Kwinana Nickel Refinery

Eucalyptus gomphocephala (Tuart)

TEC Assessment

Memorandum prepared for BHP Nickel West

8 September 2021

1. Introduction and Background

BHP Nickel West (Nickel West) operates the Kwinana Nickel Refinery in Kwinana, approximately 45 kilometres (km) south of Perth, Western Australia (Figure 1). Nickel West proposes to clear up to 10 hectares (ha) of native and remnant vegetation located in the Shires of Rockingham and Kwinana and has applied for a Purpose Permit (CPS 9105 – yet to be approved) with the Department of Water and Environmental Regulation (DWER). This clearing will support maintenance for the infrastructure at Kwinana and Baldivis including the existing pipeline between the two facilities.

Nickel West has previously submitted a Native Vegetation Clearing Permit (NVCP) application for proposed clearing to support the construction of two interconnecting Effluent Storage Ponds. The NVCP (CPS 8462) was granted under section 51E of the *Environmental Protection Act 1986* (EP Act) on 14 June 2019. An extension to the current clearing permit was granted to allow clearing up until July 2023.

The current area proposed for clearing on the CPS 9105 is associated with:

- Threatened Ecological Community (TEC) Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain (SCP) (the Tuart TEC);
- Threatened flora; and
- Known nesting habitat for endangered fauna - black cockatoo.

Following DWER's review of the NVCP application, an assessment for the presence and extent of the Tuart TEC within the application area was requested by DWER for pre-approval of the application CPS 9105. Biologic Environmental Survey Pty Ltd (Biologic) was commissioned by Nickel West to complete two stages of field assessment and associated reporting for separate Survey Areas encompassing the infrastructure corridor and facilities. Stage one assesses the presence and extent of the Tuart TEC and Stage two is a targeted survey for significant flora and black cockatoo habitat (to be completed in spring 2021). This memorandum reports the findings from Stage one, the field assessment for Tuart TEC of 70 ha of remnant bushland. This includes the traverse of Tuart TEC Survey Area and vicinity to assess for species and composition, and the presence or absence of the Tuart TEC.

For this memorandum, the proposed clearing area associated with the Purpose Permit CPS 9105 will be referred to as the Survey Area. The area surveyed was greater than this to explore potential remnant patches of vegetation that intersect the Survey Area. These have been outlined in Section 2 and Figure 1 and are referred to collectively as the Survey Area or individually by their patch number.

2. Methods

Database Searches

Prior to the field survey Biologic undertook a database and desktop search to identify the presence of the Tuart TEC on the Swan Coastal Plain, and in close proximity to the Survey Area to determine the key characteristics that define the TEC. The databases that were searched included:

- DBCA (2021) Threatened and Priority Ecological Communities Database; and
- Department of Agriculture, Water and Environment (DAWE, 2021) Protected Matters Search.

In addition to the database searches, the project and field team reviewed the conservation advice released by DAWE (formerly the Department of the Environment and Energy; DoEE (2019)) and the Threatened Species Scientific Committee (TSSC, 2019) in relation to determining the key diagnostic criteria for the presence of a Tuart TEC.

Field Survey

Prior to mobilisation, using aerial imagery the Survey Area was broken down into six potential patches of Tuart Woodland to assess for the presence of the Tuart TEC (Figure 1). The Survey was conducted over four person days from the 27-28th of July by a team consisting of one senior botanist and one graduate botanist.

Five quadrats and six relevé sample sites (Figure 2) were sampled to assess the vegetation characteristics and values. Supplementary collections of flora and vegetation compositions were opportunistically recorded where there was the potential to indicate the presence of the Tuart TEC. The field survey comprised of meandering traverses through the Survey Area, concentrating in areas with tuart (*Eucalyptus gomphocephala*) trees present, and the areas directly adjacent to the Survey Area to assess for the presence/ absence and extent of the Tuart TEC. Comprehensive site data is provided separately in the Index of Biodiversity Surveys for Assessment (IBSA) data format.

Tuart TEC

Each TEC has defining characteristics to assess for representations of that unique community as defined by the DoEE (2019) and TSSC (2019). Table 1 outlines the defining characteristics used to assess for the Tuart TEC (TSSC, 2019). The occurrence of the Tuart TEC was identified from the database searches within 10 km of the Survey Area. The Tuart TEC is listed as critically endangered at a federal level and a priority 3 at a state level. The TEC at the federal level also incorporates several TECs and Priority Ecological Communities (PECs) at the state level, including the PEC SCP25 (Southern Swan Coastal Plain *Eucalyptus gomphocephala* - *Agonis flexuosa* woodlands). This community is under threat from vegetation clearing and is significant as these woodlands and forests provide vital habitat for unique plants and animals (DoEE, 2019) including threatened species such as Carnaby's Cockatoos and Western Ringtail Possums.

