

6 KEY ENVIRONMENTAL FACTORS

6.1 PRELIMINARY KEY ENVIRONMENTAL FACTORS

Preliminary Key Environmental Factors have been identified for the Proposal based on review of Proposal details, pre-referral discussions with OEPA assessment officers and relevant EPA guidance documents. Preliminary Key Environmental Factors for the Proposal are presented in Table 8.

Table 8: Preliminary Key Environmental Factors

Factor	Proposal Area	Environmental Aspect	Potential Impact
Hydrological Processes	Proposal Area Mine Pit Area Borefield Area	<ul style="list-style-type: none"> • Construction of Proposal infrastructure • Physical presence of mine pit, TSF, camp, borefield and all supporting infrastructure • Operation of light and heavy vehicles, equipment and machinery • Mining of orebody • Dewatering • Groundwater abstraction 	<ul style="list-style-type: none"> • Groundwater drawdown • Modification to surface flows • Soil erosion • Weeds • Groundwater drawdown • Modification to subsurface levels and flows • Modification to subsurface levels and flows
Flora and Vegetation	Proposal Area	<ul style="list-style-type: none"> • Construction of Proposal infrastructure 	<ul style="list-style-type: none"> • Clearing of native vegetation • Removal of conservation significant species • Removal of conservation significant vegetation communities • Fragmentation of populations or communities • Soil erosion
Terrestrial Fauna	Mine Pit Area Borefield Area Proposal Area Administration Buildings, Accommodation Camp	<ul style="list-style-type: none"> • Modification of surface flows • Dewatering • Groundwater abstraction • Construction of Proposal infrastructure • Physical presence of mine pit, TSF, camp, borefield and all supporting infrastructure • Generation of waste 	<ul style="list-style-type: none"> • Groundwater dependant vegetation • Groundwater dependant vegetation • Groundwater dependant vegetation • Removal of fauna habitat • Displacement of fauna • Construction of linear infrastructure / habitat barriers • Lighting in sensitive habitat • Displacement of fauna • Feral animal activity • Scavenging / human dependency
Rehabilitation	Proposal Area	<ul style="list-style-type: none"> • Revegetation of native species • Replacement of fauna habitats • Reestablishment of natural land contours 	<ul style="list-style-type: none"> • Topsoil viability • Plant propagation success • Fauna re-habitation success

Factor	Proposal Area	Environmental Aspect	Potential Impact
Heritage	Proposal Area	<ul style="list-style-type: none"> • Construction of Proposal infrastructure 	<ul style="list-style-type: none"> • Disturbance or removal of heritage sites or places

6.2 ASSESSMENT OF KEY ENVIRONMENTAL FACTORS

Each of the Preliminary Key Environmental Factors identified in Table 8 have been reviewed in order to assess the likely impacts posed by the implementation of the Proposal. The following sections summarise existing knowledge of each factor, potential impacts, proposed mitigation measures to prevent and/or minimise likely impacts and justification as to how the Proponent can meet the EPAs overall objectives. The outcomes of this assessment are also summarised in Table 19 at the end of this Section.

6.2.1 Flora and Vegetation

Three surveys (refer to Table 7) have been conducted in the Proposal Area in order to describe the existing flora and vegetation within the vicinity of the Thunderbird Deposit. A Level 1 survey was initially completed for the proposed active mining areas (i.e. mine pit, TSF, process plants, power plant, eastern portion of the borefield and northern sections of access roads) in 2012. Whilst the field survey did not record any locations of Threatened species, the desktop assessment identified a total of 20 flora species of conservation significance that had a medium to high likelihood of occurring in the survey area (Ecologia 2012). As such, Level 2 surveys were recommended to provide a thorough assessment of potential impacts. Level 2 surveys of the mine site impacts areas (as described above) were conducted in April 2013, and the internal haul roads and accommodation camp areas in May 2015.

