



Yandicoogina Creek Reconnaissance Vegetation Survey and Impact Assessment

Prepared for BHP WAIO
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EXECUTIVE SUMMARY

BHP Western Australia Iron Ore Pty Ltd (BHP WAIO) commissioned Onshore Environmental Consultants Pty Ltd (Onshore Environmental) to undertake a reconnaissance vegetation survey of Yandicoogina Creek (hereafter referred to as the study area). The focus of the survey was to identify groundwater dependent, riparian and terrestrial vegetation that may potentially be impacted by surplus water discharge or groundwater drawdown from adjacent mining operations. An impact assessment was completed to determine vegetation at high risk.

The study area was located approximately 85 km north-west of Newman and includes a 17 km corridor along the main drainage channel of Yandicoogina Creek, including a 7.5 km section extending upstream and a 9.5 km section extending downstream of BHP WAIO's Ministers North project area (Figure 1).

Reconnaissance Survey

The field survey was conducted under 'poor' seasonal conditions between the 4th and 6th of June 2018. The field survey time was impacted by heavy rainfall, resulting in approximately half of the study area not being assessed. Vegetation mapping was inferred for these areas. Six vegetation associations supporting groundwater dependent vegetation (i.e. *Melaleuca argentea*, *Eucalyptus camaldulensis* and/or *Eucalyptus victrix*) were described and mapped within the 428 ha study area. One of the six vegetation associations supported zones of permanent pooling scattered throughout the mapped extent of the unit¹:

- MA EcMa TtEuaSopl CyvTydEgen - Woodland of *Eucalyptus camaldulensis* and *Melaleuca argentea* over Open Tussock Grassland of *Themeda triandra*, *Eulalia aurea* and *Sorghum plumosum* over Open Sedges of *Cyperus vaginatus*, *Typha domingensis* and *Eleocharis geniculata* on brown loam on major drainage lines.

The remaining four vegetation associations described and mapped along Yandicoogina Creek did not support groundwater dependent vegetation, or stands of Mulga or *Acacia citrinoviridis* that are known to be susceptible to prolonged inundation that may result from surface water discharge.

None of the ten vegetation associations mapped within the study area were aligned with Federal or State listed Threatened Ecological Communities (TECs), or State listed Priority Ecological Communities (PECs).

Vegetation condition ranged from *good* to *poor*, with a majority of vegetation associations rated as *good*. The major disturbance recorded throughout the study area was related to grazing by domestic cattle, resulting in altered vegetation structure and the introduction of weeds. Ten introduced flora species were recorded from the study area, none of which are listed as a Declared Pest under the *Biosecurity and Agriculture Management Act 2007* (BAM Act).

There were no plant taxa gazetted as Threatened Flora pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act 1950* (WC Act), or listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) recorded from the study area.

A total of five Priority listed flora were opportunistically recorded during the reconnaissance vegetation survey:

- *Aristida lazaridis* (P2);

¹ The open sedge stratum was restricted to this vegetation association.

- *Fimbristylis sieberiana* (P3);
- *Gymnanthera cunninghamii* (P3);
- *Rostellularia adscendens* var. *latifolia* (P3); and
- *Sida* sp. Barlee Range (S. van Leeuwen 1643) (P3).

Impact Assessment

Six vegetation associations within the study area support groundwater dependent vegetation that are susceptible to groundwater drawdown:

- MA EcEv TefcPIId MerTtEua;
- MA EcMa TtEuaSopl CyvTydEgen;
- MA EcEv TtEuaSopl GoroCuleAtp;
- FP SoplErtTt GoroAtpCule AtpApyAnl;
- MA EuaTtErt EvEc AcpEv; and
- MA TtCyaEua EcEv EcEv.

The obligate phreatophytic tree species *Melaleuca argentea* was recorded as a dominant tree species from one vegetation association (MA EcMa TtEuaSopl CyvTydEgen - Woodland of *Eucalyptus camaldulensis* and *Melaleuca argentea* over Open Tussock Grassland of *Themeda triandra*, *Eulalia aurea* and *Sorghum plumosum* over Open Sedges of *Cyperus vaginatus*, *Typha domingensis* and *Eleocharis geniculata* on brown loam on major drainage lines), and as scattered low trees from a second vegetation association (MA EcEv TtEuaSopl GoroCuleAtp - Woodland of *Eucalyptus camaldulensis* and *Eucalyptus victrix* over Open Tussock Grassland of *Themeda triandra*, *Eulalia aurea* and *Sorghum plumosum* with High Open Shrubland of *Gossypium robinsonii*, *Cullen leucanthum* and *Acacia tumida* var. *pilbarensis* on brown loam on major drainage lines). Groundwater drawdown by greater than 3 metres below ground level (m bgl) has the potential to result in the decline of *Melaleuca argentea* trees, and may also impact on the localised permanent pools that support the sedges *Cyperus vaginatus*, *Typha domingensis* and *Eleocharis geniculata* within the same unit.

The same six vegetation associations support the tall tree species *Eucalyptus camaldulensis* which is considered to be at moderate risk from groundwater drawdown. A second tall tree species, *Eucalyptus victrix*, occurs as a co-dominant with *Eucalyptus camaldulensis* within four of the six vegetation associations, and is considered to be at low risk from groundwater drawdown. Both tree species are classified as facultative phreatophytes², noting that *Eucalyptus victrix* may also function in some environments as a vadophyte³. While *in situ* groundwater levels are not currently known, groundwater drawdown beyond 20 m bgl will result in an increased risk of tree decline for *Eucalyptus camaldulensis*, and to a lesser extent *Eucalyptus victrix*. The impact is likely to be more severe during extended periods of drought.

The remaining four vegetation associations within the study area have been determined to have negligible risk from groundwater drawdown as they comprise a mixture of vadophytic and xerophytic⁴ plants that have no reliance on groundwater.

² Facultative Phreatophytes are capable of functioning as both a vadophyte and a phreatophyte

³ Vadophytes primarily use water held in the vadose (unsaturated) zone that occurs above the watertable.

⁴ Xerophytes are plants that have no reliance on groundwater for survival.

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1.0 INTRODUCTION

1.1 Preamble

BHP WAIO commissioned Onshore Environmental to undertake a reconnaissance vegetation survey along the main drainage channel of Yandicoogina Creek, extending 7.5 km upstream and 9.5 km downstream of BHP WAIO's Ministers North project area (Figure 1). The focus of the survey was to identify groundwater dependent, riparian and terrestrial vegetation that may potentially be impacted by surplus surface water discharge or groundwater drawdown activities from mining operations at the proposed Ministers North mine. An impact assessment was then completed for vegetation determined to be at high risk.

1.2 Previous Surveys

There are 17 previous flora and vegetation surveys that have been completed at BHP WAIO tenements or that are publicly available within a 25 km radius of the study area. These surveys are summarised in Appendix 1. There has been no previous survey work completed within the study area. However, two baseline flora and vegetation surveys were completed in 2009 and 2017 at BHP WAIO's Ministers North project area, which sits adjacent to the study area:

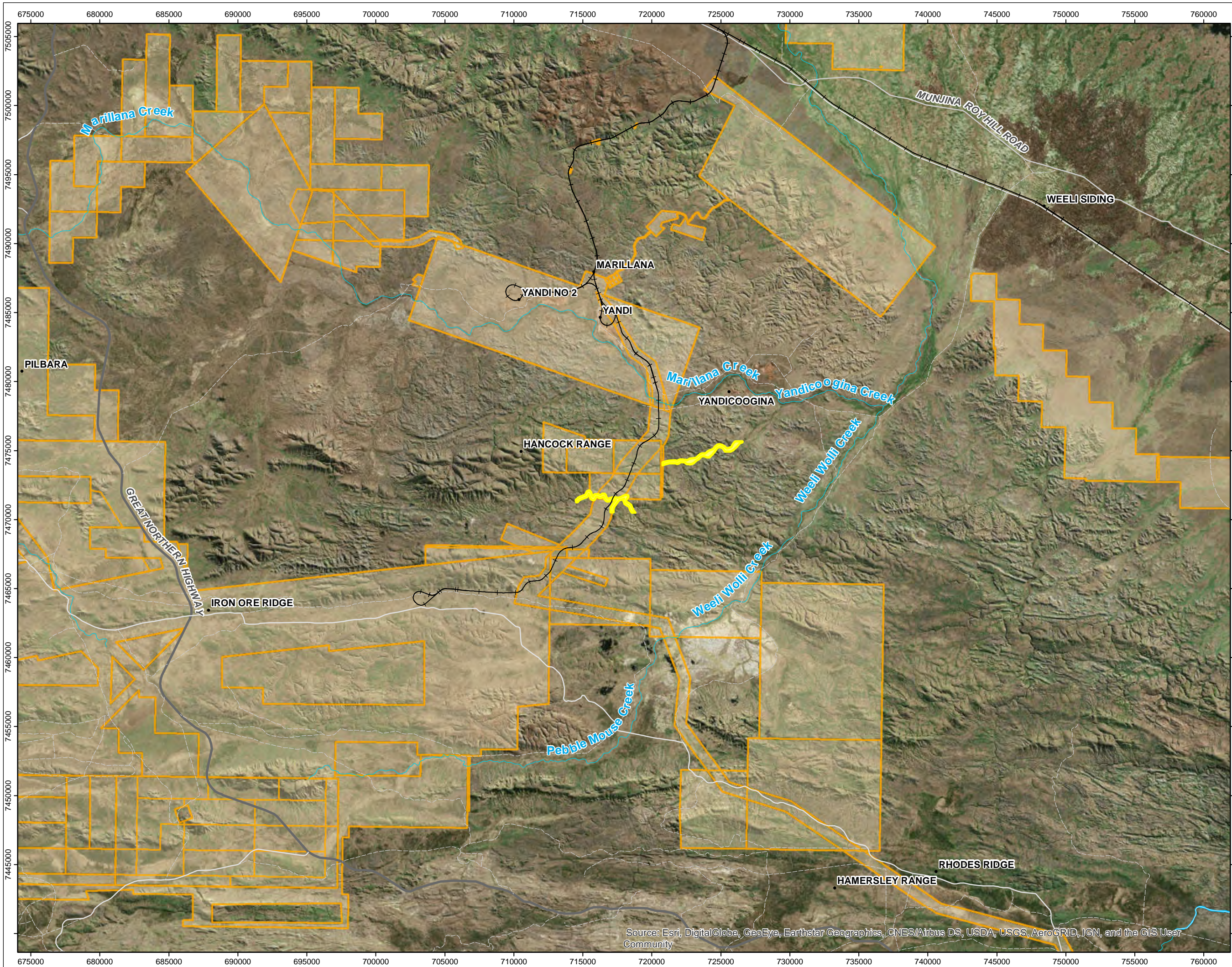
- ENV Australia (2009a) Ministers North Exploration Lease Flora and Vegetation Assessment. Consultants report prepared for BHP Billiton Iron Ore; and
- Biota Environmental Sciences (2017) Ministers North Detailed Flora and Vegetation Survey. Consultants report prepared for BHP Billiton Iron Ore.

1.3 Climate

The Pilbara region has an arid to tropical climate with two distinct seasons; a hot summer from October to April, and a mild winter from May to September. The majority of annual rainfall is received during the hot summer months associated with cyclonic activity and thunderstorms, with falls being of higher intensity and shorter duration contributing to an erratic annual range (Australian Natural Resource Atlas [ANRA] 2013).

Annual rainfall for Newman ranges from 36 mm to over 619 mm, with a long-term average of 332 mm occurring over 30 rain days (BOM 2018). Most of the annual precipitation occurs during the four summer months from December to March. The average maximum summer temperature ranges between 38°C and 40°C, while winter maximum temperatures range from 28°C to 30.5°C (BOM 2018).

Rainfall for 2017 at Newman was well above the long term average, with an annual total of 519 mm. However, the majority of this rainfall fell early in the year with June to December recording virtually no rainfall, with the exception of 30.8 mm in October. Rainfall totals for February and March 2018 were below the long term monthly averages, while January recorded 84.2 mm (above the long term monthly average of 67.9 mm) (Figure 2, BOM 2018). The field survey was undertaken in June 2018 and seasonal conditions were rated as 'poor'.

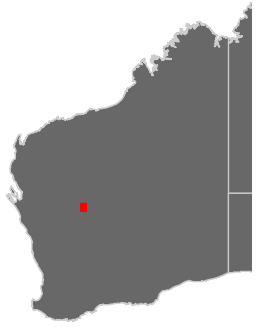


BHP
Yandicoogina Creek

Study Area Location

Legend

- Study Area
- BHP Tenure
- BHP Rail



N

0 2.5 5 7.5

Kilometers
1:250,000
Datum: GDA94
Projection: MGA Zone 50

Date: 8/06/2018
Status: Final
Figure: 1
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

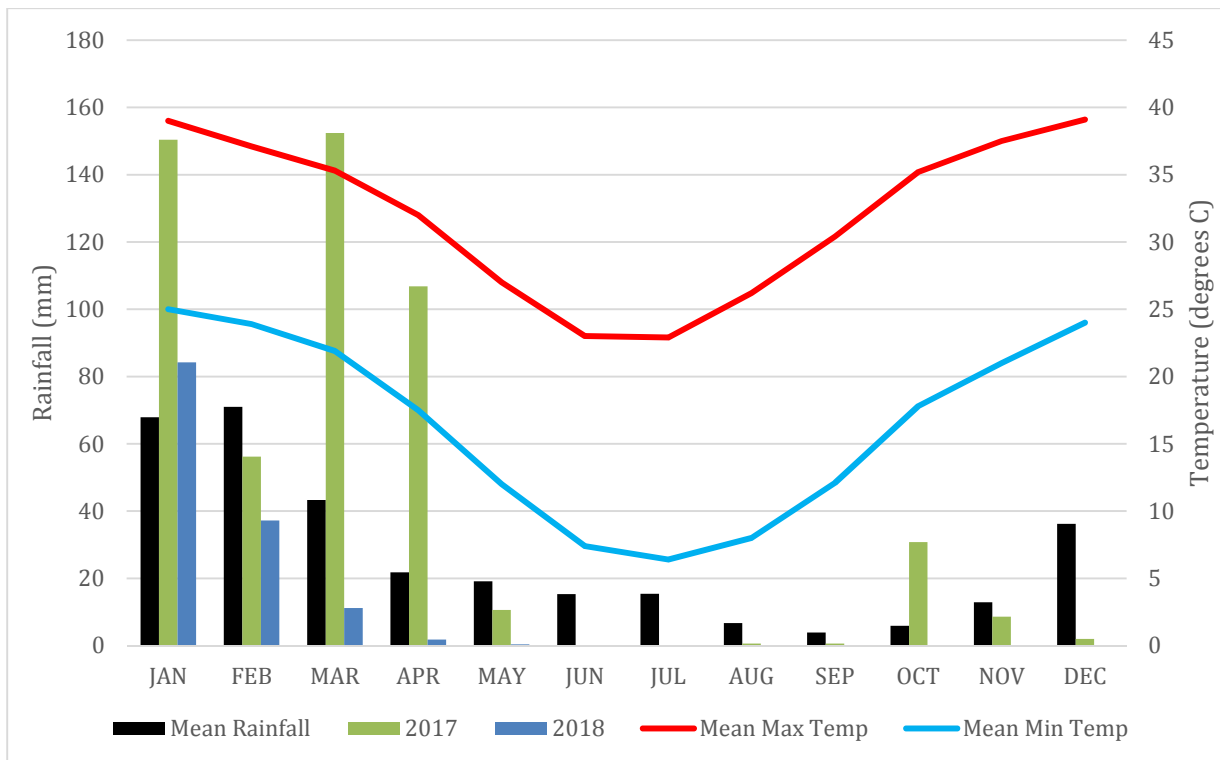


Figure 2 Climatic data recorded from Newman Airport, with long term monthly rainfall compared against monthly rainfall for 2017 and January - May 2018 (BoM 2018).

1.4 Biogeographic Regions

The Interim Biogeographic Regionalisation for Australia (IBRA7) divides Australia into 89 bioregions and 419 sub-regions based on climate, geology, landform, native vegetation and species information (Department of Environment 2013). The study area lies within the Pilbara Bioregion which consists of four sub-regions: Chichester, Fortescue, Hamersley and Roebourne. The study area is located within the Hamersley subregion (PIL3).

The Hamersley subregion is described as a mountainous area of Proterozoic sedimentary ranges and plateaux, dissected by gorges (basalt, shale and dolerite) (Kendrick 2001). It contains Mulga low woodland over bunch grasses on fine textured soils in valley floors, and Snappy Gum (*Eucalyptus leucophloia*) over *Triodia brizoides* on skeletal soils of the ranges.

1.5 Existing Land Use

Land tenure in the Pilbara consists of Aboriginal and leasehold reserves, national parks and reserves, and Crown land which fall under a range of pastoral and mining leases. The current use of lands surrounding the study area is predominantly for mineral exploration, iron ore mining and dry land agriculture, specifically pastoralism, cattle grazing and rangelands. The study area is located on Marillana Station within the Shire of East Pilbara, adjacent to BHP WAIO's Ministers North project area and approximately 4 km south of the existing Yandi mining operations (Figure 1).

Conservation lands amount to less than ten percent of the total area of the Pilbara bioregion, with the major reserves being Karijini and Millstream-Chichester National Parks. These parks are supplemented by lesser conservation estates such as Cane River and Meentheena Conservation Parks. Wetlands of national significance include the permanent pools of Karijini and Millstream-Chichester National Parks, and the Fortescue Marsh to the north of the study

area. The study area is not within or adjacent to any gazetted conservation reserves. Karijini National Park is located approximately 55 km west of the study area.

1.6 Landforms

The study area is situated within the mountainous areas of the Hamersley Range. The Hamersley Plateau is characterised by long strike ridges rising 300 m or more above valley floors and flats and dissected by variable sized drainage lines. Other characteristic landforms of the general area include stony plains and some alluvial plains and sandplains (Tille 2007). The entire region contains mainly rounded ranges and hills in contrast to the characteristic 'mesa form' hills that are located further to the north-east.

The study area encompasses the main drainage channel of Yandicoogina Creek, which flows to the northeast where it intersects with Marillana Creek and then Weeli Wolli Creek. Surface water is then directed in a northerly direction and into the Fortescue Marsh.

1.7 Soils

Tille (2007) classified the most recent and detailed mapping of Western Australia's Rangelands and Arid Interior into a hierarchy of soil-landscape mapping units. The study area is located within the following soil unit:

- 284: Fortescue Plateaux Zone, located in the Fortescue Province and described as: 'Hills and dissected plateaux (with some stony plains and hardpan wash plains) on sedimentary and volcanic rocks of the Hamersley Basin (Ophthalmia Fold Belt). Stony soils with Red shallow loams and some Red/brown non-cracking clays and Red loamy earths'.

The Australian Soil Resource Information System (CSIRO 2006) described a single soil type as occurring within the study area and surrounds:

- Fa13: Ranges of banded jaspilite and chert along with shales, dolomites, and iron ore formations; some areas of ferruginous duricrust as well as occasional narrow winding valley plains and steeply dissected pediments. This unit is largely associated with the Hamersley and Ophthalmia Ranges. The soils are frequently stony and shallow and there are extensive areas without soil cover: chief soils are shallow stony earthy loams (Um5.51) along with some (Uc5.11) soils on the steeper slopes. Associated are (Dr2.33, Dr2.32) soils on the limited areas of dissected pediments, while (Um5.52) and (Uf6.71) soils occur on the valley plains.

1.8 Geology

The ancient continental Western Shield dominates the geology of Western Australia. The Pilbara region makes up a portion of the Western Shield and consists of pre-Cambrian, Proterozoic and Archaean rocks. The area contains some of the earth's oldest rock formations, thought to be around 3.5 billion years old (ANRA 2013). Important mineral reserves, including iron ore, which is prevalent in the Pilbara, are associated with these rock formations. The study area is situated in the southern edge of the Pilbara Craton in close proximity to the sedimentary basins that separate the Yilgarn and Pilbara Cratons. These consist of the sandstone and shales of the Collier and Bresnahan Basins and granites of the Sylvania Inlier (Tille 2007).

The Pilbara Craton lies beneath the Proterozoic rocks of the Hamersley and Bangemall Basins. The Hamersley Basin covers the majority of the southern part of the Pilbara Craton

and is separated into three stratigraphic groups; the Fortescue, Hamersley and Turee Creek rock groups.

The Fortescue group consists mainly of basalt with beds of siltstone, mudstone, shale, dolomite and jaspilite. These rocks form the Chichester Plateau, which lies beneath the Hamersley Plateau. The Turee Creek group consists of interbedded mudstone, siltstone, sandstone, conglomerate and carbonate. These rocks are the youngest of the three groups and are exposed mainly in the Ashburton Valley. The Hamersley group is the most relevant to the study area as it contains both the Brockman Iron Formation and the Marra Mamba Iron Formation, which together provide most of the major iron ore deposits in the Pilbara (O'Brien and Associates 1992). This group forms the Hamersley Range and Plateau and consists of jaspilite and dolomite. The jaspilite produces deposits of haematite and limonite, which are mined for iron ore.

The surface geology of the study area is dominated by the following geological formations (Thorne and Tyler 1997):

- Phj: Weeli Wolli Formation: banded iron-formation (commonly jaspilitic), pelite, and numerous metadolerite sills;
- Phb: Brockman Iron Formation: banded iron-formation, chert, and pelite;
- Qa: Alluvium unconsolidated silt, sand, and gravel; in drainage channels and on adjacent floodplains;
- Czp: Robe Pisolite: pisolitic limonite deposits developed along river channels
- Czc: Hematite-goethite deposits on banded iron-formation and adjacent scree deposits; and
- Czc: Colluvium- partly consolidated quartz and rock fragments in silt and sand matrix; old valley-fill deposits.