Table 1: Tuart TEC requirements and criteria

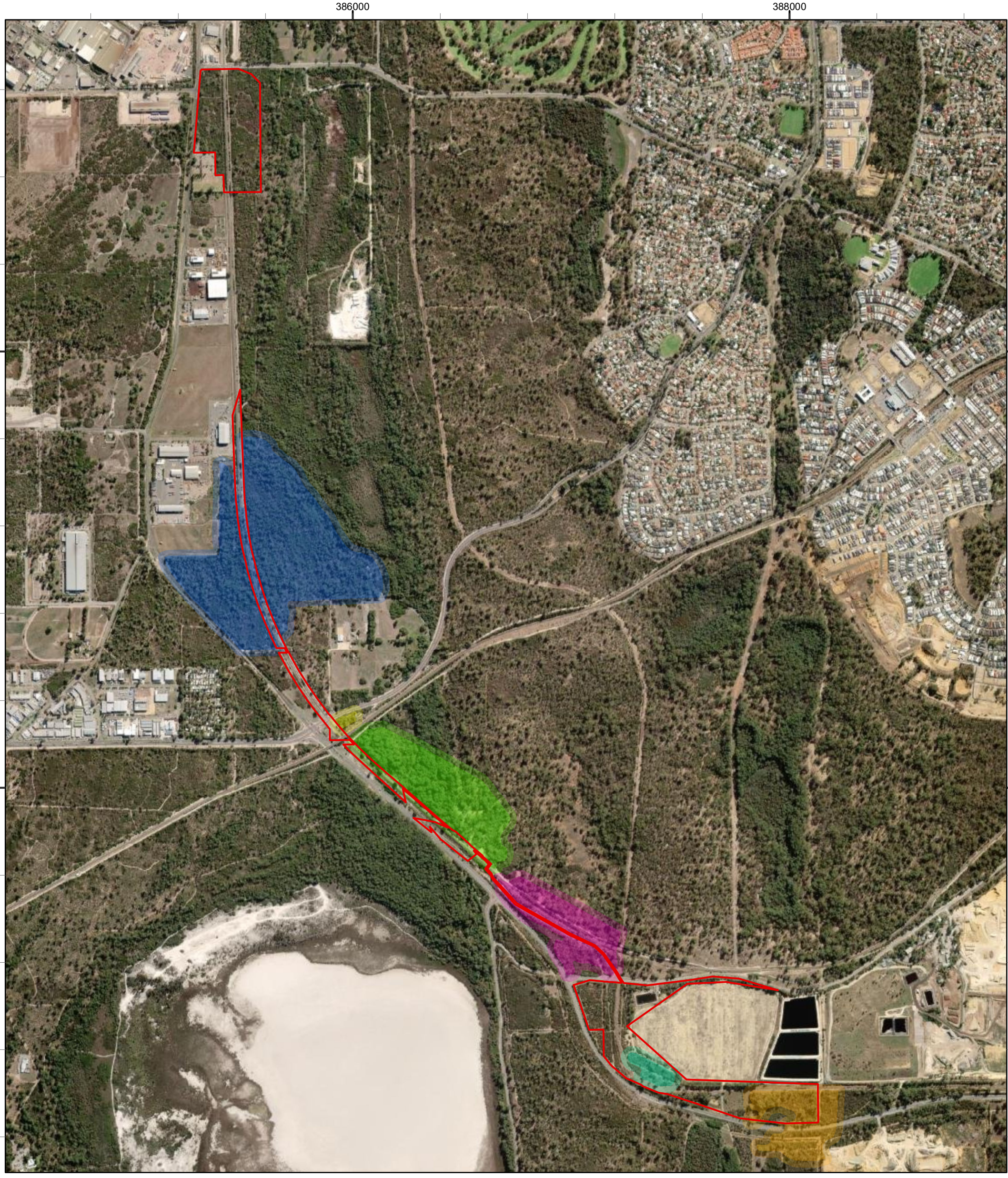
Criteria	Definition
Step One – Initial Diagnostic Characteristics	
Location & Physical Environment	Swan Coastal Plain (SCP) bioregion
Soils and Landform	Spearwood and Quindalup dunes systems (but also Bassendean dunes and Pinjarra Plain and banks of rivers and wetlands).
Composition	The presence of at least two living established *Eucalyptus gomphocephala* (tuart) trees in the uppermost canopy layer. There is a gap of no more than 60 m between the outer edges of the canopies of adjacent tuart trees, occurring as single stemmed trees or as a mallee growth form.
Structure – Woodland	Usually woodland but can be forest, open forest, woodland, open woodland, and various mallee forms.
Structure – Associated Species	Other tree species may be present in the canopy or sub-canopy. They commonly include *Agonis flexuosa*, *Banksia grandis*, *B. attenuata, Eucalyptus marginata*, *Corymbia calophylla*, *B. menziesii* and *B. prionotes.*
Structure – Understory	An understorey of native plants is typically present, which may include grasses, herbs and shrubs, although this is often modified by disturbance.
Step Two	
Minimum size	If the patch is smaller than 0.5 ha it is not part of the nationally protected ecological community. If the patch is at least 0.5 ha and up to 5 ha in size, conduct on ground surveys (criterion below).
Condition – Biotic thresholds for patches ≥0.5 ha <2 ha	**Forming Part of the PEC:** Very high condition ≥80 % of all understorey vegetation cover is native **or** at least 12 native understorey species per 0.01 ha. High condition ≥60 % of all understorey vegetation cover is native **or a**t least 8 native understorey species per 0.01 ha. **AND** That have: • an important landscape role (≤100 m to native vegetation) **or** • have a habitat role (≥2 very large trees per 0.5 ha) **or** • show regeneration (≥15 seedlings and/or saplings per 0.5 ha). **Not Forming Part of the PEC:** Moderate condition ≥50 % of all understorey vegetation cover is native **or** At least 4 native understorey species per 0.01 ha. Poor condition Less than 50 % of all understorey vegetation cover is native and less than 4 native understorey species per 0.01 ha.
Already part of the PEC, or related to any other Swan Coastal Plain TEC/PECs	The TEC intergrades and/or interacts with other ecological communities of the Swan Coastal Plain, such as: • Banksia woodlands of the SCP • Sedgelands in Holocene Dune Swales • Aquatic root mat community of caves of the SCP.
Buffer zone – does it surround or adjoin native vegetation	Surrounding or adjoining native vegetation.
Is it a revegetation area	Revegetated sites that meet the key diagnostics and minimum condition thresholds are considered part of the Tuart TEC. Sites outside of the described natural range of Tuart Woodlands and Forests are not part of the TEC.
Is it a garden	Gardens that meet the key diagnostics and minimum condition thresholds are not considered part of the Tuart TEC.

