Perth Airport

Airport West (South)

Final Major Development Plan - Part B

Environment and Heritage Assessment

December 2021

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ACKOWLEDGEMENT OF COUNTRY

Boorloo worlak kornt kaadatj Wadjak moort Noongar boodja-k wer baalabang kalyakoorl noyinang Noongar boodja-k. Ngalak kaadatj Noongar Birdiya koora-koora yeyi wer boordakan.

Perth Airport acknowledges the Whadjuk Noongar people as the Traditional Custodians of this region and respects their ongoing connection to this land. We pay our respects to Elders past, present and emerging.

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1. Introduction

This Major Development Plan report (Part B) provides details around the environmental and heritage considerations for the Airport West (South) project (the project) and is intended to be read in conjunction with Part A report.

1.1 Purpose

A review of the baseline environmental and heritage conditions for the Airport West (South) project area was undertaken based on desktop assessment and field studies along with consideration of potential impacts associated with the construction and operation of the project. This information is presented in Part B report (this report) and includes:

- The environmental and heritage approval process (Section 1.2),
- The environmental impact assessment process (Section 1.3),
- The environmental context of the project area which identifies environmental factors/issues relevant to the project and therefore requiring further discussion and assessment (Section 2),
- A description and impact assessment for each environmental factor relevant to the project,
  - Flora and vegetation (Section 3),
  - Fauna (Section 4),
  - Soils and geology (Section 5),
  - Water resources (Section 6),
  - Wetlands (Section 7),
  - Construction noise, vibration and air quality (Section 8), and
  - Heritage (Section 9),
- A 'Whole of Environment' assessment (Section 10),
- Environmental Management Measures (Section 11), and
- Proposed offsets (Section 12).

1.2 Approval Process

Section 91 of the Airports Act requires an MDP to include an assessment of the environmental impacts that might reasonably be expected to be associated with the development in question and the plans for ameliorating, preventing and dealing with associated environmental impacts. Section 160 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) requires the Minister administrating the Airports Act (Federal Minister for Infrastructure, Transport and Regional Development) to obtain advice from the Minister responsible for the EPBC Act (Federal Minister for the Environment) for the adoption or implementation of an airport's MDP.

The EPBC Act provides the Commonwealth framework for, amongst other things, protecting and managing nationally important flora, fauna, ecological communities and heritage places that are defined in the EPBC Act as Matters of National Environmental Significance (MNES). The EPBC Act also confers jurisdiction over actions that have the potential to make a significant impact on the environment where the actions affect, or are taken on, Commonwealth land or are carried out by a Commonwealth agency.

Under Part 13 of the EPBC Act, a permit is required for any action that may kill, injure, take, trade, keep or move a member of the threatened species or ecological community. As this project may impact Banksia Woodlands of the Swan Coastal Plain, an application for this permit will be submitted to the Department of Agriculture, Water and Environment (DAWE) to align with the MDP process.

This report has been prepared in accordance with the EPBC Act and the following associated guidelines:

- *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance (Guideline 1.1).*

  Guideline 1.1 provides guidance on determining whether an action is likely to have a significant impact on a matter protected under national environmental law and whether assessment and approval is required under the EPBC Act. The Matters of National Environmental Significance (MNES) protected under national environmental law include:
  - World heritage properties,
  - National heritage places,
  - Wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed),
  - Nationally threatened species and ecological communities,
  - Migratory species,
  - Commonwealth marine areas,
  - The Great Barrier Reef Marine Park,
  - Nuclear actions, and
  - A water resource, in relation to coal seam gas development and large coal mining development.
- *Significant Impact Guidelines 1.2 - Actions on, or impacting upon, Commonwealth land and Actions by Commonwealth Agencies (Guideline 1.2).*

Guideline 1.2 provides guidance for any person who proposes to take an action which is situated on or may have an impact on Commonwealth land, or for representatives of Commonwealth agencies who propose to take an action that may impact on the environment anywhere in the world. It requires a 'Whole of Environment' assessment for projects undertaken on Commonwealth land.

1.3 Impact Assessment Process

1.3.1 General

The following process has been applied to assess the potential environmental and heritage impacts of the project as per the scope defined within Part A report and meets the self-assessment requirements of Guideline 1.2 (refer Figure 1-1):

1. Baseline environmental studies,
2. Define the Environmental Context for the project. This includes identification of environmental and heritage components and features that may be impacted, either directly or indirectly. For the purposes of this document, the term "environmental and heritage components and features" is referred to as "Factors" in this assessment,
3. Identify and assess potential impacts for each environmental and heritage factor. This includes potential indirect and offsite impacts,
4. Identification of appropriate mitigation and management of potential impacts, and

5. Determine significance of potential impacts. This can be based on guidelines and policies relevant to the environmental and/or heritage factor. For example, the significance criteria in Guideline 1.1 is applied in this document to determine significance of potential impacts to flora and fauna.

Figure 1-1 Self-Assessment Requirements of EPBC Significant Impact Guidelines 1.2

Source: EPBC Significant Impact Guidelines 1.2

1.3.2 Impact Assessment Project Area

The development of the Airport West (South) project area will be designed to minimise its environmental footprint, whilst attracting new businesses and complementing existing business precincts within the Perth Airport estate. The total area of the Airport West (South) project is 65.5 hectares and up to 37 hectares, of native vegetation is proposed to be cleared for development.

1.3.3 Cumulative Impacts

Cumulative impacts are the successive, incremental and combined environmental impacts of one or more activities. Airport West (South) is the second (following the New Runway Project - NRP) in a series of development projects planned within the Perth Airport estate as detailed in Master Plan 2014. These projects are summarised in Table 1-1.

Project	Project description	Project status	Project Area (hectare)
Airport Central	Upgrades to the international terminal at Perth Airport and supporting infrastructure including apron, taxiways and carparks.	Conceptual Planning	Not defined yet
Airport North	Multi-use development of Perth Airport Estate's Northern Precinct.	Conceptual Planning	Not defined yet
Airport South	Commercial development of Perth Airport Estate's Southern Precinct.	Conceptual Planning	Not defined yet
New Runway Project	New parallel runway for Perth Airport.	Planning Stage	292.8
Airport West (South) (this report)	Commercial development of Perth Airport Estate's Western Precinct.	Planning Stage	65.5
Cumulative Total			358.3

Table 1-1 Major development projects proposed for the Perth Airport Estate

For the purposes of this assessment, cumulative impacts are defined as those impacts from all the combined proposed development projects within the Perth Airport estate for which a development envelope has been defined (listed in Table 1-1). At the time of writing this MDP, these are the New Runway Project and Airport West (South). Other industrial and urban development outside the Airport Estate was not considered in the assessment.

2. Environmental Context

As mentioned in Section 1.2, it is important to understand the environmental context of the Airport West (South) project area to ascertain the environmental features that are likely to be impacted. As such, this section defines the environmental context of the project area, in accordance with the definition of Whole of Environment required by Guideline 1.2. and identifies the following;

- The environmental and heritage matters/features in the area where the action will take place,
- The environmental or heritage factors which are likely to be impacted by the action and which therefore require assessment,
- Any sensitive and vulnerable areas,
- Any rare, endemic, unusual, important or otherwise valuable factors of the environment, and
- The history, current use and condition of the environment.

The environmental context has been assessed based on these considerations for soils and geology, water, flora and vegetation, fauna, conservation and special use areas, heritage and people and communities, as follows.

2.1 Soils and Geology

Desktop studies and intrusive investigations have been conducted for the project area. Some Areas of Potential Environmental Concern (APEC) relating to per-and poly-fluoroalkyl substances (PFAS) and Acid Sulphate Soils (ASS) have been identified as warranting further assessment. This is discussed in Section 5.

2.2 Water (Surface Water and Groundwater)

The airport estate is located on the Swan Coastal Plain near the base of the Darling Scarp and is within 500 meters of the Swan River. Groundwater beneath the estate sits at a shallow depth (surface to four metres below ground level) as an unconfined water table within the highly permeable sands of the Bassendean Dunes and as a semi-confined aquifer in the Guildford Formation. Groundwater flow direction ranges from a westerly to north-westerly direction across the airport estate.

The key hydrological features within the airport estate are:

- Munday Swamp in the north-east corner of the estate, and
- the drainage network within the airport estate (Northern Main Drain (NMD) and Southern Main Drain (SMD)).

Surface water flows through the airport estate via these two main drains; the NMD and the SMD. These drains generally flow east to west and have been constructed as extensions and modifications to naturally occurring watercourses. The NMD receives surface flow from Poison Gully (located to the east of the airport estate) and Munday Swamp. Both drains discharge into the Swan River.

There will be no impacts to Munday Swamp as a result of this project. Factors identified as relevant and warranting further assessments in Section 6 are:

- Surface water
- Ground water, and
- Stormwater infrastructure

2.3 Flora and Vegetation

A Vegetation and Flora Survey was conducted in Spring 2018 across the Perth Airport estate. Key findings relating to flora and vegetation across the project area include:

- Approximately half of the project area is comprised of cleared and/or completely degraded areas (approximately 43% of the project area),
- Vegetation condition within the project area ranges from Completely Degraded to Very Good condition. No vegetation in the project area is in Pristine condition due to the presence of weed species, evidence of disturbance from feral animals and the presence of vehicle tracks,
- No Commonwealth-listed threatened flora species will be impacted,
- Up to 6.0 hectares of the Commonwealth-listed threatened ecological community (TEC), Banksia Woodlands of the Swan Coastal Plain, may be impacted,
- Approximately 29.9 hectares of the vegetation within the project area is infested with *Phytophthora cinnamomi* (dieback), and
- Two species listed as Priority Species by the State Department of Biodiversity, Conservation and Attractions (DBCA), *Platysace ramosissima*, (Priority 3) and *Johnsonia pubescens* subsp. *cygnorum* (Priority 2) are likely to be impacted.

Factors identified as being relevant to the project and therefore warranting further assessment are detailed in Section 3 and include:

- Native Vegetation,
- Banksia Woodland TEC, and
- DBCA Listed Priority Flora Species *Platysace ramosissima* and *Johnsonia pubescens* subsp. *cygnorum*

2.4 Fauna

Key findings arising from fauna investigations within the Airport West (South) project area include:

- The development of the project may impact several broad fauna habitat types including Woodland (22.9 hectares), Dampland Heath (10.0 hectares) and Grassland (15.2 hectares), a total of approximately 48.1 hectares. A further 2.0 hectares of drains may be modified for the project,
- Six Conservation Significant Fauna (CSF) have been identified to be regularly present within the project area (referred to as 'Regularly Present CSF' in this document). These include:
    - Three MNES, the Forest Red-tailed Black-Cockatoo, Baudin's Black-Cockatoo and Carnaby's Black-Cockatoo). These Black-Cockatoo species have high conservation significance and forage around the project area, but there is no evidence they currently breed within the project area, and
    - Three species listed as Priority Species by DBCA, Quenda (Southern Brown Bandicoot), Rakali (water-rat), and one invertebrate (Native Bee).

Factors identified as being relevant to the project and therefore warranting further assessment include (refer Section 4):

- General Fauna Environment,
- Carnaby's Black-Cockatoo,
- Forest Red-tailed Black-Cockatoo,
- Baudin's Black-Cockatoo,

- Quenda,
- Rakali, and
- Native Bee.

2.5 Conservation and Special Use Areas

Figure 2-1 illustrates Conservation and Special Use Areas within a 15km radius of Perth Airport. No Conservation or Special Use Areas are expected to be impacted by the proposed Airport West (South) project.

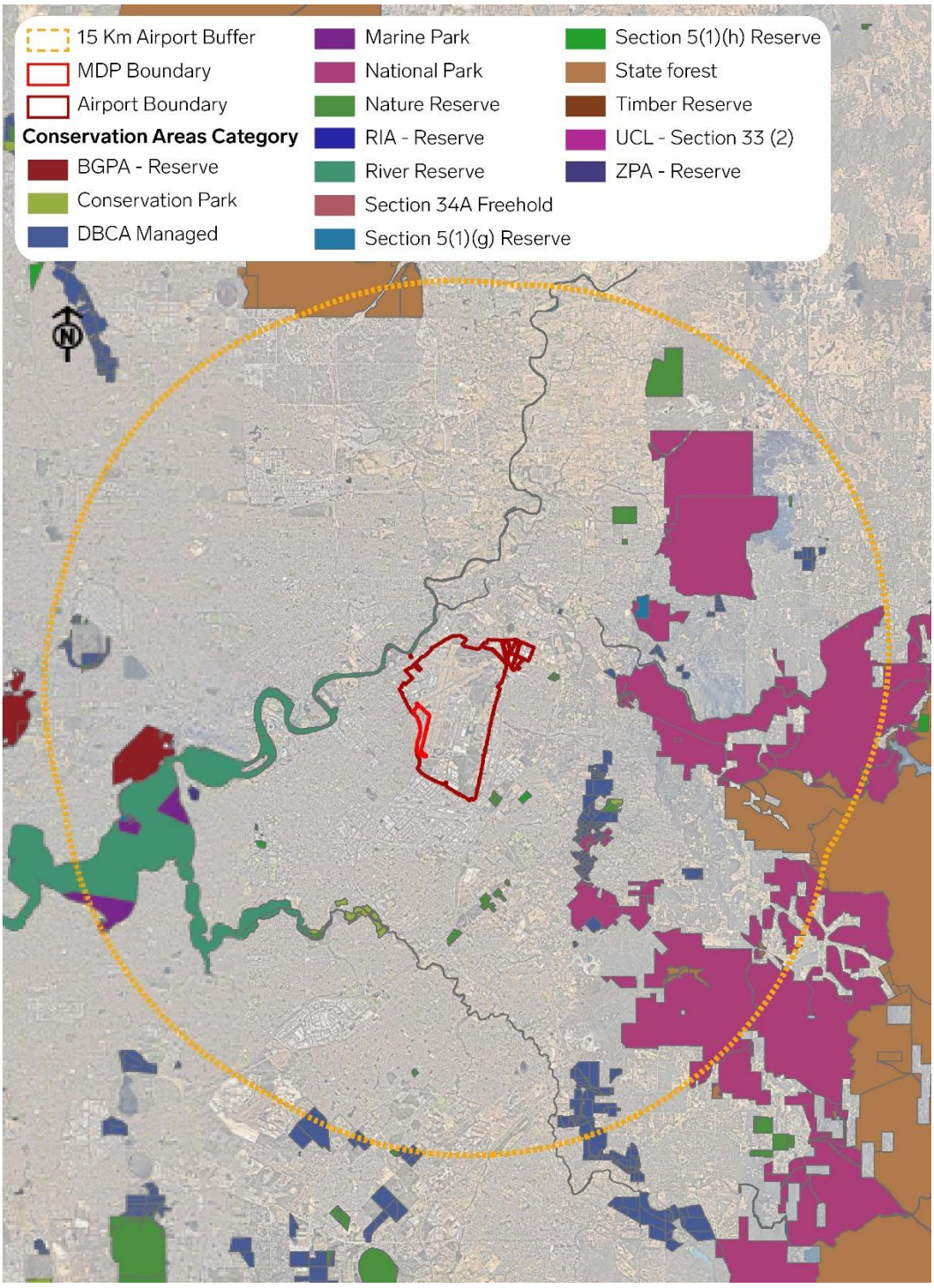

Figure 2-1 Conservation and Special Use Areas within 15km radius of Perth Airport

Source: Perth Airport

2.6 Heritage Places and Items

Key findings arising from investigations for heritage values within the Airport West (South) project area include:

- A search of the Aboriginal Heritage Inquiry System (AHIS) database identified three sites that have the status of Other Heritage Place (OHP) as occurring within the project area. These are not registered Aboriginal sites; however, there is the potential likelihood to encounter unknown heritage values during earthworks.
- There are no known historical or natural heritage sites within the project area.

The three OHPs (located within the project area) are factors identified as being relevant to the project area therefore warranting further assessment.

2.7 People and Communities

A socio-economic assessment has been completed for the Airport West (South) project, which describes the human environment relevant to the Airport West (South) project area and broader airport estate. Refer to Part A Report for details.

Aircraft noise exposure levels, both air and ground based, are also detailed in Part A of this MDP.

Factors and issues identified as being relevant to the construction phase of the Airport West (South) project and which therefore require further assessment in this Part B report include:

- PFAS impacted soil and groundwater (refer Section 5.4.1),
- Construction dust (refer Section 8.2.1), and
- Construction noise and vibration (refer Section 8.2.2).

3. Flora and Vegetation

This section provides detail on the:

- Existing flora and vegetation within and surrounding the project area,
- Flora and vegetation impact assessment (including direct, indirect and offsite impacts) and associated mitigation and avoidance measures. Impacts are considered for the following factors that are known to occur within or adjacent to the project area:
  - Native vegetation,
  - Banksia Woodlands Threatened Ecological Community (TEC), and
  - Two species listed as Priority Species by the State Department of Biodiversity, Conservation and Attractions (DBCA), *Platysace ramosissima*, (Priority 3) and *Johnsonia pubescens subsp. cygnorum* (Priority 2) which are likely to be impacted.

3.1 Policy and Legislative Context

The project area is located on Commonwealth land, therefore impacts on flora and vegetation are considered under the following:

- Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act),
- Significant Impact Guidelines 1.1: Matters of National Environmental Significance (DoE 2013) (Guideline 1.1), and
- Significant Impact Guidelines 1.2: for Actions on or impacting upon Commonwealth land and actions by Commonwealth agencies (DSEWPaC, 2013) (Guideline 1.2).

Guideline 1.2 requires that all potential impacts resulting from airport projects (on Commonwealth land) are assessed. This includes both EPBC Act protected flora and vegetation (Matters of National Environmental Significance (MNES)) and non-MNES flora and vegetation and is known as a "Whole of Environment" approach, covering MNES and non MNES impacts. This "Whole of Environment" approach to flora covers the assessment of potential impacts (direct, indirect and offsite), mitigation and significance to MNES, state listed species and other remnant native vegetation. Guideline 1.2 is considered in conjunction with Guideline 1.1 which includes criteria for assessing the significance of potential impacts to flora that may:

- lead to a long-term decrease in the size of a population,
- reduce the area of habitat of a species,
- fragment an existing population into two or more populations,
- adversely affect habitat critical to the survival of a species,
- disrupt the breeding cycle of a population,
- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline,
- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat,
- introduce disease that may cause the species to decline, or
- interfere with the recovery of the species.

Biodiversity in Western Australia is also protected under the Western Australian *Biodiversity Conservation Act 2016* (BC Act), which replaced the WA *Wildlife Conservation Act 1950* at the start of 2019. State and local matters, such as listed species and communities, are also considered in this assessment as part of the "Whole of Environment" approach to flora. In addition to the EPBC Act and Guideline 1.1, this report has been developed in consideration of the following policy documents and guidelines:

- Environmental Protection Authority (EPA) (2000) Position Statement No. 2: Clearing of Native Vegetation,
- Environmental Protection Authority (EPA) (2008) Environmental Guidance for Planning and Development, Guidance Statement No. 33,
- Environmental Protection Authority (EPA) (2016). Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment,
- Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community.

3.2 Methodology

The flora and vegetation community assessment for the Airport West (South) project has been drawn from an estate wide Level 2 Flora and Vegetation Field Survey undertaken by Woodman Environmental Consulting during spring 2018 and an impact assessment report by Woodman Environmental Consulting in 2020.

The scope of the 2018 spring survey and 2020 Woodman Environmental Consulting study was to:

- collate data regarding Conservation Significant Flora from previous surveys,
- identify the presence and significance of threatened and/or priority ecological communities and flora, and
- assess the significance of potential impacts to present threatened and/or priority ecological communities and flora.

The impact assessment methodology used is illustrated in Figure 3-1.

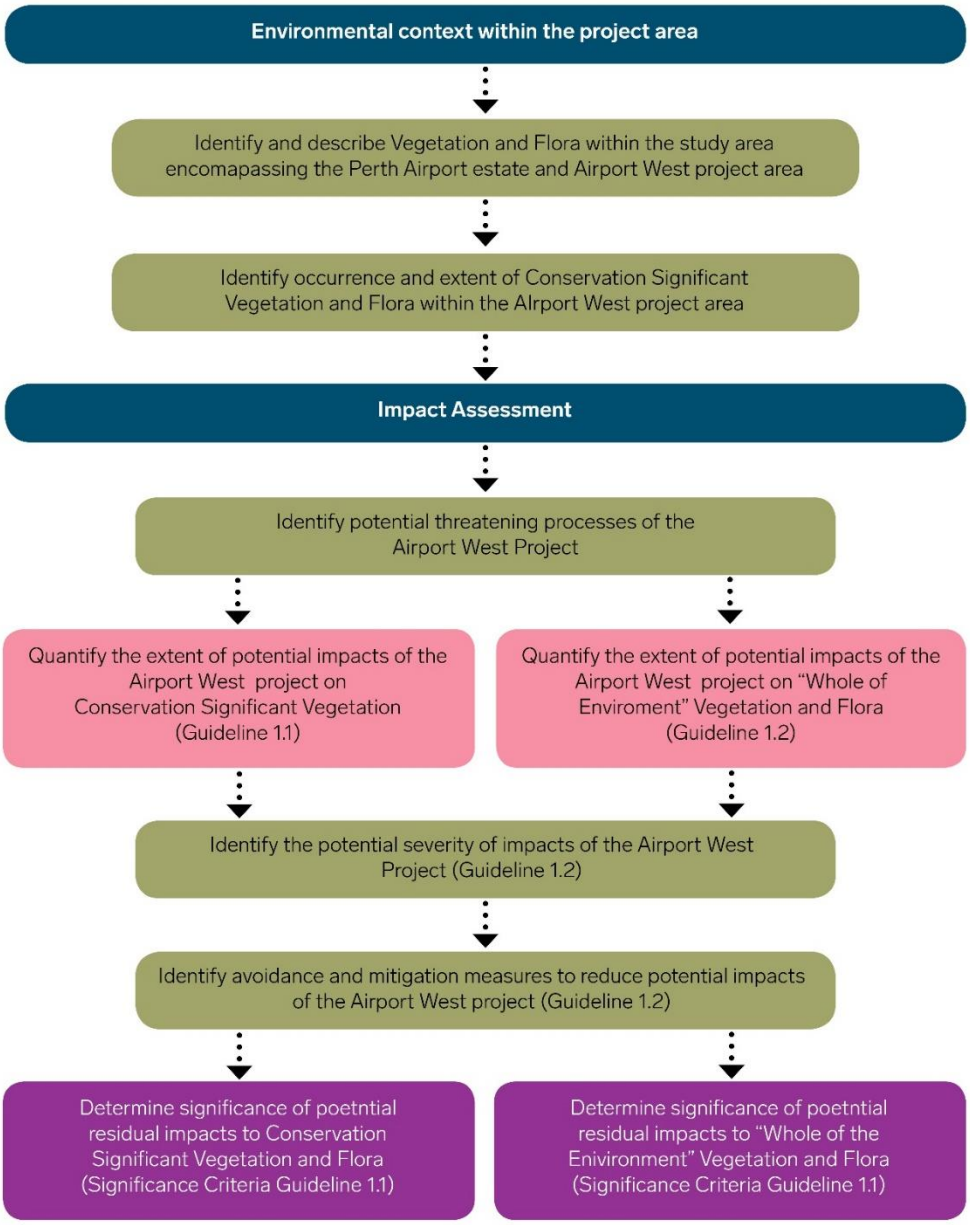

Figure 3-1 Flora Impact Assessment Methodology

Source: Woodman Environmental, 2020

For more details on the flora impact assessment process and threatening processes refer to Section 4 of Woodman Environmental Consulting 2020.

3.3 Flora and Vegetation

Four vegetation types were defined in the project area. These are mapped in Figure 3-2 and collectively represent approximately 35.9 hectares (51.7 percent) of the project area. Vegetation type 8 (Mid to low to open Marri, Jarrah and Melaleuca woodland) is the most prevalent, while vegetation types 3 (low Melaleuca woodland), 12 (mid Jarrah woodland over Sheoak and Banksia) and 13 (Low to open Banksia Woodland) have limited representation. A full description of vegetation types, definitions and percentages within the Airport West (South) project area is shown in Table 3-1.

Vegetation Type	Area (Hectares)	Percent of Project Area
3- Low woodland to open woodland dominated by *Melaleuca preissiana,* with *Banksia littoralis, Melaleuca rhaphiophylla* and Melaleuca viminea sometimes present, and occasionally with a mid woodland or forest of *Eucalyptus rudis* or *Corymbia calophylla.*	8.8	13.5%
8 - Mid to low woodland to open woodland of *Corymbia calophylla, Eucalyptus marginata* and *Melaleuca preissiana* over mid to low open shrubland of mixed species dominated by *Xanthorrhoea brunonis, Gompholobium tomentosum* and *Calytrix fraseri* over low sedgeland.	20.7	31.7%
12 - Mid woodland of *Eucalyptus marginata* over a low to mid woodland of *Allocasuarina fraseriana, Banksia menziesii* and *B. attenuata* over a low shrubland dominated by Hibbertia hypericoides subsp. hypericoides and Bossiaea eriocarpa on a mid-open sedgeland of mixed species including *Alexgeorgea nitens, Desmocladus flexuosus, Mesomelaena pseudostygia* and *Lyginia imberbis,* on dunes and low rises, soils grey sand.	1.4	2.1%
13 - Low woodland to low open forest of *Banksia menziesii, B. attenuata* and occasional *Eucalyptus todtiana* over a mid-open shrubland of *Adenanthos cygnorum subsp. cygnorum, Jacksonia floribunda, Scholtzia involucrata, Melaleuca seriata* and *Xanthorrhoea preissii* over a low open shrubland dominated by *Eremaea pauciflora var. pauciflora, Hibbertia hypericoides subsp. hypericoides* and *Bossiaea eriocarpa* on a mid-open sedgeland dominated by *Alexgeorgea nitens, Desmocladus flexuosus,* and *Lyginia imberbis,* on dunes and low rises, soils grey sand.	5.0	7.6%%
Disturbed Vegetation	1.1	1.6%
Total Native Vegetation	37.0	56.5%
Cleared or current infrastructure, no or degraded vegetation	28.5	43.5%
Total Project Area	65.5	100%

Table 3-1 Description of Vegetation Type and occurrence within the project area

Source: Woodman, 2020

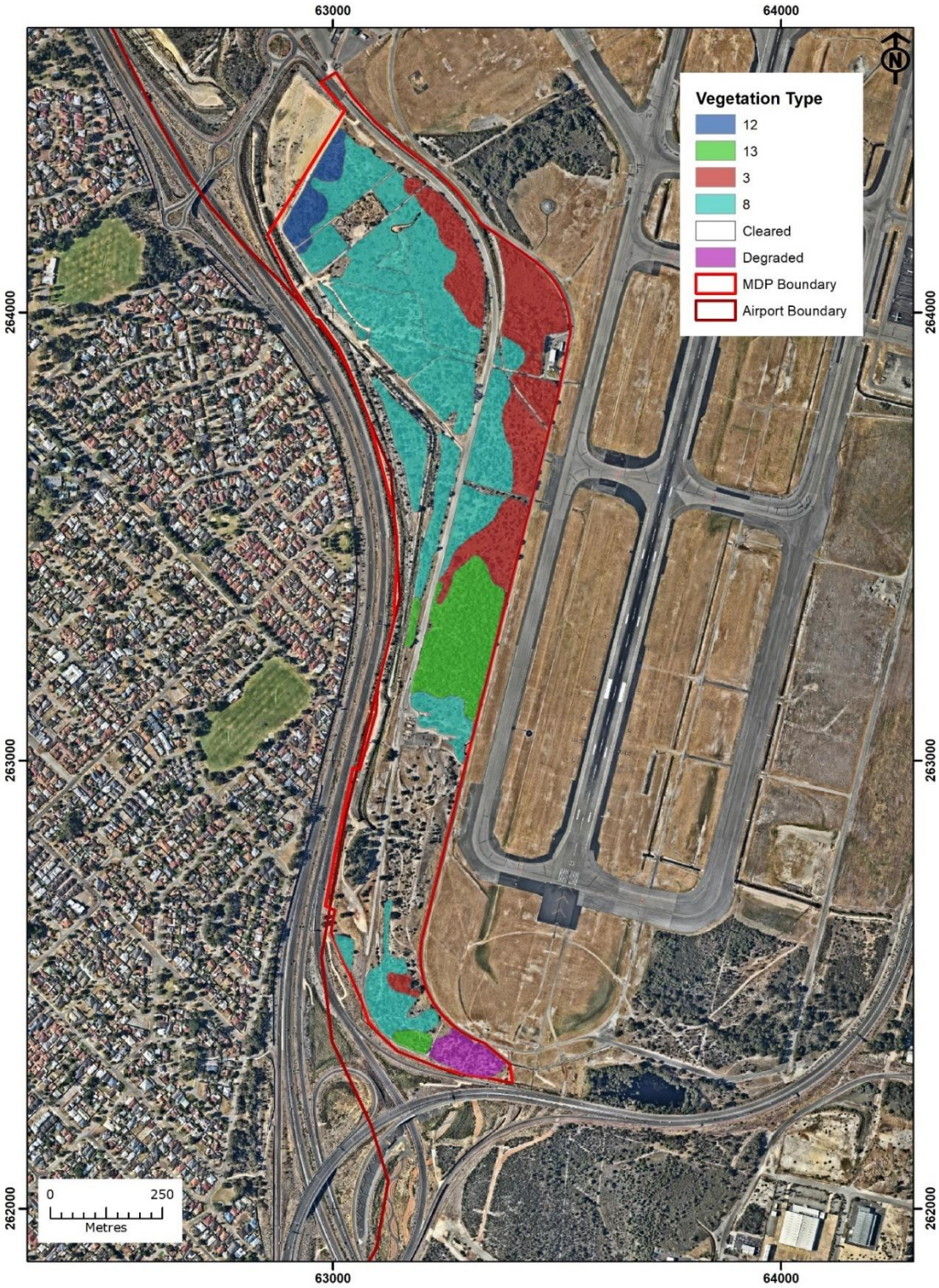

Figure 3-2 Vegetation Types recorded in the Airport West (South) project area

Source: Woodman Environmental Consulting, 2020

3.4 Vegetation Condition

The condition of vegetation across the project area ranges from Completely Degraded to Very Good, as shown in Figure 3-3. No vegetation in the Airport West (South) project area was considered to be in Pristine condition due to the presence of weed species or evidence of disturbance including feral animals and vehicle tracks across the project area. Also, there were no areas of vegetation recorded in an Excellent condition category.

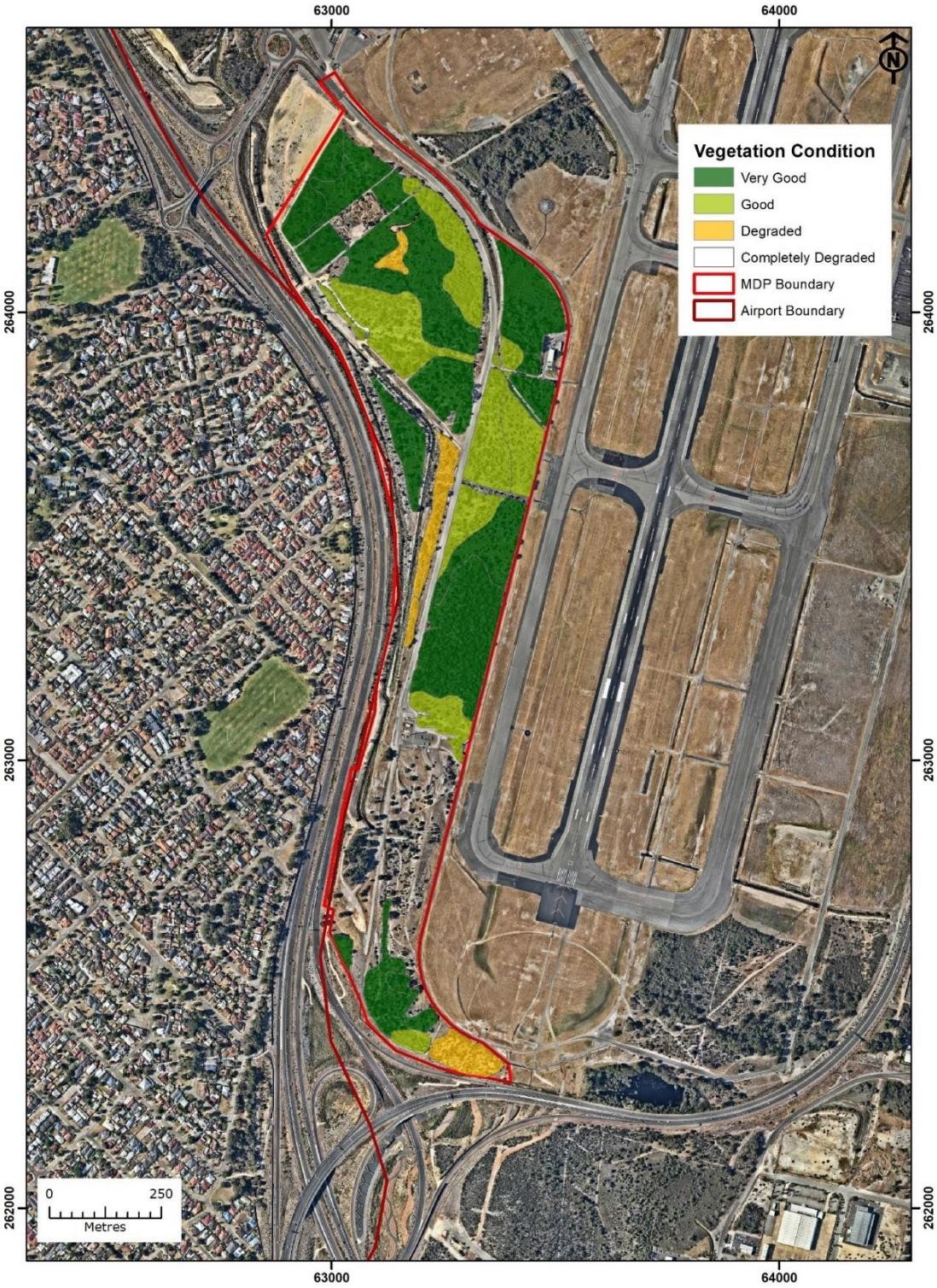

Figure 3-3 Vegetation Condition within the Airport West (South) project area

Source: Woodman Environmental Consulting, 2020

Table 3-2 summarises the condition categories (as per scale presented in EPA 2016) of the vegetation within the Airport West (South) project area; 28.5 hectares of the Airport West (South) project area (representing 43.50 percent) were in the condition category of Completely Degraded. A total of 37.0 hectares comprised native vegetation with 34.2 hectares mapped in the categories of Good to Very Good condition.

Vegetation Condition Category	Area (Hectares)	Percent of AWP area
Pristine	0	0
Excellent	0	0
Very good	23.0	35.1
Good	11.2	17.2
Degraded	2.8	4.3
Total area of remnant vegetation – Pristine to Degraded	37.0	56.5
Completely Degraded (Cleared/Developed)	28.5	43.5
Total	65.5	100

Table 3-2 Summary of the Vegetation Condition within the Airport West (South) Project area

Source: Woodman Environmental Consulting, 2020

3.5 Threatened Ecological Communities

A review of database entries for Commonwealth listed ecological communities identified two previous entries within or adjacent to the project area, as shown in Table 3-3.

Ecological Community	EPBC Act Status	Presence
Clay Pans of the Swan Coastal Plain	Critically endangered	Not present within the Project Area
Banksia Woodlands of the Swan Coastal Plain	Endangered	Confirmed within the Project Area

Table 3-3 Database records of Commonwealth listed ecological communities within or adjacent to the Project Area

Surveys conducted within the project area and broader Perth Airport estate indicate the presence of the Commonwealth listed Banksia Woodlands Threatened Ecological Community (TEC). To determine the Floristic Community Type (FCT) of the vegetation patches within the area, vegetation data was compared with the FCT definitions in Gibson *et al* (1994) and only one FCT was identified in the Banksia Woodland patches: FCT 23a (See Section 3.9 for the impact assessment).

The Clay Pans of the Swan Coastal Plain TEC was confirmed as not present during the survey of Perth Airport Estate and is absent within the project area.

3.6 Conservation significant Flora Species

The 2018 Woodman Environmental Consulting survey and the 2015 Mattiske survey identified no threatened flora species within the project area. The presence of two DBCA listed Priority Species, *Platysace ramosissima* (P3) and *Johnsonia pubescens* subsp. *cygnorum* (P2) was identified in the Airport West (South) project (See Section 3.10 for the impact assessment)

3.7 Dieback

During 2017 a dieback (Phytophthora cinnamomi disease) assessment was undertaken within the Perth Airport estate that encompassed the project area. The assessment was conducted in accordance with guidelines set out by the Phytophthora Dieback Interpreters Manual for Lands managed by the Department of Parks and Wildlife Forest and Ecosystems Management (Department of Parks and Wildlife, 2015, now part of the DBCA).

Presence of dieback was determined through the observation of host plant health and landscape vegetation change and supported by strategic sampling of soil and plant tissue.

Figure 3-4 shows the dieback status of the assessed area within the Airport estate that encompasses the Airport West (South) project area. The areas of each dieback category and the contribution to the Airport West (South) project area are summarised in Table 3-4. Uninfested areas comprised only 4.2 hectares (6.4 percent) of the Airport West (South). 14.88ha (22.74%) of the Airport West (South) project area was excluded from the survey of dieback due to the vegetation condition (cleared/developed land) restricting interpretation. A further 12.8 hectares (19.5%) was not assessed during the 2017 dieback survey. Most of this area is likely to be "Infested" considering it is adjacent to areas categorised as "Infested".

Dieback Interpretation Category	Area (hectare)	Percent of Airport West (South) project area
Uninfested	4.2	6.4
Infested	29.9	45.7
Uninterpretable	3.7	5.7
Excluded	14.9	22.7
Not Assessed	12.8	19.5
Total	65.5	100

Table 3-4 Area of each dieback category within the Airport West (South) Project area

Source: Woodman Environmental Consulting, 2020

The uninfested areas may be managed hygienically in a soil-moving operation. However, reassessment of uninfested areas will be required within 12 months prior to any soil movement activities to allow for fresh disease movement in accordance with the DBCA standard.

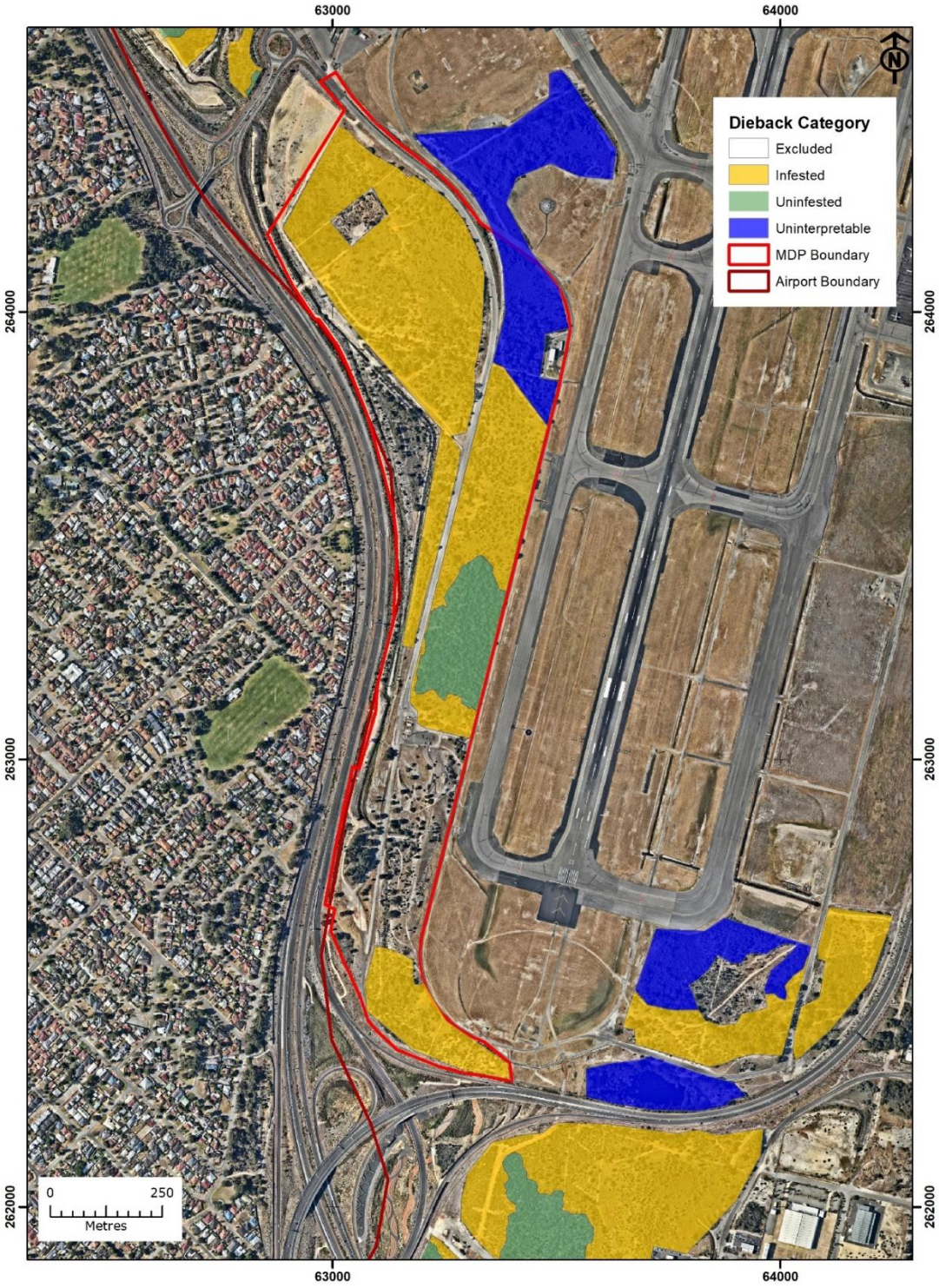

Figure 3-4 Dieback Occurrence within the Project Area

Source: Woodman Environmental Consulting, 2020

3.8 Flora Impact Assessment – Native Vegetation

Section 3.3 provides an overview of the existing native vegetation within the project area.

The conservation values of the remnant vegetation within Perth Airport relate to the large amount of clearing which has already occurred on the eastern Swan Coastal Plain. At the broader regional scale, the clearing has been for agriculture. Within the local region, intensive clearing has occurred to support industry and residential development. This historical land development has increased the importance of the relatively small amount of native vegetation which remains, especially within the Perth metropolitan area.

This project occurs within the Swan Coastal Plain 2 IBRA subregion (dominated by Banksia or Tuart on sandy soils, *Casuarina obesa* on outwash plains and paperbark (Melaleuca)) in swampy areas.

The Bassendean 1001 vegetation association is potentially impacted by the Airport West (South) project. Approximately 11,394 hectares of the vegetation association are extant representing 21.4 % of the pre-European extent. Of the current vegetation association extent, 14.1 % is located within the conservation estate.

The EPA (2000) considered the threshold level below which species loss appears to accelerate exponentially at an ecosystem level as being at a level of 30% of the pre-clearing extent of the vegetation type. A level of 10% of the original extent is considered to represent an "endangered level." The EPA (2008) proposes that ecological communities in constrained areas of the Swan Coastal Plain, that includes Airport West (South), are maintained at above 10% of the pre-clearing extent of the ecological community.

3.8.1 Direct Impacts and Associated Avoidance/Mitigation Measures

Development of the project will involve the clearing of up to 37.0 hectares of remnant vegetation.

The areas of remnant vegetation in the Airport West (South) project area recorded to be in Very Good Condition may be considered locally significant as they represent patches of comparatively high native species diversity within otherwise degraded vegetation. Surveys over the project area have not identified the presence of the EPBC Act listed threatened flora *Conospermum undulatum* and *Macarthuria keigheryi*. However, the remnant native vegetation may be considered locally significant and representative of habitat for conservation significant Priority Flora. Two Priority Flora species were recorded with the Airport West (South) project area: *Platysace ramosissima (P3)* and *Johnsonia pubescens subsp. cygnorum (P2).*

Clearing of the project area's remaining remnant vegetation has the potential to decrease the area of one conservation significant vegetation community (Banksia Woodlands of the Swan Coastal Plain), and also directly impacts two Priority Flora taxa. The potential direct impacts of the Airport West (South) project on remnant native vegetation with the proposed mitigation measures are summarised in Table 3-5.

Perth Airport proposes to revegetate approximately 4.5 hectares of an onsite detention basin proposed to be developed as part of the project. The indicative location of the basin is shown within Figure 3-5. and this detention area will be regenerated and provide an area of native vegetation and fauna habitat in the future.

Impact Type	Impacting Process	Discussion (Potential impacts)	Proposed Avoidance/mitigation Measures	Severity
Direct impact	Clearing	The project will clear up to 37.0 hectares of remnant vegetation: This represents 7.8 % of local extent of remnant vegetation within the Perth Airport estate. This represents 0.3% of the remaining area of the Bassendean Association 1001 leaving 21.3% of the pre-European extent. This is above the EPA target of 10% in constrained areas of the Swan Coastal Plain.	Avoidance from direct impact is not feasible due to the nature of locating infrastructure. Impact will be minimised as far as possible during detailed design.	Severe
Indirect impact	Clearing	There is potential for unintentional clearing of areas of remnant vegetation outside the project area.	A Construction Environmental Management Plan (CEMP) will address the design and operations for the clearing area, and demarcate (signage/fencing) exclusion zones for areas needing protection. Disturbed areas can be rehabilitated.	Minor
Indirect impact	Habitat fragmentation	Clearing for Airport West (South) is likely to result in the isolation of an adjacent area of remnant vegetation.	Avoidance from fragmentation is not feasible due to the nature of locating infrastructure. Impact will be minimised as far as possible during detailed design.	Severe
Indirect impact	Changes in genetic diversity	The potential reduction in the area of the remnant vegetation will contribute to reducing local genetic diversity of Priority Flora.	Avoidance from fragmentation is not feasible due to the nature of locating infrastructure. Impact will be minimised as far as possible during detailed design.	Minor
Indirect impact	Introduction and/or spread of weeds	Although weeds occur throughout the airport estate, the movement of soil into and around the project area may introduce or spread weeds into adjacent area of remnant vegetation.	A CEMP will address soil hygiene to prevent introduction and spread of weeds.	Minor
Indirect impact	Spread of Disease – Dieback	Most of the area of remnant vegetation within and surrounding the project area is infested or likely to be infested with dieback. Unintentional spread will accelerate the rate of infestation.	A CEMP will address soil hygiene procedures to prevent introduction and spread of dieback.	Minor
Indirect impact	Change in bushfire regime	Increased burning may adversely affect the vegetation, however native plants are adapted to fire and the vegetation is likely to recover after burning with management of weed invasion.	Perth Airport currently maintains a fuel load management fire regime.	Minor
Indirect impact	Groundwater hydrological changes	The Airport West (South) project is not expected to have any impacts to the hydrological regime (Table 6-2).	Not applicable (See Table 6-2).	Negligible

Table 3-5 Severity of potential impacts of the Airport West (South) Project on remnant native vegetation and associated avoidance or mitigation measures

Source: Woodman Environmental Consulting, 2020

Figure 3-5 Indicative location of Detention Basin to be revegetated as part of Airport West (South)

Source: Perth Airport

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3.8.2 Indirect and Off-Site Impacts and Associated Avoidance/Mitigation Measures

The potential indirect impacts of the Airport West (South) project to remnant vegetation and proposed avoidance and mitigation measures are summarised in Table 3-5.

3.8.3 Cumulative Impacts

The potential cumulative impacts of the proposed Airport West (South) project and NRP on the extent of remnant vegetation are summarised in Table 3-6.

	Area of Condition (Hectare)					
Project Area	**Excellent**	**Very Good**	**Good**	**Degraded**	**Completely Degraded**	**Total Area (hectare)**
Airport West (South) Project	-	23.0	11.2	2.8	-	37.0
NRP	7.6	91.5	17.5	21.5	1.3	139.4
Total	7.6	114.5	28.	24.25	1.3	176.4

Table 3-6 The potential cumulative impacts of the Airport West (South) and New Runway Project on Remnant Native Vegetation

Source: Woodman Environmental Consulting, 2020

The cumulative impacts of the proposed project on the extent of the Bassendean Association 1001 is summarised in Table 3-7.

Project area		**Bassendean Association 1001**
Project area	Airport West (South) project	37.0 hectare
	New Runway Project	-
Total Area (hectare) of Bassendean Association potentially impacted by the Airport West (South) and New Runway Project		37.0 hectare
Total potential cumulative impact of Airport West (South) and New Runway Project as a % of extant Association		0.32 %
Potential % of Pre-European area remaining after Airport West (South) and New Runway Project implemented		21.3 %

Table 3-7 The potential cumulative impacts of the Airport West (South) and NRP on the area of Bassendean Association 1001

Source: Woodman Environmental Consulting, 2020

3.8.4 Significance of Residual Impacts

An assessment of the potential impacts to native vegetation using Guideline 1.1 significance is provided in Section 5.4.5 of the Woodman Environmental Consulting 2020 report.

At the local scale, the Airport West (South) Project reduces the extent of remnant native vegetation by 7.8%. At the regional scale the current extent of the Bassendean vegetation association 1001 is already below the threshold of 30% of pre-clearing extent (below which the EPA (2000) considers species loss appears to accelerate). The Airport West (South) project potentially reduces the extent of Bassendean 1001 to 21.3% of the pre-European extent; this is above the 10% level representing ''endangered'' (EPA 2000). Cumulatively, given there is no impact to Bassendean 1001 by New Runway Project, the two projects reduce the extent of Bassendean 1001 to 21.3% of the pre-European extent: this is still above the 10% level representing ''endangered'' (EPA 2000).

In this context, the potential impact of the Airport West (South) project and the potential cumulative impacts on remnant vegetation at the regional scale will contribute to the decline of vegetation of the Bassendean 1001 Association toward the 10% endangered threshold, however it is not considered to constitute a significant impact to remnant vegetation as there will still be 21.3% remaining.

The potential impacts of the Airport West (South), and the cumulative impacts of the Airport West (South) and New Runway projects on remnant vegetation as a whole are therefore not considered significant.

3.9 Banksia Woodland TEC Impact Assessment

3.9.1 Overview

The 2018 Woodman Environmental Consulting Survey identified the presence of Banksia Woodland TEC within the Perth Airport estate and the Airport West (South) project area. The survey was conducted in accordance with the approved Conservation Advice sampling requirements (Threatened Species Scientific Committee 2016) (Conservation Advice). As part of this work, Woodman Environmental Consulting assigned estate wide patch numbers for those areas that meet the requirements of a patch as defined by the Conservation Advice and these patch numbers are used throughout this document.

Figure 3-6 and Table 3-8 illustrate the patches and condition of Banksia Woodland TEC located within the project area. Both patches of Banksia Woodlands TEC comprise Floristic Community Type 23a (FCT 23a). Figure 3-7 shows the dieback status of Banksia Woodlands patches within the project area: Patch 18 is completely infested whereas Patch 19 is mostly dieback free, with dieback observed only around the edges of the patch.

The Conservation Advice specifies minimum patch sizes based on vegetation condition as follows:

- Pristine - no minimum patch size,
- Excellent – 0.5 hectares,
- Very Good – one hectare, and
- Good – two hectares.

A full assessment of the Banksia Woodlands patches against key diagnostic criteria of the approved conservation advice is given in Section 5.2.1 of Woodman Environmental Consulting 2020.

