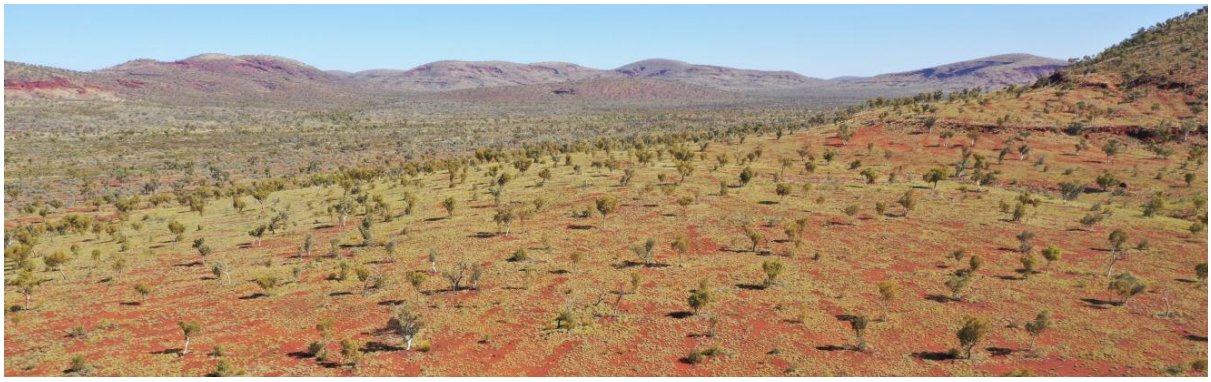
Biodiversity and Conservation Science

A Desktop Assessment and Field Survey of the Vegetation and Conservation-listed Flora within Proposed Gravel Pit Expansions in Karijini National Park.



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This document is available in alternative formats on request.

Cover image. Aerial view of Weano Rd, Karijini National Park. Credit: A. Markey

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Summary

A Level 1 reconnaissance and targeted flora survey was undertaken to document the general vegetation and conservation significant flora and ecological communities in seven proposed gravel pit expansion sites in Karijini National Park. The field survey was undertaken between August 16th and 24th 2022, following several months of average to above average rainfall and a subsequent good spring season.

None of the vegetation communities observed and described for each of the gravel pit sites aligns with Federally and State Listed Threatened Ecological Communities which are Specially Protected under the EPBC Act and BC Acts respectively. No State listed Priority Ecological Communities were identified within or adjacent to the sites.

Three conservation-significant taxa were found in or adjacent to the proposed gravel pit expansion areas. No flora were found which are gazetted as Threatened Flora under Federal Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) or WA Biodiversity Conservation Act 2016 (BC Act). All three taxa are State-listed Priority Flora taxa (DBCA 2022a)

- *Isotropis parviflora* (Priority 2) was located at 6 sites – in high abundance at the Weano Rd sites SLK8A and SLK8B.
- *Rostellularia adscendens* var. *latifolia* (Priority 3) was located in small numbers in a creek adjacent to one of the sites.
- An individual of *Sida* sp. Barlee Range (S. van Leeuwen 1642) (Priority 3) was located in a rocky gully adjacent to one of the sites.

Proposed clearing will affect *Isotropis parviflora* populations, but it is likely the species occurs at other areas within Karijini National Park. The small population of *Sida* sp. Barlee Range is not expected to be affected by gravel extraction operations if due care is taken to prevent erosion and debris entering the gully. Similarly, care should be taken to protect the creekline in which the *Rostellularia adscendens* var. *latifolia* is located from gravel extraction operations.

Three non-native weed species were found in the survey. Two species (*Malvastrum americanum* and *Bidens bipinnata*) were located in small numbers adjacent to one of the sites. Buffel Grass (*Cenchrus ciliaris)* infestations were detected at three of the pits (SLK17, SLK51 and SLK2). It is advised that these stands are eradicated to prevent further spread within and out of the gravel pits by excavation activity.

1 Introduction

1.1 Scope of Survey

Currently there are several unsealed roads in the northern half of Karijini National Park which, because of high levels of visitor use, rapidly degrade to corrugated and potentially hazardous roads within weeks of grading. Parks Management has highlighted the need to resurface and upgrade these roads, requiring gravel to be taken from within the park to limit weed and disease introduction and/or spread that may come with material sourced from outside the park. To meet the internal DBCA clearing approvals process, both a desktop assessment and subsequent field survey were undertaken. The aim of this survey was to describe the vegetation, identify invasive weeds, survey for conservation-listed taxa and conservation listed ecological communities, and to assess erosion issues. This was done as a Level 1 and reconnaissance survey, namely with targeted survey for conservation significant flora and ecological communities within predefined polygons of the impact areas (EPA 2016).

1.1.1 Location of Proposed Pit Expansion Areas

The survey sites are all located within Karijini National Park, in an area of the Hamersley Ranges between 60–80 km north-east of Tom Price. All seven proposed gravel pit expansion areas are located in the northern half of Karijini National Park, close to the gravel roads that are to be upgraded (Figure 1.1). The sites around 7 gravel pits, worked in previous decades but since inactive, were investigated by WML Consulting Engineers geotechnical consultants for their potential for gravel extraction and pit expansion. Since clearing would be required, these mapped areas around the current pits were referred for a Level 1 targeted survey conservation significant flora and vegetation.

Table 1.1: Coordinates of gravel pits proposed for further excavation for road resealing in Karijini National Park.

Pit Name/Code	Adjacent Road	Pit Midpoint Coordinates (dd GDA94)
SLK2	Dales Rd	-22.48295348°S, 118.4984773°E
SLK7	Dales Rd	-22.47799649°S, 118.5335415°E
SLK8A	Weano Rd	-22.34896319°S, 118.2485834°E
SLK8B	Weano Rd	-22.34605059°S, 118.2489297°E
SLK31	Banjima Dr	-22.41017312°S, 118.3140739°E
SLK51	Banjima Dr	-22.48973628°S, 118.4144029°E
SLK17	Banjima Dr West	-22.46102425°S, 118.1875600°E

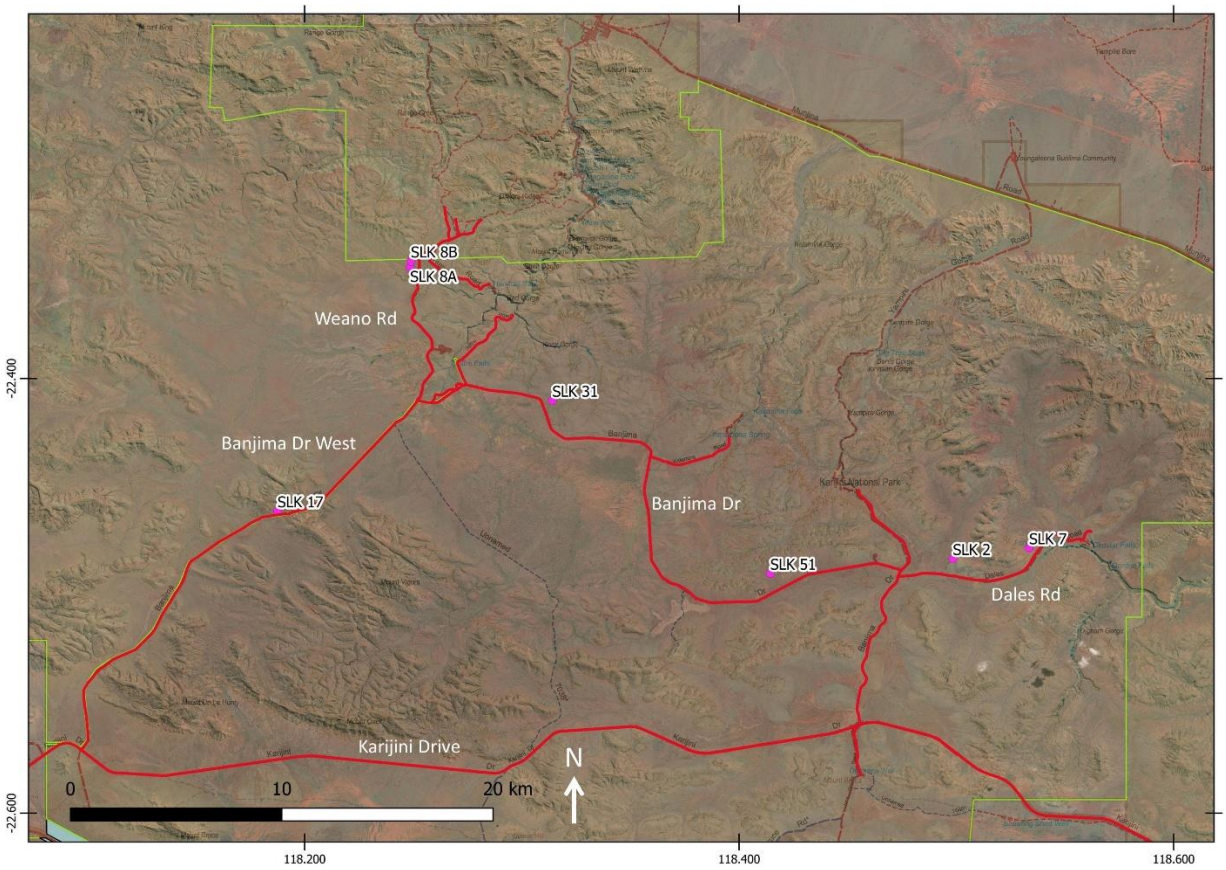

Figure 1.1. Location of pits for survey within Karijini National Park, and their locations along the major roads, Dales Rd, Banjima Rd, Weano Rd and Karijini Drive.

1.2 Physical Setting

1.2.1 Geology

The survey sites are located in the central Hamersley Plateau, a topographically complex elevated plateau region in the Pilbara of ranges and mountains over colluvial and alluvial plains, broad valley systems, deep gorges and confined stream and creek systems. These landforms span an elevational range of c. 600–1200 m amsl (van Etten & Fox 2004), and the survey sites lie mostly at the base of the ironstone hills and ranges, on stony lower slopes, foothills and dissected slopes and raised plains (Payne 2004). Much of the drainage in the area is ephemeral and creeks only intermittently flow after rainfall. The larger river channels in the gorges retain permanent pools of water which are spring-fed and persist over the dry months.

The central Hamersley Plateau is located on the granite-greenstones of the Archean Pilbara Craton, on which the iron-rich Hamersley Group of Proterozoic sediments are overlain. The surface geology are the banded iron formations, cherts and other associated metasediments of the 2479–2449 Ma Brockman Iron Formation for most

survey sites, and (in the case of one survey site), interbedded shale, chert and banded iron-formation of the Mount McRae Shale and Mount Sylvia Formation (Hickman 2021, Thorne & Tyler 1997). Being at the base of these landforms, the surface geology of the majority of the survey sites is Quaternary colluvium (partially consolidated quartz and rock fragments in silt and sand matrix, locally derived old valley fill deposits) (Thorne & Tyler 1997).

1.2.2 Climate

Karijini National Park lies in an arid region (Beard 1975) and a climate zone classified as semi-desert: tropical, which is characterised by 9–11 months of dry weather (Beard 1975, Kendrick 2001). Annual rainfall around the Karijini region is 350 mm, where rainfall is derived from both regular winter falls (averages of 40–50 mm p.a.) and erratic summer cyclonic rainfall events, the latter of which is highly variable between years (Leighton 2004, van Etten & Fox 2004). Summer temperatures and evaporation rates in the Karijini region are high, with the average January daily maximum c. 40°C, while the winter maximum is c. 24°C. (van Etten & Fox 2004).

1.3 Vegetation

The survey sites are located in the Pil-3 Hamersley subregion of the Pilbara IBRA bioregion (DCCEEW 2022a), which is congruent with the Fortescue Botanical District of Beard (1975). The vegetation broadly consists of communities dominated by *Eucalyptus*, *Acacia* and *Triodia*, notably low woodlands of *Acacia aneura* s.l. over bunch grasses on valley floors, hummock grasslands, shrub steppe over soft spinifex, *Eucalyptus leucophloia* woodland over *Triodia* on hillslopes, and *Eucalyptus victrix* and *E. camaldulensis* riverine woodlands (Beard 1975).

Van Etten & Fox (2004) described 16 plant communities in the central Hamersley Ranges that grouped into two broad vegetation groups based on landscape position. Uplands consist of communities of hummock grassland with emergent trees, while valley systems are dominated by mulga woodlands with grassy understory on alluvial fans and drainage lines. Upland community types include hummock grasslands with emergent *Eucalyptus leucophloia* on ridges, mountains and hillslopes, hummock grasslands of *Triodia basedowii* on pediment slopes, hummock grassland and mixed Acacia woodland on calcareous, alkaline soils, hummock grassland of *Triodia wiseana* with *Acacia aneura* s.l. or no/few emergent trees on a range of upland soils and landforms. Lowland types include *Triodia melvillei* hummock grasslands with emergent *Acacia aneura*, *Acacia aneura* woodlands on broad drainage lines, *Eucalyptus woodlands* confined to drainage lines (*Eucalyptus victrix* and *E. camaldulensis* dominated riparian woodlands and *Eucalyptus victrix-Acacia aneura* open woodlands over perennial tussock and bunch grasses).

Using the broad-scale vegetation mapping of Shepherd *et al*. (2001), which has been modified from Beard (1975), the proposed gravel pit expansion areas are given in Table 1.2.

Table 1.2: Vegetation complex of the proposed gravel pit expansion areas, as mapped by Shepherd et al. (2001).

Gravel Pit Sites	Vegetation System Association Code	Description	NVIS Level 6 (Sub Association) Description
SLK2 SLK7 SLK31 part	18.11	Low woodland; mulga (*Acacia aneura*)	M1+ ^*Acacia aneura*, *Eremophila fraseri*, *Acacia pruinocarpa*, *Acacia* sp. aff. ligulata, *Eremophila forrestii*\^shrub\4\i;G1 ^*Ptilotus drummondii*, *Eremophila lanceolata*, *Brachyscome* sp.,*Calocephalus*
SLK51, SLK31 part SLK8A SLK8B SLK17	82.3	Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana*	U1^*Eucalyptus kingsmillii*, *Eucalyptus gamophylla*, *Eucalyptus leucophloia, Eucalyptus* sp.\^tree mallee\6\r;M1 ^*Senna artemisioides* subsp. x *sturtii*, *Dodonaea viscosa*, *Grevillea wickhamii*, *Hakea lorea*, *Senna pleurocarpa* var. *pleurocarpa*\^shrub\4\r;G1+ ^*Triodia wiseana* ,*Ptilotus rotundifolius*, *Acacia lycopodifolia*, *Atriplex* sp., *Gompholobium polyzygum*\^hummock grass,shrub,forb\2\i

The Pilbara regional survey of rangelands provides broadscale mapping of Land Systems, which are units derived from a combination of soil, geology, drainage, landforms and vegetation (Payne 2004). The Land Systems the proposed gravel pit expansion areas are mapped as are given in Table 1.3.

Table 1.3: Land Systems of the proposed gravel pit expansion areas, as mapped by Payne (2004).

Gravel Pit Sites	Land System	Geomorphology	Vegetation
SLK2 SL31, SLK51	Boolgeeda	Stony lower slopes and plains below hill systems. Dissected by closely-spaced drainage. Depositional surfaces, very gently inclined becoming level.	Hummock grasslands of *Triodia*, tall shrublands of *Acacia aneura* s.l.
SLK17	Newman	Rugged jaspilite plateaux, ridges and mountains, lower slopes. Includes lower slopes and narrow drainage floors. Erosional surfaces. Mostly high relief, steep landforms. Lower slopes gently inclined with mantles of ironstone cobbles and gravels.	Hummock grasslands of *Triodia* with scattered shrubs and trees, including *Acacia*, *Senna* and *Eucalyptus leucophloia*.
SLK8A SLK8B SLK7	Platform	Dissected slopes and raised plains. Gently sloping erosional surfaces of Tertiary colluvium.	Hummock grasslands of *Triodia* spp., very scattered Acacia spp or *Eucalyptus leucophloia.*

2 Methods

2.1 Desktop Assessment

Searches were made of databases to identify conservation significant flora at the proposed gravel pit expansion areas. This includes taxa gazetted as Threatened Flora which are listed according to the State of Western Australia (2022) and Federally (DCCEEW 2022b). Priority Flora are listed as per DBCA (2022a). A spatial dataset of flora records of the central Hamersley Range region was obtained from the Western Australia Herbarium specimen database (WAHERB) (Western Australian Herbarium 1998-), and from the Species and Communities Program Threatened and Priority Flora List database (TPFL) (DBCA 2022a). These records were restricted to a polygon 220 × 320 km centred on the survey sites (extents 116.667°E,-24.002°S : 119.906°E,-22.029°S datum: GDA94), and filtered by conservation status. This list was further refined by ranking taxa on their potential to occur at the gravel pit expansion areas knowing that these areas support *Eucalyptus* woodlands over *Triodia* hummock grasslands on landforms of gravelly lower slopes and colluvial plains around banded ironstone hills and ranges, which are dissected by drainage. Information on the taxa was obtained from the spatial dataset, herbarium record information and taxonomic publications.

Access to the DBCA Threatened and Priority Ecological Communities database was also provided by the Department's Species and Communities Program. This spatial dataset was interrogated to locate any conservation significant communities within or close to the proposed gravel pit expansion areas, and if the vegetation observed at these sites matches conservation significant ecological communities described for Western Australia (DBCA 2022b, DBCA2018, DCCEEW 2022c). This includes Threatened Ecological Communities which are Specially Protected under Federal Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act), WA Biodiversity Conservation Act 2016 (BC Act) and Biodiversity Conservation Regulations 2018.

2.2 Field Survey

2.2.1 Survey Conditions

Field survey was undertaken between the 16th and 24th August, 2022, coinciding with the spring flowering season for Pilbara vegetation. Rainfall across the region in the preceding months were from average to well above average, with notably high falls in May (Figure 1.2), ensuring that the region had received ample rainfall for winter-spring growth and flowering. The vegetation was observed to be in good condition, growing well and winter-rainfall dependent species were in flower and fruit. Summer rainfall

dependent species (notably grasses) were mostly sterile, with only some in fruit and most of the annual grass species having dried off.

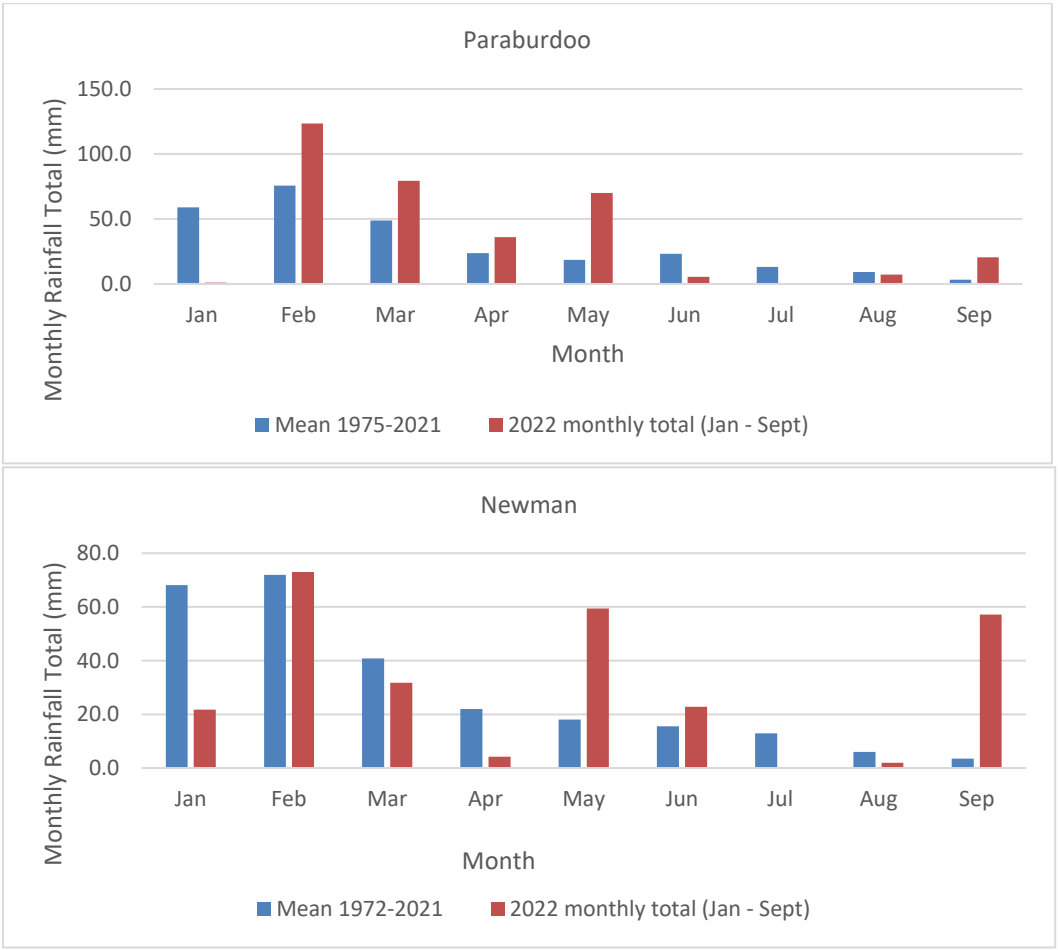

Figure 1.2: Rainfall statistics from Paraburdoo Airport (top) and Newman (bottom) meteorological stations, data from Bureau of Meteorology (BoM) (1908-).

2.2.2 Field Survey

Shapefiles of the proposed gravel pit expansion polygons were provided by the Department's Environmental Management Branch which were used to demarcate the environmental survey boundary. An additional survey polygon (SLK2 Extension) was created and added to the proposed SLK2 gravel pit expansion area after reference to the geotechnical report which indicated an area of interest to the north of the SLK2 site which may provide additional gravel (WML 2022). Shapefiles were loaded onto both Garmin 64st GPS receivers (Garmin Ltd.) and a Unistrong UT30 Android Rugged Tablet (Beijing Unistrong Science & Technology Co., Ltd.) running the Avenza Maps (Avenza Systems Inc.) and SWMaps (Softwel (P) Ltd.) applications.

Each survey polygon was traversed by two botanists experienced in survey and Pilbara flora, with these two observers walking separate tracks between 5 and 20 metres apart (depending on the vegetation density and diversity) within the survey polygons until the polygon area had been effectively covered. Sites of interest outside the polygons were also explored. Multiple geopositioned photopoints and collection points were taken as tracks were walked, where details on the vegetation composition, landform, slope, flora species and invasive non-native weeds were noted and plant specimens collected. All locations of conservation significant species were geolocated using a handheld GPS receiver. A clinometer was used to determine slope, and the Vegetation Condition Scale of Trudgen (1988, in EPA 2016) was used to score vegetation condition. A Mavic Pro 2 Drone Quadcopter (SZ DJI Technology Co., Ltd) was used to acquire aerial imagery.

Representative plant collections were made for the majority of species and most of these were confirmed or verified in the Western Australian Herbarium using the collections and relevant taxonomic publications for flora identifications. Plant nomenclature and taxonomy follows the Western Australian Plant Census (Florabase 1998-). It is intended that a subset of these will be lodged as vouchers within the Western Australian Herbarium. Only vascular flora were considered in this survey which is the expertise of the botanists. Bryophytes, Lichens and Fungi were not addressed, despite there being Conservation-listed non-vascular flora taxa in the region.

3 Desktop Assessment Results

3.1 Conservation Listed Flora and Ecological Communities.

There are no conservation significant taxa within the survey site polygons, and only one record of a conservation significant taxon being within 1 km of a survey polygon. There are no Threatened Flora within 20–50 km of each of the survey sites, these being taxa gazetted as Threatened Flora under Federal Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) or WA Biodiversity Conservation Act 2016 (BC Act), which are also not located within 20 km of each of the survey sites. There is one herbarium record of *Eremophila magnifica* subsp. *magnifica* which is 20 m from the boundary of gravel pit expansion area SLK8A. This record from 1974 is believed to be incorrectly geolocated.

A total of 127 conservation-listed taxa are recorded from within the search polygon that takes in central Hamersley Range, including Karijini National Park (Appendix 1). This list was refined to a subset of 31 taxa considered as having some potential to occur at the proposed gravel pit expansion sites, and this potential was ranked into categories of low, moderate and high (Table 2.1). This ranking was a subjective assessment based on assessing the known range, habitats, substrates, landforms and elevations that these taxa occupy, which were compiled from herbarium record habitat descriptions and relevant taxonomic publications. Taxa with the potential to occur in the gravel pit expansion areas typically occur on the mid to lower elevations of rocky ironstone hills and ranges, on colluvial deposits, on hillslopes, in gullies or drainage lines, in *Eucalyptus* woodlands over *Triodia* hummock grasslands woodlands, and have a distribution over the Hamersley Range, especially in or near the northern half of Karijini National Park. From Table 2.1, only two taxa have a high potential for occurring in the gravel pit expansion areas, while a further five taxa have a moderate or moderate-high potential.

This method of filtering taxa meant that incorrectly geocoded herbarium records could be identified. This was the case for *Eremophila magnifica* subsp. *magnifica*, which had some herbarium records with coordinates that fell within 1–5 km of the SLK8A and SLK8B polygons but which were found or assumed to be incorrectly geolocated upon further investigation.