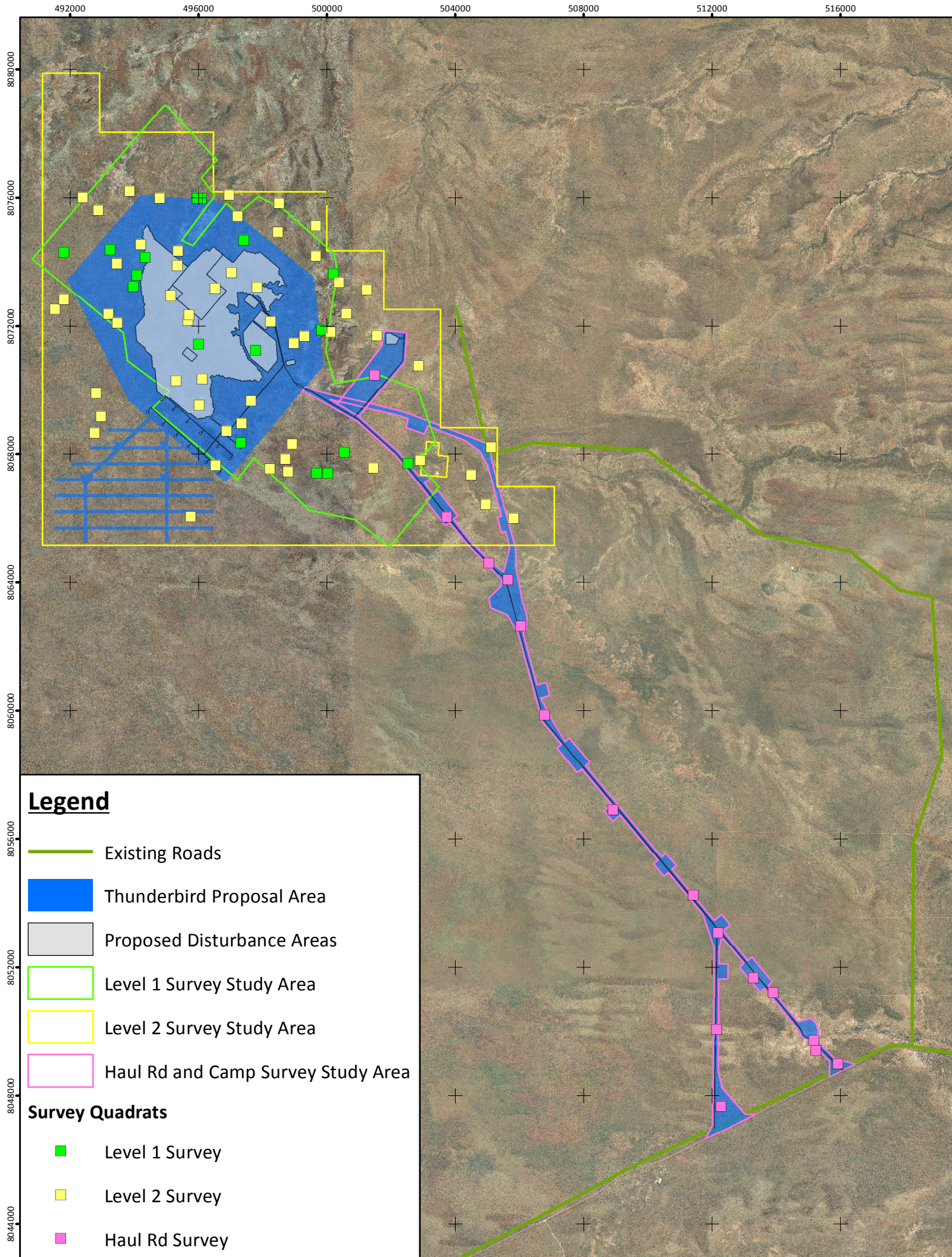
A combined survey effort equivalent to 46 person days was expended across the three surveys. In total, 87 quadrats were sampled over a combined survey area of 3,849 ha. Quadrats were typically 50 m by 50 m, with the exception of some sites that were located within linear-type strands of vegetation (i.e. along drainage lines). Transects were also walked between quadrats for the survey conducted within the proposed mine site impact areas which facilitated mapping of vegetation communities and recording additional locations of conservation significant taxa. Locations of quadrats sampled are shown on Figure 6.1.

6.2.1.1 Desktop Results







Desktop assessments were conducted prior to field surveys to identify flora species and vegetation communities of conservation significance likely to occur in the area. The assessment included review of DPAWs Threatened and Priority Flora, Threatened Ecological Communities and Priority Ecological Communities' databases, DPAW Western Australian Herbarium (WA Herb) Specimen Database and a literature review of previous projects within the vicinity.

