia occidentalis* and *Phlebocarya ciliata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation Complex, Bassendean Complex North, Cottesloe Complex - North
				23a	12	46.15	26.67	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23b	9	34.62	25.71	Northern *Banksia attenuata - Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Calytrix flavescens, Eremaea pauciflora, Petrophile linearis* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex North, Bassendean Complex - North- transition vegetation Complex, Cottesloe Complex - Central and South, Karrakatta Complex - North transition vegetation Complex
				SCP09	6	23.08	35.29	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullula Complex	Mogumber Complex - South
	B56	6, 23c	23a, 28	6	3	20.00	60.00	Weed dominated wetlands on heavy soils	Dandaragan Plateau	Cullula Complex	Guildford Complex, Yanga Complex
				23a	7	46.67	15.56	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23c	6	40.00	25.00	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullula Complex	Bassendean Complexes

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EtEpAn - Eucalyptus todtiana (cont.)	B56 (cont.)	6, 23c	23a, 28	28	6	40.00	21.43	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullula Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
	BW10	21c	23a, 28	21c	10	34.48	47.62	Low lying Banksia attenuata Woodlands or shrublands over *Lyginia barbata, Trachymene pilosa, Patersonia occidentalis, Dasypogon bromeliifolius, Gompholobium tomentosum, Petrophile linearis, Drosera erythrorhiza, Xanthorrhoea preissii, Burchardia congesta, Lomandra caespitosa, Hibbertia subvaginata, Phlebocarya ciliata* and *Stylidium brunonianum.*	Dandaragan Plateau	Cullulla Complex	Bassendean Complex - Central and South, Bassendean Complex - Central and South transition vegetation Complex, Dardanup Complex, Guildford Complex, Karrakatta Complex - Central and South, Southern River Complex, Yanga Complex
				23a	14	48.28	31.11	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullulla Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				28	12	41.38	44.44	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullulla Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
	BW11	SCP09, 23c	23a, SCP09, 28	23a	11	30.56	24.44	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullulla Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23c	10	27.78	41.67	Northern eastern *Banksia attenuata - Banksia menziesii Woodlands* over *Patersonia occidentalis, Mesomelaena pseudostygia, Anigozanthos humilis, Hibbertia hypericoides, Xanthorrhoea preissii* and *Hibbertia huegelii*	Dandaragan Plateau	Cullulla Complex	Bassendean Complexes

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EtEpAn - Eucalyptus todtiana (cont.)	BW11 (cont.)	SCP09, 23c	23a, SCP09, 28	28	8	22.22	29.63	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullulla Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
				SCP09	8	22.22	47.06	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullulla Complex	Bassendean Dune and Dandaragan Plateau
	BW12	6	SCP09, 28, 23a, 23b	6	3	13.04	60.00	Weed dominated wetlands on heavy soils	Dandaragan Plateau	Cullulla Complex	Guildford Complex, Yanga Complex
				23a	8	34.78	17.78	Central *Banksia attenuata* and *Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Petrophile linearis, Gompholobium tomentosum, Conostephium pendulum, Leucopogon conostephioides* and *Philotheca spicata*	Dandaragan Plateau	Cullulla Complex	Bassendean Complex - Central and South, Bassendean Complex North, Bassendean Complex - North - transition vegetation Complex, Beermullah Complex, Guildford Complex, Southern River Complex
				23b	7	30.43	20.00	Northern *Banksia attenuata - Banksia menziesii* Woodlands over *Bossiaea eriocarpa, Calytrix flavescens, Eremaea pauciflora, Petrophile linearis* and *Philotheca spicata*	Dandaragan Plateau	Cullulla Complex	Bassendean Complex North, Bassendean Complex - North- transition vegetation Complex, Cottesloe Complex - Central and South, Karrakatta Complex - North transition vegetation Complex
				28	7	30.43	25.00	Spearwood *Banksia attenuata* or *Banksia attenuata - Eucalyptus marginata* and/or *Corymbia calophylla* Woodlands over *Hibbertia hypericoides, Xanthorrhoea preissii, Gompholobium tomentosum* and *Acacia pulchella*	Dandaragan Plateau	Cullulla Complex	Bassendean Complex - Central and South, Beermullah Complex, Cottesloe Complex - Central and South, Cottesloe Complex - North, Karrakatta Complex - Central and South, Karrakatta Complex - Central and South, Karrakatta Complex - North, Quindalup Complex, Reagan Complex
				SCP09	6	26.09	35.29	*Banksia attenuata* Woodlands over dense low shrublands with *Eucalyptus todtiana* over *Hibbertia hypericoides, Hibbertia huegelii, Eremaea pauciflora, Petrophile linearis* and *Allocasuarina humilis*	Dandaragan Plateau	Cullulla Complex	Mogumber Complex - South

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EwXpHh - *Eucalyptus wandoo* sparse woodland	B2.09	18, 24, 19	3a,3b,3c, 18	3a	4	16.00	15.38	*Corymbia calophylla - Kingia australis* Woodlands on heavy soils	Darling Plateau	Coolakin Complex in Low Rainfall	Forrestfield Complex, Guildford Complex
				3b	7	28.00	18.42	*Corymbia calophylla - Eucalyptus marginata* Woodlands on sandy clay soils	Darling Plateau	Coolakin Complex in Low Rainfall	Cannington Complex, Guildford Complex
				3c	4	16.00	20.00	*Corymbia calophylla - Xanthorrhoea preissii* Woodlands and Shrublands	Darling Plateau	Coolakin Complex in Low Rainfall	Forrestfield Complex, Guildford Complex
				18	3	12.00	8.11	Shrublands on calareous silts	Darling Plateau	Coolakin Complex in Low Rainfall	Vasse Complex, Yoongarillup Complex
				19	1	4.00	8.33	Sedgelands in Holocene dune swales	Darling Plateau	Coolakin Complex in Low Rainfall	Quindalup Complex
				24	1	4.00	5.88	Northern Spearwood Shrublands and Woodlands with H*ardenbergia comptoniana, Melaleuca acerosa, Phyllanthus calycinus* and *Xanthorrhoea preissii*	Darling Plateau	Coolakin Complex in Low Rainfall	Cottesloe Complex - Central and South, Herdsman Complex, Quindalup Complex
	B2.45	3b	3b	3b	13	29.55	34.21	*Corymbia calophylla - Eucalyptus marginata* Woodlands on sandy clay soils	Dandaragan Plateau	Cullula Complex	Cannington Complex, Guildford Complex
	B2.47	3b	3b	3b	10	23.81	26.32	*Corymbia calophylla - Eucalyptus marginata* Woodlands on sandy clay soils	Darling Plateau	Yalanbee Complex in Low Rainfall	Cannington Complex, Guildford Complex
	B21	6	3c, 3b	6	3	6.82	60.00	Weed dominated wetlands on heavy soils	Darling Plateau	Yalanbee Complex in Low Rainfall	Guildford Complex, Yanga Complex
				3b	9	20.45	23.68	*Corymbia calophylla - Eucalyptus marginata* Woodlands on sandy clay soils	Darling Plateau	Yalanbee Complex in Low Rainfall	Cannington Complex, Guildford Complex
				3c	8	18.18	40.00	*Corymbia calophylla - Xanthorrhoea preissii* Woodlands and Shrublands	Darling Plateau	Yalanbee Complex in Low Rainfall	Forrestfield Complex, Guildford Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EwXpHh - *Eucalyptus wandoo* sparse woodland (cont.)	B22	3c, 3a, 3b	3b	3a	2	5.56	7.69	*Corymbia calophylla - Kingia australis* Woodlands on heavy soils	Darling Plateau	Yalanbee Complex in Low Rainfall	Forrestfield Complex, Guildford Complex
				3b	2	5.56	5.26	*Corymbia calophylla - Eucalyptus marginata* Woodlands on sandy clay soils	Darling Plateau	Yalanbee Complex in Low Rainfall	Cannington Complex, Guildford Complex
				3c	3	8.33	15.00	*Corymbia calophylla - Xanthorrhoea preissii* Woodlands and Shrublands	Darling Plateau	Yalanbee Complex in Low Rainfall	Forrestfield Complex, Guildford Complex
	B22.2	3c, 3a, 3b	3b, 3c	3a	7	15.91	26.92	*Corymbia calophylla - Kingia australis* Woodlands on heavy soils	Darling Plateau	Yalanbee Complex in Low Rainfall	Forrestfield Complex, Guildford Complex
				3b	8	18.18	21.05	*Corymbia calophylla - Eucalyptus marginata* Woodlands on sandy clay soils	Darling Plateau	Yalanbee Complex in Low Rainfall	Cannington Complex, Guildford Complex
				3c	6	13.64	30.00	*Corymbia calophylla - Xanthorrhoea preissii* Woodlands and Shrublands	Darling Plateau	Yalanbee Complex in Low Rainfall	Forrestfield Complex, Guildford Complex
	B23	3c, 3a, 3b	3b, 3c	3a	6	17.14	23.08	*Corymbia calophylla - Kingia australis* Woodlands on heavy soils	Darling Plateau	Yalanbee Complex in Low Rainfall	Forrestfield Complex, Guildford Complex
				3b	8	22.86	21.05	*Corymbia calophylla - Eucalyptus marginata* Woodlands on sandy clay soils	Darling Plateau	Yalanbee Complex in Low Rainfall	Cannington Complex, Guildford Complex
				3c	7	20.00	35.00	*Corymbia calophylla - Xanthorrhoea preissii* Woodlands and Shrublands	Darling Plateau	Yalanbee Complex in Low Rainfall	Forrestfield Complex, Guildford Complex
	B23.2	3c, 3a, 3b	3c, 3b	3a	4	13.79	15.38	*Corymbia calophylla - Kingia australis* Woodlands on heavy soils	Darling Plateau	Yalanbee Complex in Low Rainfall	Forrestfield Complex, Guildford Complex
				3b	6	20.69	15.79	*Corymbia calophylla - Eucalyptus marginata* Woodlands on sandy clay soils	Darling Plateau	Yalanbee Complex in Low Rainfall	Cannington Complex, Guildford Complex

Vegetation Unit	Quadrats	Inferred FCTs		FCT	Dominant/Indicator Species			Typical FCT Habitat	Habitat, Soil & Landform (System 6)		
		From SSI	From Common Species		No .in Common	% in common with Quadrat Spp.	% of FCT' s dominant species		System	Complex of FVC Quadrat	Typical FCT Complex
EwXpHh - *Eucalyptus wandoo* sparse woodland (cont)	B23.2 (cont.)	3c, 3a, 3b	3c, 3b	3c	5	17.24	25.00	*Corymbia calophylla - Xanthorrhoea preissii* Woodlands and Shrublands	Darling Plateau	Yalanbee Complex in Low Rainfall	Forrestfield Complex, Guildford Complex
	B24	3c, 3a, 3b	3b, 3c	3a	6	14.29	11.54	*Corymbia calophylla - Kingia australis* Woodlands on heavy soils	Darling Plateau	Coolakin Complex in Low Rainfall	Forrestfield Complex, Guildford Complex
				3b	7	16.67	18.42	*Corymbia calophylla - Eucalyptus marginata* Woodlands on sandy clay soils	Darling Plateau	Coolakin Complex in Low Rainfall	Cannington Complex, Guildford Complex
				3c	5	11.90	25.00	*Corymbia calophylla - Xanthorrhoea preissii* Woodlands and Shrublands	Darling Plateau	Coolakin Complex in Low Rainfall	Forrestfield Complex, Guildford Complex

Table 5 – Summary of Results of all Comparative Analyses

(shaded cells showing strongest results)

Veg Unit	Represent-ative Quadrat	Dominant Indicator Species				Summary					
		Possible FCT	# Common Species	% Common Species	% of Dominant Species	PATN	High No. Species in Common	Common Dominant FCT Species	Habitat Structure	Aligned Distribution	Inferred FCT
BaXpAn	B10	23a	21	55.81	46.67	+	+	+	+	+	Affinity to 23a, somewhat 23b
		23b	16	37.21	45.71	+	+		+	+	
		28	11	25.58	40.74	+	+			+	
	B10.2	23a	12	21.82	26.67	+	+		+	+	Affinity to 23b, somewhat 23a
		23b	18	32.73	54.28	+	+	+	+	+	
		28	12	21.82	44.44	+	+			+	
	B11	20a	14	35.90	29.79	+		+		No	Affinity to 28 and SCP 09
		20b	13	33.33	28.89	+				No	
		23c	11	28.20	45.83		+			+	
		25	3	7.70	9.68		+			No	
		28	8	20.51	29.63	+	+			+	
		SCP09	8	20.51	47.06		+		+	+	
	B2.25	6	2	6.67	40.00	+				No	Affinity to 23a
		5	3	10.00	23.08	+				No	
		4	4	13.33	28.57	+				No	
		21c	9	30.00	42.86	+	+			+	
		23a	13	43.33	28.89		+	+	+	+	
		23b	8	26.67	22.86		+		+	+	
	B2.30	SCP09	9	25.71	52.94	+	+		+	+	Affinity to 23b and SCP 09
		23b	15	42.86	42.86		+	+	+	+	
		23c	12	34.29	50.00	+				+	
		28	14	40.00	51.85		+			+	
	B2.32	21a	12	24.49	41.38		+			+	Affinity to 28
		23b	14	28.57	31.11		+		+	+	
		28	14	28.57	51.85	+	+	+		+	
	B49	23a	11	40.74	24.44		+		+	+	Affinity to 23b and SCP09
		23b	13	48.15	37.14		+	+	+	+	
		23c	11	40.74	45.83	+	+			+	
		SCP09	8	29.63	47.06	+			+	+	
	BW13	28	13	28.26	48.15	+	+	+		+	Affinity to 28
		SCP09	6	13.04	35.29		+		+	+	
	BW14	23a	19	35.85	42.22		+	+	+	+	Affinity to 23a and 23c
		23b	16	30.19	45.71		+		+	+	
		23c	14	26.42	58.33	+				+	
		28	14	26.42	51.85		+			+	
		SCP09	7	13.21	41.18	+			+	+	
	BW15	23a	16	31.37	35.56		+	+	+	+	Affinity to 23a and 28
		28	13	25.49	48.15	+	+			+	
	BW16	21a	11	20.75	37.93		+			No	Affinity to 23a
		23a	17	32.08	37.78		+	+	+	+	
		23c	13	24.53	54.17		+			+	
		28	14	26.42	51.85	+	+			+	
	BW17	6	3	7.32	60.00	+				No	Affinity to 23a
		21c	9	21.95	42.86	+	+			+	

Veg Unit	Represent-ative Quadrat	Dominant Indicator Species				Summary					
		Possible FCT	# Common Species	% Common Species	% of Dominant Species	PATN	High No. Species in Common	Common Dominant FCT Species	Habitat Structure	Aligned Distribution	Inferred FCT
BaXpAn (cont.)	BW17 (cont.)	23a	12	29.27	26.67		+	+	+	+	
		23b	10	24.39	28.57		+		+	+	
		28	11	26.83	40.74		+			+	
BaXpUa	B2.48	21a	6	13.64	20.69		+			No	Affinity to 28
		28	9	20.45	33.33	+	+	+	+	+	
	B2.49	28	14	29.17	51.85	+	+	+	+	+	Affinity to 28
		SCP09	9	18.75	52.94		+			+	
	B2.50	21a	8	17.39	27.59		+			No	Affinity to 28
		28	10	21.74	37.04	+	+	+	+	+	
	B55	21c	5	31.25	23.81		+			+	Affinity to 23a and 28
		22	4	25.00	36.36	+				+	
		23a	10	62.50	22.22		+	+		+	
		23b	7	43.75	20.00		+			+	
		28	6	37.50	22.22	+	+		+	+	
		SCP09	4	25.00	23.53		+			+	
	BW03	21c	7	19.44	33.33		+			+	Affinity to 23c and 28
		23a	11	30.56	24.44		+			+	
		23c	12	33.33	50.00	+		+		+	
		28	9	25.00	33.33		+		+	+	
		SCP09	7	19.44	41.18	+				+	
	BW04	21c	7	21.88	33.33		+			+	Affinity to 28
		23a	9	28.13	20.00		+			+	
		23c	6	18.75	25.00	+				+	
		28	10	31.25	37.04		+	+	+	+	
	BWC01	23a	14	34.15	31.11		+	+	+	+	Affinity to 23a
		23b	13	31.71	37.14		+			+	
		23c	12	29.27	50.00	+				+	
		28	12	29.27	44.44		+		+	+	
		SCP09	10	24.39	58.82	+				+	
	C04	4	2	7.69	11.76	+				No	Affinity to 28
		5	2	7.69	15.38	+				No	
		6	2	7.69	20.00	+				No	
		21a	8	30.77	27.59		+	+		No	
		21c	4	15.38	19.05	+				+	
		28	7	26.92	25.92		+		+	+	
		SCP09	3	11.54	17.65		+			+	
	C06	6	3	8.57	60.00	+				No	Affinity to 23c and 28
		23b	7	20.00	20.00		+			+	
		23c	9	25.71	37.50		+	+		+	
		28	9	25.71	33.33		+		+	+	
EmBsHh	B08	20a	12	30.00	25.53	+				No	Affinity to 21a, 21c, 23c, and 28
		20b	14	35.00	31.11	+		+		No	
		20c	10	25.00	29.41	+				No	
		21a	11	27.50	37.93		+		+	+	
		21c	7	17.50	33.33	+	+			+	
		23c	11	27.50	45.83	+				+	

Veg Unit	Represent-ative Quadrat	Dominant Indicator Species				Summary					
		Possible FCT	# Common Species	% Common Species	% of Dominant Species	PATN	High No. Species in Common	Common Dominant FCT Species	Habitat Structure	Aligned Distribution	Inferred FCT
EmBsHh (cont.)	B08 (cont.)	28	10	25.00	37.04	+	+			+	Affinity to 21a, 21c, 23c, and 28
	B09	1a	9	23.68	25.71	+	+	+		No	Weak affinity to 1a
		1b	8	21.05	20.51	+	+			No	
	B09.2	1a	10	27.03	28.57	+	+	+		No	Weak affinity to 1a
		1b	10	27.03	25.64	+	+			No	
	B15R	20b	10	37.04	22.22		+	+		No	Weak affinity to 20b
		23c	6	22.22	25.00	+				+	
		28	9	33.33	33.33		+			+	
	B2.31	3a	5	16.13	19.23	+				No	Weak affinity to 3b
		3b	9	29.03	23.68	+	+	+		No	
		3c	5	16.13	25.00		+			No	
	B2.33	3a	6	18.18	23.08	+				No	Weak affinity to 3b
		3b	10	30.30	26.32	+	+	+		No	
	B28	3a	4	10.00	15.38	+				No	Weak affinity to 3b, 3c
		3b	7	17.50	18.42	+	+			No	
		3c	4	10.00	50.00		+	+		No	
	B28.2	3a	4	11.76	15.38	+				No	Weak affinity to 3b
		3b	8	23.53	21.05	+	+	+		No	
		3c	3	8.82	15.00		+			No	
	C03	3a	6	20.69	23.08	+				No	Weak affinity to 3b
		3b	10	34.48	26.32	+	+	+		No	
		3c	5	17.24	25.00		+			No	
	C09	3a	5	11.63	19.23	+				No	Weak affinity to 3b
		3b	15	34.88	39.47	+	+	+		No	
		3c	6	13.95	30.00		+			No	
EmXpAn	B07	21a	13	28.26	44.83						Affinity to 23a
		21c	11	23.91	52.38		+			+	
		23a	17	36.96	37.78		+	+	+	+	
		23c	12	26.09	50.00	+				+	
		28	12	26.09	44.44		+		+	+	
	B07.2	21a	11	23.40	37.93		+		+	+	Affinity to 23a and 23c
		21c	9	19.15	42.86		+			+	
		23a	17	36.17	37.78		+	+	+	+	
		23c	11	23.40	45.83	+				+	
		28	12	25.53	44.44		+		+	+	
	B2.19	3a	6	15.38	23.08	+				No	Affinity to 23a and 21a
		3b	10	25.64	26.32	+				No	
		21a	10	25.64	34.48	+	+		+	+	
		23a	14	35.90	31.11		+	+	+	+	
		23b	11	28.21	31.43		+			+	
		25	4	10.26	12.90	+				No	
		28	9	23.08	33.33		+		+	+	
	B2.51	21c	6	21.43	28.57		+			+	Affinity to 23a and 23c

Veg Unit	Represent-ative Quadrat	Dominant Indicator Species				Summary					
		Possible FCT	# Common Species	% Common Species	% of Dominant Species	PATN	High No. Species in Common	Common Dominant FCT Species	Habitat Structure	Aligned Distribution	Inferred FCT
EmXpAn (cont.)	B2.51 (cont.)	22	2	7.14	18.18	+				No	Affinity to 23a and 23c
		23a	12	42.86	26.67		+	+	+	+	
		23c	9	32.14	37.50	+				+	
		28	9	32.14	33.33		+		+	+	
	B32	21c	9	25.71	42.86		+			+	Affinity to 28
		22	1	2.86	9.09	+				No	
		23c	8	22.86	33.33	+				+	
		28	10	28.57	37.04		+	+	+	+	
	B32.2	21c	4	15.38	19.05		+			+	Affinity to 23c
		23c	8	30.77	33.33	+		+	+	+	
		28	7	26.92	25.93		+		+	+	
Em Xp Hh	B2.12	3a	7	15.91	26.92	+				No	Weak affinity to 3b
		3b	13	29.55	34.21	+	+	+		No	
EtBeAn	B15	21c	9	33.33	42.86	+	+			+	Affinity to 23a and 21c
		23a	11	40.74	24.44		+	+	+	+	
		23b	8	29.63	22.86		+			+	
		23c	7	25.93	29.17	+				+	
		28	9	33.33	33.33		+			+	
	B16R	20a	19	38.00	42.22	+		+	+	No	Some affinity to 20a
		23b	15	30.00	42.86		+			+	
		SCP09	8	16.00	47.06		+		+	+	
	B17	28	6	20.69	22.22	+	+	+		+	Affinity to 28
	B18	21a	6	14.29	20.69		+			+	Affinity to 23c
		23a	12	28.57	26.67		+		+	+	
		23c	12	28.57	50.00	+		+		+	
		28	8	19.05	29.63		+			+	
	B18.2	23a	13	28.26	28.89		+	+	+	+	Affinity to 23a
		23c	12	26.09	50.00	+	+			+	
		28	7	15.22	25.92		+			+	
	B19	23a	14	29.17	31.11		+		+	+	Some affinity to 23a, 23b, 23c
		23b	16	33.33	45.71		+	+		+	
		23c	12	25.00	50.00	+	+			+	
		28	10	20.83	37.04		+			+	
	B19.2	23a	13	38.24	28.89		+		+	+	Some affinity to 23a, 23b, SCP09
		23b	13	38.24	37.14		+	+		+	
		23c	11	32.35	45.83	+				+	
		28	9	26.47	33.33		+			+	
		SCP09	9	26.47	52.94		+		+	+	
	B51	23a	13	35.14	28.89		+	+	+	+	Affinity to 23a, SCP09
		28	7	18.92	25.93		+			+	
		SCP09	8	21.62	47.06	+	+		+	+	
	B54	23a	11	36.67	24.44		+		+	+	Affinity to 23a, SCP09
		23b	13	43.33	37.14		+			+	
		23c	13	43.33	54.17			+		No	
		SCP09	10	33.33	58.82	+			+	+	

Veg Unit	Represent-ative Quadrat	Dominant Indicator Species				Summary					
		Possible FCT	# Common Species	% Common Species	% of Dominant Species	PATN	High No. Species in Common	Common Dominant FCT Species	Habitat Structure	Aligned Distribution	Inferred FCT
EtBeAn (cont.)	BW06	23c	10	27.78	41.67	+		+		+	Affinity to SCP09
		28	9	25.00	33.33		+			+	
		SCP09	8	22.22	47.06	+	+		+	+	
	BW07	23b	8	20.00	22.86		+			+	Affinity to 23c, SCP09
		23c	10	25.00	41.67	+		+		+	
		28	8	20.00	29.63		+			+	
		SCP09	8	20.00	47.06	+			+	+	
	BW08	23a	8	18.60	17.78		+		+	+	Affinity to 23a, 23c, SCP09
		23c	9	20.93	37.50	+		+		+	
		28	4	9.30	14.81		+			+	
		SCP09	9	20.93	52.94	+			+	+	
	BW09	23a	14	34.15	31.11		+	+	+	+	Affinity to 23a
		23c	11	26.83	45.83	+				+	
		SCP09	8	19.51	47.06	+			+	+	
	BW18	21a	10	19.23	34.48		+			+	Affinity to 23c, SCP09
		23c	14	26.92	58.33	+		+		+	
		28	12	23.08	44.44		+			+	
		SCP09	11	21.15	64.71	+			+	+	
	BWC02	23a	15	46.88	33.33		+	+	+	+	Affinity to 23a
		23c	14	43.75	58.33	+				+	
		28	13	40.63	48.45		+			+	
		SCP09	10	31.25	58.82	+			+	+	
	BWC03	23a	9	25.00	20.00		+		+	+	Some affinity to 23a, 23c, SCP09
		23c	12	33.33	50.00	+		+		+	
		28	8	22.22	29.63		+			+	
		SCP09	9	25.00	52.94	+			+	+	
	C01	23b	14	38.89	40.00		+	+		+	Affinity to 23b, SCP09
		23c	12	33.33	50.00	+	+			+	
		SCP09	8	22.22	47.06	+	+		+	+	
	C02	23c	11	27.50	45.83	+		+		+	Affinity to 23c, SCP09
		28	7	17.50	25.93		+			+	
		SCP09	8	20.00	47.06	+	+		+	+	
EtEpAn	B42	6	4	16.00	80.00	+			Incon-clusive	No	Some affinity to 21a
		21a	7	28.00	24.14		+	+	Incon-clusive	+	
		21c	5	20.00	23.81		+		Incon-clusive	+	
		28	5	20.00	18.50		+		Incon-clusive	+	
	B46	21c	6	24.00	28.57		+			+	Affinity to 23a and SCP09
		22	3	12.00	27.27	+				No	
		23a	14	56.00	31.11		+	+	+	+	
		28	8	32.00	29.63		+			+	
		SCP09	6	24.00	35.29	+			+	+	
	B46.2	21c	7	26.92	33.33		+			+	Affinity to 23a and SCP09
		22	3	11.54	27.27	+				No	

Veg Unit	Represent-ative Quadrat	Dominant Indicator Species				Summary					
		Possible FCT	# Common Species	% Common Species	% of Dominant Species	PATN	High No. Species in Common	Common Dominant FCT Species	Habitat Structure	Aligned Distribution	Inferred FCT
EtEpAn (cont.)	B46.2 (cont.)	23a	12	46.15	26.67		+	+	+	+	Affinity to 23a and SCP09
		23b	9	34.62	25.71		+			+	
		SCP09	6	23.08	35.29	+			+	+	
	B56	6	3	20.00	60.00	+				No	Affinity to 23a
		23a	7	46.67	15.56		+	+	+	+	
		23c	6	40.00	25.00	+				+	
		28	6	40.00	21.43		+			+	
	BW10	21c	10	34.48	47.62	+				+	Affinity to 23a and 21c
		23a	14	48.28	31.11		+	+	+	+	
		28	12	41.38	44.44		+			+	
	BW11	23a	11	30.56	24.44		+	+	+	+	Affinity to 23a, SCP09
		23c	10	27.78	41.67	+				+	
		28	8	22.22	29.63		+			+	
		SCP09	8	22.22	47.06	+	+		+	+	
	BW12	6	3	13.04	60.00	+				No	Affinity to 23a
		23a	8	34.78	17.78		+	+	+	+	
		23b	7	30.43	20.00		+			+	
		28	7	30.43	25.00		+			+	
		SCP09	6	26.09	35.29		+		+	+	
	B2.09	3a	4	16.00	15.38		+			No	Weak affinity to 3b
		3b	7	28.00	18.42		+	+		No	
		3c	4	16.00	20.00		+			No	
		18	3	12.00	8.11	+	+			No	
		19	1	4.00	8.33	+				No	
		24	1	4.00	5.88	+				No	
	B2.45	3b	13	29.55	34.21	+	+	+		No	Weak affinity to 3b
	B2.47	3b	10	23.81	26.32	+	+	+		No	Weak affinity to 3b
	B21	6	3	6.82	60.00	+				No	Weak affinity to 3b
		3b	9	20.45	23.68		+	+		No	
		3c	8	18.18	40.00		+			No	
	B22	3a	2	5.56	7.69	+				No	Weak affinity to 3b, 3c
		3b	2	5.56	5.26	+	+			No	
		3c	3	8.33	15.00	+		+		No	
	B22.2	3a	7	15.91	26.92	+				No	Weak affinity to 3b
		3b	8	18.18	21.05	+	+	+		No	
		3c	6	13.64	30.00	+	+			No	
	B23	3a	6	17.14	23.08	+				No	Weak affinity to 3b
		3b	8	22.86	21.05	+	+	+		No	
		3c	7	20.00	35.00	+	+			No	
	B23.2	3a	4	13.79	15.38	+				No	Weak affinity to 3b
		3b	6	20.69	15.79	+	+	+		No	
		3c	5	17.24	25.00	+	+			No	
	B24	3a	6	14.29	11.54	+				No	Weak affinity to 3b
		3b	7	16.67	18.42	+	+	+		No	
		3c	5	11.90	25.00	+	+			No	

4. DISCUSSION

'Batch' and SSI analysis of the quadrat data using PATN™ analysis was carried out for all quadrats within the Development Envelope considered to potentially represent TECs or PECs. 'Batch' analysis was conducted in grouping of five to eight quadrats for all eight vegetation units. The batch analysis indicated variations in FCTs within each vegetation unit, which was confirmed with initial SSI for randomly selected quadrats. The SSI results for the majority of quadrats did not align with the 'batch' analysis results and therefore, SSI was conducted for all quadrats (**Table 2**).

The comparison of presence/absence flora species data for all potential Banksia woodland quadrats in comparison to the consolidated Gibson *et al.* (1994) and Keighery *et al.* (2008) datasets (targeting detection of Banksia woodland FCTs and other FCTs that represent TECs and PECs) which was conducted using PATN analysis, indicates discrepancies in the results between 'batch' analysis and SSI analysis (**Table 3**). For the majority of the quadrats, simple 'number of species in common' analysis confirmed the results of either the 'batch' or SSI PATN analysis in variable but inconsistent instances. However, in some instances, quadrats exhibited a higher percentage of species in common with FCTs other than those that PATN analysis results (dendrograms) suggested affinity with.

The variation between the 'batch' analysis and the SSI results may be attributed to the Gibson *et al.* (1994) and Keighery *et al.* (2008) studies having been predominantly carried out on the Swan Coastal Plain. The Bindoon Bypass study area traverses the Jarrah Forrest and interzone between the Swan Coastal Plain and Jarrah Forest and may not provide conclusive results due to this.

Further to this, the assessment against the key dominant indicator species for each FCT, habitat, vegetation complexes and the current known FCT distribution, the site-specific species data and geographical location (**Table 4**) also indicates that a large proportion of the sampled quadrats do not occur on the Swan Coastal Plain, but rather on the Darling Plateau of the Jarrah Forrest IBRA Region.

The consolidated results of the data analysis that aimed to further determine FCTs (**Table 5**) indicates that as previously reported in FVC (2018c), BaXpAn, BaXpAn, EmXpAn, EtBeAn and EtEpAn show affinity to FCTs that are considered representative of the Banksia woodland TEC. At FCT level, the Banksia woodland vegetation of the study area is concluded to be mostly representative of FCT 28, S09 or FCT 23a, with smaller representations of FCT 20a, FCT 20b, FCT 21a, FCT 21c, FCT 23b and FCT 23c.

In summary, the results of the FCT analysis conclude that the Banksia woodland vegetation units are likely to be representative of the following FCTs:

- SCP 09 - *Banksia attenuata* woodlands over dense low shrublands
- SCP 20a – *Banksia attenuata* woodlands over species rich dense shrublands (WA Endangered TEC)
- SCP 20b - Eastern *Banksia attenuata* and/or *Eucalyptus marginata* woodlands (WA Endangered TEC)
- SCP 21a – Central *Banksia attenuata – Eucalyptus marginata* woodlands
- SCP 21c – Low lying *Banksia attenuata* woodlands or shrublands (WA Priority 3 PEC)
- SCP 23a - Central *Banksia attenuata - Banksia menziesii* woodlands
- SCP 23b - Northern *Banksia attenuata - Banksia menziesii* woodlands (WA Priority 3 PEC)
- SCP 23c - North-eastern *Banksia attenuata - Banksia menziesii* woodlands
- SCP 28 - Spearwood *Banksia attenuata* or *Banksia attenuata – Eucalyptus* woodlands.

Ten of the assessed quadrats that occur within the Development Envelope were found to show affinity to FCTs that are representative of State-listed TECs or PECs listed above, as summarised in **Table 6**. The majority of these affinities are considered 'weak', or the affinity detected from floristic and qualitative analysis shows only 'some' affinity for that FCT (**Table 5**).

Table 6 – Quadrats within the Development Envelope that Show Affinity to FCTs of Conservation-Significance

		Significant Banksia Woodland FCTs				Comments
		WA Endangered TEC		WA Priority 3 PEC		
Quadrat No.	Vegetation Unit	20a	20b	21c	23b	
B10	BaXpAn				weak	Has a stronger affinity to the more common FCT 23a
B10.2					weak	Previous results for this quadrat (B10) showed stronger affinity to common FCT 23a
B2.30					yes	However, PATN analysis indicates stronger affinity with the more common FCT SCP09
B49					yes	However, PATN analysis indicates stronger affinity with the more common FCT SCP09
B08	EmBsHh			weak		PATN analysis indicates stronger affinity with the more common FCT 23c
B15(R)			weak			FCT 20b not known to be distributed in the region, therefore less likely to be represented. Also shows affinity with the more common FCT 28.
B15	EtBeAn			weak		Assessment of dominant FCT species indicates stronger species correlation with more common FCT 23a
B16(R)		weak				FCT 20a not known to be distributed in the region, therefore less likely to be represented. Also shows affinity with the more common SCP 09.
B19					weak	PATN analysis indicates stronger affinity with more common FCT 23c
B19.2					weak	PATN analysis indicates stronger affinity with more common FCT 23c
C01					weak	PATN analysis indicates stronger affinity with more common FCT 23c and SCP09
BW10	EtEpAn			weak		Assessment of dominant FCT species indicates stronger affinity with more common FCT 23a

The quadrats presented in **Table 6** were recorded within four different vegetation units as defined and mapped across the study area. Within each of these vegetation units, the various quadrats sampled show affinities to several different FCTs, including different significant Banksia woodland FCTs, as shown in **Figure 6**. This result highlights that vegetation units defined and mapped via detailed flora and vegetation surveys often do not support a single FCT, and that FCTs often occur with patchy distribution and may have subtle differences not detectable immediately on the ground.

Two quadrats, B2.30 and B49, were found to have affinity with FCT 23b, which is a State-listed Priority 3 PEC. These two affinities are the only affinities detected that are considered 'strong', based on the results of floristic and qualitative analysis (**Table 6**). Both quadrats B2.30 and B49, were found to have also have affinity with the more common SCP 09, and given this floristic community's widespread distribution in the region, has a greater probability of being represented in the locations of these quadrats within the DE. Similarly, all other quadrats presented in **Table 6**, that show affinity with FCTs of conservation-significance (in relation to Banksia woodlands), also show affinity to other more common FCTs. Again, given these floristic communities' widespread distribution in the region, there is a greater probability that these common FCTs are represented in these quadrat locations within the DE.

5. CLOSING

Should you require further information or clarification regarding the information provided in this memorandum, please do not hesitate to contact the undersigned.

Best Regards,
Kellie Bauer-Simpson
Director & Principal Ecologist/Environmental Manager
Focused Vision Consulting Pty Ltd

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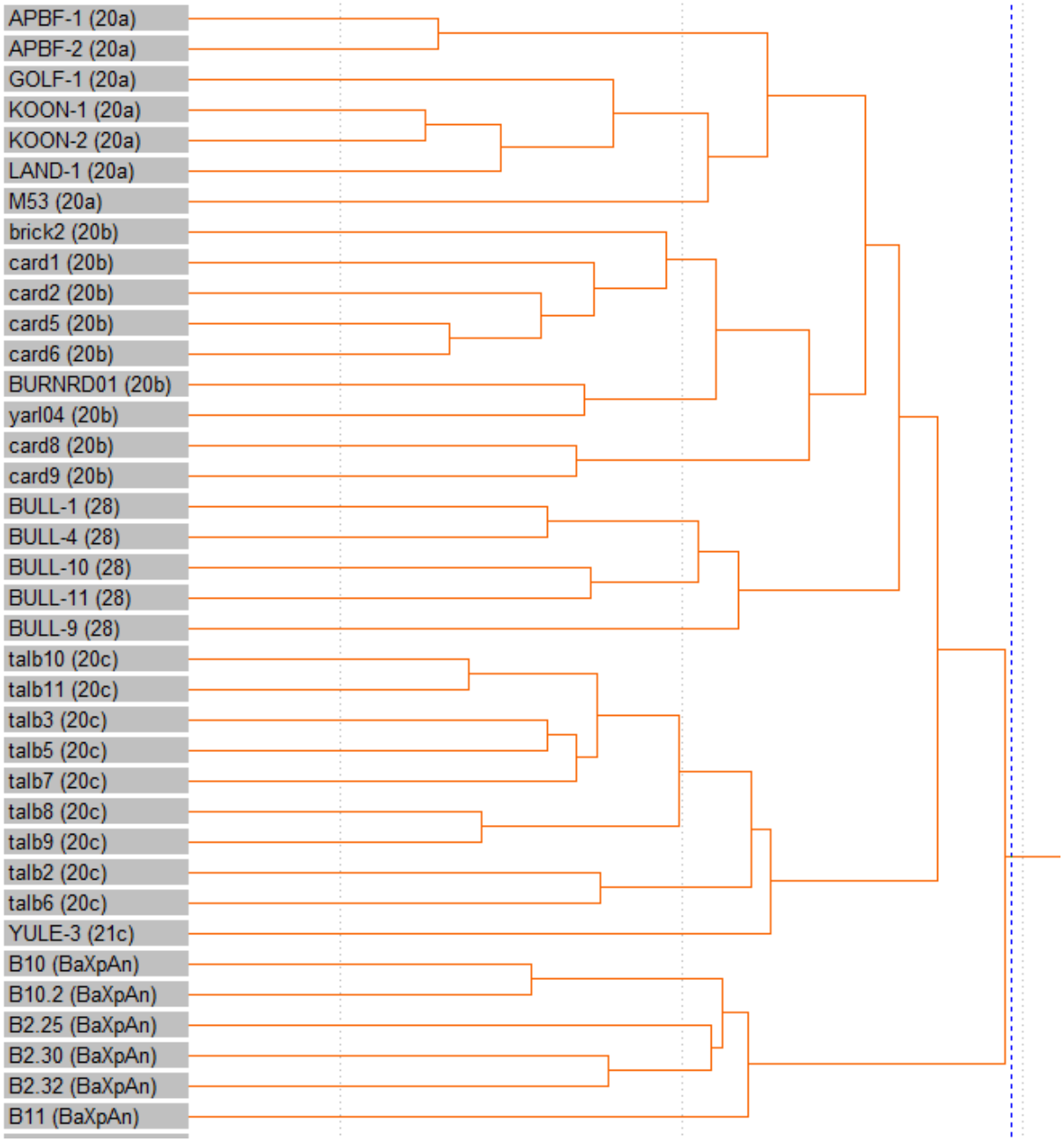
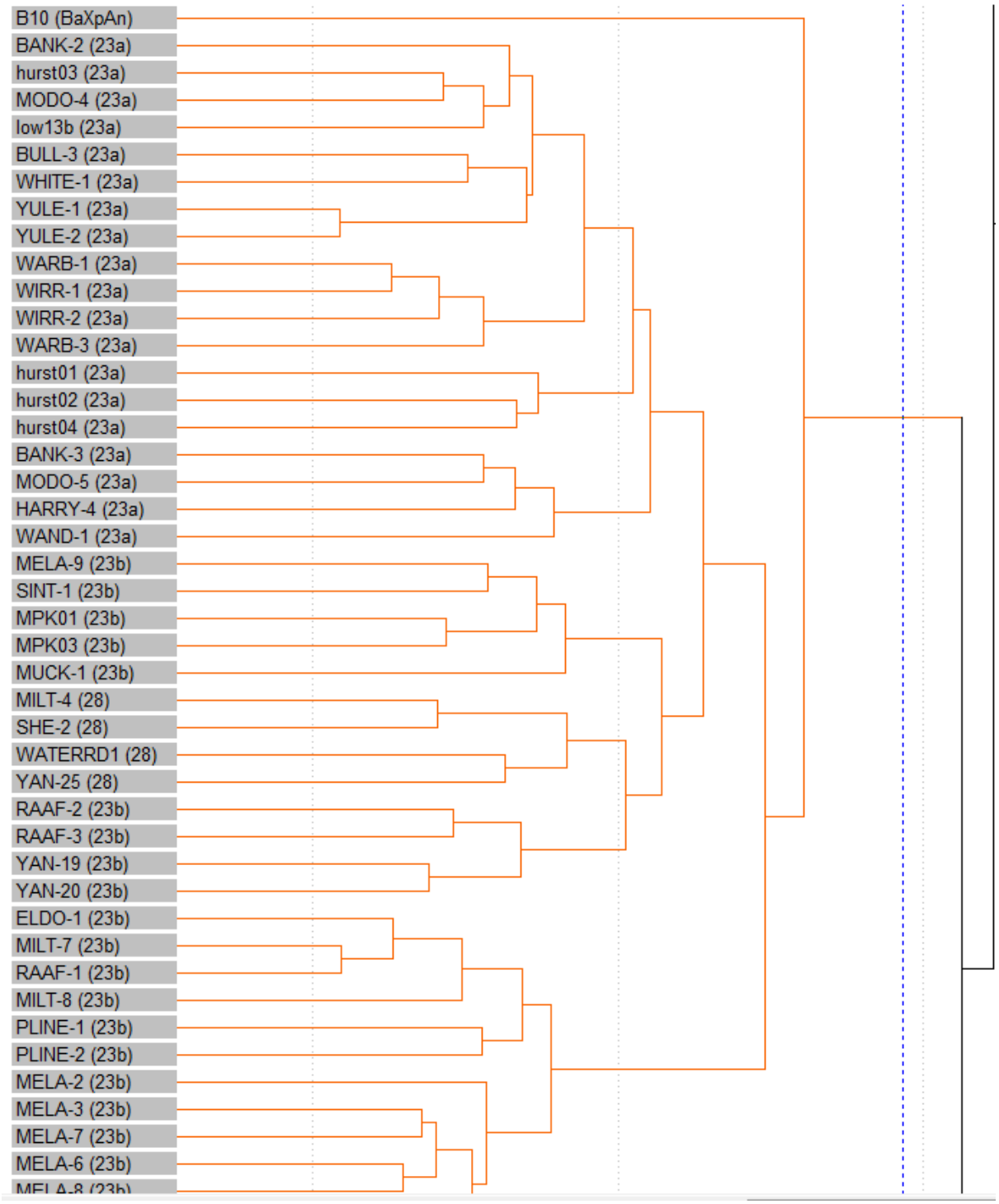
APPENDIX 1 – BATCH AND SSI DENDROGRAMS

