

## **Appendix M - Vegetation Survey Report**



# Vegetation survey report for Rustlers Roost & Quest 29

Primary Gold



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### APPENDIX A LAND UNIT SURVEY SITES AND RESULTS

# 1 INTRODUCTION

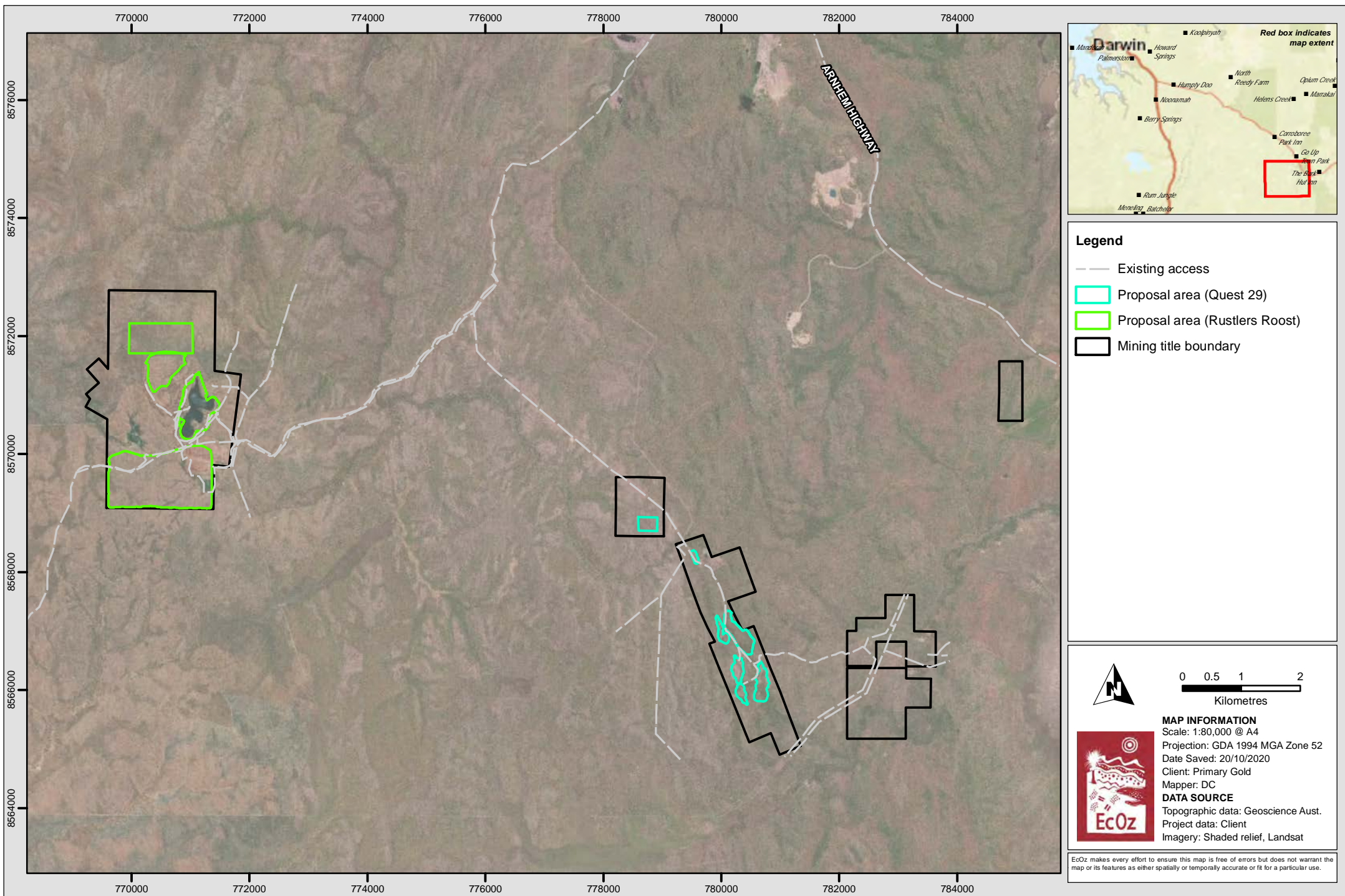
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The Rustlers Roost and Quest 29 (here-in referred to as the *proposal area*) is a brownfields site with a history of gold mining activity on mineral leases located in the Mount Bunday locality, approximately 100 km south-east of Darwin (Figure 1-1). Primary Gold Limited is proposing to redevelop the proposal area, expanding open-cut gold mining operations. The action is being referred to the NT EPA for consideration under section 48 of the *Environmental Protection Act*.

Flora and fauna values in the broader mining leases have previously been assessed and surveyed by Low Ecological in 2016 and 2017. The Flora and Fauna Division at the Department of Environment and Natural Resources (DENR) advised that this survey effort for fauna was adequate, but that further flora surveys were required. EcOz were engaged to undertake vegetation surveys to address the outstanding information gaps for the proposal area. The purpose of these surveys is to:

- Verify available land unit mapping within the proposal area.
- Document riparian habitat value and current condition within, and adjacent to, the proposal area.
- Survey for the Endangered sub-shrub *Helicteres macrothrix* where there is suitable habitat within the proposal area.
- Assess habitat suitability for the Endangered trigger plant *Stylidium ensatum*.

This report presents the methodology and results of the above surveys which were conducted in September and October 2020. *Stylidium ensatum* detection surveys can only be conducted in June and July when flowering and fruiting occurs, therefore only a habitat suitability assessment was possible at this time.



**Figure 1. Map of project location and proposal area**

## 2 VEGETATION SURVEYS

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### 2.1 Land unit mapping

#### 2.1.1 Methods

This survey focused on land units. A land unit is a reasonably homogenous part of a land surface, distinct from surrounding terrain with consistent properties in landform, soil and vegetation (Jessop & King 1997).

Existing land unit mapping of the region is outlined in the *Report of the land units of the Western Section of Annaburroo Station, Northern Territory* (Fett & Hall 1983) at a scale of 1:25,000. The report mapped five land units as occurring within the proposal area.

The aim of this survey was to verify that the existing land units assigned to the proposal area were correct in areas that have not been previously surveyed by Low Ecology (LES 2017). The proposal area was visited between 28 September – 1 October by botanist Nicole Clark and ecologist Clare Millen to ground-truth the existing land units.

In preparation for the field visit, proposed vegetation assessment sites (VS) and photo sites (PS) were plotted on a geo-rectified map, using a combination of land unit mapping and aerial imagery. Sites were placed in the centre of each land unit, and/or where aerial imagery showed a potential change in land units (Figure 2, Figure 3). The following information was collected for each site:

- Landform – indicating topography of the land, aspect and slope (%)
- Soil and landform types based on surface characteristics (i.e. presence of surface gravel/rock outcrops or inundation areas) and digital photos of surface soils.
- Drainage potential (rapid, well or poor).
- Broad vegetation description for characterisation to a standard equivalent to Level V of the National Vegetation Information System, in line with the NT Guidelines and Field Methodology (Brocklehurst et al. 2007). Within each stratum (upper, mid and ground), the three dominant species were recorded and general structure was noted.
- Disturbance – presence of weeds, fire history and signs of feral animals.

#### 2.1.2 Results

Five land units were recorded in the proposal area; these are summarised in Table 1, and displayed in Figure 2 and Figure 3. Vegetation and soils were generally consistent with existing land unit descriptions, with only some minor corrections made. It is noted that 25% of the proposal area has been disturbed due to mining activities. This has been demarcated in the corrected land unit mapping. See Appendix A for a detailed description of each land unit.

##### ***Land unit 2b – occurring in Rustlers Roost only***

This was the overall dominant land unit accounting for 60% of the total proposal area, but only occurred within Rustlers Roost (Figure 2). The landform was rises and ridges with some deep gullies (ranging between 4 – 6 m) and slopes between 6 – 15 %, with extensive surface stone outcrops. The vegetation in the upper strata comprised of *Corymbia polysciada*, *Eucalyptus miniata*, *Corymbia dichromophloia* and occasional *Eucalyptus tintinnans* low to mid high open woodland; lower woodland occurred on the slopes. It was not uncommon for *Erythrophleum chlorostachys* to grow as tall as the upper strata species. The mid strata comprised of *Erythrophleum chlorostachys*, *Corymbia dichromophloia* and *Gardenia megasperma* mid-high open shrubland to shrubland. Other common shrubs recorded at photo point assessment sites

included *Livistona humilis*, *Grevillea decurrens*, *Buchanania obovata* and *Acacia* sp. The understorey (ground cover) was dominated by patchy grasses, although these were poorly represented at the time of survey due to the dry conditions. The most commonly encountered species in the ground cover were *Eriachne* sp., *Heteropogon triticeus* and *Triodia bitextura* low to mid high open tussock grassland.

Soils were brown sandy loam with high surface gravels (small pebbles) on the lateritic upland plateaux and yellow/brown sandy clay loam on the hills/ridges with greater amount of siltstones and sandstones.