1.9 Flora and Vegetation

The study area is located within the Hamersley Botanical District, which is part of the Eremaean Province (Beard 1990). It is dominated by tree and shrub steppe communities consisting mainly of *Eucalyptus* and *Acacia* species; *Triodia pungens* and *Triodia wiseana* and some Mulga (*Acacia aptaneura*) occur within valley areas and short grass plains occur on alluvia.

Vegetation within the study area (Figure 3) is classified as the following vegetation association, as mapped by Beard (1975) and later refined by Shepherd *et al.* (2002); Hamersley 82: hummock grasslands, low tree steppe, and snappy gum over *Triodia wiseana*. The study area also occurs on the border of Hamersley 18: low woodland, mulga (*Acacia aneura*). While the Pre-European extent for each vegetation association is approximately 100 percent, less than nine percent of the associations occurs within formal or informal reserves (Table 1).

Table 1 Pre-European extent of vegetation associations occurring within the study area (Shepherd *et al.* 2002).

Vegetation Association	Description	Pre-Euro. Extent Remaining (ha)	Remaining area IUCN Class I-IV Reserves	% remaining Other Reserves	% remaining DBCA Managed PL
Hamersley - 82	Hummock grasslands, low tree steppe; Snappy gum over <i>Triodia wiseana</i>	2,290,910 (100%)	8.9 ha	0.2	1.0
Hamersley - 18	Low woodland; mulga (<i>Acacia aneura</i>)	24,659,110 (99.9%)	2.0 ha	0.3	2.5

Riparian zones in the Pilbara are typically ephemeral and comprise an incised drainage channel surrounded by levee banks and floodplains. Surface water is rare but does occur at localised pools or springs. Dominant tree species of the riparian zone are *Eucalyptus camaldulensis*, *Eucalyptus victrix* and *Melaleuca argentea*. *Eucalyptus camaldulensis* and *Eucalyptus victrix* are facultative phreatophytes that draw on groundwater in times of drought, but also utilise surface water. *Melaleuca argentea* is an obligate phreatophyte associated with shallow groundwater and/or permanent pools of surface water along the major creeklines.

1.10 Land Systems

The Department of Agriculture and Food (now the Department of Primary Industries and Regional Development) conducted inventory and condition surveys of the Pilbara (van Vreeswyk *et al.* 2004) using an integrated survey method involving the land system approach to rangeland description evaluation. The primary objective of the surveys was to provide comprehensive descriptions and mapping of the biophysical resources of the region, as well as an evaluation on the condition of soils and vegetation.

A total of 102 land systems were defined in the Pilbara at a scale of 1:250,000 (van Vreeswyk *et al.* 2004), two of which occur within the study area (Table 2, Figure 4). The southern portion of the study area comprises spinifex grasslands of the Newman land system, while the majority of the northern portion of the study area comprises flood plains and rivers of the River land system (Figure 4).

Table 2 Land systems occurring within the study area (descriptions from van Vreeswyk *et al.* 2004).

Land System	Representation in the Pilbara	Description
Newman	14,580 km ² or 8.0%	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.
River	4,088 km ² or 2.3%	Active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands.




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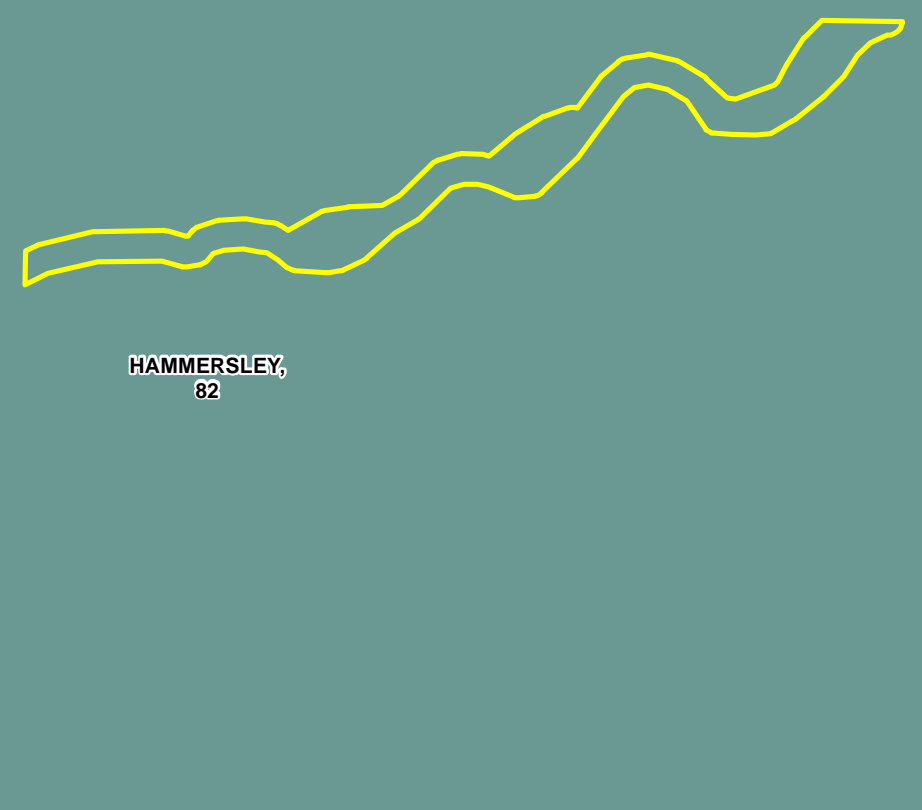
Beard (1975) vegetation complexes within the study area

Legend

-  Study
- Pre-European Vegetation (Beard 1975)**
 -  HAMMERSLEY, 18
 -  HAMMERSLEY, 82

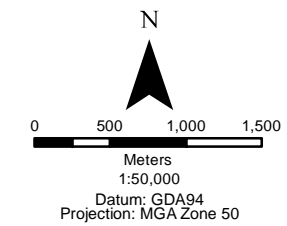
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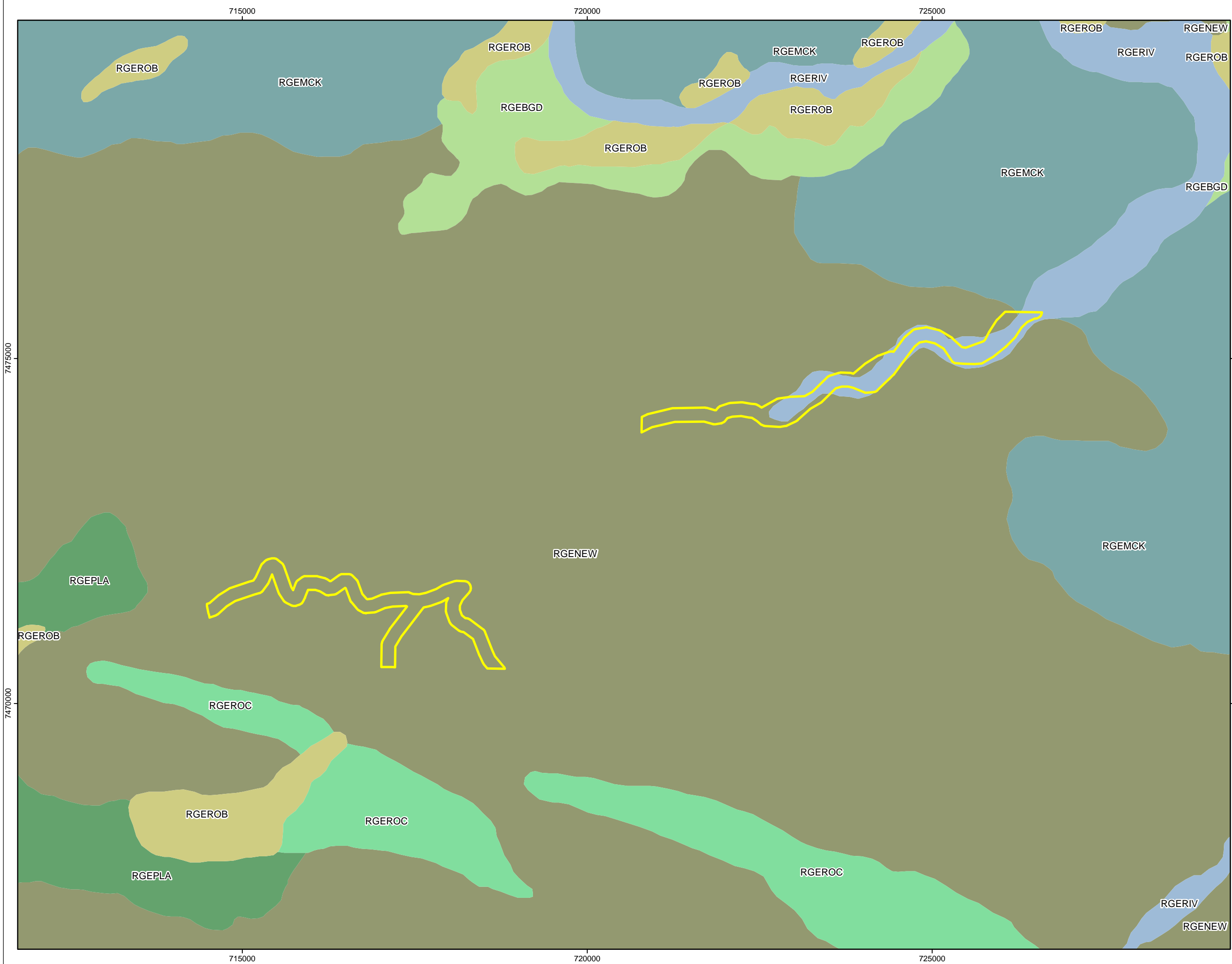
Land systems occurring
within the study area
(descriptions from van
Vreeswyk *et al.* 2004)

Legend

Study

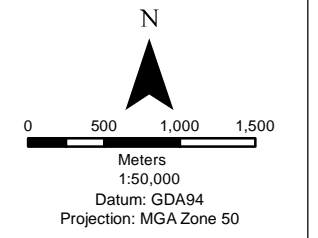
Land Systems (within)

- RGEBGD, Boolgeeda Land System
- RGEMCK, McKay Land System
- RGENEW, Newman Land System
- RGEPLA, Platform Land System
- RGERIV, River Land
- RGEROB, Robe Land
- RGEROC, Rocklea Land



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Date: 08/06/2018
Status: Final
Figure: 4
Sheet Size: A3
Internal Reference: YC_LandSys
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2.0 METHODOLOGY

2.1 Legislation and Guidance Statements

The reconnaissance vegetation survey was carried out in a manner that was compliant with Environmental Protection Authority (EPA) requirements for the environmental surveying and reporting of flora and vegetation in Western Australia:

- Statement of Environmental Principles, Factors and Objectives (EPA 2016a);
- Environmental Factor Guideline Flora and Vegetation (EPA 2016b); and
- Technical Guidance Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016c).

The survey was also conducted in accordance with BHP WAIO's Vegetation and Flora Survey Procedure (BHP 2018).

2.2 Desktop Assessment

2.2.1 Literature Review

A comprehensive literature review of surveys previously completed within or in close proximity to the study area was completed, with a focus on species and/or communities with the potential to be impacted from groundwater drawdown or surplus surface water discharge.

2.2.2 Database Searches

Three database searches were completed for information relating to significant flora previously collected or described within, or in close proximity to the study area (DBCA 2018a):

- The DBCA Threatened Flora Database;
- The DBCA Threatened and Priority Flora List; and
- The Western Australian Herbarium Specimen Database for Priority flora species opportunistically collected in the search area.

A separate database search was completed with the Species and Community Branch of DBCA for significant vegetation communities including TECs, PECs and Environmentally Sensitive Areas (ESAs) (DBCA 2018b).

The database searches extended beyond the immediate survey boundary to place flora and vegetation values in a local and regional context. Searches were conducted using a 25 km radius around the central point of the study area; 767000E 7471000N (Zone 50 GDA94).

A search of the EPBC Act Protected Matters database was undertaken (Department of the Environment and Energy [DoEE] 2018), as well as a search of the International Union for Conservation of Nature (IUCN) database (IUCN 2018) and NatureMap (DBCA 2018c).

The database search results were reviewed prior to the commencement of the field survey, with a particular focus on species or communities with the potential to be impacted from groundwater drawdown or surplus surface water discharge.

2.3 Reconnaissance Vegetation Survey Methodology

2.3.1 Timing and Personnel

The reconnaissance vegetation survey was completed by Principal Botanist Dr Jerome Bull and Senior Botanist Ms Jessica Waters working over a three-day period between the 4th and 6th of June 2018. The survey was planned to be undertaken over a four-day period, however due to heavy rain the botanists could not safely access the study area on the third or fourth day.

2.3.2 Vegetation Association Mapping

The field survey focused on identifying vegetation associations with groundwater dependent, riparian and terrestrial vegetation that may potentially be impacted by discharge or groundwater drawdown activities.

A 1 km grid was overlaid on aerial photography of the study area at a scale of 1:7,500. The study area was then surveyed on foot from two access points along existing access tracks. The transects were each surveyed by the two botanist working in pairs and walking on one side of the drainage line to the end of the transect, and then along the alternate side of the drainage line to the start point of the transect.

Where the target vegetation was recorded, the vegetation association boundaries were mapped utilising high-resolution aerial photography, and flora and vegetation data were collected to provide vegetation association descriptions for the polygons defined. Relevés were undertaken within each target polygon and dominant structural layers were recorded. Additional data collected covered a range of environmental parameters including:

- Landform and habitat;
- Aspect;
- Soil colour and soil type;
- Rock type;
- Slope (angle);
- Vegetation condition;
- Disturbance (caused by fire, clearing, grazing etc.);
- Age since fire;
- Broad floristic formation; and
- Vegetation association description.

Other parameters recorded for each study site were:

- Releve site number and date of assessment;
- Names of the botanists undertaking the assessment;
- Location description a waypoint - GPS coordinate (GDA94) using a handheld GPS; and
- Photograph number.

Description of vegetation structure follows the height, life form and density classes of Specht (1970) as modified by Aplin (1979) and Trudgen (2009) (see Appendix 2). This is largely a structural classification suitable for broader scale mapping, but taking all ecologically significant strata into account.

The condition for each of the vegetation associations mapped was determined using a recognised rating scale (based on Keighery 1994, see Appendix 3).

2.3.3 Vegetation Association Coding

A vegetation association code was applied to each vegetation association mapped. This code is comprised of the dominant landform on which the vegetation association occurs followed by up to three dominant plant taxa occurring within up to three vegetation strata.

2.3.4 Opportunistic Records

Opportunistic recordings for flora of conservation significance or introduced flora species were made while moving through the study area during the reconnaissance survey.

2.3.5 Vouchering

Voucher specimens were taken to verify the identification of species within dominant structural layers, or any species that could potentially be of conservation significance. Taxonomy was completed by Dr Jerome Bull, with selected voucher specimens provided to the specialist botanists within the Western Australian Herbarium (WAH) for further study were required. Use was made of the WAH for confirmation of species identification.

2.3.6 Field Survey Constraints

The EPA Technical Guidance (EPA 2016c) list seven potential limitations that field surveys may encounter. These limitations are addressed in Table 3. There were no survey-specific limitations for this survey.

Table 3 Relevance of limitations, as identified by EPA (2016c), to the flora and vegetation survey.

Constraint	Relevance
Availability of contextual information at a regional and local scale	The Ministers North to Yandi locality has been well surveyed in recent years, with numerous unpublished reports reviewed as part of the desktop review. Publicly available databases supporting flora species lists, conservation significant flora records, and significant vegetation communities (TEC's and PEC's) were also interrogated as part of the database investigations. Regional and local level information is therefore not considered to be a limiting factor for this study.
Proportion of flora recorded and/or collected, any identification issues	The objective of the survey was to identify and map groundwater dependent and riparian vegetation for use in impact assessment. The majority of plant specimens collected during the reconnaissance field survey were of sufficient quality to be fully determined, noting that seasonal conditions were rated as 'poor'. All of the expected groundwater dependent species expected to be encountered within the study area were recorded. Due to heavy rain, the field survey duration was reduced by two days. This resulted in a large portion of the study area not being assessed; vegetation mapping within this area was inferred. Fungi and non-vascular flora (algae, mosses and liverworts) were not sampled, which is consistent with the accepted level of effort for a survey of this type and scale.
Survey timing, rainfall, season of survey	The survey was completed in June 2018 under 'poor' seasonal conditions owing to low summer rainfall during months preceding field work. The seasonal conditions did not have have a significant impact on the identification and mapping of groundwater dependent, riparian and terrestrial vegetation. However, a number of the annual and ephemeral plant taxa may not have been present at the time of survey. The survey timing was not considered a significant limitation.
Disturbance that may have affected the results of survey such as fire, flood or clearing	Disturbances within the study area included grazing of vegetation by domestic stock (cattle), and the presence of introduced species. None of the disturbances were a constraint to completing the survey.

Constraint	Relevance
Was the appropriate area fully surveyed (effort and extent)	Two botanists working over a three-day period walked two transects totalling 5 km in length, and assessed approximately 30 relevé plots, representing a high intensity assessment for the portion of the study area surveyed. However, the field survey time was reduced by two days due to heavy rainfall, resulting in approximately half of the study area not being assessed. Vegetation mapping was inferred for these areas.
Access restrictions within the survey area	The study area was accessed by vehicle and on foot, however due to heavy rain the field survey duration was reduced by two days, resulting in a large portion of the study area not being accessed. There was a single access point in to the western start point of the northern section of the study area, further reducing access. Access was considered to be a limiting factor for the survey.
Competency/experience of the team carrying out the survey, including experience in the bioregion surveyed	The Principal Botanist working on the survey has over 15 years Pilbara experience, and the accompanying Senior Botanist has in excess of seven years Pilbara experience. Together the survey team has completed numerous surveys in close proximity to the study area over recent years. The vast local and regional experience of both botanists working on the survey is considered a significant asset to the survey.

2.3.7 Assessment of Conservation Significance

The conservation significance of flora and ecological communities are classified at a Commonwealth, State and Local level on the basis of various Acts and Agreements, including:

Commonwealth Level:

- EPBC Act: The DoEE lists Threatened flora and ecological communities, which are determined by the Threatened Species Scientific Committee according to criteria set out in the Act. The Act lists flora that are considered to be of conservation significance under one of six categories (Appendix 4).

State Level:

- WC Act: At a State level, native flora species are protected under the *WC Act – Wildlife Conservation Notice*. A number of species are assigned an additional level of conservation significance based on a limited number of known populations and the perceived threats to these locations.
- DBCA Priority list: DBCA produces a list of Priority species and ecological communities that have not been assigned statutory protection under the WC Act. Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added under Priorities 1, 2 or 3. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been removed from the threatened species list for other taxonomic reasons, are placed in Priority 4. These species require regular monitoring (see Appendix 5). The list of PECs identifies those that need further investigation before nomination for TEC status at a State level.

Local Level:

- Species may be considered of local conservation significance because of their patterns of distribution and abundance. Although not formally protected by legislation, such species are acknowledged to be in decline as a result of threatening processes, primarily habitat loss through land clearing.

3.0 SURVEY RESULTS

3.1 Desktop Assessment

3.1.1 Previous Flora and Vegetation Surveys

The flora and vegetation of the Pilbara has been assessed at a broad scale by Burbidge (1959) and Beard (1975). More recently, the Department of Agriculture and Food completed an inventory and condition survey of the Pilbara based on land system mapping (van Vreeswyk *et al.* 2004). More specific data has been collected as part of DBCA's Pilbara Region Biological Survey 2002-2013 (DBCA 2013). This dataset has recently been published and will provide a regional context that will benefit impact assessment for future development proposals within the Pilbara.

In addition to the larger broad scale surveys, an increasing number of smaller intensive flora and vegetation surveys have been completed in recent years associated with resource development projects. These surveys have resulted in the collection of a significant amount of site-specific biological survey data, most of which has been undertaken for formal environmental impact assessment. There are 17 relevant flora and vegetation surveys that have been completed within a 25 km radius of the study area (Appendix 1).

3.1.2 Threatened Flora listed under the EPBC Act

A search of the EPBC Act Protected Matters database was undertaken for a 50 km buffer around the study area (DoEE 2018). The database search listed one Threatened Flora or its habitat as likely to occur within the search radius; *Lepidium catapycnon* (Hamersley Lepidium). DBCA has recently downgraded *Lepidium catapycnon* from Threatened (Declared Rare) Flora to Priority 4 status.

3.1.3 Threatened Flora listed under the IUCN Red List

A search of the International Union for Conservation of Nature (IUCN) database (IUCN 2018) determined that no Threatened Flora taxon was likely to occur within the study area.

3.1.4 Threatened Flora listed under the WA Wildlife Conservation (Rare Flora) Notice

The DBCA rare flora database search (DBCA 2018a) did not identify any plant taxon gazetted as Threatened Flora (T) pursuant to subsection (2) of Section 23F of the WC Act, from a 25 km radius around the study area.

3.1.5 Priority Flora recognised by the DBCA

The DBCA rare flora database search (DBCA 2018a) identified 51 Priority flora taxa as potentially occurring within a 25 km radius of the study area. An additional six Priority flora taxa were identified from the NatureMap database search (DBCA 2018c). These taxa are described in more detail in Table 4.