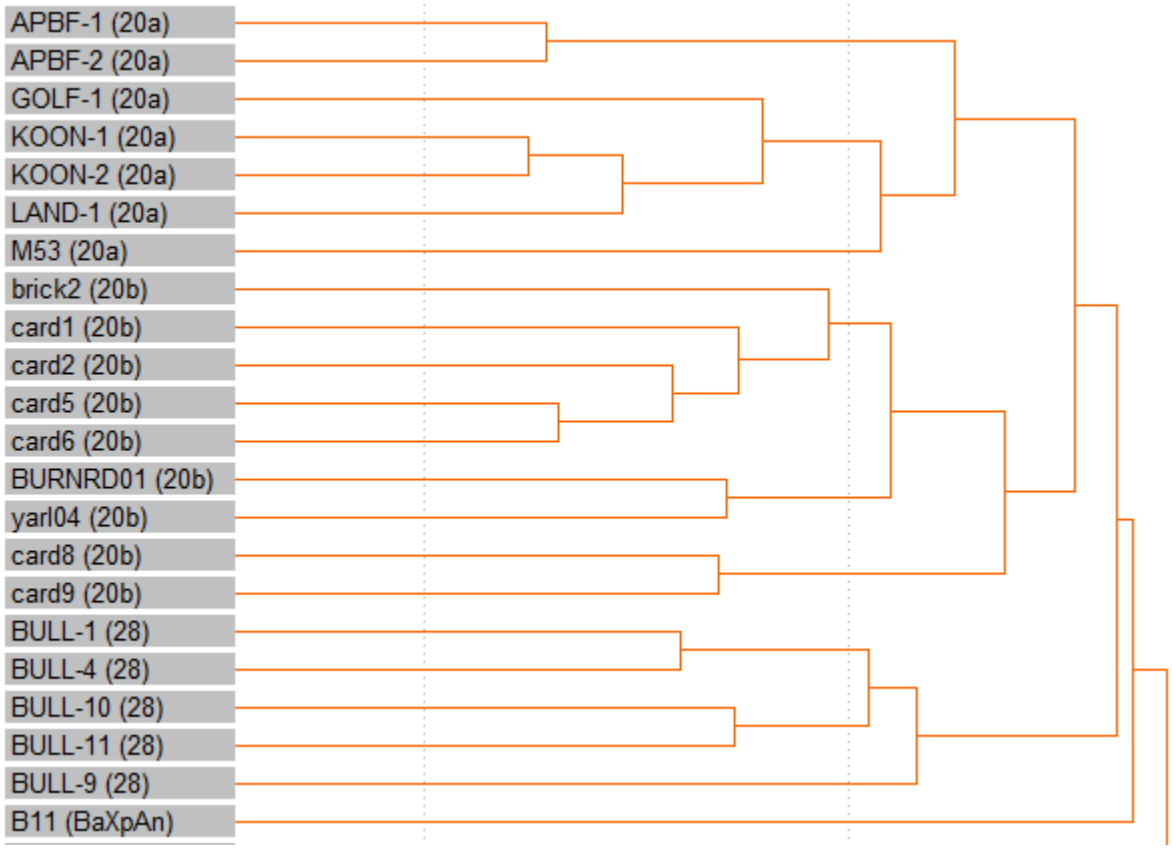
Dendrogram 1.1 – BAXpAn Batch 1



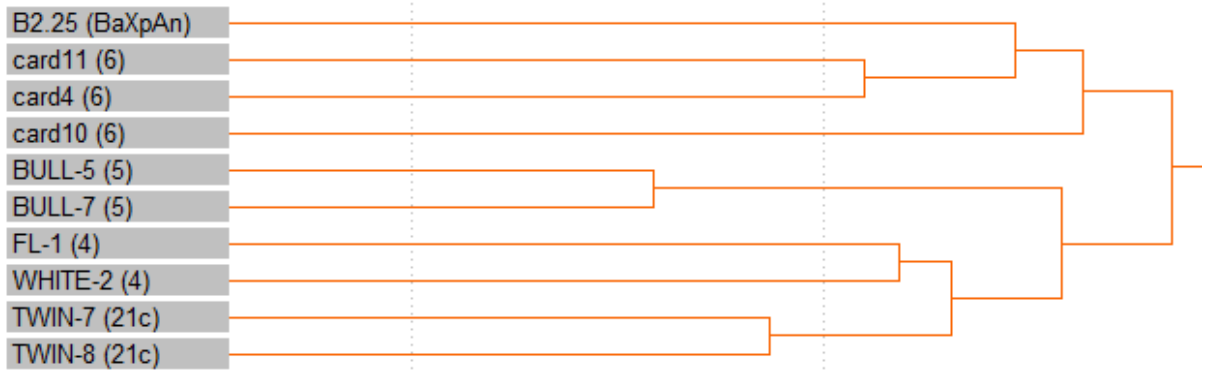
Dendrogram 1.2 – BaXpAn SSI B10



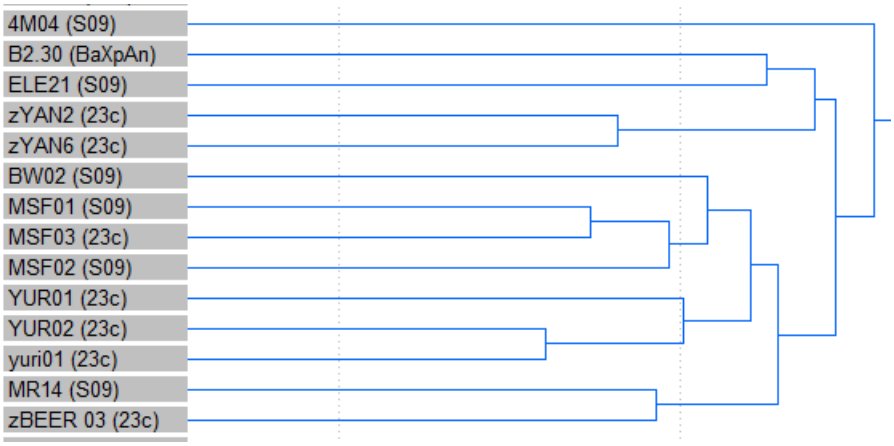
Dendrogram 1.3 – BaXpAn SSI B11



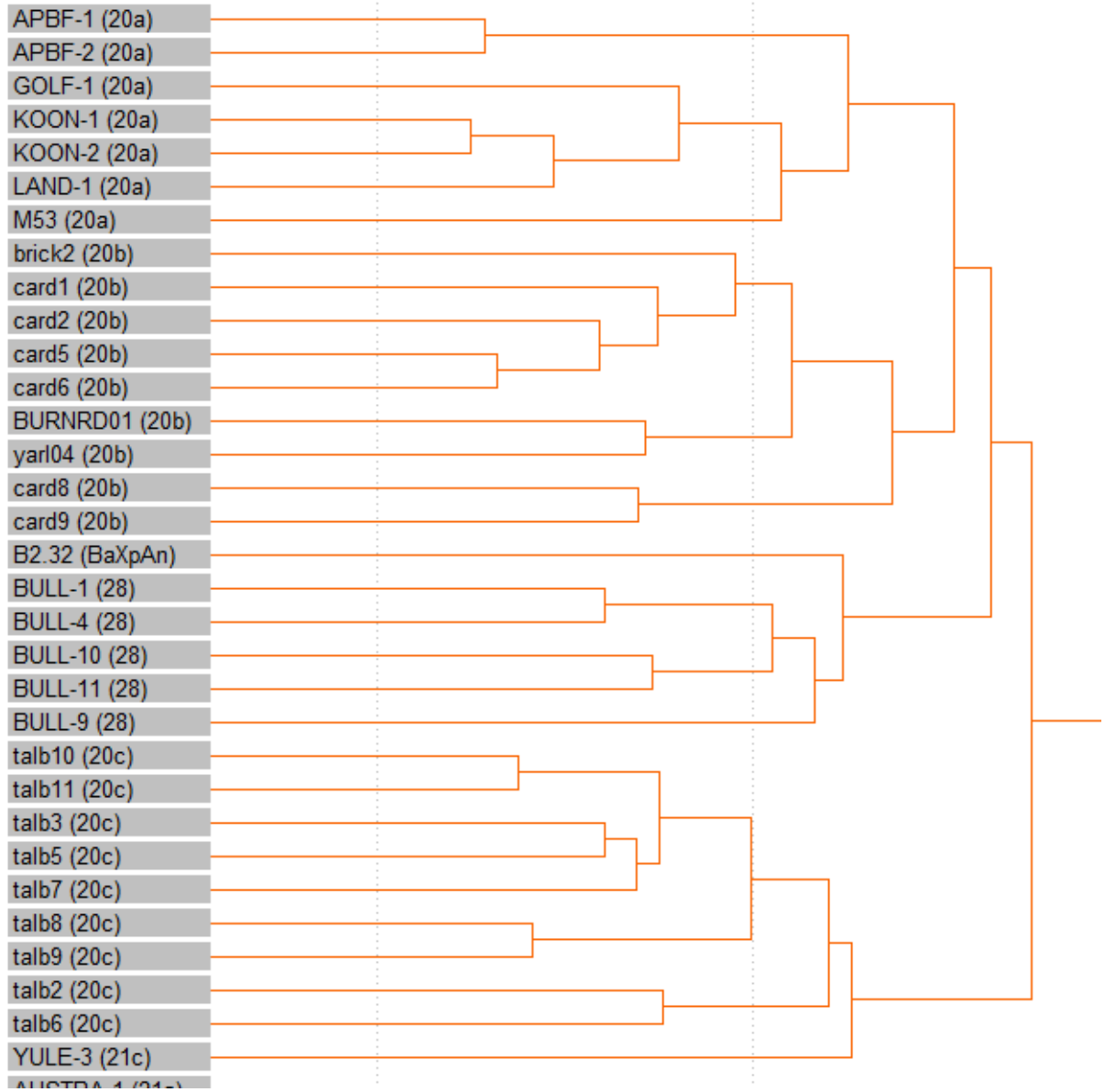
Dendrogram 1.4 – BaXpAn SSI B2.25



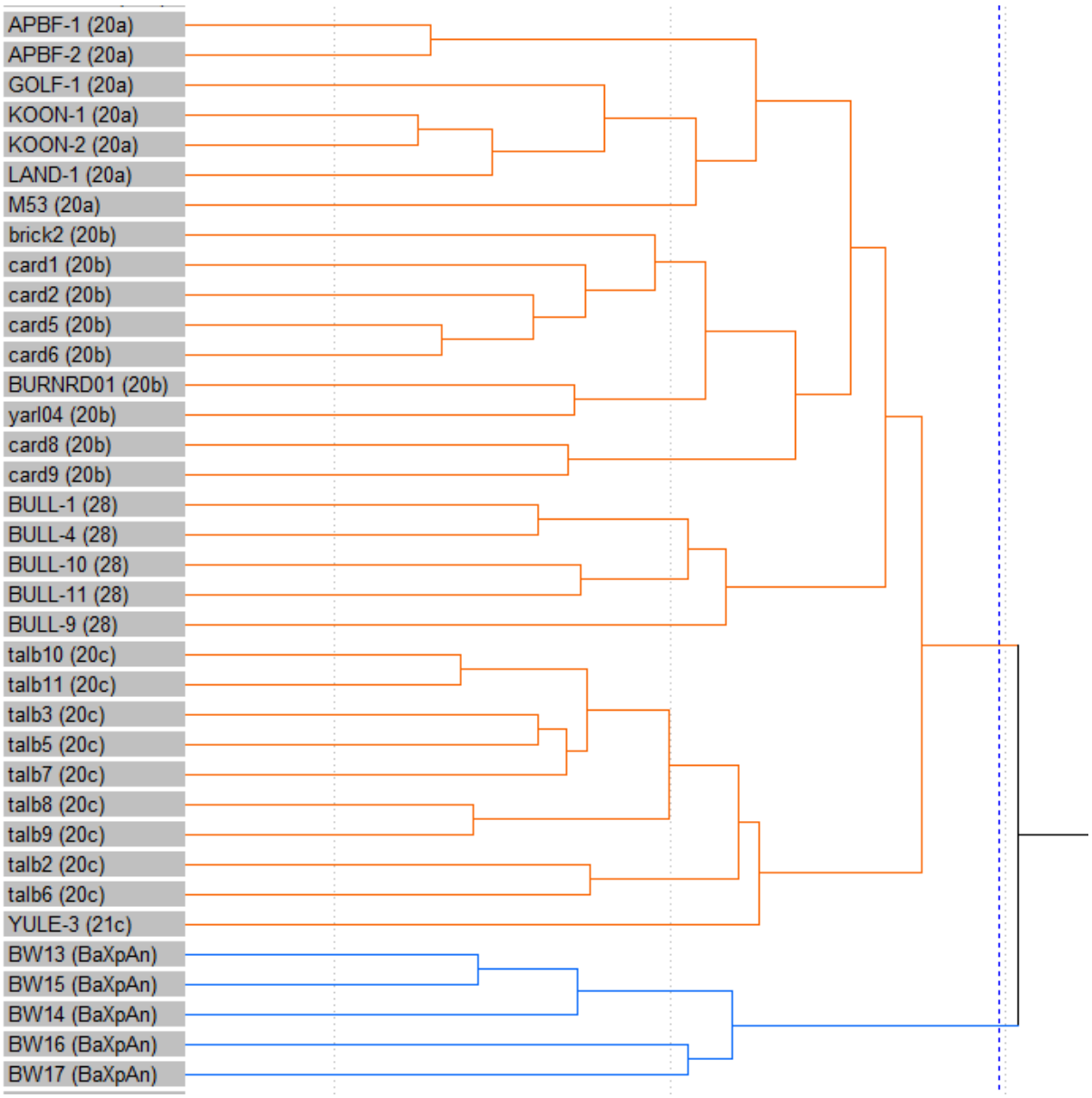
Dendrogram 1.5– BaXpAn SSI B2.30



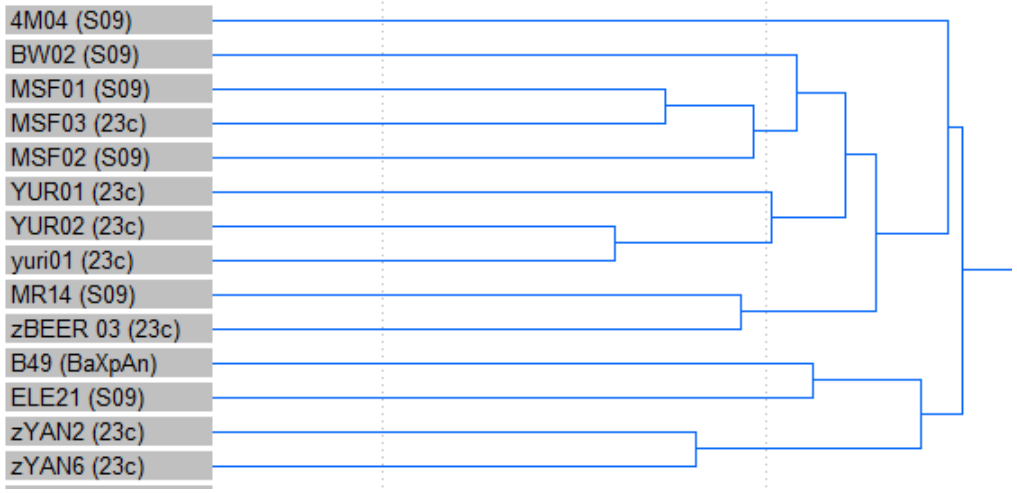
Dendrogram 1.6 – BaXpAn SSI B2.32



Dendrogram 2.1 – BaXpAn Batch 2

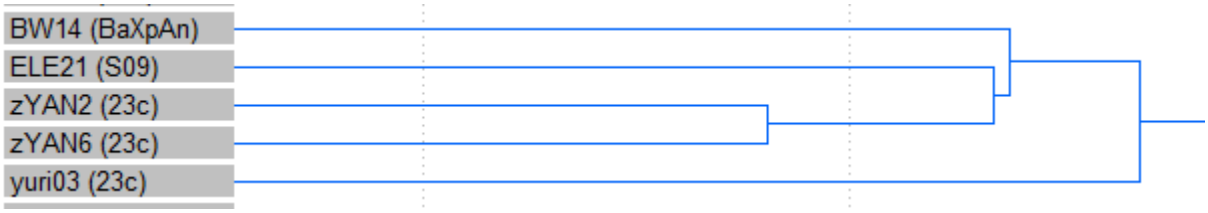


Dendrogram 2.2 – BaXpAn SSI B49



Dendrogram 2.3 – BaXpAn SSI BW13

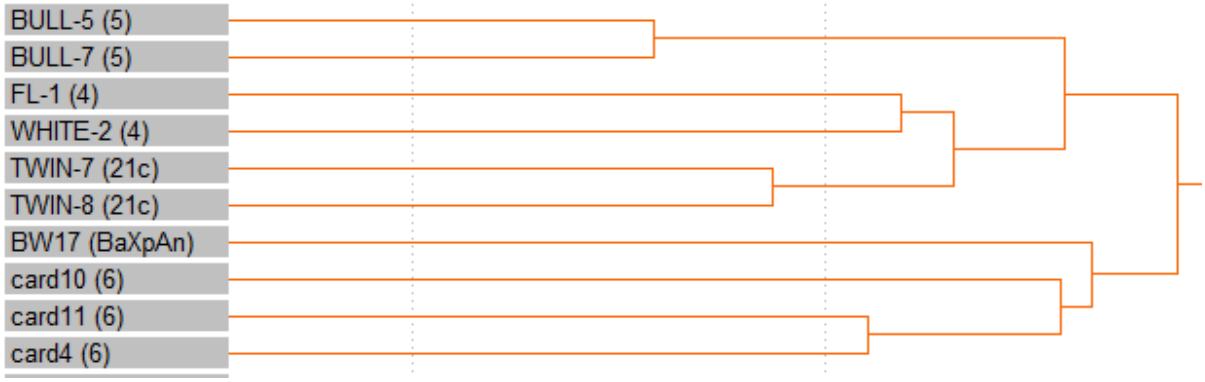
Dendrogram 2.4 – BaXpAn SSI BW14



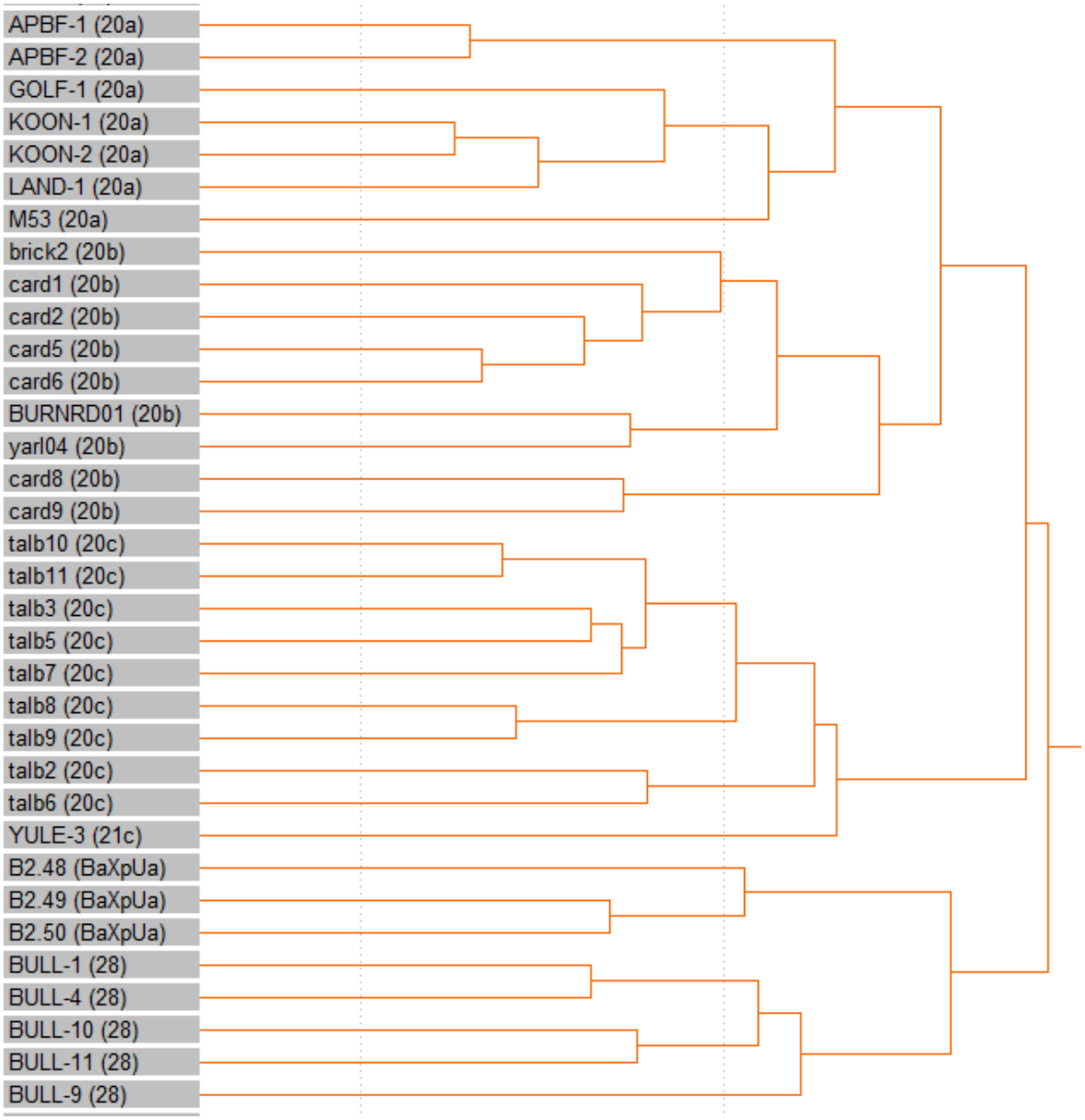
Dendrogram 2.5 – BaXpAn SSI BW15

Dendrogram 2.6 – BaXpAn SSI BW16

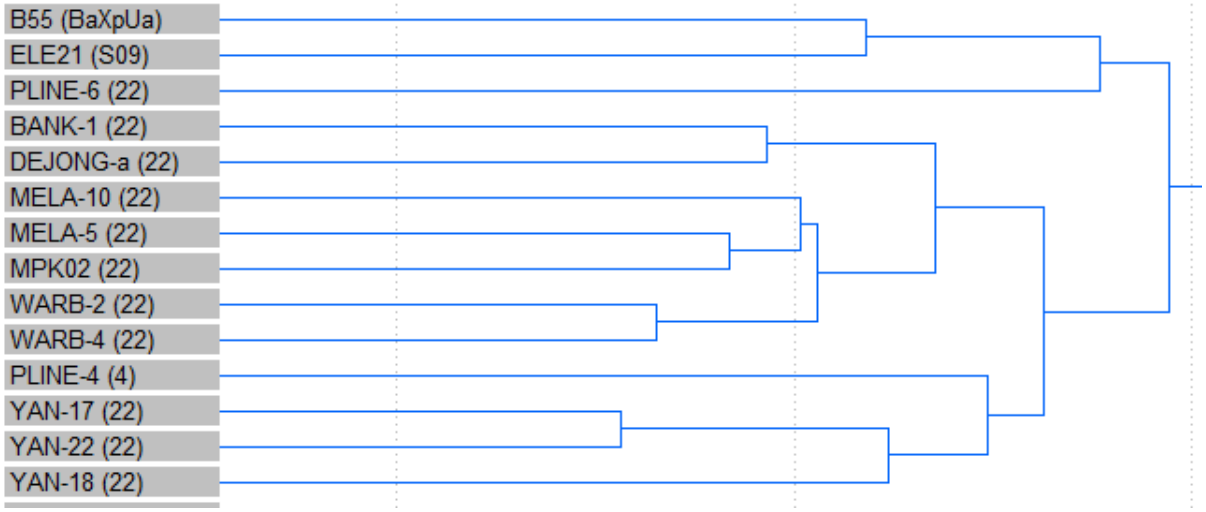
Dendrogram 2.7 – BaXpAn SSI BW17



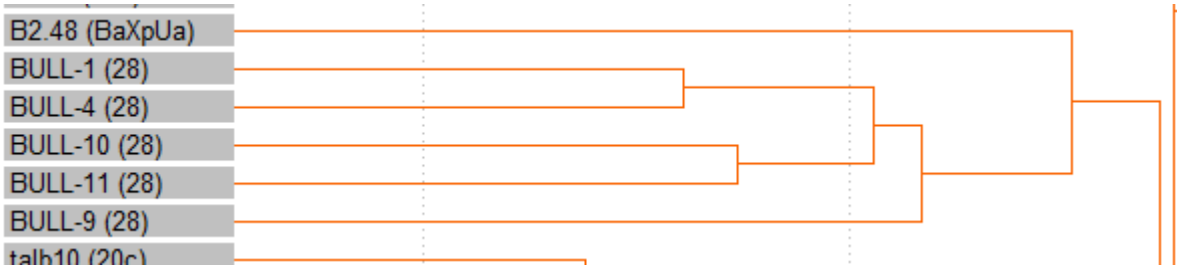
Dendrogram 3.1a – BaXpUa Batch 1



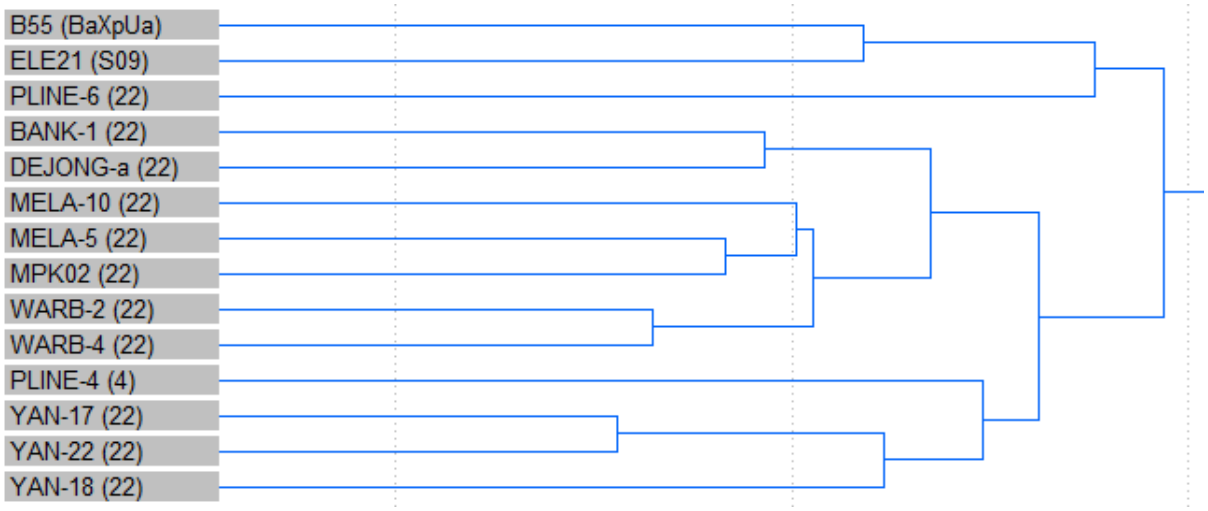
Dendrogram 3.1b – BaXpUa Batch 1



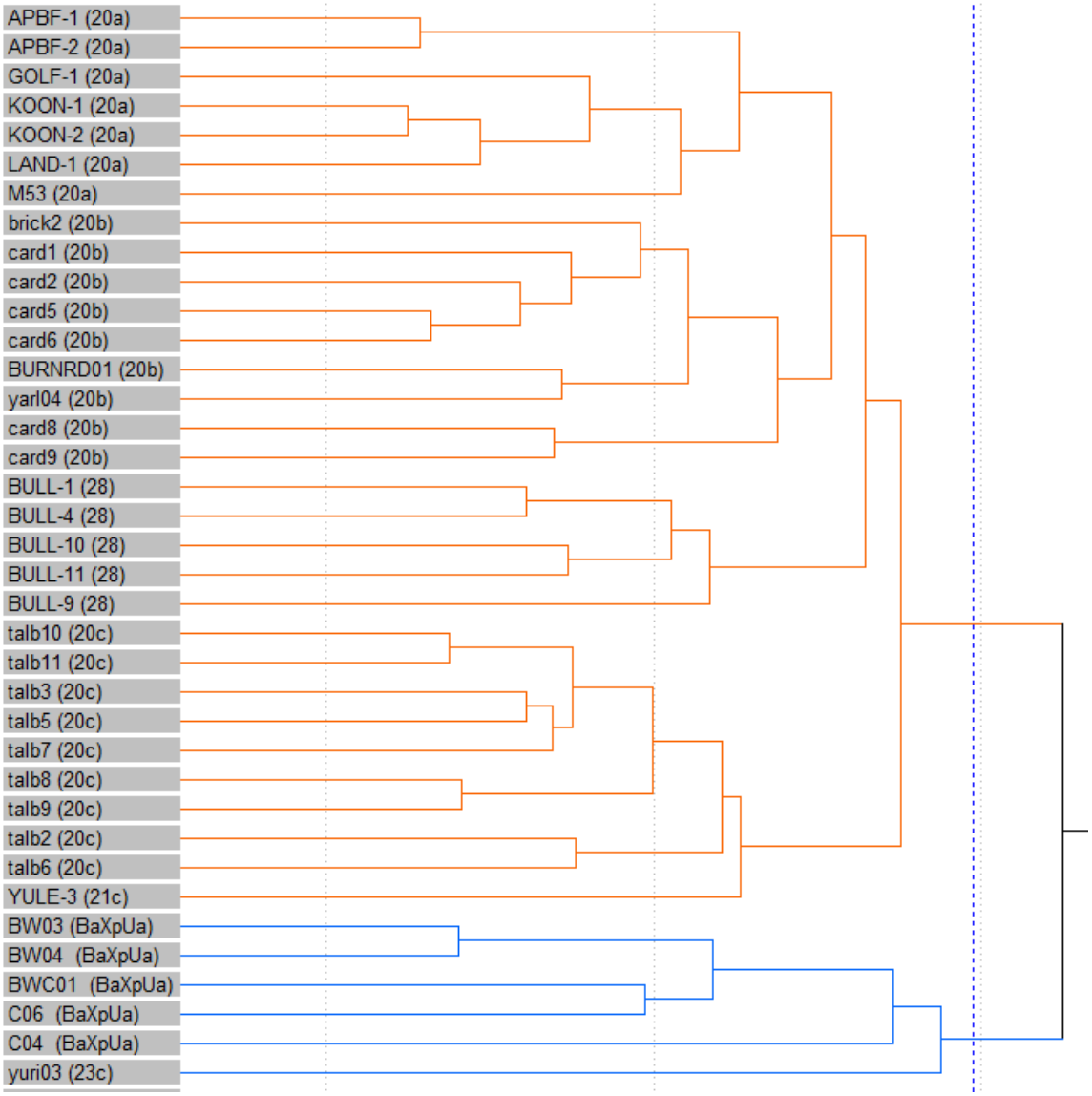
Dendrogram 3.2 – BaXpUa SSI B2.48



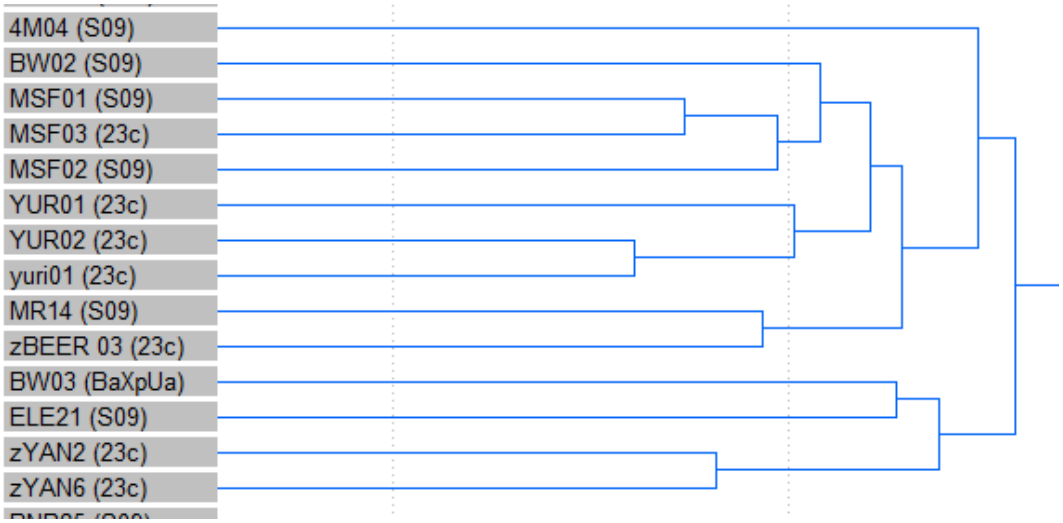
Dendrogram 3.3 – BaXpUa SSI B55



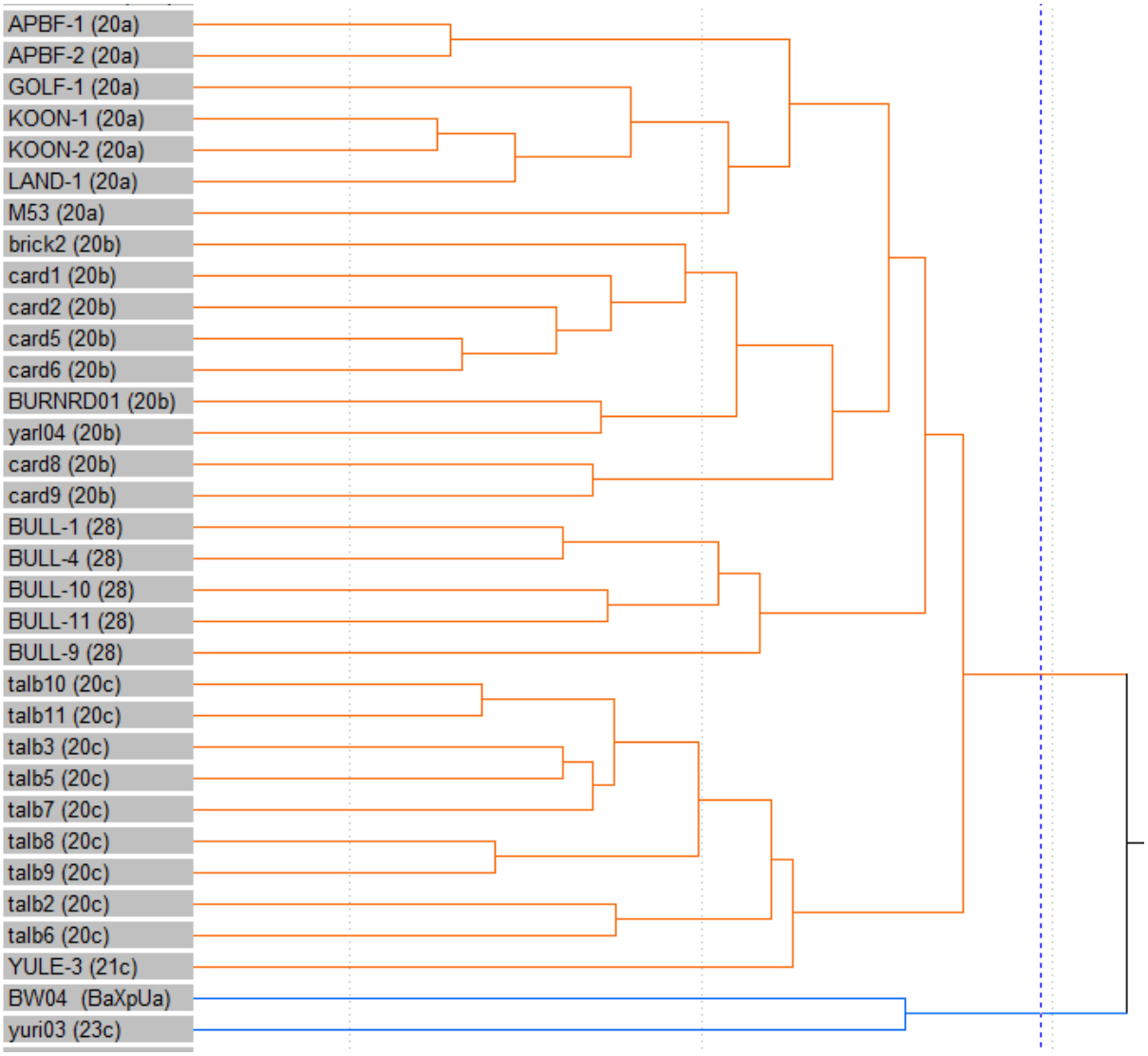
Dendrogram 4.1 – BaXpUa Batch 2



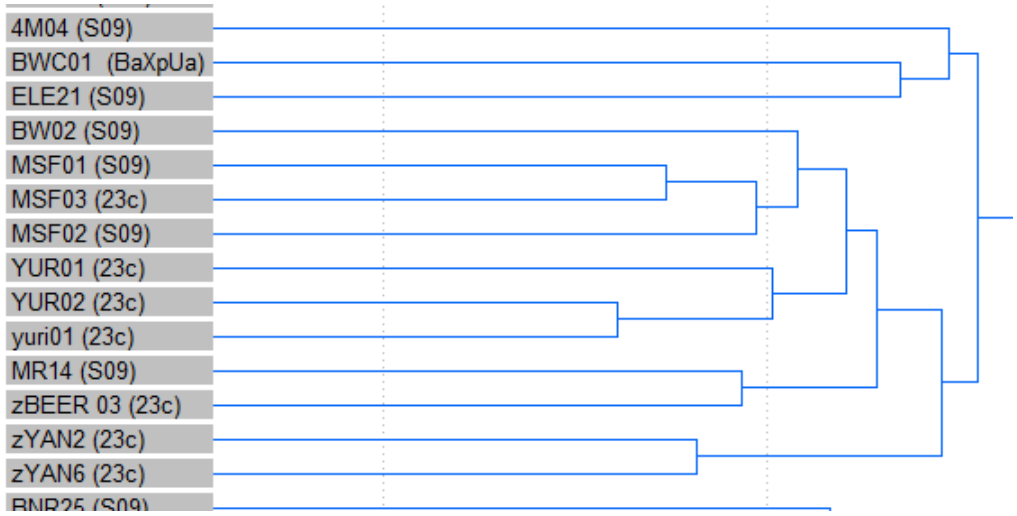
Dendrogram 4.2 – BaXpUa SSI BW03



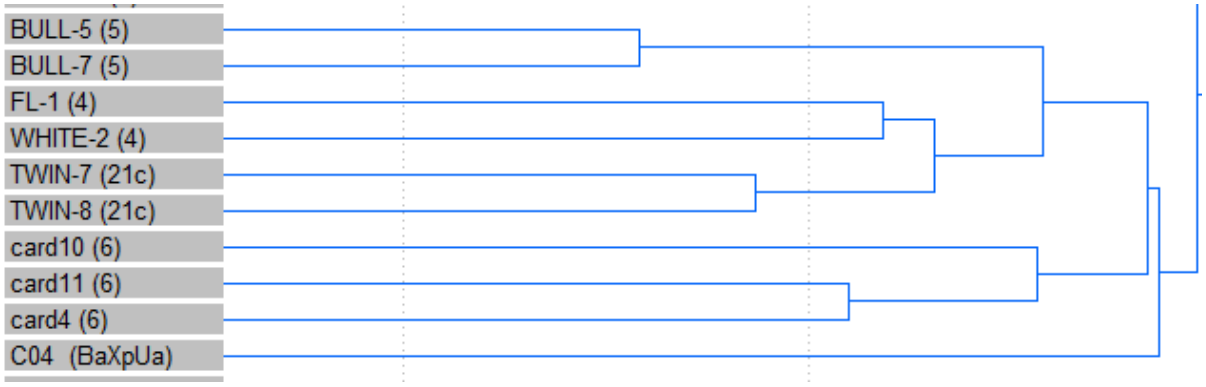
Dendrogram 4.3 – BaXpUa SSI BW04



Dendrogram 4.4 – BaXpUa SSI BWC01

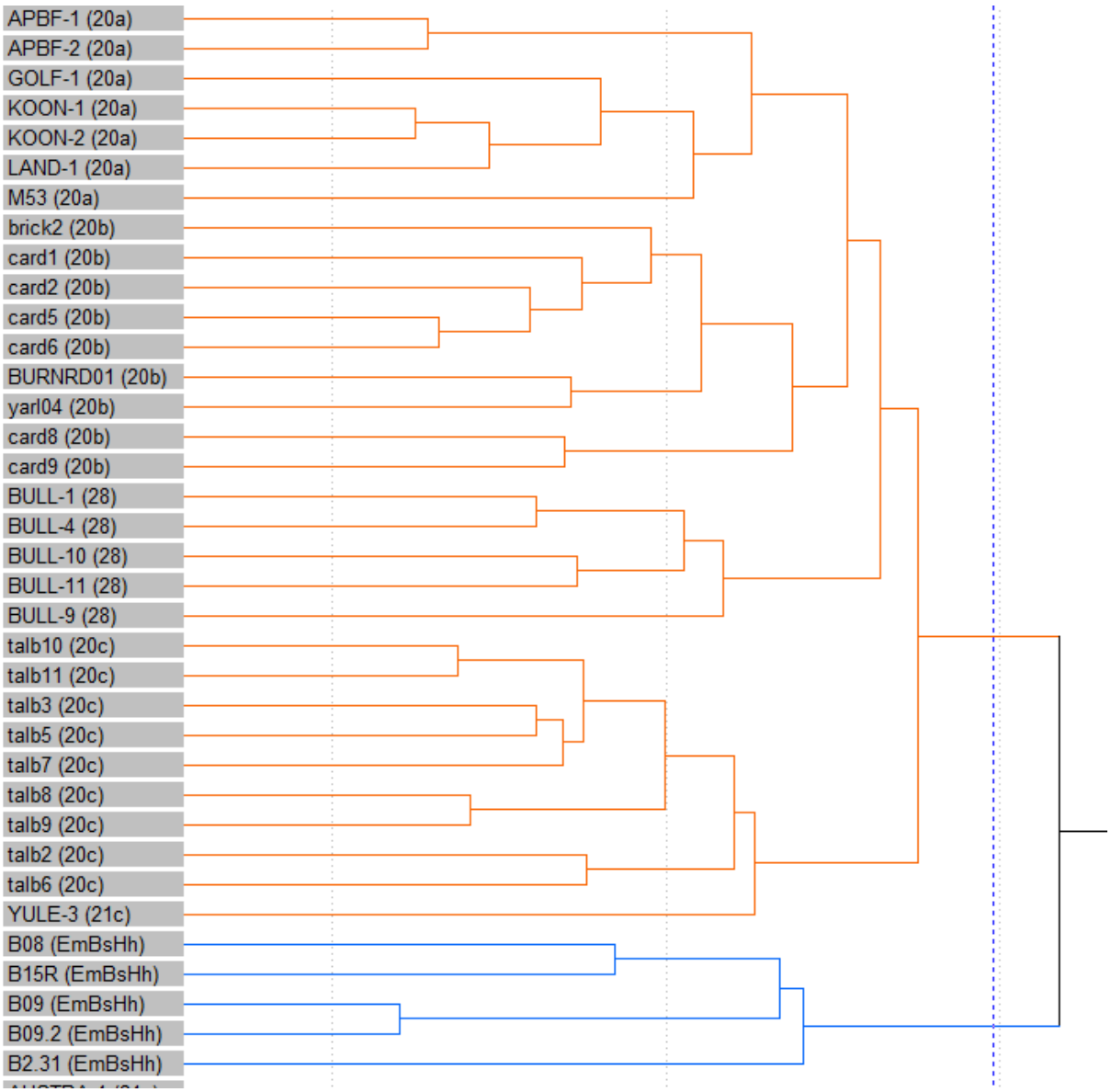


Dendrogram 4.5 – BaXpUa SSI C04

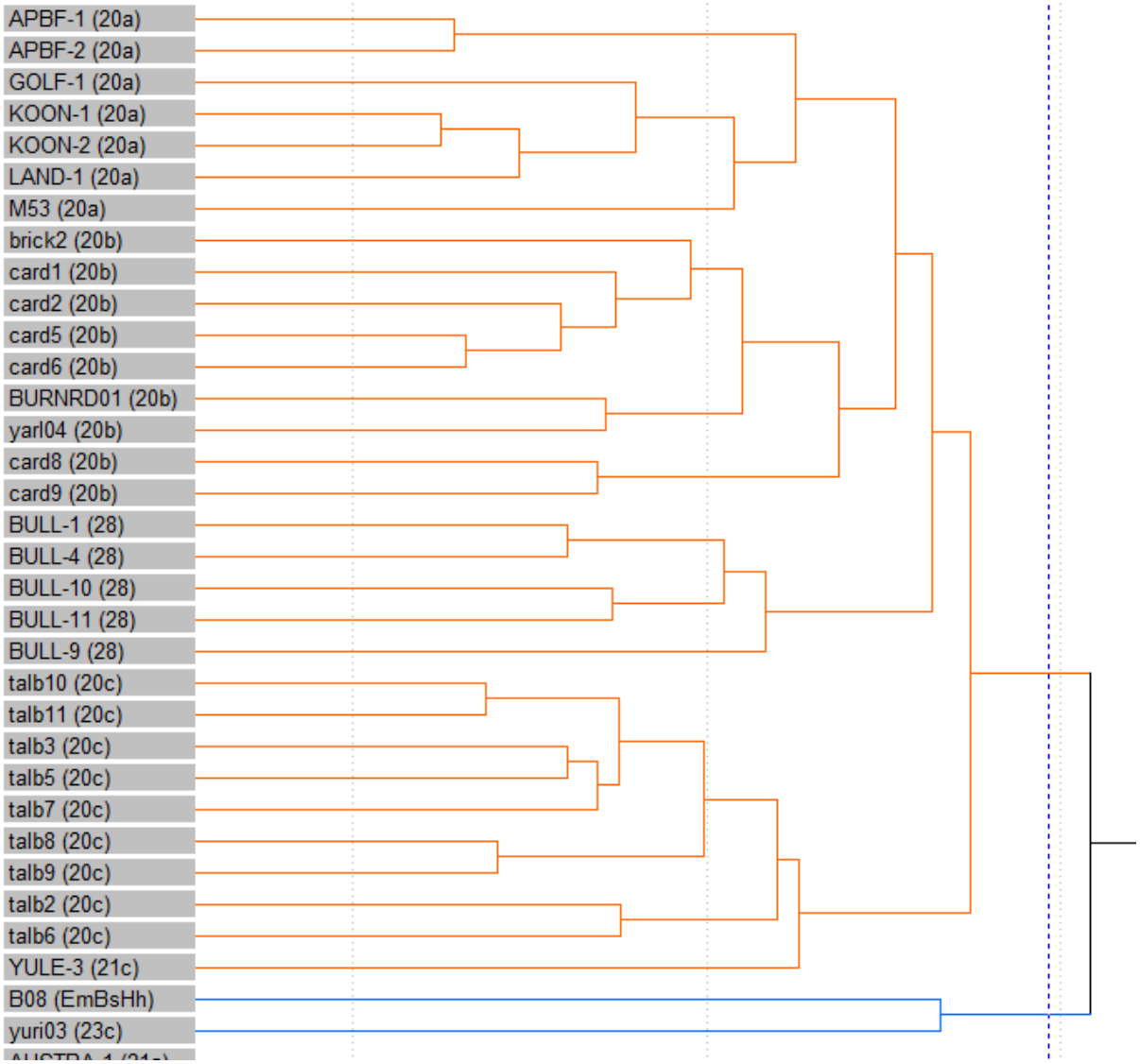


Dendrogram 4.6 – BaXpUa SSI C06

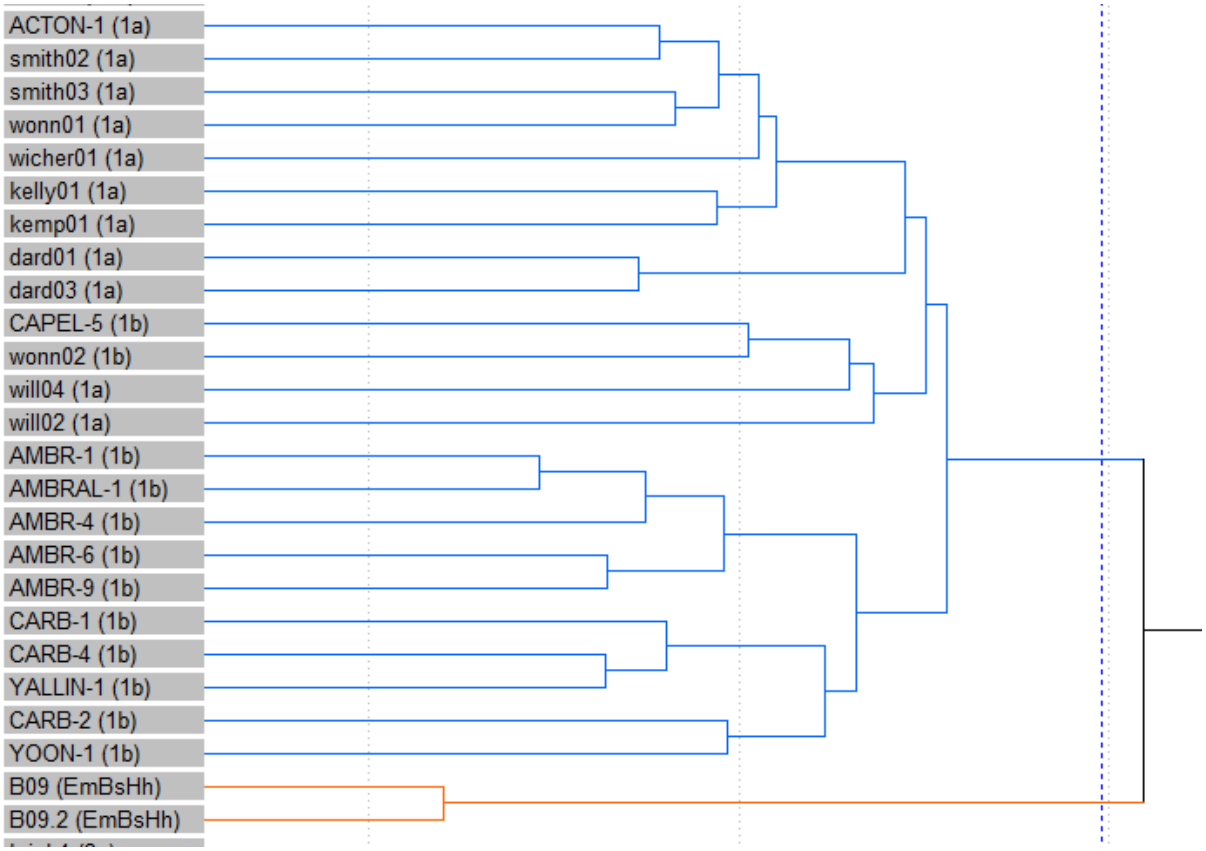
Dendrogram 5.1 – EmBsHh Batch 1



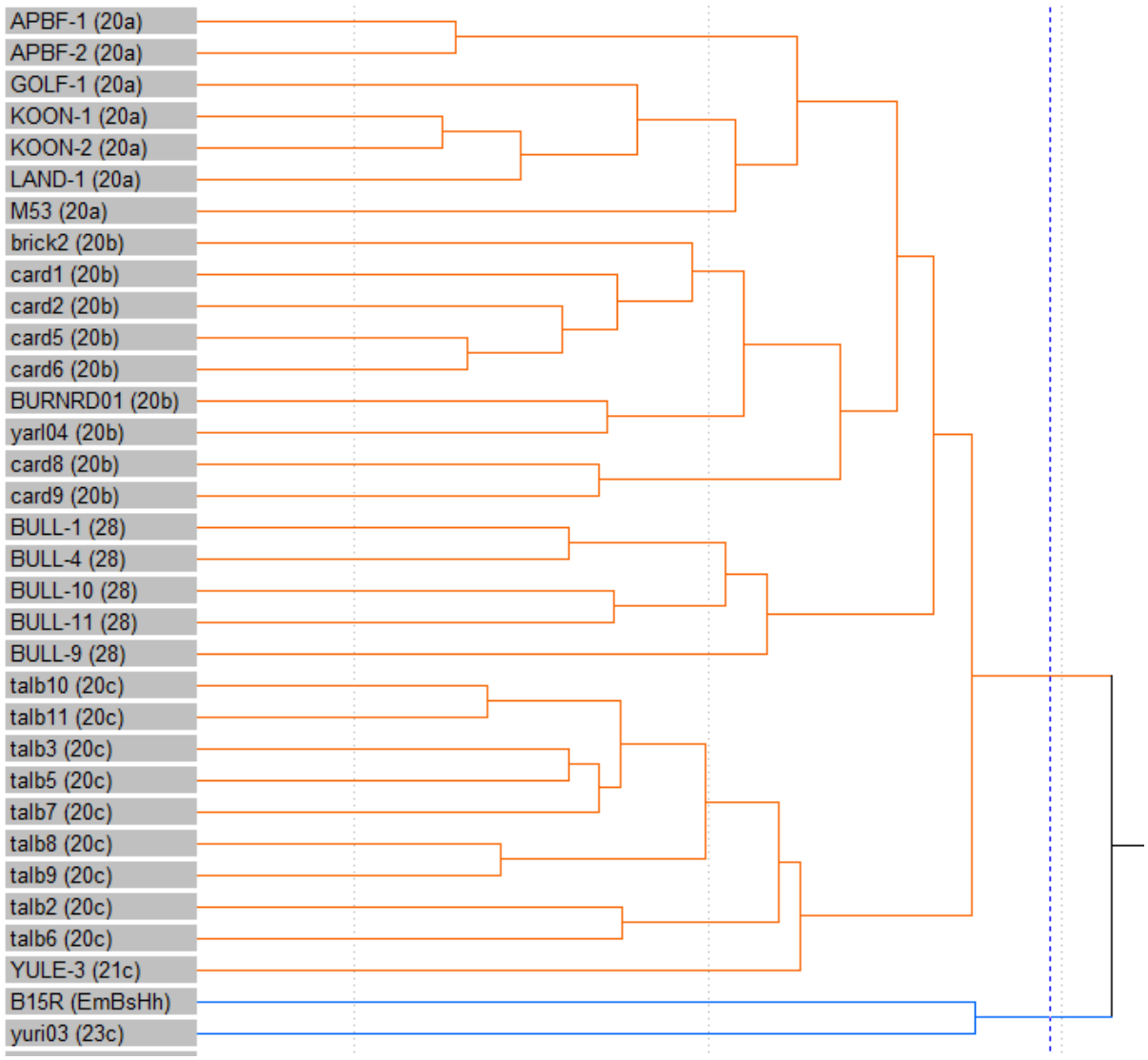
Dendrogram 5.2 – EmBsHh SSI B08



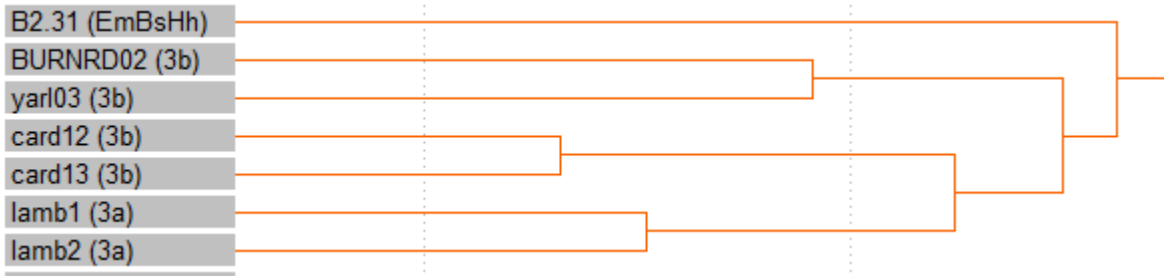
Dendrogram 5.3 – EmBsHh SSI B09



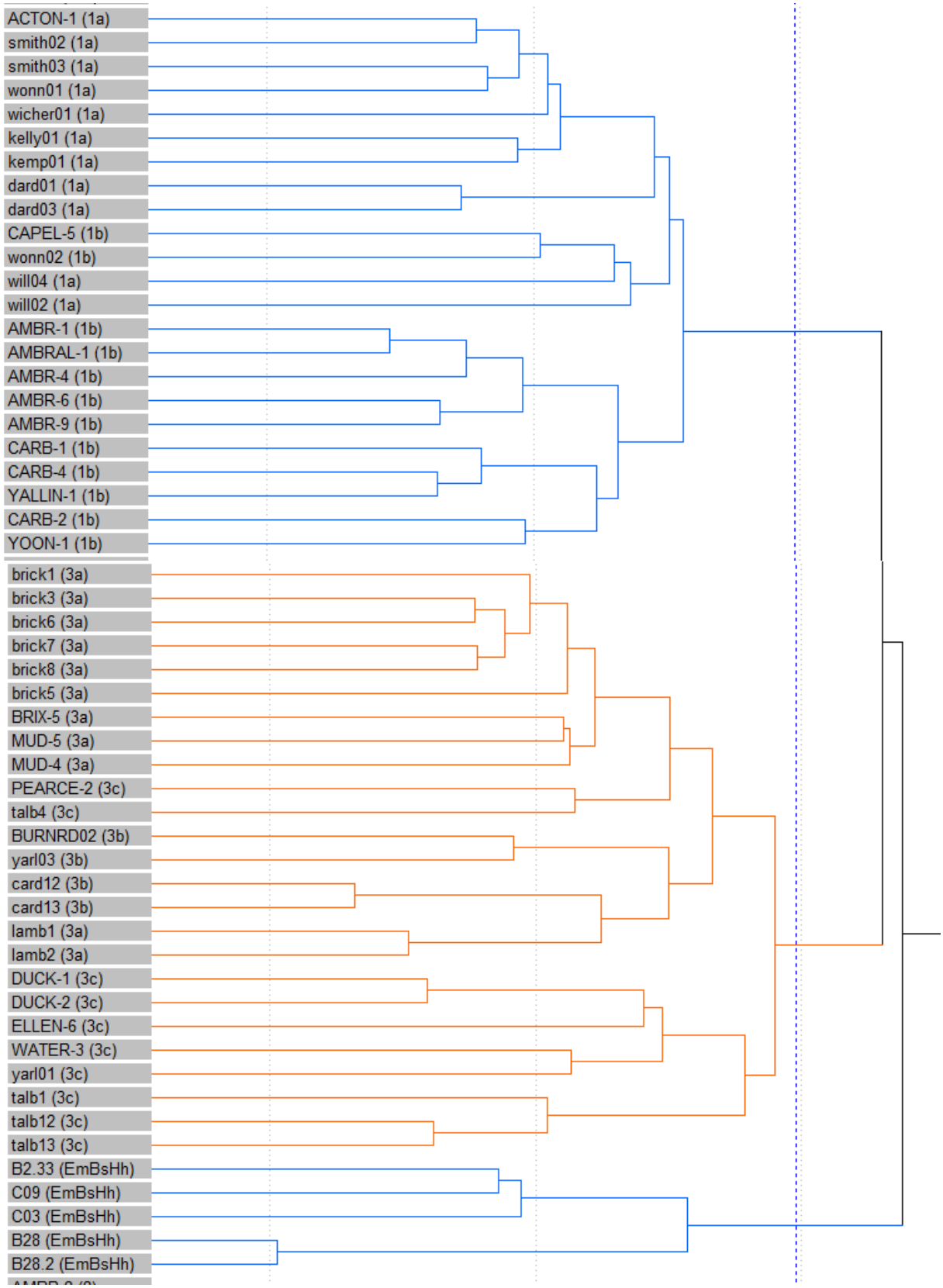
Dendrogram 5.4 – EmBsHh SSI B15(R)