Currently, 74 Threatened and Priority flora taxa are listed as occurring in the Dampierland bioregion (WA Herbarium, July 2015). Results of the assessment did not identify any Threatened species listed under either the EPBC Act or the EP Act within 50 km of the Proposal Area. Two Threatened species known to occur in the area (*Keraudrenia exastia*, found on coastal dunes, and *Pandanus spiralis* var. *flammeus*, which prefers white clay springs) were considered unlikely to occur due to absence of their preferred habitat within the survey area.




A total of 27 Priority flora species were identified from desktop assessments, of which three are known to occur within the Thunderbird survey area and six were assessed as likely to occur (ecologia 2014a; 2015). All Priority species identified during the desktop assessment and their likely occurrence within the survey area are summarised below Table 9 and where spatial data is available, locations are shown on Figure 6.2.

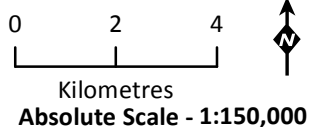


Legend

-  Existing Roads
-  Thunderbird Proposal Area
-  Proposed Disturbance Areas
-  Level 1 Survey Study Area
-  Level 2 Survey Study Area
-  Haul Rd and Camp Survey Study Area

Survey Quadrats

-  Level 1 Survey
-  Level 2 Survey
-  Haul Rd Survey




**Flora and Vegetation
Survey Areas and
Quadrat Locations**

Figure: 6.1
Project ID: 1645



















Drawn: BH
Date: 04.11.15

Coordinate System
Name: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994


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 Thunderbird Proposal Area

Priority Flora Records - Desktop Search Results

-  *Aphyllodium parvifolium* - P1
-  *Byblis guehoi* - P1
-  *Ipomoea gracilis* - P1
-  *Ipomoea* sp. A Kimberley Flora (L.J. Penn 84) - P1
-  *Utricularia stellaris* - P1
-  *Gomphrena pusilla* - P2
-  *Nymphoides beaglensis* - P2
-  *Aphyllodium glossocarpum* - P3
-  *Fuirena incassata* - P3
-  *Goodenia sepalosa* var. *glandulosa* - P3
-  *Lophostemon grandiflorus* subsp. *grandiflorus* - P3
-  *Phyllanthus aridus* - P3
-  *Polymeria distigma* - P3
-  *Pterocaulon intermedium* - P3
-  *Stylidium costulatum* - P3
-  *Triodia acutispicula* - P3
-  *Triodia caelestialis* - P3
-  *Pittosporum moluccanum* - P4

Priority Ecological Community Records

-  Assemblages of Disaster Bay organic mound springs
-  Assemblages of Lolly Well Springs wetland complex