Table 4 Significant flora previously recorded from a 25 km search radius of the study area (DBCA 2018a, DBCA 2018c). SCC - State Conservation Code (WC Act) and DBCA (2018), FCC - Federal Conservation Code (EPBC Act)

Taxon	Cons. Code	Life Form	Habitat Preference ⁵
<i>Acacia aphanoclada</i>	1	Perennial	Skeletal stony soils. Rocky hills, ridges & rises.
<i>Acacia bromilowiana</i>	4	Perennial	Red skeletal stony loam, orange-brown pebbly, gravel loam, laterite, banded ironstone, basalt. Rocky hills, breakaways, scree slopes, gorges, creek beds.
<i>Acacia cyperophylla</i> var. <i>omearana</i>	1	Perennial	Stony & gritty alluvium. Along drainage lines.
<i>Acacia dawweana</i>	3	Perennial	Stony red loamy soils. Low rocky rises, along drainage lines.
<i>Acacia effusa</i>	3	Perennial	Stony red loam. Scree slopes of low ranges.
<i>Acacia fecunda</i>	3	Perennial	Quartzite gibbers over grey-red skeletal soil. Along shallow creeks and drainage lines, hills, road verges.
<i>Acacia</i> sp. Nullagine (B.R. Maslin 4955)	1	Perennial	Rocky clay. Low-lying areas between rocky hills.
<i>Acacia subtiliformis</i>	3	Perennial	On rocky calcrete plateau.
<i>Adiantum capillus-veneris</i>	2	Perennial	Moist, sheltered sites in gorges and on cliff walls.
<i>Amaranthus centralis</i>	3	Annual	River banks. Sand plains. Mulga woodlands.
<i>Ampelopteris prolifera</i>	3	Perennial	Near water or in wet ground.
<i>Aristida calycina</i> var. <i>calycina</i>	2	Perennial	Red earths, sands, alluvial soils.
<i>Aristida jerichoensis</i> var. <i>subspinulifera</i>	3	Perennial	Hardpan plains.
<i>Aristida lazaridis</i>	2	Perennial	Sand or loam.
<i>Atriplex flabelliformis</i>	3	Perennial	Clay loam, loam. Saline flats or marshes.
<i>Atriplex spinulosa</i>	1	Annual	-
<i>Cardamine paucijuga</i>	2	Annual	In moist to dry habitats.
<i>Cladium procerum</i>	2	Perennial	Perennial pools.
<i>Cochlospermum macnamarae</i>	1	Perennial	-
<i>Dampiera anonyma</i>	3	Perennial	Skeletal red-brown to brown gravelly soil over banded ironstone, basalt, shale and jaspilite. Hill summits, upper slopes (above 1000m).
<i>Dampiera metallorum</i>	3	Perennial	Skeletal red-brown gravelly soil over banded ironstone. Steep slopes, summits of hills.
<i>Dipteracanthus chichesterensis</i>	1	Perennial	Red-brown cracking clay soils associated with basalts on the Chichester Plateau, slopes, tablelands, benches and creek margins.
<i>Eremophila magnifica</i> subsp. <i>velutina</i>	3	Perennial	Skeletal soils over ironstone. Summits.
<i>Eremophila pusilliflora</i>	2	Perennial	-
<i>Eremophila</i> sp. Hamersley Range (K. Walker KW 136)	1	Perennial	Rocky soils.
<i>Eremophila spongiorcarpa</i>	1	Perennial	Weakly saline alluvial plain on margins of marsh.
<i>Eremophila youngii</i> subsp. <i>lepidota</i>	4	Perennial	Stony red sandy loam. Flats plains, floodplains, sometimes semi-saline, clay flats.
<i>Eucalyptus rowleyi</i>	3	Perennial	-
<i>Euphorbia australis</i> var. <i>glabra</i>	2	Both	Variety of soils.
<i>Euphorbia stevenii</i>	3	Perennial	Clay, sandy soils.
<i>Glycine falcata</i>	3	Perennial	Black clayey sand. Along drainage depressions in crabhole plains on river floodplains.
<i>Goodenia lyrata</i>	3	Annual	Red sandy loam. Near claypan.
<i>Goodenia nuda</i>	4	Annual	Sandy loam soils on floodplains and drainage lines.
<i>Goodenia</i> sp. East Pilbara (A.A. Mitchell PRP 727)	3	Annual	Red-brown clay soil, calcrete pebbles. Low undulating plain, swampy plains.

⁵ Source: DBCA (2018d)

Taxon	Cons. Code	Life Form	Habitat Preference ⁵
<i>Grevillea saxicola</i>	3	Perennial	Rocky hillslopes of ranges, southern aspect preference.
<i>Hibiscus</i> sp. Gurinbiddy Range (M.E. Trudgen MET 15708)	2	Perennial	-
<i>Indigofera ixocarpa</i>	2	Perennial	Skeletal red soils over massive ironstone.
<i>Iotasperma sessilifolium</i>	3	Annual	Cracking clay, black loam. Edges of waterholes, plains.
<i>Ipomoea racemigera</i>	2	Annual	Flats and stream channels.
<i>Isotropis parviflora</i>	2	Perennial	Valley slope of ironstone plateau.
<i>Lepidium catapycnon</i>	4	Perennial	Skeletal soils. Hillsides.
<i>Myriophyllum balladoniense</i>	4	Perennial	Semi-permanent rock pools on granite outcrops.
<i>Myriocephalus scalpellus</i>	1	Annual	Clay. Depression on flood plain.
<i>Nicotiana umbratica</i>	3	Annual	Shallow soils. Rocky outcrops.
<i>Oxalis</i> sp. Pilbara (M.E. Trudgen 12725)	2	Perennial	Shaded gully on the lower slopes of a large hill, in the flowline in the gully. Pebbly/gravelly red-brown loam soils amongst boulders.
<i>Ptilotus subspinescens</i>	3	Perennial	Gentle rocky slopes, screes and the bases of screes.
<i>Ptilotus wilsonii</i>	1	Perennial	Stony gravelly soils. Rocky hills.
<i>Rhodanthe ascendens</i>	1	Annual	Clay. Roadside verge.
<i>Rhagodia</i> sp. Hamersley (M. Trudgen 17794)	3	Perennial	Stony plains supporting Mulga.
<i>Sida</i> sp. Barlee Range (S. van Leeuwen 1642)	3	Perennial	Skeletal red soils pockets. Steep slope.
<i>Stylidium weeliwolli</i>	3	Annual	Gritty sand soil, sandy clay. Edge of watercourses.
<i>Synostemon hamersleyensis</i>	1	Perennial	Ironstone upper hill slopes.
<i>Tecticornia medusa</i>	3	Perennial	Saline flats, marsh.
<i>Teucrium pilbaranum</i>	2	Perennial	Clay. Crab hole plain in a river floodplain, margin of calcrete table.
<i>Tribulus minutus</i>	1	Annual	-
<i>Triodia triticoides</i>	1	Perennial	Rocky sandstone & limestone hillslopes.
<i>Xerochrysum boreale</i>	3	Perennial	-

3.1.6 TECs listed under State and Federal Legislation

A search of the EPBC Act Protected Matters database (DoEE 2018) confirmed there were no Federal listed TECs previously recorded within, or adjacent to, the study area. Similarly, a search of the State communities database (DBCA 2018b) confirmed there were no listed TEC records for the immediate study area or surrounds.

3.1.7 PECs recognised by DBCA

A search of the DBCA communities database (DBCA 2018b) confirmed that two PECs occur within a 25 km radius of the study area (Table 5, Figure 5):

- Fortescue Marsh (Marsh Land System) (Priority 1); and
- Weeli Wolli Spring community (Priority 1).

Table 5 PECs occurring within a 25 km radius of the study area (DBCA 2018b).

PEC	Description	Location
Fortescue Marsh (Marsh Land System) Priority 1	An extensive, episodically inundated samphire marsh at the upper terminus of the Fortescue River and the western end of Goodiadarrie Hills. It is regarded as the largest ephemeral wetland in the Pilbara. It is a highly diverse ecosystem with fringing mulga woodlands (on the northern side), samphire shrublands and groundwater dependant riparian ecosystems. Endemic <i>Eremophila</i> species, populations of priority flora and several near endemic and new to science samphires.	The buffer zone for this PEC begins ~15 km north of the study area
Weeli Wolli Spring community Priority 1	Riparian woodland and forest associations are unusual as a consequence of the composition of the understorey. The sedge and herbfield communities that fringe many of the pools and associated water bodies along the main channels of Weeli Wolli Creek have not been recorded from any other wetland site in the Pilbara. The spring and creekline are also noted for their relatively high diversity of stygofauna and this is probably attributed to the large-scale calcrete and alluvial aquifer system associated with the creek.	The buffer zones of this PEC is ~5 km south-east of the study area



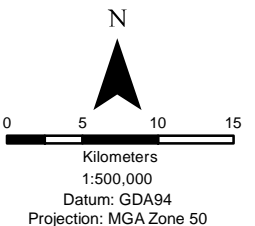
BHP

Yandicoogina Creek

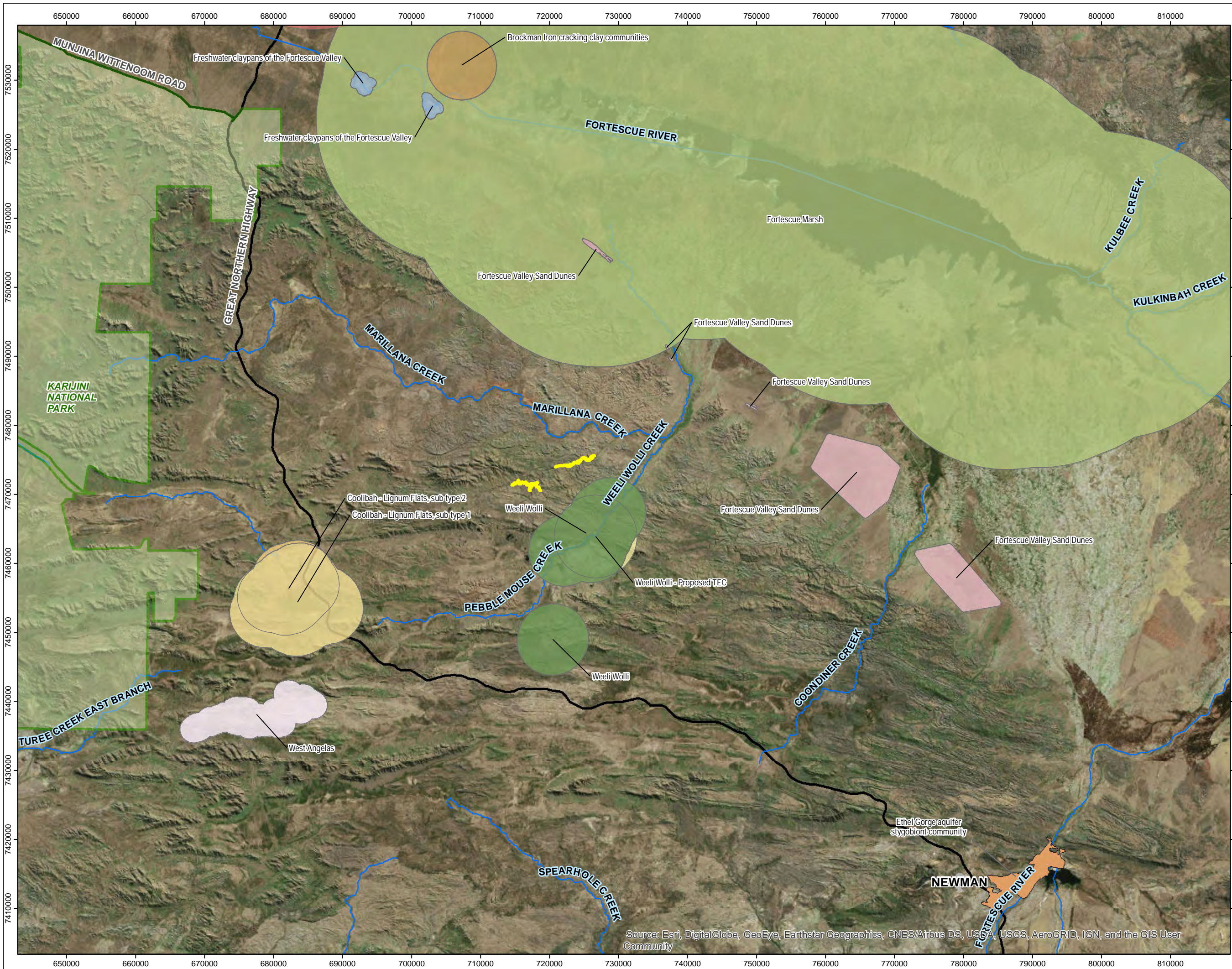
Location of the TECs and PECs within a 50 km radius of the Study Area

Legend

- Study
- PEC Locations**
 - Brockman Iron cracking clay communities
 - Coolibah - Lignum Flats, sub type 1
 - Coolibah - Lignum Flats, sub type 2
 - Fortescue Marsh
 - Fortescue Valley Sand Dunes
 - Freshwater claypans of the Fortescue Valley
 - Weeli Wolli
 - Weeli Wolli - Proposed TEC
 - West
- TEC Location**
 - Ethel Gorge



Date: 08/06/2018
 Status: Final
 Figure: 5
 Sheet Size: A3
 Internal Reference: YC_PEC_TEC
 Drawn by: GSM
 Requested by: DB



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

3.2 Vegetation Associations

There were a total of ten vegetation associations described and mapped from the main drainage channel of Yandicoogina Creek within the study area. Vegetation was classified into eight broad floristic formations:

- *Eucalyptus* Woodland;
- *Acacia* High Shrubland;
- *Gossypium* High Shrubland;
- *Sorghum* Tussock Grassland;
- *Eulalia* Tussock Grassland;
- *Themeda* Open Tussock Grassland;
- *Triodia* Open Hummock Grassland; and
- **Cenchrus* Closed Tussock Grassland.

Six of the ten vegetation associations supported groundwater dependent vegetation (i.e. *Melaleuca argentea*, *Eucalyptus camaldulensis* and *Eucalyptus victrix*) (Table 6; Figure 6). One vegetation association (MA EcMa TtEuaSopl CyvTydEgen - Woodland of *Eucalyptus camaldulensis* and *Melaleuca argentea* over Open Tussock Grassland of *Themeda triandra*, *Eulalia aurea* and *Sorghum plumosum* over Open Sedges of *Cyperus vaginatus*, *Typha domingensis* and *Eleocharis geniculata* on brown loam on major drainage lines) supported zones of permanent pooling scattered throughout the mapped extent of this unit. The open sedge stratum was restricted to these permanent pools.

The remaining four vegetation associations described and mapped along Yandicoogina Creek did not support groundwater dependent vegetation, or stands of Mulga or *Acacia citrinoviridis* that are known to be susceptible to prolonged inundation that may result from surface water discharge (Table 6; Figure 6).

Vegetation condition for almost all of the entire riparian vegetation along the main drainage channels surveyed was rated as *good*, with a small area along the eastern section was rated as *poor* (Figure 7). The main impacts recorded were directed related to grazing by cattle, and included trampling of native vegetation and the introduction of weeds.

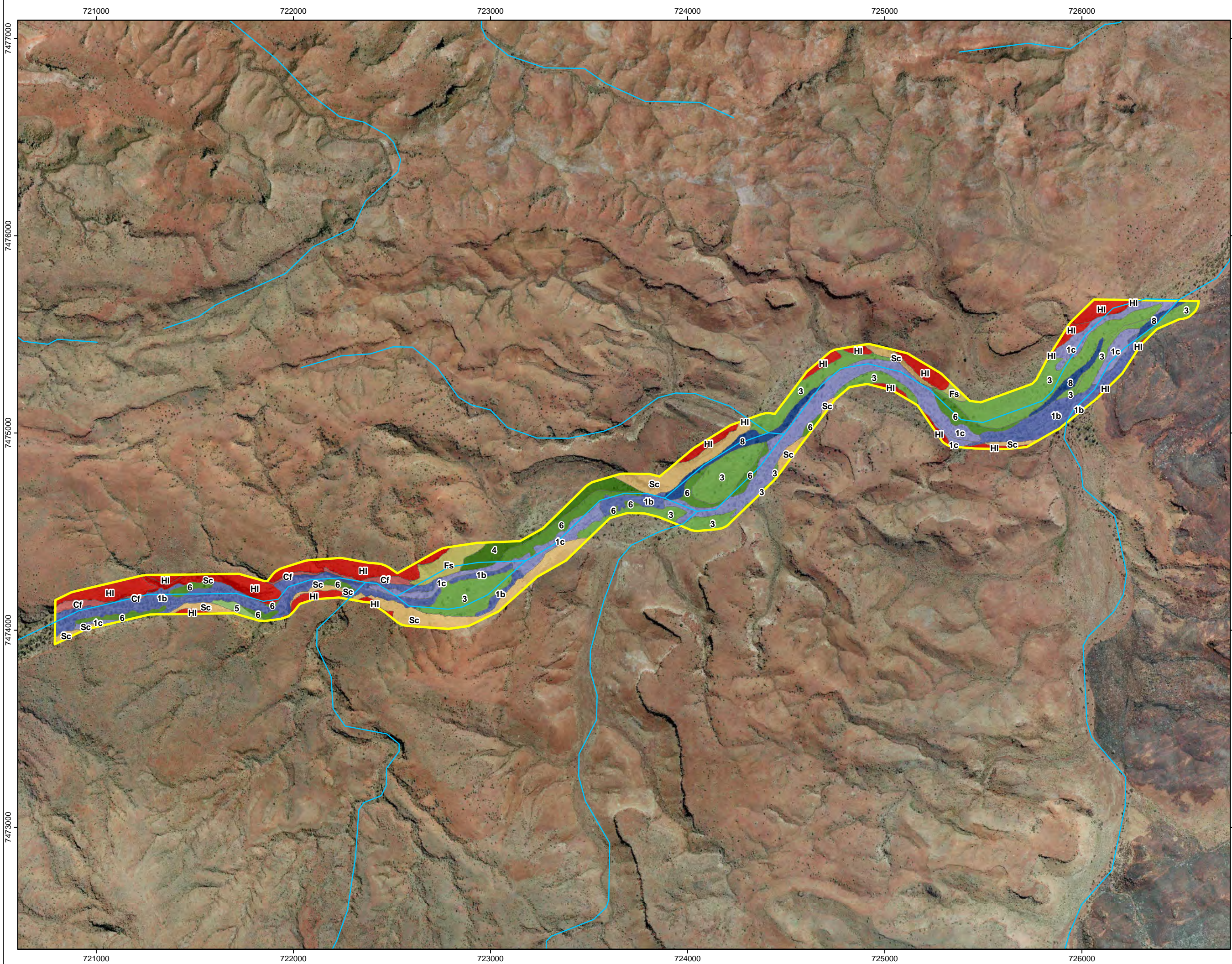
Table 6 Vegetation descriptions for vegetation associations mapped within the study area.

Broad Floristic Formation	Vegetation Code	Mapping Code	Vegetation Association	Other Strata or Common Taxa	Condition
Vegetation associations supporting groundwater dependent vegetation					
<i>Eucalyptus</i> Woodland	MA EcEv TefcPld MerTtEua	1a	Woodland of <i>Eucalyptus camaldulensis</i> and <i>Eucalyptus victrix</i> over Low Shrubland of <i>Tephrosia rosea</i> var. Fortescue creeks (M.I.H. Brooker 2186) and <i>Pluchea dentex</i> over Open Tussock Grassland of * <i>Melinis repens</i> , <i>Themeda triandra</i> and <i>Eulalia aurea</i> on brown sand on major drainage line	Low Open Woodland of <i>Acacia coriacea</i> subsp. <i>pendens</i> and <i>Atalaya hemiglauca</i> , High Open Shrubland of <i>Acacia tumida</i> var. <i>pilbarensis</i> and <i>Acacia pyrifolia</i> , Very Open Sedges of <i>Cyperus vaginatus</i> , Very Open Herbs of <i>Centipeda minima</i> var. <i>macrocephala</i> , <i>Alternanthera nodiflora</i> , <i>Marselia hirsuta</i> , <i>Ammania multiflora</i> and <i>Goodenia lamprosperma</i>	Good
	MA EcMa TtEuaSopl CyvTydEgen	1b	Woodland of <i>Eucalyptus camaldulensis</i> and <i>Melaleuca argentea</i> over Open Tussock Grassland of <i>Themeda triandra</i> , <i>Eulalia aurea</i> and <i>Sorghum plumosum</i> over Open Sedges of <i>Cyperus vaginatus</i> , <i>Typha domingensis</i> and <i>Eleocharis geniculata</i> on brown loam on major drainage lines	Low Woodland of <i>Eucalyptus camaldulensis</i> , <i>Acacia coriacea</i> subsp. <i>pendens</i> and <i>Melaleuca argentea</i> , High Open Shrubland of <i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Grevillea wickhamii</i> and <i>Cullen leucanthum</i> , Low Open Shrubland of <i>Pluchea dentex</i> , <i>Tephrosia rosea</i> var. Fortescue Creeks and <i>Pteracaulon sphacelatum</i>	Good
	MA EcEv TtEuaSopl GoroCuleAtp	1c	Woodland of <i>Eucalyptus camaldulensis</i> and <i>Eucalyptus victrix</i> over Open Tussock Grassland of <i>Themeda triandra</i> , <i>Eulalia aurea</i> and <i>Sorghum plumosum</i> with High Open Shrubland of <i>Gossypium robinsonii</i> , <i>Cullen leucanthum</i> and <i>Acacia tumida</i> var. <i>pilbarensis</i> on brown loam on major drainage lines	Low Open Shrubland of <i>Pluchea dentex</i> and <i>Tephrosia rosea</i> var. Fortescue Creeks, Very Open Herbs of <i>Goodenia lamprosperma</i> , Scattered Low Trees of <i>Eucalyptus camaldulensis</i> , <i>Acacia coriacea</i> subsp. <i>pendens</i> and <i>Melaleuca argentea</i> <i>Melaleuca glomerata</i>	Good