Table 2.1: Conservation Listed Vascular flora with the potential to occur in the Gravel Pit Expansion Area. Conservation Status current as of October 2022 (DBCA 2022a)

Taxon	Conservation Code	Potential
Acacia bromilowiana	4	low
Acacia daweana	3	low
Acacia effusa	3	medium
Acacia subtiliformis	3	low
Aristida lazaridis	2	low
Dicladanthera glabra	2	low
Eragrostis sp. Mt Robinson (S. van Leeuwen 4109)	2	low
Gompholobium karijini	2	medium - high
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708)	2	low
Hibiscus sp. Mt Brockman (E. Thoma ET 1354)	1	low
Indigofera gilesii	3	low
Indigofera ixocarpa	2	medium
Indigofera rivularis	3	low
Isotropis parviflora	2	high
Lepidium catapycnon	4	medium - high
Olearia mucronata	3	low
Oxalis sp. Pilbara (M.E. Trudgen 12725)	2	low
Ptilotus mollis	4	low
Ptilotus subspinescens	3	low
Rhagodia sp. Hamersley (M. Trudgen 17794)	3	low
Rhynchosia bungarensis	4	low
Rostellularia adscendens var. *latifolia*	3	high
Scaevola sp. Hamersley Range basalts (S. van Leeuwen 3675)	2	low
Sida sp. Barlee Range (S. van Leeuwen 1642)	4	medium
Sida sp. Hamersley Range (K. Newbey 10692)	1	low
Solanum kentrocaule	3	low
Solanum sp. Red Hill (S. van Leeuwen et al. PBS 5415)	3	low
Triodia basitricha	3	low
Triodia pisoliticola	3	low
Triodia sp. Karijini (S. van Leeuwen 4111)	1	low
Triodia sp. Mt Ella (M.E. Trudgen 12739)	3	low

3.2 Threatened and Priority Ecological Communities.

From the DBCA Threatened and Priority Ecological Communities spatial database, no conservation significant ecological communities are mapped within or close (within 1 km) to the proposed gravel pit expansion areas. Two Priority Ecological Communities (DBCA 2022b) are located within 20 km of three of the proposed gravel pit expansion areas.

- The riparian flora and plant communities of springs and river pools with high water permanence of the Pilbara Regions (Priority 2) are found in the gorges within 6 km of sites SLK2 and SLK7. Weano Gorge with similar riparian communities is within 6km of SLK8A and SLK8B and SLK31, but these have not been mapped as priority ecological communities.

- The Kumina Land System (Priority 3) is described as ferricrete duricrust plains, uplands and plateaux remnants, relief up to 15 m, supporting hard spinifex grassland. The nearest examples of these landforms and their associated ecological community are 6–10 km east of sites SLK7 and SLK2.

Neither of these ecological communities are likely to occur on the landforms and locations that the proposed gravel pit expansion areas are situated.

4 Field Survey Results

4.1 Conservation Significant Flora

Three Priority Flora taxa were located within or adjacent to the pit survey areas. No Threatened Flora taxa were located in the survey areas and were not expected for these landforms. A summary is provided in Table 3.1. The mapped occurrences of these taxa within the gravel pit expansion areas are given in Section 4.

Table 3.1. Counts of Individual Plants in the Seven Gravel Pit Expansion Area polygons for State-listed or potentially conservation significant taxa.

Taxon	Pit Expansion Area						
	SLK2	SLK7	SLK8A	SLK8B	SLK17	SLK31	SLK51
Isotropis parviflora	2	1	164	83	0	11	7
Rostellularia adscendens* var. *latifolia							8
***Sida* sp. Barlee Range (S. van Leeuwen 1642)**					1*		

**adjacent to survey polygon*

It is noted that, at the time of survey (August 2022), two species (*Seringia exastia* and *Goodenia nuda*) were listed as being of conservation significance and were targeted for survey. However, these were delisted shortly after the survey was completed (DBCA 2022). *Seringia exastia* was noted but not intensively surveyed since its taxonomic and conservation status was already under review (Binks *et al*. 2019). *Goodenia nuda* was recorded in detail but these results are omitted from this survey.

4.1.1 *Isotropis parviflora* Benth. (Priority 2)

Isotropis parviflora (Fabaceae) is a short-lived (annual or perennial), compact subshrub 10–30 cm tall with pink flowers, unifoliate leaves, an indumentum of ascending to spreading hairs, and pods with characteristically laterally-compressed bases (S. Dillon per. obs) (Figure 2.1.1) (Bailey 1899). *Isotropis parviflora* was the most frequently encountered conservation-listed taxon in the overall survey, with a total of 268 plants counted over 6 survey polygons (Table 3.1). Four proposed pit expansion areas had only a few plants, but pits SLK8A and 8B had high counts of

individuals and were by far the areas with the highest densities of this species. Although one plant was observed by S. Dillon at the base of Mt Meharry in 2016, these are the first collections of this species from within Karijini National Park. *Isotropis parviflora* was found outside of the SLK8A, SLK8B and SLK7 polygons, and located across six widely dispersed sites. The landforms on which this species is found are widespread in Karijini National Park, so this species would be expected to be found elsewhere outside of the proposed gravel pit expansion areas.

Figure 2.1.1. Isotropis parviflora, showing A: subshrub habit B: mature pod and C: flowers.

4.1.2 *Rostellularia adscendens* var. *latifolia* (Domin) R.M.Barker (Priority 3)

Rostellularia adscendens var. *latifolia* (Acanthaceae) is a small decumbent to erect shrub with pink flowers (Barker 1986). It is distinguished from *Rostellularia adscendens* var. *clementii* by having a moderately dense indumentum of long, spreading hairs on the stems (as opposed to a very sparse indumentum of short hairs), and by the shape of the floral bracts and the occurrence of eglandular hairs on the central portion of the bracts (S. Dillon pers. obs). A total of 8 plants of *Rostellularia adscendens* var. *latifolia* were located from the one creekline immediately adjacent to gravel pit expansion site SLK51 (see Section 3.4). Plants were found growing in gravelly, bare creekbed channels which had been scoured from previously flows. Plants ranged in height from 10–15 cm, and were found in fruit and flower (Figure 2.1.2).

Figure 2.1.2: Rostellularia adscendens *var.* latifolia *A: Habit and B: detail of inflorescences.*

4.1.3 *Sida* sp. Barlee Range S. van Leeuwen 1642) (Priority 4)

One individual of *Sida* sp. Barlee Range (S. Van Leeuwen 1642) (Malvaceae) is a subshrub to 1 m, intricately branched, with a densely woolly-velvety hairy indumentum, ovate leaves with crenate margins, yellow flowers and fruits with 6-8 mericarps. It is characterised by a combination of characters including glabrous mericarps and a mericarp number exceeding 5 (from Barker 2007). This taxon was located in a rocky gully of weathered laterised ironstone adjacent to gravel pit expansion area SLK17 (see Section 3.5). This individual wasn't located growing on gravel pit substrates and associated habitat, but on skeletal loam soils on exposed bedrock in a rocky gully adjacent to the site (Figure 2.1.3) (see Section 5.5). The size of this population in the gully is unknown but unlikely to be more than a few scattered individuals. Although outside of the proposed pit expansion area, plants could be affected by excavation activities if these affect the gully or if Buffel Grass spreads from the pit area.

Figure 2.1.3: Sida *sp. Barlee Range (S. van Leeuwen 1642). A: Habit and B: detail of flower and foliage.*

4.2 Priority and Threatened Ecological Communities

The vegetation communities observed and described for each of the gravel pit sites (see Section 5) did not match any of the Priority Ecological Communities described for Western Australia (DBCA 2022b) nor any Threatened Ecological Communities listed for the state (State of Western Australia 2022).

5 Individual Site Findings

5.1 Gravel Pit Expansion Area SLK2 and SLK2 Extension

5.1.1 Site Description

Landform: The SLK2 proposed gravel pit expansion area is 6.5km west of Circular Pool in Dales Gorge, in an area of undulating hills and valleys which eventually lead into Dales Gorge. The gravel pit polygons are located on the eastern margins of a wide, shallow, north-south oriented valley, and a minor creek passes north of the SLK2 polygon and gravel pit (Figure 5.1.1 and Figure 5.1.2). Runoff from the adjacent hillslopes is rapid and flows west into this minor creek before draining into the wide valley flats west of the proposed pit expansion areas. A cutting and old road both now direct water into the current pit, creating a small claypan at the lowest point in the gravel pit cleared area. The eastern half of the SLK2 survey polygon takes in the lower slopes of an ironstone hill, with slope angles of 3–5° and deep gravelly clay soils with >90% surface gravel cover. The western half is of a low gradient (slopes of ≤1°.) sloping southwards but ground surfaces are uneven from previous excavation and heaped mounds of gravel and soil. The elevation range over SLK2 survey polygon is 697–708 m amsl, and that of SLK2 Extension is 703–709 m amsl.

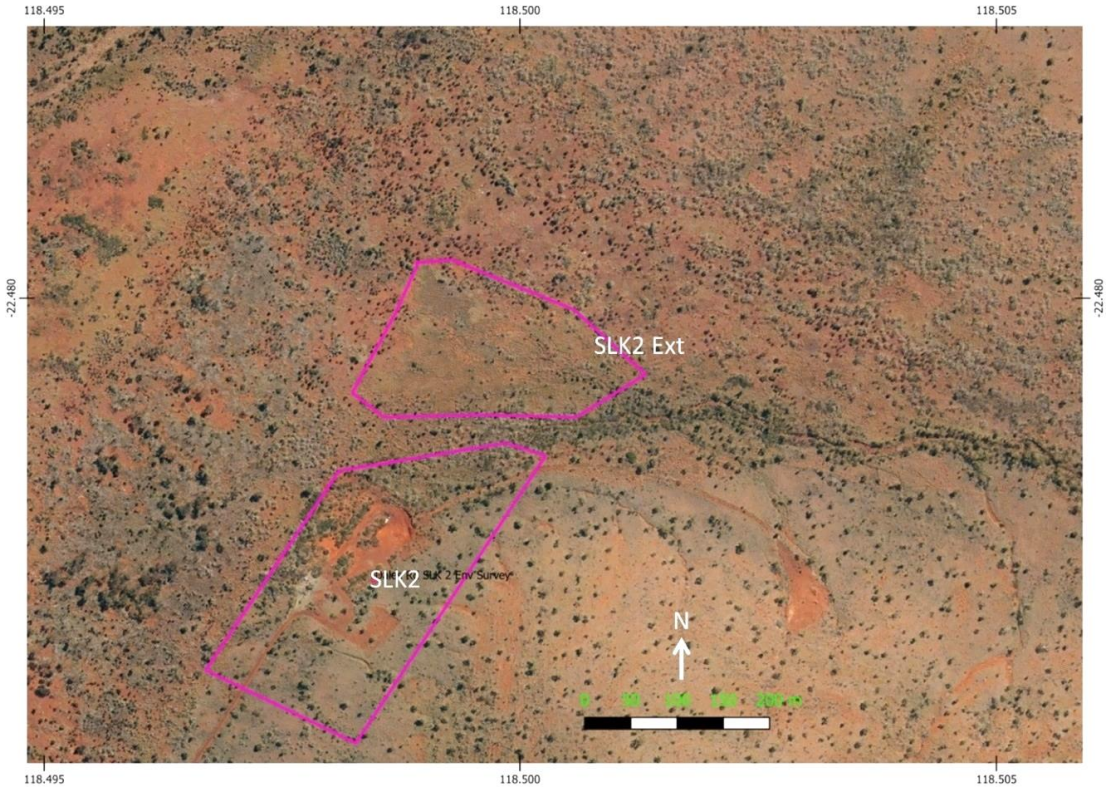

Figure 5.1.1. Location of the SLK2 SLK2 Extension gravel pit expansion areas (pink polygons) superimposed on aerial imagery. Basemap of aerial imagery from WA Now Mosaic (Landgate 2022).

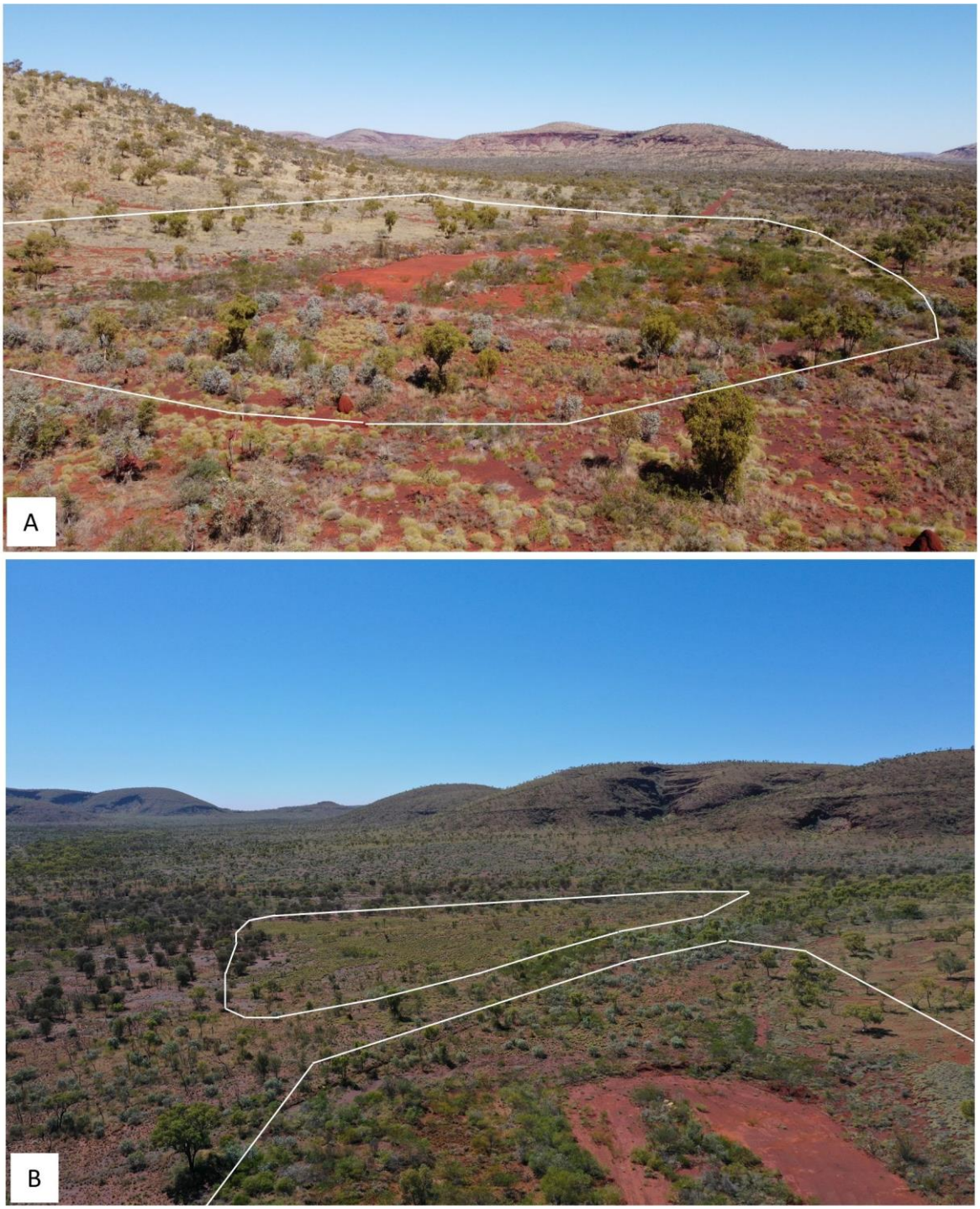

Figure 5.1.2. Oblique aerial views of the SLK2 and SLK2 Extension gravel pit expansion areas A: facing south-west across SLK2 and B: facing north-west across SLK2 and SLK2 Extension. The survey polygons are outlined in white.

The northern potential expansion of the SLK2 excavation area (the SLK2 Extension polygon) covers a slightly elevated flat area of deep gravelly clay soils. There is no discernable slope, and drainage from upslope is both directed around this area via drainage lines or rapidly washes off this area into the adjacent valley (Figure 5.1.1 and Figure 5.1.2).

Geology (Thorne & Tyler 1997)**:** Quaternary colluvium)

Land System (Payne 2004)**.** Boolgeeda Land System on stony lower slopes and plains below rugged jaspilite hills and ranges.

Fire History: At the time of survey, the lower half of the hillslopes in polygon SLK2 had been recently burnt (1–3 years previously), while the remaining flatter areas of the polygon had a mosaic of burn histories, from recent (1–3 years previously) to unburnt for a longer period (>5 years). Most of SLK2 Extension area was long-unburnt (>10 years since last fire), except for along the western boundary which had been burnt 3–5 years previously.

Vegetation Condition: Very-Excellent in undisturbed areas (there are some vehicle tracks). Good-Degraded around the current gravel pit clearing areas (weeds and clearing but rich shrublands on pit margins).

5.1.2 Survey Effort

Figure 5.1.3 illustrates the extent of search coverage of SLK2 and SLK2 Extension from the tracks walked by two observers within the polygons.

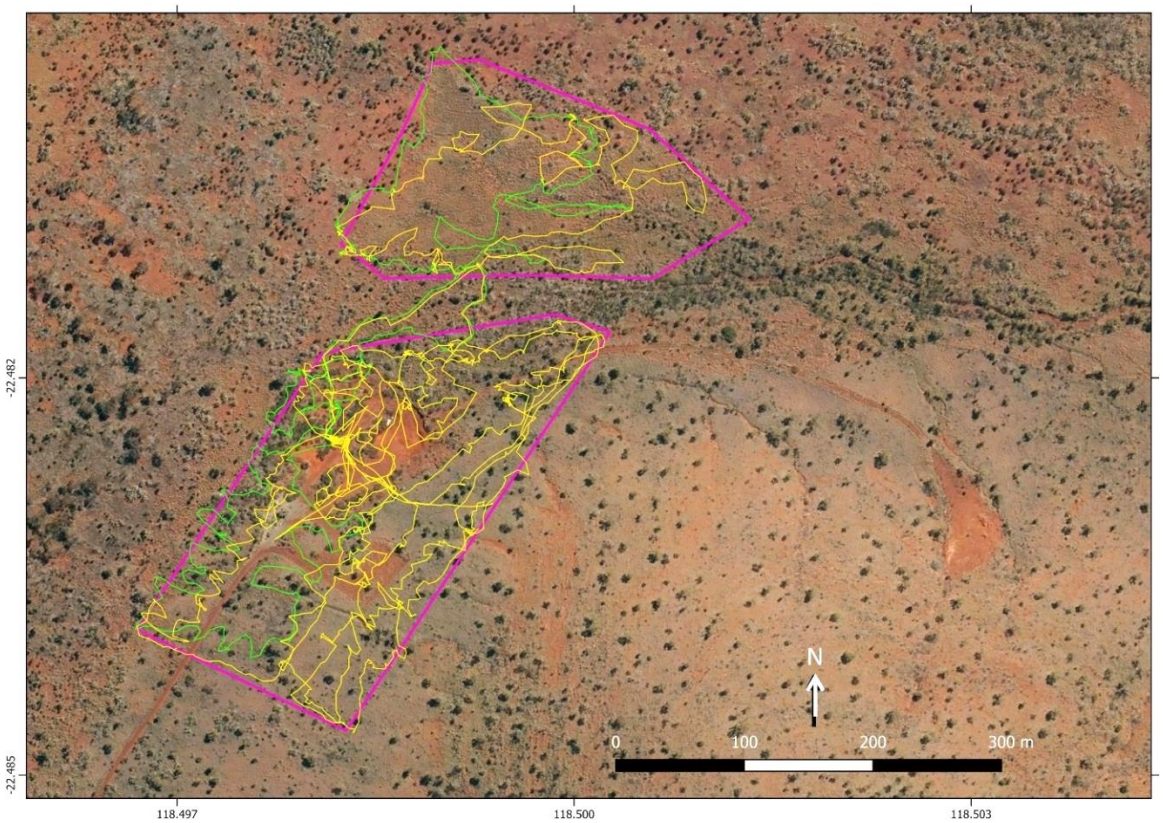

Figure 5.1.3. Tracks walked by two observers (each with a different coloured track) within the survey polygon for SLK2 and SLK2 Extension gravel pit expansion areas. Basemap of aerial imagery from WA Now Mosaic (Landgate 2022).

5.1.3 Vegetation of the Proposed Clearing Area

Lower hillslope (Figure 5.1.4A): Open woodland of *Eucalyptus leucophloia* subsp*. leucophloia* and *Corymbia hamersleyana* over dense hummock grassland/shrubland of *Triodia vanleeuwenii* hummock grassland, with low shrubs of *Acacia hilliana* and *Acacia adoxa* var. *adoxa* and patches of *Triodia wiseana* under trees or in gullies. Other taxa include scattered tall shrubs of *Hakea chordophylla*, *Grevillea wickhamii*, *Acacia tenuissima* and *Acacia cowleana*. Common herbs include *Goodenia stobbsiana*, *Goodenia triodiophila*.

Flats adjacent to hillslope (Figure 5.1.4B): Open woodland – mallee woodland of *Eucalyptus gamophylla* and *Corymbia hamersleyana* over dense tussock grassland/shrubland of *Themeda triandra*, *Triodia wiseana* and *Acacia adoxa,* with stands of *Grevillea wickhamii*, *Acacia ancistrocarpa, Acacia cowleana, Acacia tenuissima* and *Acacia monticola,* and patches of *Seringia exastia.* With scattered low shrubs and herbs of *Gompholobium oreophila, Ptilotus obovatus*, *Scaevola parviflora* var. *pilbarensis*, *Bonamia erecta, Dampiera canescens*. *Jasminum didymum* subsp. *lineare*, Scattered plants of *Goodenia nuda* were located in this vegetation.

Gravel pit margins (Figure 5.1.4C). Stands of various tall shrubs have established on the disturbed ground around the current gravel pit. This mixed shrubland includes *Acacia cowleana*, *Acacia maitlandii, Acacia tumida* ssp *pilbarensis*, *Gossypium robinsonii*, *Grevillea wickhamii*, *Petalostigma labicheoides*, *Androcalva luteiflora*, *Acacia atkinsiana* and *Acacia bivenosa*, over dense patches of *Themeda triandra and Eulalia aurea*. There are emergent trees of *Corymbia hamersleyana*. Water drains into the pit via an eroded channel, and it has formed a small claypan with herbaceous annuals (*Haloragis gossei, Ptilotus exaltatus*, *Dysphania rhadinostachya* var *rhadinostachya, Wahlenbergia tumidifructa, Stemodia grossa)* and tussocks of *Eulalia aurea* and *Themeda triandra* **(Figure 5.1.4D)**.

The SLK2 Extension area is dominated by a dense *Triodia wiseana* hummock grassland with scattered shrubs and isolated stands of *Senna ferraria, Acacia steedmanii* subsp. *borealis*, and *Senna pleurocarpa* and *Ptilotus astrolasius* (Figure 5.1.4C). Most of this *Triodia wiseana* grassland is surrounded by *Eucalyptus gamophylla and E. xerothermica* mallee woodland, over sparse *Triodia wiseana* hummock grassland or dense *Themeda triandra* and *Chrysopogon* sp. grassland.

The western boundary of the SLK2 Extension area borders a belt of *Acacia aptaneura* open woodland over sparse tussocks of *Themeda triandra* and *Chrysopogon* sp. with scattered *Ptilotus obovatus*, *Triodia wiseana* and patches of *Seringia exastia*. This mulga woodland continues into shallow valley to the west of the SLK2 Extension area.