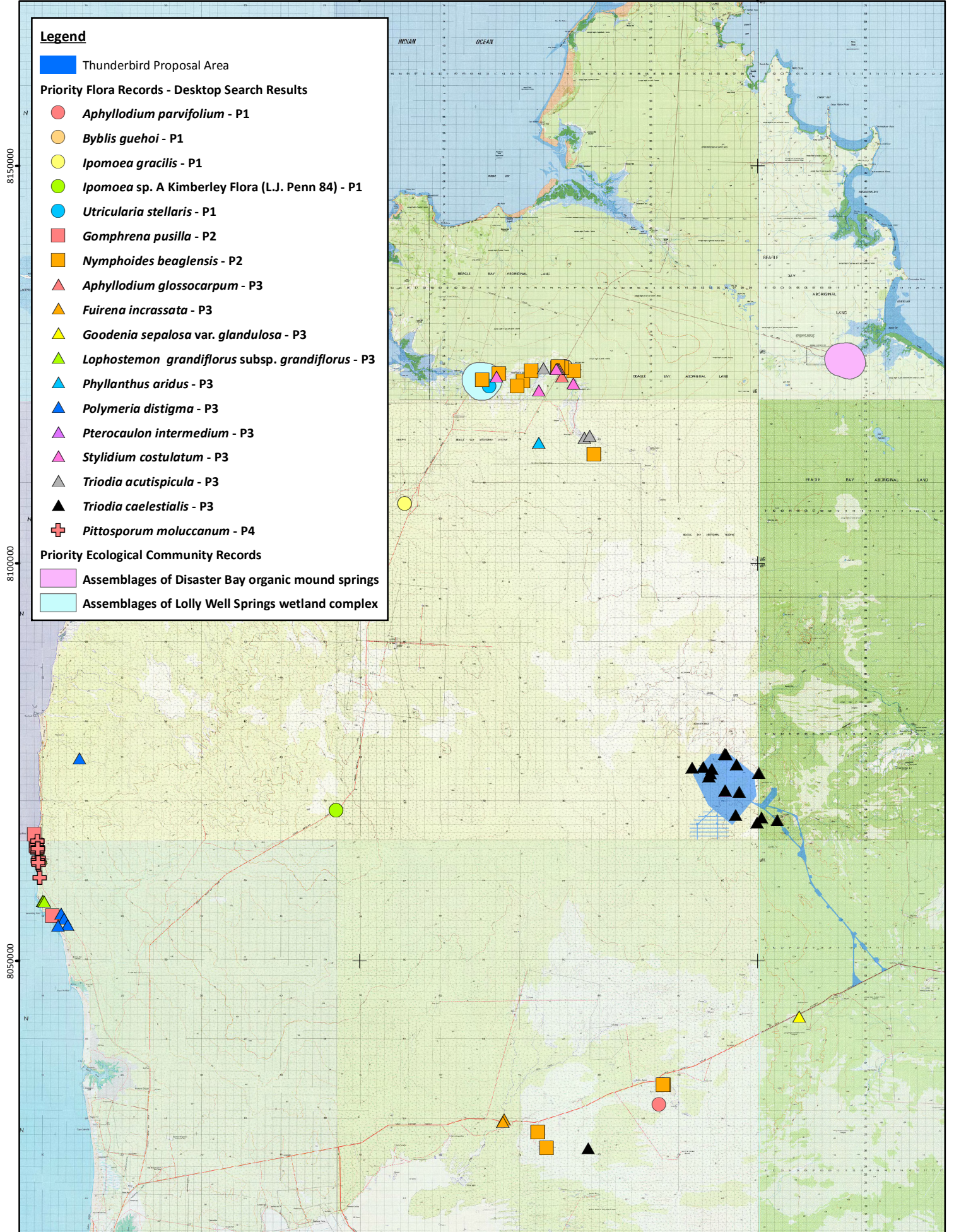


Table 9: Priority flora recorded within 50 km of the Proposal

Taxon	DPaW Status	Preferred Habitat	Distribution	Likelihood of Occurrence in Thunderbird Survey Area
<i>Aphyllodium parvifolium</i>	P1	Occurs in sand and clay, can be close to water.	Broome, McLarty Hills	Unlikely
<i>Byblis guehoi</i>	P1	Occurs in sand and silt-loam soils that are waterlogged in the wet season but dry soon after.	Dampier Peninsula	Possible
<i>Cyperus haspan</i> subsp. <i>haspan</i>	P1	Occurs in peat bank on the edge of spring	Dampier Peninsula	Unlikely
<i>Ipomoea gracilis</i>	P1	Occurs on clay or irrigated sand, close to rivers.	Kununurra, Ord River.	Unlikely
<i>Ipomoea</i> sp. A Kimberley Flora (L.J. Penn 84)	P1	Occurs in shallow soils on sandstone	Dampier Peninsula	Possible
<i>Jacquemontia</i> sp. Broome (A.A. Mitchell 3028)	P1	Occurs in woodlands on Pindan plain	Dampier Peninsula	Likely
<i>Nicotiana heterantha</i>	P1	Black clay. Seasonally wet flats.	Broome, Dampier Peninsula, Roy Hill, Mandora, Anna Plains	Possible
<i>Parsonsia kimberleyensis</i>	P1	Occurs on vine thickets	Dampier Peninsula	Unlikely
<i>Thespidium basiflorum</i>	P1	Occurs in sandy soil creek beds	Dampier Peninsula	Unlikely
<i>Utricularia stellaris</i>	P1	Occurs in swampy areas, commonly submerged in water.	Wyndham, Dampier Peninsula, Mitchell Plateau	Possible
<i>Nymphoides beaglensis</i>	P2	In shallow freshwater. Edges of permanent waterholes or in seasonally inundated claypans & depressions.	Dampier Peninsular, Beagle Bay, Lake Champion, Yabbagoody Clay Pan	Unlikely
<i>Acacia</i> sp. Riddell Beach (T. Willing 71)	P3	Occurs on cliffs and gullies, and close to roads. In sand, loam and rocky soil.	Broome, Dampier Peninsula	Unlikely
<i>Aphyllodium glossocarpum</i>	P3	Occurs in sand verging onto cleared areas and open grassland fringes	Dampier Peninsula	Possible
<i>Cupaniopsis anacardioides</i>	P3	Vine thickets	Dampier Peninsula, Mitchell Plateau, Middle Osborn Is., Bouganville Peninsula, NT, QLD	Possible
<i>Dendrophthoe odontocalyx</i>	P3	Occurs in swamp areas and woodlands.	Koolan Is., Dampier Peninsula, Prince Regent N.R.,	Likely
<i>Fuirena incrassata</i>	P3	Occurs in sand and claypans, generally close to water	Googhenama Creek, Broome	Recorded
<i>Gomphrena pusilla</i>	P3	Occurs on coastal sand dunes, with either calcrete sands or fine shell grit	Dampier Peninsula, Pt Hedland	Likely
<i>Goodenia sepalosa</i> var. <i>glandulosa</i>	P3	Occurs in Pindan sand or loam	Derby, Lake Argyle, Robinson River, Fitzroy Crossing, Yeeda	Possible
<i>Lophostemon grandiflorus</i> subsp. <i>grandiflorus</i>	P3	Occurs in damp habitats	Dampier Peninsula, Edgar Range	Likely
<i>Phragmites karka</i>	P3	Edges of pools and creeks	Scattered throughout the Kimberley and Pilbara	Unlikely
<i>Phyllanthus aridus</i>	P3	Rangeland and hillside. Sandstone. Red sand and ironstone gravel. With exposed rocks	Broome, Derby-West Kimberley, East Pilbara, Halls Creek, Wyndham-East Kimberley.	Likely