Broad Floristic Formation	Vegetation Code	Mapping Code	Vegetation Association	Other Strata or Common Taxa	Condition
<i>Sorghum</i> Tussock Grassland	FP SoplErtTt GoroAtpCule AtpApyAnI	6	Tussock Grassland of <i>Sorghum plumosum</i> , <i>Eriachne tenuiculmis</i> and <i>Themeda triandra</i> with High Open Shrubland of <i>Gossypium robinsonii</i> , <i>Acacia tumida</i> var. <i>pilbarensis</i> and <i>Cullen leucanthum</i> and Open Shrubland of <i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Acacia pyrifolia</i> and <i>Androcalva luteiflora</i> on brown silty loam on floodplains ⁶	Scattered Low Trees of <i>Eucalyptus camaldulensis</i> , Low Open Shrubland of <i>Tephrosia rosea</i> var. <i>Fortescue</i> Creeks, <i>Indigofera monophylla</i> and <i>Corchorus croziforifolius</i>	Good
<i>Eulalia</i> Tussock Grassland	MA EuaTtErt EvEc AcpEv	7	Tussock Grassland of <i>Eulalia aurea</i> , <i>Themeda triandra</i> and <i>Eriachne tenuiculmis</i> with Woodland of <i>Eucalyptus victrix</i> and <i>Eucalyptus camaldulensis</i> and Low Open Woodland of <i>Acacia coriacea</i> subsp. <i>pendens</i> and <i>Eucalyptus victrix</i> on brown sand on major drainage lines	High Open Shrubland of <i>Melaleuca glomerata</i> and <i>Acacia tumida</i> var. <i>pilbarensis</i> , Open Shrubland of <i>Acacia tumida</i> var. <i>pilbarensis</i> and <i>Acacia pyrifolia</i>	Good
<i>Themeda</i> Open Tussock Grassland	MA TtCyaEua EcEv EcEv	8	Open Tussock Grassland of <i>Themeda triandra</i> , <i>Cymbopogon ambiguus</i> (riverine) and <i>Eulalia aurea</i> with Open Woodland of <i>Eucalyptus camaldulensis</i> and <i>Eucalyptus victrix</i> over Low Open Woodland of <i>Eucalyptus camaldulensis</i> , <i>Eucalyptus victrix</i> and <i>Acacia coriacea</i> subsp. <i>pendens</i> on brown loam on major drainage lines	High Open Shrubland of <i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Gossypium robinsonii</i> and <i>Cullen leucanthum</i> , Low Open Shrubland of <i>Tephrosia rosea</i> var. <i>Fortescue</i> Creeks, <i>Corchorus croziforifolius</i> and <i>Acacia pyrifolia</i>	Good
Vegetation unlikely to be negatively impacted by either groundwater drawdown or surface water discharge					
<i>Acacia</i> High Shrubland	FP AtpGrwhPI Tp Tt EuaCc	2	High Shrubland of <i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Grevillea wickhamii</i> subsp. <i>hispidula</i> and <i>Petalostylis labicheoides</i> over Open Hummock Grassland of <i>Triodia pungens</i> over Open Tussock Grassland of <i>Themeda triandra</i> , <i>Eulalia aurea</i> and <i>Cenchrus ciliaris</i> on brown sandy loam on floodplains	Low Open Shrubland of <i>Pterocaulon sphacelatum</i> and <i>Bonamia erecta</i> , Open Shrubland of <i>Acacia pyrifolia</i> , <i>Stylobasium spathulatum</i> and <i>Androcalva luteiflora</i> and <i>Grevillea pyramidalis</i> , Low Open Woodland of <i>Corymbia hamsersleyana</i> <i>Acacia maitlandii</i>	Good

⁶ *Eucalyptus camaldulensis* trees present within this vegetation association, however was not a dominant component of the association.

Broad Floristic Formation	Vegetation Code	Mapping Code	Vegetation Association	Other Strata or Common Taxa	Condition
<i>Gossypium</i> High Shrubland	FP GoroPICule AtpPIGrwh TtSoplErt	3	High Shrubland of <i>Gossypium robinsonii</i> , <i>Petalostylis labicheoides</i> and <i>Cullen leucanthum</i> over Shrubland of <i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Petalostylis labicheoides</i> and <i>Grevillea wickhamii</i> subsp. <i>hispidula</i> over Open Tussock Grassland of <i>Themeda triandra</i> , <i>Sorghum plumosum</i> and <i>Eriachne tenuiculmis</i> on brown loamy sand on floodplains	Scattered Low Trees of <i>Eucalyptus camaldulensis</i> , Low Open Shrubland of <i>Tephrosia rosea</i> var. <i>Fortescue</i> Creeks, <i>Indigofera monophylla</i> and <i>Corchorus croziforifolius</i> , Very Open Hummock Grassland of <i>Triodia pungens</i>	Good
<i>Triodia</i> Open Hummock Grassland	FP Tp ChfErerTt ChHallAthe	4	Open Hummock Grassland of <i>Triodia pungens</i> over Open Tussock Grassland of <i>Chrysopogon fallax</i> , <i>Eragrostis eriopoda</i> and <i>Themeda triandra</i> and Low Open Woodland of <i>Corymbia hamersleyana</i> , <i>Hakea lorea</i> subsp. <i>lorea</i> and <i>Atalaya hemiglauca</i> on brown sandy loam on floodplains	Open Shrubland of <i>Stylobasium spathulatum</i> , <i>Androcalva luteiflora</i> , Low Open Shrubland of <i>Gossypium australe</i> , <i>Acacia bivenosa</i> , <i>Senna artemisioides</i> subsp. <i>oligophylla</i> , <i>Ptilotus astrolasicus</i> , High Open Shrubland of <i>Gossypium robinsonii</i> <i>Eucalyptus camaldulensis</i> , <i>Eulalia aurea</i> , <i>Paraneurachne muelleri</i>	Good
* <i>Cenchrus</i> Closed Tussock Grassland	FP CcTtErer HallAthe StspAniGoro	5	Closed Tussock Grassland of * <i>Cenchrus ciliaris</i> , <i>Themeda triandra</i> and <i>Eragrostis eriopoda</i> with Low Open Woodland of <i>Hakea lorea</i> subsp. <i>lorea</i> , <i>Atalaya hemiglauca</i> and <i>Acacia pruinocarpa</i> and Open Shrubland of <i>Stylobasium spathulatum</i> , <i>Androcalva luteiflora</i> and <i>Gossypium robinsonii</i> on brown loamy sand on floodplains	<i>Cullen leucanthum</i> , <i>Acacia tumida</i> var. <i>pilbarensis</i>	Poor

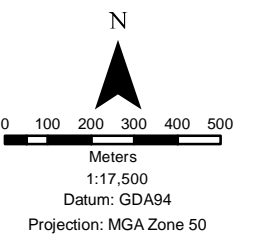


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YANDICOOGINA CREEK

Vegetation Types
Northern Section

Legend

Study Area



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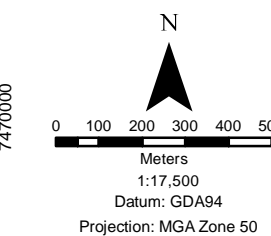


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YANDICOOGINA CREEK

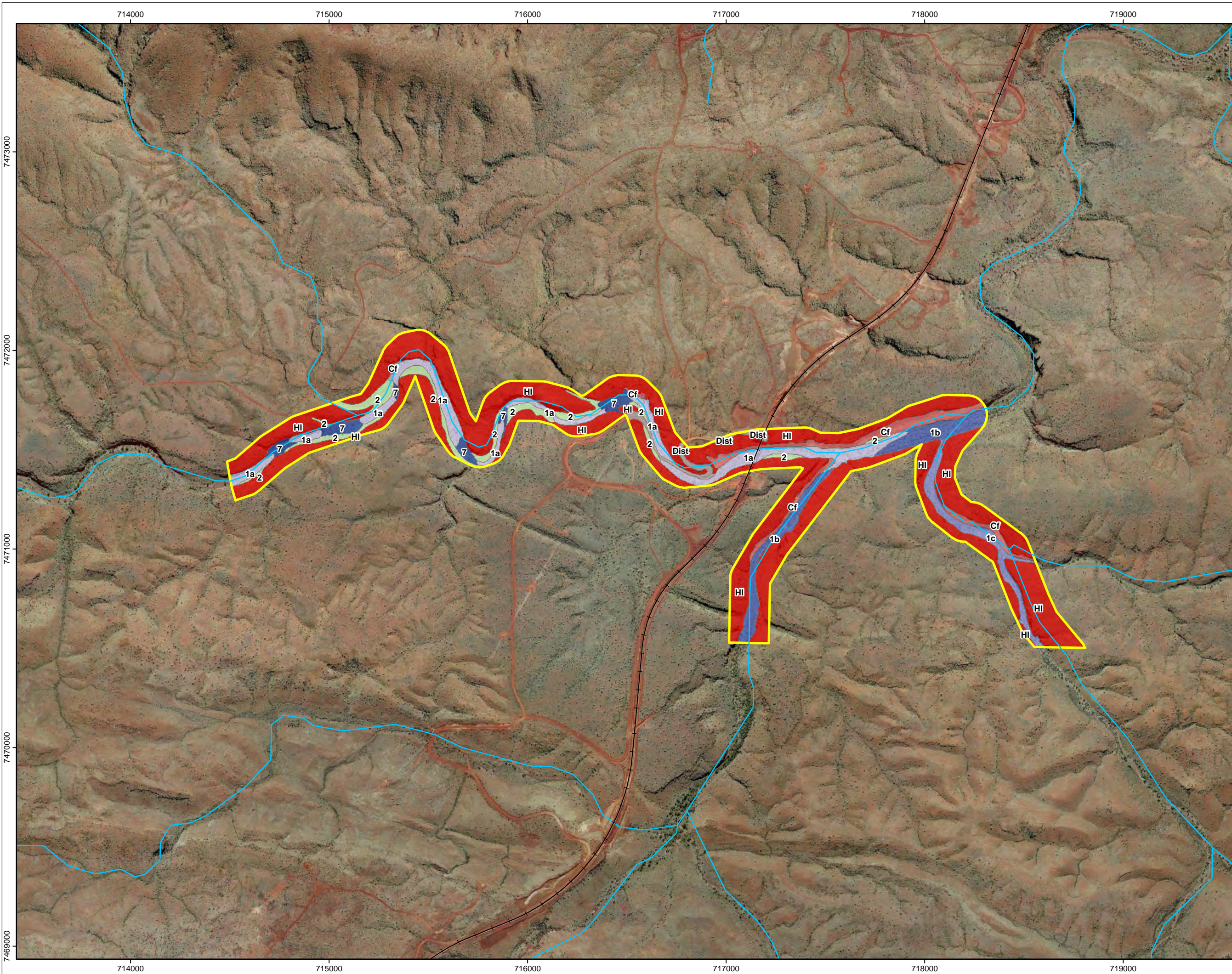
Vegetation Types
Southern Section

Legend


- Study Area
- Rail




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Requested by: DB








Legend

 Study Area






 Rail

Vegetation Types






Flood Plain

-  FP AtpGrwhPI Tp Tt EuaCc - 2 High Shrubland of *Acacia tumida* var. *pilbarensis*, *Grevillea wickhamii* subsp. *hispidula* and *Petalostylis labicheoides* over Open Hummock Grassland of *Triodia pungens* over Open Tussock Grassland of *Themeda triandra*, *Eulalia aurea* and **Cenchrus ciliaris* on brown sandy loam on floodplains
-  FP CcTtErer HallAthe StspAnlGoro- 5 Closed Tussock Grassland of **Cenchrus ciliaris*, *Themeda triandra* and *Eragrostis eriopoda* with Low Open Woodland of *Hakea lorea* subsp. *lorea*, *Atalaya hemiglauca* and *Acacia pruinocarpa* and Open Shrubland of *Stylobasium spathulatum*, *Androcalva luteiflora* and *Gossypium robinsonii* on brown loamy sand on floodplains
-  FP GoroPICule AtpPIGrwh TtSoplErt - 3 High Shrubland of *Gossypium robinsonii*, *Petalostylis labicheoides* and *Cullen leucanthum* over Shrubland of *Acacia tumida* var. *pilbarensis*, *Petalostylis labicheoides* and *Grevillea wickhamii* subsp. *hispidula* over Open Tussock Grassland of *Themeda triandra*, *Sorghum plumosum* and *Eriachne tenuiculmis* on brown loamy sand on floodplains
-  FP SoplErtTt GoroAtpCule AtpApyAnl - 6 Tussock Grassland of *Sorghum plumosum*, *Eriachne tenuiculmis* and *Themeda triandra* with High Open Shrubland of *Gossypium robinsonii*, *Acacia tumida* var. *pilbarensis* and *Cullen leucanthum* and Open Shrubland of *Acacia tumida* var. *pilbarensis*, *Acacia pyrifolia* and *Androcalva luteiflora* on brown silty loam on floodplains
-  FP Tp ChfErerTt ChHallAthe - 4 Open Hummock Grassland of *Triodia pungens* over Open Tussock Grassland of *Chrysopogon fallax*, *Eragrostis eriopoda* and *Themeda triandra* and Low Open Woodland of *Corymbia hamersleyana*, *Hakea lorea* subsp. *lorea* and *Atalaya hemiglauca* on brown sandy loam on floodplains

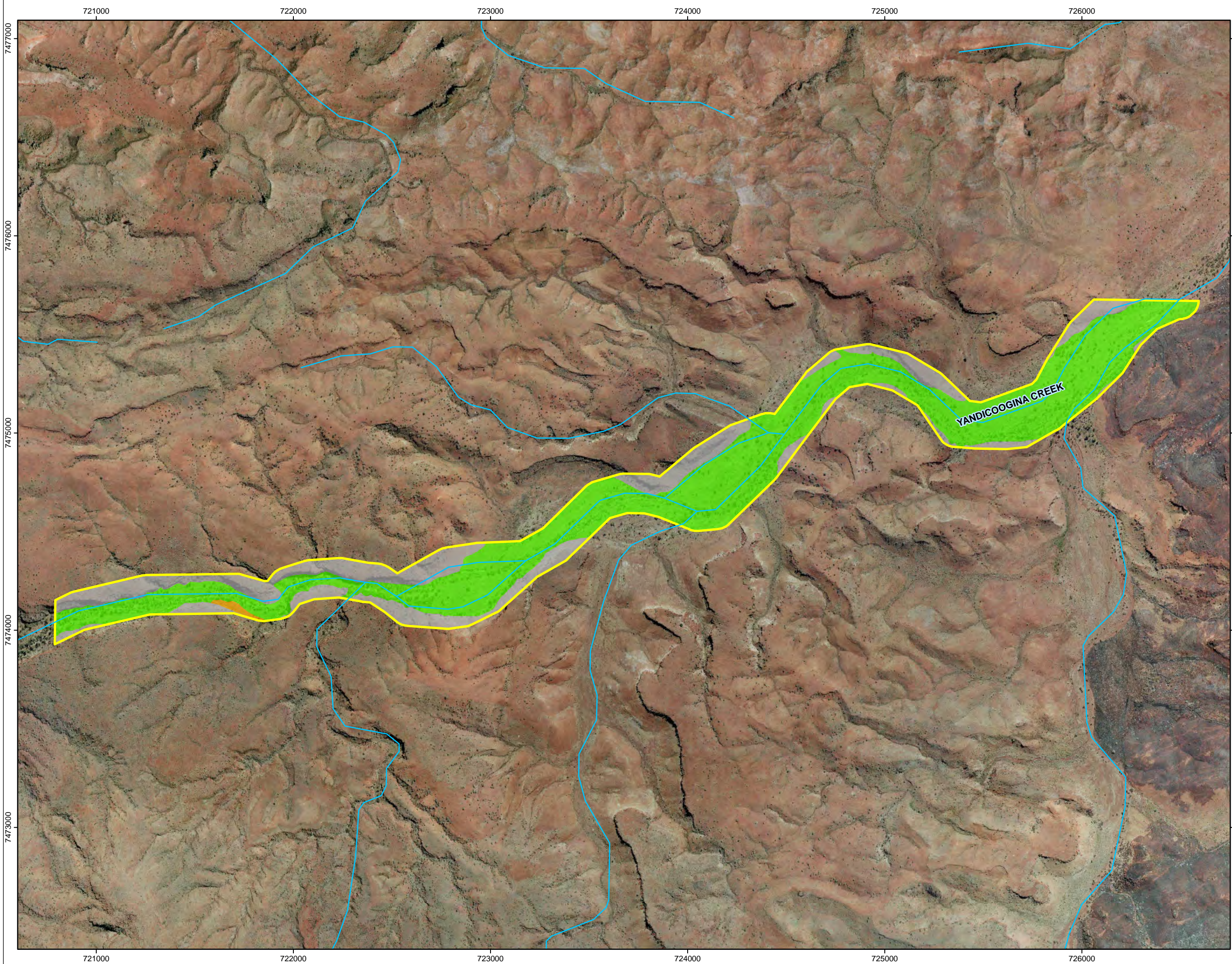
Major Drainage

-  MA EcEv TefcPld MerTtEua - 1a Woodland of *Eucalyptus camaldulensis* and *Eucalyptus victrix* over Low Shrubland of *Tephrosia rosea* var. *Fortescue* creeks (M.I.H. Brooker 2186) and *Pluchea dentex* over Open Tussock Grassland of **Melinis repens*, *Themeda triandra* and *Eulalia aurea* on brown sand on major drainage line
-  MA EcEv TtEuaSopl GoroCuleAtp - 1c Woodland of *Eucalyptus camaldulensis* and *Eucalyptus victrix* over Open Tussock Grassland of *Themeda triandra*, *Eulalia aurea* and *Sorghum plumosum* with High Open Shrubland of *Gossypium robinsonii*, *Cullen leucanthum* and *Acacia tumida* var. *pilbarensis* on brown loam on major drainage lines
-  MA EcMa TtEuaSopl CyvTydElat - 1b Woodland of *Eucalyptus camaldulensis* and *Melaleuca argentea* over Open Tussock Grassland of *Themeda triandra*, *Eulalia aurea* and *Sorghum plumosum* over Open Sedges of *Cyperus vaginatus*, *Typha domingensis* and *Eleocharis 'robust spears'* on brown loam on major drainage lines
-  MA EuaTtErt EvEc AcpEv - 7 Tussock Grassland of *Eulalia aurea*, *Themeda triandra* and *Eriachne tenuiculmis* with Woodland of *Eucalyptus victrix* and *Eucalyptus camaldulensis* and Low Open Woodland of *Acacia coriacea* subsp. *pendens* and *Eucalyptus victrix* on brown sand on major drainage lines
-  MA TtCyaEua EcEv EcEv - 8 Open Tussock Grassland of *Themeda triandra*, *Cymbopogon ambiguus* (riverine) and *Eulalia aurea* with Open Woodland of *Eucalyptus camaldulensis* and *Eucalyptus victrix* over Low Open Woodland of *Eucalyptus camaldulensis*, *Eucalyptus victrix* and *Acacia coriacea* subsp. *pendens* on brown loam on major drainage lines

Others

-  Cliff - Cf
-  Disturbed - Dist
-  Footslopes - Fs
-  Hill - HI
-  Scree - Sc

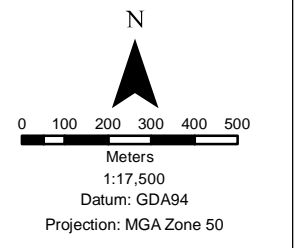
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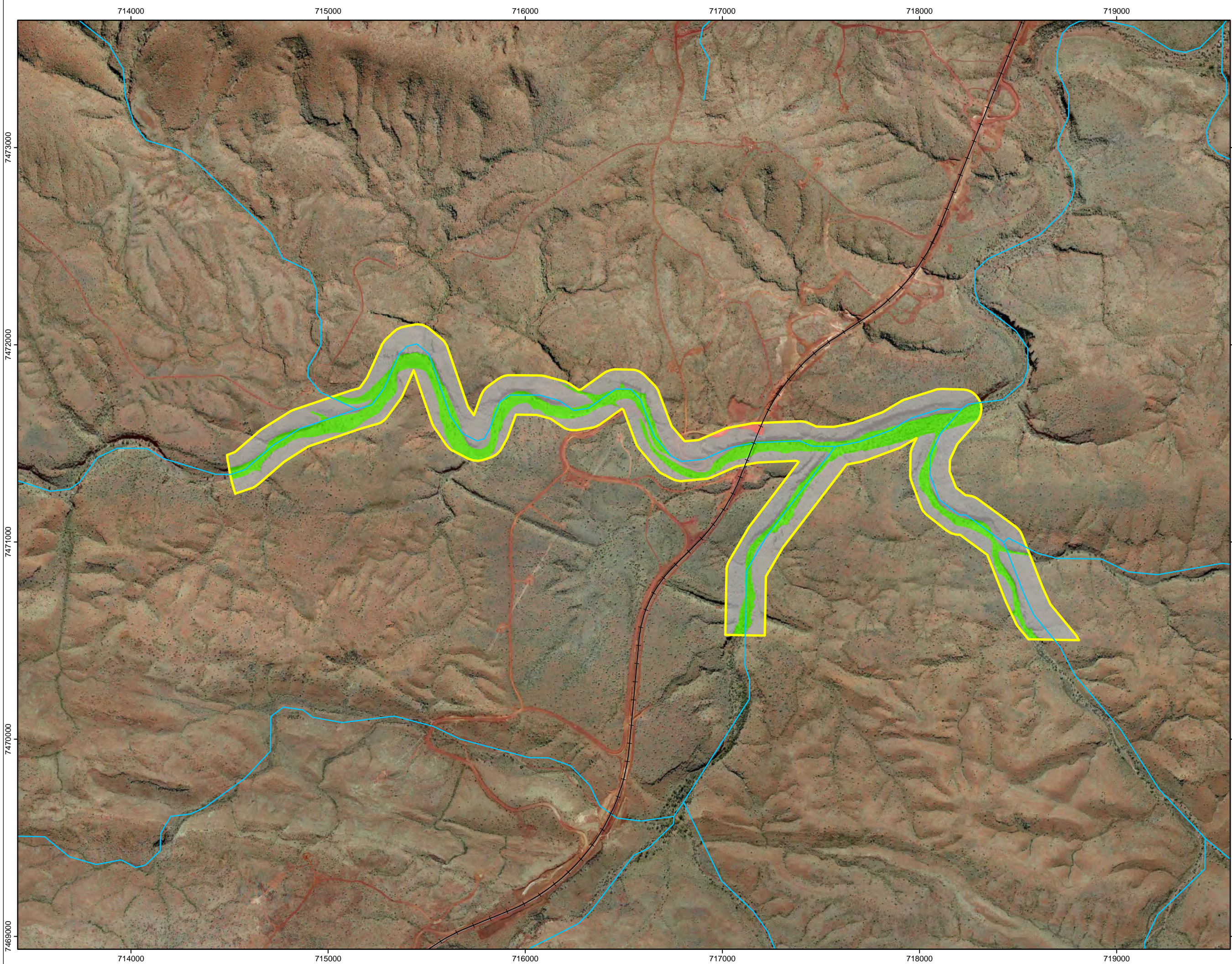
Vegetation Condition
Northern Section