386000

388000

6430000

6428000



Legend

Survey Area

Tuart Patch with 30 m Buffer

Patch ID

1

2

3

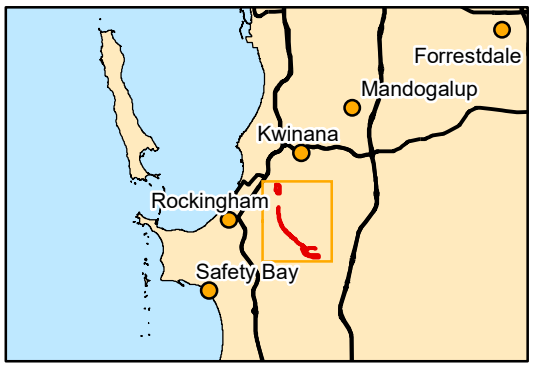
4

5

6

0 250 500 750 Meters

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 07/09/2021



N

biologic Environmental Survey

Scale: 1:16,500

BHP NICKEL WEST
NiW Tuart TEC Assessment Kwinana

Figure 2: Survey Area and potential TEC Patches

385500

386000

6429500

6429500

KTT-07

KTT-09

KTT-08

6429000

6429000

KTT-10

6428500

6428500

Legend

Survey Area

Sample Site

Quadrat

Relevé

Traverse

Tuart Patch with 30 m Buffer

Patch ID

1

2

3

4

5

6

0 50 100 150 200 Meters

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 07/09/2021

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biologic Environmental Survey

Scale: 1:4,100

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Figure 2a: Survey effort and sample sites

386000
386500
6428500
6428000
6427500
KTT-06
KTT-05
KTT-04

Legend

Survey Area

Sample Site

Quadrat

Relevé

Traverse

Tuart Patch with 30 m Buffer

Patch ID

1

2

3

4

5

6

0 50 100 150 Meters

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 07/09/2021

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Scale: 1:3,400

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Figure 2b: Survey effort and sample sites

387000

6427500

6427000

KTT-04

KTT-11

Legend

Survey Area

Sample Site

Quadrat

Relevé

Traverse

Tuart Patch with 30 m Buffer

Patch ID

1

2

3

4

5

6

0 50 100 Meters

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 07/09/2021

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Scale: 1:2,300

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Figure 2c: Survey effort and sample sites

387500

388000

6427000

6426500

6426000

KTT-01

KTT-03

KTT-02

Legend

Survey Area

Sample Site

Quadrat

Relevé

Traverse

Tuart Patch with 30 m Buffer

Patch ID

1

2

3

4

5

6

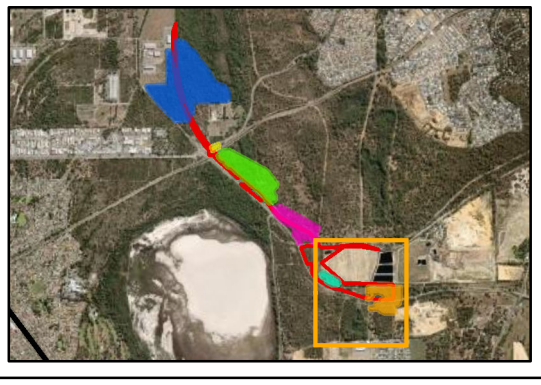
0 50 100 150 200 Meters

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 07/09/2021

N

biologic Environmental Survey

Scale: 1:4,000



BHP NICKEL WEST

NiW Tuart TEC Assessment Kwinana

Figure 2d: Survey effort and sample sites

3. Results

Six potential Tuart TEC patches were identified as intersecting the Survey Area prior to mobilisation. These patches were ground-truthed during the field survey and assessed with the diagnostic characteristics for potential to represent the Tuart TEC (Table 1). A summary of the results is provided at Table 2, the full assessment for each patch is detailed in Appendix A with representative photos presented in Appendix B. All patches intersected the Survey Area, with the Survey Area intersection detailed in Figure 2. It is important to note that the boundaries of the patches in Figure 1 and Figure 2 are mapped to the area surveyed during the field visit and do have the potential to extend out past these mapped boundaries. Four potential patches met the initial diagnostic characteristics (Table 1) at step one, they were:

- Patch 1;
- Patch 3;
- Patch 4; and
- Patch 6.

These patches all met the following criteria:

- Occurring on the Swan Coastal Plain;
- Occurring on the Quindalup dune system;
- Presence of two or more alive tuart trees in the upper most canopy;
- Patches of vegetation supporting a low open woodland to low woodland of tuart trees; and
- Native understorey flora present (although in limited density and diversity).

These patches also met the condition thresholds and categories described in step two:

- The size of the patches is greater than 0.5 hectares (ha), but less than 5 ha; and
- Having a high condition rating.

Patch 2 and Patch 5 although meeting the initial diagnostic characteristics in step one of the assessment did not meet the criteria in step two. This was due to the patches size, condition, and the limited native understorey present (Table 2) (Appendix A). Patch 2, although in good condition and with a Moderate understorey condition, is less than 0.5 ha and does not form a continuous patch with surrounding vegetation (separated by 75 m from nearest patch), while patch 5 is 1.6 ha it contained less than four native understorey species (moderate condition) and less than 50 % understorey cover.

Table 2: Summary of patch criteria assessment

Criteria	Patch 1	Patch 2	Patch 3	Patch 4	Patch 5	Patch 6
Step 1 – Diagnostic Characteristics						
Location & Physical Environment	Yes	Yes	Yes	Yes	Yes	Yes
Soils and Landform	Yes	Yes	Yes	Yes	Yes	Yes
Composition	Yes	Yes	Yes	Yes	Yes	Yes
Structure – Woodland	Yes	Possible	Yes	Yes	Possible	Yes

Criteria	Patch 1	Patch 2	Patch 3	Patch 4	Patch 5	Patch 6
Structure – Associated Species	No	Yes	No	No	No	No
Structure – Understory	Yes	Yes	Yes	Yes	Yes	Yes
Step 2 – Condition thresholds and categories						
Minimum size	Yes	No	Yes	Yes	Yes	Yes
Condition	High	Moderate	High	High	Moderate	High
Already part of the PEC	Yes	No	Yes	Yes	No	Yes
Related to any other TEC/PECs	No	No	No	No	No	No
Buffer zone – does it surround or adjoin native vegetation	No, but still meets criteria	No	No, but still meets criteria	No, but still meets criteria	No	No, but still meets criteria
Is it a revegetation area	N/A					
Is it a garden	N/A					
Conclusion						
Does this patch meet the criteria for inclusion as the TEC?	Yes	No	Yes	Yes	No	Yes

In step 1 of Table 2, one of the diagnostic characteristics of a Tuart TEC is the presence of key associated species. These species are significant indicators of the presence of a Tuart TEC and are often seen within the TEC. Table 3 presents these species, however only Patch 2 contained one of these species, the rest of the patches did not. Although only one patch contained one of these species, Patch 3 and Patch 6 did contain *Banksia sessilis* (Appendix C), however this is not a key associated species. All the flora species found during the field survey are in Appendix D.