There was one slight variation in landform, and thus vegetation/soil composition, within land unit 2b – the presence of upland plateaux with more lateritic surface gravels (often smaller pebbles than those recorded throughout remaining of land unit 2b). Vegetation comprised of *Eucalyptus tetradonta* and minor *Eucalyptus miniata*, with a mid-stratum of Eucalyptus saplings, *Erythrophleum chlorostachys*, *Livistona humilis* open shrubland, over a ground cover of *Petalostigma quadriloculare* and mixed grasses. The trees were taller (to ~14m) in these areas. An additional vegetation assessment site was undertaken to capture this variation.

There was one minor open depression/drainage system within Rustlers Roost north. The vegetation comprised of tussock grassland dominated by *Eriachne* sp., *Themeda triandra* with isolated trees which were mostly wet-indicator species; *Corymbia polycarpa*, *Xanthostemon paradoxus*, *Syzygium eucalyptoides*, and *Eucalyptus bigalerita*.

Land unit 2b was the main land unit occurring within Rustlers Roost – in the southern portion species composition and surface soils were similar to the northern section; however, the landform was more undulating, with more minor open depressions and less gullies present.

#### ***Land unit 2a – occurring in Quest 29 only***

Land unit 2a was found to be largely consistent with existing land unit mapping; however, the existing land unit area was corrected to capture a drainage system which is an extension of land unit 6a (Figure 3). The landform was hills and ridges with some steep slopes. The vegetation in the upper strata was comprised of *Eucalyptus miniata*, *Corymbia polysciada*, *Corymbia dichromophloia* and occasional *Corymbia clavigera* low to mid high open woodland, with an *Erythrophleum chlorostachys* and *Corymbia dichromophloia* open shrubland, over *Eriachne* sp. and *Triodia bitextura* tussock grassland. The weed *Hyptis suaveolens* was a common ground cover within Quest 29. This land unit had skeletal soils made up of greyish/brown sandy clay loam.

#### ***Land unit 3a – occurring in Quest 29 only***

Land unit 3a was generally consistent with existing land units in terms of landform – low rounded hills with some upland surfaces and erosion potential; however, the species present were slightly different – *Eucalyptus miniata* was one of the dominant species recorded during field investigations, a species which is not recorded within the existing land unit vegetation description. The vegetation in the upper strata comprised of *Eucalyptus miniata*, *Corymbia* sp., *Corymbia clavigera* mid-high woodland with an *Erythrophleum chlorostachys*, *Acacia auriculiformis* and *Calytrix exstipulata* shrubland, over dense leaf litter and sparse tussock grassland. Soils were shallow brown sandy loam with scattered surface gravel.

#### ***Land unit 6a – occurring in Quest 29 only***

Some key characteristics (landform, soil and vegetation) within the existing land unit 6a (located south of Quest 29) remains intact, but field investigations found a portion was disturbed. The landform was defined as a creek channel ranging in width and depths forming large pools in places. Vegetation comprised of riparian and monsoon vine species, with an upper stratum of *Corymbia bella* and *Corymbia polycarpa*, *Ficus racemosa* and occasional *Melaleuca leucadendra*, *Alstonia actinophylla*, *Barringtonia acutangula* and Banyan trees mid high woodland to open forest, over *Erythrophleum chlorostachys*, *Terminalia* sp., and *Acacia auriculiformis* open shrubland and occasional *Planchonia careya* over *Aristida* sp, and *Hyptis suaveolens* mid high open tussock grassland. Soils were yellowish/brown sandy clay.

### ***Land unit 6a1 – occurring in both Rustlers Roost and Quest 29***

Land unit 6a1 occurred in the south of Rustlers Roost, and in a minor section in Quest 29 north (Figure 2 and Figure 3) and was consistent with the existing land unit description – i.e. associated with minor creek lines and broad drainage systems. The vegetation in the upper strata comprised of mixed *Corymbia* species; *Corymbia bella*, *Corymbia polycarpa* and *Corymbia grandiflora* mid high (10 to 15 m tall) and occasional *Eucalypt bigalerita* woodland over shrubland of mixed species over *Eriachne sp* and *Mnesithea sp.* sparse tussock grassland. Soils varied between the sites. At Rustlers Roost there was reddish/brown sandy clay within creek bed, with more skeletal soils on the upper bank. At Quest 29, soils were yellow/brown sandy clay with less surface gravel present.

### ***Disturbed areas***

Several areas within the proposal area at both Rustlers Roost and Quest 29 had been previously cleared and were highly modified and/or disturbed, and so were classed as 'disturbance areas' rather than as a land unit (see Figure 2 and Figure 3). These areas contained establishing native flora species such as Acacias and Eucalypts; weeds were commonly recorded within these areas.

### **2.1.3 Weeds and other disturbance**

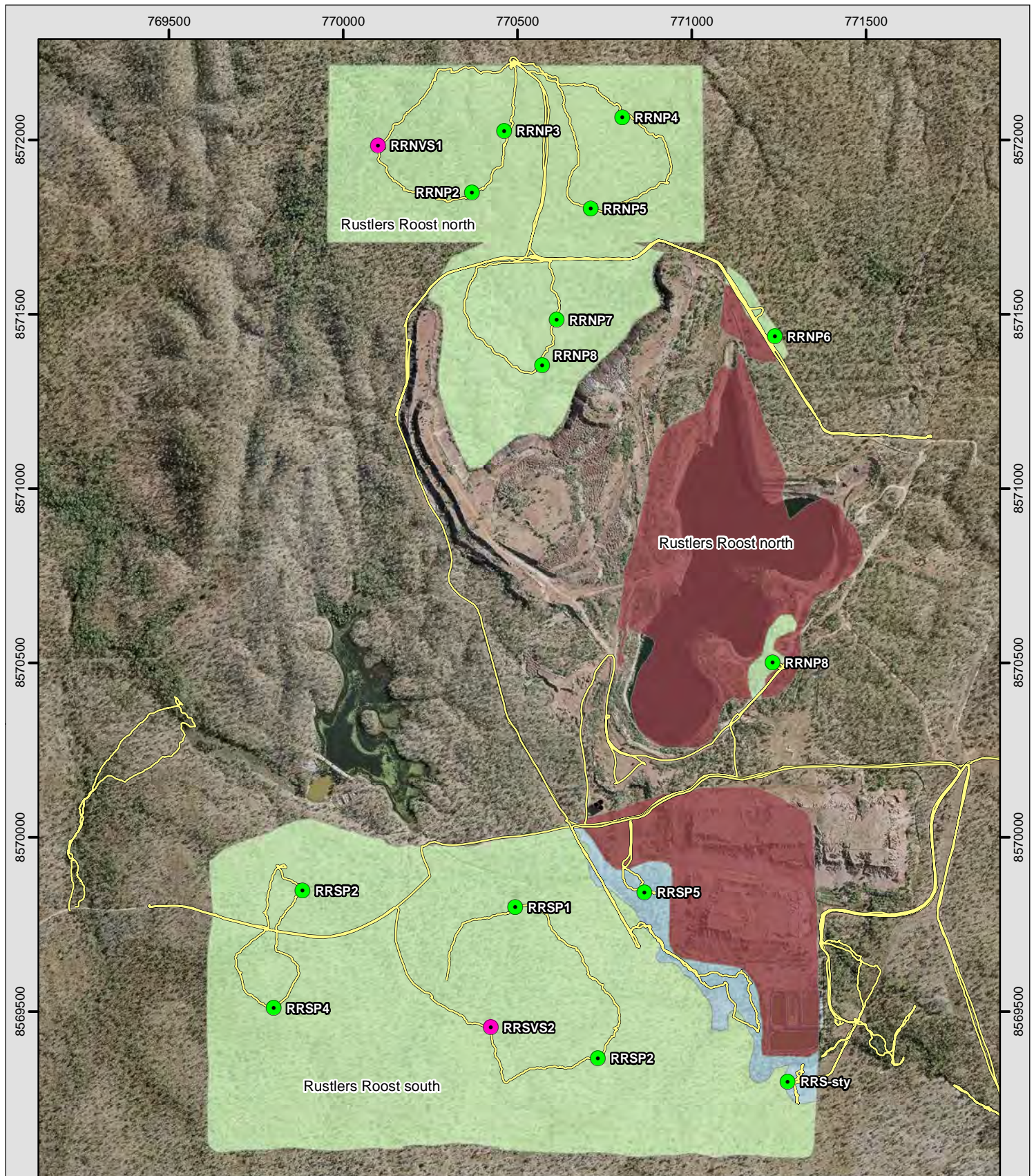
Invasive weed species incidentally observed within proposal area were recorded, with the majority established in disturbed areas, and occasionally occurring in native bushland. The declared weed species, Hyptis (*Hyptis suaveolens*) was the most abundant within the proposal area; it was recorded in high densities in Quest 29 south. Scattered Perennial Mission Grass (*Cenchrus polystachios*) and Gamba Grass (*Andropogon gayanus*) were also observed, mostly within Quest 29 south and along roadsides. Other weed species included *Sida sp.* Detailed weed data are presented in Appendix A.