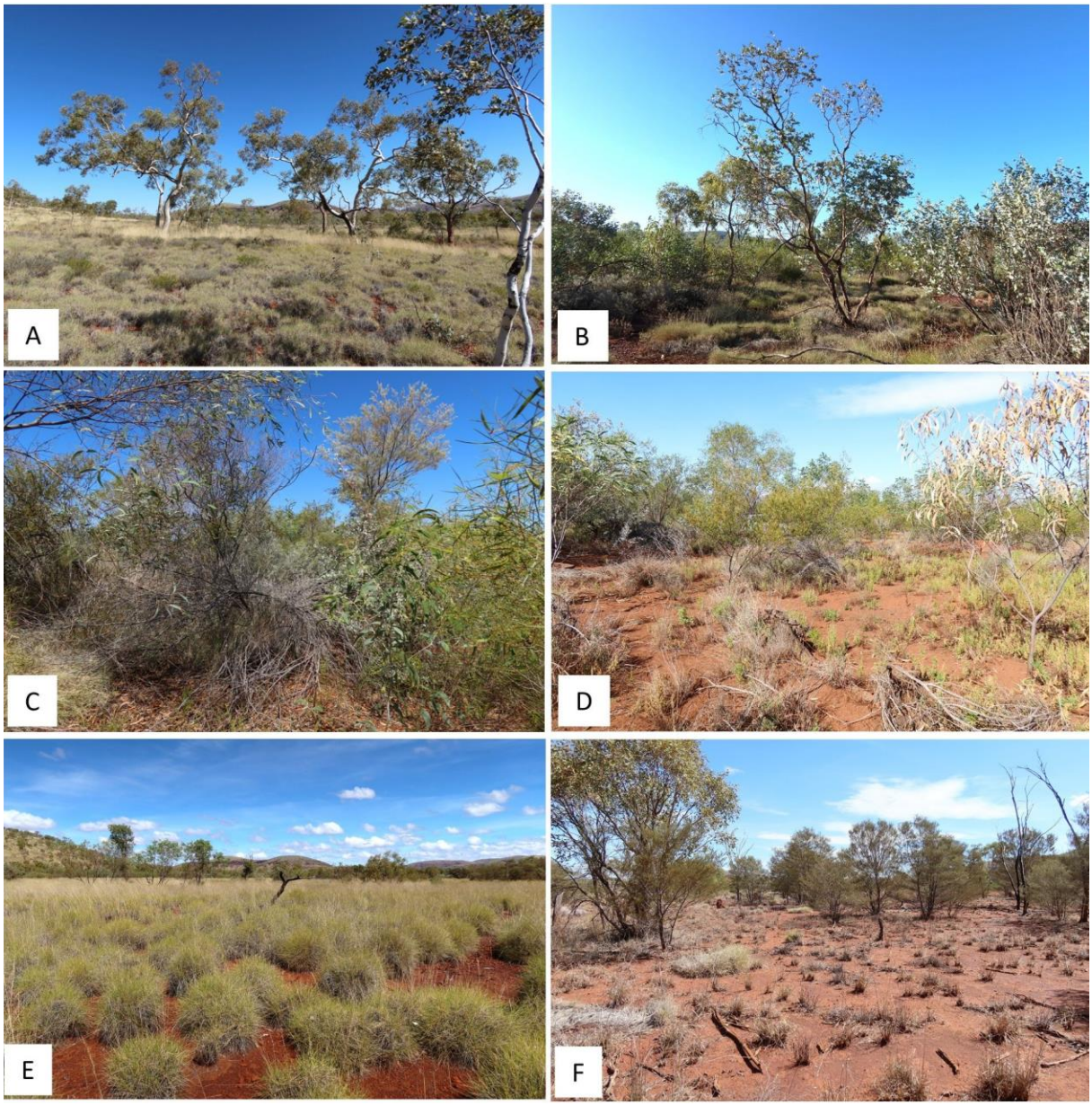

Figure 5.1.4: Vegetation of SLK2 proposed pit expansion areas. A: Open woodlands over Triodia vanleeuwenii *grasslands on hillslopes, B:* C. hamersleyana *and* E. gamophylla *open woodlands, C: Mixed shrublands around the current gravel pit, D: herbaceous annuals and perennial grasses in an artificial claypan, E:* Triodia wiseana *grassland in the SLK2 Extension survey polygon, F:* Acacia aptaneura *woodland west of the SLK2 Extension area.*

East of the proposed expansion areas, the creekline vegetation consists of a *Corymbia hamersleyana* woodland over tall thickets of *Acacia cowleana*, *Acacia tumida* var. *pilbarensis, Acacia maitlandii* and *Acacia ancistrocarpa*, over dense grassland of *Themeda triandra*. The clay loam flats in the valley west of SLK2 polygon are dominated by an open tall *Corymbia desertorum* woodland over *Eucalyptus gamophylla* mallees, over a sparse tussock grassland of *Themeda triandra*, with scattered shrubs of *Acacia maitlandii*, *Petalostylis labicheoides*, *Eremophila longifolia*, *Sida arenicola* and *Sida cardiophylla*.

5.1.4 Conservation significant flora

Isotropis parviflora was the only conservation-listed species found, with two plants being located in the SLK2 survey polygon (Figure 5.1.5), One plant was found on a gravel mound in main pit area, and the second in an intact patch of lower hillslope *Eucalyptus leucophloia* and *E. gamophylla* open woodland.

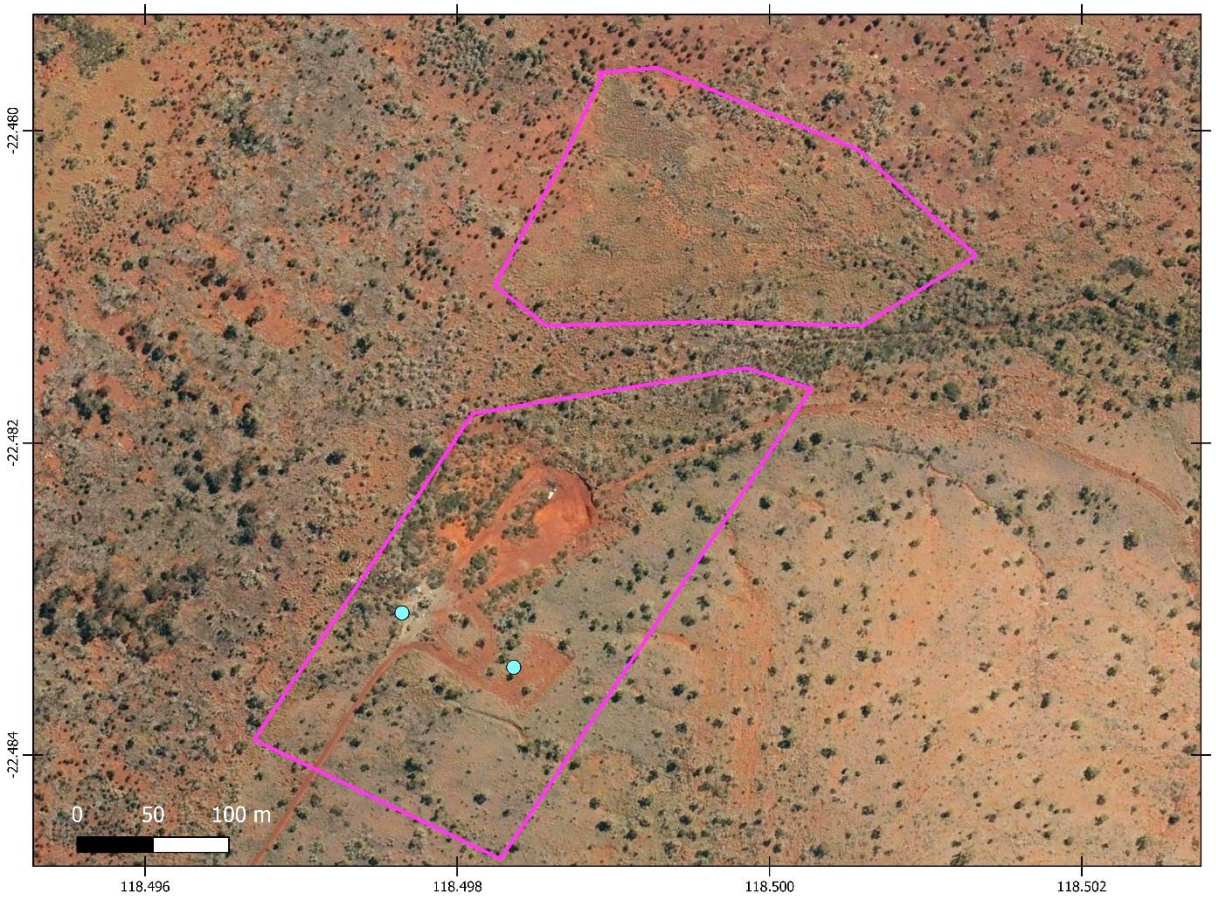

Figure 5.1.5: Locations of plants of Isotropis parviflora *within the SLK2 survey polygon,* (●). *This species was absent from the SLK Extension survey polygon*

5.1.5 Introduced and invasive flora

Three patches of *Cenchrus ciliaris* located on western margin of the current gravel pit (Figure 5.1.6). All three patches were close together within an area of 116 m^2, all confined to disturbed embankments and which hadn't spread beyond this area.

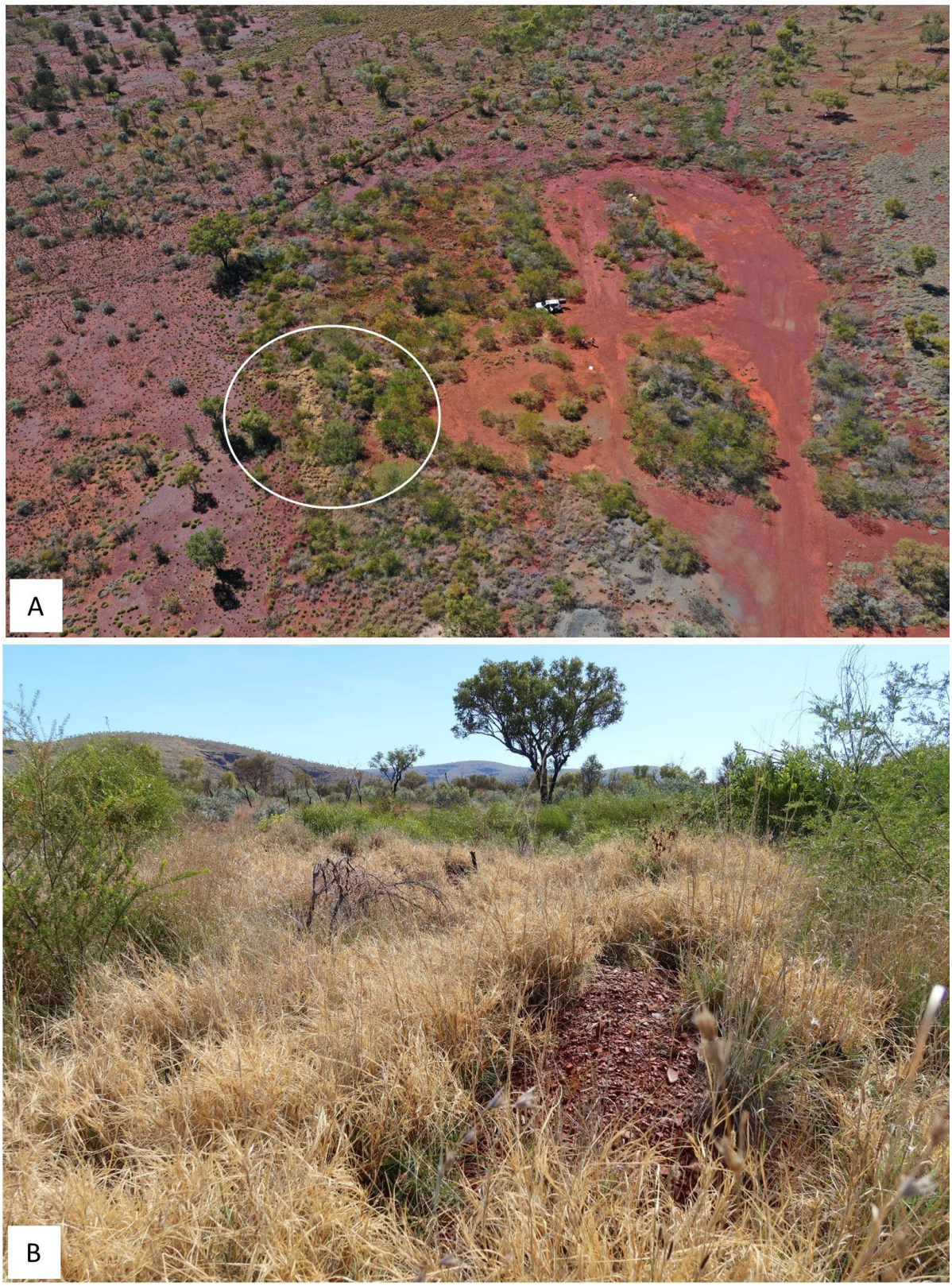

Figure 5.1.6: A: Aerial view of SLK2 facing north-west with the Cenchrus ciliaris *patch circled, B: ground view of the same dense patch of* Cenchrus ciliaris on the western *bank of the gravel pit.*

5.1.6 Erosion Issues

Runoff is moderately-rapid to rapid around the SLK2 gravel pit expansion area and causes some erosion of the natural drainage channels and tracks. The hillslopes east of the main pit and the SLK2 polygon are inclined to 3–5°, runoff is rapid and minor erosion was noted for some of the gullies (Figure 5.1.7). This is a feature of all the hillslopes in the wider area. The flat areas downslope of these hillslopes have both natural drainage in the minor creek, and what appears to be a dug channel which has since been scoured into a deep, narrow channel (Figure 5.1.8) and an old track which has also been affected by minor erosion. Both the channel and the track channel water into an area of the pit which has become a small claypan (Figure 5.1.7).

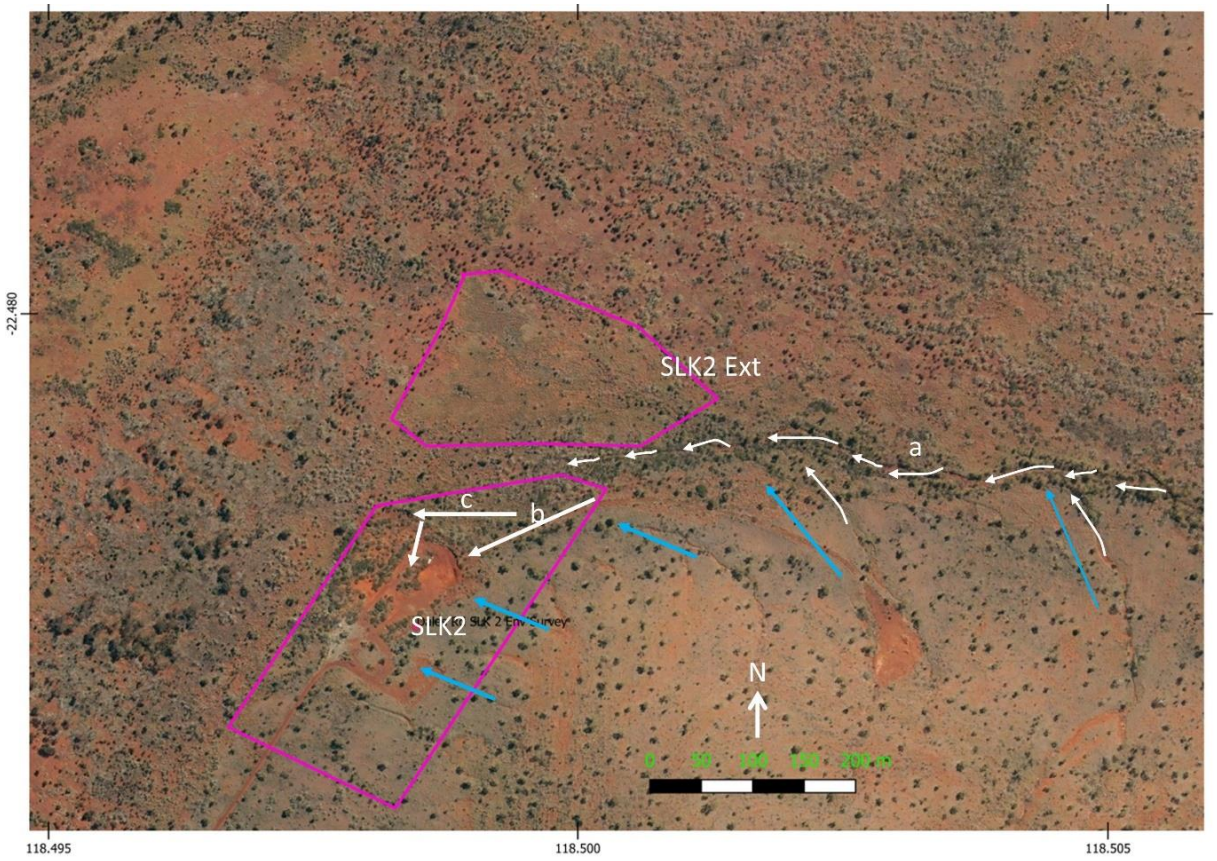

Figure 5.1.7: Erosion and potential erosion at SLK2 survey site. White arrows delineate direction of flow of water in channels, in a: a creekline, b: the old track and c: a narrow channel (the latter two drain into the current pit). Blue arrows delineate direction of slope on hillslope.

Figure 5.1.8: A narrow channel on the northern margin of SLK2 and which has been eroded into a deep, narrow gully by runoff.

5.2 Gravel Pit Expansion Area SLK7

5.2.1 Site Description

Landform: The SLK7 survey polygon is located on a minor ridge at elevations of between 679–695 m amsl, between two minor creeklines and incised by several rocky gullies. It lies in an area of gently sloping foothills (slopes ≤1°) of ironstone hills incised by steep gullies and numerous drainage lines. Water infiltration is low while runoff is rapid and directed into the numerous drainage lines before entering major creeks that drain into Dales Gorge. The deeper gully and creekline sides can become rocky and steep (3–>20° slope). The rocky gravel bed of the creek north of SLK7 is scoured bare, sometimes with exposed conglomerate.

Geology: Quaternary colluvium (Thorne & Tyler 1997)

Land System (Payne 2004). Platform Land System, on dissected slopes and raised plains below rugged jaspilite hills and ranges.

Fire History: Most of the area within and around the survey polygon was recently burnt (2–3 years previously) at the time of survey. Around the current gravel pit margins is relatively unburnt vegetation (burnt c. 5–7 years previously). The ages of the deeper gullies and creekline varies from 2–3 to 5–7 (–10) years previously.

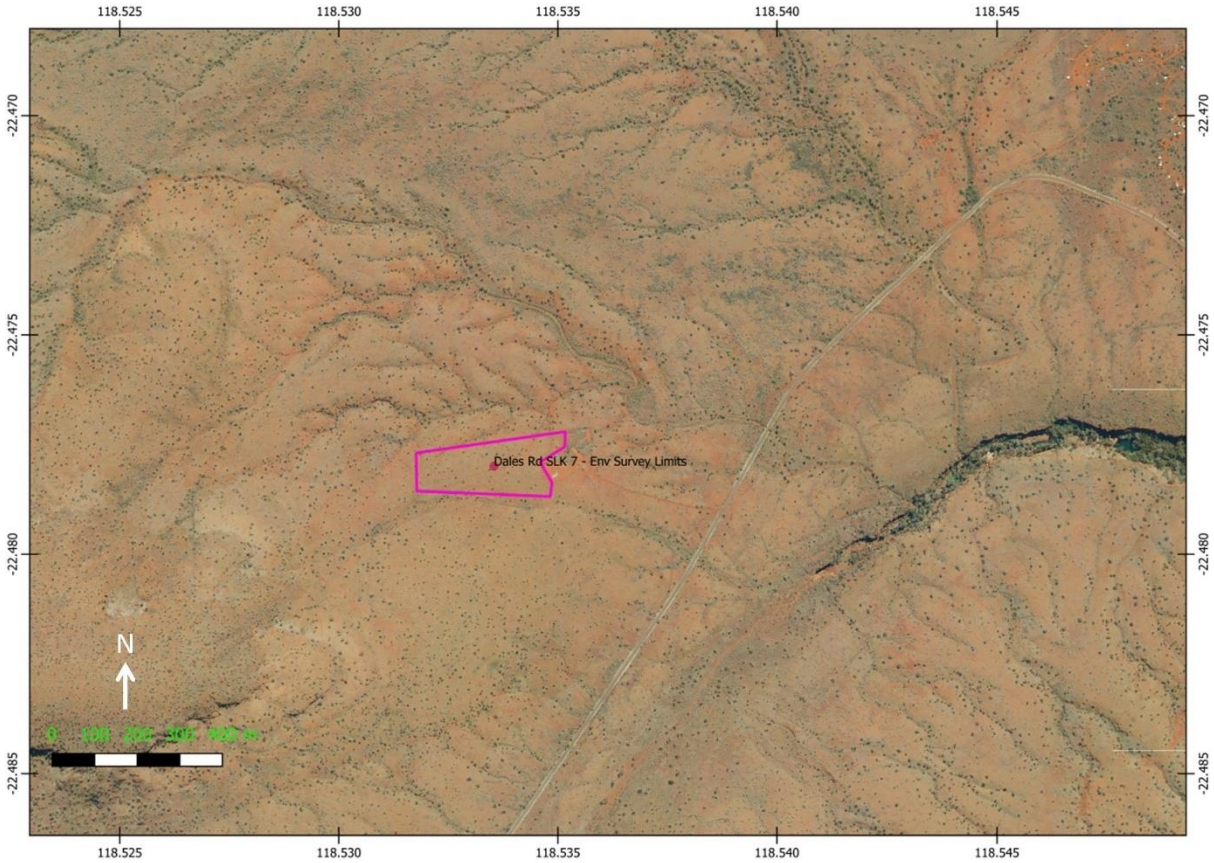

Figure 5.2.1. Location of the SLK7 gravel pit expansion area (pink polygon) superimposed on aerial imagery. Basemap of aerial imagery from WA Now Mosaic (Landgate 2022).

Figure 5.2.2. Oblique aerial view of the SLK7 gravel pit expansion area facing west. The survey polygon is outlined in white.

Vegetation Condition: Very Good -Excellent in wider undisturbed area (could be issues with frequent, hot fires). Degraded around the current gravel pit cleared areas.

5.2.2 Survey Effort

Figure 5.2.3 illustrates the extent of search coverage of SLK7 from the tracks walked by two observers within the polygon.

5.2.3 Vegetation of the Proposed Clearing Area

Minor ridge (majority of survey polygon area (Figure 5.2.4A): Very open woodland to emergent trees of *Eucalyptus leucophloia* and *Corymbia hamersleyana*, with occasional trees of *Corymbia deserticola*, over sparse mixed hummock grassland/shrubland of *Triodia vanleeuwenii*, *Acacia adoxa* var. *adoxa*, *Goodenia stobbsiana*, *Seringia exastia* and *Bonamia erecta*. Common species include *Mirbelia viminalis, Exocarpos sparteus, Corchorus lasiocarpus* ssp. *parvus* and *Hakea chordophylla*. Localised patches of *Eulalia aurea* and *Paraneurachne muelleri* occur under eucalypts.

Shrubland in main pit (Figure 5.2.4B): Burnt 5–7 years previously, shrubland of *Acacia tumida* ssp. *pilbarensis*, *Acacia ancistrocarpa* and *Grevillea wickhamii* with emergent *Corymbia hamersleyana* and *Eucalyptus leucophloia* trees, over dense patches of *Themeda triandra* and *Triodia wiseana*, with patches of *Seringia exastia*. Other species include *Indigofera monophylla*, *Acacia adoxa*, *Goodenia stobbsiana*, *Acacia atkinsiana Petalostylis labicheoides*, *Mirbelia* viminalis, *Acacia hilliana*, *Acacia maitlandii*, *Dodonaea coriacea*, *Ptilotus calostachyus*, *Eriachne mucronata* and *Paraneurachne muelleri.*

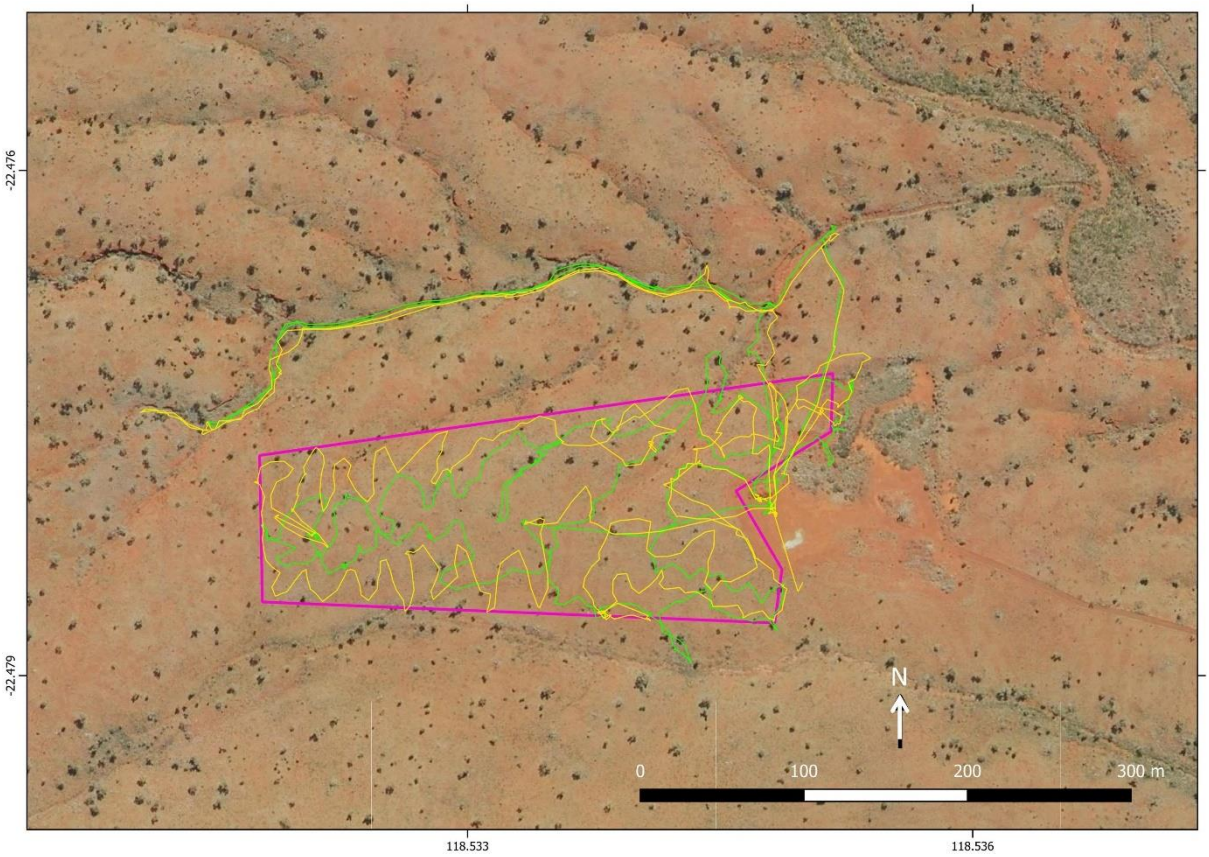

Figure 5.2.3. Tracks walked by two observers (each with a different coloured track) within the survey polygon for SLK7 gravel pit expansion areas. Basemap of aerial imagery from WA Now Mosaic (Landgate 2022).

Shallow gullies (Figure 5.2.4C): Low shrublands dominated by mixed grassland/shrubland of *Gompholobium oreophilum*, *Mirbelia viminalis*, *Acacia adoxa*, *Acacia tumida* subsp *pilbarensis*, *Dodonaea lanceolata, Eriachne lanata, Triodia wiseana* and *Mirbelia viminalis,* with few emergent trees of *Corymbia hamersleyana*.