Taxon	DPaW Status	Preferred Habitat	Distribution	Likelihood of Occurrence in Thunderbird Survey Area
<i>Pterocaulon intermedium</i>	P3	Flat plains and sometimes claypans. In pindan red sand - loam.	Broome, Derby-West Kimberley, Port Hedland, Wyndham-East Kimberley.	Recorded
<i>Stylidium costulatum</i>	P3	Sandy or clayey soils. Creeks or seasonally wet areas.	Dampier Peninsula, Beverley Springs Stn, Mt Barnett Stn, Coulomb Point	Possible
<i>Triodia acutispicula</i>	P3	Sandy soils. River levees, pindan plains, rocky hillslopes & outcrops.	Scattered throughout Western Kimberley	Possible
<i>Triodia caelestialis</i>	P3	Red-brown, sand-silt-clay and pindan soils usually in low plains	Central Kimberley, Dampierland, Northern Kimberley. Broome, Derby-West Kimberley.	Recorded
<i>Haemodorum gracile</i>	P4	Occurs in sand, and sandy clay in open woodlands and creek banks	Cahmpagny Is., Yampi Peninsula, Dampier Peninsula, Edkins Range, Kimbolton Stn., Prince Regent River N.R., Derby	Unlikely
<i>Pittosporum moluccanum</i>	P4	White sand. Sand dunes	Dampier Peninsula, N of Broome, Berthier Is., Maret Is., N.T., SE Asia	Unlikely

No Threatened Ecological Communities (TECs) or Environmental Sensitive Areas (ESAs) listed under either the EPBC Act or WC Act was identified from the desktop assessment as occurring within or adjacent to the Proposal area. Two Priority Ecological Communities (PECs) listed by DPAW (DEC 2010) were recorded within 60 km of the Proposal (Figure 6.2):

- Assemblages of Lolly Well Springs wetland complex (Priority 3) – located approximately 54 km north-west of the Proposal
- Assemblages of Disaster Bay organic mound springs (Priority 3) – located approximately 51 km north-north-east of the Proposal.