Patch Number	Area of Patch Condition (Hectare)					Total Area of Patch (Hectare)	Area of Patch Remaining (Hectare)
	Excellent	Very Good	Good	Degraded	Completely Degraded		
18	-	1.4		-	-	1.4	0.0
19	-	4.4		0.2	-	4.6	0.0
Total area of TEC within the project (hectare)	0.0	5.8	-	0.20	0.0	-	-

Table 3-8 Banksia Woodland Patches and Corresponding Area

Source: Woodman Environmental Consulting, 2020

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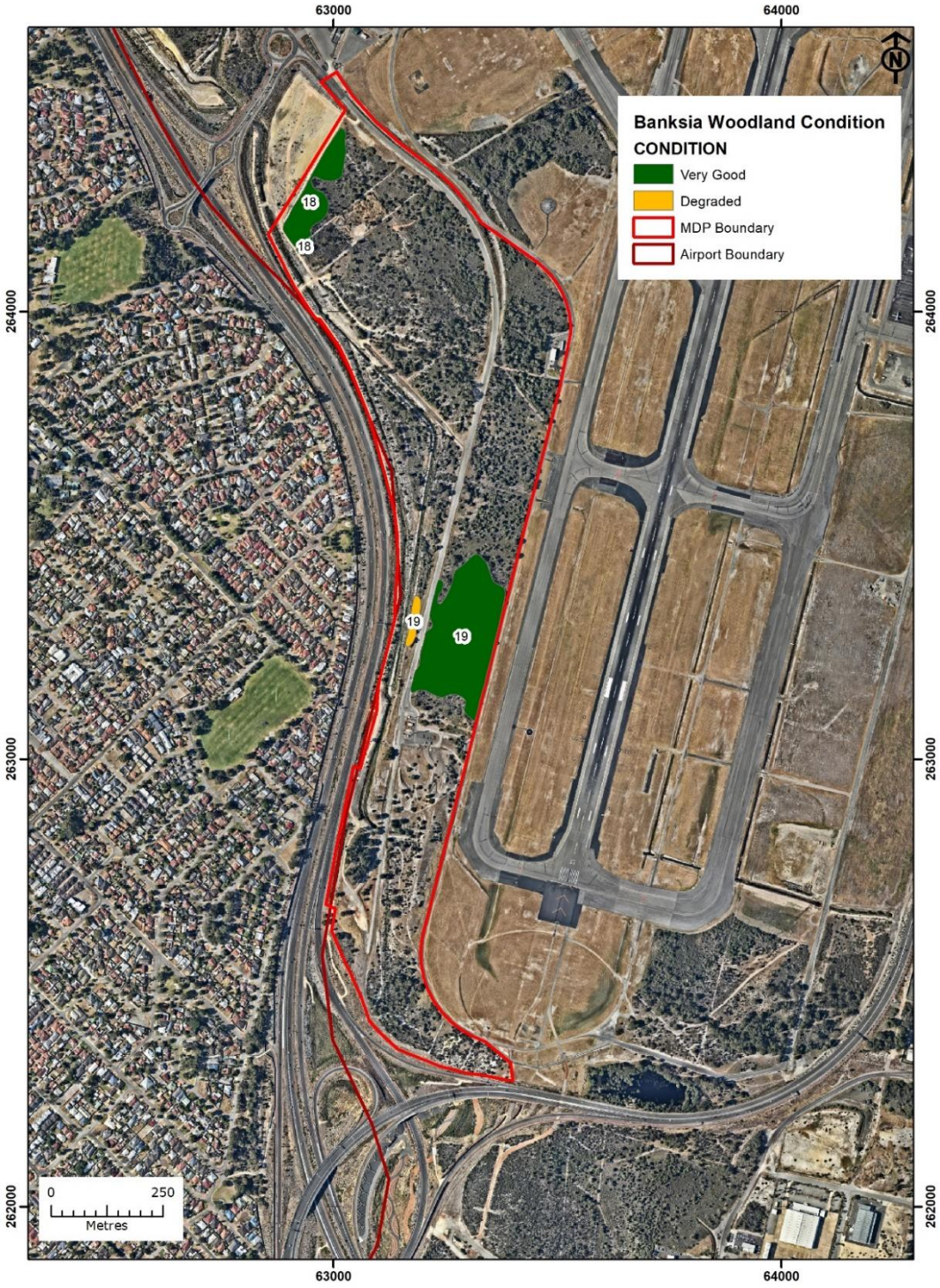

Figure 3-6 Location and Patch Numbers of Banksia Woodland patches within the Project Area

Source: Woodman Environmental Consulting, 2020

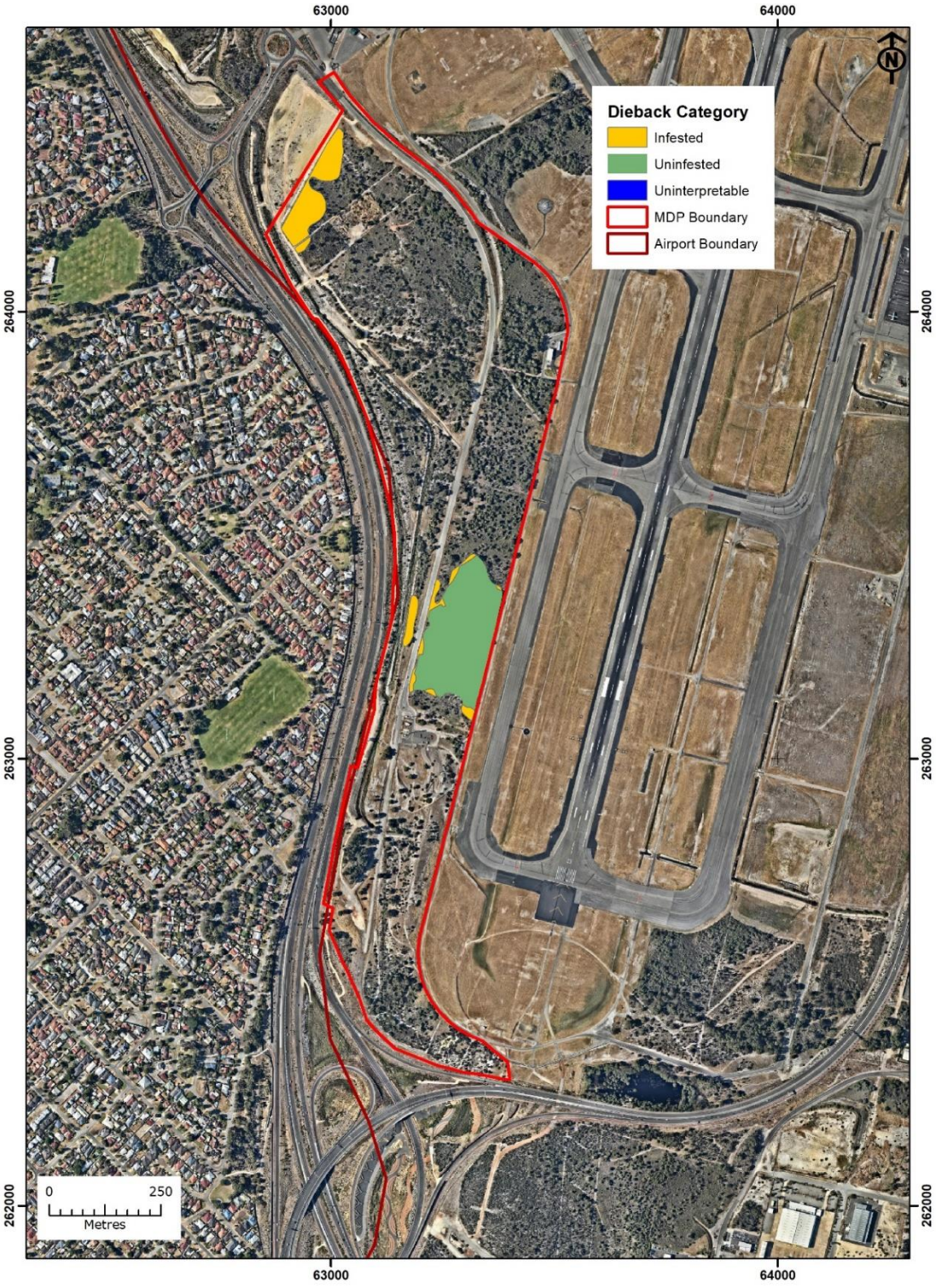

Figure 3-7 Dieback Status of Banksia Woodland patches within Airport West (South)

Source: Woodman Environmental Consulting, 2020

3.9.2 Direct Impacts and Associated Avoidance/Mitigation Measures

Development of the Airport West (South) project will involve the clearing of up to approximately 6.0 hectares of Banksia Woodlands TEC which comprises of FCT23a. The potential direct impacts of the Airport West (South) project on remnant native vegetation with proposed mitigation measures are summarised in Table 3-9.

3.9.3 Indirect and Offsite Impacts and Associated Avoidance/Mitigation Measures

There are no areas of Banksia Woodland TEC adjacent to the Airport West (South) project area and therefore there is unlikely to be any indirect or offsite impacts of the project to Banksia Woodland TEC. Refer to Table 3-9 for further details.

Impact Type	Impacting Process	Discussion (Potential impacts)	Proposed Avoidance/Mitigation Measures	Severity
Direct impact	Clearing	The Airport West (South) project will impact up to 6.0 hectares of Banksia Woodland TEC: This represents • 4.14 % of local extent within the Perth Airport estate • 0.002 % of the regional extent of the Banksia Woodland TEC.	Avoidance from direct impact is not feasible due to the nature of locating infrastructure. Impact will be minimised as far as possible during detailed design.	Severe
Indirect Impact	Clearing	There is unlikely to be indirect impacts due to clearing as there are no areas of Banksia Woodland TEC adjacent to the Airport West (South) project area.	Not applicable.	Negligible
Indirect impact	Habitat fragmentation	Fragmentation is unlikely as the project potentially remove all areas of patches 18 and 19.	Not applicable.	Negligible
Indirect impact	Changes in genetic diversity	The reduction of up to 6.0 hectares area of the Banksia Woodland TEC within the airport estate will reduce the local genetic diversity.	Avoidance from fragmentation is not feasible due to the nature of locating infrastructure. Impact will be minimised as far as possible during detailed design.	Moderate
Indirect impact	Introduction and/or spread of weeds	There is unlikely to be introduction or spread of weeds as there are no areas of Banksia Woodland TEC adjacent to project area.	Not applicable.	Negligible
Indirect impact	Spread of Disease – Dieback	There is unlikely to be spread of disease as there are no areas of Banksia Woodland TEC adjacent to the project area.	Not applicable.	Negligible
Indirect impact	Change in bushfire regime	There is unlikely to be a change of fire regime as there are no areas of Banksia Woodland TEC adjacent to the project area.	Perth Airport currently maintains a fuel load management fire regime.	Minor
Indirect impact	Groundwater hydrological changes	The Airport West (South) project is not expected to have any impacts to the hydrological regime. There are no areas of Banksia Woodland TEC adjacent to the project area.	Not applicable.	Negligible

Table 3-9 Severity of potential impacts of the Airport West (South) project on the Banksia Woodland TEC and associated avoidance or mitigation measures

Source: Woodman Environmental, 2020

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3.9.4 Cumulative Impacts

Table 3-10 summarises the potential cumulative impacts of Airport West (South) and New Runway Project on Banksia Woodlands TEC.

	Area of Condition (Hectare)					
Project Area	**Excellent**	**Very good**	**Good**	**Degraded**	**Completely Degraded**	**Total Area (hectare)**
Airport West (South)	-	5.8	-	0.20	-	6.0
New Runway Project	0.5	32.3	5.3	2.0	1.3	41.4
Total Area	1.3	38.2	5.34	2.2	1.3	47.4

Table 3-10 The potential cumulative impacts of the Airport West (South) Project and New Runway Project on the extent of Banksia Woodlands TEC in the Perth Airport estate

Source: Woodman Environmental, 2020

3.9.5 Significance of Residual Impacts

An assessment of the potential impacts to Banksia Woodlands TEC using Guideline 1.1 significance is provided in Section 5.2.5 of the Woodman Environmental Consulting 2020 report.

The potential impacts of the Airport West (South) project on the Banksia Woodland TEC will reduce the community's extent by 6.0 hectares representing 4.14 % of the occurrence in the airport estate.

Cumulatively the Airport West (South) and New Runway Project projects potentially impact on 47.4 hectares of Banksia Woodland TEC, representing 32.7 percent of the occurrence in the airport estate.

At a regional scale the 6.0 hectares potentially impacted by the Airport West (South) project represents less than 0.002 percent of the extant area of the Banksia Woodland TEC on the Swan Coastal Plain. The potential cumulative impacts of the Airport West (South) and NRP represent less than 0.01 percent of the extant area of the Banksia Woodland TEC on the Swan Coastal Plain.

Approximately 24.4% (81,830 hectares) of the estimated regional extent (336,490 hectares) of Banksia Woodlands TEC is in reserves within conservation estate (DEE, 2016). Due to the large remaining area, with much in conservation reserves and the localised impact area of the Airport West (South) project, the potential cumulative impacts of the Airport West (South) and New Runway Project on the Banksia Woodland TEC are not considered significant with respect to the survival of the ecological community across its range.

3.9.6 Offsets

Proposed Offsets for the 6.0-hectare impact to the Banksia Woodland TEC are outlined in Section 12.

3.10 State Listed Priority Flora Impact Assessment

3.10.1 Overview

Two Priority Flora species were recorded within the Airport West (South) project area. The listing as a Priority species denotes further survey is required to determine their status and potential listing as conservation significant under the BC Act.

Johnsonia pubescens subsp. *cygnorum* (P2) is a tufted perennial herb, growing to 0.25 m high on flats and seasonally wet sites. It is known to occur over a range of approximately 70 km from the suburb of Bentley in the Perth Metropolitan Area (PMA) in the north to 5 km east of Pinjarra in the south (Figure 3-8). This taxon is known from 17 records (Woodman Environmental Consulting 2020). The occurrence reported by Woodman Environmental (2020) at Perth Airport represents a new population for this species with a small extension to the north of its range.

Platysace ramosissima (P3) is a perennial herb, growing up to 0.3 metres high, occurring on sandy soils. Figure 3-9 shows the regional range of records for *P ramosissima* over approximately 385 km, from near Bunbury in the south to near Eneabba in the north

A review by Woodman Environmental (2018b) identified a total of 44 records, representing approximately 18 populations grouped into four general localities:

- South of Perth (Busselton-Capel to Lake Clifton): 2 populations
- PMA: 5 populations
- Swan Coastal Plain/Northern Sandplains: 9 populations
- East / North –East of PMA: 2 populations

At least five populations occur within DBCA-managed tenure, including Drummond Nature Reserve, Bartletts Well Nature Reserve, South Eneabba Nature Reserve, Wandoo National Park and Yalgorup National Park.

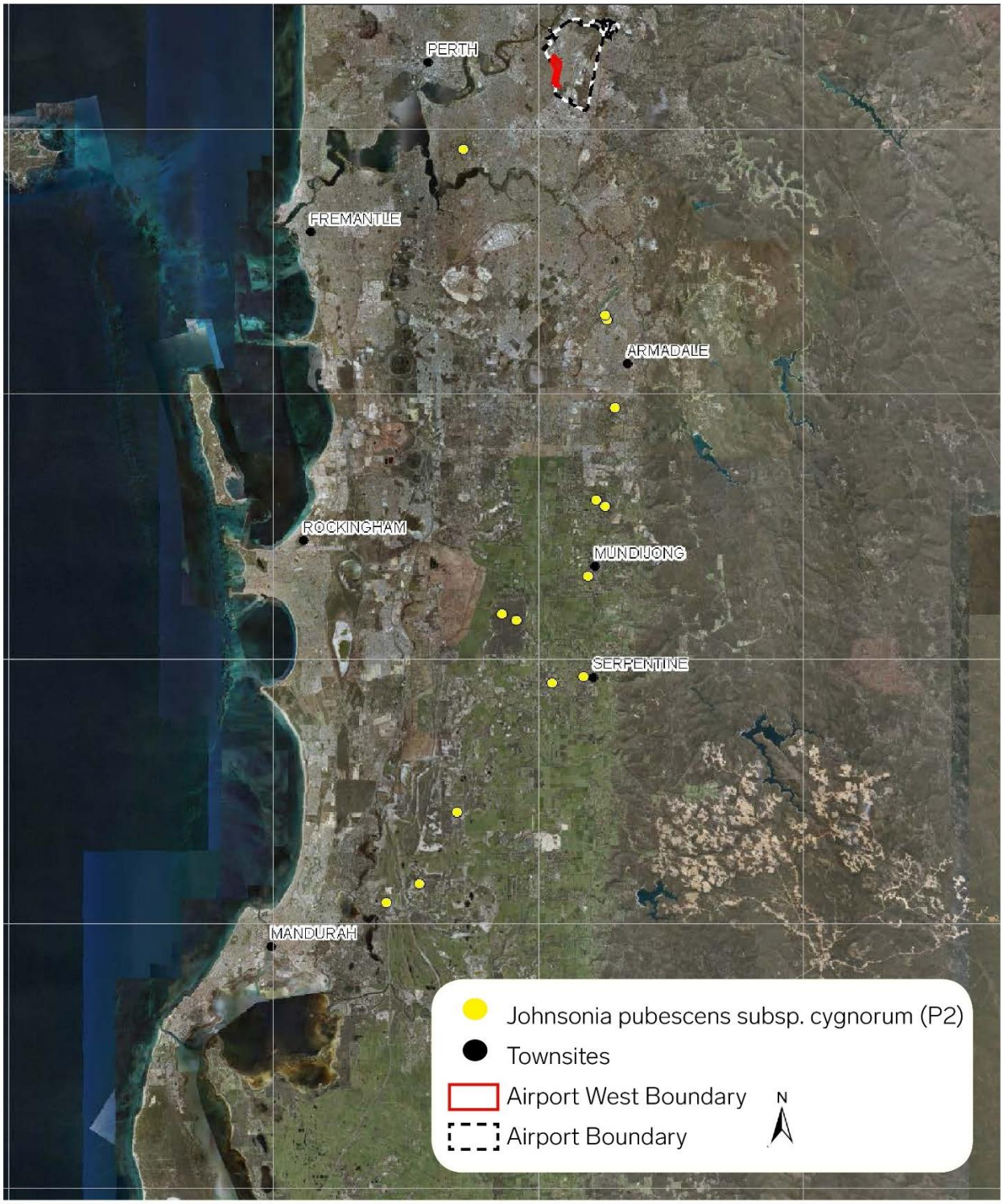

Figure 3-8 Regional reported location of *Johnsonia pubescens* subsp. *cygnorum* (P2)

Source: Woodman Environmental Consulting, 2020

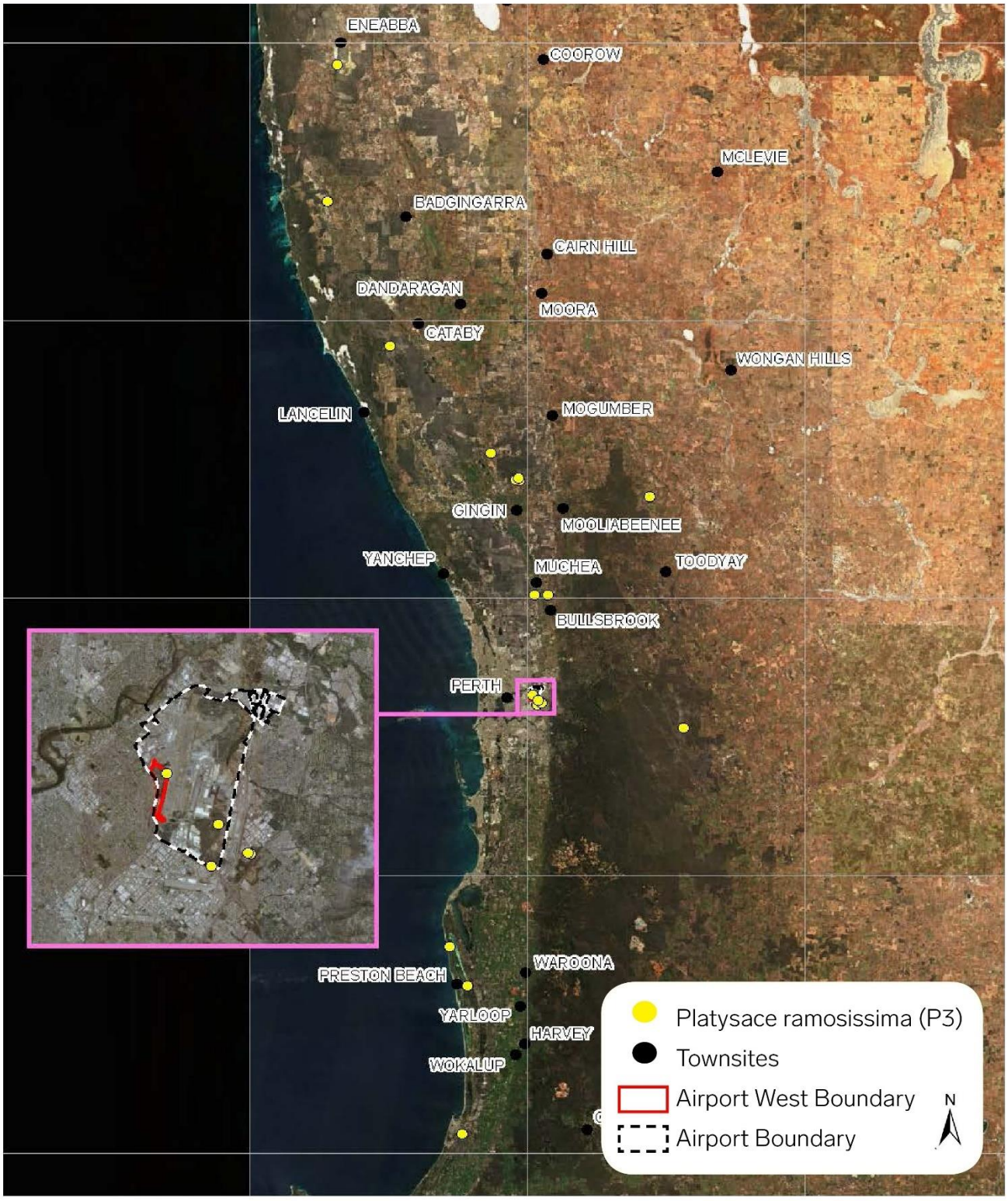

Figure 3-9 Regional reported locations of *Platysace ramosissima (P3)*

Source: Woodman Environmental Consulting, 2020

3.10.2 Direct and Indirect Impacts and Associated Avoidance/Mitigation Measures

The locations of the two Priority Flora species recorded within the project area is shown in Figure 3-10 and both locations are likely to be impacted.

The available abundance data were limited for all Priority Flora species, and most locations had no abundance data, both within the Perth Airport estate and regionally. Flora data for the Perth Airport estate have been derived predominately from surveys that varied in intensity ranging from gridded transects of selected areas, to opportunistic observations when moving between quadrats. The various surveys also covered the same area and therefore may have given repeated records of the same plants. The number of reported locations/populations has therefore been used for the impact assessment and significance of Airport West (South) Priority Flora, at the local and regional scales.

Table 3-11 summarises the avoidance and mitigation measures for the potential direct and indirect impacts of the Airport West (South) development on Priority Flora taxa.

Impact Type	Impacting Process	Discussion (Potential impacts)	Proposed Avoidance/mitigation Measures
Direct impact	Clearing	One location for each Priority flora taxa will be potentially impacted through clearing.	Avoidance from direct impact is not feasible due to the nature of locating infrastructure. Impact will be minimised as far as possible during detailed design.
Indirect impact	Clearing	There is unlikely to be indirect impacts due to clearing as there are no occurrences of Priority Flora adjacent to the Airport West (South) project boundary.	Not applicable.
Indirect impact	Habitat fragmentation	The Airport West (South) project potentially impacts on 36.99 hectares of remnant vegetation. Although reducing the area of potential habitat, the remaining native vegetation is not fragmented.	Avoidance from direct impact is not feasible due to the nature of locating infrastructure. Impact will be minimised as far as possible during detailed design.
Indirect impact	Changes in genetic Diversity	The potential reduction in plants will contribute to reducing the local genetic diversity of two Priority Flora taxa in the local area.	Avoidance from direct impact is not feasible due to the nature of locating infrastructure. Impact will be minimised as far as possible during detailed design.
Indirect impact	Introduction and/or spread of weeds	Although weeds occur throughout the airport estate, the movement of soil into and around the project area may introduce or spread weed into adjacent area of remnant vegetation.	A CEMP will address soil hygiene to prevent introduction and spread of weeds.
Indirect impact	Spread of Disease – Dieback	Most of the area of remnant vegetation within and surrounding the project area is infested with dieback. Unintentional spread will accelerate the rate of infestation into the small areas remaining uninfested areas.	A CEMP will address soil hygiene procedures to prevent introduction and spread of dieback.
Indirect impact	Change in bushfire regime	Increase burning may adversely affect the vegetation, however native plants are adapted to fire and the vegetation likely to recover after burning with management of weed invasion.	Perth Airport currently maintains a fuel load management fire regime.
Indirect impact	Groundwater hydrological changes	The Airport West (South) project is not expected to have any impacts to the hydrological regime ((See Table 6-2)).	Not applicable.

Table 3-11 The potential impacts of the Airport West (South) project on Priority Flora and associated avoidance or mitigation measures

Source: Woodman Environmental Consulting, 2020

Figure 3-10 Location of State Listed Priority Flora populations in the Project Area

Source: Woodman Environmental Consulting, 2020

3.10.3 Cumulative Impact

Cumulatively, five locations of *Johnsonia pubescens* subsp. *cygnorum* and two locations of *Platysace ramosissima* occur will be impacted by Airport West (South) and New Runway Project.

3.10.4 Significance of Residual Impacts

The ranking used to assess the significance of potential impacts of Airport West (South) and the cumulative impacts of the Airport West (South) and NRP on Priority Flora is shown in Table 3-12. For the purposes of this impact assessment, at the regional level the plants of each Priority Flora taxon within the Perth Airport estate are considered to comprise a population of that taxon.

Significance of Potential Impact	Level	Description of Impact
Low Impact	Local	<25 % of known local individuals or known locations may potentially be impacted
	Regional	<25 % of known regional locations/populations may potentially be impacted
Moderate Impact	Local	25 - 50 % (inclusive) of known local individuals or known locations may potentially be impacted
	Regional	25 - 50 % (inclusive) of known regional locations/populations may potentially be impacted
High Impact	Local	>50 % of known local individuals or locations may potentially be impacted
	Regional	>50 % of known regional locations/populations may potentially be impacted

Table 3-12 The potential impacts at the local and regional level used to rank the significance of potential impacts on priority flora

Source: Woodman Environmental Consulting, 2020

Table 3-13 summarises the significance of the potential impacts of the Airport West (South) Project on the Priority Flora at the local and regional scale.

Species	Project area	Ranking of Impact at the Local Scale of the Perth Airport estate	Ranking of Impact at the Regional Scale
Johnsonia pubescens subsp. cygnorum (P2)	Airport West (South)	Low -9.1 % of locations in Airport estate potentially impacted	Low - Species is known known from 17 records with a distribution over 70 km
	Cumulative	Moderate – 45.5 % of locations in Airport estate potentially impacted	
Platysace ramosissima (P3)	Airport West (South)	Moderate – 50 % of locations in Airport estate potentially impacted	Low - Species has a wide distribution over 385km and is known from 18 populations
	Cumulative	High – 100 % of locations in Airport estate potentially impacted	

Table 3-13 The significance of potential impacts of the Airport West Project (AWP) and the potential cumulative impacts of the Airport West Project and NRP on Priority Flora

Source: Woodman Environmental Consulting, 2020

Significance of impacts to *Johnsonia pubescens subsp. cygnorum* P2

The location of *J. pubescens subsp. cygnorum* at Perth Airport represents a new population for the species. The Airport West (South) project potentially impacts on 9.1 % (one location) of the 11 known locations within the Perth Airport estate. Cumulatively the Airport West (South) project and the NRP potentially impact 45.5 % of locations within the airport estate. There are no other known populations in very close proximity to the airport estate, and therefore the potential loss of plants within the Airport West (South) project area may contribute to the long-term decline of this species within the Perth Airport estate. The new population at Perth Airport estate is close to the northern-most extent of its 70km range from the PMA extending to Pinjarra. This taxon is known from 13 other populations, of which at least two are located on conservation reserves indicating the impacts of the Airport West (South) project and the cumulative impacts of Airport West (South) and NRP are unlikely to change the conservation status of this taxon. The potential impacts of this project and its cumulative impacts are not considered to be significant for *J. pubescens subsp. Cygnorum.*

Significance of impacts to *Platysace ramosissima* P3

Airport West (South) will potentially impact one of the two known locations (50 %) of *P. ramosissima* within the Perth Airport estate. Cumulatively, the Airport West (South) project and NRP potentially impact on both locations within the airport estate. There are 21 known regional populations, with the small population on Perth Airport estate located central to this species' distribution that ranges over 385 km. Two records of *P. ramosissima* that are located in the PMA are close to the Perth Airport. The potential impact of the Airport West (South) project and the cumulative potential impacts of the Airport West (South) project and NRP on *P. ramosissima* is not considered significant

4. Fauna

This section provides details on:

- Existing fauna species and habitat within and surrounding the project area,
- Fauna impact assessment (including direct, indirect and offsite impacts) and associated mitigation and avoidance measures. Impacts are considered for the following factors that are known to occur within or adjacent to the project area:
  - General Fauna Environment,
  - Carnaby's Cockatoo,
  - Baudin's Cockatoo,
  - Forest Red-Tailed Black-Cockatoo,
  - Quenda,
  - Native Bee, and
  - Water Rat.

4.1 Policy and Legislative Context

The project area is located on Commonwealth land, therefore impacts on fauna must be considered under the following:

- Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act),
- Significant Impact Guidelines 1.1: Matters of National Environmental Significance (DoE, 2013) (Guideline 1.1), and
- Significant Impact Guidelines 1.2: for Actions on or impacting upon Commonwealth land and actions by Commonwealth agencies (DSEWPaC, 2013) (Guideline 1.2).

Guideline 1.2 requires that potential impacts resulting from airport projects (on Commonwealth land) assess impacts to both EPBC Act protected fauna species (Matters of National Environmental Significance (MNES)) and non-MNES fauna species. This "Whole of Environment" approach to fauna requires assessment of potential impacts (direct, indirect and offsite), mitigation and significance to MNES, state listed species and other fauna in general. Guideline 1.2 is considered in conjunction with Guideline 1.1 which includes criteria considered when assessing the significance of potential impacts to a fauna species, including that which may;

- Lead to a long-term decrease in the size of a population,
- Reduce the area of occupancy of a species,
- Fragment an existing population into two or more populations,
- Adversely affect habitat critical to the survival of a species,
- Disrupt the breeding cycle of a population,
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline,
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat,
- Introduce disease that may cause the species to decline, or
- Interfere with the recovery of the species.

Biodiversity in Western Australia is protected under the Western Australian *Biodiversity Conservation Act 2016* (BC Act), which replaced the *WA Wildlife Conservation Act 1950* at the start of 2019. Fauna species listed under the BC Act are assessed as part of the "Whole of Environment" approach to fauna. To inform this, the following state policy documents and guidance have been applied in the assessment of potential impacts to fauna.

- Western Australian Biodiversity Conservation Act 2016,
- EPA Position Statement No 3, Terrestrial Biological Surveys as an element of Biodiversity Protection (EPA 2002),
- EPA Guidance Statement No 56, Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004),
- EPA Technical guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (Hyder et al. 2010),
- EPBC Act referral guidelines for three threatened Black-Cockatoo species (DSEWPaC, 2012a), and
- Revised draft referral guideline for three threatened Black-Cockatoo species: Carnaby's, Baudin's and the Forest Red-Tailed Black-Cockatoos (DEE, 2017).

4.2 Methodology

Bamford Consulting Ecologists (Bamford Consulting Ecologists) developed a methodology for identifying and assessing project impacts to fauna. This has been refined or extended by Bamford Consulting Ecologists from the guidance for fauna investigations for impact assessment provided by the State Environment Protection Authority (EPA) and the DAWE.

The methodology is referred to as the 'values and impacts approach' and is used to assess the significance of an area for fauna species and the potential impacts to fauna. This is initiated by assembling an expected-species list for the project area and then assessing those species for individual conservation significance (see Figure 4-1).

The values and impacts approach then examine fauna values within the project area, including:

- the overall fauna assemblage, in terms of uniqueness, completeness and richness,
- the vegetation and substrate associations (VSAs) present (that provide habitat for fauna),
- the patterns of biodiversity across the landscape, and
- ecological processes upon which the fauna depend.

The fauna values are reviewed against recognised impacting processes. Refer to Bamford Consulting Ecologists (2020) for further detail.

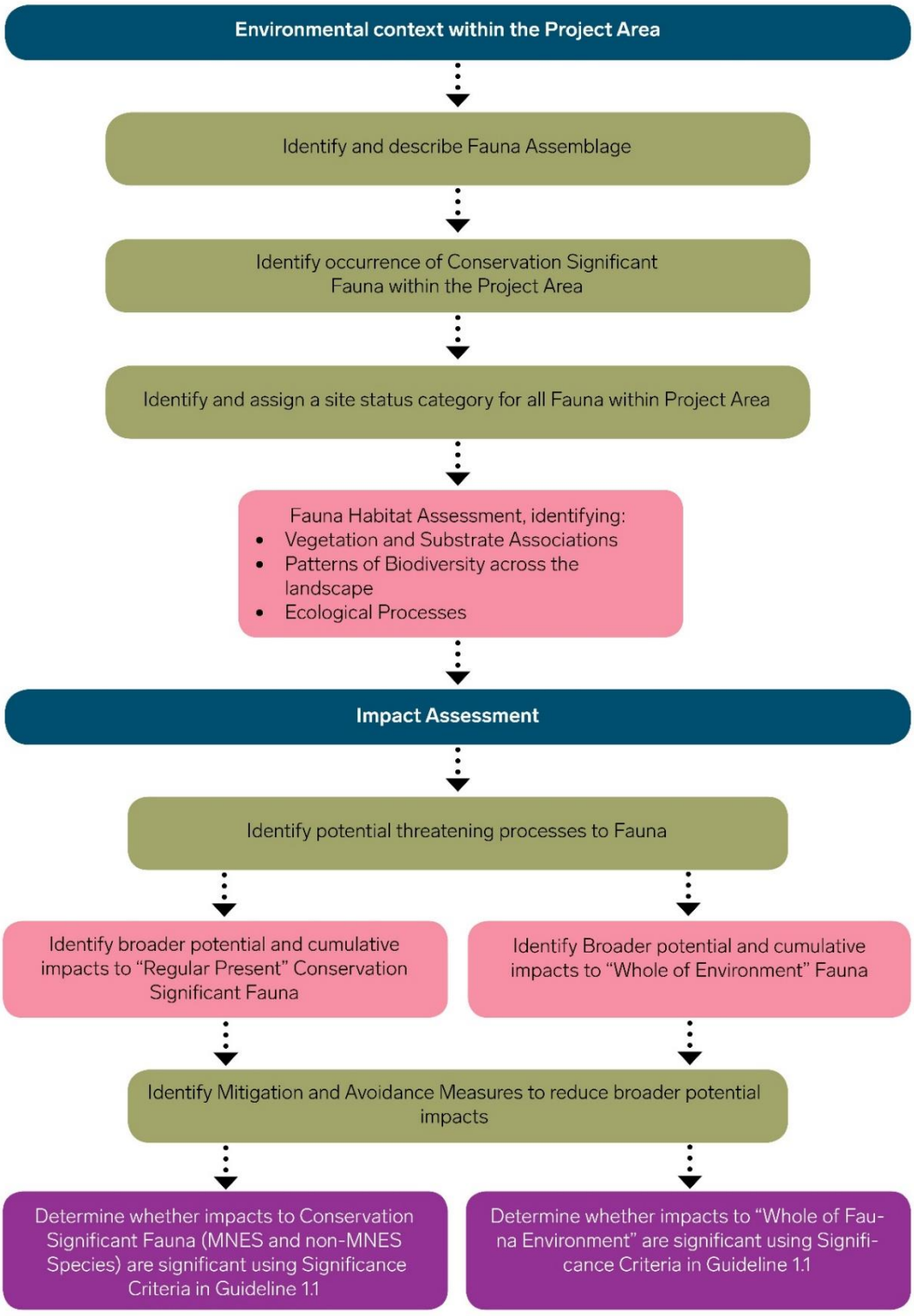

Figure 4-1 Fauna Impact Assessment Methodology

Source: Bamford Consulting Ecologists, 2020

4.3 Conservation Significant Fauna

Species of conservation significance (CS fauna) are of special importance in the conduct of impact assessment. The conservation status of fauna species in Australia are assessed under Commonwealth and State Acts including the EPBC Act and the BC Act. In addition, DBCA recognises priority levels which are not legislated but are afforded further consideration. Therefore, two broad levels of conservation significance have been developed by Bamford Consulting Ecologists and are used for the purposes of this impact assessment (Table 4-1).

Conservation Significance Level	Description
Conservation Significance 1 (CS1)	Species listed under State or Commonwealth Acts
Conservation Significance 2 (CS2)	Species listed as Priority by DBCA but not under legislative acts.

Table 4-1 Levels of conservation significance used for species in this report

Source: Bamford Consulting Ecologists, 2020

CS fauna that are "regularly present" within the project area, are specifically addressed in the fauna impact assessment. "Regularly present" species are those that are known (or expected) to occur in the project area and are known/expected to be resident or regular migrants/visitors to the area.

4.4 Impact Assessment Process

The impact assessment process involves reviewing the fauna values identified during the desktop assessment and field investigations with respect to the project and impacting processes. Impact assessment criteria are based on the severity of impacts on the fauna assemblage and Regularly Present CS fauna and were quantified on the basis of predicted population change. Population change can be the result of direct habitat loss and/or impacts upon ecological processes.

Significant impacts may occur if:

- There is direct impact upon a VSA and the VSA is rare, a large proportion of the VSA is affected and/or the VSA supports significant fauna,
- There is direct impact upon Regularly Present CS fauna, and/or
- Ecological processes are altered, and this affects large numbers of species or large proportions of populations, including significant species.

The significance of population change is contextual. The EPA (2004) suggests that the availability of fauna habitats within a radius of 15km can be used as a basis to predict low, moderate or high impacts. In this case, a high impact is where the impacted environment and its component fauna is rare (<5% of the landscape within a 15km radius or within the Bioregion), whereas a low impact is where the environment is widespread (10% of the landscape within a 15km radius or within the Bioregion). Under the Ramsar Convention, a wetland that regularly supports 1% of a population of a water bird species is considered to be significant. These provide some guidance for impact assessment criteria but are only appropriate when considering very large proposed developments. In the case of the current project area which lies in a complex, and in part urban landscape, a radius of 12km for regional context is used, being based on the maximum foraging range of nesting Black-Cockatoos (Saunders 1980), which is a key significant species in the project area. Table 4-2 provides assessment criteria of impacts

upon fauna where the significance of impacts are based upon the estimated percentage fauna population decline within the immediate area of the surroundings, and upon the effect of the decline upon the conservation status of a recognised taxon (recognisably discrete genetic population, sub-species or species). Note that percentage declines can usually only be estimated on the basis of distribution of a species derived from the extent of available habitat.

In addition, DEE (2013) provides guidance for the significance of impacts in relation to MNES, and DSEWPaC (2012a) and DEE (2017) provide guidance specific to Black-Cockatoos. These guidance statements state that an action is likely to have a significant impact if it results in a population decline or decline in population viability with respect to MNES. Unlike the EPA (2004), the EPBC guidance does not address the significance of impact upon species that are not listed, but the guidance does help to inform the general impact significance criteria presented. The approach is consistent with the determination of impact significance in EPBC Guideline 1.1.

Impact Category	Observed Impact
Negligible	Effectively no population decline; at most few individuals impacted and any decline in population size within the normal range of annual variability.
Minor	Population decline temporary (recovery after end of project such as through rehabilitation) or permanent, but <1% within 12km radius. No change in viability or conservation status of taxon.
Moderate	Permanent population decline 1-10% within 12km radius. No change in viability or conservation status of taxon.
Major	Permanent population decline >10% within 12km radius. No change in viability or conservation status of taxon.
Critical	Taxon extinction within 12km radius and/or change in viability or conservation status of taxon.

Table 4-2 Assessment criteria of impacts upon fauna

Source: Bamford Consulting Ecologists, 2020

4.5 Sources of Information

Information on fauna within the Airport West (South) project has been drawn from a wide range of resources, including:

- a desktop assessment of State and Commonwealth Government databases and results from previous fauna assessment conducted in the vicinity of the project area,
- a range of field surveys in accordance with State and Commonwealth guidelines, and
- a Black-Cockatoo survey conducted on the Perth Airport estate.

4.6 Existing Fauna Environment

4.6.1 Overview of Fauna Assemblage

Bamford, et al.(2017) identified 204 vertebrate species as potentially occurring within the Perth Airport estate. These include: five fish, 12 frogs, 42 reptiles, 130 birds (six introduced) and 15 mammals (five introduced).

Of these, 174 species (two fish, 11 frogs, 32 reptiles, 116 birds and 13 mammals) have been recorded on the airport estate and are considered highly likely to be present in the Airport West (South) project area. A small number of species (six birds) have been recorded recently but are now probably locally extinct, leaving a current assemblage of 168 vertebrate species (refer Table 4-3). Not all species listed are likely to occur in the Airport West (South) project area, some species may be resident, while others may be regular or irregular visitors to the site as a part of an annual cycle.

	Potential	Recorded	Highly Likely	Locally Extinct
Fish	5 (1 int.)	1 (1 int.)	1	1
Frogs	12	10	1	0
Reptiles	42	22	10	4
Birds	130 (6 int.)	103 (4 int.; 6 prob LE)	13 (1 int.)	1
Mammals	15 (5 int.)	12 (5 int.)	1	13
TOTAL	204	148 174 (168 current)	26	19

Table 4-3 Composition of vertebrate fauna assemblage of the Airport Estate

Source: Bamford Consulting Ecologists, 2020

'Potential' species are those returned from the literature review and deemed as 'likely' to occur in the vicinity of the project area. 'Recorded' species have been detected in one or more surveys; some of these are now considered to be probably locally extinct ('prob. LE'). 'Highly Likely' species are those not recorded but considered very likely to utilise the project area, at least occasionally. 'Locally extinct' species formerly occurred in the project area and airport estate but are now absent. The numbers of introduced ('int.') species are shown in parentheses, where relevant.

Of the 174 species of vertebrate fauna that have been recorded, or that are highly likely to occur in the area, 10 are considered to be of conservation significance (CS1 or CS2; Table 4-4). Of these, only six species are expected to be regularly present and one species irregularly present within the project area (refer Table 4-4). These species are discussed separately in Sections 4.7 to 4.12.

Species		Conservation Category (MNES species)	Presence	Expected Occurrence in the broader Airport Estate	Expected Occurrence in the Project Area	Regularly Present in the Project Area
Conservation Significance 1						
Plegadis falcinellus	Glossy Ibis	M,S5 (MNES)	Highly likely	Irregular visitor	Irregular visitor	
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo	V,S3 (MNES)	Recorded	Regular visitor	Regular visitor	*
Calyptorhynchus baudinii	Baudin's Black-Cockatoo	E,S2,WR (MNES)	Recorded	Irregular visitor	Irregular visitor	
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	E,S2,WR (MNES)	Recorded	Regular visitor	Regular visitor	*
Apus pacificus	Fork-tailed Swift	M,S5 (MNES)	Highly likely	Irregular visitor	Irregular visitor	
Falco peregrinus	Peregrine Falcon	S7	Highly likely	Irregular visitor	Irregular visitor	
Conservation Significance 2						
Oxyura australis	Blue-billed Duck	P4	Highly likely	Irregular visitor	Irregular visitor	
Isoodon fusciventer	Quenda, Brown Bandicoot	P4	Recorded	Resident	Resident	*
Hydromys chrysogaster	Water-rat, Rakali	P4	Highly likely	Regular visitor	Regular visitor	*
Hylaeus globuliferus	a Native Bee	P3	Highly likely	Regular visitor	Regular visitor	*

Table 4-4 Species of conservation significance recorded or that are highly likely to occur in the project area

Source: Bamford Consulting Ecologists, 2020

  |

EPBC Act listings: E = Endangered, V = Vulnerable, M = Migratory. Biodiversity Conservation Act listings: S1 to S7 = Schedules 1 to 7. DBCA Priority species: P1 to P5 = Priority 1 to 5

Expected occurrence categories:

Resident: species with a population permanently present in the project area;

Regular visitor or migrant: species that occur within the project area regularly in at least moderate numbers, such as part of annual cycle;

Irregular Visitor: species that occur within the project area irregularly such as nomadic and irruptive species. The length of time between visitations could be decades but when the species is present, it uses the project area in at least moderate numbers and for some time.

4.6.2 Locally Extinct Fauna

The following species have been identified as locally extinct fauna at the airport estate.

4.6.2.1 Western Swamp Tortoise

The Western Swamp Tortoise *Pseudemydura umbrina* has not been recorded alive at the Perth Airport estate since 1970 (c.a. 50 years). The historic record consisted of the capture of a single juvenile animal "at airport swamps adjacent Hardey Road" (Western Swamp Tortoise database maintained by the DBCA), leading to the suggestion that the Five Mile Swamp area in the southern part of the estate harboured a Western Swamp Tortoise population at least until the early 1970s (Burbidge *et al.,* 2010). This population was not monitored, and no specimens were found during surveys in 1995 (Kuchling and Burbidge, 1996) and 2005 (Burbidge and Kuchling, 2005). The 1995 survey was intensive, using trapping methods developed during decades of research on the species at Twin Swamps and Ellen Brook Nature Reserves. Kuchling and Burbidge (1996) also provided anecdotal accounts of the species in the Perth Airport area from several long-term residents, with dates from the early 1940s, late 1960s/early 1970s, and 1995. The account from 1995 was of a tortoise shell only.

Burbidge *et al.* (2010) note the original distribution of the species as from "near Pearce Airforce Base south to Perth Airport" but provide no detail of the airport records. They give the current natural distribution of the species as Ellen Brook and Twin Swamps Reserves. The current fauna profile also supports this and provides no records from the airport (DBCA, 2017). Multiple fauna surveys have been undertaken on the estate and the tortoise has not been found (or evidence to suggest its presence), and it therefore seems improbable that the species persists. Kuchling and Burbidge (1996) did caution that their survey was slightly delayed from the ideal seasonal timing, and that it could not be concluded that the species was extinct at the Perth Airport at the time of their survey, and that further surveys were warranted. For example, the species was thought to be 'effectively extinct' at Twin Swamps Nature Reserve in 1985, but two adult females were found in 1994 after an increase in survey effort, despite routine monitoring over the intervening decade. However, given that the species has not been observed at the estate for 50 years, and the Five Mile Swamp area (located in the southern portion of the estate) where the species was originally recorded has since been highly developed, it seems highly unlikely that the species is still present in the area. Furthermore, hydrogeological conditions at the northern wetlands were found to be unsuitable for the species in recent years (Geo and Hydro, 2014). As the species is unlikely to be present, no direct or indirect impacts are anticipated and therefore measures to avoid or mitigate impacts are not included in this assessment.

Burbidge *et al.* (2010) list the northern end of the estate as critical habitat for the species and a key translocation site. However, since this time, hydrogeological investigations (including trial water pumping) in 2013 found that wetlands north of Munday Swamp were unable to support ponding sufficient to maintain the Tortoise in recent, dry years (Geo and Hydro 2014), and therefore are unlikely to be appropriate translocation sites.

4.6.2.2 Invertebrates

Two conservation significant invertebrate species, the crickets *Throscodectes xiphos* (Priority 1) and *Austrosaga spinifer* (Priority 2), may formerly have occurred in the project area, but are now considered to be locally extinct. There is little information available on the distribution and habitat of these species; Everard and Bamford (2014) note that there are records in the general Perth region and *T. xiphos* is associated with Banksia Woodland, and *A. spinifer* is associated with Heathland. Locations where the species have been recorded in the past (Melaleuca Park Reserve) were visited to provide a habitat comparison (Bamford and Knowles, 2019). Some on-ground searching for these species, head-torching and light-trapping, was carried out in early 2019 in the airport estate and neither was found (Bamford and Knowles 2019). The timing of these surveys was consistent with activity periods of the species determined from specimen records held by the WA Museum. While a single survey cannot confirm absence, the conclusion that these species are locally extinct was made

based upon the survey result, the lack of any other recent records in the broader region, and the high level of disturbance across the project and the airport estate, including lighting which is known to cause local extinction of some invertebrate species (Rich and Longcore, 2012).

4.6.3 Vegetation Substrate Associations

Principal VSAs recorded in the project area are:

- Woodland (Marri/Banksia Woodlands) (22.9 hectares),
- Dampland Heath (10.0 hectares),
- Grassland that is not mown and may include scattered shrubs and small trees (15.2 hectares),
- Drains (2.0 hectares), and
- Cleared and built areas (including roads, infrastructure and mown grass near runways) (15.4 hectares).

Principal VSAs identified within the project area are presented in Figure 4-2.

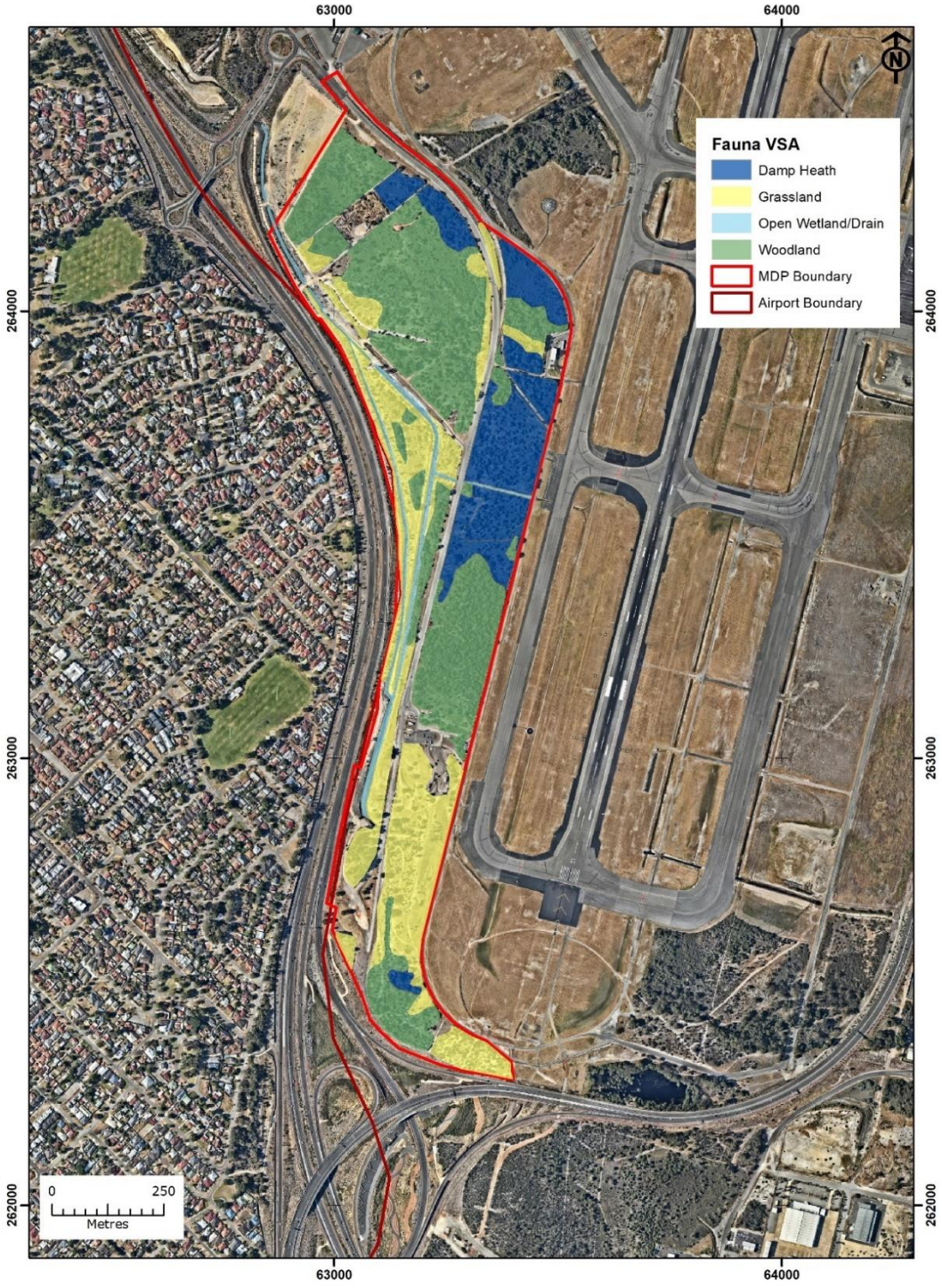

Figure 4-2 Principal Vegetation and Substrate Associations within the project area

Source: Bamford Consulting Ecologists, 2020

4.6.4 Summary of Fauna Values

The fauna assemblage of the project area is likely to be substantially intact but probably still losing species and is unusual because it exists in a region of extensive regional clearing and development. It includes a suite of significant species, including the Black-Cockatoos, Quenda, Rakali, and a Native Bee species. The assemblage is supported by a range of VSAs which are important for different components of the assemblage. Woodland areas are particularly notable for supporting Black-Cockatoos and Quenda, and drains through the project area are of interest for potentially supporting Rakali. Woodlands support the greatest range of reptile and bird species, including many of conservation significance. All three Black-Cockatoo species have been recorded foraging in the woodland in the area; Carnaby's focusses on areas with a high proportion of Banksia, while the Forest Red-tail and Baudin's favour Marri woodland.

Damp heathland and grassland are also likely to support populations of Quenda and some bird species. Drains, while artificial, may be important for facilitating fauna movements (e.g. Rakali) through the landscape. Ecological processes of particular importance with respect to the fauna assemblage include feral species and hydrology.

