

Appendix D Black-Cockatoo Habitat Survey 2022 – Assessment of Values for Black-Cockatoos for Beach Energy in the Beharra Springs Project Area

**Beach Energy: Assessment of Black-Cockatoo Values at
(i) Crusoe Well and access easement, (ii) flowline easements
for Beharra Springs Deep 2, Redback Deep 1 and Tarantula
Deep, and (iii) a proposed Operations Camp location**



Sedgeland along the proposed Crusoe Well access track easement. Photo: Wes Bancroft.

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Executive Summary

Beach Energy is proposing to extend its operations at its Beharra Springs Gas Facility (BSGF) at Mount Adams, Western Australia. This includes the development of:

- (i) the Crusoe well site and its access easement;
- (ii) flowlines for the Beharra Springs Deep 2, Redback Deep 1 and Tarantula Deep well sites; and
- (iii) an upgraded Operations Camp adjacent to the current gas facility.

These may require the clearing of vegetation that is suited to use by threatened black-cockatoos (for breeding, foraging and/or roosting). One taxon of threatened black-cockatoo, Carnaby's Black-Cockatoo (*Zanda latirostris*), is likely to occur in the survey areas. Bamford Consulting Ecologists (BCE) was commissioned to conduct a targeted desktop assessment and site inspection to better understand the use, and potential use, of the survey areas by black-cockatoos.

It is intended that this report is read in close conjunction with a similar report prepared recently for other potential development areas at the same location: "*Assessment of Values for Black-Cockatoos for Beach Energy in the Beharra Springs Project Area*" (Bancroft and Bamford 2023).

Vegetation and substrate associations (VSAs)

Ten major vegetation and substrate associations (VSAs) have now been identified in relation to fauna in the survey areas:

- VSA01: Banksia shrubland
- VSA02: Banksia woodland
- VSA03: Mixed shrubland
- VSA04: Sedgeland
- VSA05: Calothamnus shrubland
- VSA06: Coastal Blackbutt/Woody Pear woodland
- VSA07: Dampland
- VSA08: Cleared or disturbed
- VSA09: Tammar shrubland
- VSA10: Sedgeland with mixed shrubland

Black-cockatoo habitat analysis

No species of black-cockatoo was recorded within the survey areas during the site inspection, and there was no indirect (foraging) evidence observed. Despite this, BCE has regular records of Carnaby's Black-Cockatoo in the general area, suggesting that it is a regular visitor over this region, but may visit small locations, such as the Beach Energy survey areas, irregularly.

All the survey areas are unsuited to breeding by black-cockatoos; there were no hollow-bearing trees present.

Foraging habitat for the Carnaby's Black-Cockatoo was present throughout the survey areas. A detailed BCE foraging habitat assessment was conducted (including mapping), and these data are

presented within the report and have also been provided in electronic (spatial file) format. The quality of potential foraging habitat varied considerably within the boundaries of most areas but a relatively small proportion of the total area surveyed was considered to have 'high' value vegetation scores.

Despite extensive searching, there was no evidence of foraging by Carnaby's Black-Cockatoo recorded within the survey areas.

The survey areas are therefore, generally, of low to moderate value for potential foraging by the Carnaby's Black-Cockatoo.

The DCCEEW foraging quality scoring tool was also used to assess the survey areas and these data are presented within.

No black-cockatoo night-roosts are known from within the survey areas and there was no suitable roosting habitat. Night roosts are, however, known from the region (the nearest of these is within c. 9 km of the proposed Camp boundary).

No potential water sources for black-cockatoos were observed within the survey areas.

Conclusion

Carnaby's Black-Cockatoo is the only black-cockatoo of conservation significance present in the general region where it is a regular visitor. Several roost sites are known and breeding is likely to occur within the region. For the survey areas, however, the species is probably only an irregular visitor and there is no breeding or roosting habitat. The survey areas provide foraging habitat of low to moderate value. These are very small areas within a region that provides extensive foraging habitat of similar value.

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1 Introduction

Beach Energy is looking to extend its operations at its Beharra Springs Gas Facility at Mount Adams, c. 30 km south-east of Dongara and c. 40 km north of Eneabba, Western Australia. This includes the development of:

- (iv) the Crusoe well site and its access easement;
- (v) flowlines for the Beharra Springs Deep 2 (BSD2), Redback Deep 1 (RD1) and Tarantula Deep (TD) well sites; and
- (vi) an upgraded Operations Camp adjacent to the current gas facility.

These may require the clearing of vegetation that is suited to use by threatened black-cockatoos (for breeding, foraging and/or roosting). It is possible that one taxon of threatened black-cockatoo may make use of the project sites (for breeding, foraging and/or roosting):

- *Zanda* (previously *Calyptorhynchus*) *latirostris* (Carnaby's Black-Cockatoo) – listed as Endangered under the Federal *Environment Protection and Biodiversity Conservation Act 1999* and also as Endangered under the Western Australian *Biodiversity Conservation Act 2016* (see Appendix 1 for more details).

Beach Energy requires a black-cockatoo habitat assessment of the areas listed above to assist in managing and/or reducing the impacts to black-cockatoos. It should be noted that the Beharra Springs Deep 2, Redback Deep 1 and Tarantula Deep well sites were recently assessed (Bancroft and Bamford 2023) and that it is only the proposed flowline easements for these sites that are the focus of this current assessment.

Bamford Consulting Ecologists (BCE) was commissioned to conduct a targeted desktop assessment and site inspection to better understand the use, and potential use, of the survey areas by black-cockatoos. This report presents the findings of that survey.

1.1 Background and description of survey area

For the broader survey area, Bancroft and Bamford (2023) provided background information on black-cockatoo ecology and also a description of the survey area and associated environmental information, including:

- Interim Biogeographic Regionalisation of Australia (IBRA) and landscape characteristics
- Land systems and vegetation complexes
- Recognised sensitive sites

This information is still relevant to the present survey areas. See Bancroft and Bamford (2023) for more details, if required.



Figure 1. Location of the survey areas.

2 Methods

2.1 Overview

2.1.1 Spatial terminology

A range of terms are used through the report to refer to the spatial environment around the proposed project, and these are defined below:

- Study area – the outermost boundary of the desktop assessment that is almost always a specified buffer distance around the *survey area*. The study area thus encompasses the *survey area* but includes the area from which databases are sourced.
- Survey area – the *survey area* is the area to which the results of the desktop analysis are directed and/or the area within which field investigations are conducted. Note that while the term ‘*survey area*’ is used throughout the guidance provided by EPA (2020), it does not appear to be explicitly defined and, therefore, the above definition has been developed with interpretation of both the guidance and BCE report structure.
- Project area – this may be equivalent to the *survey area* but is strictly the land over which the proponent has tenure or some control and within which on-site impacts may occur. For this project, there are six project areas.
- Development footprint – the expected extent of land clearing and/or development.

Where available, these spatial boundaries are mapped in Figure 1.

2.2 Identification of vegetation and substrate associations (VSAs)

Vegetation and substrate associations (VSAs) combine vegetation types, the soils or other substrate with which they are associated, and the landform. In the context of fauna assessment, VSAs are the environments that provide habitats for fauna.

BCE deliberately makes the distinction between ‘habitat’ (a species-specific term that may encompass the whole or part of one or more VSAs and is the physical subset of an ecosystem that a given species, or species group, utilises) and ‘VSA’ (a general, discrete and mutually exclusive spatial division of a target area, based on soil, vegetation and topography). It is recognised, however, that, within the broader EIA literature/guidance, the former term is used more or less synonymously to indicate the latter (e.g. ‘habitat assessment’ used by EPA 2020). Further discussion is provided in Appendix 2.

For the current assessment, VSAs were identified based on the consultant’s previous experience in the area and on observations made during the field investigations.

2.3 Desktop methods

2.3.1 Nomenclature and taxonomy

As per the recommendations of the EPA (2020), the nomenclature and taxonomic order presented in this report are generally based on the Western Australian Museum’s (WAM) Checklist of the Fauna of Western Australia 2022. The authorities used for each vertebrate group were: fish (Morgan *et al.* 2014), frogs (Doughty 2022a), reptiles (Doughty 2022b), birds (BirdLife Australia 2022; Gill *et al.* 2023), and mammals (Travouillon 2022). In some cases, more widely-recognised names and naming

conventions have been followed, particularly for birds where there are national and international naming conventions in place (e.g. the BirdLife Australia working list of names for Australian Birds, and the International Ornithological Congress' 'World Bird List'). Similarly, the group name 'black-cockatoo' is consistently used for all three taxa in the South-West. English common names of species, where available, are used throughout the text; Latin names are presented with corresponding English names in tables in the appendices. The use of subspecies is limited to situations where there is an important (and relevant) geographically distinct population, or where the taxonomic distinction has direct relevance to the conservation status or listing of a taxon.

2.4 Field investigations

2.4.1 Overview

Field investigations were focussed on black-cockatoo habitat analysis (comprising breeding, foraging and roosting assessments), with the major focus on identification of foraging habitat suited to Carnaby's Black-Cockatoo. Methods are detailed below.

2.4.2 Dates

The survey areas were visited on the 15th and 16th of March 2023, and between the 24th and 26th of March 2023.

2.4.3 Black-cockatoo habitat analysis

2.4.3.1 Guidelines

The Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) provides guidelines for the referral of actions that may result in impact to black-cockatoos (for assessment under the EPBC Act). The survey and analysis reported here have been conducted with strong reference to both the existing guidelines (DAWE 2022) as well as the previous guidelines (DEE 2017). In addition, survey methodology followed the recommendations listed on the DCCEEW's Species Profile and Threats Database (DCCEEW 2023a, 2023b, 2023c). Ecological values for black-cockatoos within the site were based on the definitions of breeding, foraging and roosting habitat as per the EPBC Act referral guidelines for black-cockatoos (DAWE 2022).

The DBCA has also indicated that the methodology developed and applied previously by BCE (e.g. Bancroft and Bamford 2021), and as described below, is an acceptable approach to score nesting value and foraging habitat.

2.4.3.2 *Breeding*

The aim of the breeding surveys was to sample the survey area for potential hollow-bearing trees (suitable for black-cockatoo nesting). All survey areas (see Figure 1) were examined for the presence of these trees. The following information was recorded for every suitable tree¹ with a diameter at breast height (DBH) equal to or greater than 500 mm (or equal to or greater than 300 mm for *Eucalyptus accedens* and *E. wandoo*):

- tree location;
- tree species;
- life status;
- DBH; and
- nest-tree rank: trees were assessed (from the ground) for the potential presence/quality of nest-hollows and allocated a nesting rank (developed by BCE) as described in Table 1.

¹ the revised EPBC Act referral guidelines (DAWE 2022) note that “any species of tree may develop suitable hollows for breeding” however there are some species that are much more likely to provide breeding sites. These species are listed on the DCCEEW SPRAT database and were the focus of the field investigations here.

Table 1. Ranking system for the assessment of potential nest-trees for black-cockatoos (revised 08/01/2021).

As per DCCEEW (2023a, 2023b, 2023c) guidance, a potential nest-tree is any tree with a diameter at breast height >500 mm (or >300 mm for *Eucalyptus accedens*, *E. salmonophloia* and *E. wandoo*). Note that black-cockatoos favour vertical hollows for the nest chamber, but the hollow entrance may be vertical (a chimney hollow), have a side entrance or have a horizontal spout entrance.

Rank	Description of tree and hollows/activity
1	Activity at hollow observed; adult (or immature) bird seen entering or emerging from hollow. Can also be used for a known nest tree active in the previous 12 months (although this should be noted in the description). Note that activity at a hollow does not absolutely mean that breeding is occurring unless a young bird in hollow is observed.
2	Hollow of suitable size visible with chew marks around entrance. Record if chew-marks are recent or old.
3	Potentially suitable hollow visible but no chew marks present at entrance; or potentially suitable hollow suspected to be present - as suggested by structure of tree, such as large, vertical trunk broken off at a height of >8 m; but note that hollow height is contextual. Carnaby's Black-Cockatoo will nest in hollows <5 m so in a Wheatbelt breeding site a lower criterion may be more appropriate.
4	Tree with large hollows or broken branches that might contain large hollows, but hollows or potential hollows (nest chamber) are not vertical or near-vertical; thus a tree with or likely to have hollows of sufficient size but not to have hollows of the angle preferred by Black-Cockatoos. Trees with low but otherwise suitable hollows can also be assigned a rank or 4, depending on the species of black-cockatoo likely to be present.
5	Tree lacking large hollows or broken branches that might have large hollows; a tree with more or less intact branches and a spreading crown.

2.4.3.3 Foraging

The foraging value of the study area was assessed by calculating a foraging score for areas of similar vegetation type/condition (see Appendix 3). The foraging score provides a numerical value that reflects the significance of vegetation as foraging habitat for black-cockatoos, and this numerical value is designed to provide the sort of information needed by DCCEEW, Department of Water and Environmental Regulation (DWER) and the Environmental Protection Authority (EPA) to assess impact significance and offset requirements. The foraging value of the vegetation depends upon the type, density and condition of trees and shrubs in an area, and can be influenced by the context such as the availability of foraging habitat nearby. The BCE scoring system for value of foraging habitat has three components as detailed in Appendix 3. These three components are drawn from the DCCEEW offset calculator but with the scoring approach developed by BCE:

- A score out of six for the vegetation composition, condition and structure.
- A score out of three for the context of the site.
- A score out of one for species density.

Foraging value can thus be assigned a score out of six, based upon site vegetation characteristics, or a score out of 10 if context and species density are also considered. A higher score represents better foraging value. A score out of 10 is presented for the purposes of aiding offset calculations. The approach to assigning scores for vegetation, context and species density are outlined in Appendix 3. Foraging value scores are calculated differently for the three black-cockatoo species (Appendix 3) depending upon the vegetation present; thus a separate score is given for each VSA for each species.

Black-cockatoo foraging signs were also recorded in conjunction with the breeding tree surveys (see Section 0) and general site inspections. When observed, the location, tree species and approximate age of the foraging evidence were recorded. Black-cockatoo foraging evidence may persist for some months or years after the foraging event. There is currently no published evidence documenting the deterioration process of forage. Factors that help to establish the time since foraging include: the colour of nuts/foilage, the degree of weathering or decay of debris, the presence of small fragments of nut debris, the position/compression of the foraging debris relative to surrounding vegetation and leaf litter, and the strength of the eucalypt smell emitted. Despite the absence of empirical data, four categories of foraging activity were recognised, based on the time since foraging:

- (i) Active – where birds were observed in the act of foraging;
- (ii) Recent – foraging signs (e.g. chewed nuts or vegetation) were ‘fresh’ (i.e. foraging was likely to have occurred within days to weeks). Recent foraging signs were typically green and/or with very little sign of weathering. Approximately less than four weeks old;
- (iii) Intermediate – foraging was likely to have occurred within weeks to months previously. Approximately one to six months old; and
- (iv) Old – foraging was likely to have occurred months to years previously. Approximately more than six months old.

As an indication, Appendix 5 shows examples of Forest Red-tailed Black-Cockatoo foraging signs across the range of these categories (note that it is uncertain as to the exact time frame for each stage).

2.4.3.4 Night roosting

As the breeding and foraging surveys were conducted, areas likely to be used as night roosting sites (e.g. sites adjacent to watercourses with large trees) or areas that had cockatoo activity in the late-afternoon were noted.

2.4.4 Opportunistic observations

At all times, observations of fauna were noted when they contributed to the accumulation of information on the fauna of the site. These included such casual observations as reptiles, birds or mammals seen while travelling through and near the site.

2.5 Personnel

Personnel involved in the field investigations and report preparation are listed in

Table 2. Note that both personnel have had extensive previous field experience in the Beharra area over the period 2005 to 2022.

Table 2. Personnel involved in the field investigations and report preparation.

Personnel	Consulting Experience	Field Investigations	Report Preparation
Dr Mike Bamford <i>BSc (Biol.), Hons (Biol.), PhD (Biol.)</i>	43 years		+
Dr Wes Bancroft <i>BSc (Zool./Microbiol.), Hons (Zool.), PhD (Zool.)</i>	26 years	+	+
Peter Smith <i>Assoc. Dip. Ag. (Farm Management)</i>	40 years	+	
Sarah Smith <i>B.Sc. (Biol.)</i>	40 years	+	

2.6 Mapping and spatial data

Low resolution maps have been provided within the body this report. Higher resolution maps and GIS files have already been supplied. While the recommendation of the EPA (2020) was that maps use the GDA94 datum (and are projected into the appropriate Map Grid of Australia (MGA94) zone), this has been superseded by the GDA2020 (projected to MGA2020) datum used here (and recommended by DWER 2023).

3 Results and Discussion

3.1 Vegetation and substrate associations (VSAs) ['Habitat assessment']

Bancroft and Bamford (2023) identified eight major vegetation and substrate associations (VSAs) in relation to fauna within the areas surveyed in October 2022. These have been refined in light of the March 2023 field investigations and an additional two VSAs have been added. A summary of all VSAs, to date, is presented in Table 3. The extent of the VSAs in each of the survey areas is mapped in Figure 2 to Figure 13.

Table 3. Vegetation and substrate associations (VSAs) within the survey areas.

VSA	Variant Description
VSA01: Banksia shrubland	<i>Banksia attenuata</i> shrubland over moderately diverse shrubland on white and/or pale grey sands.
	<i>Banksia attenuata</i> shrubland with occasional <i>Eucalyptus tottiana</i> over moderately diverse shrubland on pale yellow sands.
	<i>Banksia attenuata</i> shrubland with occasional <i>Eucalyptus tottiana</i> over moderately diverse shrubland on white and/or pale grey sands.
	<i>Banksia attenuata</i> shrubland with occasional <i>Eucalyptus tottiana</i> over very diverse heath on white and/or pale grey sands.
	<i>Banksia sessilis</i> shrubland over very diverse heath on white and/or pale grey sands.
	<i>Banksia telmatiaea</i> (?) shrubland over moderately diverse heathland on pale yellow sands.
	Dense shrubland of <i>Banksia sessilis</i> (with some <i>B. telmatiaea</i>).
	Mixed tall Banksia shrubland, including <i>B. sessilis</i> on yellow sands.
	Shrubland including sparse Banksias (including <i>B. attenuata</i> , <i>B. sessilis</i> , <i>B. telmatiaea</i>) with very stunted <i>Eucalyptus tottiana</i> on white sands.
	Shrubland including sparse Banksias (including very low shrub spp.) with some sedges.
Shrubland of <i>Banksia attenuata</i> and 'flat-topped cone' <i>Banksia</i> sp. with diverse other shrubs on pale yellow sands, with occasional low <i>Eucalyptus tottiana</i> overstorey.	
Shrubland of <i>Banksia attenuata</i> and 'flat-topped cone' <i>Banksia</i> sp. with diverse other shrubs on pale yellow sands.	