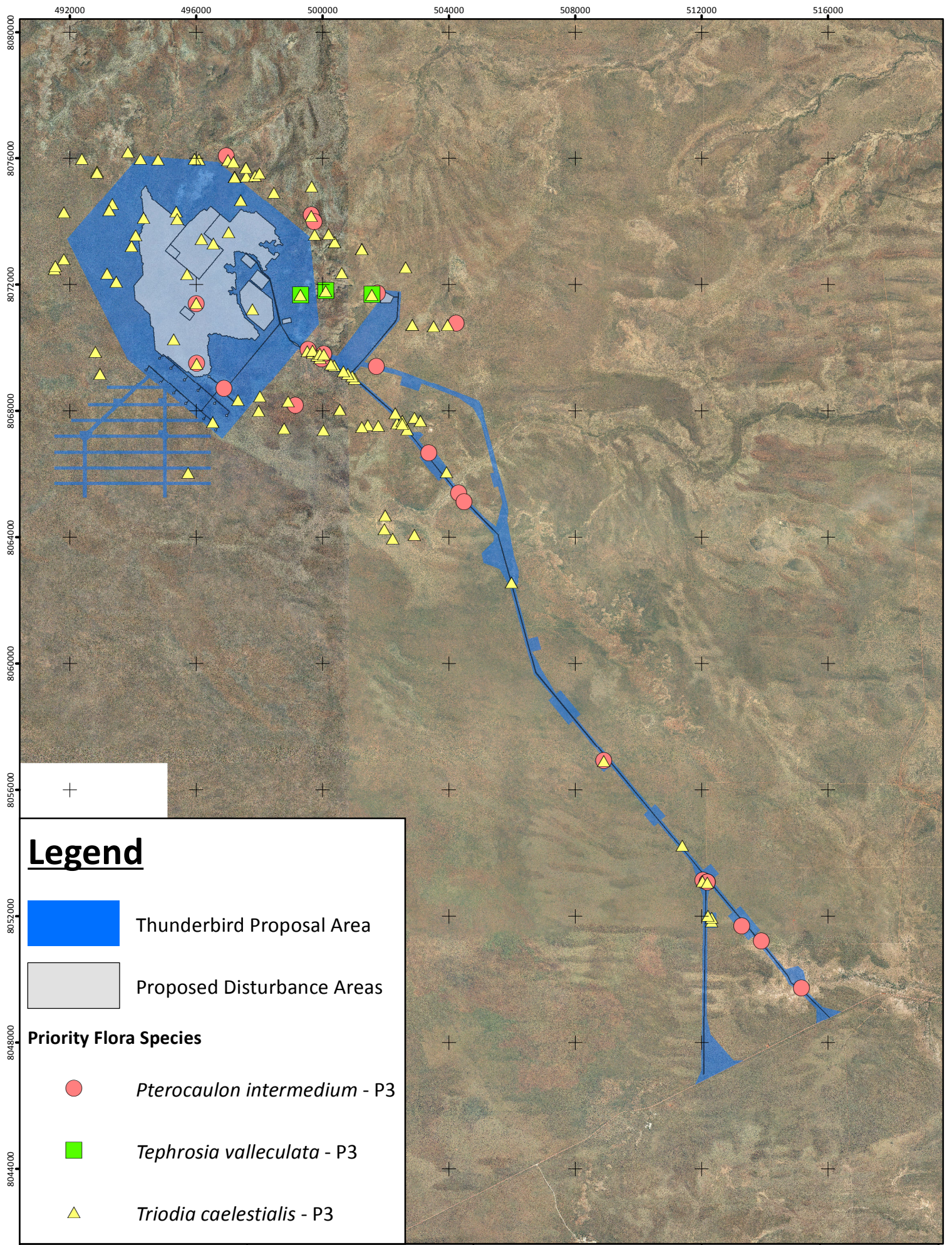
6.2.1.2 Conservation Significant Flora

A total of 352 native vascular flora taxa were recorded across the three surveys conducted within the Proposal Area, representing 56 families. No species listed as Threatened under either the EPBC Act or WC Act were recorded during any of the surveys.

Five Priority Flora species were recorded during the surveys, however, only three Priority Flora species were from the Proposal Area. The number of records for each Priority taxa found within the Proposal Area is detailed in Table 10 below and shown on Figure 6.3.

Table 10: Priority species recorded within the Proposal Area

Species	Conservation Status	No. of Locations Recorded During Surveys	No. of Locations Recorded Within Proposal Area (% of total recorded during Thunderbird surveys)	No. of Locations Recorded Within Proposal Disturbance Areas (% of total recorded during Thunderbird surveys)
<i>Pterocaulon intermedium</i>	P3	23	17 (74%)	2 (9%)
<i>Tephrosia valleculata</i>	P3	3	1 (33%)	0 (0%)
<i>Triodia caelestialis</i>	P3	104	52 (50%)	12 (12%)
TOTAL NUMBER OF PRIORITY FLORA RECORDS		130	70 (53%)	14 (11%)

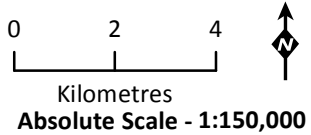


Legend

- Thunderbird Proposal Area
- Proposed Disturbance Areas

Priority Flora Species

- Pterocaulon intermedium* - P3
- Tephrosia valleculata* - P3
- Triodia caelestialis* - P3



**Priority Flora Species
Recorded in the
Proposal Area**

Figure: 6.3
Project ID: 1645

Drawn: BH
Date: 04.11.15

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Regional and Local Significance

Regional significance addresses the representation of species and habitats at a biogeographic regional level. Species or vegetation communities that are restricted to the Dampierland IBRA region and whose distributions are limited or unknown are considered regionally significant. Local significance is when a species is confined to a specialised habitat type that is not common and potentially restricted to the local area and whose disturbance or removal may lead to local extinction.