Gamba Grass and Perennial Mission Grass are listed as Class B weeds under the NT *Weeds Management Act*, with Gamba Grass also listed as a Weed of National Significance (WoNS).

Pigs and cattle were commonly observed in the proposal areas, mainly located around drainage channels and remaining pools at Quest 29.

Table 1. Land units within the proposal area

Land unit	Survey sites	Landform	Soil	Vegetation	Area (ha)
2b	RRNVS1, RRSVS2, RRNP2, RRNP3, RRNP4, RRNP5, RRNP6, RRNP7, RRNP8, RRNP8, RRSP1, RRSP2, RRSP2, RRSP4, RRSP5	Rises and ridges; some upland plateaus; Well drained (nil to low level waterlogging); slope 6 to 15 %	Kandosol; mix of lateritic soils; brown sandy loam with high surface gravels (small pebbles) and siltstones and sandstones (larger in size); yellow/brown sandy clay loam	<b>Rises and ridges:</b> <i>Corymbia polysciada</i> , <i>Eucalyptus miniata</i> , <i>Corymbia dichromophloia</i> (V1) and occasional <i>Eucalyptus tintinnans</i> low to mid high open woodland, over <i>Erythrophleum chlorostachys</i> , <i>Corymbia dichromophloia</i> and <i>Gardenia megasperma</i> mid high open shrubland to shrubland, over <i>Eriachne</i> sp., <i>Heteropogon triticeus</i> and <i>Triodia bitextura</i> low to mid high open tussock grassland. <b>Upland plateau:</b> <i>Eucalyptus tetradonta/miniata</i> woodland over Eucalypt saplings, <i>Erythrophleum chlorostachys</i> , <i>Livistona humilis</i> open shrubland and a ground cover of <i>Petalostigma quadriloculare</i> , and mixed grasses.	214.5
2a	Q29SVS5, Q29NP3, Q29SP1, Q29SP2, Q29SP3, Q29SP4, Q29SP5, Q29SP6, Q29SP7	Hills and ridges with some steep slopes; very well drained; slope >10%	Rudosol; Skeletal soils; greyish/brown sandy clay loam.	<i>Eucalyptus miniata</i> , <i>Corymbia polysciada</i> , <i>Corymbia dichromophloia</i> and <i>Corymbia clavigera</i> low to mid high open woodland, over <i>Erythrophleum chlorostachys</i> , <i>Corymbia dichromophloia</i> open shrubland, over <i>Eriachne</i> sp., and <i>Triodia bitextura</i> tussock grassland.	18.3
3a	Q29NVS3, Q29NP1, Q29NP2	Low rounded hills; some upland surfaces; well drained (nil to low level waterlogging); slope 3 to 4 %.	Kandosol; Brown sandy loam, shallow soils; scattered surface gravel present	<i>Eucalyptus miniata</i> , <i>Corymbia</i> sp., <i>Corymbia clavigera</i> mid high woodland over <i>Erythrophleum chlorostachys</i> , <i>Acacia auriculiformis</i> , <i>Calytrix exstipulata</i> shrubland, over leaf litter and <i>Eriachne</i> sp. sparse tussock grassland	13.9
6a	Q29SVS6, Q29SP, Q29SP8	Creek channel ranging in width and depths forming large pools; poorly drained (wet season waterlogging); slope 1 to 4 %.	Hydrosol; Yellowish/brown sandy clay	<i>Corymbia bella</i> , <i>Corymbia polycarpa</i> , <i>Ficus racemosa</i> and occasional <i>Melaleuca leucadendra</i> , <i>Alstonia actinophylla</i> , <i>Barringtonia acutangula</i> and Banyan trees mid high woodland to open forest, over <i>Erythrophleum chlorostachys</i> , <i>Terminalia</i> sp., and <i>Acacia auriculiformis</i> and occasional <i>Planchonia careya</i> open shrubland, over <i>Aristida</i> sp., and <i>Hyptis</i> mid high open tussock grassland.	9.9
6a1	Q29NVS4, RRS-sty	Minor creek lines and broad drainage systems; poorly drained (wet season waterlogging); slope 1 to 6 %	Hydrosol; Soils vary between sites; reddish/brown sandy clay within creek bed at Rustlers Roost, and more skeletal on the upper bank and yellow/brown sandy clay at Quest 29 with less surface gravel	Mixed <i>Corymbia</i> species; <i>Corymbia bella</i> , <i>Corymbia polycarpa</i> and <i>Corymbia grandiflora</i> mid high (10 -15 m tall) and occasional <i>Eucalypt bigalerita</i> and <i>Eucalyptus tectifera</i> woodland over shrubland of mixed species over <i>Eriachne</i> sp. and <i>Mnesithea</i> sp. sparse tussock grassland.	9.1



**Project data**

**Survey assessment**

- Photo site (PS)
- Vegetation site (VS)
- Field tracks
- 2b - Rises and some upland plateau; Kandosol soils
- 6a1 - Drainage systems and channels; Hydrosol soils
- Disturbed - Mining activities/native vegetation clearing



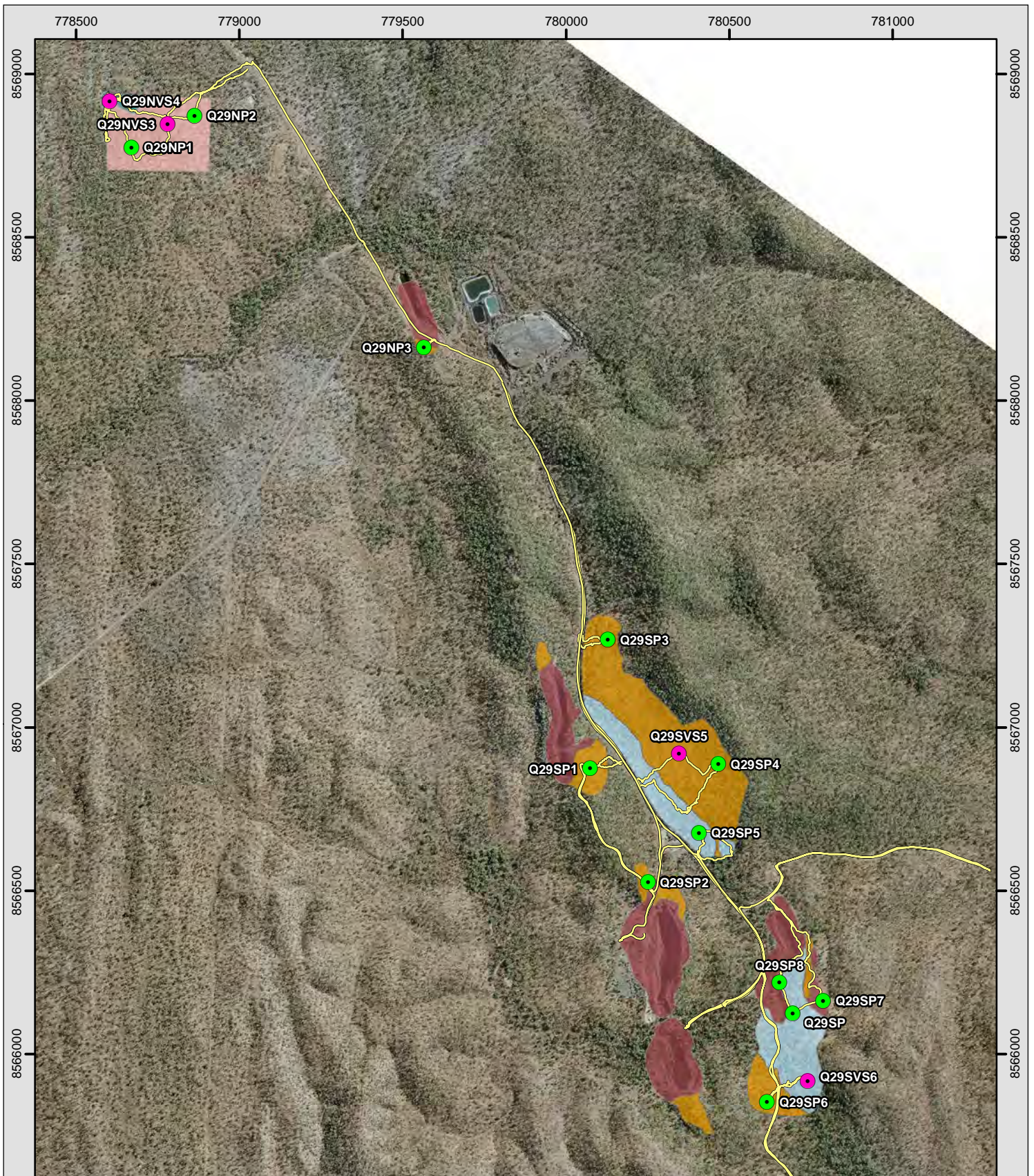
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Metres