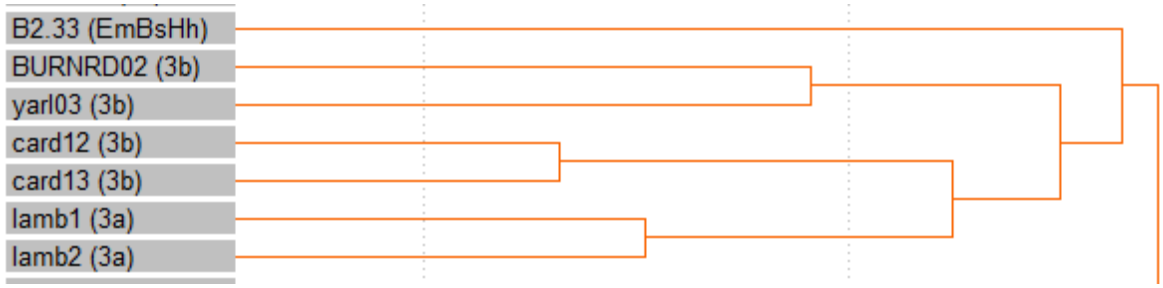
Dendrogram 5.5 – EmBsHh SSI B2.31



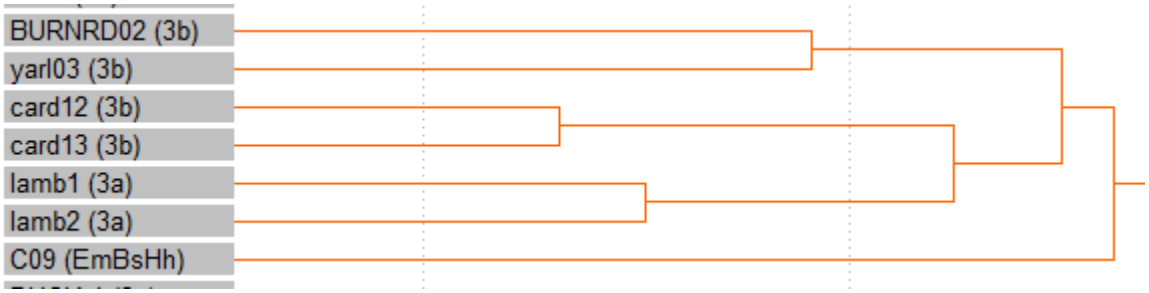
Dendrogram 6.1 – EmBsHh Batch 2



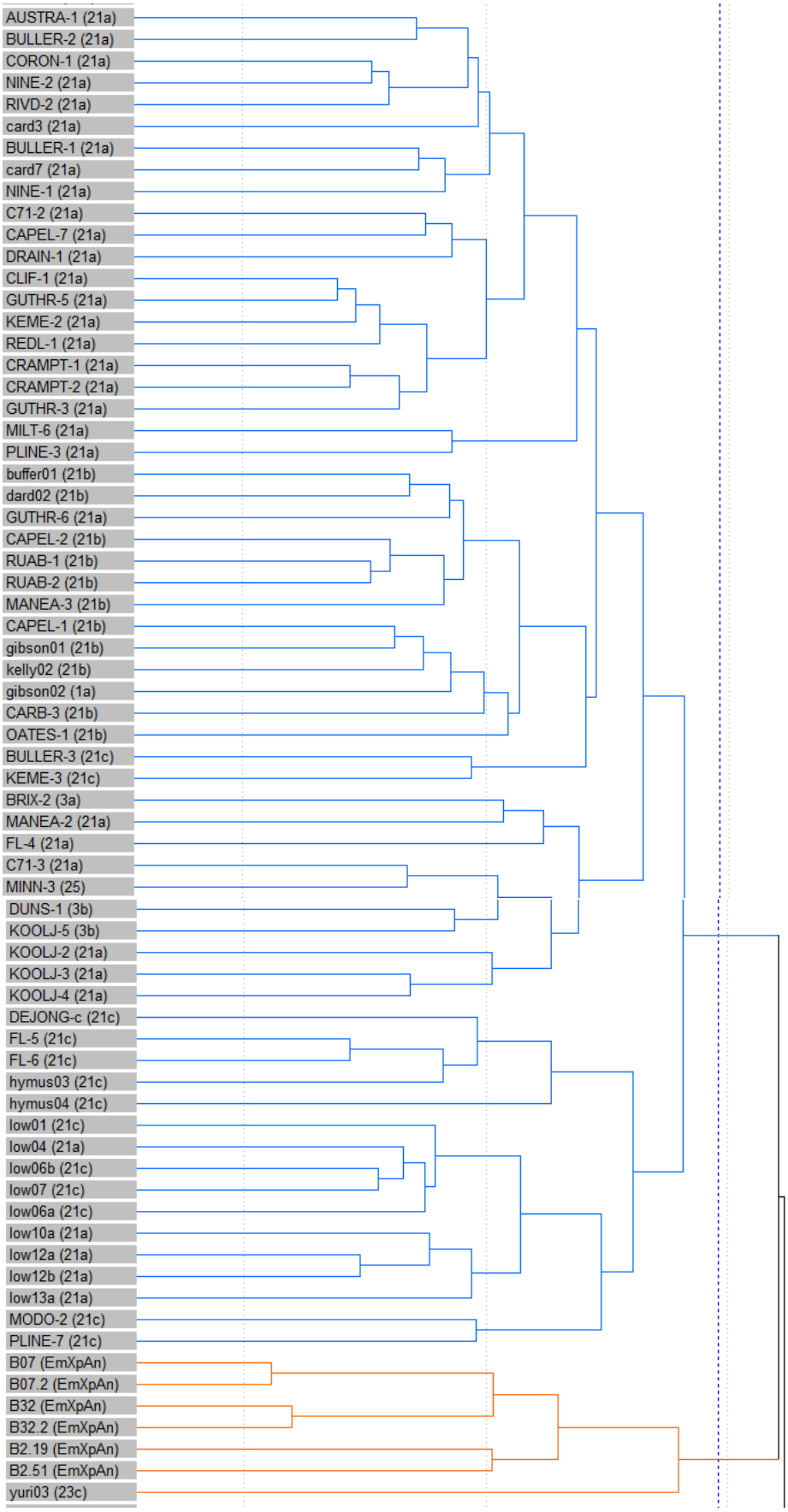
Dendrogram 6.2 – EmBsHh SSI B2.33



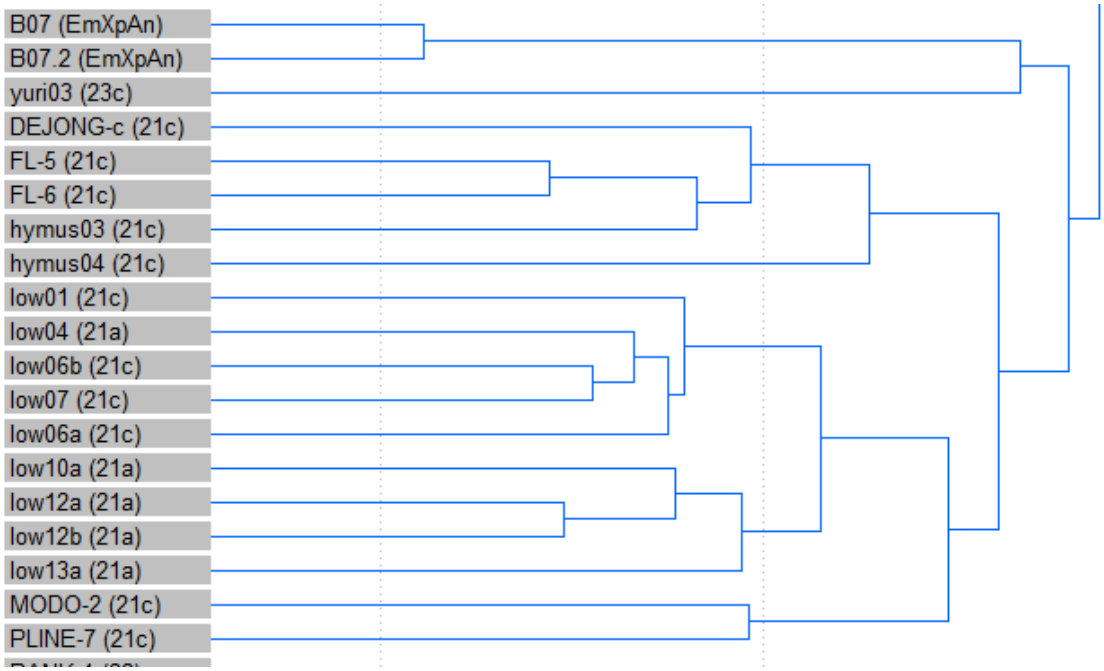
Dendrogram 6.3 – EmBsHh SSI C09



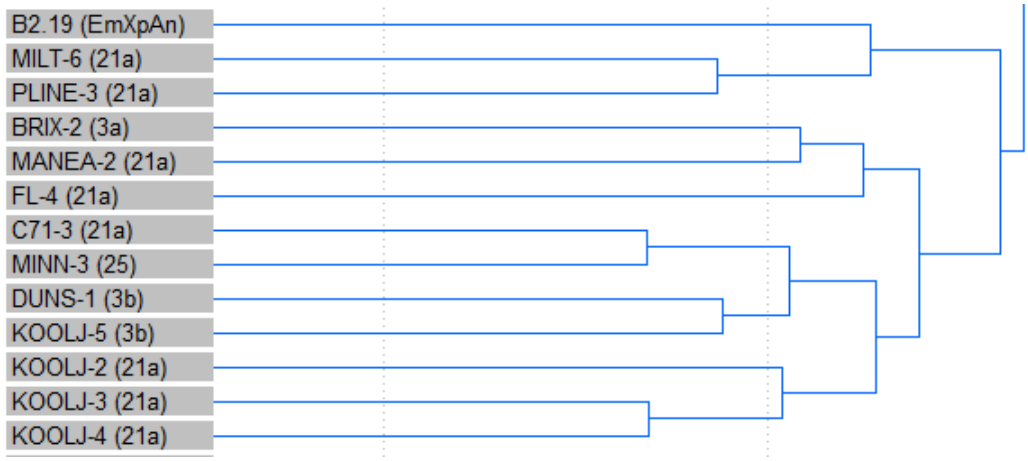
Dendrogram 7.1 – EmXpAn Batch 1



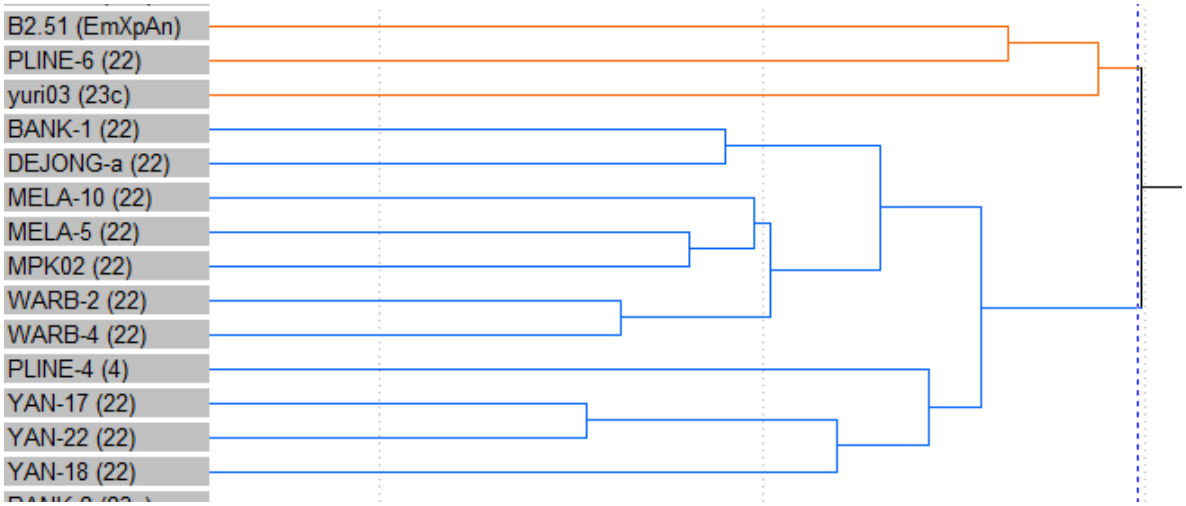
Dendrogram 7.2 – EmXpAn SSI B07



Dendrogram 7.3 – EmXpAn SSI B2.19

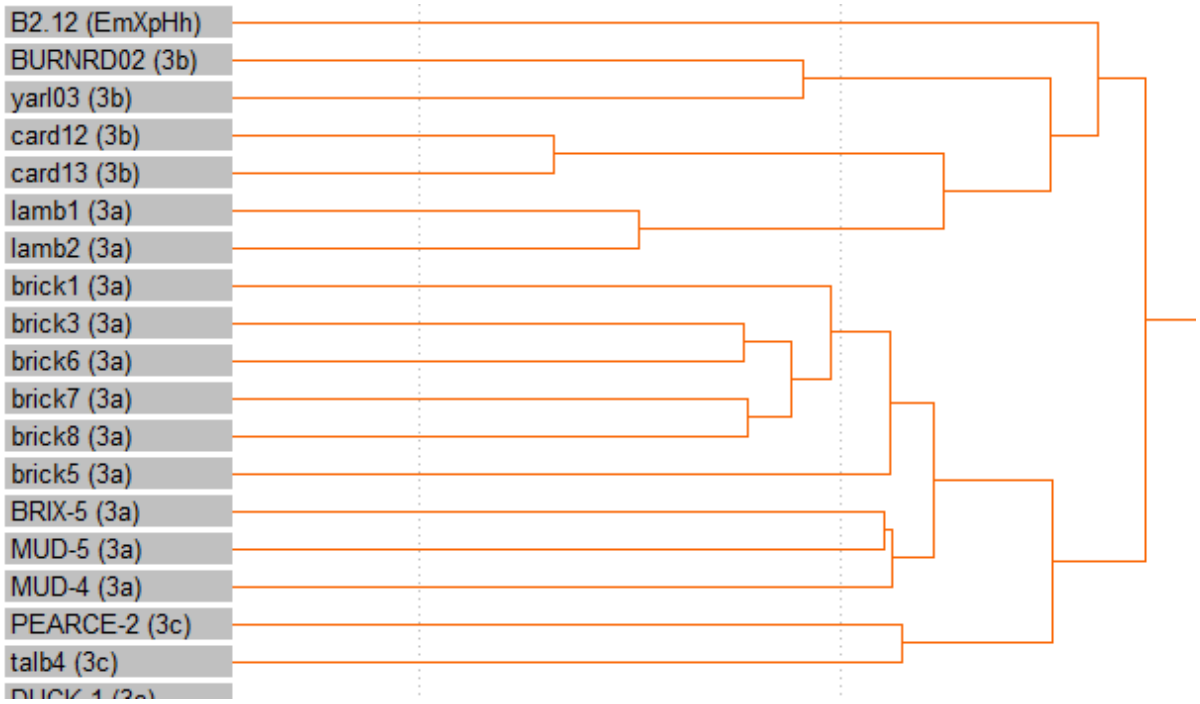


Dendrogram 7.4 – EmXpAn SSI B2.51

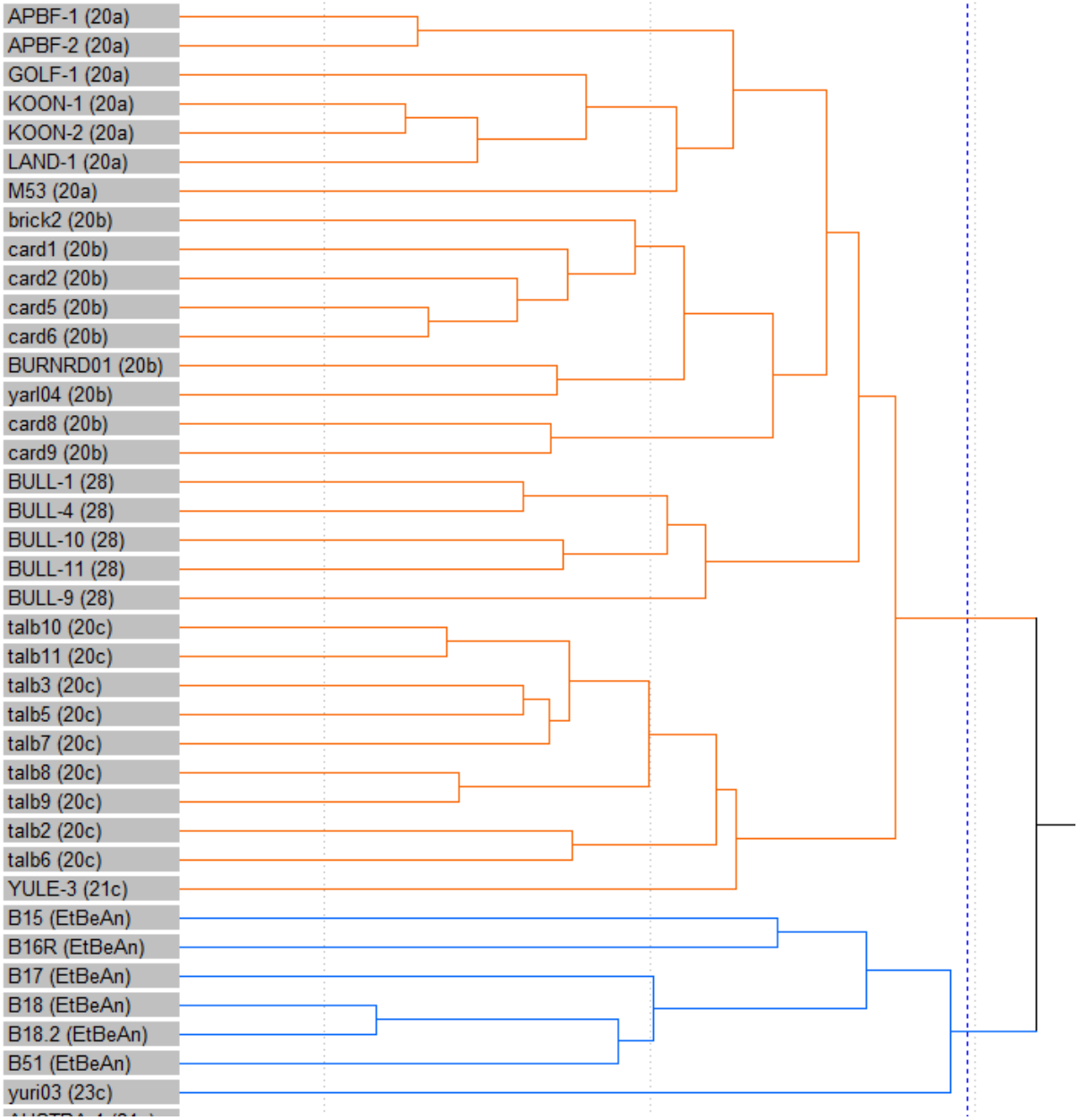


Dendrogram 7.5 – EmXpAn SSI B32 and B32.2

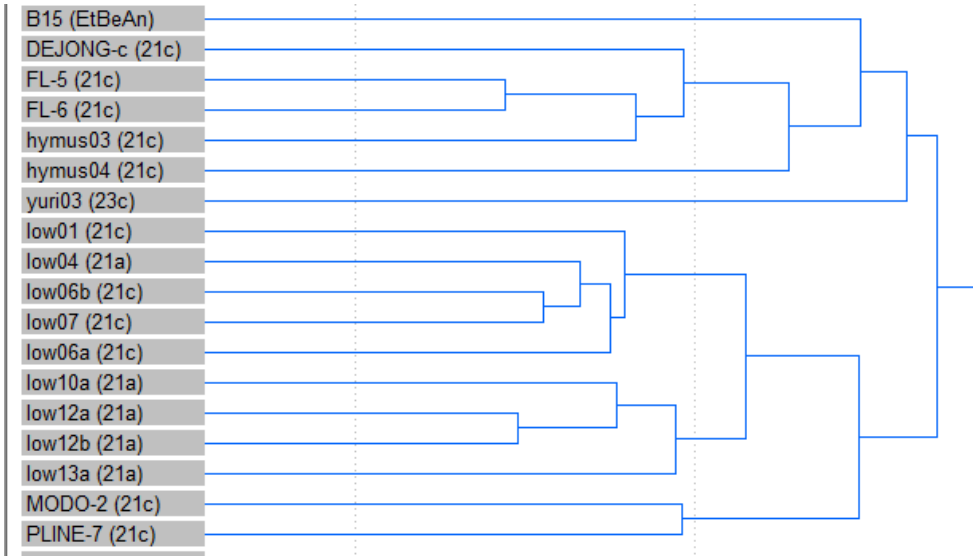
Dendrogram 8.1 – EmXpHh SSI B2.12



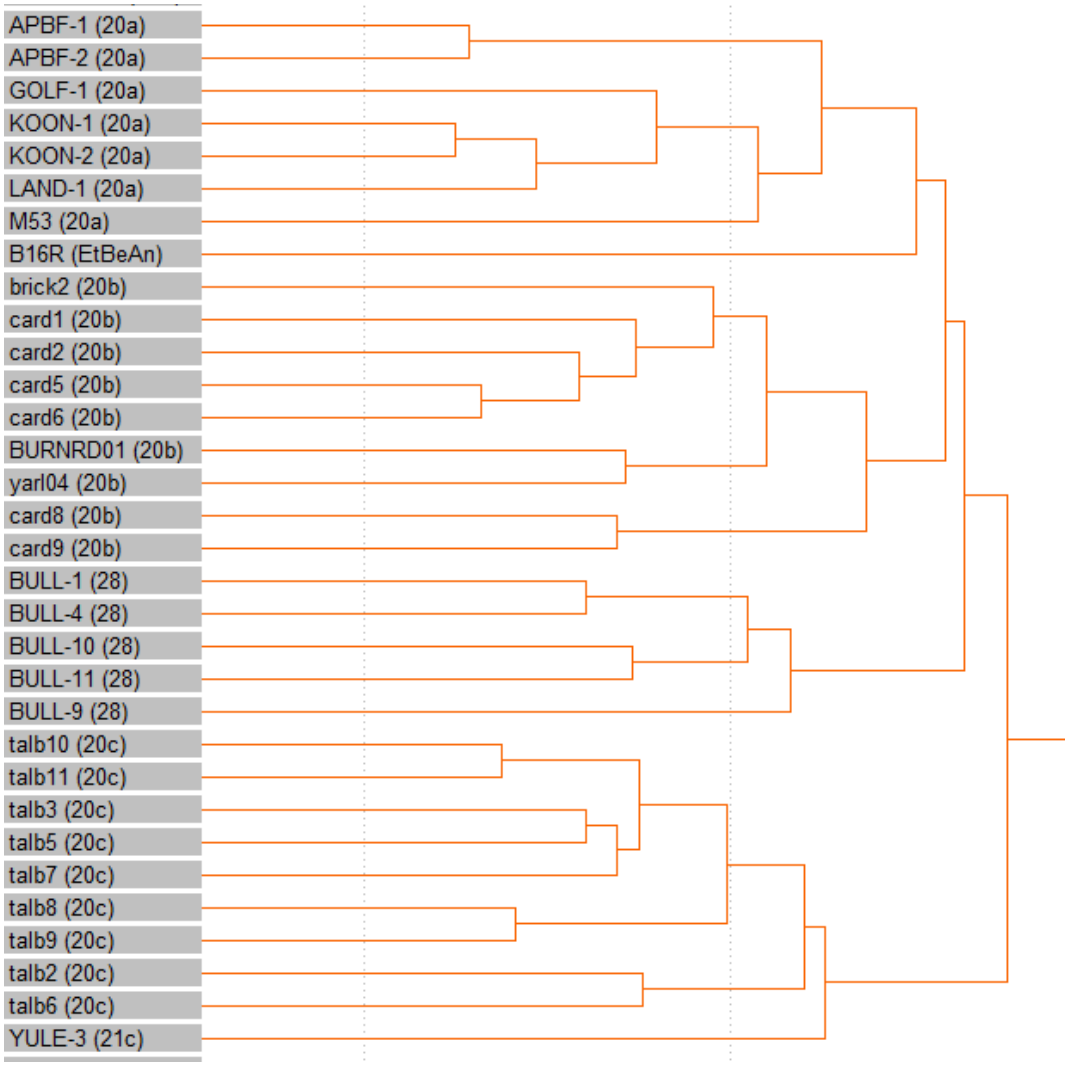
Dendrogram 9.1 – EtBeAn Batch 1



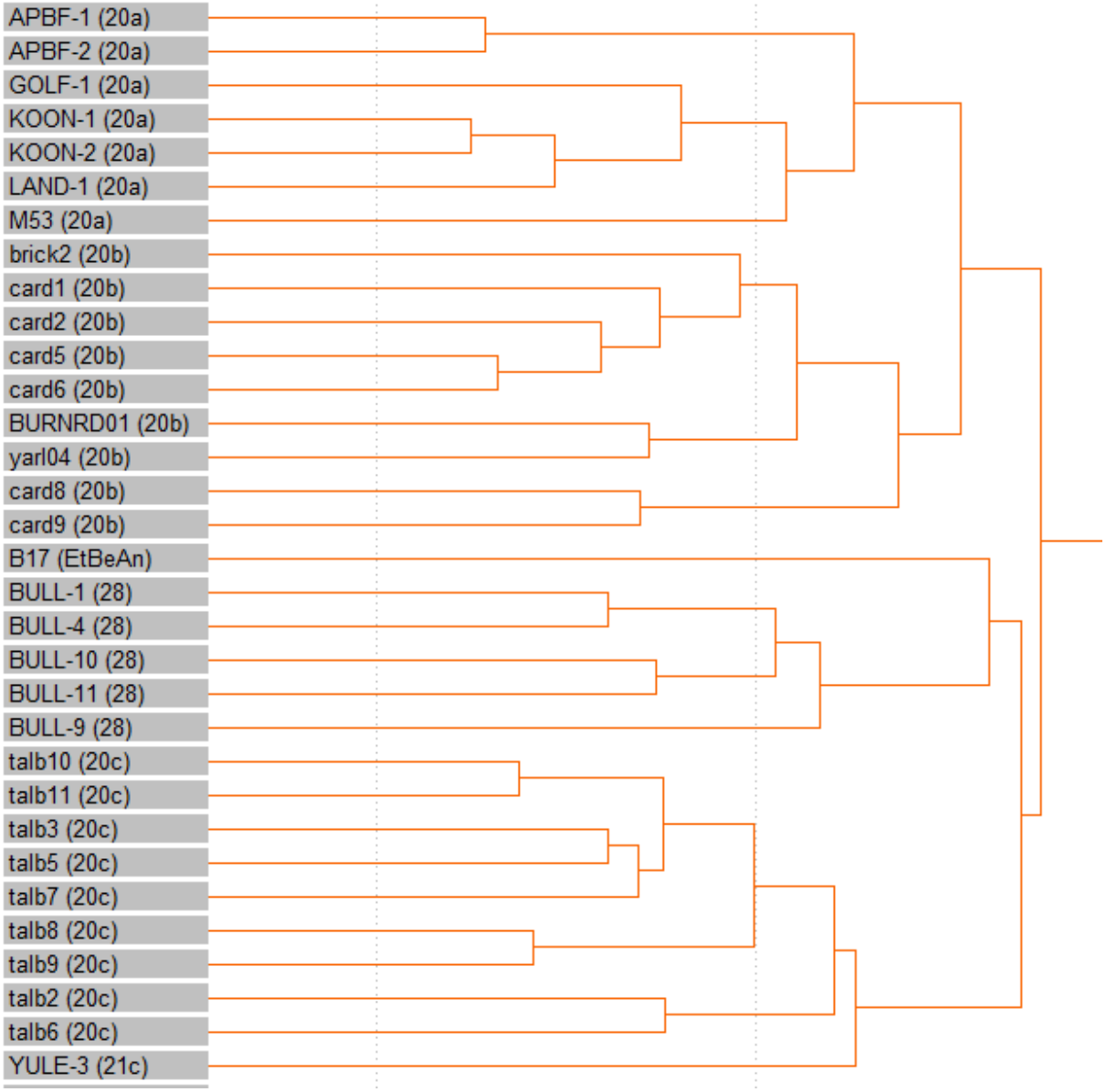
Dendrogram 9.2 – EtBeAn SSI B15



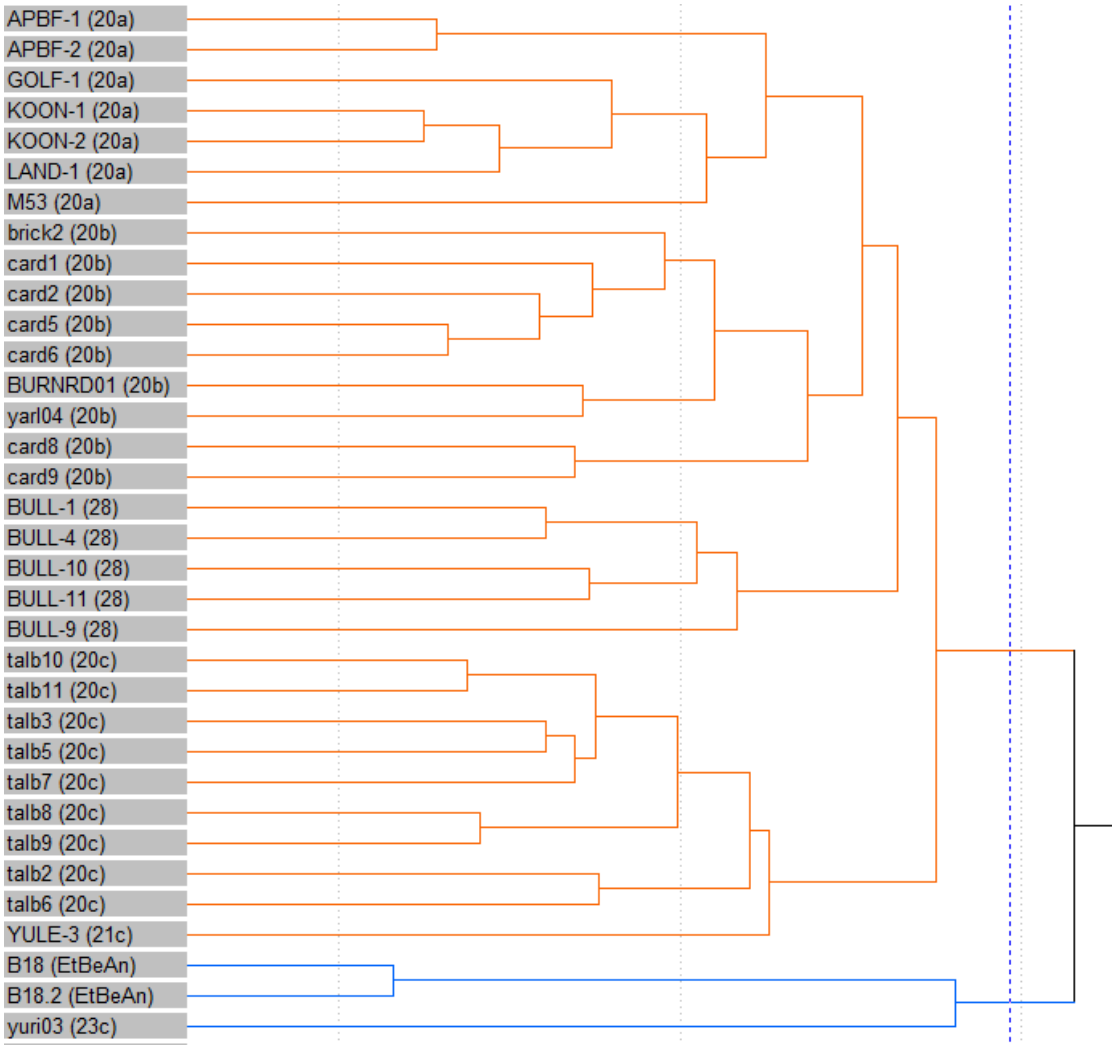
Dendrogram 9.3 – EtBeAn SSI B16R



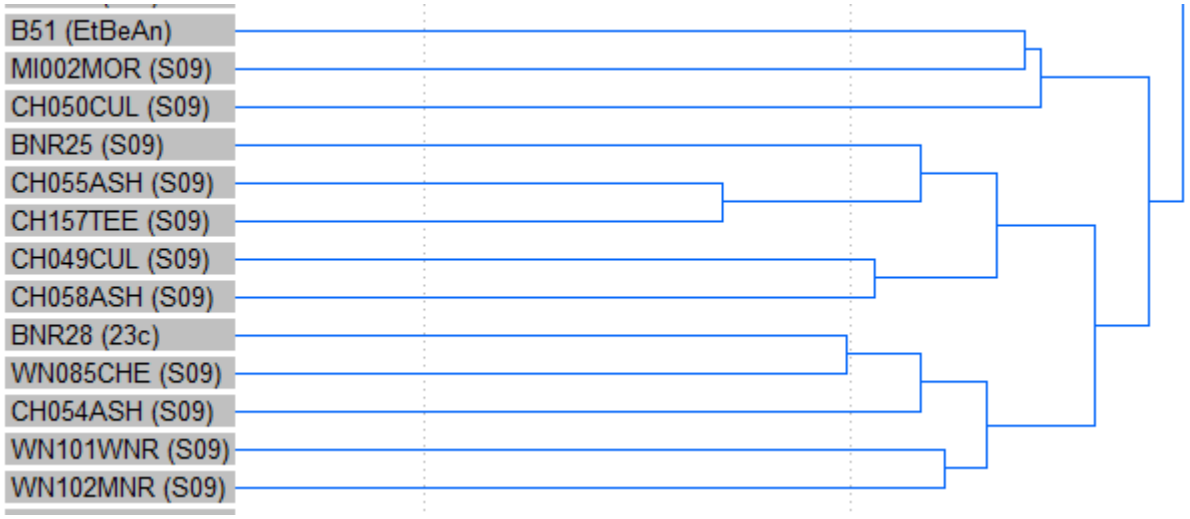
Dendrogram 9.4 – EtBeAn SSI B17



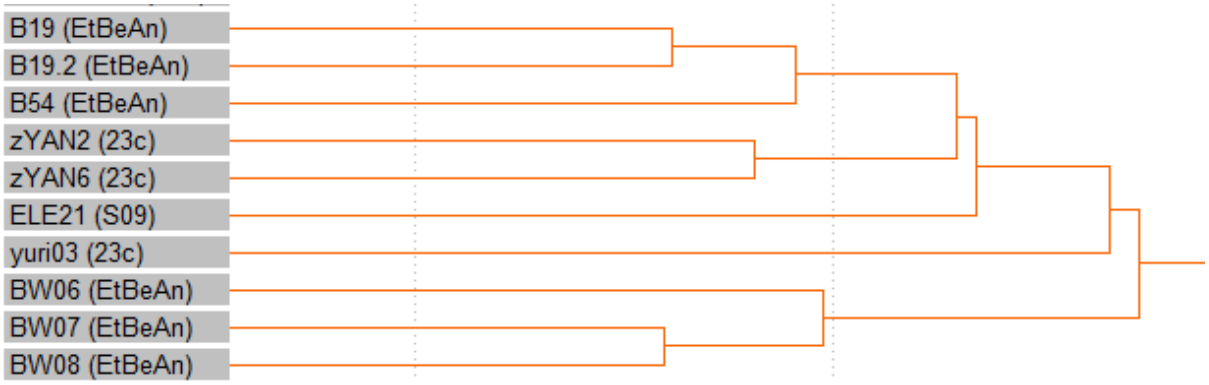
Dendrogram 9.5 – EtBeAn SSI B18



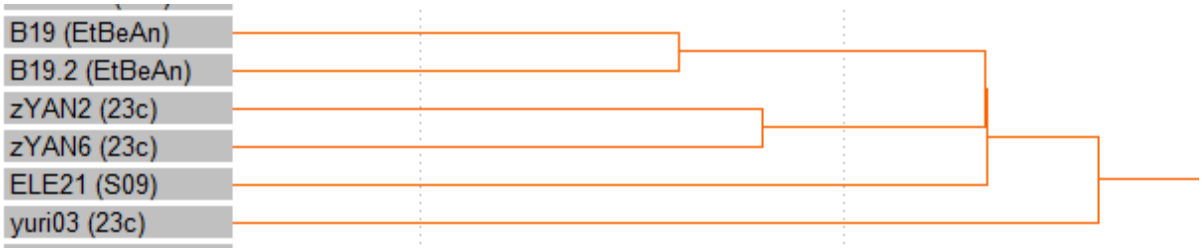
Dendrogram 9.6 – EtBeAn SSI B51



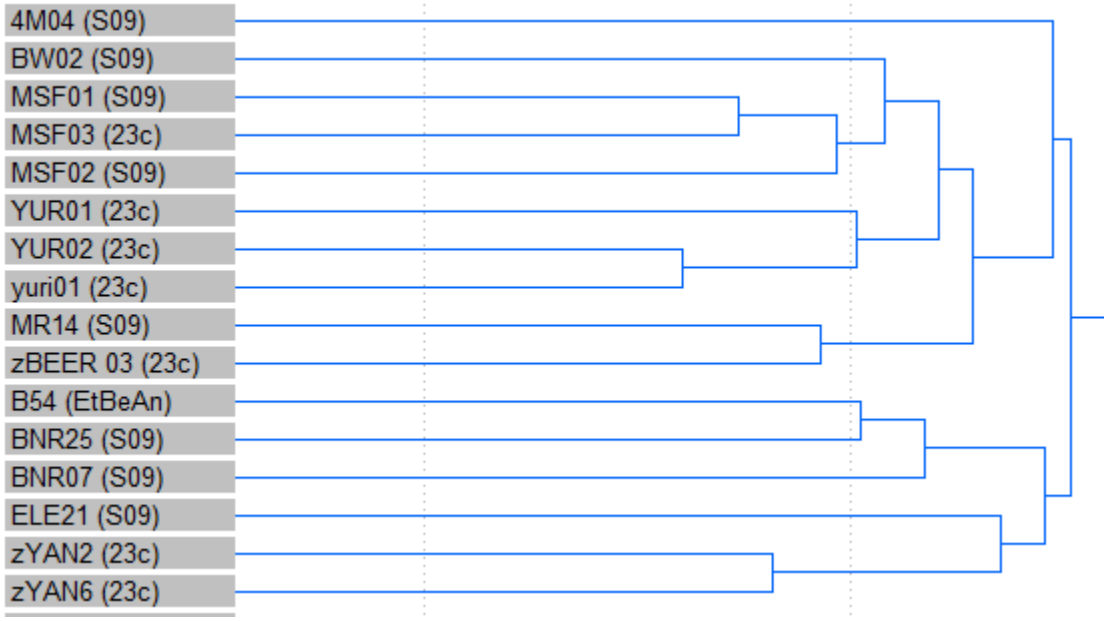
Dendrogram 10.1 – EtBeAn Batch 2



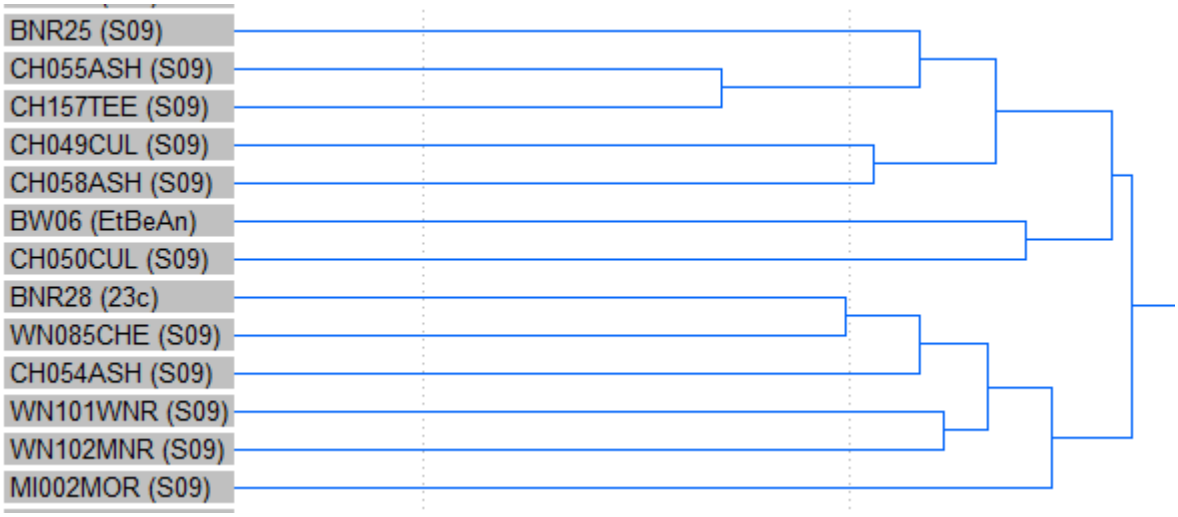
Dendrogram 10.2 – EtBeAn SSI B19



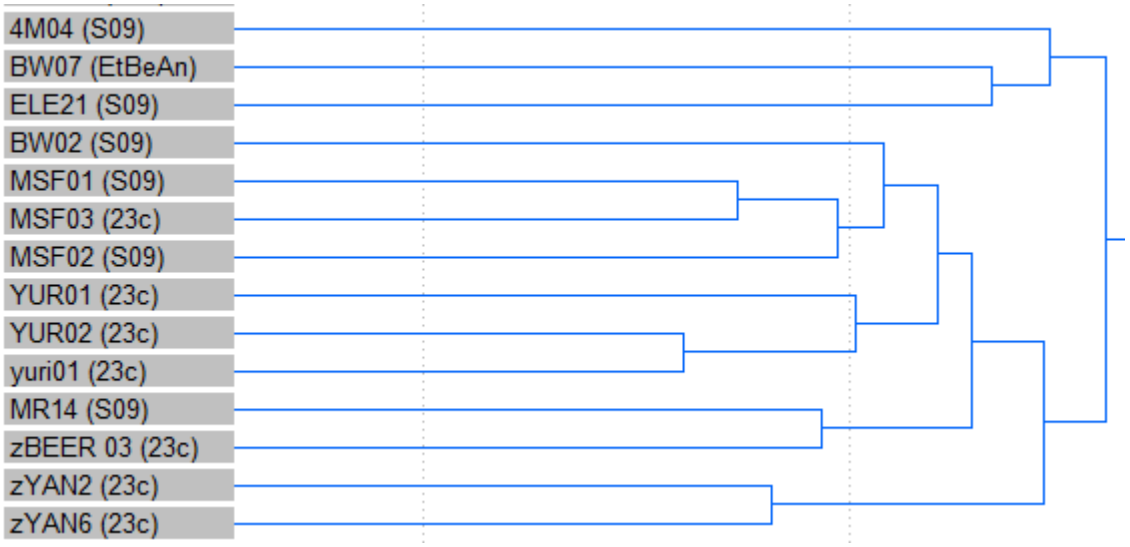
Dendrogram 10.3 – EtBeAn SSI B54



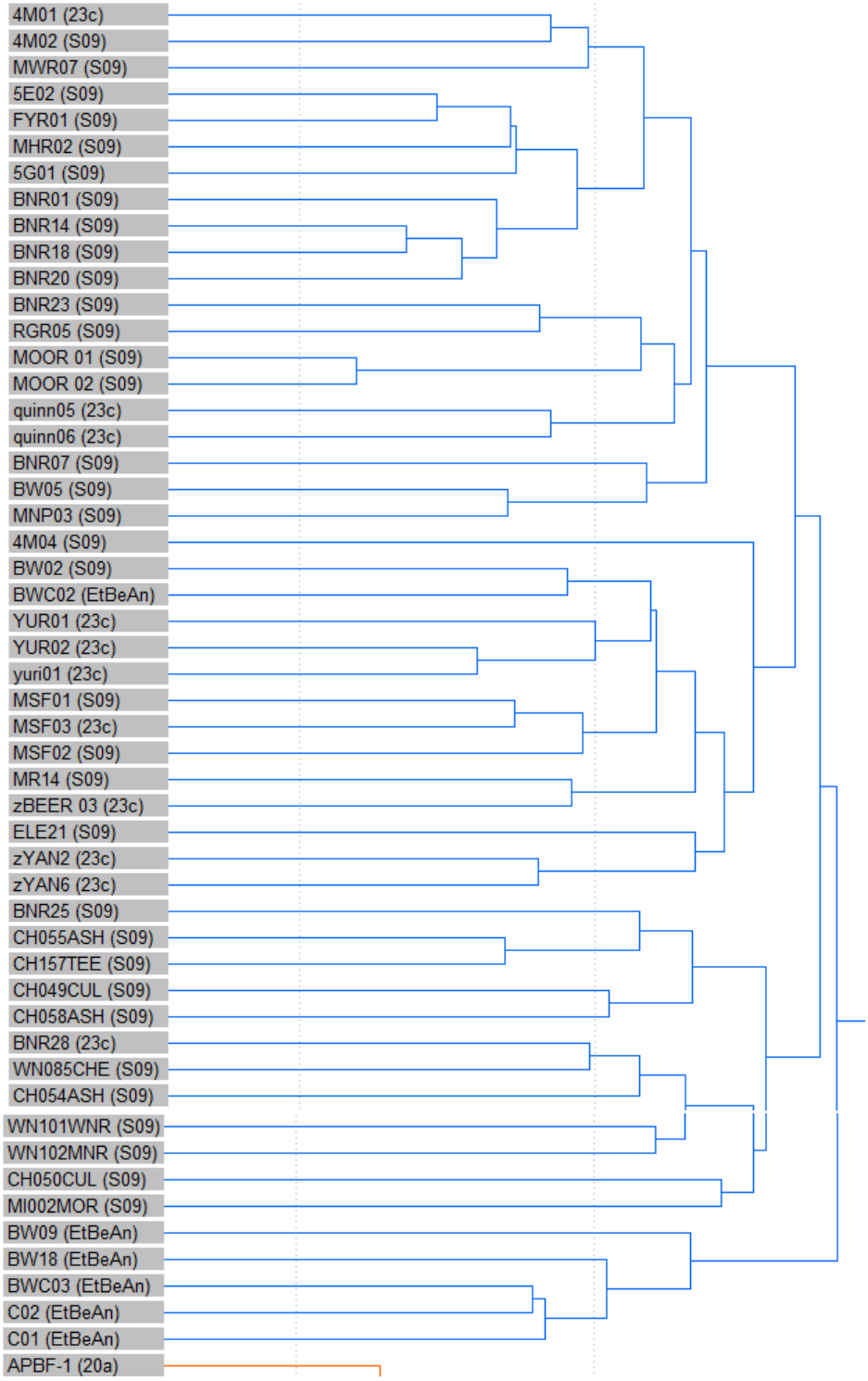
Dendrogram 10.4 – EtBeAn SSI BW06



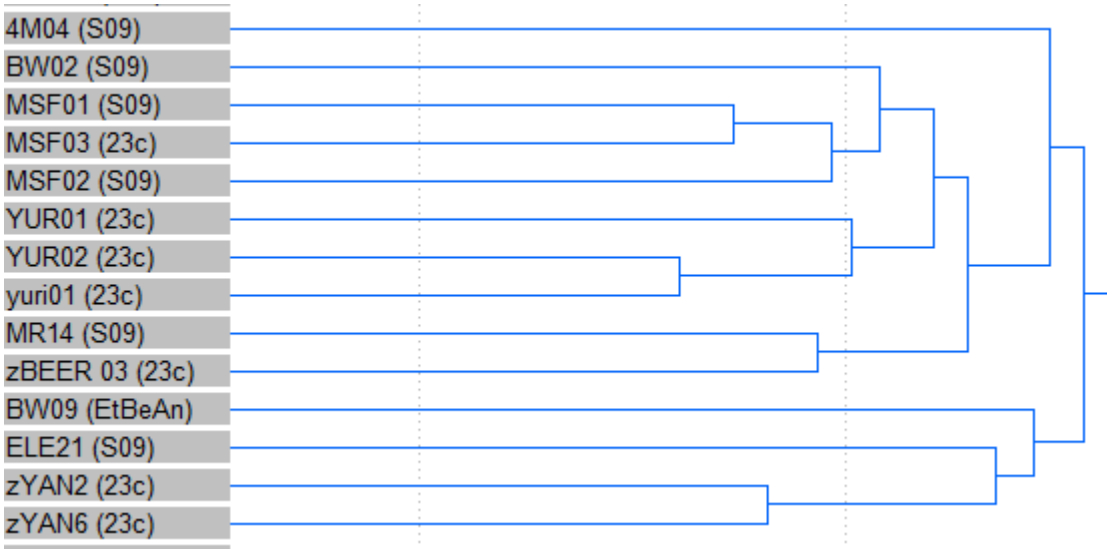
Dendrogram 10.5 – EtBeAn SSI BW07



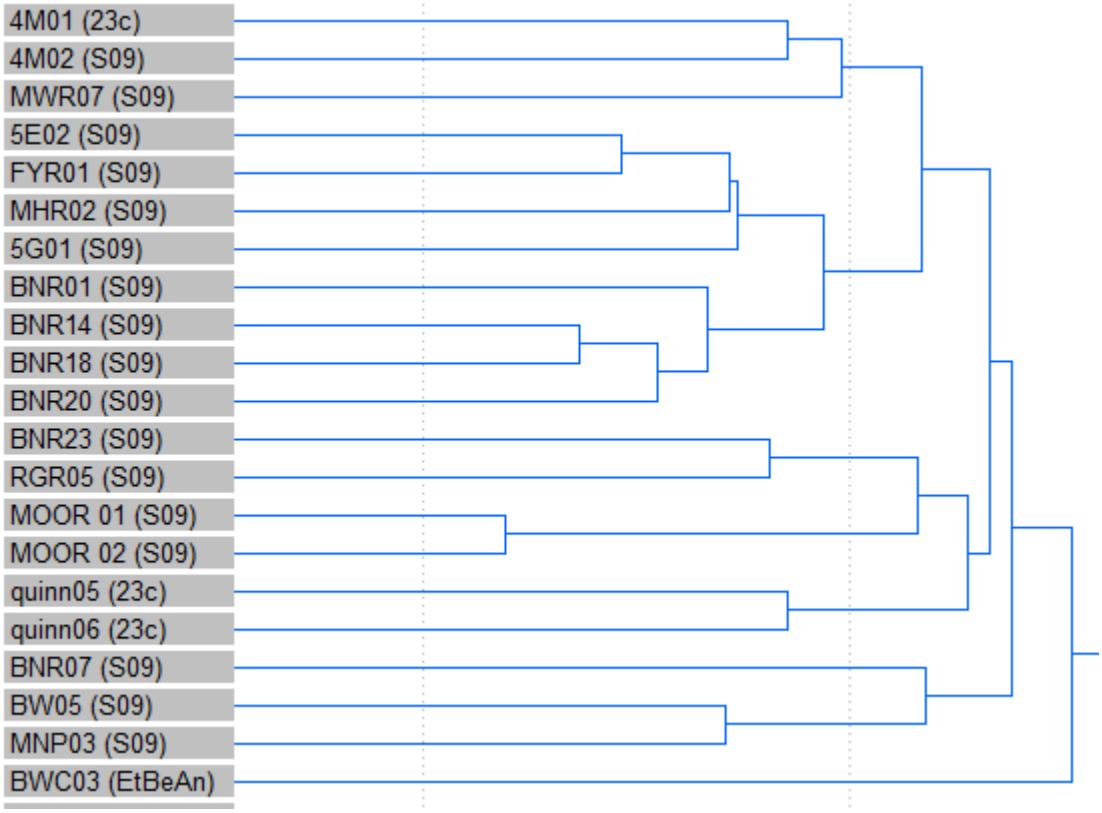
Dendrogram 11.1 – EtBeAn Batch 3



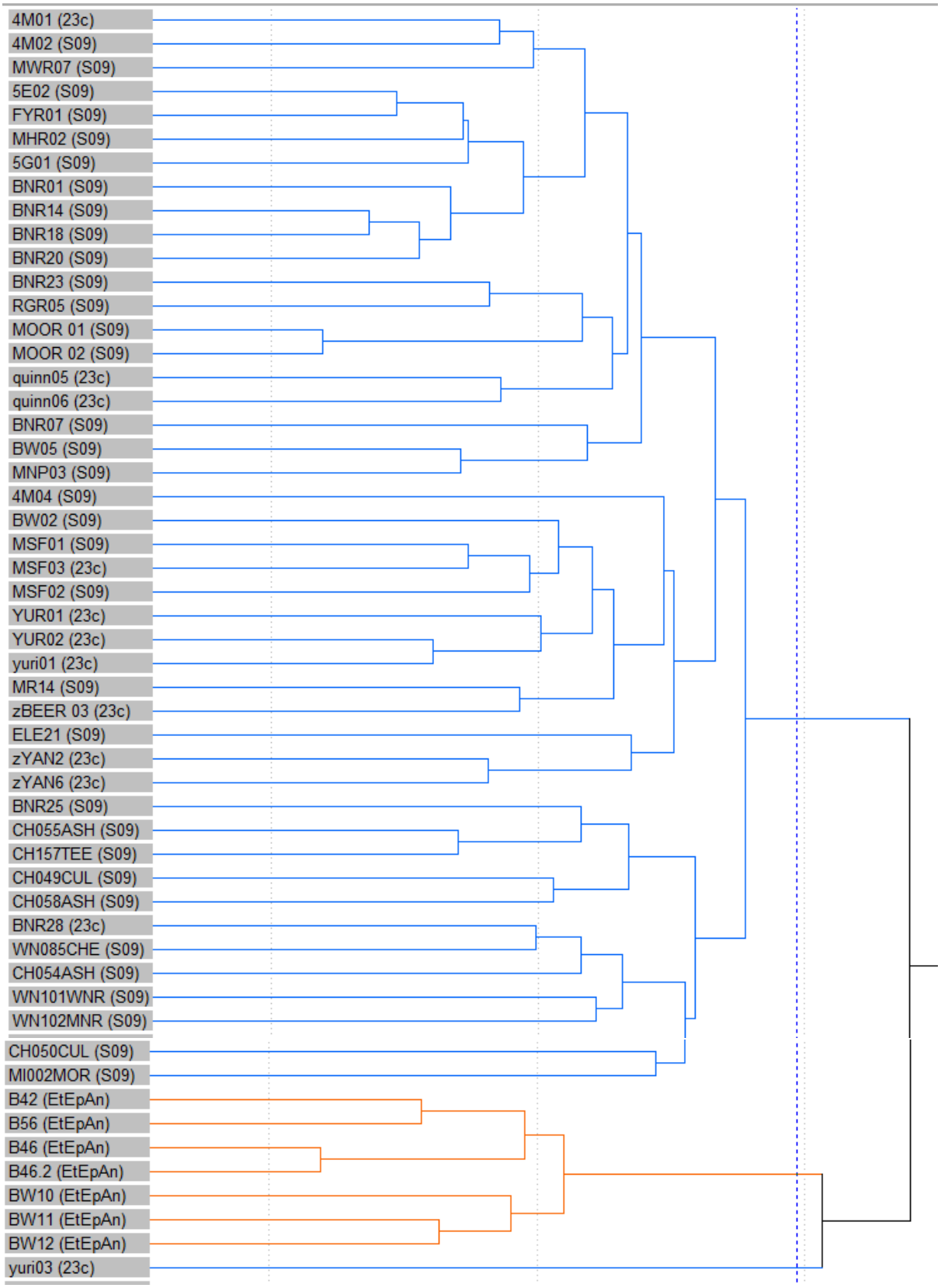
Dendrogram 11.2 – EtBeAn SSI BW09



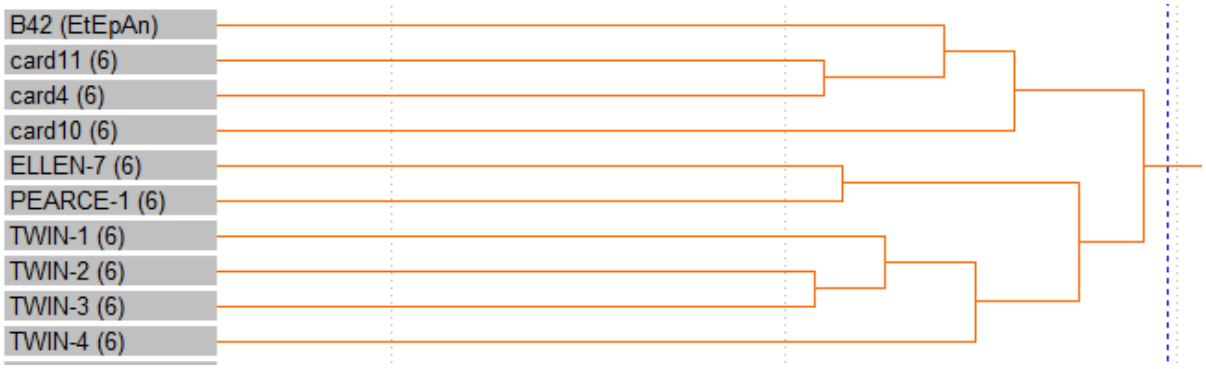
Dendrogram 11.3 – EtBeAn SSI BWC03



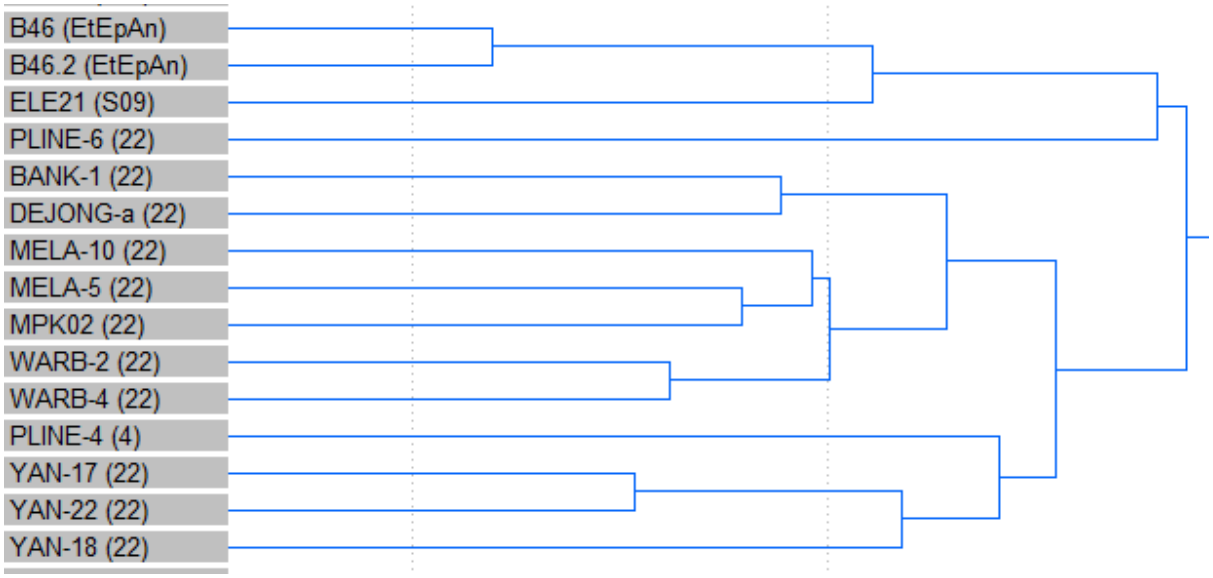
Dendrogram 12.1 – EtEpAn Batch



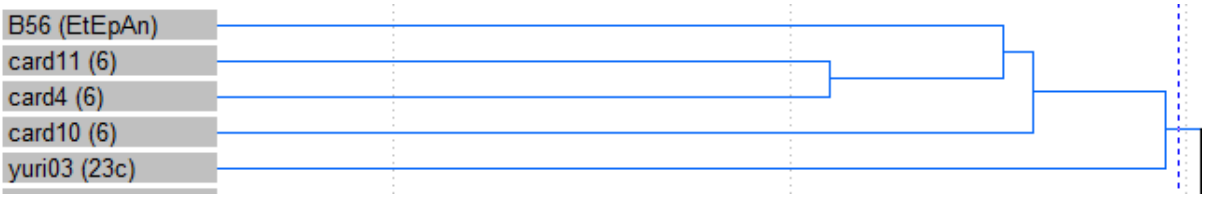
Dendrogram 12.2 – EtEpAn SSI B42



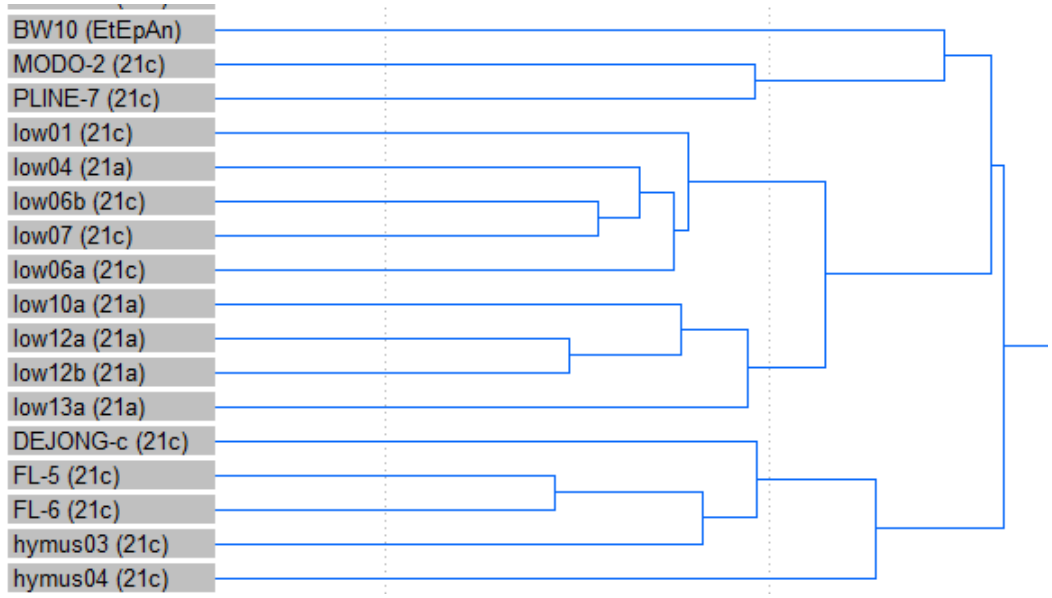
Dendrogram 12.3 – EtEpAn SSI B46



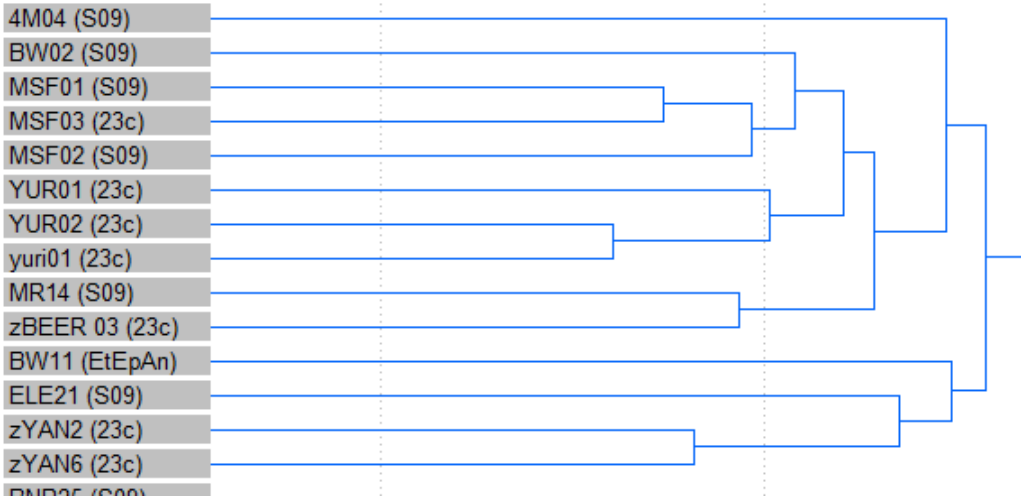
Dendrogram 12.4 – EtEpAn SSI B56



Dendrogram 12.5 – EtEpAn SSI BW10

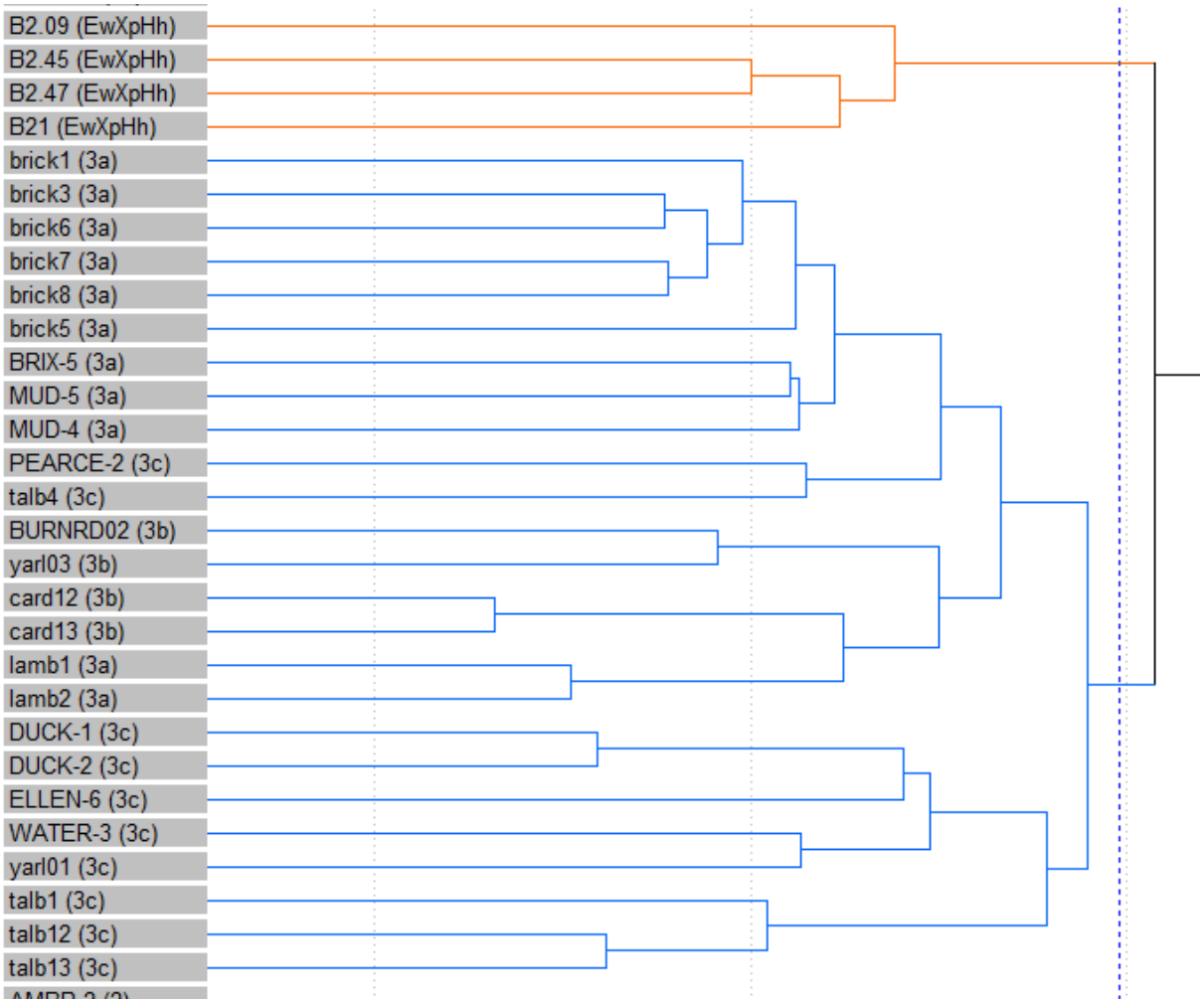


Dendrogram 12.6 – EtEpAn SSI BW11

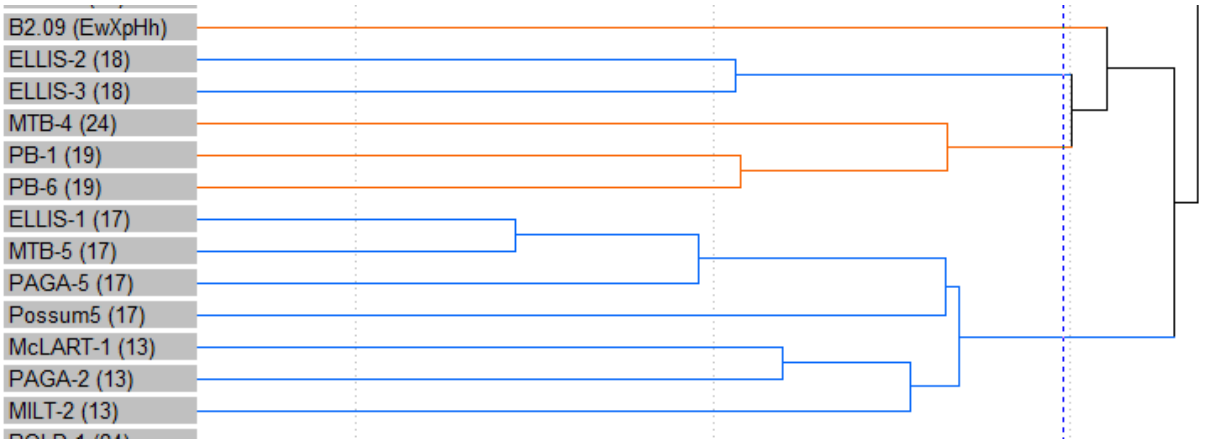


Dendrogram 12.7 – EtEpAn SSI BW12

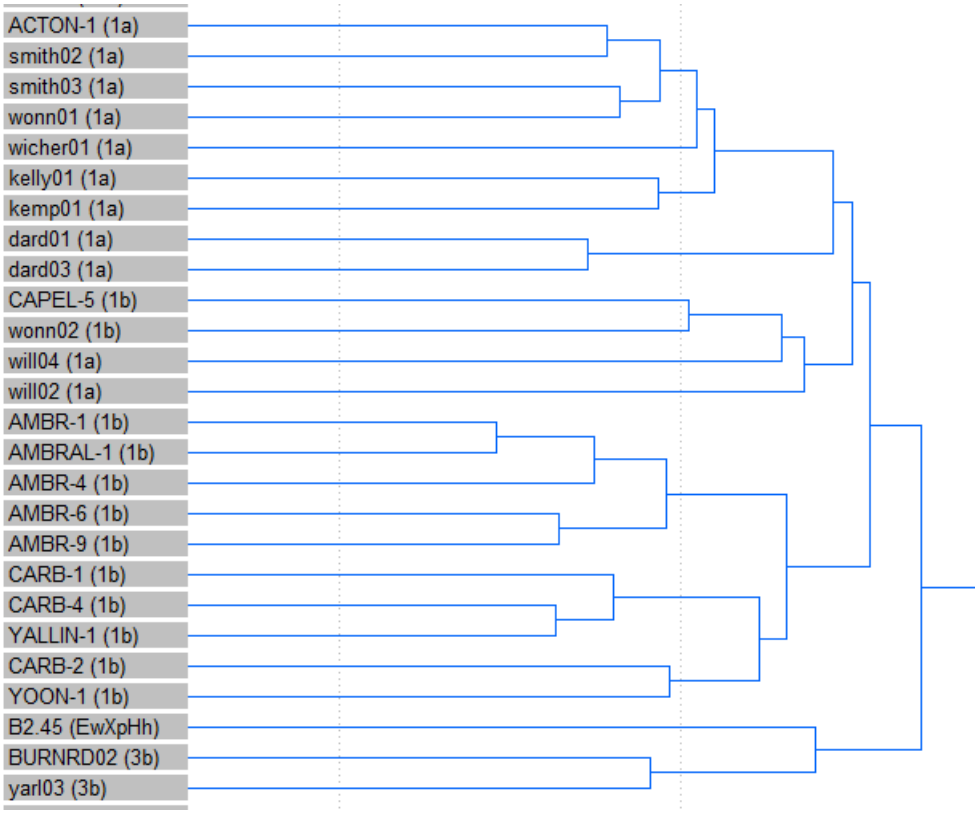
Dendrogram 13.1 – EwXpHh Batch 1



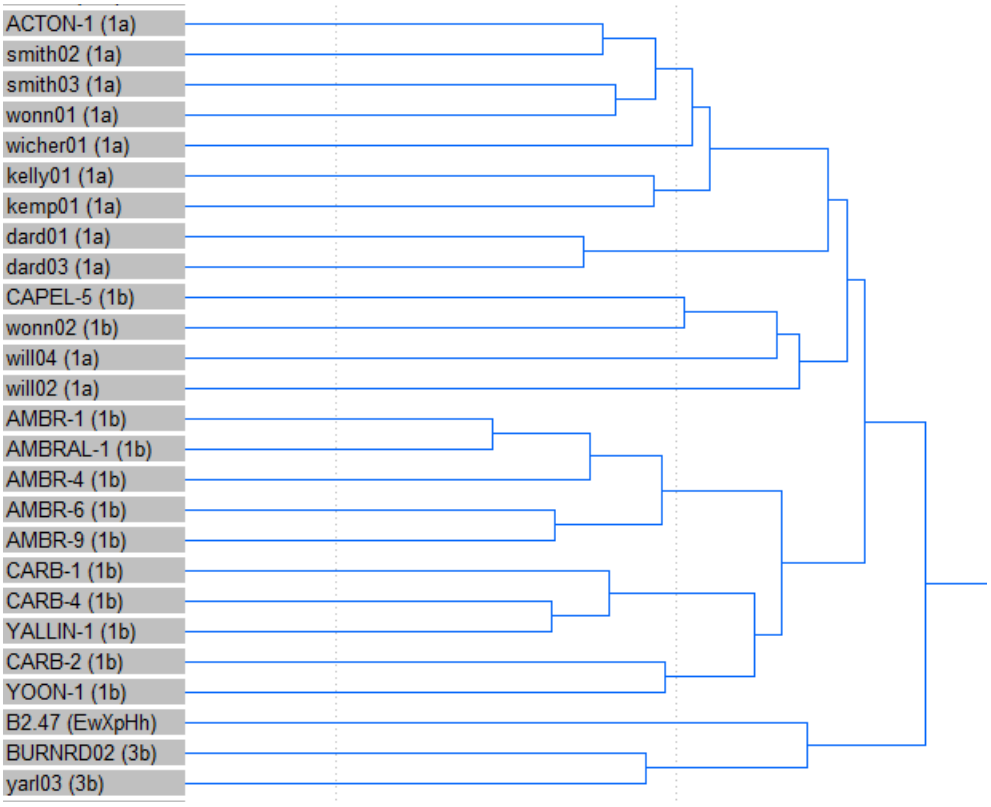
Dendrogram 13.2 – EwXpHh SSI B2.09



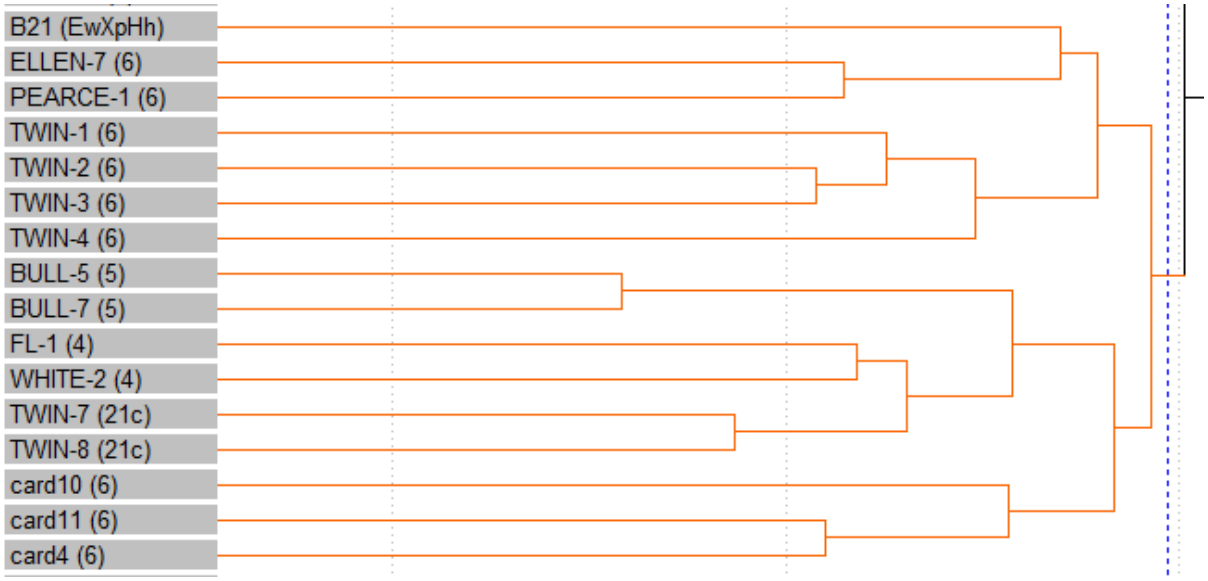
Dendrogram 13.3 – EwXpHh SSI B2.45



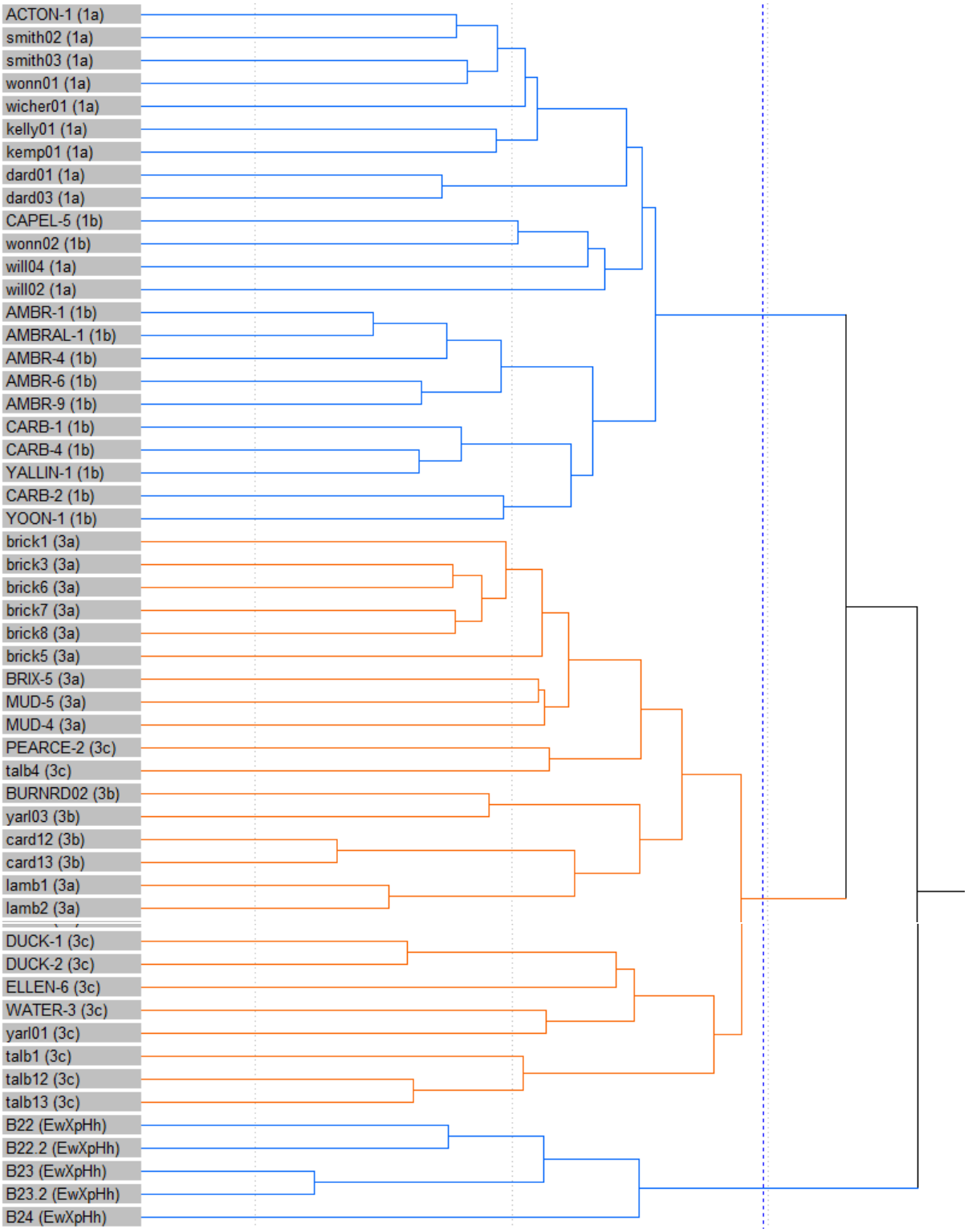
Dendrogram 13.4 – EwXpHh SSI B2.47



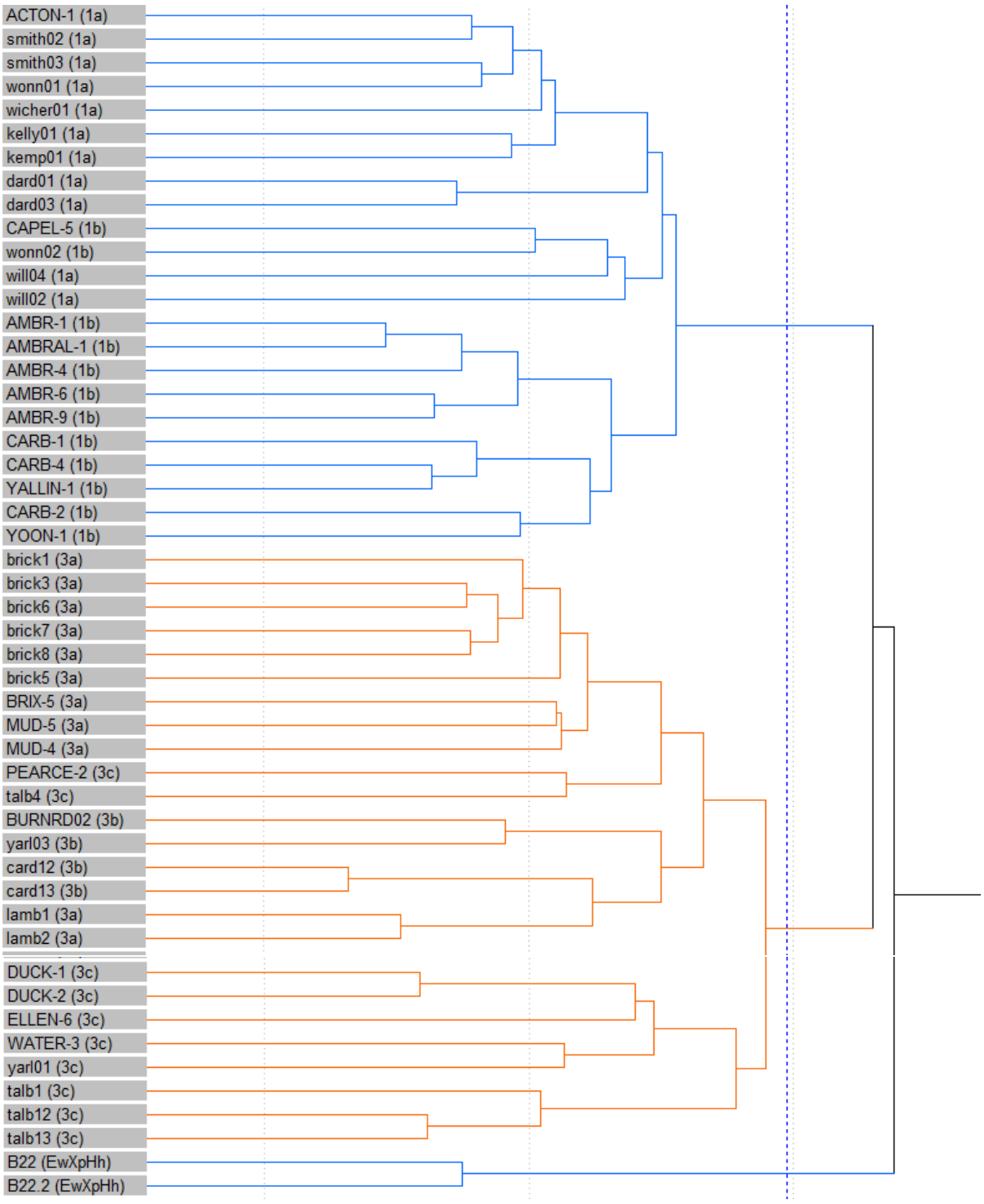
Dendrogram 13.5 – EwXpHh SSI B21



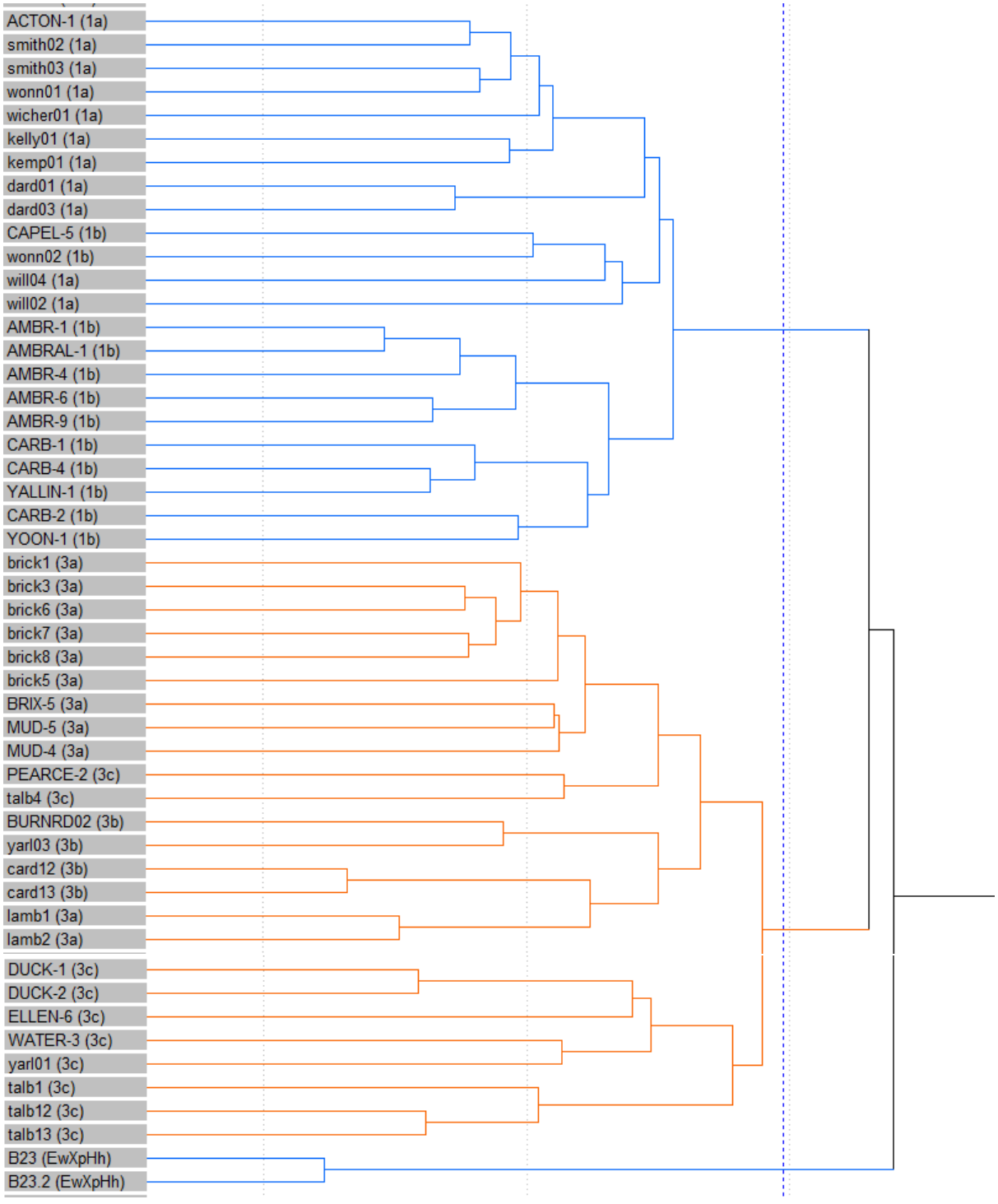
Dendrogram 14.1 – EwXpHh Batch 2



Dendrogram 14.2 – EwXpHh SSI B22



Dendrogram 14.3 – EwXpHh SSI B23



Appendix D. FVC 2020 Corrigendum Page

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Focused Vision Consulting Pty Ltd (FVC) (2020). *Flora and Vegetation Assessment, Bindoon Bypass, Great Northern Highway*. Unpublished report prepared for the Integrated Project Team (IPT) of Main Roads Western Australia, Arup and Jacobs, for the Great Northern Highway Upgrades.

CORRIGENDUM

With reference to the technical report, *Flora and Vegetation Assessment, Bindoon Bypass, Great Northern Highway* (FVC 2020), as cited in full above, please note a correction to a year (date) in a citation in several instances. The correction applies to the citations:

Keighery *et al.* (2008) and Keighery (2008)

some of which are which are incorrect and should read:

Keighery *et al.* (2012)

in some, but not all instances, in the following locations in the document:

Page 56, Section 5.4, second paragraph, second line

Page 59, Section 5.5, eighth paragraph, fourth line

Page 60, Section 5.5, second paragraph (of that page), second line

Page 60, Section 5.5, second paragraph (of that page), fifth line

Page 100, Section 6.3.5, third paragraph, second line

Page 109, Section 7.2.1, first paragraph, second line

Page 109, Section 7.2.1, first paragraph, fourth line

Page 110, Section 7.2.1, first paragraph (of that page), second line

Page 110, Section 7.2.1, second paragraph (of that page), second line

Page 110, Section 7.2.2, fifth paragraph, third line

Page 111, Section 7.2.2, fourth paragraph (of that page), sixth line

The following reference should also be listed in Section 10, References:

Keighery, B., Keighery, G., Longman, V.M., and Clarke, K.A. (2012). *Weed and native flora quadrat data compiled between 1990 - 1996 for the Southern Swan Coastal Plain*. Data compiled for the Departments of Environmental Protection and Conservation and Land Management, Perth

_____ END _____

Appendix E. DBCA Confirmation of Floristic Analysis Method

Boulden, Lisa

From: Kellie Bauer-Simpson <kellie@focusedvision.com.au>
Sent: Tuesday, 30 March 2021 11:33 AM
To: Boulden, Lisa; BRAID John (PEO)
Cc: Lisa Chappell
Subject: [EXTERNAL] FW: Main Roads, Bindoon Bypass - Revised FCT Analysis

Hi Lisa, John,

FYI, see feedback from Val English below. Good to have a clear way forward now, endorsed by Val herself.

We would be able to get started on this after Easter and it would likely take several days. Then we will need to review the outputs and tidy them up, so realistically a 2-3 week exercise, as we are extremely busy with other project work (sorry!). We should be ok to get something to you by 23/4, but will turn it around faster if we can and will keep you updated if that look like stretching out. We will run this analysis for only quadrats within the proposed footprint (unless you see value in still analysing them all? – this will take longer). Since we can save time by not analysing all quadrats, but will need a little more time to address all the other elements Val has suggested (the "Ted Griffin table"), we think this work will take around 40-50 hours, which equates to up to $6,500 ex GST.

Are you happy for us to proceed?

Regards,
Kellie.

Kellie Bauer-Simpson
Managing Director & Principal

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e: kellie@focusedvision.com.au
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From: Val English <val.english@dbca.wa.gov.au>
Sent: Monday, 29 March 2021 1:18 PM
To: Kellie Bauer-Simpson <kellie@focusedvision.com.au>

Cc: Cho Lamb <cho.lamb@dbca.wa.gov.au>; Jacqui Clinton <jacqui.clinton@dbca.wa.gov.au>
Subject: RE: Main Roads, Bindoon Bypass - Revised FCT Analysis

HI Kellie

Jacqui forwarded your email to me. A few suggested amendments below, in red.

Run PATN analysis of the quadrat data in small groups (say 5-8 quadrats at a time) for all veg units that are considered to remotely represent TECs or PECs and then also run a few single site insertions for each, to test whether results are aligning. Unsure if Gibson et al 1994 data will provide a useful comparison for this location, but worth applying for a few key quadrats to check results.
Then also undertake further analysis of species composition (dominant and indicator species), habitats, structure, soil and landforms (system 6 mapping) and geographical extent. Also recommend considering key combinations of species that are characteristic of particular FCTs.
then tie it all together in a combined ~~analysis~~ evaluation, reflective of the table which Ted Griffin had prepared that Val showed us.
We would also make reference to the "number of species in common" calculations we already have included in the report.
Based on these results, we would attempt to assign FCTs to each quadrat and then make conclusions regarding the presence of any TEC/PEC FCTs in the study area.
Recommend a conclusions column that summarises the logic as to why a particular FCT is considered to occur.

Regards
Val

From: Kellie Bauer-Simpson <kellie@focusedvision.com.au>
Sent: Monday, 29 March 2021 11:09 AM
To: Jacqui Clinton <jacqui.clinton@dbca.wa.gov.au>
Cc: Cho Lamb <cho.lamb@dbca.wa.gov.au>; Boulden, Lisa <Lisa.Boulden@jacobs.com>; Lisa Chappell <lisa@focusedvision.com.au>
Subject: Main Roads, Bindoon Bypass - Revised FCT Analysis

Hi Jacqui,

Further to our recent meeting regarding the above, we propose the below approach and wish to seek Val's feedback on this.

Run PATN analysis of the quadrat data in small groups (say 5-8 quadrats at a time) for all veg units that are considered to remotely represent TECs or PECs and then also run a few single site insertions for each, to test whether results are aligning. Then also undertake further analysis of species composition (dominant and indicator species), habitats, structure, landforms and geographical extent then tie it all together in a combined analysis, reflective of the table which Ted Griffin had prepared that Val showed us. We would also make reference to the "number of species in common" calculations we already have included in the report. Based on these results, we would attempt to assign FCTs to each quadrat and then make conclusions regarding the presence of any TEC/PEC FCTs in the study area.

Are you please able to pass this onto Val for her feedback? If she indicates that such an approach seems sound, we will proceed in this way.

Many thanks,
Kellie.

Kellie Bauer-Simpson
Managing Director & Principal

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Please consider the environment before printing this email

Appendix F. Bindoon Bypass – Revised FCT Analysis

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MEMORANDUM

Date	6 April 2022	**Title**	Bindoon Bypass – Revised FCT Analysis
Ref	ASJV17001_MEM_Rev3	**Distribution**	John Braid Main Roads Western Australia
Author	Lisa Chappell Senior Environmental Scientist/Botanist	**Review**	Kellie Bauer-Simpson Principal Ecologist/Environmental Manager

1. BACKGROUND

Main Roads Western Australia (Main Roads) is upgrading the 218 km section of the Great Northern Highway (GNH) between Muchea and Wubin. Jacobs and Arup together with Main Roads formed the Integrated Project Team (IPT) (formerly the Arup SKM Joint Venture (ASJV)) for the delivery of the upgrade project. As part of the GNH upgrades project, the IPT is also progressing work for a section of the GNH that will bypass the town of Bindoon (the Bindoon Bypass).

During 2016, Focused Vision Consulting Pty Ltd (FVC), supported by specialist sub-consultants, were engaged by the IPT to conduct initial spring flora, vegetation, fauna and habitat assessments of the proposed corridor for the Bindoon Bypass.

Multiple flora and vegetation assessments, commencing in spring 2016 were conducted by FVC within the study area during all seasons until spring 2018. The spring 2018 flora and vegetation assessment focused on assessing and determining Floristic Community Types (FCTs) within the project area, with a focus on the presence of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) listed Endangered Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community (EPBC Banksia Woodlands TEC).

Following publication of the Environmental Review Document (ERD) for the public review period, the WA Department of Biodiversity, Conservation and Attractions (DBCA) requested additional information regarding the determination of Floristic Community Types (FCTs) and quadrat statistical analysis. Liaison with DBCA during 2021 identified that further analysis of quadrat data may be appropriate to determine with increased certainty the likely presence of any Threatened or Priority Ecological Communities, with a focus on the EPBC-listed Banksia woodlands TEC and FCTs which are considered to be representative of the TEC. FCT analysis was conducted for quadrats with the specific focus of determining the Banksia Woodlands TEC and/or the corresponding FCT (**Table 1**).

Other FCTs of conservation significance such as 3a, 3b and 3c that are not typically known to geographically occur in the region or form part of the EPBC Banksia Woodland TEC were excluded from the assessment.

This memorandum presents the results of the additional data analysis for Banksia woodland quadrats within the development envelope (DE) and should be read conjunction with FVC (2018a, 2018b, 2018c).

Twenty-one FCTs described by Gibson *et al.* (1994), in Bush Forever (Government of Western Australia 2000), Keighery *et al.* (2008) and Urban Bushland Council (2011) best correspond to the EPBC Banksia woodlands TEC (Threatened Species Scientific Committee 2016) and these are summarised in **Table 1**.

Table 1 - Floristic Community Types Corresponding to the EPBC Banksia Woodlands TEC

FCT	FCT Name	WA TEC/PEC	EPBC TEC
Supergroup 3 – Uplands centred on Bassendean Dunes and Dandaragan Plateau			
20a	*Banksia attenuata* woodlands over species rich dense shrublands	Endangered	
20b	Eastern *Banksia attenuata* and/or *Eucalyptus marginata* woodlands	Endangered	
20c	Eastern shrublands and woodlands	Critically Endangered	Endangered
21a	Central *Banksia attenuata* - *Eucalyptus marginata* woodlands		
21b	Southern *Banksia attenuata* woodlands	P3	
21c	Low lying *Banksia attenuata* woodlands or shrublands	P3	
22	*Banksia ilicifolia* woodlands	P2	
23a	Central *Banksia attenuata* - *Banksia menziesii* woodlands		
23b	Northern *Banksia attenuata* - *Banksia menziesii* woodlands	P3	
23c	North-eastern *Banksia attenuata* - *Banksia menziesii* woodlands		
S09	*Banksia attenuata* woodlands over dense low shrublands		
Supergroup 4 – Uplands centred on Spearwood and Quindalup Dunes			
24	Northern Spearwood shrublands and woodlands	P3	
25	Southern *Eucalyptus gomphocephala – Agonis flexuosa* woodlands	P3	
28	Spearwood *Banksia attenuata* or *Banksia attenuata – Eucalyptus* woodlands		
Whicher Scarp FCTs (Keighery *et al.* 2008)			
A1	Central Whicher Scarp Mountain Marri Woodland WHSFCT_A1	P1	
A2	North Whicher Scarp Jarrah and Woody Pear woodland WHSFCT_A2		
A3	North Whicher Scarp *Banksia* and Woody Pear woodland WHSFCT_A3		
A4	Whicher Scarp *Banksia grandis*, Jarrah and Marri woodland WHSFCT_A4		
B1	Swan Coastal Plain /North Whicher Scarp *Banksia attenuata* woodland WHSFCT_B1		
B2	West Whicher Scarp *Banksia attenuata* woodland WHSFCT_B2		
C2	Whicher Scarp Jarrah woodland on deep coloured sands WHSFCT_C2		

The DBCA database search results for the study revealed the following State-listed TEC and two PECs as known to or potentially occurring in the local region:

- SCP 20a – *Banksia attenuata* woodlands over species rich dense shrublands (Endangered TEC)
- Banksia woodlands of the Gingin area restricted to soils dominated by yellow to orange sands (Priority 2 PEC)
- SCP 23b – Northern Swan Coastal Plain *Banksia attenuata – Banksia menziesii* woodlands (Priority 3 PEC).

All three of these ecological communities are also representative of the Commonwealth-listed TEC, EPBC Banksia woodlands TEC (Threatened Species Scientific Committee 2016). This was further supported by the search results from the Commonwealth Protected Matters Search Tool (PMST) for Matters of National Environmental Significance (MNES). Therefore, the further analysis in this memorandum is focused on quadrats within the DE that are considered Banksia woodland.

2. METHODOLOGY

Further to the data processing and analysis presented in *Detailed Flora and Vegetation Assessment, Bindoon Bypass, Great Northern* (FVC 2018c), additional statistical analysis of data was conducted against the Gibson *et. al.*, (1994) and a subset of the Keighery (2012) datasets, utilising methodologies derived from consultation with the DBCA, with a focus on determining the presence of the EPBC Banksia Woodlands TEC and the FCTs represented in the study area (including FCTs that correspond to the EPBC Banksia Woodlands TEC).

The FVC sampled quadrats (excluding those occurring on the Darling Plateau) occurring within the current DE, that were identified to be representative or potentially representative of known TECs or PECs for the region, including the EPBC Banksia Woodlands TEC (consolidated in FVC (2018c)) were analysed utilising PATN™ (Belbin 2013) multivariate cluster analysis of species presence/absence.

For each of the FVC (2018c) recorded Banksia woodland vegetation units, a 'batch' of five to eight quadrats was initially analysed using PATN™ with reference to the Gibson *et al.* (1994) and Keighery *et al.* (2012) datasets. The resulting dendrograms were interrogated to determine if representative FCTs could be assigned to each quadrat or if Single Site Insertion (SSI) for all quadrats was required. In order to confirm the inferred FCTs resulting from the 'batch' analysis, species data from single quadrats were then analysed against the Gibson *et al.* (1994) and Keighery *et al.* (2012) datasets using Single Site Insertion (SSI). It was deemed that the 'batch' analysis and 'SSI' analysis showed little correlation and therefore 'batch' analysis' was discarded. 'SSI' analysis was conducted for all potential quadrats with the potential to be representative of the Commonwealth Banksia Woodland TEC.

The species composition of each individual Banksia quadrat was then also compared to the Gibson *et al.* (1994) and Keighery *et al.* (2012) datasets utilising the Bray-Curtis dissimilarity Index in PATN. Results ranged from 0 to 1, where 0 would indicate that the quadrats are identical (PATN 2013) and 1 indicating no shared species (Hao *et al.* 2019). The closer the value to 0, the greater the similarity. A dissimilarity index value of greater than 0.6 is considered to be high (Maguire *et al.* 2016) and tends to indicate little similarity.

The resulting dendrograms from the SSI analyses are presented in **Appendix A**, with the summary of results including dissimilarity index values presented in **Table 2**.

The resulting dissimilarity indices and percentage of species in common (**Table 2**), indicated that analysed quadrats are representative of 13 different Banksia woodland FCTs (20a, 20b, 20c, 21a, 21c, 22, 23a, 23b, 23c, 24, 25, 28 and S09). Despite some of the quadrats returning lower dissimilarity indices with the aforementioned FCTs, based on known Gibson *et. al.* (1994) and Keighery *et. al.* (2012) distribution, FCTs 20b, 20c, 21a, 21c, 23a, 24 and 25 are not considered to occur on the Dandaragan Plateau. Based on this, it was inferred that these FCTs are unlikely to be represented within the DE.

FCT affinities were then further tested by carrying out an analysis of flora species presence-absence data, which compared recorded quadrat data with that of the Gibson *et al.* (1994) and Keighery *et al.* (2012) datasets. This simplified comparison provided numbers and percentages of species in common (between FVC (2018c) recorded data and the Gibson *et al.* (1994) and Keighery *et al.* (2012) datasets) as further justification of FCT inferences made for each sampled quadrat (**Appendix 2**).

In summary, the following information was assessed for each quadrat:

1. 'Batch' floristic analysis of quadrat data against Gibson *et al* (1994) and a subset of Keighery *et al.* (2012) datasets.
2. SSI for all individual quadrats was conducted to confirm or disprove PATN results returned for the 'batch' analysis.
3. SSI dendrograms did not align with 'batch' analysis results and 'batch' analysis results were therefore discounted.
4. Further analysis of dissimilarity indices, flora species presence-absence data, comparing the number of common species occurring within the recorded quadrat and the Gibson *et al* (1994) and Keighery *et al.* (2012) sampled sites.
5. Quadrat data was subsequently compared to other information relevant to each FCT; key dominant species, typical habitat, vegetation complexes and geographical distribution.
6. Final conclusions were made based on the consolidated results of all comparative analyses.

3. RESULTS

'Batch' and SSI analysis of the quadrat data using multivariate cluster analysis of species presence/absence in PATN™ was carried out for all potential TEC/PEC (Banksia woodland) quadrats within the DE. The initial 'Batch' analysis dendrograms of all vegetation units did not align with Single Site Insertion dendrogram results and therefore, SSI was conducted for all quadrats. The resulting dendrograms from the SSI analysis are presented in **Appendix 1**, with the summary of results including dissimilarity index values presented in **Table 2**. The comparison for all analysed quadrats in comparison to the consolidated Gibson *et al* (1994) and Keighery (2012) datasets is presented in **Appendix 2**.

The consolidated results of the data analysis that aimed to further determine FCTs (**Table 3**) indicates that as previously reported in FVC (2018c), vegetation units BaXpAn, EmXpAn, EtBeAn and EtEpAn show affinity to FCTs that are considered representative of the Banksia woodland TEC. The Banksia woodland vegetation units were determined to be representative of the following five FCTs:

- SCP S09 - *Banksia attenuata* woodlands over dense low shrublands
- SCP 20a – *Banksia attenuata* woodlands over species rich dense shrublands
- SCP 23a - Central *Banksia attenuata - Banksia menziesii* woodlands
- SCP 23b - Northern *Banksia attenuata - Banksia menziesii* woodlands (DBCA-listed Priority 3 PEC)
- SCP 23c - North-eastern *Banksia attenuata - Banksia menziesii* woodlands
- SCP 28 - Spearwood *Banksia attenuata* or *Banksia attenuata – Eucalyptus* woodlands.

The Banksia woodland vegetation of the study area is concluded to be mostly representative of FCT 28 (14 quadrats) with smaller representations of S09 (10 quadrats), FCT 23a (11 quadrats), FCT 23b (10 quadrats), FCT 23c (four quadrats) and FCT 20a (one quadrat).

The summary of inferred FCT results from; the PATN analysis (dendrograms and dissimilarity indices), FCT species comparison, and distribution is presented in **Tables 3** and **4**. A portion of vegetation unit EtBeAn was considered likely to be representative of State Vulnerable Ecological Community FCT 20a (*Banksia attenuata* woodlands over species rich dense shrublands), whilst portions of four of the recorded vegetation units with affinity to the Priority 3 Ecological Community, FCT 23b – Northern *Banksia attenuata – Banksia menziesii* woodlands were identified to occur, as spatially presented in the **Figure 1** series.

Other FCTs of conservation significance such as 3a, 3b and 3c that are not typically known to be distributed within the DE region or form part of the EPBC-listed Banksia woodlands TEC were excluded from the assessment. However, during the analysis to determine the presence of the Banksia woodland TEC, six quadrats B2.12, B2.31, B2.33, B2.45, C03 and C09, were identified to show the greatest similarity with FCT 3b. Correspondence with the DBCA suggests that this may be a northern expression of FCT 3b (DBCA 2022). The locations of the possible representations of FCT 3b are spatially presented in the **Figure 1** series.

Table 2 – Summary of Single Site Insertion PATN Analysis Results

Vegetation Unit	Representative Quadrat	Vegetation condition	System	Dissimilarity value[ϟ]	SCP Quadrat	FCT	Dissimilarity value[ϟ]	SCP Quadrat	FCT	Dissimilarity value[ϟ]	SCP Quadrat	FCT	SSI Dendrogram Result*	FCT Based on Greatest % Species in Common^	Inferred FCT
BaXpAn - *Banksia* spp. sparse woodland	B10	Very Good - Excellent	Dandaragan Plateau	0.5780	hurst03	23a	0.6071	BULL-3	23a	0.6162	MELA-9	23a	23a, 23b, 28	24, 23a, 23b	Greatest similarly to 23a, however 23b, more widely distributed on Dandaragan Plateau
	B10.2	Very Good-Excellent	Dandaragan Plateau	0.5447	BULL-3	23a	0.5536	WHITE-1	23a	0.5798	YAN-19	23b	23a, 23b, 28	23b, 23a, 28	Greatest similarity to 23a, however 23b, more widely distributed on Dandaragan Plateau
	B11	Excellent	Dandaragan Plateau	0.5926	BULL-3	23a	0.6344	RAAF-2	23b	0.6591	PLINE-2	23b	28, 20b, 20a	23c, S09, 25, 28	Greatest similarity to 23a, however 23b, more widely distributed on Dandaragan Plateau
	B2.25	Very Good - Excellent	Dandaragan Plateau	0.6364	WAND-1	23a	0.6429	NINE-2	21a	0.6471	yuri01	23c	6, 5, 4, 21c	22, 21c	Greatest similarity to 23a, however 23a and 21a not distributed on Dandaragan Plateau, FCT 23c distributed on Dandaragan Plateau
	B2.30	Excellent	Dandaragan Plateau	0.5714	YUR02	23c	0.5800	YAN-20	23b	0.5802	BNR18	S09	S09, 23c	S09, 28, 23b	Close in values. 23c known to occur on Dandaragan Plateau
	B2.32	Good-Very Good	Dandaragan Plateau	0.5462	BULL-3	23a	0.5556	BULL-11	28	0.5614	card5	20b	28	28, 21a, 23b	Greatest similarly to 23a, however 28 is more widely distributed on Dandaragan Plateau
	B49	Good-Very Good	Dandaragan Plateau	0.5926	MSF02	S09	0.6170	ELE21	S09	0.6296	ELDO-1	23b	S09, 23c	23a, 23b, 23c	Greatest similarity S09
	BW14	Very Good	Dandaragan Plateau	0.6000	YULE-1	23a	0.6117	NINE-2	21a	0.6296	WHITE-1	23a	S09, 23c	23b, 28, 23a	Greatest similarity to 23a, however 23a and 21a have limited distribution on Dandaragan Plateau, therefore considered most aligned with S09 from dendrogram and distribution
	BW15	Very Good-Excellent	Dandaragan Plateau	0.6238	PAGA-4	21a	0.6344	NEER-3	28	0.6383	SHENT-1	28	28	28, 23a	Greatest similarity to 28, FCT 21a not distributed on Dandaragan Plateau

ϟ - scale for 0 – 1: 0=identical, 1=nothing in common (<0.6 tends to indicate low similarity; green reasonably similar, red not very similar)

*Nearest neighbour listed first

^red indicates the highest % species in common

Vegetation Unit	Representative Quadrat	Vegetation condition	System	Dissimilarity value[ϟ]	SCP Quadrat	FCT	Dissimilarity value[ϟ]	SCP Quadrat	FCT	Dissimilarity value[ϟ]	SCP Quadrat	FCT	SSI Dendrogram Result*	FCT Based on Greatest % Specie in Common^	Inferred FCT
BaXpAn -(cont.)	BW16	Very Good	Dandaragan Plateau	0.6102	YAN-20	23b	0.6262	yuri01	23c	0.6296	YAN-4	28	28	28, 21a, 23a, 23c	23b - More widely distributed on Dandaragan Plateau
	BW17	Very Good-Excellent	Dandaragan Plateau	0.6200	WHITE-1	23a	0.6634	GOLF-1	20a	0.6852	hurst03	23a	6, 21c	23a, 28, 21c, 23b	Closest dissimilarity value to 23a, however limited distribution on Dandaragan Plateau. Two of the three quadrats with the lowest dissimilarity values are 23a. GOLF-1 (FCT 20a) occurs in Marangaroo, approximately 45 km south-west of the project area.
BaXpUa - *Banksia attenuata* sparse woodland	B2.48	Good	Dandaragan Plateau	0.6383	BULL-1	28	0.6610	BULL-4	28	0.6696	WELL-2	21a	28	28, 21a	Greatest similarity to 28
	B2.49	Good-Very Good	Dandaragan Plateau	0.5772	BULL-4	28	0.5932	talb9	20c	0.6147	WARI-2	28	28	28, S09	Greatest similarity to 28
	B2.50	Good	Dandaragan Plateau	0.6275	YAN-4	28	0.6694	BULL-4	28	0.6991	hurst03	23a	28	28, 21a	Greatest similarity to 28
	B55	Good-Very Good	Dandaragan Plateau	0.6216	ELE21	S09	0.6364	MELA-5	22	0.6389	MPK03	23b	S09, 22	21c, 23a, 23b, S09, 28	Greatest similarity to S09
	BW03	Very Good	Dandaragan Plateau	0.6727	ELE21	S09	0.6818	PAGA-4	21a	0.6829	zYAN2	23c	S09, 23c	23a, 21c, 28	Inconclusive. High dissimilarity values. Greatest similarity to S09
	BW04	Very Good-Excellent	Dandaragan Plateau	0.6316	THOM-2	24	0.6471	FL-6	21c	0.6842	SHENT-1	28	23c	21c, 23a, 28	Inconclusive. Variable results Gibson/Keighery comparison quadrat located some distance from project area. Site THOM-2 adjacent to Thompsons Lake, site FL-6 adjacent to Forrestdale Lake. FCT 28 is distributed on Dandaragan Plateau

ϟ - scale for 0 – 1: 0=identical, 1=nothing in common (<0.6 tends to indicate low similarity; green reasonably similar, red not very similar)
*Nearest neighbour listed first
^red indicates the highest % species in common

Vegetation Unit	Representative Quadrat	Vegetation condition	System	Dissimilarity value[ϟ]	SCP Quadrat	FCT	Dissimilarity value[ϟ]	SCP Quadrat	FCT	Dissimilarity value[ϟ]	SCP Quadrat	FCT	SSI Dendrogram Result*	FCT Based on Greatest % Specie in Common^	Inferred FCT
BaXpUa - (cont.)	BWC01	Good-Very Good	Dandaragan Plateau	0.6545	talb9	20c	0.6600	GOLF-1	20a	0.6632	RAAF-2	23b	S09, 23c	28, 23a, 23b	23b distributed on Dandaragan Plateau. FCT 20c not distributed on Dandaragan Plateau. Key indicator species of BWC01 (*Eucalyptus todtiana)* does not occur within FCT 20a.
	C04	Good-Very Good	Dandaragan Plateau	0.6944	SHENT-1	28	0.7067	card3	21a	0.7097	CHO58ASH CH157TEE	S09	6, 21c, 4, 5	21a, S09, 28	High dissimilarity values. Greatest similarity to 28
	C06	Very Good	Dandaragan Plateau	0.6923	NEER-3	28	0.6962	WOODV-2	28	0.7073	NEER-2	28	6	23b, 23c, 28	High dissimilarity values. Greatest similarity to 28
EmBsHh - *Eucalyptus marginata* and *Banksia sessilis* sparse woodland	B08	Good-Very Good	Dandaragan Plateau	0.6790	card7	21a	0.6901	PLINE-3	21a	0.6907	CAPEL-1	21b	23c, 21c, 20c, 28, 20b, 20a	28, 21a, 21c	Greatest similarity to 23c. 21a and 21b are not distributed on Dandaragan Plateau
	B09	Good	Dandaragan Plateau	0.6238	card1	20b	0.6404	BULL-11	28	0.6504	card5	20b	1b, 1a	1a, 1b	Greatest similarity to 28. 20b not distributed on Dandaragan Plateau, Dominant indicator species of B09 (*Banksia sessilis*) does not occur in FCT 20b
	B09.2	Good	Dandaragan Plateau	0.6600	card1	20b	0.6952	yarl04	20b	0.6986	CH157TEE	S09	1b, 1a	1b, 1a	B09 exhibits similarity to 28. 20b not distributed on Dandaragan Plateau. Dominant indicator species of B09.2 (*Banksia sessilis*) does not occur in FCT 20b
	B15R	Very Good	Dandaragan Plateau	0.6757	low06b	21c	0.6829	YAN-25	28	0.6923	TRIG-3	28	23c	28, 20b	Greatest similarity to 28
	B2.31	Very Good-Excellent	Dandaragan Plateau	0.6907	card13	3b	0.7143	BURNRD 02	3b	0.7183	TRIG-4	28	3b, 3a	3b, 3c	High dissimilarity values. Greatest similarity to 3b

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Vegetation Unit	Representative Quadrat	Vegetation condition	System	Dissimilarity value[ϟ]	SCP Quadrat	FCT	Dissimilarity value[ϟ]	SCP Quadrat	FCT	Dissimilarity value[ϟ]	SCP Quadrat	FCT	SSI Dendrogram Result*	FCT Based on Greatest % Specie in Common^	Inferred FCT
EmXpAn - *Eucalyptus marginata* sparse woodland (cont.).	B2.33	Very Good-Excellent	Dandaragan Plateau	0.6889	card12	3b	0.6939	card13	3b	0.7176	NEER-21	28	3b, 3a	3b	High dissimilarity values. Greatest similarity to 3b
	C03	Very Good-Excellent	Dandaragan Plateau	0.6552	card12	3b	0.6667	CH055ASH	S09	0.6721	PLINE-3	21a	3a, 3b	3b, 3a, 3c	High dissimilarity values. Greatest similarity to 3b
	C09	Very Good	Dandaragan Plateau	0.6627	NEER-5	28	0.6832	card12	3b	0.7045	NEER-3	28	3b, 3a	3b, 3c	High dissimilarity values. Greatest similarity to 3b
	B2.19	Very Good-Excellent	Dandaragan Plateau	0.6056	PLINE-3	21a	0.6415	hurst03	23a	0.6458	MELA-9	23a	21a, 3a, 25, 3b	21a, 28, 23a, 23b	21a not widely distributed on Dandaragan Plateau. Closest to 23a
	B2.51	Good-Very Good	Dandaragan Plateau	0.6735	BULL-3	23a	0.6809	hurst01	23a	0.6812	DEJONG-c	21c	22, 23c	23a, 21c, 28	High dissimilarity value. Greatest similarity to 23a, limited distribution on Dandaragan Plateau
	B2.12	Very Good-Excellent	Dandaragan Plateau	0.6667	card13	3b	0.6800	card12	3b	0.6939	C71-3	21a	3b, 3a	3b	Greatest similarity to 3b
EtBeAn - *Eucalyptus todtiana* sparse woodland	B15	Very Good	Dandaragan Plateau	0.5581	WHITE-1	23a	0.6308	FL-6	21c	0.6386	YULE-1	23a	21c, 23c	23a, 28, 21c, 23b	Greatest similarity to 23a, however limited distribution on Dandaragan Plateau
	B16R	Good-Very Good	Dandaragan Plateau	0.5962	ELDO-1	23b	0.6167	BULL-3	23a	0.6336	MILT-4	28	20a	23b, S09	Greatest similarity to 23b, however the dendrograms indicate greater affinity to FCT20a. Considered likely to be representative of FCT20a, however analysis was based on a sampled relevé due to access constraints.
	B17	Good-Very Good	Dandaragan Plateau	0.6571	MWR07	S09	0.6818	BULL-11	28	0.7045	BULL-10	28	28	28	Greatest similarity to 28
	B18	Very Good	Dandaragan Plateau	0.6607	BULL-3	23a	0.6818	low04	21a	0.7009	card5	20b	23c	28, 21a, 23a	Greatest similarity to 23a. 21a and 20b limited distribution on Dandaragan Plateau

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*Nearest neighbour listed first

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Vegetation Unit	Representative Quadrat	Vegetation condition	System	Dissimilarity value[ϟ]	SCP Quadrat	FCT	Dissimilarity value[ϟ]	SCP Quadrat	FCT	Dissimilarity value[ϟ]	SCP Quadrat	FCT	SSI Dendrogram Result*	FCT Based on Greatest % Specie in Common^	Inferred FCT
EtBeAn - *Eucalyptus todtiana* sparse woodland (cont.)	B18.2	Very Good	Dandaragan Plateau	0.6174	BULL-3	23a	0.6346	BULL-11	28	0.6600	yuri01	23c	23c	28, 23a, 23c	Greatest similarity to 23a, however limited distribution on Dandaragan Plateau
	B19	Good-Very Good	Dandaragan Plateau	0.6102	BULL-3	23a	0.6122	MELA-2	23b	0.6262	WHITE-1	23a	23c	28, 23a, 23b, 23c	Greatest similarity to 23b. FCT 23b widely distributed on Dandaragan Plateau. FCT 23a not distributed on Dandaragan Plateau
	B19.2	Very Good	Dandaragan Plateau	0.5949	MELA-6	23b	0.6226	ELE21	S09	0.6267	MILT-3	23b	23c	S09, 28, 23a, 23b	Greatest similarity to 23b
	B51	Good	Dandaragan Plateau	0.6415	BULL-3	23a	0.6421	BULL-11	28	0.6552	talb7	20c	S09	S09, 28, 23a	Greatest similarity to 23a, however not distribution on Dandaragan Plateau
	B54	Excellent	Dandaragan Plateau	0.5455	YUR02	23c	0.5556	BNR20	S09	0.5584	BNR18	S09	S09, 23c	23b, 23a	Greatest similarity to S09.
	BW06	Very Good-Excellent	Dandaragan Plateau	0.6000	YAN-4	28	0.6709	NEER-3	28	0.6750	WOODV-2	28	S09, 23c	28, S09	Greatest similarity to 28
	BW07	Very Good-Excellent	Dandaragan Plateau	0.6750	FYR01	S09	0.6949	ELE21	S09	0.7021	yuri01	23c	S09, 23c	28, 23b	Greatest similarity to S09. S09 more widely distributed
	BW08	Very Good	Dandaragan Plateau	0.6875	yuri01	23c	0.6991	MOOR 02	S09	0.7073	MWR07	S09	S09, 23c	28, 23a	High dissimilarity values. Greatest similarity to S09 sites
	BW09	Very Good	Dandaragan Plateau	0.6559	ELDO-1	23b	0.6596	RAAF-2	23b	0.6596	yuri01	23c	S09, 23c	23a, 21c, 23b	Greatest similarity to 23b
	BW18	Very Good	Dandaragan Plateau	0.5085	YAN-20	23b	0.5417	MUCK-1	23b	0.5472	ELDO-1	23b	23b, 28	28, 21a	Greatest similarity to 23b
	BWC02	Very Good-Excellent	Dandaragan Plateau	0.6000	MPK03	23b	0.6061	YUR02	23c	0.6140	MSF02	S09	S09, 23c	28, 23a, 23b	Greatest similarity to 23b

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Vegetation Unit	Representative Quadrat	Vegetation condition	System	Dissimilarity value[ϟ]	SCP Quadrat	FCT	Dissimilarity value[ϟ]	SCP Quadrat	FCT	Dissimilarity value[ϟ]	SCP Quadrat	FCT	SSI Dendrogram Result*	FCT Based on Greatest % Specie in Common^	Inferred FCT
EtBeAn (cont.)	BWC03	Very Good-Excellent	Dandaragan Plateau	0.6111	YUR02	23c	0.6364	MILT-8	23b	0.6436	KOON-1	20a	S09, 23c	23a, 28	Greatest similarity to 23c
	C01	Good-Very Good	Dandaragan Plateau	0.5490	YAN-19	23b	0.5556	ELDO-1	23b	0.5844	MILT-8	23b	S09, 23c	23b, 23c, S09	Greatest similarity to 23b
	C02	Good-Very Good	Dandaragan Plateau	0.6286	YAN-22	22	0.6381	M53	20a	0.6415	YAN-19	23b	S09	S09, 28	YAN-19 (23b) is closest distributed site. FCT 22 does not contain key dominant species
EtEpAn - *Eucalyptus todtiana* sparse woodland	B42	Very Good	Dandaragan Plateau	0.6438	BNR01	S09	0.6750	card9	20b	0.6875	BULL-3	23a	6	28, 21a, 21c	Greatest similarity to S09
	B46	Good	Dandaragan Plateau	0.5714	ELE21	S09	0.6061	MUCK-1	23b	0.6250	WAND-1	23a	S09, 22	21c, 23a, 28	Greatest similarity to S09
	B46.2	Good	Dandaragan Plateau	0.6000	ELE21	S09	0.6145	WAND-1	23a	0.6250	MPK03	23b	S09, 22	23a, 21c, 23b	Greatest similarity to S09
	B56	Good-Very Good	Dandaragan Plateau	0.7000	NEER-3	28	0.7049	MELA-6	23b	0.7097	BNR18	S09	6, 23c	23a, 28	High dissimilarity values. Greatest similarity to 28
	BW10	Very Good-Excellent	Dandaragan Plateau	0.6267	YAN-3	28	0.6389	NEER-3	28	0.6438	THOM-2	24	21c	23a, 28	Greatest similarity to 28
	BW11	Very Good-Excellent	Dandaragan Plateau	0.6559	WAND-1	23a	0.6600	KOON-1	20a	0.6629	ELDO-1	23b	S09, 23c	23a, S09, 28	Greatest similarity to 23a, however not distribution on Dandaragan Plateau
	BW12	Very Good-Excellent	Dandaragan Plateau	0.6962	MELA-9	23b	0.7037	WHITE-1	23a	0.7143	ELE21	S09	6	S09, 28, 23a, 23b	High dissimilarity values. Greatest similarity to 23b

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Vegetation Unit	Representative Quadrat	Vegetation condition	System	Dissimilarity value[ϟ]	SCP Quadrat	FCT	Dissimilarity value[ϟ]	SCP Quadrat	FCT	Dissimilarity value[ϟ]	SCP Quadrat	FCT	SSI Dendrogram Result*	FCT Based on Greatest % Specie in Common^	Inferred FCT
EwXpHh *Eucalyptus wandoo* sparse woodland	B2.45	Very Good-Excellent	Dandaragan Plateau	0.6667	BURNRD 02	3b	0.6909	card13	3b	0.7053	BRIX-2	3a	3b	3b	High dissimilarity values. Greatest similarly to 3b

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Table 3 – Summary of Analysis Results

Vegetation Unit and Description	Representative Quadrats	Inferred FCT	Justification	WA TEC/PEC~
BaXpAn - *Banksia* spp. sparse woodland	B10	23a	Greatest similarly to 23a	NA
	B10.2	23a	Greatest similarity to 23a	NA
	B11	23a	Greatest similarity to 23a, however 23b, more widely distributed on Dandaragan Plateau	NA
	B2.25	23c	Greatest similarity to 23a, however 23a and 21a not distributed on Dandaragan Plateau. FCT 23c distributed on Dandaragan Plateau	NA
	B2.30	23c	Close in similarly values. 23c known to occur on Dandaragan Plateau	NA
	B2.32	28	Greatest similarly to 23a, however 28 is more widely distributed on Dandaragan Plateau	NA
	B49	S09	Greatest similarity S09	NA
	BW14	S09	Greatest similarity 23a, however 23a and 21a have limited distribution on Dandaragan Plateau, therefore best aligned with S09 based on dendrogram result and known distribution	NA
	BW15	28	Greatest similarity to 28. FCT 21a not distributed on Dandaragan Plateau	NA
	BW16	23b	23b - More widely distributed on Dandaragan Plateau	Priority 3- Northern *Banksia attenuata - Banksia menziesii* woodlands
	BW17	23a	Greatest similarity to 23a	NA
BaXpUa - *Banksia attenuata* sparse woodland	B2.48	28	Greatest similarity to 28	NA
	B2.49	28	Greatest similarity to 28	NA
	B2.50	28	Greatest similarity to 28	NA
	B55	S09	Greatest similarity to S09	NA
	BW03	S09	Inconclusive. High dissimilarity values. Greatest similarity to S09	NA
	BW04	28	Inconclusive. Variable results. Comparative Gibson/Keighery quadrat located some distance from DE. FCT 28 distributed on Dandaragan Plateau. Site THOM-2 adjacent to Thompsons Lake, site FL-6 adjacent to Forrestdale Lake.	NA
	BWC01	23b	23b distributed on Dandaragan Plateau. FCT 20c not distributed on Dandaragan Plateau. Key indicator species of BWC01 (*Eucalyptus todtiana)* does not occur within FCT 20a.	Priority 3 - Northern *Banksia attenuata - Banksia menziesii* woodlands

Vegetation Unit and Description	Representative Quadrats	Inferred FCT	Justification	WA TEC/PEC~
BaXpUa - *Banksia attenuata* sparse woodland (cont.)	C04	28	High dissimilarity values. Greatest similarity to 28	NA
	C06	28	High dissimilarity values. Greatest similarity to 28	NA
EmBsHh - *Eucalyptus marginata* and *Banksia sessilis* sparse woodland	B08	23c	Greatest similarity to 23c. 21a and 21b are not distributed on Dandaragan Plateau	NA
	B09	28	Greatest similarity to 28. 20b not distributed on Dandaragan Plateau. Dominant indicator species of B09 (*Banksia sessilis*) does not occur in FCT 20b	NA
	B09.2	28	B09 exhibits similarity to 28. 20b not distributed on Dandaragan Plateau. Dominant indicator species of B09.2 (*Banksia sessilis*) does not occur in FCT 20b	NA
	B15R	28	Greatest similarity to 28	NA
	B2.31	3b	Greatest similarly to 3b. The most similar Gibson quadrat CARD13 (FCT 3b) occurs 85 km south of the project area and is reflected in the high dissimilarly value (0.6907 and therefore only 30.93% similar). Despite the high dissimilarity, may be considered a northern expression of FCT 3b (DBCA 2022)	WA Vulnerable TEC– *Corymbia calophylla – Eucalyptus marginata* woodland on sandy clay soils
	B2.33	3b	Greatest similarly to 3b. The most similar Gibson quadrat CARD12 (FCT 3b) occurs 85 km south of the project area and is reflected in the high dissimilarly value (0.6889 and therefore only 31.11% similar). Despite the high dissimilarity, may be considered a northern expression of FCT 3b (DBCA 2022)	WA Vulnerable TEC– *Corymbia calophylla – Eucalyptus marginata* woodland on sandy clay soils
	C03	3b	Greatest similarly to 3b. The most similar Gibson quadrat CARD12 (FCT 3b) occurs 85 km south of the project area and is reflected in the high dissimilarly value (0.6552, and therefore only 31.11% similar). Despite the high dissimilarity, may be considered a northern expression of FCT 3b (DBCA 2022)	WA Vulnerable TEC – *Corymbia calophylla – Eucalyptus marginata* woodland on sandy clay soils
EmBsHh - *Eucalyptus marginata* and *Banksia sessilis* sparse woodland (cont.)	C09	3b	Greatest similarly to 3b. The most similar Gibson quadrat CARD12 (FCT 3b) occurs 85 km south of the project area and is reflected in the high dissimilarly value (0.6627, and therefore only 33.73% similar). Despite the high dissimilarity, may be considered a northern expression of FCT 3b (DBCA 2022)	WA Vulnerable TEC– *Corymbia calophylla – Eucalyptus marginata* woodland on sandy clay soils

Vegetation Unit and Description	Representative Quadrats	Inferred FCT	Justification	WA TEC/PEC~
EmXpAn - *Eucalyptus marginata* sparse woodland	B2.19	23a	21a not widely distributed on Dandaragan Plateau. Closest to 23a	NA
	B2.51	23a	High dissimilarity value. Greatest similarity to 23a	NA
EmXpHh - *Eucalyptus marginata* sparse woodland	B2.12	3b	Greatest similarity to 3b. The most similar Gibson quadrat CARD13 (FCT 3b) occurs 85 km south of the project area and is reflected in the high dissimilarly value (0.6627, and therefore only 33.73% similar). Despite the high dissimilarity, may be considered a northern expression of FCT 3b (DBCA 2022)	WA Vulnerable TEC – *Corymbia calophylla – Eucalyptus marginata* woodland on sandy clay soils
EtBeAn - *Eucalyptus todtiana* sparse woodland	B15	23a	Greatest similarity to 23a, however limited distribution on Dandaragan Plateau	NA
	B16R	20a	Greatest similarity to 23b, however the resulting dendrograms indicate greater affinity to FCT20a. Considered most likely to be representative of FCT20a, however, not possible to ascertain based on relevé data, sampled due to assess constraints	WA Endangered TEC – *Banksia attenuata* woodlands over species rich dense shrublands
	B17	28	Greatest similarity to 28	NA
	B18	23a	Greatest similarity to 23a. 21a and 20b limited distribution on Dandaragan Plateau	NA
	B18.2	23a	Greatest similarity to 23a, however limited distribution on Dandaragan Plateau	NA
	B19	23b	Greatest similarity to 23b	Priority 3 - Northern *Banksia attenuata - Banksia menziesii* woodlands
	B19.2	23b	Greatest similarity to 23b	Priority 3 - Northern *Banksia attenuata - Banksia menziesii* woodlands
	B51	23a	Greatest similarity to 23a, however limited distribution on Dandaragan Plateau.	NA
	B54	S09	Greatest similarity to S09	NA
	BW06	28	Greatest similarity to 28	NA
EtBeAn - *Eucalyptus todtiana* sparse woodland (cont.)	BW07	S09	Greatest similarity to S09. S09 more widely distributed	NA
	BW08	S09	High dissimilarity values. Greatest similarity to S09 sites	NA
	BW09	23b	Greatest similarity to 23b	Priority 3 - Northern *Banksia attenuata - Banksia menziesii* woodlands
	BW18	23b	Greatest similarity to 23b	Priority 3 - Northern *Banksia attenuata - Banksia menziesii* woodlands

Vegetation Unit and Description	Representative Quadrats	Inferred FCT	Justification	WA TEC/PEC~
	BWC02	23b	Greatest similarity to 23b	Priority 3 - Northern *Banksia attenuata - Banksia menziesii* woodlands
	BWC03	23c	Greatest similarity to 23c	NA
	C01	23b	Greatest similarity to 23b	Priority 3 - Northern *Banksia attenuata - Banksia menziesii* woodlands
	C02	23b	Inconclusive. YAN-19 (23b) is closest distributed site. FCT 22 does not contain key dominant species	Priority 3 - Northern *Banksia attenuata - Banksia menziesii* woodlands
EtEpAn - *Eucalyptus todtiana* sparse woodland	B42	S09	Greatest similarity to S09	NA
	B46	S09	Greatest similarity to S09	NA
	B46.2	S09	Greatest similarity to S09	NA
	B56	28	High dissimilarity values. Greatest similarity to 28	NA
	BW10	28	Greatest similarity to 28	NA
	BW11	23a	Greatest similarity to 23a, however not distributed on Dandaragan Plateau	NA
	BW12	23b	High dissimilarity values. Greatest similarity to 23b	Priority 3 - Northern *Banksia attenuata - Banksia menziesii* woodlands
EwXpHh - *Eucalyptus wandoo* sparse woodland	B2.45	3b	Greatest similarly to 3b. The most similar Gibson quadrat BURNRD02 (FCT 3b) occurs 140 km south of the project area and is reflected in the high dissimilarly value (0.6667, and therefore only 33.33% similar). Despite the high dissimilarity, may be considered a northern expression of FCT 3b (DBCA 2022)	WA Vulnerable TEC– *Corymbia calophylla – Eucalyptus marginata* woodland on sandy clay soils

~Areas of TEC/PEC mapped within the DE shown in **Figure 1**

Table 4 – Summary of Results of all Comparative Analyses

Vegetation Unit	FCT	Representative Quadrats	Comments	WA TEC PEC~	Extent in DE (ha)	% in DE
BaXpAn - *Banksia* spp. sparse woodland	23a	B10, B10.2, B11, BW17	FCT 23a predominantly occurs on the Swan Coastal Plain. One Gibson/Keighery Quadrat occurs approximately 80 m from the boundary of the Swan Coastal Plain and the Dandaragan Plateau. This FCT is not widely distributed on the Dandaragan Plateau	-	-	-
	23c	B2.25, B2.30,	FCT 23c has distribution within the Dandaragan Plateau, closest Gibson/Keighery quadrat occurs approximately 12 km from the project area	-	-	-
	28	B2.32, BW15	FCT 28 is known to occur on Dandaragan Plateau approximately 30 km north west of the project area	-	-	-
	S09	B49, BW14	S09 is widely distributed through the Dandaragan Plateau	-	-	-
	23b	BW16	FCT **23b** is widely distributed through the Dandaragan Plateau	Priority 3	4.67	0.18
BaXpUa - *Banksia attenuata* sparse woodland	28	B2.48, B2.49, B2.50, BW04, C04, C06	FCT 28 is known to occur on Dandaragan Plateau approximately 30 km north west of the project area	-	-	-
	S09	B55, BW03	S09 is widely distributed through the Dandaragan Plateau	-	-	-
	23b	BWC01	FCT **23b** is widely distributed through the Dandaragan Plateau	Priority 3	2.02	0.08
EmBsHh - *Eucalyptus marginata* and *Banksia sessilis* sparse woodland	23c	B08	FCT 23c has distribution within the Dandaragan Plateau, closest Gibson/Keighery quadrat occurs approximately 12 km from the project area	-	-	-
	28	B09, B09.2, B15R	FCT 28 is known to occur on Dandaragan Plateau approximately 30 km north west of the project area	-	-	-
	3b	B2.31, B2.33, C03, C09	FCT 3b is not widely distributed on the Dandaragan Plateau and predominantly occurs south of Perth CBD in the Peel Region. High dissimilarity values resulted from analysis of quadrats in comparison to FCT 3b reference sites. Correspondence with DBCA (2022) considered vegetation in the locations of these quadrats to possibly be a northern expression of FCT 3b	Vulnerable (WA)	16.56	0.64
EmXpAn - *Eucalyptus marginata*	23a	B2.19, B2.51	FCT 23a predominantly occurs on the Swan Coastal Plain. One Gibson/Keighery quadrat occurs approximately 80 m from the boundary of the Swan Coastal Plain and the Dandaragan Plateau. This FCT is not widely distributed on the Dandaragan Plateau	-	-	-

Vegetation Unit	FCT	Representative Quadrats	Comments	WA TEC PEC~	Extent in DE (ha)	% in DE
EmXpHh - *Eucalyptus marginata* sparse woodland	3b	B2.12	FCT 3b is not widely distributed on the Dandaragan Plateau and predominantly occurs south of Perth CBD in the Peel Region. High dissimilarity values resulted from analysis of this quadrat in comparison to FCT 3b reference sites. Correspondence with DBCA (2022) considered vegetation in the location of this quadrat to possibly be a northern expression of FCT 3b	Vulnerable (WA)	4.75	0.19
EtBeAn - *Eucalyptus todtiana* sparse woodland	20a	B16R	FCT 20a has a limited distribution on the Swan Coastal Plain. One outlier Gibson *et al.* (1994) quadrat occurs approximately 6 km WSW west of the most southern end of the project area	Endangered	7.88	0.31
	23a	B15, B18, B18.2, B51,	FCT 23a predominantly occurs on the Swan Coastal Plain. One Gibson/Keighery Quadrat occurs approximately 80m from the boundary of the Swan Coastal Plain and the Dandaragan Plateau. This FCT is not widely distributed on the Dandaragan Plateau	-	-	-
	23b	B19, B19.2, BW09, BW18, BWC02, C01, C02	FCT **23b** is widely distributed through the Dandaragan Plateau	Priority 3	16.07	0.63
	28	B17, BW06,	FCT 28 is known to occur on Dandaragan Plateau approximately 30 km north-west of the project area	-	-	-
	S09	B54, BW07, BW08	S09 is widely distributed through the Dandaragan Plateau	-	-	-
	23c	BWC03	FCT 23c has distribution within the Dandaragan Plateau, closest Gibson/Keighery quadrat occurs approximately 12 km from the project area	-	-	-
EtEpAn - *Eucalyptus todtiana* sparse woodland	S09	B42, B46, B46.2,	S09 is widely distributed through the Dandaragan Plateau	-	-	-
	28	B56, BW10,	FCT 28 is known to occur on Dandaragan Plateau approximately 30 km north west of the project area	-	-	-
	23a	BW11	FCT 23a predominantly occurs on the Swan Coastal Plain. One Gibson/Keighery quadrat occurs approximately 80 m from the boundary of the Swan Coastal Plain and the Dandaragan Plateau. This FCT is not widely distributed on the Dandaragan Plateau	-	-	-
	23b	BW12	FCT **23b** is widely distributed through the Dandaragan Plateau	Priority 3	3.83	0.15