Table 3: Presence of key associated species within patches

Species	Patch 1	Patch 2	Patch 3	Patch 4	Patch 5	Patch 6
Agonis flexuosa	None located					
Banksia grandis	None located					
Banksia attenuata	None located					
Banksia menziessii	None located					
Banksia prionotes	None located					
Corymbia calophylla	None located	Yes	None located			
Eucalyptus marginata	None located					

The overall vegetation condition of these patches ranged from very good to degraded with all patches containing a mixture of native species and introduced grasses and herbs, located predominantly in disturbed areas along roads, cleared vegetation and boundary lines. In relation to the patch criteria (Table 2), all the patches that were determined to be a part of the Tuart TEC were assessed as being in High condition (≥60 % of all understorey vegetation cover is native and at least eight native understorey species per 0.01 ha), while Patch 2 and Patch 5 which are not considered to represent a Tuart TEC, were rated as being in Moderate condition (≥50 % of all understorey vegetation cover is native **or** At least four native understorey species per 0.01 ha).

4. Discussion

Patch 1 is the largest of the four patches representing the Tuart TEC (46.1 ha) and was in good condition containing woodlands/forests of mature *Eucalyptus gomphocephala* trees. This patch forms a continuous patch that extends into adjacent vegetation and contained a diverse understory of greater than eight native flora taxa. Some of these taxa include *Acacia cyclops, Xanthorrhoea preissii, Melaleuca raphiophylla, Spyridium globulosum, Hardenbergia comptoniana, Templetonia retusa* and *Gahnia trifida* over introduced grasses and herbs. The biotic threshold for Patch 1 is High condition with ≥60 % of all understorey vegetation cover is native with at least eight native understorey species per 0.01 ha (or 10 m × 10 m quadrat). Although this patch meets the criteria for it to be considered a TEC, due to its large size (>5 ha) it is automatically considered as part of the Tuart TEC, regardless of its understory condition, due to Patch 1 meeting the key diagnostic characteristics and patch definitions.

Patch 3 (17.5 ha), Patch 4 (10.8 ha) and Patch 6 (9 ha) are all considered as part of the TEC due to their size (i.e. greater than 5 ha). All these patches form a continuous patch that extends into adjacent vegetation and contained a diverse understory of greater than eight native flora taxa. Like Patch 1, these patches were graded as being in High condition (with ≥60 % of all understorey vegetation cover is native with at least eight native understorey species per 0.01 ha) and due to their large size (>5 ha) they are automatically considered as part of the Tuart TEC, regardless of its understory condition, due to these three patches meeting the key diagnostic characteristics and patch definitions.

Patch 2 is the smallest of the six patches at 0.4 ha, followed by Patch 5 at 1.6 ha. These two patches of vegetation are both considered to not be part of the TEC, but for differing reasons. Patch 2 is not considered as part of the TEC due to the size of the patch being less than 0.5 ha, which automatically excludes this patch as a TEC according to the criteria (TSSC, 2019). Patch 5 met the minimum patch size requirements of the TEC and contained large trees significant for habitat, however the sparse native understorey and subsequent biotic threshold grading of Moderate condition (≥50 % of all understorey vegetation cover is native or at least four native understorey species per 0.01 ha) precludes it from being representative of the TEC.

It is important to note that the patches mapped for the field survey and used for the TEC assessment were mapped to the area surveyed during the field visit and do have the potential to extend out past these mapped boundaries. This is particularly in relation to patches 1, 3, 4 and 6, and not in relation to patches 2 and 5 as these two patches were isolated and did not form a continuous patch with surrounding vegetation.

5. Conclusion

Four out of the six patches assessed as representative of the Tuart TEC assessment met the criteria for acceptance as the "Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain" TEC. They are:

- Patch 1;
- Patch 3;
- Patch 4; and
- Patch 6.

Two patches, Patch 2 and Patch 5, did not meet the criteria for acceptance as the "Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain" TEC, however these two patches still retain many of the significant values outlined in the federal conservation advice. Therefore, these patches are considered to hold a level of local significance and play a role as a refuge and contain large habitat trees, significant to local fauna.

6. References

DAWE, Department of Agriculture, Water and the Environment. (2021). Protected Matters Search Tool (custom search). from DAWE, Department of Agriculture, Water and the Environment www.environment.gov.au/erin/ert/epbc/index.html

DBCA. (2021). Threatened and Priority Ecological Communities Database (custom search). from Department of Biodiversity, Conservation and Attractions http://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-animals

DoEE. (2019). *Approved Conservation Advice (incorporating listing advice) for the Tuart (Eucalyptus gomphocephala) woodlands and forests of the Swan Coastal Plain ecological community. Canberra: Department of the Environment and Energy. Available from: http://www.environment.gov.au/biodiversity/threatened/communities/pubs/153-conservation-advice.pdf. In effect under the EPBC Act from 04-Jul-2019*. Department of the Environment and Energy,

TSSC, Threatened Species Scientific Committee. (2019). *Approved Conservation Advice (incorporating listing advice) for the Tuart (Eucalyptus gomphocephala) woodlands and forests of the Swan Coastal Plain ecological community*. Canberra: TSSC,, Threatened Species Scientific Committee.