**MAP INFORMATION**  
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 Date Saved: 20/10/2020  
 Client: Primary Gold  
 Mapper: NC

**DATA SOURCE**  
 Topographic data: Geoscience Aust.  
 Project data: Client, EcOz  
 Imagery: Client

**Figure 2. Map of corrected land unit within Rustlers Roost proposal area**



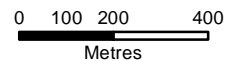
**Project data**

**Survey assessment**

- Photo site (PS)
- Vegetation site (VS)
- Field tracks

**Corrected land units**

- 2a - Hills and ridges; Rudosol soils
- 3a - Low rounded hills; Kandosol soils
- 6a - Creek channels and levees; Hydrosol soils
- 6a1 - Drainage systems and channels; Hydrosol soils
- Disturbed - Mining activities/native vegetation clearing



**MAP INFORMATION**

Scale: 1:16,000 @ A4  
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 Client: Primary Gold  
 Mapper: NC

**DATA SOURCE**  
 Topographic data: Geoscience Aust.  
 Project data: Client  
 Imagery: Shaded relief, Landsat

**Figure 3. Map of corrected land units within Quest 29 proposal area**

## 2.2 Riparian habitat assessment

Riparian vegetation is defined as native vegetation surrounding a waterway and plays a critical role in protecting wetland systems, providing habitat, shade and food resources for native fauna, maintaining nutrient levels in waterways, and providing bank stabilisation (DENR 2020). The aim of the riparian habitat assessment was to collect baseline information about community structure, and assess the riparian habitat value and current condition of riparian areas both upstream and downstream of the proposal area.

### 2.2.1 Methods

Riparian surveys were undertaken on 31 October 2020. In preparation, potential riparian areas were plotted on a geo-rectified map, using a combination of aerial imagery and surface water drainage mapping. Riparian areas within the proposal areas had been surveyed as part of the land unit mapping surveys and these results are also discussed below.

### 2.2.2 Results

#### *Rustlers Roost*

Four riparian areas within and adjacent to Rustlers Roost were visited – two to the west of the Rustlers Roost proposal area, one to the east, and one within the proposal area on the eastern edge (Figure 9). The proposal area at Rustlers Roost south sits at the top of two catchments; the riparian survey sites were located to capture both catchments. All were downstream of the proposal area; due to its position in the catchments, there is no upstream riparian habitat at Rustlers Roost.

#### Eastern side

Generally, the riparian vegetation in the eastern riparian areas was comprised of mixed Eucalypts (*Corymbia polycarpa*, *Eucalyptus bigalerita*, *Eucalyptus tectifica*) and occasional *Melaleuca viridiflora*) mid-high woodland in the upper strata, over *Alphitonia excelsa*, *Erythrophleum chlorostachys*, *Terminalia* sp., *Acacia auriculiformis*, *Xanthostemon paradoxus* shrubland. Ground cover was relatively sparse in the creek bed with some *Pandanus spiralis* and mixed tussock grasses including *Themeda triandra*, *Aristida* sp. and *Sorghum* sp. occurring on the upper banks (Figure 4).



**Figure 4. Photographs of riparian vegetation on the eastern side of Rustlers Roost south**

There was one open forest patch recorded at site *RP8-DS* (Figure 9). In this patch, the species composition was similar to other downstream sites, with additional monsoon species; *Maranthes corymbosa* and some large Milkwood trees were recorded.

The main channel ranged between 2 – 10 m, with a few small pools, and the flow path was draining to the east. Much of the riparian area was disturbed due to mining activities adjacent to the main channel. Weeds were common along the banks (*Hyptis suaveolens* and *Sida* sp.). Some clearing of vegetation near tracks and stockpiling of fill material from mining activities was observed. Pigs and cattle were common through this area and observed on numerous occasions during field investigations.



**Figure 5. Photographs of open forest patch at Rustlers Roost (site *RP8-DS*)**

#### Western side

The riparian vegetation on the western side was more intact and the survey sites were free of weeds. The vegetation at site *RP7-US* was fringed by *Corymbia polycarpa* (8 – 10 m tall) open woodland in the upper strata, over *Melaleuca* sp and *Pandanus spiralis* woodland to open forest (6 – 8 m) tall, over *Themeda triandra* on the upper banks.

The vegetation recorded at site *RP6-US* was most representative of undisturbed riparian vegetation and was classified as a closed forest patch (Figure 6). The vegetation comprised of *Corymbia polycarpa* and *Erythrophleum chlorostachys* mid-high closed forest (18 – 20 m tall trees) over *Terminalia* sp, *Lophostemon lactifluus*, and *Alstonia actinophylla* shrubland.

The vegetation was edging a meandering 4 m wide channel, 1 m deep. Water was clear, trickling to the north-west. Ferns and Native Olive Hymenachne (*Hymenachne acutigluma*) were present in the water. There was evidence of groundwater seepage adjacent to the stream (Figure 7).



**Figure 6. Photographs of riparian vegetation along channel at *site RP6-US***



**Figure 7. Photographs of groundwater seepage at site RP6-US**

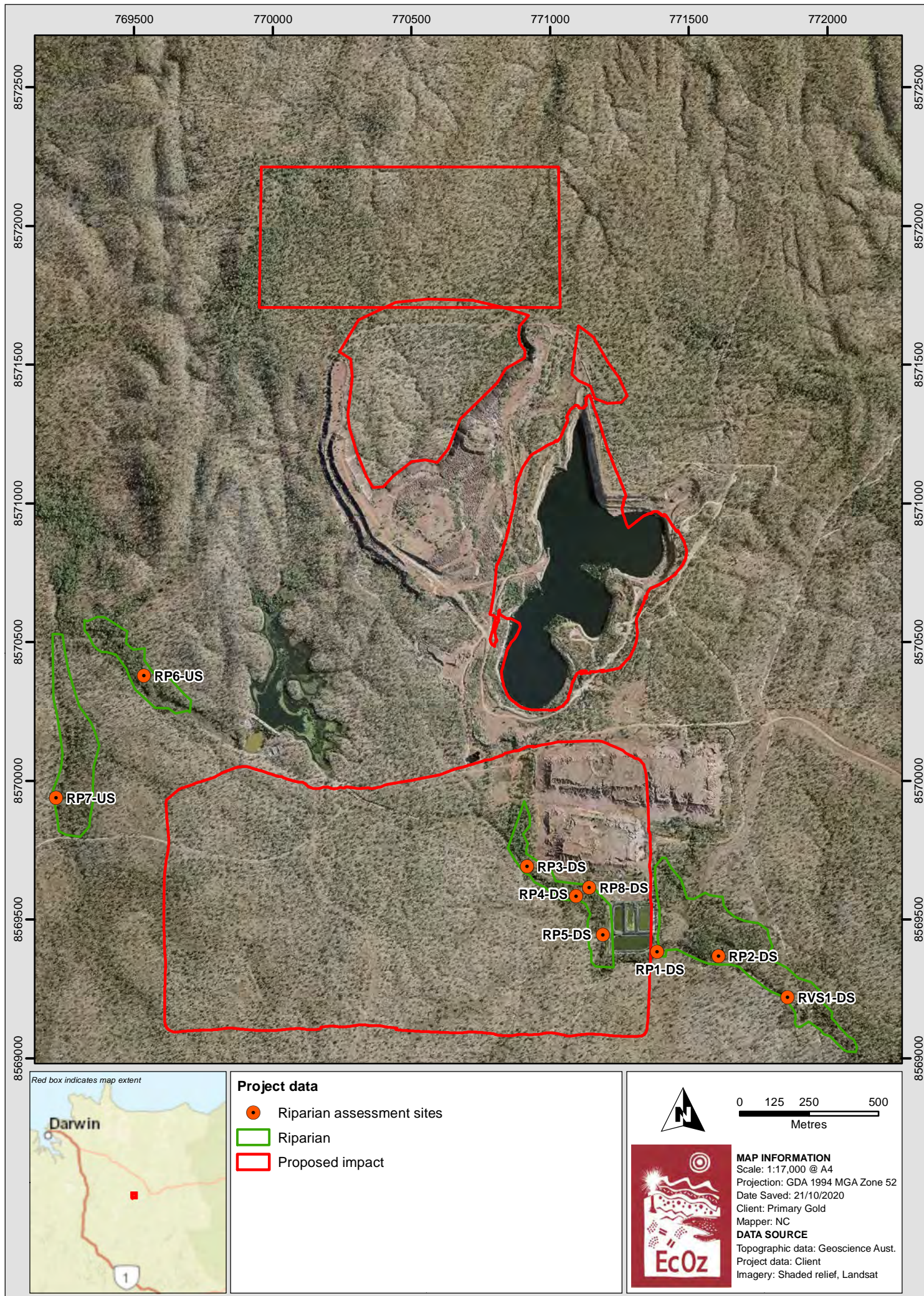
### ***Quest 29***

Like Rustlers Roost, because of its position in the catchment there is no riparian habitat upstream of Quest 29. Riparian areas within Quest 29 were surveyed as part of the land unit mapping surveys (Figure 3) and were attributed to land unit 6a.