Vegetation Unit	FCT	Representative Quadrats	Comments	WA TEC PEC~	Extent in DE (ha)	% in DE
EwXpHh - *Eucalyptus wandoo* sparse woodland	3b	B2.45	FCT 3b is not widely distributed on the Dandaragan Plateau and predominantly occurs south of Perth CBD in the Peel Region. High dissimilarity values resulted from analysis of this quadrat in comparison to FCT 3b reference sites. Correspondence with DBCA (2022) considered vegetation in the location of this quadrat to possibly be a northern expression of FCT 3b	Vulnerable (WA)	4.05	0.16
				Area of FCT 3b	**25.36**	**0.99**
				Area of FCT 20a	**7.88**	**0.31**
				Area of FCT 23b	**26.59**	**1.04**
				Area of Important FCTs	**59.83**	**2.34**

~Areas of FCT23b mapped within the DE shown in **Figure 1**

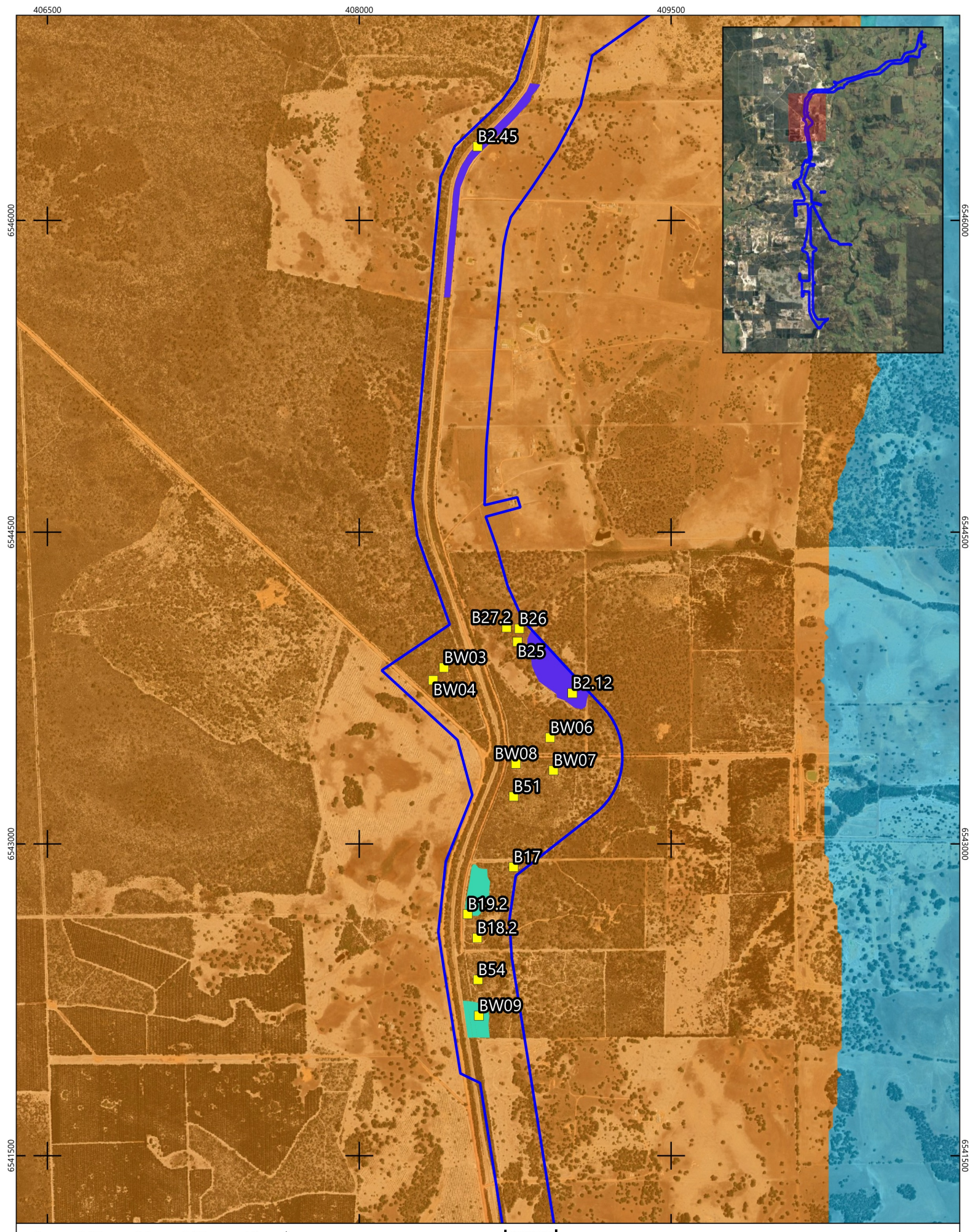

Figure 1a - DBCA-Listed TEC and PEC Extent

ASJV17001 02 May 2022

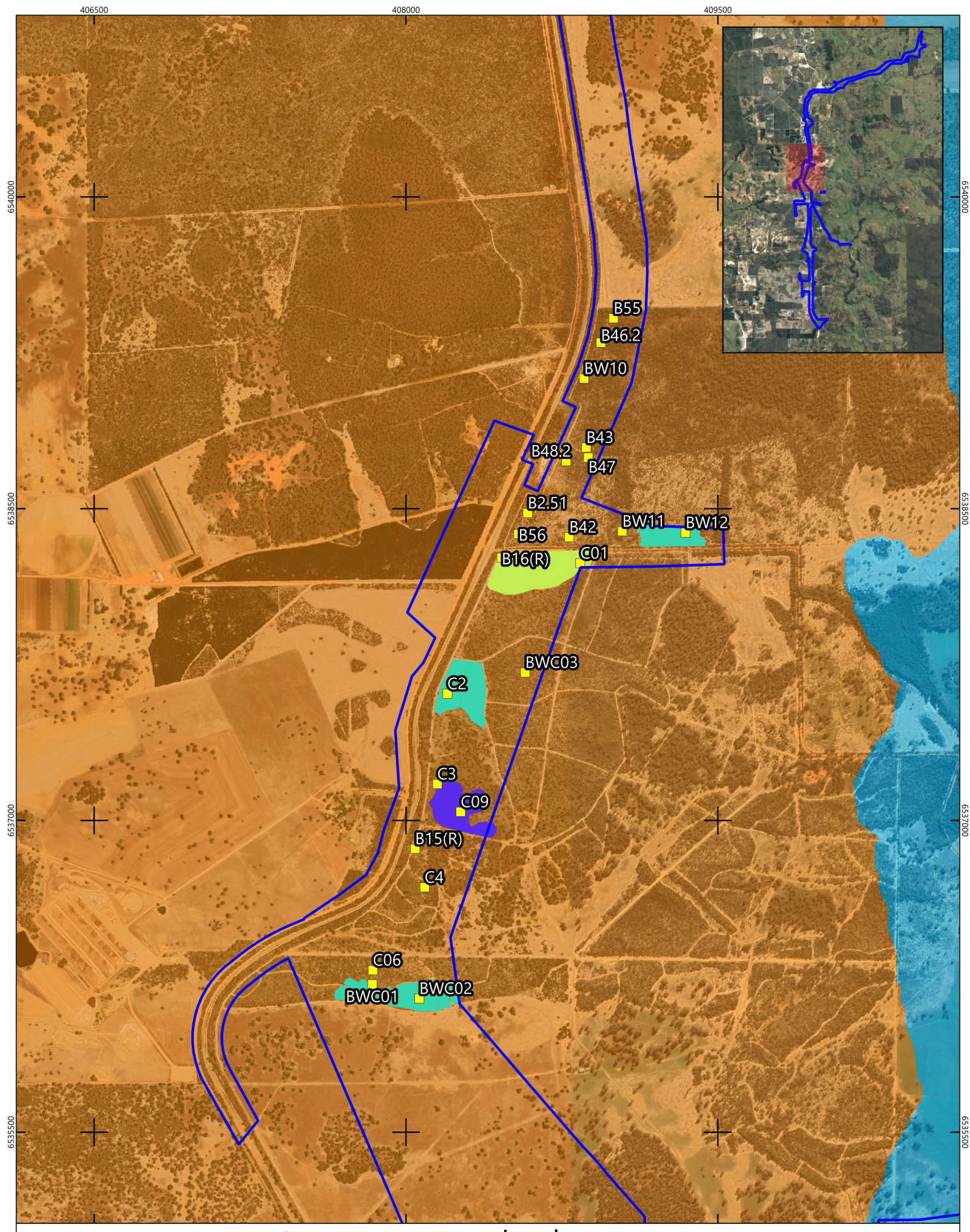

Figure 1b - DBCA-Listed TEC and PEC Extent

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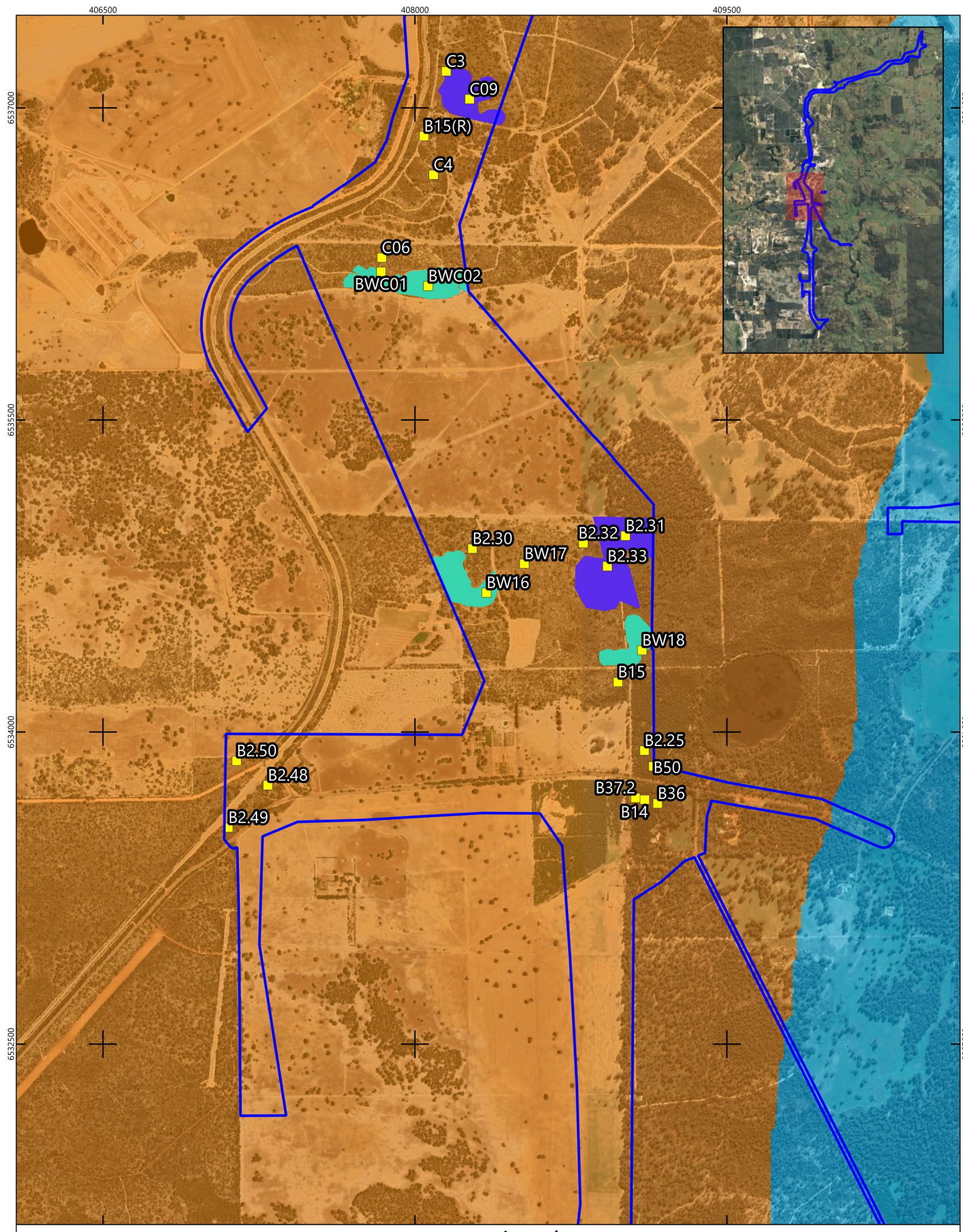

Figure 1c - DBCA-Listed TEC and PEC Extent

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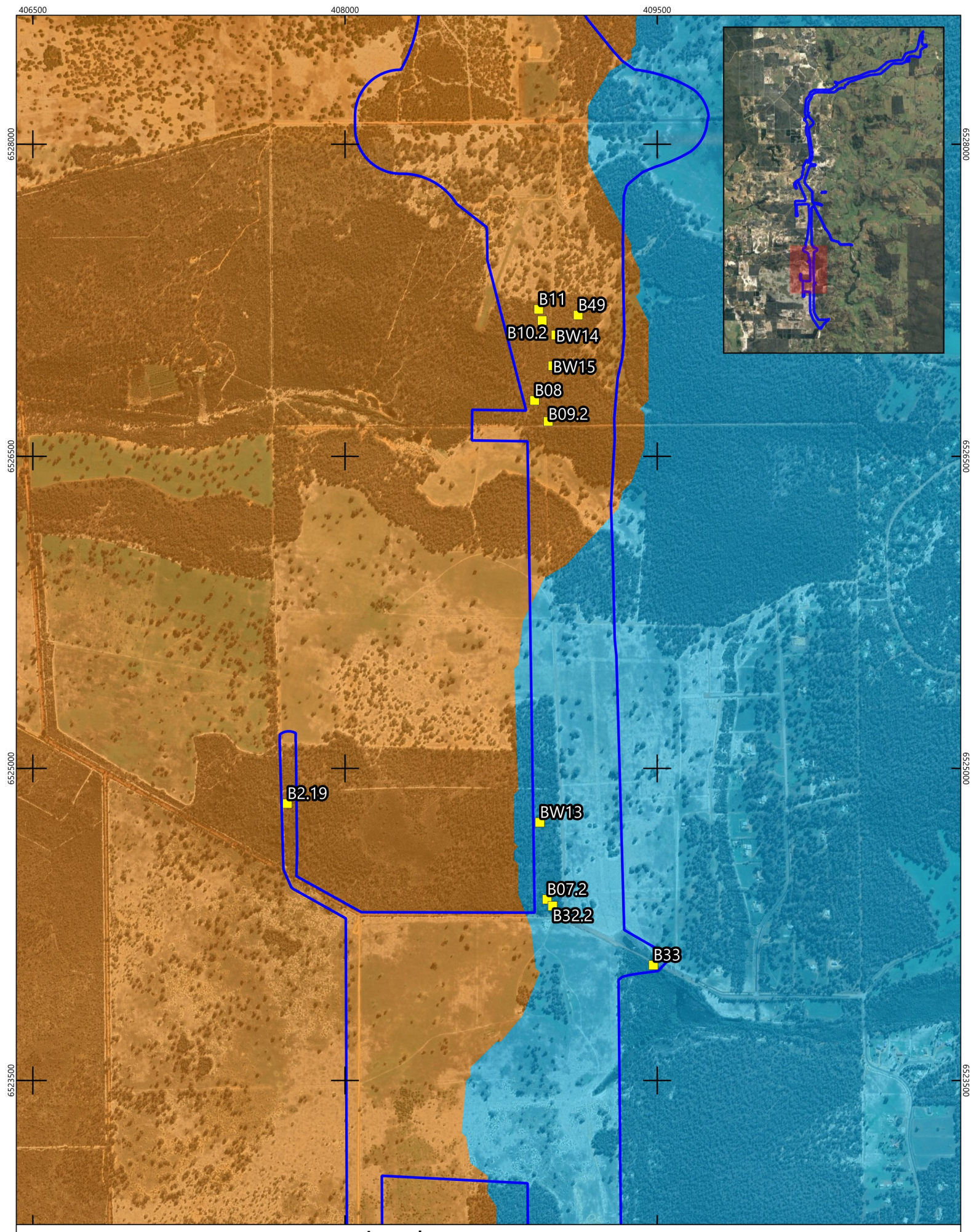

Figure 1d - DBCA-Listed TEC and PEC Extent

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4. DISCUSSION

'Batch' and SSI analysis of the quadrat data using PATN™ software was carried out for all quadrats within the DE considered to potentially represent TECs or PECs, with a focus on the determination of FCTs that comprises the Banksia woodlands TEC (**Table 1**). 'Batch' analysis was conducted in grouping of five to eight quadrats for all eight vegetation units. The batch analysis indicated variations in FCTs within each vegetation unit, which was confirmed with initial SSI for randomly selected quadrats. The SSI results for the majority of quadrats did not align with the 'batch' analysis results and therefore, SSI was conducted for all quadrats (**Table 2**).

The comparison of presence/absence flora species data for all potential Banksia woodland quadrats in comparison to the consolidated Gibson *et al.* (1994) and Keighery *et al.* (2008) datasets (targeting detection of Banksia woodland FCTs and other FCTs that represent TECs and PECs) which was conducted using PATN analysis, indicated discrepancies in the results between 'batch' analysis and SSI analysis. Therefore, the results from the 'batch' analysis were disregarded, and rather, the results from the SSI analysis were utilised as a main basis for the inference of the FCTs. Other FCTs of conservation significance such as 3a, 3b and 3c that are not typically known to occur in the region of the DE or form part of the EPBC-listed Banksia woodland TEC were not part of the assessment.

Statistical analysis of sampled quadrats containing Banksia species (in order to determine the presence of the Banksia Woodland TEC), determined that six quadrats; B2.12, B2.31, B2.33, B2.45, C03 and C09, showed the greatest similarity to FCT 3b. These quadrats exhibited high dissimilarity index values in comparison to Gibson *et. al* (1994) sites which may be attributed to the distance of these sites from the project area. Despite the high dissimilarity indices and the distance (the closest sites being approximately 65 km away) from the project area, as suggested by DBCA, the vegetation in the locations of the six sampled quadrats may be considered northern expressions of FCT 3b (DBCA 2022).

The species composition of each individual Banksia quadrat was compared against the Gibson *et al.* (1994) and Keighery *et al.* (2012) dataset utilising the Bray-Curtis Dissimilarity Index in PATN. All of the quadrats analysed displayed dissimilarly values of greater than 0.5 (less than 50% similarity). Of these, fifteen quadrats displayed a dissimilarity value between 0.5 and 0.6, indicating that the species similarities between these quadrats and a Gibson and Keighery quadrats is 40 -50%. Quadrat BW18 (vegetation unit EtBeAn) was found to have the lowest dissimilarity value (0.5085) compared with Gibson *et al.* (1994) and Keighery *et al.* (2012) quadrat, YAN-20 (FCT 23b) and was therefore considered to show affinity to FCT 23b.

One EtEpAn quadrat (B56) returned a dissimilarity value of 0.7 to its closest aligned Gibson *et al.* (1994) and Keighery *et al.* (2012) quadrat (NEER-3, FCT 28)). This indicates that there is only 30% species in common and therefore does not show strong correlation between the quadrats. The remaining 47 quadrats range between 0.6 – 0.7 indicating some affinity to various Banksia-dominated FCTs.

For the majority of the quadrats, simple 'number of species in common' analysis confirmed the results of the SSI PATN analysis in variable but inconsistent instances. However, in some instances, quadrats exhibited a higher percentage of species in common with FCTs other than those that PATN analysis results (dendrograms) suggested affinity with.

The Gibson *et al.* (1994) and Keighery *et al.* (2012) studies were predominantly carried out on the Swan Coastal Plain and therefore, the majority of the quadrats within the DE which contained *Banksia* spp. occurring on the Darling Plateau, were not included in the analysis. The Bindoon Bypass DE traverses the Jarrah Forrest and interzone between the Swan Coastal Plain and Jarrah Forest and may not provide conclusive results due to the geographical location. Six of the assessed quadrats were found to show affinity

to FCT 3b – *Eucalyptus calophylla-Eucalyptus* marginata woodlands on sandy clay soils of the southern Swan Coastal Plain (**Table 2**).

FCT 3b is not typically known to occur on the Dandaragan Plateau, but rather along the scarp south of Maddington. The comparison of quadrat data to the Gibson *et al.* (1994) and Keighery *et al.* (2012) datasets indicates high dissimilarity values, ranging from 0.6552 to 0.7143 which are therefore considered to have weaker affinity or lesser similarity. The high dissimilarity values and the geographic distribution for FCT 3b may be attributed to the DE occurring within the Swan Coastal Plain and Jarrah Forest interzone and the distance to Gibson *et al.* (1994) sites. Despite this, the vegetation in the locations of the six discussed quadrats may be considered a northern expression of FCT 3b (DBCA 2022).

Through the interrogation of the dissimilarity indices, one quadrat BWC01 (BaXpUa), recorded an index of 0.6545 to State Critically Endangered FCT 20c – *Eastern shrublands and woodlands* and an index of 0.6600 to Endangered FCT 20a - *Banksia attenuata* woodlands over species rich dense shrublands. The species composition of BWC01 identified *Banksia attenuata* and *Eucalyptus todtiana* to be the key dominant upper-storey species. Examination of the species composition for Gibson *et al.* (1994) and Keighery *et al.* (2008) quadrats for FCT 20c and FCT 20a indicates that *Eucalyptus todtiana* does not occur within Keighery *et al.* (2012) quadrats. *Eucalyptus todtiana* is known to occur in other vegetation units in Hazelmere recently confirmed to be representative of FCT 20c (DBCA 2022) and therefore, the presence of FCT 20c within the project area cannot be discounted. However, based on the known distribution of the FCTs, it is considered more likely that quadrat BWC01 is representative of the more widely distributed FCT 23b – Northern *Banksia attenuata – Banksia menziesii* woodlands.

Sampled relevé B16r recorded the greatest similarity to FCT 23b (0.5962), however, the resulting dendrogram clustering (**Appendix 1**) indicates a greater affinity to FCT 20a (DBCA 2022). Correspondence with DBCA (2022) indicates that this quadrat is likely to be representative of FCT 20a, however, due to access constraints, as the analysis was conducted using relevé rather than quadrat data, this may not provide definitive results.

The consolidated results of the data analysis that aimed to further determine FCTs (**Table 3**) indicate that as previously reported in FVC (2018c), BaXpAn, EmXpAn, EtBeAn and EtEpAn show affinity to FCTs that are considered representative of the Banksia woodland TEC. At FCT level, the Banksia woodland vegetation of the study area is concluded to be mostly representative of FCT 28 with smaller representations of S09, FCT 23a, FCT 23b, FCT 23c and FCT 20a.

In summary, the results of the FCT analysis conclude that the Banksia woodland vegetation units are likely to be representative of the following FCTs:

- SCP S09 - *Banksia attenuata* woodlands over dense low shrublands
- SCP 20a – *Banksia attenuata* woodlands over species rich dense shrublands
- SCP 23a - Central *Banksia attenuata - Banksia menziesii* woodlands
- SCP 23b - Northern *Banksia attenuata - Banksia menziesii* woodlands (WA Priority 3 PEC)
- SCP 23c - North-eastern *Banksia attenuata - Banksia menziesii* woodlands
- SCP 28 - Spearwood *Banksia attenuata* or *Banksia attenuata – Eucalyptus* woodlands.

In addition to the afore mentioned Banksia Woodland FCTs, three additional vegetation units EmBsHh, EmXpHh and EwXpHh may be considered a northern expression of FCT 3b (DBCA 2022) (**Table 5**).

Table 5 – Quadrats within the Development Envelope that Show Affinity to TECs or PECs

Quadrat No.	Vegetation Unit	TEC or PEC	Comments
B16R	EtBeAn	20a	Greatest similarity to 23b, however the resulting dendrograms indicate greater affinity to FCT 20a. It is considered most likely to be representative of FCT 20a
BW16	BaXpAn	23b	Lowest dissimilarity value, 23b more widely distributed on Dandaragan Plateau
BWC01	BaXpUa	23b	23b widely distributed on Dandaragan Plateau
B16R	EtBeAn	23b	Lowest dissimilarity value, 23b more widely distributed on Dandaragan Plateau
B19		23b	Shows affinity to 23a and 23b. Comparison of B19 and B19.2 identified the greatest similarity to 23b. 23a has limited distribution on Dandaragan Plateau
B19.2		23b	Shows affinity to 23a and 23b. Comparison of B19 and B19.2 identified the greatest similarity to 23b. 23a has limited distribution on Dandaragan Plateau
BW09		23b	Greatest similarity to 23b
BW18		23b	Greatest similarity to 23b
BWC02		23b	Lowest dissimilarity value, 23b more widely distributed on Dandaragan Plateau
C01		23b	Greatest similarity to 23b
C02		23b	YAN-19 (23b) is closest distributed site. FCT 22 does not contain key dominant species
BW12	EtEpAn	23b	High dissimilarity values. Greatest similarity to 23b
B2.31	EmBsHh	3b	Greatest similarly to 3b, although dissimilarity index is high (less similar). The most similar Gibson *et al.* (1994) quadrat CARD13 (FCT 3b) occurs 85 km south of the project area, with high dissimilarity likely a reflection of the large distance away
B2.33		3b	Greatest similarly to 3b, although dissimilarity index is high (less similar). The most similar Gibson *et al.* (1994) quadrat CARD12 (FCT 3b) occurs 85 km south of the project area, with high dissimilarity likely a reflection of the large distance away
C03		3b	Greatest similarly to 3b, although dissimilarity index is high (less similar). The most similar Gibson *et al.* (1994) quadrat CARD12 (FCT 3b) occurs 85 km south of the project area, with high dissimilarity likely a reflection of the large distance away
C09		3b	Greatest similarly to 3b, although dissimilarity index is high (less similar). The most similar Gibson *et al.* (1994) quadrat CARD12 (FCT 3b) occurs 85 km south of the project area, with high dissimilarity likely a reflection of the large distance away
B2.12	EmXpHh	3b	Greatest similarly to 3b, although dissimilarity index is high (less similar). The most similar Gibson *et al.* (1994) quadrat CARD13 (FCT 3b) occurs 85 km south of the project area, with high dissimilarity likely a reflection of the large distance away
B2.45	EwXpHh	3b	Greatest similarly to 3b, although dissimilarity index is high (less similar). The most similar Gibson *et al.* (1994) quadrat BURNRD (FCT 3b) occurs 140 km south of the project area, with high dissimilarity likely a reflection of the large distance away

The quadrats presented in **Table 5** were recorded within four different vegetation units as defined and mapped across the study area. Within each of these vegetation units, the various quadrats sampled show affinities to Priority 3 Ecological Community, FCT 23b. This result highlights that vegetation units defined and mapped via detailed flora and vegetation surveys often do not support a single FCT, and that FCTs often occur with patchy distribution and may have subtle differences not detectable immediately on the ground.

Eleven of the assessed quadrats that occur within the DE were found to show affinity to FCT 23b – Northern *Banksia attenuata – Banksia menziesii* woodlands a State listed PEC listed above, as summarised in **Table 5** and spatially presented in **Figure 1**. The dissimilarity indices for these eleven quadrats ranged from 0.5085 to 0.962. Quadrat BW18 and C01, both within EtBeAn, showed strong affinity to FCT 23b with indices of 0.5085 and 0.549, respectively. All other quadrats displayed dissimilarity indices of greater than 0.6 and are therefore considered to have weaker affinity or similarity.

5. CLOSING

Should you require further information or clarification regarding the information provided in this memorandum, please do not hesitate to contact the undersigned.

Best Regards,
Kellie Bauer-Simpson
Principal Ecologist/Environmental Manager
Focused Vision Consulting Pty Ltd

6. REFERENCES

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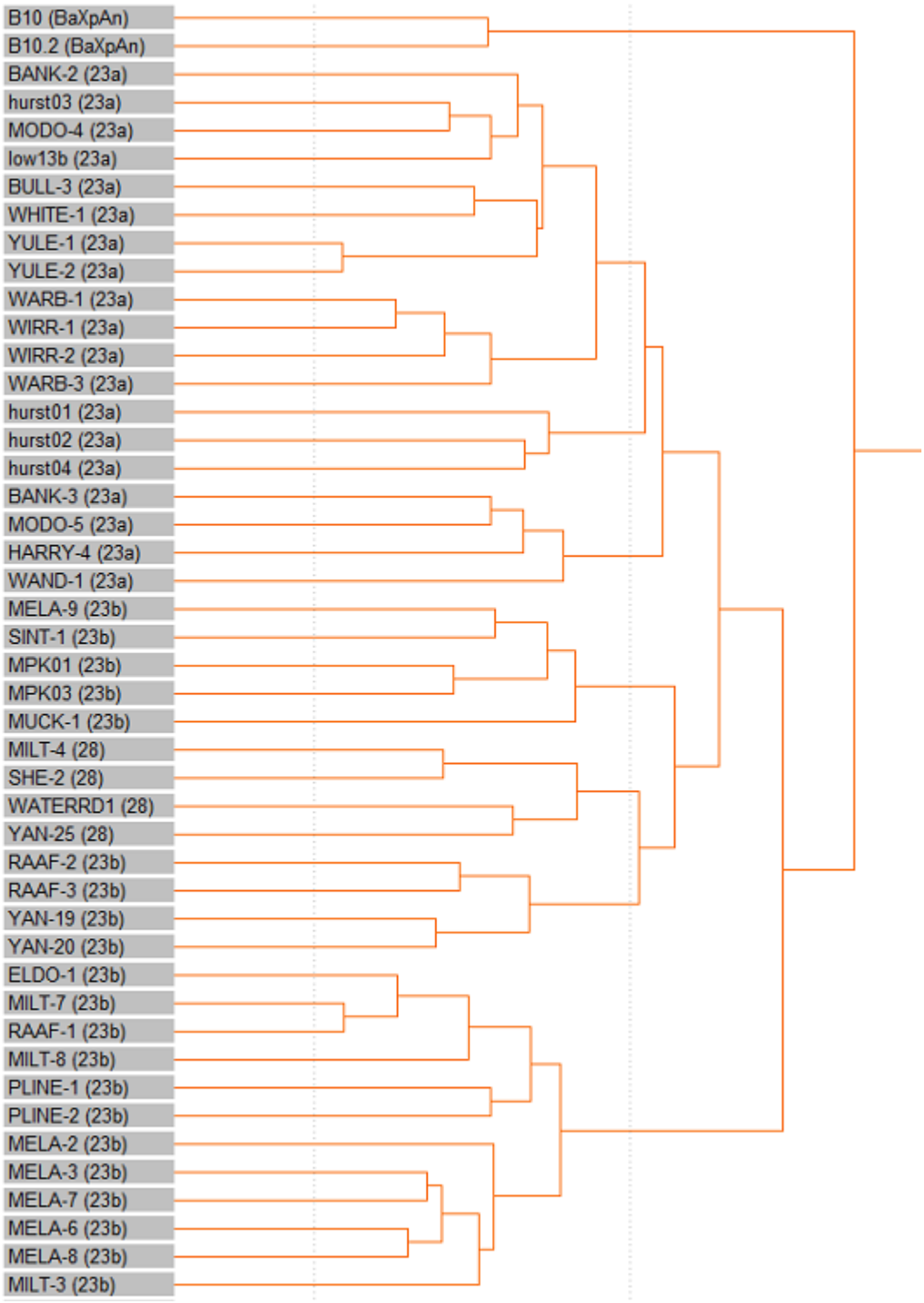
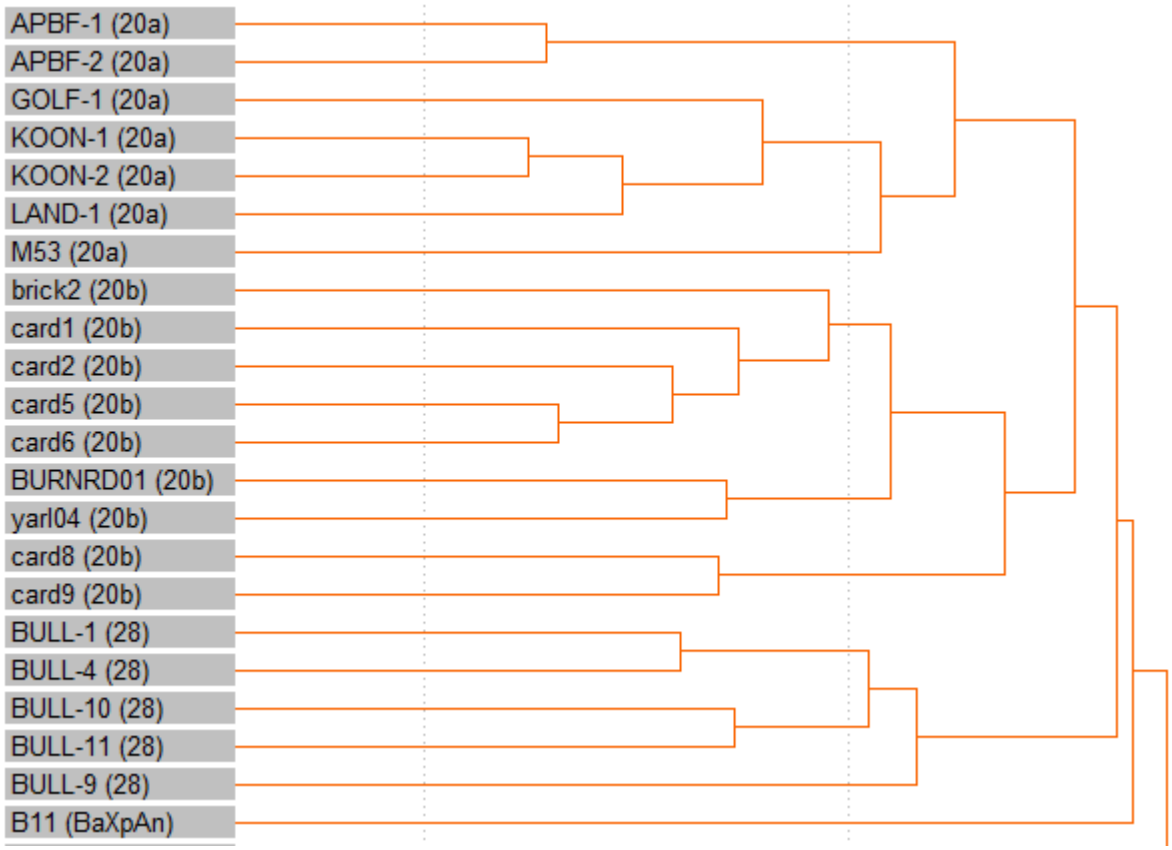
APPENDIX 1 – BATCH AND SSI DENDROGRAMS

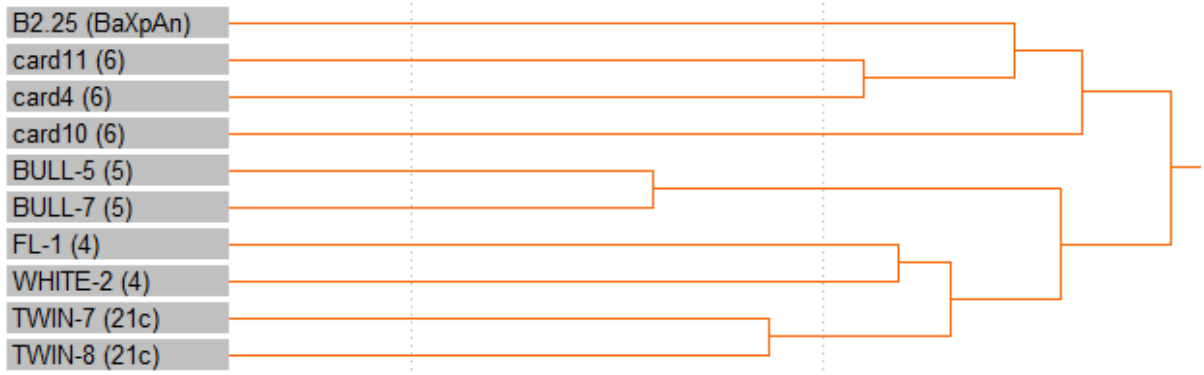
Dendrogram 1.01 – BaXpAn SSI B10/B10.2



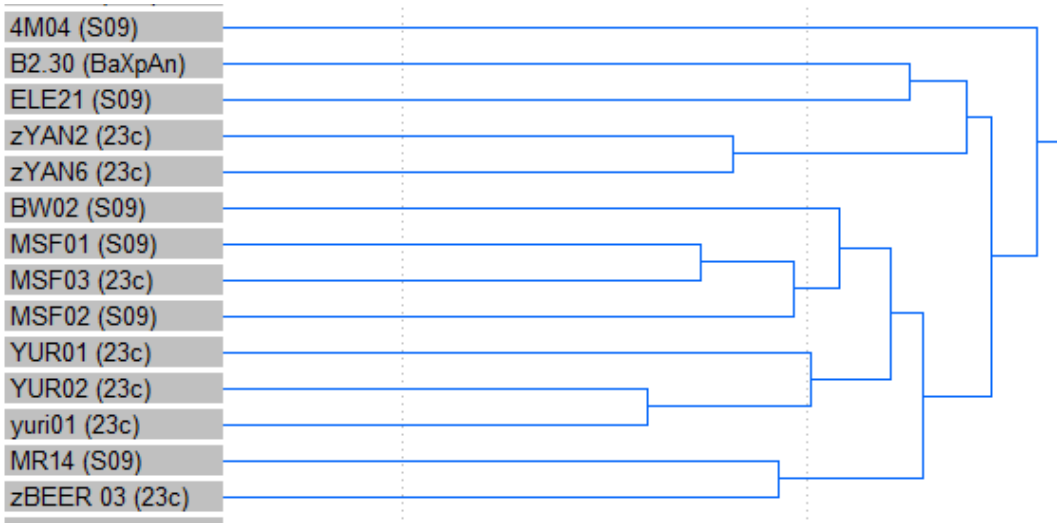
Dendrogram 1.02 – BaXpAn SSI B11



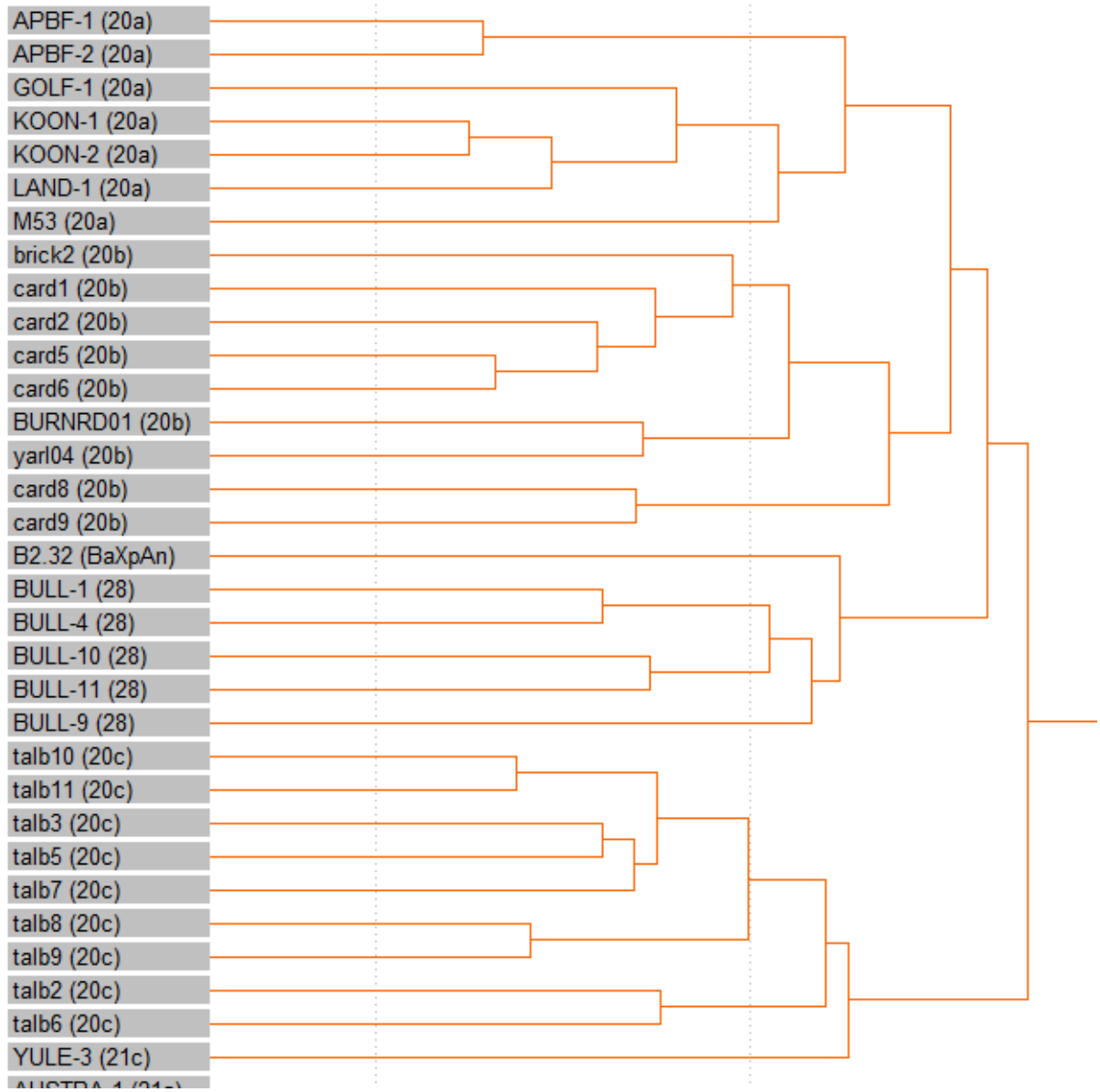
Dendrogram 1.03 – BaXpAn SSI B2.25



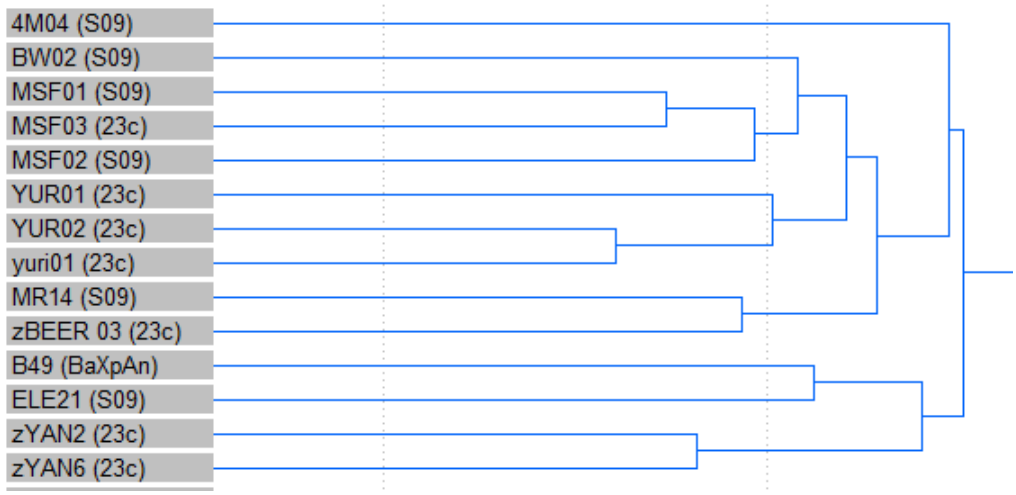
Dendrogram 1.04– BaXpAn SSI B2.30



Dendrogram 1.05 – BaXpAn SSI B2.32

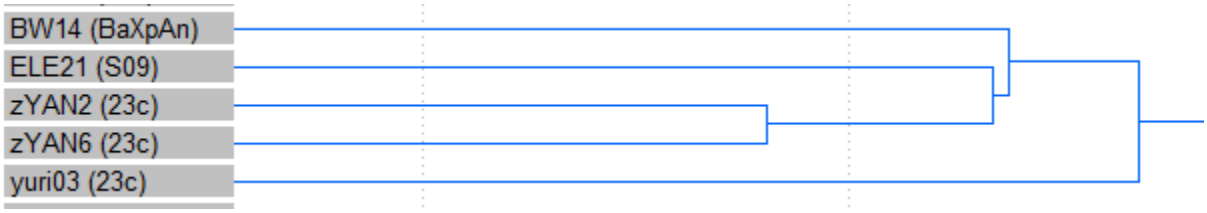


Dendrogram 1.06 – BaXpAn SSI B49



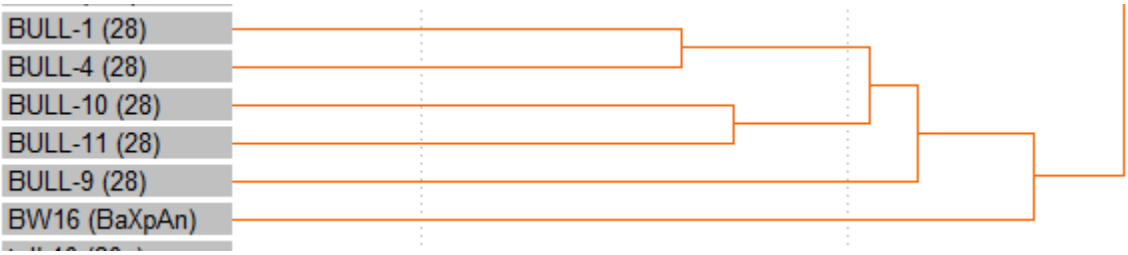
Dendrogram 1.07 – BaXpAn SSI BW13

Dendrogram 1.08 – BaXpAn SSI BW14

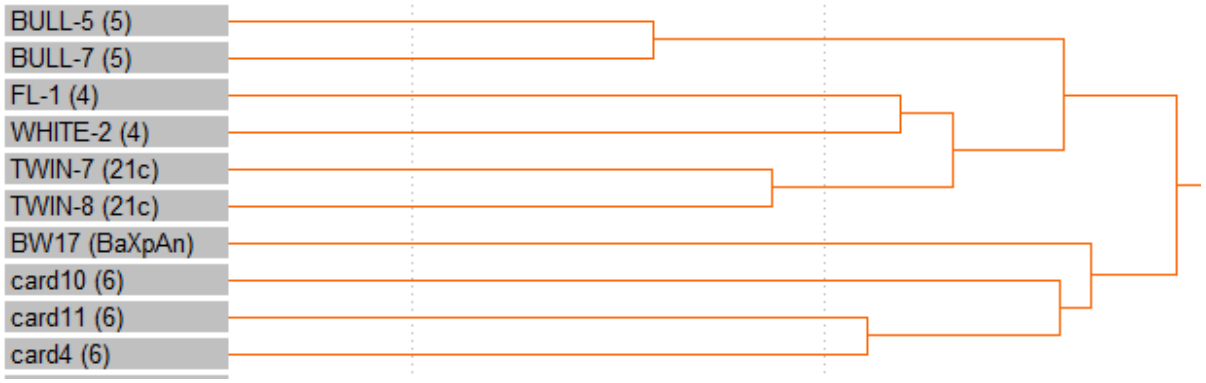


Dendrogram 1.09 – BaXpAn SSI BW15

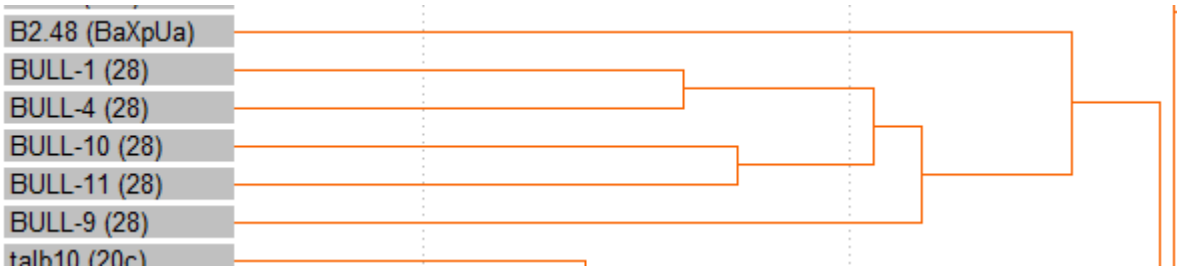
Dendrogram 1.10 – BaXpAn SSI BW16



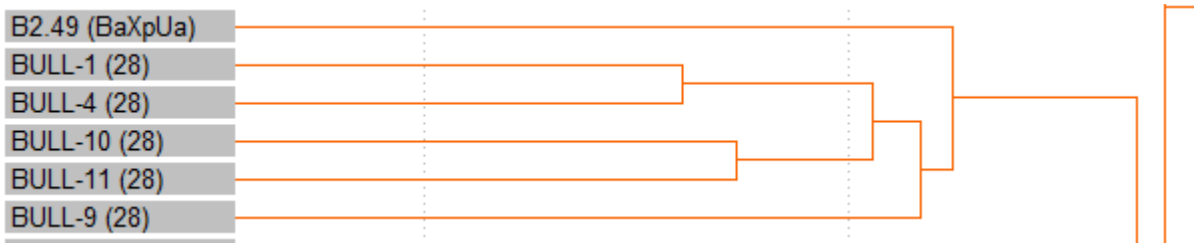
Dendrogram 1.11 – BaXpAn SSI BW17



Dendrogram 2.01 – BaXpUa SSI B2.48

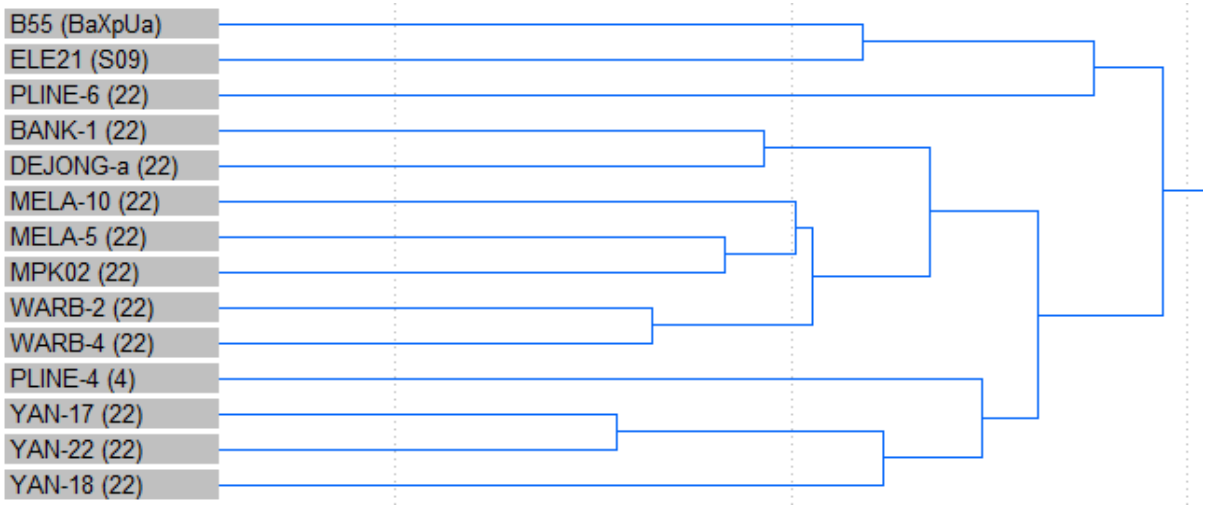


Dendrogram 2.02 – BaXpUa SSI B2.49



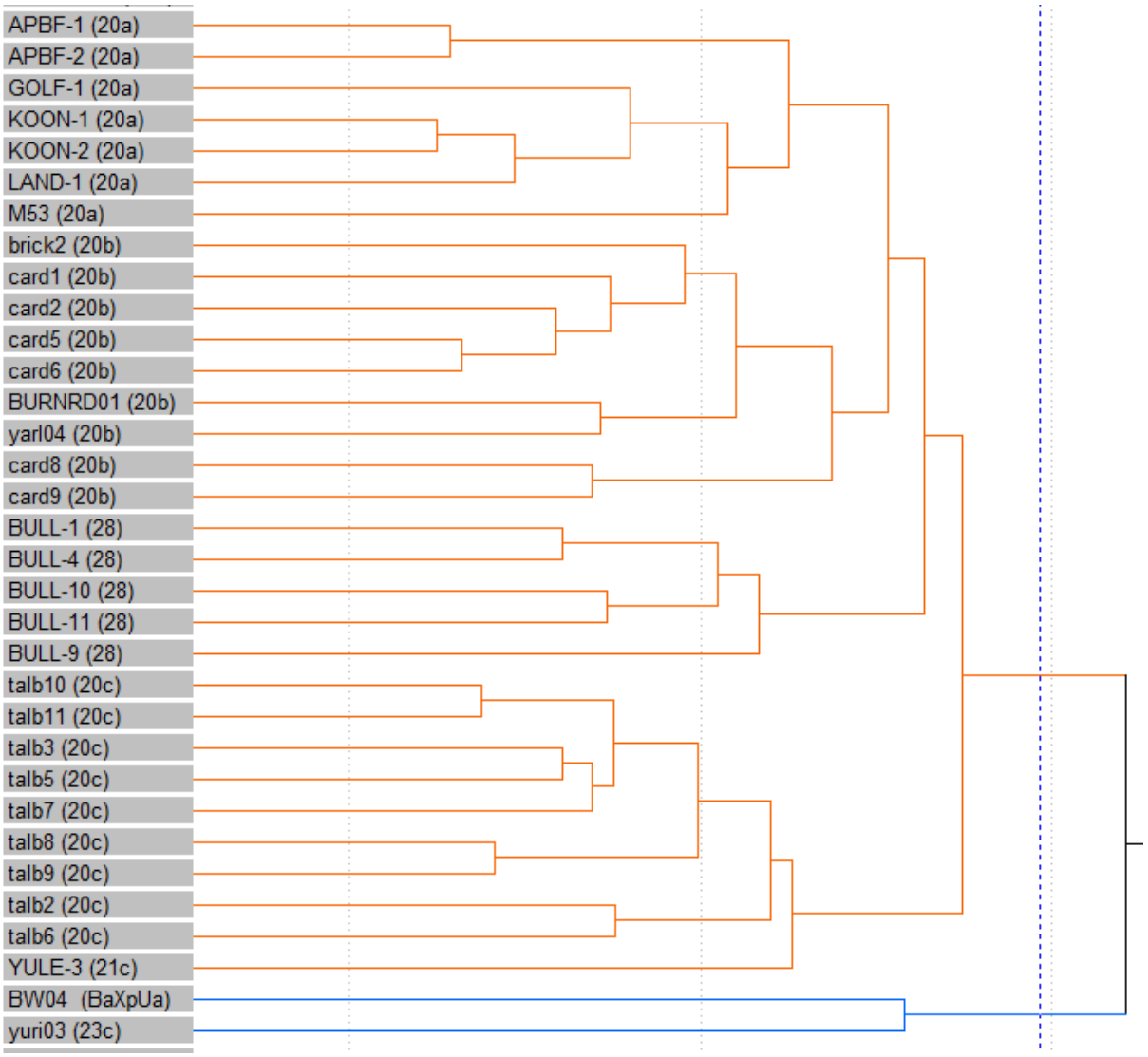
Dendrogram 2.03 – BaXpUa SSI B2.50

Dendrogram 2.04 – BaXpUa SSI B55

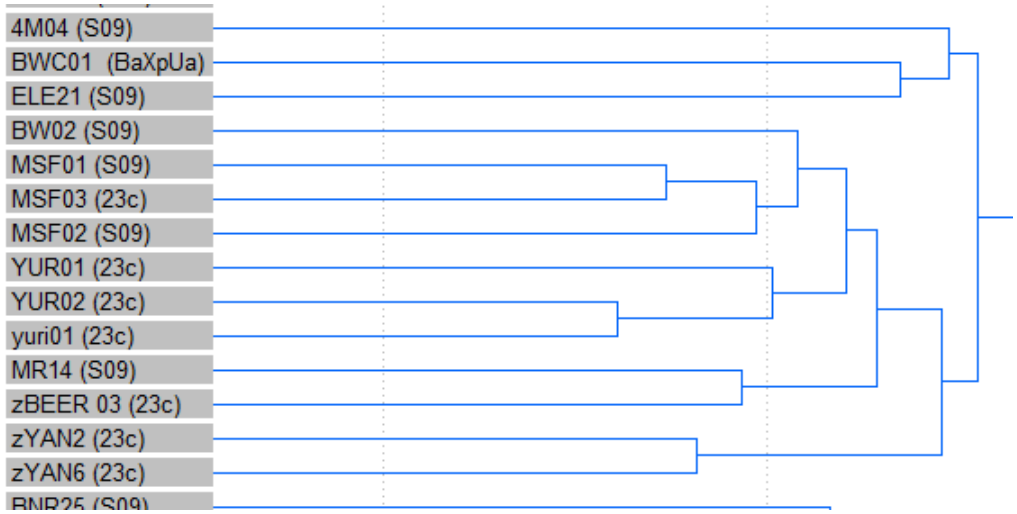


Dendrogram 2.05 – BaXpUa SSI BW03

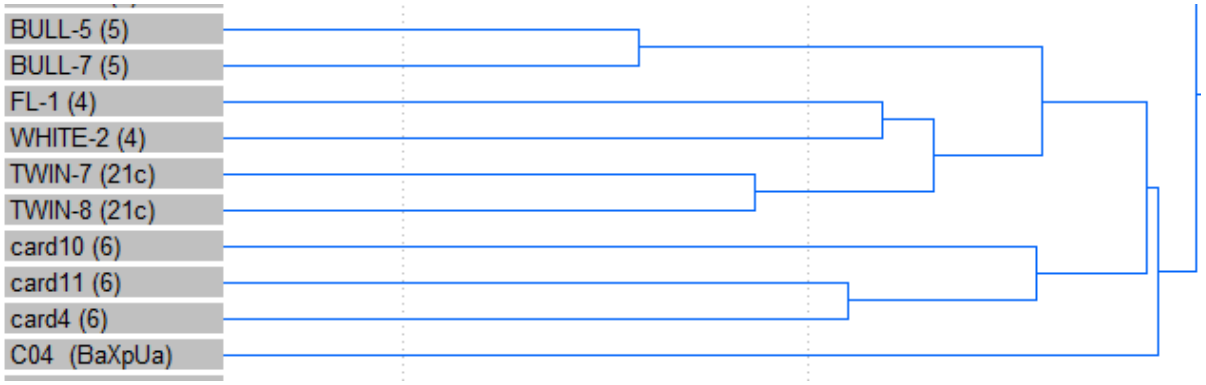
Dendrogram 2.06 – BaXpUa SSI BW04



Dendrogram 2.07 – BaXpUa SSI BWC01

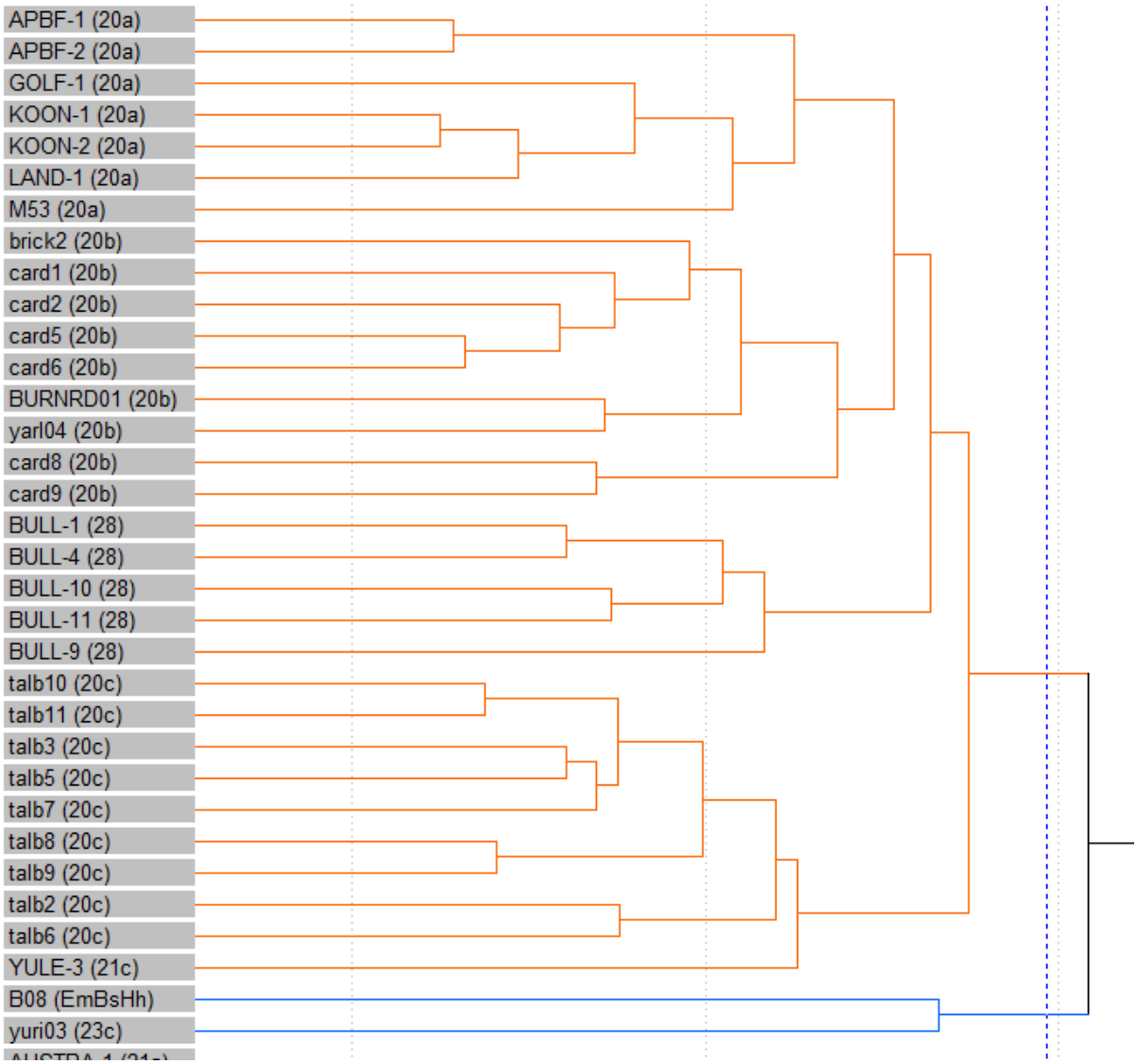


Dendrogram 2.08 – BaXpUa SSI C04

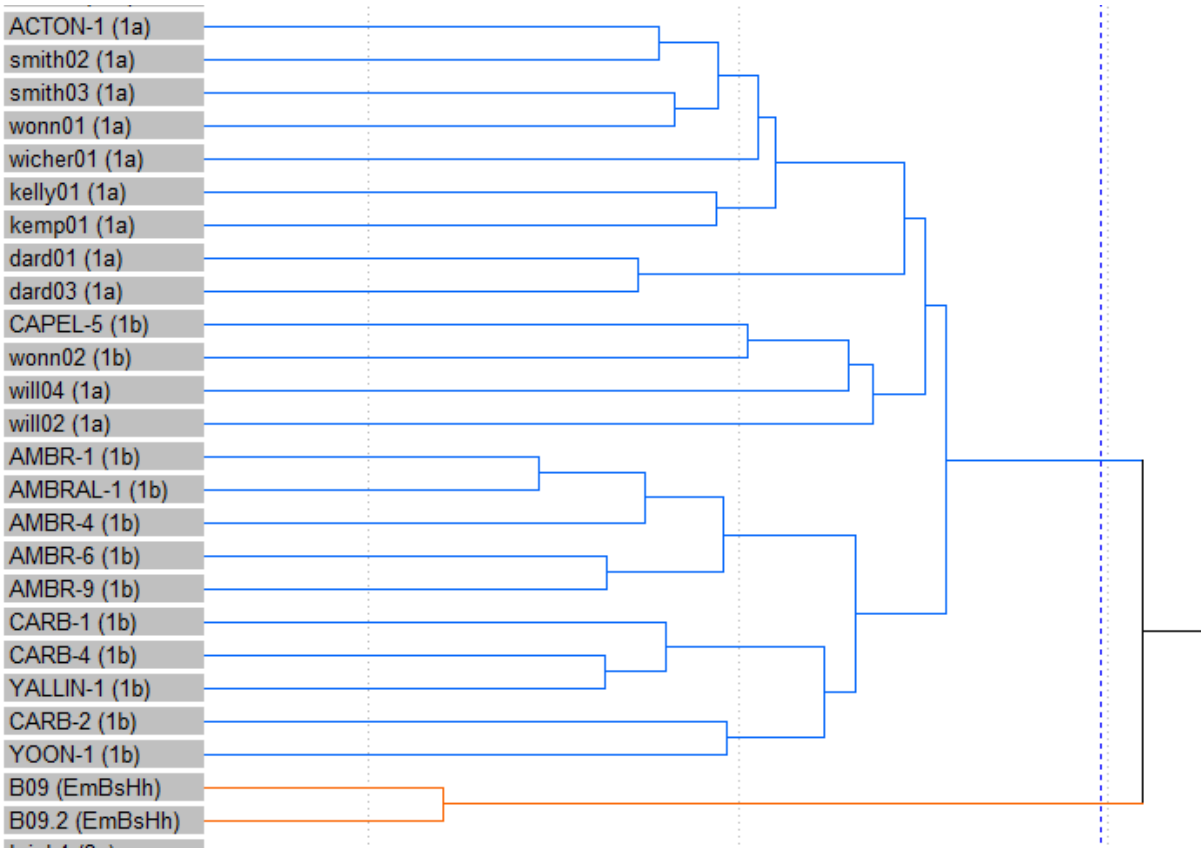


Dendrogram 2.09 – BaXpUa SSI C06

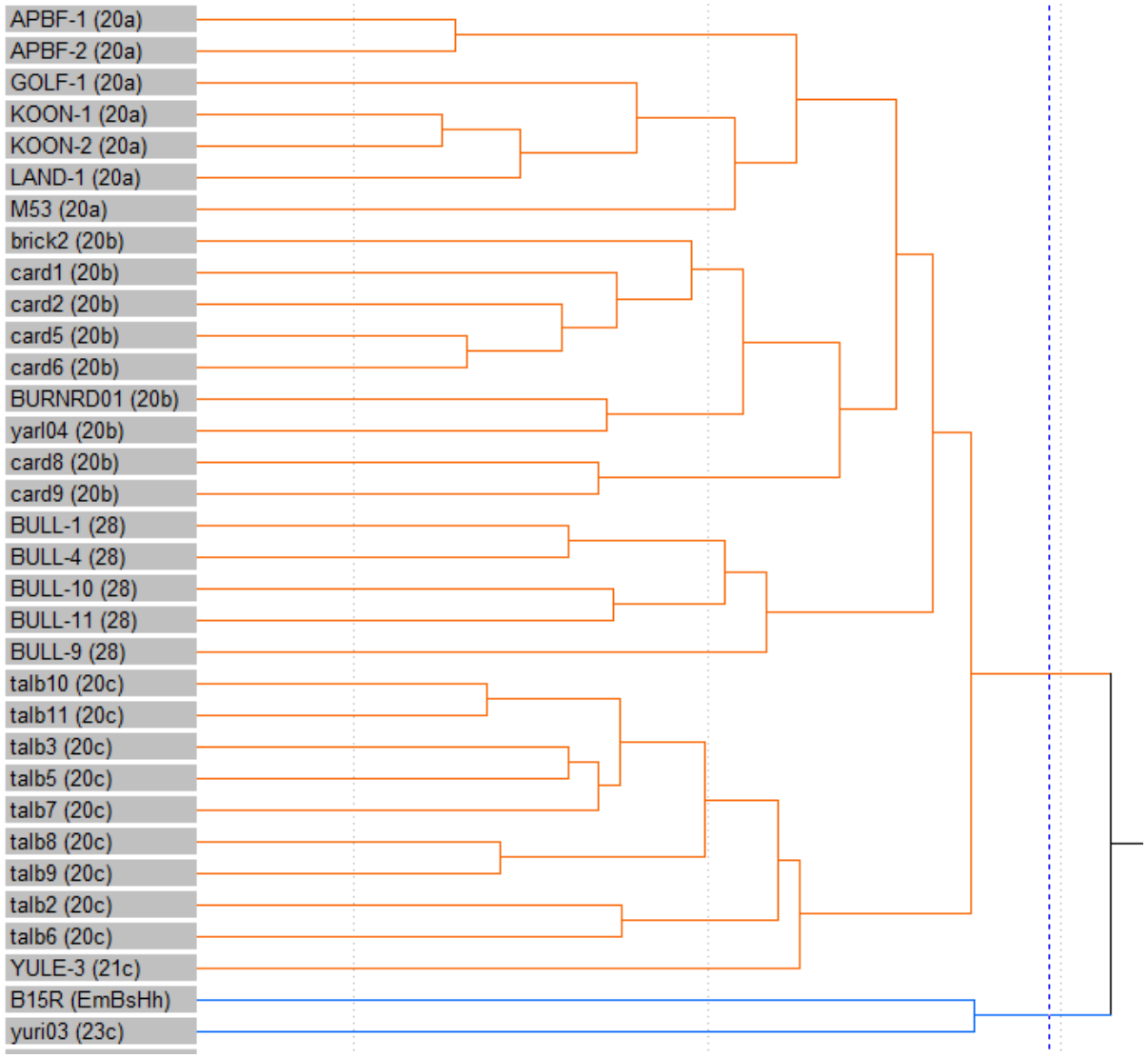
Dendrogram 3.01 – EmBsHh SSI B08



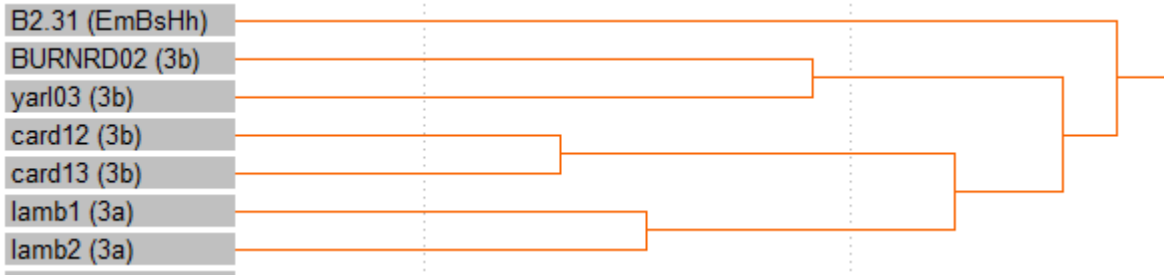
Dendrogram 3.02 – EmBsHh SSI B09/B09.2



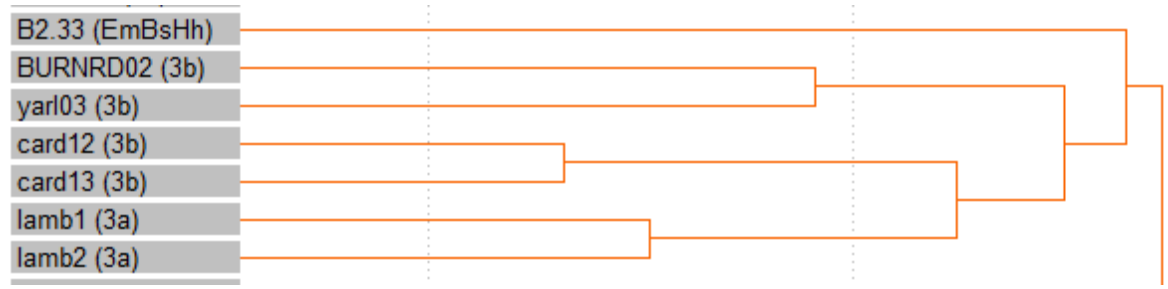
Dendrogram 3.03 – EmBsHh SSI B15(R)