Deep gullies and creeklines adjacent to survey polygon (Figure 5.2.4D): Open woodland – emergent trees of *Corymbia hamersleyana* over tall shrublands - thickets of *Grevillea wickhamii*, *Acacia hamersleyensis, Exocarpos sparteus*, *Petalostylis labicheoides* and *Acacia monticola*, with low shrubs and tussocks on gully sides of *Mirbelia viminalis*, *Dampiera canescens*, *Acacia adoxa* and Scaevola browniana subsp. browniana, *Eriachne mucronata*, *Triodia wiseana* and *Triodia vanleeuwenii*. Dense areas of *Themeda triandra* along creek banks.

Figure 4.2.4: Vegetation of SLK7. A: Open woodlands – emergent trees of Eucalyptus leucophloia and Corymbia hamersleyana *over* Triodia vanleeuwenii hummock *grassland, B: Tall shrublands of unburnt vegetation in current SLK7 gravel pit, C: shallow gully vegetation in SLK7 survey polygon, D:* Corymbia hamersleyana *open woodland over mixed tall shrublands over low grassland/shrublands along creek banks and gully sides in areas adjacent SLK7 survey polygon.*

5.2.4 Conservation significant flora

Only one plant of *Isotropis parviflora* was located within the survey polygon, on relatively recently burnt but otherwise undisturbed ground. (Figure 5.2.5)

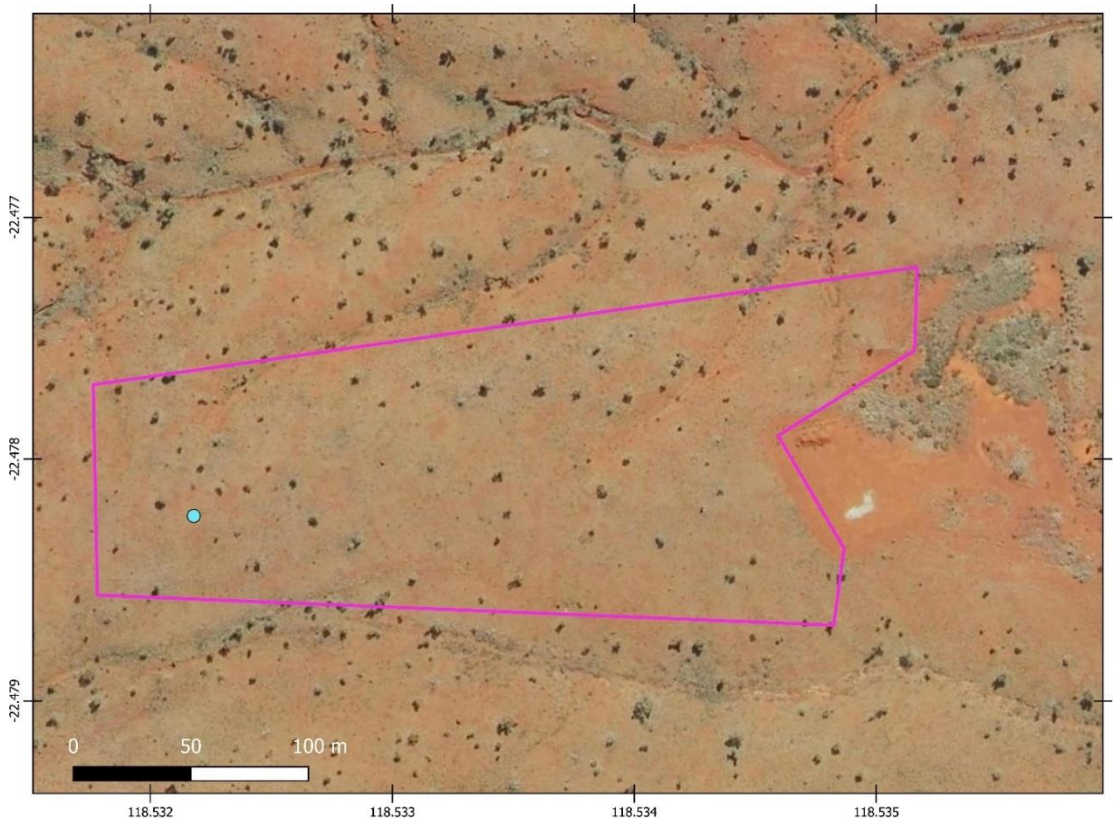

Figure 5.2.5: Location of the single plant of Isotropis parviflora *located within SLK7 survey polygon* (●).

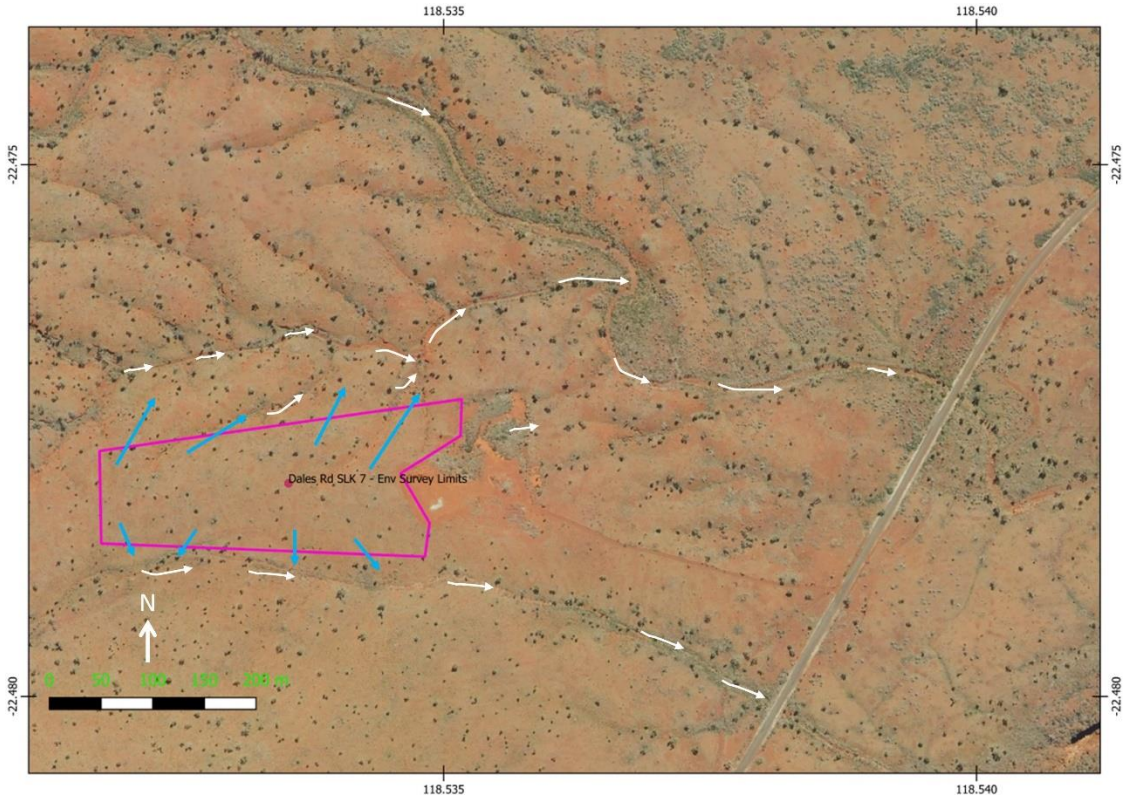

Figure 5.2.6: Erosion and potential erosion at SLK7 proposed gravel pit expansion area. White arrows delineate direction of flow of water in channels, and blue arrows delineate direction of slope on hillslope.

5.2.5 Introduced and invasive flora

No introduced and significant invasive flora species were located within the survey polygon or adjacent gullies and creek.

5.2.6 Erosion Issues

Runoff is rapid on these surfaces, and the gullies and creek channels show some signs of scouring. There may be some erosion issues with the gullies and creeks along the boundaries of the proposed gravel pit extension area (Figure 5.2.6), especially if more drainage and debris is directed into these or if the pit walls fail.

5.3 Gravel Pit Expansion Area SLK31

5.3.1 Site Description

Landform: On gently undulating plains of colluvium at the base of ironstone hills and ranges, dissected by wide drainage lines with alluvium. The sites lies at elevations of between 703 and 719 m amsl. Half of the site lies along the lower slopes of a low hill, with a gentle slope of c.1–2° and some minor gullies. The other half is more or less flat (<1). Soils are deep, gravelly clays with low water infiltration and rapid runoff into the adjacent wide, shallow alluvial flats south of the site.

Geology: Quaternary colluvium (Thorne & Tyler 1997)

Land System (Payne 2004). Boolgeeda Land System, on stony lower slopes and plains below rugged jaspilite hills and ranges.

Fire History: The area is relatively long unburnt, at least 5–10 since last fire.

Vegetation Condition: Very Good-Excellent in wider undisturbed areas (some vehicle tracks). Good-degraded around the current gravel pit.

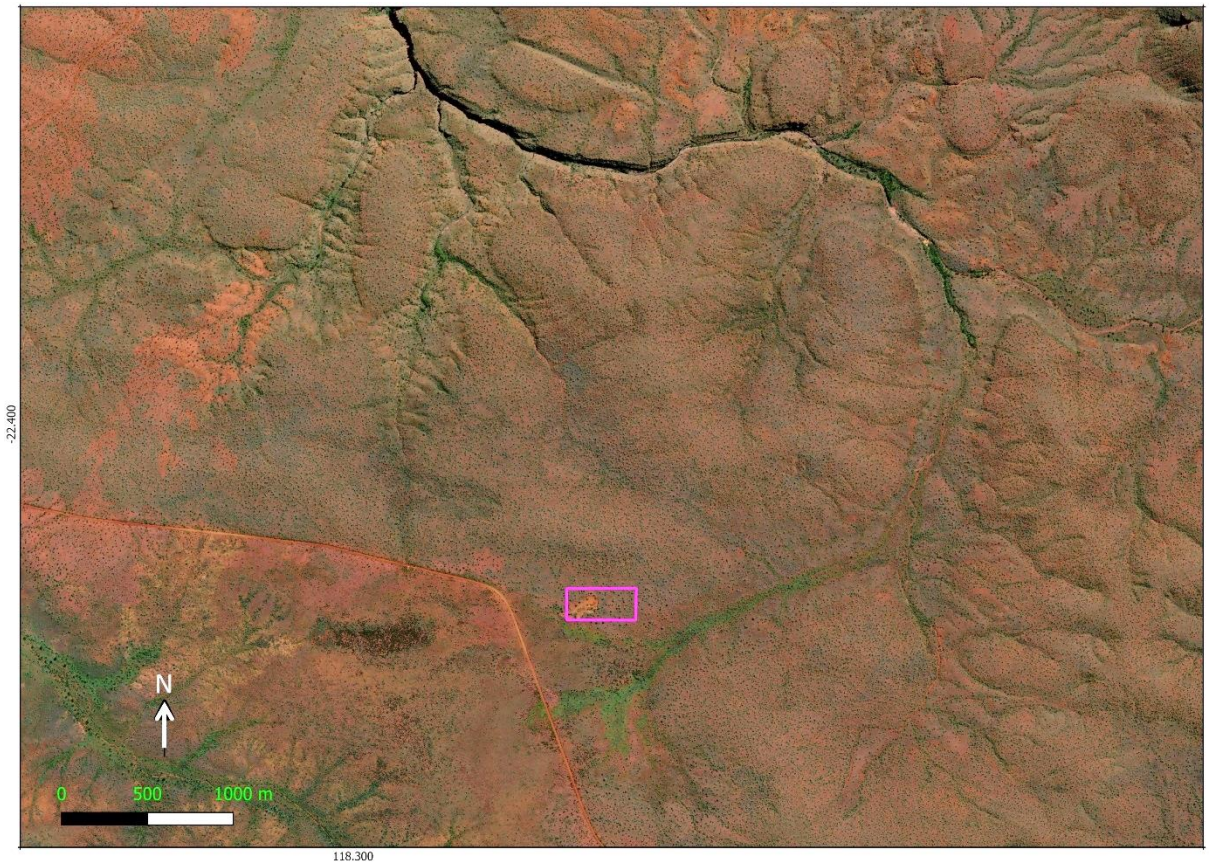

Figure 5.3.1. Location of the SLK31 gravel pit expansion area (pink polygon) superimposed on aerial imagery. Basemap of aerial imagery from Microsoft© Bing™.

Figure 5.3.2. Oblique aerial view of the SLK31 gravel pit expansion area facing east. The survey polygon is outlined in white.

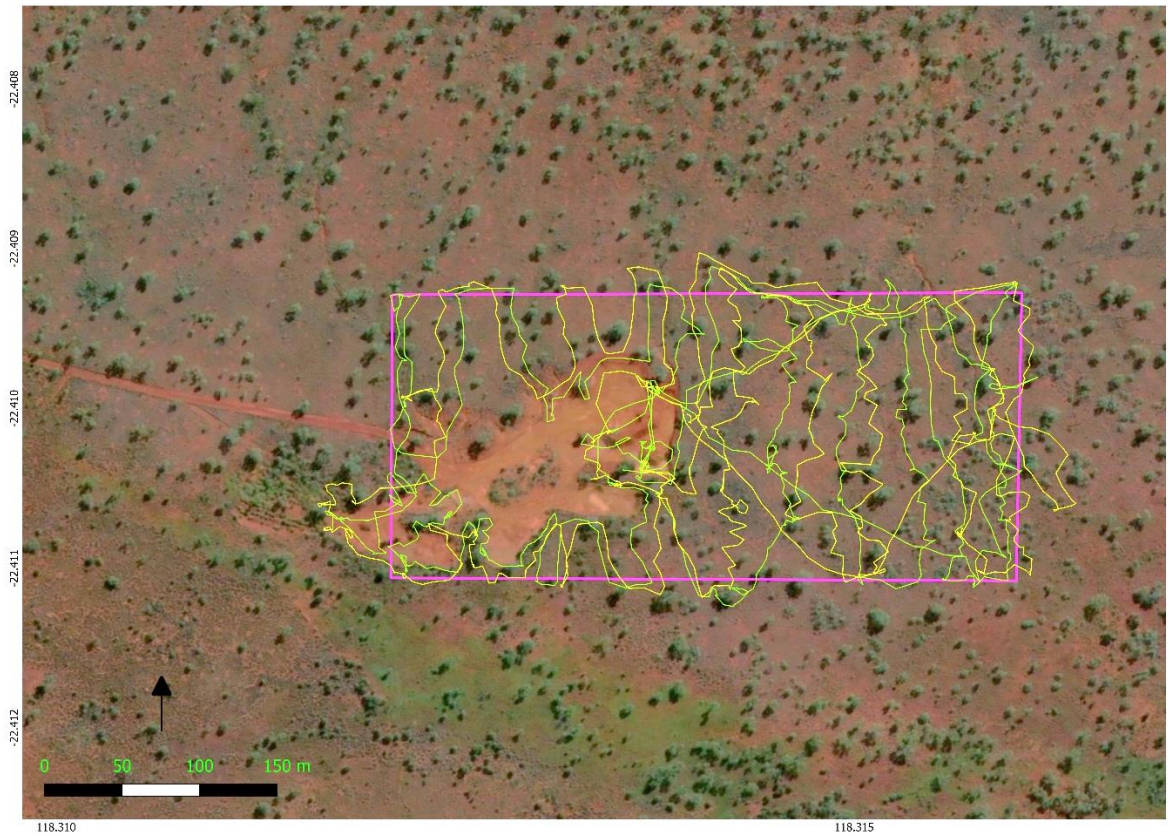

Figure 5.3.3. Tracks walked by two observers (each with a different coloured track) within the survey polygon for SLK31 gravel pit expansion area. Basemap of aerial imagery from Microsoft© Bing™.

5.3.2 Survey Effort

Figure 5.3.3 illustrates the extent of search coverage of SLK31 from the tracks walked by two observers within the pit expansion survey polygon.

5.3.3 Vegetation of the Proposed Clearing Area

Open woodland mosaic of *Eucalyptus leucophloia* subsp. *leucophloia, E. gamophylla, Corymbia hamersleyana and E. xerothermica* over mid-dense hummock grassland/low shrubland dominated by *Triodia vanleeuwenii* and *Acacia adoxa*, with some *Triodia wiseana* and small, dense patches of *Eulalia aura* and *Themeda triandra* tussocks under eucalypts (Figure 5.3.4A, B). *Corymbia hamersleyana* dominates in the minor gullies and *Eucalyptus xerothermica* and a range of taller shrubs becomes more abundant in the southern half of the survey polygon (Figure 5.3.4C). Other common species include scattered shrubs of *Acacia ancistrocarpa*, *Maytenus* sp. Mt Windell (S. van Leeuwen 846), *Ptilotus astrolasius*, *Gompholobium oreophilum, Acacia hilliana, Acacia tenuissima, Acacia cowleana, Acacia maitlandii, Acacia monticola, Exocarpos sparteus, Hakea chordophylla*, *Mirbelia viminalis*, *Seringia exastia, Bonamia erecta* and *Ptilotus astrolasius.*

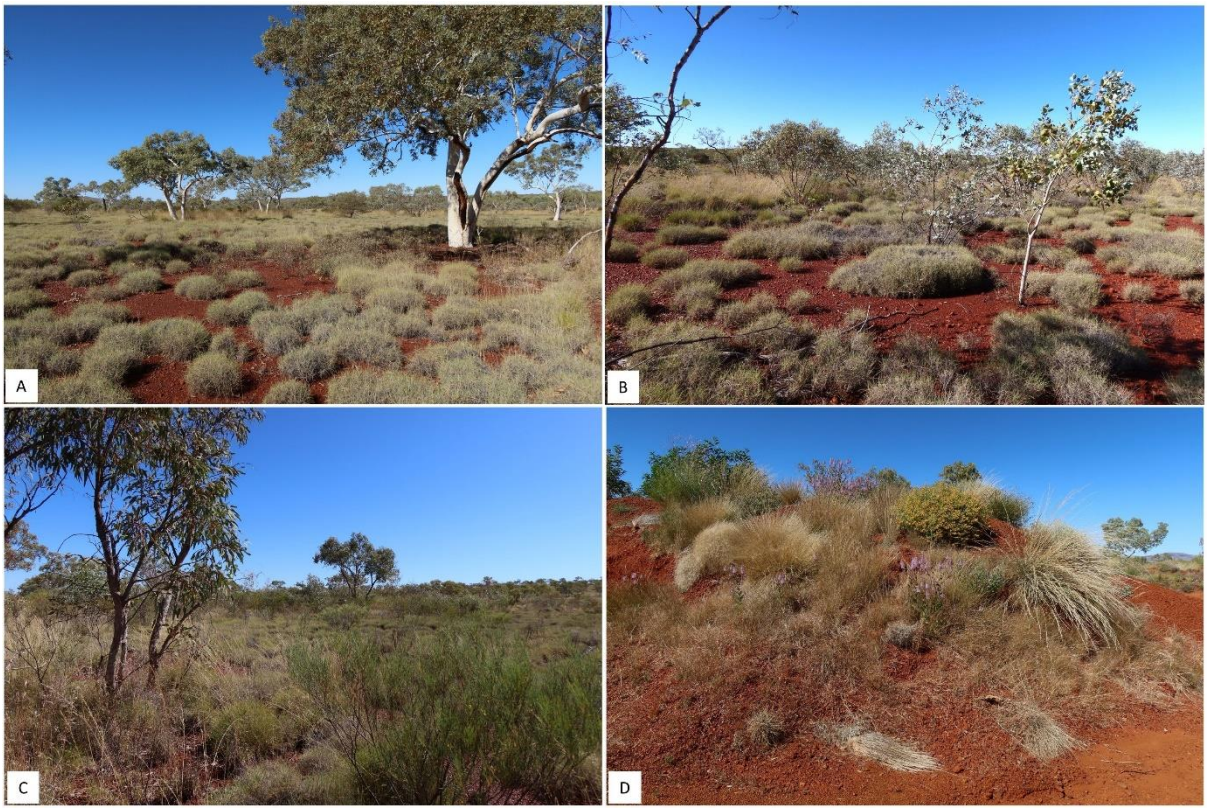

Figure 5.3.4: Vegetation of SLK31. A: Open woodlands of Eucalyptus leucophloia *over* Triodia vanleeuwenii hummock *grassland, B: Mallee woodland of* Eucalyptus gamophylla *and* Corymbia hamersleyana *over* Triodia spp. *grassland, C: Open woodland of* Eucalyptus leucophloia *and* E. xerothermica *over* Acacia spp. *shrubland, D: mixed shrubs and grasses on gravel mounds and banks in main pit.*

On the steeper slopes along the northern boundary of SLK31 polygon the vegetation shifts to an open woodland of *Eucalyptus leucophloia* and areas of *E. gamophylla,* over a mid-dense hummock grassland of *Triodia vanleeuwenii* with scattered individuals or patches of *Acacia tenuissima*, *Acacia ancistrocarpa*, *Seringia exastia*, *Ptilotus calostachyus*, *Exocarpos sparteus*, *Gompholobium oreophilum* and *Hakea chordophylla* (Figure 5.3.4B).

A range of shrubs and grasses have re-established on the disturbed banks and mounds of gravel around the current gravel pit, including *Acacia tumida* subsp. *pilbarensis, Acacia hilliana*, *Grevillea wickhamii, Gompholobium oreophilum*, *Seringia exastia*, *Amphipogon sericeus*, dense patches of *Themeda triandra* and *Triodia* spp. (Figure 5.3.4D)

5.3.4 Conservation significant flora

Eleven individuals of *Isotropis parviflora* were located across the survey polygon (Figure 5.3.5), with only one plant located in undisturbed open woodland. Most plants were found on previously disturbed sites, either on isolated gravel heaps in the middle of the bare gravel pit, or on the south-western margin among gravel heaps that had since become revegetated after excavation (Figure 5.3.4D).

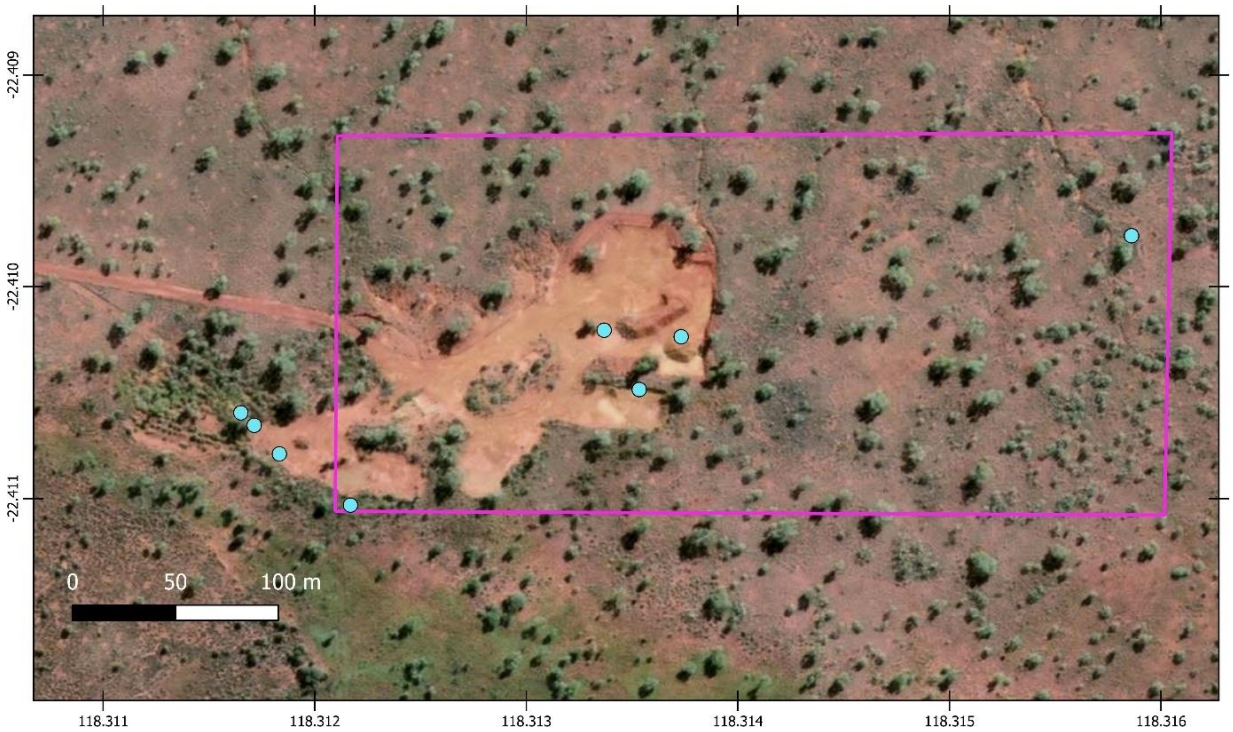

Figure 5.3.5: Locations of Isotropis parviflora *within SLK31 survey polygon, Isotropis parviflora* (●). *Basemap of aerial imagery from Microsoft© Bing™.*

5.3.5 Introduced and invasive flora

No invasive flora species were observed in the SLK31 survey polygon, and only native grasses and shrubs were established in the disturbed soils around the gravel pit.

5.3.6 Erosion Issues

Runoff is rapid and there are indications that the steeper slopes on the lower hillslopes may be prone to some erosion. There is both rill erosion on the up-slope margins of the current gravel pit (Figure 5.3.6) and minor gullies forming along the general slope. There is no indication that the water that drains into the current pit flows out into the flats downslope of the pit.