Appendix A: Detailed Patch Criteria Assessment

Key Diagnostic Characteristic/ Threshold		Does it meet the criteria?		
		Patch 1	Patch 2	Patch 3
Step 1 – Diagnostic characteristics				
Location and physical environment	Swan Coastal Plain bioregion	Yes, all patches included in the assessment were within the Swan Coastal Plain bioregion.		
Soils and landform	Spearwood and Quindalup dunes systems (but also Bassendean dunes and Pinjarra Plain and banks of rivers and wetlands).	Yes, all patches in the assessment were in the Quindalup dune system.		
Composition	The presence of at least two living established *Eucalyptus gomphocephala* (tuart) trees in the uppermost canopy layer, although they may co-occur with trees of other species. There is a gap of no more than 60 m between the outer edges of the canopies of adjacent tuart trees. The tuart trees may occur either as single stemmed trees or as a mallee growth form.	Yes Multiple Tuart trees present with canopy gap of <60 m.	Yes Multiple Tuart trees within the patch with canopy gap <60 m.	Yes Multiple Tuart trees within the patch with canopy gap <60 m.
Structure	Usually woodland but can be forest, open forest, woodland, open woodland, and various mallee forms.	Yes Tuart trees in open woodland vegetation.	Possible Scattered tuart trees.	Yes Tuart trees in open woodland vegetation.
	Other tree species may be present in the canopy or sub-canopy. They commonly include *Agonis flexuosa*, *Banksia grandis*, *B. attenuata, Eucalyptus marginata*, *Corymbia calophylla*, *B. menziesii* and *B. prionotes.*	No Next dominant species are *Acacia cyclops, Xanthorrhoea preissii, Melaleuca raphiophylla* and *Spyridium globulosum* canopy over *Hardenbergia comptoniana, Templetonia retusa* and *Gahnia trifida* over introduced grasses and herbs.	Yes *Corymbia calophylla* was recorded. Next dominant species are *Acacia cyclops, Acacia saligna, Melaleuca raphiophylla* and *Spyridium globulosum* canopy over *Hardenbergia comptoniana* and *Gahnia trifida* over introduced grasses and herbs.	No Next dominant species are *Acacia cyclops, Banksia sessilis, Macrozamia riedlei* canopy over *Hardenbergia comptoniana* and *Rhagodia baccata* over introduced grasses and herbs.

Key Diagnostic Characteristic/ Threshold		Does it meet the criteria?		
		Patch 1	**Patch 2**	**Patch 3**
	An understorey of native plants is typically present, which may include grasses, herbs and shrubs, although this is often modified by disturbance.	Yes Vegetation was in relatively good condition with native vegetation mixed with some introduced grasses and herbs.	Yes Vegetation was in relatively good condition with native vegetation mixed with some introduced grasses and herbs.	Yes Vegetation was in relatively good condition with native vegetation mixed with some introduced grasses and herbs.

Key Diagnostic Characteristic/ Threshold		Does it meet the criteria?		
		Patch 1	Patch 2	Patch 3
Step 2 – Condition thresholds and categories				
Indicative condition measures/thresholds	If the patch is smaller than 0.5 ha it is not part of the nationally protected ecological community. If the patch is at least 0.5 ha and up to 5 ha in size, conduct on ground surveys. **Biotic thresholds for patches ≥0.5 ha <2 ha:** **Very high condition** ≥80 % of all understorey vegetation cover is native **or** at least 12 native understorey species per 0.01 ha (10m x 10m plot or equivalent). Part of the protected ecological community. **High condition** ≥60 % of all understorey vegetation cover is native **or a**t least 8 native understorey species per 0.01 ha. **AND** That have: an important landscape role (≤100 m to native vegetation) **or** have a habitat role (≥2 very large trees per 0.5 ha) **or** show regeneration (≥15 seedlings and/or saplings per 0.5 ha). Part of the protected ecological community. **Moderate condition** ≥50 % of all understorey vegetation cover is native **or** At least 4 native understorey species per 0.01 ha. Not part of the protected ecological community (but may be a focus for local protection or restoration) **Poor condition** Less than 50 % of all understorey vegetation cover is native# and less than 4 native understorey species per 0.01 ha. Not part of the protected ecological community (but may be a focus for local protection or restoration)	Patch is 46.1 ha, excluding the buffer zone. All patches that are >5 ha are part of the nationally protected ecological community, regardless of their understory condition. **Part of the protected ecological community**	Patch is 0.42 ha, excluding the buffer zone. Patch does not meet the minimum size requirements of the protected ecological community. **Not part of the protected ecological community** But still has regional and local significance.	Patch is 17.5 ha, excluding the buffer zone. All patches that are >5 ha are part of the nationally protected ecological community, regardless of their understory condition. **Part of the protected ecological community**

Key Diagnostic Characteristic/ Threshold		Does it meet the criteria?		
		Patch 1	Patch 2	Patch 3
Relevant further considerations				
Relationship with Other Ecological Communities:	The TEC intergrades and/or interacts with other ecological communities of the Swan Coastal Plain, including some listed under the EPBC Act. Most of these are distinct from Tuart Woodlands and Forests, but several have similar characteristics in some occurrences. The TEC intergrades and/or interacts with: • Banksia woodlands of the SCP • Sedgelands in Holocene Dune Swales • Aquatic root mat community of caves of the SCP. Contextual factors including disturbance histories (including fire, flooding and grazing), recent rainfall and drought conditions should all be taken into account when identifying areas that are part of the TEC, taking into account that these factors may sometimes temporarily mask good condition states.	Although some *Banksia* species were found such as *Banksia sessilis*, the patches did not contain any *Banksia* species that are significant to another TEC or PEC. None of the Survey Area met the criteria and had no characteristics of any other ecological communities of the Swan Coastal Plain.		
Buffer zone	Surrounding or adjoining native vegetation	To calculate patch size, 30 m buffer zones were used, but these did include roads and paddocked areas surrounding the patches. The patches themselves (excluding Patch 2) however still met the size criteria without the buffers.		
Revegetated Areas	Revegetated sites that meet the key diagnostics and minimum condition thresholds are considered part of the Tuart TEC. Sites outside of the described natural range of Tuart Woodlands and Forests are not part of the TEC.	NA	NA	NA
Gardens	Gardens that meet the key diagnostics and minimum condition thresholds are not considered part of the Tuart TEC.	NA	NA	NA
Do patches meet criteria for inclusion as TEC?		**Yes**	**No**	**Yes**