VSA	Variant Description
	Shrubland of <i>Banksia attenuata</i> with diverse other shrubs on pale yellow sands.
	Shrubland of <i>Banksia attenuata</i> with diverse other shrubs on pale sands.
	Shrubland of <i>Banksia attenuata</i> with diverse other shrubs on pale sands. Occasional low <i>Eucalyptus todtiana</i> trees.
	Shrubland of mixed Banksias (including <i>B. candolleana</i> , <i>B. attenuata</i>) with occasional <i>B. prionotes</i> trees on yellow sands.
	Shrubland of mixed Banksias (including <i>B. sessilis</i> , <i>B. telmatiaea</i>) and <i>Hakeas</i> , with occasional <i>B. prionotes</i> and <i>Xylomelum</i> sp. trees, on pale orange/yellow sands.
	Shrubland of mixed Banksias (including <i>B. sessilis</i> , <i>B. telmatiaea</i>) and other shrub species with occasional <i>Eucalyptus todtiana</i> and <i>Xylomelum</i> sp. trees, on pale cream/grey sands.
	<i>Banksia menziesii</i> woodland with <i>B. attenuata</i> shrubland (and occasional low trees) over moderately diverse shrubland on white and/or pale grey sands.
	Low woodland of <i>Banksia attenuata</i> and <i>B. menziesii</i> trees, over reasonably diverse mixed shrubs on pale sands.
	Open to very open <i>Banksia menziesii</i> woodland with <i>B. attenuata</i> shrubland (and occasional low trees) over moderately diverse shrubland on white and/or pale grey sands.
	Open woodland of <i>Banksia prionotes</i> , <i>Nuytsia floribunda</i> and <i>Xylomelum</i> sp. trees (and occasional <i>Eucalyptus todtiana</i>) over Banksia shrubs (including <i>B. attenuata</i> , <i>B. candolleana</i>) and other mixed shrubland on yellow sands.
VSA02: Banksia woodland	Scattered <i>B. menziesii</i> , shrubby <i>B. attenuata</i> , <i>B. sp</i> aff <i>sphaerocarpa</i> , other Banksia spp. and mixed low shrubs on white sand.
	Very open low woodland of <i>Banksia menziesii</i> trees with <i>B. attenuata</i> shrubs and reasonably diverse mixed shrubs on pale sands.
	Very open low woodland of <i>Banksia menziesii</i> with <i>B. attenuata</i> shrubs and reasonably diverse other shrubs on pale sands.
	Very open low woodland of <i>Banksia prionotes</i> over shrubland of <i>Banksia attenuata</i> and 'flat-topped cone' Banksia sp. with diverse other shrubs on yellow sands.

VSA	Variant Description
VSA03: Mixed shrubland	Diverse mixed shrubland dominated by <i>Conospermum</i> spp. with occasional stunted <i>Eucalyptus tottiana</i> on pale yellow sands.
	Diverse mixed shrubland dominated by <i>Conospermum</i> spp. with some <i>Banksia</i> spp. on pale yellow sands.
	Fine-leaved <i>Acacia</i> sp. and <i>Grevillea</i> sp. shrubland, with some shrubby <i>Banksia</i> spp. and other mixed shrubs.
	Mixed shrubland on pale orange sands.
	Mixed shrubland on white sands.
	Mixed shrubland, including sparse <i>Banksia attenuata</i> and <i>B. candolleana</i> shrubs on pale sands.
	Mixed shrubland, including sparse <i>Banksia attenuata</i> and <i>B. candolleana</i> shrubs on pale sands. Some sedges.
VSA04: Sedgeland	Sedgeland with <i>Calothamnus</i> and other sparse shrubs on white sands.
VSA05: Calothamnus shrubland	Shrubland or thicket of <i>Calothamnus</i> sp. with overstorey of <i>Xylomelum</i> sp. over lower diversity mixed shrubland on white sands.
VSA06: Coastal Blackbutt/Woody Pear woodland	Very open <i>Eucalyptus tottiana</i> woodland with mixed shrubs and sedgeland elements on pale yellow sands.
	<i>Xylomelum</i> sp. and <i>Eucalyptus tottiana</i> woodland over lower diversity shrubland on white sands.
VSA07: Dampland	Seasonal dampland area with mixed shrubland on grey clays and/or loams.
VSA08: Cleared or disturbed	Cleared, disturbed or developed.
VSA09: Tammar shrubland	Mixed shrubs dominated by <i>Allocasuarina campestris</i> (Tammar), Acacia and other mixed low shrubs on a pale grey loam with patches of orange loam (indicating laterite a shallow depth).
VSA10: Sedgeland with mixed shrubland	Sedgeland (<i>Mesomelaena</i>) with diverse mixed shrubland (including <i>Melaleuca</i> , <i>Isopogon</i> and <i>Beaufortia</i> species) on pale sands with surface gravel.
	Sedgeland (<i>Mesomelaena</i>) with diverse mixed shrubland (including <i>Melaleuca</i> , <i>Isopogon</i> and <i>Beaufortia</i> species) on pale yellow/grey sands or loams.

VSA	Variant Description
	Sedgeland (<i>Mesomelaena</i>) with diverse mixed shrubland (including <i>Melaleuca</i> , <i>Isopogon</i> and <i>Beaufortia</i> species) on pale yellow/grey sands or loams. Occasional Banksia shrubs.

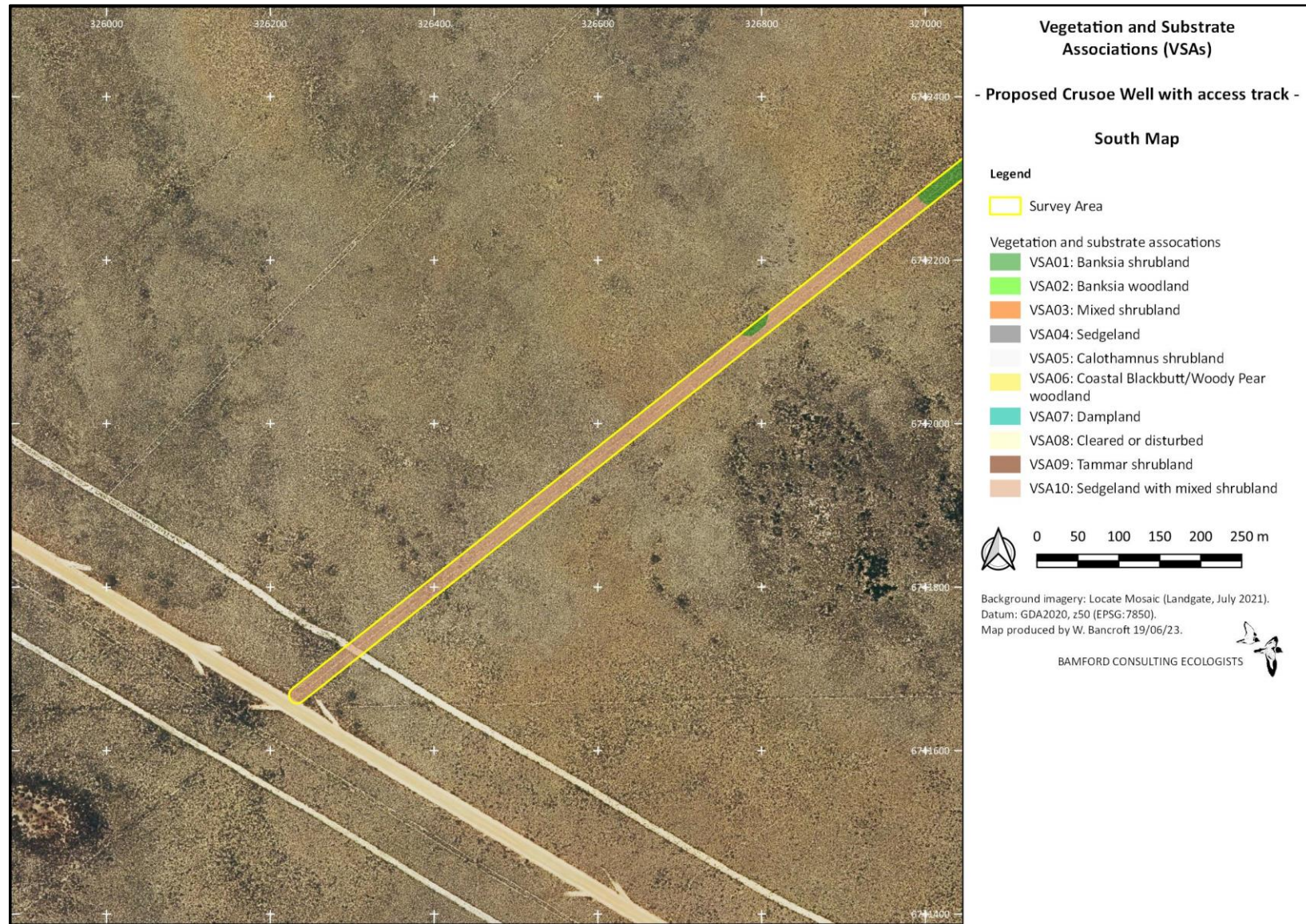


Figure 2. Vegetation and substrate associations at Crusoe Well: south.

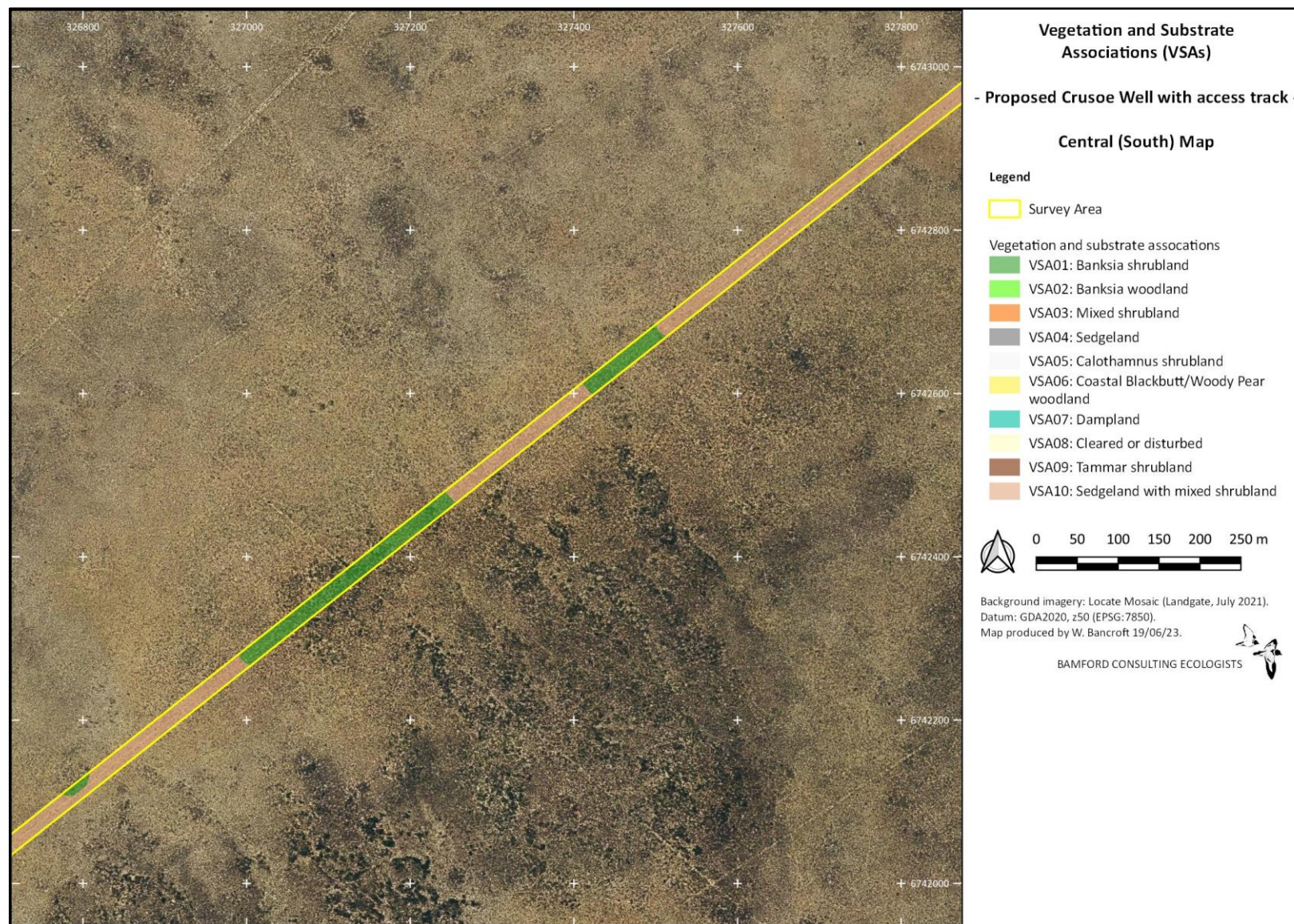


Figure 3. Vegetation and substrate associations at Crusoe Well: central (south).

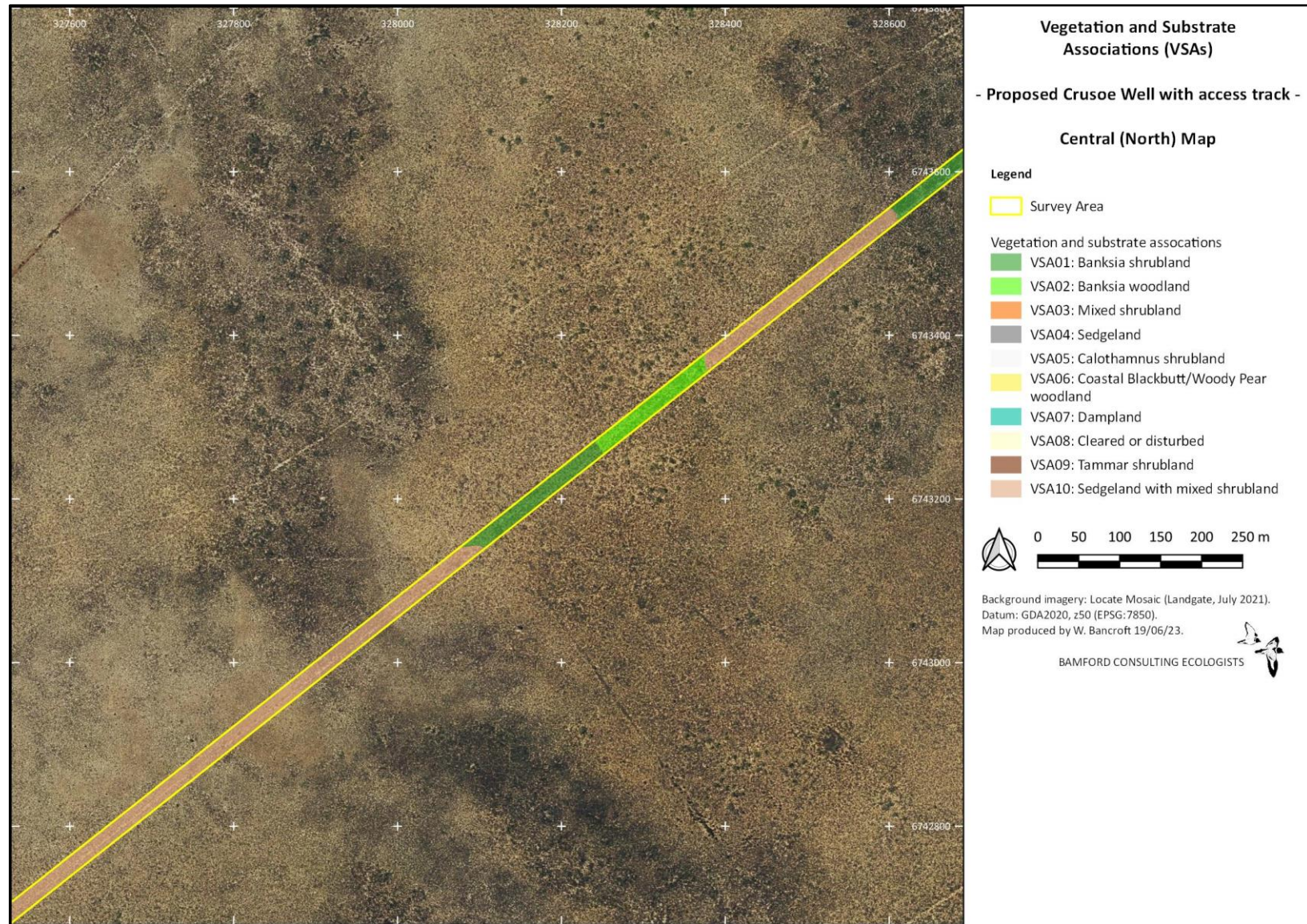


Figure 4. Vegetation and substrate associations at Crusoe Well: central (north).