Much of the riparian vegetation within Quest 29 proposal area had been disturbed, with original native vegetation already cleared and large stockpiles of fill material present adjacent to the riparian zones (Figure 8). The riparian vegetation at Quest 29 was patches of open forest to closed forest along the channel associated with land unit 6a (refer Figure 3). See Appendix A for vegetation/soil descriptions.



**Figure 8. Photographs of riparian habitat at sites Q29SP5 (right) and Q29SVS6 (left)**



**Project data**

- Riparian assessment sites
- Riparian
- Proposed impact

0 125 250 500

Metres

**MAP INFORMATION**  
 Scale: 1:17,000 @ A4  
 Projection: GDA 1994 MGA Zone 52  
 Date Saved: 21/10/2020  
 Client: Primary Gold  
 Mapper: NC

**DATA SOURCE**  
 Topographic data: Geoscience Aust.  
 Project data: Client  
 Imagery: Shaded relief, Landsat

**Figure 9. Map of riparian survey areas within and adjacent to Rustlers Roost**

## 2.3 *Helicteres macrothrix* survey

This section presents the methodology and results of a targeted survey for *H. macrothrix* conducted in September and October 2020 as part of the ecological assessment for the proposal area.

### 2.3.1 Status and ecology

*Helicteres macrothrix* is a multi-stemmed subshrub, one of approximately 13 species of the genus *Helicteres* from the Northern Territory (Cowie 2011). *H. macrothrix* is endemic to the Northern Territory and is listed as Endangered under both the *Territory Parks and Wildlife Conservation Act* and the *Commonwealth Environment Protection and Biodiversity Conservation Act*.

The species grows to 50 cm tall with ascending to erect branches, pink to purple flowers, and fruits, leaves and branches that are green and woolly-hairy. The aerial parts of the plant are annual, with perennial root stock. The plant is known to re-sprout from root stock, often vigorously, after fire. The species has been recorded from three populations – near Mt Bundey, near Batchelor and in the Lake Bennett area. The known extent of occurrence for this species is 915 km<sup>2</sup>. *H. macrothrix* flowers from November to March and fruits from January to March (DENR 2012).

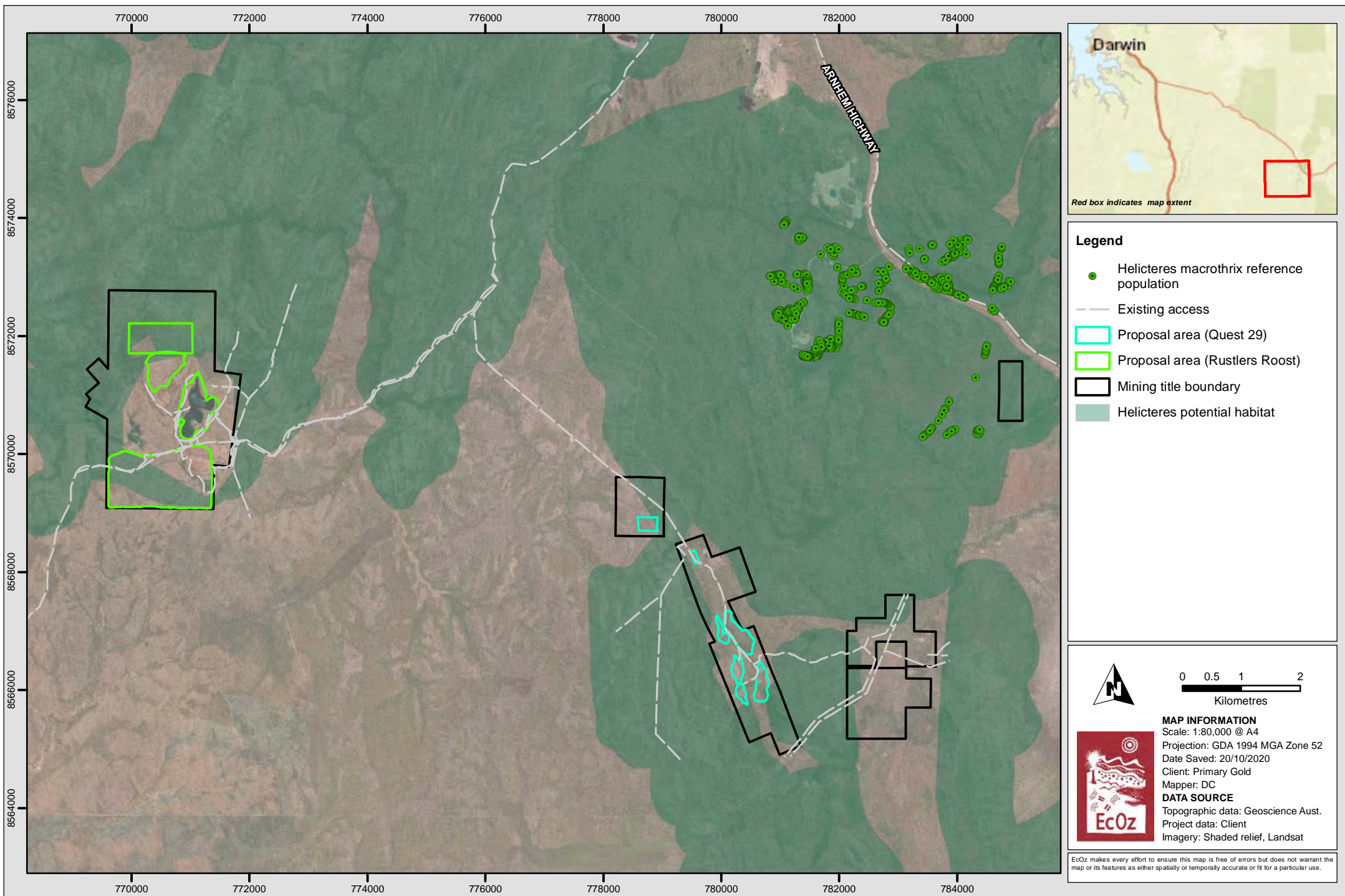
This species is associated with *Eucalyptus tectifica*, *E. miniata* and/or *E. tetradonta* woodland on clayey soils derived from siltstone or sandier soils derived from the granite-like rock syenite.



Figure 10. Photographs of *Helicteres macrothrix* leaves and flowers. Images I. D. Cowie

### 2.3.2 Known extent of occurrence

The NT Government has mapped the extent of occurrence of *H. macrothrix* based on known recorded locations (DLRM 2016a). Potential habitat for the species has been modelled from historical land resource information that includes existing land unit, vegetation and geological mapping. This model serves as a guide to identify areas where the species may be present (DLRM 2016a). While the species has not previously been recorded from the Rustlers Roost or Quest 29 mining lease area, the model identified approximately 133 ha of potential *H. macrothrix* habitat within the proposed area at both the Rustlers Roost and Quest 29 sites (Figure 11).



Path: Z:\01 EcOz\_Documents\04 EcOz Vantage GIS\EZ20181 - Rustlers Roost and Quest29 Ecology Report\01 Project Files\Figure 1-1, Project location and proposal area map.mxd

**Figure 11. Map of *Helicteres macrothrix* modelled habitat and reference population at Mt Bunday**

### 2.3.3 Methods

The field surveys were led by ecologists Clare Millen and Nicole Clark, who have extensive experience in undertaking vegetation surveys in the Top End, including surveys for and identification of threatened flora. They were assisted by Cameron Jones.

#### ***Pre-survey preparation***

Advice was sought from DENR regarding best practice field methods to detect *Helicteres macrothrix*. Prior to the field survey, surveyors visited the NT Herbarium to inspect the diagnostic features of the plant in the available reference material, to assist with identification in the field. Other species within the genus including *H. darwinensis*, *H. cana* and *H. angustifolia* can be similar in appearance; these species were also examined at the NT Herbarium for comparison.

A reference site at McKinlay Quarry in Mt Bunday – approximately 5 km north-east of Quest 29 and 12 km east of Rustlers Roost – with a known *H. macrothrix* population was visited at the time of the field surveys to confirm the presence, habitat, phenological state and detectability of the species in the general area.

Although the above ground parts of the plants at the reference site were senesced and the leaves were in poor condition, they were readily detectable in unburnt habitat by meandering through the area.

In burnt areas at the reference site, where a late season burn had been recorded in August 2020 (NAFI 2020) the plant was not detected. Although the plant has been observed to re-sprout vigorously after a fire, the intensity of a late season burn – and the particularly dry conditions at the time of survey – may have delayed re-sprouting.

The field methodology assumes that any *H. macrothrix* plants in unburnt habitat within the proposal area would be in a comparable phenological state and have similar detectability to plants observed at the reference site.