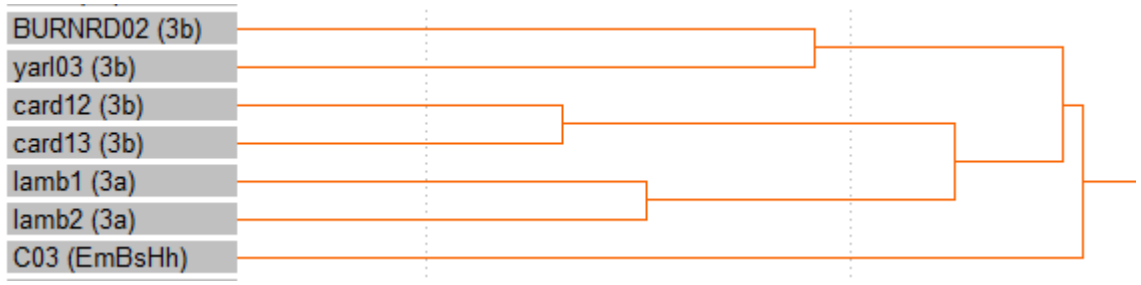
Dendrogram 3.04 – EmBsHh SSI B2.31



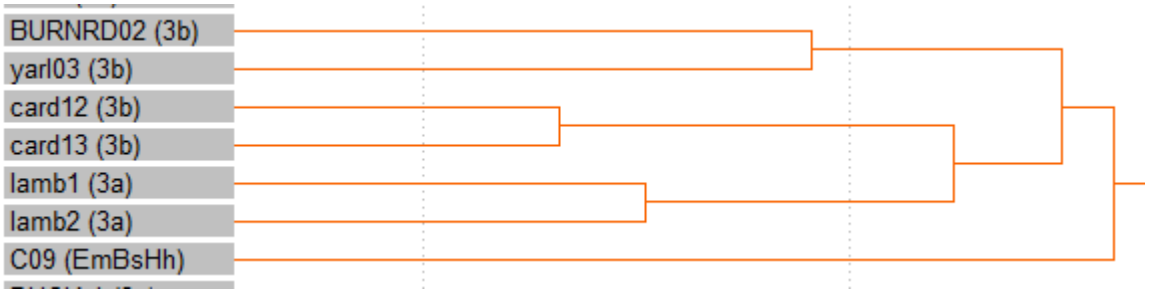
Dendrogram 3.05 – EmBsHh SSI B2.33



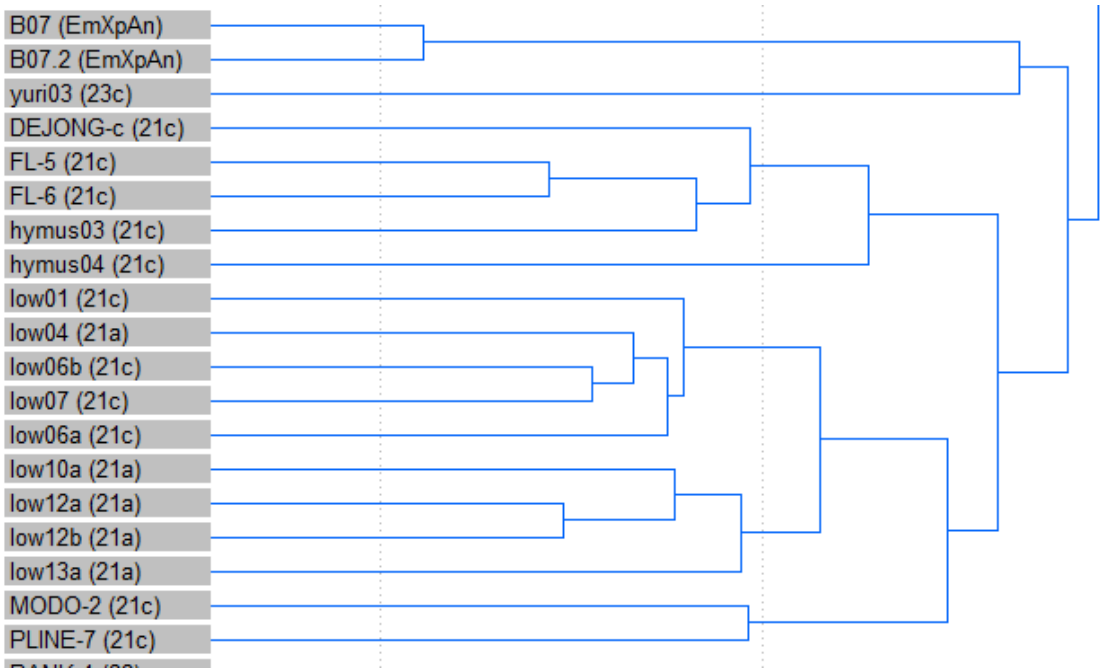
Dendrogram 3.06 – EmBsHh SSI C03



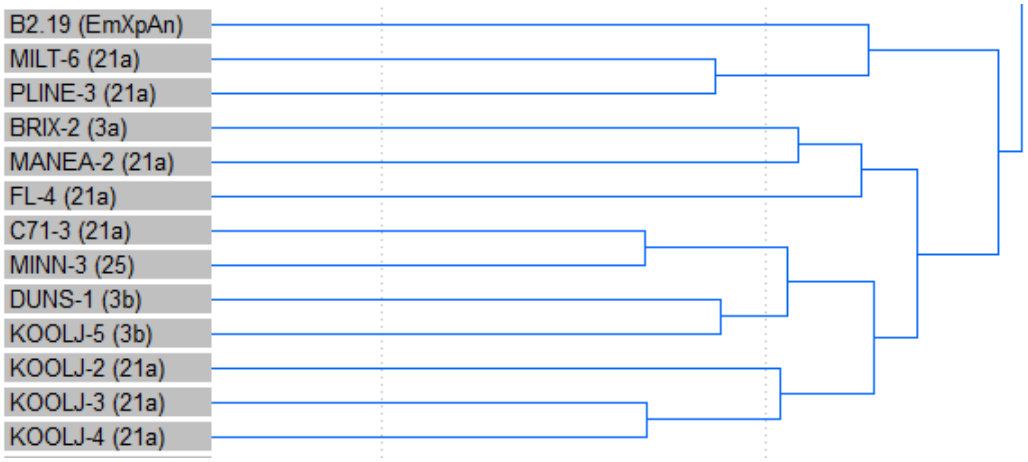
Dendrogram 3.07 – EmBsHh SSI C09



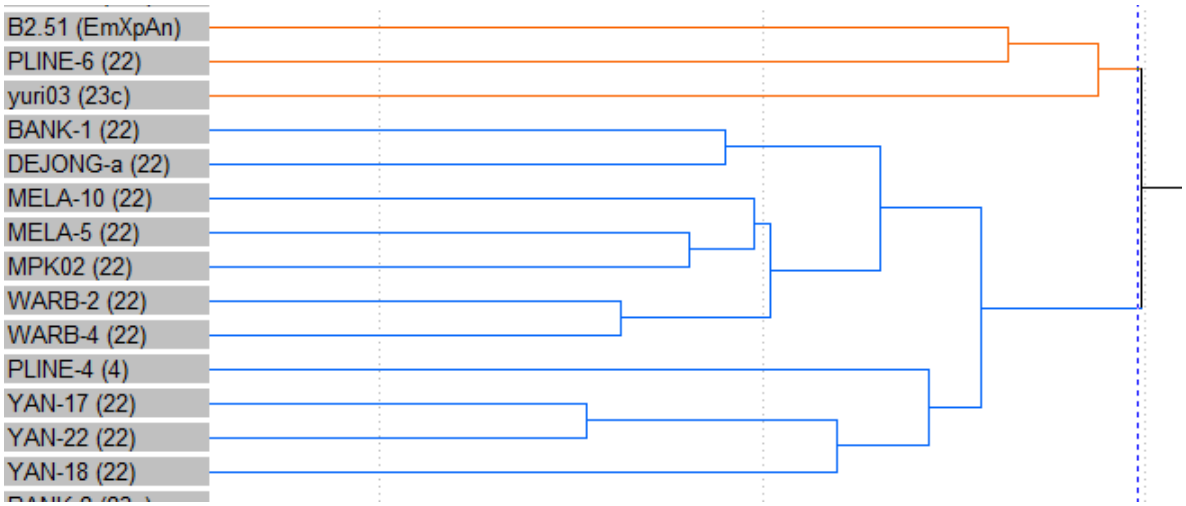
Dendrogram 4.01 – EmXpAn SSI B07/B07.2



Dendrogram 4.02 – EmXpAn SSI B2.19

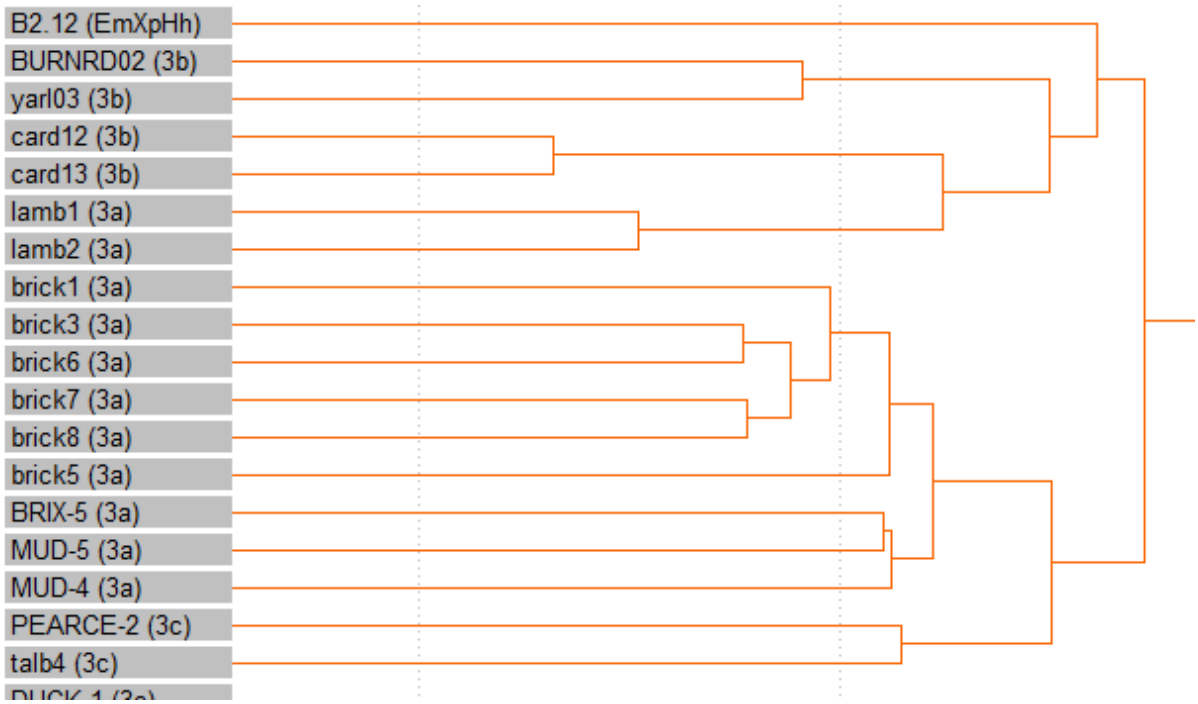


Dendrogram 4.03 – EmXpAn SSI B2.51

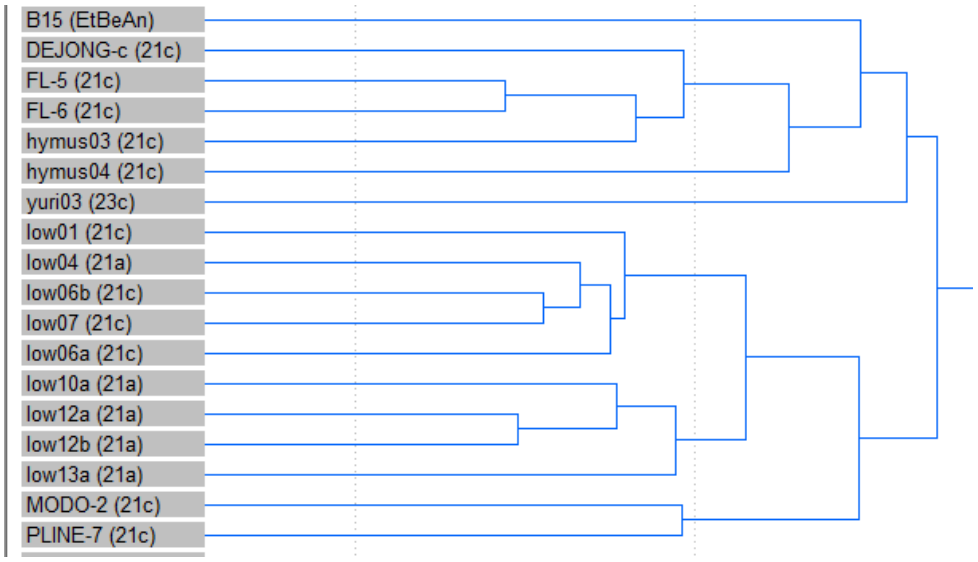


Dendrogram 4.04 – EmXpAn SSI B32 and B32.2

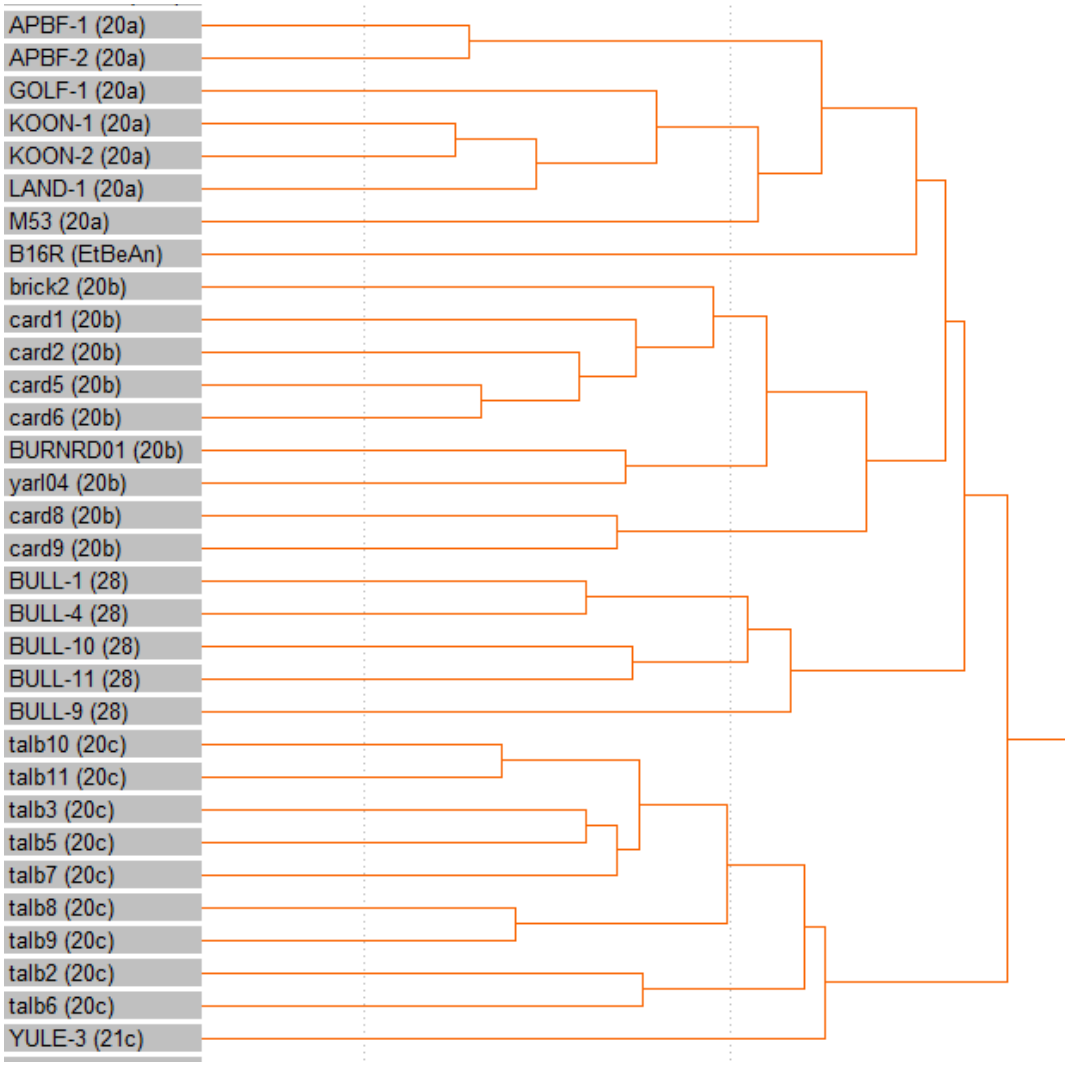
Dendrogram 5.01 – EmXpHh SSI B2.12



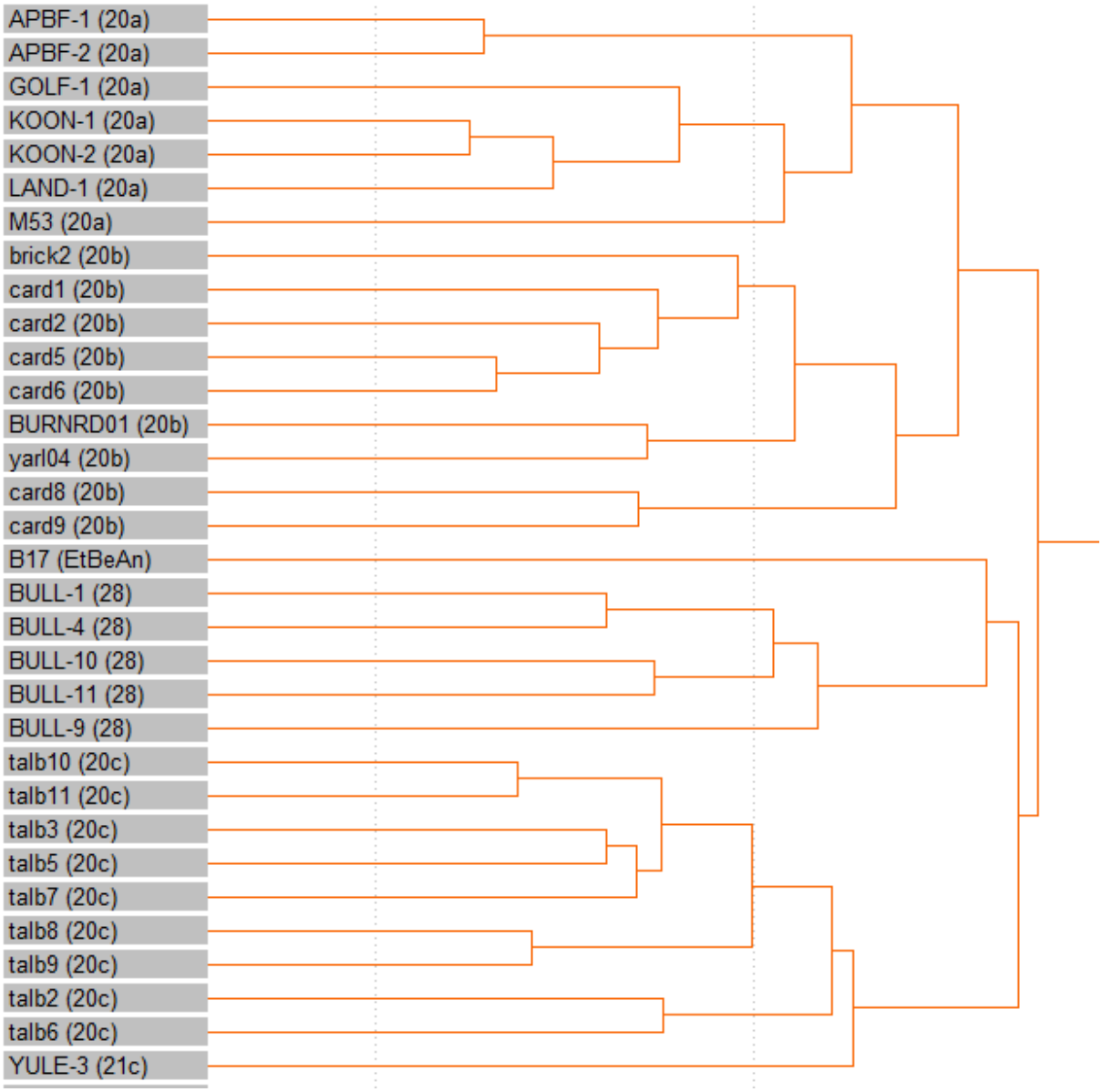
Dendrogram 6.01 – EtBeAn SSI B15



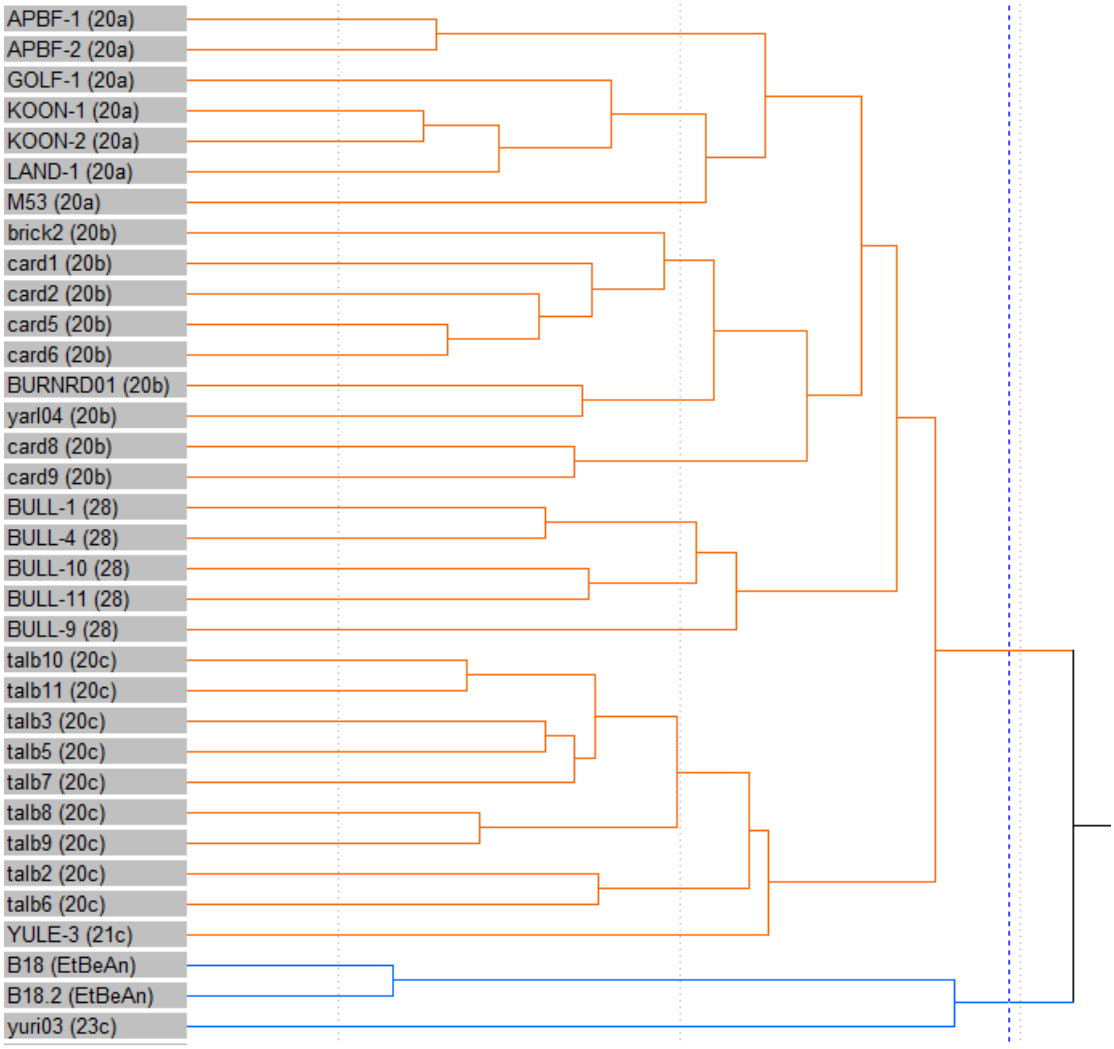
Dendrogram 6.02 – EtBeAn SSI B16R



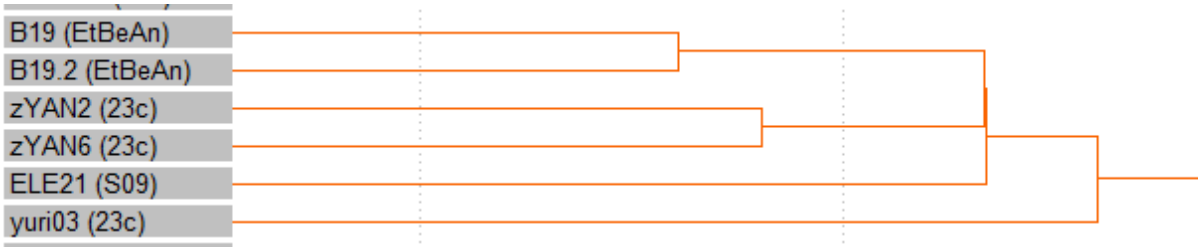
Dendrogram 6.03 – EtBeAn SSI B17



Dendrogram 6.04 – EtBeAn SSI B18/B18.2

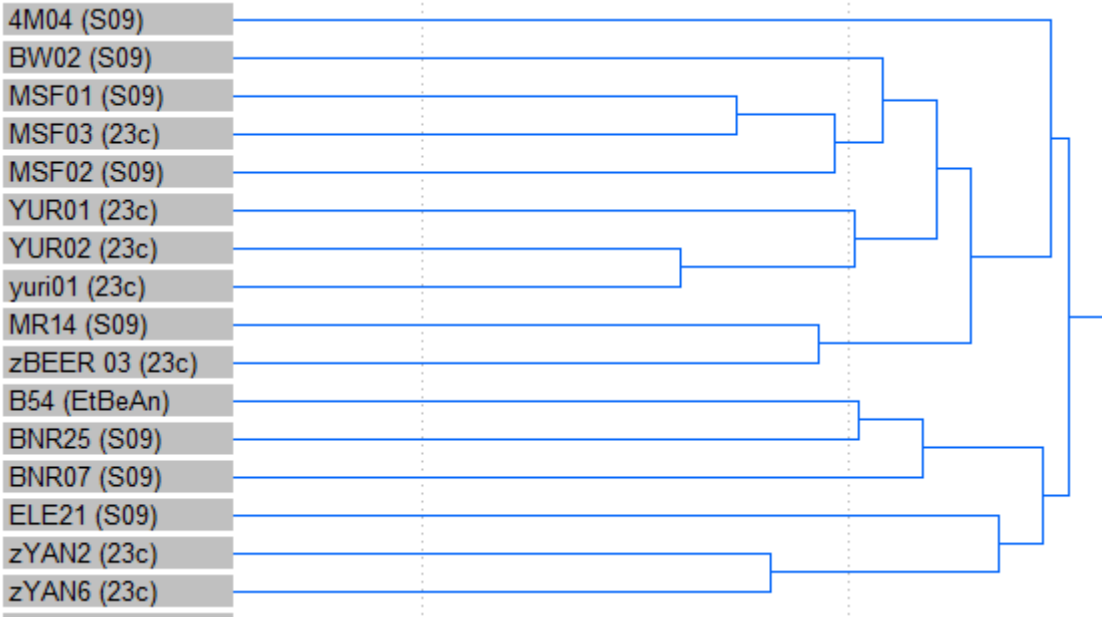


Dendrogram 6.05 – EtBeAn SSI B19/B19.2

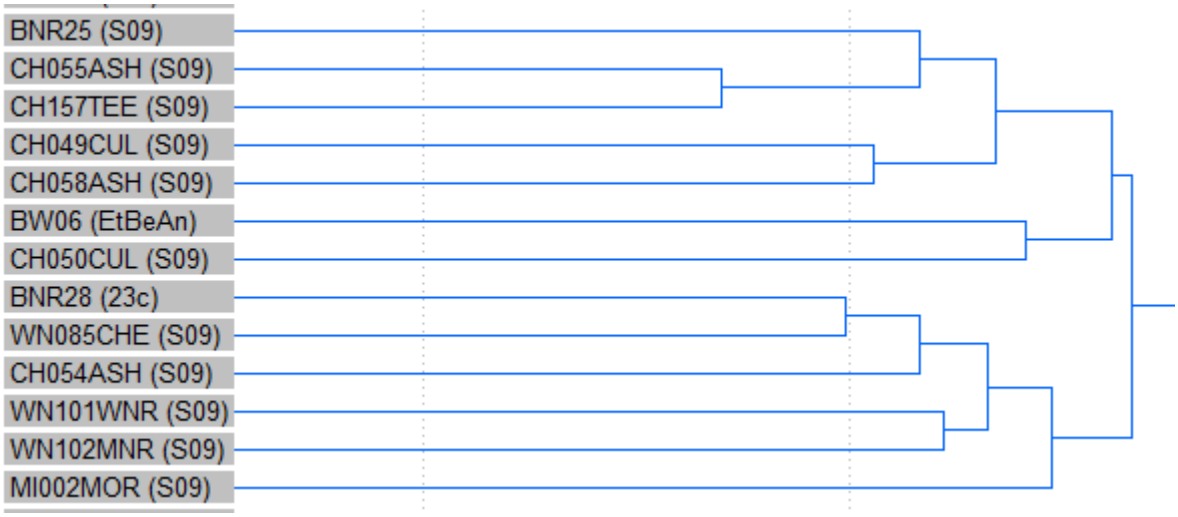


Dendrogram 6.06 – EtBeAn SSI B51

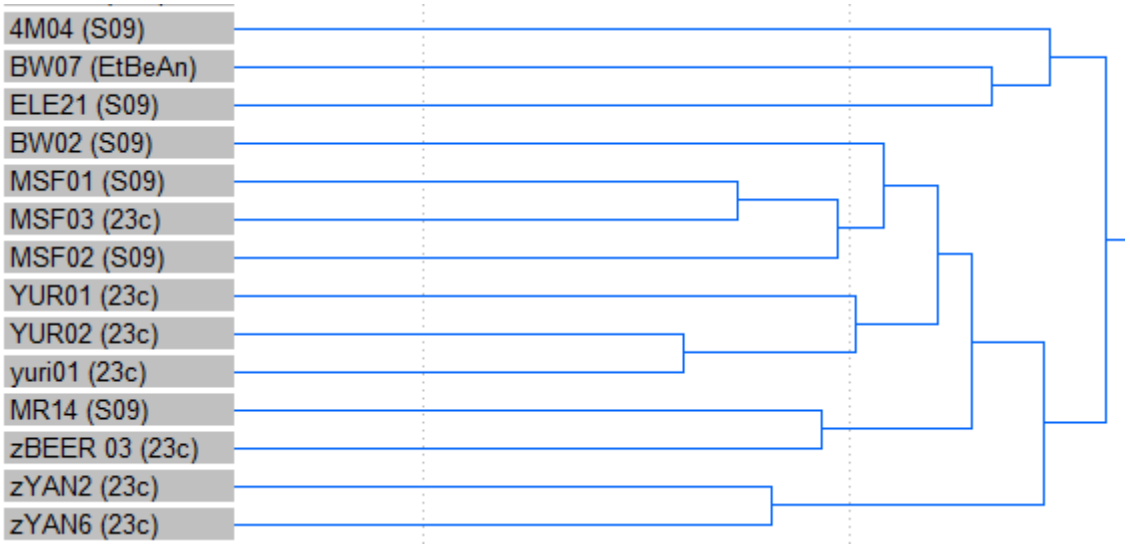
Dendrogram 6.07 – EtBeAn SSI B54



Dendrogram 6.08 – EtBeAn SSI BW06

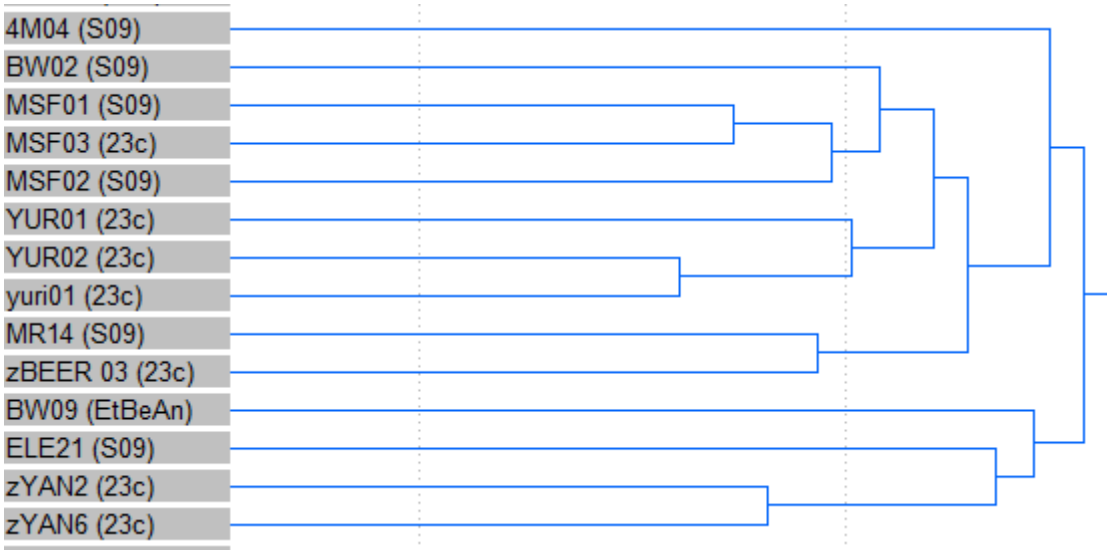


Dendrogram 6.09 – EtBeAn SSI BW07

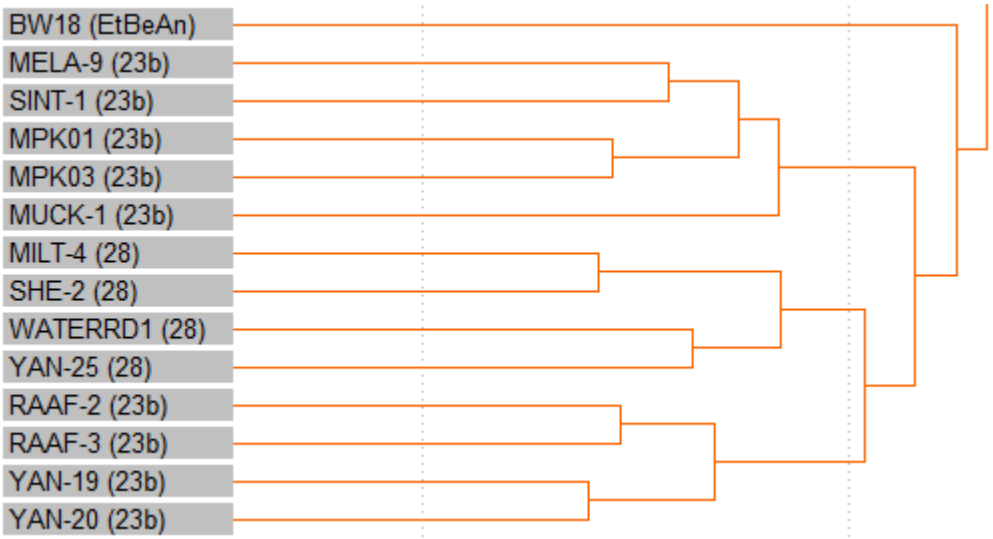


Dendrogram 6.10 – EtBeAn SSI BW08

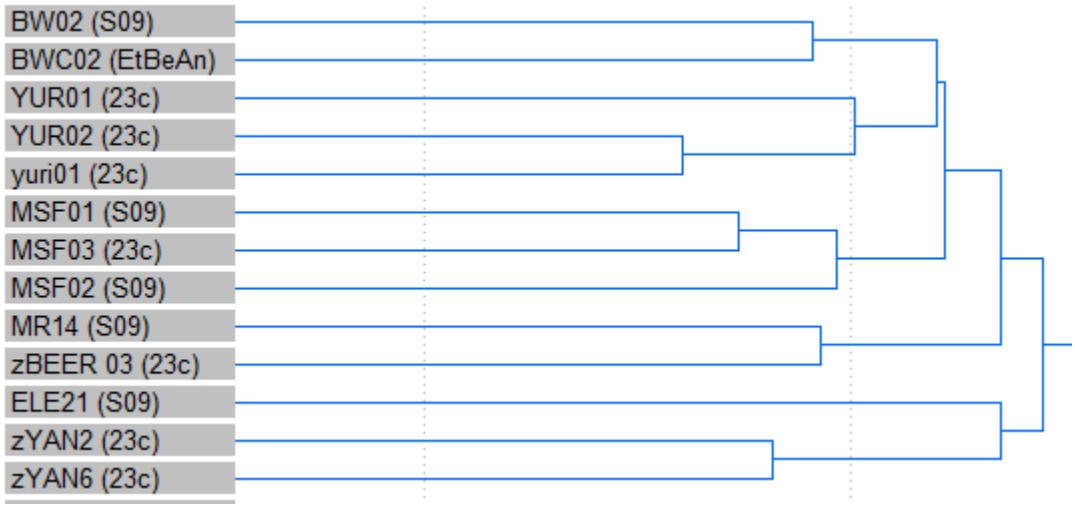
Dendrogram 6.11 – EtBeAn SSI BW09



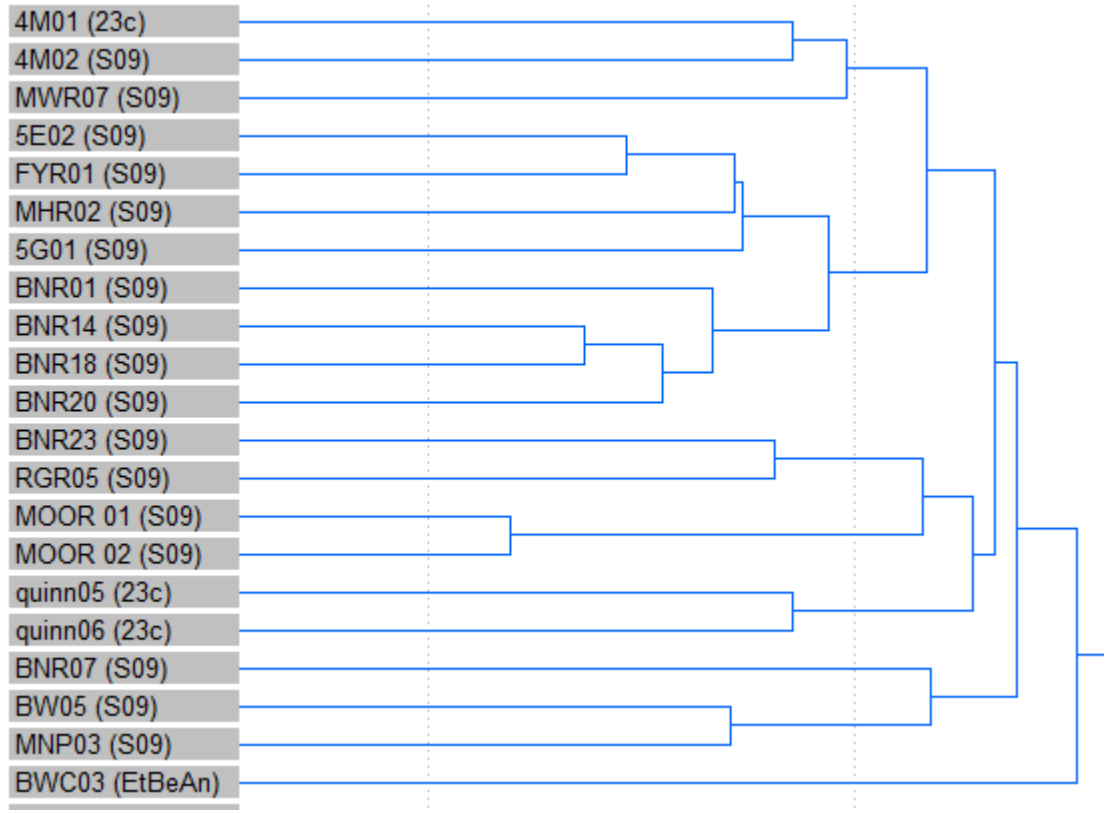
Dendrogram 6.12 – EtBeAn SSI BW18



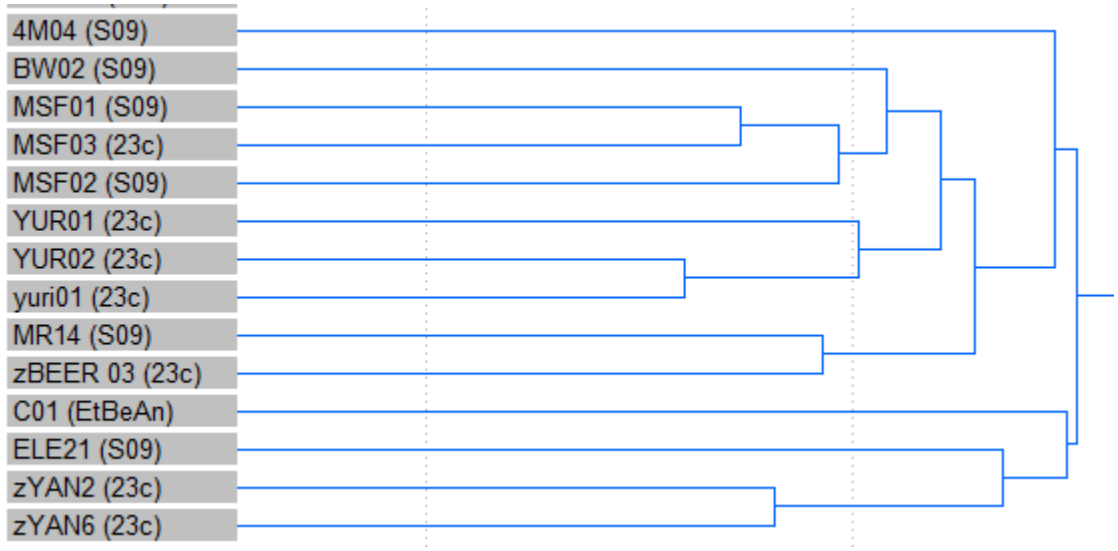
Dendrogram 6.13 – EtBeAn SSI BWC02



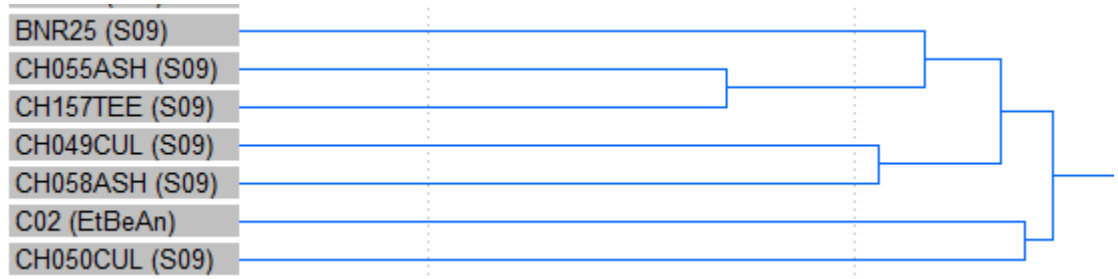
Dendrogram 6.14 – EtBeAn SSI BWC03



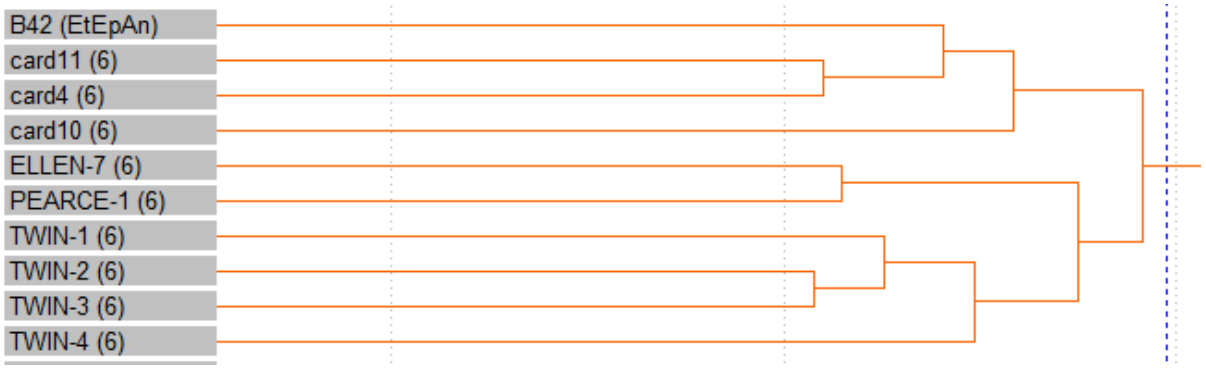
Dendrogram 6.15 – EtBeAn SSI C01



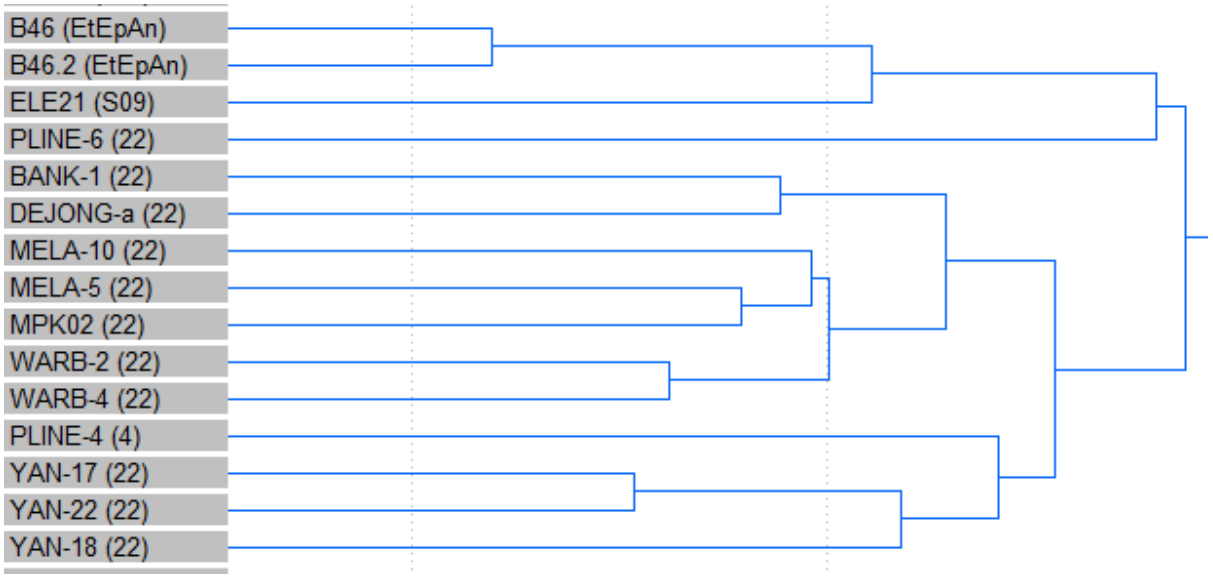
Dendrogram 6.16 – EtBeAn SSI C02



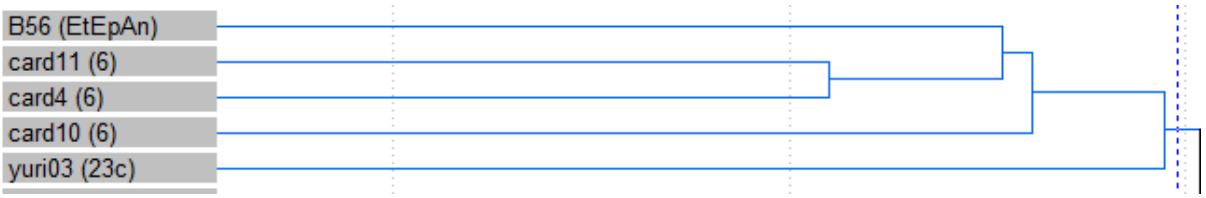
Dendrogram 7.01 – EtEpAn SSI B42



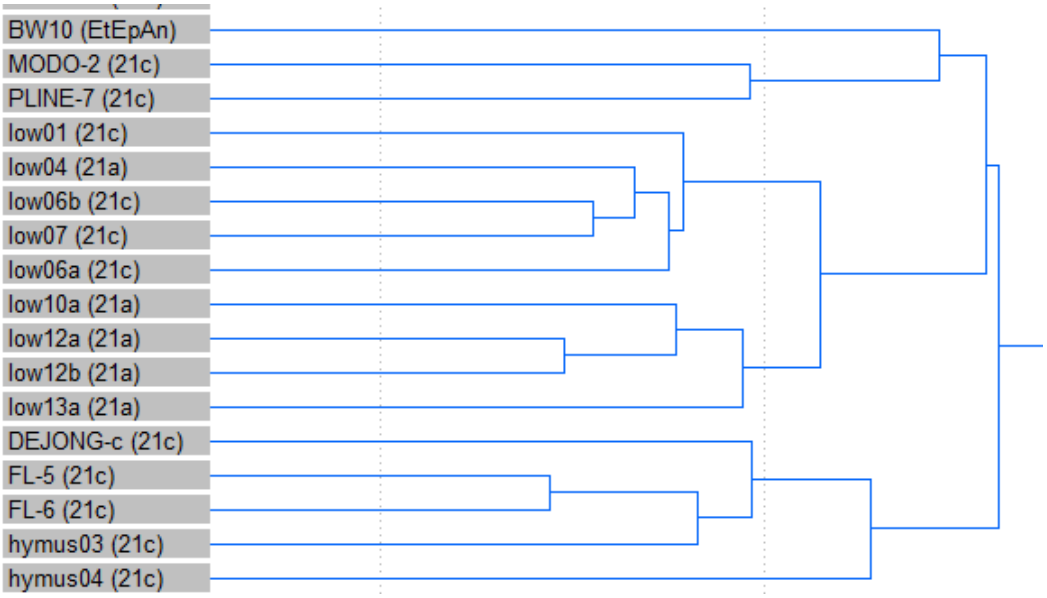
Dendrogram 7.02 – EtEpAn SSI B46/B46.2



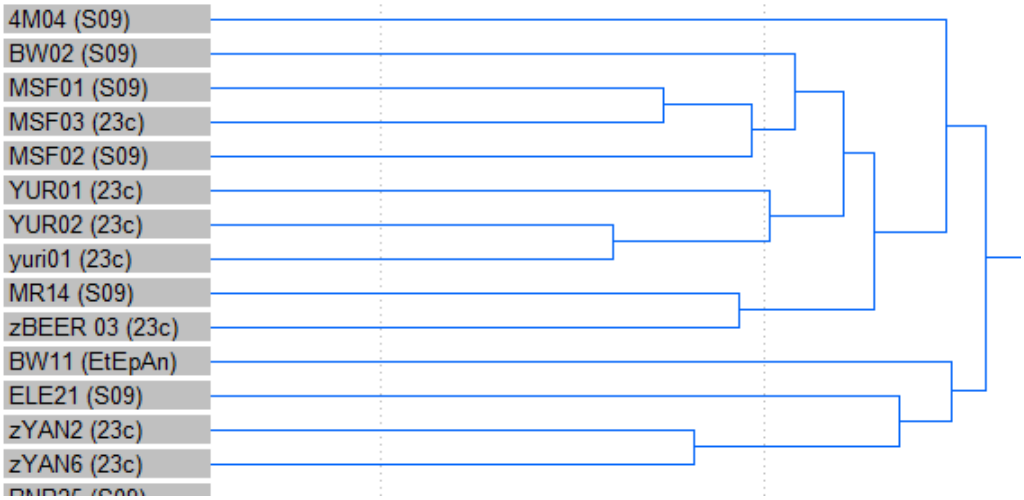
Dendrogram 7.03 – EtEpAn SSI B56



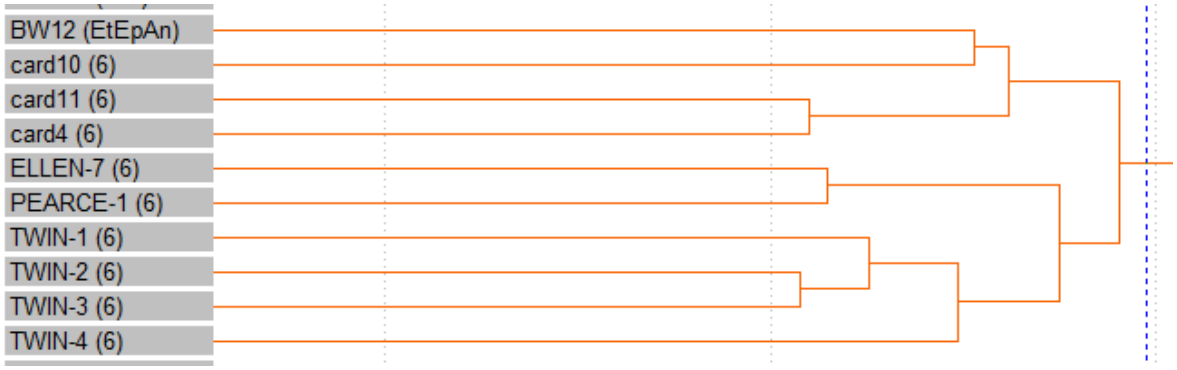
Dendrogram 7.04 – EtEpAn SSI BW10



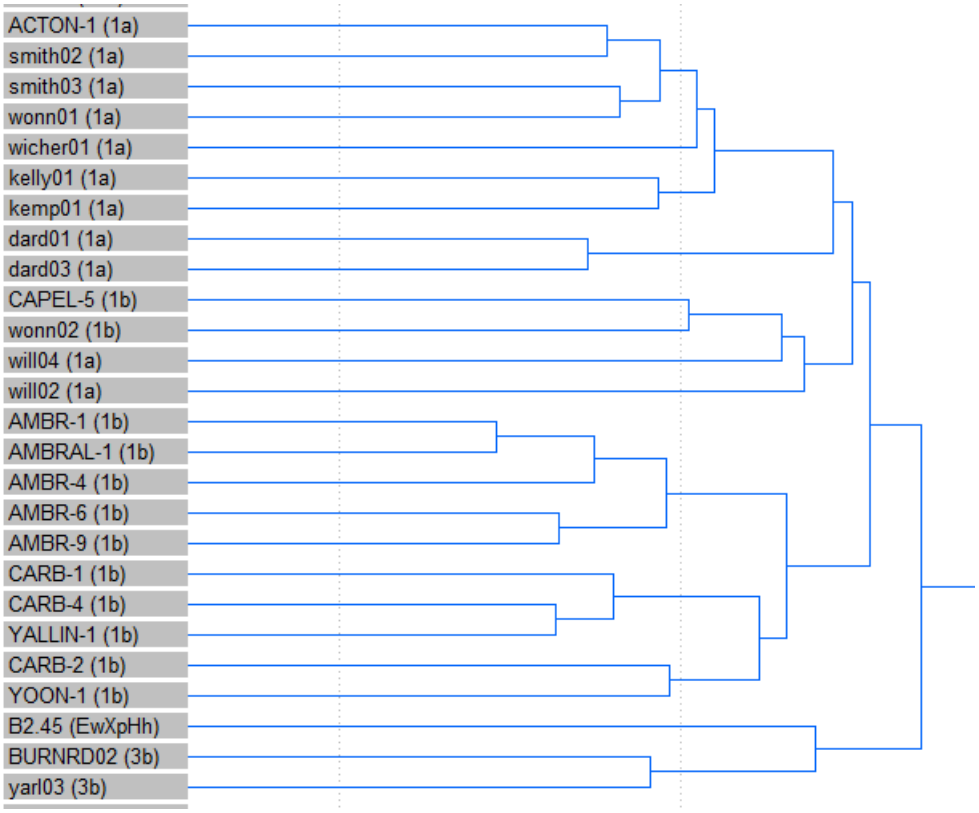
Dendrogram 7.05 – EtEpAn SSI BW11



Dendrogram 7.06 – EtEpAn SSI BW12



Dendrogram 8.01 – EwXpHh SSI B2.45



APPENDIX 2.1 – SUMMARY OF POTENTIAL BANKSIA WOODLAND QUADRAT SPECIES COMPARISON

					FCT 20a		FCT20b		FCT20c		FCT21a		FCT21b		FCT21c		FCT22		FCT23a		FCT23b		FCT23c	
Vegetation Unit and Description	Representative Quadrats	Single Site Insertion Result	Dendrogram Preliminary Inferred FCT	Dendrogram	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common
BaXpAn - *Banksia* spp. sparse woodland	B10	23a, 23b, 28,	23a	1.2	18	41.86	18	41.86	19	44.19	21	48.84	19	44.19	26	47.27	14	32.56	23	53.49	23	53.49	17	39.53
	B10.2	23a, 23b, 28,	23a	1.2	25	45.45	22	40.00	21	38.18	27	49.09	26	47.27	25	45.45	22	40.00	31	56.36	32	58.18	28	50.91
	B11	28, 20b, 20a	28	1.3	20	51.28	17	43.59	17	43.59	19	48.72	19	48.72	19	48.72	15	38.46	21	53.85	21	53.85	22	56.41
	B2.25	6, 5, 4, 21c	6	1.4	18	60.00	19	63.33	18	60.00	21	70.00	16	53.33	22	73.33	16	53.33	21	70.00	21	70.00	17	56.67
	B2.30	S09, 23c	S09	1.5	21	60.00	18	51.43	19	54.29	22	62.86	21	60.00	21	60.00	20	57.14	24	68.57	25	71.43	25	71.43
	B2.32	28	28	1.6	27	55.10	28	57.14	27	55.10	29	59.18	22	44.90	27	55.10	22	44.90	28	57.14	29	59.18	25	51.02
	B49	S09, 23c	S09	2.2	15	55.56	15	55.56	14	51.85	20	74.07	17	62.96	19	70.37	16	59.26	22	81.48	21	77.78	21	77.78
	BW14	S09, 23c	S09	2.4	19	35.85	20	37.74	18	33.96	23	43.40	21	39.62	23	43.40	19	35.85	26	49.06	27	50.94	20	37.74
	BW15	28	28	2.5	22	43.14	25	49.02	18	35.29	25	49.02	21	41.18	22	43.14	20	39.22	26	50.98	24	47.06	18	35.29
	BW16	28	28	2.6	25	47.17	26	49.06	25	47.17	29	54.72	27	50.94	24	45.28	23	43.40	29	54.72	26	49.06	29	54.72
	BW17	6, 21c	6	2.7	17	32.69	15	28.85	16	30.77	15	28.85	13	25.00	18	34.62	13	25.00	19	36.54	18	34.62	17	32.69
BaXpUa - *Banksia attenuata* sparse woodland	B2.48	28	28	3.2	13	29.55	18	40.91	17	38.64	21	47.73	13	29.55	14	31.82	13	29.55	15	34.09	10	22.73	14	31.82
	B2.49	28	28	3.1	27	56.25	20	41.67	24	50.00	26	54.17	19	39.58	23	47.92	17	35.42	22	45.83	21	43.75	26	54.17
	B2.50	28	28	3.1	16	34.78	18	39.13	18	39.13	21	45.65	14	30.43	17	36.96	8	17.39	17	36.96	15	32.61	17	36.96
	B55	S09, 22	S09	3.3	10	58.82	8	47.06	11	64.71	9	52.94	9	52.94	13	76.47	10	58.82	12	70.59	12	70.59	10	58.82
	BW03	S09, 23c	S09	4.2	16	44.44	18	50.00	16	44.44	21	58.33	17	47.22	22	61.11	15	41.67	23	63.89	20	55.56	20	55.56

Highest affinity

High affinity

					FCT 20a		FCT20b		FCT20c		FCT21a		FCT21b		FCT21c		FCT22		FCT23a		FCT23b		FCT23c	
Vegetation Unit and Description	Representative Quadrats	Single Site Insertion Result	Dendrogram Preliminary Inferred FCT	Dendrogram	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common
	BW04	23c	23c	4.3	14	43.75	12	37.50	13	40.63	17	53.13	16	50.00	19	59.38	12	37.50	19	59.38	17	53.13	16	50.00
	BWC01	S09, 23c	S09	4.4	19	46.34	19	46.34	21	51.22	21	51.22	18	43.90	24	58.54	14	34.15	23	56.10	23	56.10	19	46.34
	C04	6, 21c, 4, 5	6	4.5	16	61.54	14	53.85	16	61.54	18	69.23	16	61.54	15	57.69	8	30.77	15	57.69	13	50.00	15	57.69
	C06	6	6	4.6	13	37.14	15	42.86	13	37.14	15	42.86	12	34.29	18	51.43	9	25.71	18	51.43	17	48.57	17	48.57
EmBsHh - *Eucalyptus marginata* and *Banksia sessilis* sparse woodland	B08	23c, 21c, 20c, 28, 20b, 20a	23c	5.2	18	46.15	18	46.15	18	46.15	20	51.28	18	46.15	20	51.28	16	41.03	19	48.72	16	41.03	15	38.46
	B09	1b, 1a	1b	5.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B09.2	1b, 1a	1b	5.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B15R	23c	23c	5.4	13	48.15	16	59.26	15	55.56	15	55.56	15	55.56	14	51.85	12	44.44	15	55.56	12	44.44	11	40.74
	B2.31	3b, 3a	3b	5.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B2.33	3b, 3a	3b	6.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	C03	3b, 3a	3b	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	C09	3b, 3a	3b	6.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EmXpHh - *Eucalyptus marginata* sparse woodland	B2.19	21a, 3a, 25, 3b	21a	7.3	21	53.85	18	46.15	19	48.72	25	64.10	20	51.28	21	53.85	16	41.03	22	56.41	22	56.41	21	53.85
	B2.51	22, 23c	22	7.4	15	53.57	11	39.29	13	46.43	15	53.57	10	35.71	16	57.14	14	50.00	17	60.71	15	53.57	14	50.00
	B2.12	3b, 3a	3b	8.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EtBeAn - *Eucalyptus todtiana* sparse woodland	B15	21c, 23c	21c	9.2	13	48.15	12	44.44	12	44.44	14	51.85	10	37.04	17	62.96	11	40.74	18	66.67	17	62.96	12	44.44
	B16R	20a	20a	9.3	24	48.00	17	34.00	20	40.00	21	42.00	17	34.00	19	38	22	44.00	25	50.00	28	56.00	26	52.00
	B17	28	28	9.4	11	37.93	13	44.83	12	41.38	13	44.83	9	31.03	12	41.38	9	31.03	12	41.38	12	41.38	12	41.38
	B18	23c	23c	9.5	15	35.71	18	42.86	18	42.86	21	50.00	15	35.71	18	42.86	13	30.95	21	50.00	19	45.24	19	45.24
	B18.2	23c	23c	9.5	21	45.65	22	47.83	22	47.83	23	50.00	19	41.30	22	47.83	16	34.78	25	54.35	24	52.17	25	54.35
	B19	23c	23c	10.2	20	41.67	16	33.33	19	39.58	22	45.83	18	37.50	20	41.67	19	39.58	24	50.00	24	50.00	24	50.00

Highest affinity

High affinity

					FCT 20a		FCT20b		FCT20c		FCT21a		FCT21b		FCT21c		FCT22		FCT23a		FCT23b		FCT23c	
Vegetation Unit and Description	Representative Quadrats	Single Site Insertion Result	Dendrogram Preliminary Inferred FCT	Dendrogram	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common
	B19.2	23c	23c	10.2	18	52.94	16	47.06	17	50.00	19	55.88	15	44.12	20	58.82	18	52.94	22	64.71	21	61.76	19	55.88
	B51	S09	S09	9.6	19	51.35	18	48.65	19	51.35	17	45.95	15	40.54	20	54.05	16	43.24	22	59.46	21	56.76	21	56.76
	B54	S09, 23c	S09	10.3	21	70.00	16	53.33	17	56.67	22	73.33	16	53.33	19	63.33	18	60.00	23	76.67	24	80.00	21	70.00
	BW06	S09, 23c	S09	10.4	14	38.89	14	38.89	15	41.67	14	38.89	11	30.56	16	44.44	12	33.33	15	41.67	15	41.67	16	44.44
EtBeAn - *Eucalyptus todtiana* sparse woodland (cont)	BW07	S09, 23c	S09	10.5	14	35.00	16	40.00	15	37.50	15	37.50	10	25.00	18	45	11	27.50	18	45.00	19	47.50	16	40.00
	BW08	S09, 23c	S09	10.1	17	39.53	21	48.84	19	44.19	21	48.84	13	30.23	20	46.51	19	44.19	25	58.14	23	53.49	21	48.84
	BW09	S09, 23c	S09	11.2	19	46.34	20	48.78	18	43.90	22	53.66	17	41.46	24	58.54	18	43.90	26	63.41	24	58.54	18	43.90
	BW18	S09, 23c	S09	11.1	27	51.92	32	61.54	27	51.92	33	63.46	27	51.92	24	46.15	26	50.00	30	57.69	32	61.54	30	57.69
	BWC02	S09, 23c	S09	11.1	16	50.00	17	53.13	17	53.13	18	56.25	15	46.88	18	56.25	15	46.88	20	62.50	19	59.38	18	56.25
	BWC03	S09, 23c	S09	11.3	21	58.33	22	61.11	20	55.56	21	58.33	19	52.78	21	58.33	19	52.78	26	72.22	24	66.67	22	61.11
	C01	S09, 23c	S09	11.1	22	61.11	22	61.11	23	63.89	22	61.11	22	61.11	22	61.11	20	55.56	26	72.22	27	75.00	26	72.22
	C02	S09, 23c	S09	11.1	25	62.50	26	65.00	23	57.50	25	62.50	21	52.50	22	55	23	57.50	27	67.50	28	70.00	27	67.50
EtEpAn - *Eucalyptus todtiana* sparse woodland	B42	6	6	12.2	15	57.69	13	50.00	12	46.15	16	61.54	13	50.00	16	61.54	12	46.15	15	57.69	13	50.00	14	53.85
	B46	S09, 22	S09	12.3	13	54.17	11	45.83	14	58.33	13	54.17	12	50.00	17	70.83	13	54.17	17	70.83	16	66.67	14	58.33
	B46.2	S09, 22	S09	12.3	15	57.69	12	46.15	15	57.69	14	53.85	14	53.85	19	73.08	16	61.54	20	76.92	19	73.08	15	57.69
	B56	6, 23c	6	12.4	9	60.00	8	53.33	9	60.00	9	60.00	7	46.67	9	60	7	46.67	10	66.67	9	60.00	9	60.00
	BW10	21c	21c	12.5	12	41.38	13	44.83	11	37.93	13	44.83	13	44.83	16	55.17	12	41.38	17	58.62	16	55.17	15	51.72
	BW11	S09, 23c	S09	12.6	17	47.22	17	47.22	15	41.67	18	50.00	17	47.22	18	50	16	44.44	22	61.11	20	55.56	18	50.00
	BW12	6	6	12.7	9	37.50	9	37.50	9	37.50	9	37.50	9	37.50	11	45.83	7	29.17	12	50.00	12	50.00	10	41.67

Highest affinity

High affinity

					FCT 20a		FCT20b		FCT20c		FCT21a		FCT21b		FCT21c		FCT22		FCT23a		FCT23b		FCT23c	
Vegetation Unit and Description	Representative Quadrats	Single Site Insertion Result	Dendrogram Preliminary Inferred FCT	Dendrogram	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common	#species in common	%species in Common
EwXpHh - *Eucalyptus wandoo* sparse woodland	B2.45	3b	3b	13.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Highest affinity

High affinity

APPENDIX 2.2 - SUMMARY OF POTENTIAL BANKSIA WOODLAND QUADRAT SPECIES COMPARISON

Vegetation Unit and Description	Representative Quadrat	SSI Result	Dendrogram Preliminary Inferred FCT	Dendrogram	S09		FCT24		FCT25		FCT28		FCT 1a		FCT1b		FCT3a		FCT3b		FCT3c		FCT18	
					# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common
BaXpAn - *Banksia* spp. sparse woodland	B10	23a, 23b, 28,	23a	1.2	21	48.84	12	27.91	13	30.23	24	55.81	-	-	-	-	-	-	-	-	-	-	-	-
	B10.2	23a, 23b, 28,	23a	1.2	27	49.09	19	34.55	17	30.91	29	52.73	-	-	-	-	-	-	-	-	-	-	-	-
	B11	28, 20b, 20a	28	1.3	22	56.41	12	30.77	22	56.41	22	56.41	-	-	-	-	-	-	-	-	-	-	-	-
	B2.25	6, 5, 4, 21c	6	1.4	16	53.33	15	50.00	13	43.33	19	63.33	-	-	-	-	-	-	-	-	-	-	-	-
	B2.30	S09, 23c	S09	1.5	26	74.29	18	51.43	17	48.57	26	74.29	-	-	-	-	-	-	-	-	-	-	-	-
	B2.32	28	28	1.6	26	53.06	20	40.82	18	36.73	33	67.35	-	-	-	-	-	-	-	-	-	-	-	-
	B49	S09, 23c	S09	2.2	19	70.37	14	51.85	12	44.44	20	74.07	-	-	-	-	-	-	-	-	-	-	-	-
	BW13	28	28	2.3	24	53.33	18	40.00	17	37.78	27	60.00	-	-	-	-	-	-	-	-	-	-	-	-
	BW14	S09, 23c	S09	2.4	23	43.40	19	35.85	16	30.19	27	50.94	-	-	-	-	-	-	-	-	-	-	-	-
	BW15	28	28	2.5	22	43.14	20	39.22	19	37.25	29	56.86	-	-	-	-	-	-	-	-	-	-	-	-
	BW16	28	28	2.6	27	50.94	22	41.51	22	41.51	30	56.60	-	-	-	-	-	-	-	-	-	-	-	-
	BW17	6, 21c	6	2.7	17	32.69	13	25.00	10	19.23	19	36.54	-	-	-	-	-	-	-	-	-	-	-	-
BaXpUa - *Banksia attenuata* sparse woodland	B2.48	28	28	3.2	16	36.36	17	38.64	14	31.82	26	59.09	-	-	-	-	-	-	-	-	-	-	-	-
	B2.49	28	28	3.1	28	58.33	20	41.67	17	35.42	30	62.50	-	-	-	-	-	-	-	-	-	-	-	-
	B2.50	28	28	3.1	15	32.61	13	28.26	12	26.09	23	50.00	-	-	-	-	-	-	-	-	-	-	-	-
	B55	S09, 22	S09	3.3	12	70.59	6	35.29	5	29.41	12	70.59	-	-	-	-	-	-	-	-	-	-	-	-
	BW03	S09, 23c	S09	4.2	20	55.56	16	44.44	13	36.11	22	61.11	-	-	-	-	-	-	-	-	-	-	-	-
	BW04	23c	23c	4.3	16	50.00	16	50.00	11	34.38	19	59.38	-	-	-	-	-	-	-	-	-	-	-	-
	BWC01	S09, 23c	S09	4.4	19	46.34	18	43.90	13	31.71	25	60.98	-	-	-	-	-	-	-	-	-	-	-	-
	C04	6, 21c, 4, 5	6	4.5	18	69.23	12	46.15	11	42.31	18	69.23	-	-	-	-	-	-	-	-	-	-	-	-
	C06	6	6	4.6	13	37.14	11	31.43	10	28.57	17	48.57	-	-	-	-	-	-	-	-	-	-	-	-
EmBsHh - *Eucalyptus marginata* and *Banksia sessilis* sparse woodland	B08	23c, 21c, 20c, 28, 20b, 20a	23c	5.2	16	41.03	17	43.59	18	46.15	21	53.85	-	-	-	-	-	-	-	-	-	-	-	-
	B09	1b, 1a	1b	5.3	-	-	-	-	-	-	-	-	16	42.11	15	39.47	-	-	-	-	-	-	-	-
	B09.2	1b, 1a	1b	5.3	-	-	-	-	-	-	-	-	15	40.54	16	43.24	-	-	-	-	-	-	-	-
	B15R	23c	23c	5.4	13	48.15	11	40.74	13	48.15	18	66.67	-	-	-	-	-	-	-	-	-	-	-	-

Highest affinity

High affinity

Vegetation Unit and Description	Representative Quadrat	SSI Result	Dendrogram Preliminary Inferred FCT	Dendrogram	S09		FCT24		FCT25		FCT28		FCT 1a		FCT1b		FCT3a		FCT3b		FCT3c		FCT18	
					# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common
	B2.31	3b, 3a	3b	5.5	-	-	-	-	-	-	-	-	-	-	-	-	9	29.03	20	64.52	13	41.93	-	-
	B2.33	3b, 3a	3b	6.2	-	-	-	-	-	-	-	-	-	-	-	-	5	31.25	13	81.25	5	31.25	-	-
EmBsHh - *Eucalyptus marginata* and *Banksia sessilis* sparse woodland (cont.)	C03	3b, 3a	3b	6.1	-	-	-	-	-	-	-	-	-	-	-	-	13	44.83	19	65.52	13	44.83	-	-
	C09	3b, 3a	3b	6.3	-	-	-	-	-	-	-	-	-	-	-	-	18	41.86	24	55.81	20	46.51	-	-
EmXpAn - *Eucalyptus marginata* sparse woodland	B07	23c	23c	7.2	21	45.65	19	41.30	21	45.65	28	60.87	-	-	-	-	-	-	-	-	-	-	-	-
	B07.2	23c	23c	7.2	24	51.06	17	36.17	19	40.43	27	57.45	-	-	-	-	-	-	-	-	-	-	-	-
	B2.19	21a, 3a, 25, 3b	21a	7.3	21	53.85	13	33.33	14	35.90	23	58.97	-	-	-	-	-	-	-	-	-	-	-	-
	B2.51	22, 23c	22	7.4	14	50.00	12	42.86	12	42.86	16	57.14	-	-	-	-	-	-	-	-	-	-	-	-
	B32	22, 23c	23c	7.5	16	45.71	19	54.29	19	54.29	24	68.57	-	-	-	-	-	-	-	-	-	-	-	-
	B32.2	23c	23c	7.5	14	53.85	15	57.69	17	65.38	20	76.92	-	-	-	-	-	-	-	-	-	-	-	-
EmXpHh - *Eucalyptus marginata* sparse woodland	B2.12	3b, 3a	3b	8.1	-	-	-	-	-	-	-	-	-	-	-	-	12	27.27	24	54.54	12	27.27	-	-
EtBeAn - *Eucalyptus todtiana* sparse woodland	B15	21c, 23c	21c	9.2	13	48.15	15	55.56	10	37.04	18	66.67	-	-	-	-	-	-	-	-	-	-	-	-
	B16R	20a	20a	9.3	27	54.00	21	42.00	15	30.00	26	52.00	-	-	-	-	-	-	-	-	-	-	-	-
	B17	28	28	9.4	12	41.38	8	27.59	3	10.34	16	55.17	-	-	-	-	-	-	-	-	-	-	-	-
	B18	23c	23c	9.5	17	40.48	13	30.95	13	30.95	24	57.14	-	-	-	-	-	-	-	-	-	-	-	-
	B18.2	23c	23c	9.5	24	52.17	12	26.09	13	28.26	29	63.04	-	-	-	-	-	-	-	-	-	-	-	-
	B19	23c	23c	10.2	22	45.83	21	43.75	16	33.33	27	56.25	-	-	-	-	-	-	-	-	-	-	-	-
	B19.2	23c	23c	10.2	23	67.65	17	50.00	11	32.35	23	67.65	-	-	-	-	-	-	-	-	-	-	-	-
	B51	S09	S09	9.6	23	62.16	14	37.84	8	21.62	23	62.16	-	-	-	-	-	-	-	-	-	-	-	-
	B54	S09, 23c	S09	10.3	22	73.33	14	46.67	12	40.00	22	73.33	-	-	-	-	-	-	-	-	-	-	-	-
	BW06	S09, 23c	S09	10.4	18	50.00	13	36.11	9	25.00	19	52.78	-	-	-	-	-	-	-	-	-	-	-	-
	BW07	S09, 23c	S09	10.5	17	42.50	11	27.50	7	17.50	23	57.50	-	-	-	-	-	-	-	-	-	-	-	-
	BW08	S09, 23c	S09	NA	20	46.51	15	34.88	12	27.91	29	67.44	-	-	-	-	-	-	-	-	-	-	-	-
	BW09	S09, 23c	S09	11.2	18	43.90	18	43.90	13	31.71	22	53.66	-	-	-	-	-	-	-	-	-	-	-	-
	BW18	S09, 23c	S09	NA	26	50.00	21	40.38	21	40.38	37	71.15	-	-	-	-	-	-	-	-	-	-	-	-

Highest affinity

High affinity

Vegetation Unit and Description	Representative Quadrat	SSI Result	Dendrogram Preliminary Inferred FCT	Dendrogram	S09		FCT24		FCT25		FCT28		FCT 1a		FCT1b		FCT3a		FCT3b		FCT3c		FCT18	
					# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common	# Species in common	% Species in Common
	BWC02	S09, 23c	S09	11.1	17	53.13	14	43.75	9	28.13	21	65.63	-	-	-	-	-	-	-	-	-	-	-	-
	BWC03	S09, 23c	S09	11.3	25	69.44	18	50.00	14	38.89	26	72.22	-	-	-	-	-	-	-	-	-	-	-	-
EtBeAn - *Eucalyptus todtiana* sparse woodland (cont.)	C01	S09, 23c	S09	NA	26	72.22	16	44.44	16	44.44	23	63.89	-	-	-	-	-	-	-	-	-	-	-	-
	C02	S09, 23c	S09	11.1	31	77.50	17	42.50	13	32.50	29	72.50	-	-	-	-	-	-	-	-	-	-	-	-
EtEpAn - *Eucalyptus todtiana* sparse woodland	B42	6	6	12.2	12	46.15	12	46.15	9	34.62	17	65.38	-	-	-	-	-	-	-	-	-	-	-	-
	B46	S09, 22	S09	12.3	16	66.67	11	45.83	8	33.33	17	70.83	-	-	-	-	-	-	-	-	-	-	-	-
	B46.2	S09, 22	S09	12.3	17	65.38	12	46.15	9	34.62	18	69.23	-	-	-	-	-	-	-	-	-	-	-	-
	B56	6, 23c	6	12.4	8	53.33	8	53.33	7	46.67	10	66.67	-	-	-	-	-	-	-	-	-	-	-	-
	BW10	21c	21c	12.5	16	55.17	14	48.28	10	34.48	17	58.62	-	-	-	-	-	-	-	-	-	-	-	-
	BW11	S09, 23c	S09	12.6	22	61.11	15	41.67	12	33.33	22	61.11	-	-	-	-	-	-	-	-	-	-	-	-
	BW12	6	6	12.7	13	54.17	8	33.33	7	29.17	13	54.17	-	-	-	-	-	-	-	-	-	-	-	-
EwXpHh - *Eucalyptus wandoo* sparse woodland	B2.45	3b	3b	13.3	-	-	-	-	-	-	-	-	-	-	-	-	12	27.27	24	54.54	17	38.64	-	-

Highest affinity

High affinity

Appendix G. Revised Residual Impacts Significance Model

Residual Impact Classification	EP Act Part IV Environmental Factors							
	Vegetation and Flora							All Factors
				Terrestrial Fauna				
	Rare Flora	Threatened Ecological Communities	Remnant Vegetation	Wetlands and Watercourses	Conservation Areas	High Biological Diversity	Habitat for Fauna	Other
Residual impacts that is environmentally unacceptable and cannot be offset	None	None	None	None	None	None	None	None
Significant residual impacts that will require an offset	None	• Clearing of 60 ha of the EPBC Act listed Banksia Woodlands TEC • Clearing of up to 2.0 ha of FCT20a (*Banksia attenuata* woodlands over species rich dense shrublands) • Clearing of up to 4.5 ha FCT23b (Northern *Banksia attenuata - Banksia menziesii* woodlands P3 PEC) • Clearing of up to 3.0 ha of FCT3b (*Corymbia calophylla – Eucalyptus marginata* woodland on sandy clay soils – northern expression)	• Clearing of up to 2.5 ha of vegetation corresponding to the Nooning complex. • Clearing of up to 107.9 ha of native vegetation in Good or better condition	• Clearing or disturbance of 2.7 ha within the boundaries of Conservation Category wetlands	None	None	• Clearing of 204.8 ha of foraging habitat which includes 79.3 ha of potential breeding habitat for Carnaby's Black Cockatoo • Clearing of 168 ha of foraging habitat which includes 69.2 ha of potential breeding habitat for the Forest Red-tailed Black Cockatoo • Clearing of 10 hollows previously used by either Carnaby's Black Cockatoo or the Forest Red-tailed Black Cockatoo[1] • Clearing of 117 trees with hollows suitable for use by Black Cockatoos. • 1,358 potential breeding trees for Black Cockatoos. • Clearing of 54.4 ha of Chuditch habitat identified as critical to the survival of the species	None

Residual Impact Classification	EP Act Part IV Environmental Factors							
	Vegetation and Flora							All Factors
				Terrestrial Fauna				
	Rare Flora	Threatened Ecological Communities	Remnant Vegetation	Wetlands and Watercourses	Conservation Areas	High Biological Diversity	Habitat for Fauna	Other
Potentially significant residual impact that may require an offset	None	None	None	• Clearing of 13.5 ha of riparian vegetation in Good or better condition	None	• Clearing of four occurrences (42 individuals) of the P2 species *Drosera sewelliae* • Clearing of four occurrences (four individuals) of the P2 species *Leucopogon squarrosus* subsp. *trigynus*	None	None
Residual impacts that are not significant and do not require an offset	None	None	• Clearing of 459.5 ha of vegetation corresponding to the South West Vegetation Complexes with more than 30% of their pre-European extent remaining (Coolakin, Cullalla, Mogumber – south, Moondah and Yalanbee (Y6) complexes) • 208 ha of native vegetation in Degraded or Completed Degraded condition (native trees over pasture). • Disturbance of 182.8 ha of paddocks with scattered native trees	• Clearing of 15.5 ha of riparian vegetation in Degraded or Completely Degraded condition	None	• Clearing of two occurrences (two individuals) of the P3 species *Verticordia rutilastra* • Clearing of one individual of the P4 species *Anigozanthos humilis* subsp. *chrysanthus* • Clearing of 57 occurrences (108 individuals) of the P4 species *Verticordia paludosa*	• Clearing of 130.3 ha of Brush Wallaby habitat • Clearing of 69.2 ha of Brush-tailed Phascogale habitat • Clearing of 6.8 ha of Water-rat habitat	None

Appendix H. WA Environmental Offsets Calculator

WA Environmental Offsets Calculator

Step 1: Determining conservation significance

Key:
- Data to be entered
- Drop-down selection
- Automatically-generated scores (Or, if appropriate, manual data entry permitted)

Area / feature **(Impact site)**

Conservation significance determination for the environmental value impacted		
Conservation significance	**Description**	Black Cockatoo breeding hollows
	Type of environmental value	Species (flora/fauna)
	Conservation significance of environmental value	Rare/threatened species - endangered
	Conservation significance score	**1.2%**

Please select *area* or *feature* for the calculations	**Feature**

WA Environmental Offsets Calculator

Step 2: Calculating significant residual impact

Key:
- Data to be entered
- Drop-down selection
- Automatically-generated scores

Environmental value (step 1)	Black Cockatoo breeding hollows

(SCROLL DOWN FOR FEATURE CALCULATION)

Feature **(impact site)**

Part A: Significant impact calculation
Feature

Significant impact	Description	Quantum of impact	
		Type of feature	Number
	Clearing of 10 hollows showing evidence of use	breeding hollows	10.00
		Total quantum of impact	10.00

Part B: Rehabilitation credit calculation
Feature **(onsite)**

Rehabilitation credit	Description	Start number (of type of feature)		Time until ecological benefit (years)	
		Future number WITHOUT rehabilitation		Confidence in rehabilitation result (%)	
		Future number WITH rehabilitation		Rehabilitation credit	0.00

Part C: Significant residual impact calculation ***Feature***

Significant residual impact		
	Total quantum of impact	10.00
	Rehabilitation credit	0.00
	Significant residual impact	10.00

WA Environmental Offsets Calculator

Step 3: Calculating offsets

Key:
- Data to be entered
- Drop-down selection
- Automatically-generated scores

Environmental value (step 1)	Black Cockatoo breeding hollows	Significant impact (step 2, part A)	10.00
		Rehabilitation credit (step 2, part B)	0.00
		Significant residual impact (step 2, part C)	10.00

(SCROLL DOWN FOR FEATURE CALCULATION)

Feature **(offset site)**

Offset calculation *Feature*							
Offsets calculation	Description	Start number (of type of feature)	0.00	Time until ecological benefit (years)	1.00	Offset value (applied to step 2, part C)	10.28
	Installation of Artificial Hollows	Future number WITHOUT offset	0.00	Confidence in offset result (%)	80.0%		102.8%
		Future number WITH offset	13.00				
						OFFSET ADEQUATE?	YES

WA Environmental Offsets Calculator

Rationale for scores used in the offsets calculator

Environmental value to be offset			
Calculation		***Score (Feature)***	***Rationale***
Conservation significance			
Description		Black Cockatoo breeding hollows	Breeding hollows are important for Black Cockatoos
Type of environmental value		Species (flora/fauna)	Habitat for listed threatened species is being impacted
Conservation significance of environmental value		Rare/threatened species - endangered	Carnaby's Black Cockatoo is listed as Endangered. Forest Red-tailed Black Cockatoo is listed as Vulnerable
Landscape-level value impacted		yes/no	N/A
Significant impact			
Description		Clearing of 10 hollows showing evidence of use	Number of hollows with evidence of use within the indicative footprint that cannot be avoided
Significant impact (hectares) / Type of feature		breeding hollows	Feature being impacted
Quality (scale) / Number		10.00	Number of hollows with evidence of use within the indicative foot print that cannot be avoided
Rehabilitation credit			
Description		0	N/A no rehabilitation credit proposed
Proposed rehabilitation (area in hectares)		N/A	N/A no rehabilitation credit proposed
Current quality of rehabilitation site / Start number (of type of feature)		0.00	N/A no rehabilitation credit proposed
Future quality WITHOUT rehabilitation (scale) / Future number WITHOUT rehabilitation		0.00	N/A no rehabilitation credit proposed
Future quality WITH rehabilitation (scale) / Future number WITH rehabilitation		0.00	N/A no rehabilitation credit proposed
Time until ecological benefit (years)		0.00	N/A no rehabilitation credit proposed
Confidence in rehabilitation result (%)		0	N/A no rehabilitation credit proposed
Offset			
Description		Installation of Artificial Hollows	Research has shown that artificial hollows are successfully used for breeding by Black Cockatoos
Proposed offset (area in hectares)		N/A	N/A
Current quality of offset site / Start number (of type of feature)		0.00	It is likely that the ultimately selected offset site will not have any existing artificial hollows
Future quality WITHOUT offset (scale) / Future number WITHOUT offset		0.00	No artificial hollows will be installed if the offset is not aquired
Future quality WITH offset (scale) / Future number WITH offset		13.00	Determined using the "What if Analysis" and rounded up to the next whole number
Time until ecological benefit (years)		1.00	Black Cockatoos have been shown to use artificial hollows in the first year following installation
Confidence in offset result (%)		0.8	As research shows that artificial hollows are successfully used for breeding by Black Cockatoos and the offset sites will be managed by DBCA and protected in perpetuity, there is a high level of confidence that the averted risk will be realised.
Duration of offset implementation (maximum 20 years)		N/A	N/A
Time until offset site secured (years)		N/A	N/A
Risk of future loss WITHOUT offset (%)		N/A	N/A
Risk of future loss WITH offset (%)		N/A	N/A
Offset ratio (Conservation area only)		N/A	N/A

WA Environmental Offsets Calculator

Step 1: Determining conservation significance

Key:
- Data to be entered
- Drop-down selection
- Automatically-generated scores (Or, if appropriate, manual data entry permitted)

Area / feature **(Impact site)**

Conservation significance determination for the environmental value impacted		
Conservation significance	**Description**	Black Cockatoo Suitable Hollows
	Type of environmental value	Species (flora/fauna)
	Conservation significance of environmental value	Rare/threatened species - endangered
	Conservation significance score	**1.2%**

Please select *area* or *feature* for the calculations	**Feature**

WA Environmental Offsets Calculator

Step 2: Calculating significant residual impact

Key:
- Data to be entered
- Drop-down selection
- Automatically-generated scores

Environmental value (step 1)	Black Cockatoo Suitable Hollows

(SCROLL DOWN FOR FEATURE CALCULATION)

Feature **(impact site)**

Part A: Significant impact calculation
Feature

Significant impact	Description	Quantum of impact	
	Clearing of 117 suitable hollows	Type of feature	Number
		suitable hollows	117.00
		Total quantum of impact	117.00