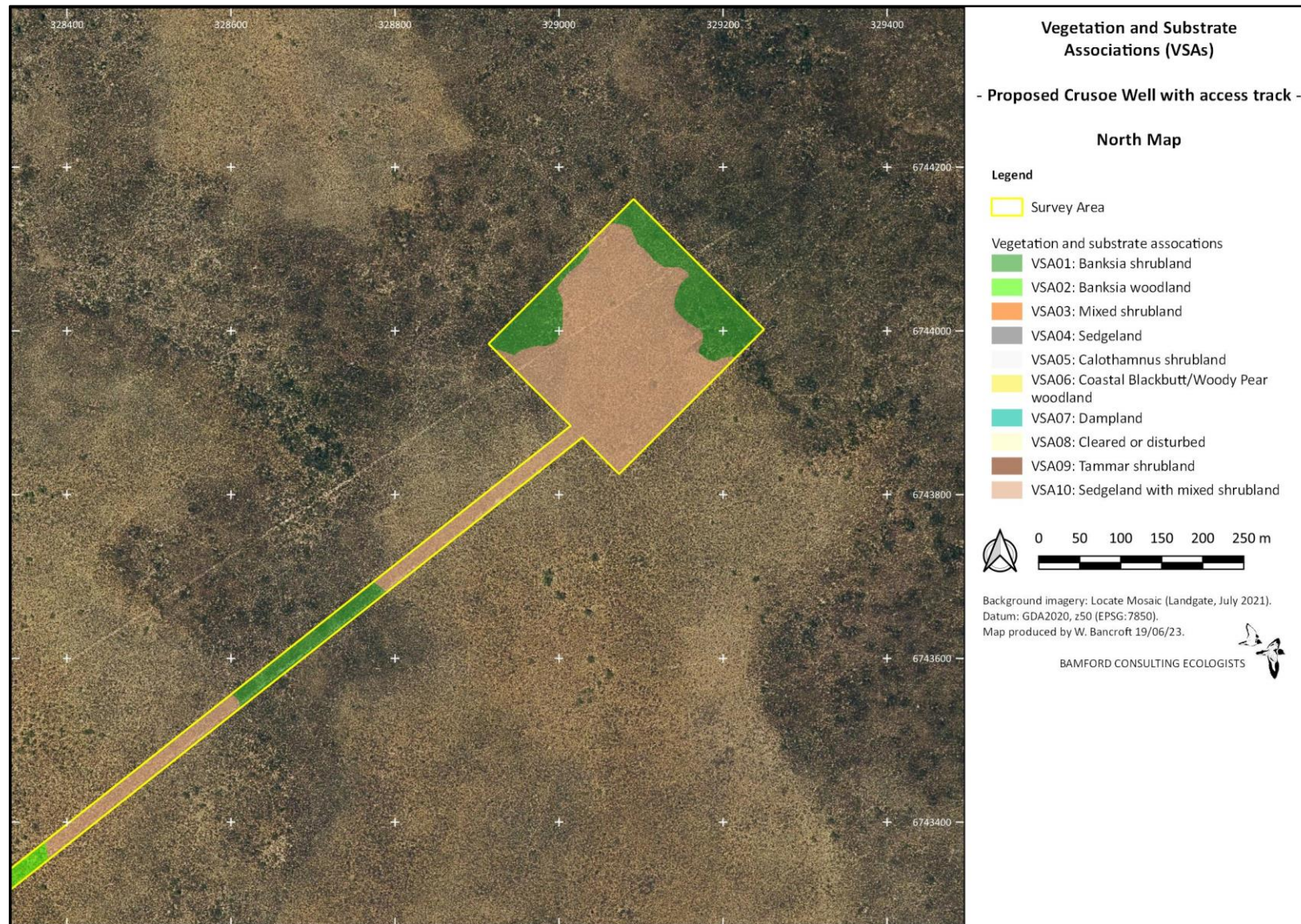


Figure 5. Vegetation and substrate associations at Crusoe Well: north.

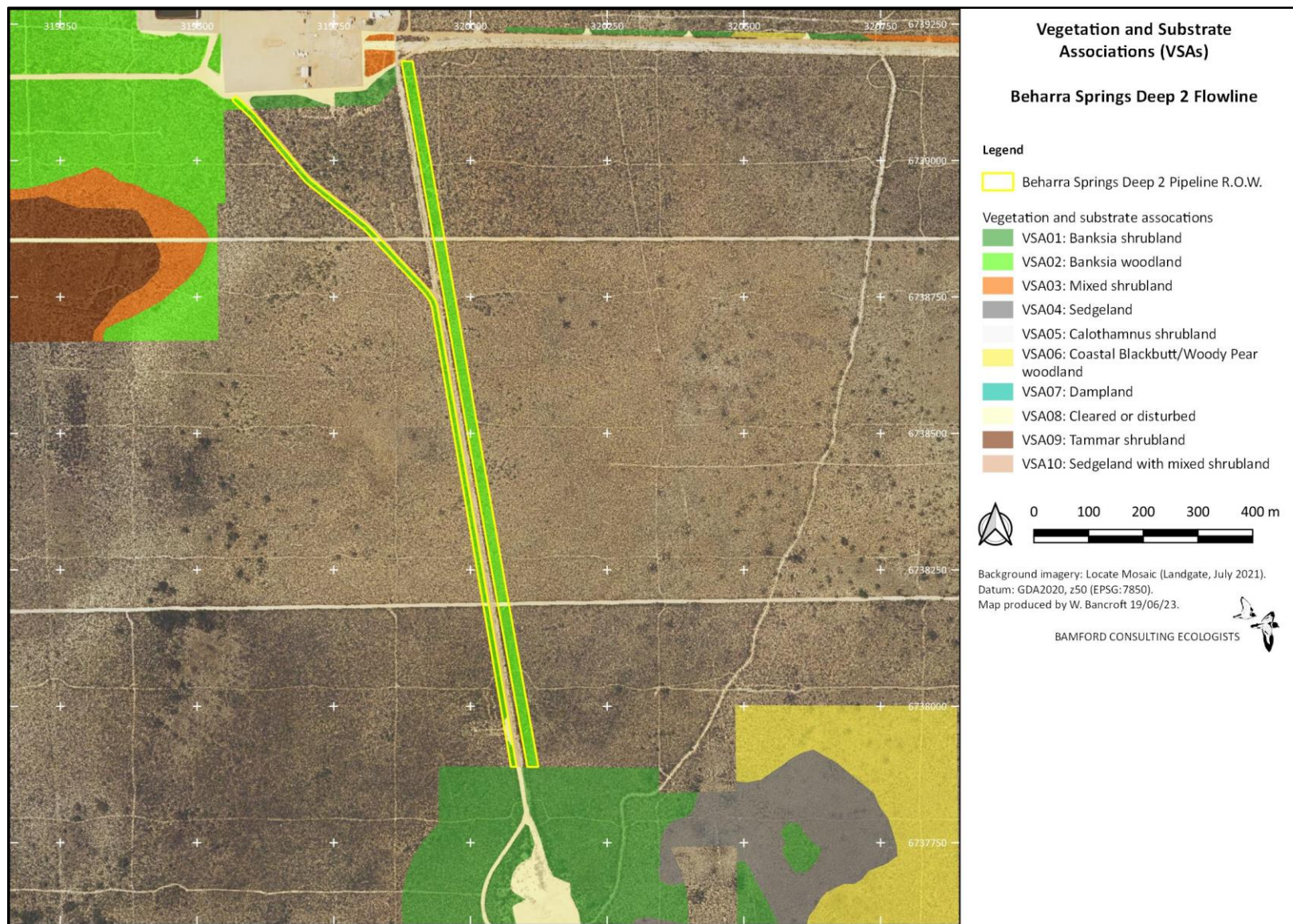


Figure 6. Vegetation and substrate associations at Beharra Springs Deep 2 flowline.

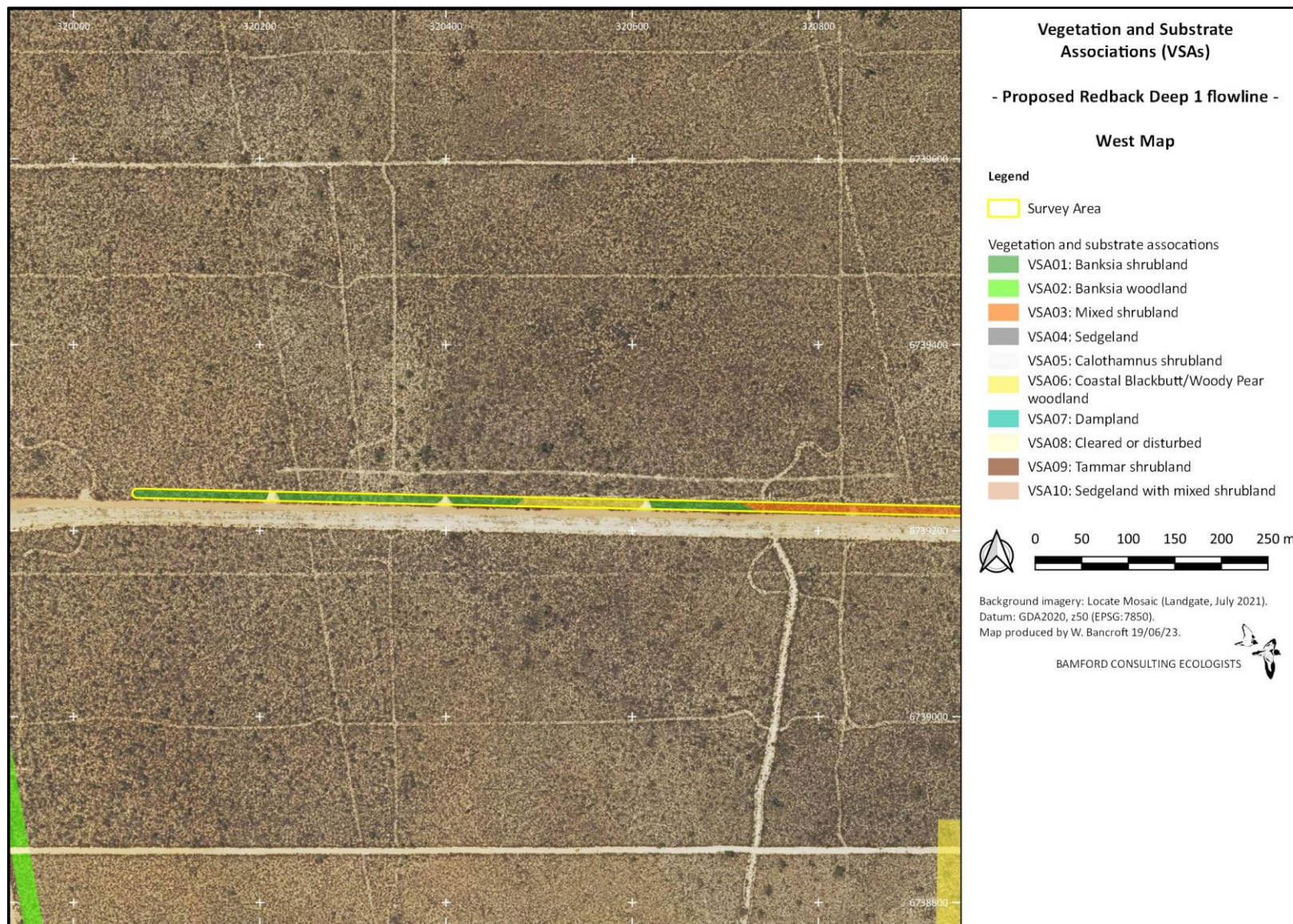


Figure 7. Vegetation and substrate associations at Redback Deep 1 flowline: west.

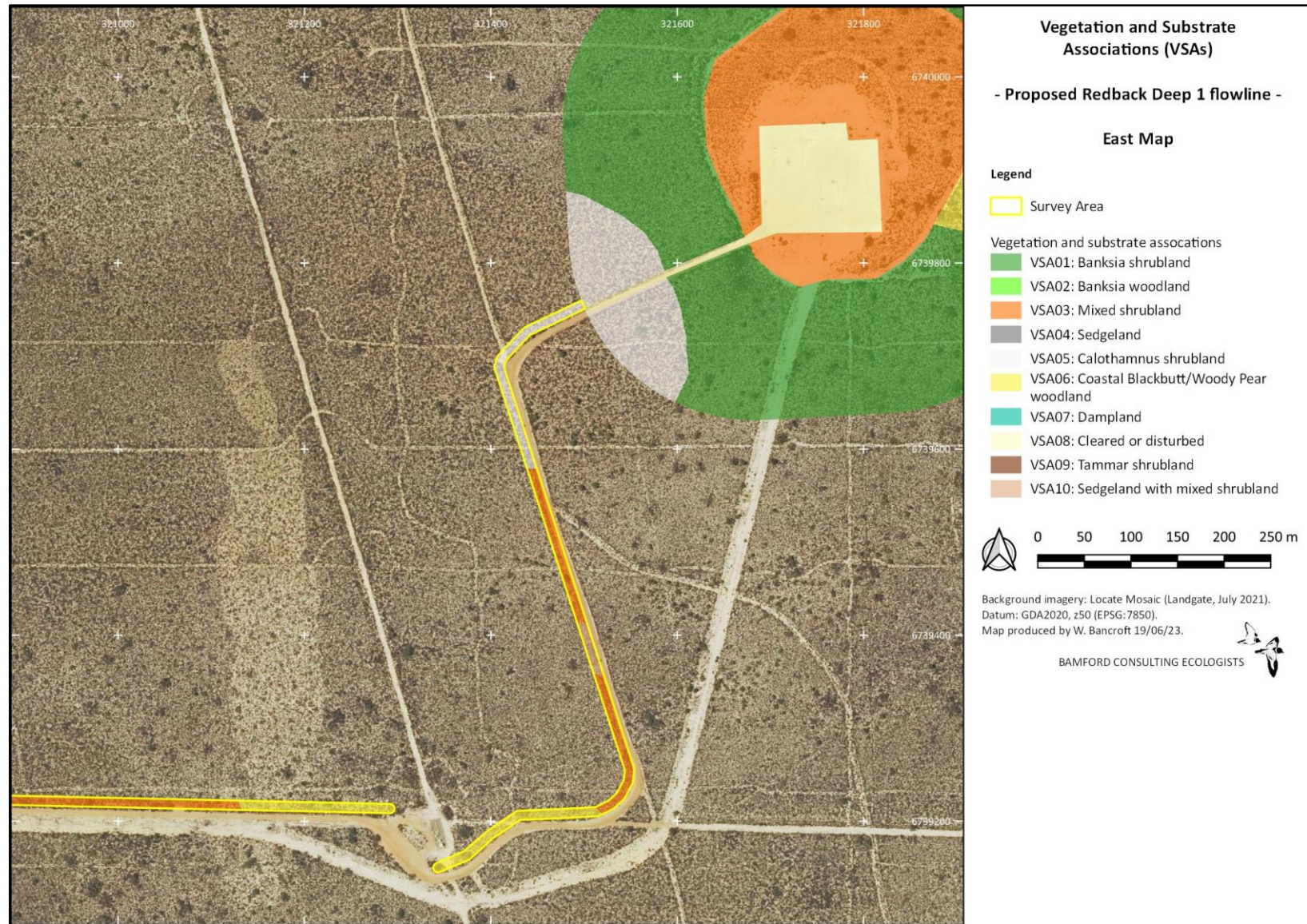


Figure 8. Vegetation and substrate associations at Redback Deep 1 flowline: east.

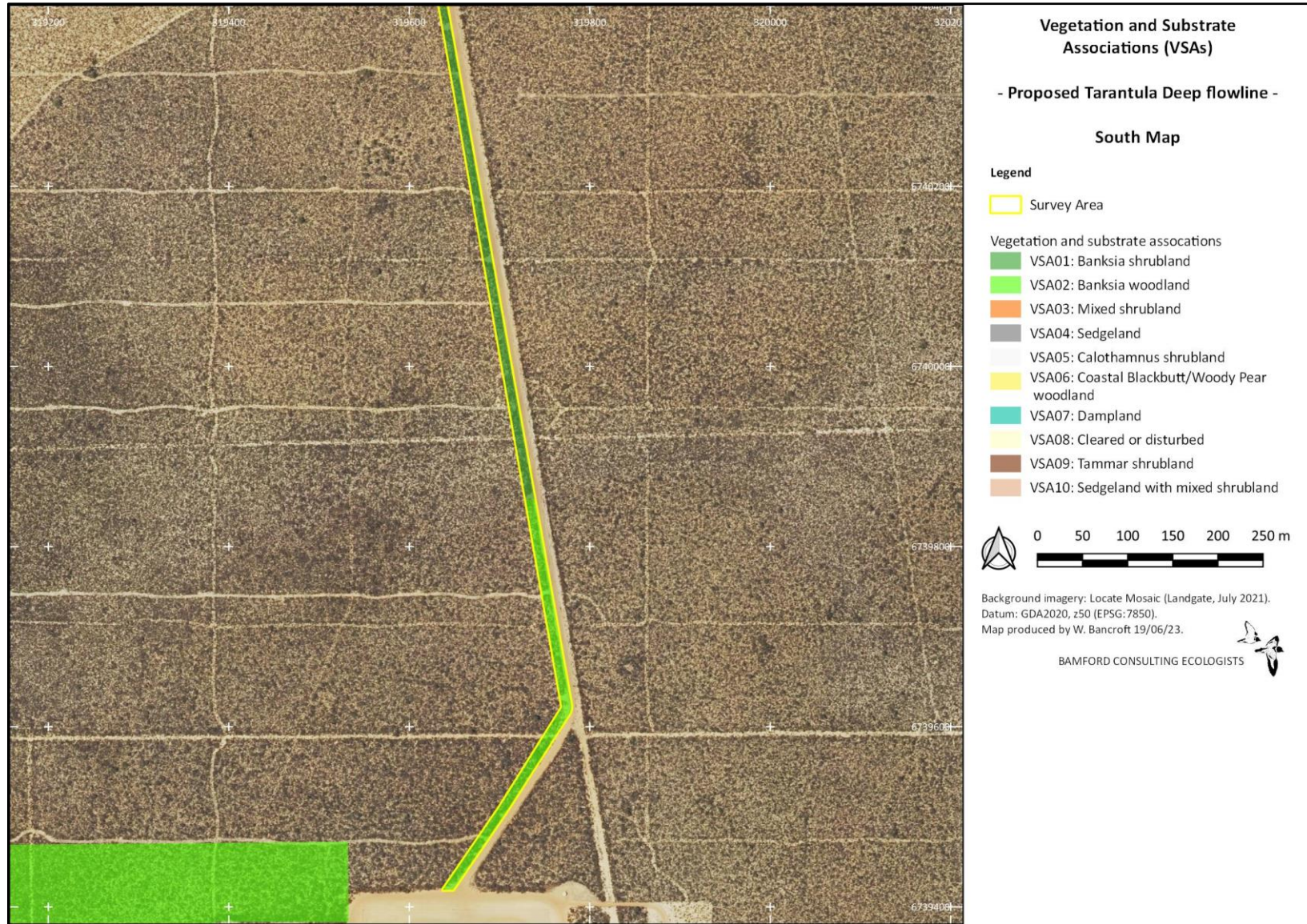


Figure 9. Vegetation and substrate associations at Tarantula Deep flowline: south.