4.6.5 Regional Vegetation Context Analysis

To provide context of the impact, a regional vegetation assessment was conducted within a 12 km radius of Airport West (South) (Figure 4-3). The project area, including all roads, infrastructure and native vegetation, covers an area of 65.5 hectares. The project area is located within the 'Bassendean Complex-Central and South' vegetation complex, as described by Heddle et al. (1980), and 33.0 hectares of this vegetation type remains within the Airport West (South) area (Figure 4-3). This represents 11.1% of the remaining extent of the Bassendean Complex-Central and South complex within a radius of 12 km (297 hectares). Only 145 hectares or 5.2% of this vegetation type is managed for conservation within 12 km.

The 12 km radius covers an area of 45,239 hectares; of this, the remaining extent of all native vegetation (i.e. not just the Bassendean Complex-Central and South complex discussed above) is 5,528 hectares, or 12.2% of the radius. Native vegetation extends over 50.4% of Airport West (South); hence a higher proportion than the broader region. A total of 2,772 hectares, or 6.1% of lands, is managed by the DBCA (Figure 4-3). This is mostly for conservation but includes small areas of State Forest, and areas for recreation and management. No land within the Airport West (South) boundary is managed by DBCA.

Refer to Section 4.6 of the Bamford Consulting Ecologists (2020) report for further details.

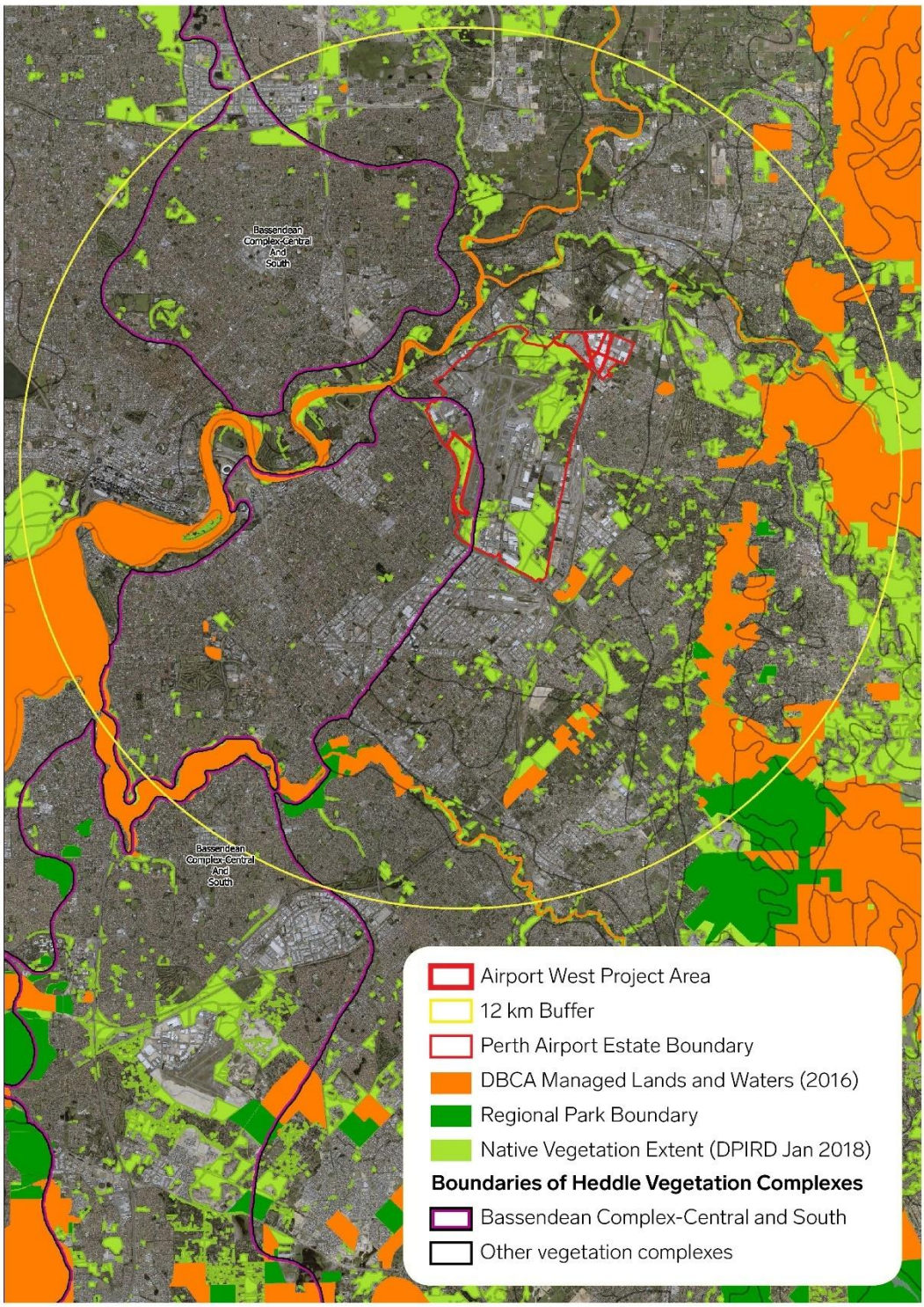

Figure 4-3 Regional vegetation context map with 12 km radius

Source: Bamford Consulting Ecologists, 2020

4.7 Carnaby's Cockatoo Impact Assessment

4.7.1 Overview

Carnaby's Black-Cockatoo is the most abundant of the Black-Cockatoos on the Perth Airport estate and on the coastal plain in the Perth region. It is generally a non-breeding migrant (but with a few pairs breeding on the coastal plain in recent years), being most abundant from late summer to mid-winter. The species is present on the airport estate in large numbers, with flocks of several hundred observed (typically in the autumn) and is likely to visit the project area.

The Black-Cockatoo survey recorded foraging habitat for Carnaby's Black-Cockatoo in the project area (Figure 4-4). Approximately 48.2 hectares provide some foraging value for Carnaby's Black-Cockatoo with a foraging value (condition) score of between 1 (negligible to low foraging value) to 6 (high foraging value). Of note, there are 5.9 hectares of moderate to high foraging habitat (score 4 to 6) for this species within the project area

An assessment of the foraging value of vegetation for Carnaby's Black-Cockatoo in the project area, in accordance with the scoring system described in Appendix 7 of Bamford Consulting Ecologists (2020), is provided in Table 4-5 and Figure 4-4. This identifies that the majority of vegetation within the project area is considered to have negligible to low foraging value.

Score Based on Vegetation Characteristics (out of 6)	Area (Hectares)	% of Total Project Area of 69.5 Hectares
1 – Negligible to Low	19.0	27.7
2 – Low	11.2	16.0
3 – Low to Moderate	12.1	17.4
4 – Moderate	1.5	2.1
5 – Moderate to High	4.4	6.3
6 – High	0	0
Total	48.2	69.5

Table 4-5 Summary of Carnaby's Black-Cockatoo vegetation characteristics foraging habitat in the Project Area

Source: Bamford Consulting Ecologists, 2020

Carnaby's Black-Cockatoo does not currently breed in the project area or wider estate, noting the limited availability of suitable habitat, however the species does breed elsewhere on the coastal plain in small numbers. The Black-Cockatoo survey documented 33 potential nest trees, of which 30 were given a rank of 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) and 3 were given a rank of 4 (tree with large hollows or broken branches that might contain large hollows, but hollows or potential hollows 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) (see Bamford Consulting Ecologists (2020) for more information on nesting tree ranking).

Thus, none of the trees had hollows that might be useful to the species. The location of potential nest trees is provided in Figure 4-5. No roosting sites or activity was recorded in the project area or airport estate, although

there are some known roost sites in the region from the “Great Cocky Count” (Peck *et al*. 2017) as shown in Figure 4-7.

Figure 4-6 shows that approximately 5,528 hectares of potential Carnaby's Cockatoo Feeding Habitat remains within the 12 km radius as mapped by DBCA (2011). It has been updated by highlighting those areas of potential habitat that have been cleared between 2011 when the mapping was originally undertaken, and 2018 when the remnant vegetation mapping was updated by the State Department of Primary Industries and Regional Development

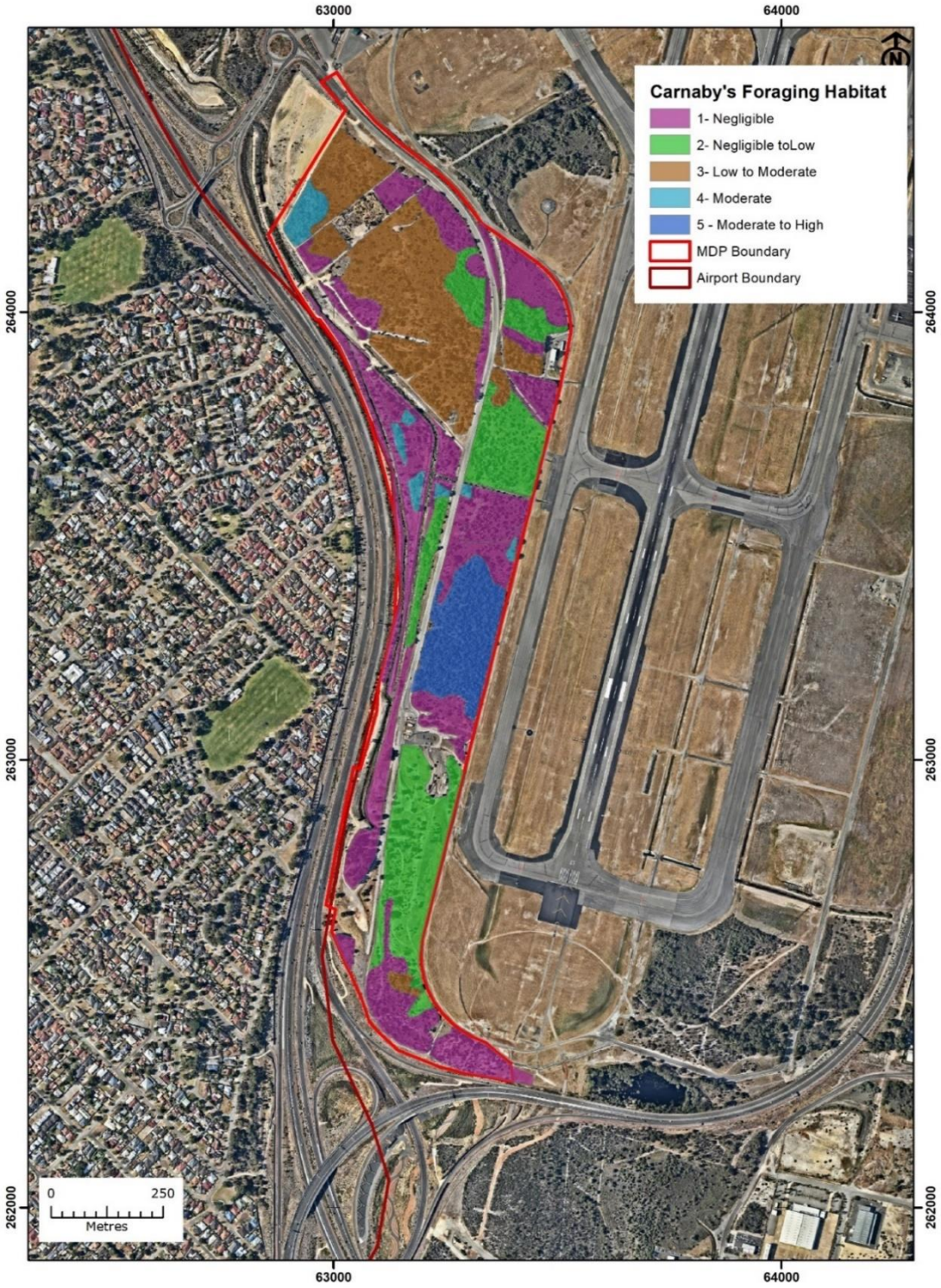

Figure 4-4 Carnaby's Black-Cockatoo Foraging Habitat

Source: Bamford Consulting Ecologists, 2020

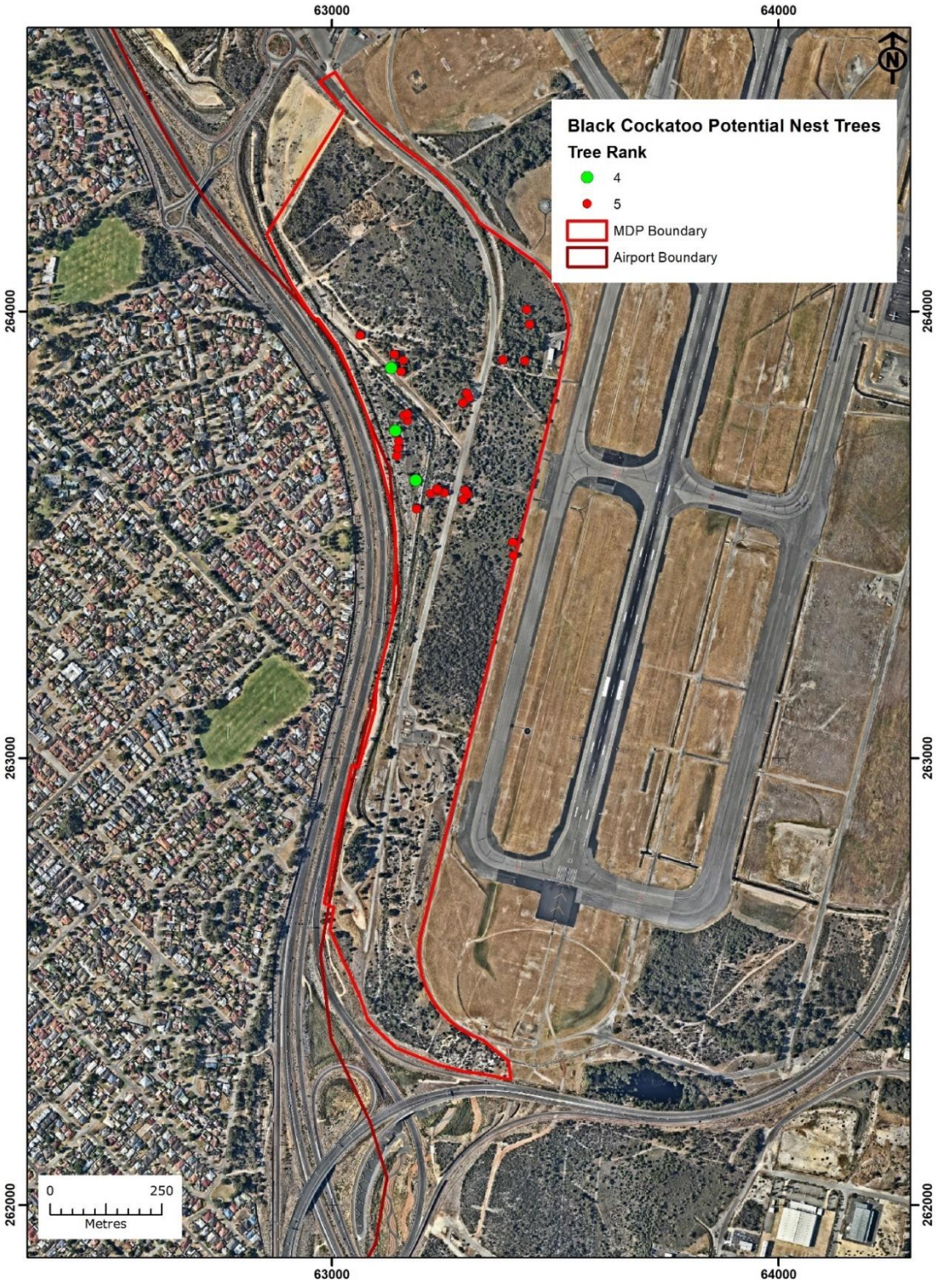

Figure 4-5 Black-Cockatoo Potential Nesting Trees

Source: Bamford Consulting Ecologists, 2020

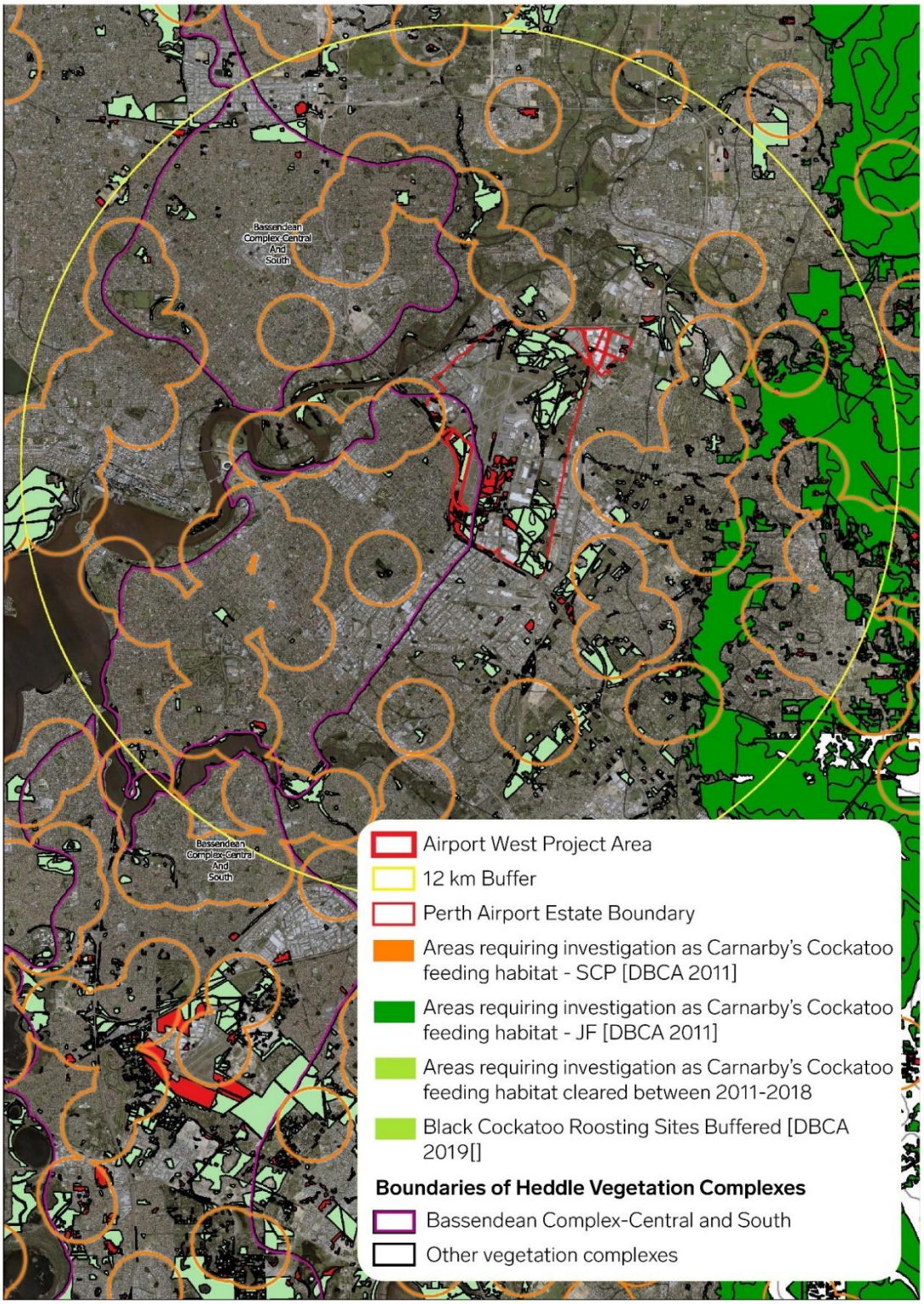

Figure 4-6 Potential Carnaby's Cockatoo Foraging Habitat within 12kms radius

Source: Bamford Consulting Ecologists, 2020

Figure 4-7 Black-cockatoo roost locations in the vicinity of Airport West (South) and the Airport Estate

Source: Bamford Consulting Ecologists, 2020

4.7.2 Direct Impacts and Associated Avoidance/Mitigation Measures

The development of the Airport West (South) project area will result in the loss of:

- up to approximately 48.2 hectares of foraging habitat for Carnaby's Black-Cockatoo. The majority of this (87.8%) is of negligible (score 1), low (score 2) and low-moderate (score 3) foraging value for the species.
- up to 33 potential nest trees, of which 30 are a rank of 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) and 3 are a rank of 4 (tree with large hollows or broken branches that might contain large hollows, but hollows or potential hollows 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). (See Bamford Consulting Ecologists (2020) for more details on the Ranking System).

4.7.3 Indirect and Offsite Impacts and Associated Avoidance/Mitigation Measures

Table 4-6 provides a summary of potential impacts to the Carnaby's Black-Cockatoo and associated avoidance and mitigation measures.

Impact Type	Threatening process	Significance	Discussion	Proposed Avoidance/Mitigation Measure
Direct	Habitat loss leading to population decline /local extinction	Minor (<1% decline in carrying capacity within 12 km).	Loss of 48.2 hectares of Carnaby's foraging habitat (Scores 1-6 only) will occur as a result of the Airport West (South) development. An additional 17.3 hectares of land that is unsuitable for foraging (Score 0, no forage value), including built environment and mown grass, also occurs within the project area (refer to Impact Tables). Foraging habitat remaining within a 12 km radius is in the order of approximately 5,528 hectares (comprising all Heddle veg complexes). Removing 48.2 hectares of Carnaby's foraging habitat will result in a decline of 0.9% in carrying capacity within that region.	Well-defined and rationalised clearing footprint that avoids sensitive habitat where possible. Retain gardens and verges where possible Landscape with foraging species suitable for Carnaby's Black-Cockatoo and replant degraded areas.
Indirect (ecosystem function)	Population Fragmentation	Negligible	The Carnaby's Black-Cockatoo is a strong-flying species known to cross large areas of open land and to move through built environments to access feeding areas. Development of Airport West (South) is unlikely to result in fragmentation of existing populations.	Replanting to replace/ enhance connectivity.
Indirect (ecosystem function)	Degradation of surrounding habitat within the estate due to weed invasion	Negligible	The development of Airport West (South) will result in all native vegetation being cleared from the site. Therefore, surrounding remnant native vegetation within the estate (e.g. vegetation to the south of Airport West (South)) may be impacted by weeds. However, impacts are likely to be negligible and can be managed with existing weed management protocols. No offsite impacts as a result of weed invasion are expected.	Weed management during earthworks. Active weed management post-development to rehabilitate degraded areas.
Direct	Ongoing Mortality	Negligible	Ongoing mortality can occur during project operations; for example, from birds colliding with approaching and departing planes (runway adjacent to the project area) and from vehicle strike.	Road speeds reduced in areas of high fauna activity. Avoid Black-Cockatoo forage trees along high-speed roads.

Impact Type	Threatening process	Significance	Discussion	Proposed Avoidance/Mitigation Measure
			Bird strike may decrease due to removal of vegetation from the project area.	
Indirect (ecosystem function)	Species interactions	Negligible	Not relevant to Carnaby's Black-Cockatoo. However, existing feral management procedures need to be continued.	Not applicable.
Indirect (ecosystem function)	Changes to Hydroecology	Negligible	There may be a risk to habitat used by Carnaby's Black-Cockatoo due to altered hydrology (such as increased surface water runoff), although with standard management procedures, the risk is considered low. There could be some off-site hydrological change, but this would also not affect habitat for the species.	Understand and manage local hydrology. Ensure standard approaches minimise hydrological change. (See Table 6-2)
Indirect (ecosystem function)	Changes to Fire Regime	Negligible	Not relevant to Carnaby's Black-Cockatoo given the lack of foraging and nesting habitat that will be retained in the project area. Surrounding habitat (outside of the project area, but within the estate) can be managed with existing fire management protocols.	Existing fire management and suppression around the Airport estate.
Indirect (ecosystem function)	Dust, light, vibration, noise	Negligible	Not relevant to Carnaby's Black-Cockatoo as the species is very tolerant to noise and light in urban environments.	Legal environmental limits.

Table 4-6 Summary of potential impacts to Carnaby's Black-Cockatoo and proposed mitigation measures

Source: Bamford Consulting Ecologists, 2020

4.7.4 Cumulative Impacts

The development of the two project areas listed in Table 1-1 will result in the cumulative total loss of 280.9 hectares of foraging habitat for Carnaby's Black-Cockatoo. Vegetation scores range from '1' (Negligible to Low Foraging Value) to '6' (High Foraging Value).

Carnaby's Black-Cockatoo does not currently breed on the airport estate, but limited suitable habitat is present and the species does breed elsewhere on the coastal plain in small numbers. The two project developments (Table 1-1) will result in the combined loss of 135 Marri trees and 31 Jarrah trees that meet the basic criterion of 500 mm DBH, but only seven Marri and five Jarrah were given a rank of 3 (potentially suitable hollow). Thus, 12 trees had hollows that might be useful to the species (or other species that require large hollows). No roosting sites or activity was recorded in the airport estate, although there are some known roost sites from the Great Cocky Count in the region (Peck *et al.* 2017).

4.7.5 Significance of Residual Impacts

An assessment of the potential impacts to Carnaby's Black-Cockatoo using Guidelines 1.1 (DoE, 2013) significance criteria is provided in Section 5.1.3 of Bamford Consulting Ecologists (2020) report.

It is expected that two of the nine EPBC significance criteria will be triggered for the Carnaby's Black-Cockatoo. The proposed action will result in some residual impact to the Carnaby's Black-Cockatoo, through the direct and permanent removal of up to 48.2 hectares of (low to high quality) foraging habitat and 33 potential nest-trees that might be of future use to the species (i.e. trees >500 mm DBH that currently have no hollows). This impact is unavoidable due to the removal of vegetation and subsequent development. There is likely to be an impact to Carnaby's Black-Cockatoo at the local- (major impact within the project area, moderate impact within the surrounding airport estate) and regional- (minor impact within 12 km) scales through the loss of foraging habitat and a potentially altered local distribution of the species, but this is not expected to have a significant impact at the species-scale.

Cumulative impacts of known proposed projects at Perth Airport (see Table 1-1) to Carnaby's Black-Cockatoo are expected at the local- (major impact within the airport estate) and regional- (moderate impact within 12 km) scales, but these are not expected to be significant at the species-scale.

4.7.6 Offsets

Section 12 outlines the offsets proposed to address the residual impact to up 48.2 hectares of Carnaby's Black-Cockatoo foraging habitat.

4.8 Baudin's Cockatoo Impact Assessment

4.8.1 Overview

Baudin's Black-Cockatoo is primarily a species present in tall eucalypt forests of the South-West and Perth is at the northern limit of its range. It is present, and breeds, in the forests of the escarpment east of Perth. Bamford *et al.* (2017) concluded that the species "is probably only an irregular visitor, with a single record in 2014 (Everard and Bamford, 2014)". The single record was located outside the Airport West (South) project area and was of distinctive foraging signs on Marri fruit under one tree and these could have been made by a few birds in one feeding session. There were no other records despite multiple visits by experienced zoologists. In August and September 2018 however, surveys by Bamford Consulting Ecologists found recent and intermediate foraging evidence (chewed Marri nuts) in 14 locations in the north, west and south of the airport estate. Foraging evidence was recorded at three locations within the project area. Birds were also seen actively foraging in Marri trees just north of the project area. It is not known if these records are indicative of a movement of the species onto the coastal plain or whether this was only an infrequent event that might not happen again. Note that the Forest Red-tailed Black-Cockatoo has only recently (since about 2008) been recorded regularly on the coastal plain in the Perth area, including on the airport estate, and previously was also restricted to eucalypt forests of the escarpment. The possibility of Baudin's Black-Cockatoo making a similar behavioural change must be considered.

Prior to 2018, it was considered that the project area and estate was so little-used by Baudin's Black-Cockatoo that it was not considered in impact assessment and that at such a low level of usage, the impact would be negligible (Bamford *et al.*, 2017). However, recent surveys suggest that the species may forage in both areas more often than previously expected, but is still likely to be an irregular visitor.

Approximately 40.9% of the project area (26.8 hectares) provides some foraging value for Baudin's Black-Cockatoo with a foraging value score of between 1 (low foraging value) to 4 (moderate foraging value), out of a possible total score of six (Table 4-7). There is 1.5 hectares of moderate foraging habitat (score 4) for this species within the project area and the remainder is of negligible to moderate foraging value for the species. Approximately 59.1% (38.7 hectares) of the project area had no foraging value for the species. The distribution of foraging habitat across the project area is shown in Figure 4-8 and Table 4-7.

Baudin's Black-Cockatoo does not currently breed in the project area or estate and it seems unlikely it will do so. The Black-Cockatoo survey documented 33 potential nest trees, of which 30 were given a rank of 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) and 3 were given a rank of 4 (tree with large hollows or broken branches that might contain large hollows, but hollows or potential hollows 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) (see Bamford Consulting Ecologists (2020) for details of the ranking system).

Thus, none of the trees had hollows that might be useful to the species. The location of potential nest trees is provided in Figure 4-5. No roosting sites or activity was recorded in the project area or estate, although there are some known roost sites in the region from the "Great Cocky Count" (Peck *et al.*, 2017) as shown in Figure 4-7.

Score Based on Vegetation Characteristics (out of 6)	Area (Hectares)	% of Total Project Area of 69.45 Hectares
1 – Negligible to Low	8.5	13.1
2 – Low	3.9	6.0
3 – Low to Moderate	12.9	19.5
4 – Moderate	1.5	2.3
5 – Moderate to High	0	0
6 – High	0	0
Total	26.8 hectares	40.9

Table 4-7 Summary of Baudin's Black-Cockatoo vegetation characteristics foraging habitat in the Project Area

Source: Bamford Consulting Ecologists, 2020

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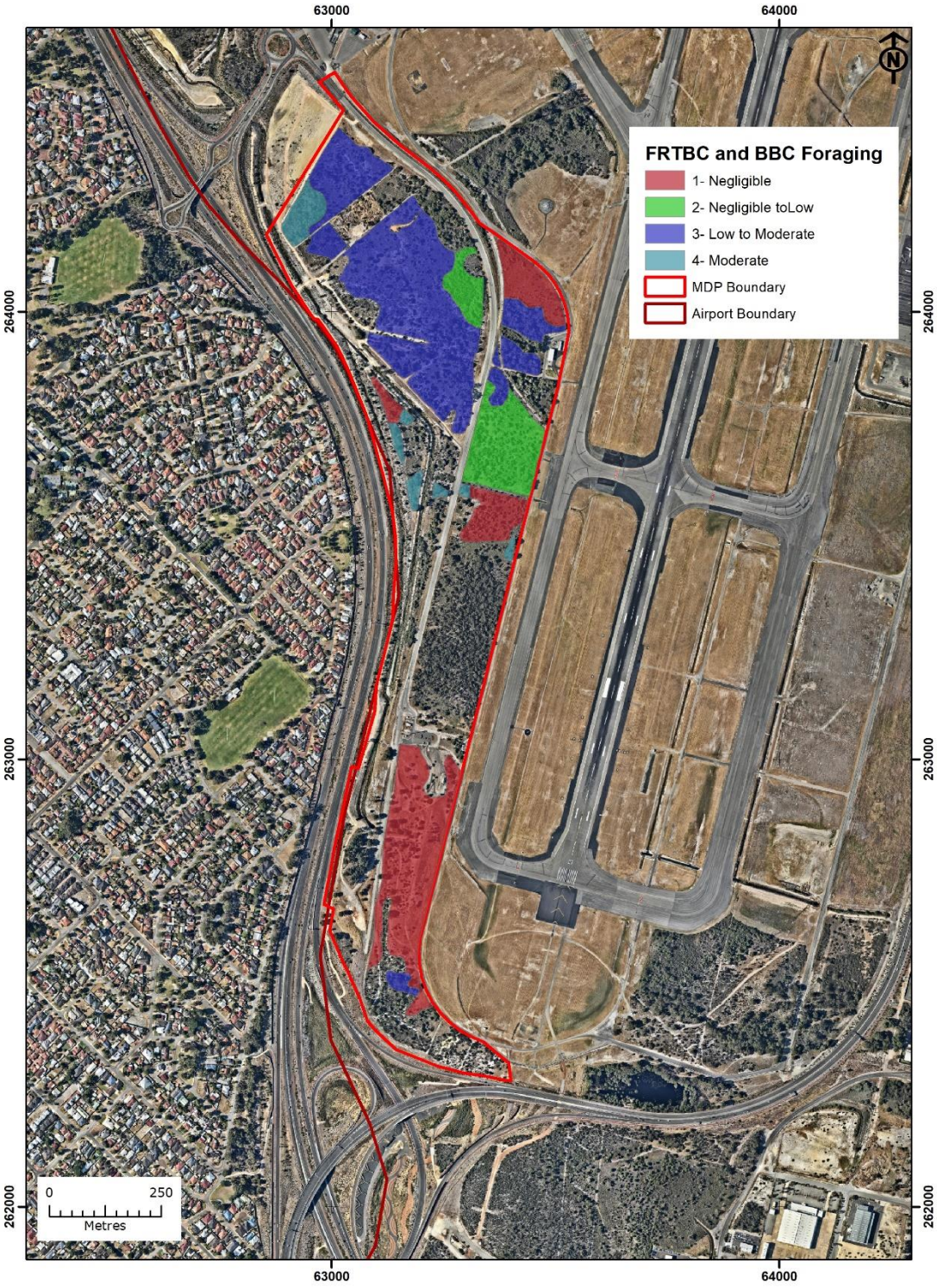

Figure 4-8 Forest Red-Tailed and Baudin's Black-Cockatoo Foraging Habitat in the Project Area

Source Bamford Consulting Ecologists, 2020

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4.8.2 Direct Impacts and Associated Avoidance/Mitigation Measures

The development of the project area will result in the loss of:

- up to approximately 26.8 hectares of foraging habitat for the Baudin's Black-Cockatoo. The majority of this (95%) is of negligible (score 1), low (score 2) and low-moderate (score 3) foraging value for the species (refer Table 4-7 and Figure 4-8).
- up to 33 potential nest trees, of which 30 are a rank of 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) and 3 are a rank of 4 (tree with large hollows or broken branches that might contain large hollows, but hollows or potential hollows 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) (see Bamford Consulting Ecologists (2000) for Ranking System details).

4.8.3 Indirect and Offsite Impacts and Associated Avoidance/Mitigation Measures

Table 4-8 provides a summary of potential impacts to the Baudin's Black-Cockatoo and associated avoidance and mitigation measures.

Impact Type	Threatening process	Discussion	Proposed Avoidance/Mitigation Measure	Significance
Direct	Habitat loss leading to population decline /local extinction	Loss of 26.8 hectares of foraging habitat (Scores 1-6 only) will occur as a result of the proposed project, but on current knowledge this is used irregularly. An additional 38.7 hectares of land that is unsuitable for foraging (Score 0, no forage value), including built environment and mown grass, also occurs within the project area (refer to Impact Tables). Foraging habitat remaining within a 12 km radius is in the order of approximately 5,528 hectares (comprising all Heddle vegetation complexes). Thus, a decline of approximately 0.5% in carrying capacity could occur, but because the habitat in the project area is not used consistently, the value to the species would be less than this.	Well-defined and rationalised clearing footprint that avoids sensitive habitat where possible. Retain gardens and verges. Landscape with foraging species suitable for Baudin's Black-Cockatoo and replant degraded areas.	Minor
Indirect (ecosystem function)	Population Fragmentation	Baudin's Black-Cockatoo is a strong-flying species known to cross large areas of open land and to move through built environments to access feeding areas. Development of the project area is unlikely to result in fragmentation of existing populations.	Replanting to replace/ enhance connectivity.	Negligible
Indirect (ecosystem function)	Degradation of surrounding habitat within the estate due to weed invasion	The development of Airport West (South) will result in all native vegetation being cleared. Therefore, surrounding remnant native vegetation (e.g. vegetation around Munday Swamp) will be sensitive to weed invasion.	Weed management during earthworks. Active weed management post-development to rehabilitate degraded areas.	Negligible
Direct	Ongoing Mortality	Ongoing mortality can occur during project operations; for example, from birds colliding with approaching and departing planes	Road speeds reduced in areas of high fauna activity.	Negligible

Impact Type	Threatening process	Discussion	Proposed Avoidance/Mitigation Measure	Significance
		(runway adjacent to Airport West (South)) and from vehicle strike. Bird strike may decrease due to removal of vegetation from the project area.	Avoid black-cockatoo forage trees along high-speed roads.	
Indirect (ecosystem function)	Species interactions	Not relevant to Baudin's Black-Cockatoo. However, existing feral management procedures need to be continued.	Not applicable.	Negligible
Indirect (ecosystem function)	Changes to Hydroecology	There may be a risk to habitat used by Baudin's Black-Cockatoo due to altered hydrology (such as increased surface water runoff), although with standard management procedures the risk is considered low. There could be some off-site hydrological change but this would also not affect habitat for the species.	Understand and manage local hydrology. Ensure standard approaches minimise hydrological change.	Negligible (See Table 6-2)
Indirect (ecosystem function)	Changes to Fire Regime	Not relevant to Baudin's Black-Cockatoo given the lack of foraging and nesting habitat that will be retained in the project area. Surrounding habitat (outside of the project area, but within the estate) can be managed with existing fire management protocols.	Existing fire management and suppression around the airport estate.	Negligible
Indirect (ecosystem function)	Dust, light, vibration, noise	Not relevant to Baudin's Black-Cockatoo as the species is very tolerant to noise and light in urban environments.	Legal environmental limits.	Negligible

Table 4-8 Summary of potential impacts to Baudin's Black-Cockatoo and proposed mitigation measures

Source: Bamford Consulting Ecologists, 2020

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4.8.4 Cumulative Impacts

The development of the two project areas listed in Table 1-1 will result in the cumulative total loss of 90.7 hectares of foraging habitat for Baudin's Black-Cockatoo. Vegetation scores range from '1' (Negligible to Low Foraging Value) to '6' (High Foraging Value).

Baudin's Black-Cockatoo does not currently breed on the airport estate, and it is considered unlikely to do so. The two project developments (Table 1-1) will result in the combined loss of 135 Marri trees and 31 Jarrah trees that met the basic criterion of 500 mm DBH, but only seven Marri and five Jarrah were given a rank of 3 (potentially suitable hollow). Thus, 12 trees had hollows that might be useful to the species (or other species that require large hollows). No roosting sites or activity was recorded in the airport estate, although there are some known roost sites from the Great Cocky Count in the region (Peck *et al*., 2017).

4.8.5 Significance of Residual Impacts

An assessment of the potential impacts to Baudin's Black-Cockatoo using Guidelines 1.1 (DoE, 2013) significance criteria is provided in Section 5.2.4 of Bamford Consulting Ecologists (2020) report.

It is not expected that any EPBC significance criteria will be triggered for the Baudin's Black-Cockatoo. The proposed action will result in some residual impact to the Baudin's Black-Cockatoo, through the direct and permanent removal of up to 26.8 hectares of (low to high quality) foraging habitat (considered to be used irregularly by the species) and 33 potential nest-trees that might be of future use to the species (i.e. trees >500 mm DBH that currently have no hollows). This impact is unavoidable due to the removal of vegetation and nature of the project. There is likely to be an impact to Baudin's Black-Cockatoo at the local- (moderate impact within the project area and surrounding airport estate) and regional- (minor impact within 12 km) scales through the loss of foraging habitat and a potentially altered local distribution of the species, but this is not expected to have a significant impact on the local population or at the species-scale.

Cumulative impacts of known proposed projects at Perth Airport (see Table 1-1) to Baudin's Black-Cockatoo are expected at the local- (moderate impact within the airport estate) and regional- (moderate impact within 12 km) scales, but these are not expected to be significant at the species-scale

4.8.6 Offsets

Section 12 outlines the offsets proposed to address the residual impact to 26.8 hectares of Baudin's Black-Cockatoo foraging habitat and 33 potential nest trees.

4.9 Forest Red-Tailed Black-Cockatoo Impact Assessment

4.9.1 Overview

The Forest Red-Tailed Black-Cockatoo has undergone a recent (since about 2010) influx onto the coastal plain in the Perth area; it was not recorded on the airport estate in early surveys, but has been regularly sighted since 2008. Bamford *et al.* (2017) concluded that it is now a regular visitor to the site and has been recorded in bushland in the northern area of the airport estate. Small numbers of Forest Red-Tailed Black-Cockatoos occur around the estate quite consistently, with flocks of two to five birds seen daily around Brearley/Dunreath Avenue intersection while Bamford Consulting Ecologists personnel were conducting fauna relocation in May 2016.

The Forest Red-Tailed Black-Cockatoo has similar foraging requirements to Baudin's Black-Cockatoo, relying heavily on Marri and to a lesser extent on Jarrah, but it also forages on a suite of exotic plants within the project area, Perth Airport estate and in surrounding suburbs. The amount of quality native foraging habitat within the project area is small, so the presence of the species is probably supported by exotic plants within and outside the area.

Approximately 40.9% of the project area (26.8 hectares) provides some foraging value for Forest Red-Tailed Black-Cockatoo with a foraging value score of between 1 (low foraging value) to 4 (moderate foraging value), out of a possible total score of six (Table 4-9). There is 1.5 hectares of moderate foraging habitat (score 4) for this species within the project area and the remainder is of negligible to moderate foraging value for the species. Approximately 51.1% (38.7 hectares) of the project area had no foraging value for the species. The distribution of foraging habitat across the project area is shown in Figure 4-8 and Table 4-9.

Score based on vegetation characteristics (out of 6)	Area (hectares)	% of Total Project Area of 65.5 hectares
1 – Negligible to Low	8.6	13.1
2 – Low	3.9	6.0
3 – Low to Moderate	12.8	19.5
4 – Moderate	1.5	2.3
5 – Moderate to High	0	0
6 – High	0	0
Total	26.8 hectare	40.9

Table 4-9 Summary of Forest Red-Tailed Black-Cockatoo vegetation characteristics foraging habitat in the Project Area

Source: Bamford Consulting Ecologists, 2020

The Forest Red-Tailed Black-Cockatoo does not currently breed in the project area or airport estate and it seems unlikely it will do so. The Black-Cockatoo survey documented 33 potential nest trees, of which 30 were given a rank of 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) and 3 were given a rank of 4 (tree with large hollows or broken branches that might contain large hollows, but hollows or potential hollows 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) (see Bamford Consulting Ecologists (2020) for details on Ranking System).

Thus, none of the trees had hollows that might be useful to the species. The location of potential nest trees is provided in Figure 4-5. No roosting sites or activity was recorded in the project area or airport estate, although there are some known roost sites in the region from the "Great Cocky Count" (Peck *et al.* 2017) as shown in Figure 4-7.

4.9.2 Direct Impacts and Associated Avoidance/Mitigation Measures

The development of the project area will result in the loss of:

- up to approximately 26.8 hectares of foraging habitat for the Forest Red-Tailed Black-Cockatoo. The majority of this (95%) is of negligible (score 1), low (score 2) and low-moderate (score 3) foraging value for the species. (refer Table 4-9 and Figure 4-8).
- up to 33 potential nest trees, of which 30 are a rank of 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) and 3 are a rank of 4 (tree with large hollows or broken branches that might contain large hollows, but hollows or potential hollows 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).

4.9.3 Indirect and Offsite Impacts and Associated Avoidance/Mitigation Measures

Table 4-10 provides a summary of potential impacts to the Forest Red-Tailed Black Cockatoo and associated avoidance and mitigation measures.

Impact Type	Threatening process	Discussion	Proposed Avoidance/Mitigation Measure	Significance
Direct	Habitat loss leading to population decline /local extinction	Loss of 26.8 hectares of foraging habitat (Scores 1-6 only) will occur as a result of the proposed project. An additional 38.7 hectares of land that is unsuitable for foraging (Score 0, no forage value), including built environment and mown grass, also occurs within the project area (refer to Impact Tables). Foraging habitat remaining within a 12 km radius is in the order of approximately 5,528 hectares (comprising all Heddle vegetation complexes). Thus, a decline of 0.5% in carrying capacity is likely to occur with the removal of 26.8 hectares of foraging habitat.	Well-defined and rationalised clearing footprint that avoids sensitive habitat where possible. Retain gardens and verges. Landscape with foraging species suitable for the Forest Red-tailed Black-Cockatoo and replant degraded areas.	Minor
Indirect (ecosystem function)	Population Fragmentation	The Forest Red-tailed Black-Cockatoo is a strong-flying species known to cross large areas of open land and to move through built environments to access feeding areas. Development of the project area is unlikely to result in fragmentation of existing populations.	Replanting to replace/ enhance connectivity.	Negligible
Indirect (ecosystem function)	Degradation of surrounding habitat within the estate due to weed invasion	The development of the Airport West (South) area will result in all native vegetation being cleared. Therefore, surrounding remnant native vegetation (e.g. vegetation around Munday Swamp) will be sensitive to weed invasion.	Weed management during earthworks. Active weed management post-development to rehabilitate degraded areas.	Negligible
Direct	Ongoing Mortality	Ongoing mortality can occur during project operations; for example, from birds colliding with approaching and departing planes	Road speeds reduced in areas of high fauna activity.	Negligible

Impact Type	Threatening process	Discussion	Proposed Avoidance/Mitigation Measure	Significance
		(runway adjacent to Airport West (South) and from vehicle strike). Bird strike may decrease due to removal of vegetation from the project area.	Avoid black-cockatoo forage trees along high-speed roads.	
Indirect (ecosystem function)	Species interactions	Not relevant to Forest Red-tailed Black-Cockatoo. However, existing feral management procedures need to be continued.	Not applicable.	Negligible
Indirect (ecosystem function)	Changes to Hydroecology	There may be a risk to habitat used by the Forest Red-tailed Black-Cockatoo due to altered hydrology (such as increased surface water runoff), although with standard management procedures the risk is considered low. There could be some off-site hydrological change, but this would also not affect habitat for the species.	Understand and manage local hydrology. Ensure standard approaches minimise hydrological change.	Negligible (See Table 6-2)
Indirect (ecosystem function)	Changes to Fire Regime	Not relevant to the Forest Red-tailed Black-Cockatoo given the lack of foraging and nesting habitat that will be retained in the project area. Surrounding habitat (outside of the project area, but within the estate) can be managed with existing fire management protocols.	Existing fire management and suppression around the airport estate.	Negligible
Indirect (ecosystem function)	Dust, light, vibration, noise	Not relevant to the Forest Red-tailed Black-Cockatoo as the species is very tolerant to noise and light in urban environments.	Legal environmental limits.	Negligible

Table 4-10 Summary of potential impacts to the Forest Red-tailed Black-Cockatoo and proposed mitigation measures

Source: Bamford Consulting Ecologists, 2020

4.9.4 Cumulative Impacts

The development of the two project areas listed in Table 1-1 will result in the cumulative total loss of 90.7 hectares of foraging habitat for Forest Red-tailed Black-Cockatoo. Vegetation scores range from '1' (Negligible to Low Foraging Value) to '6' (High Foraging Value).

Forest Red-tailed Black-Cockatoo does not currently breed on the airport estate, but limited suitable habitat is present and the species does breed elsewhere on the coastal plain in small numbers. The two project developments (Table 1-1) will result in the combined loss of 135 Marri trees and 31 Jarrah trees that met the basic criterion of 500 mm DBH, but only seven Marri and five Jarrah were given a rank of 3 (potentially suitable hollow). Thus, 12 trees had hollows that might be useful to the species (or other species that require large hollows). No roosting sites or activity was recorded in the airport estate, although there are some known roost sites from the Great Cocky Count in the region (Peck *et al.*, 2017).

4.9.5 Significance of Residual Impacts

An assessment of the potential impacts to the Forest Red-tailed Black-Cockatoo using Guidelines 1.1 (DoE, 2013) significance criteria provided in Section 5.3.4 of Bamford Consulting Ecologists (2020) report.

It is expected that two of the nine EPBC significance criteria will be triggered for the Forest Red-tailed Black-Cockatoo. The proposed action will result in some residual impact to the Forest Red-tailed Black-Cockatoo, through the direct and permanent removal of up to 26.8 hectares of (low to high quality) foraging habitat and 33 potential nest-trees that might be of future use to the species (i.e. trees >500 mm DBH that currently have no hollows). This impact is unavoidable due to the removal of vegetation and nature of the project. There is likely to be an impact to Forest Red-tailed Black-Cockatoo at the local- (moderate impact within Airport West (South) and surrounding airport estate) and regional- (minor impact within a 12 km radius) scales through the loss of foraging habitat and a potentially altered local distribution of the species, but this is not expected to have a significant impact at the species-scale. Residual impacts to the Forest Red-tailed Black-Cockatoo are proposed to be compensated by securing restoration and land purchase offsets.

Cumulative impacts of known proposed projects at Perth Airport (see Table 1-1) to Forest Red-tailed Black-Cockatoo are expected at the local- (moderate impact within the airport estate) and regional- (moderate impact within 12 km) scales but these are not expected to be significant at the species-scale.

4.9.6 Offsets

Section 12 outlines the offsets proposed to address the residual impact to 26.8 hectares of Forrest Red-tailed Black-Cockatoo foraging habitat.

4.10 Quenda Impact Assessment

4.10.1 Overview

Surveys have found Quenda to be abundant across the project area and the Perth Airport estate. Evidence of the species (e.g. tracks and foraging holes) have been found, including in native vegetation, in areas where weeds provide dense cover and even in garden beds. However, animals in garden beds are likely to represent a very small proportion of the population and may represent displaced individuals. Fauna relocation carried out by Bamford Consulting Ecologists in the January to May 2016 period found Quenda to be using virtually any available shelter, even amongst the carparks and light industry south of Terminal 1 (Bamford et al. 2017).

Everard and Bamford (2014) provide some relative abundance data which suggest the following:

- Dampland heaths such as in the eastern part of the project area have maximum densities of Quenda (except where recently burnt, where densities reduced to about 20% of maximum),
- Woodland areas (Marri and Banksia) have Quenda densities of about 40-60% the maximum, and
- Grassland areas have Quenda densities of about 10-20% the maximum.

Thomas (1990) gives a high density of Quenda as 1/hectare, but Everard and Bamford (2014) recorded densities as high as 2.8 animals/hectare on the estate, with the highest densities occurring in dampland heaths. This high density may reflect the impact of on-going fox control but is in the same order of magnitude as the high density noted by Thomas (1990). Using this density as a maximum value and the estimated proportional densities in different vegetation types, it is therefore possible to assign Quenda densities to the three broad vegetation types described above as 2.8/hectare in dampland heaths, about 1.4/hectare in woodland and about 0.25/hectare in grasslands.

While this categorisation is simplistic, it does allow undeveloped parts of the project area to be assigned a Quenda value, for a population estimate to be made, and for proportional population impacts to be calculated based upon areas of the three broad vegetation types. Quenda population estimates for each vegetation type are as follows:

- Dampland heaths (10.0ha) – 28 individuals,
- Woodlands (22.9ha); 32 individuals, and
- Grasslands (15.2ha): 4 individuals.

The total Quenda population within the project area is therefore considered to be in the order of approximately 64 individuals. Quenda habitat mapping in the project area is provided in Figure 4-9.

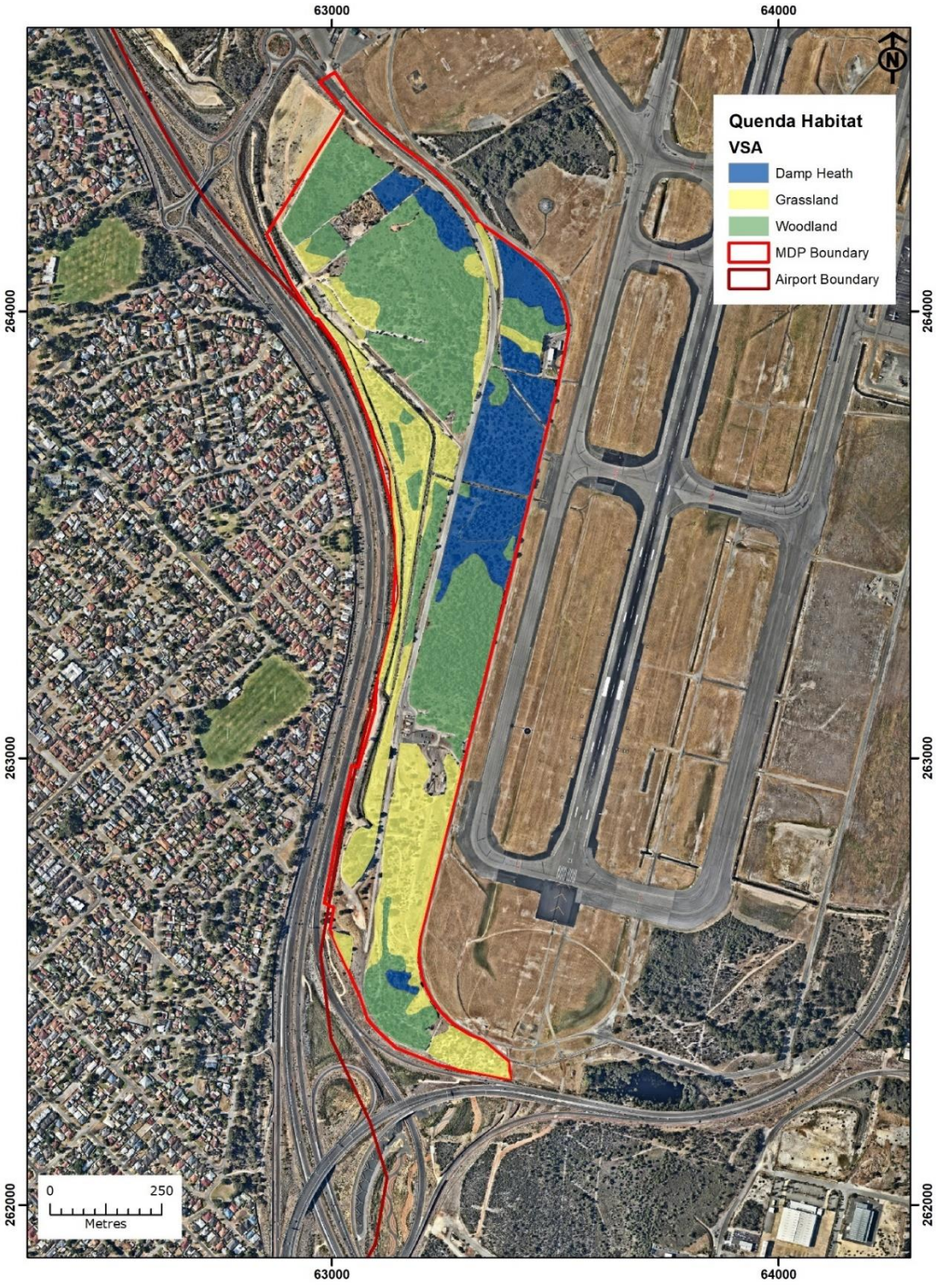

Figure 4-9 Quenda Habitat (Woodland, Damp Heathland and Grassland) in the project area

Source: Bamford Consulting Ecologists, 2020

4.10.2 Direct Impacts and Associated Avoidance/Mitigation Measures

The development of the project area will result in the loss of up to 48.1 hectares of Quenda habitat. A further 18.3ha of cleared/built areas and 2.18ha of wetlands/drains are present in the project area (See Table 4-11).