- Legend**
- Study Area
 - Vegetation Condition**
 - Completely Degraded
 - Poor
 - Good
 - Upland - Not Assessed



Date: 20/07/2018
Status: Final
Figure: 7
Sheet Size: A3
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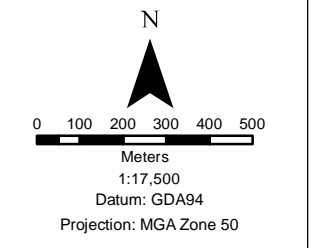




BHP
YANDICOOGINA CREEK

Vegetation Condition
Southern Section

- Legend**
- Study Area
 - Rail
 - Vegetation Condition**
 - Completely Degraded
 - Poor
 - Good
 - Upland - Not Assessed



Date: 20/07/218
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Figure: 7
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Broad Floristic Formation

1a. MA EcEv TefcPld MerTtEua
Eucalyptus Woodland

Vegetation Association

Woodland of *Eucalyptus camaldulensis* and *Eucalyptus victrix* over Low Shrubland of *Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186) and *Pluchea dentex* over Open Tussock Grassland of **Melinis repens*, *Themeda triandra* and *Eulalia aurea* on brown sand on major drainage line



Area Mapped	15.35 ha
Releves Sampled	YC02
Soils and Geology	Brown sand with moderate BIF outcropping
Land Form	Gravelly/ rocky creek bed of major drainage line
TEC or PEC	No
Conservation Significant Flora	<i>Gymnanthera cunninghamii</i> (P3)
Introduced (Weed) Species	<i>*Argemone ochroleuca</i> , <i>*Melinis repens</i> , <i>*Sisymbrium orientale</i> , <i>*Sonchus oleraceus</i>
Vegetation Condition	Good
Disturbances	Weeds
Average Fire Age	Old (6+years)
Vegetation Structure & Floristics	
Trees 10-30m	<i>Eucalyptus camaldulensis</i> , <i>Eucalyptus victrix</i>
Trees <10m	<i>Acacia coriacea</i> subsp. <i>pendens</i> , <i>Atalaya hemiglauca</i>
Shrubs >2m	<i>Melaleuca glomerata</i>
Shrubs 1-2m	<i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Acacia pyrifolia</i>
Shrubs <1m	<i>Tephrosia rosea</i> var. Fortescue creeks (M.I.H. Brooker 2186)
Tussock Grasses	<i>*Melinis repens</i> , <i>Themeda triandra</i> , <i>Eulalia aurea</i>
Sedges	<i>Cyperus vaginatus</i>
Herbs	<i>Centipeda minima</i> subsp. <i>macrocephala</i> , <i>Alternanthera nodiflora</i> , <i>Marsilea hirsuta</i> , <i>Ammannia multiflora</i> , <i>Goodenia lamprosperma</i>

Broad Floristic Formation

1b. MA EcMa TtEuaSopl CyvTydEgen
Eucalyptus Woodland

Vegetation Association

Woodland of *Eucalyptus camaldulensis* and *Melaleuca argentea* over Open Tussock Grassland of *Themeda triandra*, *Eulalia aurea* and *Sorghum plumosum* over Open Sedges of *Cyperus vaginatus*, *Typha domingensis* and *Eleocharis geniculata* on brown loam on major drainage lines



Area Mapped	34.55 ha
Releves Sampled	YC06
Soils and Geology	Brown loam
Land Form	Major drainage line- with water pools
TEC or PEC	No
Conservation Significant Flora	<i>Fimbristylis sieberiana</i> (P3), <i>Rostellularia adscendens</i> var. <i>latifolia</i> (P3)
Introduced (Weed) Species	* <i>Conyza bonariensis</i> , * <i>Melinis repens</i> , * <i>Setaria verticillata</i> , * <i>Sisymbrium orientale</i> , * <i>Tridax procumbens</i> * <i>Vachellia farnesiana</i>
Vegetation Condition	Good
Disturbances	Weeds, cattle grazing
Average Fire Age	Moderate (3-5 years)
Vegetation Structure & Floristics	
Trees 10-30m	<i>Eucalyptus camaldulensis</i> , <i>Melaleuca argentea</i>
Trees >10m	<i>Eucalyptus camaldulensis</i> , <i>Acacia coriacea</i> subsp. <i>pendens</i> , <i>Melaleuca argentea</i>
Shrubs >2m	<i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Grevillea wickhamii</i> subsp. <i>hispidula</i> , <i>Cullen leucanthum</i> , <i>Melaleuca bracteata</i>
Shrubs <1m	<i>Pluchea dentex</i> , <i>Tephrosia rosea</i> var. <i>Fortescue creeks</i> (M.I.H. Brooker 2186), <i>Pteracaulon sphacelatum</i>
Tussock Grasses	<i>Themeda triandra</i> , <i>Eulalia aurea</i> , <i>Sorghum plumosum</i>
Sedges	<i>Cyperus vaginatus</i> , <i>Typha domingensis</i> , <i>Eleocharis geniculata</i> , <i>Schoenoplectus subulatus</i>

Broad Floristic Formation

1c. MA EcEv TtEuaSopl GoroCuleAtp
Eucalyptus Woodland

Vegetation Association

Woodland of *Eucalyptus camaldulensis* and *Eucalyptus victrix* over Open Tussock Grassland of *Themeda triandra*, *Eulalia aurea* and *Sorghum plumosum* with High Open Shrubland of *Gossypium robinsonii*, *Cullen leucanthum* and *Acacia tumida* var. *pilbarensis* on brown loam on major drainage lines



Area Mapped	31.05 ha
Releves Sampled	YC22, YC28
Soils and Geology	Brown loam with limited detrital outcropping
Land Form	Flow line of major drainage line
TEC or PEC	No
Conservation Significant Flora	None
Introduced (Weed) Species	* <i>Argemone ochroleuca</i>
Vegetation Condition	Good
Disturbances	Cattle grazing, weeds
Average Fire Age	Moderate (3-5 years)
Vegetation Structure & Floristics	
Trees 10-30m	<i>Eucalyptus camaldulensis</i> , <i>Eucalyptus victrix</i>
Trees <10m	<i>Eucalyptus camaldulensis</i> , <i>Acacia coriacea</i> subsp. <i>pendens</i>
Shrubs >2m	<i>Gossypium robinsonii</i> , <i>Cullen leucanthum</i> , <i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Melaleuca glomerata</i>
Shrubs <1m	<i>Pluchea dentex</i> , <i>Tephrosia rosea</i> var. <i>Fortescue creeks</i> (M.I.H. Brooker 2186), <i>Corchorus crozophorifolius</i>
Tussock Grasses	<i>Themeda triandra</i> , <i>Eulalia aurea</i> , <i>Sorghum plumosum</i>
Herbs	<i>Goodenia lamprosperma</i>

Broad Floristic Formation

2. FP AtpGrwhPI Tp Tt EuaCc
Acacia High Shrubland

Vegetation Association

High Shrubland of *Acacia tumida* var. *pilbarensis*, *Grevillea wickhamii* subsp. *hispidula* and *Petalostylis labicheoides* over Open Hummock Grassland of *Triodia pungens* over Open Tussock Grassland of *Themeda triandra*, *Eulalia aurea* and **Cenchrus ciliaris* on brown sandy loam on floodplains



Area Mapped	7.98 ha
Relevés Sampled	YC01
Soils and Geology	Brown sandy loam with minor BIF outcropping
Land Form	Floodplains
Priority Ecological Community	No
Conservation Significant Flora	<i>Aristida lazaridis</i> (P2), <i>Sida</i> sp. Barlee Range (P3)
Introduced (Weed) Species	<i>*Cenchrus ciliaris</i> , <i>*Bidens bipinnata</i> , <i>*Setaria verticillata</i>
Vegetation Condition	Good
Disturbances	Road/access track, weeds
Average Fire Age	Old (6+ years)
Vegetation Structure & Floristics	
Trees <10m	<i>Corymbia hamersleyana</i>
Shrubs >2m	<i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Grevillea wickhamii</i> subsp. <i>hispidula</i> , <i>Petalostylis labicheoides</i> , <i>Acacia maitlandii</i> , <i>Grevillea pyramidalis</i> , <i>Gossypium robinsonii</i> , <i>Dodonea viscosa</i> subsp. <i>spathulata</i>
Shrubs 1-2m	<i>Acacia pyrifolia</i> , <i>Stylobasium spathulatum</i> , <i>Androcalva luteiflora</i>
Shrubs <1m	<i>Pterocaulon sphacelatum</i> , <i>Bonamia erecta</i>
Hummock Grasses	<i>Triodia pungens</i>
Tussock Grasses	<i>Themeda triandra</i>

Broad Floristic Formation

3. FP GoroPICule AtpPIGrwh TtSoplErt
Gossypium High Shrubland

Vegetation Association

High Shrubland of *Gossypium robinsonii*, *Petalostylis labicheoides* and *Cullen leucanthum* over Shrubland of *Acacia tumida* var. *pilbarensis*, *Petalostylis labicheoides* and *Grevillea wickhamii* subsp. *hispidula* over Open Tussock Grassland of *Themeda triandra*, *Sorghum plumosum* and *Eriachne tenuiculmis* on brown loamy sand on floodplains



Area Mapped	38.13 ha
Releves Sampled	YC24, YC26, YC27
Soils and Geology	Brown loamy sand
Land Form	Floodplains/levee banks
TEC or PEC	No
Conservation Significant Flora	None
Introduced (Weed) Species	* <i>Cenchrus ciliaris</i>
Vegetation Condition	Good
Disturbances	Cattle grazing, weeds
Average Fire Age	Moderate (3-5 years)
Vegetation Structure & Floristics	
Trees 10-30m	<i>Eucalyptus camaldulensis</i>
Shrubs >2m	<i>Gossypium robinsonii</i> , <i>Petalostylis labicheoides</i> , <i>Cullen leucanthum</i> , <i>Acacia tumida</i> var. <i>pilbarensis</i>
Shrubs 1-2m	<i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Petalostylis labicheoides</i> , <i>Grevillea wickhamii</i> subsp. <i>hispidula</i>
Shrubs <1m	<i>Tephrosia rosea</i> var. Fortescue creeks (M.I.H. Brooker 2186), <i>Indigofera monophylla</i> , <i>Corchorus crozophorifolius</i>
Tussock Grasses	<i>Themeda triandra</i> , <i>Eriachne tenuiculmis</i> , <i>Sorghum plumosum</i>
Hummock Grasses	<i>Triodia pungens</i>

Broad Floristic Formation

4. FP Tp ChfErerTt ChHallAthe
Triodia Open Hummock Grassland

Vegetation Association

Open Hummock Grassland of *Triodia pungens* over Open Tussock Grassland of *Chrysopogon fallax*, *Eragrostis eriopoda* and *Themeda triandra* and Low Open Woodland of *Corymbia hamersleyana*, *Hakea lorea* subsp. *lorea* and *Atalaya hemiglauca* on brown sandy loam on floodplains



Area Mapped	4.68 ha
Releves Sampled	YC23
Soils and Geology	Brown sandy loam
Land Form	Raised floodplains
TEC or PEC	No
Conservation Significant Flora	None
Introduced (Weed) Species	None recorded
Vegetation Condition	Good
Disturbances	Cattle grazing
Average Fire Age	Moderate (3-5 years)
Vegetation Structure & Floristics	
Trees >10m	<i>Corymbia hamersleyana</i> , <i>Hakea lorea</i> subsp. <i>lorea</i> , <i>Atalaya hemiglauca</i>
Shrubs 1-2m	<i>Stylobasium spathulatum</i> , <i>Androcalva luteiflora</i>
Shrubs <1m	<i>Gossypium australe</i> , <i>Acacia bivenosa</i> , <i>Senna artemisioides</i> subsp. <i>oligophylla</i>
Hummock Grasses	<i>Triodia pungens</i>
Tussock Grasses	<i>Chrysopogon fallax</i> , <i>Eragrostis eriopoda</i> , <i>Themeda triandra</i> , <i>Eulalia aurea</i> , <i>Paraneurachne muelleri</i>

Broad Floristic Formation

5. FP CcTtEreH HallAthe StspAnIGoro
**Cenchrus* Closed Tussock Grassland

Vegetation Association

Closed Tussock Grassland of **Cenchrus ciliaris*, *Themeda triandra* and *Eragrostis eriopoda* with Low Open Woodland of *Hakea lorea* subsp. *lorea*, *Atalaya hemiglauca* and *Acacia pruinocarpa* and Open Shrubland of *Stylobasium spathulatum*, *Androcalva luteiflora* and *Gossypium robinsonii* on brown loamy sand on floodplains



Area Mapped	0.83 ha
Releves Sampled	YC15, YC16
Soils and Geology	Brown loamy sand with limited CID outcropping
Land Form	Floodplains
TEC or PEC	No
Conservation Significant Flora	None
Introduced (Weed) Species	* <i>Cenchrus ciliaris</i> , * <i>Vachellia farnesiana</i>
Vegetation Condition	Poor
Disturbances	Weeds, Cattle grazing, frequent fire
Average Fire Age	Moderate (3-5 years)
Vegetation Structure & Floristics	
Trees >10m	<i>Hakea lorea</i> subsp. <i>lorea</i> , <i>Atalaya hemiglauca</i> , <i>Acacia pruinocarpa</i>
Shrubs 1-2m	<i>Stylobasium spathulatum</i> , <i>Androcalva luteiflora</i> , <i>Gossypium robinsonii</i> , <i>Cullen leucanthum</i> , <i>Acacia tumida</i> var. <i>pilbarensis</i>
Tussock Grasses	* <i>Cenchrus ciliaris</i> , <i>Themeda triandra</i> , <i>Eragrostis eriopoda</i>

Broad Floristic Formation

6. FP SoplErtTt GoroAtpCule AtpApyAnl
Sorghum Tussock Grassland

Vegetation Association

Tussock Grassland of *Sorghum plumosum*, *Eriachne tenuiculmis* and *Themeda triandra* with High Open Shrubland of *Gossypium robinsonii*, *Acacia tumida* var. *pilbarensis* and *Cullen leucanthum* and Open Shrubland of *Acacia tumida* var. *pilbarensis*, *Acacia pyrifolia* and *Androcalva luteiflora* on brown silty loam on floodplains



Area Mapped	11.62 ha
Releves Sampled	YC13, YC20, YC25
Soils and Geology	Brown silty loam
Land Form	Drainage area/floodplain- gravelly islands within or fringing major drainage line
TEC or PEC	No
Conservation Significant Flora	None
Introduced (Weed) Species	None recorded
Vegetation Condition	Good
Disturbances	Cattle grazing, weeds
Average Fire Age	Moderate (3-5 years)
Vegetation Structure & Floristics	
Trees 10-30m	<i>Eucalyptus camaldulensis</i>
Trees <10m	<i>Acacia coriacea</i> subsp. <i>pendens</i> , <i>Hakea lorea</i> subsp. <i>lorea</i>
Shrubs >2m	<i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Gossypium robinsonii</i> , <i>Cullen leucanthum</i>
Shrubs 1-2m	<i>Androcalva luteiflora</i> , <i>Gossypium robinsonii</i> , <i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Corchorus crozophorifolius</i>
Shrubs <1m	<i>Pluchea dentex</i> , <i>Pterocaulon sphacelatum</i> , <i>Acacia pyrifolia</i> , <i>Tephrosia rosea</i> var. <i>Fortescue creeks</i> (M.I.H. Brooker 2186), <i>Indigofera monophylla</i>
Tussock Grasses	<i>Sorghum plumosum</i> , <i>Eriachne tenuiculmis</i> , <i>Themeda triandra</i> , <i>Eulalia aurea</i> , <i>Cymbopogon ambiguus</i> (riverine form)

Broad Floristic Formation

7. MA EuaTtErt EvEc AcpEv
Eulalia Tussock Grassland

Vegetation Association

Tussock Grassland of *Eulalia aurea*, *Themeda triandra* and *Eriachne tenuiculmis* with Woodland of *Eucalyptus victrix* and *Eucalyptus camaldulensis* and Low Open Woodland of *Acacia coriacea* subsp. *pendens* and *Eucalyptus victrix* on brown sand on major drainage lines



Area Mapped	3.87 ha
Relevés Sampled	YC03
Soils and Geology	Brown sand with minor BIF outcropping
Land Form	Gravelly raised areas within major drainage lines
TEC or PEC	No
Conservation Significant Flora	None
Introduced (Weed) Species	None recorded
Vegetation Condition	Good
Disturbances	Weeds
Average Fire Age	Old (6+ years)
Vegetation Structure & Floristics	
Trees 10-30m	<i>Eucalyptus victrix</i> , <i>Eucalyptus camaldulensis</i>
Trees >10m	<i>Eucalyptus victrix</i> , <i>Acacia coriacea</i> subsp. <i>pendens</i>
Shrubs >2m	<i>Melaleuca glomerata</i> , <i>Acacia tumida</i> var. <i>pilbarensis</i>
Shrubs 1-2m	<i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Acacia pyrifolia</i>
Tussock Grasses	<i>Eulalia aurea</i> , <i>Themeda triandra</i> , <i>Eriachne tenuiculmis</i>

Broad Floristic Formation

8. MA TtCyaEua EcEv EcEv
Themeda Open Tussock Grassland

Vegetation Association

Open Tussock Grassland of *Themeda triandra*, *Cymbopogon ambiguus* (riverine) and *Eulalia aurea* with Open Woodland of *Eucalyptus camaldulensis* and *Eucalyptus victrix* over Low Open Woodland of *Eucalyptus camaldulensis*, *Eucalyptus victrix* and *Acacia coriacea* subsp. *pendens* on brown loam on major drainage lines



Area Mapped	5.91 ha
Releves Sampled	None
Soils and Geology	Brown loam
Land Form	Gravelly river bed of major drainage line
TEC or PEC	No
Conservation Significant Flora	None
Introduced (Weed) Species	None recorded
Vegetation Condition	Good
Disturbances	Cattle grazing, weeds
Average Fire Age	Moderate (3-5 years)
Vegetation Structure & Floristics	
Trees 10-30m	<i>Eucalyptus camaldulensis</i> , <i>Eucalyptus victrix</i>
Trees >10m	<i>Eucalyptus camaldulensis</i> , <i>Eucalyptus victrix</i> , <i>Acacia coriacea</i> subsp. <i>pendens</i>
Shrubs >2m	<i>Cullen leucanthum</i> , <i>Gossypium robinsonii</i> , <i>Acacia tumida</i> var. <i>pilbarensis</i>
Shrubs <1m	<i>Pluchea dentex</i> , <i>Tephrosia rosea</i> var. <i>Fortescue</i> creeks (M.I.H. Brooker 2186), <i>Corchorus crozophorifolius</i> , <i>Cleome viscosa</i> , <i>Stemodia grossa</i>
Tussock Grasses	<i>Themeda triandra</i> , <i>Cymbopogon ambiguus</i> (riverine), <i>Eulalia aurea</i>

3.3 Threatened Ecological Communities

The field survey confirmed that no TECs occur within the study area.

3.4 Priority Ecological Communities

The field survey confirmed that no PECs occur within the study area.

3.5 Significant Flora

3.5.1 Threatened Flora listed under the WC Act and EPBC Act

No plant taxon gazetted as Threatened Flora (T) pursuant to subsection (2) of Section 23F of the WC Act or listed under the EPBC Act was recorded from the study area.

3.5.2 Priority Flora

A total of five Priority flora, as defined by DBCA, were opportunistically recorded during the reconnaissance vegetation survey (Table 7, Figure 8):

- *Aristida lazaridis* (P2);
- *Fimbristylis sieberiana* (P3);
- *Gymnanthera cunninghamii* (P3);
- *Rostellularia adscendens* var. *latifolia* (P3); and
- *Sida* sp. Barlee Range (S. van Leeuwen 1643) (P3).



BHP

YANDICOOGINA CREEK

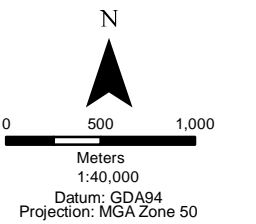
Significant Flora

Legend

Study Area

Significant Flora



- *Aristida lazaridis* (A.l)
- *Fimbristylis sieberiana* (F.s)
- *Gymnanthera cunninghamii* (G.c)
- *Rostellularia adscendens* var. *latifolia* (R.a)
- *Sida* sp. Barlee Range (S. van Leeuwen 1642) (S.b)


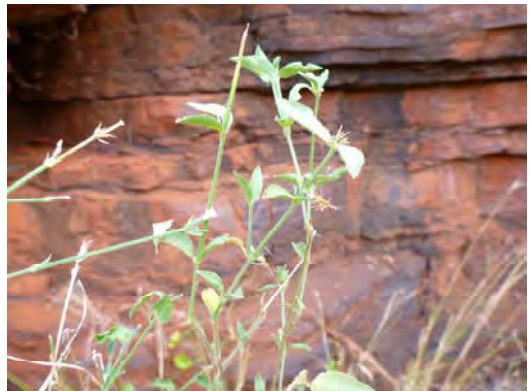


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Table 7 Priority Flora species recorded from the study area.