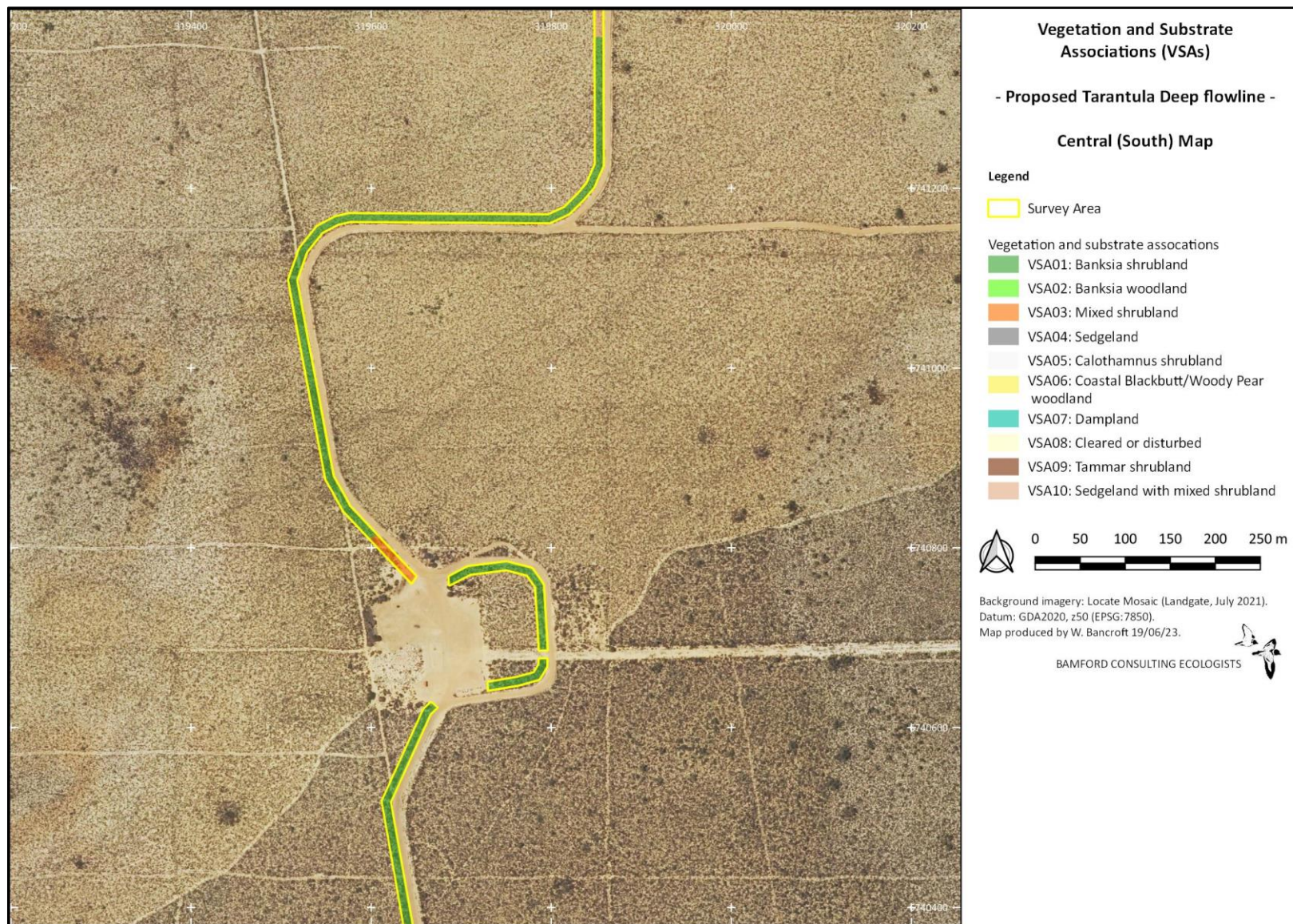


Figure 10. Vegetation and substrate associations at Tarantula Deep flowline: central (south).

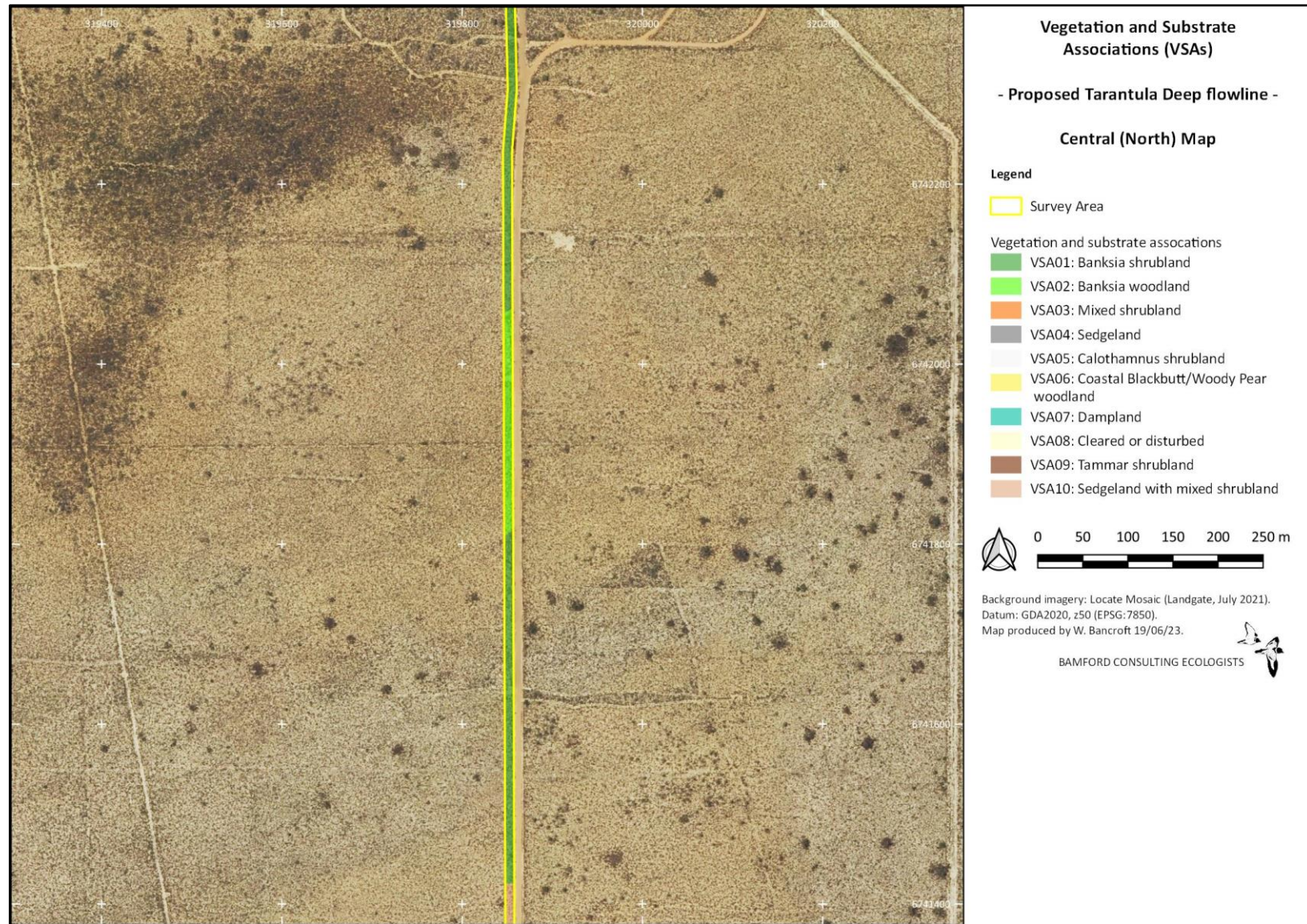


Figure 11. Vegetation and substrate associations at Tarantula Deep flowline: central (north).

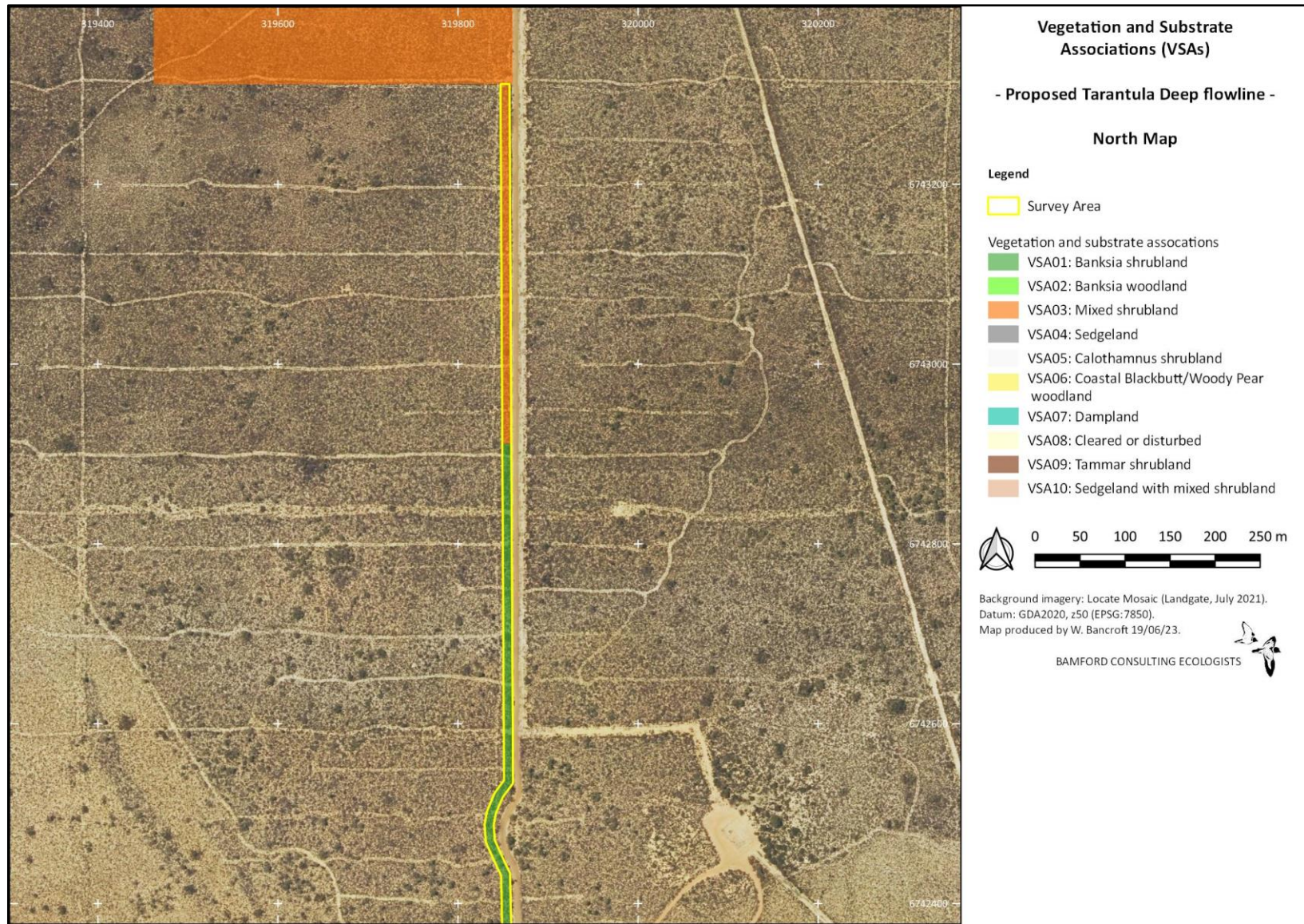


Figure 12. Vegetation and substrate associations at Tarantula Deep flowline: north.

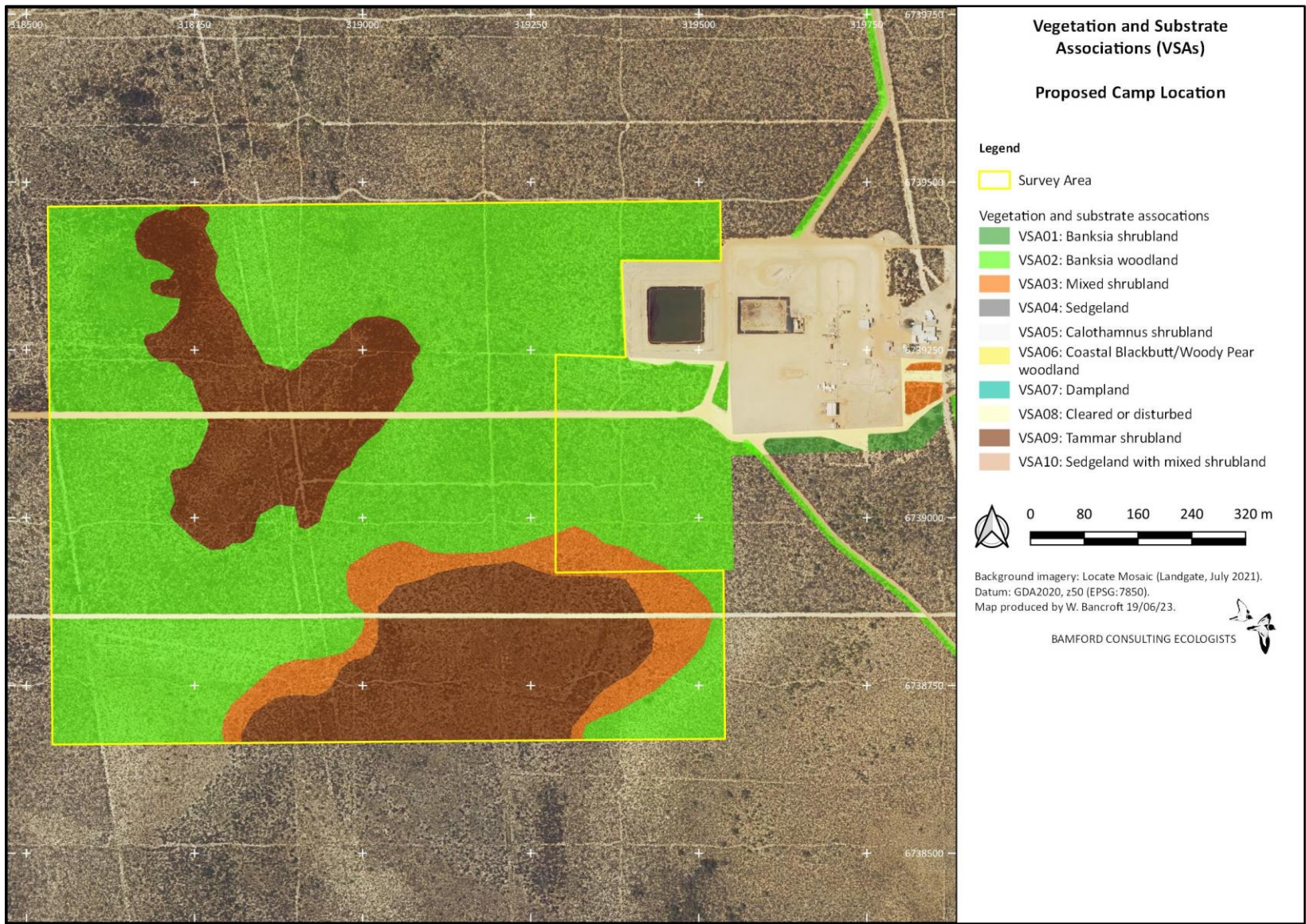


Figure 13. Vegetation and substrate associations at the Camp.

3.2 Black-cockatoo habitat analysis

3.2.1 *Black-cockatoo presence*

Only one of the three species of black-cockatoos known to occur in the south-west of Western Australia is expected to occur regularly in the vicinity of the survey areas (Carnaby's Black-Cockatoo) but this was not directly recorded on the site by during the site inspections in 2023 (this survey and Bancroft and Bamford 2023). Anecdotal evidence suggested that Carnaby's Black-Cockatoos are likely to occur irregularly and infrequently within the survey areas and this is supported by very scant indirect (foraging) evidence presented by Bancroft and Bamford (2023) and no additional foraging evidence recorded in the 2023 surveys (see Section 3.2.3 below). As noted by Bancroft and Bamford (2023), in studies carried out in the Beharra to Arrowsmith area to the west of the current study area, Carnaby's Black-Cockatoo was seen occasionally and in small numbers (except around a roost west of the Brand Highway) and a single Red-tailed Black-Cockatoo (inland subspecies *Calyptorhynchus banksia escondidus* which is not threatened) was observed near this roost (M. Bamford pers. obs.).

Given these direct observations, indirect (foraging) records, roosting data (see also regional analysis by Bancroft and Bamford 2023) and the literature review (including current species distributions) of Bancroft and Bamford (2023), it is considered that, currently:

- Carnaby's Black-Cockatoo is a regular visitor to the broader region but an irregular visitor to small sites such as the Beach Energy project areas.

3.2.2 *Black-cockatoo breeding habitat*

All of the 2023 survey areas (see Figure 1) are unsuited to breeding by black-cockatoos; there were no hollow-bearing trees that met the potential nest-tree criteria of DCCEEW (2023a, 2023b, 2023c) and DAWE (2022) present at any of the sites.

3.2.3 *Black-cockatoo foraging habitat*

3.2.3.1 *Carnaby's Black-Cockatoo*

Foraging habitat for the Carnaby's Black-Cockatoo was present throughout the survey areas. This is predominantly due to the presence of several *Banksia* species (in either tree and/or shrub form; *B. attenuata*, *B. menziesii*, *B. sessilis*) known to be mainstays of the Carnaby's Black-Cockatoo diet (Groom 2011). The most widespread of these was *B. attenuata* and, where it occurred, it was generally in moderate density. *B. menziesii* and *B. sessilis* were more irregular in their occurrence but, when present, were in moderate to high densities. There were also several other *Banksia* spp. shrubs recorded throughout.

The areas (and percentages) of each vegetation score in each survey area are shown for the Carnaby's Black-Cockatoo in Table 4.

Following Bancroft and Bamford (2023), a 'context' score of 1 (out of 3) has been assigned to the survey areas for this species (see also Appendix 3).

There was no evidence of foraging by Carnaby's Black-Cockatoo within the survey areas. It is expected that Carnaby's Black-Cockatoo will occur irregularly (only for foraging) within the survey areas.

Therefore, the survey areas were assigned a species 'density' score for Carnaby's Black-Cockatoo of 1 (out of 1; see Appendix 3).

The context and density values have been added on to the vegetation scores to yield the overall foraging value scores (with areas and percentages) that are also presented in Table 4. Maps of foraging scores for Carnaby's Black-Cockatoo foraging within each survey area is presented in Figure 14 to Figure 25.

By considering the area of each foraging score² and the size of the site, it is possible to calculate an overall foraging score for each of the six sites. These average foraging scores are presented in Table 5.

The survey areas are, generally, of low to moderate value for foraging by the Carnaby's Black-Cockatoo.

The foraging habitat mapping has been provided to the client in electronic (spatial file) format.

² For a foraging score <3, a value of 3 is assumed for the calculation of these averages

Table 4. Areas (ha) and proportions (%) of each category (vegetation score, combined foraging score) of foraging habitat in each survey area for Carnaby's Black-Cockatoo.

See Section 2.4.3.3 and Appendix 3 for explanation of vegetation, context, species density and (combined) foraging scores.