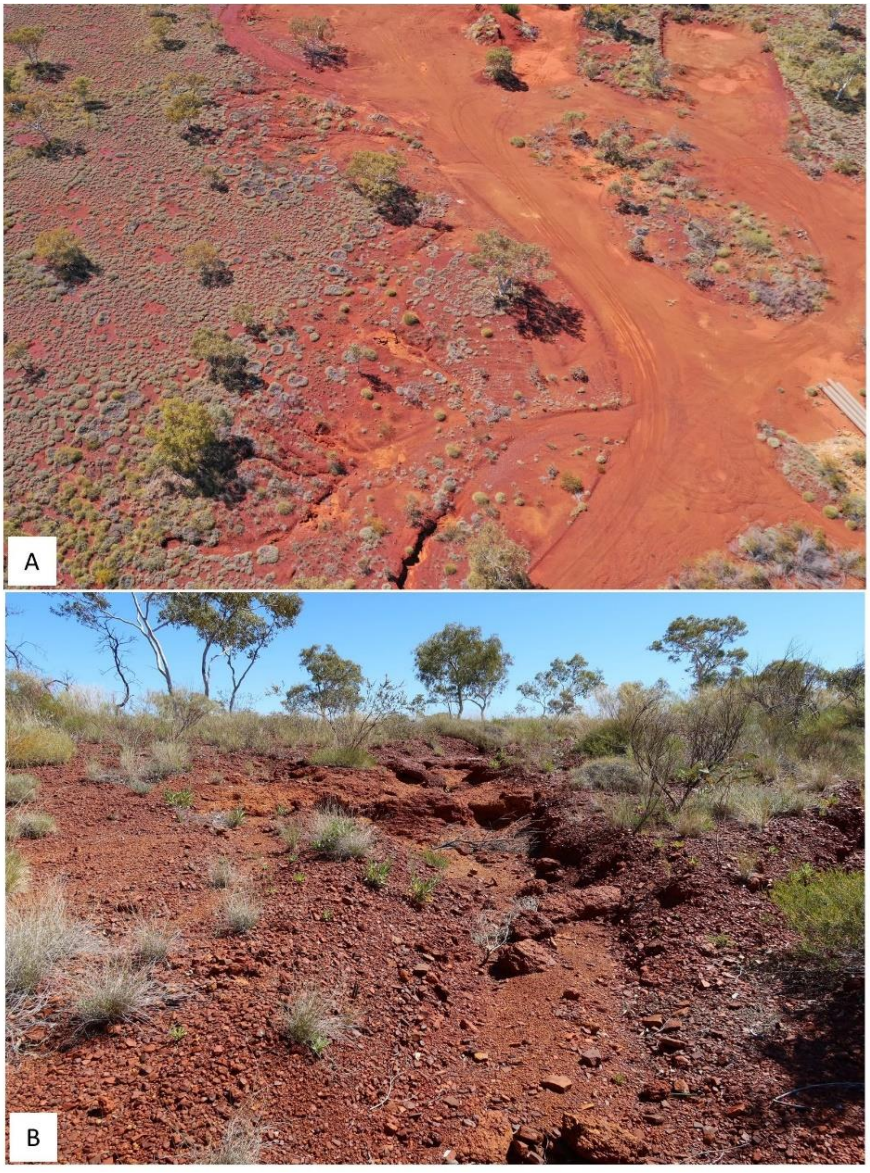

Figure 5.3.6: A: Aerial view of SLK31 facing west, showing rill erosion along the northern margins of the current gravel pit, B: ground view of the rill erosion facing upslope.

5.4 Gravel Pit Expansion Area SLK51

5.4.1 Site Description

Landform: The SLK51 gravel pit and proposed expansion is located off Banjima Drive 5 km east of the Karijini Visitor Centre, on the gently sloping footslopes of ironstone hills at the head of a minor valley (Figures 5.4.1 and 5.4.2). Multiple creeks and minor gullies drain downslope off these footslopes and through this valley in a southerly direction. The survey polygon is bounded on the west and east sides by two dry creeklines. The northern boundary of the SLK51 polygon lies at the transition from steeper hillslopes (from inclines of 5° to 12°) to gentle gradients and slopes of 0–2° across the current gravel pit and proposed expansion area. The survey polygon occurs at elevations of between 743–754 m amsl. Soils are deep gravelly clays with 80–>90% surface cover of loose gravel.

Geology: Quaternary colluvium (Thorne & Tyler 1997)

Land System (Payne 2004). Boolgeeda Land System on stony lower slopes below rugged jaspilite hills and ranges (Payne 2004).

Fire History: The area has not been recently burnt, with the last fire estimated to be over 5–10 years ago.

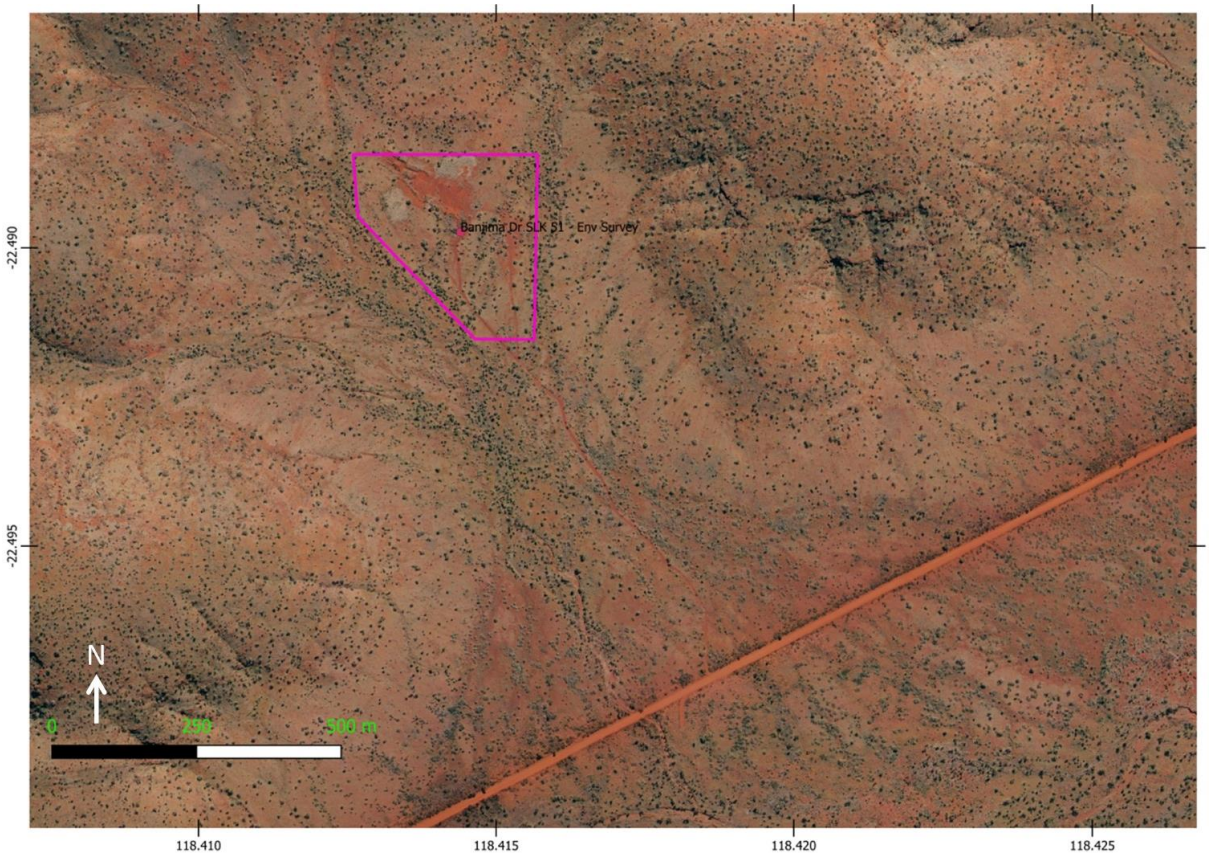

Figure 5.4.1. Location of the SLK51 gravel pit expansion area (pink polygon) superimposed on aerial imagery. Basemap of aerial imagery from WA Now Mosaic (Landgate 2022).

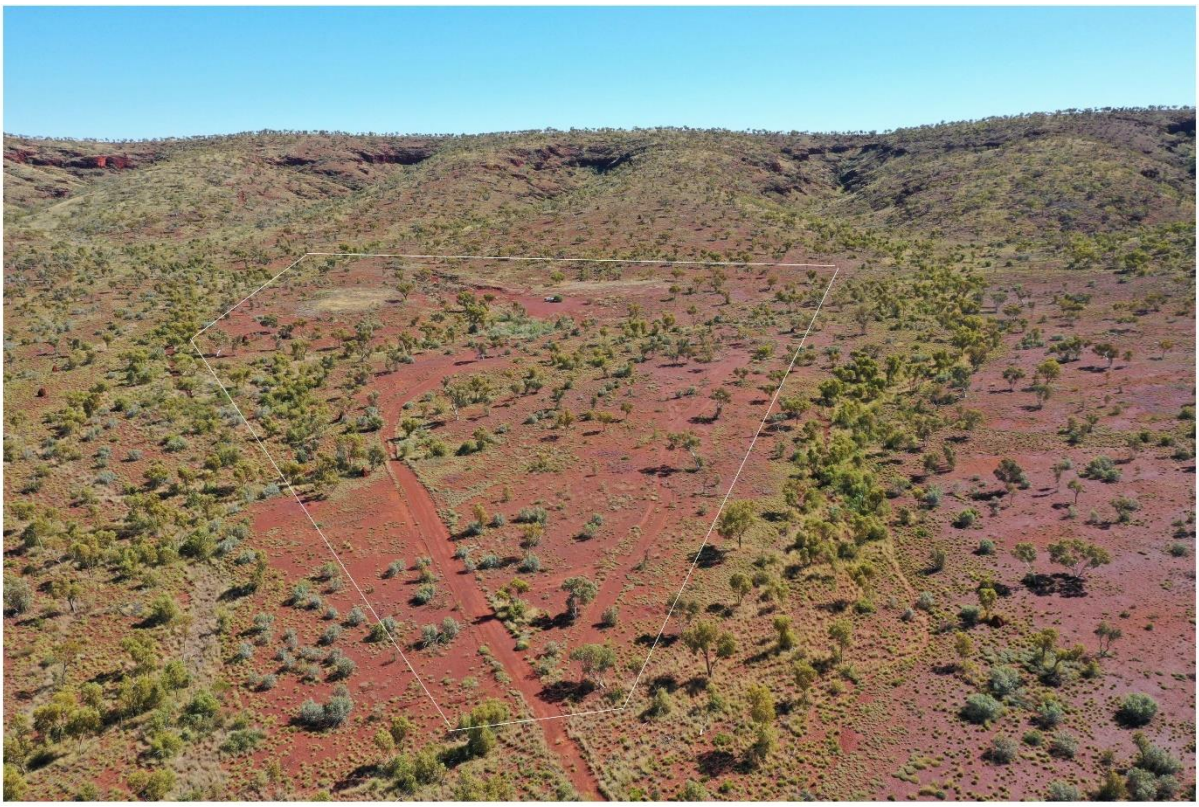

Figure 5.4.2. Oblique aerial view of the SLK51 gravel pit expansion area facing north. The survey polygon is outlined in white.

Vegetation Condition: Very Good-Excellent around wider area, Degraded-Poor around the current gravel pit disturbed areas.

5.4.2 Survey Effort

Figure 5.4.3 illustrates the extent of search coverage of SLK51 from the tracks walked by two observers within and around the survey polygon.

5.4.3 Vegetation of the Proposed Clearing Area

Main survey polygon area with open woodlands of *Corymbia hamersleyana, Eucalyptus gamophylla* and *Eucalyptus leucophloia,* over mid-dense *Triodia wiseana* and *T. vanleeuwenii* hummock grassland with low shrubs of *Acacia adoxa* and *Seringia exastia*. Patches of *Themeda triandra* occur under trees. Other tree species include: *Eucalyptus xerothermica* and *Corymbia deserticola*, and other common species include, *Goodenia stobbsiana, Hakea chordophylla* and *Indigofera monophylla*. Stands of *Santalum lanceolatum, Grevillea wickhamii, Acacia cowleana*, *Capparis umbonata* and *Abutilon cunninghamii* (Figure 5.4.4A).

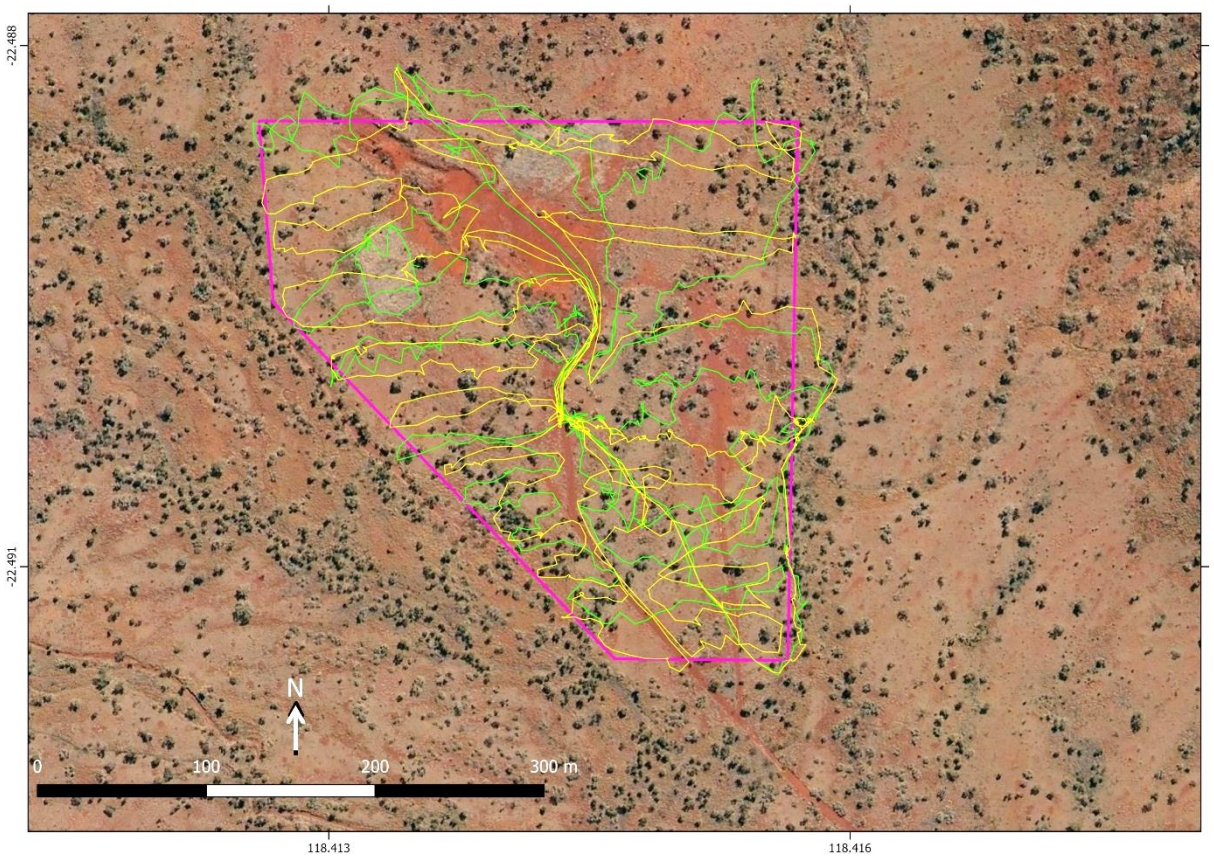

Figure 5.4.3. Tracks walked by two observers (each with a different coloured track) within the survey polygon for SLK51 gravel pit expansion area. Basemap of aerial imagery from WA Now Mosaic (Landgate 2022).

Gravelly open areas: *Eucalyptus leucophloia* and *Corymbia hamersleyana* very open woodland over a hummock grassland of *Triodia vanleeuwenii*, with *Acacia adoxa*, *Ptilotus calostachyus* and *Goodenia stobbsiana.* There are patches of *Seringia exastia* low shrubland in the grassland and other common species includes *Acacia hilliana, Ptilotus exaltatus*, *Gompholobium oreophilum* and *Aristida holathera* subsp. *holathera*

Creeklines: Woodlands dominated by *Corymbia. hamersleyana, over thickets of Acacia cowleana, Gossypium robinsonii*, *Acacia pyrifolia* subsp. *pyrifolia, Acacia steedmanii* subsp. *borealis*., *Eremophila longifolia* and *Acacia monticola*, over a dense tussock grassland of *Themeda triandra* along the banks and tussocks of *Cymbopogon ambiguus* (tall creek form) in the creek bed (Figure 5.4.4C).

Steeper slopes on northern boundary: *Eucalyptus leucophloia* and *Corymbia hamersleyana* open woodland over sparse hummock grassland of *Triodia vanleeuwenii* (dominant), *Triodia wiseana*, shrubs of *Seringia exastia* and herbs of *Goodenia stobbsiana*. Other common species include *Senna glutinosa* subsp.

glutinosa, *Scaevola browniana* and *Tricoryne* sp. Hamersley Range (S. van Leeuwen 915), and patches of *Themeda* and *Eulalia* under trees or in minor gullies (Figure 5.4.4D).

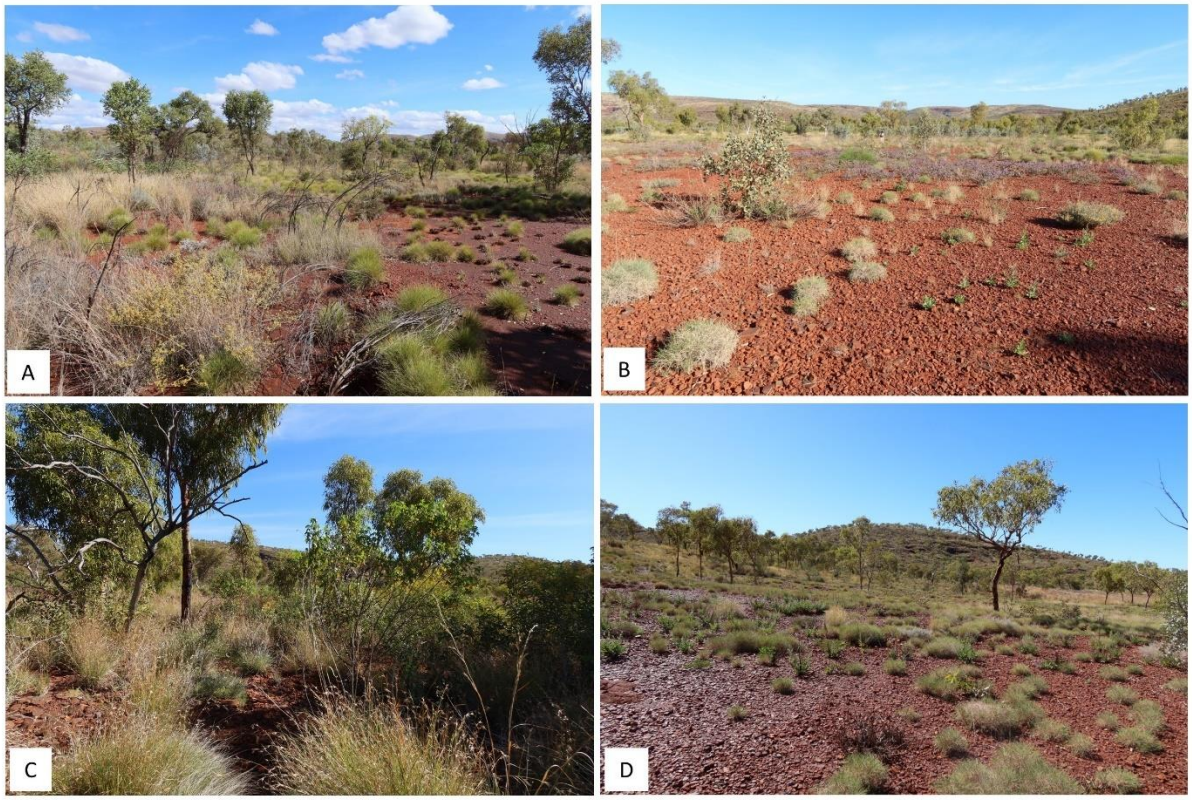

Figure 5.4.4: Vegetation of SLK51. A: Open woodlands over Triodia *grassland in main area of survey polygon, B: open area of* Triodia *grassland and Seringia exastia shrubland., C: creekline vegetation, D: open woodland on steeper slopes on northern boundary of survey polygon.*

5.4.4 Conservation significant flora

Two conservation listed taxa were found in the proposed gravel pit expansion survey polygon (Figure 5.4.5). Seven individual plants of *Isotropis parviflora* were found scattered across the area, while 8 plants of *Rostellularia adscendens* var. *latifolia* were located in the dry creekbed that runs along the eastern boundary of the survey polygon.

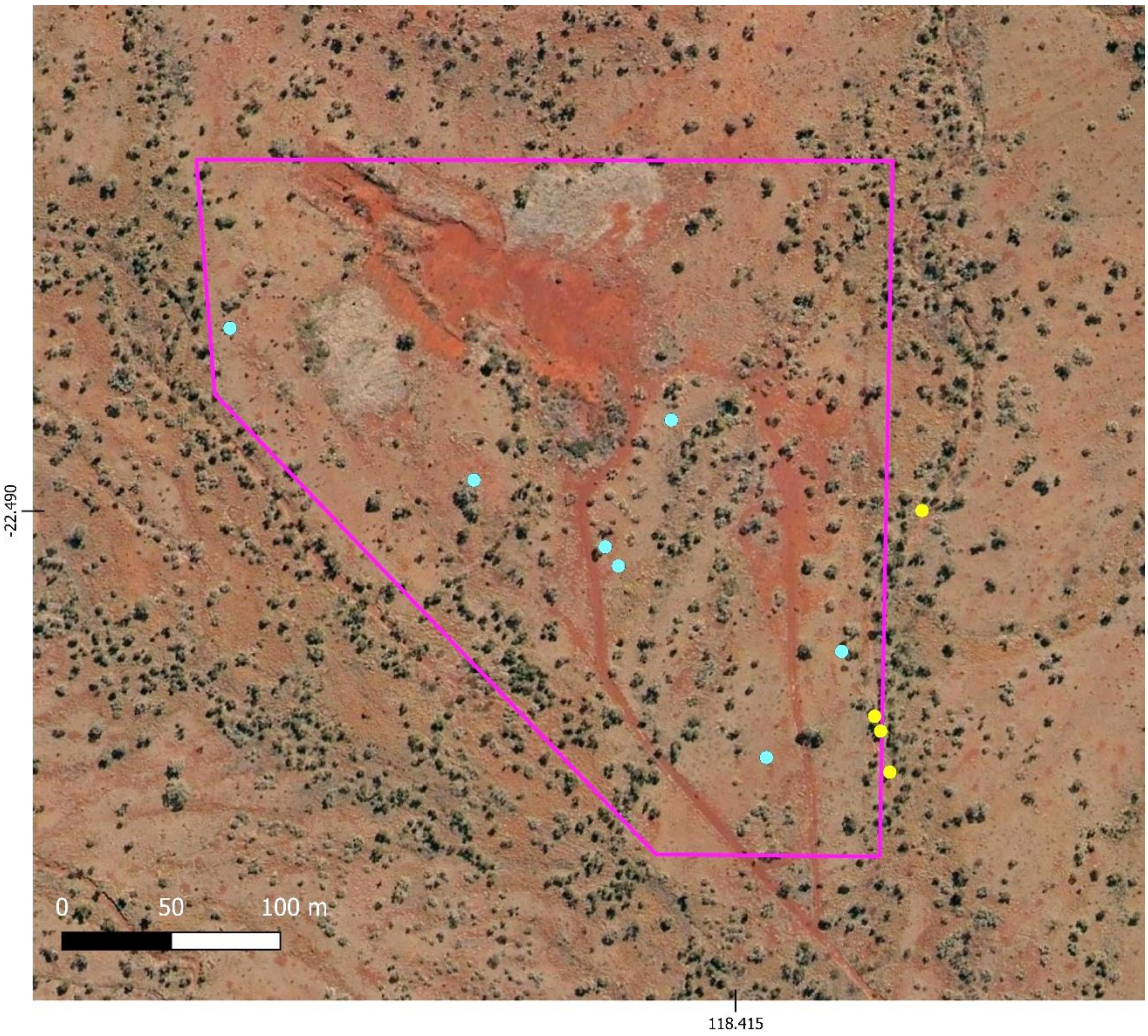

Figure 5.4.5: Locations of significant flora within SLK51 survey polygon, Isotropis parviflora (●) *and* Rostellularia adscendens *var.* latifolia (●). *Basemap of aerial imagery from WA Now Mosaic (Landgate 2022).*

5.4.5 Introduced and invasive flora

A large, dense, rectangular stand of buffel 55 × 30 m was found on the western edge of the current pit, on a gentle slope of 1° and with history of soil excavation, stockpiling and grading (Figure 5.4.6). This was the only area of Buffel Grass located in the pit area, while other similarly disturbed areas in the polygon supported dense stands of native grasses (*Enneapogon polyphyllus*, *Eriachne mucronata* and *Themeda triandra*) and/or shrubs. Buffel Grass currently appears to be restricted to this disturbed area and wasn't observed in the adjacent creeklines nor observed along the track.