Pterocaulon intermedium (P3) was recorded from 23 locations, on red sandy plains, representing 89 individuals. Seventeen of these records are located within the Proposal Area, of which two lie within current proposed disturbance areas. These two records are within the mine pit boundary and therefore it is unlikely impacts to these two individuals can be avoided. An additional 23 locations of *Pterocaulon intermedium* are also known from Flora Base records (Ecologia 2015), one of which is within conservation estate (Ecologia 2014a). This species is not confined to specialised habitats, occurring on widespread pindan sandplains in the area and is expected to occur in similar habitat outside the Proposal Area. *Pterocaulon intermedium* is distributed relatively widely across northern WA and also in the Northern Territory and Queensland and is not considered regionally significant.



Plate 4: *Pterocaulon intermedium* from 2014 Survey (Ecologia 2014)



Plate 3: *Tephrosia valleculata* from 2014 Survey (Ecologia 2014)

Tephrosia valleculata (P3) was recorded from only three locations during the surveys, representing 45 individuals. Only one record is located within the Proposal Area, however, it is situated approximately 850 m east of the closest planned infrastructure (initial TSF and internal haul road) and therefore is unlikely to be impacted as part of the Proposal. Another nine regional records of *Tephrosia valleculata* are known from Flora Base records (Ecologia 2014a), although none are within conservation estates. The species has a wide distribution across northern Australia and is not considered regionally significant.

Triodia caelestialis (P3) is the dominant understorey species in some of the vegetation units identified, such as *GpAmStTc*. The species was recorded from 104 locations during the surveys, representing 19,591 individuals. Fifty two of these records are within the Proposal Area, 12 of which lie within proposed disturbance areas. Four records are located along the haul road alignment and may be avoided where possible. The remaining eight records are situated within the mine pit boundary and therefore it is unlikely impacts to these individuals can be avoided. An additional 18 records of *Triodia caelestialis* are also known from the Flora Base database (Ecologia 2015), one of which is within conservation estate (Ecologia 2014a). *Triodia caelestialis* not confined to specialised habitats, occurring on widespread pindan sandplains in the area and is expected to occur in similar habitat outside the Proposal Area. This species is distributed across northern WA in the Dampierland,

Central Kimberley and Northern Kimberley bioregions. *Triodia caelestialis* is not considered regionally significant.



Plate 5: *Triodia caelestialis* from 2014 Survey (Ecologia 2014)

6.2.1.3 Introduced Species

A total of eight introduced species listed on the WA Herbarium’s database were identified during the flora and vegetation surveys conducted for the Thunderbird area. Of these, five taxa were identified within the Proposal Area. None of the species identified within the Proposal Area are listed as weeds of National Significance or Declared Pests. All are listed by the Department of Agriculture and Food (DAF) under the *Biosecurity and Agriculture Management Act 2007* as Permitted (section 11). Introduced species recorded in the Proposal Area are listed below and locations are mapped in Figure 6.4:

- *Cynodon dactylon*
- *Malvastrum americanum*
- *Stylosanthes hamata*
- *Stylosanthes scabra*
- *Tridax procumbens*.

Malvastrum americanum and *Stylosanthes hamata* are the only two introduced species that overlie currently proposed disturbance areas. *Malvastrum americanum* was recorded along the proposed haul route on the boundary of an existing track. It is likely this plant will be cleared during road upgrade works for the Proposal. *Stylosanthes hamata* is located within the proposed pit boundary which is unlikely to change. This plant will be cleared as part of the Proposal.

6.2.1.4 Vegetation

A total of eleven vegetation communities have been described within the Proposal Area. These communities are described below in Table 12 and locations are mapped on Figure 6.5.

All 11 vegetation communities mapped within the relevant survey areas also occur within the Proposal Area and proposed disturbance areas. Table 11 below provides the total area for each community mapped during the survey and the calculated area of each community occurring within both the Proposal Area and proposed disturbance areas.