Part B: Rehabilitation credit calculation
Feature **(onsite)**

Rehabilitation credit	Description	Start number (of type of feature)		Time until ecological benefit (years)	
		Future number WITHOUT rehabilitation		Confidence in rehabilitation result (%)	
		Future number WITH rehabilitation		Rehabilitation credit	0.00

Part C: Significant residual impact calculation ***Feature***

Significant residual impact		
	Total quantum of impact	117.00
	Rehabilitation credit	0.00
	Significant residual impact	117.00

WA Environmental Offsets Calculator

Step 3: Calculating offsets

Key:

	Data to be entered
	Drop-down selection
	Automatically-generated scores

Environmental value (step 1)	Black Cockatoo Suitable Hollows	Significant impact (step 2, part A)	117.00
		Rehabilitation credit (step 2, part B)	0.00
		Significant residual impact (step 2, part C)	117.00

(SCROLL DOWN FOR FEATURE CALCULATION)

Feature **(offset site)**

Offset calculation *Feature*							
Offsets calculation	**Description**	**Start number (of type of feature)**	0.00	**Time until ecological benefit (years)**	1.00	**Offset value** (applied to step 2, part C)	**117.00**
	Land containing trees with suitable hollows	**Future number WITHOUT offset**	0.00	**Confidence in offset result (%)**	80.0%		**100.0%**
		Future number WITH offset	148.00				
						OFFSET ADEQUATE?	**NO**

WA Environmental Offsets Calculator

Rationale for scores used in the offsets calculator

Environmental value to be offset			
Calculation		***Score (Feature)***	***Rationale***
Conservation significance			
Description		Black Cockatoo Suitable Hollows	Suitable tree hollows within breeding areas are important for Black Cockatoos
Type of environmental value		Species (flora/fauna)	Habitat for listed threatened species is being impacted
Conservation significance of environmental value		Rare/threatened species - endangered	Carnaby's Black Cockatoo is listed as Endangered. Forest Red-tailed Black Cockatoo is listed as Vulnerable
Landscape-level value impacted		yes/no	N/A
Significant impact			
Description		Clearing of 117 suitable hollows	Number of suitable hollows within the indicative footprint
Significant impact (hectares) / Type of feature		suitable hollows	Feature being impacted
Quality (scale) / Number		117.00	Number of suitable hollows within the indicative footprint
Rehabilitation credit			
Description		0	N/A no rehabilitation credit proposed
Proposed rehabilitation (area in hectares)		N/A	N/A no rehabilitation credit proposed
Current quality of rehabilitation site / Start number (of type of feature)		0.00	N/A no rehabilitation credit proposed
Future quality WITHOUT rehabilitation (scale) / Future number WITHOUT rehabilitation		0.00	N/A no rehabilitation credit proposed
Future quality WITH rehabilitation (scale) / Future number WITH rehabilitation		0.00	N/A no rehabilitation credit proposed
Time until ecological benefit (years)		0.00	N/A no rehabilitation credit proposed
Confidence in rehabilitation result (%)		0	N/A no rehabilitation credit proposed
Offset			
Description		Land containing trees with suitable hollows	Acquisition of land to provide inperpeturity protection of Black Cocaktoo habitat
Proposed offset (area in hectares)		N/A	N/A
Current quality of offset site / Start number (of type of feature)		0.00	
Future quality WITHOUT offset (scale) / Future number WITHOUT offset		0.00	
Future quality WITH offset (scale) / Future number WITH offset		148.00	Determined using the "What if Analysis" and rounded up to the next whole number
Time until ecological benefit (years)		1.00	Vegetated land will be acquired and transferrred to secure tenure prior to commencement of the Proposal. An agreement for the ongoing management of the land will be established between Main Roads and DBCA. The ecological benefit will be realised within 1 year.
Confidence in offset result (%)		0.8	As the offset sites will be managed by DBCA and protected in perpetuity, there is a high level of confidence that the offset result will be realised.
Duration of offset implementation (maximum 20 years)		N/A	N/A
Time until offset site secured (years)		N/A	N/A
Risk of future loss WITHOUT offset (%)		N/A	N/A
Risk of future loss WITH offset (%)		N/A	N/A
Offset ratio (Conservation area only)		N/A	N/A

WA Environmental Offsets Calculator

Step 1: Determining conservation significance

Key:
- Data to be entered
- Drop-down selection
- Automatically-generated scores (Or, if appropriate, manual data entry permitted)

Area / feature **(Impact site)**

Conservation significance determination for the environmental value impacted		
Conservation significance	**Description**	Carnaby's Black Cockatoo Potential Breeding Trees
	Type of environmental value	Species (flora/fauna)
	Conservation significance of environmental value	Rare/threatened species - endangered
	Conservation significance score	**1.2%**

Please select *area* or *feature* for the calculations	**Feature**

WA Environmental Offsets Calculator

Step 2: Calculating significant residual impact

Key:
- Data to be entered
- Drop-down selection
- Automatically-generated scores

Environmental value (step 1)	Carnaby's Black Cockatoo Potential Breeding Trees

(SCROLL DOWN FOR FEATURE CALCULATION)

Feature **(impact site)**

Part A: Significant impact calculation
Feature

Significant impact	Description	Quantum of impact	
	Clearing of 1,358 potential breeding trees	Type of feature	Number
		Potential breeding tree	1358.00
		Total quantum of impact	1358.00

Part B: Rehabilitation credit calculation
Feature **(onsite)**

Rehabilitation credit	Description	Start number (of type of feature)		Time until ecological benefit (years)	
		Future number WITHOUT rehabilitation		Confidence in rehabilitation result (%)	
		Future number WITH rehabilitation		Rehabilitation credit	0.00

Part C: Significant residual impact calculation ***Feature***

Significant residual impact		
	Total quantum of impact	1358.00
	Rehabilitation credit	0.00
	Significant residual impact	1358.00

WA Environmental Offsets Calculator

Step 3: Calculating offsets

Key:

	Data to be entered
	Drop-down selection
	Automatically-generated scores

Environmental value (step 1)	Carnaby's Black Cockatoo Potential Breeding Trees	Significant impact (step 2, part A)	1358.00
		Rehabilitation credit (step 2, part B)	0.00
		Significant residual impact (step 2, part C)	1358.00

(SCROLL DOWN FOR FEATURE CALCULATION)

Feature **(offset site)**

Offset calculation *Feature*							
Offsets calculation	**Description**	**Start number (of type of feature)**	0.00	**Time until ecological benefit (years)**	1.00	**Offset value** (applied to step 2, part C)	**1358.10**
	Land containg potential breeding trees	**Future number WITHOUT offset**	0.00	**Confidence in offset result (%)**	80.0%		**100.0%**
		Future number WITH offset	1718.00				
						OFFSET ADEQUATE?	**YES**

WA Environmental Offsets Calculator

Rationale for scores used in the offsets calculator

Environmental value to be offset			
Calculation		***Score (Feature)***	***Rationale***
Conservation significance			
Description		Carnaby's Black Cockatoo Potential Breeding Trees	Potential breeding trees are important for Black Cockatoos for future supply of breeding hollows
Type of environmental value		Species (flora/fauna)	Habitat for listed threatened species is being impacted
Conservation significance of environmental value		Rare/threatened species - endangered	Carnaby's Black Cockatoo is listed as Endangered. Forest Red-tailed Black Cockatoo is listed as Vulnerable
Landscape-level value impacted		yes/no	N/A
Significant impact			
Description		Clearing of 1,358 potential breeding trees	Number of potential breeding trees within the indicative footprint
Significant impact (hectares) / Type of feature		Potential breeding tree	Feature being impacted
Quality (scale) / Number		1358.00	Number of potential breeding trees within the indicative footprint
Rehabilitation credit			
Description		0	N/A no rehabilitation credit proposed
Proposed rehabilitation (area in hectares)		N/A	N/A no rehabilitation credit proposed
Current quality of rehabilitation site / Start number (of type of feature)		0.00	N/A no rehabilitation credit proposed
Future quality WITHOUT rehabilitation (scale) / Future number WITHOUT rehabilitation		0.00	N/A no rehabilitation credit proposed
Future quality WITH rehabilitation (scale) / Future number WITH rehabilitation		0.00	N/A no rehabilitation credit proposed
Time until ecological benefit (years)		0.00	N/A no rehabilitation credit proposed
Confidence in rehabilitation result (%)		0	N/A no rehabilitation credit proposed
Offset			
Description		Land containg potential breeding trees	Acquisition of land to provide inperpeturity protection of Black Cocaktoo habitat
Proposed offset (area in hectares)		N/A	N/A
Current quality of offset site / Start number (of type of feature)		0.00	
Future quality WITHOUT offset (scale) / Future number WITHOUT offset		0.00	
Future quality WITH offset (scale) / Future number WITH offset		1718.00	Determined using the "What if Analysis" and rounded up to the next whole number
Time until ecological benefit (years)		1.00	Vegetated land will be acquired and transferrred to secure tenure prior to commencement of the Proposal. An agreement for the ongoing management of the land will be established between Main Roads and DBCA. The ecological benefit will be realised within 1 year.
Confidence in offset result (%)		0.8	As the offset sites will be managed by DBCA and protected in perpetuity, there is a high level of confidence that the offset result will be realised.
Duration of offset implementation (maximum 20 years)		N/A	N/A
Time until offset site secured (years)		N/A	N/A
Risk of future loss WITHOUT offset (%)		N/A	N/A
Risk of future loss WITH offset (%)		N/A	N/A
Offset ratio (Conservation area only)		N/A	N/A

WA Environmental Offsets Calculator

Step 1: Determining conservation significance

Key:
- Data to be entered
- Drop-down selection
- Automatically-generated scores (Or, if appropriate, manual data entry permitted)

Area / feature **(Impact site)**

Conservation significance determination for the environmental value impacted		
Conservation significance	**Description**	Habitat for Chuditch
	Type of environmental value	Species (flora/fauna)
	Conservation significance of environmental value	Rare/threatened Species - vulnerable
	Conservation significance score	**0.2%**

Please select *area* or *feature* for the calculations	**Area**

WA Environmental Offsets Calculator

Step 2: Calculating significant residual impact

Key:
- Data to be entered
- Drop-down selection
- Automatically-generated scores

Environmental value (step 1)	Habitat for Chuditch

Area **(impact site)**

Part A: Significant impact calculation *Area*

Significant impact	Description	Quantum of impact	
	Clearing of 54.5 ha of Chuditch habitat	Significant impact (hectares)	54.50
		Quality (scale)	7.00
		Total quantum of impact	38.15

Part B: Rehabilitation credit calculation *Area* (onsite)

Rehabilitation Credit	Description	Proposed rehabilitation (area in hectares)		Time until ecological benefit (years)	
		Current quality of rehabilitation site (scale)		Confidence in rehabilitation result (%)	
		Future quality WITHOUT rehabilitation (scale)		Rehabilitation credit	0.00
		Future quality WITH rehabilitation (scale)			

Part C: Significant residual impact calculation *Area*

Significant residual impact		
	Total quantum of impact	38.15
	Rehabilitation credit	0.00
	Significant residual impact	38.15

WA Environmental Offsets Calculator

Step 3: Calculating offsets

Key:
- Data to be entered
- Drop-down selection
- Automatically-generated scores

Environmental value (step 1)	Habitat for Chuditch	Significant impact (step 2, part A)	54.50
		Rehabilitation credit (step 2, part B)	0.00
		Significant residual impact (step 2, part C)	38.15

Area **(offset site)**

Offset calculation *Area*							
Offsets calculation	**Description**	**Proposed offset (area in hectares)**	277.00	**Duration of offset implementation (maximum 20 years)**	20.00	**Offset value** (applied to step 2, part C)	**38.15**
	Land acquisition	**Current quality of offset site (scale)**	7.00	**Time until offset site secured (years)**	1.00		**100.0%**
		Future quality WITHOUT offset (scale)	6.00	**Risk of future loss WITHOUT offset (%)**	15.0%		
		Future quality WITH offset (scale)	7.00	**Risk of future loss WITH offset (%)**	5.0%		
		Time until ecological benefit (years)	1.00				
		Confidence in offset result (%)	80.0%			**OFFSET ADEQUATE?**	**YES**

WA Environmental Offsets Calculator

Rationale for scores used in the offsets calculator

Environmental value to be offset			
Calculation	***Score (Area)***		***Rationale***
Conservation significance			
Description	Habitat for Chuditch		Habitat for Chuditch has been identified in surveys undertaken for the project
Type of environmental value	Species (flora/fauna)		Habitat for listed threatened species is being impacted
Conservation significance of environmental value	Rare/threatened Species - vulnerable		Chuditch is listed as Vulnerable
Landscape-level value impacted	yes/no		N/A
Significant impact			
Description	Clearing of 54.5 ha of Chuditch habitat		Amount of habitat within indicative footprint
Significant impact (hectares) / Type of feature	54.50		Area of habitat within indicative footprint
Quality (scale) / Number	7.00		Vegetation condition ranges from CD/D to VG/Ex. Ecological linkages identified in Chittering Biodiversity Strategy cross the footprint. Five recent records (2000 - 2016) within 5 - 10 km of footprint
Rehabilitation credit			
Description	0		N/A no rehabilitation credit proposed
Proposed rehabilitation (area in hectares)	0.00		N/A no rehabilitation credit proposed
Current quality of rehabilitation site / Start number (of type of feature)	0.00		N/A no rehabilitation credit proposed
Future quality WITHOUT rehabilitation (scale) / Future number WITHOUT rehabilitation	0.00		N/A no rehabilitation credit proposed
Future quality WITH rehabilitation (scale) / Future number WITH rehabilitation	0.00		N/A no rehabilitation credit proposed
Time until ecological benefit (years)	0.00		N/A no rehabilitation credit proposed
Confidence in rehabilitation result (%)	0		N/A no rehabilitation credit proposed
Offset			
Description	Land acquisition		Acquisition of land to provide perpetuity protection of Chuditch habitat
Proposed offset (area in hectares)	277.00		Area that achieves 100% direct offset using the "What if Analysis"
Current quality of offset site / Start number (of type of feature)	7.00		Properties targeted for acquisition will be required to provide vegetation that is at least Very Good in Condition. Acquisition will target properties that are adjacent to existing reserves or vegetation corridors
Future quality WITHOUT offset (scale) / Future number WITHOUT offset	6.00		It is assumed that acquired land will be freehold (private). If the offset site was to remain private freehold land, there is a risk of degradation to the site. This may be through illegal dumping of rubbish, grazing of the site by stock or clearing of vegetation for economic purposes such as farming or housing.
Future quality WITH offset (scale) / Future number WITH offset	7.00		The quality of the offset site will, at a minimum, be maintained through management of the offset site by DBCA.
Time until ecological benefit (years)	1.00		Vegetated land will be acquired and transferred to secure tenure prior to commencement of the Proposal. An agreement for the ongoing management of the land will be established between Main Roads and DBCA. The ecological benefit will be realised within 1 year.
Confidence in offset result (%)	0.8		As the offset sites will be managed by DBCA and protected in perpetuity, there is a high level of confidence that the offset result will be realised.
Duration of offset implementation (maximum 20 years)	20.00		The transfer of the offset site to secure tenure managed by DBCA will provide protection and management in perpetuity.
Time until offset site secured (years)	1.00		Vegetated land will be acquired and transferred to secure tenure prior to commencement of the Proposal. An agreement for the ongoing management of the land will be established between Main Roads and DBCA, which may take some time to finalise.
Risk of future loss WITHOUT offset (%)	15.0%		It is assumed that acquired land will be freehold (private). If the offset site was to remain private freehold land, there is a risk of degradation to the site. This may be through illegal dumping of rubbish, grazing of the site by stock or clearing of vegetation for economic purposes such as farming or housing.
Risk of future loss WITH offset (%)	5.0%		As the offset sites will be managed by DBCA and protected in perpetuity, there is a low 5% risk that the values will be lost.
Offset ratio (Conservation area only)	N/A		N/A

Step 1: Determining conservation significance

Key:
- Data to be entered
- Drop-down selection
- Automatically-generated scores (Or, if appropriate, manual data entry permitted)

Area / feature **(Impact site)**

Conservation significance determination for the environmental value impacted		
Conservation significance	**Description**	FCT20a (Banksia attenuata woodlands over species rich dense shrublands)
	Type of environmental value	Ecological community
	Conservation significance of environmental value	Threatened ecological community - endangered
	Conservation significance score	**1.2%**

Please select *area* or *feature* for the calculations	**Area**

WA Environmental Offsets Calculator

Step 2: Calculating significant residual impact

Key:
- Data to be entered
- Drop-down selection
- Automatically-generated scores

Environmental value (step 1)	FCT20a (Banksia attenuata woodlands over species rich dense shrublands)

Area **(impact site)**

Part A: Significant impact calculation
Area

Significant impact	Description	Quantum of impact	
	Clearing of up to 2 ha to the TEC	Significant impact (hectares)	2.00
		Quality (scale)	8.00
		Total quantum of impact	1.60

Part B: Rehabilitation credit calculation
Area **(onsite)**

Rehabilitation Credit	Description	Proposed rehabilitation (area in hectares)		Time until ecological benefit (years)	
		Current quality of rehabilitation site (scale)		Confidence in rehabilitation result (%)	
		Future quality WITHOUT rehabilitation (scale)		Rehabilitation credit	0.00
		Future quality WITH rehabilitation (scale)			

Part C: Significant residual impact calculation ***Area***

Significant residual impact		
	Total quantum of impact	1.60
	Rehabilitation credit	0.00
	Significant residual impact	1.60

WA Environmental Offsets Calculator

Step 3: Calculating offsets

Key:
- Data to be entered
- Drop-down selection
- Automatically-generated scores

Environmental value (step 1)	FCT20a (Banksia attenuata woodlands over species rich dense shrublands)	Significant impact (step 2, part A)	2.00
		Rehabilitation credit (step 2, part B)	0.00
		Significant residual impact (step 2, part C)	1.60

***Area* (offset site)**

Offset calculation
Area

Offsets calculation

Description	**Proposed offset (area in hectares)**	10.35	**Duration of offset implementation (maximum 20 years)**	20.00	**Offset value** (applied to step 2, part C)	**1.60**	
Land acquisition	**Current quality of offset site (scale)**	8.00	**Time until offset site secured (years)**	1.00		**100.0%**	
	Future quality WITHOUT offset (scale)	7.00	**Risk of future loss WITHOUT offset (%)**	15.0%			
	Future quality WITH offset (scale)	8.00	**Risk of future loss WITH offset (%)**	5.0%			
	Time until ecological benefit (years)	1.00					
	Confidence in offset result (%)	90.0%			**OFFSET ADEQUATE?**	**YES**	

WA Environmental Offsets Calculator

Rationale for scores used in the offsets calculator

Environmental value to be offset			
Calculation	***Score (Area)***		***Rationale***
Conservation significance			
Description	FCT20a (Banksia attenuata woodlands over species rich dense shrublands)		Ecological community identified from floristic analysis as present within the footprint
Type of environmental value	Ecological community		The environmental value being impacted is an ecological community
Conservation significance of environmental value	Threatened ecological community - endangered		The TEC is listed by the State as Endangered
Landscape-level value impacted	yes/no		N/A
Significant impact			
Description	Clearing of up to 2 ha to the TEC		Area of TEC within the indicative footprint
Significant impact (hectares) / Type of feature	2.00		Area of TEC within the indicative footprint
Quality (scale) / Number	8.00		This patch of TEC has been mapped as Very Good - Excellent quality. The patch is part of both regional and local biodiversity linkages identified by the Shire of Chittering.
Rehabilitation credit			
Description	0		N/A no rehabilitation credit proposed
Proposed rehabilitation (area in hectares)	0.00		N/A no rehabilitation credit proposed
Current quality of rehabilitation site / Start number (of type of feature)	0.00		N/A no rehabilitation credit proposed
Future quality WITHOUT rehabilitation (scale) / Future number WITHOUT rehabilitation	0.00		N/A no rehabilitation credit proposed
Future quality WITH rehabilitation (scale) / Future number WITH rehabilitation	0.00		N/A no rehabilitation credit proposed
Time until ecological benefit (years)	0.00		N/A no rehabilitation credit proposed
Confidence in rehabilitation result (%)	0		N/A no rehabilitation credit proposed
Offset			
Description	Land acquisition		Acquisition of land to provide perpetuity protection of the TEC.
Proposed offset (area in hectares)	10.35		Area that achieves 100% direct offset using the "What if Analysis"
Current quality of offset site / Start number (of type of feature)	8.00		Properties targeted for acquisition will be required to provide vegetation that is at least Very Good in Condition. Acquisition will target properties that are adjacent to existing reserves or vegetation corridors
Future quality WITHOUT offset (scale) / Future number WITHOUT offset	7.00		It is assumed that acquired land will be freehold (private). If the offset site was to remain private freehold land, there is a risk of degradation to the site. This may be through illegal dumping of rubbish, grazing of the site by stock or clearing of vegetation for economic purposes such as farming or housing.
Future quality WITH offset (scale) / Future number WITH offset	8.00		The quality of the offset site will, at a minimum, be maintained through management of the offset site by DBCA.
Time until ecological benefit (years)	1.00		Vegetated land will be acquired and transferred to secure tenure prior to commencement of the Proposal. An agreement for the ongoing management of the land will be established between Main Roads and DBCA. The ecological benefit will be realised within 1 year.
Confidence in offset result (%)	0.9		As the offset sites will be managed by DBCA and protected in perpetuity, there is a high level of confidence that the offset result will be realised.
Duration of offset implementation (maximum 20 years)	20.00		The transfer of the offset site to secure tenure managed by DBCA will provide protection and management in perpetuity.
Time until offset site secured (years)	1.00		Vegetated land will be acquired and transferred to secure tenure prior to commencement of the Proposal. An agreement for the ongoing management of the land will be established between Main Roads and DBCA, which may take some time to finalise.
Risk of future loss WITHOUT offset (%)	15.0%		It is assumed that acquired land will be freehold (private). If the offset site was to remain private freehold land, there is a risk of degradation to the site. This may be through illegal dumping of rubbish, grazing of the site by stock or clearing of vegetation for economic purposes such as farming or housing.
Risk of future loss WITH offset (%)	5.0%		As the offset sites will be managed by DBCA and protected in perpetuity, there is a low 5% risk that the values will be lost.
Offset ratio (Conservation area only)	N/A		N/A

Step 1: Determining conservation significance

Key:
- Data to be entered
- Drop-down selection
- Automatically-generated scores (Or, if appropriate, manual data entry permitted)

Area / feature **(Impact site)**

Conservation significance determination for the environmental value impacted		
Conservation significance	**Description**	FCT3b (Corymbia calophylla – Eucalyptus marginata woodland on sandy clay soils – northern expression)
	Type of environmental value	Ecological community
	Conservation significance of environmental value	Threatened ecological community - vulnerable
	Conservation significance score	**0.2%**

Please select *area* or *feature* for the calculations	**Area**

Step 2: Calculating significant residual impact

Key:
- Data to be entered
- Drop-down selection
- Automatically-generated scores

Environmental value (step 1)	FCT3b (Corymbia calophylla – Eucalyptus marginata woodland on sandy clay soils – northern expression)

Area **(impact site)**

Part A: Significant impact calculation *Area*

	Description	Quantum of impact	
Significant impact	Clearing of up to 3 ha of the TEC	Significant impact (hectares)	3.00
		Quality (scale)	8.00
		Total quantum of impact	2.40

Part B: Rehabilitation credit calculation *Area* (onsite)

	Description				
Rehabilitation Credit		Proposed rehabilitation (area in hectares)		Time until ecological benefit (years)	
		Current quality of rehabilitation site (scale)		Confidence in rehabilitation result (%)	
		Future quality WITHOUT rehabilitation (scale)		Rehabilitation credit	0.00
		Future quality WITH rehabilitation (scale)			

Part C: Significant residual impact calculation *Area*

Significant residual impact	Total quantum of impact	2.40
	Rehabilitation credit	0.00
	Significant residual impact	2.40

WA Environmental Offsets Calculator

Step 3: Calculating offsets

Key:
- Data to be entered
- Drop-down selection
- Automatically-generated scores

Environmental value (step 1)	FCT3b (Corymbia calophylla – Eucalyptus marginata woodland on sandy clay soils – northern expression)	Significant impact (step 2, part A)	3.00
		Rehabilitation credit (step 2, part B)	0.00
		Significant residual impact (step 2, part C)	2.40

Area **(offset site)**

Offset calculation
Area

Offsets calculation

Description							
	Proposed offset (area in hectares)	15.37	Duration of offset implementation (maximum 20 years)	20.00	Offset value (applied to step 2, part C)	2.40
Land acquisition	Current quality of offset site (scale)	8.00	Time until offset site secured (years)	1.00		100.0%
	Future quality WITHOUT offset (scale)	7.00	Risk of future loss WITHOUT offset (%)	15.0%		
	Future quality WITH offset (scale)	8.00	Risk of future loss WITH offset (%)	5.0%		
	Time until ecological benefit (years)	1.00				
	Confidence in offset result (%)	90.0%			OFFSET ADEQUATE?	YES

WA Environmental Offsets Calculator

Rationale for scores used in the offsets calculator

Environmental value to be offset			
Calculation	***Score (Area)***		***Rationale***
Conservation significance			
Description	FCT3b (Corymbia calophylla – Eucalyptus marginata woodland on sandy clay soils – northern expression)		Ecological community identified from floristic analysis as present within the footprint
Type of environmental value	Ecological community		The environmental value being impacted is an ecological community
Conservation significance of environmental value	Threatened ecological community - vulnerable		The TEC is listed by the State as Vulnerable
Landscape-level value impacted	yes/no		N/A
Significant impact			
Description	Clearing of up to 3 ha of the TEC		Area of TEC within the indicative footprint
Significant impact (hectares) / Type of feature	3.00		Area of TEC within the indicative footprint
Quality (scale) / Number	8.00		Patches of the TEC within the Developmenet Envelope are a northern expression of the TEC. These patches range in condition from Good to Excellent and are part of, or in close proximity to, both regional and local biodiversity linkages identified by the Shire of Chittering.
Rehabilitation credit			
Description	0		N/A no rehabilitation credit proposed
Proposed rehabilitation (area in hectares)	0.00		N/A no rehabilitation credit proposed
Current quality of rehabilitation site / Start number (of type of feature)	0.00		N/A no rehabilitation credit proposed
Future quality WITHOUT rehabilitation (scale) / Future number WITHOUT rehabilitation	0.00		N/A no rehabilitation credit proposed
Future quality WITH rehabilitation (scale) / Future number WITH rehabilitation	0.00		N/A no rehabilitation credit proposed
Time until ecological benefit (years)	0.00		N/A no rehabilitation credit proposed
Confidence in rehabilitation result (%)	0		N/A no rehabilitation credit proposed
Offset			
Description	Land acquisition		Acquisition of land to provide perpetuity protection of the TEC.
Proposed offset (area in hectares)	15.37		Area that achieves 100% direct offset using the "What if Analysis"
Current quality of offset site / Start number (of type of feature)	8.00		Properties targeted for acquisition will be required to provide vegetation that is at least Very Good in Condition. Acquisition will target properties that are adjacent to existing reserves or vegetation corridors
Future quality WITHOUT offset (scale) / Future number WITHOUT offset	7.00		It is assumed that acquired land will be freehold (private). If the offset site was to remain private freehold land, there is a risk of degradation to the site. This may be through illegal dumping of rubbish, grazing of the site by stock or clearing of vegetation for economic purposes such as farming or housing.
Future quality WITH offset (scale) / Future number WITH offset	8.00		The quality of the offset site will, at a minimum, be maintained through management of the offset site by DBCA.
Time until ecological benefit (years)	1.00		Vegetated land will be acquired and transferred to secure tenure prior to commencement of the Proposal. An agreement for the ongoing management of the land will be established between Main Roads and DBCA. The ecological benefit will be realised within 1 year.
Confidence in offset result (%)	0.9		As the offset sites will be managed by DBCA and protected in perpetuity, there is a high level of confidence that the offset result will be realised.
Duration of offset implementation (maximum 20 years)	20.00		The transfer of the offset site to secure tenure managed by DBCA will provide protection and management in perpetuity.
Time until offset site secured (years)	1.00		Vegetated land will be acquired and transferred to secure tenure prior to commencement of the Proposal. An agreement for the ongoing management of the land will be established between Main Roads and DBCA, which may take some time to finalise.
Risk of future loss WITHOUT offset (%)	15.0%		It is assumed that acquired land will be freehold (private). If the offset site was to remain private freehold land, there is a risk of degradation to the site. This may be through illegal dumping of rubbish, grazing of the site by stock or clearing of vegetation for economic purposes such as farming or housing.
Risk of future loss WITH offset (%)	5.0%		As the offset sites will be managed by DBCA and protected in perpetuity, there is a low 5% risk that the values will be lost.
Offset ratio (Conservation area only)	N/A		N/A

WA Environmental Offsets Calculator

Step 1: Determining conservation significance

Key:
- Data to be entered
- Drop-down selection
- Automatically-generated scores (Or, if appropriate, manual data entry permitted)

Area / feature **(Impact site)**

Conservation significance determination for the environmental value impacted		
Conservation significance	**Description**	P3 PEC Northern Banksia attenuata - Banksia menziesii woodlands (FCT 23b)
	Type of environmental value	Ecological community
	Conservation significance of environmental value	Priority ecological community
	Conservation significance score	**0.1%**

Please select *area* or *feature* for the calculations	**Area**

WA Environmental Offsets Calculator

Step 2: Calculating significant residual impact

Key:
- Data to be entered
- Drop-down selection
- Automatically-generated scores

Environmental value (step 1)	P3 PEC Northern Banksia attenuata - Banksia menziesii woodlands (FCT 23b)

***Area* (impact site)**

Part A: Significant impact calculation *Area*

Significant impact	Description	Quantum of impact	
	Clearing of up to 4.5 ha of the PEC	Significant impact (hectares)	4.50
		Quality (scale)	8.00
		Total quantum of impact	3.60

Part B: Rehabilitation credit calculation *Area* (onsite)

Rehabilitation Credit	Description				
		Proposed rehabilitation (area in hectares)		Time until ecological benefit (years)	
		Current quality of rehabilitation site (scale)		Confidence in rehabilitation result (%)	
		Future quality WITHOUT rehabilitation (scale)		Rehabilitation credit	0.00
		Future quality WITH rehabilitation (scale)			

Part C: Significant residual impact calculation *Area*

Significant residual impact		
	Total quantum of impact	3.60
	Rehabilitation credit	0.00
	Significant residual impact	3.60

WA Environmental Offsets Calculator

Step 3: Calculating offsets

Key:
- Data to be entered
- Drop-down selection
- Automatically-generated scores

Environmental value (step 1)	P3 PEC Northern Banksia attenuata - Banksia menziesii woodlands (FCT 23b)	Significant impact (step 2, part A)	4.50
		Rehabilitation credit (step 2, part B)	0.00
		Significant residual impact (step 2, part C)	3.60

Area **(offset site)**

Offset calculation
Area

Offsets calculation

Description		**Proposed offset (area in hectares)**	23.03	**Duration of offset implementation (maximum 20 years)**	20.00	**Offset value** (applied to step 2, part C)	**3.60**
Land acquisition		**Current quality of offset site (scale)**	8.00	**Time until offset site secured (years)**	1.00		**100.0%**
		Future quality WITHOUT offset (scale)	7.00	**Risk of future loss WITHOUT offset (%)**	15.0%		
		Future quality WITH offset (scale)	8.00	**Risk of future loss WITH offset (%)**	5.0%		
		Time until ecological benefit (years)	1.00				
		Confidence in offset result (%)	90.0%			**OFFSET ADEQUATE?**	**YES**

WA Environmental Offsets Calculator

Rationale for scores used in the offsets calculator

Environmental value to be offset			
Calculation	***Score (Area)***		***Rationale***
Conservation significance			
Description	P3 PEC Northern Banksia attenuata - Banksia menziesii woodlands (FCT 23b)		Ecological community identified from floristic analysis as present within the footprint. This PEC is part of the EPBC Listed Banskia Woodlands TEC
Type of environmental value	Ecological community		The environmental value being impacted is an ecological community
Conservation significance of environmental value	Priority ecological community		The PEC is listed by DBCA as Priority 3
Landscape-level value impacted	yes/no		N/A
Significant impact			
Description	Clearing of up to 4.5 ha of the PEC		Area of TEC within the indicative footprint
Significant impact (hectares) / Type of feature	4.50		Area of TEC within the indicative footprint
Quality (scale) / Number	8.00		Patches of the PEC within the Developmenet Envelope range in condition from Good to Excellent. Patches are part of, or in close proximity to, both regional and local biodiversity linkages identified by the Shire of Chittering.
Rehabilitation credit			
Description	0		N/A no rehabilitation credit proposed
Proposed rehabilitation (area in hectares)	0.00		N/A no rehabilitation credit proposed
Current quality of rehabilitation site / Start number (of type of feature)	0.00		N/A no rehabilitation credit proposed
Future quality WITHOUT rehabilitation (scale) / Future number WITHOUT rehabilitation	0.00		N/A no rehabilitation credit proposed
Future quality WITH rehabilitation (scale) / Future number WITH rehabilitation	0.00		N/A no rehabilitation credit proposed
Time until ecological benefit (years)	0.00		N/A no rehabilitation credit proposed
Confidence in rehabilitation result (%)	0		N/A no rehabilitation credit proposed
Offset			
Description	Land acquisition		Acquisition of land to provide perpetuity protection of the PEC.
Proposed offset (area in hectares)	23.03		Area that achieves 100% direct offset using the "What if Analysis"
Current quality of offset site / Start number (of type of feature)	8.00		Properties targeted for acquisition will be required to provide vegetation that is at least Very Good in Condition. Acquisition will target properties that are adjacent to existing reserves or vegetation corridors
Future quality WITHOUT offset (scale) / Future number WITHOUT offset	7.00		It is assumed that acquired land will be freehold (private). If the offset site was to remain private freehold land, there is a risk of degradation to the site. This may be through illegal dumping of rubbish, grazing of the site by stock or clearing of vegetation for economic purposes such as farming or housing.
Future quality WITH offset (scale) / Future number WITH offset	8.00		The quality of the offset site will, at a minimum, be maintained through management of the offset site by DBCA.
Time until ecological benefit (years)	1.00		Vegetated land will be acquired and transferred to secure tenure prior to commencement of the Proposal. An agreement for the ongoing management of the land will be established between Main Roads and DBCA. The ecological benefit will be realised within 1 year.
Confidence in offset result (%)	0.9		As the offset sites will be managed by DBCA and protected in perpetuity, there is a high level of confidence that the offset result will be realised.
Duration of offset implementation (maximum 20 years)	20.00		The transfer of the offset site to secure tenure managed by DBCA will provide protection and management in perpetuity.
Time until offset site secured (years)	1.00		Vegetated land will be acquired and transferred to secure tenure prior to commencement of the Proposal. An agreement for the ongoing management of the land will be established between Main Roads and DBCA, which may take some time to finalise.
Risk of future loss WITHOUT offset (%)	15.0%		It is assumed that acquired land will be freehold (private). If the offset site was to remain private freehold land, there is a risk of degradation to the site. This may be through illegal dumping of rubbish, grazing of the site by stock or clearing of vegetation for economic purposes such as farming or housing.
Risk of future loss WITH offset (%)	5.0%		As the offset sites will be managed by DBCA and protected in perpetuity, there is a low 5% risk that the values will be lost.
Offset ratio (Conservation area only)	N/A		N/A

Appendix I. Fauna Use of Underpasses

Northern Quoll
Camera Trap Monitoring Program
(2020)

Marble Bar Road
(SLK ~318.46 to SLK ~322.80)

Coongan Gorge Realignment

September 2020
V1

On behalf of:
Main Roads Western Australia
C/- MACA Civil Pty Ltd
PO Box 625
Welshpool DC WA 6986

Prepared by:
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TABLE OF CONTENTS

FIGURES

PLATES

TABLES

APPENDICES

SUMMARY

This report details the results of the first year of a three year northern quoll (*Dasyurus hallucatus*) camera trap monitoring program along a ~4.4km section of the at the Marble Bar Road (SLK ~318.46 to SLK ~322.80) (survey area) carried out on behalf of Main Roads Western Australia (MRWA).

The Marble Bar Road in the vicinity of Coongan Gorge was realigned in 2019 to improve traffic safety. As part of the approval process a northern quoll management plan was formulated and implemented with the primary aims of minimising, mitigating and managing potential impacts to the local northern quoll population.

The approved Northern Quoll Management Plan (Astron 2017) required, among other management measures, the installation of culverts under the new road alignment to act as fauna underpasses. The management plan requires bi-annual monitoring of the use of these culverts by northern quolls over a three year period, post construction.

Culverts were installed at 20 locations along the new road realignment. Twelve sites utilised pipe culverts and eight, box culverts (Figure 1). The number of actual culverts at each site ranges for one to five as determined by anticipated hydraulic requirements.

The broad objective of the monitoring plan is to monitor and measure the effectiveness of management actions in protecting the local northern quoll population, specifically the use of the culverts by northern quolls.

Cameras were initially deployed on the 16 May 2020 however due to travel disruptions caused by Covid 19 restrictions great difficulty arose with respect to obtaining required flights to facilitate their pickup after the minimum two week deployment. As a consequence, the cameras were left in place until the 12 August 2020 (88 days).

On the 12 August 2020, batteries within the cameras were replaced and pictures downloaded. Cameras were then left in place until the 6 September 2020 (25 days) giving a total continuous deployment period of 113 days for most cameras.

Thirty two cameras were initially deployed on the 12 May 2020. An additional four cameras were deployed on the 12 August 2020.

Key Findings

- A total of 263 unique fauna detections (mammals only) were made during the 113 day monitoring period.

- Northern quolls were recorded 130 times on 65 of the 113 days of monitoring. Records were made at 10 of the 12 culverts subject to monitoring. In 84 cases (~65% of records) the individual was deemed to have passed through the culvert either heading to the north or the south (based on being photographed on either side of the culvert in a short space of time or where the individual was photographed entering the

culvert and not returning). In 46 cases (~35% of records) it could not be determined if the culvert had been used.

- The results strongly suggest that box culverts are being favoured compared to pipe culverts though it should be acknowledged that more box culverts were monitored than pipe culverts (eight compared to four) and in some cases for a longer period.

- Northern quolls were consistently recorded from the commencement of monitoring (16 May 2010) until the 11 June 2020 from which point records became relatively intermittent. From about the 8 August 2020 records increased in frequency with a peak around the 16 August 2020.

- The only feral predators recorded were cats (Felis catus). Cats were recorded on 65 unique occasions at 11 of the 12 culverts subject to monitoring. About half of the records indicated use of the culverts by individual cats to pass under the road. No actual cat/northern quoll interactions were recorded.

- The level of culvert used by northern quolls (~65% of records) does not breach the performance indicators detailed in the approved management plan (<40% recorded northern quolls using culverts - Astron 2017). Based on this criterion the management approach (i.e. installing culverts) can be deemed successful in minimising impacts on northern quoll and as such no contingency responses as detailed in the management plan are considered warranted. Based on this criterion and the level of culvert use it is also assumed that the presence of cats is not contributing to a significant decline in northern quolls or their use of culverts.

- Based on the results obtained the following recommendations are provided for implementation during the 2021 camera trap monitoring program.

    - It is recommended that some additional pipe culverts in the area of greatest northern quoll activity (between culverts 109 to 118) be monitored (i.e. 111, 113, 114 and 117) during the 2021 monitoring program.

    - It is recommended that consideration be given to running the camera trap monitoring program over a similar period as undertaken in 2020 (i.e. continuously from sometime in April/May to sometime in July/August with a visit mid survey to check units and replace batteries if required).

      Due to logistical difficulties caused by Covid-19 travel restrictions the 2020 monitoring program was run continuously from mid May to early September. This resulted in the accumulation of 130 northern quoll records which provided good data for analysis. If the monitoring program was actually run for two weeks in April/May and two weeks in July/August, as originally planned the number of records obtained is likely to have been less than half this figure which may not have provided sufficient information for a robust analysis. This proposal can be undertaken with no additional budgetary requirements.

1. INTRODUCTION

This report details the results of the first year of a three year northern quoll (*Dasyurus hallucatus*) camera trap monitoring program along a ~4.4km section of the at the Marble Bar Road (SLK ~318.46 to SLK ~322.80) (survey area) carried out on behalf of Main Roads Western Australia (MRWA).

The Marble Bar Road in the vicinity of Coongan Gorge was realigned in 2019 to improve traffic safety. The project was deemed a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*) (EPBC Ref: 2017/7880) by the federal Department of Agriculture Water and Environment (DAWE) as it was considered likely to have a significant impact on the *EPBC Act* listed (endangered) northern quoll (*Dasyurus hallucatus*).

To facilitate the DAWE and Department of Water and Environment Regulation's (DWER) approval of the project, a northern quoll management plan was formulated and implemented with the primary aims of minimising, mitigating and managing potential impacts to the local northern quoll population.

The approved Northern Quoll Management Plan (Astron 2017) required, among other management measures, the installation of culverts under the new road alignment to act as fauna underpasses. The management plan requires bi-annual monitoring of the use of these culverts by northern quolls over a three year period, post construction.

Culverts were installed at 20 locations along the new road realignment. Twelve sites utilised pipe culverts and eight, box culverts (Figure 1). The number of actual culverts at each site ranges for one to five as determined by anticipated hydraulic requirements.

The broad objective of the monitoring plan is to monitor and measure the effectiveness of management actions in protecting the local northern quoll population, specifically the use of the culverts by northern quolls. One possible outcome will also be to determine whether the box culverts are preferred by northern quolls for dispersal (compared to pipe culverts) and if they provide protection from predation.

2. SCOPE OF WORKS

The scope of works was to carry out a camera trap monitoring survey to determine the use of road culverts by northern quoll (*Dasyurus hallucatus*) along the Marble Bar Road between SLK ~318.46 and SLK ~322.80.

The surveys are to be carried out bi-annually for three years post construction with cameras to be placed out for a minimum two 14-day periods each year.

The department of Biodiversity, Conservation and Attractions (DBCA) have indicated that one survey should be carried out in April-May, to optimise determining the use of the culverts by sub-adult quolls from the previous breeding season. A second survey should

be carried out over a two week period in July-August, to optimise determining the use of the culverts by adult males in the population before they die off after the mating season.

A report is required detailing methods and results at the end of each of the first two years, with the final report summarising all three years data. The monitoring report includes reporting of monitoring trends against performance indicators, any exceedance of these performance indicators and recommendations for review and revision of management actions if required.

Table 1: Summary of the Northern Quoll Monitoring Program

Monitoring Parameter	Methodology	Annual Monitoring Effort	Timing, Frequency and Duration	Performance Indicators
Use of box culverts by northern quolls	Remote cameras	Four cameras placed at the ends (two cameras at each end) of a minimum of four box and four pipe culverts (32 cameras in total)	Annually for three years post construction. Cameras will be placed out for two 14-day periods during the breeding season.	>60% of all northern quolls captured at the entrance of the culvert are deemed to have not passed through, where a biometrically significant amount of NQ activity is actually captured on camera

The report presented here covers the first bi-annual monitoring period being part of the overall there year monitoring schedule as detailed below:

- April-May 2020 (reported on here);
- July-August 2020 (reported on here);
- April-May 2021;
- July-August 2021;
- April-May 2022; and
- July-August 2022.

3. METHODS

Cameras were initially deployed on the 16 May 2020 however due to travel disruptions caused by Covid 19 restrictions great difficulty arose with respect to obtaining required flights to facilitate their pickup after the minimum two week deployment. As a consequence, the cameras were left in place until the 12 August 2020 (88 days). On the 12 August 2020, batteries within the cameras were replaced and pictures downloaded. Malfunctioning cameras were replaced and some additional cameras were also deployed.

Cameras were then left in place until the 6 September 2020 (25 days) giving a total continuous deployment period of 113 days for most cameras.

Thirty two cameras were initially deployed on the 12 May 2020. An additional four cameras were deployed on the 12 August 2020. Table 2 details each culvert along the realignment, its type and the number and dates of camera trap deployment.

As a minimum it was initially proposed to install four infra-red motion sensing cameras (two at each end) at eight culverts (32 cameras in total) to record the movement of fauna. Some of the sites were however found to have only a single culvert and it was therefore decided to only deploy a single camera at some of these locations as camera coverage would be adequate (i.e.no blind spots). This allowed for the monitoring of 10 culverts during the first phase (16 May 2020 – 12 August 2020). An additional two culverts were monitored during the second phase (12 August 2020 to 6 September 2020).

Cameras deployed included Little Acorn Ltl-5210a, Campark T40 and Campark T70 models. Cameras were set to take three photos in succession when triggered with a five second pause between any subsequent trigger event. Cameras were tied to small metal stakes several metres in front of the culverts being monitored.

Upon collection photos on each camera were analysed to obtain the following measure (performance indicator):

- Northern quoll usage of culverts - the direction of the animal on the image and time stamps on the cameras were used to calculate the proportion of northern quolls captured at an entrance of a culvert that are deemed to have passed through to the other side.

- Any images of feral predators (and other fauna, mammals only) were recorded and stored for possible future data analysis. If any performance indicators for northern quolls are exceeded, then the data for feral predator abundance can be reviewed to determine if this is contributing to the decline in quolls or their use of culverts.

Table 2: Summary of Camera Trap Deployment at Culverts

Culvert ID	MGA 94			Culvert Type (& Number)	Monitored (Year 1)	Camera Deployment	Days Deployed	Number of Cameras	Camera Numbers
	Zone	mE	mN						
101	50K	793852	7683377	Pipe (1)	No	N/A	0	0	N/A
102	50K	793660	7683501	Box (5)	Yes	16 May to 6 Sept 2020	113	4	GH 17/GH 64 - GH 21/GH 83
103	50K	793567	7683562	Pipe (1)	Yes	16 May to 6 Sept 2020	113	2	GH 15/GH 88
104	50K	793265	7683661	Box (1)	Yes	16 May to 6 Sept 2020	113	2	GH 20/GH 34 (GH 35)
105	50K	793132	7683674	Pipe (1)	No	N/A	0	0	N/A
106	50K	793060	7683684	Pipe (2)	Yes	12 August to 6 Sept 2020	25	2	GH 10/GH 28
107	50K	793000	7683696	Pipe (1)	No	N/A	0	0	N/A
108	50K	792717	7683784	Box (5)	Yes	16 May to 6 Sept 2020	113	4	GH 26/GH 86 - GH 46 (GH 22)/GH 62
109	50K	792264	7683937	Box (2)	Yes	16 May to 6 Sept 2020	113	4	GH 42/GH 89 - GH 47/GH 65
110	50K	791846	7684081	Pipe (1)	Yes	12 August to 6 Sept 2020	25	2	GH 06 - GH 46
111	50K	791816	7684091	Pipe (1)	No	N/A	0	0	N/A
112	50K	791738	7684125	Box (1)	Yes	16 May to 6 Sept 2020	113	4	GH 29/GH 60 - GH 31/GH 80
113	50K	791682	7684151	Pipe (1)	No	N/A	0	0	N/A
114	50K	791614	7684191	Pipe (1)	No	N/A	0	0	N/A
115	50K	791412	7684333	Pipe (3)	Yes	16 May to 6 Sept 2020	113	2	GH 13/GH 87
116	50K	791323	7684405	Box (1)	Yes	16 May to 6 Sept 2020	113	2	GH 24/GH 43
117	50K	791096	7684538	Pipe (5)	No	N/A	0	0	N/A
118	50K	790875	7684604	Box (1)	Yes	16 May to 6 Sept 2020	113	4	GH 19/GH 63 - GH 25/GH 67
119	50K	790534	7684669	Box (5)	Yes	16 May to 6 Sept 2020	113	4	GH 09/GH 61 - GH 16/GH 85
120	50K	790452	7684676	Pipe (2)	No	N/A	0	0	N/A

Note: Camera numbers in brackets represent replacements for malfunctioning cameras initially deployed.

4. RESULTS

As previously indicated, camera traps were deployed continuously and for a much longer period than originally planned due to logistical difficulties. This has however resulted in the accumulation of additional data that will be used for the purpose of this current assessment.

A total of 263 unique fauna detections (mammals only) were made during the 113 day monitoring period. A summary of the species detected is shown in Table 3.

Table 3: Summary of Fauna Recorded (mammals only)

Common Name	Species	Number of Unique Records
Northern Quoll	*Dasyurus hallucatus*	130
Cat	*Felis catus*	65
Dingo/Dog	*Canus lupus*	11
Euro	*Macropus robustus*	43
Rothschild's Rock-wallaby	*Petrogale rothschildi*	14

Table 4 and Figure 2 provide a summary of the total number of northern quolls recorded at each culvert during the monitoring period. Northern quolls were recorded 130 times on 65 of the 113 days of monitoring. Records were made at 10 of the 12 culverts subject to monitoring. In 84 cases (~65% of records) the individual was deemed to have passed through the culvert either heading to the north or the south (based on being photographed on either side of the culvert in a short space of time or where the individual was photographed entering the culvert and not returning). In 46 cases (~35% of records) it could not be determined if the culvert had been used.

Table 4: Summary of Northern Quoll Movements

Culvert Number	Culvert Type (Number)	Quoll Detections	Culvert Used	Culvert Not Used/Unknown
102	Box (5)	1	0	1
103	Pipe (1)	1	1	0
104	Box (1)	7	6	1
106	Pipe (2)	0	0	0
108	Box (5)	3	2	1
109	Box (2)	25	22	3
110	Pipe (1)	0	0	0
112	Box (1)	27	7	20
115	Pipe (3)	1	0	1
116	Box (1)	35	27	8
118	Box (1)	27	16	11
119	Box (5)	3	3	0
Totals		**130**	**84**	**46**

A summary of northern quoll movements based on culvert type is provided in Table 5. The results strongly suggest that box culverts are being favoured compared to pipe culverts though it should be acknowledged that more box culverts were monitored than pipe culverts (eight compared to four) and in some cases for a longer period.

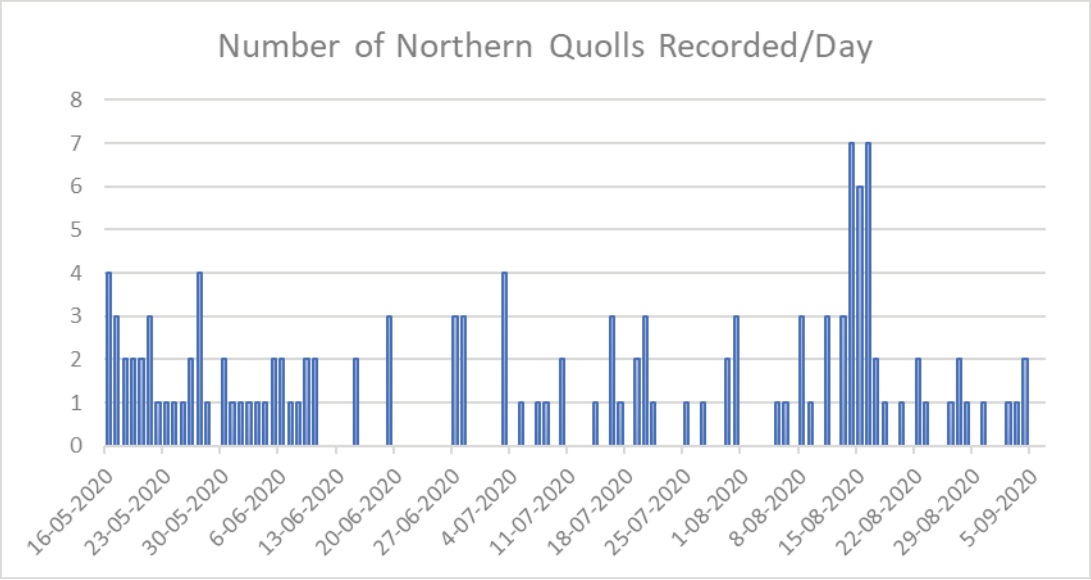
The location of the culverts within the survey area could also have an influence on how many northern quolls frequent any one particular culvert. Most northern quoll activity was detected between culverts 109 to 118 (see Table 4/Figure 2). In this zone there are four box culverts being monitored but only two pipe culverts, though as the results suggest pipe culverts even in this area appear to be extremely underutilised despite the relative high frequency of northern quoll detections at nearby box culverts.

Table 5: Summary of Northern Quoll Movements by Culvert Type

Culvert Type	Quoll Detections	Culvert Used	Culvert Not Used/Unknown
Box	128	83	45
Pipe	2	1	1
Total	**130**	**84**	**46**

A previously mentioned northern quolls were recorded on 65 of the 113 days of monitoring. The specific days and number of northern quolls recorded are shown in Plate 1.

Plate 1: Number of Northern Quolls Recorded/Day



Northern quolls were consistently recorded from the commencement of monitoring (16 May 2010) until the 11 June 2020 from which point records became relatively intermittent. From about the 8 August 2020 records increased in frequency with a peak around the 16 August 2020. Given that specific individuals cannot generally be identified from camera trap pictures the changes in the number of records obtained cannot be attributed to either an increase in the number of individuals or greater activity of single individuals

The only feral predators recorded were cats (*Felis catus*). Cats were recorded on 65 unique occasions at 11 of the 12 culverts subject to monitoring. About half of the records indicated use of the culverts by individual cats to pass under the road. No actual cat/northern quoll interactions were recorded.

The records of northern quoll activity obtained during the 2020 survey period suggests that performance indicators detailed in the approved management plan for northern quolls have not been exceeded (i.e. data obtained did not show >60% of the northern quolls recorded did not use the culvert), and based on this criterion it is assumed that the presence of cats is not contributing to a significant decline in northern quolls or their use of culverts.

5. CONCLUSION AND RECOMMENDATIONS

The camera trap monitoring program detailed in this report was carried out to monitor and measure the effectiveness of management actions in protecting the local northern quoll population, in particular the use of under road culverts by northern quolls along the recently realigned section of the Marble Bar Road at Coongan Gorge.

The results of the 2020 monitoring program clearly indicate that a significant proportion of northern quolls recorded by camera traps are utilising the culverts as a means of moving from one side of the road to the other. The results obtained to date also strongly suggest that box culverts are being used for this purpose in preference to pipe culverts.

The level of culvert used by northern quolls (~65% of records) does not breach the performance indicators detailed in the approved management plan (<40% recorded northern quolls using culverts - Astron 2017). Based on this criterion the management approach (i.e. installing culverts) can be deemed successful in minimising impacts on northern quoll and as such no contingency responses as detailed in the management plan are considered warranted. Based on this criterion and the level of culvert use it is also assumed that the presence of cats is not contributing to a significant decline in northern quolls or their use of culvert.

Based on the results obtained the following recommendations are provided for implementation during the 2021 camera trap monitoring program.

- It is recommended that some additional pipe culverts in the area of greatest northern quoll activity (between culverts 109 to 118) be monitored (i.e. 111, 113, 114 and 117) during the 2021 monitoring program.

- It is recommended that consideration be given to running the camera trap monitoring program over a similar period as undertaken in 2020 (i.e. continuously from sometime in April/May to sometime in July/August with a visit mid survey to check units and replace batteries if required).

  Due to logistical difficulties caused by Covid-19 travel restrictions the 2020 monitoring program was run continuously from mid May to early September. This

resulted in the accumulation of 130 northern quoll records which provided good data for analysis. If the monitoring program was actually run for two weeks in April/May and two weeks in July/August as originally planned the number of records obtained is likely to have been less than half this figure which may not have provided sufficient information for a robust analysis. This proposal can be undertaken with no additional budgetary requirements.

6. REFERENCES

Astron Environmental Services Pty Ltd (2017). Marble Bar Road (M030) Coongan Gorge Realignment - Northern Quoll Management Plan. Unpublished report for main Road Western Australia. May 2017.

FIGURES

Legend

- Road Alignment
- Box Culvert (Monitored)
- Pipe Culvert (Monitored)
- Pipe Culvert (Not Monitored)

N

0 0.25 0.5 0.75 1

Kilometres

Fauna Survey

Marble Bar Road
Coongan Gorge Realignment

Culvert Locations

Drawn: G Harewood	
Date: Sept 2020	
Scale: 1: 250,000	
Projection/Coordinate System: UTM/MGA Zone 50	Figure: 1

Legend

- Road Alignment
- Box Culvert (Monitored)
- Pipe Culvert (Monitored)
- Pipe Culvert (Not Monitored)

N

0 0.25 0.5 0.75 1

Kilometres

Fauna Survey

Marble Bar Road
Coongan Gorge Realignment

Number of Quoll Detections

(16 May - 6 Sept 2020)

Drawn: G Harewood	
Date: Sept 2020	
Scale: 1: 250,000	
Projection/Coordinate System: UTM/MGA Zone 50	Figure: 2

APPENDIX A

CAMERA TRAP RECORDS (MAMMALS ONLY)

Camera Trap Results
16 May - 6 September 2020
Marble Bar Road (SLK ~318.46 to SLK ~322.80)

Culvert Number	Culvert Type	Camera Numbers	Camera	Common Name	Species	Date	Time	Direction of Travel	Number	Setup
C 102	Box Culvert (5)	GH 17/GH 64 - GH 21/GH 83	GH 83	Northern Quoll	Dasyurus hallucatus	17-05-2020	9:11:00 PM	Unknown	1	Dual Cameras either end
C 102	Box Culvert (5)	GH 17/GH 64 - GH 21/GH 83	GH 17	Cat	Felis catus	26-05-2020	2:39:00 AM	Unknown	1	Dual Cameras either end
C 102	Box Culvert (5)	GH 17/GH 64 - GH 21/GH 83	GH 64	Cat	Felis catus	26-05-2020	8:40:00 PM	Unknown	1	Dual Cameras either end
C 102	Box Culvert (5)	GH 17/GH 64 - GH 21/GH 83	GH 64	Dingo/Dog	Canus lupus	29-07-2020	1:34:00 AM	Unknown	1	Dual Cameras either end
C 102	Box Culvert (5)	GH 17/GH 64 - GH 21/GH 83	GH 64	Cat	Felis catus	02-08-2020	8:14:00 PM	North	1	Dual Cameras either end
C 102	Box Culvert (5)	GH 17/GH 64 - GH 21/GH 83	GH 64, GH 83	Cat	Felis catus	05-09-2020	9:44:00 PM	North	1	Dual Cameras either end
C 103	Pipe Culvert (1)	GH 15/GH 88	GH 15	Northern Quoll	Dasyurus hallucatus	16-05-2020	10:48:00 PM	North	1	Single cameras either end
C 104	Box Culvert (1)	GH 20/GH 34	GH 20	Euro	Macropus robustus	17-05-2020	1:31:00 AM	South	1	Single cameras either end
C 104	Box Culvert (1)	GH 20/GH 34	GH 20	Cat	Felis catus	28-06-2020	5:39:00 PM	North	1	Single cameras either end
C 104	Box Culvert (1)	GH 20/GH 34	GH 20	Northern Quoll	Dasyurus hallucatus	03-07-2020	6:28:00 PM	North	1	Single cameras either end
C 104	Box Culvert (1)	GH 20/GH 34	GH 20	Cat	Felis catus	07-07-2020	11:11:00 PM	North	1	Single cameras either end
C 104	Box Culvert (1)	GH 20/GH 34	GH 20	Cat	Felis catus	10-07-2020	3:43:00 AM	North	1	Single cameras either end
C 104	Box Culvert (1)	GH 20/GH 34	GH 20	Northern Quoll	Dasyurus hallucatus	10-07-2020	7:36:00 PM	North	1	Single cameras either end
C 104	Box Culvert (1)	GH 20/GH 34	GH 20	Cat	Felis catus	16-07-2020	6:11:00 AM	South	1	Single cameras either end
C 104	Box Culvert (1)	GH 20/GH 34	GH 20	Cat	Felis catus	16-07-2020	7:23:00 PM	Unknown	1	Single cameras either end
C 104	Box Culvert (1)	GH 20/GH 34	GH 20	Cat	Felis catus	21-07-2020	12:26:00 AM	North	1	Single cameras either end
C 104	Box Culvert (1)	GH 20/GH 35	GH 35	Northern Quoll	Dasyurus hallucatus	27-08-2020	3:17:00 AM	South	1	Single cameras either end
C 104	Box Culvert (1)	GH 20/GH 35	GH 35	Northern Quoll	Dasyurus hallucatus	28-08-2020	1:01:00 AM	Unknown	1	Single cameras either end
C 104	Box Culvert (1)	GH 20/GH 35	GH 35	Northern Quoll	Dasyurus hallucatus	02-09-2020	4:58:00 AM	South	1	Single cameras either end
C 104	Box Culvert (1)	GH 20/GH 35	GH 20	Cat	Felis catus	02-09-2020	8:48:00 PM	North	1	Single cameras either end
C 104	Box Culvert (1)	GH 20/GH 35	GH 20	Cat	Felis catus	02-09-2020	11:58:00 PM	North	1	Single cameras either end
C 104	Box Culvert (1)	GH 20/GH 35	GH 35	Northern Quoll	Dasyurus hallucatus	03-09-2020	3:58:00 AM	South	1	Single cameras either end
C 104	Box Culvert (1)	GH 20/GH 35	GH 35	Northern Quoll	Dasyurus hallucatus	04-09-2020	8:00:00 PM	South	1	Single cameras either end
C 106	Pipe Culvert (2)	GH 10/GH 28	GH 28	Euro	Macropus robustus	18-08-2020	4:47:00 PM	Unknown	1	Single cameras either end
C 106	Pipe Culvert (2)	GH 10/GH 28	GH 28	Euro	Macropus robustus	01-09-2020	1:21:00 AM	Unknown	1	Single cameras either end
C 106	Pipe Culvert (2)	GH 10/GH 28	GH 28	Euro	Macropus robustus	01-09-2020	2:00:00 AM	Unknown	1	Single cameras either end
C 106	Pipe Culvert (2)	GH 10/GH 28	GH 10	Cat	Felis catus	01-09-2020	4:43:00 PM	Unknown	1	Single cameras either end
C 106	Pipe Culvert (2)	GH 10/GH 28	GH 10	Cat	Felis catus	02-09-2020	8:30:00 PM	Unknown	1	Single cameras either end
C 108	Box Culvert (5)	GH 26/GH 86 - GH 46/GH 62	GH 46	Euro	Macropus robustus	18-05-2020	11:11:00 PM	Unknown	1	Dual Cameras either end
C 108	Box Culvert (5)	GH 26/GH 86 - GH 46/GH 62	GH 86	Euro	Macropus robustus	02-06-2020	8:20:00 PM	Unknown	1	Dual Cameras either end
C 108	Box Culvert (5)	GH 26/GH 86 - GH 46/GH 62	GH 26	Euro	Macropus robustus	06-06-2020	4:14:00 AM	Unknown	1	Dual Cameras either end
C 108	Box Culvert (5)	GH 26/GH 86 - GH 46/GH 62	GH 86	Cat	Felis catus	10-06-2020	6:22:00 AM	Unknown	1	Dual Cameras either end
C 108	Box Culvert (5)	GH 26/GH 86 - GH 46/GH 62	GH 86	Cat	Felis catus	10-06-2020	6:16:00 PM	Unknown	1	Dual Cameras either end
C 108	Box Culvert (5)	GH 26/GH 86 - GH 46/GH 62	GH 62	Dingo/Dog	Canus lupus	16-06-2020	5:08:00 AM	Unknown	1	Dual Cameras either end
C 108	Box Culvert (5)	GH 26/GH 86 - GH 46/GH 62	GH 26	Euro	Macropus robustus	21-06-2020	6:51:00 AM	Unknown	1	Dual Cameras either end
C 108	Box Culvert (5)	GH 26/GH 86 - GH 46/GH 62	GH 86	Northern Quoll	Dasyurus hallucatus	03-07-2020	10:27:00 PM	Unknown	1	Dual Cameras either end
C 108	Box Culvert (5)	GH 26/GH 86 - GH 46/GH 62	GH 86	Euro	Macropus robustus	04-07-2020	5:32:00 PM	North	1	Dual Cameras either end
C 108	Box Culvert (5)	GH 26/GH 86 - GH 46/GH 62	GH 26	Cat	Felis catus	05-07-2020	5:09:00 AM	South	1	Dual Cameras either end
C 108	Box Culvert (5)	GH 26/GH 86 - GH 46/GH 62	GH 62	Cat	Felis catus	07-07-2020	5:55:00 PM	Unknown	1	Dual Cameras either end
C 108	Box Culvert (5)	GH 26/GH 86 - GH 46/GH 62	GH 46	Cat	Felis catus	11-07-2020	3:24:00 AM	Unknown	1	Dual Cameras either end
C 108	Box Culvert (5)	GH 26/GH 86 - GH 46/GH 62	GH 26	Euro	Macropus robustus	02-08-2020	3:39:00 AM	South	1	Dual Cameras either end
C 108	Box Culvert (5)	GH 26/GH 86 - GH 46/GH 62	GH 62	Northern Quoll	Dasyurus hallucatus	06-08-2020	11:57:00 PM	South	1	Dual Cameras either end

Culvert Number	Culvert Type	Camera Numbers	Camera	Common Name	Species	Date	Time	Direction of Travel	Number	Setup
C 108	Box Culvert (5)	GH 26/GH 86 - GH 46/GH 62	GH 26	Cat	Felis catus	12-08-2020	2:11:00 AM	Unknown	1	Dual Cameras either end
C 108	Box Culvert (5)	GH 26/GH 86 - GH 46/GH 62	GH 22	Northern Quoll	Dasyurus hallucatus	15-08-2020	8:44:00 PM	South	1	Dual Cameras either end
C 108	Box Culvert (5)	GH 26/GH 86 - GH 46/GH 62	GH 43	Cat	Felis catus	28-08-2020	4:12:00 AM	Unknown	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 89	Northern Quoll	Dasyurus hallucatus	18-05-2020	11:11:00 PM	Unknown	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 89	Northern Quoll	Dasyurus hallucatus	19-05-2020	12:04:00 AM	South	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 89	Northern Quoll	Dasyurus hallucatus	20-05-2020	2:04:00 AM	South	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 47	Northern Quoll	Dasyurus hallucatus	21-05-2020	11:23:00 PM	South	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 65	Northern Quoll	Dasyurus hallucatus	21-05-2020	11:42:00 PM	South	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 47	Northern Quoll	Dasyurus hallucatus	22-05-2020	1:33:00 AM	South	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 65	Cat	Felis catus	24-05-2020	1:36:00 AM	North	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 65	Cat	Felis catus	25-05-2020	6:55:00 PM	Unknown	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 89	Cat	Felis catus	25-05-2020	7:01:00 PM	South	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 65	Northern Quoll	Dasyurus hallucatus	27-05-2020	1:51:00 AM	North	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 47	Northern Quoll	Dasyurus hallucatus	27-05-2020	1:53:00 AM	South	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 89	Northern Quoll	Dasyurus hallucatus	27-05-2020	1:57:00 AM	Unknown	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 89	Northern Quoll	Dasyurus hallucatus	31-05-2020	8:45:00 PM	South	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 89	Euro	Macropus robustus	05-06-2020	12:00:00 AM	Unknown	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 47	Northern Quoll	Dasyurus hallucatus	06-06-2020	11:20:00 PM	South	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 89	Northern Quoll	Dasyurus hallucatus	06-06-2020	11:21:00 PM	North	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 89, GH 65	Northern Quoll	Dasyurus hallucatus	15-06-2020	6:57:00 PM	South	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 89, GH 65	Northern Quoll	Dasyurus hallucatus	19-06-2020	9:03:00 PM	North	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 47, GH 65	Northern Quoll	Dasyurus hallucatus	27-06-2020	1:22:00 AM	North	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 65, GH 89	Northern Quoll	Dasyurus hallucatus	27-06-2020	11:55:00 PM	North	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 47, GH 65	Northern Quoll	Dasyurus hallucatus	28-06-2020	1:06:00 AM	South	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 47, GH 65	Northern Quoll	Dasyurus hallucatus	28-06-2020	1:34:00 AM	South	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 47	Northern Quoll	Dasyurus hallucatus	07-07-2020	10:38:00 PM	Unknown	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 65	Northern Quoll	Dasyurus hallucatus	14-07-2020	10:50:00 PM	South	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 65	Northern Quoll	Dasyurus hallucatus	20-07-2020	12:19:00 AM	North	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 65	Cat	Felis catus	24-07-2020	2:30:00 AM	Unknown	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 65	Cat	Felis catus	29-07-2020	10:03:00 PM	Unknown	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 47, GH 65	Cat	Felis catus	02-08-2020	4:46:00 AM	Unknown	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 42	Northern Quoll	Dasyurus hallucatus	16-08-2020	10:19:00 AM	North	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 89	Northern Quoll	Dasyurus hallucatus	18-08-2020	5:05:00 AM	South	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 42	Northern Quoll	Dasyurus hallucatus	22-08-2020	2:02:00 AM	North	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 42, GH47	Cat	Felis catus	29-08-2020	7:53:00 AM	North	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 42, GH47	Cat	Felis catus	29-08-2020	8:19:00 AM	South	1	Dual Cameras either end
C 109	Box Culvert (2)	GH 42/GH 89 - GH 47/GH 65	GH 47	Northern Quoll	Dasyurus hallucatus	30-08-2020	12:57:00 AM	South	1	Dual Cameras either end
C 110	Pipe Culvert (1)	GH 06 - GH 46	GH 46	Cat	Felis catus	24-08-2020	4:11:00 AM	Unknown	1	Single cameras either end
C 110	Pipe Culvert (1)	GH 06 - GH 46	GH 46	Cat	Felis catus	24-08-2020	11:51:00 PM	South	1	Single cameras either end
C 110	Pipe Culvert (1)	GH 06 - GH 46	GH 46	Cat	Felis catus	27-08-2020	5:30:00 AM	Unknown	1	Single cameras either end
C 110	Pipe Culvert (1)	GH 06 - GH 46	GH 46	Euro	Macropus robustus	01-09-2020	11:11:00 PM	Unknown	1	Single cameras either end
C 110	Pipe Culvert (1)	GH 06 - GH 46	GH 46	Euro	Macropus robustus	01-09-2020	11:59:00 PM	Unknown	1	Single cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Northern Quoll	Dasyurus hallucatus	16-05-2020	7:22:00 PM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Northern Quoll	Dasyurus hallucatus	17-05-2020	7:09:00 PM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Northern Quoll	Dasyurus hallucatus	18-05-2020	7:15:00 PM	Unknown	1	Dual Cameras either end

Culvert Number	Culvert Type	Camera Numbers	Camera	Common Name	Species	Date	Time	Direction of Travel	Number	Setup
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Northern Quoll	Dasyurus hallucatus	20-05-2020	3:33:00 AM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 60	Cat	Felis catus	21-05-2020	10:18:00 PM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 43	Cat	Felis catus	24-05-2020	10:45:00 PM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Cat	Felis catus	25-05-2020	7:21:00 PM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Northern Quoll	Dasyurus hallucatus	26-05-2020	3:40:00 AM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31, GH 80	Northern Quoll	Dasyurus hallucatus	26-05-2020	8:04:00 PM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 29	Cat	Felis catus	28-05-2020	2:25:00 AM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 29	Northern Quoll	Dasyurus hallucatus	28-05-2020	7:36:00 PM	North	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Northern Quoll	Dasyurus hallucatus	30-05-2020	10:22:00 PM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 29, GH 31	Northern Quoll	Dasyurus hallucatus	02-06-2020	3:06:00 AM	South	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Northern Quoll	Dasyurus hallucatus	05-06-2020	4:09:00 AM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 29, GH 80	Northern Quoll	Dasyurus hallucatus	05-06-2020	6:24:00 PM	South	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 29	Northern Quoll	Dasyurus hallucatus	09-06-2020	6:06:00 PM	South	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Northern Quoll	Dasyurus hallucatus	08-07-2020	8:12:00 PM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Northern Quoll	Dasyurus hallucatus	10-07-2020	6:28:00 PM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Dingo/Dog	Canus lupus	14-07-2020	7:05:00 PM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 80	Dingo/Dog	Canus lupus	14-07-2020	7:25:00 PM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Northern Quoll	Dasyurus hallucatus	16-07-2020	12:00:00 AM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Northern Quoll	Dasyurus hallucatus	16-07-2020	7:54:00 PM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Northern Quoll	Dasyurus hallucatus	17-07-2020	1:12:00 AM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Northern Quoll	Dasyurus hallucatus	19-07-2020	2:53:00 AM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Northern Quoll	Dasyurus hallucatus	19-07-2020	7:21:00 PM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Northern Quoll	Dasyurus hallucatus	20-07-2020	1:17:00 AM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 29	Northern Quoll	Dasyurus hallucatus	20-07-2020	8:11:00 PM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Dingo/Dog	Canus lupus	29-07-2020	2:01:00 AM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 29	Northern Quoll	Dasyurus hallucatus	08-08-2020	7:01:00 PM	North	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Northern Quoll	Dasyurus hallucatus	09-08-2020	8:17:00 PM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 80	Dingo/Dog	Canus lupus	15-08-2020	4:48:00 AM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Northern Quoll	Dasyurus hallucatus	16-08-2020	8:50:00 PM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Northern Quoll	Dasyurus hallucatus	16-08-2020	9:16:00 PM	South	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 60	Cat	Felis catus	17-08-2020	2:19:00 AM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 29	Cat	Felis catus	17-08-2020	2:20:00 AM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 60, GH80, GH 31	Cat	Felis catus	17-08-2020	4:25:00 AM	North	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 60, GH80, GH 31	Cat	Felis catus	18-08-2020	3:01:00 AM	South	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 80	Cat	Felis catus	18-08-2020	9:19:00 PM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 29	Northern Quoll	Dasyurus hallucatus	22-08-2020	1:51:00 AM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 60	Cat	Felis catus	24-08-2020	1:36:00 AM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 80, GH 31	Cat	Felis catus	24-08-2020	3:55:00 AM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 80	Cat	Felis catus	25-08-2020	2:20:00 AM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 29	Cat	Felis catus	27-08-2020	2:11:00 AM	Unknown	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 80	Northern Quoll	Dasyurus hallucatus	04-09-2020	10:56:00 PM	North	1	Dual Cameras either end
C 112	Box Culvert (1)	GH 29/GH 60 - GH 31/GH 80	GH 31	Cat	Felis catus	14?07/2020	1:39:00 AM	Unknown	1	Dual Cameras either end
C 115	Pipe Culvert (3)	GH 13/GH 87	GH 13	Cat	Felis catus	02-02-2016	5:03:00 PM	Unknown	1	Single cameras either end
C 115	Pipe Culvert (3)	GH 13/GH 87	GH 13	Rothschild's Rock-wallaby	Petrogale rothschildi	24-02-2016	3:49:00 PM	Unknown	1	Single cameras either end
C 115	Pipe Culvert (3)	GH 13/GH 87	GH 13	Rothschild's Rock-wallaby	Petrogale rothschildi	29-02-2016	3:55:00 PM	South	1	Single cameras either end

Culvert Number	Culvert Type	Camera Numbers	Camera	Common Name	Species	Date	Time	Direction of Travel	Number	Setup
C 115	Pipe Culvert (3)	GH 13/GH 87	GH 87	Rothschild's Rock-wallaby	Petrogale rothschildi	23-05-2020	4:48:00 PM	North	1	Single cameras either end
C 115	Pipe Culvert (3)	GH 13/GH 87	GH 87	Rothschild's Rock-wallaby	Petrogale rothschildi	05-07-2020	8:32:00 PM	Unknown	1	Single cameras either end
C 115	Pipe Culvert (3)	GH 13/GH 87	GH 87	Rothschild's Rock-wallaby	Petrogale rothschildi	10-07-2020	8:38:00 PM	Unknown	1	Single cameras either end
C 115	Pipe Culvert (3)	GH 13/GH 87	GH 87	Rothschild's Rock-wallaby	Petrogale rothschildi	13-07-2020	10:00:00 PM	Unknown	1	Single cameras either end
C 115	Pipe Culvert (3)	GH 13/GH 87	GH 87	Rothschild's Rock-wallaby	Petrogale rothschildi	15-07-2020	6:26:00 PM	Unknown	1	Single cameras either end
C 115	Pipe Culvert (3)	GH 13/GH 87	GH 87	Rothschild's Rock-wallaby	Petrogale rothschildi	16-07-2020	5:38:00 AM	Unknown	1	Single cameras either end
C 115	Pipe Culvert (3)	GH 13/GH 87	GH 87	Rothschild's Rock-wallaby	Petrogale rothschildi	18-07-2020	6:33:00 PM	North	1	Single cameras either end
C 115	Pipe Culvert (3)	GH 13/GH 87	GH 87	Rothschild's Rock-wallaby	Petrogale rothschildi	19-07-2020	9:08:00 PM	Unknown	1	Single cameras either end
C 115	Pipe Culvert (3)	GH 13/GH 87	GH 87	Northern Quoll	Dasyurus hallucatus	26-08-2020	1:10:00 AM	Unknown	1	Single cameras either end
C 115	Pipe Culvert (3)	GH 13/GH 87	GH 87	Rothschild's Rock-wallaby	Petrogale rothschildi	30-08-2020	12:28:00 AM	Unknown	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 24	Northern Quoll	Dasyurus hallucatus	16-05-2020	8:23:00 PM	Unknown	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 24	Northern Quoll	Dasyurus hallucatus	16-05-2020	8:55:00 PM	North	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 24, GH 43	Northern Quoll	Dasyurus hallucatus	17-05-2020	5:55:00 PM	South	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 43	Northern Quoll	Dasyurus hallucatus	19-05-2020	8:44:00 PM	Unknown	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 24, GH 43	Rothschild's Rock-wallaby	Petrogale rothschildi	20-05-2020	6:29:00 PM	North	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 43	Northern Quoll	Dasyurus hallucatus	21-05-2020	5:49:00 PM	North	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 43	Northern Quoll	Dasyurus hallucatus	23-05-2020	6:39:00 PM	South	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 43	Northern Quoll	Dasyurus hallucatus	24-05-2020	5:59:00 AM	North	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 24	Cat	Felis catus	27-05-2020	3:39:00 AM	Unknown	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 43	Northern Quoll	Dasyurus hallucatus	27-05-2020	4:25:00 AM	Unknown	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 24, GH 43	Rothschild's Rock-wallaby	Petrogale rothschildi	29-05-2020	6:04:00 PM	North	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 43	Northern Quoll	Dasyurus hallucatus	30-05-2020	6:49:00 PM	Unknown	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 43	Northern Quoll	Dasyurus hallucatus	01-06-2020	3:22:00 AM	South	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 43	Northern Quoll	Dasyurus hallucatus	03-06-2020	10:14:00 PM	South	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 43	Northern Quoll	Dasyurus hallucatus	04-06-2020	6:50:00 PM	Unknown	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 43	Northern Quoll	Dasyurus hallucatus	07-06-2020	7:16:00 PM	South	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 43	Northern Quoll	Dasyurus hallucatus	08-06-2020	5:09:00 AM	Unknown	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 24	Northern Quoll	Dasyurus hallucatus	09-06-2020	7:13:00 PM	North	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 43	Northern Quoll	Dasyurus hallucatus	10-06-2020	6:04:00 PM	South	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 43	Northern Quoll	Dasyurus hallucatus	15-06-2020	11:48:00 PM	South	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 24	Northern Quoll	Dasyurus hallucatus	19-06-2020	5:43:00 AM	North	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 43	Dingo/Dog	Canus lupus	22-06-2020	3:23:00 AM	Unknown	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 43	Northern Quoll	Dasyurus hallucatus	27-06-2020	6:08:00 PM	Unknown	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 43	Northern Quoll	Dasyurus hallucatus	03-07-2020	4:12:00 AM	South	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 24	Northern Quoll	Dasyurus hallucatus	03-07-2020	6:34:00 PM	North	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 24	Northern Quoll	Dasyurus hallucatus	05-07-2020	1:34:00 AM	Unknown	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 24, GH 43	Rothschild's Rock-wallaby	Petrogale rothschildi	14-07-2020	10:34:00 PM	North	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 43	Dingo/Dog	Canus lupus	25-07-2020	11:34:00 PM	Unknown	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 43	Euro	Macropus robustus	28-07-2020	7:31:00 PM	Unknown	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 43	Northern Quoll	Dasyurus hallucatus	30-07-2020	6:06:00 PM	South	1	Single cameras either end
C 116	Box Culvert (1)	GH 24/GH 43	GH 43	Northern Quoll	Dasyurus hallucatus	11-08-2020	6:34:00 PM	South	1	Single Camera Facing South
C 116	Box Culvert (1)	GH 24/GH 43	GH 24, GH 43	Northern Quoll	Dasyurus hallucatus	13-08-2020	10:23:00 PM	South	1	Single Camera Facing South
C 116	Box Culvert (1)	GH 24/GH 43	GH 24, GH 43	Northern Quoll	Dasyurus hallucatus	14-08-2020	2:45:00 AM	South	1	Single Camera Facing South
C 116	Box Culvert (1)	GH 24/GH 43	GH 24, GH 43	Northern Quoll	Dasyurus hallucatus	14-08-2020	3:43:00 PM	South	1	Single Camera Facing South
C 116	Box Culvert (1)	GH 24/GH 43	GH 24, GH 43	Northern Quoll	Dasyurus hallucatus	14-08-2020	7:32:00 PM	North	1	Single Camera Facing South

Culvert Number	Culvert Type	Camera Numbers	Camera	Common Name	Species	Date	Time	Direction of Travel	Number	Setup
C 116	Box Culvert (1)	GH 24/GH 43	GH 24, GH 43	Northern Quoll	Dasyurus hallucatus	14-08-2020	8:51:00 PM	South	1	Single Camera Facing South
C 116	Box Culvert (1)	GH 24/GH 43	GH 24, GH 43	Northern Quoll	Dasyurus hallucatus	14-08-2020	10:01:00 PM	South	1	Single Camera Facing South
C 116	Box Culvert (1)	GH 24/GH 43	GH 24, GH 43	Northern Quoll	Dasyurus hallucatus	14-08-2020	10:35:00 PM	South	1	Single Camera Facing South
C 116	Box Culvert (1)	GH 24/GH 43	GH 24, GH 43	Northern Quoll	Dasyurus hallucatus	15-08-2020	2:14:00 AM	South	1	Single Camera Facing South
C 116	Box Culvert (1)	GH 24/GH 43	GH 24, GH 43	Northern Quoll	Dasyurus hallucatus	15-08-2020	3:43:00 AM	South	1	Single Camera Facing South
C 116	Box Culvert (1)	GH 24/GH 43	GH 24, GH 43	Northern Quoll	Dasyurus hallucatus	16-08-2020	5:42:00 AM	South	1	Single Camera Facing South
C 116	Box Culvert (1)	GH 24/GH 43	GH 24, GH 43	Northern Quoll	Dasyurus hallucatus	16-08-2020	7:00:00 PM	South	1	Single Camera Facing South
C 116	Box Culvert (1)	GH 24/GH 43	GH 24	Cat	Felis catus	27-08-2020	11:03:00 PM	Unknown	1	Single Camera Facing South
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 25, GH 67	Euro	Macropus robustus	26-05-2020	7:17:00 PM	Unknown	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 63, GH 67	Euro	Macropus robustus	27-05-2020	8:37:00 PM	South	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 19, GH 63, GH 25, GH 67	Euro	Macropus robustus	30-05-2020	5:30:00 PM	South	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 19, GH 63	Cat	Felis catus	30-05-2020	8:10:00 PM	North	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 25, GH 67	Euro	Macropus robustus	04-06-2020	4:10:00 AM	South	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 25	Northern Quoll	Dasyurus hallucatus	10-06-2020	7:44:00 PM	South	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 63, GH 25, GH 67	Euro	Macropus robustus	11-06-2020	7:39:00 AM	South	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 25, GH 67	Euro	Macropus robustus	16-06-2020	1:21:00 AM	Unknown	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 67	Northern Quoll	Dasyurus hallucatus	19-06-2020	10:37:00 PM	South	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 63	Cat	Felis catus	20-06-2020	10:53:00 PM	South	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 19, GH 63	Euro	Macropus robustus	27-06-2020	6:00:00 PM	North	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 19, GH 63	Northern Quoll	Dasyurus hallucatus	28-06-2020	8:16:00 PM	Unknown	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 19, GH 63	Dingo/Dog	Canus lupus	16-07-2020	5:10:00 AM	Unknown	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 67	Northern Quoll	Dasyurus hallucatus	21-07-2020	2:34:00 AM	South	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 63	Cat	Felis catus	21-07-2020	5:22:00 AM	South	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 63	Northern Quoll	Dasyurus hallucatus	25-07-2020	8:45:00 PM	North	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 25, GH 67	Euro	Macropus robustus	26-07-2020	10:35:00 PM	Unknown	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 63	Northern Quoll	Dasyurus hallucatus	27-07-2020	4:29:00 AM	Unknown	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 19, GH 63, GH 67	Cat	Felis catus	28-07-2020	5:34:00 PM	South	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 25, GH 67	Northern Quoll	Dasyurus hallucatus	30-07-2020	9:09:00 PM	South	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 25	Northern Quoll	Dasyurus hallucatus	31-07-2020	12:15:00 AM	Unknown	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 63	Northern Quoll	Dasyurus hallucatus	31-07-2020	4:44:00 AM	Unknown	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 19, GH 63, GH 25, GH 67	Euro	Macropus robustus	02-08-2020	2:01:00 AM	South	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 63, GH 67	Northern Quoll	Dasyurus hallucatus	05-08-2020	5:51:00 AM	South	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 63	Northern Quoll	Dasyurus hallucatus	08-08-2020	1:30:00 AM	North	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 25	Northern Quoll	Dasyurus hallucatus	08-08-2020	8:54:00 PM	Unknown	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 67	Cat	Felis catus	09-08-2020	9:30:00 PM	Unknown	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 63	Northern Quoll	Dasyurus hallucatus	11-08-2020	12:37:00 AM	North	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 63	Northern Quoll	Dasyurus hallucatus	11-08-2020	7:40:00 PM	Unknown	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 19, GH 63, GH 67	Euro	Macropus robustus	12-08-2020	3:11:00 AM	South	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH19, GH 63,	Northern Quoll	Dasyurus hallucatus	13-08-2020	4:11:00 AM		1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 63	Northern Quoll	Dasyurus hallucatus	13-08-2020	6:57:00 PM		1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 67	Northern Quoll	Dasyurus hallucatus	14-08-2020	3:24:00 AM	North	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 67, GH 25	Northern Quoll	Dasyurus hallucatus	15-08-2020	4:07:00 AM		1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 63, GH 67	Northern Quoll	Dasyurus hallucatus	15-08-2020	6:43:00 PM	North	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 25	Northern Quoll	Dasyurus hallucatus	15-08-2020	7:43:00 PM	South	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 67, GH 25	Northern Quoll	Dasyurus hallucatus	16-08-2020	2:45:00 AM	South	1	Dual Cameras either end

Culvert Number	Culvert Type	Camera Numbers	Camera	Common Name	Species	Date	Time	Direction of Travel	Number	Setup
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 63	Northern Quoll	Dasyurus hallucatus	16-08-2020	5:20:00 AM	North	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 25	Northern Quoll	Dasyurus hallucatus	17-08-2020	6:30:00 PM	North	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 67	Northern Quoll	Dasyurus hallucatus	17-08-2020	11:57:00 PM	Unknown	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 25	Northern Quoll	Dasyurus hallucatus	20-08-2020	6:20:00 PM	South	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 25	Northern Quoll	Dasyurus hallucatus	23-08-2020	6:42:00 PM	South	1	Dual Cameras either end
C 118	Box Culvert (1)	GH 19/GH 63 - GH 25/GH 67	GH 63	Northern Quoll	Dasyurus hallucatus	27-08-2020	12:47:00 AM		1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 61	Euro	Macropus robustus	17-05-2020	6:08:00 PM	North	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 09, GH 85	Euro	Macropus robustus	18-05-2020	8:55:00 PM	South	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 85	Euro	Macropus robustus	19-05-2020	8:57:00 PM	South	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 09	Northern Quoll	Dasyurus hallucatus	25-05-2020	10:37:00 PM	North	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 09	Euro	Macropus robustus	27-05-2020	11:49:00 PM	North	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 61, GH 16	Euro	Macropus robustus	30-05-2020	6:17:00 PM	North	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 61	Cat	Felis catus	06-06-2020	7:32:00 PM	North	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 61	Cat	Felis catus	07-06-2020	7:52:00 PM	North	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 61	Euro	Macropus robustus	08-06-2020	11:26:00 AM	South	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 09, GH 85	Cat	Felis catus	08-06-2020	7:13:00 PM	North	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 61, GH 16	Euro	Macropus robustus	10-06-2020	6:00:00 PM	North	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 61	Euro	Macropus robustus	13-06-2020	5:23:00 AM	South	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 09	Cat	Felis catus	13-06-2020	7:47:00 PM	South	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 16	Euro	Macropus robustus	18-06-2020	2:00:00 AM	Unknown	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 61	Dingo/Dog	Canus lupus	23-06-2020	12:37:00 AM	Unknown	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 16, GH 85	Dingo/Dog	Canus lupus	23-06-2020	12:40:00 AM	Unknown	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 85	Euro	Macropus robustus	01-07-2020	9:30:00 PM	South	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 61, GH 09	Northern Quoll	Dasyurus hallucatus	16-07-2020	12:29:00 AM	North	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 61	Cat	Felis catus	18-07-2020	7:19:00 PM	South	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 61	Cat	Felis catus	20-07-2020	3:43:00 AM	South	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 09, GH 85	Euro	Macropus robustus	24-07-2020	7:13:00 PM	South	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 61	Cat	Felis catus	29-07-2020	7:20:00 PM	South	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 61	Northern Quoll	Dasyurus hallucatus	31-07-2020	4:35:00 AM	South	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 85	Euro	Macropus robustus	01-08-2020	10:57:00 PM	South	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 85	Cat	Felis catus	03-08-2020	8:23:00 PM	South	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 16	Euro	Macropus robustus	04-08-2020	12:02:00 AM	Unknown	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 85	Cat	Felis catus	05-08-2020	3:43:00 AM	South	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 61, GH 09	Euro	Macropus robustus	08-08-2020	10:07:00 PM	South	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 09	Cat	Felis catus	09-08-2020	10:39:00 PM	North	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 61	Euro	Macropus robustus	18-08-2020	7:58:00 PM	South	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 61, GH 16	Cat	Felis catus	21-08-2020	9:16:00 PM	South	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 61	Euro	Macropus robustus	26-08-2020	3:54:00 AM	Unknown	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 09	Euro	Macropus robustus	03-09-2020	8:33:00 PM	Unknown	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 09, GH 61, GH 16, GH 85	Euro	Macropus robustus	03-09-2020	8:33:00 PM	North	1	Dual Cameras either end
C 119	Box Culvert (5)	GH 09/GH 61 - GH 16/GH 85	GH 85	Euro	Macropus robustus	03-09-2020	9:50:00 PM	Unknown	1	Dual Cameras either end

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The conclusions are based upon field data and the environmental monitoring and/or testing carried out over a limited period of time and are therefore merely indicative of the environmental condition of the site at the time of preparing the report. Also it should be recognised that site conditions, can change with time.