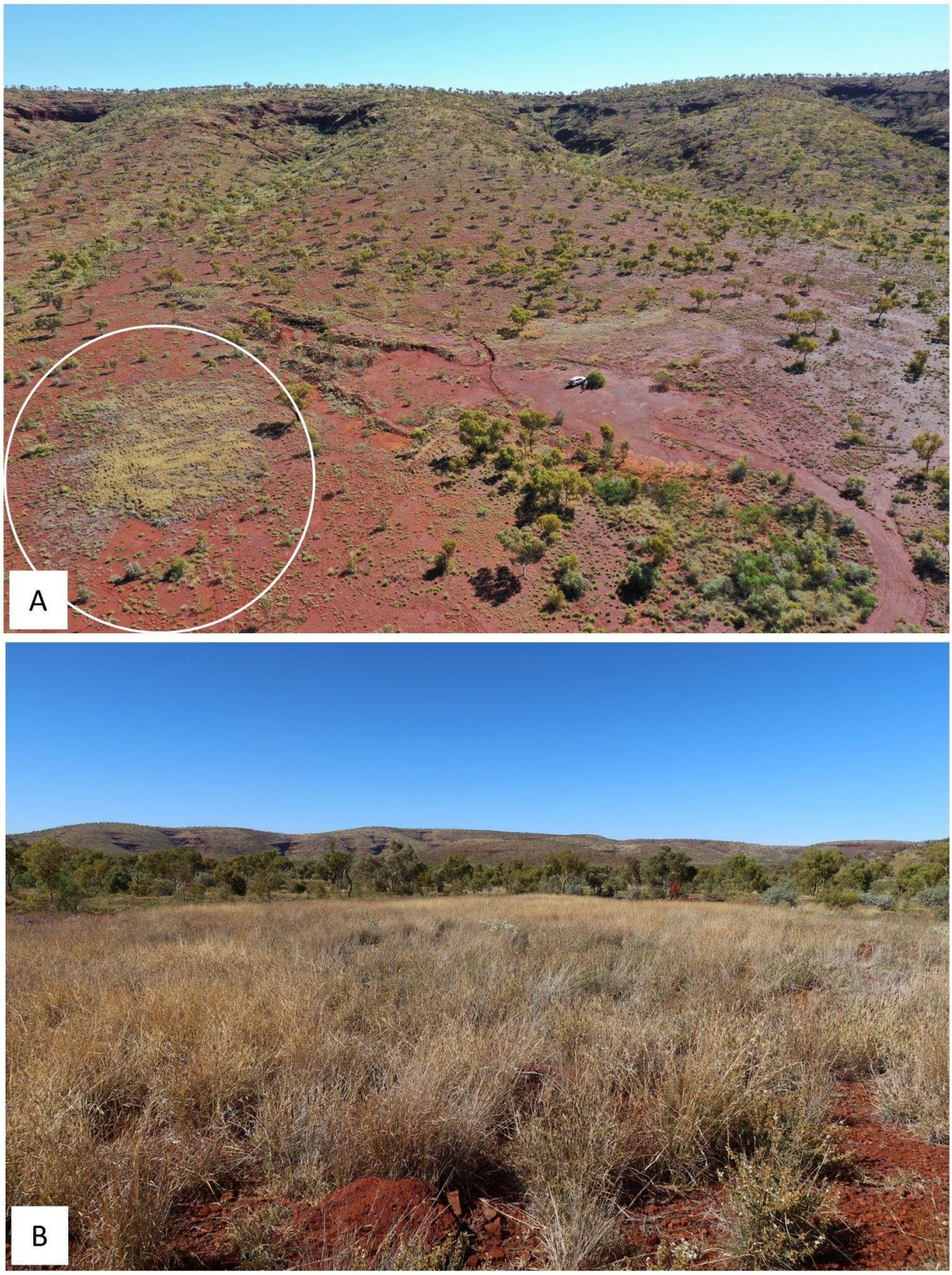

Figure 5.4.6: A: Aerial view of SLK51 facing north with the Cenchrus ciliaris *patch circled, B: ground view of the same dense patch of* Cenchrus ciliaris*. Note that the other grassland area north of the parked vehicle is composed of native species.*

5.4.6 Erosion Issues

Most of the SLK51 proposed expansion area lies on gently inclined slopes, with only the northern margin on steeper slopes. Runoff from this area and upslope is directed into gullies and creeklines which run on either side of the proposed pit area. A third drainage line runs through the pit and drainage has been directed into it via a channel cut at the top of the current pit (Figure 5.4.7, Figure 5.4.8). Water also pools in small depression in the current gravel pit along this section. Risk of erosion and changes to drainage in the expanded pit areas would be expected along the top margin of the proposed pit expansion, and along the sides parallel with the minor creeklines.

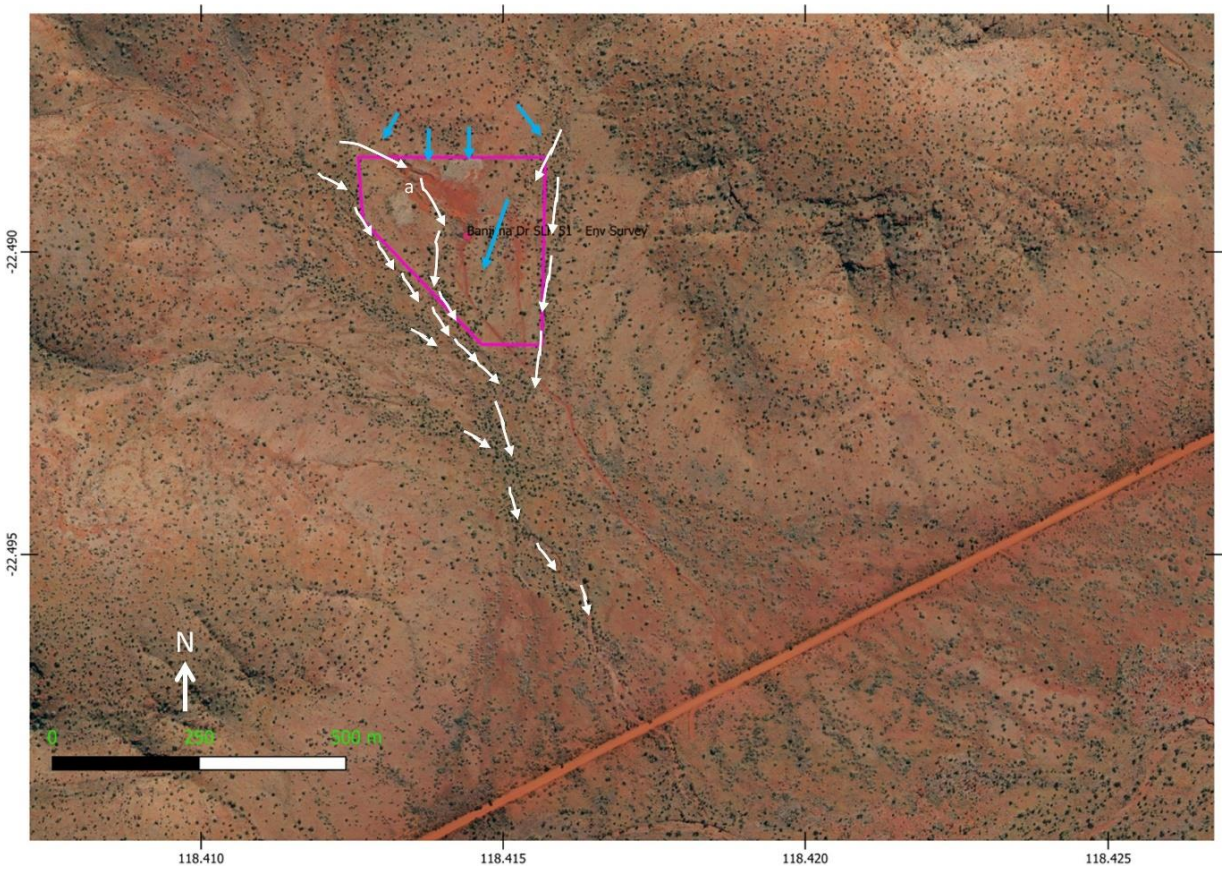

Figure 5.4.7: Erosion and potential erosion at SLK51 proposed gravel pit expansion area. White arrows delineate direction of flow of water in drainage lines, and blue arrows delineate direction of slope.

5.5 Gravel Pit Expansion Area SLK17

5.5.1 Site Description

Landform: On a low gravelly ridge (spur) off a lower hillslope in a broad saddle between ironstone hills, 5.8k m northwest of Mt Vigors, under areas of outcropping cliffs and breakaways. There is a deep (10–20 m) gulley on the northern edge of the current/proposed pit expansion area, and the southern slopes of the spur are bisected by several minor gullies (Figures 4.5.1 and 4.5.2). Most of the proposed pit area is on north-slope side of this spur. This spur is oriented east-west and with margins gently to the south and north at angles of 2–5°, increasing to steeper gradients of < 10 to 20° in the deeper gully north of the spur. The elevation over the survey polygon is 820–825 m amsl. The soil surface is 90% covered in weathered ironstone gravel over a deep gravelly clay soil. The creekline is usually dry but the rock weathering indicates that it receives high volumes after heavy rain. The sides and slopes north of this gully have exposed weathered ironstone outcrops and the gully itself is has boulders and exposed rocks.

Geology: Mount McRae Shale and Mount Sylvia Formation (Thorne & Tyler 1997)

Land System (Payne 2004): Newman Land System, on the lower slopes of rugged jaspilite plateaux, ridges and mountains.

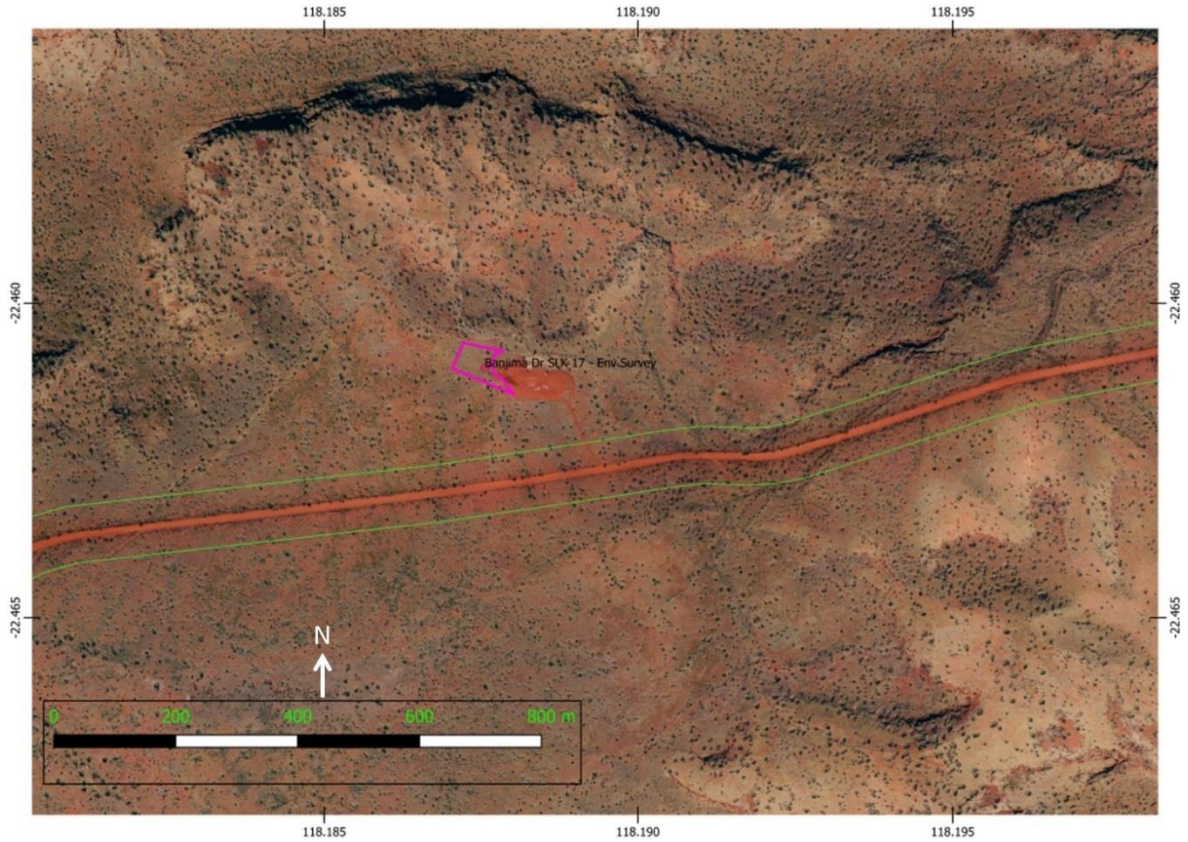

Figure 5.5.1. Location of the SLK17 gravel pit expansion area (pink polygon) superimposed on aerial imagery. Basemap of aerial imagery from WA Now Mosaic (Landgate 2022). Banjima road boundary outlines in green.

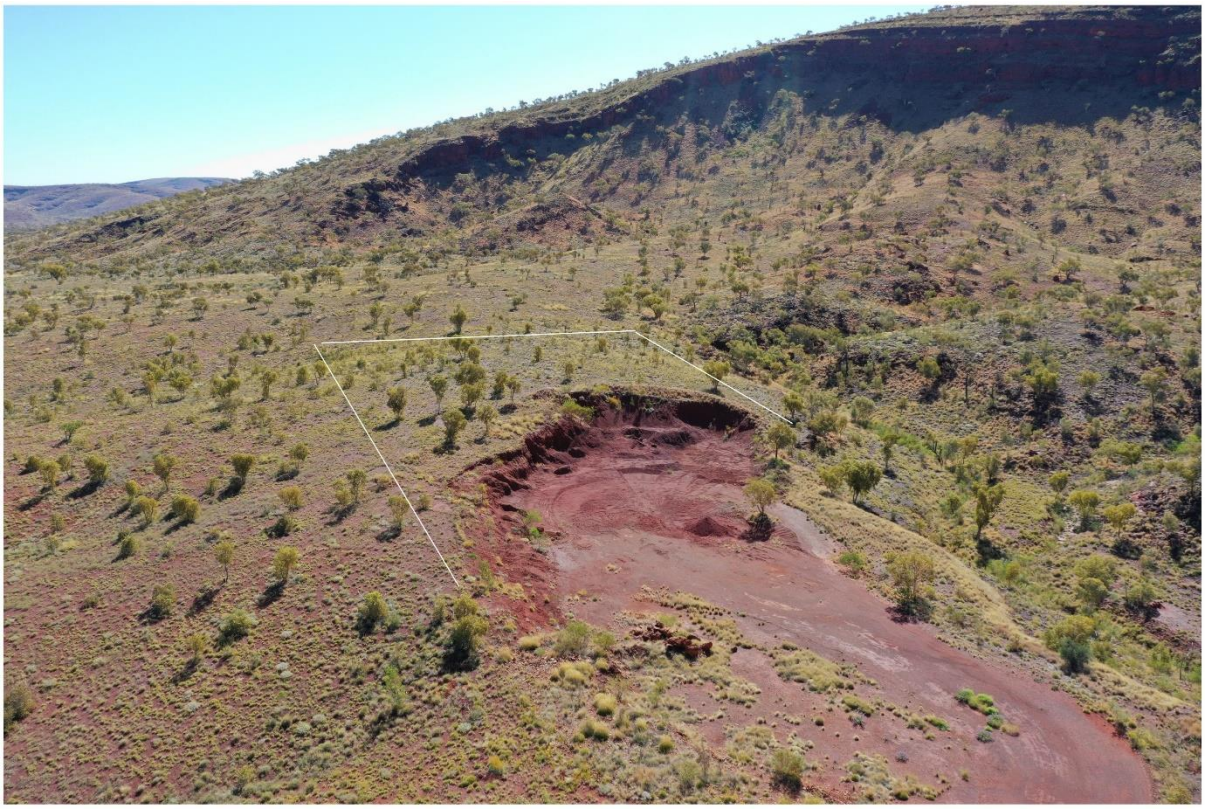

Figure 5.5.2. Oblique aerial view of the SLK17 gravel pit expansion polygon facing north-west. The survey polygon is outlined in white.

Fire History: The area had been recently burnt c. 2 years prior to survey and was noted to be recovering well.

Vegetation Condition: Very Good Excellent in wider undisturbed areas (possible frequent fires). Degraded-Poor around the current gravel pit.

5.5.2 Survey Effort

Figure 5.5.3 illustrates the extent of search coverage of SLK17 from the tracks walked by two observers within the polygon and adjacent gully.

5.5.3 Vegetation of the Proposed Clearing Area

On the spur within the survey polygon: Mid-dense hummock grassland of *Triodia wiseana* with scattered low shrubs of *Indigofera monophylla* and *Acacia adoxa*, with emergent trees of *E. leucophloia, E. xerothermica* and *C. hamersleyana* (Figure 5.5.4). Patches of *Eulalia aurea* and *Themeda triandra* in gullies and under trees. Common species observed include *Acacia trudgeniana*, *Tricoryne* sp. Hamersley Range (S. van Leeuwen 915), *Hakea chordophylla*, *Gompholobium oreophilum*, *Goodenia stobbsiana*, *Amphipogon sericeus*, *Ptilotus calostachyus*, *Acacia monticola*, Senna

artemisioides subsp*. oligophylla* × *helmsii*, *Mirbelia viminalis* and *Heliotropium* sp. *Enneapogon polyphyllus* and *Themeda triandra* have established on the disturbed pit margins.

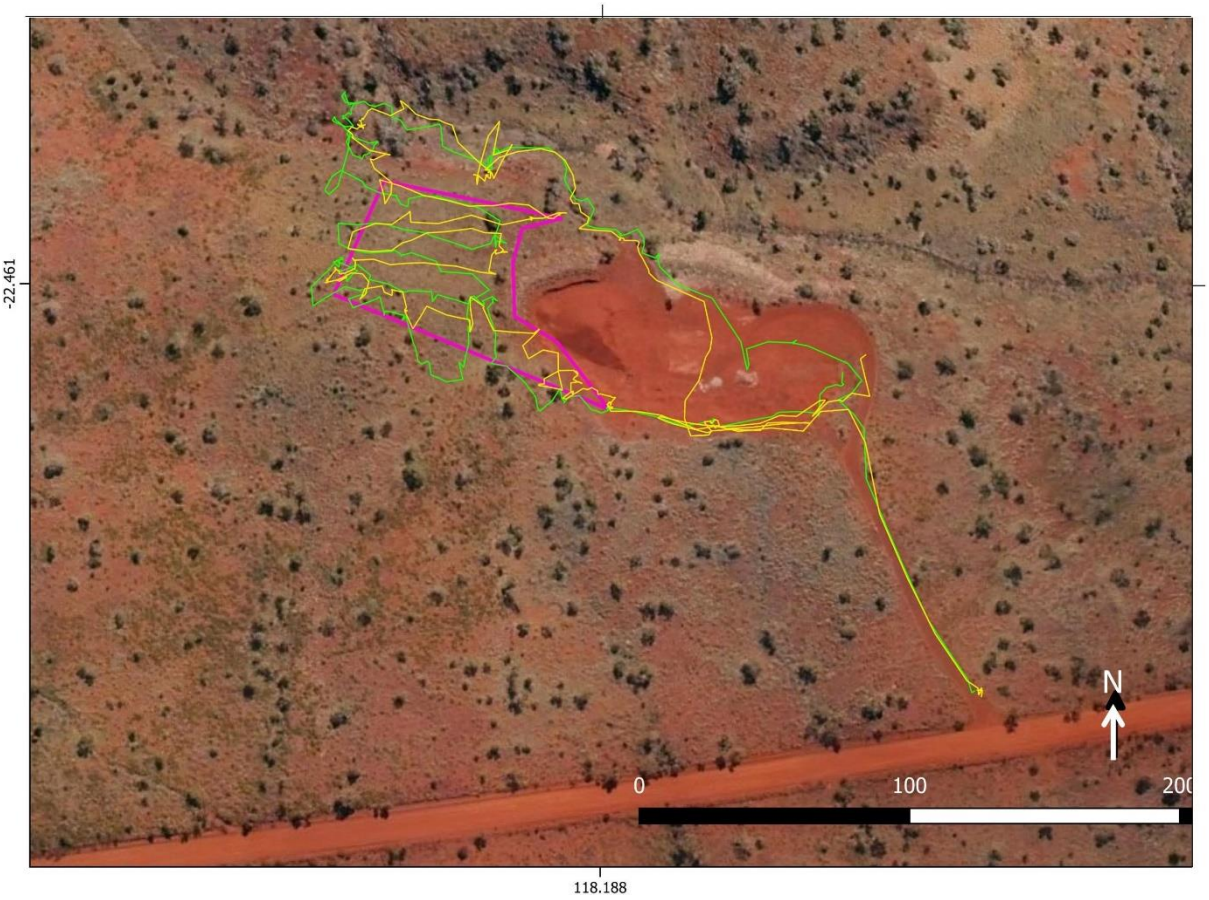

Figure 5.5.3. Tracks walked by two observers (each with a different coloured track) within the survey polygon for SLK17 gravel pit expansion area and into the adjacent gully. Basemap of aerial imagery from WA Now Mosaic (Landgate 2022).

In the adjacent gully. Woodland of *Eucalyptus leucophloia* over dense grassland of *Themeda triandra* in rocky gully, with stands of *Corymbia hamersleyana*, *Acacia monticola*, *Acacia cowleana*, *Grevillia wickhamii* and *Acacia bivenosa* in the creekline. Common species on the rocky gully sides include *Acacia hamersleyensis*, *Dodonaea viscosa*, *Cymbopogon obtectus*, *Eriachne mucronata*, *Abutilon* sp. Dioicum (A.A. Mitchell PRP 1618) and *Clerodendrum floribundum* subsp. *angustifolium. Ficus brachypoda* and *Tinospora smilacina* are growing out of rock walls.

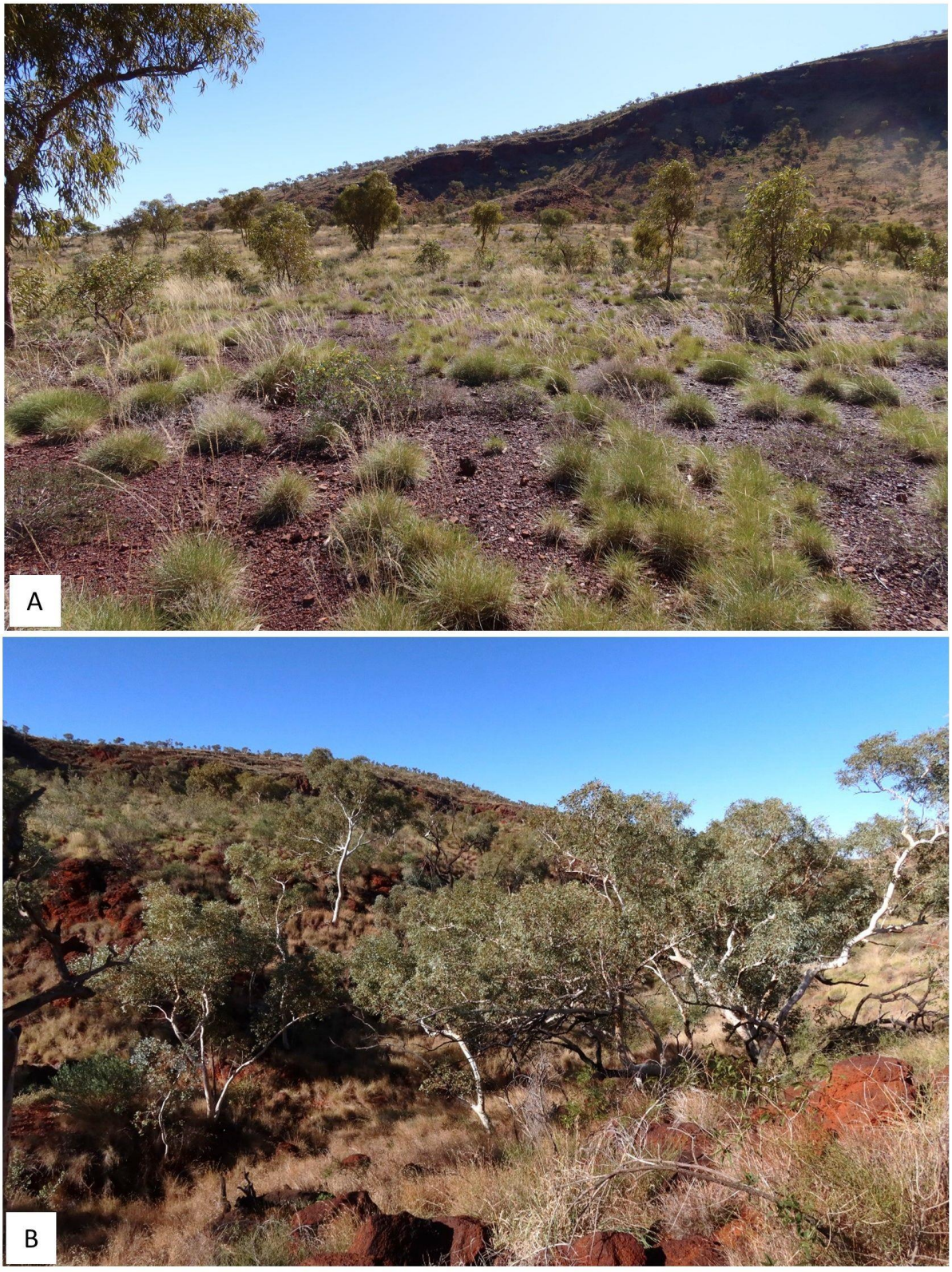

Figure 5.5.4: Vegetation of SLK17. A: Triodia *grassland with emergent trees of* Eucalyptus leucophloia *and* Corymbia hamersleyana in the survey polygon*, B: the steep, rocky gully north of SLK17 with* E. leucophloia *woodland over* Themeda triandra *tussock grassland on gully sides.*

5.5.4 Conservation significant flora

Sida sp. Barlee Range (S. van Leeuwen 1642) was located in the steep gully north of the gravel pit.