#### ***Field survey***

The *H. macrothrix* field surveys were undertaken over four days between 15 and 17 September, and on 1 October 2020. As advised by DENR, areas of modelled potential habitat within the proposed area were searched on foot by multiple observers following transects spaced 25 m apart which were pre-loaded onto hand held GPS units. Transects were placed perpendicular to the general direction of contours to ensure good coverage of topography, maximising the chance of detecting sub-populations.

In the two small survey areas in the southern portion of Quest 29, a meander technique was utilised due to the very small size of these areas, and the steep topography in places being unsuitable for transects.

GPS track log data was saved to record the survey range and effort. The differing habitat types encountered through the project area were recorded and photographed.

It is noted that the polygons constituting the proposed area were slightly modified after surveying had begun. This meant that in the northern portion of Quest 29, an area exceeding the final proposed area was surveyed because it followed the polygons provided at the time of surveying (Figure 13). In the southern portion of Rustlers Roost, an area approximately 4 ha smaller than the final proposed impact area was surveyed (Figure 14); however, vegetation surveys confirmed that the habitat types in that portion remained consistent, and transect length coverage within the polygon still satisfied the minimum coverage of km/ha recommended by DENR. All other potential *H. macrothrix* habitat within the final proposed area was surveyed via transects spaced 25 m apart.

## 2.3.4 Results and discussion

Rustlers Roost and Quest 29 were both observed to contain large areas of potentially-suitable open woodland habitat, with dominant upper strata species often being the three species associated with *H. macrothrix* – commonly *Eucalyptus miniata* and *E. tetradonta*, and less commonly, patches of *E. tectifica* – on slopes and rises over soils ranging from sandy loam to silty clay. This was interspersed with patches of less suitable habitat; *E. tintinnans* and *Corymbia*-dominated open woodland on hills and rises, and *Sorghum* grasslands with scattered *E. polycarpa* in alluvial clay depressions. The southern portion of Quest 29 was highly disturbed, with the ground strata often dominated by the declared weed *Hyptis suaveolens*; this area did not appear to contain suitable habitat for *H. macrothrix*. Appendix A provides further detail on the different habitat types recorded within the survey areas.

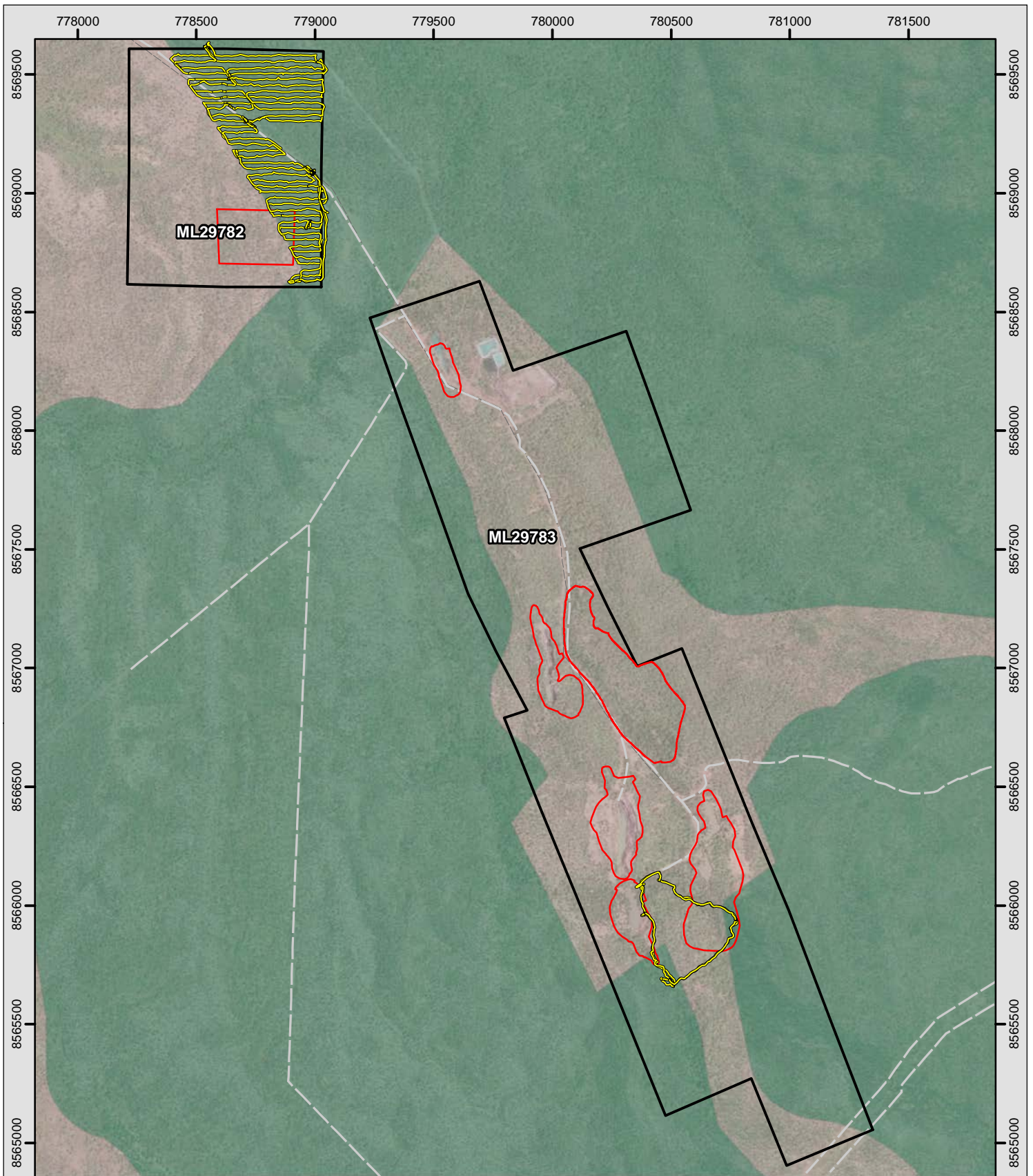
The vegetation cover at the time of surveying meant that visibility was generally good across all survey areas (Figure 12). In total, approximately 87 km were walked across approximately 168 ha of potential habitat (Figure 13, Figure 14). *H. macrothrix* was not detected during these surveys.

The similar looking *H. darwinensis* was commonly detected in the northern portion of Rustlers Roost. A specimen taken to the NT Herbarium was confirmed to be *H. darwinensis*. This species is more prostrate, smaller and less conspicuous than *H. macrothrix*. The fact that *H. darwinensis* was readily detectable via 25 m transects indicates that the survey method would likely have detected *H. macrothrix* if present, if in a similar distribution pattern and phenological state to the plants at the reference site.

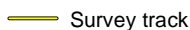
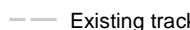



Burnt grass stumps were observed in some parts of the northern portion of Quest 29, indicating that a burn had occurred sometime in the 2020 dry season. If this was a late season burn, it may have decreased detectability of *H. macrothrix* in burnt areas, as it had at the reference site; however, the habitat types were consistent throughout this survey area and *H. macrothrix* was not detected in the larger unburnt areas. With the updated proposed area, the northern portion of Quest 29 incorporated less than 1 ha of potential *H. macrothrix* habitat.



Figure 12. Photographs of typical open woodland habitat at Quest 29 (top) and Rustlers Roost (bottom)



**Legend**

-  Survey track
-  Existing track
-  Proposal area
-  *Helicteres macrothrix* modelled potential habitat
-  Mining title