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The Author will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

Appendix J. Muchea North Artificial Hollow Monitoring Reports

PHOENIX
ENVIRONMENTAL SCIENCES

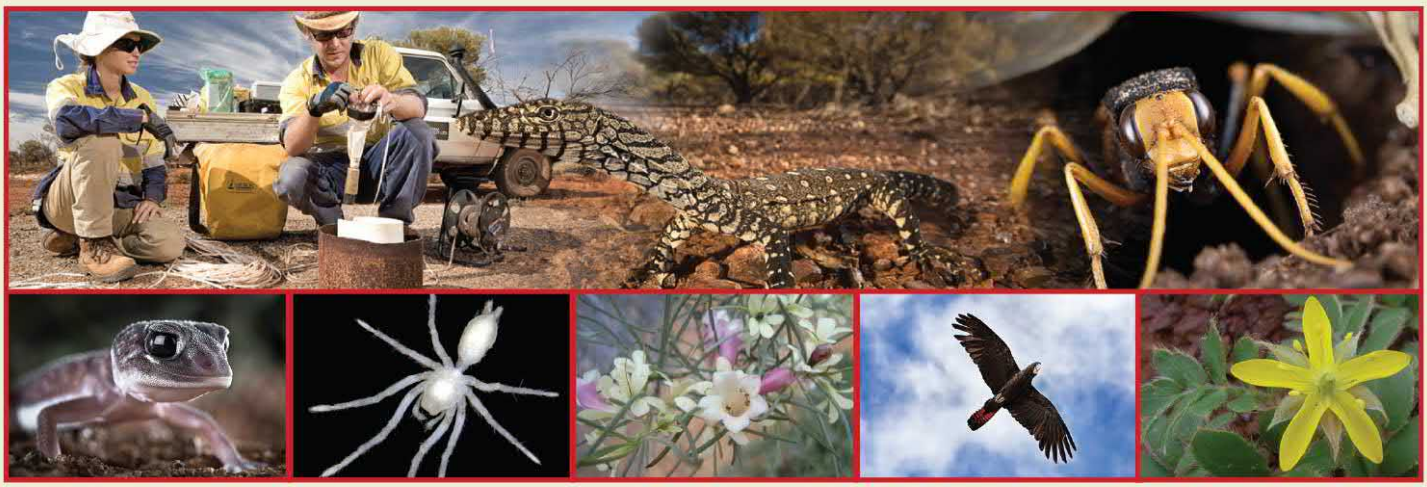
Black cockatoo breeding activity census 2018-19 for Muchea North

Great Northern Highway, Muchea to Wubin Upgrade Stage 2 Project

Prepared for Muchea to Wubin Integrated Project Team (Main Roads WA, Jacobs and Arup)

October 2019

Final report



Black cockatoo breeding activity census 2018-19 for Muchea North.

Great Northern Highway, Muchea to Wubin Upgrade Stage 2 Project.

Prepared for Muchea to Wubin Integrated Project Team (Main Roads WA, Jacobs and Arup)

Draft Report

Authors: John Scanlon, Karen Crews

Reviewer: Anna Leung

Submitted to: Lisa Boulden

Version history			
Name	**Status**	**Version**	**Date**
K. Crews	Draft issued for client review	A	20/06/2019
A. Leung	Final report	B	24/10/2019

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Project code: 1220-GNH-JA-VER

Contents

List of Figures

List of Tables

Appendices

1 INTRODUCTION

Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by the Muchea to Wubin Integrated Project Team (Main Roads WA, Jacobs and Arup) to undertake a Carnaby's Cockatoo breeding activity census over the 2018-19 breeding season within and surrounding the disturbance footprint for the Muchea North project area (Figure 1). This report presents the results of the census.

1.1 BACKGROUND

Muchea North is part of the Great Northern Highway (GNH) Muchea to Wubin Upgrade Stage 2 Project and entails proposed upgrade works to the GNH between Old Gingin Road and Chittering Roadhouse, approximately 63 km north of Perth. The proponent for Muchea North is Main Roads Western Australia ('Main Roads') who, together with industry partners Arup and Jacobs, have formed the Integrated Project Team (IPT).

Detailed black cockatoo habitat assessments conducted as part of the baseline assessments for the Muchea North Project (Phoenix 2015, 2017) recorded all potential breeding trees of species known to support black cockatoo breeding and identifed suitable nesting hollows and hollows with evidence of use.

The Commonwealth Department of Environment and Energy (DoEE) deemed Muchea North a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (EPBC ref: 2016/7656), with a contributing factor being proposed impacts to Carnaby's Cockatoo (*Calyptorhynchus latirostris*) habitat, including suitable nesting hollows. The species is listed as a matter of national environmental significance (NES) under the EPBC Act, with the conservation status of 'Endangered'. It is also listed as Endangered under the WA *Biodiversity Conservation Act 2016*.

The Muchea North proposal was approved by the Commonwealth Minister for the Environment on 10 August 2018. Conditions of approval in relation to Carnaby's Cockatoo included:

> *Condition 4: To mitigate and offset the loss of known nesting trees and suitable nesting hollows the approval holder must:*
>
> *a. install at least three artificial nesting hollows for each known nesting hollow and suitable hollow cleared*
>
> *b. install at least ten of the artificial nesting hollows required by Condition 4a prior to clearing of any known nesting hollow or suitable nesting hollow with all remaining hollows to be installed prior to the beginning of the next breeding season following the commencement of the action*
>
> *c. maintain the pre-impact breeding density of the Carnaby's Black Cockatoo within the project area by undertaking adaptive management of the artificial nesting hollows to maximimse the likelihood that the installed artificial nesting hollows are used by the Carnaby's Black Cockatoo*
>
> *d. adaptive management may cease when at least one artificial nesting hollow for each known nesting hollow cleared has shown evidence of use by the Carnaby's Black Cockatoo, as verified by the suitable qualified person, for three consecutive years, the artificaly nesting hollow in use for three consecutive years need not be the same artificial nesting hollow each year.*
>
> *e. n/a*
>
> *f. each artificial nesting hollow installed must*

i. be inspected at least twice a year by a suitably qualified person during the peak breeding season to record any evidence of use by the Carnaby's Black Cockatoo and to identify maintenance requirements.

j. be monitored and maintained in accordance with relevant artificial hollow guidance for the life of the approval, with maintenance actions, if required, undertaken outside of the breeding season and before the commencement of the next breeding season.

A native vegetation clearing permit (NVCP) for Muchea North (Permit no. 7563/2) has been approved by the WA Department of Water and Environmental Regulation (DWER) under the *Environmental Protection Act 1986* (EP Act). Permit conditions include the following in relation to artificial black cockatoo nest hollows:

"9. Fauna management – black cockatoo nesting trees

(a) Prior to undertaking any clearing of black cockatoo nesting trees outside of the period 1 March to 31 May, the Permit holder shall engage a fauna specialist to conduct a fauna survey of those trees to identify any that are being utilised by Calyptorhynchus latirostris (Carnaby's black cockatoo) or Calyptorhynchus banksii naso (forest red-tailed black cockatoo)

(b) Where a black cockatoo nesting tree(s) being utilised by Carnaby's cockatoo or forest red-tailed black cockatoo is identified, the Permit Holder shall monitor the black cockatoo nesting tree(s) to determine when the chick(s) has fledged; and

(c) The Permit Holder shall not clear a black cockatoo nesting tree identified as being utilised by Carnaby's cockatoo or forest red-tailed black cockatoo until the chick(s) had fledged.

"10. Fauna management – artificial black cockatoo nest hollows

(c) The Permit Holder must monitor and maintain the installed artificial black cockatoo nest hollows for a period of at least ten years.

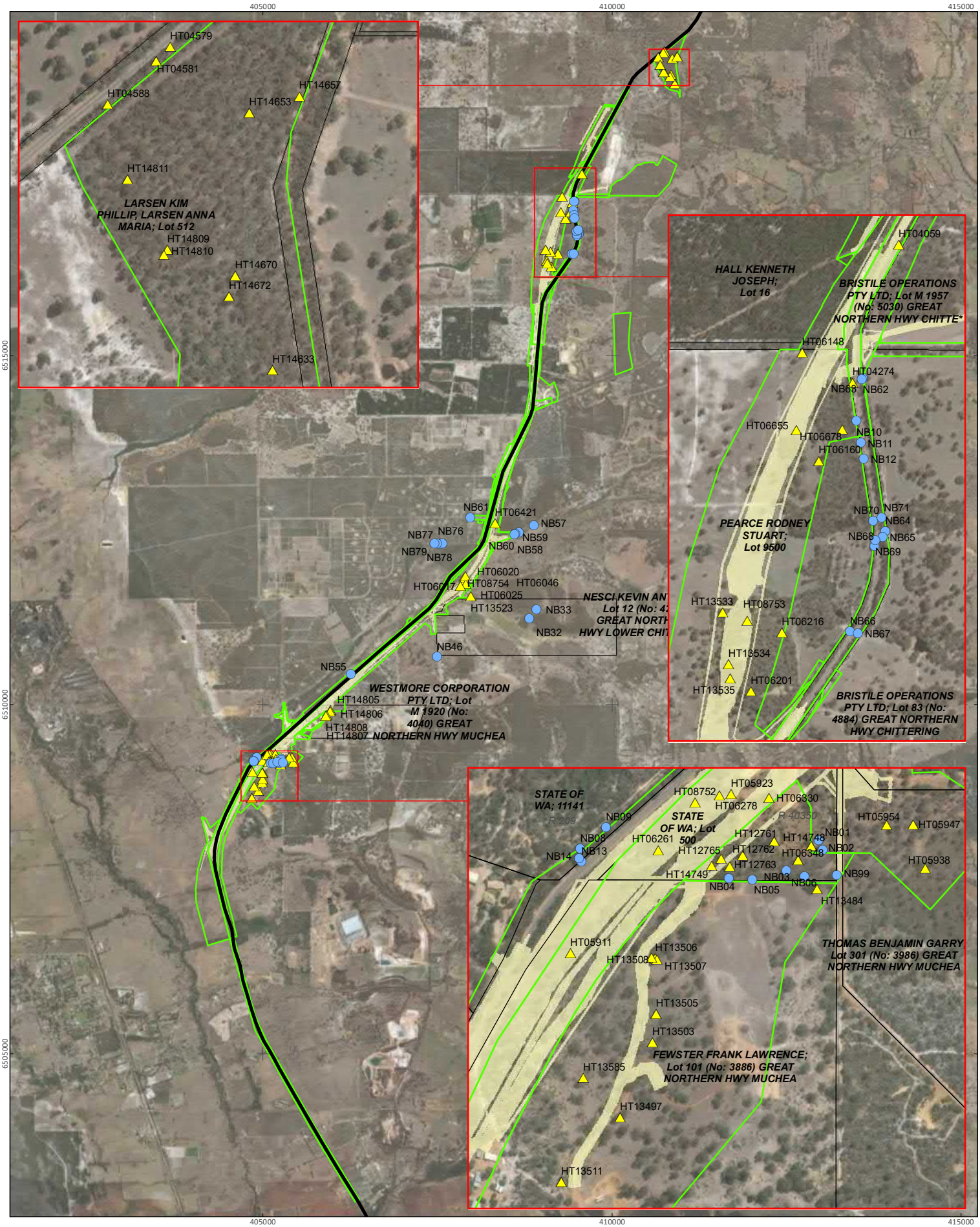
(d) Monitoring and maintenance must be undertaken in accordance with the guidelines provided in Schedule 2."

To support Condition 4c of EPBC 2016/7656, Main Roads commissioned Phoenix to undertake baseline monitoring of confirmed and suitable nesting hollows recorded within the Muchea North EPBC Act Approval Boundary and wider baseline survey (Phoenix 2015, 2017) study area (the study area; Figure 1). The initial baseline monitoring program was conducted in the 2017-18 breeding season (August 2017 – February 2018) and assessed hollow usage of suitable nesting hollows and hollows with evidence of use within the study area (Phoenix 2018).

Phoenix was subsequently commissioned to undertake a second year of monitoring for hollow usage within the study area in the 2018-19 breeding season. This report incorporates the results of the second monitoring season into the nesting hollow usage dataset for Muchea North.

In addition, artificial nesting hollows were installed for Muchea North in accordance with Condition 4a and 4b of EPBC 2016/7656 at the start of the 2018-19 breeding season. These nest boxes were also monitored for activity during the program, where possible[1], to support Condition 4f of EPBC 2016/7656 and Condition 9c of clearing permit 7563/2.

[1] Not part of original scope, this activity was added in during the program. Artifical nest boxes were only monitored if time permitted, and where accessible.



Jacobs: Great Northern Highway Muchea to Wubin Upgrade Stage 2: Carnaby's black cockatoo breeding activity census (2018-2019 breeding season)

Project No	1220
Date	18-Jun-19
Drawn by	AL
Map author	AL

0 1 2
Kilometers

1:70,000 (at A4) GDA 1994 MGA Zone 50

Study area
Disturbance footprint
Road

Monitored hollows

Artificial nesting hollow
Natural nesting hollow

Figure 1

Study area and sampling sites

PHOENIX ENVIRONMENTAL SCIENCES

1.2 SCOPE OF WORK

The scope of work was as follows:

1. Conduct a census of all known nesting trees and trees with suitable breeding hollows for Black Cockatoo within the study area – visit each tree monthly between August and February and inspect for evidence of breeding activity of these hollows
2. Time permitting, inspect artificial nesting hollows installed for Muchea North for evidence of breeding activity
3. Prepare a brief memo report documenting the results and providing an estimated utilisation rate considering the 2017-18 and 2018-19 census data.

2 CENSUS METHODOLOGY

Black cockatoos are known to "prospect" for breeding hollows to find the most suitable hollow to lay their eggs. This involves going in and out of the hollow and chewing off around the entrance to the hollow. Chewing around the hollow is often in preparation for egg-laying, as the base of the hollow is lined with these woodchips. Each year the same breeding pair may return to the same hollow, or a different hollow to breed. For Carnaby's Cockatoo, from egg-laying to fledging of the chick takes approximately 14-16 weeks (DoEE 2019). Recent chewings are generally detectable by fresh marks which are usually a brighter red/orange colour than old chewings and un-chewed wood.

In the most recent breeding season, site visits were undertaken to the study area roughly monthly between August 2018 and February 2019: 21 August, 21 September, 19 October, 28 November, 3 January 2018 and 5 February.

Each hollow was inspected for evidence of nesting activity such as prospecting (adults investigating the hollow), fresh chewing around the hollow entrance or females perched at the entrance to the hollow. Trees with evidence of nesting activity were investigated using a pole camera to determine if eggs or chicks were in the nest when adults were not around (i.e. out foraging; this was to avoid disturbance).

Baseline surveys for Muchea North identified a total of 57 trees in the study area containing suitable nesting hollows for black cockatoos, of which 25 had evidence of nesting activity (Table 1). In the 2017-18 breeding season, 37 of these were monitored as the remaining 20 were unable to be assessed due to access constraints.

In the 2018-19 season, 47 natural nesting hollows and 36 artifical nesting hollows were monitored (Table 1). This included two new natural hollows added to the census in the current season and 14 trees that were not accessible in the 2017-18 season. Twelve further natural nesting hollows were not monitored; five of these were not able to be accessed, three were not relocated and four hollows were removed from monitoring in the 2017-18 season due to collapse, cracks forming or tree death.

In this report:

- *confirmed breeding event* – means eggs were seen in hollow and/or other clear evidence observed that chick was present (i.e. female seen at hollow entrance when brooding eggs and/or parents seen preparing to feed chick in the hollow)
- *evidence of nesting activity* – means chewing around the hollow entrance and/or bird seen prospecting hollows. It does not necessarily mean that a breeding event took place that year; however, it is evidence that the hollow is suitable and was considered and may have been used in previous years.

Table 1 Monitored hollows

HT ID*	Baseline records (pre 2017-18)	Species	Monitored 2017-18	Monitored 2018-19
HT04059	Evidence of nesting activity, artificial hollow	*Eucalyptus wandoo*	Yes	Yes
HT04274	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes
HT04579	Suitable, artificial hollow, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes
HT04581	Suitable, artificial hollow, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes
HT04588	Suitable, artificial hollow, no evidence of breeding	*Eucalyptus accedens*	Yes	Yes
HT05911	Suitable, no evidence of breeding	*Eucalyptus marginata*	No access	No
HT05923	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes
HT05938	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	No
HT05947	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	No
HT05954	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes
HT06017	Evidence of nesting activity	*Eucalyptus wandoo*	No access	Yes
HT06020	Suitable, no evidence of breeding	*Corymbia calophylla*	No access	Yes
HT06025	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	Yes
HT06046	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	Yes
HT06148	Suitable, no evidence of breeding	*Corymbia calophylla*	Yes	No
HT06160	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes
HT06201	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes
HT06216	Suitable, no evidence of breeding	*Eucalyptus marginata*	Yes	Yes
HT06261	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes
HT06278	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes
HT06330	Not suitable	*Eucalyptus wandoo*	No	Yes
HT06348	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes
HT06421	Evidence of nesting activity	*Corymbia calophylla*	No access	No access
HT06655	Suitable, no evidence of breeding	*Corymbia calophylla*	Yes	No
HT06678	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes
HT08752	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes
HT08753	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes
HT08754	Evidence of nesting activity	*Eucalyptus wandoo*	No access	Yes
HT12761	Evidence of nesting activity	*Eucalyptus wandoo*	No	No
HT12762	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes
HT12763	Evidence of nesting activity (FRTBC)	*Eucalyptus wandoo*	Yes	Yes
HT12765	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes
HT13484	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	Yes
HT13497	Suitable, no evidence of breeding	*Eucalyptus marginata*	No access	Yes
HT13503	Suitable, no evidence of breeding	*Eucalyptus marginata*	No access	Yes

HT ID*	Baseline records (pre 2017-18)	Species	Monitored 2017-18	Monitored 2018-19
HT13505	Suitable, no evidence of breeding	*Eucalyptus sp.*	No access	Yes
HT13506	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	Yes
HT13507	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	Yes
HT13508	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	Yes
HT13511	Suitable, no evidence of breeding	*Corymbia calophylla*	No access	Yes
HT13523	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	Yes
HT13533	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes
HT13534	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes
HT13535	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes
HT13585	Not suitable	*Corymbia calophylla*	No	Yes
HT14633	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes
HT14653	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes
HT14657	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes
HT14670	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	No
HT14672	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes
HT14748	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes
HT14749	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes
HT14805	Evidence of nesting activity	*Eucalyptus wandoo*	No access	No access
HT14806	Evidence of nesting activity	*Eucalyptus wandoo*	No access	No access
HT14807	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	No access
HT14808	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	No access
HT14809	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes
HT14810	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes
HT14811	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes
NB01	n/a		n/a	Yes
NB02	n/a		n/a	Yes
NB03	n/a		n/a	Yes
NB04	n/a		n/a	Yes
NB05	n/a		n/a	Yes
NB06	n/a		n/a	Yes
NB08	n/a		n/a	Yes
NB09	n/a		n/a	Yes
NB10	n/a		n/a	Yes
NB11	n/a		n/a	Yes
NB12	n/a		n/a	Yes
NB13	n/a		n/a	Yes
NB14	n/a		n/a	Yes
NB32	n/a		n/a	Yes

HT ID*	Baseline records (pre 2017-18)	Species	Monitored 2017-18	Monitored 2018-19
NB33	n/a		n/a	Yes
NB46	n/a		n/a	Yes
NB55	n/a		n/a	Yes
NB57	n/a		n/a	Yes
NB58	n/a		n/a	Yes
NB59	n/a		n/a	Yes
NB60	n/a		n/a	Yes
NB61	n/a		n/a	Yes
NB62	n/a		n/a	Yes
NB63	n/a		n/a	Yes
NB64	n/a		n/a	Yes
NB65	n/a		n/a	Yes
NB66	n/a		n/a	Yes
NB67	n/a		n/a	Yes
NB68	n/a		n/a	Yes
NB69	n/a		n/a	Yes
NB70	n/a		n/a	No
NB71	n/a		n/a	Yes
NB76	n/a		n/a	Yes
NB77	n/a		n/a	Yes
NB78	n/a		n/a	Yes
NB79	n/a		n/a	Yes
NB99	n/a		n/a	Yes

* HT = habitat tree (natural); NB = nest box (artificial)

3 RESULTS

3.1 CENSUS RESULTS 2018-19 BREEDING SEASON

Eight of the trees in the monitoring program were felled during the 2018-19 breeding season for the Muchea North Project, including three with hollows that recorded evidence of nesting activity in 2017-18 (Appendix 1). On this basis, the 2018-19 breeding season does not represent a true baseline, and therefore the results for the new artificial nesting hollows – erected to offset the cleared natural hollows – have been included in the 2018-19 census.

Confirmed breeding events were recorded in three hollows by Phoenix, two natural nesting hollows and one artificial nesting hollow (Table 2; Figure 2). Evidence of nesting activity was observed in a further three natural nesting hollows and two artificial nesting hollows (Table 2; Figure 2).

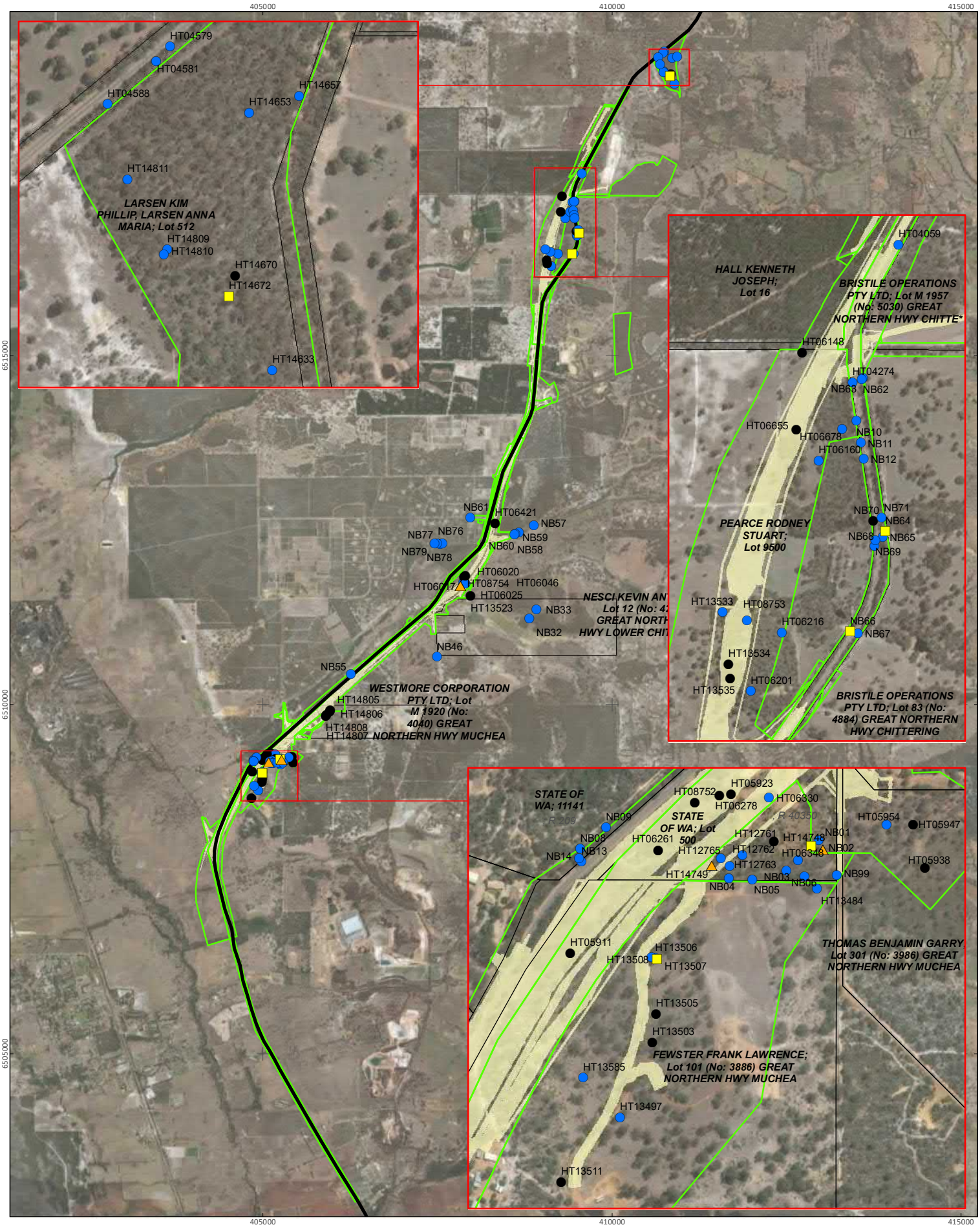
Of the confirmed breeding events:

- HT08754 – is presumed to have resulted in successful fledgling of chick. Chick photographed.
- HT14749 – is presumed to have resulted in successful fledgling of chick. The hollow is too high to inspect with a camera but activity observed suggests chick present.
- NB02 – laying of eggs is suspected but unknown if chick hatched or fledged.

No evidence of nesting was observed in 30 of the natural nesting hollows (Appendix 1). Four natural nesting hollows that were not accessible in the 2017-18 season were considered no longer suitable for use by black cockatoos and no longer require monitoring (Appendix 1).

Table 2 Evidence of breeding records by Phoenix during the 2018-19 census

	Inspection date							
HT ID	**21/08/2018**	**21/09/2018**	**19/10/2018**	**28/11/2018**	**3/01/2019**	**5/02/2019**	**Result_2018-19**	**Photo**
HT08754	No access	No flush	No flush	No flush	No flush	CBC chick photog. prev. week	Confirmed breeding event. Assumed successful.	
HT14749	No flush	Carnaby's: pair prospecting + other female in hollow with 2 entrances, female squabbling calls.	No flush (could be present with chick)	Carnaby's M+F flushed, +F inside ?feeding young	No flush	No flush, no activity all morning	Confirmed breeding event. Assumed successful.	
NB02	n/a	n/a	No flush	CBC Pair flew off and returned, F entered box. ?laying (by sound). Too high for camera.	No flush	No flush	Confirmed breeding event. Unknown if successful.	
NB66	n/a	n/a	CBC F on box, flushed	CBC 1F on nest	No flush. Camera check, empty. CBC calls to W	No flush	Evidence of nesting activity	Plate 1
HT13507	No flush	No flush	No flush	No flush. Fresh chewing	No flush	No flush	Evidence of nesting activity	
HT14672	No flush	No flush	No flush. Redtail foraging traces	No flush	No flush	No flush	Evidence of nesting activity	
HT14748	No flush	No flush	Flushed CBC female	No flush. Camera check: empty	No flush	No flush	Evidence of nesting activity	Plate 2
NB64	n/a	n/a	No flush; CBC pair in upper branches, M feeding F	No flush	No flush	No flush	Evidence of nesting activity	



Jacobs: Great Northern Highway Muchea to Wubin Upgrade Stage 2: Carnaby's black cockatoo breeding activity census (2018-2019 breeding season)

Project No	1220
Date	18-Jun-19
Drawn by	AL
Map author	AL

0 1 2
Kilometers

1:70,000 (at A4) GDA 1994 MGA Zone 50

Study area
Disturbance footprint
Road

Results

- Confirmed breeding event
- Evidence of nesting activity
- No evidence of breeding
- Not surveyed (no access, no longer suitable, not located, tree felled)

Figure 2

Monitoring result for 2018-19 breeding season

PHOENIX ENVIRONMENTAL SCIENCES

Plate 1 NB66 19 October 2018

Plate 2 HT14748 19 October 2018

3.2 COMPARISON BETWEEN 2017-18 SEASON AND 2018-19 SEASON

Abundance of confirmed nesting events and evidence of nesting activity was lower in the 2018-19 breeding season compared with the 2017-18 season (Table 3).

The average number of confirmed breeding events over the two seasons is five. The average number of hollows observed with evidence of nesting activity, but no confirmed breeding event is 10.

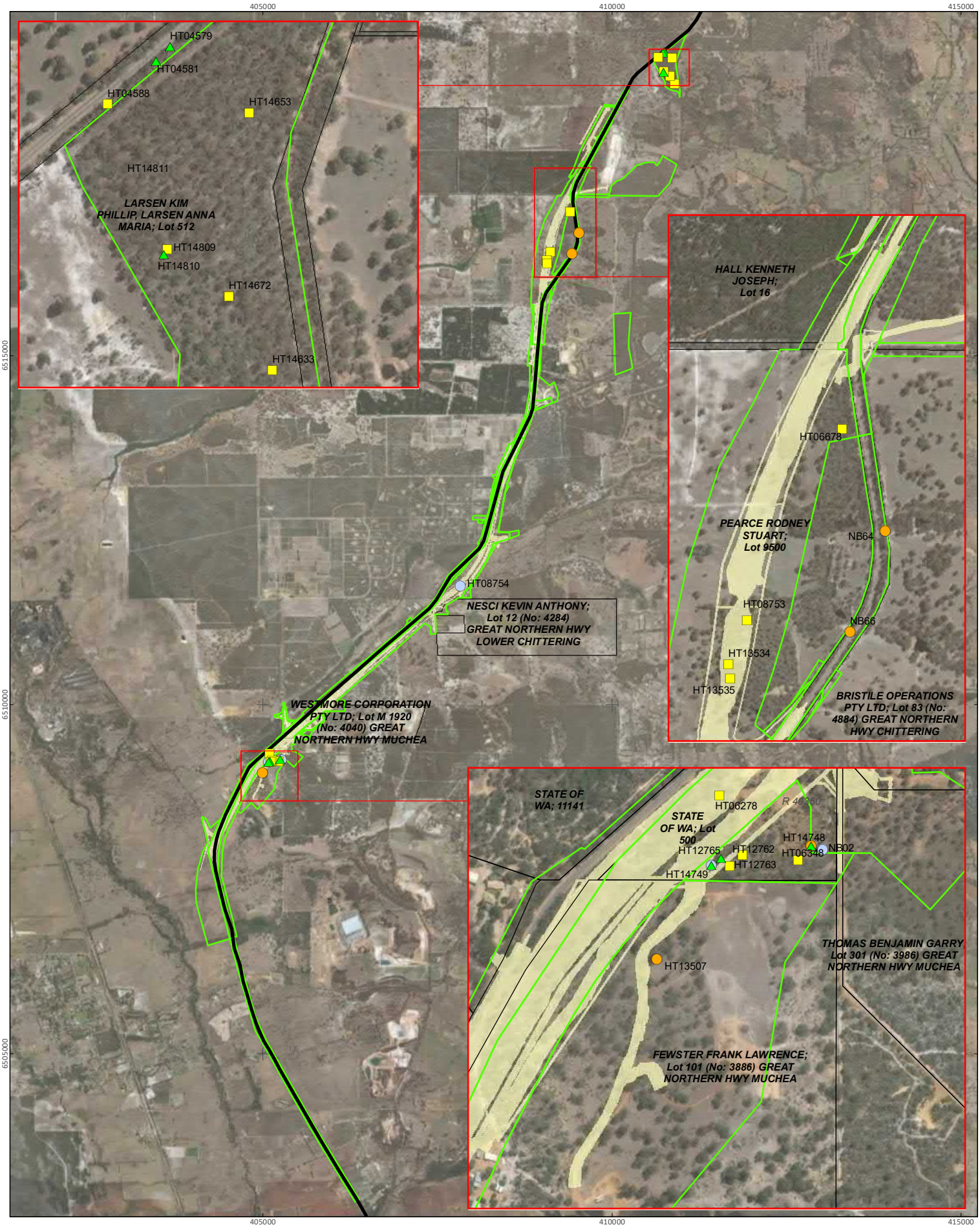
Breeding events and evidence of nesting activity in 2018-19 were identified in the same general areas as in the 2017-18 season, including the two areas that were identified as having a higher rate of breeding activity, Reserve 40350 and Lot 512 (Figure 3). The 2018-19 results indicate however that breeding activity is also occurring elsewhere in the study area and is not limited to these two lots.

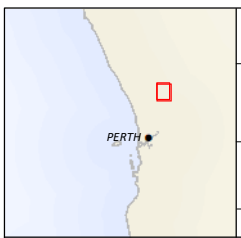
Three hollows, HT14749, HT14672 and HT14748, recorded breeding activity over both seasons (Appendix 1). The remaining hollows with breeding activity in 2018-19 were either not accessible in the 2017-18 season or were new artificial hollows (Appendix 1). Four hollows with confirmed breeding events in 2017-18 and 12 hollows with evidence of nesting activity in 2017-2018 were not recorded with any activity in 2018-19.

Table 3 Summary of results for 2017-18 and 2018-19 breeding seasons

Result type	**Baseline records pre 2017-18**[1] Natural hollows and existing aritificial hollows	**2017-18 breeding season** Natural hollows and existing aritificial hollows	**2018-19 breeding season** All hollows {natural&existing artificial hollows/new artificial hollows}	**Average across 2017-18 and 2018-19** All hollows
Confirmed breeding event	n/a	6	3 {2/1}	5
Evidence of nesting activity	24	14	5 {3/2}	10
No evidence of breeding	35	13	63 {30/33}	38
No longer suitable, not accessible, not sampled, felled	n/a	26	25 {24/1}	26

[1] Evidence of nesting activity recorded at some point. Not annual census data and cannot be compared with annual census results.





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Project No	1220
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Study area
Disturbance footprint
Road

2018-2019 breeding season
Confirmed breeding event
Evidence of nesting activity

2017-2018 breeding season
Confirmed breeding event
Evidence of nesting activity

Figure 3

Confirmed breeding events and Evidence of nesting activity across the 2017-2018 and 2018-2019 breeding seasons

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4 CONCLUSION

Three confirmed breeding events were observed in the 2018-19 season and evidence of nesting was observed in a further five hollows, with both natural and artificial nesting hollows showing activity.

The difference in nesting activity recorded between the 2017-18 and 2018-19 seasons is not unexpected as the sample size for this monitoring program is small and breeding activity can be highly variable between years.

The 2018-19 census results indicate that breeding activity is occurring throughout the Muchea North area. Due to the historic large-scale clearing of trees and continuing decline of suitable trees with hollows in the area, all remaining suitable nesting hollows in the study area should be considered of high value to Carnaby's Cockatoo.

Considering the artificial nesting hollows were installed during the current season, the observations of a breeding event and/or evidence of nesting activity in three of these indicate the readiness of Carnaby's Cockatoo to prospect new hollows.

For the purposes of future monitoring, the pre-impact breeding density is defined as:

- the average number of confirmed breeding events over two seasons = five
- the average number of hollows observed with evidence of nesting activity over two seasons = 10.

For future monitoring of the nesting hollows, consistent methodology should be employed to that used in the 2017-18 and 2018-19 breeding census. Where possible, pole cameras should be used to inspect suspected breeding events.

5 REFERENCES

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Appendix 1 Results for all hollows in 2017-18 and 2018-19 breeding season

HT ID	Result 2017-18	Result 2018-19	21/08/2018	21/09/2018	19/10/2018	28/11/2018	3/01/2019	5/02/2019
HT04059	No evidence of breeding	No evidence of breeding	No flush	No flush	No flush	No flush	No flush	No flush
HT04274	No evidence of breeding	No evidence of breeding	No flush	No flush. Bees in hollow	No flush	No flush. Bees in hollow	No flush	No flush
HT04579	Confirmed breeding event - failed	No evidence of breeding	No flush	No flush	No flush	No flush	No flush	No flush
HT04581	Confirmed breeding event - failed	No evidence of breeding	No flush	No flush	No flush	No flush	No flush	No flush
HT04588	Evidence of nesting activity	No evidence of breeding	No flush	No flush	No flush	No flush	No flush	No flush
HT05911	No access	Hollow not located						
HT05923	No evidence of breeding	Felled. Further monitoring not required.	No flush	Felled. Further monitoring not required.				
HT05938	No longer suitable hollow. Further monitoring not required							
HT05947	No evidence of breeding	Not located		Not located				
HT05954	No evidence of breeding	No evidence of breeding	No access	No flush. Duck down, bees in lower hollow	No flush	No flush	No flush	No flush
HT06017	No access	No evidence of breeding	No flush	No flush	No flush. Galah in smaller hollow	No flush	No flush	No flush
HT06020	No access	Felled. Further monitoring not required.	No flush	Felled. Further monitoring not required.				
HT06025	No access	No evidence of breeding	No flush. Hollow located has bees	No flush	No flush	No flush	No flush	No flush
HT06046	No access	Felled. Further monitoring not required.	No flush	Felled. Frogmouth				

HT ID	Result 2017-18	Result 2018-19	21/08/2018	21/09/2018	19/10/2018	28/11/2018	3/01/2019	5/02/2019
				flushed, Carnaby's pair nearby reacting to chainsaw. Further monitoring not required.				
HT06148	No longer suitable. Further monitoring not required.							
HT06160	No evidence of breeding	No evidence of breeding	No flush	No flush	No flush	No flush	No flush	No flush
HT06201	No evidence of breeding	No evidence of breeding	No flush. Marri nut carried in by FRTBC at base of tree.	No flush	No flush	No flush	No flush	No flush
HT06216	No evidence of breeding	No evidence of breeding	No flush	No flush. Carnaby's sightings & calls in vicinity	No flush	No flush	No flush	No flush
HT06261	No evidence of breeding	Felled. Further monitoring not required.	No flush	No flush	No flush	Felled. Further monitoring not required.		
HT06278	Evidence of nesting activity	Felled. Further monitoring not required.	No flush	No flush	No flush	No flush	Felled. Further monitoring not required.	
HT06330	Not sampled	No evidence of breeding. Added to breeding census in 2018-19.	No flush	No flush	No flush	No flush	No flush	No flush
HT06348	Evidence of nesting activity	No evidence of breeding	No flush	No flush	No flush	No flush	No flush	No flush
HT06421	No access. Evidence of nesting activity (from a distance)	No access	No access	No access	No access	No access	No access	
HT06655	No longer suitable. Further monitoring not required.							

HT ID	Result 2017-18	Result 2018-19	21/08/2018	21/09/2018	19/10/2018	28/11/2018	3/01/2019	5/02/2019
HT06678	Evidence of nesting activity (FRTBC)	No evidence of breeding	No flush	No flush	No flush	No flush	No flush	No flush
HT08752	No evidence of breeding	Felled. Further monitoring not required.	No flush	No flush.	No flush	No flush	Felled. Further monitoring not required.	
HT08753	Evidence of nesting activity	No evidence of breeding	No flush	No flush. Fresh scarring from Galahs.	No flush	No flush	No flush	No flush
HT08754	No access	Confirmed breeding event	No access	No flush.	No flush	No flush	No flush	CBC chick photog. prev. week; to be felled when fledged
HT12761	Hollow not located	Hollow not located		Not seen				
HT12762	Evidence of nesting activity	No evidence of breeding	No flush	No flush	No flush	No flush	No flush	No flush
HT12763	Evidence of nesting activity	No evidence of breeding	No flush	No flush. Duck scat around entrance	No flush	No flush	No flush	No flush
HT12765	Confirmed breeding event - successful	No evidence of breeding. May no longer be suitable	No flush	No flush	No flush	No flush	No flush	No flush. Lopped for powerline clearance
HT13484	No access	No evidence of breeding	No flush	No flush. Corella in other hollow	No flush. Corella in other hollow	No flush	No flush	No flush
HT13497	No access	No evidence of breeding	No flush	No flush	No flush	No flush	No flush	No flush
HT13503	No access	No longer suitable. Further monitoring not required.	Hollow no longer suitable					
HT13505	No access	No longer suitable. Further monitoring not required.	Hollow no longer suitable					
HT13506	No access	No evidence of breeding	Duck down at hollow entrance	No flush	No flush	No flush	No flush	No flush

HT ID	Result 2017-18	Result 2018-19	21/08/2018	21/09/2018	19/10/2018	28/11/2018	3/01/2019	5/02/2019
HT13507	No access	Evidence of nesting activity	No flush	No flush	No flush	No flush. Fresh chewing	No flush	No flush
HT13508	No access	No evidence of breeding	No flush	No flush	No flush	No flush	No flush	No flush
HT13511	No access	No longer suitable. Further monitoring not required.	Hollow no longer suitable					
HT13523	No access	No longer suitable. Further monitoring not required.	No flush	Hollow no longer suitable. Further monitoring not required.				
HT13533	No evidence of breeding	No evidence of breeding	No flush	No flush	No flush. Tree martins in hollows	No flush	No flush	No flush
HT13534	Evidence of nesting activity	Felled. Further monitoring not required.	No flush	Felled. Further monitoring not required.				
HT13535	Evidence of nesting activity	Felled. Further monitoring not required.	No flush	Felled. Further monitoring not required.				
HT13585	Not sampled	No evidence of breeding. Added to breeding census in 2018-19, chewing observed at hollow.		No flush		No flush	No flush	No flush
HT14633	Evidence of nesting activity	No evidence of breeding	No flush	No flush	No flush. CBC calls to south	No flush	No flush	No flush
HT14653	Evidence of nesting activity	No evidence of breeding	No flush	No flush	No flush	No flush	No flush	No flush
HT14657	No evidence of breeding	No evidence of breeding	No flush	No flush	No flush	No flush	No flush	No flush
HT14670	Collapsed, no longer suitable. Further monitoring not required.							

HT ID	Result 2017-18	Result 2018-19	21/08/2018	21/09/2018	19/10/2018	28/11/2018	3/01/2019	5/02/2019
HT14672	Evidence of nesting activity	Evidence of nesting activity	No flush	No flush. Duck flushed from lower hollow	No flush. Redtail foraging traces	No flush	No flush	No flush
HT14748	Confirmed breeding event - successful	Evidence of nesting activity	No flush	No flush	Flushed CBC female	No flush. Camera check: empty	No flush	No flush
HT14749	Confirmed breeding event - successful	Confirmed breeding event	No flush	Carnaby's: pair prospecting + other female in hollow with 2 entrances, female squabbling calls.	No flush (could be present with chick)	Carnaby's M+F flushed, +F inside ?feeding young	No flush	No flush, no activity all morning
HT14805	No access	No access	No access	No access	No access	No access		
HT14806	No access	No access	No access	No access	No access	No access		
HT14807	No access	No access	No access	No access	No access	No access		
HT14808	No access	No access	No access	No access	No access	No access		
HT14809	Evidence of nesting activity	No evidence of breeding	No flush	No flush	No flush. Ringnecks x4 at tree	No flush	No flush	No flush
HT14810	Confirmed breeding event - failed	No evidence of breeding	No flush	No flush	No flush	No flush	No flush	No flush
HT14811	No evidence of breeding	No evidence of breeding	No flush	No flush. Corella pair in other hollow	No flush	No flush	No flush. CBC calls to E & W	No flush
NB01	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush	No flush
NB02	n/a	Confirmed breeding event	n/a	n/a	No flush	CBC Pair flew off and returned, F entered box,	No flush	No flush

HT ID	Result 2017-18	Result 2018-19	21/08/2018	21/09/2018	19/10/2018	28/11/2018	3/01/2019	5/02/2019
						?laying (by sound). Too high for camera.		
NB03	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush	No flush
NB04	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush	No flush
NB05	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush	No flush
NB06	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush	No flush
NB08	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush	No flush
NB09	n/a	No evidence of breeding	n/a	n/a	Not seen	No flush	No flush	No flush
NB10	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush	No flush
NB11	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush. Marri canker	No flush
NB12	n/a	No evidence of breeding	n/a	n/a	No flush; mob of CBC ~100m S drinking at dam	Not seen	No flush	No flush
NB13	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush	No flush
NB14	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush	No flush
NB32	n/a	No evidence of breeding/no access	n/a	n/a	Not seen	No access	No access	
NB33	n/a	No evidence of breeding/no access	n/a	n/a	Not seen	No access	No access	
NB46	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush	No flush
NB55	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush	No flush
NB57	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush	No flush
NB58	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush	No flush

HT ID	Result 2017-18	Result 2018-19	21/08/2018	21/09/2018	19/10/2018	28/11/2018	3/01/2019	5/02/2019
NB59	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush	No flush
NB60	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush	No flush
NB61	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush	No flush
NB62	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush. CBC call to west	No flush
NB63	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush	No flush
NB64	n/a	Evidence of nesting activity	n/a	n/a	No flush; CBC pair in upper branches, M feeding F	No flush	No flush	No flush
NB65	n/a	No evidence of breeding	n/a	n/a	No flush; red-tails calling to E	No flush	No flush	No flush
NB66	n/a	Evidence of nesting activity	n/a	n/a	CBC F on box, flushed as vehicle passed	CBC 1F on nest	No flush. Camera check, empty. CBC calls to W	No flush
NB67	n/a	No evidence of breeding	n/a	n/a	Not seen	No flush	No flush	No flush
NB68	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush	No flush
NB69	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush	No flush
NB70	n/a	Not surveyed	n/a	n/a	Not seen	Not seen	Not seen	
NB71	n/a	No evidence of breeding	n/a	n/a	No flush	No flush	No flush	No flush
NB76	n/a	No evidence of breeding	n/a	n/a	Not seen	No flush	No flush	No flush
NB77	n/a	No evidence of breeding	n/a	n/a	Not seen	No flush	No flush	No flush
NB78	n/a	No evidence of breeding	n/a	n/a	Not seen	No flush	No flush	No flush
NB79	n/a	No evidence of breeding	n/a	n/a	Not seen	No flush	No flush	No flush

HT ID	Result 2017-18	Result 2018-19	21/08/2018	21/09/2018	19/10/2018	28/11/2018	3/01/2019	5/02/2019
NB99	n/a	No evidence of breeding	n/a	n/a	Not seen	No flush	No flush	No flush

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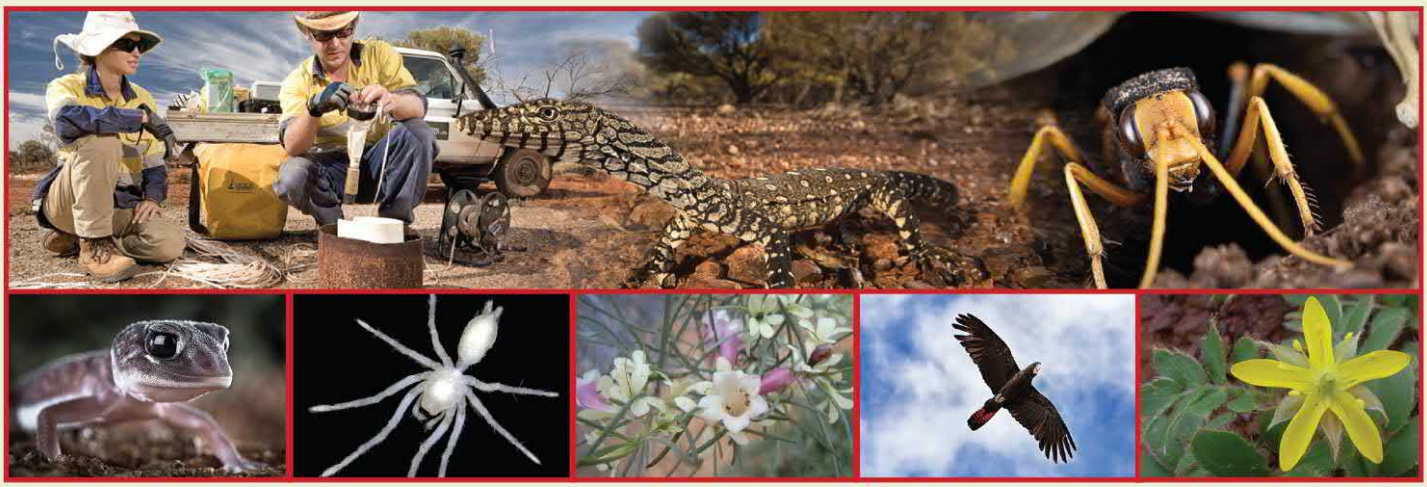
Black cockatoo breeding activity census 2019-20 for Muchea North

Great Northern Highway, Muchea to Wubin Upgrade Stage 2 Project

Prepared for Main Roads WA

April 2020

Final



Black cockatoo breeding activity census 2019-20 for Muchea North.

Great Northern Highway, Muchea to Wubin Upgrade Stage 2 Project.

Prepared for Main Roads WA

Version history				
Author	**Version**	**Version number**	**Date**	**Submitted to**
A. Jacks	Draft issued for client review	0.1	27-Mar-2020	M. Baetge
A. Jacks	Final, client comments addressed	1.0	01-Apr-2020	M. Baetge

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Project code: 1272-SR159-MR-VER

Contents

List of Figures

List of Tables

Appendices

1 INTRODUCTION

Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by Main Roads WA, to undertake a Carnaby's Cockatoo breeding activity census over the 2019-20 breeding season within and surrounding the disturbance footprint for the Muchea North project area (Figure 1). This report presents the results of the census.

1.1 BACKGROUND

Main Roads is currently upgrading the Great Northern Highway (GNH) between Straight Line Kilometre (SLK) 38.60 and 51.40 (referred to as Muchea North Upgrade). The Muchea North Upgrade proposal was referred under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 1 March 2016 (EPBC 2016/7656), assessed as a controlled action and granted conditional approval in August 2018.

Muchea North Upgrade resulted in the loss of 13 Carnaby's Black Cockatoo nesting hollows. To mitigate and offset the loss of these, Main Roads was required to install 39 artificial nest boxes (Figure 1). In accordance with EPBC 2016/7656 Conditions 4f(i) and (ii) each artificial nesting hollow installed must:

- EPBC 2016/7656 condition f(i): be inspected at least twice a year by a suitably qualified person during the peak breeding season to record any evidence of use by the Carnaby's Black Cockatoo and to identify any maintenance requirements
- EPBC 2016/7656 condition f(ii): be monitored and maintained in accordance with relevant artificial hollow guidance for the life of the approval, with maintenance actions, if required, undertaken outside of the breeding season and before the commencement of the next breeding season.

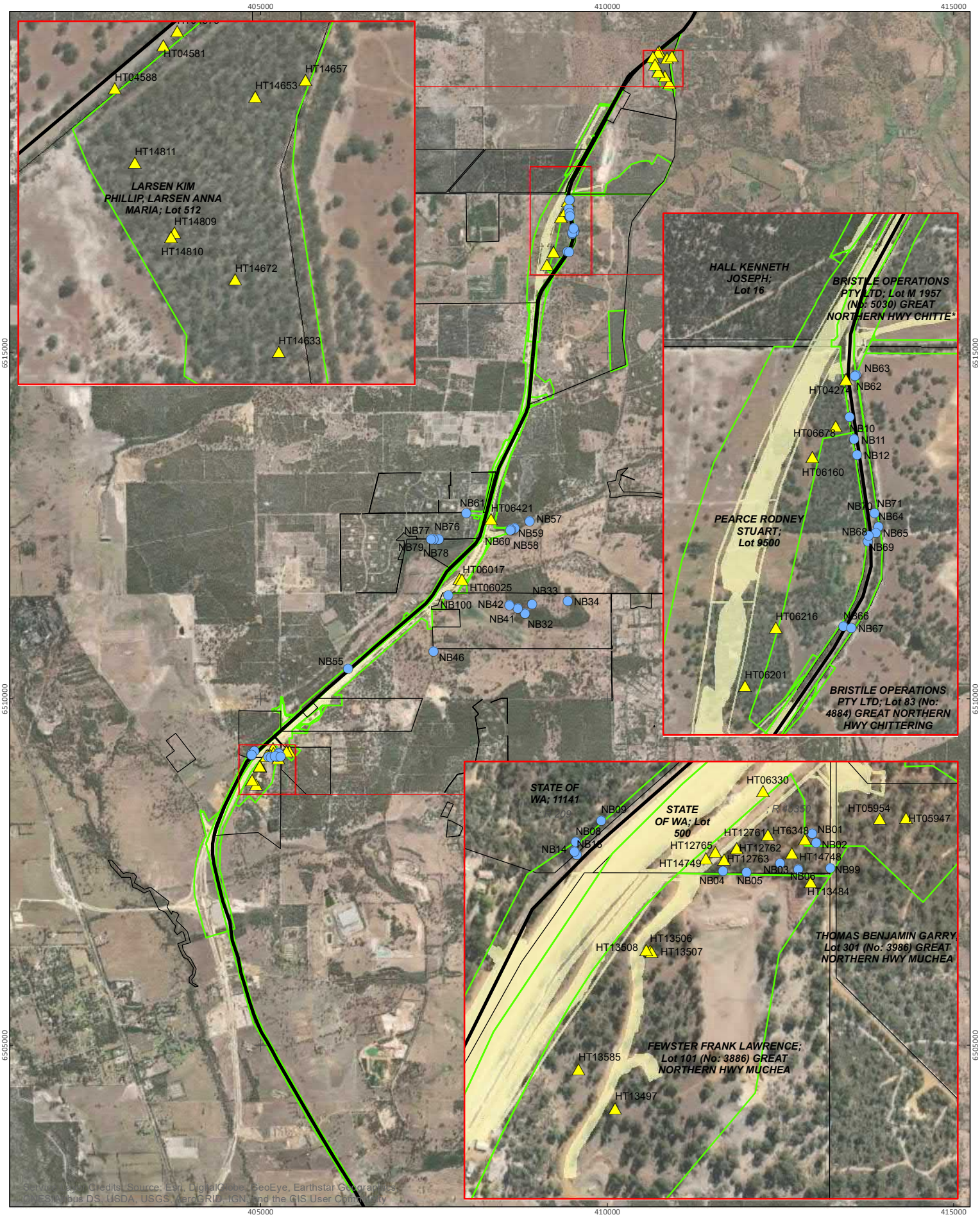
The monitoring campaign will also require monitoring of previously recorded natural hollows suitable for Carnaby's Cockatoo (Figure 1). Monitoring of artificial and natural hollows shall be monitored in accordance with How to Monitor and Maintain Artificial Hollows for Carnaby's Cockatoo (DPaW 2015).

Detailed black cockatoo habitat assessments conducted as part of the baseline assessments for the Muchea North project (Phoenix 2015, 2017a) recorded all potential breeding trees of species known to support black cockatoo breeding and identifed suitable nesting hollows and hollows with evidence of use.

A native vegetation clearing permit (NVCP) for Muchea North (Permit no. 7563/2) has been approved by the WA Department of Water and Environmental Regulation (DWER) under the *Environmental Protection Act 1986* (EP Act).

To support Condition 4c of EPBC 2016/7656, Main Roads commissioned Phoenix to undertake monitoring of confirmed and suitable nesting hollows recorded within the Muchea North EPBC Act Approval Boundary and wider baseline survey area (Phoenix 2015, 2017a) (the study area; Figure 1). The initial baseline monitoring program was conducted in the 2017-18 breeding season (August 2017 – February 2018) and assessed hollow usage of suitable nesting hollows and hollows with evidence of use within the study area (Phoenix 2018). A second year of monitoring for hollow usage within the study area in the 2018-19 breeding season was undertaken by Phoenix from August 2018 to February 2019 (Phoenix 2019). The artificial nesting hollows were installed during the 2018-2019 breeding season, therefore the results of these first two surveys collectively represent the pre-impact breeding density.

Phoenix was subsequently commissioned to undertake a third year of monitoring for hollow usage within the study area in the 2019-2020 breeding season. This report incorporates the results of the third monitoring season into the nesting hollow usage dataset for Muchea North.



Main Roads WA
Great Northern Highway, M2W Upgrade Project

Project No	1272
Date	26-Mar-20
Drawn by	AJ
Map author	AJ

0 1 2
Kilometers

1:70,000 (at A4) GDA 1994 MGA Zone 50

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- Study area
- Disturbance footprint
- Road

Monitored hollows

- Artificial nesting hollow
- Natural nesting hollow

Figure 1

Study area and sampling sites

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1.2 SCOPE OF WORK

The scope of work was as follows:

Six rounds of monitoring of artificial and natural nest hollows to be undertaken between August 2019 and January 2020.

During inspections of artificial and natural hollows, record evidence of use by Carnaby's Cockatoos at each artificial and natural hollow in accordance with (DPaW 2015).

During inspections, identify any artificial nest box maintenance needs in accordance with (DPaW 2015) and whether natural hollows remain suitable for use by Carnaby's Black Cockatoo.

Provide a report that summarises all records required by Conditions 4f(i) and (ii) of EPBC 2016/7656 for all artificial and natural hollows inspected. The draft report shall be provided to Main Roads in electronic PDF and Word version copy format.

2 CENSUS METHODOLOGY

Methods were consistent with the approach undertaken in previous monitoring events for Muchea North (Phoenix 2018, 2019).

Prior to the surveys, site locations (artificial and natural nest hollows) were loaded onto field tablets. Data was collected electronically using a customised data collection template and included:

- site code
- signs of use – birds prospecting hollows, fresh chewings, birds perching, birds entering/existing hollows, birds flushed from hollows, gender of observed birds, chick calls, eggs observed (inc. status if possible – incubated or abandoned), chick/s observed, chick/s fledged
- other indicators, e.g. gender mix of flocks, evidence of nesting at base of trees
- condition of hollow, current suitability for use (natural hollows), maintenance requirements (artificial hollows).

The knocking and scraping method was conducted at the base of trees for all monitored hollows. Other observational methods were also employed, i.e. pole camera inspections of hollows where possible, listening for nest activity, flock and individual bird behaviour.

Consistent with previous methodology the following activities were undertaken:

- evidence of nesting activity was noted where fresh chewing is around the hollow entrance and/or birds are seen prospecting hollows.
- a confirmed breeding event was noted where eggs are seen in hollow and/or other clear evidence observed that a chick is present (i.e. female seen at hollow entrance when during brooding eggs, and/or parents seen preparing to feed chick in the hollow).

Maintenance checks of artificial hollows will assess the following as a minimum:

- condition of chewing posts
- condition of attachment points
- condition of hollow bases
- stability of tree or pole used to mount the artificial hollow.

As per previous surveys, site visits were undertaken every 4-5 weeks between August 2019 and January 2020: 15 August, 17 September, 22 October, 22 November, 21 December and 20 January.

The baseline surveys for Muchea North identified a total of 57 trees in the study area containing suitable nesting hollows for black cockatoos, of which 25 had evidence of nesting activity. In the initial survey 37 of these were monitored as the remaining 20 were unable to be assessed due to access constraints.

In the 2018-19 season, 47 natural nesting hollows and 36 artifical nesting hollows were monitored. This included two new natural hollows added to the census in the current season and 14 trees that were not accessible in the 2017-18 season. Twelve further natural nesting hollows were not monitored; five of these were not able to be accessed, three were not relocated and four hollows were removed from monitoring in the 2017-18 season due to collapse, cracks forming or tree death.

In the current survey a total of 73 hollows were monitored, of which 33 were natural nesting hollows and 40 were artifical nesting hollows (Table 1). Prior to the survey, 13 trees which contained suitable nesting hollows were removed as part of the GNH road upgrades (HT05911, HT05923, HT06020, HT06046, HT06261, HT06278, HT06655, HT08752, HT08753, HT08754, HT13533, HT13534 and HT13535), 12 of these were monitored in the previous two monitoring programs and one was not accessible. These 13 trees were offset by the installation of the 39 artificial nesting hollows of which all were able to be monitored this season. An additional artificial nesting hollow (NB100) was included in the survey which was erected to replace HT04059. Four natural nesting hollows from the baseline dataset that had not been monitored in the previous two years were this year able to be surveyed because landowner access had been granted. Four trees with natural nesting hollows were not surveyed this year because the tree or hollow was no longer considered suitable.

In this report:

- *confirmed breeding event* – means eggs were seen in hollow and/or other clear evidence observed that chick was present (i.e. female seen at hollow entrance when brooding eggs and/or parents seen preparing to feed chick in the hollow)
- *evidence of nesting activity* – means chewing around the hollow entrance and/or bird seen prospecting hollows. It does not necessarily mean that a breeding event took place that year; however, it is evidence that the hollow is suitable and was considered and may have been used in previous years.

Table 1 Monitored hollows

HT ID*	Baseline records (pre-2017)	Species	2017-18	2018-19	2019-20
HT04059	Evidence of nesting activity, artificial hollow	*Eucalyptus wandoo*	Yes	Yes	No (tree cleared)
HT04274	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	Yes
HT04579	Suitable, artificial hollow, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	Yes
HT04581	Suitable, artificial hollow, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	Yes
HT04588	Suitable, artificial hollow, no evidence of breeding	*Eucalyptus accedens*	Yes	Yes	Yes
HT05911	Suitable, artificial hollow, no evidence of breeding	*Eucalyptus accedens*	No access	No access	No (tree cleared)
HT05923	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	No (tree cleared)
HT05938	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	No	No (not suitable – hollow has cracked or degraded)
HT05947	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	No	Yes
HT05954	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes
HT06017	Evidence of nesting activity	*Eucalyptus wandoo*	No access	Yes	Yes
HT06020	Suitable, no evidence of breeding	*Corymbia calophylla*	No access	Yes	No (tree cleared)
HT06025	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	Yes	Yes
HT06046	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	Yes	No (tree cleared)
HT06148	Suitable, no evidence of breeding	*Corymbia calophylla*	Yes	No	No (not suitable – hollow has cracked or degraded)
HT06160	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	Yes
HT06201	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	Yes
HT06216	Suitable, no evidence of breeding	*Eucalyptus marginata*	Yes	Yes	Yes
HT06261	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	No (tree cleared)
HT06278	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	No (tree cleared)
HT06330	Not suitable	*Eucalyptus wandoo*	No	Yes	Yes
HT06348	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes
HT06421	Evidence of nesting activity	*Corymbia calophylla*	No access	No access	No (no access)

HT ID*	Baseline records (pre-2017)	Species	2017-18	2018-19	2019-20
HT06655	Suitable, no evidence of breeding	*Corymbia calophylla*	Yes	No	No (tree cleared)
HT06678	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	Yes
HT08752	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	No (tree cleared)
HT08753	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	No (tree cleared)
HT08754	Evidence of nesting activity	*Eucalyptus wandoo*	No access	~~Yes~~	No (tree cleared)
HT12761	Evidence of nesting activity	*Eucalyptus wandoo*	No	No	Yes
HT12762	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes
HT12763	Evidence of nesting activity (FRTBC)	*Eucalyptus wandoo*	Yes	Yes	Yes
HT12765	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes
HT13484	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	Yes	Yes
HT13497	Suitable, no evidence of breeding	*Eucalyptus marginata*	No access	Yes	Yes
HT13503	Suitable, no evidence of breeding	*Eucalyptus marginata*	No access	Yes	No (not suitable – hollow has cracked or degraded)
HT13505	Suitable, no evidence of breeding	*Eucalyptus sp.*	No access	Yes	No (not suitable – hollow has cracked or degraded)
HT13506	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	Yes	Yes
HT13507	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	Yes	Yes
HT13508	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	Yes	Yes
HT13511	Suitable, no evidence of breeding	*Corymbia calophylla*	No access	Yes	No (not suitable – hollow has cracked or degraded)
HT13523	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	Yes	No (not suitable – hollow has cracked or degraded)
HT13533	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	No (tree cleared)
HT13534	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	No (tree cleared)

HT ID*	Baseline records (pre-2017)	Species	2017-18	2018-19	2019-20
HT13535	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	No (tree cleared)
HT13585	Not suitable	*Corymbia calophylla*	No	Yes	Yes
HT14633	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	Yes
HT14653	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes
HT14657	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes
HT14670	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	No	No (not suitable – hollow collapsed)
HT14672	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes
HT14748	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes
HT14749	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes
HT14805	Evidence of nesting activity	*Eucalyptus wandoo*	No access	No access	No (not suitable – hollow has cracked or degraded)
HT14806	Evidence of nesting activity	*Eucalyptus wandoo*	No access	No access	No (not suitable – hollow has cracked or degraded)
HT14807	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	No access	No (not suitable – hollow has cracked or degraded)
HT14808	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	No access	No (not suitable – hollow has cracked or degraded)
HT14809	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes
HT14810	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes
HT14811	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes
NB01	n/a	n/a	n/a	Yes	Yes
NB02	n/a	n/a	n/a	Yes	Yes
NB03	n/a	n/a	n/a	Yes	Yes
NB04	n/a	n/a	n/a	Yes	Yes
NB05	n/a	n/a	n/a	Yes	Yes
NB06	n/a	n/a	n/a	Yes	Yes
NB08	n/a	n/a	n/a	Yes	Yes
NB09	n/a	n/a	n/a	Yes	Yes
NB10	n/a	n/a	n/a	Yes	Yes

HT ID*	Baseline records (pre-2017)	Species	2017-18	2018-19	2019-20
NB11	n/a	n/a	n/a	Yes	Yes
NB12	n/a	n/a	n/a	Yes	Yes
NB13	n/a	n/a	n/a	Yes	Yes
NB14	n/a	n/a	n/a	Yes	Yes
NB32	n/a	n/a	n/a	Yes	Yes
NB33	n/a	n/a	n/a	Yes	Yes
NB34	n/a	n/a	n/a	n/a	Yes
NB41	n/a	n/a	n/a	n/a	Yes
NB42	n/a	n/a	n/a	n/a	Yes
NB46	n/a	n/a	n/a	Yes	Yes
NB55	n/a	n/a	n/a	Yes	Yes
NB57	n/a	n/a	n/a	Yes	Yes
NB58	n/a	n/a	n/a	Yes	Yes
NB59	n/a	n/a	n/a	Yes	Yes
NB60	n/a	n/a	n/a	Yes	Yes
NB61	n/a	n/a	n/a	Yes	Yes
NB62	n/a	n/a	n/a	Yes	Yes
NB63	n/a	n/a	n/a	Yes	Yes
NB64	n/a	n/a	n/a	Yes	Yes
NB65	n/a	n/a	n/a	Yes	Yes
NB66	n/a	n/a	n/a	Yes	Yes
NB67	n/a	n/a	n/a	Yes	Yes
NB68	n/a	n/a	n/a	Yes	Yes
NB69	n/a	n/a	n/a	Yes	Yes
NB71	n/a	n/a	n/a	Yes	Yes
NB76	n/a	n/a	n/a	Yes	Yes
NB77	n/a	n/a	n/a	Yes	Yes
NB78	n/a	n/a	n/a	Yes	Yes
NB79	n/a	n/a	n/a	Yes	Yes
NB99	n/a	n/a	n/a	Yes	Yes
NB100	HT04059 was cleared and this nestbox was installed to replace it in 2019	n/a	n/a	n/a	Yes

* HT = habitat tree (natural); NB = nest box (artificial)

3 RESULTS

3.1 CENSUS RESULTS 2019-20 BREEDING SEASON

Confirmed breeding events were recorded in three artificial nesting hollows and three natural nesting hollows by Phoenix, (Table 2; Figure 2). Evidence of nesting activity was observed in a further ten artificial nesting hollows and four natural nesting hollows (Table 2; Figure 2).

Of the confirmed breeding events:

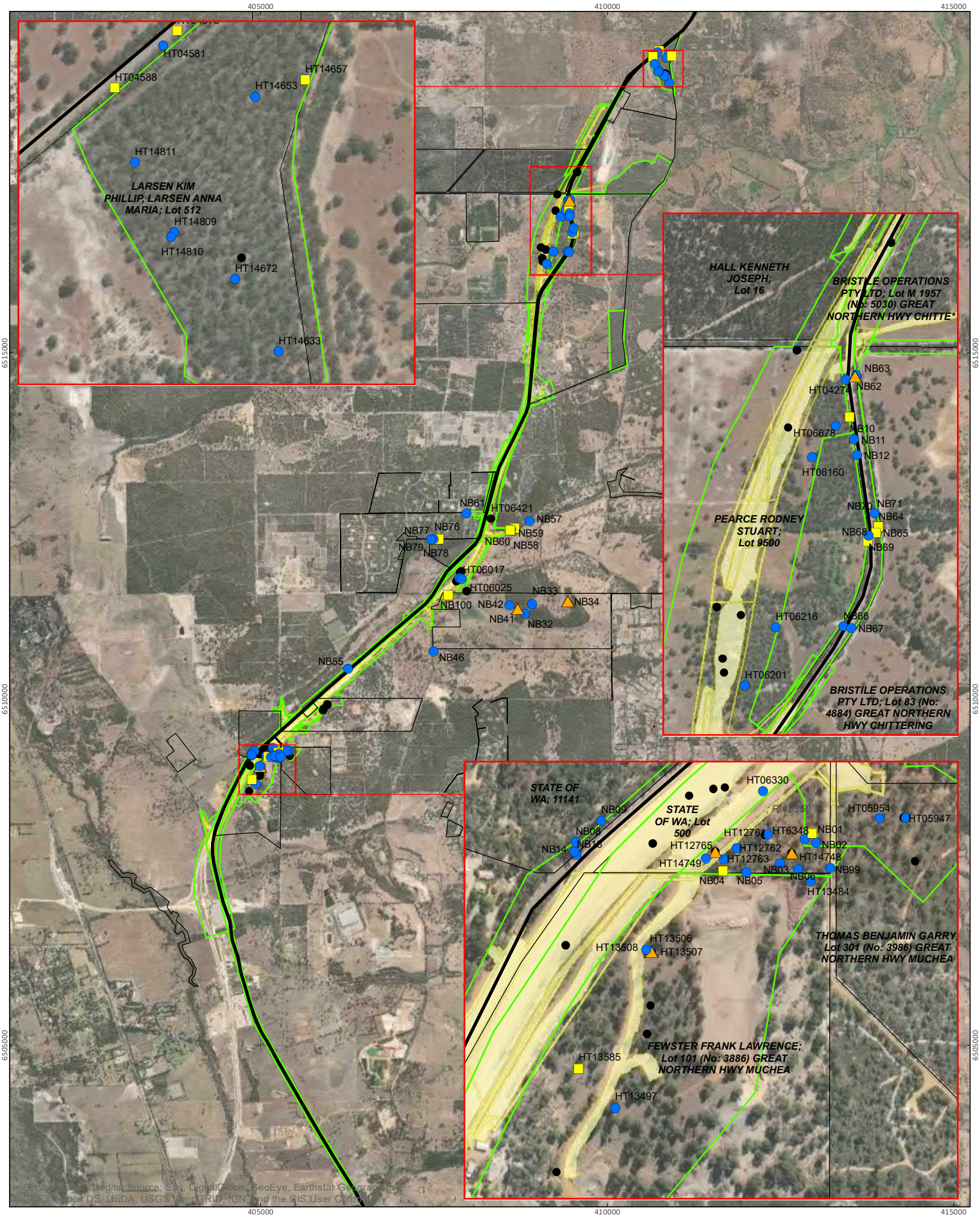
- NB34, NB41 and NB63 – are presumed to have resulted in successful fledging of a chick. Images of large chicks were seen with a camera in all three artificial nest hollows in December 2019 (Figure 3).
- HT12765 and HT13507 – female was flushed from hollow, presumed to be sitting on eggs.
- HT06348 – two eggs were observed with a camera in the hollow in October 2019, however these had been predated by November 2019.