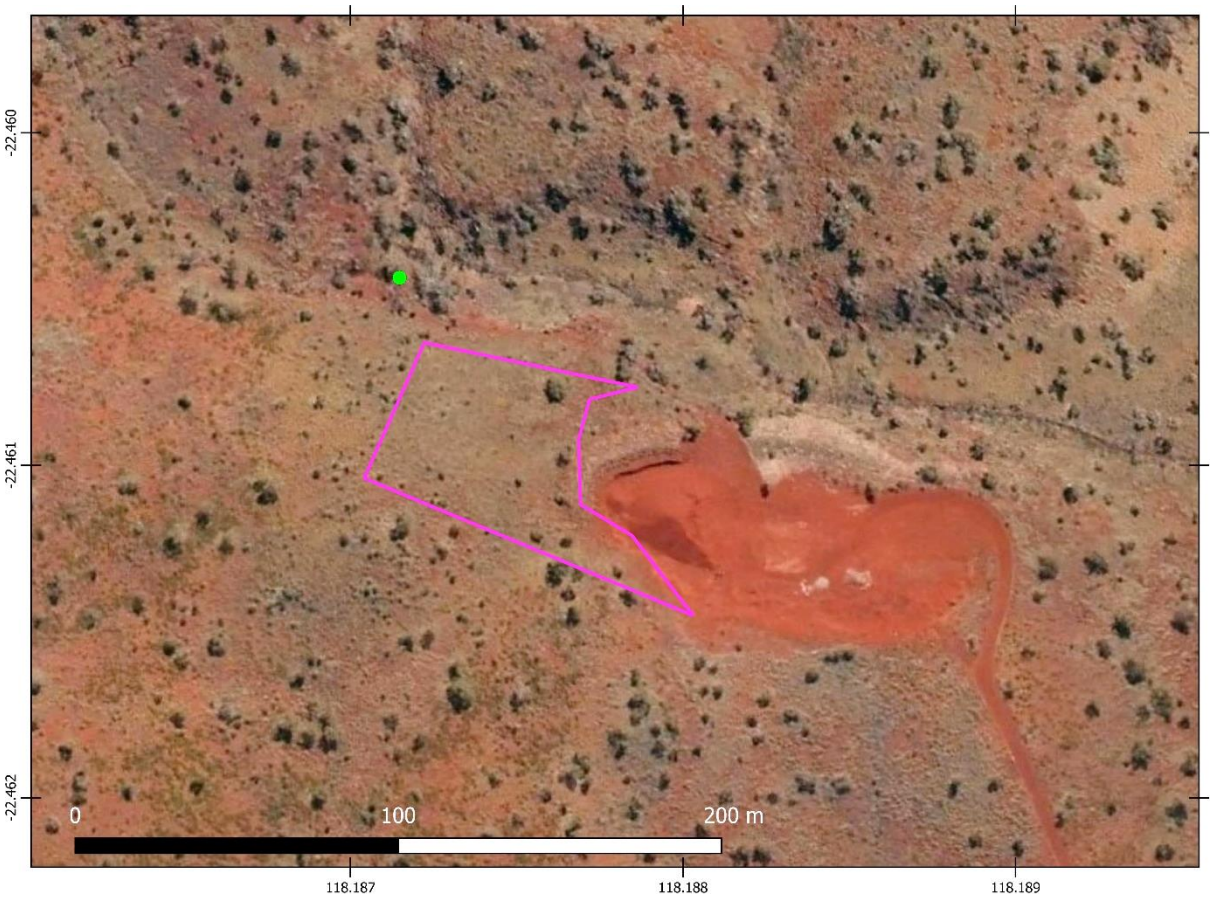

Figure 5.5.5: Locations of significant flora within SLK17survey polygon, Sida *sp. Barlee Range (S. van Leeuwen 1642)* (●).

5.5.5 Introduced and invasive flora

There is a significant patch of *Cenchrus ciliaris* all along the northern margin of the current gravel pit which extends from the north-western rim of the pit along the northern margin to cover entirely the north-eastern steep embankment (Figure 5.5.6). It hasn't spread to any degree down into the gully and creekline, which still supports a dense ground layer of *Themeda triandra*. Buffel Grass wasn't observed within the SLK17 expansion polygon, nor noted on the track into the pit or adjacent slopes. The southern margin of the pit was found to be free of Buffel Grass and instead was covered in patches of *Themeda triandra, Enneapogon polyphyllus* and *Triodia wiseana* grassland.

Two other introduced species (*Malvastrum americanum* and *Bidens bipinnata*) were observed in low numbers in the adjacent gully but not within the survey polygon.

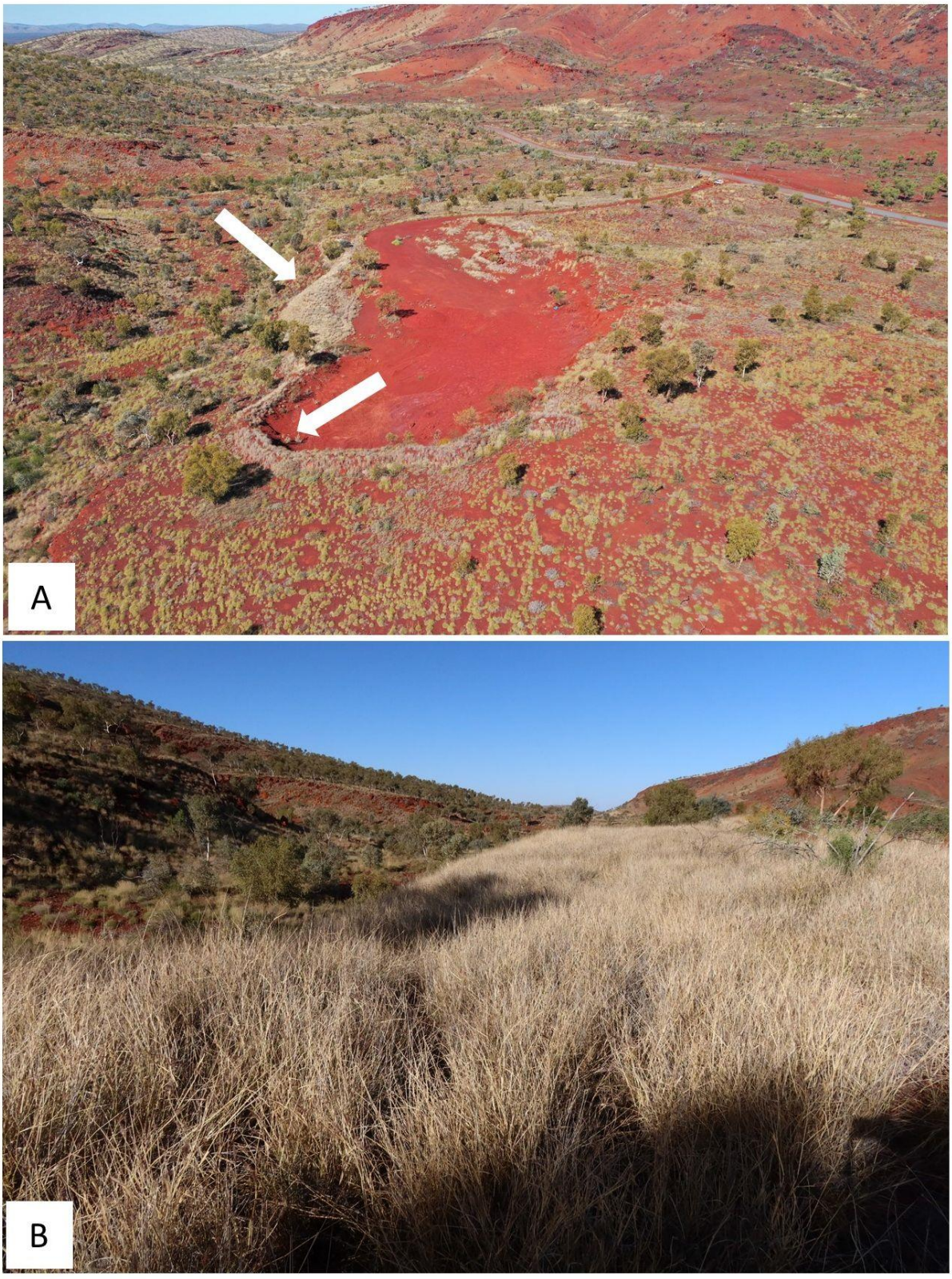

Figure 5.5.6: A: Aerial view of SLK17 facing south-east with the extent of the Cenchrus ciliaris *patch on the pit margins and northern embankment arrowed, B: ground view of the dense patch of* Cenchrus ciliaris on the steep embankment.

5.5.6 Erosion Issues

The current gravel pit at site SLK17 is on a ridge with sloping edges that direct runoff into either the steep gulley north of the pit or down the slopes and minor gullies of the slopes on southern edge of the ridge (see Figures 5.5.1 and 5.5.2). Runoff from further uphill is already directed into the steep gully. Given the steep embankments along the current pit northern and western margins. the greatest erosion issues would be from those if not stablilised. Of concern would be if debris then entered the steep gully.

5.6 Gravel Pit Expansion Area SLK8A and SLK8B

5.6.1 Site Description

Landform: Findings on two adjacent pits of SLK8A and SLK8B are combined here since they share a similar topography and vegetation. The sites are located c. 4 km west of Oxer's Lookout, on the gently undulating footslopes of ironstone hills which are incised by gullies, drainage lines and minor creeks (Figures 4.6.1 and 4.6.2). Runoff from these slopes eventually Hancock Gorge. The survey polygons are located on spurs with slope angles range from <1° to 3°. Site SLK8A is at elevations of between 707 and713 m amsl, while SLK8B lies at between 703 and 717 m amsl. The SLK8B polygon is narrower than that of SLK8A and is flanked by creeklines. Downslope of SLK8A and SLK8B is an alluvial terrace or gravelly flat associated with the wider creeklines that flow east off these footslopes.

Geology: Quaternary colluvium (Thorne & Tyler 1997)

Land System (Payne 2004): Platform Land System, consisting of dissected slopes and raised plains below rugged jaspilite hills, ranges and plateaux.

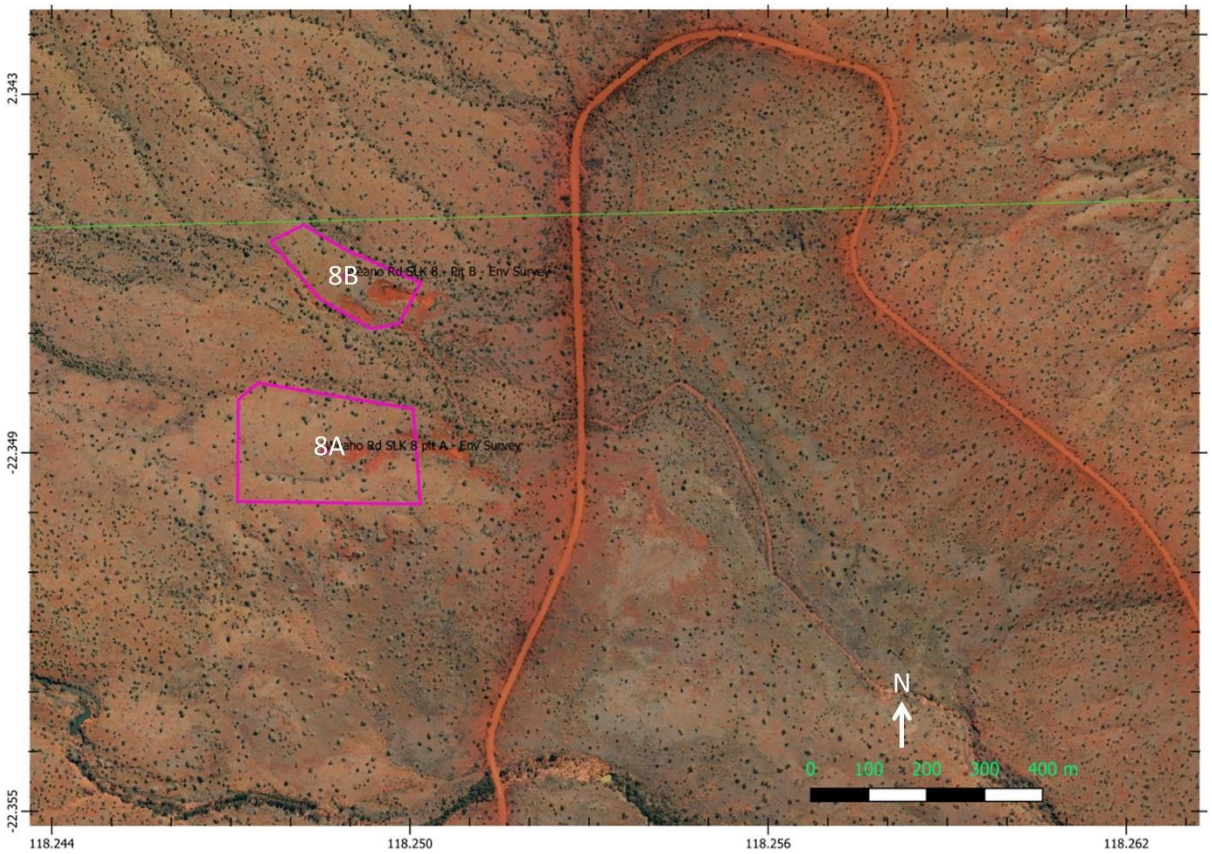

Figure 5.6.1. Location of the SLK8A and SLK8B gravel pit expansion areas (pink polygons) superimposed on aerial imagery. The northern boundary of Karijini National Park is marked as a green line. Basemap of aerial imagery from WA Now Mosaic (Landgate 2022).

Figure 5.6.2. Oblique aerial view of the SLK8A and SLK8B gravel pit expansion polygons facing north-west. The survey polygons are outlined in white.

Fire History: The area around SLK8A and SLK8B appears to be relatively long unburnt at time of survey (5 –> 10 years since last fire).

Vegetation Condition: Very Good-Excellent in the undisturbed areas within the survey polygons (presence of old vehicle tracks and the current Weano Rd has significant dust issues affecting roadside vegetation). Degraded-Poor within the current gravel pits (re-establishing shrub and grass vegetation on margins).

5.6.2 Survey Effort

Figure 4.6.3 illustrates the extent of search coverage of the survey polygons for SLK8A and SLK8B.from the tracks walked within and around sites by two observers.

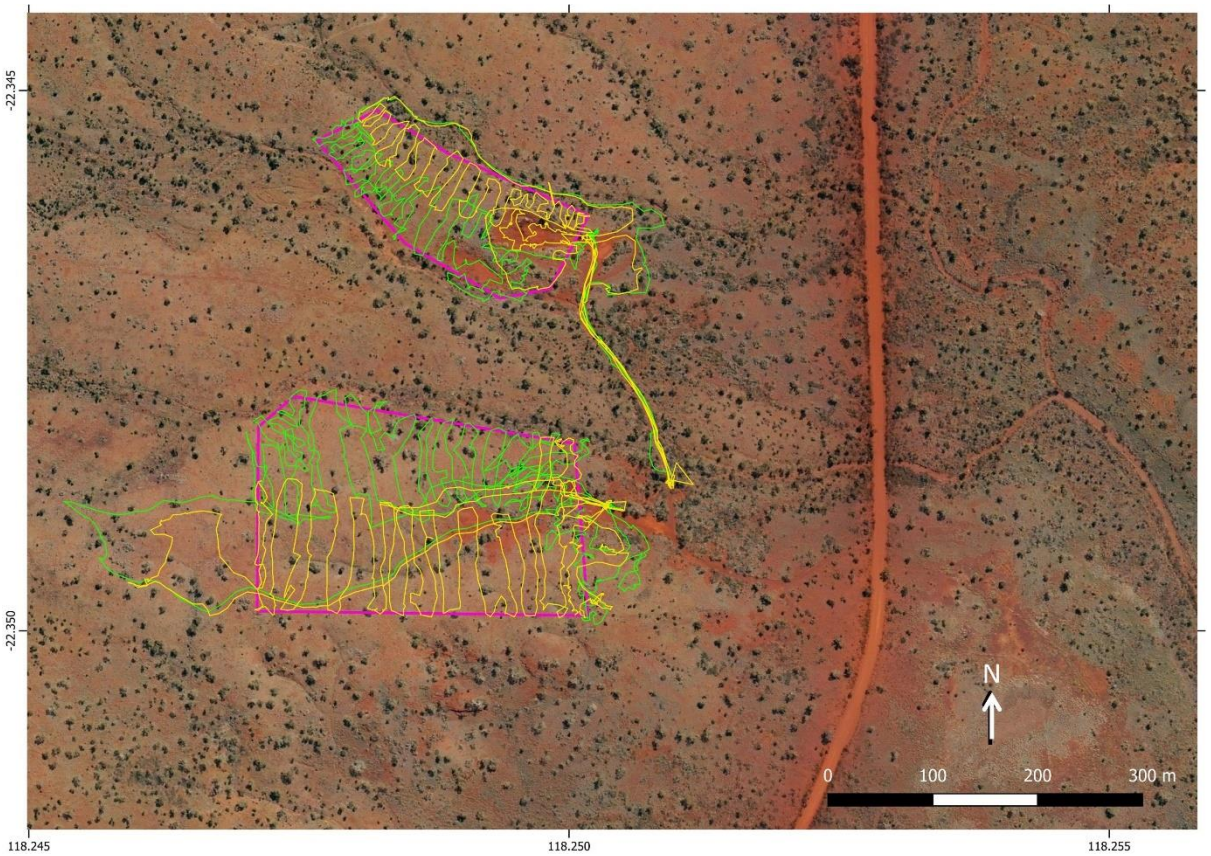

Figure 5.6.3. Tracks walked by two observers (each with a different coloured track) within the survey polygon for SLK17 gravel pit expansion area and into the adjacent gully. Basemap of aerial imagery from WA Now Mosaic (Landgate 2022).

5.6.3 Vegetation of the Proposed Clearing Area of SLK8A and SLK8B

Spurs /low ridges: *Corymbia hamersleyana* and *Eucalyptus leucophloia* open woodland over *Triodia vanleeuwenii* hummock grassland, with low shrubs of *Acacia adoxa* and *Seringia exastia,* herbs of *Goodenia stobbsiana* and tussocks of *Amphipogon sericeus* (Figure 4.6.4A). Other common species includes *Ptilotus calostachyus*, *Indigofera monophylla, Acacia tenuissima*, *Exocarpos sparteus, Gompholobium oreophila, Mirbelia viminalis*, *Capparis lasiandra*, *Hakea chordophylla, Senna glutinosa* subsp. *glutinosa, Scaevola parvifolia* and *Bonamia erecta*. Patches of *Themeda triandra* under trees. Some patches of the mallee *Eucalyptus gamophylla* and occasional trees of *Corymbia deserticola.*

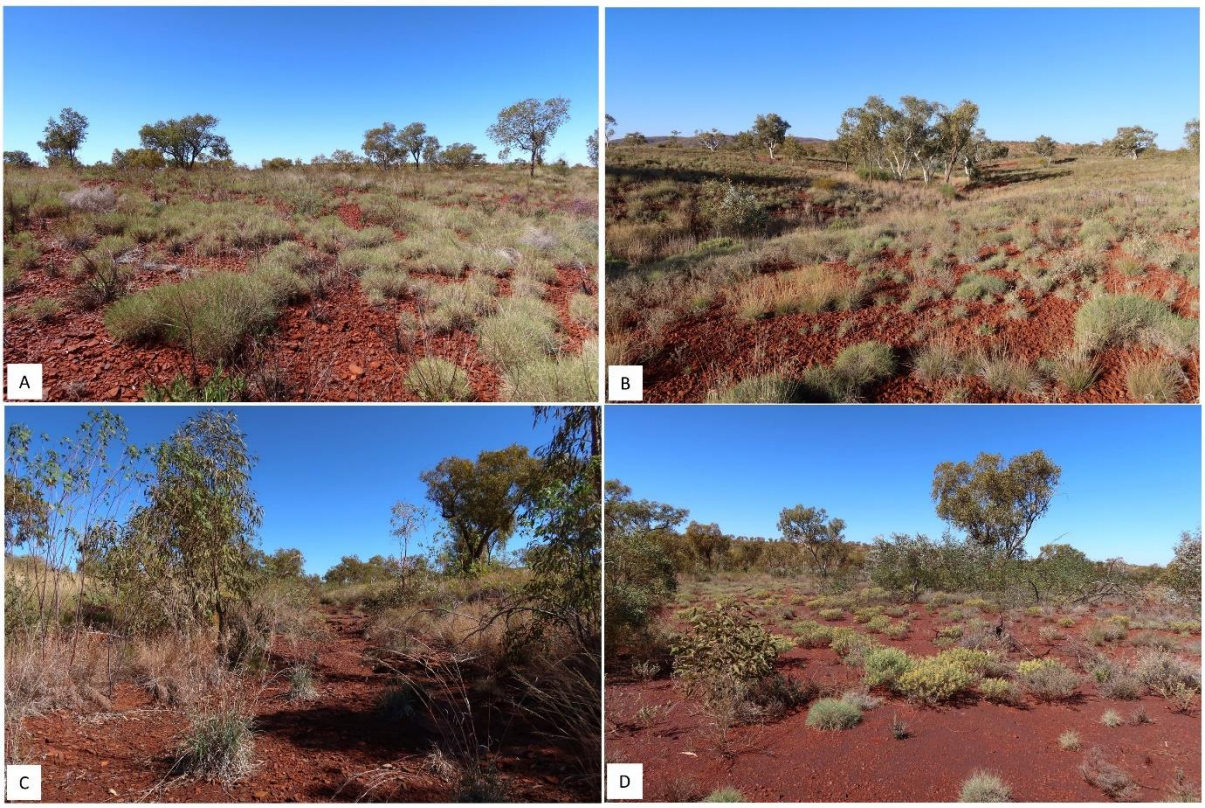

Figure 5.6.4: Vegetation of SLK8A and SLK8B survey area. A: Eucalyptus leucophloia *and* Corymbia hamersleyana *open woodland over* Triodia hummock *grassland in the survey polygon, B: gully vegetation in SLK8A, C: creekline* Corymbia hamersleyana *open woodland over* Gossypium robinsonii *and grassy banks of* Themeda triandra *and* Cymbopogon ambiguus*, D: alluvial terraces and gravelly flats downslope of SLK8B*

Minor gullies and drainage lines: *Corymbia hamersleyana* open woodland over *Triodia wiseana* hummock grassland, with scattered low shrubs of *Indigofera monophylla* and *Acacia adoxa*, and dense tussocks of *Themeda triandra* along channel edges (Figure 5.6.4B).

Deeper gullies and creeklines: *Corymbia hamersleyana* open woodland over mid-dense tall shrublands which includes *Gossypium robinsonii, Acacia cowleana*, *A. maitlandii*, *A. monticola*, *A. ancistrocarpa*, *Grevillea wickhamii, Petalostylis labicheoides, Gastrolobium grandiflorum* and *Androcalva luteiflora*, over dense *Themeda triandra* and/or *Eulalia aurea* tussock grassland along banks. Tall tussocks of *Cymbopogon ambiguus* occurs in wider creek beds, and along banks.

Alluvial area downslope of SLK8A and SLK8B: gravelly flats and alluvial terraces with a mosaic of woodlands of *Corymbia hamersleyana* and *Eucalyptus xerothermica* over *Themeda triandra,* and stands of *Eucalyptus gamophylla* and *Acacia cowleana* among areas of low shrubs of *Gompholobium oreophilum*, *Acacia adoxa*, *Indigofera monophylla* and hummocks of *Triodia vanleeuwenii* (Figure 5.6.4D).

Current Gravel Pit walls. Previously disturbed banks have been revegetated with a shrubland of various taxa, including *Acacia cowleana, Acacia maitlandii, Acacia acradenia, Petalostylis labicheoides*, *Indigofera monophylla*, *Senna artemisioides oligophylla* × *helmsii*, *Acacia bivenosa*, *Acacia ancistrocarpa* and *Acacia tenuissima*. Low shrubs and herbs include *Ptilotus astrolasius*, *Acacia adoxa*, *Gompholobium oreophilum* and *Ptilotus calostachyus* and there are dense patches of *Themeda triandra* and *Triodia wiseana*.

5.6.4 Conservation significant flora

Both SLK8A and SLK8B were found to have relatively high numbers of *Isotropis parviflora* (164 and 83 individuals respectively, see Table 3.1 & Figure 5.6.5) and it is assumed that this species is quite abundant on the extensive foothills in the surrounding area.

5.6.5 Introduced and invasive flora

No introduced and invasive weeds were observed in the SLK8A and SLK8B survey polygons.