Vegetation type	Impact Area/Hectare
Woodland	22.9
Damp heathland	10.0
Grassland	15.2
Total impact area	48.1

Table 4-11 Impact areas per vegetation type with the project area

Source: Bamford Consulting Ecologists, 2020

4.10.3Indirect and Offsite Impacts and Associated Avoidance/Mitigation Measures

Table 4-12 provides a summary of potential impacts to the Quenda and associated avoidance and mitigation measures.

Impact Type	Threatening Process	Discussion	Proposed Avoidance/Mitigation Measure	Significance
Direct	Habitat loss leading to population decline/local extinction	Loss of up to 48.1 hectares of Quenda habitat may occur as a result of the Airport West (South) project. The project area currently has an approximate population of 64 individuals, thus the loss of habitat and resultant population decline within the project area could result in a population decline in the order of 3.2% across a 12 km radius.	Well-defined and rationalised clearing footprint that avoids sensitive habitat where possible. Retain gardens and verges. Replant degraded areas and if possible, connect remnants and re-plantings with corridors of native vegetation. Translocate animals prior to clearing.	Moderate
Indirect (ecosystem function)	Population Fragmentation	The Quenda population within the Airport West (South) area is at the western extremity of the available habitat within the airport estate. The loss of individuals from the project area may reduce connectivity and fragment any remaining populations to the north (small areas of habitat will likely remain), west (along Tonkin Highway road verges) and south of the Airport West (South) area.	Replanting to replace/ enhance connectivity.	Moderate
Indirect (ecosystem function)	Degradation of surrounding habitat within the Estate due to weed invasion	The development of Airport West (South) may result in the loss of up to 48.1 hectares of Quenda habitat, but some native vegetation will be retained elsewhere on the airport estate. Retained areas may be at increased risk of weed invasion and the carrying capacity of these areas could be reduced as a result, although Quenda will utilise degraded vegetation.	Weed management during earthworks. Active weed management post-development to rehabilitate degraded areas.	Minor

Impact Type	Threatening Process	Discussion	Proposed Avoidance/Mitigation Measure	Significance
Direct	Ongoing Mortality	Ongoing mortality from vehicle strike can occur during project operations and is a concern for the proposed project.	Provide signage and reduce road speeds in areas of high fauna activity. Implement wildlife underpasses if suitable locations can be identified.	Minor, assuming controls
Indirect (ecosystem function)	Species interactions	Impacts due to species interactions (i.e. predation by feral cats) are likely to increase due to habitat loss and fragmentation.	Existing control of feral species. Extend fox control to include cats. Dieback management.	Minor, assuming controls
Indirect (ecosystem function)	Hydroecology	Offsite impacts due to hydrological change are likely to be negligible as modifications to surface water hydrology will be strictly managed onsite. It is unlikely that Quenda habitat surrounding the project area would be impacted by hydrological change, although Quenda will utilise many different vegetation types.	Understand and manage local hydrology. Ensure standard approaches minimise hydrological change	Negligible (See Table 6-2)
Indirect (ecosystem function)	Changes to Fire Regime	Not relevant to the Quenda given the lack of habitat that will be retained in the project area. Surrounding habitat (outside of the project area, but within the estate) can be managed with existing fire management protocols.	Existing fire management and suppression around the airport estate.	Negligible
Indirect (ecosystem function)	Dust, light, vibration, noise	Not relevant to Quenda as the species is tolerant to noise and light in urban environments.	Legal environmental limits.	Negligible

Table 4-12 Summary of potential impacts to Quenda and proposed mitigation measures

Source: Bamford Consulting Ecologists, 2020

4.10.4 Cumulative Impacts

The Quenda was found to be abundant across the airport estate. Cumulative quenda population estimates for each vegetation type within the two project areas listed in Table 1-1. are as follows:

- Damp heathland (80.0 hectares) – 224 individuals;
- Woodlands (88.6 hectares) - 124 individuals; and
- Grasslands (112.2 hectares) - 28 individuals.

The cumulative total Quenda population within the two project areas is therefore considered to be in the order of 376 individuals (in 280.8 hectares). This represents c. 37% of Quenda, and 39% Quenda habitat, in the airport estate, but there will be some remnant patches of native vegetation retained, and the species can exist in planted garden. Therefore, there will be substantial and permanent population decline, but a small population will remain.

4.10.5 Significance of Residual Impacts

An assessment of the potential impacts to Quenda using Guideline 1.1 significance is provided in Section 5.4.4 of the Bamford Consulting Ecologists (2020) report.

It is likely that four of the nine significance criteria under Guidelines 1.1 will be met for Quenda. Based on the assessment above, approximately 48.1 hectares of Quenda habitat will be permanently removed for the construction of airport infrastructure. This represents all the Quenda habitat within the Airport West (South) area. Remnant patches of native vegetation will be retained outside the project area, located to the north, west and south, and the species can exist in planted gardens. Therefore, there will be substantial and permanent population decline but a small population may return to areas of planted gardens and verges. There is likely to be a major impact to Quenda within the project area, but a minor impact to the Quenda population across the surrounding airport estate and regionally through the loss of foraging habitat and a potentially altered local distribution of the species; this is not expected to have a significant impact at the species-scale. Pre-clearing trapping and relocation to a suitable release site will reduce direct mortality, and the remaining population can be assisted through a revegetation program designed to create interconnected habitat through the built landscape. This would include gardens, verges and the Living Stream program. The regional (within a 12 km radius) population will persist.

Cumulative impacts of known proposed projects at Perth Airport (see Table 1-1) to Quenda are expected at the local- (major impact within the airport estate) and regional- (major impact within 12 km) scales but these are not expected to be significant at the species-scale.

4.11 Water Rat (Rakali) Impact Assessment

4.11.1 Overview

The Rakali (water-rat) is listed as Priority 4 by DBCA. The species is present in the area but likely restricted to permanent wetlands along Abernethy Road (e.g. Ollie Worrell Reserve), with seasonal dispersal into Munday Swamp and along the NMD and SMD, which flows through the project area (Bamford *et al.* 2017). Drains may provide connectivity for Rakali between the Abernethy Road wetlands and the Swan River (located to the west of the project area).

The only record of the Rakali is a feeding platform in Munday Swamp, approximately 2.5km east of the project area (at 50J 404041E, 6465939N; Bamford *et al.* 2017). As Munday Swamp is seasonal, this suggests that an animal had been present the previous winter and it was speculated that the Rakali may be an occasional visitor as individuals disperse along drains and from wetlands nearby. The Rakali is only a visitor to Munday Swamp, and as the swamp is not a part of the project area, the impacts are considered negligible. The location of drains within the project area that may be used by the species is shown in Figure 4-10.

Figure 4-10 Location of drains in the project area and Airport Estate that may be used by Rakali

Source: Bamford Consulting Ecologists, 2020

4.11.2 Direct Impacts and Associated Avoidance/Mitigation Measures

The development of the Airport West (South) project will result in the improvement of 2.0 hectares of Rakali habitat and includes existing artificial drains used by the species to move through the project area and airport estate. This will be achieved via the programme of converting drains into 'Living Streams' and providing improved connectivity and more permanent wetland habitat.

4.11.3 Indirect and Offsite Impacts and Associated Avoidance/Mitigation Measures

Table 4-13 provides a summary of potential improvement/impacts to the Rakali and associated avoidance and mitigation measures.

Impact Type	Threatening process	Discussion	Proposed Avoidance/Mitigation Measure	Significance
Direct	Habitat loss leading to population decline/extinction	The removal or modification of key habitat (2.0 hectares of existing drains) will occur as a result of the Airport West (South) project.	Well-defined and rationalised clearing footprint that avoids Rakali habitat (i.e. drains) where possible. Replanting drains to replace/ enhance habitat and connectivity.	Negligible
Indirect (ecosystem function)	Population Fragmentation and Survival	The removal or modification of 2.0 hectares of drains from within the Airport West (South) area may reduce the ability for Rakali to move through the area, e.g. between wetlands located east of the project area through to the Swan River (west of the project area).	Clearing designed to retain drains/linkage where possible. Replanting drains (as a part of the Living Streams program) to replace/ enhance connectivity.	Minor
Indirect (ecosystem function)	Degradation of surrounding habitat within the estate due to weed invasion	Impacts from weed invasion are expected to be negligible with standard weed management procedures.	Weed management during earthworks. Active weed management post-development to rehabilitate degraded areas.	Negligible
Direct	Ongoing Mortality	Ongoing mortality from vehicle strike can occur during project operations and is a concern for the Airport West (South) project. Impacts to Rakali are considered minor as the species usually moves through the landscape via drains.	Provide signage and reduce road speeds in areas of high fauna activity. Implement wildlife underpasses if suitable locations can be identified.	Moderate
Indirect (ecosystem function)	Species interactions	Impacts from species interactions assumed to be Minor as the species persists in areas where feral species are	Existing control of feral species. Extend fox control to include cats.	Moderate but reduced to minor assuming feral animal control

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Impact Type	Threatening process	Discussion	Proposed Avoidance/Mitigation Measure	Significance
		present. Existing controls on feral species may be of assistance.		
Indirect (ecosystem function)	Hydroecology	The Rakali is sensitive to hydrological change but both surface and sub-surface hydrology will be managed within the Airport West (South) area, across the airport estate and off-site. Perth Airport currently has a program of converting drains into 'Living Streams' and this may benefit the Rakali.	Understand and manage local hydrology. Ensure standard approaches minimise hydrological change. Replant drains (as a part of the Living Stream program). (See Table 6-2)	Minor
Indirect (ecosystem function)	Changes to Fire Regime	Vegetated drains and wetland areas provide key habitat for the Rakali. While vegetation in these can burn, the impact upon the Rakali is expected to be slight as it is partly aquatic.	Existing fire management around the airport estate.	Negligible/Minor
Indirect (ecosystem function)	Dust, light, vibration, noise	Not relevant to Rakali as the species is very tolerant to noise and light in urban environments.	Legal environmental limits.	Negligible

Table 4-13 Summary of potential impacts to Rakali and proposed mitigation measures

Source: Bamford Consulting Ecologists, 2020

4.11.4 Cumulative Impacts

The development of the two project areas listed in Table 1-1 will result in the total loss of approximately 7.6 hectares of Rakali habitat, including existing drains used by the species to move through the airport estate and landscape. However, the programme of converting drains into 'Living Streams' may benefit the species by providing improved connectivity and more permanent wetland habitat. The only record of the Rakali is a feeding platform in Munday Swamp (at 50J 404041E, 6465939N; Bamford et al. 2017; see Figure 4-10). The Rakali is only a visitor to Munday Swamp, and as the swamp is not earmarked for development, the impact would be considered minimal.

Cumulative impacts of known proposed projects at Perth Airport (see Table 1-1) to Rakali are expected at the local-scale (minor impact within the airport estate) but these are not expected to be significant at the regional- or species-scales.

4.11.5 Significance of Residual Impacts

An assessment of the potential impacts to Rakali using Guidelines 1.1 (DoE, 2013) significance criteria is provided in Section 5.5.4 of Bamford Consulting Ecologists (2020) report.

It is not expected that any EPBC significance criteria will be triggered for the Rakali. The proposed action will result in the disturbance of up to 2.0 hectares of drains. While there will be some modification to existing drains to accommodate the construction of airport infrastructure, other drains will be created and replanted, providing key habitat and potentially a net benefit for the Rakali. Revegetated drains will aid in the movement of the species across the built landscape. Impacts are expected to range from negligible to minor. There is likely to be an impact to Rakali at the local- (minor impact within the project area and surrounding airport estate) scale through temporary disruption of movement through the landscape, but this is not expected to have a significant impact at either the regional- or species-scale. The proposed action is unlikely to result in a significant residual impact to the Rakali.

4.12 Native Bee Impact Assessment

4.12.1 Overview

The Native Bee *Hylaeus globuliferus* (DBCA Priority 3) is known to occur in the region and from habitats represented in the project area and airport estate. While there is little information available on the distribution and habitat of the Native Bee, Everard and Bamford (2014) note that there are records in the general Perth region. Records from the DBCA database show that the species has been recorded from Perth up the northern Swan Coastal Plain to Jurien Bay and Eneabba. The species has also been recorded at several locations between Lake Grace and the Fitzgerald River National Park (southwest of Ravensthorpe).

The species is known to forage on the flowers of Woollybush (*Adenanthos cygnorum*) and *Banksia attenuata*, which are both present in the Banksia woodland of the project area. The vegetation type (VT) is mapped as VT13 by Woodman Environmental (2019) and presented in Figure 4-11.

Field investigations carried out in early 2019 for the airport estate did not locate the species, but some likelihood of presence remains (Bamford and Knowles 2019), and advice from the WA Museum notes that the species may be more widespread and common than realised (Bamford Consulting Ecologists, 2020).

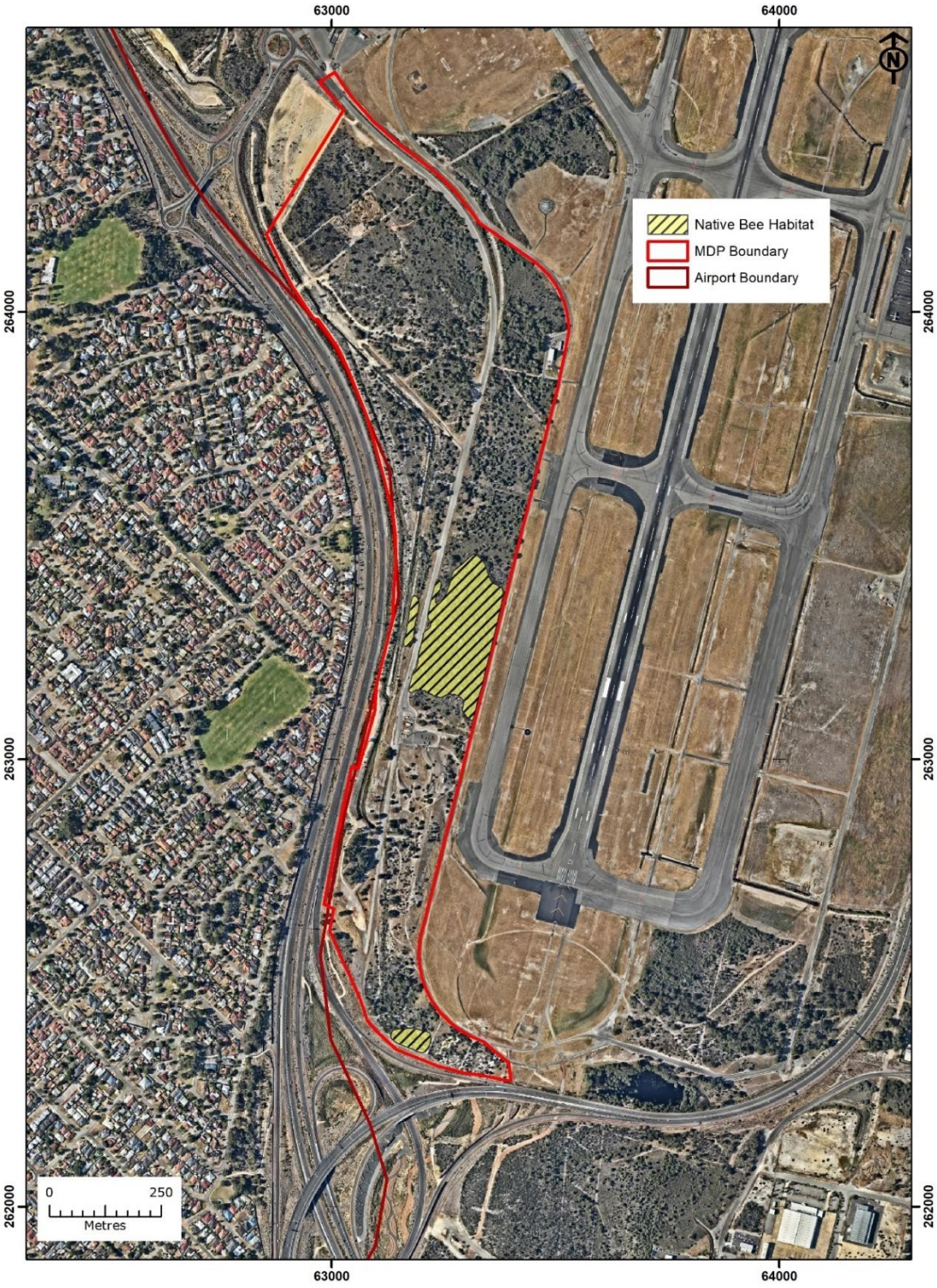

Figure 4-11 Location of Native Bee habitat in the project area

Source: Bamford Consulting Ecologists, 2020

4.12.2 Direct Impacts and Associated Avoidance/Mitigation Measures

The Native Bee is likely to be a regular visitor to the project area and airport estate. The development of the project area will result in the loss of up to 4.9 hectares of VT13 (Banksia Woodland) and Native Bee habitat.

4.12.3 Indirect and Offsite Impacts and Associated Avoidance/Mitigation Measures

Table 4-14 provides a summary of potential impacts to the Native Bee and associated avoidance and mitigation measures.

Impact Type	Threatening process	Discussion	Proposed Avoidance/Mitigation Measure	Significance
Direct	Habitat loss leading to population decline/local extinction	Loss of up to 4.9 hectares of foraging habitat (Banksia Woodland with Adenanthos cygnorum) may occur as a result of the proposed Airport West (South) project and is significant due to the scarcity of habitat for the species in a 12 km radius (approximately 1.9% of the estimated 256 hectares of regional habitat).	Well-defined and rationalised clearing footprint that avoids sensitive habitat where possible. Plant gardens and verges with foraging species suitable for the Native Bee e.g. Adenanthos cygnorum (Woollybush). Replant degraded areas if possible, with species preferred by the Native Bee.	Major
Indirect (ecosystem function)	Population Fragmentation and Survival	The loss of up to 4.9 hectares of Banksia Woodland is likely to result in further fragmentation of the local population.	Clearing designed to retain corridors/linkage where possible. Replanting to replace/ enhance connectivity.	Minor
Indirect (ecosystem function)	Degradation of surrounding habitat within the estate due to weed invasion	Impacts from weed invasion are expected to be negligible with standard weed management procedures. Woollybush is a native plant species that actually responds well to some disturbance.	Weed management during earthworks. Active weed management post-development to rehabilitate degraded areas.	Minor
Direct	Ongoing Mortality	Ongoing mortality during project operations is uncertain, but if a population is present, the proportion at risk from mortality such as that due to roadkill is probably very small.	Not applicable.	Minor
Indirect (ecosystem function)	Species interactions	Not relevant to the Native Bee.	Not applicable.	Negligible

Impact Type	Threatening process	Discussion	Proposed Avoidance/Mitigation Measure	Significance
Indirect (ecosystem function)	Hydroecology	Probably not relevant to the Native Bee assuming local hydrology is managed to prevent any significant changes.	Understand and manage local hydrology. Ensure standard approaches minimise hydrological change. (See Table 6-2)	Negligible
Indirect (ecosystem function)	Changes to Fire Regime	Not relevant to the Native Bee given the lack of habitat that will be retained in the project area. Surrounding habitat (outside of the project area, but within the estate) can be managed with existing fire management protocols. Fire events that occur in Native Bee habitat outside of the project area may impact the species at a local level.	Existing fire management and suppression around the estate.	Negligible - Minor
Indirect (ecosystem function)	Dust, light, vibration, noise	Impacts of dust, light, vibration and noise are not well known. The species must be tolerant to some degree, as it is present in the urban environment.	Legal environmental limits.	Minor

Table 4-14 Summary of potential impacts to the Native Bee and proposed mitigation measures

Source: Bamford Consulting Ecologists, 2020

4.12.4 Cumulative Impacts

The development of the two project areas listed in Table 1-1 will result in the total loss of approximately 25.5 hectares of Banksia Woodland (with Adenanthos cygnorum) and known H. *globuliferus* habitat. Impacts to the species are likely to be proportional to loss of their preferred habitat across the project areas. Impacts to the Native Bee are likely to be significant due to the lack of suitable habitat outside the airport estate.

4.12.5 Significance of Residual Impacts

An assessment of the potential impacts to the Native Bee using Guideline 1.1 significance is provided in Section 5.6.4 of Bamford Consulting Ecologists (2020) report.

It is likely that five of the nine significance criteria under Guidelines 1.1 will be triggered for the Native Bee. If present in the project area, there will be a permanent local population decline due to habitat loss. Approximately 4.9 hectares of Banksia Woodland with A. cygnorum will be permanently removed for construction of the project which represents a significant portion of bee habitat within the local area. There is likely to be an impact to *H. globuliferus* at the local- (major impact within the project area and surrounding airport estate) and regional- (moderate impact within 12 km) scales through the loss of habitat and a potentially altered local distribution of the species, but this is not expected to have a significant impact at the species-scale. Standard mitigation measures and proposed additional management measures will reduce impacts to some degree, but the proposed action is likely to result in a significant residual impact to the Native Bee. Based on the precautionary principles, a decline in the abundance and some localised loss of the species is expected even though they have not been confirmed within the project area.

Cumulative impacts of known proposed projects at Perth Airport (see Table 1-1) to A. cygnorum are expected at the local- (major impact within the airport estate) and regional- (moderate impact within 12 km) scales, but these are not expected to be significant at the species-scale.

4.13 Fauna Impact Assessment (Whole of Environment)

4.13.1 General Fauna Environment – Overview

The Whole of Environment fauna within and adjacent to the project area has been described in Section 4 of the Bamford Consulting Ecologists (2020) report, summarised in Section 4.6.1 of this MDP and below. The Whole of Environment fauna includes general fauna and any species of conservation of significance.

Bamford Consulting Ecologists identified 204 vertebrate species as potentially occurring in the Perth Airport estate. These include: five fish, 12 frogs, 42 reptiles, 130 birds (six introduced) and 15 mammals (five introduced).

Of these, 174 species (two fish, 11 frogs, 32 reptiles, 116 birds and 13 mammals) have been recorded in the Perth Airport estate and are considered highly likely to be present in the project area (Refer to Appendix 5 of Bamford Consulting Ecologists (2020) for full species list).

4.13.2 Direct Impacts and Associated Avoidance/Mitigation Measures

The development of the project will result in the loss of several broad vegetation types including Woodland (22.9 hectares), Dampland Heath (10.0 hectares), artificial drains (2.0ha) and Grassland (15.2 hectares), a total of approximately 50.1 hectares.

Table 4-15 provides a summary of potential direct impacts to the general fauna environment and associated avoidance and mitigation measures

Further to this, Perth Airport proposes to revegetate approximately 4.5 hectares of a detention basin that is to be developed as part of the project. The indicative location of the basin is shown previously within Figure 3-5 and this area will be regenerated and will provide an area of fauna habitat in the future.

4.13.3 Indirect and Offsite Impacts and Associated Avoidance/Mitigation Measures

Table 4-15 provides a summary of potential indirect impacts to the general fauna environment and associated avoidance and mitigation measures.

Impact Type	Threatening process	Discussion	Proposed Avoidance/Mitigation Measure	Significance
Direct	Habitat loss leading to population decline/extinction	Loss of 50.1 hectares of various VSAs will result in population declines at a local level for a wide suite of native fauna species, including common and conservation significant species. This would be of concern to a number of species (e.g. sedentary, insectivorous birds such as fairy-wrens, thornbills, scrubwrens, robins, whistlers and shrike-thrush, and some reptile and mammal species e.g. Quenda).	Well-defined and rationalised clearing footprint that avoids habitat where possible. Pre-clearing trapping and relocation (e.g. reptiles). Replant degraded areas. Establish gardens with native vegetation.	Moderate
Indirect (ecosystem function)	Population Fragmentation and Survival	The project area is situated in a highly urbanised and fragmented landscape. Loss of 50.1 hectares in the project area would affect local movement patterns of some bird and mammal species such as the Quenda, which at present may rely on native vegetation for the persistence of local populations.	Clearing designed to retain corridors/linkage where possible. Replanting to replace/ enhance connectivity. Creating biodiverse gardens. 'Living stream' approach to drains to create wildlife corridors.	Minor
Indirect (ecosystem function)	Degradation of surrounding habitat within the estate due to weed invasion	Weed invasion of the Airport West (South) area is currently high in parts of the native vegetation, and weed invasion will be a risk in the native vegetation that is retained. Weeds are likely to be managed intensively in gardens and Living Streams in the future, and will need to be managed in retained native vegetation.	Weed management during earthworks. Active weed management post-development to rehabilitate degraded areas and throughout.	Minor
Direct	Ongoing Mortality	Direct mortality of common species during clearing and construction is unavoidable,	Pre-clearing fauna relocation.	Minor to Moderate

Impact Type	Threatening process	Discussion	Proposed Avoidance/Mitigation Measure	Significance
		but can be minimised for some species (e.g. Bobtail, Quenda) through pre-clearing trapping and relocation. Increased mortality can occur during project operations; for example, from roadkill, animals striking infrastructure and entrapment in trenches. Some species, however, will be vulnerable to increased and ongoing mortality such as from roadkill; these would include mammals and reptiles that will persist in greatly reduced and fragmented populations, such as Bobtail, Quenda and Rakali.	Provide signage and reduce road speeds in areas of high fauna activity. Install wildlife underpasses for Quenda and some other fauna if suitable locations can be identified.	
Indirect (ecosystem function)	Species interactions	Feral species are a conservation concern for some native fauna, and at present the control of foxes is believed to have contributed to the flourishing Quenda population in the project area. Control of foxes and cats will be even more important with reduced populations of bird, mammals and reptile species.	Existing control of feral species. Extend fox control to include cats to reduce predation pressure on small mammals and birds.	Moderate, but reduced to Minor assuming feral animal control is practiced.
Indirect (ecosystem function)	Hydroecology	In the future scenario, fauna will be heavily reliant on managed landscapes where hydrology will probably be managed with drains to ensure vegetation and wetlands are protected. Therefore, fauna species that rely on wetlands and wetland-vegetation (e.g. fish, frogs and some bird species are likely to be protected from adverse impacts due to hydrological change. The Perth Airport currently has a	Understand and manage local hydrology. Ensure standard approaches minimise hydrological change. Replant drains (as a part of the Living Streams program).	Negligible to Minor

Impact Type	Threatening process	Discussion	Proposed Avoidance/Mitigation Measure	Significance
		program of converting drains into 'Living Streams' and this may benefit several fauna species. Advice is that hydrological impacts from Airport West (South) on Munday Swamp will be minimal.		
Indirect (ecosystem function)	Changes to Fire Regime	In the future scenario, intensive management may result in the virtual exclusion of fire as all native vegetation in the project area will be removed. Although 'Living Streams' could be subject to infrequent and possibly intense fires. Species that occur at low densities would be vulnerable to such fires.	Existing fire management around the estate.	Moderate
Indirect (ecosystem function)	Dust, light, vibration, noise	Impacts of dust, light, vibration and noise upon fauna are difficult to predict. Given the current setting of native vegetation in the project area, fauna is already exposed to high levels of noise, light and vibration. Separation distances will be reduced and this may be a concern for some invertebrates, but the consequences are largely unknown. Mobile species such as birds may leave the area to avoid high levels of noise and vibration.	Legal environmental limits. Direct lighting away from retained native vegetation.	Minor

Table 4-15 Summary of potential impacts to the general fauna environment and proposed mitigation measures

Source: Bamford Consulting Ecologists, 2020

4.13.4 Cumulative Impacts

The total known area of the currently proposed developments (i.e. Airport West (South) and New Runway Project) is 358.3 hectares (c. 17% of the estate). Of this, approximately 80% (288.4 hectares; 14% of the estate) is fauna habitat that will be impacted as a result of the proposed projects for which boundaries have been currently defined (Table 1-1).

The development of the two project areas listed in Table 1-1 will result in the loss of sometimes large areas of several key VSA types including Woodland (88.6 hectares), Damp Heathland (80.0 hectares), Grassland (112.2 hectares) and Drains (7.6 hectares) and represents a significant portion of habitat within the local area. This clearing will result in population declines at a local level for a wide suite of native fauna species, including common and conservation significant species. This would be of concern to a number of species (e.g. sedentary, insectivorous birds and some reptile and mammal species e.g. Quenda). Some birds (not MNES or Priority) vulnerable to habitat loss and fragmentation may become locally extinct on the estate. The construction of all the development projects will alter the local movement of some native fauna species. Mobile species such as birds may vacate the airport estate for more favourable habitats.

4.13.5 Significance of Residual Impacts

An assessment of the potential impacts to Whole of Environment fauna using Guidelines 1.1 (DoE 2013) significance criteria is provided in Section 5.74 of Bamford Consulting Ecologists (2020) report.

It is likely that three of the nine significance criteria under Guidelines 1.1 will be triggered for the Whole of Environment fauna. There will be permanent population declines at a local level due to habitat loss in the Airport West (South) area. Approximately 50.1 hectares of vegetation (and drains) will be permanently removed for the construction of airport infrastructure and represents a significant portion of habitat within the local area.

Standard mitigation measures and proposed additional management measures will reduce impacts to some degree, which are expected to range from negligible to major. The proposed action is likely to result in a significant residual impact to local populations of many species of birds and reptiles. A decline in the abundance and localised loss of the species is expected, although some bird and mammal species will exist in planted gardens. Some species will remain and can be assisted through a revegetation program designed to create interconnected habitat through the built landscape (e.g. Rakali in planted drains).

Residual impacts at a local level are expected to be permanent and highly significant, since many native species of fauna are reliant on the native vegetation that will be removed from the Airport West (South) area. However, common (Whole of Environment) fauna species present within the Airport West (South) area are widespread across the airport estate and where native vegetation is currently retained in the region, including the Swan Coastal Plain; therefore, at a regional level the impact on these species is low.

Cumulatively impacts at a local level are expected to be permanent and significant. However, many common species present within the airport estate are widespread across the Swan Coastal Plain and therefore at a species level, are at low risk from the combined actions.

5. Soils and Geology

This section provides details on:

- Soils and geology within the Airport West (South) project area,
- Impact assessment (including direct, indirect and offsite impacts) and associated mitigation and avoidance measures on the following soil and geology matters that are known to be relevant to the project.
    - Land Contamination, and
    - Acid Sulphate Soils.

5.1 Legislative and Policy Context

Commonwealth and State Government policy and guidelines have been referenced for this assessment as they provide specific guidance relevant to geology and soils, in particular acid sulphate soils and contamination.

As such the following guidance referenced:

- Western Australian Planning Commission, State Planning Bulletin 64 – Acid Sulfate Soils,
- Identification and Management of Acid Sulfate Soils and Acidic Landscapes, State Department of Environment Regulation (DER) June 2015,
- Treatment and Management of Soil and Water in Acid Sulfate Soil Landscapes, Final Version, June 2015,
- IECA 2008, Best Practice Erosion and Sediment Control. International Erosion and Sediment Control Association (Australasia), Picton NSW,
- Airports (Environment Protection) Regulations (AEPR) 1997,
- EPBC Act
- Contaminated Sites Act 2003,
- Contaminated Sites Regulations 2006,
- Assessment and Management of Contaminated Sites (December 2014),
- Interim Guideline on Assessment and Management of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) (January 2017),
- Department of Infrastructure and Regional Development – Management Actions Advice (Guideline for Environmental Management - GEM-002), and
- National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013, published by the National Environment Protection Council.
- Heads of the Environmental Protection Authority (HEPA), January 2018, PFAS National Management Plan (NEMP) (HEPA 2018).

5.2 Methodology

A desktop review of publicly available information and the findings from previous environmental studies has been undertaken to determine the project area's geological and soil conditions.

The relevant previous investigation completed at the site include:

- Senversa, 2019, PFAS Detailed Site investigation, Perth Airport estate, October 2019 (Senversa, 2019),
- AECOM, 2018, Preliminary Site Investigation and Limited Sampling, Perth Airport, October 2018 (AECOM, 2018),
- JBS&G, 2018, Drainage Channel Sediment Investigation for Perfluoroalkyl & Polyfluoroalkyl Substances, Northern Main Drain and Southern Main Drain, Perth Airport estate, August 2018 (JBS&G, 2018), and
- Coffey, 2017, Preliminary and Detailed Site Investigation, Perth Airport West (South) Precinct, August 2017 (Coffey, 2017).

In 2017, a Preliminary Site Investigation (PSI) and Detailed Site Investigation (DSI) were completed to provide further information for the soil and geology baseline and impact assessments.

The purpose of the PSI was to identify potential on-site and off-site sources of potential contamination that warrant further investigation. The PSI included a site inspection, including interviews with knowledgeable site personnel to identify potential contamination sources. The PSI also included a review of client held site data and a desktop review of historical investigations pertaining to the site, plus a review of publicly available data sources, such as historical aerial photos, heritage records, groundwater bore data and geological, hydrogeological and topographical maps.

Information obtained in the PSI was used to guide the sampling strategy for the DSI, which included the advancement of soil bores and installation of monitoring wells. Samples were collected from soils, sediments, surface water and groundwater and analysed for identified Contaminants of Potential Concern (COPC) at a National Association of Testing Authorities (NATA) accredited laboratory. The objective of the DSI was to assess the nature and extent of contamination at the site, as well as obtaining sufficient information to guide management measures during site development.

A DSI focussing on the assessment of Perfluoroalkyl & Polyfluoroalkyl Substances (PFAS) was also completed for the entire Perth Airport estate (Senversa, 2019), which included investigation within the project area.

PFAS are a group of manufactured chemicals that have been used since the 1950s in a range of common products including non-stick cookware, fabric, furniture, food packaging and fire-fighting foams. There are nearly 5,000 types of PFAS, these include Perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and perfluorohexane sulfonate (PFHxS) which were historically used more prevalent in PFAS containing products. Aqueous Film Forming Foams (AFFF) containing PFAS have been used internationally in firefighting activities since the 1960's. The PFAS used in AFFF reduces the surface tension of water and allows an aqueous film to spread over flammable liquid and suppress vapours during firefighting. PFAS are considered to be very stable with moderate mobility and are highly resistant to biological degradation and therefore persistent within the environment. In addition, PFAS are bio-accumulative and are noted to be ubiquitous in the food chain.

The PFAS DSI was completed to assess the nature and extent of PFAS contamination at the estate as well as obtaining sufficient information to guide the management measures during site development. The DSI also provides additional understanding on the geology baseline. The DSI was completed in accordance with the WA Department of Environment Regulation (DER), Assessment and Management of Contaminated Sites – Contaminated Sites Guideline, December 2014 (DER, 2014), the National Environmental Protection Council (NEPC), National Environment Protection (assessment of Site Contamination) Measure (ASC NEPM) (No.1) 1999, as amended May 2013, and the Heads of the Environmental Protection Authority (HEPA), January 2018, PFAS National Management Plan (NEMP) (HEPA, 2018). Furthermore, an independent third-party review and endorsement of the DSI was completed by a WA DWER accredited *Contaminated Sites* Auditor.

The laboratory analytical results from the Senversa (2019) DSI report, along with analytical data from other historical environmental investigations, is included in the following sections.

5.3 Existing Soils and Geology

The following information is based on the desktop review of previous environmental investigations and publicly available information available from the Government of Western Australia.

5.3.1 General

The Swan Coastal Plain comprises five major geomorphological systems (landforms) that lie parallel to the coast. From west to east these are; Quindalup Dunes, Spearwood Dunes, Bassendean Dunes, Pinjarra Plain and Ridge Hill Shelf (Churchward and McArthur, 1980; Gibson *et al.,* 1994).

The Airport West (South) project area is situated on the Bassendean Dune and Pinjarra Plain landforms (Government of Western Australia, 2000). The site geology is depicted in Figure 5-1.

The Bassendean Dune System consists of very old leached sands to various depths and are the oldest of the three dunes systems occurring on the Swan Coastal Plain. Sands within this system contain very little silt or clay and very low levels of nutrient elements (Earth Science Western Australia, 2016). A summary description of the Bassendean Sands formation is provided in Table 5-1.

Soils of the Pinjarra Plain are complex and comprise a successive layering of soils formed from erosion of material from the scarp and east of the scarp. These soils consist of alluvial flats extending from the base of the scarp to interface with the Bassendean associations (Beard 1981). A summary description of the Pinjarra formation is provided In Table 5-1.

Figure 5-1 depicts the soils across the Airport West (South) project area.

Code	Soil Zone	Description
212	Bassendean	Mid-Pleistocene Bassendean sand. Fixed dunes inland from coastal dune zone. Non-calcareous sands, podsolised soils with low-lying wet areas.
213	Pinjarra	Alluvial deposits (early Pleistocene to Recent) between the Bassendean Dunes Zone and the Darling Scarp, colluvial and shelf deposits adjacent to the Darling Scarp. Clayey to sandy alluvial soils with wet areas. Mid-Pleistocene Bassendean sand. Fixed dunes inland from coastal dune zone. Non-calcareous sands, podsolised soils with low-lying wet areas.

Table 5-1 Summary of soils within the Project area

Source: Schoknecht et. al., 2004

5.3.2 Site Specific geology

Information provided in the Senversa DSI (2019) indicates that the project area (and wider airport estate) is underlain by natural Bassendean Sand up to 2.5 m below ground level which comprises of pale grey, fine to coarse grained, well graded, sub-rounded to sub-angular sand. Underlying the Bassendean Sand is the Guildford Formation which comprises sandy clay and clayey sand which is grey to dark brown to orange/red, fine to coarse grained sand, poorly graded, sub-angular to sub rounded. The clay has low plasticity.

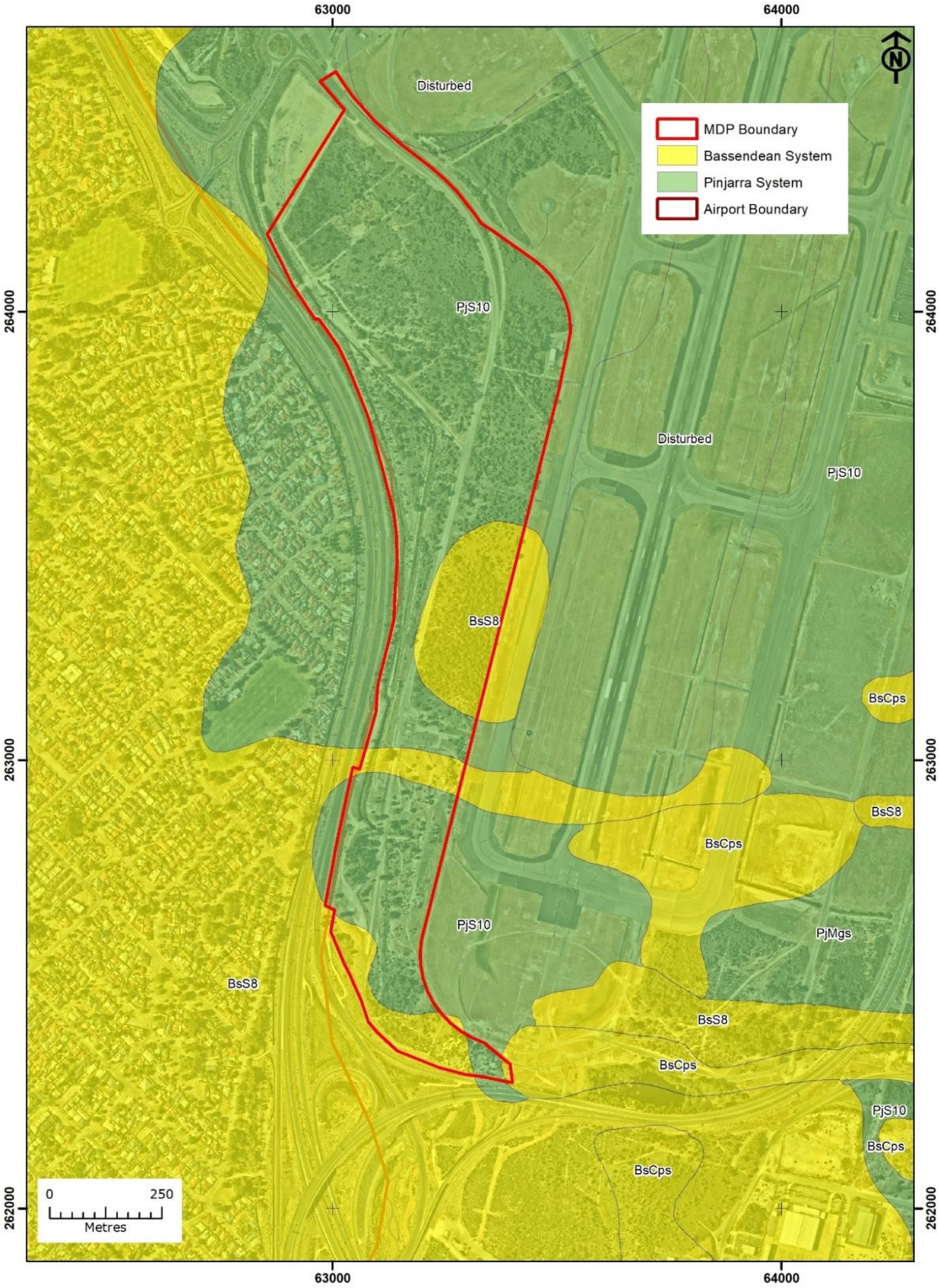

Figure 5-1 Soil Landscape Subsystems within the Airport West (South) Project area

Source: Department of Primary Industries and Regional Development

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5.4 Contaminated Land

Previous investigations as outlined in section 5.2, have identified PFAS as the main contaminants of potential concern within the project area. Other potential contaminants have also been assessed but were not deemed significant for the project area.

5.4.1 Per- and poly-fluoroalkyl substances (PFAS)

Aqueous Film Forming Foams (AFFF) containing PFAS have been used internationally in firefighting activities since the 1960s. Historical information indicates that two PFAS containing AFFF products were used at the airport estate by Aviation Rescue and Fire Fighting. These are:

- 3M Light WaterTM AFFF (PFOS based surfactant) FC-206CF 6% (approximately 17 years' use, 1983-2000); and
- ANSUL Ansulite 6% AFFF (Formula 1559-22 ICAO-B) (approximately 8 years use, 2000- 2008).

During their use and storage on site, AFFF may have been released to the environment through firefighting activities, while being used on hydrocarbon spills as fire prevention and during training activities. AFFF may have also been released to the environment during the maintenance, cleaning and testing of firefighting equipment as well as through spills and leaks from the storage and transfer of AFFF.

The PSI with limited sampling undertaken by Senversa (2019) identified eight individual PFAS Areas of Potential Environmental Concern (APEC) at the Perth Airport estate (refer Figure 5-2). These include:

- Former Workshop and Tyre Store (Airport West),
- Former Fire Station (Airfield),
- Current ARFF fire station (Airfield),
- Fire Training Ground 1 (Airport North),
- Former Fire training Area A (Airport Central)
- Former Fire Training Area B (Airport West (South)) – Located within project area,
- International Terminal Apron Fuel Spills (Airport Central), and
- Old Incinerator Building (Airport North).

Information provided in past investigations indicates that the area identified as 'Former Fire Training Area B' was historically used for fire training activities which has the potential to release PFAS to the environment.

Perth Airport is aware of PFAS contaminants on the estate and in the MDP area. Perth Airport is committed to development that conforms with the National Environmental Management Plan (NEMP) for PFAS.

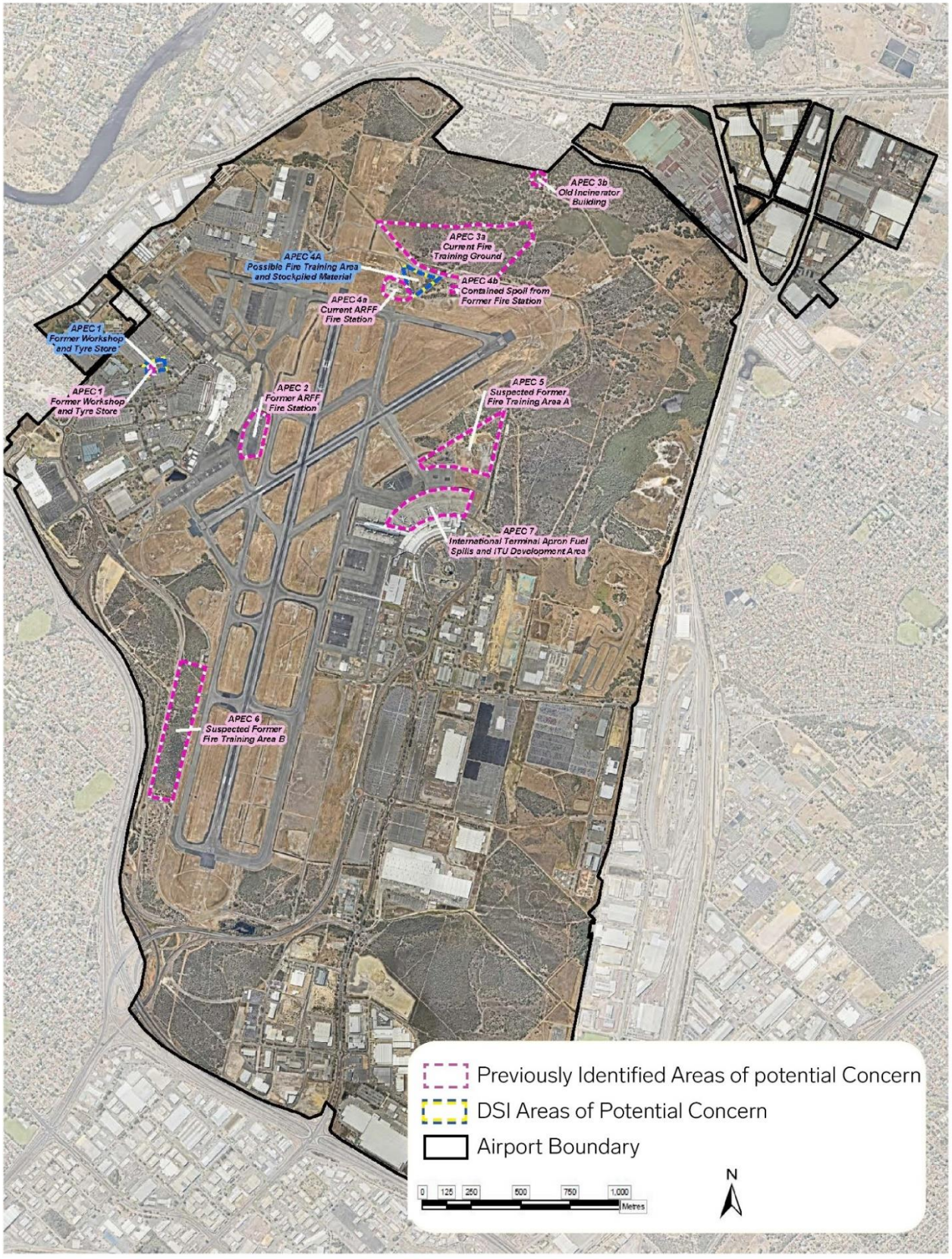

Figure 5-2 Location of PFAS Areas of Potential Environmental Concern in the Perth Airport Estate

Source: Senversa, 2019

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It is noted that the "Former Fire Training Area B" is within the project area. Historical investigations have been completed at the Former Fire Training Area B by Senversa (2019), AECOM (2018), JBS&G (2018) and Coffey (2017) with a summary of the work completed within the project area, and the results of the analytical data collected in each investigation provided in Table 5-2. The remaining PFAS areas of potential environmental concern identified in Figure 5-2 are inferred to be cross hydraulic gradient of the project area.

Report	Completed Monitoring	Maximum PFAS Detection
Senversa (2019)	• Surficial soil samples were collected from 11 locations within or immediately adjacent the project area (SS1019, SS1026, SS1034 – SS1040, SS1046 & SS1047) • Installation of 7 soil bores 1m below ground level (SB1001 – SB1009) with subsequent soil sampling. • Installation of 3 new groundwater monitoring wells (MW1701, MW1054 & MW1005). • Conducted groundwater sampling utilising 6 existing and the 3 newly installed monitoring wells.	Soil PFOS = 0.0028 mg/kg, PFOS + PFHxS = 0.0048, PFOA = non-detect (< 0.0002) Groundwater PFOS = 1.76 µg/L, PFOS + PFHxS = 2.86 µg/L, PFOA = 0.87 µg/L
AECOM (2018)	• Installation of 10 soil bores (SB1701 – SB1710). • Completion of soil sampling from the soil bore. • Conversion of SB1701 into groundwater monitoring well MW1701, SB1702 into MW1702 and SB1709 into MW1703 • Conducted groundwater sampling utilising 1 existing and the 3 newly installed monitoring wells. • Completion of surface water sampling from drainage channels at, and adjacent to, the area project area (SW1703, SW1704, SW1706 & SW1707). • Laboratory analysis for Contaminants of Potential Concern	Soil PFOS = 0.13 mg/kg, PFOA = 0.0007 mg/kg Groundwater PFOS = 3.6 µg/L, PFOA = 0.01 µg/L Surface Water PFOS = 0.14 µg/L, PFOA = Non-Detect
JBS&G (2018)	• Surficial and deeper sediment samples collected from 6 locations within the SMD. Two of which are within the project area. • Collected samples were analysed for PFAS and other physio-chemical parameters	Sediment PFOS = non-detect (<0.005 mg/kg) PFOA = non-detect (<0.005 mg/kg)
Coffey (2017)	• Installation of 4 soil bores (CMW01 – CMW04). • Completion of soil sampling from the soil bore. • Conversion of each of the soil bores into groundwater monitoring wells • Conducted groundwater sampling utilising the 4 newly installed monitoring wells. • Laboratory analysis for Contaminants of Potential Concern	Groundwater PFOS = 0.69 µg/L, PFOA = 2.1 µg/L

Table 5-2 Details of PFAS investigations completed at the Former Fire Training Area B

The reported concentrations in soil during the historical site investigations are orders of magnitude below the HEPA (2018) human health screening criteria values for commercial/industrial (PFOS/PFHxS = 20 mg/kg, PFOA = 50 mg/kg) land use and a public open space (PFOS/PFHxS = 1 mg/kg and PFOA = 10 mg/kg), residential land use with minimal opportunities for soil access (PFOS/PFHxS = 2 mg/kg and PFOA = 20 mg/kg), but above the residential land use with garden/accessible soil (PFOS/PFHxS = 0.009 mg/kg and PFOA = 0.1 mg/kg),

The reported historical concentrations are also below the ecological guideline value for ecological direct exposure (PFOS = 1 mg/kg and PFOA = 10 mg/kg). One sample collected during the AECOM (2018) investigation exceeds the ecological guidelines values for indirect exposure (0.01 mg/kg). It is recognised that indirect exposure guideline values are intended to account for the various pathways, principally bioaccumulation, through which exposure can occur for organisms whether or not they are in direct contact with PFAS contaminated soil. As outlined in the PFAS NEMP, it is recognised that the indirect exposure criterion may be over-protective for situations where the area of soil impact is too small to have an impact on food chain transfer to secondary consumers. The NEMP states that the higher criterion of 0.14 mg/kg may be applicable where the site is intensively developed (more than 80% hard stand per hectare) and where secondary consumers are effectively absent from the site. Following the development of the project area it is likely that the limited accessible soil and absence of ecological diversity will mean that the higher criterion (0.140 mg/kg) is more applicable to the site, to which all historical PFOS concentrations are below.