Vegetation Score	Crusoe Well & Access		BSD2 Flowline		RD1 Flowline		TD1 Flowline		Camp	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
6: High	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5: Moderate to High	0.5	3.9	1.5	37.5	0.0	0.0	0.1	2.2	0.0	0.0
4: Moderate	1.7	13.3	1.3	32.5	0.0	0.0	0.5	10.9	44.6	63.5
3: Low to Moderate	0.6	4.7	1.1	27.5	0.2	9.5	2.0	43.5	0.0	0.0
2: Low	1.2	9.4	0.0	0.0	1.8	85.7	1.9	41.3	4.2	6.0
1: Negligible	8.8	68.8	0.0	0.0	0.1	4.8	0.1	2.2	19.9	28.3
0: Nil	0.0	0.0	0.1	2.5	0.0	0.0	0.0	0.0	1.5	2.1
Total	12.8	100.0	4.0	100.0	2.1	100.0	4.6	100.0	70.2	100.0
Context Score	1		1		1		1		1	
Species Density Score	1		1		1		1		1	
Foraging Score										
10	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-
7	0.5	3.9	1.5	37.5	0.0	0.0	0.1	2.2	0.0	0.0
6	1.7	13.3	1.3	32.5	0.0	0.0	0.5	10.9	44.6	63.5
5	0.6	4.7	1.1	27.5	0.2	9.5	2.0	43.5	0.0	0.0
NA (Vegetation Score < 3)	10.1	78.9	0.1	2.5	1.9	90.5	1.9	41.3	25.6	36.5
Total	12.8	100.0	4.0	100.0	2.1	100.0	4.6	100.0	70.2	100.0

Table 5. Average (overall) Carnaby's Black-Cockatoo foraging scores at each survey area.

Survey Area	Overall Foraging Score (out of 10)
Crusoe Well & Access	3.6
BSD2 Flowline	6.0
RD1 Flowline	3.2
TD1 Flowline	4.3
Camp	4.9

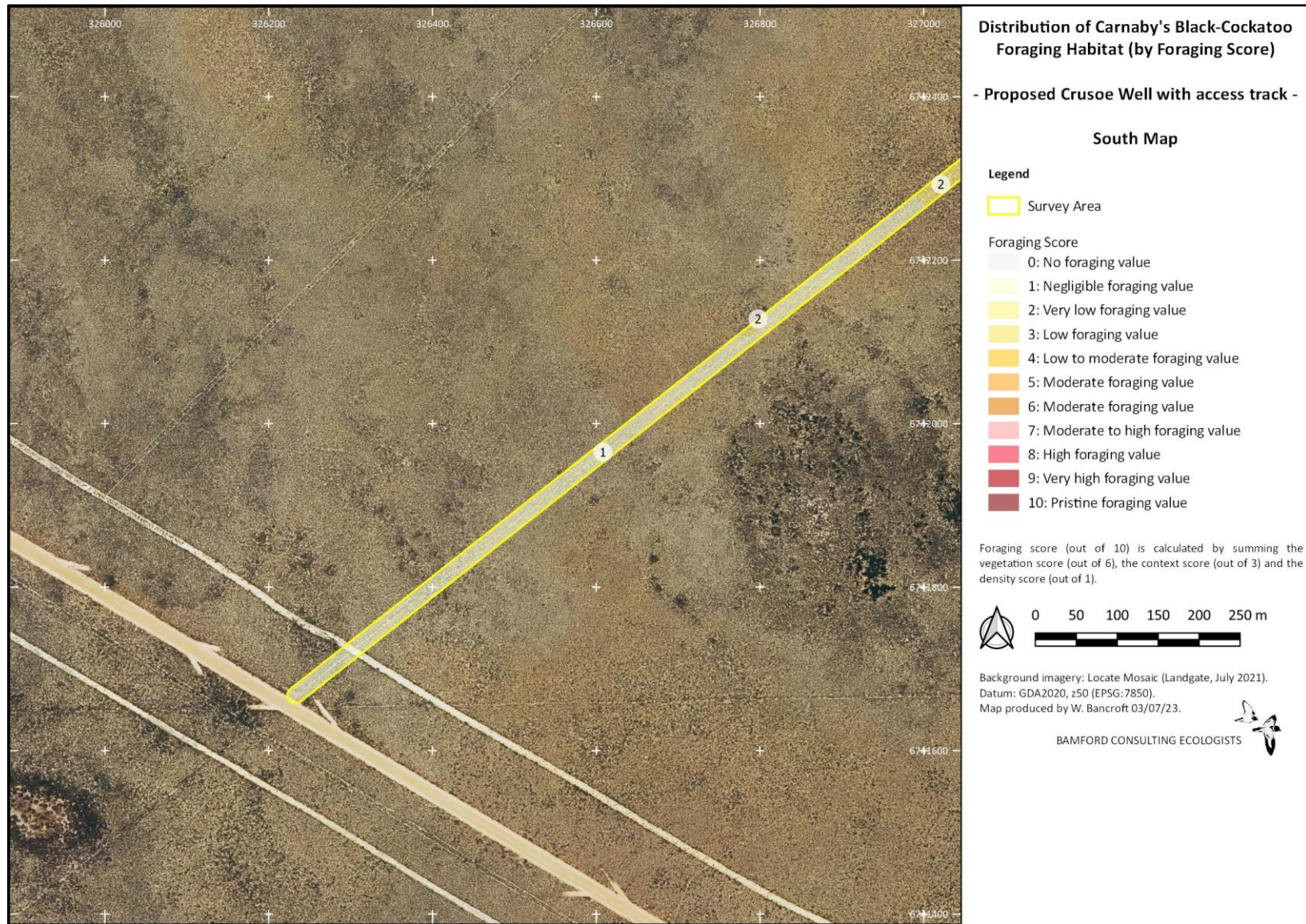


Figure 14. Distribution of Carnaby's Black-Cockatoo foraging scores at Crusoe Well: south.

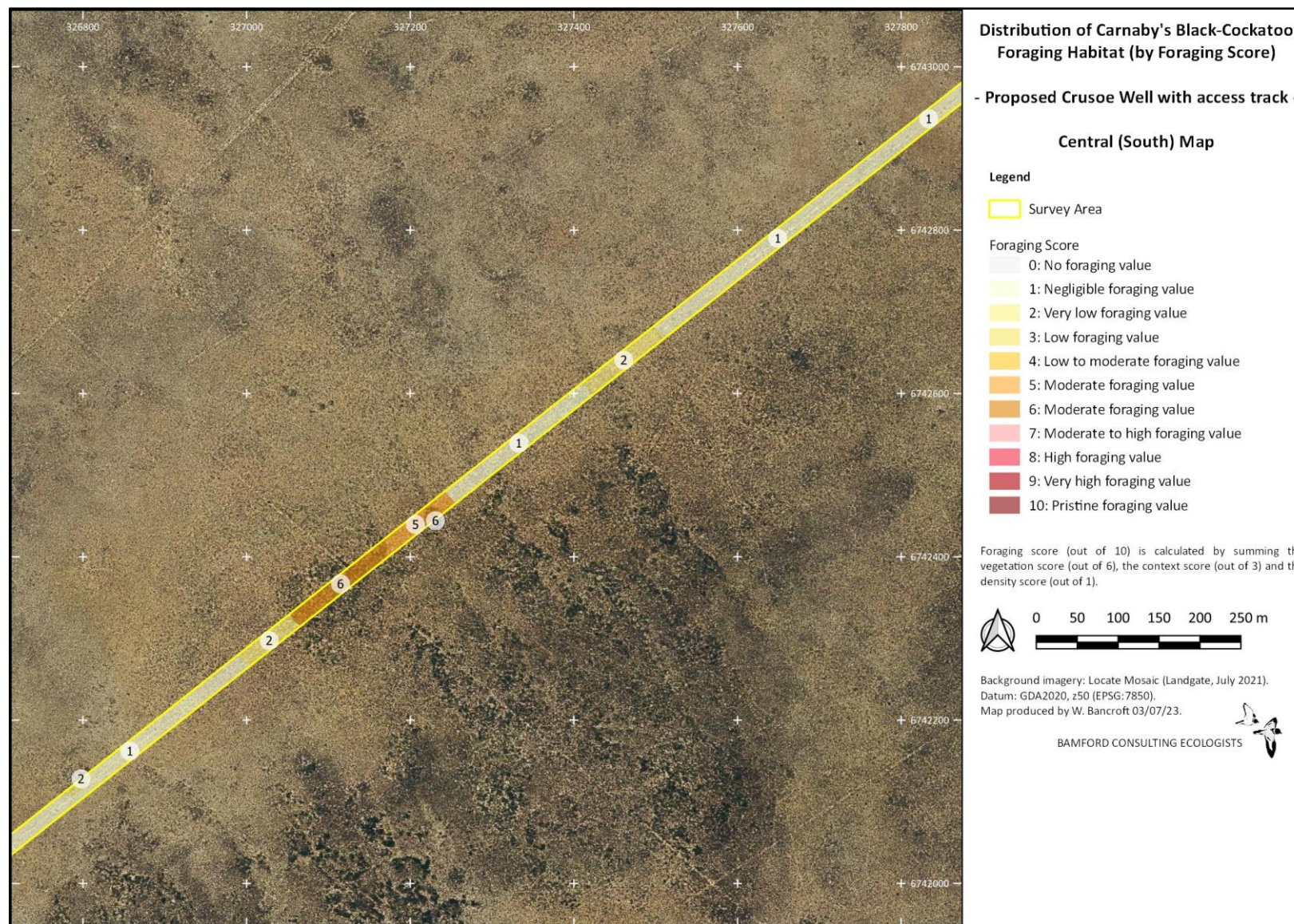


Figure 15. Distribution of Carnaby's Black-Cockatoo foraging scores at Crusoe Well: central (south).

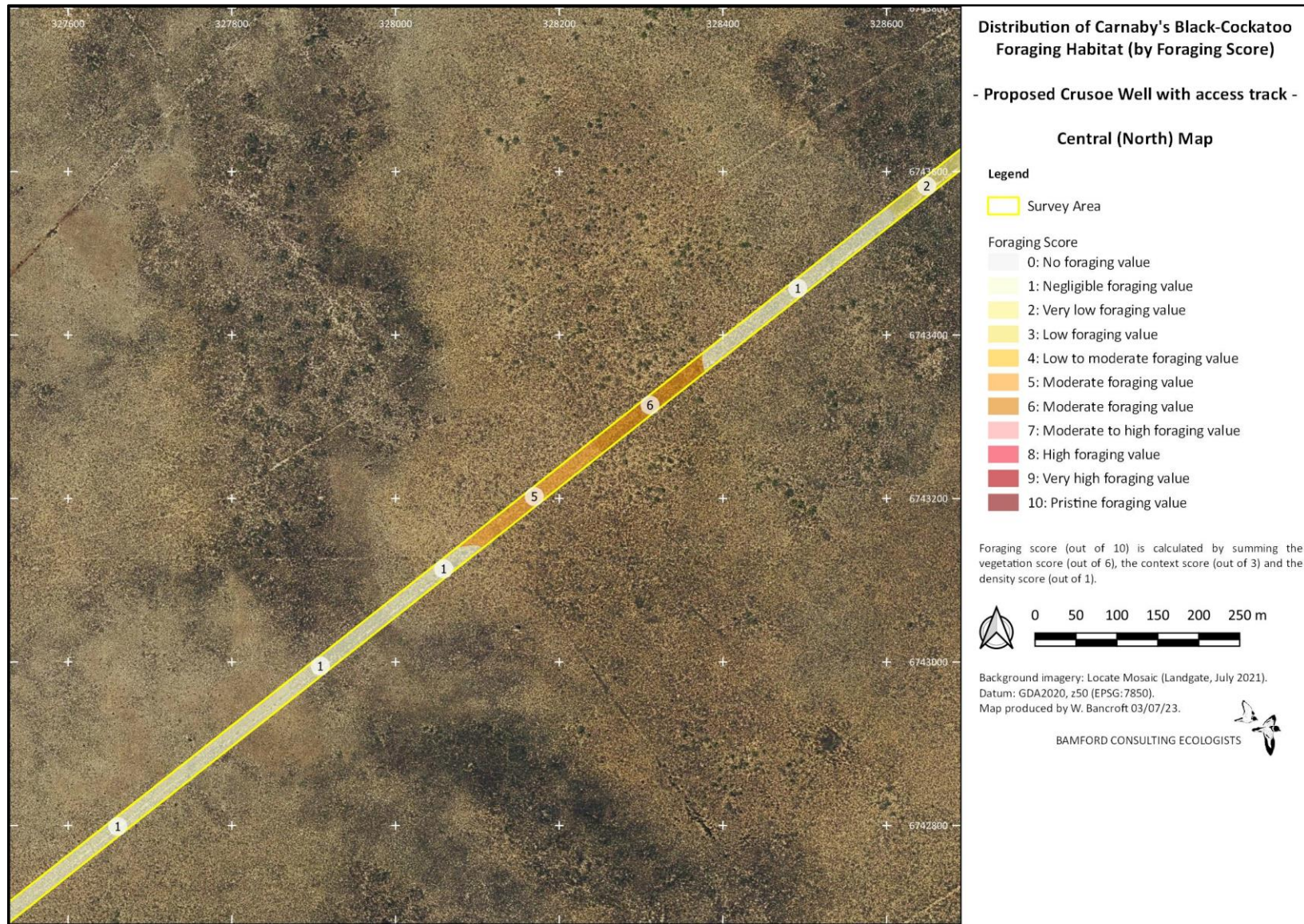


Figure 16. Distribution of Carnaby's Black-Cockatoo foraging scores at Crusoe Well: central (north).

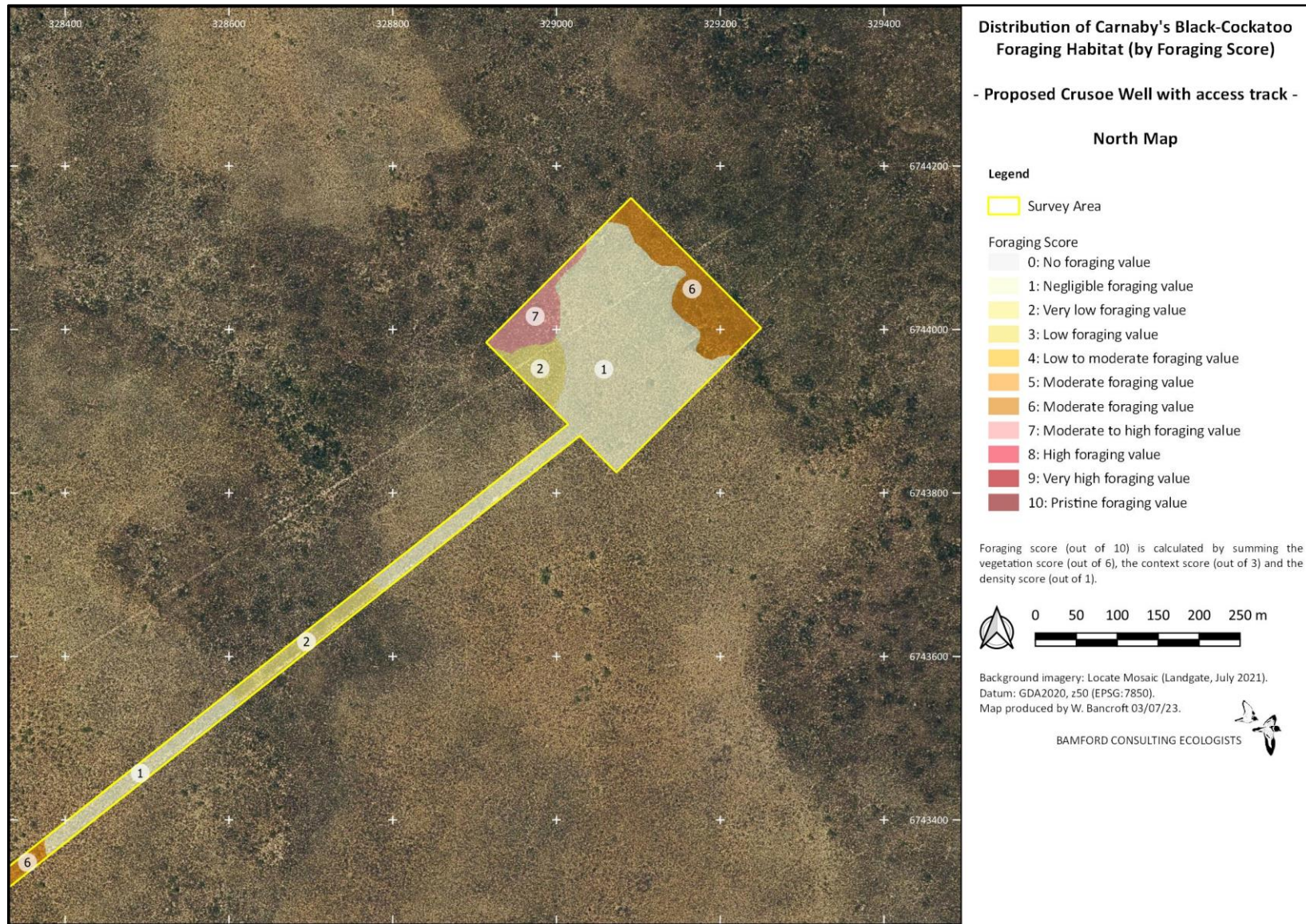


Figure 17. Distribution of Carnaby's Black-Cockatoo foraging scores at Crusoe Well: north.