Taxon	Photograph	Description	Occurrence in study area
<i>Aristida lazaridis</i> (P2)		<p>A tufted perennial grass ranging from 0.4 – 1.5 m in height. This species prefers sand or loam soils and occurs in the Pilbara and Kimberly Regions of Western Australia and in the Northern Territory, and Queensland. Regionally this species has been recorded in four locations including the north-eastern sector of Karijini National Park. This species has also been recorded from the Mudlark, Tandanya, Coondewanna Flats PEC and Marillana Creek study areas.</p>	<p><i>Aristida lazaridis</i> was recorded from a single location within vegetation association FP AtpGrwhPI Tp Tt EuaCc. It is possible that this species would occur at other locations within this vegetation association.</p>
<i>Fimbristylis sieberiana</i> (P3)		<p>A tufted perennial grass upto 0.6 m in height. This species inhabits areas of mud and skeletal soil at pool edges or sandstone cliffs. <i>Fimbristylis sieberiana</i> is known from the Pilbara and Kimberley regions, and has previously been recorded from BHP's Mainline Rail study area.</p>	<p><i>Fimbristylis sieberiana</i> was recorded from three locations within vegetation association MA EcMa TtEuaSopl CyvTydEgen. It is considered likely that this species could occur at other locations within this vegetation association.</p>

Taxon	Photograph	Description	Occurrence in study area
<p><i>Gymnanthera cunninghamii</i> (P3)</p>		<p><i>Gymnanthera cunninghamii</i> is an erect shrub that ranging from 1 – 2 m in height, and is known to grow on sandy soils. This species has previously been recorded from the Dynasty and Jimblebar Wye study areas.</p>	<p><i>Gymnanthera cunninghamii</i> was recorded from a single location within vegetation association MA EcEv TefcPld MerTtEua. It is possible that this species would occur at other locations within this vegetation association.</p>
<p><i>Rostellularia adscendens</i> var. <i>latifolia</i> (P3)</p>		<p><i>Rostellularia adscendens</i> var. <i>latifolia</i> is a low shrub to 0.3 m in height, flowering in April and May. It grows in ironstone soils with habitat ranging from creeks to rocky hills. It is currently known from 12 localities between Warrawagine and Tom Price, all within the Pilbara IBRA region. Five of these records occur within Karijini National Park. This species has previously been recorded from Area C West to Yandi, Yandi, Mudlark, Tandanya and Marillana Creek study areas.</p>	<p><i>Rostellularia adscendens</i> var. <i>latifolia</i> was recorded from a single location within vegetation association MA EcMa TtEuaSopl CyvTydEgen. It is possible that this species would occur at other locations within this vegetation association.</p>

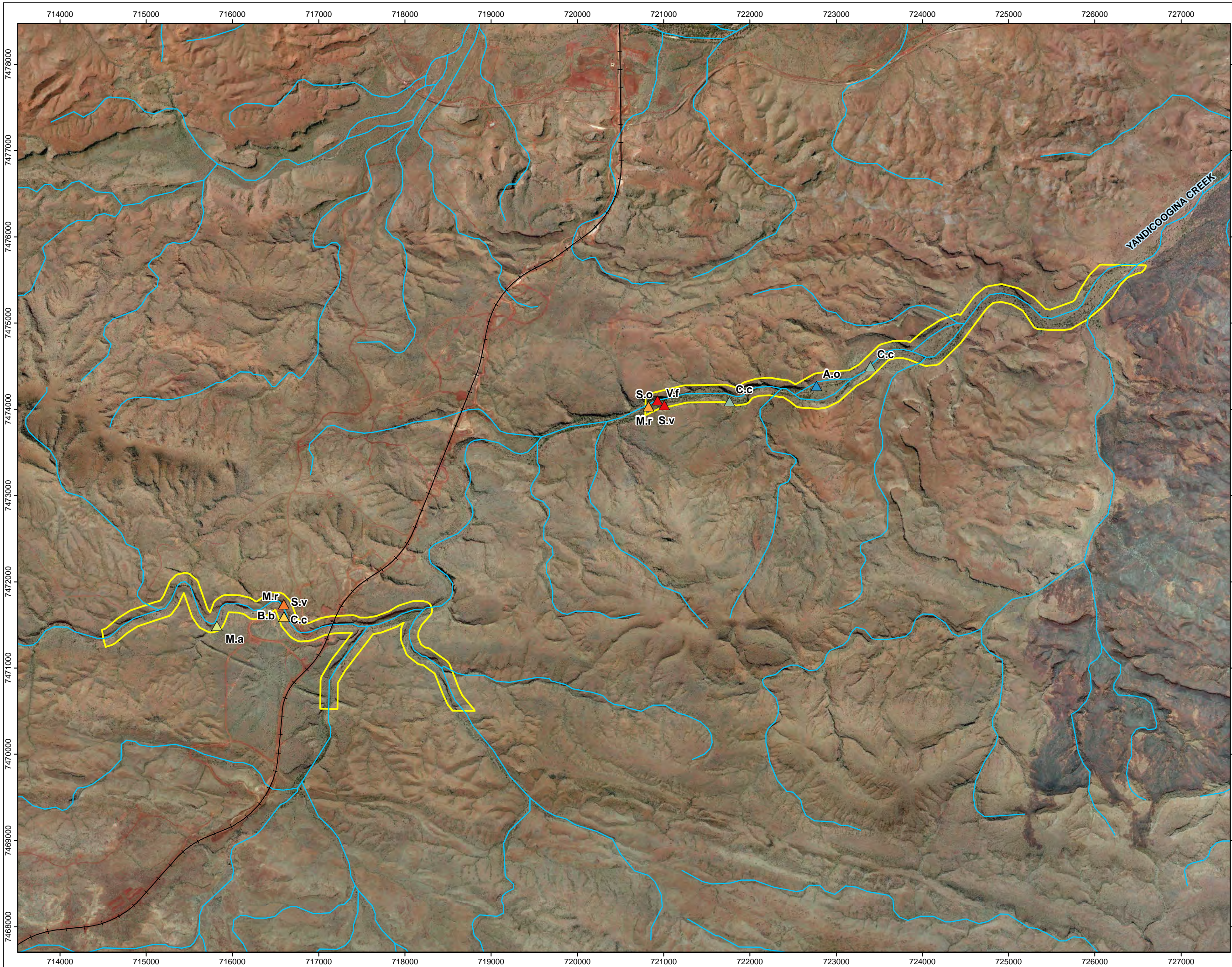
Taxon	Photograph	Description	Occurrence in study area
<p><i>Sida</i> sp. Barlee Range (S. van Leeuwen 1643) (P3)</p>		<p><i>Sida</i> sp. Barlee Range is a spreading shrub to 0.5 m tall that produces yellow flowers during August. It grows on skeletal red soil pockets and on steep slopes. This species is known within the Pilbara and Gascoyne regions of Western Australia. <i>Sida</i> sp. Barlee Range has been recorded from numerous BHP Billiton Iron Ore leases in the Pilbara.</p>	<p><i>Sida</i> sp. Barlee Range (S. van Leeuwen 1643) was recorded from a single location within vegetation association FP AtpGrwhPI Tp Tt EuaCc. It is considered likely that this species could occur along the cliffines fringing the edge of this vegetation association.</p>

3.6 Introduced Flora

There were ten introduced species recorded from the study area (Table 8, Figure 9):

- **Argemone ochroleuca* (Mexican Poppy);
- **Bidens bipinnata* (Bipinnate Beggartick);
- **Cenchrus ciliaris* (Buffel Grass);
- **Conyza bonariensis* (Flaxleaf Fleabane);
- **Melinis repens* (Rose Natal Grass);
- **Setaria verticillata* (Whorled Pigeon Grass);
- **Sisymbrium orientale* (Indian Hedge Mustard);
- **Sonchus oleraceus* (Common Sowthistle);
- **Tridax procumbens* (Tridax); and
- **Vachellia farnesiana* (Mimosa Bush).

None of these taxa are listed as a Declared Pest under the BAM Act.

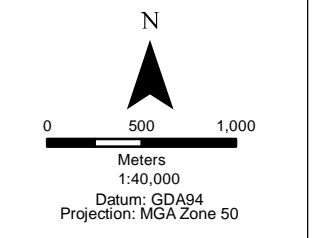


BHP
YANDICOOGINA CREEK

Introduced Flora

Legend



- Study Area
- Introduced Flora**
- ▲ Argemone ochroleuca subsp. ochroleuca (A.o)
- ▲ Bidens bipinnata (B.p)
- ▲ Cenchrus ciliaris (C.c)
- ▲ Conyza bonariensis (C.b)
- ▲ Malvastrum americanum (M.a)
- ▲ Melinis repens (M.r)
- ▲ Setaria verticillata (S.v)
- ▲ Sigesbeckia orientalis (S.o)
- ▲ Sisymbrium orientale (S.or)
- ▲ Sonchus oleraceus (S.ol)
- ▲ Vachellia farnesiana (V.f)







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Table 8 Introduced species recorded from the study area.

Taxon (Common Name)	Photograph	Description	Occurrence in study area
<p>*<i>Argemone ochroleuca</i> (Mexican Poppy)</p>		<p>A spiny annual herb growing up to 1 metre in height and flowering (white, cream or yellow) between February to March and July to November. This species grows on red, white and grey sand, or red brown clay loam along creeklines, riverbanks and roadsides. It is an aggressive coloniser originating from Mexico and has become a troublesome weed in parts of Western Australia (Hussey <i>et al.</i> 1997).</p>	<p>Recorded occurring within vegetation associations MA EcEv TefcPid MerTtEua and MA EcEv TtEuaSopl GoroCuleAtp.</p>
<p>*<i>Bidens bipinnata</i> (Bipinnate Beggartick)</p>		<p>Erect annual herb that grows up to 1 m in height. This species is widespread in the northern parts of Western Australia from Shark Bay up to the Northern Territory border. It has three pronged barbs on its seeds so it is easily spread by livestock and other animals. In the Pilbara it is common in moist habitats such as drainage lines, flood plains and gorges, and responds vigorously following rainfall.</p>	<p>Recorded occurring within vegetation association FP AtpGrwhPI Tp Tt EuaCc.</p>

Taxon (Common Name)	Photograph	Description	Occurrence in study area
<p>*<i>Cenchrus ciliaris</i> (Buffel Grass)</p>		<p>Tufted perennial grass originating from the Middle East as a fodder species by pastoralists. It grows in dense tussocks up to 1 m tall and typically occurs in monospecific stands on loamy plains and creekline levee banks. It is an aggressive colonizing species that has become well established throughout the Pilbara, Gascoyne and Murchison regions of Western Australia, and is continuing to spread in the south-west (Hussey <i>et al.</i> 1997).</p>	<p>Recorded occurring or as a dominate species within vegetation associations FP AtpGrwhPI Tp Tt EuaCc, FP GoroPICule AtpPIGrwh TtSoplErt andFP CcTtErer HallAthe StspAnlGoro.</p>
<p>*<i>Conyza bonariensis</i> (Flaxleaf Fleabane)</p>		<p>An erect annual herb that grows up to 1.5 metre in height and occurs in a variety of soils typically in cultivated areas, waste areas and roadsides. It requires disturbance to establish and is usually unsuccessful in areas of high plant density. It flowers (white) from January to December and is found across Western Australia extending from Broome and further north down to Perth, Esperance and Albany.</p>	<p>Recorded occurring within vegetation association MA EcMa TtEuaSopl CyvTydEgen.</p>

Taxon (Common Name)	Photograph	Description	Occurrence in study area
<p>*<i>Melinis repens</i> (Rose Natal Grass)</p>		<p>Atufted annual or perennial, grass-like or herb that grows between 0.3 m and 1.2 m in height. It is known from sand, loam or granite soils, and commonly recorded from roadsides.</p>	<p>Recorded occurring or as a dominate species within vegetation associations MA EcEv TefcPId MerTtEua and MA EcMa TtEuaSopl CyvTydEgen.</p>
<p>*<i>Setaria verticillata</i> (Whorled Pigeon Grass)</p>		<p>A loosely tufted annual grass-like herb, growing between 0.1 m and 1.3 m in height and flowering from December to June. It grows in a variety of soils including sand, clay and loam and has spread over much of Western Australia.</p>	<p>Recorded occurring within vegetation associations MA EcMa TtEuaSopl CyvTydEgen and FP AtpGrwhPI Tp Tt EuaCc.</p>

Taxon (Common Name)	Photograph	Description	Occurrence in study area
<p><i>*Sisymbrium orientale</i> (Indian Hedge Mustard)</p>		<p>An erect annual or biennial herb that grows to a height of 1 metres. It produces yellow flowers from March to November and grows in disturbed areas. This species is found in the south-west of Western Australia as well as in the Pilbara.</p>	<p>Recorded occurring within vegetation associations MA EcEv TefcPld MerTtEua and MA EcMa TtEuaSopl CyvTydEgen.</p>
<p><i>*Sonchus oleraceus</i> (Common Sowthistle)</p>		<p>An erect, annual herb that grows to approximately 1.5 m in height and produces yellow flowers between January to December. It occurs on a variety of soils and is a weed of disturbed ground. The leaves of <i>*Sonchus oleraceus</i> are generally flaccid and are weakly prickly or have no prickles. The weed is widespread on roadsides, gardens, market gardens and wasteland from Wittenoom to the Nullarbor and it is native to Eurasia and North Africa (Hussey <i>et al.</i> 1997).</p>	<p>Recorded occurring within vegetation association MA EcEv TefcPld MerTtEua.</p>

Taxon (Common Name)	Photograph	Description	Occurrence in study area
* <i>Tridax procumbens</i> (Tridax)		<p>Prostrate to erect perennial, herb reaching 0.4m. It produces white and yellow flowers between January and December. It occurs on wet and disturbed ground.</p>	<p>Recorded occurring within vegetation association MA EcMa TtEuaSopl CyvTydEgen.</p>
* <i>Vachellia farnesiana</i> (Mimosa Bush)		<p>An erect spreading thicket forming thorny tree or shrub. It grows up to 4 m in height and produces yellow flowers from June to August. Mimosa Bush grows on stony, sandy, clay or loam soils and is common in low lying areas such as creeks and river banks as well as in disturbed areas. It is widespread from the Kimberly to near Perth (Hussey <i>et al.</i> 1997).</p>	<p>Recorded occurring within vegetation associations MA EcMa TtEuaSopl CyvTydEgen and FP CcTtErer HallAthe StspAnlGoro.</p>

4.0 Environmental Impact Assessment

4.1 Surface Water Discharge

There is potential for future BHP WAIO operations situated adjacent to the study area to discharge surplus surface water into Yandicoogina Creek. Natural drainage patterns within the study area are ephemeral, derived from surface runoff. Yandicoogina Creek typically flows following high intensity summer rainfall events.

Additional surface water discharge resulting from dewatering activities at adjacent mining operations, has the potential to impact on susceptible flora species and vegetation communities through waterlogging of the soil profile, saturation of the plant root zones, and higher soil moisture levels. Additional impacts that will need to be managed include scouring and erosion of drainage channels, and changes to water quality (i.e. elevated salinity levels).

Based on the ten vegetation associations described and mapped during the reconnaissance vegetation survey, none of these vegetation associations were determined to be at elevated risk of decline from managed surface water discharge. Shallow rooting species that represent the most susceptible plant taxa (e.g. Mulga and *Acacia citrinoviridis*) are absent from the main drainage channel of Yandicoogina Creek surveyed.

Soil moisture is likely to be elevated for longest periods closer to the point of discharge. Prolonged waterlogging has the potential to destabilise plant roots within the soil profile, increasing the potential for collapse of trees within the immediate discharge area. Waterlogging of the soil profile also has the potential for tap root dysfunction (rotting of the tap root) for deeper rooting tree species, and longer term reliance on surface lateral roots for survival (Pauline Grierson *pers comm.* 2011).

The discharge of surplus water will increase the surface water available to vegetation located downstream of discharge location, i.e. within the wetting front. This has the potential to cause localised changes to the composition and/or density of vegetation along the length of the wetting front, with an increase in the density of young saplings of riverine tree species. Additionally, surface water discharge may increase the frequency of pooling within the lowest points of the main drainage channel. Pooling water may sustain riverine vegetation that otherwise would not be supported. This has been observed for *Melaleuca argentea* downstream of Rio Tinto's surface water discharge at Weeli Wolli Spring. Higher soil moisture conditions for prolonged periods present along the wetting front also provide favourable conditions for the growth of introduced flora (weed) species, and increase the likelihood of new weeds being supported under elevated soil moisture conditions.

At the conclusion of mining operations when the discharge of surface water ceases, downstream vegetation within the wetted front may show evidence of decline as it re-adjusts to lower soil moisture post-mining. This period may require specific management strategies aimed at gradually returning the area to a drainage pattern more typical of the natural cycle.

4.2 Groundwater Drawdown

BHP WAIO mining operations adjacent to the study area will require dewatering that may result in groundwater drawdown. While the groundwater drawdown impact is yet to modelled, it has the potential to impact on flora species and vegetation communities that are groundwater dependant. Known susceptible species include the trees *Melaleuca argentea*, *Eucalyptus camaldulensis* and *Eucalyptus victrix*.

Based on vegetation associations identified and mapped during the reconnaissance survey, six associations were identified as potentially being susceptible to groundwater drawdown, as they support groundwater dependent vegetation (Table 6).

Onshore Environmental considers any vegetation that uses groundwater is potentially at risk if it occurs at a location where the groundwater would be lowered beyond assumed natural groundwater variation. However, the impact on vegetation from lowering of the groundwater table is also likely to be relative to the species' dependence on groundwater. For example, plants that rely solely on water sourced directly from the groundwater table (obligate phreatophytes) are more likely to show signs of decline or be lost compared to plants that use soil moisture (vadophytes) or intermittently utilise groundwater, i.e during periods of extended drought (facultative phreatophytes). An assessment of the species' dependence on groundwater was informed by a desktop literature review and an understanding of the vegetation associations within the study area (Table 9).

Table 9 Tree species dependence on groundwater.

Species Dependence on Groundwater	Plant Physiology / Water Use	Indicator Species
High	Obligate Phreatophyte	<i>Melaleuca argentea</i>
Moderate	Facultative Phreatophyte or Vadophyte	<i>Eucalyptus camaldulensis</i>
Low	Facultative Phreatophyte or Vadophyte	<i>Eucalyptus victrix</i>
None	Xerophyte	All remaining tree species

The obligate phreatophytic⁷ tree species *Melaleuca argentea* is determined to be the highest risk plant taxon within the central and south-east Pilbara. It relies on the existence of shallow groundwater for survival (<3 m bgl) and is considered to be at high risk from groundwater drawdown. *Melaleuca argentea* was recorded as a dominant tree species from one vegetation association within Yandicoogina Creek (MA EcMa TtEuaSopl CyvTydEgen), and was recorded as scattered low trees at a second vegetation association (MA EcEv TtEuaSopl GoroCuleAtp). Both vegetation types are considered to be at high risk from groundwater drawdown. Groundwater drawdown by greater than 3 m bgl has the potential to result in decline of *Melaleuca argentea* trees, and may also impact on the localised permanent pools that support the sedges *Cyperus vaginatus*, *Typha domingensis* and *Eleocharis geniculata*.

There are six vegetation associations within the study area that support the tall tree species *Eucalyptus camaldulensis* which is considered to be at moderate risk from groundwater drawdown (Table 6). A second tall tree species, *Eucalyptus victrix*, occurs as a co-dominant with *Eucalyptus camaldulensis* within four of the six vegetation associations (Table 6), and is considered to be at low risk from groundwater drawdown. Both tree species are classified as facultative phreatophytes⁸, noting that *Eucalyptus victrix* may also function in some environments as a vadophyte⁹.

Eucalyptus camaldulensis is the most widespread of Australian *Eucalyptus* species. It is known to tolerate a wide range of water regimes and is considered to use a combination of groundwater and surface-soil water. It typically occurs along inland rivers and may be dependent on shallow groundwater for survival, although the root system may penetrate up to 21 m bgl. *Eucalyptus victrix* is relatively drought tolerant and appears to utilise groundwater sources opportunistically or during times of limited water conditions. This species may be susceptible to decline where groundwater is lowered and inaccessible, during extended dry periods (Muir Environmental 1995).

⁷ Phreatophytes are plant species that rely on water sourced directly from the watertable.

⁸ Facultative Phreatophytes are capable of functioning as both a vadophyte and a phreatophyte

⁹ Vadophytes primarily use water held in the vadose (unsaturated) zone that occurs above the watertable.

The six vegetation associations within the study area supporting *Eucalyptus camaldulensis* and/or *Eucalyptus victrix* were:

- MA EcEv TefcPIId MerTtEua;
- MA EcMa TtEuaSopl CyvTydEgen;
- MA EcEv TtEuaSopl GoroCuleAtp;
- FP SoplErtTt GoroAtpCule AtpApyAnl;
- MA EuaTtErt EvEc AcpEv; and
- MA TtCyaEua EcEv EcEv.

To accurately assess the potential impacts that groundwater drawdown may have on these vegetation associations, the existing groundwater levels within the study area are required to confirm that susceptible tree species are accessing and utilising the groundwater. If we assume the existing groundwater levels are accessible to these species, groundwater drawdown then has the potential to impact on susceptible tree species. If the groundwater level is lowered beyond 20 m bgl then *Eucalyptus camaldulensis* and *Eucalyptus victrix* no longer have the ability to access the groundwater, and there is an increased risk of tree decline. The impact is likely to be more severe during extended periods of drought.