The initial reported concentrations in groundwater and surface water at the site are above the HEPA (2018) human health screening criteria values for recreational use water (PFOS/PFHxS – 0.7 µg/L). It is recognised that the recreational screening criteria is likely to be conservative when assessing the potential risk to commercial/industrial site workers that intercept groundwater. This is because the criteria are based on exposure during recreational activities and assumes that 200 mL of water (equivalent to 10% of drinking water consumption) will be ingested daily over a lifetime. The exposure frequency is likely to be significantly less for maintenance workers. In addition, it is recognised that the use of Personal Protective Equipment (PPE) as would reasonably be anticipated during works within an operational airport, would further limit exposure. Groundwater and surface water concentrations exceed the freshwater and marine water guideline values for 95% species protection (PFOS – 0.13 µg/L).

5.4.2 Other Contaminants of Potential Concern

Additional contaminants of potential concern were also included during the historical assessment completed by Coffey (2017) and AECOM (2018) at the Former Fire Training Area B. These included Benzene, Toluene, Ethylbenzene, Xylene (BTEX), Total Recoverable Hydrocarbons (TRH), Polycyclic Aromatic Hydrocarbons (PAH), solvents and metals.

In both investigations the BTEX, TRH, PAH and solvents were recorded below the laboratory limit of detection, and the adopted assessment criteria, in the soils and groundwater samples.

Minor detections of TRH were detected in surface water samples collected during the AECOM (2018) investigation. However, these concentrations were only slightly above the laboratory limit of reporting and below the adopted assessment criteria.

Minor detections of chromium and nickel were detected in soil water samples collected during the Coffey (2017) investigation. However, these concentrations are below the adopted assessment criteria.

Consequently, the risk from these Other Contaminants of Potential Concerns are considered low and therefore no further assessment has been conducted.

5.5 Acid Sulphate Soils

Acid Sulphate Soils (ASS) are naturally occurring soils containing iron sulfide minerals (notably pyrite) formed under saturated anoxic conditions. In an undisturbed state below the water table, these soils are benign and non-acidic. However, if the soils are exposed to the atmosphere through activities such as drainage, excavation or dewatering, the sulfides may react with oxygen to form sulfuric acid.

ASS can be present in the form of:

- Potential Acid Sulphate Soils (PASS) – soil that contains unoxidised iron sulphides. When exposed to oxygen through drainage or disturbance, these soils produce sulphuric acid,
- Actual Acid Sulphate Soils (AASS) – PASS that has been exposed to oxygen and water and has generated acidity.

An assessment of the State Department of Water and Environmental Regulation's (DWER) ASS mapping indicates that the risk of ASS occurring within the project area is of 'moderate to low risk' as shown in Figure 5-3.

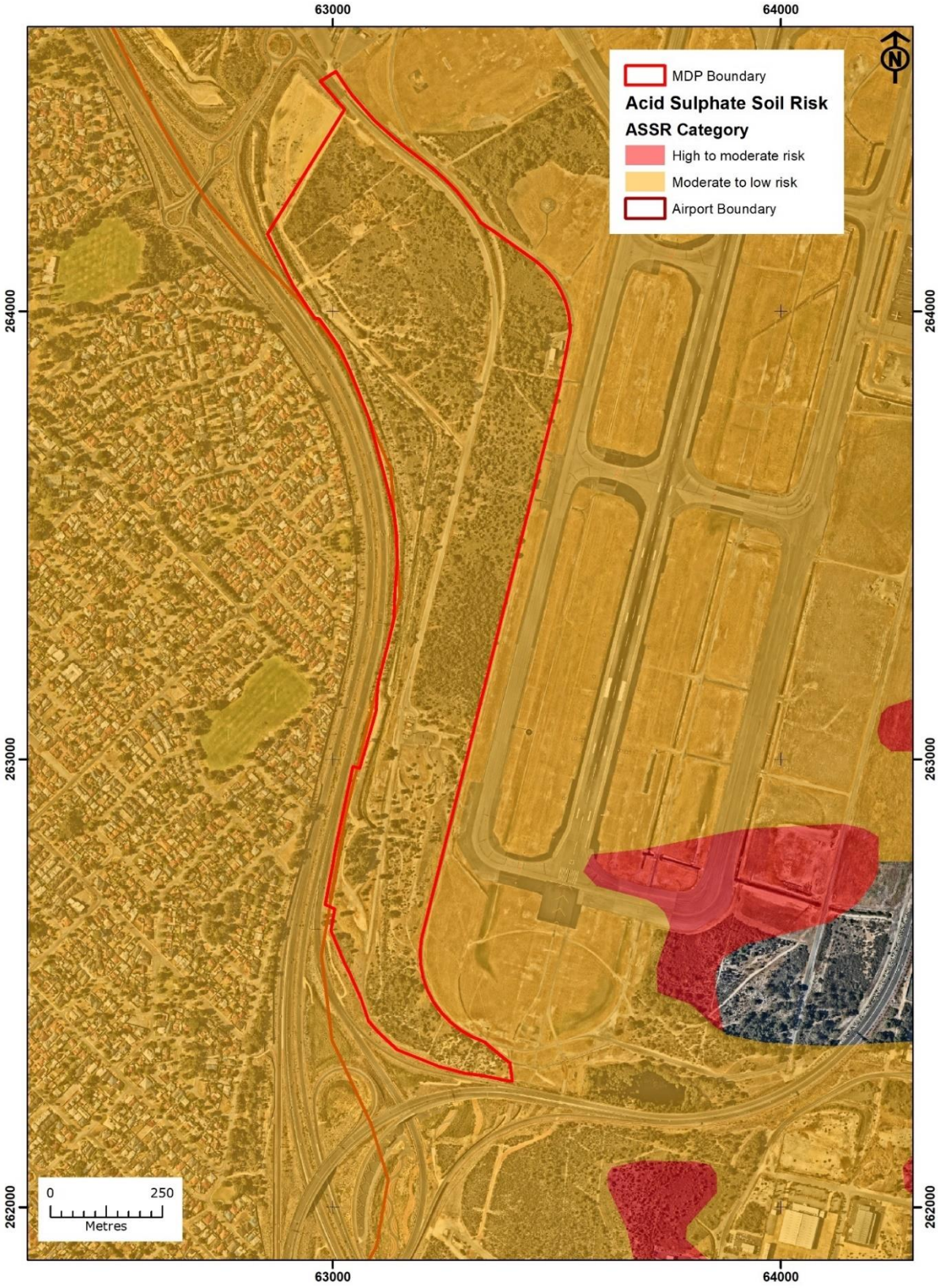

Figure 5-3 Acid Sulphate Soils in the Project Area

Source: Department of Water and Environmental Regulation

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5.6 Impact Assessment

5.6.1 Contaminated Land

5.6.1.1 Direct and Indirect Impacts

Table 5-3 below provides a summary of the potential direct and indirect impacts from the proposed development works in the project site with regards to contaminated land. Avoidance and mitigation measures to the identified impacts are outlined in Sections 5.6.1.2 and 5.6.1.3.

Impact Type	Impacting Process	Discussion	Severity
Direct	Exposure to PFAS contaminated soil.	Humans may come into contact with site soils during the construction works. However, analytical data pertaining to the site indicates that PFAS concentrations are below the human health screening criteria indicating that PFAS concentrations at the site do not pose a risk to human health.	Minor
Direct	Exposure of ecological receptors to PFAS contaminated soils.	Development of the site may expose soils to ecological receptors (flora and fauna). However, it is anticipated that during the clearing and development of the site the vast majority of potential ecological receptors will be removed. Furthermore, analytical data pertaining to the site indicates that PFAS concentrations are below the direct exposure pathway. One sample (AECOM, 2018) exceeded the indirect exposure pathway however this impact is considered to be localised rather than widespread. In addition, the higher indirect criteria of 0.14 mg/kg is likely to be more appropriate once the site is developed, to which all historical concentrations are below.	Minor
Direct	Exposure of site works to PFAS contaminated groundwater through abstraction or intrusive works.	Groundwater may be abstracted during development or intercepted during excavational work. PFAS concentrations in groundwater exceed that human health screening criteria indicating that groundwater may pose a risk to site workers.	Moderate
Direct	Exposure to PFAS contaminated surface water.	Humans may come into contact with surface water at the site including during drain realignment works. PFAS concentrations in surface water exceed that human health screening criteria indicating that surface may pose a risk to human health.	Moderate
Direct	Contamination spills.	Storage and use of fuels, oils etc is possible during development. An spills/releases to soil, surface water and/or groundwater may potentially impact human and ecological receptors. Spills are likely to be localised.	Minor

Indirect	Generation of dust and migration to off-site human and ecological receptors.	The clearing of vegetation and traffic movement across the site has the potential to generate dust which can mobilise to off-site area. PFAS concentrations exceed the residential with garden/accessible soil. However, the nearest resident properties are beyond the adjacent Tonkin Highway approximately 150m away.	Minor
Indirect	Exposure of off-site human receptors to PFAS contaminated groundwater through groundwater abstraction or intrusive works.	PFAS impacted groundwater may be migrating off-site which could pose a risk to human receptors via groundwater abstraction or interception of groundwater in excavations. Development works have the potential to disturb PFAS impacted soil and groundwater, potentially increasing the PFAS concentrations in groundwater migrating off-site.	Moderate
Indirect	Surface water discharge/surface water run-off of PFAS impacted groundwater.	The potential exists for groundwater abstraction and modifications to the surface water network during development. Poor handling of the groundwater or surface water could result in discharge of PFAS impacted water to off-site receptors.	Moderate

Table 5-3 Summary of potential direct and indirect imapcts

5.6.1.2 Direct Impact and Associated Avoidance/Mitigation Measures

A Construction Environmental Management Plan (CEMP) will be developed for assessing and managing contamination of soil and water during the project construction phase. The CEMP will be consistent with the ASC NEPM (1999, as amended May 2013), and the PFAS National Management Plan (HEPA, 2018).

The analytical data collected for the site indicates that PFAS concentrations in soil are relatively low and do not present a risk to human health of site works or ecological receptors based on the current and future land use.

The movement and placement of soil will be considered to ensure there is:

- no unacceptable increase in contamination risk,
- no increase in off-site release risk, and
- no increase in risk to groundwater and surface water.

Analytical data collected for the site indicates that PFAS concentrations in groundwater are above the human health and ecological criteria, and PFAS concentrations in surface water are above ecological criteria. Contaminant concentrations (including PFAS) in groundwater and surface water will be monitored throughout construction, including during the realignment of the SMD. Water extraction, handling and placement will be considered to ensure there is:

- no unacceptable increase in contamination risk,
- no unacceptable increase in off-site release risk, and
- no unacceptable increase in risk to groundwater and surface water.

Any exposure of workers to potentially contaminated groundwater or surface water will be managed using task specific PPE, including long-sleeved trousers and shirts, gloves and glasses. In addition, environmental awareness training and site inductions will be provided to all personal to ensure any residual risks are understood.

Perth Airport will also undertake appropriate monitoring and evaluation procedures, risk management practices and site management activities in line with the PFAS National Environment Management Plan and other relevant guidance documents.

The PFAS National Management Plan (HEPA, 2018) recognises that environmental legislation in many jurisdictions includes obligations and duties to prevent environmental harm, nuisances and contamination. Table 5-4 includes the actions outlined in the HEPA (2018) that will enable the responsible person or organisation to demonstrate compliance with the obligations and duties, to which Perth Airport have provided comments on how they intend to comply with these during the construction works.

PFAS NEMP (HEPA, 2018) Actions	Perth Airport Commitment
Understanding the PFAS content of products and/ or presence of PFAS contamination, for example, by determining the concentrations of PFAS present and/or the nature and location of PFAS sources.	Perth Airport have engaged a suitably qualified environmental consultant to complete a DSI at the airport estate, including within the project area, to assess the nature and extent of PFAS within soil, groundwater and surface water at the site. The information obtained supports previous environmental investigations completed at the site and provides an understanding of the current nature and extent of PFAS in the project area.
Understanding the environmental values that may be impacted by the contamination, both on- and off-site, such as determining the surface water and groundwater environments and determining what the water is used for. Important issues include any off-site movement, PFAS transformations and exposure pathways.	The all of estate DSI includes a review of potential human and ecological receptors. A review of analytical data collected from the boundary of the airport estate provides an assessment of potential risk to off-site receptors. The DSI includes a risk assessment to determine if source-pathway-receptor linkages exist and if an unacceptable risk is posed to identified receptors.
Taking all reasonable and practicable measures to prevent or minimise potential environmental harm from PFAS-related activities and contamination, such as ensuring PFAS wastes, contaminated materials and products are effectively stored and/or remediated to prevent release and having appropriate contingency plans to deal with leaks and spillage.	The all of estate DSI provides an understanding of the PFAS contamination status of the site so that appropriate management and mitigation measures can be implemented. A CEMP will be prepared for the site detailing the proposed management measures.
Undertaking appropriate monitoring to check the effectiveness of management measures implemented and to assess the extent and impacts of any contamination.	Perth Airport propose to assess PFAS levels in groundwater and surface water throughout construction. Sufficient prior assessment of soils will be completed to enable the appropriate excavation and reuse of any soils.
Ensuring proper disposal of PFAS-contaminated waste, for example, by properly characterising waste and sending it to a facility licensed to accept it. Dilution is not acceptable for example in soil, compost or other products.	Perth Airport aims to minimise the generation of waste in accordance with the adopted sustainability strategy. Any material that cannot be retained on site will undergo testing in accordance with the guidelines and to the satisfaction of the receiving waste management facility.
Ensuring environmental regulators and any persons or organisations likely to be adversely affected by any releases are promptly advised of any incidents and contamination.	It is recognised that the proposed CEMP will identify relevant site stakeholders and will detail the incident reporting procedure. It is recognised that the proposed CEMP will identify relevant on-site and off-site stakeholders and will detail the incident reporting procedure.

Table 5-4 PFAS NEMP Actions to comply with environmental legislation obligations and duties

Source: HEPA 2018

5.6.1.3 Indirect and Offsite Impacts and Associated Avoidance/Mitigation Measures

Information provided in the Senversa DSI (2019) indicates that soils at the site do not pose a risk to human health or the environment at the project area. PFAS concentrations in soil are also below the public open space criteria, as such potential risk to off-site receptors from the generation of dust is considered to be low.

PFAS concentrations in groundwater and surface water may pose a risk to site workers and ecological receptors. Potential contact with impacted groundwater and surface water may occur during intrusive works and dewatering activities.

A CEMP will be prepared to manage the contamination of soil and water during the project construction phase. Contaminant concentrations in groundwater and surface water will be monitored throughout construction, including during the realignment of the SMD. Water extraction, handling and placement will be considered to ensure there is:

- no unacceptable increase in contamination risk,
- no unacceptable increase in off-site release risk, and
- no unacceptable increase in risk to groundwater and surface water.

Any exposure of workers to potentially contaminated groundwater or surface water will be managed using task specific PPE, including long-sleeved trousers and shirts, gloves and glasses. In addition, environmental awareness training and site inductions will be provided to all personal to ensure any residual risks are understood.

As part of the CEMP preparation for the site, management measures to control dust generation will be included to prevent any migration of impacts to off-site locations. These measures will likely include dust suppression and avoiding earthworks during unfavourable weather conditions.

5.6.1.4 Significance of Residual Impacts

It is proposed that residual impacts in soil, groundwater and surface water will be managed in accordance with the CEMP for the site construction works. Periodic monitoring will be undertaken for groundwater and surface water, and soil material movements will be tracked and monitored to demonstrate that construction works are not causing an unacceptable increase in contamination risk or increase in off-site release.

The CEMP will include target criteria to adhere to, along with contingency measures to be implemented if site derived trigger levels are exceeded. The generation of any residual impacts are anticipated to be minimal with management measures in place and likely to be quickly and effectively mitigated through proposed contingency measures. As such, the significance of any residual impacts is considered to be low.

5.6.2 Acid Sulphate Soils

5.6.2.1 Direct Impacts and Associated Avoidance/Mitigation Measures

Impacts associated with ASS are only likely to occur during excavation or dewatering activities which expose PASS to oxygen.

Online available information indicates a moderate to low probability of ASS occurrence at the site. Additional investigations completed on adjacent sites to the project areas have included the assessment for ASS to enable appropriate management during construction works. Where required, additional investigation will be undertaken in the areas of proposed excavation to confirm the ASS risk and to support existing data collected across the airport estate. Any additional investigation will be undertaken in accordance with the DER Identification and Investigation of Acid Sulphate Soils and Acidic Landscapes (2015).

It is proposed that in order to manage any ASS risks, an Acid Sulphate Soil and Dewatering Management Plan will be developed for the site. The ASS and Dewatering Management Plan will be sent to the DITCRD AEO for review prior to the commencement of the construction works. It is anticipated that the management of any ASS risks in accordance with the management plan will significantly reduce the risk of potential impact.

As stated in the DER Interim Guideline on the Assessment and Management of PFAS, '*With respect to partitioning relationships between soil, sediment and water, leaching is highest around neutral pH and decreases in more acidic and alkaline conditions'*. As such, the generation of any acidic conditions during the disturbance of acid sulphate soils is unlikely to increase the mobility of any present PFAS. Therefore, the PFAS mobilisation risk as a result of ASS generation are considered to be low.

Groundwater and surface water will also be monitored throughout construction, which will assess the completeness of the ASS management measures and ensure there are no unacceptable increases in contamination risk, no increase in off-site release risk, and no increase in risk to groundwater and surface water.

5.6.2.2 Indirect and Offsite Impacts and Associated Avoidance/Mitigation Measures

Impacts associated with ASS are only likely to occur during excavation or dewatering activities which exposes PASS to oxygen.

It is proposed that in order to manage any ASS risks, an ASS and Dewatering Management Plan will be developed for the project area. Where required, additional investigation will be undertaken in the areas of proposed excavation to confirm the ASS risk and to support existing data previously collected across the airport estate. The ASS and Dewatering Management Plan will be sent to the Airport Environment Officer (AEO) for review prior to the commencement of the construction works. It is anticipated that the management of any ASS risks will be completed in accordance with the management plan to ensure there is no unacceptable increase in contamination risk, no increase in off-site release risk, and no increase in risk to groundwater and surface water.

5.6.2.3 Significance of Residual Impacts

It is proposed that ASS will be managed during ground disturbance and dewatering activities through an ASS and Dewatering Management Plan. Regular monitoring of groundwater quality and surface water quality will be undertaken to demonstrate the ASS is being managed appropriately during the works. Contingency measures will be included in the ASS and Dewatering Management Plan where impacts are detected during periodic monitoring. The generation of any residual impacts are likely to be minimal with management measures in place and likely to be quickly and effectively mitigated through proposed contingency measures. As such, the significance of any residual impacts is considered to be low.

6. Water Resources

This section provides details on:

- Water resources (groundwater and surface water) within and surrounding the project area.
- Impact assessment (including direct, indirect and offsite impacts) and associated mitigation and avoidance measures on the following water resource matters that are known to occur within or adjacent to the project area:
  - Groundwater
  - Surface Water

6.1 Legislative and Policy Context

Water resources management is currently managed under six separate acts in Western Australia by DWER. The *Rights in Water and Irrigation Act 1914* (RIWI Act) establishes the legislative framework for managing and allocating water resources in Western Australia and is most relevant to activities on Perth Airport. Being on Commonwealth land, activities on the estate are exempt from licensing under the RIWI Act.

State Planning Policy 2.9 – Water Resources, is the overarching sector policy and State Planning Policy 2.0 - Environment and Natural Resources, provides clarification and additional guidance to decision-makers when considering water resources in land-use planning strategies. The objectives of these policies are to:

- protect, conserve and enhance water resources that are identified as having significant economic, social, cultural and/or environmental values,
- assist in ensuring the availability of suitable water resources to maintain essential requirements for human and all other biological life with attention to maintaining or improving the quality and quantity of water resources, and
- promote and assist in the management and sustainable use of water resources.

Stormwater runoff from Commonwealth land and stormwater passing through this land ultimately drains into the Swan River. Where applicable, guidance is taken from the state planning policy when designing and managing the hydrology on the airport estate. The Swan and Canning Rivers Management Act 2006 provides protection of the Swan River to ensure maintenance of ecological and community benefits and amenity via the Act and state management policies created under the Act; in particular Corporate Policy Statements 42 and 49 (as detailed in Section 6.4). The Act and policy statements are relevant by way of receiving stormwater that has been created on the Commonwealth land.

The environmental impacts from changes to hydrology on Commonwealth land are covered by the EPBC Act and consequently Guideline 1.2.

6.2 Methodology

6.2.1 Stormwater Design Criteria

Perth Airport is developing stormwater infrastructure on the estate to provide capacity to cater for rainfall runoff from the estate and to meet inflows and peak storage requirements from upstream sources, to the same values that existed in 1997 when management of the airport was privatised. This will help to ensure Perth Airport does not increase the risk of flooding downstream of the estate boundary due to any aeronautical or non-aeronautical developments undertaken. This is consistent with the commitment described in the approved Perth Airport Master Plan 2014.

The concept for Perth Airport's stormwater design criteria relating to aeronautical infrastructure is to protect all runways, taxiways and terminals from a 1% annual exceedance probability storm event. Access

roads to car parks and terminals are designed for a 2% annual exceedance probability storm event because the main off-airport arterial roads feeding traffic to the airport are also designed to that criteria.

Local roads and precinct stormwater networks are normally designed to a 10% annual exceedance probability storm event. Finished floor levels of buildings are to be a minimum of 300 millimetres above the 1% annual exceedance probability flood level. Criteria for other parts of development sites are based on likely site use and risk. All sites for the Airport West (South) Precinct will be required to manage the first 15mm of rainfall runoff generated from constructed impervious surfaces by retaining and if required, treating, on-site. This is in line with the Western Australian Department of Water and Environment Regulation approach of managing stormwater by detaining runoff from constructed impervious surfaces at the source. Roof runoff that is drained off site by a pipe network separate from the rest of the development site stormwater can be discharged directly to airport infrastructure to help maintain ecological flows. Alternatively, the roof runoff can be collected in a tank/s for use on site. The 'Perth Airport Civil Design Guidelines' document suggests using stormwater quality improvement element such as buffer zones, filter strips, gross pollutant traps and retention ponds.

6.2.2 Stormwater Assessment

Stormwater assessment for the airport estate has been undertaken as part of the Perth Airport Master Drainage Strategy 2017 update (MDS). An 'Ultimate' development scenario model was developed for the estate based on aeronautical and non-aeronautical land uses shown in the 2014 Perth Airport Master Plan. The results of the modelling confirmed that management of peak outflows from the estate to 1997 values, subject to suitable management of inflows to 1997 values, based on concept design infrastructure can be achieved in practice.

Detailed design phases of individual projects on the airport estate optimise the stormwater infrastructure required for each project based on the MDS information, assess the introduction of water sensitive urban design elements in the area under consideration as well as assess, and if required manage, indirect impacts to wetlands and vegetation outside the development boundary.

6.2.3 Groundwater Modelling

Groundwater modelling for the estate is currently being undertaken as part of the 'Airport Estate Groundwater Modelling 2019' project. The modelled area covers the entire airport estate with the downstream boundary being the Swan River with the upstream boundary being aligned with the foothills of the Darling Scarp. The Helena River is the northern model boundary and the southern model boundary simulates groundwater flow towards the Canning River.

These extents ensure that the model boundaries are far enough away from the estate so that the boundaries do not influence results within the estate, downstream to the Swan River or any indirect impacts that may occur outside the estate to the sides.

The confidence level of the model as defined in the Australian Groundwater Modelling Guidelines is Class 3 (the highest level) for the large majority of the estate and a 'high 2' for some small areas where data is not as well defined. These levels are based on the quantifiable indicators listed in Table 2-1 Model confidence level classification - characteristics and indicators of the AGMG. The amount (18 years) and accuracy of historical groundwater data, geological data, aquifer characteristics, land use data plus rainfall and evaporation information provides good input data for the model. Calibration to the historical groundwater levels and spatial distribution is excellent in some parts of the estate while some locations were to a 'good' class 2 level. Long term trends were replicated and the aquifer parameters determined from the geological data were consistent with published data.

The model is most sensitive to applied recharge and not sensitive to a realistic range of specific yields or hydraulic conductivities. With detailed vegetation mapping of the airport estate having just been updated, aerial imagery providing current land use and a Bureau of Meteorology weather station on the estate for

historical rainfall records, the data that determines recharge is detailed and accurate therefore providing confidence in the parameters that influence change the most.

6.2.4 Water Quality

Biannual or annual groundwater and surface water monitoring has been undertaken at the airport estate since 2000. The monitoring program is completed in accordance with the Airports (Environmental Protection) Regulations 1997 (AEPR) and provides an understanding of the ongoing groundwater and surface water quality at the estate. Groundwater samples are collected for existing groundwater monitoring wells and surface water samples are collected from the drainage channels and surface water bodies across the estate. All monitoring is currently undertaken by an independent suitably qualified environmental consultant. This long history of monitoring assists with the site characterisation of groundwater and surface water quality given in this document.

6.3 Existing Surface Water and Groundwater Conditions

6.3.1 Surface Water Quality

Periodic surface water and groundwater monitoring is undertaken across the Perth Airport estate. The most recent available analytical data for surface water (SW) sampling undertaken adjacent to the project area (from within the SMD) is provided in Table 6-1 below. The location of the surface water sample point is provided in Figure 6-1. The analytical data has been compared against the accepted limits of contamination criteria for freshwater as defined in Schedule 2 of the AEPR.

Analyte	Unit	Acceptance criteria	SWO133 10/03/2020	SWO133 28/01/2020	SWO133 15/04/2019
Ammonia	mg/L	0.02	0.058	0.008	0.026
Ammonium	mg/L		0.074	0.011	0.33
Nitrate as N	mg/L		< 0.005	< 0.005	<0.005
Nitrite as N	mg/L		< 0.005	< 0.005	<0.005
Total Nitrogen	mg/L	0.1	1.8	4.3	1.8
Total Phosphorous	mg/L	0.01	0.18	0.44	0.24
pH Field	pH units		8.1	7.3	8
Dissolved Oxygen	mg/L		4.49	2.26	0.6
Electrical Conductivity -	uS/cm		840	760	790
Redox	mV		85.9	121.1	46.4
Temperature -	deg C		21	27.7	17.4
Total Dissolved Solids	mg/L		504	456	474
Turbidity	NTU		35.1	52.5	10.0

Table 6-1 Groundwater and Surface water quality data

Source: Perth Airport

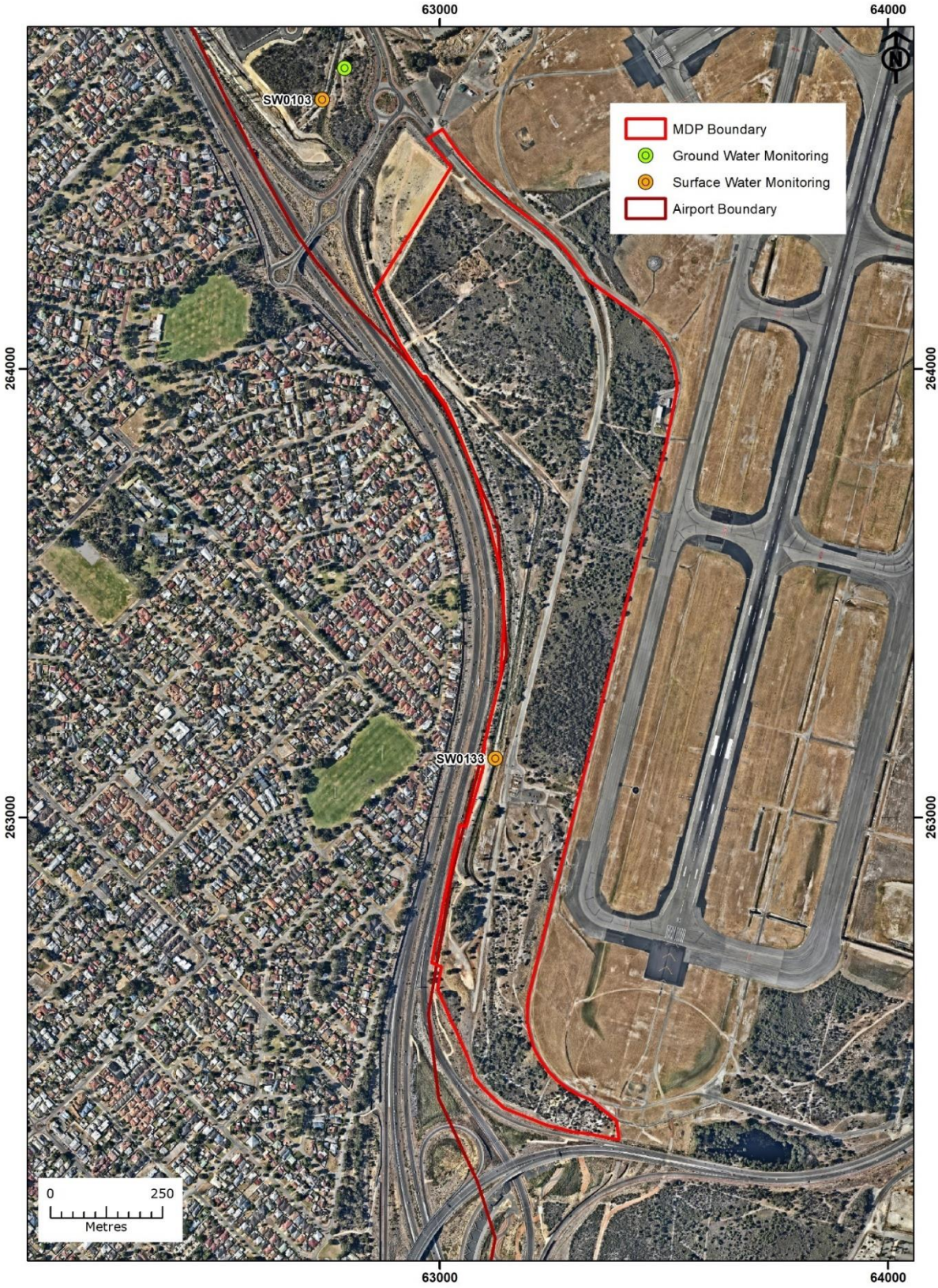

Figure 6-1 Surface water sample locations

Source: Perth Airport

6.3.2 Groundwater

The prevailing groundwater flow direction across the airport estate is generally north-west towards the Swan River. Some parts of the open channel networks on the estate have invert levels that are in the seasonal fluctuation of the groundwater. That is, when the groundwater is higher than the channel invert there will be groundwater lost as surface water flow down the channel, but when the groundwater is lower, there may be infiltration from the surface water in the drain to the groundwater system.

This occurs in the 'Previous SMD Alignment' as shown in Figure 6-2. During part of the summer this is a small amount of flow while the 2015 alignment is dry.

It is recognised that there are no groundwater monitoring wells at, or within close proximity to, the project area. However, it is expected that the groundwater quality across the estate (with the exception areas that have been impacted by localised pollution) will be representative of groundwater quality within the project area. Nutrient levels are elevated in the groundwater entering the estate and are considered to be attributed to up-gradient land uses, including agricultural land and the historical and ongoing use of septic systems for sewerage disposal.

6.3.3 Southern Main Drain

Perth Airport is located on the Swan Coastal Plain and sits within two of the 30 major stormwater catchments of the Swan and Canning rivers system. The Northern Main Drain (NMD) and Southern Main Drain (SMD) are two open-channel main drains that traverse through the estate, draining two of those 30 catchments. Both of those drains extend from the top of the Darling Scarp down to the Swan River. The airport is located just over one kilometre from where the SMD enters the river.

The SMD currently runs through the project area from the public viewing area to the Dunreath Drive/Tonkin Highway interchange and has a catchment size upstream of the airport of 1,531 hectares (refer Figure 6-2) The project area is approximately 65.5 hectares and receives direct flow from another 105 hectares that is draining into it from part of the adjacent airside area, the Tonkin Highway and City of Belmont catchments located west of the highway.

The SMD in the project area was reconstructed in 2015 to increase capacity to convey stormwater flow from a 1% annual exceedance probability (100 year) storm event. Those works also included constructing a detention basin located adjacent the Dunreath Drive/Tonkin Highway interchange. The drain was vegetated as a Living Stream to provide additional water quality improvement (refer to Figure 6-3). A fire break/gravel maintenance track was constructed adjacent to the Tonkin Highway boundary. The existing SMD and the detention basin at the Dunreath Drive/Tonkin Highway interchange do not need any upgrade works because the size and capacity has been built for a fully developed airport estate.

The SMD downstream of the project area (north of the Dunreath Drive/Tonkin Highway interchange) has been realigned in the last three years and constructed in the form of a 280 metre piped section and 700 metres of Living Stream with a detention basin adjacent to the SMD's downstream boundary.

At the airport's downstream boundary of the SMD the water enters two 1,500 millimetre diameter pipes which are Water Corporation assets. The design of these pipes was undertaken to Water Corporation standards with the Water Corporation and the City of Belmont being stakeholders in the design. The pipes can accommodate peak flows from a 1% annual exceedance probability (100 year) storm event. Construction was undertaken in 2016.

Figure 6-2 Existing Stormwater Management Conditions across Airport West (South) project site

Source: Perth Airport

Figure 6-3 Existing SMD within MDP Area – 2015 (Left) & 2020 (Right)

Source: Perth Airport

6.4 Stormwater Management Concept Design

Design work on the estate is undertaken on the basis of a 'whole of airport' approach. Discharge limitations, capacity of existing stormwater infrastructure, detention requirements and water quality are taken into account for the airport as a whole when designs are undertaken whether they are for small individual lots or large precinct areas. As part of this approach a concept design for stormwater infrastructure across the airport estate has been undertaken as part of the Master Drainage Strategy 2017. The main drain network capacity is based on a 1% annual exceedance probability (100 yr.) storm event and a fully developed estate with land use as described in the Perth Airport 2020 Master Plan. Development within the MDP was assumed to be mostly buildings or hardstand (car parks etc.) with some areas of public open space.

Works undertaken to date includes upgrading the SMD from the public viewing area to the downstream (north) boundary of the airport (2,730 metres). The open channel sections (2,450 metres) have been vegetated out as a Living Stream.

The SMD currently drains under runway 03/21, but this does not meet the 1% annual exceedance probability (100 year) storm event capacity criteria therefore the estate stormwater strategy is to create a new alignment to the south of that runway and out of the airside area. The concept is for a new alignment that will run south from the existing SMD then east to Horrie Miller Drive where there is an existing group of culverts that were installed when the road was constructed (refer to Figure 6-4). The new runway project will eventually connect to the upstream side of this culvert group to the upstream boundary of the SMD providing an upgraded SMD across the estate with increased flow capacity and detention storage. Specific drainage and stormwater requirements to be refined during detailed design and subject to change depending on drainage requirements for adjacent projects and updated hydrological modelling.

Stormwater design of individual lots or larger areas are undertaken in line with the 'Decision process for stormwater management in Western Australia', Stormwater Management Manual for Western Australia' and State Corporate Policy Statements 42 (Planning for Land Use, Development and Permitting Affecting the Swan Canning Development Control Area) and 49 (Planning for Stormwater management Affecting the Swan Canning Development Control Area). Perth Airport provide design consultants with a 'Civil Design Guidelines' document which includes stormwater drainage objectives relating to pollution, hydrological regimes, consideration of an integrated water cycle and having water sensitive urban designs to protect not only the design scope area but external areas on and off the airport. This will help to ensure that the volume and quality of the stormwater leaving the estate does not impact on the Swan River and surrounds nor the SMD and land either on or off the airport.

For individual lots the management of flows and pollution control generally starts with retention of the first 15 millimetres of rainfall runoff on the site as a minimum with exceptions for roof runoff to help with environmental flows. An assessment of pollution risk is undertaken based on the proposed land use for the site which may result in extra requirements for water quality control. For other areas like road reserves and public open spaces, the use of open channels instead of a piped network, where space permits, is utilised allowing for vegetation contact and groundwater infiltration. Eighty seven percent of the airport estate drains into either the Northern or Southern Main Drains. These are gradually being converted into Living Streams where possible, which enables vegetation contact and groundwater infiltration in some locations, providing additional water treatment prior to discharge off the estate.

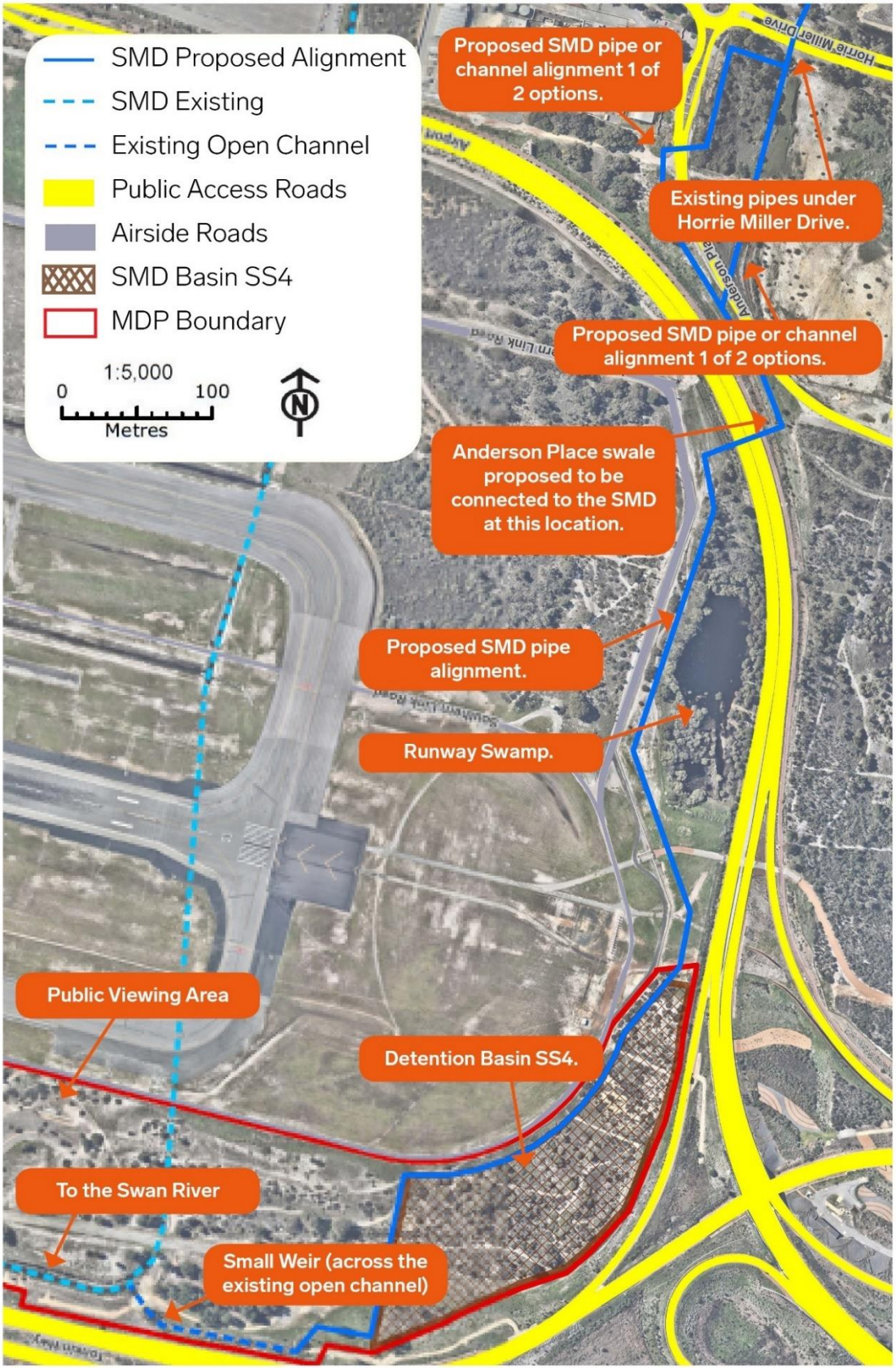

Figure 6-4 Proposed Stormwater Management Concept across Airport West (South) project area

Source: Perth Airport

6.4.1 Southern Main Drain – Works Within the MDP Area

Works for the project that will be occurring within this MDP area are the construction of a weir, the installation of pipes and/or excavation of open channel/s as well as the construction of a stormwater detention basin which will operate as an off-line storage. A weir is required to raise the level of the water so that the detention basin fills up. (Refer to Figure 6-4)

The detention basin will cater for the 1% annual exceedance probability (100 year) storm event. The water depth will vary but will drain dry as the SMD water level recedes. However, there will be nil or relatively minimal water in it most of the time. The northern part of the basin is likely to get inundated to a relatively shallow depth several times a year depending on rainfall. It will be vegetated out with suitable species based on groundwater conditions at the site, local provenance and wildlife risk.

All proposed works to the east (upstream) of the MDP boundary that are not included in the New Runway MDP will be subject to future Airport Building Controller (ABC) approvals.

PFAS impacts have been identified in the project area as outlined in the Section 5.4. An 'All of Estate' DSI has been completed for the airport estate which identified areas of PFAS impact in soil, sediment, groundwater and surface water. The analytical data obtained during the DSI has been used during consideration of the concept design work for the SMD realignment and detention storage within the MDP area plus upstream. This data will also be used to inform management measures during the construction of the SMD realignment.

Concept stormwater modelling has shown that the invert level of the proposed new SMD alignment within the MDP needs to be lower than the seasonal high groundwater level but will be above the seasonal low. While the proposed alignment will not pass through an Area of Potential Environmental Concern, the PFAS DSI shows that there is a relatively very small area that the proposed alignment drains through where groundwater concentrations of PFAS may be at or just above the recreational value of 2.0 micrograms per litre. The area of this concentration may extend slightly into the detention basin. The rest of the SMD and basin have levels lower than 2.0 micrograms per litre.

6.4.2 Groundwater

In order to mitigate any possible issues with mobilising PFAS contaminated groundwater, the SMD on the new alignment within the MDP will be piped where the invert levels are lower than the seasonal peak high groundwater level and the bottom of the detention basin will only be excavated down to remain above the seasonal high groundwater level.

Across the MDP area the existing surface is above the 1% annual exceedance probability (100 year) storm event top water level in the SMD so fill is not required to be brought in to protect lots from flooding. Soil within the MDP area is likely to be moved around to level some areas but not enough to change the groundwater level significantly enough via capillary action of the soil. The largest potential change to groundwater levels will be via the clearing of vegetation. This will raise the seasonal high and seasonal low groundwater levels. The construction of impermeable surfaces will not allow for as much rainfall infiltration to occur as previously, therefore there will be new higher groundwater levels. This may potentially mobilise soluble pollutants such as PFAS and metal from Acid Sulphate Soils. An Acid Sulphate Soil and Dewatering Management Plan will address issues raised with potential mobilisation of pollutants.

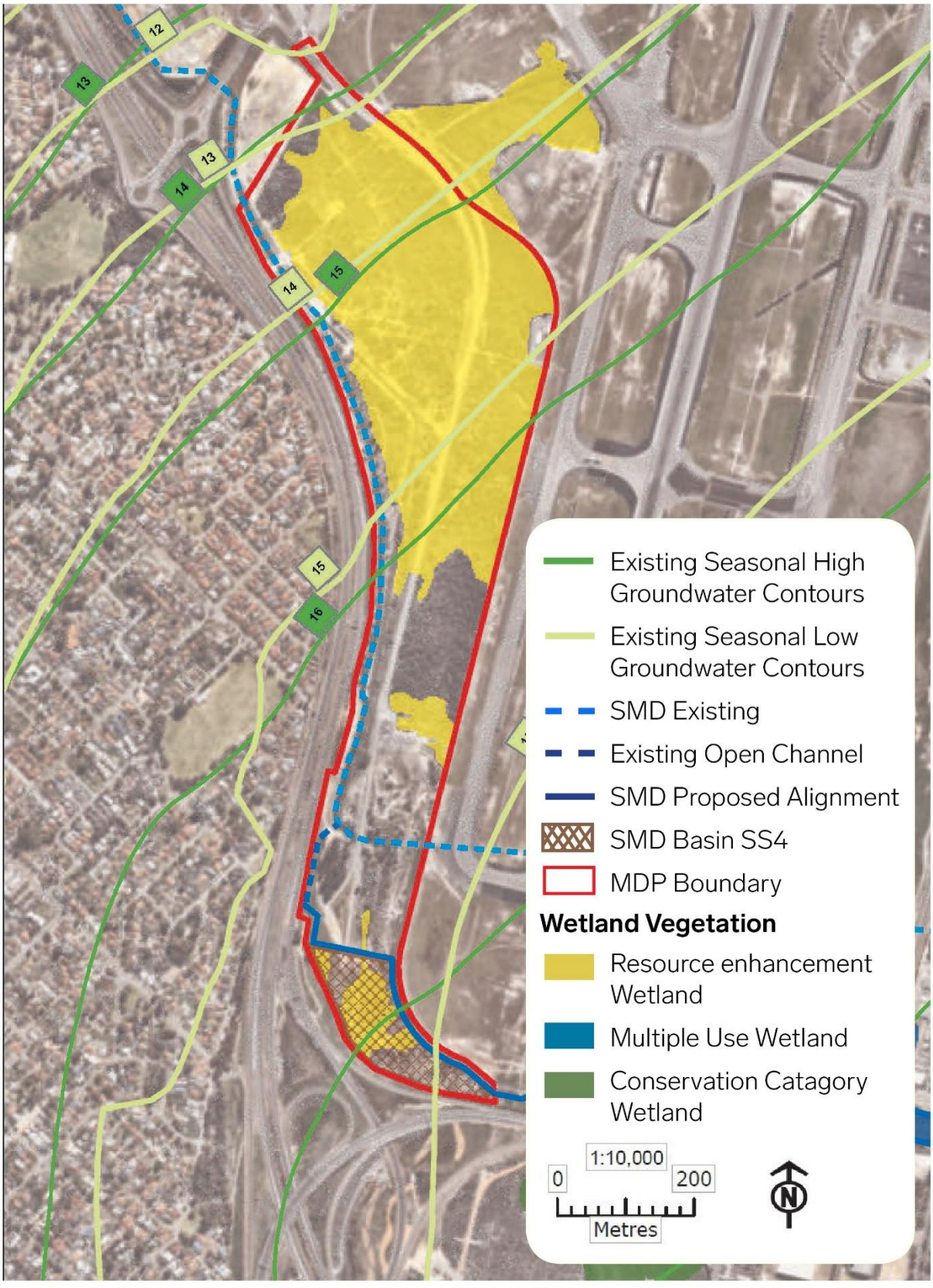

Figure 6-5 Existing Groundwater Airport West (South) project area

Source: Perth Airport

6.5 Impact Assessment of Stormwater Infrastructure and Groundwater

6.5.1 Direct Impacts and Associated Avoidance/Mitigation Measures

The Airport West (South) Project may result in changes to the hydrological regime within and surrounding the project area. Any changes to the hydrogeological regime have the potential to change the surface water and groundwater quality within the project area and wider airport estate. Consideration to the surface water and groundwater quality with regards to contaminated land is detailed previously.

In a similar manner to groundwater, the existing surface water quality (with the exception of site derived contaminants of concern – see Section 5.6.1) within the project area is comparable to the water quality within the wider airport estate, which is considered to be attributed to up-gradient land uses and geology. Slight variations in the surface water quality within the project area is likely to be influenced by the local geology, soil properties and flora.

With the exception of PFAS concentrations (see Section 5.6.1), it is recognised that the current quality of the groundwater at the project site is unknown. However, due the absence of any identified contaminant source area in the project area (with the exception of PFAS), it is likely that the groundwater quality at the project area will be comparable to groundwater in the wider airport estate.

Any construction works and excavations of site soils, including soil movements and vegetation clearing, may result in slight changes in the surface water and groundwater quality.

A CEMP will be developed for assessing and managing surface water and groundwater quality during the project construction phase. As part of the CEMP, groundwater sampling will be undertaken to establish the baseline groundwater quality prior to commencement of site development. The surface water and groundwater quality will be monitored throughout construction. Water extraction, handling and placement will be considered to ensure there is no unacceptable change in the surface water and groundwater quality. The excavation, movement and placement of soil will be considered to ensure there is no unacceptable change in the surface water and groundwater quality.

6.5.2 Indirect and Offsite Impacts and Associated Avoidance/Mitigation Measures

As stated above, the surface water and groundwater quality across the airport estate is fairly comparable, with the surface water and groundwater quality entering the site being relatively consistent with the surface water and groundwater quality (with the exception of site derived contaminants of concern - see Section 5.6.1) discharging from the site.

It is expected that the construction works will not result in a significant change to the surface water and groundwater quality down-gradient of the project area with appropriate management in place. As stated above, a CEMP will be developed for assessing and managing surface water and groundwater quality during the project construction phase.

Table 6-2 below summarises the impacts and mitigation required due to surface water and groundwater changes.

6.5.3 Significance of Residual Impacts

Given the potential impacts and mitigation measures identified, it is unlikely that the impacts to surface and groundwater will be significant.

Impact Type	Impacting Process	Discussion (Potential impacts)	Proposed Avoidance/mitigation Measures	Severity
Direct	Stormwater pipes being installed at levels below groundwater	Local drawdown of groundwater is likely to occur when trenches are excavated. Any drawdown would be short term due to the backfilling of pipes being undertaken within a day of excavation being normal practice. With all the vegetation being cleared in the MDP area the nearest significant vegetation to the stormwater pipe installation and the detention basin is over 160 metres away and they are upstream (for groundwater flow).	CEMP and an ASS and Dewatering Management Plan will be developed to manage potential impacts.	Minor
Direct	Construction (e.g. stormwater pipes) occurring in groundwater	Potential of impacting human health with exposure to PFAS contaminated groundwater and soil. Any contact time is likely to be very short.	CEMP and an ASS and Dewatering Management Plan will be developed to manage potential impacts.	Minor
Direct	Construction of a stormwater detention basin	The detention basin will only be excavated so that the base will not be below the seasonal high groundwater level so that drawdown of groundwater will not occur. The basin will be vegetated out with species tolerant to groundwater because the depth from the base to the groundwater will not allow for non-tolerant species. Installing vegetation that will utilise groundwater will cause some drawdown under the basin area. The seasonal change in groundwater levels between the wettest part of the year and the driest is almost 2 metres so any permanent impact, on or off the airport estate, would only occur if the seasonal low groundwater level was to be permanently lowered. Vegetation species will be selected based on the groundwater conditions of the site. The nearest significant vegetation to the basin installation is over 160 metres away and they are upstream (for groundwater flow).	Avoidance from direct impact is not possible. Stormwater detention is required either within the MDP area or between the MDP area and Horrie Miller Drive. Any storage area will have to be excavated out and not be purely surface inundation due to the relatively flat levels on this part of the estate. Changing the location within the nearby area will not negate the impact.	Minor

Impact Type	Impacting Process	Discussion (Potential impacts)	Proposed Avoidance/mitigation Measures	Severity
Direct	Clearing of vegetation	Clearing of vegetation will increase the seasonal high and seasonal low groundwater levels which may potentially mobilise soluble pollutants such as PFAS and metals from ASS.	CEMP and an ASS and Dewatering Management Plan will be developed to manage potential impacts.	Major
Indirect	Impact to nearby wetlands vegetation	The majority of wetlands are upgradient of the MDP site and the infrastructure proposed will not mobilise groundwater beyond the construction period. The existing data does not indicate there will an impact to the upgradient vegetation. The groundwater draining under the wetland vegetation that is east of the MDP area does not drain through the MDP area. The surface water for this vegetation is not sourced from the MDP area and therefore will not be impacted.	If the technical study finds that there will be an impact/s to wetlands vegetation then the report will include mitigation options.	Negligible (based on existing data)
Indirect	Impact to flora and fauna outside project area	Any flora and fauna impact's outside the MDP area that could be impacted by changes to surface or groundwater within the MDP area would be on the western side of the Tonkin Highway. The existing SMD currently controls the groundwater level that drains westward therefore any likely change to the groundwater levels within the MDP due to the vegetation clearing will not impact groundwater levels west of the SMD. The areas west of the Tonkin Highway have their surface water drain to the SMD. Development within the MDP area (or elsewhere on the estate) will not change the stormwater regime of those western areas.	None required	Nil

Impact Type	Impacting Process	Discussion (Potential impacts)	Proposed Avoidance/mitigation Measures	Severity
Direct	Mobilisation of metals from acid sulphate soils and PFAS into the SMD and being conveyed to the Swan River	The clearing of vegetation is likely to raise groundwater in parts of the MDP area. The likely impact is that groundwater flow will mobilise soluble pollutants which include acid sulphate soil metals and PFAS.	PFAS and ASS will be managed as per section 5.6.1	Minor, assuming controls

Table 6-2 Impact Assessment of Stormwater Infrastructure and Groundwater

7. Wetlands

The information provided in this section is based on Eco Logical Australia's (Eco Logical Australia) wetland impact assessment for the Airport West (South) project (Eco Logical Australia, 2020). Eco Logical Australia (2020) undertook a thorough process to assess project impacts on the project area's wetland values.