Key Diagnostic Characteristic/ Threshold		Does it meet the criteria?		
		Patch 4	Patch 5	Patch 6
Step 1 – Diagnostic characteristics				
Location and physical environment	Swan Coastal Plain bioregion	Yes, all patches included in the assessment were within the Swan Coastal Plain bioregion.		
Soils and landform	Spearwood and Quindalup dunes systems (but also Bassendean dunes and Pinjarra Plain and banks of rivers and wetlands).	Yes, all patches in the assessment were in the Quindalup dune system.		
Composition	The presence of at least two living established *Eucalyptus gomphocephala* (tuart) trees in the uppermost canopy layer, although they may co-occur with trees of other species. There is a gap of no more than 60 m between the outer edges of the canopies of adjacent tuart trees. The tuart trees may occur either as single stemmed trees or as a mallee growth form.	Yes Multiple Tuart trees present with canopy gap of <60 m.	Yes Multiple Tuart trees within the patch with canopy gap <60 m.	Yes Multiple Tuart trees within the patch with canopy gap <60 m.
Structure	Usually woodland but can be forest, open forest, woodland, open woodland, and various mallee forms.	Yes Tuart trees in open woodland vegetation.	Possible Scattered tuart trees.	Yes Tuart trees in open woodland vegetation.
	Other tree species may be present in the canopy or sub-canopy. They commonly include *Agonis flexuosa*, *Banksia grandis*, *B. attenuata, Eucalyptus marginata*, *Corymbia calophylla*, *B. menziesii* and *B. prionotes.*	No Contains woodlands of *Eucalyptus gomphocephala* over introduced grasses and herbs.	No Contains woodlands of *Eucalyptus gomphocephala* over introduced grasses and herbs.	No Contains woodlands of *Eucalyptus gomphocephala* over *Hardenbergia comptoniana, Spyridium globulosum, Banksia sessilis* over introduced grasses and herbs.

Key Diagnostic Characteristic/ Threshold		Does it meet the criteria?		
		Patch 4	Patch 5	Patch 6
	An understorey of native plants is typically present, which may include grasses, herbs and shrubs, although this is often modified by disturbance.	Yes Vegetation was in relatively good condition with native vegetation mixed with some introduced grasses and herbs.	Yes Vegetation was in relatively good condition with native vegetation mixed with some introduced grasses and herbs.	Yes Vegetation was in relatively good condition with native vegetation mixed with some introduced grasses and herbs.

Key Diagnostic Characteristic/ Threshold		Does it meet the criteria?		
		Patch 4	Patch 5	Patch 6
Step 2 – Condition thresholds and categories				
Indicative condition measures/thresholds	If the patch is smaller than 0.5 ha it is not part of the nationally protected ecological community. If the patch is at least 0.5 ha and up to 5 ha in size, conduct on ground surveys. **Biotic thresholds for patches ≥0.5 ha <2 ha:** **Very high condition** ≥80 % of all understorey vegetation cover is native **or** at least 12 native understorey species per 0.01 ha (10m x 10m plot or equivalent). Part of the protected ecological community. **High condition** ≥60 % of all understorey vegetation cover is native **or a**t least 8 native understorey species per 0.01 ha. **AND** That have: an important landscape role (≤100 m to native vegetation) **or** have a habitat role (≥2 very large trees per 0.5 ha) **or** show regeneration (≥15 seedlings and/or saplings per 0.5 ha). Part of the protected ecological community. **Moderate condition** ≥50 % of all understorey vegetation cover is native **or** At least 4 native understorey species per 0.01 ha. Not part of the protected ecological community (but may be a focus for local protection or restoration) **Poor condition** Less than 50 % of all understorey vegetation cover is native# and less than 4 native understorey species per 0.01 ha. Not part of the protected ecological community (but may be a focus for local protection or restoration)	Patch is 10.8 ha, excluding the buffer zone. All patches that are >5ha are part of the nationally protected ecological community, regardless of their understory condition. **Part of the protected ecological community**	Patch is 1.6 ha, excluding the buffer zone. The patch is in **Moderate Condition** with less than four native understory species per 0.01 ha and less than 50% understory cover. **Not part of the protected ecological community** But still has regional and local significance.	Patch is 9 ha, excluding the buffer zone. All patches that are >5ha are part of the nationally protected ecological community, regardless of their understory condition. **Part of the protected ecological community**

Key Diagnostic Characteristic/ Threshold		Does it meet the criteria?		
		Patch 4	Patch 5	Patch 6
Relevant further considerations				
Relationship with Other Ecological Communities:	The TEC intergrades and/or interacts with other ecological communities of the Swan Coastal Plain, including some listed under the EPBC Act. Most of these are distinct from Tuart Woodlands and Forests, but several have similar characteristics in some occurrences. The TEC intergrades and/or interacts with: • Banksia woodlands of the SCP • Sedgelands in Holocene Dune Swales • Aquatic root mat community of caves of the SCP Contextual factors including disturbance histories (including fire, flooding and grazing), recent rainfall and drought conditions should all be taken into account when identifying areas that are part of the TEC, taking into account that these factors may sometimes temporarily mask good condition states.	Although some *Banksia* species were found such as *Banksia sessilis*, the patches did not contain any *Banksia* species that are significant to another TEC or PEC. None of the Survey Area met the criteria and had no characteristics of any other ecological communities of the Swan Coastal Plain.		
Buffer zone	Surrounding or adjoining native vegetation	To calculate patch size, 30 m buffer zones were used, but these did include roads and paddocked areas surrounding the patches. The patches themselves however still met the size criteria without the buffers.		
Revegetated Areas	Revegetated sites that meet the key diagnostics and minimum condition thresholds are considered part of the Tuart TEC. Sites outside of the described natural range of Tuart Woodlands and Forests are not part of the TEC.	NA	NA	NA
Gardens	Gardens that meet the key diagnostics and minimum condition thresholds are not considered part of the Tuart TEC.	NA	NA	NA
Do patches meet criteria for inclusion as TEC?		**Yes**	**No**	**Yes**

Appendix B: Patch photos

Representative Photos from Patch 1

Representative Photos from Patch 2

Representative Photos from Patch 3

Representative Photos from Patch 4

Representative Photos from Patch 5	
	
Representative Photos from Patch 6	
	

Appendix C: Quadrat and Releve Data

Site KTT-01

Date: 27/07/2021
Described by: S. Coultas & K. Geelhoed
Type: Releve
Location: -32.2883 115.8028
Veg Condition: Degraded
Soil: Sandy Loam
Landform: Sand Dune
Vegetation: Mid *Eucalyptus gomphocephala* woodland over tall open *Acacia Cyclops* shrubland over tall Eragrostis curvula tussock grassland.