The remaining vegetation associations occurring in area have been determined to have negligible risk from groundwater drawdown as they comprise a mixture of vadophytic and xerophytic¹⁰ plants that have no reliance on groundwater.

¹⁰ Xerophytes are plants that have no reliance on groundwater for survival.

5.0 SUMMARY

The field survey was conducted under 'poor' seasonal conditions between the 4th and 6th of June 2018. The field survey time was impacted by heavy rainfall, resulting in approximately half of the study area not being assessed. Vegetation mapping was inferred for these areas. Ten vegetation associations were described and mapped from the main drainage channel of Yandicoogina Creek within the study area. Vegetation was classified into eight broad floristic formations. None of the ten vegetation associations were aligned with Federal or State listed TECs, or any State listed PECs. There were no plant taxa gazetted as Threatened Flora pursuant to subsection (2) of section 23F of the WC Act, or listed under the EPBC Act recorded from the study area. Five Priority listed flora were opportunistically recorded during the reconnaissance vegetation survey. Vegetation condition ranged from *good* to *poor*, with a total of ten introduced species recorded from the study area.

Six of the ten vegetation associations supported groundwater dependent vegetation (i.e. *Melaleuca argentea*, *Eucalyptus camaldulensis* and *Eucalyptus victrix*).

The obligate phreatophytic tree species *Melaleuca argentea* was recorded as a dominant tree species from one vegetation association (MA EcMa TtEuaSopl CyvTydEgen - Woodland of *Eucalyptus camaldulensis* and *Melaleuca argentea* over Open Tussock Grassland of *Themeda triandra*, *Eulalia aurea* and *Sorghum plumosum* over Open Sedges of *Cyperus vaginatus*, *Typha domingensis* and *Eleocharis geniculata* on brown loam on major drainage lines), and as scattered low trees from a second vegetation association (MA EcEv TtEuaSopl GoroCuleAtp - Woodland of *Eucalyptus camaldulensis* and *Eucalyptus victrix* over Open Tussock Grassland of *Themeda triandra*, *Eulalia aurea* and *Sorghum plumosum* with High Open Shrubland of *Gossypium robinsonii*, *Cullen leucanthum* and *Acacia tumida* var. *pilbarensis* on brown loam on major drainage lines). Groundwater drawdown by greater than 3 metres below ground level (m bgl) has the potential to result in the decline of *Melaleuca argentea* trees, and may also impact on the localised permanent pools that support the sedges *Cyperus vaginatus*, *Typha domingensis* and *Eleocharis geniculata* within the same unit.

The same six vegetation associations support the tall tree species *Eucalyptus camaldulensis* which is considered to be at moderate risk from groundwater drawdown. A second tall tree species, *Eucalyptus victrix*, occurs as a co-dominant with *Eucalyptus camaldulensis* within four of the six vegetation associations, and is considered to be at low risk from groundwater drawdown. While *in situ* groundwater levels are not currently known, groundwater drawdown beyond 20 m bgl will result in an increased risk of tree decline for *Eucalyptus camaldulensis*, and to a lesser extent *Eucalyptus victrix*. The impact is likely to be more severe during extended periods of drought.

The remaining four vegetation associations within the study area have been determined to have negligible risk from groundwater drawdown as they comprise a mixture of vadophytic and xerophytic plant species that have no reliance on groundwater.

The remaining four vegetation associations do not support groundwater dependent vegetation, or stands of Mulga or *Acacia citrinoviridis* that are known to be susceptible to prolonged inundation that may result within the wetting front during surface water discharge.

6.0 STUDY TEAM

The reconnaissance vegetation survey and impact assessment was planned, co-ordinated and executed by the following personnel:

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APPENDIX 1

Results from previous flora and vegetation surveys completed
in the vicinity of the study area

Project	Survey Timing	Season	Survey Type	Vegetation with potential GDV	Vegetation with Mulga or <i>Acacia citrinoviridis</i>
Biota Environmental Sciences (2017) Ministers North Detailed Flora and Vegetation Survey	20-29 Sep 2016 8-10 May & 10-14 Jul 2017	Good & Excellent	Detailed	<ul style="list-style-type: none"> Open woodland of <i>Eucalyptus victrix</i> over open tussock grassland of <i>Eulalia aurea</i> (<i>Sorghum plumosum</i> var. <i>plumosum</i>) with scattered tall shrubs of <i>Acacia coriacea</i> subsp. <i>pendens</i> over scattered low shrubs of <i>Tephrosia rosea</i> var. Fortescue Creeks (M.I.H. Brooker 2186) on dark reddish brown sand in creek beds along drainage lines Open forest of <i>Melaleuca argentea</i> (<i>Eucalyptus camaldulensis</i> subsp. <i>refulgens</i>) over open sedges of <i>Typha domingensis</i> (<i>Cyperus vaginatus</i>) with open shrubland of <i>Gossypium robinsonii</i> (<i>Cullen leucanthum</i>) over very open tussock grassland of <i>Eulalia aurea</i> (<i>Cymbopogon ambiguus</i>, <i>Sorghum plumosum</i> var. <i>plumosum</i>) on dark reddish brown clay loam along a drainage line 	None
Onshore Environmental (2015) Marillana Creek Riparian Flora and Vegetation Survey	8-19 Jun 2015	Excellent	Detailed	<ul style="list-style-type: none"> Open Forest of <i>Eucalyptus camaldulensis</i>, <i>Melaleuca argentea</i> and <i>Eucalyptus victrix</i> over Low Open Forest of <i>Acacia coriacea</i> subsp. <i>pendens</i>, <i>Atalaya hemiglauca</i> and <i>Melaleuca argentea</i> over Sedgeland of <i>Typha domingensis</i>, <i>Cyperus vaginata</i> and <i>Schoenoplectus subulatus</i> on major drainage line with pools with brown light clay or sandy loam Open Forest of <i>Eucalyptus victrix</i> and <i>Eucalyptus camaldulensis</i> over Open Scrub of <i>Melaleuca bracteata</i> and <i>Melaleuca glomerata</i> with Low Open Woodland of <i>Acacia ampliceps</i> and <i>Atalaya hemiglauca</i> on major drainage line with brown light clay Woodland of <i>Eucalyptus camaldulensis</i> and <i>Eucalyptus victrix</i> over Low Woodland of <i>Acacia coriacea</i> subsp. <i>pendens</i>, <i>Eucalyptus victrix</i> and <i>Eucalyptus camaldulensis</i> over Low Open Shrubland of <i>Corchorus crozophorifolius</i> and <i>Tephrosia rosea</i> var. Fortescue creeks (M.I.H. Brooker 2186) on major drainage line with brown clayey sand Woodland - Open Woodland of <i>Eucalyptus camaldulensis</i> and <i>Eucalyptus victrix</i> over Low Woodland of <i>Acacia coriacea</i> subsp. <i>pendens</i>, <i>Atalaya hemiglauca</i> and <i>Eucalyptus victrix</i> over Open Hummock Grassland of <i>Triodia pungens</i> and <i>Triodia longiceps</i> on levees and channel islands of major drainage lines with brown sandy loam Open Woodland of <i>Eucalyptus camaldulensis</i>, 	<ul style="list-style-type: none"> Low Woodland of <i>Acacia citrinoviridis</i>, <i>Acacia coriacea</i> subsp. <i>pendens</i> and <i>Atalaya hemiglauca</i> with Open Hummock Grassland of <i>Triodia pungens</i> and Open Tussock Grassland of <i>Eriachne tenuiculmis</i> and <i>Enneapogon lindleyanus</i> on raised levee banks of major drainage line with brown loam Hummock Grassland of <i>Triodia wiseana</i> and <i>Triodia longiceps</i> with Low Open Woodland of <i>Corymbia hamersleyana</i>, <i>Acacia aptaneura</i> and <i>Hakea lorea</i> subsp. <i>lorea</i> and Open Shrubland of <i>Acacia arida</i>, <i>Acacia ancistrocarpa</i> and <i>Acacia bivenosa</i> on plains with brown silty loam

Project	Survey Timing	Season	Survey Type	Vegetation with potential GDV	Vegetation with Mulga or <i>Acacia citrinoviridis</i>
				<p><i>Melaleuca argentea</i> and <i>Eucalyptus victrix</i> over High Open Shrubland of <i>Melaleuca glomerata</i> and <i>Myoporum montanum</i> over Very Open Herbs of <i>Pluchea rubelliflora</i> and <i>Stemodia grossa</i> on open gravel beds of major drainage line with brown sand/clay loam</p> <ul style="list-style-type: none"> • Low Open Heath of <i>Corchorus crozophorifolius</i> and <i>Tephrosia rosea</i> var. Fortescue creeks (M.I.H. Brooker 2186) with Scattered Trees of <i>Eucalyptus camaldulensis</i> and <i>Eucalyptus victrix</i> and Scattered Tussock Grasses of <i>Eriachne tenuiculmis</i>, *<i>Cenchrus ciliaris</i> and <i>Eriachne pulchella</i> subsp. <i>dominii</i> on creekbed of major drainage line with brown clay loam • Tussock Grassland of *<i>Cenchrus ciliaris</i>, <i>Themeda triandra</i> and <i>Bothriochloa ewartiana</i> with Open Woodland of <i>Eucalyptus victrix</i> and <i>Eucalyptus camaldulensis</i> and Very Open Hummock Grassland of <i>Triodia pungens</i> on floodplains and levee banks of major drainage line with brown sandy loam • Tussock Grassland of <i>Eulalia aurea</i>, <i>Themeda triandra</i> and <i>Eriachne tenuiculmis</i> with High Shrubland of <i>Acacia tumida</i> var. <i>pilbarensis</i> and <i>Gossypium robinsonii</i> and Open Woodland of <i>Eucalyptus victrix</i> on floodplains with brown sandy loam • Tussock Grassland of <i>Themeda triandra</i>, <i>Eulalia aurea</i> and <i>Aristida inaequiglumis</i> with Open Woodland of <i>Eucalyptus victrix</i> and <i>Corymbia aspera</i> and High Open Shrubland of <i>Gossypium robinsonii</i>, <i>Eremophila longifolia</i> and <i>Atalaya hemiglauca</i> on plains with brown sandy loam • Tussock Grassland of <i>Sorghum plumosum</i>, <i>Eriachne tenuiculmis</i> and <i>Themeda triandra</i> with Low Open Woodland of <i>Eucalyptus victrix</i>, <i>Eucalyptus camaldulensis</i> and <i>Acacia coriacea</i> subsp. <i>pendens</i> and High Open Shrubland of <i>Grevillea pyramidalis</i> subsp. <i>leucadendron</i>, <i>Gossypium robinsonii</i> and <i>Acacia pyrifolia</i> on levee banks of major drainage line with brown silty loam • Open Herbs of <i>Potamogeton tricarinatus</i> with Open Woodland of <i>Eucalyptus camaldulensis</i> and Very Open Sedges of <i>Typha domingensis</i>, <i>Schoenoplectus subulatus</i> and <i>Cyperus vaginatus</i> 	

Project	Survey Timing	Season	Survey Type	Vegetation with potential GDV	Vegetation with Mulga or <i>Acacia citrinoviridis</i>
				on dolerite platforms of major drainage line with brown light clay	
Onshore Environmental (2014) Mining Area C Review of Flora and Vegetation Baseline Information	N/A	N/A	Desktop	<ul style="list-style-type: none"> High Shrubland of <i>Acacia tumida</i> var. <i>pilbarensis</i>, <i>Acacia pyrifolia</i> var. <i>pyrifolia</i> and <i>Acacia sericophylla</i> with Scattered Trees of <i>Eucalyptus camaldulensis</i> subsp. refulgens over Open Tussock Grassland of <i>Themeda</i> sp. Mt Barricade (M.E. Trudgen 2471), <i>Themeda triandra</i> and <i>Cymbopogon procerus</i> on brown loam and gravels on major drainage channels Tussock Grassland of <i>Themeda triandra</i>, <i>Eulalia aurea</i> and <i>Eriachne tenuiculmis</i> with High Shrubland of <i>Acacia pyrifolia</i> var. <i>pyrifolia</i>, <i>Acacia tumida</i> var. <i>pilbarensis</i> and <i>Petalostylis labicheoides</i> and Open Woodland of <i>Eucalyptus victrix</i> and <i>Corymbia hamersleyana</i> on red brown silty loam on medium drainage lines and flood plains Tussock Grassland of <i>Themeda triandra</i>, <i>Chrysopogon fallax</i> and <i>Eulalia aurea</i> with Low Open Woodland of <i>Eucalyptus xerothermica</i>, <i>Eucalyptus victrix</i> and <i>Corymbia hamersleyana</i> and Shrubland of <i>Petalostylis labicheoides</i>, <i>Acacia pachyacra</i> and <i>Acacia pyrifolia</i> var. <i>pyrifolia</i> on red sandy loam on medium drainage lines 	<ul style="list-style-type: none"> Low Open Forest of <i>Acacia aptaneura</i> and <i>Acacia pruinoarpa</i> over Open Hummock Grassland of <i>Triodia melvillei</i>, <i>Triodia wiseana</i> and <i>Triodia pungens</i> over Tussock Grassland of <i>Themeda triandra</i>, <i>Chrysopogon fallax</i> and <i>Aristida inaequiglumis</i> on red brown loam on plains Low Woodland of <i>Acacia aptaneura</i> and <i>Acacia pruinoarpa</i> over Shrubland of <i>Eremophila jucunda</i> subsp. <i>pulcherrima</i>, <i>Acacia marramamba</i> and <i>Codonocarpus cotinifolius</i> over Open Hummock Grassland of <i>Triodia wiseana</i> and <i>Triodia pungens</i> on red brown loam on hill slopes Low Open Woodland of <i>Acacia aptaneura</i>, <i>Acacia catenulata</i> subsp. <i>occidentalis</i> and <i>Acacia paraneura</i> over Low Open Shrubland of <i>Eremophila lanceolata</i>, <i>Solanum lasiophyllum</i> and <i>Ptilotus obovatus</i> over Very Open Tussock Grassland of <i>Aristida contorta</i>, <i>Eragrostis dielsii</i> and <i>Aristida jerichoensis</i> var. <i>subspinulifera</i> on red brown clay loam on hardpan intergrove plains Hummock Grassland of <i>Triodia wiseana</i>, <i>Triodia pungens</i> and <i>Triodia</i> sp. Shovelanna Hill (S. van Leeuwen 3835) with Low Open Woodland of <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> over Open Shrubland of <i>Acacia pruinoarpa</i>, <i>Acacia aptaneura</i> and <i>Acacia ancistrocarpa</i> on red brown loam on plains and low hills Hummock Grassland of <i>Triodia pungens</i> and <i>Triodia melvillei</i> with Low Open Woodland of <i>Acacia aptaneura</i>, <i>Eucalyptus xerothermica</i> and <i>Acacia catenulata</i> subsp. <i>occidentalis</i> and Open Shrubland of <i>Acacia pachyacra</i>, <i>Eremophila forrestii</i> subsp. <i>forrestii</i> and <i>Acacia adsurgens</i> on red brown clay loam or silty loam on stony plains and floodplains
Onshore Environmental (2013) Flora and Vegetation Survey Marillana ML70/270	27-30 Apr & 28 Sep – 6 Oct 2011	Good	Detailed		<ul style="list-style-type: none"> Low Open Forest of <i>Acacia aneura</i> over Open Tussock Grassland of <i>*Cenchrus ciliaris</i> and <i>Chrysopogon fallax</i> over Very Open Hummock Grassland of <i>Triodia pungens</i> and <i>Triodia basedowii</i> in brown clayey sand on sandy plains Closed Tussock Grassland of <i>*Cenchrus ciliaris</i> and <i>*Cenchrus setiger</i> with Low Open Forest of <i>Acacia citrinoviridis</i>, <i>Atalaya hemiglaucua</i> and <i>Hakea lorea</i>

Project	Survey Timing	Season	Survey Type	Vegetation with potential GDV	Vegetation with Mulga or <i>Acacia citrinoviridis</i>
					<p>subsp. <i>lorea</i> and Scattered Trees of <i>Eucalyptus victrix</i> in brown loamy sand along levee banks of major drainage lines</p> <ul style="list-style-type: none"> Closed Tussock Grassland of *<i>Cenchrus setiger</i> and *<i>Cenchrus ciliaris</i> with Low Open Woodland of <i>Acacia citrinoviridis</i>, <i>Atalaya hemiglauc</i>, <i>Hakea lorea</i> subsp. <i>lorea</i> and Scattered Trees of <i>Eucalyptus victrix</i> in red brown loamy sand on floodplains
Onshore Environmental (2012) Flora and Vegetation Survey Weeli Wolli Spring Priority Ecological Community	4-6 May, 9 May & 23-25 May 2011	Very Good	Reconnaissance (targeted to mapping PEC)	<ul style="list-style-type: none"> Open Forest of <i>Melaleuca argentea</i> and <i>Eucalyptus camaldulensis</i> over Low Woodland of <i>Acacia citrinoviridis</i>, <i>Acacia coriacea</i> subsp. <i>pendens</i> and <i>Acacia ampliceps</i> over Open Sedges of <i>Typha domingensis</i>, <i>Cyperus vaginatus</i> and <i>Fimbristylis sieberiana</i> 	<ul style="list-style-type: none"> Open Forest of <i>Melaleuca argentea</i> and <i>Eucalyptus camaldulensis</i> over Low Woodland of <i>Acacia citrinoviridis</i>, <i>Acacia coriacea</i> subsp. <i>pendens</i> and <i>Acacia ampliceps</i> over Open Sedges of <i>Typha domingensis</i>, <i>Cyperus vaginatus</i> and <i>Fimbristylis sieberiana</i>
Onshore Environmental (2011a) Flora and Vegetation Survey Area C and Surrounds	26 Nov – 6 Dec 2009 9-18 Feb 2010 14-21 June 2010	Poor	Detailed	<ul style="list-style-type: none"> Woodland to Forest of <i>Eucalyptus camaldulensis</i> var. <i>obtusa</i>, <i>Melaleuca argentea</i> and <i>Eucalyptus victrix</i> over Low Open Woodland of <i>Acacia citrinoviridis</i> and <i>Acacia coriacea</i> subsp. <i>pendens</i> over Shrubland of <i>Acacia bivenosa</i>, <i>Gossypium sturtianum</i> and <i>Gossypium robinsonii</i> in brown silty sand and clay soils along Weeli Wolli Creek 	<ul style="list-style-type: none"> Woodland to Forest of <i>Eucalyptus camaldulensis</i> var. <i>obtusa</i>, <i>Melaleuca argentea</i> and <i>Eucalyptus victrix</i> over Low Open Woodland of <i>Acacia citrinoviridis</i> and <i>Acacia coriacea</i> subsp. <i>pendens</i> over Shrubland of <i>Acacia bivenosa</i>, <i>Gossypium sturtianum</i> and <i>Gossypium robinsonii</i> in brown silty sand and clay soils along Weeli Wolli Creek Low Open Forest of <i>Acacia aneura</i> var. <i>tenuis</i> over Tussock Grassland of <i>Themeda triandra</i>, <i>Chrysopogon fallax</i> and <i>Aristida inaequiglumis</i> in red brown clay loam soils on flood plains Low Open Forest of <i>Acacia aneura</i> var. <i>intermedia</i> and <i>Acacia aneura</i> var. <i>tenuis</i> over Hummock Grassland of <i>Triodia pungens</i> with Open Shrubland of <i>Eremophila forrestii</i> subsp. <i>forrestii</i>, <i>Acacia pruinocarpa</i> and <i>Eremophila longifolia</i> in red brown clay loam soils on flood plains Low Open Forest of <i>Acacia catenulata</i> subsp. <i>occidentalis</i>, <i>Acacia aneura</i> var. <i>tenuis</i> and <i>Grevillea</i> aff. <i>berrryana</i> over Open Shrubland of <i>Scaevola acacioides</i> and <i>Acacia tetragonophylla</i> over Very Open Tussock Grassland of <i>Eriachne mucronata</i> in light brown loam soils on steep breakaway scree slopes Low Open Woodland of <i>Acacia aneura</i> var. <i>tenuis</i> and <i>Acacia pruinocarpa</i> over Open Shrubland of <i>Acacia pachyacra</i> over Open Tussock Grassland of <i>Themeda triandra</i>, <i>Aristida inaequiglumis</i> and <i>Aristida contorta</i> in red brown clay loam soils on stony plains