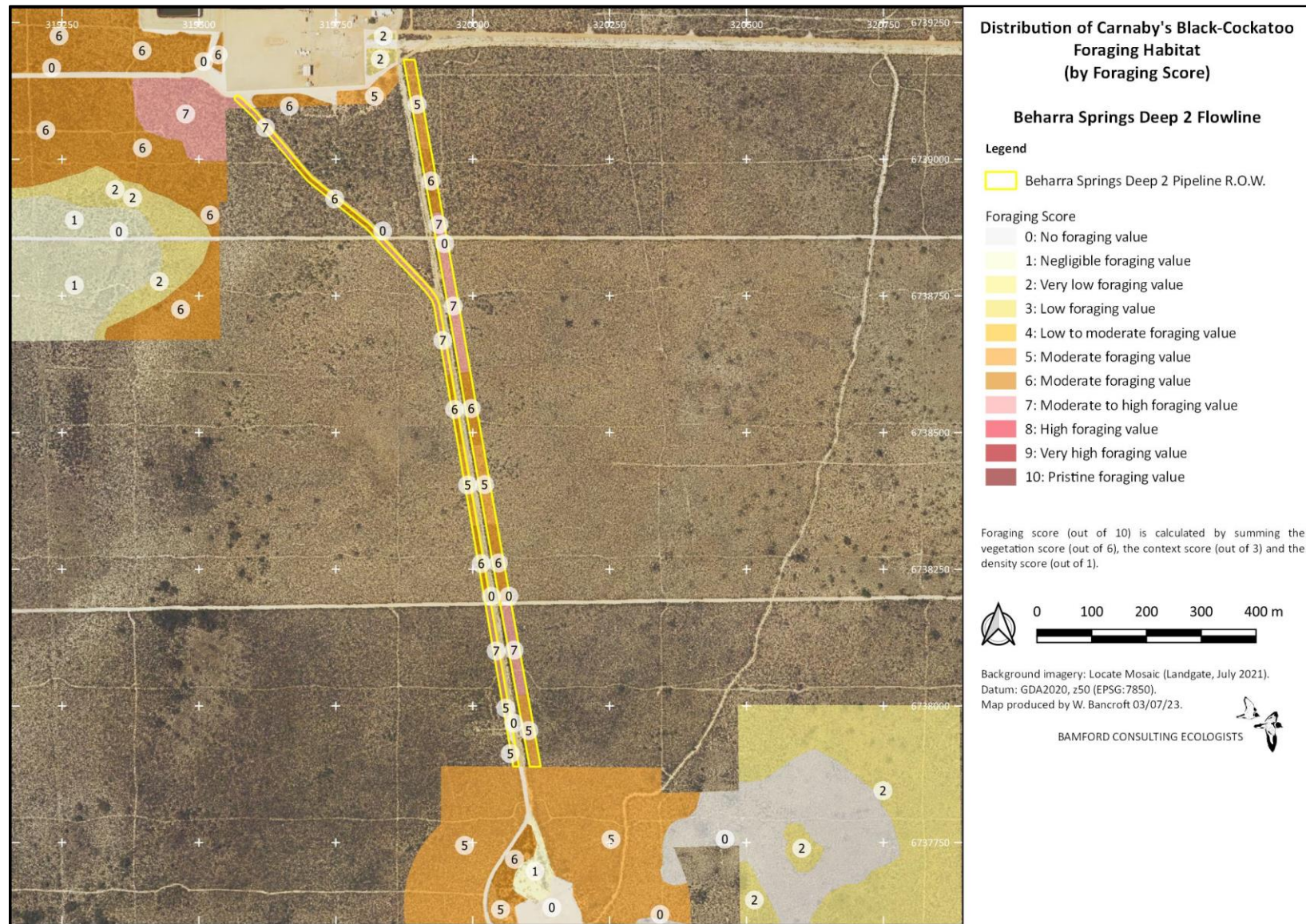


Figure 18. Distribution of Carnaby's Black-Cockatoo foraging scores at Beharra Springs Deep 2 flowline.

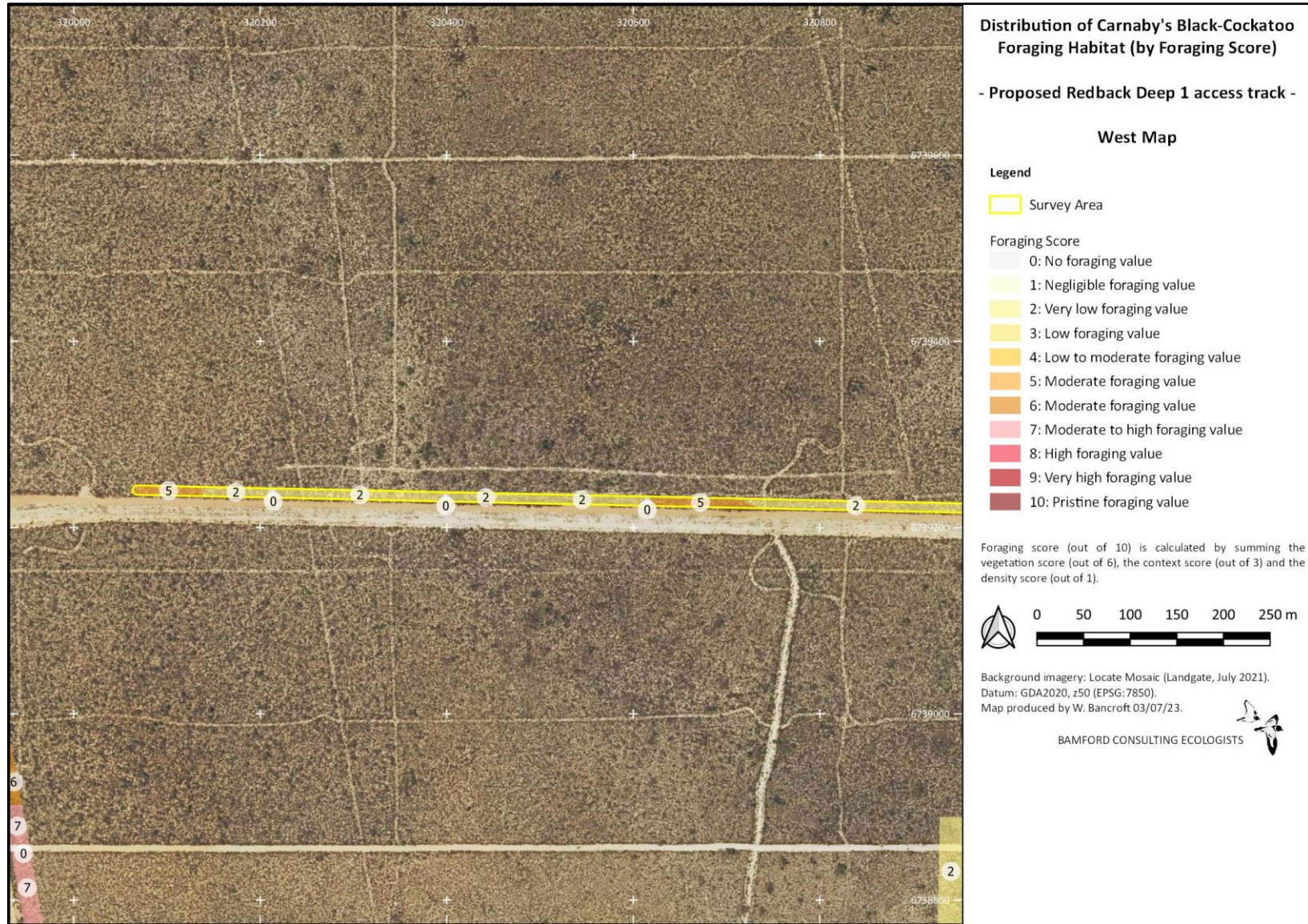


Figure 19. Distribution of Carnaby's Black-Cockatoo foraging scores at Redback Deep 1 flowline: west.

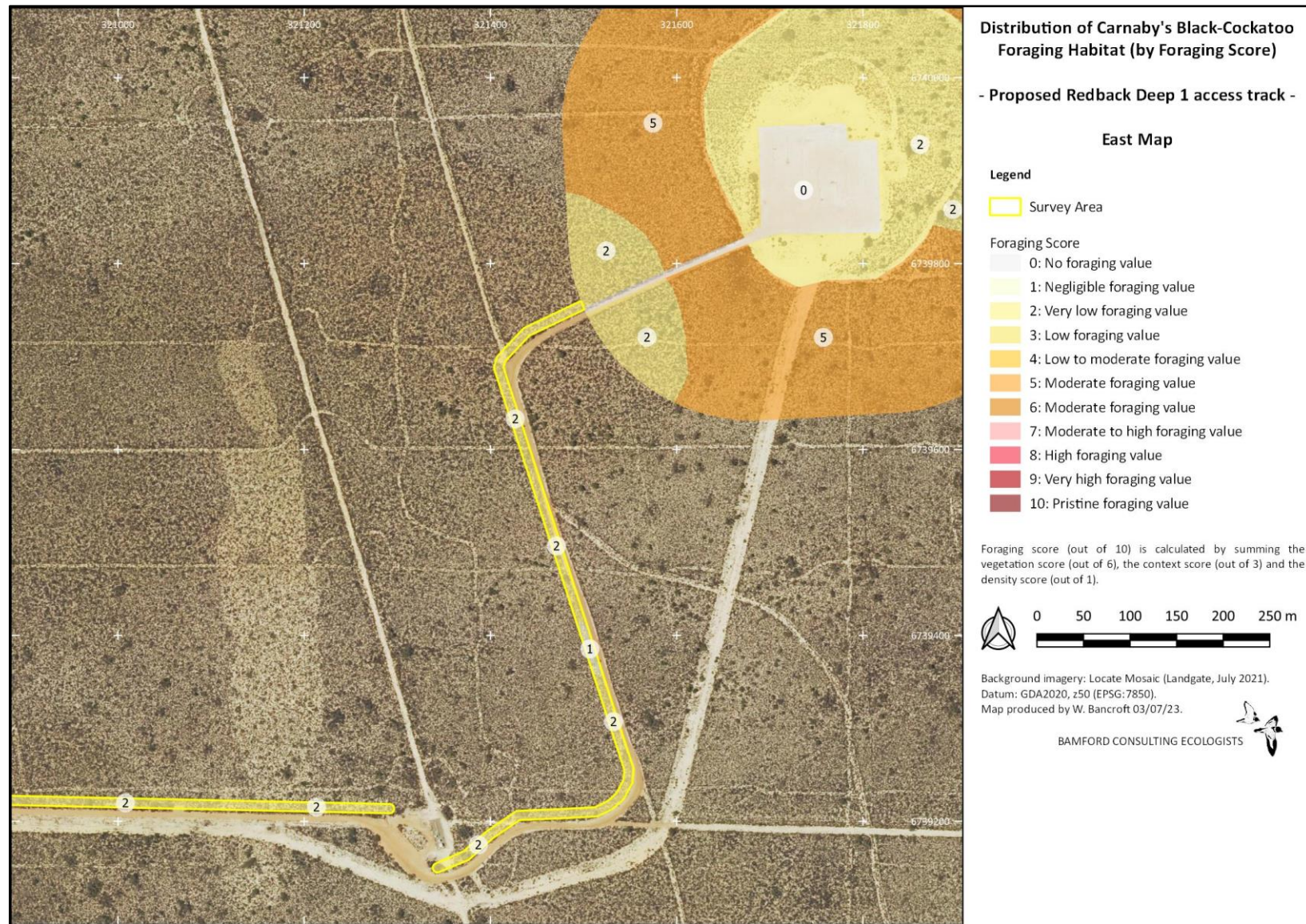


Figure 20. Distribution of Carnaby's Black-Cockatoo foraging scores at Redback Deep 1 flowline: east.



Figure 21. Distribution of Carnaby's Black-Cockatoo foraging scores at Tarantula Deep flowline: south.

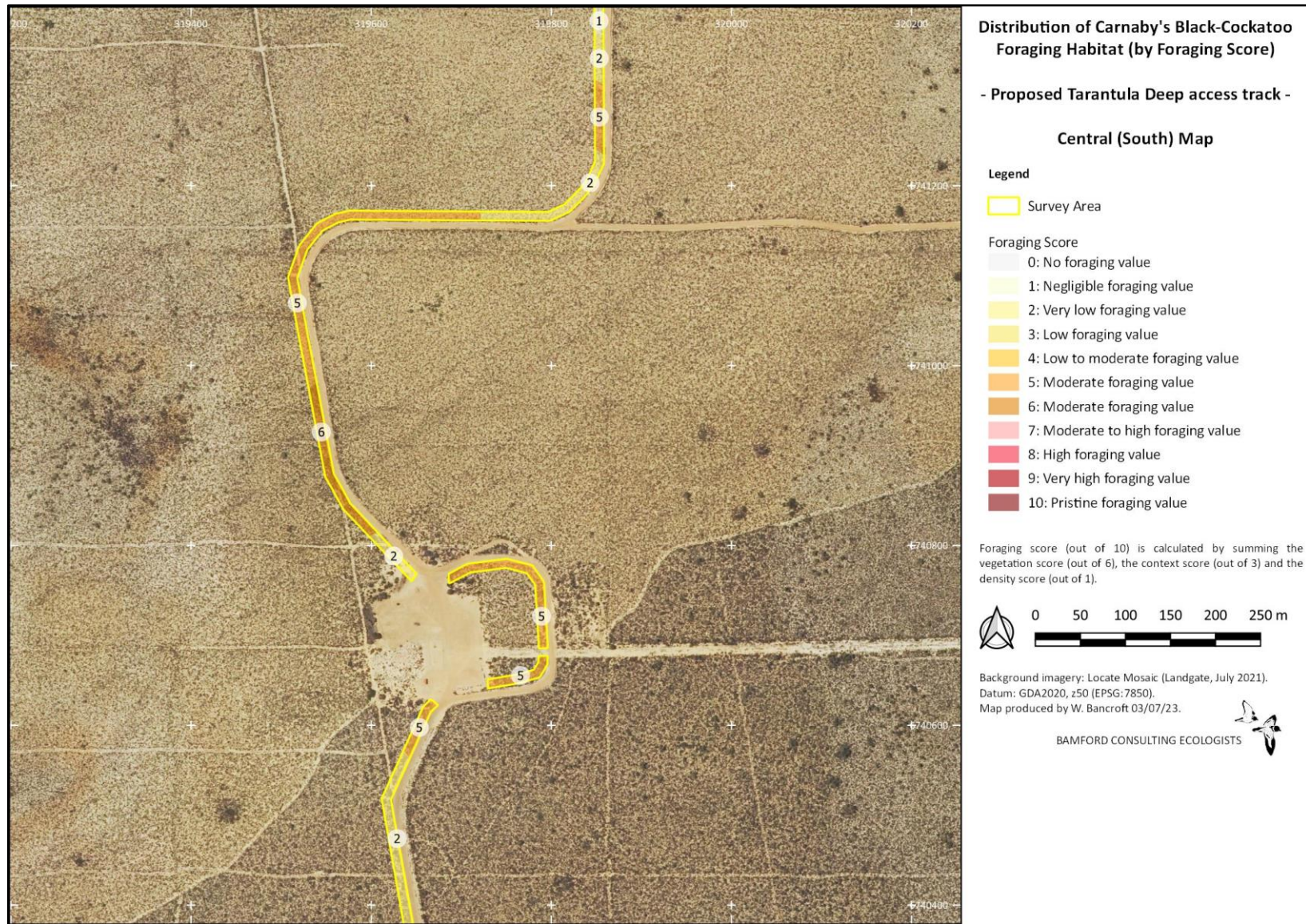


Figure 22. Distribution of Carnaby's Black-Cockatoo foraging scores at Tarantula Deep flowline: central (south).

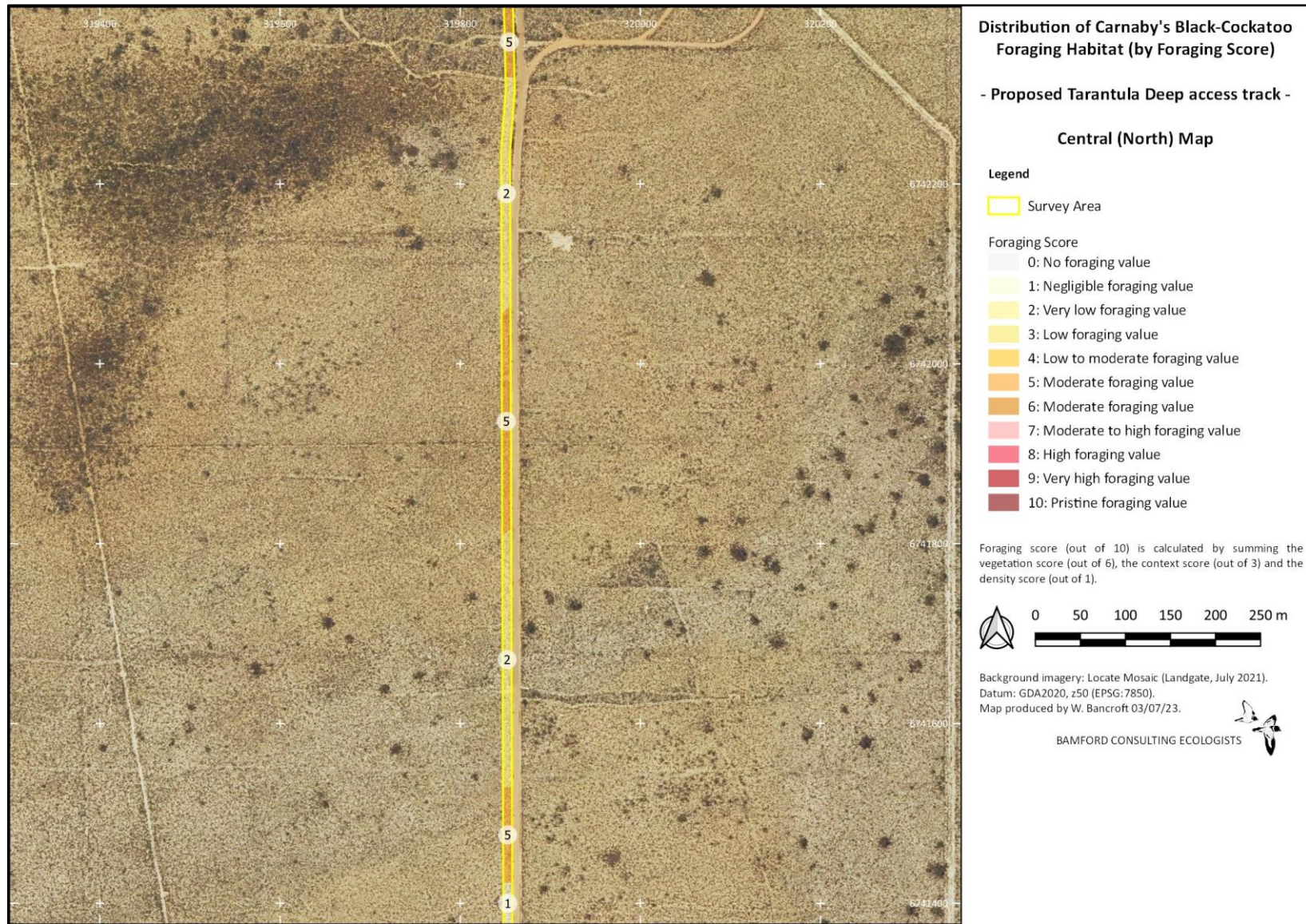


Figure 23. Distribution of Carnaby's Black-Cockatoo foraging scores at Tarantula Deep flowline: central (north).