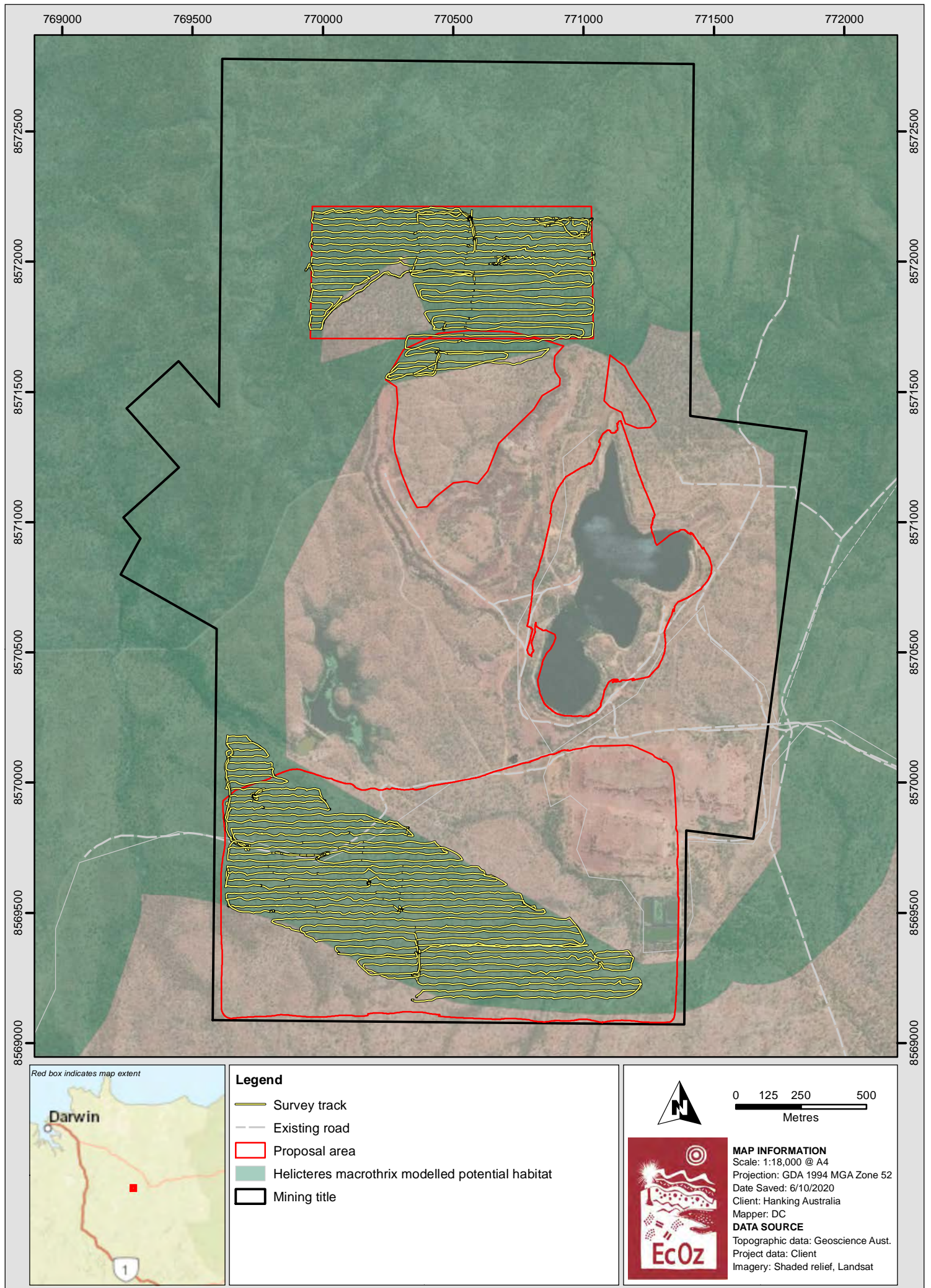


0 125 250 500  
Metres



**MAP INFORMATION**  
 Scale: 1:22,000 @ A4  
 Projection: GDA 1994 MGA Zone 52  
 Date Saved: 6/10/2020  
 Client: Hanking Australia  
 Mapper: DC  
**DATA SOURCE**  
 Topographic data: Geoscience Aust.  
 Project data: Client  
 Imagery: Shaded relief, Landsat

**Figure 13. Map of *Helicteres macrothrix* survey tracks at Quest 29**



Path: Z:\01 EcOz\_Documents\04 EcOz Vantage GIS\IEZ20181 - Rustlers Roost and Quest29 Ecology Report\01 Project Files\Figure 2-2. Rustlers Roost - Helicteres macrothrix habitat and survey tracks.mxd

**Figure 14. Map of *Helicteres macrothrix* survey tracks at Rustlers Roost**

## 2.4 *Stylidium ensatum* habitat assessment

### 2.4.1 Status and ecology

The trigger plant, *Stylidium ensatum*, is endemic to the NT and is listed as Endangered under both the *Territory Parks and Wildlife Conservation Act* and the Commonwealth *Environment Protection and Biodiversity Conservation Act*.

The species grows to 22 cm tall, has sessile obovate or orbicular leaves attached to a short stem, and small pink flower with lobed petals, as shown in Figure 15. *S. ensatum* is a member of the *Stylidium* subgenus *Andersonia*, species known from South-east Asia and northern Australia (Bean 2000), where the climate is monsoonal and rainfall is strongly seasonal. As is typical of other species of *Stylidium*, *S. ensatum* is likely to germinate where water has recently receded in seepage areas and seasonally-inundated sites. Plants grow in the early dry season, and are best able to be detected between June and July when flowering and fruiting occurs (Donna Lewis, NT Herbarium, pers. comm. 2020).

*Stylidium ensatum* inhabits margins of drainage areas in damp heavy clay or peaty soil (Cowie & Westaway 2012), although it may prefer sandier or loamy soils (Ian Cowie, NT Herbarium, pers. comm. 2017). Suitable areas for *S. ensatum* tend to be adjacent to Lophostemon swamps, where surface moisture is maintained into the early to mid-dry season (Nick Cuff, NT Herbarium, pers. comm., 2017). The preferred habitat for *S. ensatum* generally supports *Melaleuca viridiflora*, *Eucalyptus alba* and *Lophostemon lactifluus*, but also perennial grasses such as *Eriachne burkittii*, *Pandanus spiralis*, *Osbeckia australiana* and scattered *Banksia dentata* (Donna Lewis, NT Herbarium, pers. comm. 2020).

### 2.4.2 Known extent of occurrence

The NT Government has mapped the extent of occurrence of *Stylidium ensatum* based on known recorded locations close to Darwin and a site at Hayes Creek (NTG 2016). Potential habitat for the species has been modelled from historical land resources that includes existing land unit and vegetation mapping, and defines areas of low and moderate-high likelihood habitat. The model serves as a guide to identify areas where the species may be present (NT Government 2016). While the species has not previously been recorded from the Mount Bunday region, habitat modelling indicates the potential for habitat in portions of the investigation area (Figure 18).



**Figure 15. Photographs of *Stylidium ensatum* leaves and flower; plants from the Girraween Road location**

### 2.4.3 Methods

The habitat model identified three areas totalling approximately 3 ha of potential *S. ensatum* habitat within the proposal area (Figure 18). A habitat survey was planned within each area to assess suitability. Species detection surveys could not be undertaken at this time as the plant is only detectable when it is flowering and fruiting in June and July (Donna Lewis, NT Herbarium, pers. comm. 2020).

The following habitat features are preferred by *S. ensatum* and were used to assess habitat suitability:

- Margins of drainage systems; areas that are poorly drained with seasonal inundation or waterlogging and have hydrosols soils – i.e. they are saturated with water for extended periods, are generally a greyish colour and have a high organic content.
- Shallow inundation or saturated soils in the mid dry season.
- Overstorey consisting of *Melaleuca* spp. and/or *Lophostemon lactifluus*, *Pandanus spiralis*.
- Ground layer incorporating grasses and herbs that occur in poorly-drained habitats.
- Relatively open overstorey.

### 2.4.4 Results

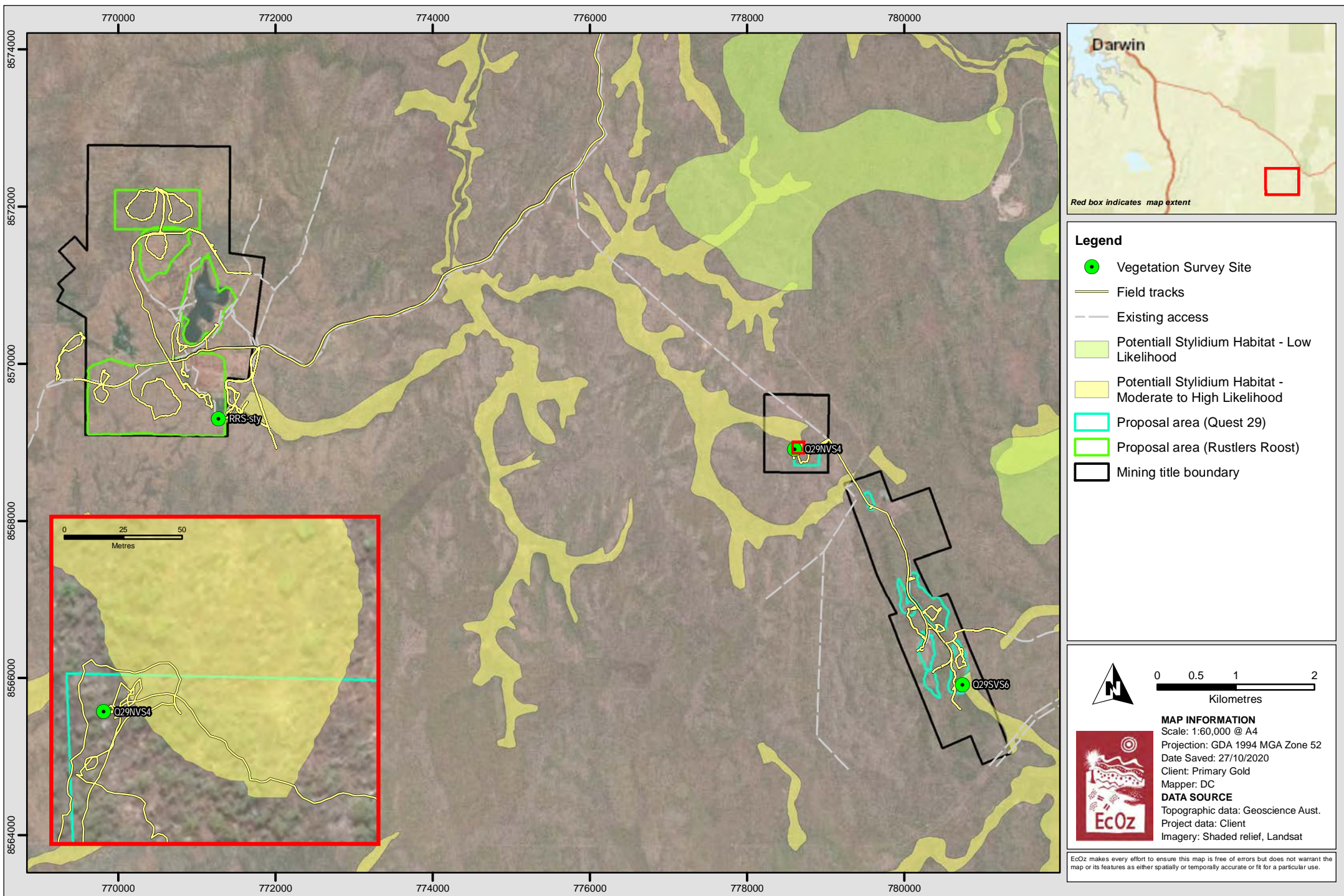
Habitat surveys were conducted in October 2020. Of the three areas modelled as potential habitat, only one approximately 3,000m<sup>2</sup> area in Quest 29 North – conforming to vegetation site Q29NVS1 – was considered to be marginally-suitable habitat for *Stylidium ensatum* based on landform and soil type (Figure 16). This site was an alluvial plain with yellowish-brown organic sandy clay soils and poor drainage, and may have a higher water-holding capacity later into the dry season compared to the other modelled areas. The vegetation was classed as open woodland but it did not contain the overstorey species generally associated with *Stylidium ensatum*. Groundcovers were sparse, perhaps due to dry conditions, but did include some sedge species, indicating a seasonally-inundated area. This area was assessed to be marginally-suitable habitat for *Stylidium ensatum*. The two remaining modelled areas at Quest 29 South and Rustlers Roost were evidently seasonally-saturated but were dry at the surface at the time of the survey. These were associated with channel systems and had red kandosol soils with scattered surface gravels present (Figure 17) indicating relatively well-drained areas; therefore, these modelled areas are unlikely to provide suitable habitat for *Stylidium ensatum*.