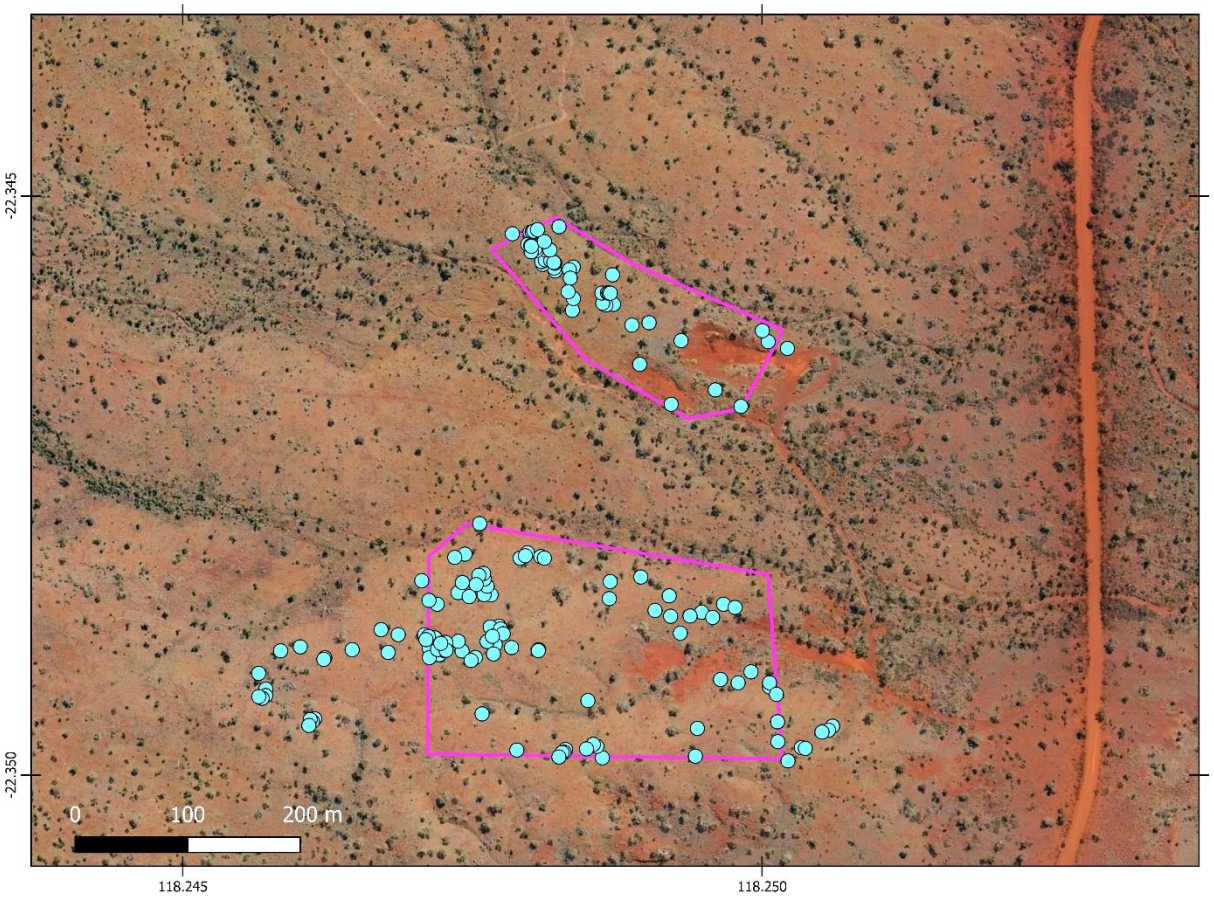

Figure 5.6.5: Locations of Isotropis parviflora *plants within and adjacent to the SLK8A and SLK8B survey polygons* (●). *Basemap of aerial imagery from WA Now Mosaic (Landgate 2022).*

5.6.6 Erosion Issues

Both proposed pits expansion areas are located on gentle slopes surrounded by extensive drainage lines receiving runoff from the surrounding hills (Figure 5.6.6). Creeklines run along the northern and southern boundaries of the SLK8B proposed expansion area, with part of the southern boundary creekline having become diverted down the access track causing gully erosion along a section of its length (Figure 5.6.6). A cleared area upslope may be increasing runoff here. Rill erosion is also occurring on the western pit margin in SLK8B from runoff off the ridge (Figure 5.6.7B). There is a creekline forming the northern boundary of SL8A proposed pit expansion area and a drainage line currently flowing through the southern third and into the current pit area where there is some erosion as it flows down the pit wall (Figure 5.6.6).

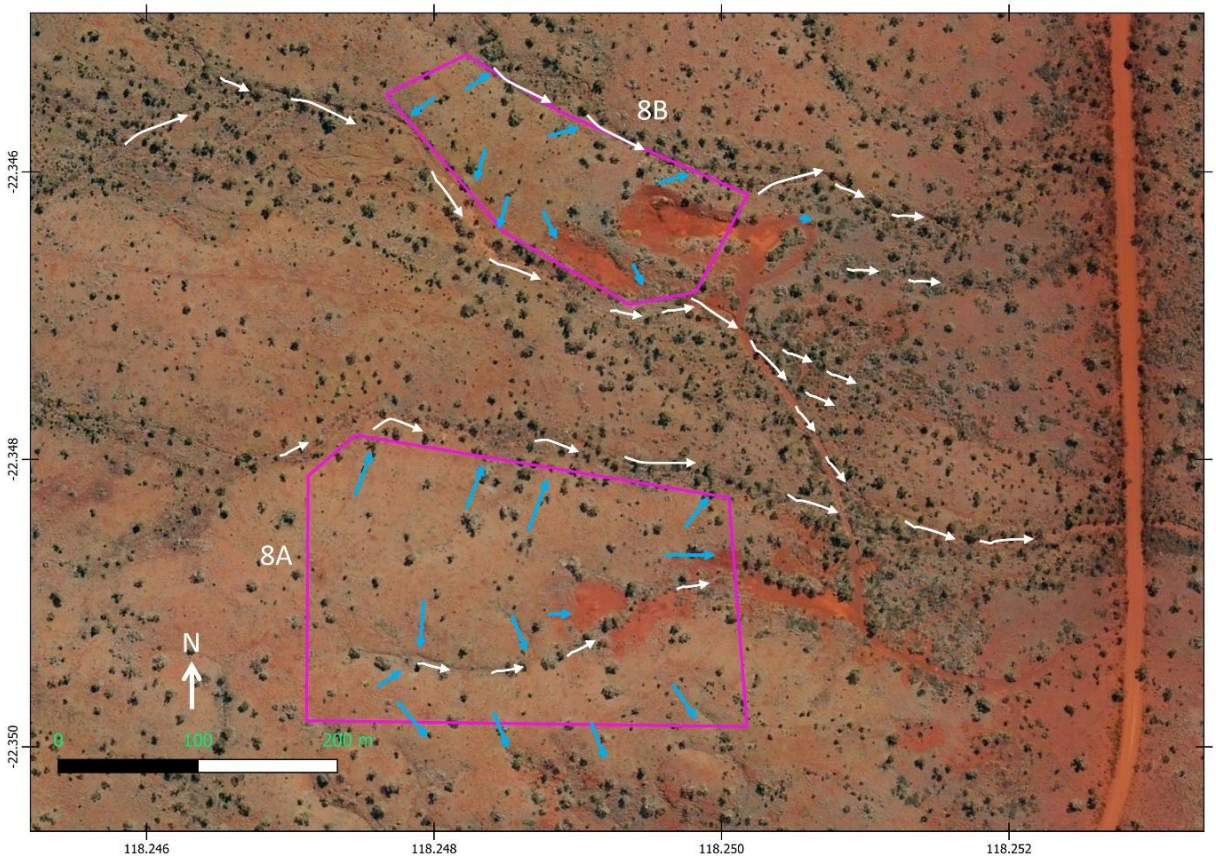

Figure 5.6.6: Erosion and potential erosion at SLK8A and SLK8B proposed gravel pit expansion areas. White arrows delineate direction of flow of water in channels, and blue arrows delineate direction of slope.

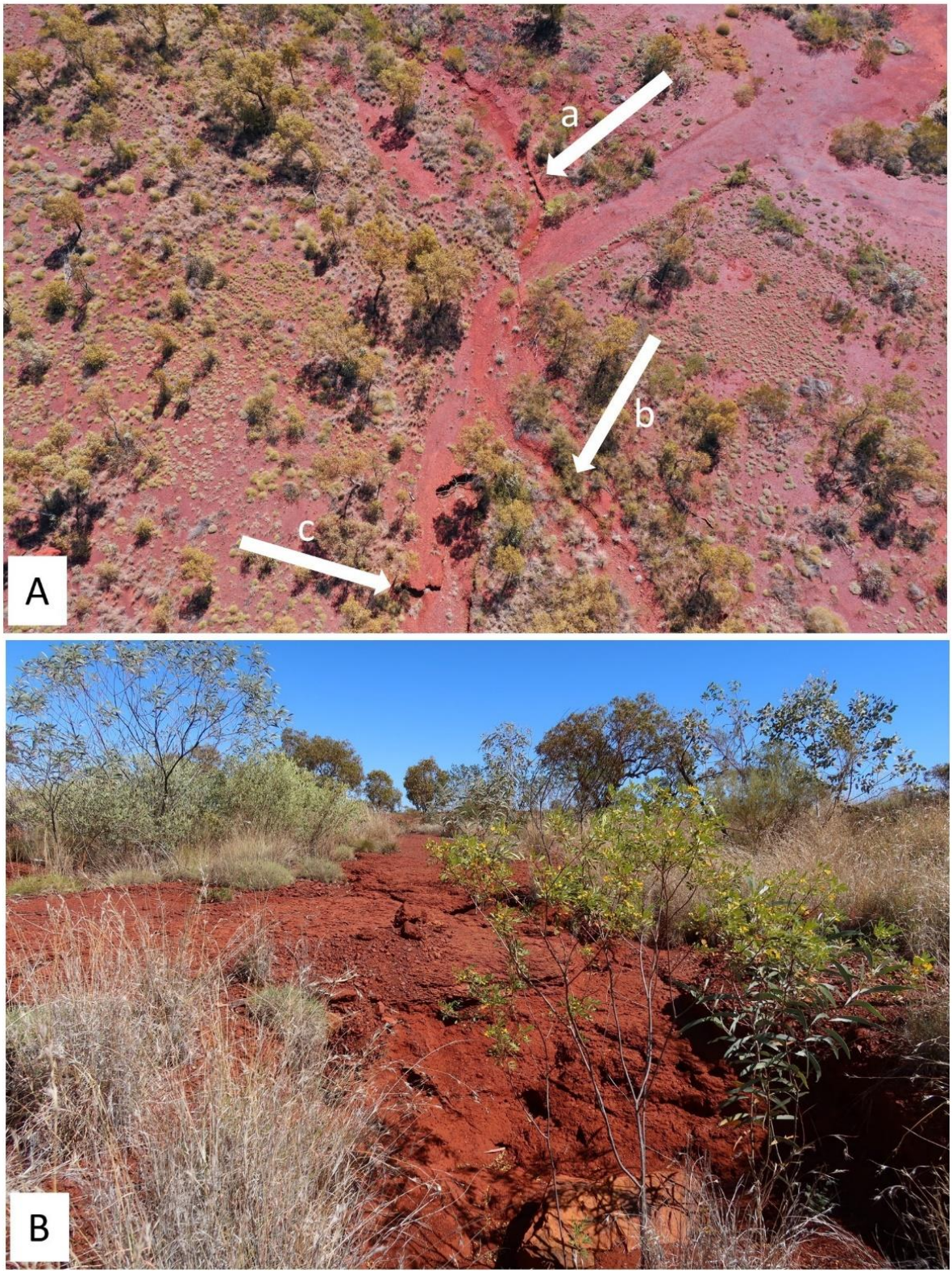

Figure 5.6.7: A: Aerial view of the entry track into SLK8B, where the creekline (a, b) splits and part of it deviates down the track. Gully erosion is arrowed (c). B: Pit wall in SLK8A (facing upslope) which has been eroded by runoff.

6 Discussion and Conclusion

The survey was undertaken during the winter months after good rainfall, during a field season where winter-spring flowering species were present, conspicuous, and identifiable. Conversely, grass species which respond to summer rainfall were found to be flowering poorly. In the case of *Triodia*, sterile material was still identifiable based on foliage characters, and some plants still managed to set seed. It is concluded that the absences of taxa listed in Table 2.1 from the sites during the field survey is not a function of the winter-spring season.

None of the vegetation communities observed and described for each of the gravel pit sites aligns with the descriptions for Threatened and Priority Ecological Communities listed in Western Australia. It is unlikely that any clearing or extraction activities will the Priority Ecological Communities which are located >5 km from the proposed pit clearing areas.

The proposed clearing in the gravel pit expansion areas will directly affect local *Isotropis parviflora* populations, but it is likely the species is more widespread in Karijini National Park since plants were found over distances of over 30 km, and the landforms it grows on (i.e., stony lower slopes, dissected footslopes and raised plains at below hills and ridges) are widespread across the park. Only more survey across the extent of these landforms (a regional survey) can confirm this. This species may have been overlooked in previous surveys in the park as it is a small, short-lived subshrub/herb which responds to good seasons and probably declines or dies off during dry seasons. As observed at sites SLK31 and SLK2, it responds to disturbance and will grow in spoil heaps and disturbed ground. However, it's abundance at sites SLK8A and SLK8B shows that it also grows well on undisturbed substrates and that there is some other attribute of those sites near Weano Rd which supported such large populations at time of survey.

The population of *Rostellularia adscendens* var. *latifolia* in the dry creekbed adjacent to proposed gravel pit expansion area SLK51 is not in the area of clearing but there may be some risk if extraction activities send debris into the creekline or redirect water away from the creek. Pit planning and management should aim to protect the creekline from gravel extraction operations.

Similarly, while there is no direct risk to the small population of *Sida* sp. Barlee Range (S. van Leeuwen 1642) in the gully north of SLK17, pit planning and management should aim to protect the creekline from gravel extraction operations.

A regional survey of these landforms in the park would put these findings and knowledge of these species in greater context (such as knowing more about the extent of *Isotropis parviflora*).

The vegetation of the sites was all found to be in Very Good-Excellent condition outside of the current gravel pits in the surrounding areas (meaning there were relatively slight signs of human activities since European settlement – no obvious signs). None of the three non-native flora taxa are listed in the state as Declared Pests requiring control under the *Biosecurity and Agriculture Management Act 2007* (DPIRD 2022). Two of these species (*Malvastrum americanum* and *Bidens bipinnata*) were found in low numbers adjacent to site SLK17 and are not considered as an issue requiring management and pit planning.

Buffel Grass (*Cenchrus ciliaris)* infestations were detected at three of the pits (SLK17, SLK51 and SLK2). These were mainly confined to disturbed pit walls, where they formed dense, monospecific stands. It is advised that the Buffel Grass is eradicated prior to excavation works and moving gravel around in the park. Control must be continued over the life of the pits as the soil disturbance will create ideal conditions for further establishment and re-invasion.

The sites are located in an arid region with low rainfall, high temperatures, sparse vegetation and infrequent but still significant high intensity rainfall events with the potential to wash out tracks, unstable embankments and scour gullies and creeks. Runoff is moderately rapid – rapid, depending on slope, but slopes are generally low and the landforms are dissected by numerous drainage lines. All sites are prone to some erosion which may be an issue for the proposed areas of excavation that should be managed by pit design and management. With all pits, the potential issues would be rill and gulley erosion on pit walls and tracks, and channelling debris into current drainage lines/creeks and tracks. For each of the gravel pit expansion areas, the following recommendations are;

SLK2 and SLK2 Extension	Control erosion on hillslope on eastern margin of pit SLK2. Manage the dug channel and old track for erosion. Avoid or minimise changes to flows and debris entering through natural drainage lines.

SLK7	Design and manage pit so that adjacent drainage lines (gullies, creeks) do not receive debris and runoff, and natural water flow is still maintained down these if possible.
SLK31	Control erosion on hillslope on northern margin.
SLK51	Design and manage pit so that adjacent drainage lines (gullies, creeks) do not receive debris and runoff, and natural water flow is still maintained down these if possible.
SLK17	Avoid erosion into steep gulley and southern slopes from steep embankments.
SLK8A and SLK8B	Manage water channeling and movement of debris. Avoid or minimise changes to flows and debris entering through natural drainage lines Address the track erosion.

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Appendices

Appendix 1 Conservation listed flora in the central Hamersley Ranges region, obtained from records from the Western Australian Herbarium.

Taxon	Conservation Code	Likelihood of occurring in pits	Reason
Abutilon sp. Pritzelianum (S. van Leeuwen 5095)	3	none	Unsuitable habitat
Acacia bromilowiana	4	low	Occasionally suitable habitat
Acacia daweana	3	low	Suitable habitat, not known from northern Karijini NP
Acacia effusa	3	medium	Suitable habitat, in range
Acacia subtiliformis	3	low	Occasionally suitable habitat
Adiantum capillus-veneris	2	none	Unsuitable habitat
Aluta quadrata	T	none	Out of range, unsuitable habitat
Amaranthus centralis	3	none	Unsuitable habitat
Ampelopteris prolifera	3	none	Unsuitable habitat
Aristida jerichoensis var. subspinulifera	3	none	Unsuitable habitat
Aristida lazaridis	2	low	Occasionally suitable habitat
Arthropodium vanleeuwenii	2	none	Unsuitable habitat
Astrebla lappacea	3	none	Unsuitable habitat
Atriplex flabelliformis	3	none	Unsuitable habitat
Bothriochloa decipiens var. *cloncurrensis*	1	none	Unsuitable habitat
Bulbostylis burbidgeae	4	none	Unsuitable habitat
Calotis squamigera	1	none	Unsuitable habitat
Cladium procerum	2	none	Unsuitable habitat
Cyanthillium gracile	3	none	Out of range, unsuitable elevation
Dampiera anonyma	3	none	Unsuitable habitat
Dampiera metallorum	3	none	Unsuitable habitat
Dicladanthera glabra	2	low	Occasionally suitable habitat
Dolichocarpa sp. Hamersley Station (A.A. Mitchell PRP 1479)	3	none	Unsuitable habitat
Dicrastylis mitchellii	1	none	Unsuitable habitat
Dipteracanthus chichesterensis	1	none	Out of range, unsuitable habitat
Dysphania congestiflora	3	none	Unsuitable habitat
Eleocharis papillosa	3	none	Unsuitable habitat
Eragrostis crateriformis	3	none	Unsuitable habitat
Eragrostis sp. Erect spikelets (P.K. Latz 2122)	3	none	Unsuitable habitat
Eragrostis sp. Mt Robinson (S. van Leeuwen 4109)	2	low	Unsuitable habitat

Taxon	Conservation Code	Likelihood of occurring in pits	Reason
Eragrostis surreyana	3	none	Out of range, unsuitable habitat
Eremophila coacta	3	none	Out of range, unsuitable habitat
Eremophila magnifica subsp. *magnifica*	4	none	Unsuitable habitat
Eremophila magnifica subsp. *velutina*	3	none	Unsuitable habitat
Eremophila pusilliflora	2	none	Unsuitable habitat
Eremophila naaykensii	3	none	Out of range, unsuitable habitat
Eremophila rhegos	1	none	Out of range, unsuitable habitat
Eremophila rigens	3	none	Out of range, unsuitable habitat
Eremophila rigida	3	none	Out of range, unsuitable habitat
Eremophila sp. Mt Channar Range (C. Keating & M.E. Trudgen CK 408)	1	none	Out of range, unsuitable habitat
Eremophila sp. Pingandy dentate (B. Buirchell BB 331)	1	none	Out of range, unsuitable habitat
Eremophila sp. Snowy Mountain (S. van Leeuwen 3737)	1	none	Out of range, unsuitable habitat
Eremophila sp. West Angelas (S. van Leeuwen 4068)	2	none	Out of range, unsuitable habitat
Eremophila spongiocarpa	3	none	Out of range, unsuitable habitat
Eremophila youngii subsp. *lepidota*	4	none	Out of range, unsuitable habitat
Eucalyptus lucens	1	none	Unsuitable habitat
Eucalyptus rowleyi	3	none	Unsuitable habitat
Euphorbia australis var. *glabra*	3	none	Unsuitable habitat
Euphorbia inappendiculata var. *inappendiculata*	2	none	Unsuitable habitat
Euphorbia inappendiculata var. *queenslandica*	2	none	Unsuitable habitat
Euphorbia stevenii	3	none	Unsuitable habitat
Fimbristylis sieberiana	3	none	Unsuitable habitat
Geijera salicifolia	3	none	Unsuitable habitat
Glycine falcata	3	none	Unsuitable habitat
Gompholobium karijini	2	moderate-high	Suitable habitat but appears to not be widespread across KNP.
Goodenia berringbinensis	4	none	Unsuitable habitat
Goodenia lyrata	3	none	Unsuitable habitat
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)	3	none	Unsuitable habitat
Grevillea saxicola	3	none	Unsuitable habitat

Taxon	Conservation Code	Likelihood of occurring in pits	Reason
Gymnanthera cunninghamii	3	none	Unsuitable habitat
Helichrysum oligochaetum	1	none	Unsuitable habitat
Hibiscus campanulatus	1	none	Out of range
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708)	2	low	Out of range
Hibiscus sp. Mt Brockman (E. Thoma ET 1354)	1	low	Unsuitable habitat
Indigofera gilesii	3	low	Out of range
Indigofera ixocarpa	2	moderate	Occasionally suitable habitat, in range
Indigofera rivularis	3	low	Out of range
Iotasperma sessilifolium	3	none	Unsuitable habitat
Ipomoea racemigera	2	none	Unsuitable habitat
Isotropis forrestii	1	none	Out of range
Isotropis parviflora	2	high	suitable habitat and within range
Josephinia sp. Woodstock (A.A. Mitchell PRP 989)	1	none	Unsuitable habitat
Kohautia australiensis	2	none	Out of range, unsuitable habitat
Lepidium catapycnon	4	medium-high	suitable habitat and within range
Lindernia sp. Pilbara (M.N. Lyons & L. Lewis FV 1069)	1	none	unsuitable habitat
Livistona alfredii	4	none	Out of range, unsuitable habitat
Maireana prosthecochaeta	3	none	Out of range, unsuitable habitat
Myriocephalus scalpellus	1	none	Out of range, unsuitable habitat
Olearia mucronata	3	low	Occasionally suitable habitat
Oxalis sp. Pilbara (M.E. Trudgen 12725)	2	low	suitable habitat, out of range
Paranotis sp. Pilbara (H. Ajduk HAOP04a)	1	none	Out of range, unsuitable elevation
Paspalidium retiglume	2	none	Out of range, unsuitable habitat
Pentalepis trichodesmoides subsp. *hispida*	2	none	Unsuitable habitat
Pilbara trudgenii	3	none	Out of range, unsuitable elevation
Ptilotus mitchellii	1	none	Out of range, unsuitable elevation
Ptilotus mollis	4	low	Occasionally suitable habitat
Ptilotus subspinescens	3	low	Out of range
Ptilotus trichocephalus	4	none	Unsuitable habitat
Rhagodia sp. Hamersley (M. Trudgen 17794)	3	low	Occasionally suitable habitat

Taxon	Conservation Code	Likelihood of occurring in pits	Reason
Rhodanthe ascendens	1	none	Unsuitable habitat
Rhodanthe frenchii	2	none	Out of range
Rhynchosia bungarensis	4	low	Occasionally suitable habitat
Rorippa sp. Fortescue Valley (M.N. Lyons & R.A. Coppen FV 0760)	1	none	Out of range, unsuitable elevation
Rostellularia adscendens var. latifolia	3	high	Suitable habitat, in range
Samolus sp. Fortescue Marsh (A. Markey & R. Coppen FM 9702)	1	none	Out of range, unsuitable elevation
Scaevola sp. Hamersley Range basalts (S. van Leeuwen 3675)	2	low	Occasionally suitable habitat, just out of range.
Senna sp. Barlee Range (S. van Leeuwen 1520)	2	none	Out of range
Sida sp. Barlee Range (S. van Leeuwen 1642)	4	medium	Suitable habitat
Sida sp. Hamersley Range (K. Newbey 10692)	1	low	Out of range
Solanum albostellatum	3	none	Unsuitable habitat
Solanum kentrocaule	3	low	unsuitable elevation, out of range
Solanum pycnotrichum	2	none	Out of range
Solanum sp. Red Hill (S. van Leeuwen et al. PBS 5415)	3	low	Suitable habitat, just out of range
Solanum sp. W Hamersley Range (S. Colwill & B. Duncan LCR99-01)	1	none	Out of range
Stackhousia clementii	3	none	Unsuitable habitat
Stemodia sp. Battle Hill (A.L. Payne 1006)	1	none	Unsuitable habitat
Streptoglossa sp. Cracking clays (S. van Leeuwen et al. PBS 7353)	3	none	Unsuitable habitat
Stylidium weeliwolli	3	none	Unsuitable habitat
Swainsona thompsoniana	3	none	Unsuitable habitat
Synostemon hamersleyensis	1	none	Out of range, unsuitable habitat
Tecticornia globulifera	1	none	Unsuitable habitat
Tecticornia medusa	3	none	Unsuitable habitat
Tecticornia sp. Christmas Creek (K.A. Shepherd & T. Colmer et al. KS 1063)	1	none	Unsuitable habitat
Terminalia supranitifolia	3	none	Out of range
Tetratheca butcheriana	1	none	Out of range, unsuitable habitat
Tetratheca fordiana	2	none	Unsuitable habitat
Teucrium pilbaranum	2	none	Unsuitable habitat
Themeda sp. Hamersley Station (M.E. Trudgen 11431)	3	none	Unsuitable habitat
Thryptomene wittweri	T	none	Unsuitable habitat
Triodia basitricha	3	low	Suitable habitat, just out of range
Triodia pisoliticola	3	low	Suitable habitat, just out of range

Taxon	Conservation Code	Likelihood of occurring in pits	Reason
Triodia sp. Karijini (S. van Leeuwen 4111)	1	low	Unsuitable elevation
Triodia sp. Mt Ella (M.E. Trudgen 12739)	3	low	Suitable habitat, just out of range
Triodia sp. Silvergrass (P.-L. de Kock BES 00808)	1	none	Out of range
Triodia veniciae	1	none	Out of range
Vittadinia sp. Coondewanna Flats (S. van Leeuwen 4684)	3	none	Unsuitable habitat
Xerochrysum boreale	3	none	Unsuitable habitat