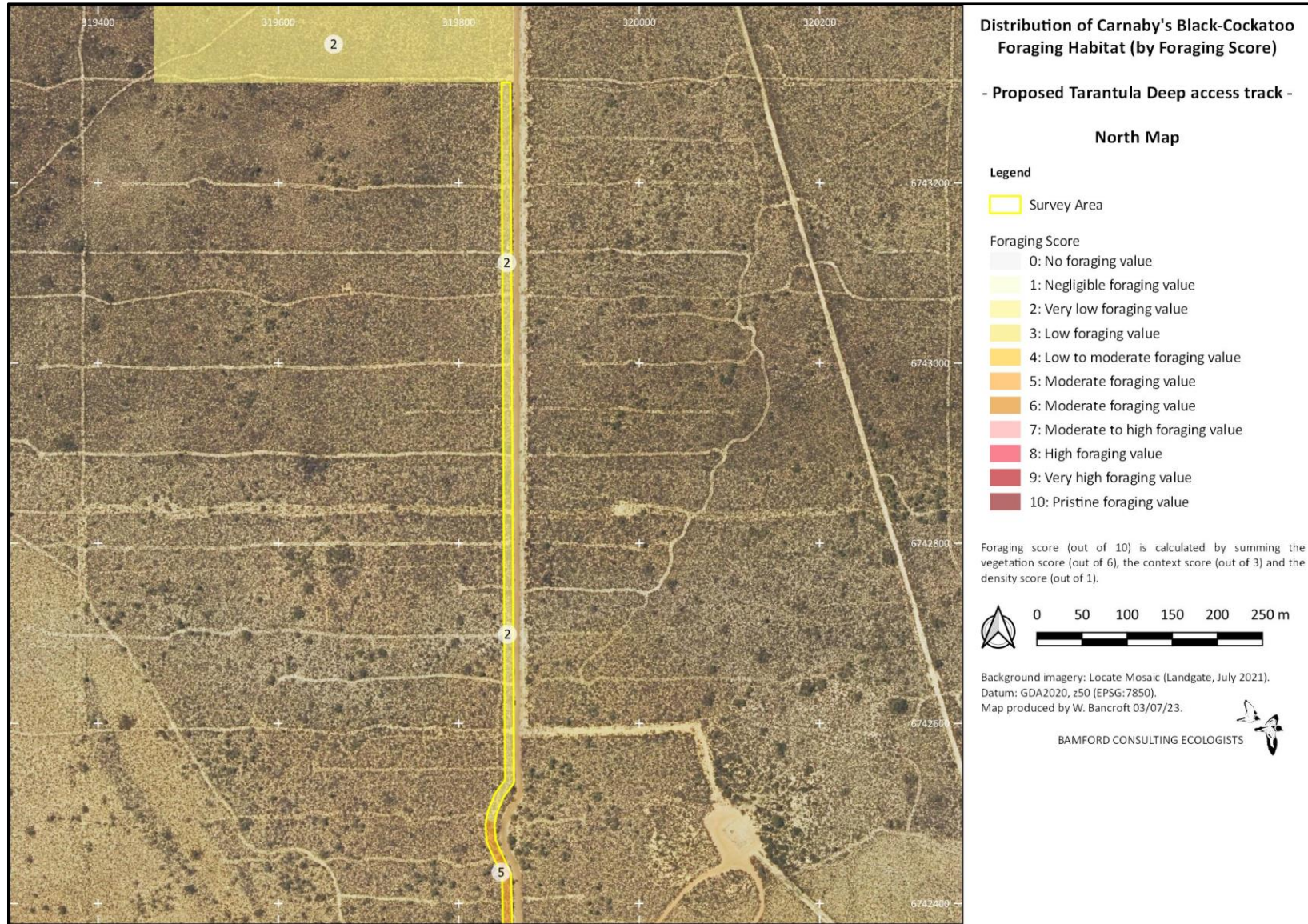


Figure 24. Distribution of Carnaby's Black-Cockatoo foraging scores at Tarantula Deep flowline: north.

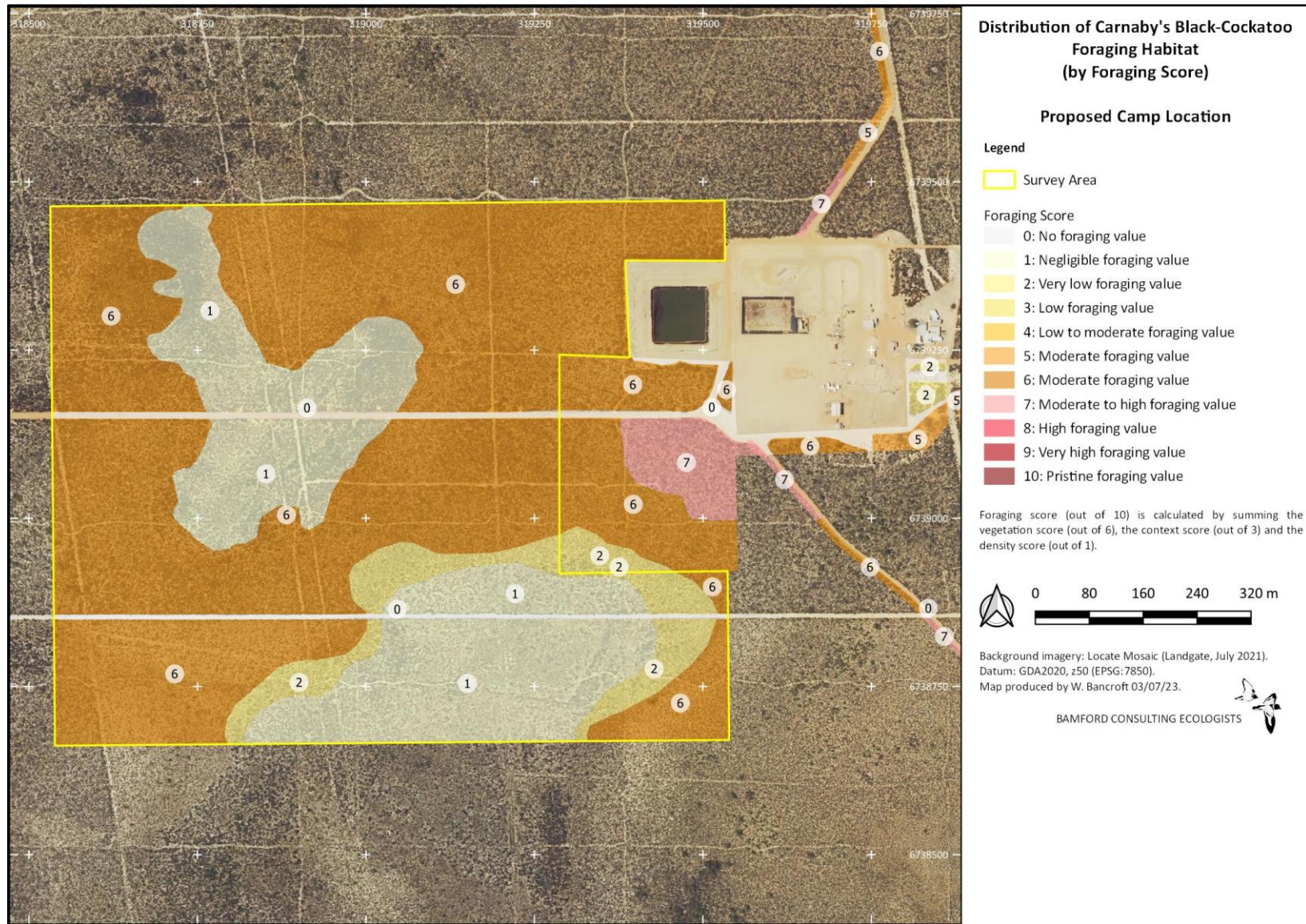


Figure 25. Distribution of Carnaby's Black-Cockatoo foraging scores at the Camp.

3.2.3.2 *DCCEEW foraging quality scoring tool*

The DCCEEW foraging quality scoring tool (provided by DAWE 2022) was used to assess the whole of each survey area for Carnaby's Black-Cockatoo (see Appendix 4 for DAWE methodology). The calculations are presented in Table 6 and these generated a total score (out of 10) for each survey area. These give very high foraging value scores compared with the scores determined using the BCE assessment method. This is because the DCCEEW approach does not differentiate on the basis of vegetation condition and assumes that any vegetation that may provide foraging habitat is of equal starting value, and adjusts only on the basis of a range of other site characteristics, such as foraging evidence and proximity to breeding and roosting areas.

Table 6. DCCEW foraging quality scoring tool calculations for Carnaby’s Black-Cockatoo in each of the survey areas.

Attribute	Crusoe Well & Access	BSD2 Flowline	RD1 Flowline	TD1 Flowline	Camp
Starting score	10	10	10	10	10
	-2	-2	-2	-2	-2
Foraging potential	(No evidence of foraging debris.)	(No evidence of foraging debris.)	(No evidence of foraging debris.)	(No evidence of foraging debris.)	(No evidence of foraging debris.)
	0	0	0	0	0
Connectivity	(Foraging habitat within 12 km.)	(Foraging habitat within 12 km.)	(Foraging habitat within 12 km.)	(Foraging habitat within 12 km.)	(Foraging habitat within 12 km.)
	0	0	0	0	0
Proximity to breeding	(Breeding habitat within 12 km.)	(Breeding habitat within 12 km.)	(Breeding habitat within 12 km.)	(Breeding habitat within 12 km.)	(Breeding habitat within 12 km.)
	0	0	0	0	0
Proximity to roosting	(Known night roosting habitat within 20 km.)	(Known night roosting habitat within 20 km.)	(Known night roosting habitat within 20 km.)	(Known night roosting habitat within 20 km.)	(Known night roosting habitat within 20 km.)
	0	0	0	0	0
Impact from significant plant disease	(<i>Phytophthora</i> spp. Or Marri canker affects less than 50% of preferred food plants.)	(<i>Phytophthora</i> spp. Or Marri canker affects less than 50% of preferred food plants.)	(<i>Phytophthora</i> spp. Or Marri canker affects less than 50% of preferred food plants.)	(<i>Phytophthora</i> spp. Or Marri canker affects less than 50% of preferred food plants.)	(<i>Phytophthora</i> spp. Or Marri canker affects less than 50% of preferred food plants.)
Total Score	8	8	8	8	8

3.2.4 Black-cockatoo night roosting habitat

No night roosts were located during the site inspections.

The region around the survey areas is known to support black-cockatoo roosting, however there are no known records of roost sites within the survey areas themselves. Previously known roost locations (provided by DBCA 2022a and that reflect data collected in BirdLife Australia's Great Cocky Counts) within 15 km of the survey area were mapped by Bancroft and Bamford (2023). The nearest of these known roosts is within c. 12 km of the northern end of the Tarantula Deep 1 flowline. Further details on these roosts can be provided, if required, by requesting data from BirdLife Australia. In addition, BCE has a number of known night-roost locations in its database that occur in the vicinity of the survey areas, with the nearest c. 9 km from the proposed Camp area.

The absence of roosts within the survey areas is very reasonable; there are no taller trees (e.g. eucalypts, pines) preferred by black-cockatoos as roost locations. It is almost certain that black-cockatoos do not depend on any of the survey areas for roosting habitat.

3.2.5 Black-cockatoo watering points

No potential water sources for black-cockatoos were observed within the survey areas.

3.3 Conclusion; value of project areas for black-cockatoos

Carnaby's Black-Cockatoo is the only black-cockatoo of conservation significance present in the general region where it is a regular visitor. Several roost sites are known and breeding is likely to occur within the region. For the survey areas, however, the species is probably only an irregular visitor and there is no breeding or roosting habitat. The survey areas provide foraging habitat of low to moderate value. These are very small areas within a region that provides extensive foraging habitat of similar value.

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5 Appendices

Appendix 1. Categories used in the assessment of conservation status.

IUCN (International Union for the Conservation of Nature) categories, as outlined by IUCN (2012), and as used for the *Environment Protection and Biodiversity Conservation Act 1999*:

EX	Extinct	Taxa not definitely located in the wild during the past 50 years.
EW	Extinct in the Wild	Taxa known to survive only in captivity.
CR	Critically Endangered	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
EN	Endangered	Taxa facing a very high risk of extinction in the wild in the near future.
VU	Vulnerable	Taxa facing a high risk of extinction in the wild in the medium-term future.
NT	Near Threatened	Taxa that risk becoming Vulnerable in the wild.
CD	Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.
DD	Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
LC	Least Concern	Taxa that are not Threatened.

Categories used in the *WA Biodiversity Conservation Act 2016*:

<i>THREATENED SPECIES</i>		
CR	Critically Endangered	Threatened species considered to be “facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines”.
EN	Endangered	Threatened species considered to be “facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines”.
VU	Vulnerable	Threatened species considered to be “facing a high risk of extinction in the wild in the medium term future, as determined in accordance with criteria set out in the ministerial guidelines”.
<i>EXTINCT SPECIES</i>		
EX	Extinct	Species where “there is no reasonable doubt that the last member of the species has died”, and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).
EW	Extinct in the Wild	Species that “is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form”, and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).

SPECIALLY PROTECTED SPECIES

MI	Migratory	Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act).
CD	Conservation Dependent	Species of special conservation need that are dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act).
OS	Other Specially Protected	Species otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).

WA DBCA Priority species (species not listed under the *WA Biodiversity Conservation Act 2016*, but for which there is some concern).

		Poorly-known species.
P1	Priority 1	Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, for example, agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements for threatened listing and appear to be under immediate threat from known threatening processes. These species are in urgent need of further survey.
		Poorly-known species.
P2	Priority 2	Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, for example, national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements for threatened listing and appear to be under threat from known threatening processes. These species are in urgent need of further survey.
		Poorly-known species.
P3	Priority 3	Species that are known from several locations and the species does not appear to be under imminent threat or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. These species need further survey.

Rare, Near Threatened and other species in need of monitoring.

- P4** Priority 4
- (a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands.
 - (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as a conservation dependent specially protected species.
 - (c) Species that have been removed from the list of threatened species or lists of conservation dependent or other specially protected species, during the past five years for reasons other than taxonomy.
 - (d) Other species in need of monitoring.
-

Appendix 2. Extended rationale for chosen methodology.

Vegetation and substrate associations (VSAs)

VSAs combine broad vegetation types, the soils or other substrate with which they are associated, and the landform. In the context of fauna assessment, VSAs are the environments that provide habitats for fauna. The term habitat is widely used in this context, but by definition an animal's habitat is the environment that it utilises (Calver *et al.* 2009), not the environment as a whole. Habitat is a function of the animal and its ecology, rather than being a function of the environment. For example, a species may occur in eucalypt canopy or in leaf-litter on sand, and that habitat may be found in only one or in several VSAs. VSAs are not the same as vegetation types since these may not incorporate soil and landform, and recognise floristics to a degree that VSAs do not. Vegetation types may also not recognise minor but often significant (for fauna) structural differences in the environment. VSAs also do not necessarily correspond with soil types, but may reflect some of these elements.

Because VSAs provide the habitat for fauna, they are important in determining assemblage characteristics. For the purposes of impact assessment, VSAs can also provide a surrogate for detailed information on the fauna assemblage. For example, rare, relictual or restricted VSAs should automatically be considered a significant fauna value. Impacts may be significant if the VSA is rare, a large proportion of the VSA is affected and/or the VSA supports significant fauna. The disturbance of even small amounts of habitat in a localised area can have significant impacts to fauna if rare or unusual habitats are disturbed.

VSA assessment was made with reference to the key attributes provided by EPA (2020):

- soil type and characteristics
- extent and type of ground surfaces and landforms
- height, cover and dominant flora within each vegetation stratum
- presence of specific flora or vegetation of known importance to fauna
- evidence of fire history including, where possible, estimates of time since fire
- evidence and degree of other disturbance or threats, e.g. feral species
- presence of microhabitats and significant habitat features, such as coarse woody debris, rocky
- outcrops, tree hollows, water sources and caves
- evidence of potential to support significant fauna
- function of the habitat as a fauna refuge or part of an ecological linkage.

Appendix 3. Scoring system for the assessment of foraging value of vegetation for Black-Cockatoos.

Bamford Consulting Ecologists

Revised 4th April 2021

Introduction

Application of the Offset Assessment Guide (offsets guide) developed by the federal environment department for assessing Black-Cockatoo foraging habitat requires the calculation of a score out of 10. The following system has been developed by Bamford Consulting Ecologists (BCE) with assistance from Quessentia Consulting to provide an objective scoring system that is practical and can be used by trained field zoologists with experience in the environments frequented by the species.

The foraging value score provides a numerical value that reflects the significance of vegetation as foraging habitat for Black-Cockatoos, and this numerical value is designed to provide the information needed by the Federal Department of Agriculture, Water and the Environment (DAWE) to assess impact significance and offset requirements. The foraging value of the vegetation depends upon the type, density and condition of trees and shrubs in an area and can be influenced by the context such as the availability of foraging habitat nearby. The BCE scoring system for value of foraging habitat has three components as detailed above. These three components are drawn from the DAWE offsets guide but the scoring approach was developed by BCE and includes a fourth (moderation) component. Note that the scoring system can only be applied within the range of the species or at least where the species could reasonably be expected to occur based upon existing information.

Calculating the total score (out of 10) requires the following steps:

- A. Site condition. Determining a score out of six for the vegetation composition, condition and structure; plus
- B. Site context. Determining a score out of three for the context of the site; plus
- C. Species stocking rate. Determining a score out of one for species density.
- D. Determining the total score out of 10, which may require moderation for context and species density with respect to the site condition (vegetation) score. Moderation also includes consideration of pine plantations as a special case for foraging value.

The BCE scoring system places the greatest weight on site condition (scale of 0 to 6) because this has the highest influence on the foraging values of a site, which in turn is the fundamental driver in meeting ecological requirements for continued survival.

Site context has a lower weight (scale of 0 to 3) in recognition of the mobility of the species, which means they can access good foraging habitat even in fragmented landscapes, but allowing for recognition of the extent of available habitat in a region and context in relation to activity (such as breeding and roosting). The application of scoring site context is further discussed below.

Species stocking rate is given a low weight (0 to 1) as it is a means only of recognising that a species may or may not be abundant at a site, but that abundance is dependent upon site condition and context and is thus not an independent variable. The abundance of a species is also sensitive to

sampling effort, and to seasonal and annual variation, and is therefore an unreliable indicator of actual importance of a site to a species.

Calculation of scores and the moderation process are described in detail below.