Project	Survey Timing	Season	Survey Type	Vegetation with potential GDV	Vegetation with Mulga or <i>Acacia citrinoviridis</i>
					<ul style="list-style-type: none"> • Closed Tussock Grassland of <i>Themeda triandra</i>, <i>Aristida inaequiglumis</i> and <i>Digitaria ammophila</i> with Low Woodland of <i>Acacia aneura</i> var. <i>tenuis</i> and <i>Eucalyptus xerothermica</i> in red brown loam soils on flood plains and drainage foci • Tussock Grassland of <i>Themeda triandra</i>, <i>Eulalia aurea</i> and <i>Aristida lazaridis</i> with Low Woodland of <i>Eucalyptus xerothermica</i> and <i>Acacia aneura</i> var. <i>tenuis</i> over Open Shrubland of <i>Acacia pruinocarpa</i>, <i>Eremophila longifolia</i> and <i>Acacia pyrifolia</i> var. <i>pyrifolia</i> in red brown clay loam soils on unincised drainage lines and drainage foci
Onshore Environmental (2011b) Flora and Vegetation Review Yandi ML270SA	9-16 Dec 2010	Good	Desktop and Targeted	<ul style="list-style-type: none"> • High Open Forest of <i>Melaleuca argentea</i>, <i>Eucalyptus camaldulensis</i> var. <i>obtusata</i> over High Shrubland of <i>Melaleuca glomerata</i>, <i>Acacia bivenosa</i>, <i>Acacia sericophylla</i> over Very Open Sedges of <i>Cyperus vaginatus</i> in alluvial gravelly soils along major drainage channels • Scattered Tall Trees of <i>Eucalyptus camaldulensis</i> var. <i>obtusata</i> over Scattered Tall Shrubs of <i>Acacia sericophylla</i>, <i>Acacia ampliceps</i>, <i>Atalaya hemiglauca</i> over Low Scattered Shrubs of <i>Crotalaria novae-hollandiae</i> subsp. <i>novae-hollandiae</i>, <i>Melhania oblongifolia</i>, <i>Tephrosia rosea</i> var. <i>glabrior</i> in alluvial gravelly soils along scoured creek beds in major drainage lines • Open Forest (to Woodland) of <i>Eucalyptus camaldulensis</i> var. <i>obtusata</i>, <i>Eucalyptus victrix</i> over Open Scrub of <i>Acacia pyrifolia</i>, <i>Acacia tumida</i>, <i>Gossypium robinsonii</i> over Low Shrubland of <i>Corchorus crozophorifolius</i>, <i>Indigofera monophylla</i>, <i>Tephrosia rosea</i> var. <i>glabrior</i> in dark red brown loam soils along major drainage lines • Hummock Grassland of <i>Triodia pungens</i> with High Shrubland of <i>Acacia dictyophleba</i>, <i>Acacia bivenosa</i>, <i>Eremophila longifolia</i> and Scattered Low Trees of <i>Corymbia hamersleyana</i>, <i>Eucalyptus victrix</i>, <i>Eucalyptus xerothermica</i> in brown clay loam soils on outwash plains bordering major drainage lines 	<ul style="list-style-type: none"> • Low Open Forest of <i>Acacia aneura</i>, <i>Eucalyptus xerothermica</i> over Open Hummock Grassland of <i>Triodia pungens</i> and Open Tussock Grassland of <i>Chrysopogon fallax</i>, <i>Themeda triandra</i>, <i>Eulalia aurea</i> in red brown clay loam soils on flood plains and along medium drainage lines • Low Open Forest of <i>Acacia aneura</i> over Open Hummock Grassland of <i>Triodia pungens</i>, <i>Triodia wiseana</i>, <i>Triodia</i> sp. Shovellana Hill in red brown loam soils on undulating low hills • High Shrubland of <i>Acacia pruinocarpa</i>, <i>Acacia aneura</i>, <i>Acacia synchronicia</i> over Open Hummock Grassland of <i>Triodia pungens</i>, <i>Triodia wiseana</i> in red clay soils on stony plains • Shrubland of <i>Acacia aneura</i>, <i>Acacia ancistrocarpa</i>, <i>Acacia pruinocarpa</i> with High Open Shrubland of <i>Acacia aneura</i>, <i>Acacia tetragonophylla</i>, <i>Hakea lorea</i> subsp. <i>lorea</i> and Very Open Hummock Grassland of <i>Triodia wiseana</i> in red clay soils on stony plains • Hummock Grassland of <i>Triodia wiseana</i> with High Shrubland of <i>Acacia aneura</i> in brown loam soils on low hills
Astron Environmental Services (2010) Area C to Yandi Flora and Vegetation Survey	6-11 Sept 2010	Poor	Detailed	<ul style="list-style-type: none"> • Woodland of <i>Eucalyptus victrix</i> over Tussock Grassland of <i>Eulalia aurea</i>, <i>Eriachne mucronata</i> and <i>Eriachne tenuiculmis</i> with Scattered Shrubs of <i>Tephrosia rosea</i> var. <i>glabrior</i>, <i>Gossypium robinsonii</i> and <i>Acacia pyrifolia</i> var. <i>pyrifolia</i> on Orange-brown Fine Clayey Loams in some Major Incised 	None

Project	Survey Timing	Season	Survey Type	Vegetation with potential GDV	Vegetation with Mulga or <i>Acacia citrinoviridis</i>
				<p>Creeklines</p> <ul style="list-style-type: none"> • Woodland of <i>Eucalyptus camaldulensis</i> and <i>Eucalyptus victrix</i> over Tussock Grassland of <i>Eulalia aurea</i>, <i>Cyperus vaginatus</i> and <i>Cymbopogon</i> sp. indeterminate over High Open Shrubland of <i>Melaleuca glomerata</i>, <i>Gossypium robinsonii</i> and <i>Acacia tumida</i> var. <i>pilbarensis</i> on Brown Coarse Sands and Sandy Loams in some Major Incised Creeklines 	
Biota Environmental Sciences (2010) Vegetation and Flora Survey of the Oxbow and Junction South West Deposits, near Yandicoogina	4-16 Jun 2007 27 Jul – 6 Aug 2008 3-9 Jun 2009	Good (2007 and 2009) Poor (2008)	Detailed	<ul style="list-style-type: none"> • <i>Eucalyptus camaldulensis</i>, <i>E. victrix</i> woodland over <i>Melaleuca argentea</i>, <i>M. glomerata</i> low open woodland • <i>Eucalyptus victrix</i> scattered low trees over <i>Acacia tumida</i> var. <i>pilbarensis</i>, <i>Grevillea wickhamii</i> subsp. <i>hispidula</i>, <i>Rulingia luteiflora</i> tall shrubland over <i>Tephrosia rosea</i> low shrubland over <i>Cymbopogon procerus</i>, <i>Eriachne tenuiculmis</i> very open tussock grassland • <i>Eucalyptus victrix</i>, <i>E. camaldulensis</i> scattered low trees over <i>Acacia tumida</i>, <i>Rulingia luteiflora</i> shrubland over <i>Tephrosia rosea</i> low open shrubland over <i>Eriachne tenuiculmis</i>, <i>Themeda triandra</i> open tussock grassland 	None
ENV Australia (2009a) Ministers North Exploration Leases Flora and Vegetation Assessment	13-19 Sep 2007	Poor	Detailed	None	None
ENV Australia (2009b) Newman to Yandi Transmission Line Flora and Vegetation Assessment	5-15 May 2009	Excellent	Detailed	<ul style="list-style-type: none"> • Tussock Grassland of <i>Themeda triandra</i>, *<i>Cenchrus ciliaris</i> and <i>Sorghum plumosum</i> (with very open sedges of <i>Cyperus vaginatus</i>) with Low Open Shrubland of <i>Rulingia luteiflora</i>, <i>Acacia inaequilatera</i> and <i>Tephrosia rosea</i> var. <i>glabrior</i> with Open Woodland of <i>Eucalyptus victrix</i> on Red-brown Clayey Loam with on Drainage Lines. • Open Tussock / Hummock Grassland of <i>Themeda triandra</i>, <i>Triodia wiseana</i> and *<i>Cenchrus ciliaris</i> (sedges of <i>Cyperus vaginatus</i>) with Open Shrubland of <i>Acacia bivenosa</i> and <i>Melaleuca glomerata</i> with Open Woodland of <i>Eucalyptus victrix</i> and <i>Corymbia hamersleyana</i> on Alluvial Redbrown Loam with on Minor Drainage Lines/Floodplains • Tussock Grassland of <i>Eulalia aurea</i> and <i>Themeda triandra</i> with Open Shrubland of <i>Petalostylis labicheoides</i>, <i>Rulingia luteiflora</i> and <i>Acacia pyrifolia</i> var. <i>pyrifolia</i> with Low Open Woodland of 	<ul style="list-style-type: none"> • Hummock Grassland of <i>Triodia pungens</i> and <i>T. brizoides</i> with High Open Shrubland of <i>Acacia aneura</i>, <i>Acacia catenulata</i> subsp. <i>occidentalis</i> and <i>Astrotricha hamptonii</i> with Scattered Low Trees of <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> and <i>Corymbia ferriticola</i> subsp. <i>ferriticola</i> with Scattered Tussock Grass of <i>Eriachne mucronata</i> on Red-brown Loam on Outcrops/Cliff Faces • Tussock / Hummock Grassland of <i>Triodia pungens</i>, <i>Eriachne mucronata</i> and <i>Themeda triandra</i> with High Open Shrubland of <i>Acacia citrinoviridis</i>, <i>A. tumida</i> var. <i>pilbarensis</i> and <i>A. pruinocarpa</i> with Low Open Woodland of <i>Corymbia deserticola</i> subsp. <i>deserticola</i>, <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> and <i>C. candida</i> subsp. <i>dipsodes</i> on Skeletal Red-brown Loam on Major Gullies • Hummock Grassland of <i>Triodia</i> sp. Shovelanna Hill (S. van Leeuwen 3835) with (High) Shrubland of <i>Acacia ayersiana</i>, <i>A. aneura</i> and <i>A. catenulata</i>

Project	Survey Timing	Season	Survey Type	Vegetation with potential GDV	Vegetation with Mulga or <i>Acacia citrinoviridis</i>
				<p><i>Eucalyptus camaldulensis</i>, <i>E. victrix</i> and <i>E. xerothermica</i> on Red-brown Clay on Major Drainage Lines</p> <ul style="list-style-type: none"> Open Forest of <i>Eucalyptus camaldulensis</i> var. <i>obtusa</i> over Shrubland of <i>Melaleuca argentea</i>, <i>M. glomerata</i> and <i>Eremophila margarethae</i> with Open Tussock Grassland of <i>Cymbopogon procerus</i> and <i>Themeda triandra</i> with on redbrown loam with on Major Drainage Lines 	<p>subsp. <i>occidentalis</i> with Scattered Mallees of <i>Eucalyptus gamophylla</i> on Red- brown Loam on Plains/Floodplains</p> <ul style="list-style-type: none"> Hummock / Tussock Grassland of <i>Triodia angusta</i>, <i>T. pungens</i> and *<i>Cenchrus ciliaris</i> with (Open) Shrubland of <i>Acacia aneura</i>, <i>A. pruinocarpa</i> and <i>Acacia tetragonophylla</i> on Red-brown Loam on Plains/Floodplains Hummock Grassland of <i>Triodia wiseana</i> and <i>T. pungens</i> with Shrubland of <i>Acacia ancistrocarpa</i>, <i>Stylobasium spathulatum</i> and <i>Acacia aneura</i> with Low Open Woodland of <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> and <i>Eucalyptus xerothermica</i> on Red- brown Loam on Minor Drainage Lines Open Tussock Grassland of *<i>Cenchrus ciliaris</i> with High Shrubland of <i>Acacia citrinoviridis</i> on Red-brown Loam on Disturbed Drainage Lines Open to Closed Hummock / Tussock Grassland of <i>Themeda triandra</i>, <i>Triodia pungens</i> and <i>Eriachne tenuiculmis</i> with High Shrubland of <i>Acacia citrinoviridis</i>, <i>A. bivenosa</i> and <i>Rulingia luteiflora</i> with Low Woodland of <i>Eucalyptus victrix</i> and <i>E. xerothermica</i> on Alluvial Red-brown Sand and Loam (some clay) on Drainage Lines Open Scrub of <i>Acacia catenulate</i> subsp. <i>occidental</i>, <i>A. pruinocarpa</i> and <i>A. aneura</i> over Hummock Grassland of <i>Triodia melvillei</i> with Scattered Low Trees of <i>Corymbia deserticola</i> subsp. <i>deserticola</i> and <i>C. hamersleyana</i> on Red-brown Sandy Loam on Plains High Shrubland of <i>Acacia aneura</i>, <i>Petalostylis labicheoides</i> and <i>Rulingia luteiflora</i> over (Very Open) Hummock / Tussock Grassland of <i>Themeda triandra</i>, <i>Triodia pungens</i> and <i>Chrysopogon fallax</i> with Low Open Woodland of <i>Eucalyptus xerothermica</i>, <i>Corymbia hamersleyana</i> and (mallee) <i>E. gamophylla</i> on Red-brown Loam (some clay) on Floodplains/Drainage Lines High (Open) Shrubland of <i>Acacia aneura</i> with Open Tussock Grassland of <i>Aristida contorta</i>, <i>Chrysopogon fallax</i> and <i>Enneapogon polyphyllus</i> on Redbrown Loam with Clay Surface on Plains High Open Shrubland of <i>Acacia aneura</i>, <i>A. catenulata</i> subsp. <i>occidentalis</i> and <i>A. pruinocarpa</i> over Very Open Hummock Grassland of <i>Triodia</i>

Project	Survey Timing	Season	Survey Type	Vegetation with potential GDV	Vegetation with Mulga or <i>Acacia citrinoviridis</i>
					<i>wiseana</i> and <i>T. melvillei</i> with Low Open Shrubland <i>Eremophila forrestii</i> subsp. <i>forrestii</i> and <i>Ptilotus obovatus</i> on Red-brown Loam on Plains/Low Undulations
Woodman Environmental Consulting (2009) Flora and Vegetation Assessment Area C Mining Operations Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits	12 Apr – 16 May 2008 9-13 Jun 2008 23-27 Jun 2008	-	Detailed	None	<ul style="list-style-type: none"> Mixed <i>Eucalyptus</i> spp. Open Woodland over <i>Acacia eremaea</i> and <i>A. aneura</i> Scrub over <i>Triodia pungens</i> and/or <i>Triodia wiseana</i> on red-brown clay from plains to hill crests Scrubland to Thicket of <i>Acacia aneura</i> with <i>Acacia bivenosa</i> and/or <i>Acacia pruinocarpa</i> over a Grassland of mixed species on red-orange loam on the flood plain Thicket to Open Scrub of <i>Acacia aneura</i> with <i>Acacia pachyacra</i> or <i>Acacia pruinocarpa</i> over mixed grass species of <i>Aristida</i> spp. and <i>Themeda</i> spp and herbs on flood plains to lowerslopes
Ecologia Environment (2008) Two Phase Assessment of the Flora and Vegetation of the Proposed Marillana Creek (Yandi) Mine Extension Areas RGP5 - KBR	13-19 Nov 2007 10-17 Mar 2008	Poor & Good	Detailed	<ul style="list-style-type: none"> <i>Eucalyptus camaldulensis</i>/E. <i>victrix</i> +/- <i>Melaleuca leucadendra</i> over open to moderately dense tall shrubland over moderately dense soft grasses 	<ul style="list-style-type: none"> Sparse <i>E. leucophloia</i> over open to moderately dense <i>Acacia aneura</i> woodland over sparse shrubs over open to moderately dense <i>Triodia epactia</i> Sparse <i>Corymbia candida</i> over moderately dense <i>Acacia aneura</i>/A. <i>pruinocarpa</i> over moderately dense *<i>Cenchrus ciliaris</i> and other soft grasses
Ecologia Environmental (2006) Ministers North Biological Survey	10-14 May 2006	Good	Reconnaissance	None	None
Halpern Glick Maunsell (1999) Marillana Creek Western Access Corridor – Biological Assessment	23-30 Apr 1999	-	Detailed	<ul style="list-style-type: none"> Dense <i>Melaleuca argentea</i> / <i>Eucalyptus camaldulensis</i> woodland Tall woodland of <i>Eucalyptus camaldulensis</i> over dense mixed shrubs 	<ul style="list-style-type: none"> Moderately dense <i>Eucalyptus xerothermica</i> / <i>Acacia aneura</i> over shrubs and <i>Triodia pungens</i> Sparse <i>Acacia aneura</i>/A. <i>pruinocarpa</i> over sparse shrubs and open herbs and grasses. <i>Acacia aneura</i> groves over herbs and soft grasses and sparse <i>Triodia pungens</i> <i>Acacia aneura</i> tall shrubland over <i>Triodia wiseana</i> <i>Acacia aneura</i> over mixed <i>Triodia</i> Moderately dense <i>Eucalyptus xerothermica</i> / <i>Acacia aneura</i> over <i>Triodia</i> / <i>Plectrachne</i> Sparse <i>Eucalyptus xerothermica</i> / <i>Acacia aneura</i> over <i>Triodia</i> / <i>Plectrachne</i>
Ecologia Environmental Consultants (1998a) Mining Area C Biological Survey	Apr-May 1997	-	Detailed	<ul style="list-style-type: none"> Sparse <i>Eucalyptus victrix</i> / E. <i>camaldulensis</i> / <i>Melaleuca argentea</i> over mixed shrubs, <i>Cyperus</i> spp, grasses and herbs 	<ul style="list-style-type: none"> <i>Eucalyptus gamophylla</i>, <i>Acacia aneura</i> and/or <i>A. citrinoviridis</i> over dense tall shrubs and sparse to dense <i>Triodia pungens</i> or grasses <i>Acacia aneura</i> over sparse shrubs and <i>Triodia pungens</i> Groves of <i>Acacia aneura</i> over dense soft grasses

Project	Survey Timing	Season	Survey Type	Vegetation with potential GDV	Vegetation with Mulga or <i>Acacia citrinoviridis</i>
					and herbs • Sparse <i>Acacia aneura</i> /A. <i>pruinocarpa</i> over sparse shrubs and open herbs and grasses
Ecologia Environmental Consultants (1998b) Yandi Vegetation and Soil Survey	27 May – 1 Jun 1998	-	Detailed	• Dense <i>Eucalyptus camaldulensis</i> / <i>E. victrix</i> / <i>Melaleuca argentea</i> in major drainage lines	• <i>Acacia aneura</i> /A. <i>pruinocarpa</i> /A. <i>victoriae</i> shrublands • Mature <i>Acacia aneura</i> over sparse <i>Triodia pungens</i> / <i>T. wiseana</i>

APPENDIX 2

Vegetation Classifications for the Pilbara based on Specht (1970), as modified by Aplin (1979) and Trudgen (2009)

Height Class	Canopy Cover				
	100 - 70%	70 - 30%	30 - 10%	10 - 2%	< 2%
Trees > 30 m	High Closed Forest	High Open Forest	High Woodland	High Open Woodland	Scattered Tall Trees
Trees 10-30m	Closed Forest	Open Forest	Woodland	Open Woodland	Scattered Trees
Trees < 10 m	Low Closed Woodland	Low Open Forest	Low Woodland	Low Open Woodland	Scattered Low Trees
Mallee	Closed Mallee	Mallee	Open Mallee	Very Open Mallee	Scattered Mallees
Shrubs > 2 m	Closed Scrub	Open Scrub	High Shrubland	High Open Shrubland	Scattered Tall Shrubs
Shrubs 1-2 m	Closed Heath	Open Heath	Shrubland	Open Shrubland	Scattered Shrubs
Shrubs < 1 m	Low Closed Heath	Low Open Heath	Low Shrubland	Low Open Shrubland	Low Scattered Shrubs
Hummock Grass	Closed Hummock Grassland	Hummock Grassland	Open Hummock Grassland	Very Open Hummock Grassland	Scattered Hummock Grass
Tussock Grass	Closed Tussock Grassland	Tussock Grassland	Open Tussock Grassland	Very Open Tussock Grassland	Scattered Tussock Grass
Bunch Grass	Closed Bunch Grassland	Bunch Grassland	Open Bunch Grassland	Very Open Bunch Grassland	Scattered Bunch Grass
Sedges	Closed Sedges	Sedges	Open Sedges	Very Open Sedges	Scattered Sedges
Herbs	Closed Herbs	Herbs	Open Herbs	Very Open Herbs	Scattered Herbs

Source: S. Van Leeuwen (DBCA)

APPENDIX 3

Vegetation condition scale
(adapted from Keighery 1994 and Trudgen 2002)

Condition	Code	Description
Excellent	1	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
Very Good	2	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks cause by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
Good	3	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.
Poor	4	Still retains basic vegetation structure or ability to regenerate it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.
Degraded	5	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.
Completely Degraded	6	Areas that are completely or almost completely without native species in the structure of their vegetation; i.e. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

APPENDIX 4

Conservation categories for flora described
under the EPBC Act

Category	Description
Extinct	A species is extinct if there is no reasonable doubt that the last member of the species has died.
Extinct in the Wild	A species is categorised as extinct in the wild if it is only known to survive in cultivations, in captivity, or as a naturalised population well outside its past range; or if it has not been recorded in its known/expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered	The species is facing an extremely high risk of extinction in the wild and in the immediate future.
Endangered	The species is likely to become extinct unless the circumstances and factors threatening its abundance, survival, or evolutionary development cease to operate; or its numbers have been reduced to such a critical level, or its habitats have been so drastically reduced, that it is in immediate danger of extinction.
Vulnerable	Within the next 25 years, the species is likely to become endangered unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate.
Conservation Dependent	The species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

APPENDIX 5

Conservation Codes for Western Australian Flora and Fauna

Specially protected fauna or flora are species* which have been adequately searched for and are deemed to be, in the wild, either rare, at risk of extinction, or otherwise in need of special protection, and have been gazetted as such. Categories of specially protected fauna and flora are:

T Threatened Species

Published as Specially Protected under the *Wildlife Conservation Act 1950*, and listed under Schedules 1 to 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora (which may also be referred to as Declared Rare Flora).

Threatened fauna is that subset of 'Specially Protected Fauna' declared to be 'likely to become extinct' pursuant to section 14(4) of the Wildlife Conservation Act.

Threatened flora is flora that has been declared to be 'likely to become extinct or is rare, or otherwise in need of special protection', pursuant to section 23F(2) of the Wildlife Conservation Act.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

CR Critically endangered species

Threatened species considered to be facing an extremely high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

EN Endangered species

Threatened species considered to be facing a very high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

VU Vulnerable species

Threatened species considered to be facing a high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

EX Presumed extinct species

Species which have been adequately searched for and there is no reasonable doubt that the last individual has died. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora.

IA Migratory birds protected under an international agreement

Birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice.

CD Conservation dependent fauna

Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice.

OS Other specially protected fauna

Fauna otherwise in need of special protection to ensure their conservation. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice.

Priority Species

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

1: Priority One - Poorly Known Taxa

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

2: Priority Two - Poorly Known Taxa

Species that are known from one or a few collections (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

3: Priority Three - Poorly Known Taxa

Species that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

4: Priority Four - Rare, Near Threatened and other taxa in need of monitoring

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands.

(b) Near Threatened. Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.

(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.