Species List

Name	% Cover	Height (m)	Specimen No.	Notes
Xanthorrhoea gracilis				
Asparagus asparagoides				
Ursinia anthemoides				
Gomphocarpus fruticosus				
Pelargonium capitatum				

Site KTT-02

Date: 27/07/2021
Described by: S. Coultas & K Geelhoed
Type: Releve
Location: -32.2924 115.8117
Veg Condition: Good
Soil: Sandy Loam
Landform: Sand dune
Vegetation: *Eucalyptus gomphocephala* mid forest over tall open *Acacia Cyclops, Banksia sessilis* and *Acacia saligna* shrubland over *Ehrharta calycina* and *Eragrostis curvula* tussock grassland.

Species List

Name	% Cover	Height (m)	Specimen No.	Notes
Hardenbergia comptoniana				
Asparagus asparagoides				
Conostylis setigera subsp. *setigera*				
Spyridium globulosum				
Clematis linearifolia				
Macrozamia fraseri				

Site KTT-03

Date: 27/07/2021
Described by: S. Coultas & K Geelhoed
Type: Quadrat 10 x 10m
Location: -32.2922 115.8096
Veg Condition: Degraded
Soil: Sandy Loam
Landform: Sand dune
Vegetation: *Eucalyptus gomphocephala* mid forest over tall sparse *Banksia sessilis* shrubland over *mid Ehrharta calycina* tussock grassland

Species List

Name	% Cover	Height (m)	Specimen No.	Notes
Eucalyptus gomphocephala	60	14		
Banksia sessilis var. *sessilis*	4	4		
Rhagodia preissii subsp. *preissii*	1	0.5		
Hardenbergia comptoniana	1			
Macrozamia fraseri	0.5	1		
Lomandra sp.	0.1	0.2	KTT03-01	Sedge
Gomphocarpus fruticosus	0.1	0.5		
Ehrharta calycina	30	0.5		
Asparagus asparagoides	0.1			

Site KTT-04

Date: 27/07/2021
Described by: S. Coultas & K Geelhoed
Type: Quadrat 10 x 10m
Location: -32.2815 115.796
Veg Condition: Good
Soil: Sandy Loam
Landform: Sand dune
Vegetation: Low *Eucalyptus gomphocephala* woodland over tall *Banksia sessilis* and *Acacia cyclops* shrubland over low sparse *Macrozamia reidleii* and *Acanthocarpus preisii* shrubland over weedy grasses and herbs.

Species List

Name	% Cover	Height (m)	Specimen No.	Notes
Euphorbia terracina	0.1			
Eucalyptus gomphocephala	40	14		
Banksia sessilis	0.5	2.5		
Macrozamia riedlei	0.5	1		
Acacia cyclops	5	4		
Clematis linearifolia	3			
Melaleuca huegelii subsp. *huegelii*	0.2	3		
Asparagus asparagoides	0.5			
Oxalis pes-caprae	5	0.2		
Rhagodia baccata	0.1	0.2		
Trachymene pilosa	0.1	0.1		
Hardenbergia comptoniana	0.1	0.1		
Ehrharta calycina	25	0.2		
Euphorbia terracina	0.1	0.2		

Site KTT-05

Date: 27/07/2021
Described by: S. Coultas & K Geelhoed
Type: Quadrat 10 x 10m
Location: -32.2794 115.793
Veg Condition: Very Good
Soil: Sandy Clay Loam
Landform: Wetland
Vegetation: *Eucalyptus gomphocephala* mid forest over tall scattered *Acacia saligna* and *Templetonia retusa* over tall closed sedgeland of *Gahnia trifida*

Species List

Name	% Cover	Height (m)	Specimen No.	Notes
Eucalyptus gomphocephala	65	18		
Templetonia retusa	1	2.5		
Acacia saligna	0.1	3		
Clematis linearifolia	1			
Asparagus asparagoides	0.1			
Sonchus asper	0.1	0.3		
Melaleuca rhaphiophylla	0.1	1.5		
Leucopogon sp.	0.1	0.2	KTT-05-01	
Juncus sp.	0.1	0.3	KTT05-02	
Ipomoea sp.	0.1		KTT05-03	

Site KTT-06

Date: 27/07/2021
Described by: S. Coultas & K Geelhoed
Type: Releve
Location: -32.2761 115.789
Veg Condition: Good
Soil: Loamy Sand
Landform: Drainage area/floodplain
Vegetation: Mid *Eucalyptus gomphocephala* forest over low sparse *Melaleuca rhaphiophylla* woodland over tall open *Acacia Cyclops, Acacia saligna* and *Spyridium globulosum* shrubland over tall open *Gahnia trifida* sedgeland over weedy grasses and herbs

Species List

Name	% Cover	Height (m)	Specimen No.	Notes
Eucalyptus gomphocephala				
Melaleuca rhaphiophylla				
Acacia saligna				
Acacia cyclops				
Spyridium globulosum				
Clematis linearifolia				
Hardenbergia comptoniana				
Gahnia trifida				
Oxalis pes-caprae				
Gomphocarpus fruticosus				
Cynodon dactylon				
Asparagus asparagoides				
Corymbia calophylla				

Site KTT-07

Date: 27/07/2021
Described by: S. Coultas & K Geelhoed
Type: Releve
Location: -32.2667 115.785
Veg Condition: Good
Soil: Sandy Loam
Landform: Sand Plain
Vegetation: Mid *Eucalyptus gomphocephala* woodland over tall *Acacia cyclops* over mid open *Xanthorrhoea preissii, Gahnia trifida* and *Lepidosperma* sp. over weedy grasses and herbs

Species List

Name	% Cover	Height (m)	Specimen No.	Notes
Eucalyptus gomphocephala	30	15		
Acacia cyclops	30	4.5		
Gahnia trifida	8	1.2	KTT-01	
Lepdiosperma sp.	2	0.8	KTT07-01	
Xanthorrhoea preissii	1	1.8		
Hardenbergia comptoniana	0.1			
Clematis linearifolia	0.1			
Spyridium globulosum	0.5	1.2		
Gomphocarpus fruticosus	0.1	0.6		
Asparagus asparagoides	1			
Oxalis pes-caprae	0.1	0.2		

Site KTT-08

Date: 27/07/2021
Described by: S. Coultas & K Geelhoed
Type: Quadrat 10 x 10m
Location: -32.2692 115.785
Veg Condition: Good
Soil: Sandy Loam
Landform: Sand Dune
Vegetation: Mid *Eucalyptus gomphocephala* woodland over mid tall *Acacia cyclops* and *Xanthorrhoea preissii* shrubland over scattered weedy herbs and grasses.