7.1 Legislative and Policy Context

The wetland impact assessment (Eco Logical Australia, 2020) was prepared in accordance with:

- The EPBC Act,
- Guideline 1.2,
- Department of Biodiversity, Conservation and Attractions (DBCA) 2017a. *A methodology for the evaluation of wetlands on the Swan Coastal Plain, Western Australia*. DBCA, Perth, and
- Department of Biodiversity, Conservation and Attractions (DBCA) 2017b. Wetland identification and delineation: information for mapping and land use planning on the Swan Coastal Plain. DBCA, Perth.

Perth Airport is located on the Swan Coastal Plain, where detailed mapping has been undertaken at a scale of 1:25,000 (DBCA 2019a). The Geomorphic Wetlands Swan Coastal Plain (GWSCP) dataset is accepted by Western Australian planning and regulatory bodies (e.g. Environment Protection Authority (EPA)) as the primary dataset for wetlands within the region. This mapping was originally compiled by Hill et al. (1996) and is modified by the Department of Biodiversity, Conservation and Attractions (DBCA; as the current dataset custodian) as new information becomes available.

Each wetland within the GWSCP dataset has been evaluated and assigned a management category that provides guidance on how these wetlands should be managed and protected. The three management categories used are Conservation Category Wetland (CCW), Resource Enhancement Wetland (REW) and Multiple Use Wetland (MUW) (Table 7-1).

Management category	Description	Management objectives
Conservation (CCW)	Wetlands which support a high level of attributes and functions.	Highest priority Objective: to preserve and protect the existing conservation values of the wetlands. *No development or clearing is deemed appropriate. Any activity that may lead to further loss or degradation is inappropriate.*
Resource enhancement (REW)	Wetlands which may have been partially modified but still support substantial ecological attributes and functions.	Priority wetlands Objective: manage, restore and protect towards improving their conservation value. Have the potential to be restored to Conservation category by restoring wetland function, structure and biodiversity.
Multiple Use Wetland (MUW)	Wetlands with few remaining important attributes and functions.	Use, development and management should be considered in the context of ecologically sustainable development and best management practice catchment planning through landcare.

Table 7-1 DBCA Management categories and objectives for wetlands on the Swan Coastal Plain

Source: Eco Logical Australia, 2020

At a Commonwealth level, wetlands can be recognised as being of international importance (Ramsar wetlands) or national importance. Nationally important wetlands are listed in the *Directory of Important Wetlands in Australia*, an online inventory first published in 1993, which acts as a knowledge base and tool for wetland managers. Although Ramsar wetlands are specifically protected under the EPBC Act as a matter of national environmental significance (MNES), Nationally important wetlands do not have any specific level of statutory protection. There are 120 wetlands in Western Australia recognised in the directory; of those, eight occur on Commonwealth land and one occurs at Perth Airport ('Perth Airport Woodland Swamps').

7.2 Methodology

In 2019, Eco Logical Australia conducted a Wetland Assessment to review the boundaries and values of all wetlands within the Perth Airport estate (Eco Logical Australia, 2019) and assigned wetland identifications (IDs) for each wetland on the estate. These IDs have been used in the MDP for consistency.

The remapped boundaries form Eco Logical Australia (2019) have been used as the basis for the Airport West (South) wetland impact assessment by Eco Logical Australia (Eco Logical Australia, 2019). The assessment was undertaken in accordance with Guideline 1.2 and included:

- An analysis and validation of current State and Commonwealth mapping and evaluation categories for wetlands occurring within and surrounding the project area, using the GWSCP dataset,
- A description of potential direct impacts to wetlands occurring within the project area, and
- A discussion around the significance of removing wetlands within the project area, on broader wetland values.

Outside of the Airport West (South) project area, a significant proportion of the remaining wetlands at Perth Airport are identified for development under other projects as part of the Perth Airport Master Plan, with only three wetland areas identified to be retained. These include:

- The majority of Munday Swamp CCW and a small portion of the Airport Central wetland directly adjoining it,
- Runway Swamp 'Infrastructure Only Conservation Zone' (IOCZ), and
- Approximately 7 hectares of CCW outside of the south-west corner of the New Runway Project boundary.

Multiple use wetlands are not considered priority wetlands as they are highly modified and retain few or no important attributes or functions (DBCA, 2017a). As such, impacts to these wetlands are generally not considered in impact assessment in Western Australia as they are not defined as significant ecosystems (EPA, 2018). On this basis, wetlands with a Multiple use classification have been excluded from the impact assessment analysis undertaken for the Airport West (South) project. In the context of Significant Impact Guideline 1.2, multiple use wetlands are not likely to be sensitive or vulnerable to impacts and are not rare, endemic, unusual, important or otherwise valuable. This approach is therefore consistent with Commonwealth guidance on assessing impacts to the environment on Commonwealth land.

For more information on methodology, please refer to Section 3.1 of Eco Logical Australia, 2020.

7.3 Existing Wetland System

7.3.1 General

Wetlands on the Swan Coastal Plain vary in a number of characteristics including size, shape and hydrology as a result of their physical setting and development processes (DBCA 2017a). Semeniuk (1988) proposed a system of grouping wetlands on the Swan Coastal Plain with common features such as geomorphic setting and origin, labelling these similar wetlands 'consanguineous'. On the Swan Coastal Plain there are 62 recognised consanguineous wetland suites (Department of Parks and Wildlife, 2016).

The Perth Airport lies within the 'Mungala' consanguineous suite. DBCA (2017a) has reported that the Mungala suite covers approximately 26,000 hectares of wetlands, and of that, the wetlands within the Perth Airport cover approximately 1,143 hectares. The Mungala suite wetlands occur within the transition between the Bassendean Dunes and Pinjarra Plain landform units, above a complex of sands, clays, silcrete and laterite (Semeniuk and Semeniuk, 2001). Wetlands lie along depressions at the distributary ends of the creeks or adjacent to intermittent disconnected drainage channels (Hill et al, 1996).

Wetlands on the Perth Airport estate were considered of national importance as they meet four out of six criteria that identify a nationally important wetland (Environment Australia, 2001):

- Criteria 1: It is a good example of a wetland type occurring within a biogeographic region in Australia.
- Criteria 3: It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles or provides a refuge when adverse conditions such as drought prevail.
- Criteria 5: The wetland supports native plant or animal taxa or communities which are considered endangered or vulnerable at the national level.
- Criteria 6: The wetland is of outstanding historical significance or cultural significance.

7.3.2 Wetlands within the Project Area

Aerial imagery from 1953 shows one extensive wetland covering the northern and central portions of Airport West (South) (Figure 7-1). In the south of the Airport West (South) project area, the image shows the far eastern end of a linear east-west wetland system, separated from the northern system by a prominent sand dune feature. Over time, land use change and introduction of major drainage lines have resulted in the loss of large areas of these wetlands, as well as apparent changes in hydrology.

Figure 7-1 Historical wetland aerial imagery

Source: Eco Logical Australia, 2020

Given the previously extensive nature of the wetlands systems within Airport West (South), significant modification to geomorphology and widespread clearing, it was considered appropriate to review the wetland boundaries based on recent vegetation extent mapping. Ecological attributes and functions are considered no longer present in large cleared areas and therefore have been assigned as either Multiple use wetland or no longer a wetland.

One of the vegetation types recently defined and mapped across much of Airport West (South) (Vegetation Type 8; Woodman Environmental Consulting 2020), covers areas previously identified as wetland (Hill *et al* 1996a, GWSCP dataset) and includes some wetland species. However, the vegetation type is described as occurring on dry flats and also includes a range of non-wetland species. This suggests that the vegetation unit is either a transitional unit or is reflective of changing water regimes over time. Vegetation Type 8 is described as:

"Mid to low woodland to open woodland of *Corymbia calophylla*, *Eucalyptus marginata* and *Melaleuca preissiana* over mid to low open shrubland of mixed species dominated by *Xanthorrhoea brunonis*, *Gompholobium tomentosum* and *Calytrix fraseri* over low sedgeland and rushland dominated by *Phlebocarya ciliate*, *Alexgeorgea nitens*, *Dasypogon bromeliifolius*, *Patersonia occidentalis* and *Hypolaena exsulca*".

Therefore, these areas should possibly be considered no longer a wetland, with characteristics more akin to a groundwater dependent ecosystem. However, in the absence of targeted hydrological monitoring as a conservative measure, these areas have been mapped as wetland for the purpose of this impact assessment.

Inundated or waterlogged landform units completely devoid of native vegetation were assumed to represent Multiple use wetlands and further work was not undertaken to refine geomorphic boundaries of these wetlands. Multiple use wetlands are not considered priority wetlands as they are highly modified and retain few or no important attributes or functions (DBCA, 2017a). As such, impacts to these wetlands are generally not considered in impact assessment in Western Australia as they are not defined as significant ecosystems (EPA, 2018). On this basis, wetlands with a Multiple use classification have been excluded from the impact assessment analysis undertaken for the Airport West (South) project. In the context of Significant Impact Guideline 1.2, Multiple use wetlands are not likely to be sensitive or vulnerable to impacts and are not rare, endemic, unusual, important or otherwise valuable. This approach is therefore consistent with Commonwealth guidance on assessing impacts to the environment on Commonwealth land.

The boundary remapping process resulted in a total of four wetland areas across 36.4 hectares being identified as potential REW within the Airport West (South) project boundary (Table 7-2 and Figure 7-2).

Wetland ID	Total Area	Area Intersecting Project (hectare)
27	1.9	1.9
28	0.2	0.2
29	1.1	1.1
30	39.8	33.2
Total	43.0	36.4

Table 7-2 Airport West (South) REW Wetlands

Source: Eco Logical Australia, 2020

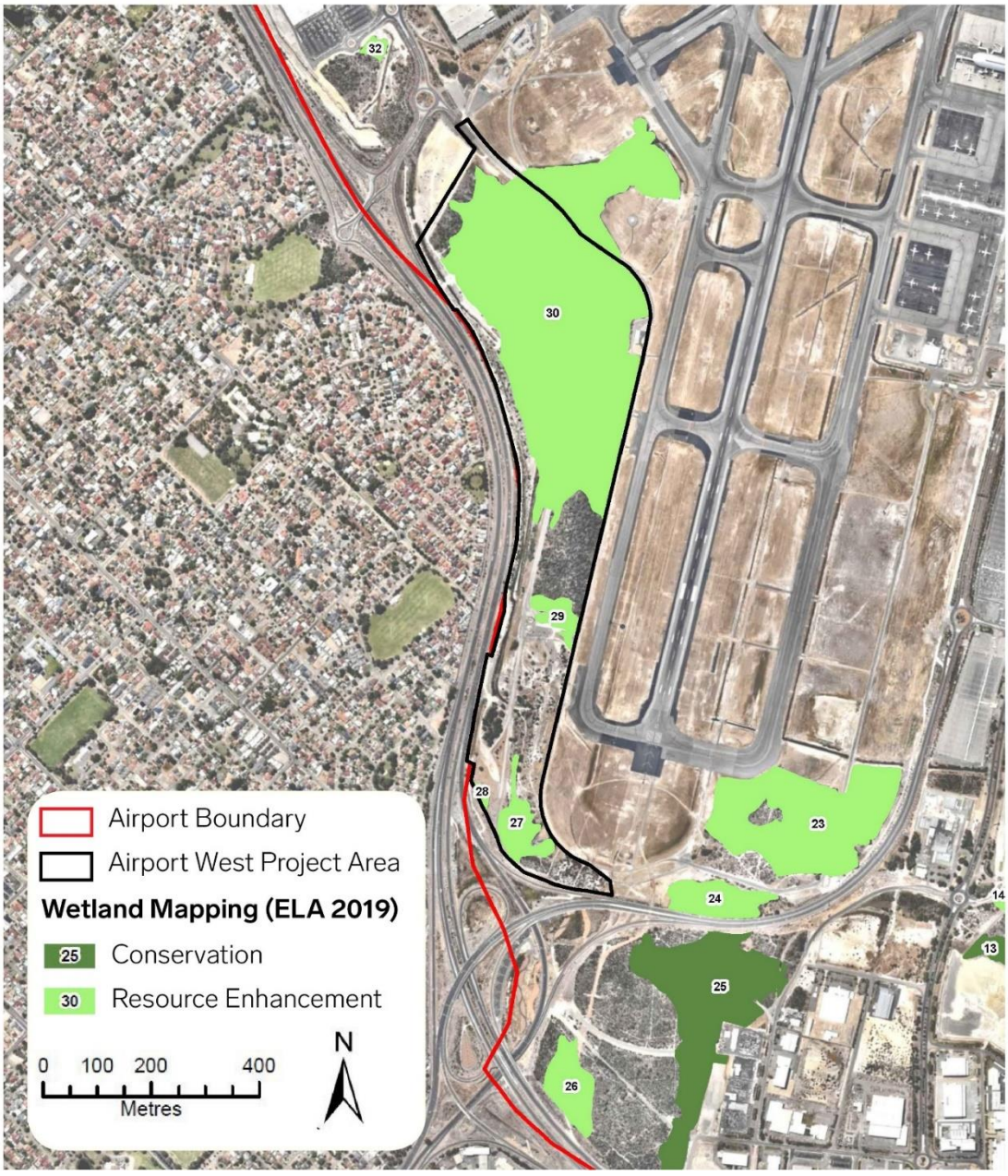

Figure 7-2 Airport West (South) wetland boundaries

Source: Eco Logical Australia, 2020

DBCA have published *A methodology for the evaluation of wetlands on the Swan Coastal Plain, Western Australia* which provides guidance on assigning an appropriate management category to a wetland (Table 7-1). This methodology has been used to determine an appropriate management category (i.e. CCW or REW) for the Airport West (South) wetlands as an indicator of current wetland values present within the Airport West (South) project boundary. The evaluation of wetlands is based primarily on their attributes and functions, independent of decisions regarding protection and management of the wetlands (DBCA, 2017a).

The methodology identifies a number of preliminary evaluation criterion. The methodology states:

"If a 'yes' can be answered to any one of the criteria then the wetland is considered to support the highest level of values, attributes and functions. Wetlands supporting a high level of values, attributes and functions are automatically assigned to Conservation management category."

The Airport West (South) wetlands meet several preliminary criteria that would assign them to CCW category. Airport West (South) wetlands are included in DBCA mapping of the Perth Airport Woodland Swamps Directory of Important wetlands in Australia site, however this area (west of the main runway) is not consistent with the site description included in the original listing, bringing into question whether these wetlands do or do not met the criteria for a nationally important wetland. The smaller three wetlands also meet the criteria of equal to or greater than 90% of the wetland supporting vegetation in good or better condition, however this is due to boundary mapping based on vegetation extent rather than geomorphic boundaries.

Due to these factors, further evaluation was considered appropriate, and as such the secondary evaluation scoring has been completed in accordance with DBCA (2017a). Key considerations in the secondary evaluation process include the representativeness, scarcity and naturalness of the following attributes/functions/values (DBCA 2017a):

- geomorphology,
- wetland processes,
- linkages,
- habitat,
- flora,
- fauna,
- cultural, and
- scientific and educational.

A short summary for each of these as it relates to the Airport West (South) wetlands is provided in Section 3.2 of Eco Logical Australia, 2020.

7.3.2.1 Airport West (South) Wetland Evaluation

On the basis of the information provided in the sections above and using DBCA's evaluation criteria scoring template for the evaluation of wetlands on the Swan Coastal Plain, it is considered that all four wetlands are consistent with the REW management category.

7.4 Direct Impacts and Associated Avoidance/Mitigation Measures

Based on the wetland boundary remapping and evaluations undertaken by Eco Logical Australia, direct impacts to wetlands as a result of the Airport West (South) project relate to clearing of 36.4 hectares of four wetlands assessed as being consistent with REWs.

Although the scale of direct loss of wetlands within the Airport West (South) project area is small to moderate, the impact represents a complete (i.e. high intensity, permanent and irreversible) loss of wetland within the Airport West (South) project area. In the context of the *Significant Impact Guidelines 1.2*, the severity of impacts to wetlands is severe. This does not in itself indicate significance and must be considered within the environmental context in which it is proposed to occur. Discussion relating to the significance of potential impacts of the Airport West (South) project is provided in Section 7.7.

No avoidance of impacts to wetlands within the Airport West (South) boundary is proposed and as such there is a high level of certainty associated with the predicted direct impacts. Perth Airport proposes however to revegetate approximately 4.5 hectares of a retention basin that is to be developed as part of the project. The indicative location of the basin is shown within Figure 3-5. This area will be regenerated and provide an area of re-established wetland, providing habitat for flora and fauna in the future.

7.5 Indirect and Offsite Impacts and Associated Avoidance/Mitigation Measures

Outside of the Airport West (South) project area, a significant proportion of the remaining wetlands at Perth Airport are identified for development under other projects as part of the Perth Airport Master Plan. As such, indirect impacts are considered here only as they relate to areas outside of the airport estate or areas identified for retention under the Airport Master Plan.

Wetland areas which may be retained (referred to from here forward as 'wetland retention areas') within the Perth Airport estate as detailed in Figure 7-3 are:

- A portion of Wetland 30, to the north-east of Airport West (South).
- The majority of Munday Swamp (Wetland 1) and small areas of adjoining vegetation mapped as REW.
- Approximately 7 hectares of Wetland 17, outside of the south-west corner of the New Runway Project.
- The Kwenda Malark constructed wetland (Wetland 19).
- Wetland 26 and part of Wetland 25, which occur within an 'Infrastructure Only Conservation Zone'

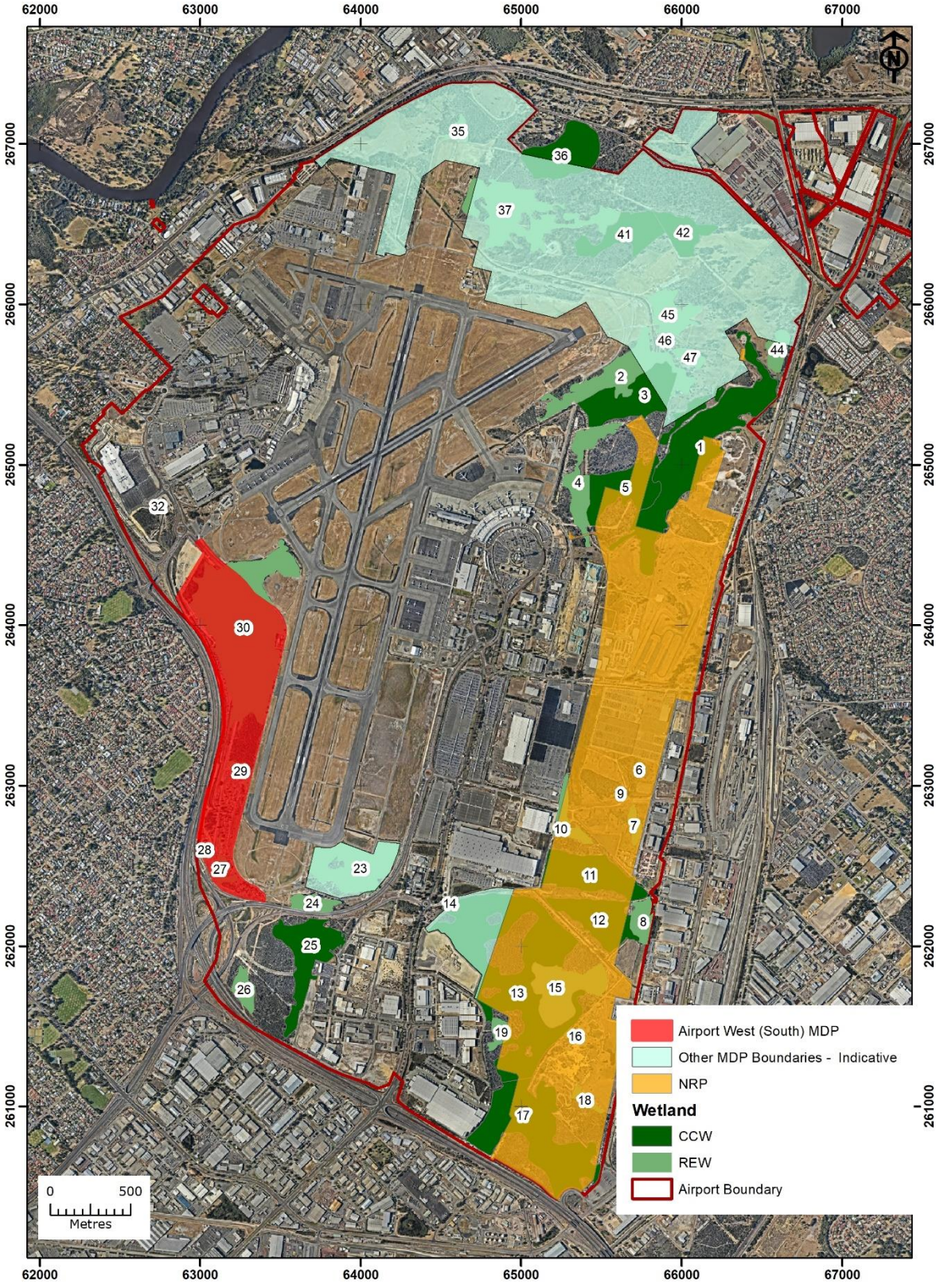

Figure 7-3 Wetland Retention Areas

Source Eco Logical Australia, 2020

Impacts to priority (REW or CCW) wetlands outside of the Perth Airport boundary as a result of the construction or operation of Airport West (South) are unlikely due to the distance from the project area. Whilst an area adjacent to Wetland 27 and 28 external to the Perth Airport boundary is mapped as REW, aerial imagery indicates that this area has been cleared as part of road upgrades (part of the Tonkin Highway/Leach Highway interchange) and no longer holds ecological values. No other REWs or CCWs are mapped within 2 km of the Airport West (South) boundary outside of the airport estate.

In the vicinity of the Airport West (South) project, wetlands could be indirectly impacted due to construction activities which give rise to any of the following:

- emissions such as dust or contaminants,
- unauthorised pedestrian or vehicular access,
- introduction of dieback to previously uninfested areas,
- spread or introduction of weeds,
- inappropriate surface water management, or
- temporary groundwater drawdown due to dewatering or abstraction for construction purposes.

The wetlands with most potential to be indirectly impacted are those within the "Infrastructure Only Conservation Zone", adjacent to the southern tip of Airport West (South). Whilst some of this area is planned for development and repurposing for flood storage, it is likely that a 2.5 hectare wetland remnant close to the south-west corner of the airport estate will be retained.

A Construction Environmental Management Plan (refer to Section 0) for the Airport West (South) project will be developed which includes, but is not limited to, management actions to address these threats to the wetland remnant over the construction period. This plan will include monitoring to assess performance of the management measures against specific targets. As mentioned previously, a separate Acid Sulfate Soils and Dewatering Management Plan will be developed in accordance with Department of Water and Environmental Regulation guidelines to manage the specific risks associated with construction related groundwater drawdown.

During operation of Airport West (South), indirect impacts to wetlands are possible as a result of changes in hydrology which could affect Perth Airport wetland retention areas. Hydrological impacts to wetland values could result from:

- changes in groundwater levels (from altered recharge or from groundwater abstraction) affecting the wetland hydroperiod or peak water levels,
- changes in inundation from drainage pathways due to realignment and increased surface runoff affecting the wetland hydroperiod or peak water levels, or
- changes in water quality.

Hydrological changes could potentially lead to a change in flora, vegetation and fauna values of wetland areas including weed burden, vegetation condition and floristic assemblage.

Perth Airport is aware of significant challenges in maintaining water quality, relating to the potential mobilisation of existing contamination. Drainage for Airport West (South) will be designed to minimise the risk of mobilisation of potential contaminants. Engineering options include keeping open channels above the groundwater level or piping through areas that have higher than background levels of contamination. Given the direction and groundwater flow and lack of connecting surface water pathways the remaining portion of Wetland 30 and any areas retained within Wetlands 25 and 26 are not likely to be impacted by changes to water quality.

No changes to surface drainage within the remaining portion of Wetland 30 or wetlands within the Infrastructure Only Conservation Zone (IOCZ) are expected as a result of the Airport West (South) project. The retained portion of Wetland 30 currently has open drains along the eastern and northern edges of the

wetland, which connect to a piped drainage system heading north. These will not be altered as a result of the Airport West (South) project and no additional stormwater or drainage inputs to this area are planned in association with Airport West (South). The IOCZ area is up-gradient hydrologically of Airport West (South) and receives surface water inputs from commercial areas to the east of the IOCZ. No changes to surface water flow pathways or volumes in this area will result from the Airport West (South) works.

The Airport West (South) project is planned to be implemented as part of a broader Master Plan. As such, it is not practicable to consider changes to hydrology as a result of the Airport West (South) project in isolation from the other projects, as this would not be reflective of actual future hydrological conditions. Comprehensive assessment of indirect impacts to wetland retention areas as a result of changed hydrology is not possible at this stage, as targeted wetland specific hydrological investigations have not been undertaken and detailed design or concept plans for these areas have not been finalised. However, given that the superficial aquifer within the Airport estate is generally 'full', with maximum groundwater levels controlled by drainage inverts (Eco Logical Australia, 2019), and the likelihood that the Airport West (South) project will require filling of low lying areas as opposed to any significant excavation it is unlikely that there will be significant long term increasing or decreasing water level trends as a result of the Airport West (South) project.

It is currently proposed to undertake modelling of changes to groundwater levels of the superficial aquifer across the airport estate on the basis of complete build-out of all Perth Airport Master Plan projects. Any likely impacts and related mitigation strategies will be identified at the time when regional groundwater modelling becomes available.

7.6 Potential Cumulative Impacts

Apart from the Airport West (South) project, there are a number of existing and planned projects identified under the Perth Airport Master Plan, including the New Runway Project currently under assessment and other projects potentially needing Major Development Plans (Figure 7-3). Table 7-3 lists known cumulative impacts to Perth Airport wetlands based on implementation of the proposed New Runway Project, and Airport West (South).

Management Category	CCW (Hectare)	REW (Hectare)
Total within Airport estate	177.1	133.7
Airport West (South)	-	36.4
New Runway Project	79.8	17.8
Cumulative direct impact (known)	79.8	54.2

Table 7-3 Known Cumulative Impacts to CCWs and REWs

Source: Eco Logical Australia, 2020

7.7 Significance of Residual Impacts

Significant Impact Guideline 1.2, *Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies*, provides no specific guidance on determination of significance in relation to wetlands, other than to advise that the determination of significance should consider environmental context, the severity and nature of potential impacts and planned avoidance, mitigation and management.

Historically, there has been significant loss of wetlands on the Swan Coastal Plain. In addition, remaining wetlands in the region are under threat from land clearing associated with a highly urbanised environment and drying as a result of reduced rainfall.

Clearing associated with the Airport West (South) project will result in the direct loss of 43 hectares of priority wetlands, approximately 14% of the wetland areas within the Perth Airport estate which retain ecological values (equivalent to a CCW or REW). Despite significant historical disturbance, this wetland area has been assessed as having rehabilitation potential. In combination with other proposed projects across the airport estate, a total of approximately 230 hectares of mapped wetland vegetation is proposed to be cleared, comprising 78% of the total area within the airport estate including approximately 3% of CCWs occurring within the Mungala consanguineous suite.

Direct impacts to wetland areas within the Airport West (South) Project boundary are unavoidable, however as part of the larger Master Plan some wetland areas have been flagged for retention. Hydrology of these areas will be managed to protect wetlands values, as far as this is consistent with broader Perth Airport objectives.

Considering the historical loss of wetlands on the Swan Coastal Plain, the Very Good or Excellent condition of some of the wetlands vegetation and the context of the Airport West (South) wetland within a broader mosaic of wetland and bushland vegetation within the Perth Airport boundary, the direct loss of 43 hectares of the Airport West (South) wetlands may be considered significant.

Whilst planning is still on-going for areas outside of New Runway Project, and Airport West (South), it also appears likely that a substantial portion of the remaining wetlands within the airport estate will be impacted through implementation of the Perth Airport Master Plan.

The loss of the majority of wetland vegetation across the airport is likely to contribute to a decreased value associated with the remaining remnants. This is due to the loss of broader values relating to regional linkages, as well as impacts to viability as a result of fragmentation and decreased functional area. For example, wetland invertebrate fauna richness has been found to be influenced by proximity to other wetlands, due to fauna that actively disperse between adjacent wetlands and could therefore be affected. In order to counterbalance some of the impacts of wetland losses and mitigate potential indirect impacts, Perth Airport proposes to construct a number of Living Streams, which in the long-term could serve to re-establish ecological corridors between wetland remnants and can of themselves offer diverse habitats and assist in managing water quality for downstream receiving environments.

8. Construction Noise, Vibration and Air Quality

This section provides detail on the:

- Sensitive air, noise and vibration receptors within and surrounding the Airport West (South) project area for the construction phase.
- Impact assessment (including direct, indirect and offsite impacts) and associated mitigation and avoidance measures on the following construction matters that are known to be relevant to the project:
  - Construction dust , and
  - Construction noise and vibration.

8.1 Legislative Context

Air and noise emissions and vibration are regulated by the Airports (Environment Protection) Regulations 1997 (AEPR). The AEPR includes specific limits for certain activities at certain times of the day. They also provide other more general principles to avoid pollution and offensive noise that intrudes on individual, community or commercial amenity.

Regulation 4.01 of the AEPR requires airports to take all reasonable and practicable steps to avoid and/or minimise offensive pollution. This includes construction dust, noise and vibration.

The AEPR states that noise generated from construction, maintenance or demolition of a building or other structure at an airport should not exceed 75 dBA L10,15min at the site of a sensitive receptor. Sensitive receptor is defined under Regulation 2.04 of the AEPR and means:

a) a dwelling, or;
b) an impermanent dwelling in a place designed, or reserved, for impermanent dwellings (for example, a caravan park or residential marina), or
c) a hotel, motel or hostel, or;
d) a child care institution, kindergarten, school, college, university or other educational institution, or;
e) a hospital, medical centre or nursing home, or;
f) a building that is a church or similar place of worship (Regulation 2.04).

The AEPR does not specify construction noise or vibration limits at the site of a commercial receptor. Noise and vibration impacts to commercial receptors are managed under the AEPR's general duty on airports to take all reasonable and practicable steps to avoid and/or minimise offensive pollution (refer Regulation 4.01 of AEPR).

8.2 Impact Assessment

This section provides a qualitative assessment of potential impacts of construction dust, noise and vibration levels on sensitive receptors and commercial receptors (as defined under the AEPR). No modelling was conducted for this assessment, however, modelling conducted for the New Runway Project is still relevant and has been applied for this project.

8.2.1 Construction Dust

8.2.1.1 Overview

This section describes the impact of dust arising from Airport West (South) project construction on nearby sensitive and commercial receptors. Tonkin Highway separates the proposed development site from the nearest residential properties and sensitive receivers in Redcliffe and Cloverdale. Tonkin Highway is three to four lanes wide in each direction along the sections bordering the Airport West (South) site and the distance from the construction site to the nearest residential properties ranges from 100m (the approximate width of the Tonkin Highway road reserve) to over 500m in parts of the site. The dominant prevailing wind direction comes from the southwest, meaning that the wind will generally take any dust from construction works away from these sensitive receivers and further into the site. Therefore, the nearest sensitive receiver would most often be the operational airport. In the months of May, June and July, the dominant prevailing wind at Perth Airport blows from the North and North East. These winds present the potential for transporting fugitive dust and emissions from the construction site to the nearby residential areas across Tonkin Highway, however the months of May to July generally receive higher rainfall and therefore potential dust impacts from construction are naturally mitigated. There is also potential for dust from construction works to impact on traffic utilising Tonkin Highway, however with appropriate mitigation as outlined below, the potential for impact is minimal.

8.2.1.2 Impacts and Associated Avoidance/Mitigation Measures

The potential impacts and proposed mitigation strategies are summarised in Table 8-1.

Construction activities identified as those likely to generate the most significant amount of dust emissions during construction are as follows:

- Clearing and grubbing works,
- Scrapers removing topsoil,
- Excavation, movement and transportation of soil,
- Large trucks and other vehicles using unpaved roads,
- Wind erosion from exposed areas, and
- Grading of temporary unsealed roads.

Given the above activities there is potential for sensitive receptors to be impacted by dust.

The CEMP will include standard measures for the management of dust during construction, including watering where required. Potential mitigation measures to reduce construction dust impacts include:

- Continual site management and supervision including observation of dust levels,
- Water carts/spraying on exposed soil, site roads and stockpiles,
- Use of dust suppressants for areas of site and/or stockpiles that will not be disturbed for considerable periods,
- Wind breaks on stockpiles and exposed areas,
- Control of stockpiles including placement away from sensitive receptors, limiting height or total enclosure where possible,
- Restricting the movement of vehicles and plant on site to defined site roads unless required for construction or operations,

- Maintaining a low speed limit on site roads to limit the production of dust,
- Install wheel wash stations at site exit points to public roads,
- Periodic use of street sweepers to clear dirt tracked from site onto public roads.

The implementation of these management measures will limit the potential for sensitive receptors to be impacted.

Impact Type	Impacting Process	Discussion (Potential impacts)	Proposed Avoidance/Mitigation Measures	Severity
Direct Impact	Clearing and grubbing	Clearing and grubbing of the site is likely to produce dust which has the potential to negatively impact sensitive receivers: • Residential properties to the west across Tonkin Highway • Commercial properties to the west across Tonkin Highway • Traffic on Tonkin Highway • Commercial properties to the northwest within Perth Airport Estate • Operating Perth Airport airfield to the east	• Target clearing and grubbing operations for period May-September when rainfall provides natural dust suppression and wind speeds are lower, reducing potential for dust to carry to sensitive receptors • Progressively clear and then stabilise areas to reduce the total area likely to produced dust • Use regular dust suppression via water trucks on site tracks and haul roads, and on cleared areas prior to stabilisation • Use dust suppression agents (e.g. hydromulch, dustex) for stabilising areas which will remain cleared but not worked for a long period of time • Ensure all site vehicles and plant movement remain on defined tracks and haul roads • Maintain a low speed limit for movement of vehicles on site • Maintain site roads in good condition and utilise dust suppression during grading operations • Monitor weather conditions and do not perform clearing and grubbing operations during periods of high wind • Install rumble grids or wheel wash stations at exit points to the work site to prevent dirt and mud being transferred onto public roads. • Use as street-sweeper where required to keep public roads adjacent to the site clean. • Regular inspections to include assessment of the effectiveness of dust management and control measures	Minor – negligible assuming all controls implemented
Direct Impact	Clearing and grubbing	Clearing and grubbing of the site is likely to produce dust which has the potential to negatively impact vegetation and native fauna in the area	• Controls as noted above • Also note that as entire project area (65.5ha) is intended to be cleared, the potential for negative impacts to flora and fauna is negligible	Negligible

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Impact Type	Impacting Process	Discussion (Potential impacts)	Proposed Avoidance/Mitigation Measures	Severity
Direct impact	Topsoil stripping	The stripping of topsoil by scrapers is likely to produce dust which has the potential to negatively impact sensitive receivers: • Residential properties to the west across Tonkin Highway • Commercial properties to the west across Tonkin Highway • Traffic on Tonkin Highway • Commercial properties to the northwest within Perth Airport Estate • Operating Perth Airport airfield to the east	• Monitor weather conditions and do not perform topsoil stripping operations during periods of high wind • Use water sprayers to dampen spoil during topsoil transfer operations where the risk of creating nuisance dust is high • Cover loads during operations to transfer topsoil offsite • Use dust suppression agents (e.g. hydromulch, dustex) for stabilising stockpiles • Use regular dust suppression via water trucks on site tracks and haul roads, and on cleared areas prior to stabilisation • Ensure all site vehicles and plant movement remain on defined tracks and haul roads • Maintain a low speed limit for movement of vehicles on site • Install rumble grids or wheel wash stations at exit points to the work site to prevent dirt and mud being transferred onto public roads. • Use as street-sweeper where required to keep public roads adjacent to the site clean. • Regular inspections to include assessment of the effectiveness of dust management and control measures	Minor
Direct impact	Bulk earthworks (including excavation and trenching for services)	Bulk earthworks operations is likely to produce dust which has the potential to negatively impact sensitive receivers: • Residential properties to the west across Tonkin Highway • Commercial properties to the west across Tonkin Highway • Traffic on Tonkin Highway • Commercial properties to the northwest within Perth Airport Estate • Operating Perth Airport airfield to the east	• Monitor weather conditions and do not perform bulk earthworks operations that are likely to create dust during periods of high wind • Use water sprayers to dampen spoil during spoil transfer operations where the risk of creating nuisance dust is high • Cover loads during operations to transfer spoil offsite • Use dust suppression agents (e.g. hydromulch, dustex) for stabilising stockpiles • Use dust suppression agents (e.g. hydromulch, dustex) for stabilising areas which will remain cleared but not worked for a long period of time	Minor

Impact Type	Impacting Process	Discussion (Potential impacts)	Proposed Avoidance/Mitigation Measures	Severity
			• Where possible, target early implementation of landscaping works to assist with topsoil stabilisation • Use regular dust suppression via water trucks on site tracks and haul roads, and on cleared areas prior to stabilisation • Ensure all site vehicles and plant movement remain on defined tracks and haul roads • Maintain a low speed limit for movement of vehicles on site • Install rumble grids or wheel wash stations at exit points to the work site to prevent dirt and mud being transferred onto public roads. • Use as street-sweeper where required to keep public roads adjacent to the site clean. • Regular inspections to include assessment of the effectiveness of dust management and control measures	

Table 8-1 Impacts and mitigation measures for construction dust

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8.2.1.3 Significance of Residual Impacts

With mitigation measures implemented, it is expected that impacts to sensitive receptors will be negligible.

8.2.2 Noise and Vibration

8.2.2.1 Overview

This section describes the noise and vibration impacts arising from Airport West (South) project construction activities on nearby sensitive and commercial receptors.

As mentioned above, Tonkin Highway separates the Airport West (South) development site from the nearest residential properties and sensitive receivers in Redcliffe and Cloverdale. Tonkin Highway a multi-lane major road in the sections bordering the Airport West (South) site and the distance from the construction site to the nearest residential properties ranges from 100m to over 500m in parts of the site. Noise from construction plant and equipment will typically dissipate quickly from source, as demonstrated in the table of construction equipment noise levels below.

Construction Plant	Sound Power Levels (dbA) – at source	Sound Pressure Levels – at 7m
Caterpillar 657 Scraper	118	93
Caterpillar 825 Compactor	108	83
Caterpillar 966 Loader	114	89
Caterpillar D11 Bulldozer	120	95
Caterpillar D8 Bulldozer	110	85
30,000 litre Water Truck	103	78
200 tonne Excavator	117	92
Dump Truck	105	80
Moving Floor Truck	105	80
30 tonne Excavator	105	80
B-double Truck	105	80
Concrete Truck	105	80
16' Grader	111	86
14' Grader	109	84
Bobcat	103	78
Pad Foot Roller	104	79
Smooth Drum Roller	105	80
Multi-tyre Roller	100	75
Gravel Paver	109	84
Asphalt Paver	109	84

Construction Plant	Sound Power Levels (dbA) – at source	Sound Pressure Levels – at 7m
Paver Train	110	85
Concrete Cutting	115	90
Concrete Batch Plant	110	85
Asphalt Batch Plant	114	89

Table 8-2 Typical construction sound power levels and sound pressure levels

at Seven Metres

Considering the information in Table 8-1, it is expected that construction noise at the site boundary would typically be within acceptable limits for normal working hours. Any construction noise leaving the site boundary is unlikely to exceed existing noise from traffic along Tonkin Highway, and therefore potential noise impacts from construction are anticipated to be negligible. Additional mitigation of potential noise impacts is provided by the noise walls already erected between the residential properties and Tonkin Highway. The noise walls provide effective mitigation for properties exposed to noise from Tonkin Highway traffic, and would also act as a barrier to any noise from construction at Airport West (South), making any potential impact on these properties from construction noise negligible.

Vibration from construction equipment is not expected to result in any impact to sensitive receptors. Vibration is most often assessed against the German Standard DIN 4150-3: 1999 which notes conservative frequency dependent values for peak particle velocity (mm/s) to determine limits for vibration that may be considered to cause damage to structures. Limits proposed are 5mm/s for standard dwellings and buildings and 3mm/s for vibration sensitive buildings, such as heritage buildings. Vibration from construction equipment will typically dissipate quickly, generally being within acceptable limits within 10-20m from source. Considering that Tonkin Highway separates construction works from sensitive receptors, vibration impacts on sensitive receptors from construction works will be negligible.

8.2.2.2 Impacts and Associated Avoidance/Mitigation Measures

Noise emissions and vibration during construction will predominately be from earthworks, construction equipment (e.g. compressed air-driven tools), heavy plant and vehicles working on site and the delivery of materials.

Based on modelling of similar projects at Perth Airport, it is unlikely that noise and vibration emissions arising from construction will have any impact on sensitive receptors. Further, the impact to sensitive receptors from construction noise and vibration is likely to be negligible compared to existing operational noise and vibration associated with aircraft and local traffic movements.

The project area is located in close proximity to existing airport commercial operations and therefore, has the potential to impact on commercial amenity during construction.

A range of mitigation measures for reducing the impact of construction noise and vibration will be considered in the project CEMP and implemented where reasonable and practicable, including:

- construction hours (having regard to the day of the week, work locations and distance to sensitive and commercial receptors),
- specific noise management plans developed for out of hours construction works (i.e. night works (7pm-7am), Sundays and/or Public Holidays)
- best practice noise and vibration levels for equipment (potential controls include use of noise-compliant equipment, periodic compliance audit of equipment, use of broadband reverse alarms or quackers instead of reversing beepers, use of noise enclosures or barriers for noisy equipment etc),

- training of equipment operators,
- noise and vibration monitoring and reporting (where required for works in close proximity to sensitive receptors),
- regular communication with potentially affected terminal users/businesses, and
- complaints management and response.

8.2.2.3 Significance of Residual Impacts

The potential impact from ground-based construction noise and vibration is mostly benign and naturally mitigated by the presence of Tonkin Highway between the Airport West (South) development site and the nearest sensitive receptors. Therefore, the impact is expected to be negligible.

This section provides details on:

- Aboriginal, Historical and Natural heritage values within and surrounding the project area.
- Impact assessment (including direct, indirect and offsite impacts) and associated mitigation and avoidance measures on heritage values that are known to be relevant to the project.

9. Heritage

9.1 Legislative and Policy Context

Aboriginal and State heritage is an important part of Australia's heritage and history. Heritage is protected and assessed under both State and Commonwealth legislation as follows.

Aboriginal Heritage Act 1972 (WA)

The *Aboriginal Heritage Act 1972* (WA) (AH Act) is the main legislative framework for Aboriginal heritage in Western Australia. Aboriginal sites and objects are protected under the AH Act and consent is required from the Minister for Aboriginal Affairs for any activity which will negatively impact Aboriginal sites. An Aboriginal site is an area that meets the definition under Section 5 of the AH Act. For example:

a) *any place of importance and significance where persons of Aboriginal descent have, or appear to have, left any object, natural or artificial, used for, or made or adapted for use for, any purpose connected with the traditional cultural life of the Aboriginal people, past or present, and*

b) *any sacred, ritual or ceremonial site, which is of importance and special significance to persons of Aboriginal descent.*

Other Heritage Places (OHPs) are areas that demonstrate heritage values but do not fulfil the definition of Section 5 and are afforded no protection under the AH Act. In some instances, OHPs were previously registered Aboriginal sites, but they no longer meet the definition for a site as outlined under the AH Act which could be due to:

- no cultural material was observed within the boundary of the then registered site,
- the condition of the site is poor and the heritage values had been heavily impacted by activities such as complete surface salvage, clearing of land and vehicle activity,
- there is a low likelihood for temporal context to be defined as a result of the absence of heritage objects and a low likelihood of an intact subsurface deposit to exist within the site area due to the disturbance sustained, and/or
- Traditional Custodians consider the area to possess a metaphysical relationship with the other artefact scatters previously identified within the region. Though this relationship offers insight into a broader cultural landscape which reflects where past Aboriginal people may once have camped, the relationship between objects and place, and this place with other places, has now been tangibly removed.

Under Section 17 of the AH Act it is an offence to disturb an Aboriginal site without prior written permission under Section 18 or 16 of the AH Act. Importantly, the AH Act protects all Aboriginal sites which can be determined to meet the definition of Section 5, irrespective of a site being either known, or assessed, and/or on the Aboriginal Heritage Inquiry System (AHIS) Register of Sites.

The Department of Planning, Lands and Heritage (DPLH) and the Department of Premier and Cabinet (DPC) has developed the Aboriginal Heritage Due Diligence Guidelines (2013) (the Guidelines) to assist proponents in meeting their statutory obligations under the AH Act. The Guidelines advocates the application of The Precautionary Principle to the assessment of risk to Aboriginal heritage to ensure all aspects of potential risk are considered and appropriate steps are applied to avoid or minimise damage to Aboriginal sites. Perth Airport has therefore adopted a precautionary approach to the assessment of risk to Aboriginal heritage and, where practical, applies appropriate steps to avoid or minimise damage to heritage.

Environment Protection and Biodiversity Conservation Act 1999(Cth)

The *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) establishes the National Heritage List, which includes natural, Indigenous and historic places that are of outstanding heritage value to the nation. Under the EPBC Act, there are penalties for anyone who takes an action that has or will have a significant impact on the Indigenous heritage values of a place that is recognised in the National Heritage List.

The EPBC Act also establishes the Commonwealth Heritage List, which includes places on Commonwealth lands and waters or under Australian Government control that have Indigenous heritage significance.

In addition, the EPBC Act protects heritage on Commonwealth land and from actions undertaken by the Commonwealth. This heritage assessment therefore follows the requirements of Guideline 1.2.

Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Cth)

The *Commonwealth Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth) (ATSIHP Act) generally applies where State or Territory laws and processes prove ineffective. Under the ATSIHP Act, the responsible Minister can make temporary or long-term declarations to protect areas and objects of significance under threat of injury or desecration. The ATSIHP Act also encourages heritage protection through mediated negotiation and agreement between land users, developers and Aboriginal people.

Heritage Act 2018 (WA)

The *Heritage Act 2018* (Heritage Act) provides for and encourages the conservation of places which have significance to the cultural heritage in the State. The Heritage Council of Western Australia is the State advisory body on heritage matters and is vested with functions and powers under the Heritage Act. The Heritage Council determines the organisation's strategy, policies and makes key decisions on places to be entered into the State Register of Heritage Places and development referrals.

9.2 Methodology

Since the late 1970s, twenty-two archaeological and ethnographic reports have been commissioned by Perth Airport. A search of the DPLH Register and unpublished heritage consultancy reports indicates at least ten archaeological and ethnographic assessments in or adjacent to the Airport West (South) project area.

In addition, a desktop assessment of the area focused on the identification of any registered Aboriginal sites and/or state heritage sites within the area, which need to be considered within this MDP. The desktop research relies largely on the AHIS Register of Sites, maintained by the DPLH; Commonwealth Heritage List, maintained by the DAWE; and the inHerit portal, maintained by the State Heritage Office, which provides an indication of the presence and nature of any heritage values previously recorded and registered within the area.

9.2.1 Aboriginal Heritage

The land on which Perth Airport is located forms part of the traditional network of communication routes, meeting places and camping sites of the Whadjuk Noongar people. The Noongar groups traditionally lived throughout the south-west corner of Western Australia. As the Traditional Custodians, the Noongar people maintain a strong interest in the airport and its operations.

A search of the National Heritage List and the Commonwealth Heritage List confirmed there are no nationally protected Aboriginal sites located on the Perth Airport estate.

A search of the AHIS register identified 3 OHPs as occurring in the project area (see Figure 9-1 and Table 9-1). Section 9.3 provides further details of these sites.

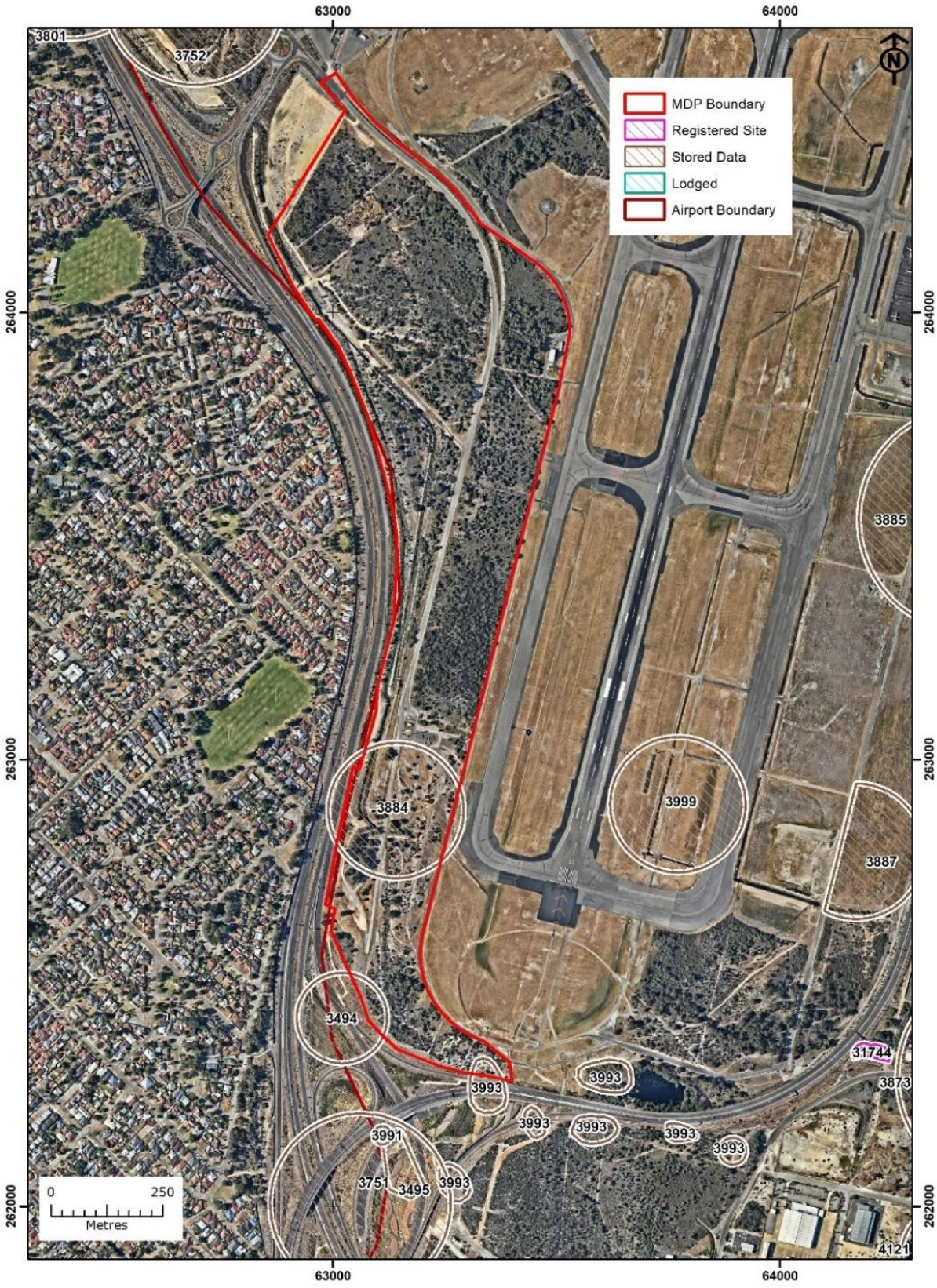

Figure 9-1 Location of Registered Sites and Other Heritage Places in relation to the Airport North Project Area

Source: Department of Planning, Land and Heritage

9.2.2 Historical Heritage

Post-Colonial occupation of the land within the vicinity of the estate dates to the mid-late 1800's and is intrinsically related to the establishment of the Swan River Colony in 1829. The foundation of Guildford to the north-west of the estate occurred within the first years of the colony. It was chosen for its ideal location between the Swan and Helena Rivers and the town site served as an inland river port and market centre for the surrounding agricultural districts.

Today evidence exists of historical (European) land use throughout the Perth Airport estate in the form of building foundations, wells, farming paraphernalia and pastoral land.

A search of the Australian Heritage Database has revealed that no built form places of heritage significance exist within the project area.

Results of the historical and archaeological work undertaken within the project footprint indicate the construction of Tonkin Highway by the State Government and Perth Airport expansion appear to have resulted in a high degree of land disturbance resulting in the likely removal of historical and archaeological structures and deposits. The historical research indicates that remains of historical state or national significance do not exist in the project area.

9.2.3 Natural Heritage

A search of the National Heritage List and the Commonwealth Heritage List confirmed there are no areas of natural heritage located within the Airport West (South) footprint.