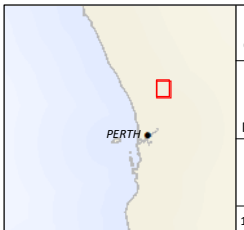
There were several instances where females were flushed from a hollow but a later inspection saw no chicks or eggs and the bird was likely to be prospecting. No evidence of nesting activities were observed in the remaining 27 natural nesting hollows or 26 artificial nesting hollows (Appendix 1).

Table 2 Evidence of breeding records by Phoenix during the 2019-20 census

	Inspection date						
HT ID	**15/08/2019**	**17/09/2019**	**22/10/2019**	**22/11/2019**	**21/12/2019**	**20/01/2020**	**Result**
NB01	Fresh chewing at post	No flush	No flush	No flush	No flush	No flush	Evidence of nesting activity
NB04	No flush	No flush	No flush	Flushed female CBC, likely to be prospecting hollow	No flush, no eggs in hollow	No flush	Evidence of nesting activity
NB10	No flush	Prospecting pair in tree: female flushed from hollow , likely to be propsecting hollow	No flush, no eggs in hollow	No flush	No flush	No flush	Evidence of nesting activity
NB34	No flush	No flush	No flush	No access	Camera check: Large chick in nest	Chick fledged	Confirmed breeding event: assumed successful
NB41	No flush	No flush	No flush	No access	Camera check: Large chick in nest	Chick fledged	Confirmed breeding event: assumed successful
NB58	No flush	No flush	No flush	Flushed female CBC, possibly prospecting hollow	No flush, no eggs in hollow	No flush	Evidence of nesting activity
NB60	No flush	Chewing at post	No flush	No flush	No flush	No flush	Evidence of nesting activity
NB63	No flush	Flushed female CBC, likely to be incubating eggs	Flushed female CBC, likely to be incubating eggs	Camera check: small chick in nest	Camera check: Large chick in nest	Chick fledged	Confirmed breeding event: assumed successful
NB64	No flush	Chewing at post	No flush	No flush	No flush	No flush	Evidence of nesting activity

	Inspection date						
HT ID	**15/08/2019**	**17/09/2019**	**22/10/2019**	**22/11/2019**	**21/12/2019**	**20/01/2020**	**Result**
NB65	No flush	Chewing at post	No flush	No flush	No flush	No flush	Evidence of nesting activity
NB68	No flush	No flush	No flush	Flushed female CBC, likely to be propsecting hollow	No flush, no eggs in hollow	No flush	Evidence of nesting activity
NB76	No flush	No flush	No flush	Chewing at post	No flush	No flush	Evidence of nesting activity
NB77	No flush	No flush		Chewing at post	No flush	No flush	Evidence of nesting activity
HT04579	No flush	No flush	Chewing at hollow entrance	No flush	No flush	No flush	Evidence of nesting activity
HT04588	No flush	No flush	Chewing at hollow entrance	No flush	No flush	No flush	Evidence of nesting activity
HT06348	No flush	No flush	Flushed female CBC, camera check: 2 eggs in nest	Camera check: eggs predated	No flush	No flush	Confirmed breeding event: unsuccessful
HT12765	No flush	No flush	No flush	Flushed female CBC, likely to be incubating eggs	No flush, tree too close to powerlines to inspect with pole camera	No flush	Confirmed breeding event
HT13507	No flush	Flushed female CBC, likely to be incubating eggs	No flush, hollow too high to inspect with pole camera	No flush	No flush	No flush	Confirmed breeding event
HT13585	No flush	No flush	Chewing at hollow entrance	No flush	No flush	No flush	Evidence of nesting activity
HT14657	No flush	Flushed female CBC, likely to be propsecting hollow	No flush	No flush, no eggs or chicks seen in hollow	Prospecting pair in tree hollows	No flush	Evidence of nesting activity





Main Roads WA
Great Northern Highway, M2W Upgrade Project

Project No	1272
Date	26-Mar-20
Drawn by	AJ
Map author	AJ

0 1 2
Kilometers

1:70,000 (at A4) GDA 1994 MGA Zone 50

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Study area
Disturbance footprint
Road

Results

Confirmed breeding event
Evidence of nesting activity
No evidence of breeding
Not surveyed (no access/no longer suitable, cleared)

Figure 2

Monitoring results for 2018-19 breeding season

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Figure 3 Female flushed from a nest box (September 2019)

Figure 4 Chick in nest box (December 2019)

3.2 COMPARISON BETWEEN MONITORING SEASONS

The number of confirmed Carnaby's Cockatoo breeding events in the 2019-20 breeding season is about consistent with the pre-impact average, however the nesting activity was significantly higher than the pre-impact average, particularly the 2018-2019 breeding season which surveyed a comparable number of artificial and natural nesting hollows (Table 3).

Breeding events and evidence of nesting activity in the 2019-20 season were identified in the same general areas as in the previous seasons, including the two areas that were identified as having a higher rate of breeding activity, Reserve 40350 and Lot 512 (Figure 3). An additional cluster where there was evidence of nesting or breeding activity was on a property where several artificial nesting hollows were installed after it was observed that Carnaby's Cockatoos were present in higher numbers, indicating the area could be a favourable breeding area (Nesci Estate and surrounding road reserve) (Phoenix 2017b).

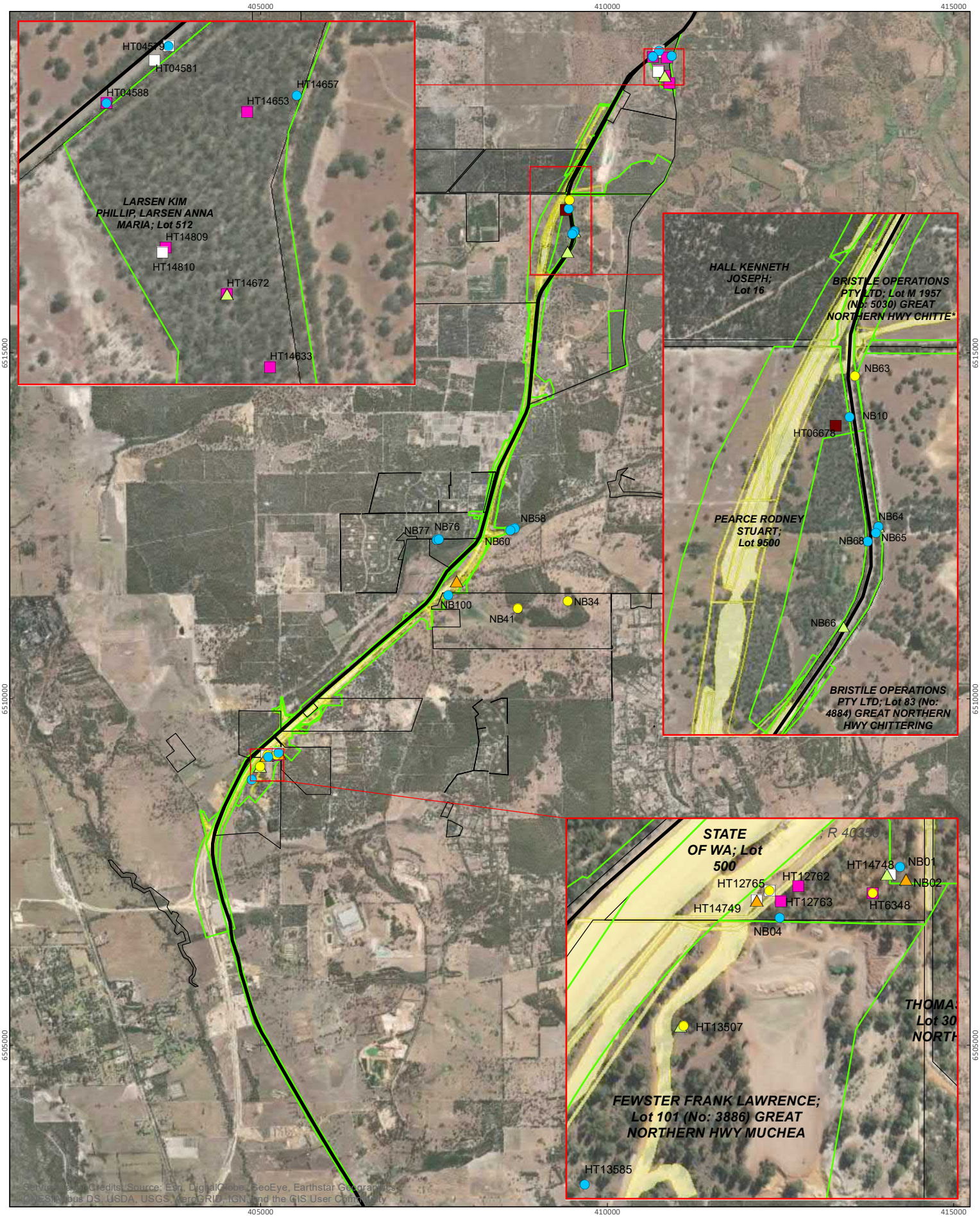
The natural nesting hollows which recorded a confirmed breeding event also had evidence of use in the previous breeding seasons, one had a successful breeding event in the 2017-2018 season. Of the four natural nesting hollows which recorded evidence of nesting activity, two had previous evidence, and of these, one had a confirmed breeding event.

The artificial nesting hollows were installed during the 2018-2019 breeding season so there are a few records of use by Carnaby's Cockatoo. However, the 2019-2020 breeding season recorded a higher number of artificial nesting hollows with both confirmed breeding events and evidence of nesting activity other than in the natural nesting hollows. Three of the four confirmed breeding events were observed in the artificial nesting hollows, and these were also the three that had successful outcome (a chick that hatched and had fledged). An additional 10 artificial nesting hollows had evidence of nesting which was also higher than the natural nesting hollows of which six hollows had evidence of nesting activities. This is a good indication that the artificial nesting hollows are providing a suitable alternative to natural nesting hollows in the Muchea area.

Table 3 Summary of results for 2017-18 and 2018-19 breeding seasons

Result type	**Baseline records pre 2017-18**[1] Natural hollows and existing aritificial hollows	**2017-18 breeding season** Natural hollows and existing aritificial hollows	**2018-19 breeding season** All hollows (natural & existing artificial hollows/new artificial hollows)	**Pre-impact average (2017-18 and 2018-19)** All hollows	**2019-20 breeding season** All hollows (natural & existing artificial hollows/new artificial hollows)
Confirmed breeding event	n/a	6	3 (2/1)	5	6 (3/3)
Evidence of nesting activity	24	14	5 (3/2)	10	15 (4/11)
No evidence of breeding	35	13	63 (30/33)	38	52 (26/26)
No longer suitable, not accessible, cleared	n/a	26	25 (24/1)	23	17 (17/0)

[1] Evidence of nesting activity recorded at some point. Not annual census data and cannot be compared with annual census results.



Main Roads WA
Great Northern Highway, M2W Upgrade Project

Project No	1272
Date	01-Apr-20
Drawn by	AJ
Map author	AJ

0 1 2
Kilometers

1:70,000 (at A4) GDA 1994 MGA Zone 50

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Study area
Disturbance footprint
Road

2019-2020 breeding season
- Confirmed breeding event
- Evidence of nesting activity

2018-2019 breeding season
- Confirmed breeding event
- Evidence of nesting activity

2017-2018 breeding season
- Confirmed breeding event
- Evidence of nesting activity
- Evidence of nesting activity (FRTBC)

Figure 5

Confirmed breeding events and Evidence of nesting activity across breeding seasons

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4 CONCLUSION

Four confirmed Carnaby's Cockatoo breeding events were observed in the 2019-20 season and evidence of nesting was observed in a further 16 hollows, with both natural and artificial nesting hollows showing activity.

The difference in nesting activity recorded between the breeding seasons is not unexpected as the sample size for this monitoring program is small and breeding activity can be highly variable between years.

The 2019-2020 census results indicate that breeding activity is occurring throughout the Muchea North area. Due to the historic large-scale clearing of trees and continuing decline of suitable trees with hollows in the area, all remaining suitable nesting hollows in the study area should be considered of high value to Carnaby's Cockatoo.

Considering the artificial nesting hollows were installed during the previous season, the uptake of many of these for breeding events and several more with evidence of nesting activity indicate the willingness of Carnaby's Cockatoo to utilise these as an alternative to natural nest hollows.

All of the artificial nesting hollows were in good condition and none required any maintenance.

For future monitoring of the nesting hollows, consistent methodology should be employed to that used in the 2019-2020 breeding census. Where possible, pole cameras should be used to inspect suspected breeding events.

5 REFERENCES

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Phoenix. 2019. *Muchea North Black Cockatoo breeding activity census*. Phoenix Environmental Sciences Pty Ltd, Osbourne Park, WA. Unpublished report prepared for Main Roads Western Australia.

Appendix 1 Results for all hollows in in the 2019-20 breeding season

HT ID	15-Aug-19	17-Sep-19	22-Oct-19	22-Nov-19	21-Dec-19	20-01-2020
HT04274	No flush	No flush	No flush	No flush	No flush	no flush
HT04579	No flush	No flush	Chewing at entrance	No flush	No flush	no flush
HT04581	No flush	No flush	No flush	No flush	No flush	no flush
HT04588	No flush	No flush	Slight chewing at entrance	No flush	No flush	no flush
HT05947	No flush	No flush	No flush	No flush	No flush	no flush
HT05954	No flush	No flush	No flush	No flush	No flush	no flush
HT06017	No flush	No flush	No flush	No flush	No flush	no flush
HT06025	No flush	No flush	No flush	No flush	No flush	no flush
HT06160	No flush	No flush	No flush	No flush	No flush	no flush
HT06201	No flush	No flush	No flush	No flush	No flush	no flush
HT06216	No flush	No flush	No flush	No flush	No flush	no flush
HT06330	No flush	No flush	No flush	No flush	No flush	no flush
HT06348	No flush	No flush	Carnaby flushed. 2 eggs	Eggs predated	No flush	no flush
HT06678	No flush	No flush	No flush	No flush	No flush	no flush
HT12761	No flush	No flush	No flush	No flush	No flush	no flush
HT12762	No flush	No flush	No flush	No flush	No flush	no flush
HT12763	No flush	No flush	No flush	No flush	No flush	no flush
HT12765	No flush	No flush	No flush	Carnaby's flushed	No flush	no flush
HT13484	No flush	No flush	No flush	No flush	No flush	no flush

HT13497	No flush	No flush	No flush	No flush	No flush	no flush
HT13506	No flush	No flush	No flush	No flush	No flush	no flush
HT13507	No flush	Carnaby flushed	No flush	No flush	No flush	no flush
HT13508	No flush	No flush	No flush	No flush	No flush	no flush
HT13585	No flush	No flush	Slight chewing at entrance	No flush	No flush	no flush
HT14633	No flush	No flush	No flush	No flush	No flush	no flush
HT14653	No flush	No flush	No flush	No flush	No flush	no flush
HT14657	No flush	Carnaby flushed	No flush	No flush	Pair prospecting hollows	no flush
HT14672	No flush	No flush	No flush	No flush	No flush	no flush
HT14748	No flush	No flush	No flush	No flush	No flush	no flush
HT14749	No flush	No flush	No flush	No flush	No flush	no flush
HT14809	No flush	No flush	No flush	No flush	No flush	no flush
HT14810	No flush	No flush	No flush	No flush	No flush	no flush
HT14811	No flush	No flush	No flush	No flush	No flush	no flush
NB01	Chewing at post	Chewing at post	No flush	No flush	No flush	no flush
NB02	No flush	No flush	No flush	No flush	No flush	no flush
NB03	No flush	No flush	No flush	No flush	No flush	no flush
NB04	No flush	No flush	No flush	Carnaby's flushed	No flush	no flush
NB05	No flush	No flush	No flush	No flush	No flush	no flush
NB06	No flush	No flush	No flush	No flush	No flush	no flush

NB08	No flush	No flush	No flush	No flush	No flush	no flush
NB09	No flush	No flush	No flush	No flush	No flush	no flush
NB10	No flush	Prospecting: female Carnaby flushed then leaves with male. Probably prospecting	No flush	No flush	No flush	no flush
NB11	No flush	No flush	No flush	No flush	No flush	no flush
NB12	No flush	No flush	No flush	No flush	No flush	no flush
NB13	No flush	No flush	No flush	No flush	No flush	no flush
NB14	No flush	No flush	No flush	No flush	No flush	no flush
NB32	No flush	No flush	No flush	No flush	No flush	no flush
NB33	No flush	No flush	No flush	No flush	No flush	no flush
NB34	no flush	no flush	no flush	No flush	Large chick in nest	Chick fledged
NB41	no flush	No flush	No flush	No flush	Large chick in nest - still has dowm on neck	Chick fledged
NB42	no flush	No flush	No flush	No flush	No flush	no flush
NB46	No flush	No flush	No flush	No flush	No flush	no flush
NB55	No flush	No flush	No flush	No flush	No flush	no flush
NB57	No flush	No flush	No flush	No flush	No flush	no flush
NB58	No flush	No flush	No flush	Carnaby's flushed	No flush	no flush
NB59	No flush	No flush	No flush	No flush	No flush	no flush
NB60	No flush	No flush	Post chewed	No flush	No flush	no flush
NB61	No flush	No flush	No flush	No flush	No flush	no flush

NB62	No flush	No flush	No flush	No flush	No flush	no flush
NB63	No flush	Carnaby's flushed	Carnaby's flushed	Pin feathered chick in nest	Large chick in nest	Chick fledged
NB64	No flush	Post chewed	No flush	No flush - empty	No flush	no flush
NB65	No flush	Post chewed	No flush	No flush	No flush	no flush
NB66	No flush	No flush	No flush	No flush	No flush	no flush
NB67	No flush	No flush	No flush	No flush	No flush	no flush
NB68	No flush	No flush	No flush	Carnaby flushed	No flush	no flush
NB69	No flush	No flush	No flush	No flush	No flush	no flush
NB71	No flush	No flush	No flush	No flush	No flush	no flush
NB76	No flush	No flush	No flush	Post chewed but nest empty	No flush	no flush
NB77	No flush	No flush	No flush	Post chewed but nest empty	No flush	no flush
NB78	no flush	No flush	No flush	No flush. Pair of Carnaby's nearby. Male making mating call	No flush	no flush
NB79	No flush	No flush	No flush	No flush	No flush	no flush
NB99	No flush	no flush	no flush	No flush	No flush	no flush
NB100	no flush	no flush	no flush	No flush	No flush - very old Carnaby's tail feather in nest	no flush

Appendix 2 Results for all hollows in 2017-18 and 2018-19 breeding season

HT ID	Result 2017-18	Result 2018-19	Result 2019-20
HT04059	No evidence of breeding	No evidence of breeding	Tree cleared. Further monitoring not required
HT04274	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT04579	Confirmed breeding event - failed	No evidence of breeding	No evidence of breeding
HT04581	Confirmed breeding event - failed	No evidence of breeding	No evidence of breeding
HT04588	Evidence of nesting activity	No evidence of breeding	Evidence of nesting activity
HT05911	No access	Hollow not located	Tree cleared. Further monitoring not required
HT05923	No evidence of breeding	Tree cleared. Further monitoring not required	n/a
HT05938	No longer suitable hollow. Further monitoring not required	n/a	n/a
HT05947	No evidence of breeding	Not located	No evidence of breeding
HT05954	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT06017	No access	No evidence of breeding	No evidence of breeding
HT06020	No access	Tree cleared. Further monitoring not required	n/a
HT06025	No access	No evidence of breeding	No evidence of breeding
HT06046	No access	Tree cleared. Further monitoring not required	n/a
HT06148	No longer suitable. Further monitoring not required	n/a	n/a
HT06160	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT06201	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT06216	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT06261	No evidence of breeding	Tree cleared. Further monitoring not required.	n/a

HT ID	Result 2017-18	Result 2018-19	Result 2019-20
HT06278	Evidence of nesting activity	Tree cleared. Further monitoring not required.	n/a
HT06330	Not sampled	No evidence of breeding. Added to breeding census in 2018-19	No evidence of breeding
HT06348	Evidence of nesting activity	No evidence of breeding	Confirmed breeding event - failed
HT06421	No access. Evidence of nesting activity (from a distance)	No access	n/a
HT06655	No longer suitable. Further monitoring not required	Tree cleared. Further monitoring not required	n/a
HT06678	Evidence of nesting activity (FRTBC)	No evidence of breeding	No evidence of breeding
HT08752	No evidence of breeding	Tree cleared. Further monitoring not required	n/a
HT08753	Evidence of nesting activity	No evidence of breeding	Tree cleared. Further monitoring not required
HT08754	No access	Confirmed breeding event	Tree cleared. Further monitoring not required
HT12761	Hollow not located	Hollow not located	No evidence of breeding
HT12762	Evidence of nesting activity	No evidence of breeding	No evidence of breeding
HT12763	Evidence of nesting activity	No evidence of breeding	No evidence of breeding
HT12765	Confirmed breeding event - successful	No evidence of breeding	Confirmed breeding event
HT13484	No access	No evidence of breeding	No evidence of breeding
HT13497	No access	No evidence of breeding	No evidence of breeding
HT13503	No access	No longer suitable. Further monitoring not required	n/a
HT13505	No access	No longer suitable. Further monitoring not required	n/a
HT13506	No access	No evidence of breeding	No evidence of breeding
HT13507	No access	Evidence of nesting activity	

HT ID	Result 2017-18	Result 2018-19	Result 2019-20
HT13508	No access	No evidence of breeding	No evidence of breeding
HT13511	No access	No longer suitable. Further monitoring not required	n/a
HT13523	No access	No longer suitable. Further monitoring not required	n/a
HT13533	No evidence of breeding	No evidence of breeding	Tree cleared. Further monitoring not required
HT13534	Evidence of nesting activity	Tree cleared. Further monitoring not required	n/a
HT13535	Evidence of nesting activity	Tree cleared. Further monitoring not required	n/a
HT13585	Not sampled	No evidence of breeding. Added to breeding census in 2018-19, chewing observed at hollow	Evidence of nesting activity
HT14633	Evidence of nesting activity	No evidence of breeding	No evidence of breeding
HT14653	Evidence of nesting activity	No evidence of breeding	No evidence of breeding
HT14657	No evidence of breeding	No evidence of breeding	Evidence of nesting activity
HT14670	Collapsed, no longer suitable. Further monitoring not required	n/a	n/a
HT14672	Evidence of nesting activity	Evidence of nesting activity	No evidence of breeding
HT14748	Confirmed breeding event - successful	Evidence of nesting activity	No evidence of breeding
HT14749	Confirmed breeding event - successful	Confirmed breeding event	No evidence of breeding
HT14805	No access	No access	No longer suitable. Further monitoring not required
HT14806	No access	No access	No longer suitable. Further monitoring not required
HT14807	No access	No access	No longer suitable. Further monitoring not required
HT14808	No access	No access	No longer suitable. Further monitoring not required
HT14809	Evidence of nesting activity	No evidence of breeding	No evidence of breeding

HT ID	Result 2017-18	Result 2018-19	Result 2019-20
HT14810	Confirmed breeding event - failed	No evidence of breeding	No evidence of breeding
HT14811	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB01	n/a	No evidence of breeding	Evidence of nesting activity
NB02	n/a	Confirmed breeding event	No evidence of breeding
NB03	n/a	No evidence of breeding	No evidence of breeding
NB04	n/a	No evidence of breeding	Evidence of nesting activity
NB05	n/a	No evidence of breeding	No evidence of breeding
NB06	n/a	No evidence of breeding	No evidence of breeding
NB08	n/a	No evidence of breeding	No evidence of breeding
NB09	n/a	No evidence of breeding	No evidence of breeding
NB10	n/a	No evidence of breeding	Evidence of nesting activity
NB11	n/a	No evidence of breeding	No evidence of breeding
NB12	n/a	No evidence of breeding	No evidence of breeding
NB13	n/a	No evidence of breeding	No evidence of breeding
NB14	n/a	No evidence of breeding	No evidence of breeding
NB32	n/a	No evidence of breeding/no access	No evidence of breeding
NB33	n/a	No evidence of breeding/no access	No evidence of breeding
NB34	n/a	n/a	Confirmed breeding event
NB41	n/a	n/a	Confirmed breeding event
NB42	n/a	n/a	No evidence of breeding
NB46	n/a	No evidence of breeding	No evidence of breeding

HT ID	Result 2017-18	Result 2018-19	Result 2019-20
NB55	n/a	No evidence of breeding	No evidence of breeding
NB57	n/a	No evidence of breeding	No evidence of breeding
NB58	n/a	No evidence of breeding	Evidence of nesting activity
NB59	n/a	No evidence of breeding	No evidence of breeding
NB60	n/a	No evidence of breeding	Evidence of nesting activity
NB61	n/a	No evidence of breeding	No evidence of breeding
NB62	n/a	No evidence of breeding	No evidence of breeding
NB63	n/a	No evidence of breeding	Confirmed breeding event
NB64	n/a	Evidence of nesting activity	Evidence of nesting activity
NB65	n/a	No evidence of breeding	Evidence of nesting activity
NB66	n/a	Evidence of nesting activity	No evidence of breeding
NB67	n/a	No evidence of breeding	No evidence of breeding
NB68	n/a	No evidence of breeding	Evidence of nesting activity
NB69	n/a	No evidence of breeding	No evidence of breeding
NB71	n/a	No evidence of breeding	No evidence of breeding
NB76	n/a	No evidence of breeding	Evidence of nesting activity
NB77	n/a	No evidence of breeding	Evidence of nesting activity
NB78	n/a	No evidence of breeding	No evidence of breeding
NB79	n/a	No evidence of breeding	No evidence of breeding
NB99	n/a	No evidence of breeding	No evidence of breeding
NB100	n/a	n/a	Evidence of nesting activity

PHOENIX
ENVIRONMENTAL SCIENCES

Black cockatoo breeding activity census 2020-21 for Muchea North

Great Northern Highway, Muchea to Wubin Upgrade Stage 2 Project

Prepared for Main Roads WA

June 2021

Final

Black cockatoo breeding activity census 2020-21 for Muchea North.

Great Northern Highway, Muchea to Wubin Upgrade Stage 2 Project.

Prepared for Main Roads WA

Author/s	Reviewer/s	Version	Version number	Date submitted	Submitted to
A. Jacks	K. Crews	Draft for client comments	0.1	17-Mar-21	L. Zimmermann
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Contents

List of Figures

List of Tables

Appendices

1 INTRODUCTION

Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by Main Roads WA, to undertake a Carnaby's Cockatoo breeding activity census over the 2020-21 breeding season within and surrounding the disturbance footprint for the Muchea North Upgrade project area (Figure 1). This report presents the results of the census.

1.1 BACKGROUND

Main Roads has recently upgraded the Great Northern Highway (GNH) between Straight Line Kilometre (SLK) 38.60 and 51.40, referred to as Muchea North Upgrade (Muchea North in this report). The Muchea North proposal was referred under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 1 March 2016 (EPBC 2016/7656), assessed as a controlled action and granted conditional approval in August 2018 (DotEE 2018).

Muchea North resulted in the loss of 13 Carnaby's Black Cockatoo nesting hollows. To mitigate and offset the loss of these, Main Roads was required to install 39 artificial nest boxes (Figure 1). In accordance with EPBC 2016/7656 Conditions 4f(i) and (ii) each artificial nesting hollow installed must:

- EPBC 2016/7656 condition f(i): be inspected at least twice a year by a suitably qualified person during the peak breeding season to record any evidence of use by the Carnaby's Black Cockatoo and to identify any maintenance requirements.
- EPBC 2016/7656 condition f(ii): be monitored and maintained in accordance with relevant artificial hollow guidance for the life of the approval, with maintenance actions, if required, undertaken outside of the breeding season and before the commencement of the next breeding season.

The monitoring program also required monitoring of previously recorded natural hollows suitable for Carnaby's Cockatoo (Figure 1). Monitoring of artificial and natural hollows is required to be monitored in accordance with How to Monitor and Maintain Artificial Hollows for Carnaby's Cockatoo (DPaW 2015).

Detailed black cockatoo habitat assessments conducted as part of the baseline assessments for the Muchea North (Phoenix 2015, 2017a) recorded all potential breeding trees of species known to support black cockatoo breeding and identifed suitable nesting hollows and hollows with evidence of use.

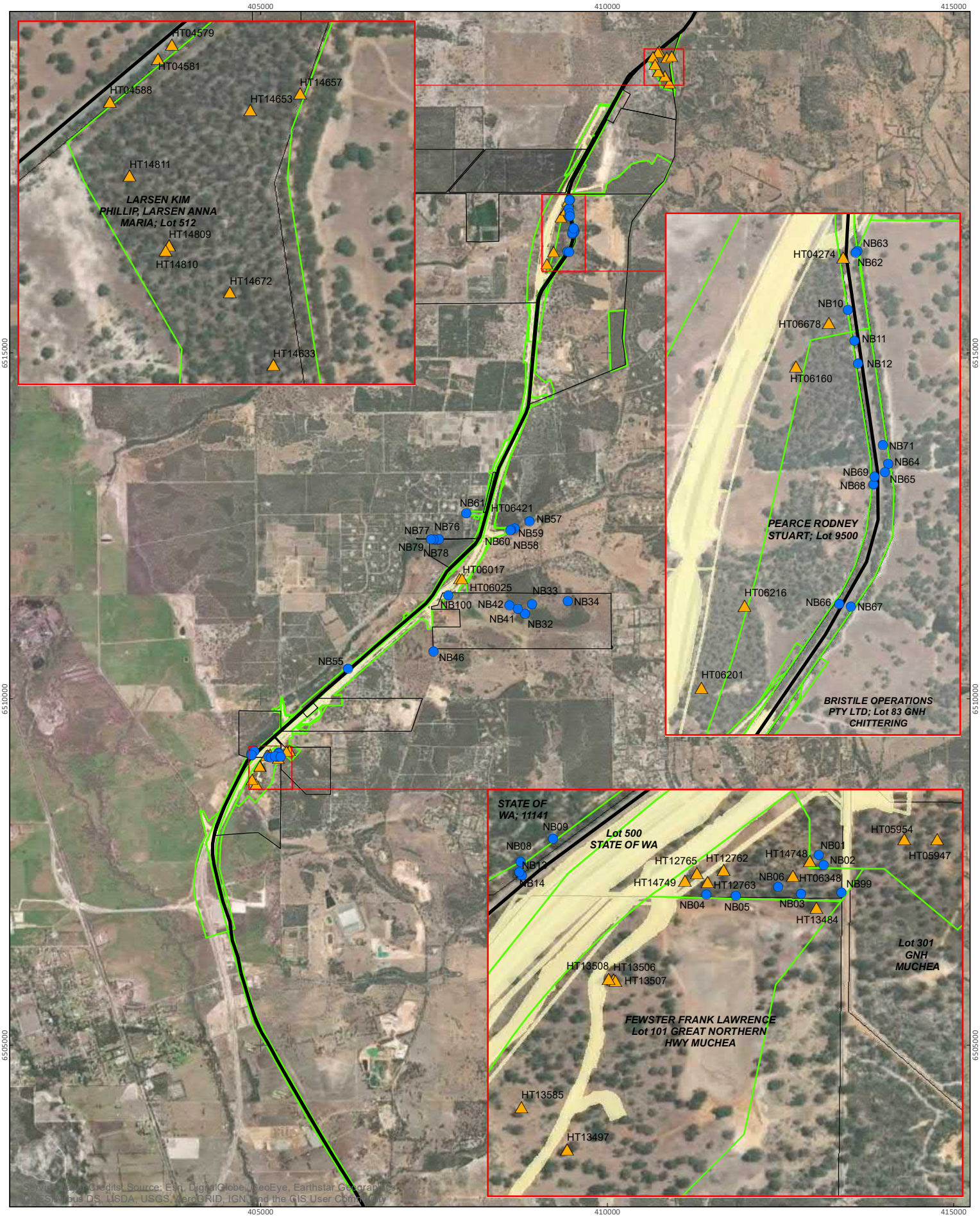
A native vegetation clearing permit (NVCP) for Muchea North (Permit no. 7563/2) has been approved by the WA Department of Water and Environmental Regulation (DWER) under the *Environmental Protection Act 1986* (EP Act).

To support Condition 4c of EPBC 2016/7656, Main Roads commissioned Phoenix to undertake monitoring of confirmed and suitable nesting hollows recorded within the EPBC Act Approval Boundary and wider baseline survey area (Phoenix 2015, 2017a) (the study area; Figure 1). A series of monitoring events have taken place to support this condition (Table 1). The initial baseline monitoring program was conducted in the 2017-18 breeding season (August 2017 – February 2018) and assessed hollow usage of suitable nesting hollows and hollows with evidence of use within the study area (Phoenix 2018). A second year of monitoring for hollow usage within the study area in the 2018-19 breeding season was undertaken by Phoenix from August 2018 to February 2019 (Phoenix 2019). The artificial nesting hollows were installed during the 2018-2019 breeding season, therefore the results of these first two surveys collectively represent the pre-impact breeding density.

Impact monitoring was subsequently conducted in the 2019-2020 breeding season (Phoenix 2020) and the 2020-2021 season. This report incorporates the results of the 2020-2021 monitoring season into the nesting hollow usage dataset for Muchea North.

Table 1 Summary of black cockatoo monitoring activity

Year	Activity
2014-2016 Various times	Habitat assessment including recording all potential breeding trees and suitability for nesting.
2017-2018 August to January	Baseline assessment: Assessment of nest hollows for evidence of breeding.
2018-2019 August to February	Baseline assessment: Assessment of nest hollows for evidence of breeding. *Road works commenced and artificial nesting hollows were installed during this breeding season.*
2019-2020 August to January	Assessment of both natural nest hollows and artificial neststing hollows for evidence of breeding
2020-2021 August to February	Assessment of both natural nest hollows and artificial neststing hollows for evidence of breeding



Main Roads WA
Great Northern Highway, M2W Upgrade Project

Project No	1333
Date	09-Mar-21
Drawn by	AJ
Map author	AJ

0 1 2
Kilometers

1:70,000 (at A4) GDA 1994 MGA Zone 50

P:\GIS\Projects\MainRoadsPanel\Projects\1333-SR342-MR-VER\Mapping\MapDocuments\Figures\1333-Fig1_TreeLocations.mxd

- Study area
- Disturbance footprint
- Road
- Artificial nesting hollow
- Natural nesting hollow

Figure 1

Study area and sampling sites

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1.2 SCOPE OF WORK

The scope of work was as follows:

- Six rounds of monitoring of artificial and natural nest hollows to be undertaken between August 2020 and January 2021.
- During inspections of artificial and natural hollows, record evidence of use by Carnaby's Cockatoos at each artificial and natural hollow in accordance with (DPaW 2015).
- During inspections, identify any artificial nest box maintenance needs in accordance with (DPaW 2015) and whether natural hollows remain suitable for use by Carnaby's Black Cockatoo.
- Provide a report that summarises all records required by Conditions 4f(i) and (ii) of EPBC 2016/7656 for all artificial and natural hollows inspected. The draft report shall be provided to Main Roads in electronic PDF and Word version copy format.

2 CENSUS METHODOLOGY (DPAW 2015)

Methods were consistent with the approach undertaken in previous monitoring events for Muchea North (Phoenix 2018, 2019, 2020).

Prior to the surveys, site locations (artificial and natural nest hollows) were loaded onto field tablets. Data was collected electronically using a customised data collection template and included:

- site code
- signs of use – birds prospecting hollows, fresh chewings, birds perching, birds entering/existing hollows, birds flushed from hollows, gender of observed birds, chick calls, eggs observed (inc. status if possible – incubated or abandoned), chick/s observed, chick/s fledged
- other indicators, e.g. gender mix of flocks, evidence of nesting at base of trees
- condition of hollow, current suitability for use (natural hollows), maintenance requirements (artificial hollows).

The knocking and scraping method was conducted at the base of trees for all monitored hollows. Other observational methods were also employed, i.e. pole camera inspections of hollows where possible, listening for nest activity, flock and individual bird behaviour.

Consistent with previous methodology the following activities were undertaken:

- evidence of nesting activity was noted where fresh chewing is around the hollow entrance and/or birds are seen prospecting hollows.
- a confirmed breeding event was noted where eggs are seen in hollow and/or other clear evidence observed that a chick is present (i.e. female seen at hollow entrance when during brooding eggs, and/or parents seen preparing to feed chick in the hollow).

Maintenance checks of artificial hollows will assess the following as a minimum:

- condition of chewing posts
- condition of attachment points
- condition of hollow bases
- stability of tree or pole used to mount the artificial hollow.

As per previous surveys, site visits were undertaken every 4-5 weeks between August 2020 and January 2021: 24 August, 22 September, 26 October, 27 November, 31 December and 07 February.

The baseline surveys for Muchea North identified a total of 57 trees in the study area containing suitable nesting hollows for black cockatoos, of which 25 had evidence of nesting activity (Table 2). In the initial survey, 37 of these were monitored as the remaining 20 were unable to be assessed due to access constraints.

In the 2018-19 season, 47 natural nesting hollows and 36 artifical nesting hollows were monitored (Table 2). This included two new natural hollows added to the census in the current season and 14 trees that were not accessible in the 2017-18 season. Twelve further natural nesting hollows were not monitored; five of these were not able to be accessed, three were not relocated and four hollows were removed from monitoring in the 2017-18 season due to collapse, cracks forming or tree death.

In the 2019-2020 season, 73 hollows were monitored, of which 33 were natural nesting hollows and 40 were artifical nesting hollows (Table 2). Prior to that survey, 13 trees which contained suitable nesting hollows were removed as part of the GNH road upgrades (HT05911, HT05923, HT06020, HT06046, HT06261, HT06278, HT06655, HT08752, HT08753, HT08754, HT13533, HT13534 and HT13535), 12 of these were monitored in the previous two monitoring programs and one was not accessible. These 13 trees were offset by the installation of the 39 artificial nesting hollows of which all were able to be monitored in the 2019-2020 season. An additional artificial nesting hollow (NB100) was included in the survey which was erected to replace HT04059. Four natural nesting hollows from the baseline dataset that had not been monitored in the previous two years were able to be surveyed in the 2019-2020 season because landowner access had been granted. Four trees with natural nesting hollows were not surveyed in the 2019-2020 season because the tree or hollow was no longer considered suitable.

In the current 2020-2021 survey, the same trees and artificial nesting hollows from the 2019-2020 season were monitored.

In this report:

- *confirmed breeding event* – means eggs were seen in hollow and/or other clear evidence observed that chick was present (i.e. female seen at hollow entrance when brooding eggs and/or parents seen preparing to feed chick in the hollow)
- *evidence of nesting activity* – means chewing around the hollow entrance and/or bird seen prospecting hollows. It does not necessarily mean that a breeding event took place that year; however, it is evidence that the hollow is suitable and was considered and may have been used in previous years.

Table 2 Monitored hollows

HT ID*	Baseline records (pre-2017)	Species	2017-18	2018-19	2019-20	2020-21
HT04059	Evidence of nesting activity, artificial hollow	*Eucalyptus wandoo*	Yes	Yes	No (tree cleared)	n/a
HT04274	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	Yes	Yes
HT04579 (NB)	Suitable, *artificial hollow*, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	Yes	Yes
HT04581 (NB)	Suitable, *artificial hollow*, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	Yes	Yes
HT04588 (NB)	Suitable, *artificial hollow*, no evidence of breeding	*Eucalyptus accedens*	Yes	Yes	Yes	Yes
HT05911	Suitable, artificial hollow, no evidence of breeding	*Eucalyptus accedens*	No access	No access	No (tree cleared)	n/a
HT05923	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	No (tree cleared)	n/a
HT05938	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	No	No (not suitable – hollow has cracked or degraded)	n/a
HT05947	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	No	Yes	Yes
HT05954	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes	Yes
HT06017	Evidence of nesting activity	*Eucalyptus wandoo*	No access	Yes	Yes	Yes
HT06020	Suitable, no evidence of breeding	*Corymbia calophylla*	No access	Yes	No (tree cleared)	
HT06025	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	Yes	Yes	Yes
HT06046	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	Yes	No (tree cleared)	n/a
HT06148	Suitable, no evidence of breeding	*Corymbia calophylla*	Yes	No	No (not suitable – hollow has cracked or degraded)	n/a
HT06160	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	Yes	Yes
HT06201	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	Yes	Yes
HT06216	Suitable, no evidence of breeding	*Eucalyptus marginata*	Yes	Yes	Yes	Yes
HT06261	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	No (tree cleared)	n/a

HT ID*	Baseline records (pre-2017)	Species	2017-18	2018-19	2019-20	2020-21
HT06278	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	No (tree cleared)	n/a
HT06330	Not currently suitable	*Eucalyptus wandoo*	No	Yes	No (tree cleared)	n/a
HT06348	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes	Yes
HT06421	Evidence of nesting activity	*Corymbia calophylla*	No access	No access	No (no access)	n/a
HT06655	Suitable, no evidence of breeding	*Corymbia calophylla*	Yes	No	No (tree cleared)	n/a
HT06678	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	Yes	Yes
HT08752	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	No (tree cleared)	n/a
HT08753	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	No (tree cleared)	n/a
HT08754	Evidence of nesting activity	*Eucalyptus wandoo*	No access	Yes	No (tree cleared)	n/a
HT12761	Evidence of nesting activity	*Eucalyptus wandoo*	No	No	Yes	No (not suitable – hollow has cracked or degraded)
HT12762	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes	Yes
HT12763	Evidence of nesting activity (FRTBC)	*Eucalyptus wandoo*	Yes	Yes	Yes	Yes
HT12765	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes	Yes
HT13484	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	Yes	Yes	Yes
HT13497	Suitable, no evidence of breeding	*Eucalyptus marginata*	No access	Yes	Yes	Yes
HT13503	Suitable, no evidence of breeding	*Eucalyptus marginata*	No access	Yes	No (not suitable – hollow has cracked or degraded)	n/a
HT13505	Suitable, no evidence of breeding	*Eucalyptus sp.*	No access	Yes	No (not suitable – hollow has cracked or degraded)	n/a
HT13506	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	Yes	Yes	Yes
HT13507	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	Yes	Yes	Yes
HT13508	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	Yes	Yes	Yes
HT13511	Suitable, no evidence of breeding	*Corymbia calophylla*	No access	Yes	No (not suitable –	n/a

HT ID*	Baseline records (pre-2017)	Species	2017-18	2018-19	2019-20	2020-21
					hollow has cracked or degraded)	
HT13523	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	Yes	No (not suitable – hollow has cracked or degraded)	n/a
HT13533	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	No (tree cleared)	n/a
HT13534	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	No (tree cleared)	n/a
HT13535	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	No (tree cleared)	n/a
HT13585	Not currently suitable	*Corymbia calophylla*	No	Yes	Yes	Yes
HT14633	Suitable, no evidence of breeding	*Eucalyptus wandoo*	Yes	Yes	Yes	Yes
HT14653	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes	Yes
HT14657	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes	Yes
HT14670	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	No	No (not suitable – hollow collapsed)	n/a
HT14672	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes	Yes
HT14748	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes	Yes
HT14749	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes	Yes
HT14805	Evidence of nesting activity	*Eucalyptus wandoo*	No access	No access	No (not suitable – hollow has cracked or degraded)	n/a
HT14806	Evidence of nesting activity	*Eucalyptus wandoo*	No access	No access	No (not suitable – hollow has cracked or degraded)	n/a
HT14807	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	No access	No (not suitable – hollow has cracked or degraded)	n/a
HT14808	Suitable, no evidence of breeding	*Eucalyptus wandoo*	No access	No access	No (not suitable – hollow has	n/a

HT ID*	Baseline records (pre-2017)	Species	2017-18	2018-19	2019-20	2020-21
					cracked or degraded)	
HT14809	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes	Yes
HT14810	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes	Yes
HT14811	Evidence of nesting activity	*Eucalyptus wandoo*	Yes	Yes	Yes	Yes
NB01	n/a	n/a	n/a	Yes	Yes	Yes
NB02	n/a	n/a	n/a	Yes	Yes	Yes
NB03	n/a	n/a	n/a	Yes	Yes	Yes
NB04	n/a	n/a	n/a	Yes	Yes	Yes
NB05	n/a	n/a	n/a	Yes	Yes	Yes
NB06	n/a	n/a	n/a	Yes	Yes	Yes
NB08	n/a	n/a	n/a	Yes	Yes	Yes
NB09	n/a	n/a	n/a	Yes	Yes	Yes
NB10	n/a	n/a	n/a	Yes	Yes	Yes
NB11	n/a	n/a	n/a	Yes	Yes	Yes
NB12	n/a	n/a	n/a	Yes	Yes	Yes
NB13	n/a	n/a	n/a	Yes	Yes	Yes
NB14	n/a	n/a	n/a	Yes	Yes	Yes
NB32	n/a	n/a	n/a	Yes	Yes	Yes
NB33	n/a	n/a	n/a	Yes	Yes	Yes
NB34	n/a	n/a	n/a	n/a	Yes	Yes
NB41	n/a	n/a	n/a	n/a	Yes	Yes
NB42	n/a	n/a	n/a	n/a	Yes	Yes
NB46	n/a	n/a	n/a	Yes	Yes	Yes
NB55	n/a	n/a	n/a	Yes	Yes	Yes
NB57	n/a	n/a	n/a	Yes	Yes	Yes
NB58	n/a	n/a	n/a	Yes	Yes	Yes
NB59	n/a	n/a	n/a	Yes	Yes	Yes
NB60	n/a	n/a	n/a	Yes	Yes	Yes
NB61	n/a	n/a	n/a	Yes	Yes	Yes
NB62	n/a	n/a	n/a	Yes	Yes	Yes
NB63	n/a	n/a	n/a	Yes	Yes	Yes
NB64	n/a	n/a	n/a	Yes	Yes	Yes
NB65	n/a	n/a	n/a	Yes	Yes	Yes
NB66	n/a	n/a	n/a	Yes	Yes	Yes
NB67	n/a	n/a	n/a	Yes	Yes	Yes
NB68	n/a	n/a	n/a	Yes	Yes	Yes
NB69	n/a	n/a	n/a	Yes	Yes	Yes

HT ID*	Baseline records (pre-2017)	Species	2017-18	2018-19	2019-20	2020-21
NB71	n/a	n/a	n/a	Yes	Yes	Yes
NB76	n/a	n/a	n/a	Yes	Yes	Yes
NB77	n/a	n/a	n/a	Yes	Yes	Yes
NB78	n/a	n/a	n/a	Yes	Yes	Yes
NB79	n/a	n/a	n/a	Yes	Yes	Yes
NB99	n/a	n/a	n/a	Yes	Yes	Yes
NB100	HT04059 was cleared and this nestbox was installed to replace it in 2019	n/a	n/a	n/a	Yes	Yes

* HT = habitat tree (natural); NB = nest box (artificial); HT (NB) = this tree had an artificial nest box installed prior to the baseline records (pre-2017) and has been counted as a natural habitat tree for the pre- and post- baseline analysis.

3 RESULTS

3.1 CENSUS RESULTS 2020-21 BREEDING SEASON

Confirmed breeding events were recorded in 12 artificial nesting hollows and one natural nesting hollow during the 2020-2021 monitoring season (Table 3; Figure 2). Evidence of nesting activity was observed in a further seven artificial nesting hollows and six natural nesting hollows (Table 3; Figure 2).

Of the confirmed breeding events:

- HT14809, NB01, NB03, NB32, NB34, NB41, NB62, NB71 and NB78 – are presumed to have resulted in successful fledging of a chick. Images of chicks were seen with a camera in all three artificial nest hollows between October and February 2020 (Figure 3).
- NB10 – a single egg was seen in the nest in October but the nest was empty in December. The nest could not be accessed in November so unsure if this chick fledged or was predated.
- NB12, NB63 and NB99 – two addled or broken eggs were observed with a camera in the hollow in October and November 2020.

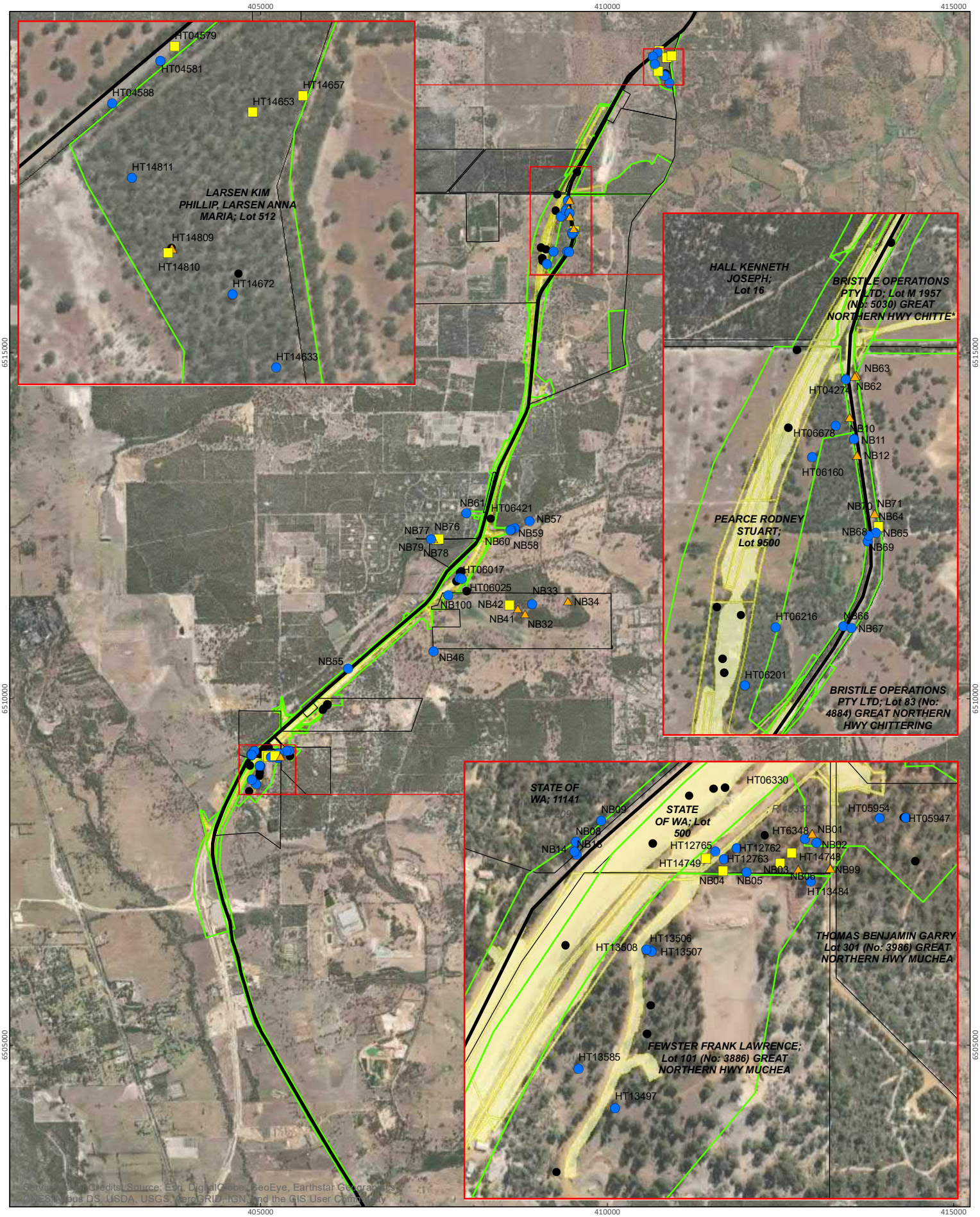
There were eight instances where females were flushed from a hollow but a later inspection saw no chicks or eggs and the bird was likely to be prospecting. A further five had observations of prospecting birds or recent chewing around the hollow or on the post. No evidence of nesting activities were observed in the remaining natural nesting hollows or artificial nesting hollows (Appendix 1).

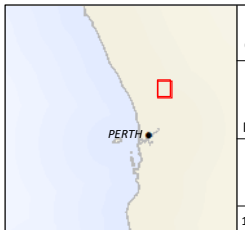
Table 3 Evidence of breeding records by Phoenix during the 2020-21 census

HT ID	Inspection date						Result
	24/08/2020	22/09/2020	26/10/2020	27/11/2020	31/12/2020	07/02/2021	
HT04579 (NB)^				Post chewed			Evidence of nesting activity
HT06348			Carnaby flushed				Evidence of nesting activity
HT14653				Chewed entrance, pair prospecting			Evidence of nesting activity
HT12657		Female prospecting		Pair prospecting			Evidence of nesting activity
HT14749			Carnaby flushed				Evidence of nesting activity
HT14809			Carnaby flushed	Pin feathered chick	Large-feathered chick	Chick fledged	Confirmed breeding event: assumed successful
HT14810		Carnaby flushed					Evidence of nesting activity
NB01			Carnaby flushed	Pin feathered chick in nest	Large-feathered chick in nest	Chick fledged	Confirmed breeding event: assumed successful
NB03				Small chick and addled egg	Chick in nest	Chick fledged	Confirmed breeding event: assumed successful
NB04				Flushed female Carnaby, likely to be prospecting hollow	No flush, no eggs in hollow		Evidence of nesting activity
NB06		Carnaby flushed					Evidence of nesting activity
NB10		Carnaby flushed	Single egg in nest	No access			Confirmed breeding event: uncertain outcome
NB12			Carnaby flushed	2 broken eggs			Confirmed breeding event: unsuccessful

HT ID	Inspection date						Result
	24/08/2020	22/09/2020	26/10/2020	27/11/2020	31/12/2020	07/02/2021	
NB32			Carnaby flushed	Check in nest	Chick in nest	Chick fledged	Confirmed breeding event: assumed successful
NB34			Prospecting female	Single egg in nest	Chick in nest	Chick fledged	Confirmed breeding event: assumed successful
NB41		Carnaby flushed	Chick in nest				Confirmed breeding event: assumed successful
NB42					Pair of Carnaby prospecting		Evidence of nesting activity
NB62	Carnaby flushed	Carnaby flushed	Downy chick in nest	Large-feathered chick in nest	Chick fledged		Confirmed breeding event: assumed successful
NB63	Carnaby flushed	Carnaby flushed	Cracked egg in nest				Confirmed breeding event: unsuccessful
NB64	Carnaby flushed			*Chick in natural hollow underneath NB64*			Evidence of nesting activity (Confirmed breeding event: assumed successful - in a natural hollow under the box in the same tree)
NB71			Carnaby flushed	Nestling in hollow	Feathered chick in hollow	Chick fledged	Confirmed breeding event: assumed successful
NB76		Heavily chewed post					Evidence of nesting activity
NB77			Carnaby flushed				Evidence of nesting activity
NB78		Carnaby flushed		Pin-feathered chick	Chick fledged		Confirmed breeding event: assumed successful
NB79			Post chewed				Evidence of nesting activity
NB99		Pair at nest, female stays		Two addled or broken eggs			Confirmed breeding event: unsuccessful

^ this tree had an artificial nest box installed prior to the baseline records (pre-2017).





Main Roads WA
Great Northern Highway, M2W Upgrade Project

Project No	1333
Date	19-Feb-21
Drawn by	AJ
Map author	AJ

0 1 2
Kilometers

1:70,000 (at A4) GDA 1994 MGA Zone 50

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Study area
Disturbance footprint
Road

Results

- Confirmed breeding event
- Evidence of nesting activity
- No evidence of breeding
- Not surveyed (no access/no longer suitable, cleared)

Figure 2

Monitoring results for 2020-21 breeding season

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Figure 3 Pin-feathered chick a nest box (November 2020)

Figure 4 Almost ready to fledge (December 2020)

3.2 COMPARISON BETWEEN BREEDING SEASONS

The number of hollows which had either confirmed Carnaby's Cockatoo breeding events in the 2020-21 breeding season is significantly higher than both the pre-impact average and the previous year's (2019-2020) post-impact survey. Overall, the number of confirmed breeding events in 2020-2021 (13) was more than double that of the pre-impact average of five (Table 4). Evidence of nesting activity has also been higher in the two post impact monitoring events than the pre-impact average (Table 4). The current breeding season was slightly lower than the previous year, but this was offset but a much higher number of confirmed breeding events.

Most significantly, the results of the monitoring program clearly show a trend toward increased usage of the artificial nesting hollows installed under the Muchea North offset. The nest boxes were installed during the 2018-2019 breeding season so there were few records of use of these during that season, with only one confirmed breeding event and two records of evidence of nesting activity (Table 4). This increased in the 2019-2020 breeding season to three confirmed breeding events and 11 records of nesting activity in the artificial nesting hollows. In 2020-2021, the number of confirmed breeding events in the artificial nesting hollows increased by 400% to 12, with the majority assumed to have had a successful outcome i.e., a chick hatched and fledged (Table 4).

In contrast, the number of confirmed breeding events in natural nest hollows declined from three in 2020-2021 to one in the current breeding season. The results suggest the birds are preferentially choosing the artificial hollows over the natural hollows.

Repeated use of the same hollows for breeding was also apparent from the 2020-2021 season. All of the natural nesting hollows which had evidence of nesting or a confirmed breeding event in the current season also had evidence of use or a confirmed breeding in previous breeding seasons.

Of the 19 new artificial nesting hollows which recorded evidence of nesting activity or a confirmed breeding event in the current breeding season, six had evidence of nesting activity in the previous (2019-20) season and three had a successful breeding event. The three artificial nesting boxes that recorded a confirmed breeding event in 2019-2020 also had confirmed breeding in 2020-2021.

Breeding events and evidence of nesting activity in the 2020-21 season were identified in the same general areas as in the previous seasons, including the three areas that were identified as having a higher rate of breeding activity, Reserve 40350 and Lot 512, and the old GNH adjacent to Lot 9500. An additional cluster of activity was identified at Nesci Estate and the surrounding road reserve; this was a location where several artificial nesting hollows were installed after it was observed that Carnaby's Cockatoos were present in higher numbers, indicating the area could be a favourable breeding area (Phoenix 2017b).

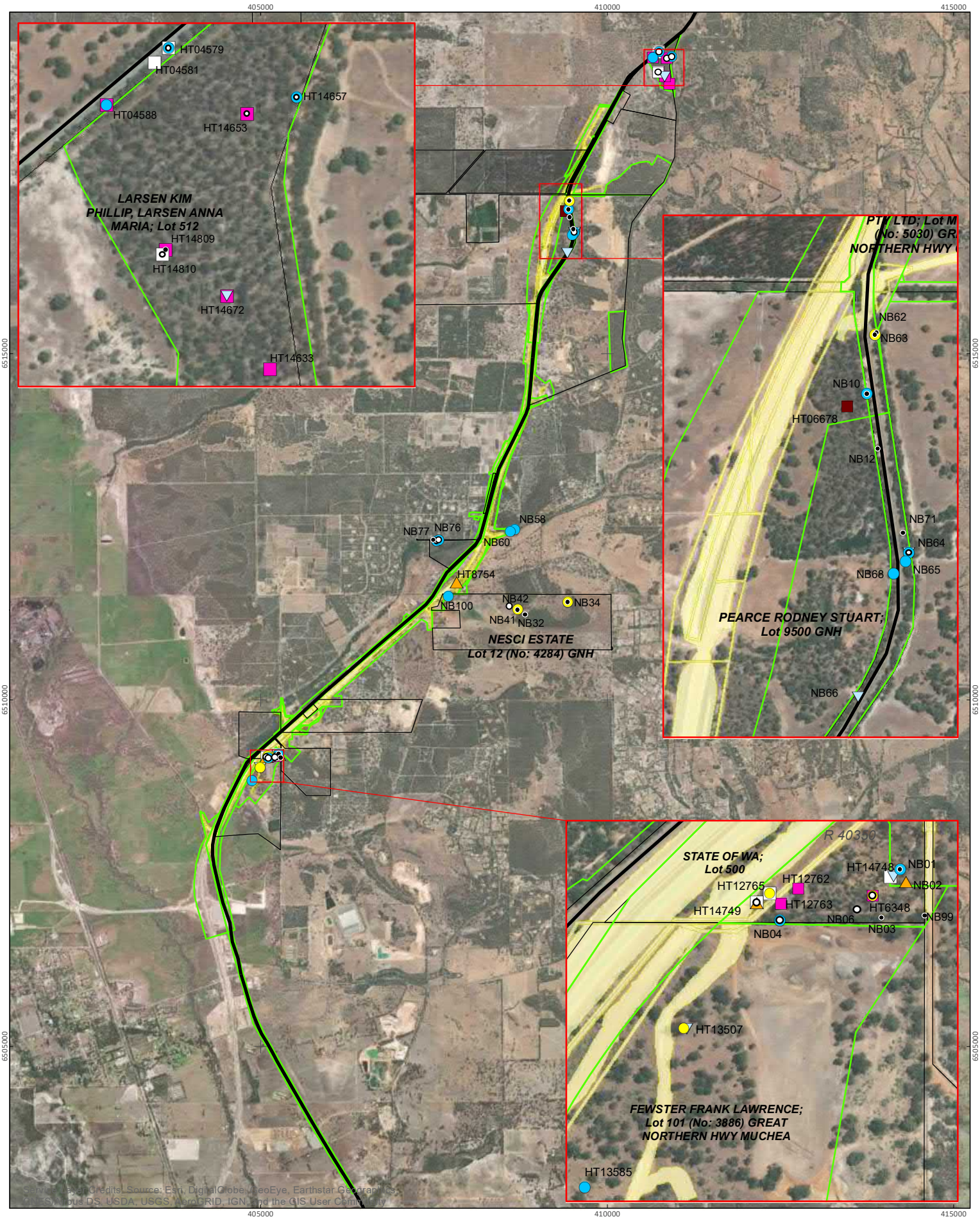
3.1 CONDITION OF ARTIFICIAL NESTING HOLLOWS

All of the artificial nesting hollows surveyed were observed to be in good condition.

Table 4 Summary of results for each breeding season

Result type	**Baseline records pre 2017-18**[1] Natural hollows and existing aritificial hollows	**2017-18 breeding season** Natural hollows and existing aritificial hollows	**2018-19 breeding season** All hollows (natural & existing artificial hollows/new artificial hollows)	**Pre-impact average (2017-18 and 2018-19)** All hollows	**2019-20 breeding season** All hollows (natural & existing artificial hollows/new artificial hollows)	**2020-21 breeding season** All hollows (natural & existing artificial hollows/new artificial hollows)	**Post-impact average (2019-20 and 2020-21)** All hollows
Confirmed breeding event	n/a	6	3 (2/1)	5	6 (3/3)	13 (1/12)	10 (2/8)
Evidence of nesting activity	24	14	5 (3/2)	10	15 (4/11)	13 (6/7)	14 (5/9)
No evidence of breeding	35	13	63 (30/33)	38	52 (26/26)	45 (24/21)	49 (25/23)
Total no. hollows surveyed	59	33	71	53	73	71	72
Trees not surveyed: no longer suitable, not accessible, cleared	n/a	26	25 (24/1)	23	17 (17/0)	19 (19/0)	18

[1] Evidence of nesting activity recorded at some point. Not annual census data and cannot be compared with annual census results.



Main Roads WA
Great Northern Highway, M2W Upgrade Project

Project No	1333
Date	19-Mar-21
Drawn by	AJ
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0 1 2
Kilometers

1:70,000 (at A4) GDA 1994 MGA Zone 50

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Study area
Disturbance

2020-2021 breeding
- Confirmed breeding
- Evidence of nesting activity

2019-2020 breeding
- Confirmed breeding
- Evidence of nesting activity

2018-2019 breeding
- Confirmed breeding
- Evidence of nesting activity

2017-2018 breeding
- Confirmed breeding
- Evidence of nesting activity
- Evidence of nesting activity

Figure 5

Confirmed breeding events and evidence of nesting activity across breeding seasons

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4 CONCLUSION AND RECOMMENDATIONS

The 2020-2021 breeding season results indicate that breeding activity is occurring throughout the Muchea North area and that it is an important breeding area for Carnabys Cockatoo. This breeding season was remarkably more successful than previous seasons, with more than double the number of confirmed breeding events recorded compared to last breeding season and also the pre-impact average. Thirteen confirmed Carnaby's Cockatoo breeding events were observed in the 2020-21 season and evidence of nesting was observed in a further 13 hollows. Both natural and artificial nesting hollows showed activity but there was a clear trend towards confirmed breeding in the artificial nesting hollows.

The difference in nesting activity recorded between the breeding seasons is not unexpected as the sample size for this monitoring program is small and breeding activity can be highly variable between years; however, the increased rate of post-impact breeding observed over the past three years is promising for mitigating population decline.

The willingness of Carnabys Cockatoo to utilise the artificial nesting hollows as an alternative to natural nest hollows is evident from the 2020-2021 breeding data. Considering the artificial nesting hollows were installed during the 2018-2019 season, the uptake of many of these for breeding and several more with evidence of nesting activity in the first two years post-installation is encouraging, particularly this breeding season where the rate of confirmed breeding breeding events is much higher in artificial nesting hollows than natural nesting hollows.

Of the 13 hollows with evidence of breeding, eight were from artificial nesting hollows (seven from the new and one from an existing artificial nesting hollows), and five from natural nesting hollows. This is a good indication that the artificial nesting hollows are providing a suitable alternative to natural nesting hollows and may even be preferred in the Muchea area.

The repeated use of the same hollows suggests that Carnaby's Cockatoo have preferred locations, either in the landscape, breeding areas or within the tree itself. Additional years of monitoring are required to confirm this notion.

The rate of unsuccessful breeding events is standard across the monitoring project so far.

All of the artificial nesting hollows were in good condition and none required any maintenance.

Due to the historic large-scale clearing of trees and continuing decline of suitable trees with hollows in the area, all remaining suitable nesting hollows in the study area should be considered of high value to Carnaby's Cockatoo.

Under EPBC 2016/7656 (DotEE 2018), condition 4d states: "*Adaptive management may cease when at least one artificial nesting hollow for each known nesting hollow cleared has shown evidence of use by the Carnaby's Black Cockatoo, as verified by the suitable qualified person, for three consecutive years; the artificial nesting hollow in use for three consecutive hears need not be the same artificial nesting hollow each year*". At least one more year of monitoring is therefore required to demonstrate that condition 4d has been met.

For future monitoring of the nesting hollows, consistent methodology should be employed to that used in the 2019-2020 and 2020-2021 breeding censusses, including continuing the use of pole cameras to inspect suspected breeding events where possible.

5 REFERENCES

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Phoenix. 2020. *Black cockatoo breeding activity census 2019-2020 for Muchea North*. Phoenix Environmental Sciences Pty Ltd, Osborne Park, WA. Unpublished report prepared for Main Roads WA.

Appendix 1 Results for all hollows in in the 2019-20 breeding season

HT ID	24/08/20	22/09/20	26/10/ 20	27/11/20	31/12/20	07/02/2021
HT04274	No flush	No flush	No flush	No flush	No flush	No flush
HT04579	No flush	No flush	No flush	Post chewed	No flush	No flush
HT04581	No flush	No flush	No flush	No flush	No flush	No flush
HT04588	No flush	No flush	No flush	No flush	No flush	No flush
HT05947	No flush	No flush	No flush	No flush	No flush	No flush
HT05954	No flush	No flush	No flush	No flush	No flush	No flush
HT06017	No flush	No flush	No flush	No flush	No flush	No flush
HT06025	No flush	No flush	No flush	No flush	No flush	No flush
HT06160	No flush	No flush	No flush	No flush	No flush	No flush
HT06201	No flush	No flush	No flush	No flush	No flush	No flush
HT06216	No flush	No flush	No flush	No flush	No flush	No flush
HT06330	No flush	No flush	No flush	No flush	No flush	No flush
HT06348	No flush	No flush	Carnaby flushed	No flush	No flush	No flush
HT06678	No flush	No flush	No flush	No flush	No flush	No flush
HT12761	No flush	No flush	No flush	No flush	No flush	No flush
HT12762	No flush	No flush	No flush	No flush	No flush	No flush
HT12763	No flush	No flush	No flush	No flush	No flush	No flush
HT12765	No flush	No flush	No flush	No flush	No flush	No flush
HT13484	No flush	No flush	No flush	No flush	No flush	No flush

HT ID	24/08/20	22/09/20	26/10/ 20	27/11/20	31/12/20	07/02/2021
HT13497	No flush	No flush	No flush	No flush	No flush	No flush
HT13506	No flush	No flush	No flush	No flush	No flush	No flush
HT13507	No flush	No flush	No flush	No flush	No flush	No flush
HT13508	No flush	No flush	No flush	No flush	No flush	No flush
HT13585	No flush	No flush	No flush	No flush	No flush	No flush
HT14633	No flush	No flush	No flush	No flush	No flush	No flush
HT14653	No flush	No flush	No flush	Chewed entrance, pair prospecting	No flush	No flush
HT14657	No flush	Female prospecting	No flush	Pair prospecting	No flush	No flush
HT14672	No flush	No flush	No flush	No flush	No flush	No flush
HT14748	No flush	No flush	No flush	No flush	No flush	No flush
HT14749	No flush	No flush	Carnaby flushed	No flush	No flush	No flush
HT14809	No flush	No flush	Carnaby flushed	Pin-feathered chick	Large-feathered chick	Chick fledged
HT14810	No flush	Carnaby flushed	No flush	No flush	No flush	No flush
HT14811	No flush	No flush	No flush	No flush	No flush	No flush
NB01	No flush	No flush	Carnaby flushed	Pin feathered chick in nest	Large-feathered chick in nest	Chick fledged
NB02	No flush	No flush	No flush	No flush	No flush	No flush
NB03	No flush	No flush	No flush	Small chick in nest	Chick in nest	Chick fledged
NB04	No flush	No flush	No flush	Flushed female CBC, likely to be prospecting	No flush, no eggs in hollow	No flush

HT ID	24/08/20	22/09/20	26/10/ 20	27/11/20	31/12/20	07/02/2021
NB05	No flush	No flush	No flush	No flush	No flush	No flush
NB06	No flush	Carnaby flushed	No flush	No flush	No flush	No flush
NB08	No flush	No flush	No flush	No flush	No flush	No flush
NB09	No flush	No flush	No flush	No flush	No flush	No flush
NB10	No flush	Carnaby flushed	Single egg in nest	No access	No flush	No flush
NB11	No flush	No flush	No flush	No flush	No flush	No flush
NB12	No flush	No flush	Carnaby flushed	2 broken eggs	No flush	No flush
NB13	No flush	No flush	No flush	No flush	No flush	No flush
NB14	No flush	No flush	No flush	No flush	No flush	No flush
NB32	No flush	No flush	Carnaby flushed	Check in nest	Chick in nest	Chick fledged
NB33	No flush	No flush	No flush	No flush	No flush	No flush
NB34	No flush	No flush	Prospecting female	Single egg in nest	Chick in nest	Chick fledged
NB41	No flush	Carnaby flushed	Chick in nest	No flush	No flush	No flush
NB42	No flush	No flush	No flush	No flush	Pair of Carnaby's prospecting	No flush
NB46	No flush	No flush	No flush	No flush	No flush	No flush
NB55	No flush	No flush	No flush	No flush	No flush	No flush
NB57	No flush	No flush	No flush	No flush	No flush	No flush
NB58	No flush	No flush	No flush	No flush	No flush	No flush
NB59	No flush	No flush	No flush	No flush	No flush	No flush
NB60	No flush	No flush	No flush	No flush	No flush	No flush

HT ID	24/08/20	22/09/20	26/10/ 20	27/11/20	31/12/20	07/02/2021
NB61	No flush	No flush	No flush	No flush	No flush	No flush
NB62	Carnaby flushed	Carnaby flushed	Downy chick in nest	Large-feathered chick in nest	No flush	No flush
NB63	Carnaby flushed	Carnaby flushed	Cracked egg in nest	No flush	No flush	No flush
NB64	Carnaby flushed	No flush	No flush	*Chick in natural hollow underneath NB64*	No flush	No flush
NB65	No flush	No flush	No flush	No flush	No flush	No flush
NB66	No flush	No flush	No flush	No flush	No flush	No flush
NB67	No flush	No flush	No flush	No flush	No flush	No flush
NB68	No flush	No flush	No flush	No flush	No flush	No flush
NB69	No flush	No flush	No flush	No flush	No flush	No flush
NB71	No flush	No flush	Carnaby flushed	Nestling in hollow	Feathered chick in hollow	Chick fledged
NB76	No flush	Heavily chewed post	No flush	No flush	No flush	No flush
NB77	No flush	No flush	Carnaby flushed	No flush	No flush	No flush
NB78	No flush	Carnaby flushed	No flush	Pin-feathered chick	Chick fledged	No flush
NB79	No flush	No flush	Post chewed	No flush	No flush	No flush
NB99	No flush	Pair propsecting	No flush	Two old eggs	No flush	No flush
NB100	No flush	No flush	No flush	No flush	No flush	No flush

Appendix 2 Results for all hollows in all breeding seasons

HT ID	Result 2017-18	Result 2018-19	Result 2019-20	Result 2020-2021
HT04059	No evidence of breeding	No evidence of breeding	Tree cleared. Further monitoring not required	n/a
HT04274	No evidence of breeding	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT04579	Confirmed breeding event - failed	No evidence of breeding	No evidence of breeding	Evidence of nesting activity
HT04581	Confirmed breeding event - failed	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT04588	Evidence of nesting activity	No evidence of breeding	Evidence of nesting activity	No evidence of breeding
HT05911	No access	Hollow not located	Tree cleared. Further monitoring not required	n/a
HT05923	No evidence of breeding	Tree cleared. Further monitoring not required	n/a	n/a
HT05938	No longer suitable hollow. Further monitoring not required	n/a	n/a	n/a
HT05947	No evidence of breeding	Not located	No evidence of breeding	No evidence of breeding
HT05954	No evidence of breeding	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT06017	No access	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT06020	No access	Tree cleared. Further monitoring not required	n/a	n/a
HT06025	No access	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT06046	No access	Tree cleared. Further monitoring not required	n/a	n/a
HT06148	No longer suitable. Further monitoring not required	n/a	n/a	n/a
HT06160	No evidence of breeding	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT06201	No evidence of breeding	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT06216	No evidence of breeding	No evidence of breeding	No evidence of breeding	No evidence of breeding

HT ID	Result 2017-18	Result 2018-19	Result 2019-20	Result 2020-2021
HT06261	No evidence of breeding	Tree cleared. Further monitoring not required.	n/a	No evidence of breeding
HT06278	Evidence of nesting activity	Tree cleared. Further monitoring not required.	n/a	No evidence of breeding
HT06330	Not sampled	No evidence of breeding. Added to breeding census in 2018-19	No evidence of breeding	No evidence of breeding
HT06348	Evidence of nesting activity	No evidence of breeding	Confirmed breeding event - failed	Evidence of nesting activity
HT06421	No access. Evidence of nesting activity (from a distance)	No access	n/a	n/a
HT06655	No longer suitable. Further monitoring not required	Tree cleared. Further monitoring not required	n/a	n/a
HT06678	Evidence of nesting activity (FRTBC)	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT08752	No evidence of breeding	Tree cleared. Further monitoring not required	n/a	n/a
HT08753	Evidence of nesting activity	No evidence of breeding	Tree cleared. Further monitoring not required	n/a
HT08754	No access	Confirmed breeding event	Tree cleared. Further monitoring not required	n/a
HT12761	Hollow not located	Hollow not located	No evidence of breeding	n/a
HT12762	Evidence of nesting activity	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT12763	Evidence of nesting activity	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT12765	Confirmed breeding event - successful	No evidence of breeding	Confirmed breeding event	No evidence of breeding
HT13484	No access	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT13497	No access	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT13503	No access	No longer suitable. Further monitoring not required	n/a	n/a
HT13505	No access	No longer suitable. Further monitoring not required	n/a	n/a

HT ID	Result 2017-18	Result 2018-19	Result 2019-20	Result 2020-2021
HT13506	No access	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT13507	No access	Evidence of nesting activity	No evidence of breeding	No evidence of breeding
HT13508	No access	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT13511	No access	No longer suitable. Further monitoring not required	n/a	n/a
HT13523	No access	No longer suitable. Further monitoring not required	n/a	n/a
HT13533	No evidence of breeding	No evidence of breeding	Tree cleared. Further monitoring not required	n/a
HT13534	Evidence of nesting activity	Tree cleared. Further monitoring not required	n/a	n/a
HT13535	Evidence of nesting activity	Tree cleared. Further monitoring not required	n/a	n/a
HT13585	Not sampled	No evidence of breeding. Added to breeding census in 2018-19, chewing observed at hollow	Evidence of nesting activity	No evidence of breeding
HT14633	Evidence of nesting activity	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT14653	Evidence of nesting activity	No evidence of breeding	No evidence of breeding	Evidence of nesting activity
HT14657	No evidence of breeding	No evidence of breeding	Evidence of nesting activity	Evidence of nesting activity
HT14670	Collapsed, no longer suitable. Further monitoring not required	n/a	n/a	n/a
HT14672	Evidence of nesting activity	Evidence of nesting activity	No evidence of breeding	No evidence of breeding
HT14748	Confirmed breeding event - successful	Evidence of nesting activity	No evidence of breeding	No evidence of breeding
HT14749	Confirmed breeding event - successful	Confirmed breeding event	No evidence of breeding	Evidence of nesting activity
HT14805	No access	No access	No longer suitable. Further monitoring not required	n/a
HT14806	No access	No access	No longer suitable. Further monitoring not required	n/a

HT ID	Result 2017-18	Result 2018-19	Result 2019-20	Result 2020-2021
HT14807	No access	No access	No longer suitable. Further monitoring not required	n/a
HT14808	No access	No access	No longer suitable. Further monitoring not required	n/a
HT14809	Evidence of nesting activity	No evidence of breeding	No evidence of breeding	Confirmed breeding event
HT14810	Confirmed breeding event - failed	No evidence of breeding	No evidence of breeding	Evidence of nesting activity
HT14811	No evidence of breeding	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB01	n/a	No evidence of breeding	Evidence of nesting activity	Confirmed breeding event
NB02	n/a	Confirmed breeding event	No evidence of breeding	No evidence of breeding
NB03	n/a	No evidence of breeding	No evidence of breeding	Confirmed breeding event
NB04	n/a	No evidence of breeding	Evidence of nesting activity	Evidence of nesting activity
NB05	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB06	n/a	No evidence of breeding	No evidence of breeding	Evidence of nesting activity
NB08	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB09	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB10	n/a	No evidence of breeding	Evidence of nesting activity	Confirmed breeding event
NB11	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB12	n/a	No evidence of breeding	No evidence of breeding	Confirmed breeding event
NB13	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB14	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB32	n/a	No evidence of breeding/no access	No evidence of breeding	Confirmed breeding event
NB33	n/a	No evidence of breeding/no access	No evidence of breeding	No evidence of breeding

HT ID	Result 2017-18	Result 2018-19	Result 2019-20	Result 2020-2021
NB34	n/a	n/a	Confirmed breeding event	Confirmed breeding event
NB41	n/a	n/a	Confirmed breeding event	Confirmed breeding event
NB42	n/a	n/a	No evidence of breeding	Evidence of nesting activity
NB46	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB55	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB57	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB58	n/a	No evidence of breeding	Evidence of nesting activity	No evidence of breeding
NB59	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB60	n/a	No evidence of breeding	Evidence of nesting activity	No evidence of breeding
NB61	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB62	n/a	No evidence of breeding	No evidence of breeding	Confirmed breeding event
NB63	n/a	No evidence of breeding	Confirmed breeding event	Confirmed breeding event
NB64	n/a	Evidence of nesting activity	Evidence of nesting activity	Evidence of nesting activity
NB65	n/a	No evidence of breeding	Evidence of nesting activity	No evidence of breeding
NB66	n/a	Evidence of nesting activity	No evidence of breeding	No evidence of breeding
NB67	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB68	n/a	No evidence of breeding	Evidence of nesting activity	No evidence of breeding
NB69	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB71	n/a	No evidence of breeding	No evidence of breeding	Confirmed breeding event
NB76	n/a	No evidence of breeding	Evidence of nesting activity	Evidence of nesting activity

HT ID	Result 2017-18	Result 2018-19	Result 2019-20	Result 2020-2021
NB77	n/a	No evidence of breeding	Evidence of nesting activity	Evidence of nesting activity
NB78	n/a	No evidence of breeding	No evidence of breeding	Confirmed breeding event
NB79	n/a	No evidence of breeding	No evidence of breeding	Evidence of nesting activity
NB99	n/a	No evidence of breeding	No evidence of breeding	Confirmed breeding event
NB100	n/a	n/a	Evidence of nesting activity	No evidence of breeding