Species List

Name	% Cover	Height (m)	Specimen No.	Notes
Eucalyptus gomphocephala	20	15		
Xanthorrhoea preissii	10	1.5		
Acacia cyclops	4	3.5		
Asparagus asparagoides	1			
Clematis linearifolia	0.1			
Hardenbergia comptoniana	0.1			
Desmocladus asper	0.1	0.3		
Lepidosperma sp.	0.1	0.5	KTT-07	
Cassytha flava	0.1			
Ipomoea sp.	0.1		KTT-06	
Phyllanthus sp.	0.1	0.4		
Spyridium globulosum	1	3		
Lomandra caespitosa	0.1	0.4		
Cyrtostylis huegelii	0.1	0.1		
Caladenia sp.	0.1	0.1		
Ehrharta calycina	0.1	0.1		

Site KTT-09

Date: 27/07/2021
Described by: S. Coultas & K Geelhoed
Type: Quadrat 10 x 10m
Location: -32.2678 115.784
Veg Condition: Good
Soil: Sandy Clay Loam
Landform: Sand Dune
Vegetation: Mid *Eucalyptus gomphocephala* forest over tall *Acacia Cyclops* shrubland over tall *Gahnia trifida* sedgeland over scattered weedy grasses and herbs

Species List

Name	% Cover	Height (m)	Specimen No.	Notes
Eucalyptus gomphocephala	65	16		
Acacia cyclops	25	4.5		
Xanthorrhoea preissii	0.1	0.5		
Gahnia trifida	55	1.5		
Clematis linearifolia	0.1			
Hardenbergia comptoniana	0.1			
Asparagus asparagoides	1			
Templetonia retusa	0.1	1		
Oxalis pes-caprae	4	0.1		
Dianella revoluta	0.1	0.3		
Ipomoea sp.	0.1	0.3		
Melaleuca rhaphiophylla	1	3		
Spyridium globulosum	0.1	1.2		
Cynodon dactylon	0.1	0.2		
Lepidosperma pubisquameum	0.1	0.3		
Conyza bonariensis	0.1	0.3		
Gomphocarpus fruticosus	0.1	0.4		

Site KTT-10

Date: 27/07/2021
Described by: S. Coultas & K Geelhoed
Type: Releve
Location: -32.271 115.785
Veg Condition: Good
Soil: Sandy Loam
Landform: Sand Plain
Vegetation: Mid *Eucalyptus gomphocephala* forest over tall *Acacia cyclops* and *Spyridium globulosum* shrubland over low scattered *Lepidosperma* sp. and *Asparagus asparagoides* mixed shrubland over weedy grasses and herbs

Species List

Name	% Cover	Height (m)	Specimen No.	Notes
Austrostipa macalpinei				
Thomasia sp.			KTT10-01	
Caladenia sp.				
Clematis linearifolia				
Leucopogon sp.				

Site KTT-11

Date: 27/07/2021
Described by: S. Coultas & K Geelhoed
Type: Releve
Location: -32.2859 115.8
Veg Condition: Degraded
Soil: Sandy Loam
Landform: Sand Dune
Vegetation: *Eucalyptus gomphocephala* mid woodland over *Acacia cyclops* tall closed shrubland over dense coverage of weedy grasses and herbs

Species List

Name	% Cover	Height (m)	Specimen No.	Notes
Asparagus asparagoides				
Zantedeschia aethiopica				
Fumaria capreolata				
Ehrharta calycina				

Appendix D: Species by Site Matrix

Species	KTT-01	KTT-02	KTT-03	KTT-04	KTT-05	KTT-06	KTT-07	KTT-08	KTT-09	KTT-10	KTT-11
Acacia cyclops	•	•		•		•	•	•	•	•	•
Acacia saligna		•			•	•					
Acanthocarpus preisii				•							
Asparagus asparagoides	•	•	•	•	•	•	•	•	•	•	•
Austrostipa macalpinei										•	
Banksia sessilis var. *sessilis*		•	•	•							
Caladenia sp.								•			
Caladenia sp.										•	
Cassytha flava								•			
Clematis linearifolia		•		•	•	•	•	•	•	•	
Conostylis setigera subsp. *setigera*		•									
Conyza bonariensis									•		
Corymbia calophylla						•					
Cynodon dactylon						•			•		
Cyrtostylis huegelii								•			
Desmocladus asper								•			
Dianella revoluta									•		
Ehrharta calycina		•	•	•				•			•
Eragrostis curvula	•	•									
Eucalyptus gomphocephala	•	•	•	•	•	•	•	•	•	•	•
Euphorbia terracina				•							
Fumaria capreolata											•
Gahnia trifida					•	•			•		
Gahnia trifida							•				
Gomphocarpus fruticosus	•	•	•			•	•				
Hardenbergia comptoniana			•	•		•	•	•	•		
Juncus sp.					•						
Lepidosperma pubisquameum									•		
Lepidosperma sp.								•			
Lepidosperma sp.							•			•	
Leucopogon sp.					•						
Leucopogon sp.										•	
Lomandra caespitosa								•			
Lomandra sp.			•								
Macrozamia fraseri		•	•								

Species	KTT-01	KTT-02	KTT-03	KTT-04	KTT-05	KTT-06	KTT-07	KTT-08	KTT-09	KTT-10	KTT-11
Macrozamia riedlei				•							
Melaleuca huegelii subsp. *huegelii*				•							
Melaleuca rhaphiophylla					•	•			•		
Oxalis pes-caprae				•		•	•		•		
Pelargonium capitatum	•										
Phyllanthus sp.								•			
Rhagodia baccata				•							
Rhagodia preissii subsp. *preissii*			•								
Sonchus asper					•						
Ipomoea sp.					•			•			
Spyridium globulosum		•				•	•	•	•	•	
Templetonia retusa					•						
Thomasia sp.										•	
Trachymene pilosa				•							
Ursinia anthemoides	•										
Xanthorrhoea gracilis	•										
Xanthorrhoea preissii							•	•	•		
Zantedeschia aethiopica											•