Environmental values and impacts are assessed in the environmental sections of this document.

9.3 Impact Assessment

9.3.1 Overview

A search of the AHIS register identified three Other Heritage Places (OHP) as occurring in the project area (refer Table 9-1 and Figure 91).

Name and ID	Type	Status	Comment
3494 Airport: Tonkin Highway	Artefact scatter, Water Source	OHP Stored Data / Not a Site	No gender restrictions
3884 Airport: Sutherland Way A+B	Artefacts / scatter	OHP Stored Data / Not a Site	No gender restrictions
3993 Airport: Crash Gate 5 A+B	Artefacts / Scatter	OHP Stored Data / Not a Site	No gender restrictions

Table 9-1 Other Heritage Places identified in the project area

9.3.1.1 3494 Airport: Tonkin Highway

OHP 3494 was previously a registered Aboriginal site, however it no longer meets the definition of an Aboriginal site under Section 5 of the AH Act. The site was originally recorded in 1989 and all artefacts were collected at the time (Hallam). A 2009 audit of the site did not locate any cultural material (Bergin & Mattner, 2009).

In 2010, consent was granted under Section 18 of the AH Act to disturb the site. The majority of the area has been disturbed by the construction of a road to connect Tonkin Highway to the Internal Terminal Road, the construction of a public viewing platform, additional ground disturbance and total surface collections (Winton, 2010 & Wright 2010).

9.3.1.2 3884 Airport: Sutherland Way A+B

OHP 3884 was previously a registered Aboriginal site, however it no longer meets the definition of an Aboriginal site under Section 5 of the AH Act. The site was originally recorded in 1979 and at that point, the archaeological team collected all surface artefacts (Hallam, 1983).

Subsequent archaeological investigations indicate that few artefacts remain. For example, a 2007 assessment could not locate any artefacts, however a 2009 assessment identified four artefacts though to be part of the original assemblage (Bergin & Mattner, 2009 and Archae-aus, 2016).

In 2010, the site was assessed and determined as having low to moderate archaeological significance (Dortch, 2010). Consent to disturb the site was granted under Section 18 of the AH Act. The area has been disturbed by the upgrade and re-alignment of the airside perimeter security fence and surface collections (Wright & Mulcock 2008 and Dortch, 2009).

9.3.1.3 3993 Airport: Crash Gate 5 A+B

OHP 3993 was previously a registered Aboriginal site, however it no longer meets the definition of an Aboriginal site under Section 5 of the AH Act.

The site was originally recorded in 1979 as an artefact scatter (Hallam, 1983). All visible artefacts were collected at the time and subsequent archaeological assessment of the area identified further scatters east of the Airport West (South) project area (Anderson, 1983).

A consent was granted under Section 18 of the AH Act to disturb the site for an infrastructure project. Artefact scatters that fall within the boundary of the Airport West (South) precinct have been totally destroyed as a result of ground disturbances and surface collections (McDonald & Murphy, 1989 and Bergin & Mattner, 2009).

9.3.2 Direct Impacts and Associated Avoidance/Mitigation Measures

The development of the Airport West (South) area will not directly impact areas with known Aboriginal heritage values for the following reason:

- The Other Heritage Places are classified as "Stored Data - not a site", meaning they do not meet the evaluation criteria for a registered site,
- The Other Heritage Places have been disturbed as a result of historic ground disturbances and total surface collections

Irrespective of a site either being registered or assessed by the DPLH, and/or the Register, the AH Act affords protection to all Aboriginal sites which can be determined to meet the Section 5 definition. The Perth Airport Aboriginal Heritage Monitoring Procedure was developed in consideration of the Aboriginal Heritage Due Diligence Guidelines and the Guidelines for the Engagement of Aboriginal Heritage Monitors, published by the State Department of Aboriginal Affairs (now under the DPLH) and the DPC in 2013.

Although the project footprint does not intersect any registered Aboriginal sites, as part of the broader risk assessment and taking the precautionary approach, Perth Airport has determined the presence of monitors during clearing of certain areas and some ground disturbance activities could prevent harm to unknown heritage.

9.3.3 Indirect and Offsite Impacts and Associated Avoidance/Mitigation Measures

Perth Airport consults the Partnership Agreement Group (PAG) quarterly on heritage matters. As part of the consultations with the PAG, Perth Airport provided an overview of the Airport West (South) project. Perth Airport will continue to discuss the project, including environmental impacts and mitigation measures, with the PAG.

9.3.4 Engagement

Perth Airport consults the PAG at least quarterly on heritage matters. The PAG is a partnership between Perth Airport and seven families who have a longstanding interest in heritage issues in the Perth metropolitan region. The Partnership Agreement was signed in 2009 and recognises the willingness of the signatories, representing Perth Airport, the Traditional Custodians, Owners and other Aboriginal Elders, to engage in good faith for the ongoing development of the airport and Aboriginal heritage.

Through the Partnership Agreement, Perth Airport commits to, but is not limited to:

- establish and facilitate a high-level Aboriginal heritage steering group to facilitate on-going communication, with meetings held at least three times per year,
- include the Traditional Custodians and other Aboriginal Elders in the land use planning process as part of the regular steering group,
- implement an annual schedule of events to celebrate and enhance awareness of Aboriginal heritage and culture at Perth Airport,
- continue to undertake activities in a manner that complies with the AH Act,
- continue to make Munday Swamp available for cultural activities,
- sponsor projects to benefit the local Aboriginal community,
- employ members of the Aboriginal community in cultural heritage awareness and land management planning activities, and
- provide scholarships for Aboriginal students undertaking university study.

Perth Airport ensures consultation with Traditional Custodians, Owners and Aboriginal knowledge holders is aligned with the Commonwealth Government's Engage Early (DAWE, 2016) and Ask First (Australian Heritage Commission, 2002) guidelines for best practice Indigenous engagement. Best practice consultation includes:

- identifying and acknowledging all relevant affected Indigenous peoples and communities,
- committing to early engagement at the pre-referral stage,
- building trust through early and ongoing communication for the duration of the project, including approvals, implementation and future management,
- setting appropriate timeframes for consultation, and
- demonstrating cultural awareness.

9.3.5 Significance of Residual Impacts

There are no registered Aboriginal sites within the Airport West (South) project area. Perth Airport has assessed the potential impacts to heritage and concluded the significance of residual impacts will be negligible.

The use of Monitors, as a mitigation measure, will minimise potential harm to any unknown heritage items that may be encountered during earthworks.

9.3.6 Offsets

Heritage offsets are not required for the Airport West (South) project as there are no nationally listed heritage sites within the project area.

10. Whole of Environment on Commonwealth Land

10.1 Overview

The Airport West (South) project is located on Commonwealth land associated with Perth Airport and as such, impacts to the Whole of Environment require consideration as per Guideline 1.2. In accordance with Guideline 1.2 and EPBC Act, the environment is defined as:

a) Ecosystems and their constituent parts including people and communities ('ecosystem' is defined in the EPBC Act as 'a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functioning unit'),
b) Natural and physical resources,
c) Qualities and characteristics of locations, places and areas,
d) Heritage values of places ('heritage value' is defined in the EPBC Act as including 'the place's natural and cultural environment having aesthetic, historic, scientific or social significance, or other significance, for current and future generations of Australians.' 'Indigenous heritage value' is defined as meaning 'a heritage value of the place that is of significance to Indigenous persons in accordance with their practices, observances, customs, traditions, beliefs or history'), and
e) The social, economic and cultural aspects of a thing mentioned in paragraphs a, b or c.

10.2 Potential impacts to the environment

Table 10-1 provides a summary of the likely direct and indirect impacts to the Whole of Environment and the significance of these.

Environmental Context	Significance of Impacts
Impacts on landscapes and soils	It is proposed that residual impacts in soil, groundwater and surface water will be managed in accordance with the CEMP to be prepared for the site construction works. Periodic monitoring will be undertaken of groundwater and surface water, and soil material movements will be tracked and monitored to demonstrate that construction works are not causing an unacceptable increase in contamination risk or increase in off-site release. The CEMP will include target criteria to adhere to, along with contingency measures to be implemented if site derived trigger levels are exceeded. The generation of any residual impacts are likely to be minimal with management measures in place and likely to be quickly and effectively mitigated through proposed contingency measures. As such, the significance of any residual impacts is considered to be low.
Impacts on water resources	<u>Wetlands</u> Assessment of potential impacts of the project related to wetlands are outlined in Section 7 and Eco Logical Australia (2020). Clearing associated with the Airport West (South) project will result in the direct loss of 43 hectares of priority wetlands, approximately 14% of the wetland areas within the Perth Airport estate which retain ecological values (equivalent to a CCW or REW). Despite significant historical disturbance, this wetland area has been assessed as having rehabilitation potential. In combination with other proposed projects across the airport estate, a total of approximately 230 hectares of

	mapped wetland vegetation is proposed to be cleared, comprising 78% of the total area within the airport estate including approximately 3% of CCWs occurring within the Mungala consanguineous suite. Eco Logical Australia concluded that considering the historical loss of wetlands on the Swan Coastal Plain, the Very Good or Excellent condition of some of the wetlands vegetation and the context of the Airport West (South) wetland within a broader mosaic of wetland and bushland vegetation within the Perth Airport boundary, the direct loss of 43 hectares of the Airport West (South) wetlands may be considered significant. Groundwater and Surface Water The Airport West (South) project may result in changes to the hydrological regime within and surrounding the project area. Any changes to the hydrogeological regime have the potential to change the surface water and groundwater quality within the project area and wider airport estate. Consideration to the surface water and groundwater quality with regards to contaminated land is detailed previously. In a similar manner to groundwater, the existing surface water quality (with the exception of site derived contaminants of concern – see Section 5.6.1) within the project area is comparable to the water quality within the wider airport estate, which is considered to be attributed to up-gradient land uses and geology. Slight variations in the surface water quality within the project area are likely to be influenced by the local geology, soil properties and flora. Due the absence of any identified contaminant source area in the project area (with the exception of PFAS), it is likely that the groundwater quality at the project area will be comparable to groundwater in the wider airport estate. Any construction works and excavations of site soils, including soil movements and vegetation clearing, may result in slight changes in the surface water and groundwater quality. A CEMP will be developed for assessing and managing surface water and groundwater quality during the project construction phase. As part of the CEMP, groundwater sampling will be undertaken to establish the baseline groundwater quality prior to commencement of site development. The surface water and groundwater quality will be monitored throughout construction. Water extraction, handling and placement will be considered to ensure there is no unacceptable change in the surface water and groundwater quality. The excavation, movement and placement of soil will be considered to ensure there is no unacceptable change in the surface water and groundwater quality.
Pollutants, chemicals and toxic substances	Impacts by pollutants, chemical and toxic substance are likely to be localised (if any) and will be managed by the CEMP and in line with the airport Master Plan Environment Strategy. It is unlikely that any impact will be significant.
Impacts on flora and vegetation	Assessment of the potential flora and vegetation impacts to the project are outlined in Section 3 and Woodman Environmental Consulting (2020).

	At the local scale, the Airport West (South) project reduces the extent of remnant native by 7.8% At the regional scale the current extent of the Bassendean vegetation association 1001 is below the threshold of 30% of pre-clearing extent which the EPA (2000) considers species loss appears to accelerate. The Airport West (South) project potentially reduces the extent of Bassendean 1001 to 21.3% of the pre-European extent: this is above the 10% level representing "endangered" (EPA, 2000). Cumulatively the Airport West (South) and New Runway Projects reduce the extent of Bassendean 1001 to 21.3% of the pre-European extent: this is still above the 10% level representing "endangered" (EPA, 2000). In this context, the potential impact of the Airport West (South) project and the potential cumulative impacts on remnant vegetation at the regional scale will contribute to the decline of vegetation of the Bassendean 1001 Association toward the 10% endangered threshold, however it is not considered to constitute a significant impact to remnant vegetation.
Impacts on fauna	Assessment of the potential fauna impacts to the project are outlined in Section 4 and Bamford Consulting Ecologists (2020). There will be permanent population declines at a local level due to habitat loss in the Airport West (South) area. Approximately 50.1 hectares of vegetation (and drains) will be permanently removed for the construction of airport infrastructure and represents a significant portion of habitat within the local area. Standard mitigation measures and proposed additional management measures will reduce impacts to some degree, which are expected to range from negligible to major. The proposed action is likely to result in a significant residual impact to local populations of many species of birds and reptiles. A decline in the abundance and localised loss of the species is expected, although some bird and mammal species will exist in planted gardens. Some species will remain and can be assisted through a revegetation program designed to create interconnected habitat through the built landscape (e.g. Rakali in planted drains). Residual impacts at a local level are expected to be permanent and highly significant, since many native species of fauna are reliant on the native vegetation that will be removed from the Airport West (South) area. However, common (Whole of Environment) fauna species present within the Airport West (South) area are widespread across the airport estate and where native vegetation is currently retained in the region, including the Swan Coastal Plain; therefore, at a regional level the impact on these species is low.
Impacts on people and communities	A socio-economic analysis was undertaken to quantify the benefits arising from the MDP. The analysis estimated a total of 370 direct and indirect full-time jobs will be created from the works associated with this MDP. The MDP works are estimated to cost $36 million, and this figure will be injected into the local economy. Further, based on a conceptual land use mix for the future development of the precinct, a total of 3,145 direct and indirect jobs will be created. The cost to develop the precinct

	is estimated at $274 million and the construction employment is anticipated to generate $898 million in total output for the broader economy. Future development will provide amenity for the growing number of nearby residents, tourists and on-estate employees. The Airport West (South)Project is not expected to have a negative impact on people and communities outside of the Perth Airport estate for the following reasons: • The Airport West (South) project will occur on Commonwealth land currently managed by Perth Airport. No residences or businesses will need to be removed to facilitate the project. • The Airport West (South) project is consistent with the approved Perth Airport Master Plan 2014, and long-term State and local planning objectives for WA and localities adjacent to the Perth Airport estate. • The construction and operation of Airport West (South) will not by itself provide a change to the volume of passenger traffic (refer Section 5 Part A report for the project's traffic assessment). Construction dust, noise and vibration arising from the construction of the project may impact on the amenity of the general area. Measures to mitigate dust, noise and vibration will be incorporated into the project CEMP. With the implementation of these measures, dust, noise and vibration impacts are expected to be minor.
Impacts on heritage	There are no registered Aboriginal sites within the Airport West (South) project area. Perth Airport has assessed the potential impacts to heritage and concluded the significance of residual impacts will be negligible. The use of Monitors, as a mitigation measure, will minimise potential harm to any unknown heritage items that may be encountered during earthworks. The historical research results indicate it is unlikely that remains of historical state or national significance exist in the project area.

Table 10-1 Assessment of Airport West (South) Project in relation to the Whole of the Environment

11. Environmental Management Measures

11.1 Perth Airport Environment Strategy

Perth Airport has an Environment Strategy which is detailed in both the 2014 Master Plan and Master Plan 2020. The Environment Strategy encompasses an Environmental Management Framework (EMF) which sets out how Perth Airport meets its obligations under Commonwealth and State legislation. The Perth Airport EMF is presented in Figure 11-1.

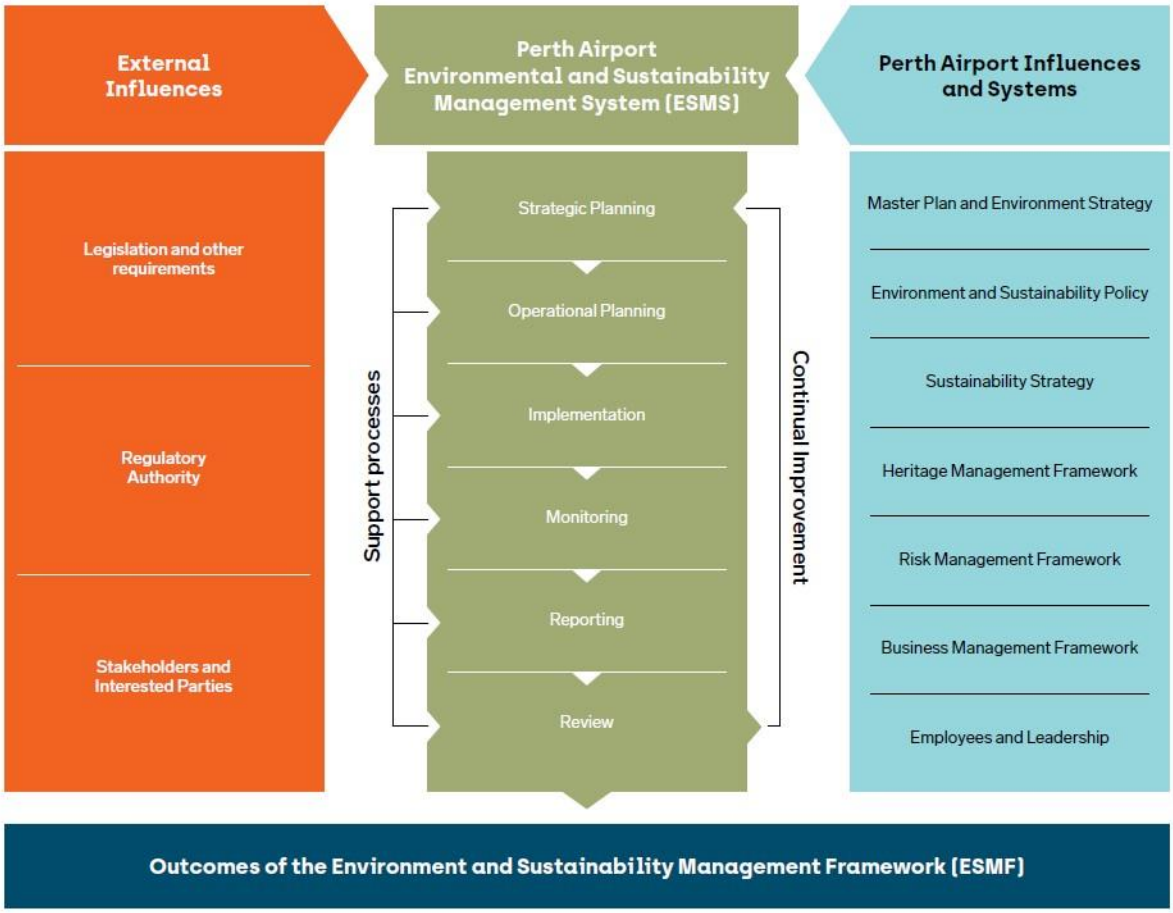

Figure 11-1 Perth Airport Environmental Management Framework

Source: Perth Airport Master Plan 2014 and 2020

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11.2 Environmental Management Plan

Perth Airport will incorporate the principles of the EMF into an Airport West (South) CEMP. The CEMP will address the design, construction and operational phases of the project and include the management measures outlined in this MDP, input from key technical specialists and conditions of approval. The CEMP will address potential impacts and management measures for the following environmental factors:

- Fauna. This includes general measures to protect fauna as well as specific measures for:
  - Carnaby's Black-Cockatoo,
  - Baudin's Black-Cockatoo,
  - Forest Red-Tailed Black-Cockatoo,
  - Quenda,
  - Rakali, and
  - Native bee.
- Flora and vegetation. This includes general measures to protect flora and vegetation as well as specific measures for:
  - Native vegetation,
  - Banksia Woodland TEC,
  - two DBCA listed Priority Species, *Platysace ramosissima* and *Johnsonia pubescens* subsp. *Cygnorum.*
- Wetlands,
- Contaminated land/PFAS,
- Water resources,
- Heritage, and
- Construction dust, noise and vibration.

The CEMP will also include the following:

- Objectives for each environmental factor,
- Roles and responsibilities,
- Reporting requirements,
- Environmental training,
- Emergency contacts and procedures,
- A risk assessment,
- Environmental management activities, controls and performance targets,
- Environmental management maps and diagrams,
- Environmental monitoring,
- Waste management
- Corrective actions, and
- Audit and review.

All mitigation measures identified in this MDP will be implemented in the CEMP and Operational Management Plan (OEMP) as appropriate.

12. Draft Airport West (South) Offset Proposal

Residual impacts of the Airport West (South) project to one Threatened Ecological Community (TEC), 3 protected species and wetlands will require consideration in terms of offset. These comprise:

- Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community (Banksia Woodlands TEC),
- Carnaby's Black-Cockatoo,
- Baudin's Black-Cockatoo,
- Forest Red-tailed Black-Cockatoo, and
- Resource Enhancement Wetlands.

Offsets in relation to the above have been identified in keeping with the requirements of the following documents:

- Department of the Environment and Energy (DAWE) Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy (the Offsets Policy) (DSEWPaC, 2012a),
- Offsets Assessment Guide (the Offsets Guide) (DSEWPaC, 2012b),
- Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain Ecological Community (Conservation Advice for Banksia Woodlands TEC) (Threatened Species Scientific Committee, 2016), and
- EPBC Act referral guidelines for three threatened black cockatoo species: Carnaby's Black-Cockatoo, *Calyptorhynchus latirostris* (Endangered), Baudin's Black-Cockatoo, *Calyptorhynchus baudinii*, (Vulnerable) and Forest Red-Tailed Black-Cockatoo, *Calyptorhynchus banksii naso* (Vulnerable) (DSEWPaC, 2012c).

This section of the document outlines the Offsets Guide inputs and outputs for the proposed offsets for the following residual impacts resulting from the Airport West (South) project:

- the loss of 6.0 hectares of Banksia Woodlands TEC,
- the loss of 48.2 hectares of Carnaby's Black-Cockatoo foraging habitat,
- the loss of 26.8 hectares of Baudin's and Forest Red-tailed Black-Cockatoo foraging habitat and
- 37.4 hectares of Resource Enhancement Wetlands

Carnaby's Black-Cockatoos can forage on a larger range of plant species than Baudin's and Red-tailed Black-Cockatoos, and as such, impacts for Carnaby's Black-Cockatoo have been considered separately to the other two Black-Cockatoo species.

The proposed offsets for the Airport West (South) project include an offsite restoration component for residual impacts to the Banksia Woodlands TEC, with this offset also contributing to the offset required for residual impacts to Black-Cockatoos. In addition, a land purchase offset will comprise the remaining requirements to address the residual impacts to the Black-Cockatoos, as illustrated in Figure 12-1.

Offsets for the Resource Enhancement Wetlands are still being developed and will be provided in the final Offset proposal.

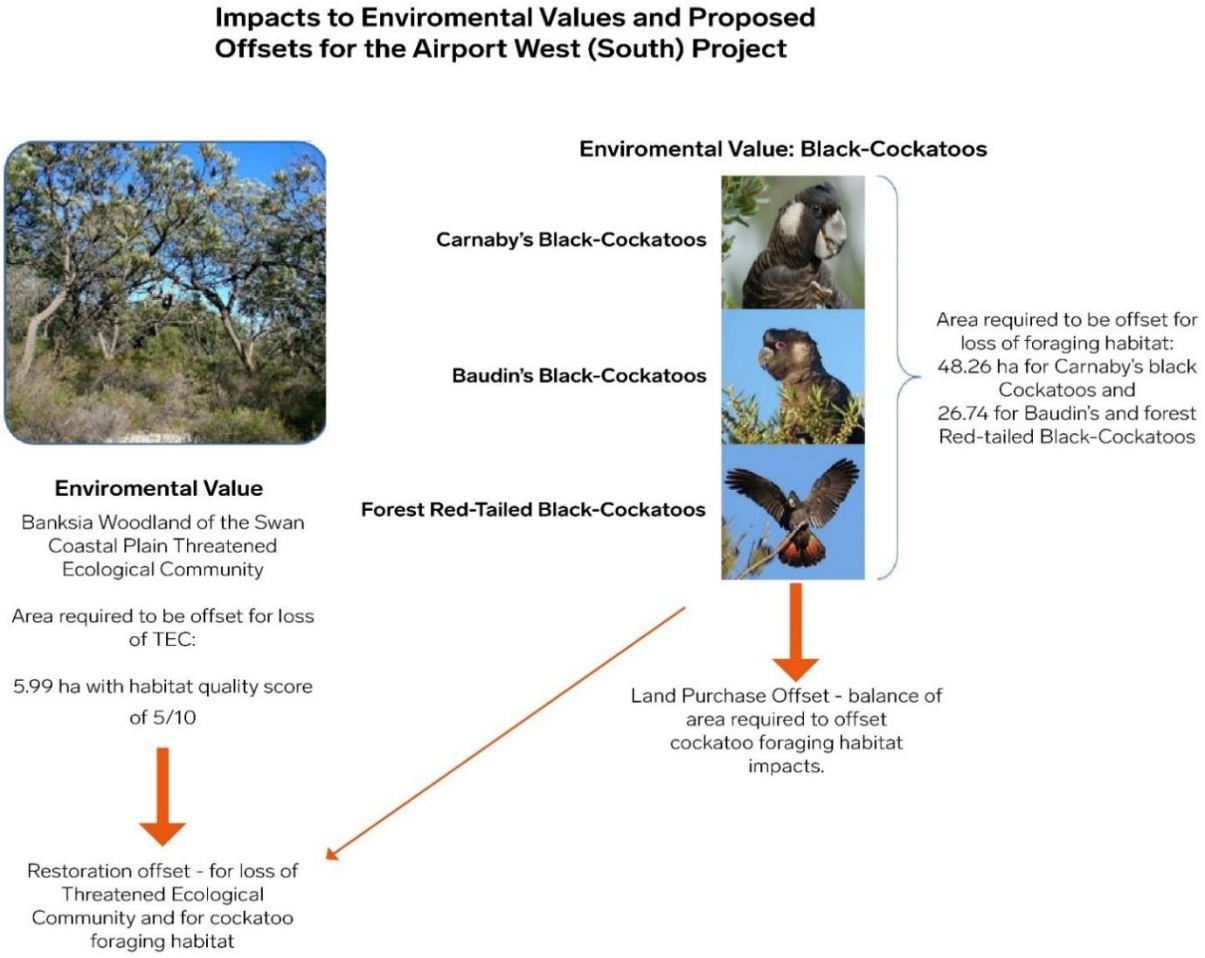

Figure 12-1 Overview of Proposed Offsets to mitigate residual impacts of the Airport West (South) project excluding offsets for wetlands

12.1 Application of the Offsets Guide

The Offsets Guide (DSEWPaC, 2012b) is used to support application of the EPBC Offsets Policy (DSEWPaC, 2012a). It is a calculation tool to assist in determining the suitability of offset strategies. It includes four parts:

- Matter of National Environmental Significance (MNES) assessment table,
- Impact Calculator,
- Offset Calculator, and
- Summary Box.

The document 'How to Use the Offsets Assessment Guide' (DSEWPaC, 2012c), together with consultation with DAWE on various elements during the process of calculating the offsets has been used to inform inputs to the Offsets Guide. Table 12-1 summarises the inputs required for completing the Offsets Guide.

Guide Part	Input Item	Explanation
MNES Table	MNES Table	The Offsets Guide requires the name and conservation status of the impacted protected matter as listed under the EPBC Act. Separate worksheets are required for each impacted protected matter. The Offsets Guide allows for overlapping offset requirements for multiple species/ecological communities if one offset can compensate for impacts to more than one species/ecological community.
Impact Calculator	Protected Matter Attributes	Protected matter attributes show the various options to calculate a suitable offset depending on a protected matter's habitat or ecology that a proposed action may be likely to impact. Examples include the area of habitat, area of community or birth rate. The attribute that most effectively captures the nature of the residual impact should be selected. The same attribute should be selected in both the impact calculator and the offset calculator.
	Impact Description Column	This column requires a description of the impacts that the proposed action is likely to have on the species/ecological community to be offset.
	Quantum of Impact	The quantum of impact assesses how big the impact is. It integrates considerations of the area of impact and quality of habitat to provide a total quantum of impact. Quality of habitat is based on the Habitat Quality Score (HQS).
	Information Source	This section requires a list of information sources on which the conclusions are based. These may include consultancy reports, vegetation mapping, scientific articles or field data. It does not affect the offset calculation but provides an important reference point.
Offset Calculator	Protected Matter Attributes	The same attribute should be selected in both the impact and offset calculators. Once selected, the total quantum of impact column is automatically populated from the impact calculator.

Guide Part	Input Item	Explanation
	Offset Description Column	The Offsets Guide requires a description of the proposed offset. This does not affect the calculation but provides important information about the proposed offset.
	Time Horizon Over Which Loss is Averted	This captures the time over which averted loss can be calculated. This is capped at 20 years or the life of an offset, whichever is shorter.
	Time Until Ecological Benefit	This is the estimated time that it will take for the habitat quality improvement of the proposed offset to be realised. Shorter time frames until ecological benefits are realised are valued more highly than longer timeframes.
	Offset Start Area and Quality	This is the current area and quality of the proposed offset and is based on the HQS of the offset.
	Risk of Loss	This considers risk of loss under two scenarios (with and without offset). • Risk of Loss (%) without offset: This is a percentage figure that describes the chance that the habitat on the proposed offset site will be completely lost over the foreseeable future (either the life of the offset or 20 years, whichever is shorter). • Risk of Loss (%) with offset: This describes the chance that the habitat on the proposed offset site will be lost over the foreseeable future (either the life of the offset or 20 years, whichever is shorter), if the site becomes an offset. Perth Airport has developed a Risk of Loss methodology and provided this to the DAWE in 2018. This methodology meets the requirements of Section F of the How to use the Offsets Assessment Guide (DSEWPaC, 2012b).

Guide Part	Input Item	Explanation
	Confidence in Result	Confidence in result is a percentage that records the level of certainty regarding the success of the proposed offset. Proposed offset actions that are designed to have a lower risk of failure should have a higher confidence in result score. For the "area of community" and "area of habitat" attributes, there are two components to which confidence in result relates: • Change in habitat quality: the confidence in result captures the level of certainty about the successful achievement of the proposed change in quality. • Averted loss: the confidence in result captures the level of certainty about the strength and effectiveness of the proposed risk-mitigation measures and the capacity of these measures to mitigate the risk of loss of the site.
	Net Present Value (adjusted hectares)	The Offsets Guide calculates the net present value of the proposed offset taking into account the annual probability of extinction, the time horizon and the adjusted gain. It is used to reflect the fact that a given benefit (i.e. improving habitat quality or averting loss) today holds more value for a protected matter than the same benefit realised in the future.
Summary of Inputs	Summary Box	The summary box incorporates the cost of the direct offset and the percentage of impact that has been offset to determine the cost associated with other compensatory measures. All values are automatically populated from the offset calculator.

Table 12-1 Required Inputs for the Offsets Assessment Guide

12.2 Habitat Quality Score

A key input for the Offsets Guide is the Habitat Quality Score (HQS) for both the impact site and the proposed offsets. The HQS is a measure of how well a particular site supports a specific ecological community or threatened species and contributes to its ongoing viability. It needs to be assessed consistently in both the Impact and Offset Calculators of the Offsets Guide.

The HQS assessment methodology is shown in Figure 12-2 and is based on the following three components:

- Site condition is the condition of a site in relation to the ecological requirements of an ecological community or threatened species. This includes considerations such as vegetation condition and structure, the diversity of habitat species present, and the number of relevant habitat features.
- Site context is the relative importance of a site in terms of its position in the landscape, taking into account the connectivity needs of an ecological community. This includes the proximity of the site in relation to other areas of suitable habitat, and the role of the site in relation to the overall population or extent of a species or community.
- Species stocking rate is the usage and/or density of a species at a particular site. This principle acknowledges that a particular site may have a high value for a particular threatened species, despite appearing to have poor condition and/or context. It includes considerations such as survey data for a site for a particular species population or, in the case of a threatened ecological community this may be a number of different populations. It also includes consideration of the role of the site population with regard to the overall species population viability or community extent.

Figure 12-2 Required components of a Habitat Quality Score (HQS)

These components contribute to the final HQS. However, the application of, and weighting given to, each component is dependent on the ecological requirements of the impacted species or ecological community.

Overall, key considerations in determining the habitat quality of threatened species or an ecological community include:

- Evaluation of the key ecological attributes of the species or ecological community (habitat requirements and variability, lifecycle and population dynamics, movement and distribution patters, and threatening processes); and
- Determination of site characteristics in relation to the species or ecological community ecology (site condition, site context and species stocking rate).

Further discussion on the HQS methodology developed specifically for the Banksia Woodlands TEC and Black Cockatoo Foraging habitat is provided in Appendix A.

12.3 Offset for Banksia Woodlands TEC

This sub section:

- describes the application of the Habitat Quality Score methodology for Banksia Woodlands TEC (Appendix A) at both impact and offset sites,
- applies the Offsets Guide the Airport West (South) project's impacts to the Banksia Woodlands TEC, and
- details how this sub-section the proposed offset is consistent with EPBC Offsets Policy.

12.3.1 Banksia Woodlands TEC Habitat Quality Score of the Impact Area

The Airport West (South) project will result in the clearing of 6.0 hectares of Banksia Woodlands TEC which is comprised of two TEC patches as defined by the Conservation Advice for Banksia Woodlands TEC. Woodman Environmental has conducted an estate-wide survey and assessment of the TEC and assigned estate-wide patch numbers for those areas that meet the requirements of a patch as defined by the Conservation Advice for the Bankia Woodlands TEC. These estate-wide patch numbers are used throughout this section. Table 12-2 and Figure 12-3 provides the HQS of each of the Banksia Woodlands TEC patches intersecting the project area.

The overall HQS of Banksia Woodlands for the Airport West (South) project's impact, based on individual patch habitat quality and weighted by area, is five out of ten as shown in Table 12-3.

Component	Sub-components	18	19
Site Condition (50%)	*Vegetation condition (Keighery 1994)* • Pristine (100) • Excellent (80) • Very Good (60) • Good (40) • Degraded (20) • Completely Degraded (0)	60	58
	Species richness • Average native species richness within the top half of recorded range for the TEC (10) • Less than average native species richness within the top half of the recorded range for the TEC (0)	0	0
	Presence of Threatened taxa • Patch is critical habitat for, and hosts Threatened taxa (10) • Patch is critical habitat for Threatened taxa (5) • Patch is not critical habitat for Threatened taxa (0)	0	0
	Contains State listed TEC/PEC • Patch contains WA Floristic Community Type (FCT) listed as a State TEC (20) • Patch contains WA Floristic Community Type (FCT) listed as a State PEC (10)	10	10
	Presence of Dieback • Patch is dieback Free (10) • Patch is partly dieback free (5) Patch is dieback infested (0)	5	5
	Condition Total (150)	75	73
	Condition Total 150/3	25	24

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Site Context (50%)	*Connectivity* • Patch is continuous with remnant native vegetation and forms a corridor that links different landscape units (30) • Patch is continuous with remnant native vegetation that forms a medium to large local remnant (20) • Patch is in close proximity to (within 1 km) of other medium to large remnants (10) • Patch is within 12 km*3 of other significant remnants and contributes to support of significant avifauna (i.e. known Black Cockatoo Breeding sites are located within 12km of the patch) (5) • Patch is not within 12km of other remnants and is not known to support significant avifauna (0)	20	20
	Patch size • 20ha (50) • 10 - 20 (40) • 5 -10ha (30) • 2 - 5ha (20) • <2ha (10)	10	30
	Site location and risk • Patch located in an area where the TEC has been extensively cleared (10) • Patch located at the geographical edge of the recorded range (10)	10	10
Site Context Total /2		20	30
Quality total (100)	Site Condition Total +Site Context Total	45	54
Quality (10)		5	5

Table 12-2 Habitat Quality Score for Banksia Woodlands TEC Patches at Impact Site for the Airport West (South) project area

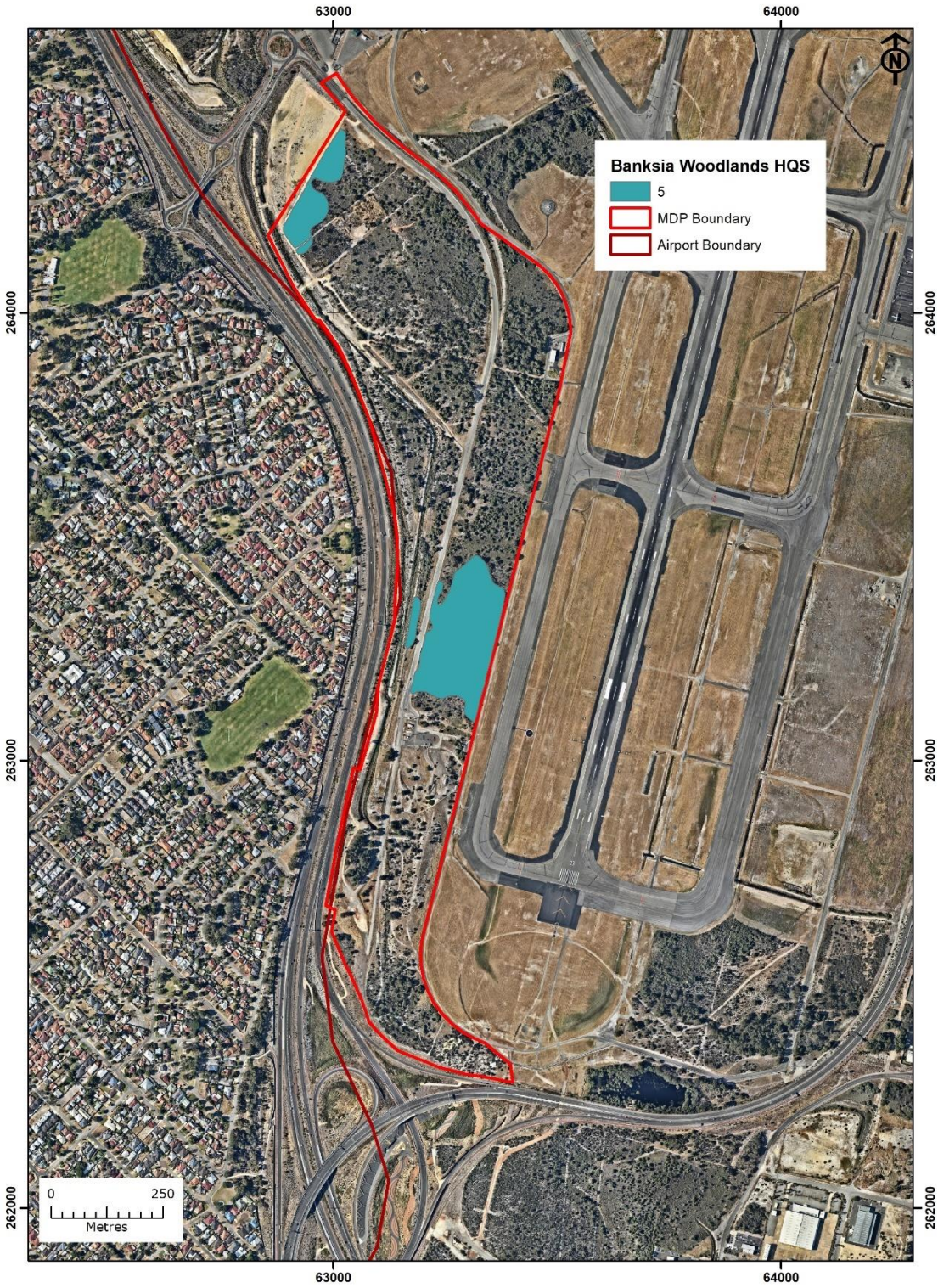

Figure 12-3 Banksia Woodlands Habitat Quality Score

Source: Woodman Environmental Consulting, 2020

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Patch Number	Impact Area (Hectares)	Habitat Quality Score (10)	Weighted Score (Area X HQS)	Overall Habit Quality Score
18	1.39	5	6.95	
19	4.60	5	22.95	
Total	5.99		29.9	
Average				5
Weighted Average Score				4.99
Overall Habitat Quality Score (to nearest whole number)				5

Table 12-3 Overall Banksia Woodlands Habitat Quality Score for the Airport West (South) project

12.3.1.1 Proposed Offset for Banksia Woodlands TEC

The Offset Proposal for the residual impact of the clearing of 6.0 hectares of Banksia Woodlands TEC within the Airport West (South) project area is to restore cleared or degraded areas of the respective Floristic Community Type (FCT) in the Perth metropolitan area (the Restoration Offset). The Proposed Restoration Offset site/s will be chosen to optimise outcomes for the TEC, by identifying sites that:

- increase the area of Banksia Woodlands that meets the diagnostic criteria for the TEC,
- improve the condition of remnants and corridors in the metropolitan area through removing fragmentation and threats to the remnants,
- restore TEC within close proximity to the impact area of clearing, and
- maximise 'like for like' offset outcomes (that is, providing offsets with similar species composition of the impacted FCTs).

The restoration offset site/s will be selected based on site characteristics with a preference given to land that:

- is close to Perth Airport,
- is located on soils and landforms most similar to the area to be cleared at Perth Airport (in order to provide confidence that the restored ecosystem will provide a more 'like for like' offset),
- increases the size and or connectivity of existing patch/es of the Banksia Woodlands TEC,
- has as few threats to the success of the restoration as possible (for example, significant or declared weeds or evidence of Phytophthora dieback), and
- has secure tenure either within the existing conservation estate or is currently managed for the purposes of conservation and manage via a restoration management plan.

Perth Airport considers it is highly likely that it will be able to deliver sufficient offsets for the loss of 6.0 hectares of Banksia Woodlands TEC. FCT 23a is a relatively common vegetation type in the central Swan Coastal Plain; inhabiting primarily mid to upper slopes of sand dunes in the Bassendean sand unit. The current Swan Coastal Plain floristic quadrat dataset held by DBCA identifies 41 quadrats of FCT 23a 'Central *Banksia attenuata – Banksia menziesii* woodlands' located within remnant vegetation patches within 30km of the Perth Airport (refer to Figure 12-4). This indicates that suitable habitat for this FCT occurs in proximity to Perth Airport, with patches likely to have a wide variety of habitat qualities.

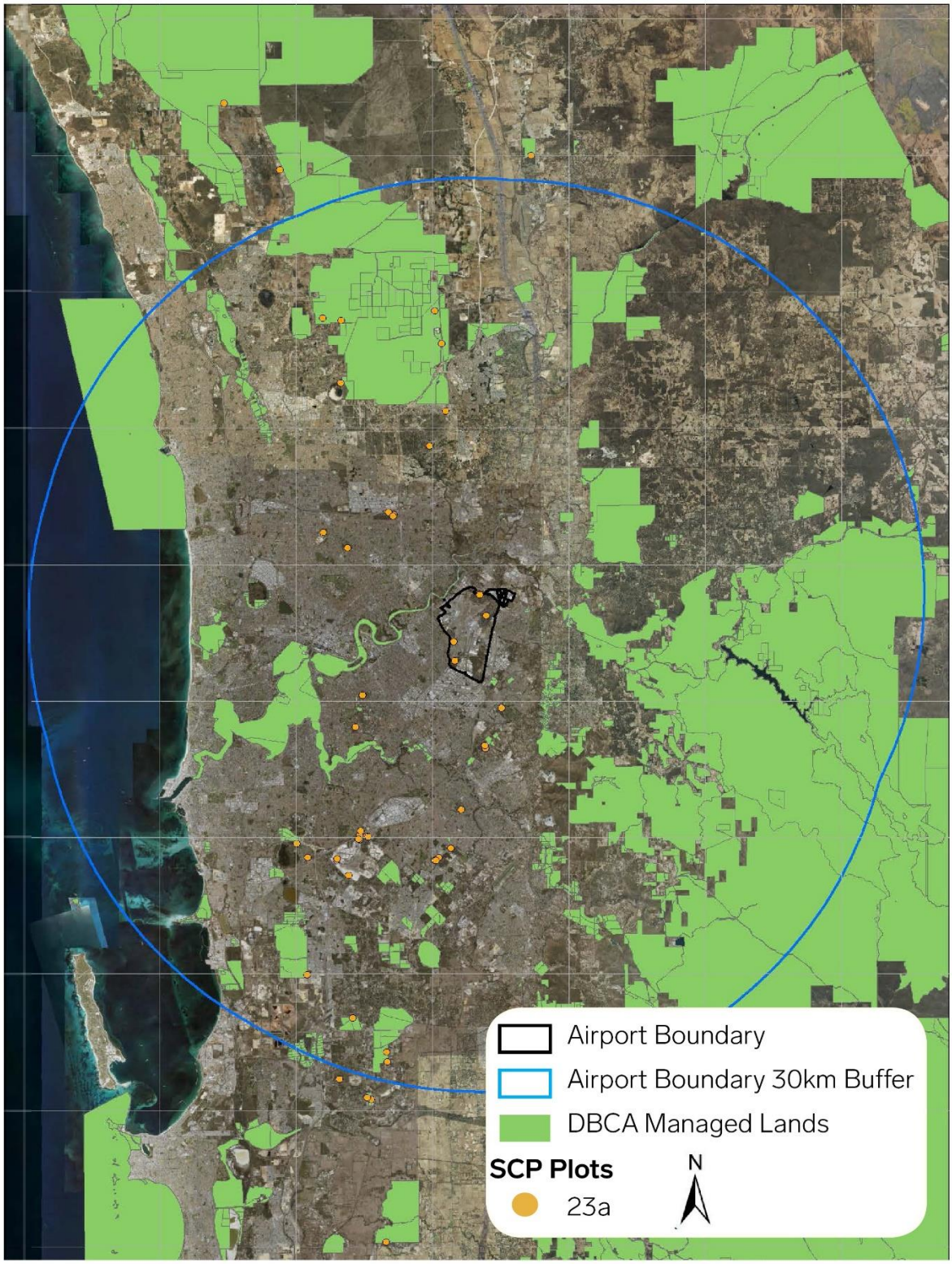

Figure 12-4 Locations of known 23a FCTs within 30km of Perth Airport

Source: Woodman Environmental Consulting, 2020

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12.3.2 Habitat Quality Score of the Offset Site for the Banksia Woodlands TEC

The Restoration Offset will create and/or connect to a single patch of woodland, larger than 20 hectares, which improves connectivity in the landscape. This equates to a HQS for the offset of six out of 10. Table 12-4 outlines how the HQS methodology has been applied to offset the Banksia Woodlands TEC impact.

Component (maximum score)	Sub-components	Offset Site	Comment
Site Condition (50%)	*Vegetation condition* (Keighery 1994) **(100)** • Pristine (100) • Excellent (80) • Very Good (60) • Good (40) • Degraded (25) • Completely Degraded (0)	40	The restoration activity will seek to create vegetation cover and quality to provide a functioning native system, recognising that the creation of Excellent or Pristine vegetation on a restoration site may ultimately be unachievable. Given appropriate actions and management the creation of Good or Very Good vegetation is considered achievable using current leading practice restoration methods.
	Species richness (10) • Average native species richness within the top half of recorded range for the TEC (10) • Average native species richness not within the top half of recorded range for the TEC (0)	10	Perth Airport will ensure that the restoration program will target the introduction/return of highly diverse vegetation during restoration activities. Species lists will be developed to reflect target Floristic Community Types and monitoring will inform adaptive management of the site that will direct ongoing maintenance and remedial actions as required.
	Presence of Threatened taxa (5) • Patch is critical habitat for, and hosts Threatened taxa (10) • Patch is critical habitat for Threatened taxa (5) • Patch contains no critical habitat for Threatened Taxa (0)	0	N/A
	Contain State listed TEC/PEC (20) • Patch contains WA Floristic Community Type (FCT) listed as a State TEC (20)	10	The restoration activities will focus on returning those species belonging to FCT 23a, with full range of canopy, mid-

	• Patch contains WA Floristic Community Type (FCT) listed as a State PEC (10)		and under-story species to be included in the species list.
	Presence Dieback (10) • Patch is dieback Free (10) • Patch is partly dieback free (5) • Patch is dieback infested (0)	5	Being in the Perth metropolitan region, adjacent sites are likely to be dieback infested
Total Site Condition	150/3	22	
Site Context (50%)	*Connectivity (30)* • Patch is continuous with remnant native vegetation and forms a corridor that links different landscape units (30) • Patch is continuous with remnant native vegetation that forms a medium to large local remnant (20) • Patch is in close proximity to (within 1 km) of other medium to large remnants (10) • Patch is within 12 km*3 of other significant remnants and contributes to support of significant avifauna (i.e. known Black Cockatoo Breeding sites are located within 12km of the patch) (5) • Patch is not within 12 km*3 of other significant remnants and contributes to support of significant avifauna (i.e. known Black Cockatoo Breeding sites are located within 12km of the patch) (0)	20	Perth Airport will ensure that the restoration activity will enhance connectivity in the local bioregion through the selection of specific areas.
	Patch size (50) • >20ha (50) • 10- 20ha (40) • 5 -10ha (30) • 2 - 5ha (20) • <2ha (10)	50	The area under consideration for restoration will be part of an area of native vegetation that will be in excess of 20ha.
	Site location and risk (10+10) • Patch located in an area where the TEC has been extensively cleared (10) • Patch located at the geographical edge of the recorded range (10)	10	The restoration area is located in an area where the TEC has been extensively cleared and will lead to an increase in the TEC in the area.

Site Context total	*100/2*	45	No comment required.
Quality total (out of 100)	Site Condition total + Site Context total	57	No comment required.
Quality (above /10)		5.7	No comment required.
	Rounded to nearest whole number	6	No comment required.

Table 12-4 Habitat Quality Score of Offset Site for the Banksia Woodlands TEC

12.3.2.1 Banksia Woodlands TEC Offsets Guide

Table 12-5 summarises the inputs for the Offsets Guide for offset of 6.0 hectares of clearing of the Banksia Woodlands TEC with restoration. As the offset site/s has not been finalised, an estimated start quality of 1 has been assumed for the offset site and will be updated using thee HQS method in Appendix A to determine the final offset area.

Based on these inputs, the Restoration Offset requires 11 hectares to address the loss of 6.0 hectares of Banksia Woodlands TEC habitat for the Airport West (South) project.

Offset Calculator Attribute	Input	Explanation
Time Horizon		
Time over which loss is averted	20	It is expected that the final restoration offset site will be either part of an existing conservation estate or under an existing conservation covenant. A timeframe of 20 years (the maximum number of years that can be entered into the Offsets Guide) has therefore been selected.
Time until ecological benefit	20	Perth Airport recognises that development of a Banksia Woodland restored habitat will take 10 to 20 years to achieve. Habitat function and diversity will not be realised until mature trees dominate the woodland and the vegetation has achieved a state where nutrient cycles are in place and the vegetation is self-sustaining.
Start area (hectare)	11	This is the area of restoration required by the Offsets Guide to satisfy 100% of the offsets required.
Start quality (scale of 1-10)	1	The restoration offset site to be selected will be highly degraded/ cleared and adjacent to an existing patch of Banksia Woodlands TEC within the Perth metropolitan area.
Future area and quality with and without offset (%)		
Risk of Loss (%) without offset	5%	5% has been allocated because it is intended to select a restoration offset site that is already within a conservation estate or under an existing conservation covenant. A score of 0% has not been allocated because land can still be removed from the conservation estate through an Act of Parliament and a conservation covenant can be removed by amending a title deed. Given this, there still remains a very small risk that the site could in future be subject to developments that may not align with the Restoration Offset.
Future quality without offset (scale 1-10)	1	Without an offset, it is unlikely that the quality of the selected restoration offset site will improve and the future quality of the site without an offset remains at 1.
Risk of loss (%) with offset	5%	The tenure and level of protection over the final restoration offset site is unlikely to change as a result of this offset proposal. Perth Airport intends to select a site that is already part of a conservation estate or under a conservation covenant. Therefore, the risk of loss remains at 5%.
Future quality with offset (scale 1-10)	6	It is expected that the Restoration Offset will increase the quality of the TEC habitat to 6.

Offset Calculator Attribute	Input	Explanation
Confidence in result (%)	75%	Leading practice restoration methods will be employed to ensure that confidence in the outcome is as high as possible. It is expected that the project will have a long duration that will be informed by a monitoring program and adaptive management process to ensure restoration processes allow the site to achieve the target HQS.
Net present value (adjusted hectares)	3.09	
% of impact offset	103.07	

Table 12-5 Summary of Offset Guide Inputs

12.3.2.2 Consistency with Offsets Policy for Banksia Woodlands TEC Offset

Table 12-6 demonstrates how the Proposed Offset for the loss of Banksia Woodlands TEC is consistent with the principles of the Offsets Policy and hence the offset requirements within the Conservation Advice for Banksia Woodlands TEC.

Offsets Policy Requirement	Proposed Offset
Suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of a protected matter.	The proposed offset will provide an increased area of the TEC within the Perth metropolitan area and will seek to increase the integrity, quality and ecological functioning of existing patch/es.
Suitable offsets must be built around direct offsets but may include other compensatory measures.	Restoration of Banksia Woodlands TEC is a direct offset.
Suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter.	The Airport West (South) Proposed Offset is considered appropriate and consistent with the DAWE policy, as it takes into account the Banksia Woodlands TEC level of statutory protection, specific attributes of the protected matters, the ongoing viability of the protected matter, the permanent nature of the residual impacts to the species, and the time taken to yield a conservation gain for the species, as indicated by the Offsets Guide.
Suitable offsets must be of a size and scale proportionate to the residual impacts on the protect matter.	The Airport West (South) project will result in the clearing of 6.0 hectares of the Banksia Woodlands TEC that is currently exposed to significant threats from weeds and Phytophthora dieback. The Airport West (South) Proposed Offset includes restoration of 60 hectares of Banksia Woodlands TEC that balances the remainder of the residual impact as defined through use of the Offsets Guide. The offset is of a size and scale proportionate to the residual impacts on the protected matter, as indicated by the Offsets Guide. The final offset site will be selected to ensure that threats from weeds will be less than that of the impact from the Airport West (South) project and can be effectively managed through existing land management practices. The Restoration and Monitoring Plan for the Proposed Offset will target species richness values above those recorded during pre-clearing surveys of the impact site.