A. Site condition. Vegetation composition, condition and structure scoring

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	Baudin's Black-Cockatoo	Forest Red-tailed Black-Cockatoo
0	<p>No foraging value. No Proteaceae, eucalypts or other potential sources of food. Examples:</p> <ul style="list-style-type: none"> • Water bodies (e.g. salt lakes, dams, rivers); • Bare ground; • Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits) or with vegetation of no food value, such as some suburban landscapes. • Mown grass 	<p>No foraging value. No eucalypts or other potential sources of food. Examples:</p> <ul style="list-style-type: none"> • Water bodies (e.g. dams, rivers); • Bare ground; • Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits). 	<p>No foraging value. No eucalypts or other potential sources of food. Examples:</p> <ul style="list-style-type: none"> • Water bodies (e.g. dams, rivers); • Bare ground; • Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits).
1	<p>Negligible to low foraging value. Examples:</p> <ul style="list-style-type: none"> • Scattered specimens of known food plants but projected foliage cover of these is < 2%. This could include urban areas with scattered foraging trees; • Paddocks that are lightly vegetated with melons or other known food-source weeds (e.g. <i>Erodium</i> spp.) that represent a short-term and/or seasonal food source; • Blue Gum plantations (foraging by Carnaby's Black-Cockatoos has been reported but appears to be unusual). 	<p>Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these < 1%. This could include urban areas with scattered foraging trees.</p>	<p>Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these < 1%. Could include urban areas with scattered foraging trees.</p>

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	Baudin's Black-Cockatoo	Forest Red-tailed Black-Cockatoo
2	<p>Low foraging value. Examples:</p> <ul style="list-style-type: none"> • Shrubland in which species of foraging value, such as shrubby banksias, have < 10% projected foliage cover; • Woodland with tree banksias 2-5% projected foliage cover; • Woodland with tree banksias (of key species <i>B. attenuata</i> and <i>B. menziesii</i>) with <10% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Open eucalypt woodland/mallee of small-fruited species; • Paddocks that are densely vegetated with melons or other known food-source weeds (e.g. <i>Erodium</i> spp.) that represent a short-term and/or seasonal food source. 	<p>Low foraging value. Examples:</p> <ul style="list-style-type: none"> • Woodland with scattered specimens of known food plants (e.g. Marri and Jarrah) 1-5% projected foliage cover; • Marri-Jarrah Woodland with <10% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Parkland-cleared Eucalypt Woodland/Forest with known food plants <10% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants <10% projected foliage cover (establishing food sources with good long-term viability); • Urban areas with scattered foraging trees. 	<p>Low foraging value. Examples:</p> <ul style="list-style-type: none"> • Woodland with scattered specimens of known food plants (e.g. Marri, Jarrah) 1-5% projected foliage cover; • Marri-Jarrah Woodland with <10% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Sheoak Woodland with <10% projected foliage cover; • Parkland-cleared Eucalypt Woodland/Forest with known food plants <10% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants <10% projected foliage cover (establishing food sources with good long-term viability); • Urban areas with scattered food plants such as Cape Lilac, <i>Eucalyptus caesia</i> and <i>E. erythrocorys</i>.

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	Baudin's Black-Cockatoo	Forest Red-tailed Black-Cockatoo
3	<p>Low to Moderate foraging value. Examples:</p> <ul style="list-style-type: none"> • Shrubland in which species of foraging value, such as shrubby banksias, have 10-20% projected foliage cover; • Woodland with tree banksias 5-20% projected foliage cover; • Woodland with tree banksias (of key species <i>B. attenuata</i> and <i>B. menziesii</i>) with 10-40% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Eucalypt Woodland/Mallee of small-fruited species; • Eucalypt Woodland with Marri < 10% projected foliage cover. 	<p>Low to Moderate foraging value. Examples:</p> <ul style="list-style-type: none"> • Eucalypt Woodland with known food plants (especially Marri) 5-20% projected foliage cover; • Marri-Jarrah Woodland with 10-40% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Parkland-cleared Eucalypt Woodland/Forest with known food plants 10-40% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants 10-40% projected foliage cover (establishing food sources with good long-term viability). 	<p>Low to Moderate foraging value. Examples:</p> <ul style="list-style-type: none"> • Eucalypt Woodland with known food plants (especially Marri and Jarrah) 5-20% projected foliage cover; • Marri-Jarrah Woodland with 10-40% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Sheoak Forest with 10-40% projected foliage cover; • Parkland-cleared Eucalypt Woodland/Forest with known food plants 10-40% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants 10-40% projected foliage cover (establishing food sources with good long-term viability).

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	Baudin's Black-Cockatoo	Forest Red-tailed Black-Cockatoo
4	<p>Moderate foraging value. Examples:</p> <ul style="list-style-type: none"> Woodland/low forest with tree banksias (of key species <i>B. attenuata</i> and <i>B. menziesii</i>) 20-40% projected foliage cover; Woodland/low forest with tree banksias (of key species <i>B. attenuata</i> and <i>B. menziesii</i>) with 40-60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; Kwongan/ Shrubland in which species of foraging value, such as shrubby banksias, have 20-40% projected foliage cover; Eucalypt Woodland/Forest with Marri 20-40% projected foliage cover. 	<p>Moderate foraging value. Examples:</p> <ul style="list-style-type: none"> Marri-Jarrah Woodland/Forest with 20-40% projected foliage cover; Marri-Jarrah Forest with 40-60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; Parkland-cleared Eucalypt Woodland/Forest with known food plants 40-60% projected foliage cover (poor long-term viability without management); Younger areas of (managed) revegetation with known food plants 40-60% projected foliage cover (establishing food sources with good long-term viability); Orchards with highly desirable food sources (e.g. apples, pears, some stone fruits). 	<p>Moderate foraging value. Examples:</p> <ul style="list-style-type: none"> Marri-Jarrah Woodland/Forest with 20-40% projected foliage cover; Marri-Jarrah Forest with 40-60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; Sheoak Forest with 40-60% projected foliage cover; Parkland-cleared Eucalypt Woodland/Forest with known food plants 40-60% projected foliage cover (poor long-term viability without management); Younger areas of (managed) revegetation with known food plants 40-60% projected foliage cover (establishing food sources with good long-term viability).

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	Baudin's Black-Cockatoo	Forest Red-tailed Black-Cockatoo
5	<p>Moderate to High foraging value. Examples:</p> <ul style="list-style-type: none"> • Banksia Low Forest (of key species <i>B. attenuata</i> and <i>B. menziesii</i>) with 40-60% projected foliage cover; • Banksia Low Forest (of key species <i>B. attenuata</i> and <i>B. menziesii</i>) with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Kwongan/ Shrubland in which species of foraging value, such as shrubby banksias, have 40-60% projected foliage cover; • Marri-Jarrah Forest with 40-60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term). • Pine plantations with trees more than 10 years old (but see pine note below in moderation section). 	<p>Moderate to High foraging value. Examples:</p> <ul style="list-style-type: none"> • Marri-Jarrah Forest with 40-60% projected foliage cover; • Marri-Jarrah Forest with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Parkland-cleared Eucalypt Woodland/Forest with known food plants >60% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants >60% projected foliage cover (establishing food sources with good long-term viability). 	<p>Moderate to High foraging value. Examples:</p> <ul style="list-style-type: none"> • Marri-Jarrah Forest with 40-60% projected foliage cover; • Marri-Jarrah Forest with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Sheoak Forest with > 60% projected foliage cover; • Parkland-cleared Eucalypt Woodland/Forest with known food plants >60% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants >60% projected foliage cover (establishing food sources with good long-term viability).

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	Baudin's Black-Cockatoo	Forest Red-tailed Black-Cockatoo
6	<p>High foraging value. Example:</p> <ul style="list-style-type: none"> Banksia Low Forest (of key species <i>B. attenuata</i> and <i>B. menziesii</i>) with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term). Kwongan/ Shrubland in which species of foraging value, such as shrubby banksias, have >60% projected foliage cover; Marri-Jarra Forest with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term). 	<p>High foraging value. Example:</p> <ul style="list-style-type: none"> Marri-Jarra Forest with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term). 	<p>High foraging value. Example:</p> <ul style="list-style-type: none"> Marri-Jarra Forest with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term).

Vegetation structural class terminology follows Keighery (1994).

B. Site context.

Site Context is a function of site size, availability of nearby habitat and the availability of nearby breeding areas. Site context includes consideration of connectivity, although Black-Cockatoos are very mobile and will fly across paddocks to access foraging sites. Based on BCE observations, Black-Cockatoos are unlikely to regularly go over open ground for a distance of more than a few kilometres and prefer to follow tree-lines.

The maximum score for site context is 3, and because it is effectively a function of presence/absence of nearby breeding and the distribution of foraging habitat across the landscape, the following table, developed by Bamford Consulting in conjunction with the Department of the Environment and Energy (DEE), provides a *guide* to the assignment of site context scores. Note that ‘local area’ is defined as within a 15 km radius of the centre point of the study site. This is greater than the maximum distance of 12km known to be flown by Carnaby’s Black-Cockatoo when feeding chicks in the nest.

Site Context Score	Percentage of the existing native vegetation within the ‘local’ area that the study site represents.	
	‘Local’ breeding known/likely	‘Local’ breeding unlikely
3	> 5%	> 10%
2	1 - 5%	5 - 10%
1	0.1 - 1%	1 - 5%
0	< 0.1%	< 1%

The table above provides weighting for where nearby breeding is known (or suspected) and for the proportion of foraging habitat within 15 km represented by the site being assessed. Some adjustments may be needed based on the judgement of the assessor and in relation to the likely function of the site. For example, a small area of foraging habitat (e.g. 0.5% of such habitat within 15 km) could be upgraded to a context of 2 if it formed part of a critical movement corridor. In contrast, the same sized area of habitat, of the same local proportion, could be downgraded if it were so isolated that birds could never access it.

C. Species density (stocking rate).

Species stocking rate is described as “the usage and/or density of a species at a particular site” in the offsets guide. The description also implies that a site supports a discrete population, which is unlikely in the case of very mobile black-cockatoos. Assignment of the species density score (0 or 1) is based upon the black-cockatoo species being either abundant or not abundant. A score of 1 is used where the species is seen or reported regularly and/or there is abundant foraging evidence. Regularly is when the species is seen at intervals of every few days or weeks for at least several months of the year. A score of 0 is used when the species is recorded or reported very infrequently and there is little or no foraging evidence. Where information on actual presence of birds is lacking, a species density score can be assigned by interpreting the landscape and the site context. For example, a site with a moderate condition score that is part of a network of such habitat where a black-cockatoo species is

known would get a species density score of 1 even without clear presence data, while a species density score of 0 can be assigned to a site where the level of usage can confidently be predicted to be low.

D. Moderation of scores for the calculation of a value out of 10.

The calculation out of 10 requires the vegetation characteristics (out of 6) to be combined with the scores given for context and species density. It is considered that the context and density scores are not independent of vegetation characteristics; otherwise habitat of absolutely no value for black-cockatoo foraging (such as concrete or a wetland) could get a foraging score out of 10 as high as 4 if it occurred in an area where the species breed (context score of 3) and are abundant (species density score of 1). Similarly, vegetation of negligible or low characteristics which could not support black-cockatoos could be assigned a score as high as 6 out of 10. In that case, the score of 6 would be more a reflection of nearby vegetation of high characteristics than of the foraging value of the negligible to low scoring vegetation. The Black-Cockatoos would only be present because of vegetation of high characteristics, so applying the context and species density scores to vegetation of low characteristics would not give a true reflection of their foraging value.

For this reason, the context and species density scores need to be moderated for the vegetation characteristic score to prevent vegetation of little or no foraging value receiving an excessive score out of 10. A simple approach is to assign a context and species density score of zero to sites with a Condition score of low (2), negligible (1) or none (0), on the basis that birds will not use such areas unless they are adjacent to at least low-moderate quality foraging habitat (≥ 3). The approach to calculating a score out of 10 can be summarised as follows:

Vegetation composition, condition and structure score	Context score	Species density score
3-6 (low/moderate to high value)	Assessed as per B above	Assessed as per C above
0-2 (no to low value)	0	0

Note that this moderation approach may require interpretation depending on the context. For example, vegetation with a condition score of 2 could be given a context score of 1 under special circumstances. Such as when very close to a major breeding area or if strategically located along a movement corridor.

Pine plantations

Pine plantations are an important foraging resource for Carnaby's Black-Cockatoo (only) but are not directly comparable with native vegetation. In comparing native vegetation with pine plantations for the purpose of calculating offsets, the following should be noted:

- Pine plantations are a commercial crop established with the intention of being harvested and thus have short-term availability (30-50 years), whereas native vegetation is available indefinitely if protected. Due to the temporary nature of pines as a food source, site condition and context differs between pines and native vegetation.
- Although pines provide a high abundance of food in the form of seeds, they are a limited food resource compared with native vegetation which provides seeds, insect larvae, flowers and nectar. The value of insect larvae in the diet of Carnaby's Black-Cockatoo has not been quantified, but in the vicinity of Perth, the birds forage very heavily on insect larvae in young cones of *Banksia attenuata* in winter, ignoring the seeds in these cones and seeds in older cones on the same trees (Scott and Black 1981; M. Bamford pers. obs.). This suggests that insect larvae are of high nutritional importance immediately prior to the breeding season.
- Pine plantations have very little biodiversity value other than their importance as a food source for Carnaby's Black-Cockatoos. They inhibit growth of other flora. While this is not a factor for direct consideration with respect to Carnaby's Black-Cockatoo, it is a factor in regional conservation planning of which offsets for the cockatoos are a part.

Taking the above points into consideration, it is possible to assign pine plantations a foraging value as follows:

- Site condition. The actual foraging value of pines is high. Stock *et al.* (2013) report that it takes nearly twice as many seeds of *Pinus pinaster* to meet the daily energy requirements for Carnaby's Black-Cockatoo compared with Marri, and three times as many *P. pinaster* seeds compared with Slender Banksia. However, pines are planted at a high density so the food supply per hectare can be high. Taking account of the lack of variety of food from pines, this suggests a site condition score of 4 or 5 out of 6 (5 is used in Section A above). As a source of food, pines are thus comparable to the best banksia woodland. This site condition score then needs to be adjusted to take account of the short-term nature of the food supply (for pine plantations to be harvested. Where pines are 'ornamental, such as in some urban contexts, they can be treated as with other trees in urban landscapes). The foraging value of a site after pines are harvested will effectively be 0, or possibly 1 if there is some retention. It is proposed that this should approximately halve the site condition score; young pine plantations could be redacted slightly less than old plantations on the basis that a young plantation provides a slightly longer term food supply. If a maximum site condition score of 5 is given, then a young plantation (>10 but <30 years old) could be assigned a score of 3, and an old plantation (>30 years old) could be assigned a score of 2. Plantations <10 years old and thus not producing large quantities of cones could also get a score of 2, but recognising they may increase in value.
- Site context. Although a temporary food source, pines can be very important for Carnaby's Black-Cockatoo in some contexts; they could be said to carry populations in areas where there is little native vegetation. The system for assigning a context score as outlined above (Section B) also applies to pines. Thus, a context score of 3 can be given where pines are a significant

proportion of foraging habitat (>5% if breeding occurs; >10% if no breeding), but where pines are a small part of the foraging landscape they will receive a context score of less than this.

- Species density. As outlined above (Section C), pines will receive a species density score of 1 where Carnaby's Black-Cockatoo are regular visitors. This is irrespective of an old plantation having a moderated condition score of 2.

Based on the above, pine plantations that represent a substantial part of the foraging landscape, such as in the region immediately north of Perth, would receive a total score (out of 10) of 6; young plantations in this area would receive a score of 7. In contrast, isolated and small plantations in rural landscapes could receive a score of just 2 if they are only a small proportion of foraging habitat and Carnaby's Black-Cockatoos are not regularly present.

Appendix 4. The foraging quality scoring tool template from DAWE (2022).

Table A1 Foraging quality scoring tool template

Starting score		Baudin's Cockatoo	Camaby's Cockatoo	Forest Red-tailed Black-Cockatoo
10		Start at a score of 10 if your site is native eucalypt woodlands and forest, and proteaceous woodland and heath, particularly Marri, within the range of the species, including along roadsides and parkland cleared areas. Can include planted vegetation. This tool only applies to sites equal to or larger than 1 hectare in size.	Start at a score of 10 if your site is native shrubland, kwongan heathland or woodland, dominated by proteaceous plant species such as <i>Banksia</i> spp. (including <i>Dryandra</i> spp.), <i>Hakea</i> spp. and <i>Grevillea</i> spp., as well as native eucalypt woodland and forest that contains foraging species, within the range of the species, including along roadsides and parkland cleared areas. Also includes planted native vegetation. This tool only applies to sites equal to or larger than 1 hectare in size.	Start at a score of 10 if your site is Jarrah or Marri woodland and/or forest, or if it is on the edge of Karri forest, or if Wandoo and Blackbutt occur on the site, within the range of the subspecies, including along roadsides and parkland cleared areas. This tool only applies to sites equal to or larger than 1 hectare in size.
Attribute	Sub-tractions	Context adjustor (attributes reducing functionality of foraging habitat)		
Foraging potential	-2	Subtract 2 from your score if there is no evidence of feeding debris on your site.	Subtract 2 from your score if there is no evidence of feeding debris on your site.	Subtract 2 from your score if there is no evidence of feeding debris on your site.
Connectivity	-2	Subtract 2 from your score if you have evidence to conclude that there is no other foraging habitat within 12 km of your site.	Subtract 2 from your score if you have evidence to conclude that there is no other foraging habitat within 12 km of your site.	Subtract 2 from your score if you have evidence to conclude that there is no other foraging habitat within 12 km of your site.
Proximity to breeding	-2	Subtract 2 if you have evidence to conclude that your site is more than 12 km from breeding habitat	Subtract 2 if you have evidence to conclude that your site is more than 12 km from breeding habitat.	Subtract 2 if you have evidence to conclude that your site is more than 12 km from breeding habitat.
Proximity to roosting	-1	Subtract 1 if you have evidence to conclude that your site is more than 20 km from a known night roosting habitat.	Subtract 1 if you have evidence to conclude that your site is more than 20 km from a known night roosting habitat.	Subtract 1 if you have evidence to conclude that your site is more than 20 km from a known night roosting habitat.
Impact from significant plant disease	-1	Subtract 1 if your site has disease present (e.g. <i>Phytophthora</i> spp. or Marri canker) and the disease is affecting more than 50% of the preferred food plants present.	Subtract 1 if your site has disease present (e.g. <i>Phytophthora</i> spp. or Marri canker) and the disease is affecting more than 50% of the preferred food plants present.	Subtract 1 if your site has disease present (e.g. <i>Phytophthora</i> spp. or Marri canker) and the disease is affecting more than 50% of the preferred food plants present.
Total score		<i>Enter score</i>	<i>Enter score</i>	<i>Enter score</i>
Appraisal		To support your habitat score, you should provide an overall appraisal of the habitat on the impact site and within 20km of the impact area to clearly explain and justify the score. It should include discussion on the foraging habitat's proximity to other resources (e.g. exact distance to proximate resources), frequency of use of proximate sites, the degree of evidence and description of vegetation type and condition.		

Appendix 5. Examples of Forest Red-tailed Black-Cockatoo foraging signs across the range of age categories used in this study.

Active/Recent



Intermediate



Old

Jarrah nuts



Jarrah leaves



Marri nuts



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