Offsets Policy Requirement	Proposed Offset
Suitable offsets must effectively account for and manage the risk of the offset not succeeding.	The Airport West (South) Proposed Offset will be located within existing conservation lands under appropriate management. The offset restoration project will be planned and implemented utilising the principles described in the Society for Ecological Restoration National Restoration Standards. The Airport West (South) Proposed Offset will be implemented under a Restoration and Monitoring Plan that will include: • Restoration objectives • Completion criteria • Implementation methods • Monitoring and reporting program • Contingency actions • Site maintenance/management program. The Restoration and Monitoring Plan will be submitted to DAWE for review and approval prior to implementation of the offset.
Suitable offsets must be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programmes.	The Airport West (South) Proposed Offset is proposed solely to satisfy the requirements of the EPBC Act.
Suitable offsets must be efficient, effective, timely, transparent, scientifically robust and reasonable.	<u>Efficient</u> The Airport West (South) Proposed Offset will directly offset the loss of 6.0 hectares of the TEC through the application of existing knowledge and technology. Species establishment will be achieved through accepted practices utilised in other restoration and rehabilitation programs in WA. The offset site will be chosen to ensure that an in situ natural landform and soil profile exists on the site that will reduce the requirement for expensive earthworks and the associated risks to project outcomes. <u>Effective</u> The Airport West (South) Proposed Offset will establish an area of Banksia Woodlands within the Perth metropolitan area larger than being cleared at the Perth Airport West (South) project site. The offset will be situated to enhance the integrity, quality and extent of urban bushland and where possible, improve ecological functions of the region. <u>Timely</u> The Airport West (South) Proposed Offset will be a long-term project that will not realise the full values of the target habitat for between 10 and 20 years. However, the establishment and associated management actions will gradually improve the ecological functioning of the site over time in terms of hydrological

Offsets Policy Requirement	Proposed Offset
	function, habitat for flora and fauna and reductions in weed presence. Transparent The Airport West (South) Proposed Offset will be managed under a Restoration and Monitoring Plan that will contain a monitoring and reporting requirement. The offset site will be located on existing conservation lands and as such will be overseen by the land manager. Scientifically robust The Airport West (South) Proposed Offset will be based on the Commonwealth endorsed Society for Ecological Restoration National Restoration Standards. The Restoration and Monitoring Plan will only be implemented following review and acceptance by the DAWE and the respective land manager. Reasonable Existing remnant bushland within the Perth metropolitan area of a suitable vegetation type to constitute a direct offset for the Airport West (South) project is not readily available. Most are held in private property and is either highly degraded or too small to provide a secure long-term remnant. The Airport West (South) Proposed Offset has been developed to directly replace lost habitat while enhancing the existing conservation estate through improvement in habitat condition and extent. The proposed offset for the Airport West (South) project will increase the Banksia Woodlands TEC area through the sound allocation of resources in a timely manner.
Suitable offsets must have transparent governance arrangements, including being able to be readily measured, monitoring, audited and enforced.	Implementation of the offset will be in accordance with a formal agreement with the DBCA and a Restoration and Monitoring Plan, approved by DAWE, and which is able to be monitored, audited and enforced.

Table 12-6 Offsets Policy Requirements and Proposed Offset for Banksia Woodlands TEC

12.4 Offset for Black-Cockatoos

This sub section describes how Habitat Quality Score methodology for the three species of Black Cockatoo has been applied at both impact and offset sites. This is followed by application of the Offsets Guide and description of how the proposed offset is consistent with EPBC Offsets Policy.

12.4.1 Black-Cockatoos Habitat Quality Score of the Impact Area

The residual impacts of the Airport West (South) project to Black-Cockatoos include:

- loss of 48.3 hectares of Carnaby's Black-Cockatoo foraging habitat; and
- loss of 26.8 hectares of Baudin's and Forest Red-tailed Black-Cockatoo foraging habitat.

There is a difference between the impacts to the foraging habitat of Carnaby's Black-Cockatoos and that of Baudin's and Forest Red-tailed Black-Cockatoos because Carnaby's can forage on a larger range of plant species than Baudin's and Forest Red-tailed Black-Cockatoos. As such, impacts for Carnaby's Black-Cockatoo have been considered separately to the other two Black-Cockatoo species.

The HQS for Carnaby's Black-Cockatoo is shown in Table 12-7 and Figure 12-5. The HQS for Baudin's and Forest Red-tailed Black-Cockatoos is shown in Table 12-8 and Figure 12-6.

Foraging Score Based on Vegetation Characteristics (out of 6)	Area (Hectares)	Site Context (0 to 3)	Density / Presence (0 to 1)	Score Including Context and Density
1 – Negligible to low	19.2	0	0	1
2 – Low	11.1	0	0	2
3 – Low to moderate	12.1	3	1	7
4 – Moderate	1.5			8
5 – Moderate to high	4.4			9
6 – High	0			10
Total	48.3			
Weighted Average Score				4

Table 12-7 Carnaby's Black-Cockatoo HQS of the Airport West (South) Impact Site

Source Bamford Consulting Ecologists, 2020

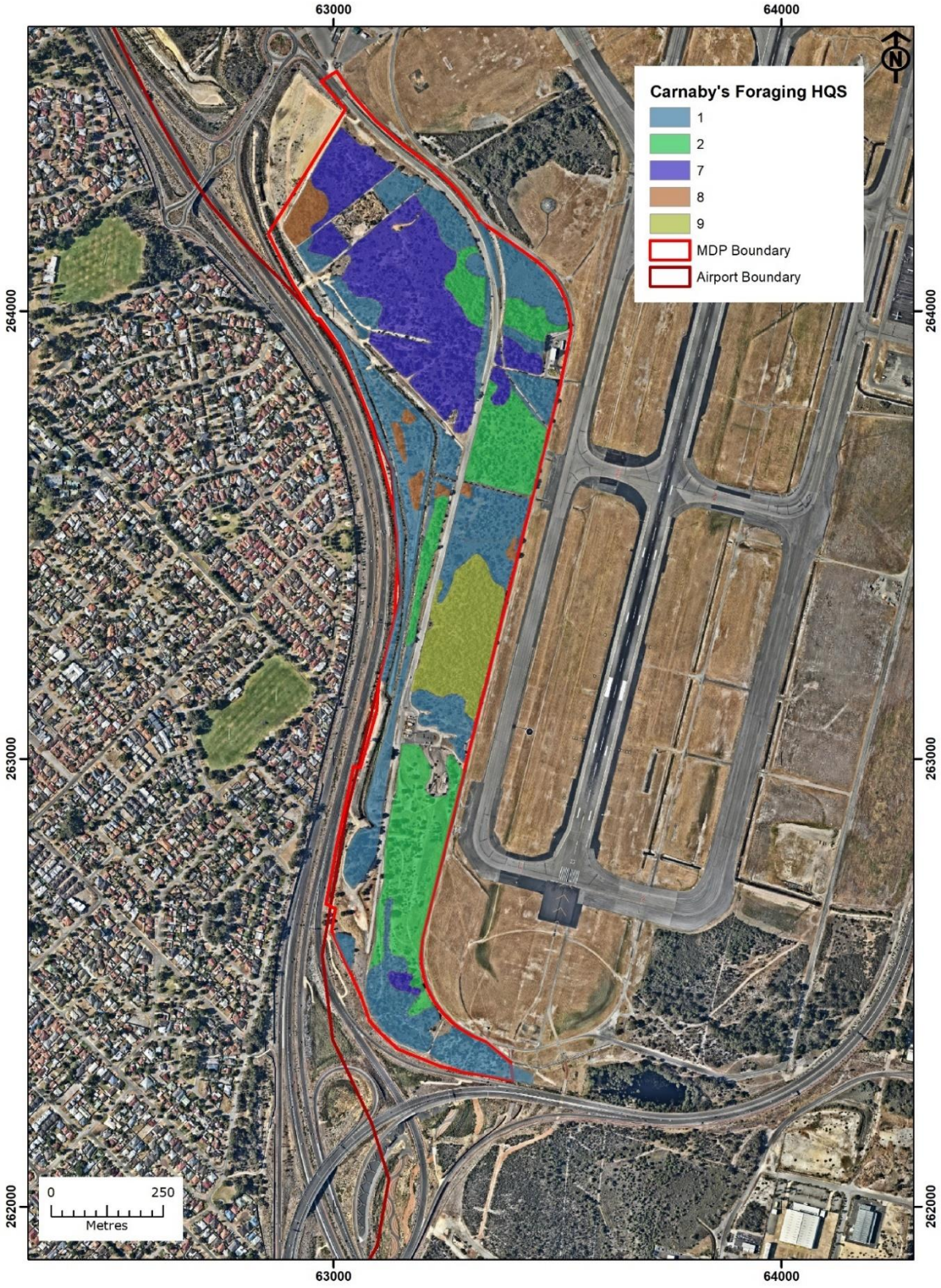

Figure 12-5 Carnaby's Black Cockatoo HQS

Source: Bamford Consulting Ecologists, 2020

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Foraging Score Based on Vegetation Characteristics (out of 6)	Area (Hectares)	Site Context (0 to 3)	Density / Presence (0 to 1)	Score Including Context and Density
1 – Negligible to low	8.5	0	0	1
2 – Low	3.9	0	0	2
3 – Low to moderate	12.9	3	1	7
4 – Moderate	1.5			8
5 – Moderate to high	0			0
6 – High	0			0
Total	26.8			
Weighted Average Score				4

Table 12-8: Baudin's and Forest Red-tailed Black-Cockatoo HQS of the Airport West (South) Impact Site

Source: Bamford Consulting Ecologists, 2020

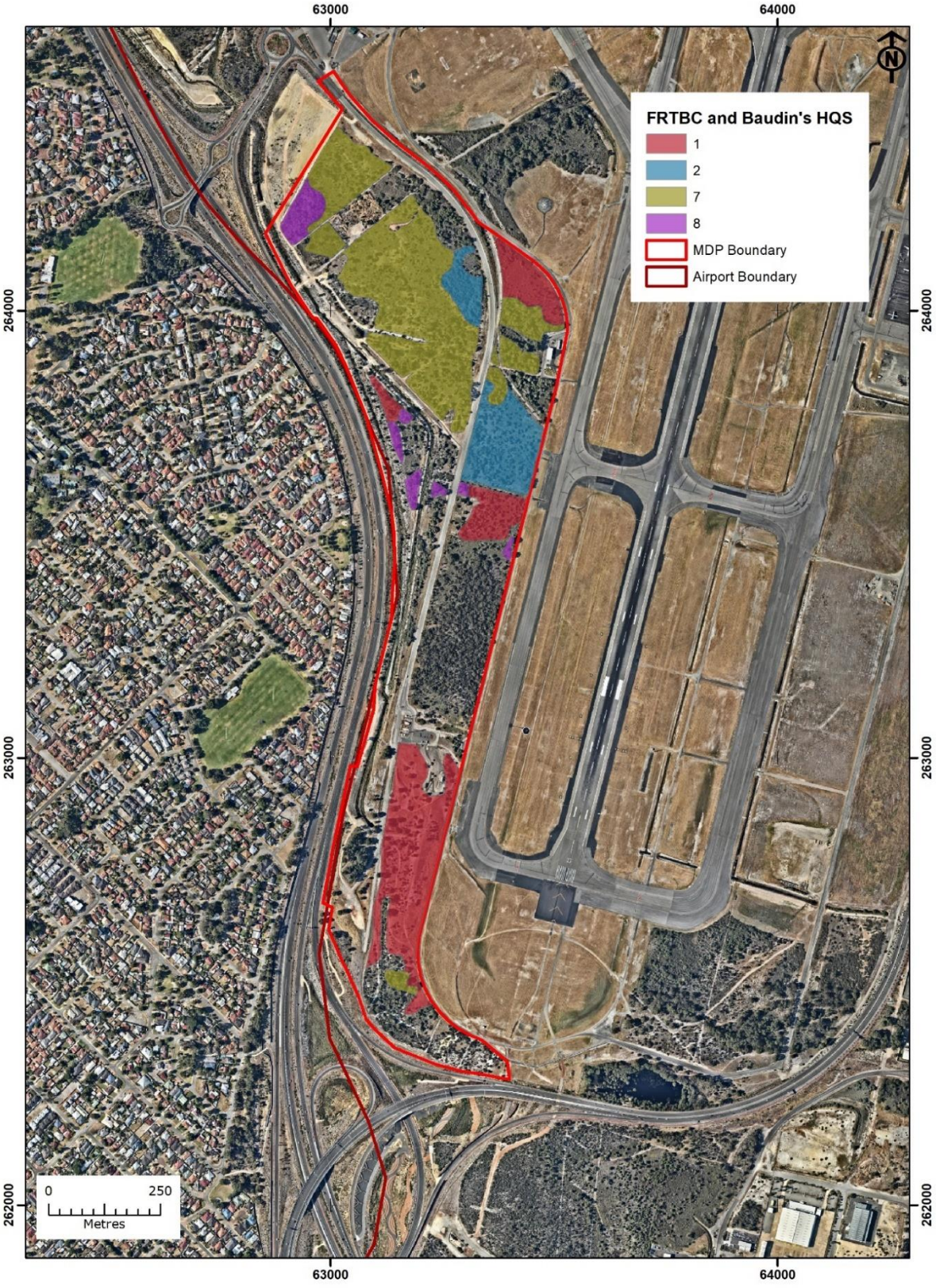

Figure 12-6 Forest Red-tailed and Baudin's Black Cockatoo HQS

Source: Bamford Consulting Ecologists, 2020

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12.4.2 Habitat Quality Score of the Black-Cockatoos Offset Site

Offsets for residual impacts to Black-Cockatoos will comprise:

1) a Restoration Offset (the Banksia Woodlands offset as discussed in Section 12.3 with an estimated HQS of 10 (refer to Table 12-9). This habitat quality score will be revised once the offset site/s are confirmed and offset area will be amended through the application of the HQS and offset guide.
2) Land Purchase Offset that consists of existing habitat.

Component (score range)	Offset Site Score	Comment
Condition Score (0-6)	6	A score of 3 is given as Perth Airport is confident that at least 60% cover of foliage within Banksia Woodlands can be achieved within the given timeframe.
Site Context Score (0-3)	3	A score of 3 is given as the percentage of native vegetation containing Black-Cockatoo breeding habitat within a 15km radius is greater than 10%.
Species Density (1)	1	Perth Airport is confident that Black-Cockatoos will be regularly sighted in the restoration areas within the given timeframe.
HQS	10	

Table 12-9 Restoration Offset HQS

Source: Bamford Consulting Ecologists, 2020

Existing habitat will be purchased and managed for conservation purposes and added to the conservation estate to address the remainder of the residual impacts not addressed by the Restoration Offset. This land purchase offset has been assigned an estimated HQS of 7 at this stage to aid in the Offsets Guide calculations. At the time of selecting the property to be implemented, in consultation with DAWE and DBCA, the methodology outlined in Appendix A will be applied to confirm the HQS and the Offsets Guide calculations amended accordingly.

12.4.3 Black-Cockatoos Offsets Guide

Table 12-10 summarises the inputs and outputs for the Offsets Guide for the three species of Black-Cockatoo for impact to foraging habitat. It should be noted that:

- 11 hectares of restoration and 52 hectares of land purchase offset are required to address the impact of the loss of 48.2 hectares of Carnaby's Black-Cockatoo foraging habitat, and
- 52 hectares of land purchase offset is required to offset the loss of 26.7 hectares of Baudin's and Forest Red-tailed Black Cockatoos foraging habitat. This will cover the 52 hectares of Carnaby's foraging habitat as they can forage in the same areas.

Offset Calculator Attribute	Input for Restoration Portion of Offset	Input for Land Purchase Portion of Offset	Explanation
Time Horizon			
Time over which loss is averted (years)	20	20	It is expected that the final restoration offset site will be either part of an existing conservation estate or under an existing conservation covenant. It is also expected that the land purchase offset will become part of an existing conservation estate. A timeframe of 20 years (the maximum number of years that can be entered into the Offsets Guide) has therefore been selected.
Time until ecological benefit (years)	20	1	Perth Airport recognises that development of a Banksia Woodland restored habitat may take up to 20 years achieve. Habitat function and diversity will not be realised until mature trees dominate the woodland and the vegetation has achieved a state where nutrient cycles are in place and the vegetation has achieved a self-sustaining state. The Land Purchase Offset will already be providing ecological benefit.
Start area (hectare) Carnaby's Black-Cockatoo	11	52	This is the area of restoration required by the Offsets Guide to satisfy 100% of the offsets required.
Start area (hectare) Baudin's Black-Cockatoo	0	52	This is the area of restoration required by the Offsets Guide to satisfy 100% of the offsets required.
Start area (hectare) Forest Red tailed Black-Cockatoo	0	52	This is the area of restoration required by the Offsets Guide to satisfy 100% of the offsets required.
Start quality (scale of 1-10)	1	7	The restoration offset site to be selected will be highly degraded/ cleared and adjacent to an existing patch of Banksia Woodlands TEC within the Perth metropolitan area. An assumed starting score of 7 is allocated to land purchase offsets. This will be revised once land parcels are identified.
Risk of Loss (%) without offset	5%	30%	5% has been allocated because it is intended to select a restoration offset site that is already within a conservation estate or under an existing conservation covenant. A score of 0% has not been allocated because land can still be removed from the conservation estate through an Act of Parliament and a conservation covenant can be removed by amending a title deed. Given this, there still remains a very small risk that the site could in future be subject to developments that may not align with the Restoration Offset. Land purchase offsets will be freehold land where there are developmental pressures such as mining, agriculture or

Offset Calculator Attribute	Input for Restoration Portion of Offset	Input for Land Purchase Portion of Offset	Explanation
			urban/rural expansion. Hence the attribution of 30% risk of loss.
Future quality without offset (scale 1-10)	1	6	Without an offset, it is unlikely that the quality of the selected restoration offset site will improve and the future quality of the site without an offset remains at 1. Land purchased site is expected to decrease in quality due to lack of management and hence a score of 6.
Risk of loss (%) with offset	5%	5%	The tenure and level of protection over the final restoration offset site is unlikely to change as a result of this offset proposal. Perth Airport intends to select a site that is already part of a conservation estate or under a conservation covenant. Therefore, the risk of loss remains at 5%. Land purchased would become part of the conservation estate and risk of loss remains at 5%.
Future quality with offset (scale 1-10)	10	8	It is expected that the Restoration Offset will increase the quality of the TEC habitat to 10. It is expected that Land Purchase Offset will have an increase in quality to a score of 8 due to being managed.
Confidence in result (%)	75%	90%	Leading practice restoration methods will be employed to ensure that confidence in the outcome is as high as possible. In populating the offsets calculator, a confidence level of 75% was used to provide a conservative view of the Restoration project. However, it is expected that the Project will have a 20 year duration that will be informed by a monitoring program and adaptive management process to ensure restoration processes allow the site to achieve the target HQS. Land purchase offsets will already have the values and will be improved by management. Hence a confidence level of 90%.
Net present value (adjusted hectares)- Carnaby's Black-Cockatoo	5.56	42.61	
% of impact offset – Carnaby's Black-Cockatoo	28.76%	71.68%	Total 100.44% meets 100% minimum criteria.
Net present value (adjusted hectares)- Baudin's Black-Cockatoo	n/a	13.85	

Offset Calculator Attribute	Input for Restoration Portion of Offset	Input for Land Purchase Portion of Offset	Explanation
% of impact offset - Baudin's Black-Cockatoo	n/a	129.47%	Total 129.47% meets 100% minimum criteria.
Net present value (adjusted hectares)- Forest Red tailed Black Cockatoo	n/a	11.24	
% of impact offset – Forest Red tailed Black- Cockatoo	n/a	145.43%	Total 100.68% meets 100% minimum criteria.

Table 12-10 Summary of Offsets Guide Inputs and Outputs for Black-Cockatoos

Source: Bamford Consulting Ecologists, 2020

12.4.4 Consistency with Offsets Policy for Black Cockatoo Offsets

Table 12-11 demonstrates how the Airport West (South) Offset Proposal for the three Black-Cockatoo species is consistent with the principles of the Offsets Policy and hence the offset requirements within the Conservation Advice for the Black-Cockatoos.

Offsets Policy Requirement	Proposed offset
Suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of a protected matter.	The Airport West (South) Proposed Offset for all Black-Cockatoo species will secure a conservation area of 65 hectares of foraging habitat vegetated land with a nominal Habitat Quality Score of 7. These areas of foraging habitat are currently not secure for conservation purposes but will be added to the conservation estate and managed by the Department of Biodiversity, Conservation and Attractions. The Airport West (South) Proposed Offset also includes a further 11 hectares of restoration of Banksia Woodlands TEC as foraging habitat.
Suitable offsets must be built around direct offsets but may include other compensatory measures.	Restoration of Banksia Woodlands TEC and purchase of land that is quality foraging habitat are direct offsets.
Suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter.	The Airport West (South) Proposed Offset is considered appropriate and consistent with the DAWE policy, as it takes into account the Black-Cockatoos' level of statutory protection, specific attributes of the protected matters, the ongoing viability of the protected matter, the permanent nature of the residual impacts to the species, and the time taken to yield a conservation gain for the species, as indicated by the Offsets Guide.
Suitable offsets must be of a size and scale proportionate to the residual impacts on the protect matter.	The Airport West (South) project will result in the clearing of 48.3 hectares of Carnaby's Black-Cockatoo foraging habitat, and 26.8 hectares of Baudin's and Forest Red-tailed Black-Cockatoo foraging habitat. The Airport West (South) Proposed Offset will secure a conservation area of 65 hectares of foraging habitat vegetated land and includes restoration of 11 hectares of Banksia Woodlands TEC that balances the remainder of the residual impact as defined through use of the Offsets Assessments Guide. The offset is therefore of a size and scale proportionate to the residual impacts on the protected matter.

Offsets Policy Requirement	Proposed offset
Suitable offsets must effectively account for and manage the risk of the offset not succeeding.	The Airport West (South) Proposed Offset will be located within existing conservation lands under appropriate management, and on land purchased for inclusion into the conservation estate. The offset restoration project will be planned and implemented utilising the principles described in the Society for Ecological Restoration National Restoration Standards. The Airport West (South) Proposed Offset will be implemented under a Restoration and Monitoring Plan that will include: • Restoration objectives • Completion criteria • Implementation methods • Monitoring and reporting program • Contingency actions • Site maintenance/management program The Restoration and Monitoring Plan will be submitted to DAWE for review and approval prior to implementation of the offset.
Suitable offsets must be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programmes.	The Airport West (South) Proposed Offset is proposed solely to satisfy the requirements of the EPBC Act.
Suitable offsets must be efficient, effective, timely, transparent, scientifically robust and reasonable.	<u>Efficient</u> The Airport West (South) Proposed Offset will directly offset the loss of 48.3 hectares of Carnaby's Black-Cockatoo habitat, and 26.8 hectares of Baudin's and Forest Red-tailed Black-Cockatoo habitat, through the proposed measures including restoration of 11 hectares of Banksia Woodlands TEC and securing a conservation area of a further 65 hectares of quality Black-Cockatoo foraging habitat. <u>Effective</u> The Airport West (South) Proposed Offset will establish an area of quality Black-Cockatoo foraging habitat larger than being cleared for the Airport West (South). The offset will be situated to enhance the integrity, quality and extent of urban bushland in order to improve ecological functions of the region. The offset site will also be chosen to have a size, shape and location to ensure that the restored habitat will be subject to a reduced level of ecological threat compared to Airport West (South) area. <u>Timely</u> The Airport West (South) Proposed Offset will be a long-term project that will not realise the full values of the target habitat for between 10 and 20 years. However, the establishment and associated management actions will gradually improve the ecological functioning of the site over time in

Offsets Policy Requirement	Proposed offset
	terms of hydrological function, habitat for flora and fauna and reductions in weed loading. Transparent The Airport West (South) Proposed Offset will be managed under a Restoration and Monitoring Plan that will contain a monitoring and reporting requirement. The offset site will be located on existing conservation lands and as such will be overseen by the land manager. Scientifically robust The Airport West (South) Proposed Offset will be based on the Commonwealth endorsed Society for Ecological Restoration National Restoration Standards. The Restoration and Monitoring Plan will only be implemented following review and acceptance by the DAWE and respective land manager. Reasonable The proposed offset for the Airport West (South) project will maintain or improve the viability of Black-Cockatoos in the local region through the sound allocation of resources in a timely manner.
Suitable offsets must have transparent governance arrangements, including being able to be readily measured, monitoring, audited and enforced.	Implementation of the offset in accordance with a documented agreement with the land manager and a Restoration and Monitoring Plan approved by the DAWE is considered readily measurable, able to be monitored, audited and enforced.

Table 12-11 Offsets Policy Requirements and Proposed Offset for Black-Cockatoo Habitat

12.5 Offset for Wetlands

Offsets for the Resource Enhancement Wetlands are still being developed and will be provided in the final Offset proposal. This will describe how the Habitat Quality Score methodology is applied at both impact and offset sites, followed by application of the Offsets Guide and description of how the proposed offset is consistent with EPBC Offsets Policy.

12.6 Conclusion

The offset for Airport West (South) is being designed to be scientifically robust, transparent and consistent with the EPBC offset policy.

The specific matters of concern in the Airport West (South) project area include the Banksia Woodlands TEC and the three species of Black-Cockatoo. These matters are interdependent, and as such, the Offset Proposal for the Airport West (South) has been designed as summarised in Figure 12-7.

Firstly, the Habitat Quality Score of the impact of the Airport West (South) project to the Banksia Woodlands TEC was calculated. Then the HQS was used in conjunction with the other Offset Guide inputs discussed above to determine an area required of Banksia Woodland restoration to offset the residual impacts to the TEC. This resulted in a Restoration Offset amount of 11 hectares for the residual impact to 6.0 hectares of the TEC.

Then the HQS of the impact to Carnaby's Black-Cockatoo foraging habitat was calculated, and the restoration area of 11 hectares was used, along with the other inputs above, to determine a percentage of impact offset for Carnaby's Black-Cockatoos foraging habitat. As the 11-hectare Restoration Offset will also offset the Black-Cockatoo foraging habitat, that input was used to determine a percentage of impact offset figure of 28.76 percent. This figure was then input into the Offsets Guide to determine the remaining amount required to offset the Carnaby's Black-Cockatoo foraging habitat, giving a figure of 71.68 percent and an area of 52 hectares of Land Purchase Offset required to fulfil 100 percent of the direct offset requirement.

The HQS was calculated for Baudin's and Forest Red-tailed Black-Cockatoos and together with the inputs discussed above, utilised in the Offsets Guide. This resulted in the 65 hectares being sufficient to fulfil 100 percent of the direct offset requirement. Given that Carnaby's Black Cockatoo will forage on the same species as Baudin's and Forrest Red-tailed Black Cockatoo, the 65 hectares will fulfil the offset requirement for all three species.

Therefore, the resulting Offset Proposal for the residual impacts to the Banksia Woodlands TEC and the three Black-Cockatoo species are 11 hectares of Banksia Woodland Restoration and 52 hectares of Land Purchase. Site selection and other considerations will require some adjustment to the Offset Guide inputs which may then result in larger or smaller areas depending on a range of factors. Perth Airport is working in conjunction with DBCA and DAWE. to identify suitable sites for both restoration and purchase.

Offsets for the Resource Enhancement Wetlands are still being developed and will be provided in the final Offset proposal.

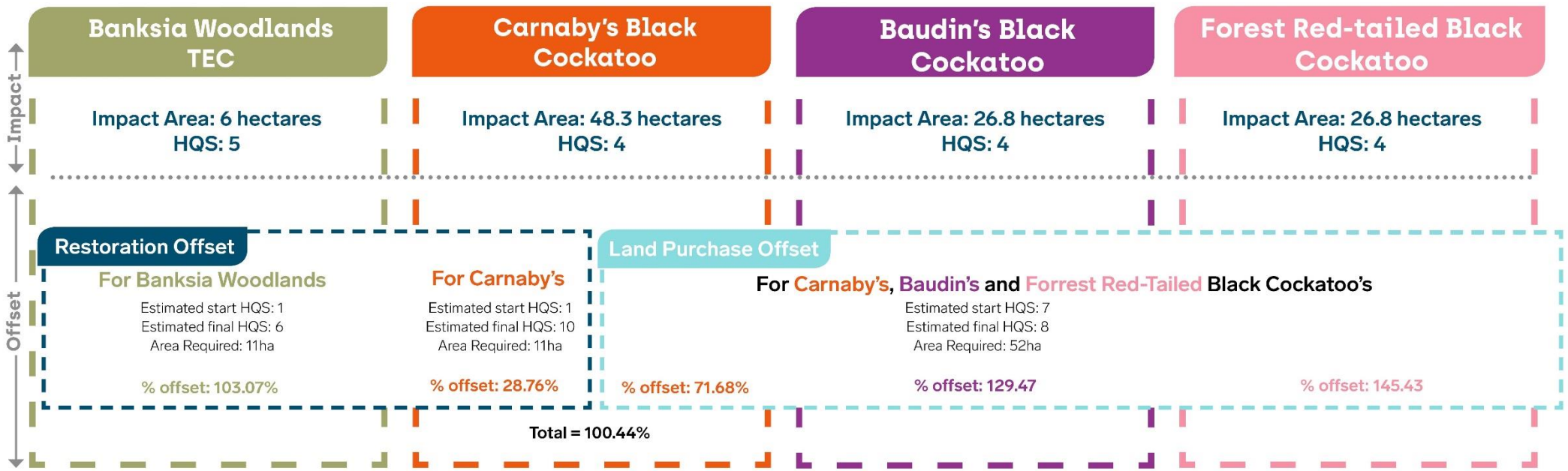

Figure 12-7 Offset Summary (excluding offsets for Resource Enhancement Wetlands)

Source: Perth Airport

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14. Glossary and Acronyms

AEO	Airport Environment Officer
AH Act	*Aboriginal Heritage Act 1972* (WA)
AHIS	Aboriginal Heritage Inquiry System
Airports Act	*Airports Act 1996* (Cth)
APEC	Areas of Potential Environmental Concern
AS	Australian Standard
ASS	Acid Sulphate Soil
ATSIHP Act	*Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth)
BC Act	*Biodiversity Conservation Act 2016* (WA)
BFE	Bamford Consulting Ecologists
CCW	Conservation Category Wetland
CEMP	Construction Management Plan
CHSLMP	Cultural Heritage Site Land Management Plan
CS	Conservation Significance
DAWE	Department of Agriculture, Water and the Environment
DBCA	Department of Biodiversity, Conservation and Attractions
DESEWPaC	Department of Sustainability, Environment, Water, Population and Communities
Dieback	Phytophthora cinnamomi
DoE	Department of Energy
DPC	Department of Premier and Cabinet
DPLH	Department of Planning, Lands and Heritage
DSI	Detailed Site Investigation
DWER	Department of Water and Environmental Regulation
CEMP	Construction Environmental Management Plan
EPA	Environmental Protection Authority
EPBC	Environmental Protection and Biodiversity Conservation
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999* (Cth)
FCT	Floristic Community Type
Guideline 1.1	Significant Impact Guidelines 1.1 - Matters of National Environmental Significance
Guideline 1.2	Significant Impact Guidelines 1.2 - Actions on, or impacting upon, Commonwealth land and Actions by Commonwealth Agencies
Guidelines	Aboriginal Heritage Due Diligence Guidelines
GWSCP	Geomorphic Wetlands of the Swan Coastal Plain
Heritage Act	*Heritage Act 2018* (WA)
HQS	Habitat Quality Score
ICAO	International Civil Aviation Organisation
MDP	Major Development Plan
MNES	Matters of National Environmental Significance
MUW	Multiple Use Wetland
NMD	Northern Main Drain
NRP	New Runway Project
OHP	Other Heritage Places

PAG	Partnership Agreement Group
PAPL	Perth Airport Proprietary Limited
PASS	Potential Acid Sulphate Soil
PFAS	Per and Poly Fluoro Alkyl Substances
PFOS	Per Florooctane Sulphonate
PMA	Perth Metropolitan Area
Qantas	Queensland and Northern Territory Aerial Services Ltd
REW	Resource Enhancement Wetland
SCP	Swan Coastal Plain
Settlement	South West Native Title Settlement
SMD	Southern Main Drain
T1	Terminal 1
T2	Terminal 2
T3	Terminal 3
T4	Terminal 4
TEC	Threatened Ecological Community
VSA	Vegetation and Substrate Associations
WEC	Woodman Environmental Consulting
WELS	Water Efficiency Labelling and Standards

Appendix A: Habitat Quality Score Methodology

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TECHNICAL MEMO

Our Reference: PAIR20-105-03
To: Meethylesh Ramgobin, Perth Airport
Subject: New Runway Project Banksia Woodland Habitat Quality Score
Date: May 2021

1. INTRODUCTION

The purpose of this document is to provide a method for quantifying the Habitat Quality Score (HQS) for the threatened ecological community (TEC) Banksia Woodlands of the Swan Coastal Plain for use in the Commonwealth *Environmental Protection Biodiversity Conservation Acts* offsets calculator for the New Runway Project (NRP).

The Banksia Woodlands TEC was approved for inclusion as an Endangered Threatened Ecological Community under the EPBC Act on 16 September 2016, as per the Approved Conservation Advice (incorporating listing advice) (DEE 2016). The Approved Conservation advice defines offsets as measures that compensate for the residual adverse impacts of an action on the environment and should only be proposed as an attempt to compensate for damage to the ecological community (Banksia Woodlands) that is deemed unavoidable. The offsets guide states that, "the quality score for area of habitat or area of community is a measure of how well a particular site supports a particular threatened species or ecological community and contributes to its ongoing viability."

A method to derive the HQS for the Banksia Woodland TEC for the Site 6 and Living Streams Project was developed by Woodman Environmental Consulting (WEC) in accordance with the Offsets guide, relevant EPBC Act guidelines, the Approved Conservation Advice for the Banksia Woodland TEC, and in consultation with the Department of Water and Environment (DAWE) (then the Department of Environment and Energy, DoEE), and the Department of Biodiversity, Conservation an Attractions (DBCA) (Perth Airport 2019a and b).

The approach to developing the methodology for determining the HQS for the NRP involved reviewing the Banksia Woodland HQS produced for the Site 6 and Living Streams Project to identify where potential improvements could be incorporated in the HQS.

2. NEW RUNWAY PROJECT – BANKSIA WOODLANDS THREATENED ECOLOGICAL COMMUNITY -HABITAT QUALITY SCORE

A key input for the Offsets Guide is the Habitat Quality Score (HQS) for both the impact site and the proposed offsets. The HQS is a measure of how well a particular site supports a specific ecological community or threatened species and contributes to its ongoing viability. The Offsets Guide requires the **habitat quality** to be assessed consistently on both the Impact and Offset Calculators.

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2.1 Habitat Quality Score for the Banksia Woodland TEC

In accordance with the requirements of the Offset Guide, land offsets are assigned in terms of their HQS in supporting and contributing to the ongoing viability of the ecological community to be offset.

The HQS assessment methodology is shown in Figure 1. The Offsets Guide requires the HQS to be calculated using the three components comprising:

1) Site condition is the condition of a site in relation to the ecological requirements of an ecological community or threatened species. This includes considerations such as vegetation condition and structure, the diversity of habitat species present, and the number of relevant habitat features.
2) Site context is the relative importance of a site in terms of its position in the landscape, taking into account the connectivity needs of an ecological community. The includes the proximity of the site in relation to other areas of suitable habitat, the role of the site in relation to the overall population or extent of a species or community.
3) Species stocking rate is the usage and/or density of a species at a particular site. This principle acknowledges that a particular site may have a high value for a particular threatened species, despite appearing to have poor condition and or context. It includes considerations such as survey data for a site and a particular species population or, in the case of a threatened ecological community this may be a number of different populations. It also includes consideration of the role of the site population with regard to the overall species population viability or community extent.

Figure 1: Required components of a Habitat Quality Score

For the Banksia Woodlands TEC, the species stocking rate is excluded as the stocking rate does not apply to ecological communities: The HQS is reduced to the two components of Site Condition and Site Context as shown in Figure 2.

Figure 2: Components of the Banksia Woodland TEC Habitat Quality Score

Each of the two **components** are divided into **sub-components** that contribute to the final HQS. The contributions of two components and sub-components are weighted dependent on the ecological requirements of the Banksia Woodland TEC.

Overall, key considerations in determining the habitat quality of an ecological community include:

- Evaluation of the key ecological attributes of the ecological community (habitat requirements and variability, lifecycle and population dynamics, movement and distribution patterns, and threatening processes); and
- Determination of site characteristics in relation to the ecological community ecology (site condition, site context).

Table 1 shows the proposed scoring methodology applied to the Banksia Woodland TEC for calculating the HQS for the New Runway Project impacts and offsets. As per the Offset Guide, the scoring system addresses the requirement for a HQS ranging from 0 to 10.

Table 1: Habitat Quality Scoring methodology for the Banksia Woodland TEC.

Component	Sub component
Site Condition (70%)	Vegetation Condition (Keighery 1994) -Pristine (100) -Excellent (80) -Very Good (60) -Good (40) -Degraded (20) -Completely Degraded (0)
	Species richness - Average native species richness within top half of recorded range for the TEC (10) - Average native species richness within the bottom half of recorded range for the TEC (0)
	Presence of Threatened taxa -Patch is critical habitat for, and hosts Threatened taxa (10) -Patch is critical habitat for Threatened taxa (5) -Patch is not critical habitat for Threatened taxa (0)
	Contain State listed TEC/PEC -Patch contains WA Floristic Community Type (FCT) listed as State TEC (20) -Patch contains WA Floristic Community Type (FCT) listed as State PEC (10) -Patch does not contain WA Floristic Community Type (FCT) listed as either TEC or PEC (0)
	Presence Dieback -Patch is dieback free (10) -Patch is partly dieback free (5) -Patch is dieback infested (0)
	Condition total (out of 150)
	Condition Score (Condition total / 150 * 70)

Component	Sub component
Site Context (30%)	Connectivity -Patch is continuous with remnant vegetation and forms a corridor that links different landscape units (30) -Patch is continuous with remnant vegetation that forms a medium to large local remnant (20) -Patch is within 1k of other medium to large remnants (10) -Patch is within 12km of other significant remnants and contributes to support of significant avifauna (i.e. known Black Cockatoo Breeding sites are located within 12 km (5) -Patch does not meet any of the above criteria (0)
	Patch Size - >20 ha (50) - 10-20 ha (40) - 5-10 ha (30) - 2-5 ha (20) - Less than 2 ha (10)
	Site Location and Risk -Patch is located in an area where the TEC has been extensively cleared (10)
	Site Location and Risk -Patch is located at the geographical edge of the recorded range (10)
	Context total (out of 100)
	Context score- (Context total / 100 * 30)
Quality total (out of 100)	**Condition Score + Context Score**
Final Patch Habitat Quality Score (out of 10)	**Quality total / 10**
Weighted Patch Score	**Final patch Habitat Quality Score * area of patch (ha)**
Site habitat Quality Score (out of 10)	**All Weighted Patch Scores / total impact area**

Areas of Banksia Woodland TEC within impact and offset sites are assessed in accordance with criteria outlined in the Approved Conservation Advice (incorporating listing advice) (Threatened Species Scientific Committee 2016). For the purposes of this methodology, the Banksia Woodland TEC is categorised into Sites, Patches and Sub-patches (refer to Figure 3):

- "Site" refers to the overall impact or offset area such as the Perth Airport estate.
- "Patch" refers to discrete areas of Banksia Woodland TEC within the Site as defined by the diagnostic criteria within the Approved Conservation Advice (incorporating listing advice) (Threatened Species Scientific Committee 2016).
- "Sub-patch" refers to discrete areas within a patch that differ in vegetation condition score.

Figure 4 presents the methodology for determining the HQS for individual Patches of Banksia Woodland TEC, with the weighted averages of the scores for all Patches used to determine the overall HQS for the Site.

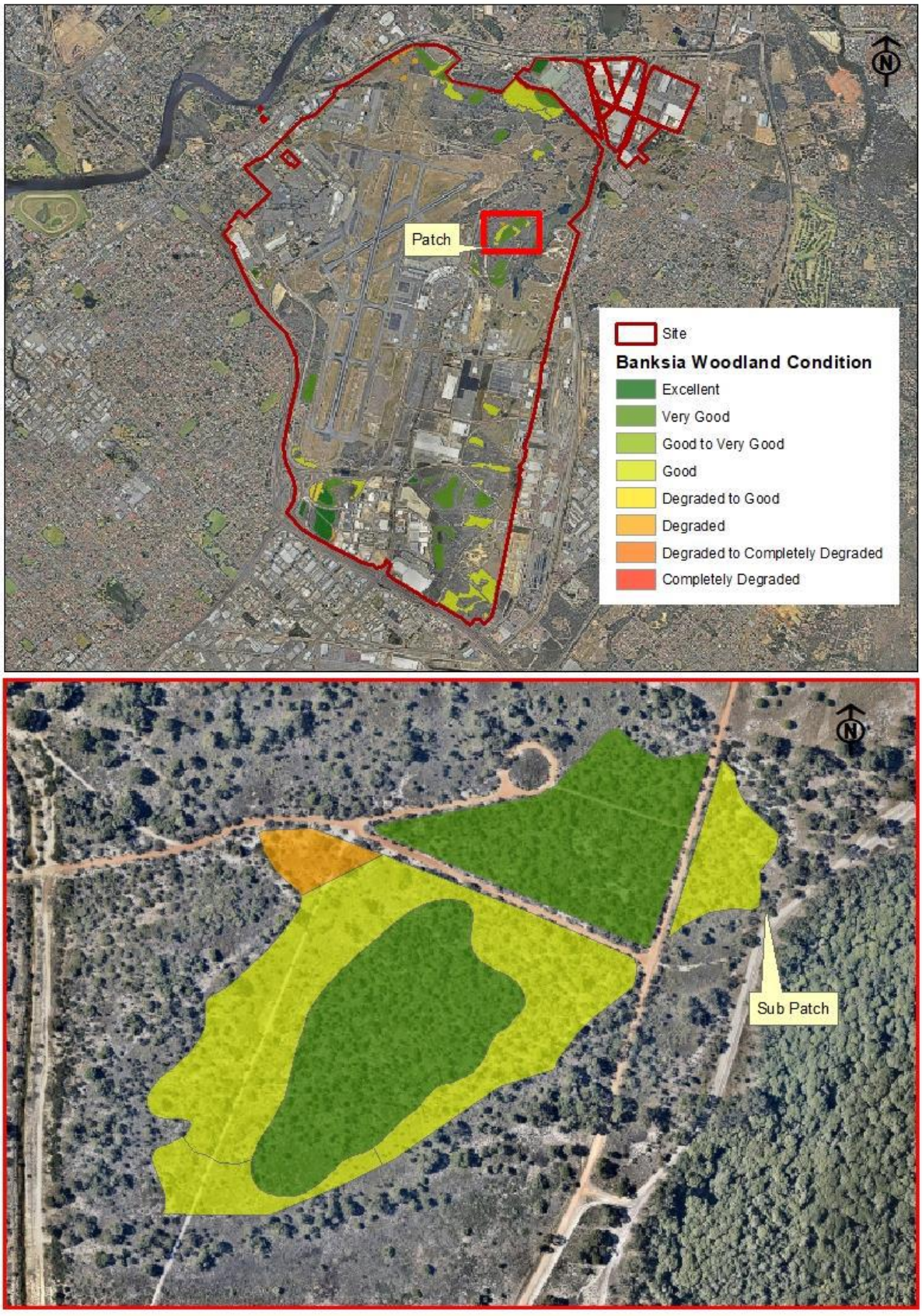

Figure 3: Diagrammatic presentation of Site, Patch and Sub-patch of Banksia Woodland TEC

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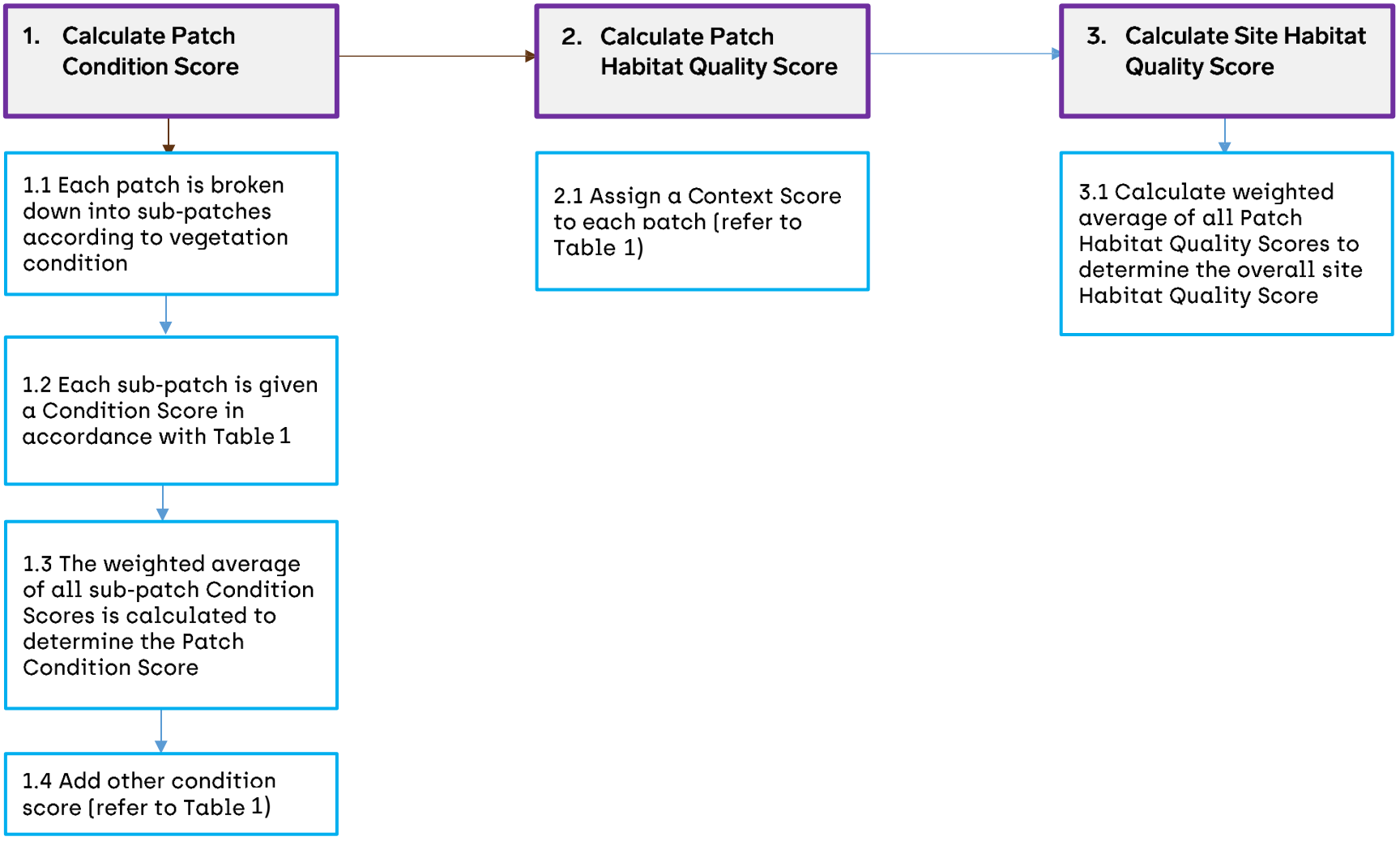

Figure 4: Methodology for determining the HQS for individual Patches of Banksia Woodland TEC

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Scoring system for the assessment of foraging value of vegetation for black-cockatoos.

Revised 5th August 2018 – Bamford Consulting Ecologists

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 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.

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

A Determining a score out of six for the vegetation composition, condition and structure,

B Determining a score out of three for the context of the site, plus

C 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 vegetation composition.

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

A Vegetation composition, condition and structure scoring

DESCRIPTION OF VEGETATION VALUES

SITE SCORE	CARNABY'S BLACK-COCKATOO	BAUDIN'S BLACK-COCKATOO	FOREST RED-TAILED BLACK-COCKATOO
0	No foraging value. No Proteaceae, eucalypts or other potential sources of food. Examples: • Water bodies (e.g. salt lakes, dams, rivers); • Bare ground; • Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits).	No foraging value. No eucalypts or other potential sources of food. Examples: • Water bodies (e.g. dams, rivers); • Bare ground; • Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits).	No foraging value. No eucalypts or other potential sources of food. Examples: • Water bodies (e.g. dams, rivers); • Bare ground; • Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits).
1	Negligible to low foraging value. Examples: • 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 partly vegetated with melons or other known food-source weeds (e.g. *Erodium* 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).	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.	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.
2	Low foraging value. Examples: • 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; • Open eucalypt woodland/mallee of small-fruited species; • Paddocks that are densely vegetated with melons or other known food-source weeds (e.g. *Erodium* spp.) that represent a short-term and/or seasonal food source.	Low foraging value. Examples: • Woodland with scattered specimens of known food plants (e.g. Marri and Jarrah) 1-5% projected foliage cover; • Urban areas with scattered foraging trees.	Low foraging value. Examples: • Woodland with scattered specimens of known food plants (e.g. Marri, Jarrah or Sheoak) 1-5% projected foliage cover; • Urban areas with scattered food plants such as Cape Lilac, *Eucalyptus caesia* and *E. erythrocorys*.

Perth Airport

DESCRIPTION OF VEGETATION VALUES

SITE SCORE	CARNABY'S BLACK-COCKATOO	BAUDIN'S BLACK-COCKATOO	FOREST RED-TAILED BLACK-COCKATOO
3	Low to Moderate foraging value. Examples: • 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; • Eucalypt Woodland/Mallee of small-fruited species; • Eucalypt Woodland with Marri < 10% projected foliage cover.	Low to Moderate foraging value. Examples: • Eucalypt Woodland with known food plants (especially Marri) 5-20% 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).	Low to Moderate foraging value. Examples: • Eucalypt Woodland with known food plants (especially Marri and Jarrah) 5-20% 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).
4	Moderate foraging value. Examples: • Woodland/forest with tree banksias 20-40% projected foliage cover; • Eucalypt Woodland/Forest with Marri 20-40% projected foliage cover.	Moderate foraging value. Examples: • 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. • Eucalypt Woodland/Forest with diverse, healthy understorey and known food trees (especially Marri) 10-20% projected foliage cover. • Orchards with highly desirable food sources (e.g. apples, pears, some stone fruits).	Moderate foraging value. Examples: • 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.
5	Moderate to High foraging value. Examples: • Banksia Forest with 40-60% projected foliage cover; • Banksia Forest with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Pine plantations with trees more than 10 years old.	Moderate to High foraging value. Examples: • 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.	Moderate to High foraging value. Examples: • 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.

DESCRIPTION OF VEGETATION VALUES

SITE SCORE	CARNABY'S BLACK-COCKATOO	BAUDIN'S BLACK-COCKATOO	FOREST RED-TAILED BLACK-COCKATOO
6	High foraging value. Example: • Banksia 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).	High foraging value. Example: • Marri-Jarrah 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).	High foraging value. Example: • Marri-Jarrah 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

The maximum score is given in situations where foraging habitat is supporting breeding birds. It can also be given in fragmented landscapes where there is little foraging habitat remaining and thus what is left has a high contextual value. The site context score is species-specific as it depends upon factors such as the vegetation type and extent, and the presence of breeding birds, and the following table, developed by Bamford consulting in conjunction with DEE, provides a *guide* to the assignation of site context scores (note that 'local area' is defined as within a 15 km radius of the centre point of the study site):

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%	0.1 - 5%
0	< 0.1%	< 0.1%

C Species density

Assignation of the species density score (0 or 1) is based upon the black-cockatoo species being either abundant or not abundant, and is species specific. 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.

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

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 the Environment and Energy (DoEE) 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 DoEE offsets guide but the scoring approach was developed by Bamford Consulting Ecologists.

A A score out of six for the vegetation composition, condition and structure; plus

B A score out of three for the context of the site; plus

C 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 considered. Assigning a score out of 10 represents step D and may require moderation rather than simple addition.

The score out of six for vegetation characteristics and value can be compared across a site, while a score out of 10 is the overall foraging value and is used for the purposes of aiding offset calculations. 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 with a characteristic 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 ($\geq$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