**Figure 16. Photographs showing marginally-suitable *S. ensatum* habitat at Site Q29NVS4**



**Figure 17. Photographs showing unsuitable habitat at Site RRS-Sty (left) and Q29SVS6 (right)**



Path: Z:\01 EcOz\_Documents\04 EcOz Vantage GIS\EZ20181 - Rustlers Roost and Quest29 Ecology Report\01 Project Files\Figure X-X. Map of Stylidium.mxd

**Figure 18. Map of modelled habitat and survey tracks for *Stylidium ensatum* (inset map details area of marginally suitable habitat)**

### 3 CONCLUSION

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Field surveys confirmed that the land units within the proposal areas were largely consistent with the existing mapped land units, with some minor corrections. In total, approximately 25% of the proposal area was disturbed and did not represent a natural land unit.

Much of the riparian area within and to the east of Rustlers Roost were disturbed due to mining activities, but did contain some monsoonal species. Riparian areas to the west of Rustlers Roost were largely intact and weed free. A patch of closed forest was recorded in Rustlers Roost south. Areas within the Quest 29 proposal area were classified as the riparian land unit 6a and comprised of riparian and monsoon vine species. Much of these riparian areas have been disturbed by previous clearing and stockpiling of fill material; weeds and feral animals were observed in these areas. Closed forest, riparian and monsoon vine vegetation are considered to be sensitive and significant vegetation types in the NT, meaning that they are easily impacted by adjacent land uses or management, and/or are spatially restricted habitat types important to a number of wildlife species (DENR 2020).

Targeted intensive transect surveys did not detect *Helicteres macrothrix* in proposal areas modelled as potential habitat. As the plants of that species at a nearby reference population were readily detectable, it appears unlikely that *Helicteres macrothrix* occurs within the proposal area.


Only one small (approximately 3,000 m<sup>2</sup>) patch of modelled *Stylidium ensatum* habitat was considered to be marginally-suitable habitat based on the known ecology of the plant; however, as the plant is only detectable in June/July, it is not possible to confirm presence or absence of the species at this time. Other areas modelled as potential *Stylidium ensatum* habitat within the proposal area were assessed as being unsuitable and unlikely to support this species.





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## APPENDIX A LAND UNIT SURVEY SITES AND RESULTS

<b>Land unit</b>	2b - rises and ridges; some upland plateaus	<b>Survey sites</b>	RRNVS1, RRSVS2, RRNP2, RRNP3, RRNP4, RRNP5 RRNP6, RRNP7, RRNP8, RRNP8, RRSP1, RRSP2, RRSP2, RRSP4, RRSP5	<b>Slope</b>	6 - 15%	<b>Area (ha)</b>	214.5
<b>Vegetation type</b>	<p>RRNVS2 (rises and ridges): <i>Corymbia polysciada</i> (V4), <i>Eucalyptus miniata</i>, <i>Corymbia dichromophloia</i> (V1) and occasional <i>Eucalyptus tintinnans</i> low to mid high open woodland, over <i>Erythrophleum chlorostachys</i>, <i>Corymbia dichromophloia</i> (V1) and <i>Gardenia megasperma</i> mid high open shrubland to shrubland, over <i>Eriachne</i> sp. (V3), <i>Heteropogon triticeus</i> (V12) and <i>Triodia bitextura</i> low to mid high open tussock grassland</p> <p>RRSVS1 (plateau): <i>Eucalyptus tetradonta/miniata</i> woodland over Eucalypt saplings, <i>Erythrophleum chlorostachys</i>, <i>Livistona humilis</i> open shrubland and a ground cover of <i>Petalostigma quadriloculare</i>, and mixed grasses</p>			 <p style="text-align: center;">RRSVS2 Surface soil                      RRSVS1 Surface soil</p>			
<b>Vegetation</b>	<b>Upper stratum</b>	<b>Mid stratum</b>	<b>Ground stratum</b>				
% cover	30	20	40				
Height range (m)	8 - 12	1 – 8	0.2 – 0.8				
Average height (m)	10	4	0.5				
Dominant species	<p><i>Corymbia polysciada</i> (V4)</p> <p><i>Eucalyptus miniata</i></p> <p><i>Corymbia dichromophloia</i></p> <p><i>Eucalyptus tetradonta</i></p> <p><i>Eucalyptus miniata</i></p>	<p><i>Erythrophleum chlorostachys</i></p> <p><i>Corymbia dichromophloia</i></p> <p><i>Gardenia megasperma</i></p> <p><i>Erythrophleum chlorostachys</i></p> <p><i>Eucalypt tetradonta</i> saplings</p> <p><i>Livistona humilis</i></p>	<p><i>Eriachne</i> sp. (V3)</p> <p><i>Heteropogon triticeus</i> (V12)</p> <p><i>Triodia bitextura</i></p> <p><i>Petalostigma quadriloculare</i></p> <p><i>Small sedge sp1</i> (V5)</p>				
<b>Soil description</b>	RRNVS1: Lateritic soils; brown sandy loam with high surface gravels (small pebbles). RRNVS2: Siltstones and sandstones (larger in size); yellow/brown sandy clay loam						
<b>Other site notes</b>	Minor depressions also occur within land unit; vegetation comprised of mixed grasses and grey cracking clay soils. Scattered Hyptis present.						
<b>Site photos and location</b>							

					
RRSVS2		RRSVS2		RRSVS1	
<b>Land unit</b>	3a - Low rounded hills; some upland surfaces	<b>Survey sites</b>	Q29NVS3, Q29NP1, Q29NP2		
<b>Vegetation type</b>	<i>Eucalyptus miniata</i> , <i>Corymbia</i> sp., <i>Corymbia clavigera</i> mid high woodland over <i>Erythrophleum chlorostachys</i> , <i>Acacia auriculiformis</i> , <i>Calytrix exstipulata</i> shrubland, over leaf litter and <i>Eriachne</i> sp. sparse tussock grassland				
<b>Vegetation</b>	<b>Upper stratum</b>	<b>Mid stratum</b>	<b>Ground stratum</b>		
% cover	45	25	10		
Height range (m)	12 – 14	2 – 8	0.2 – 1		
Average height (m)	13	5	0.6		
Dominant species	<i>Eucalyptus miniata</i> <i>Corymbia</i> sp. <i>Corymbia clavigera</i>	<i>Erythrophleum chlorostachys</i> <i>Acacia auriculiformis</i> <i>Calytrix exstipulata</i> <i>Eucalyptus ferruginous</i> saplings	<i>Eriachne</i> sp. Other mixed (unidentifiable grasses)		
					
		Q29NVS3 Surface soil			

<b>Soil description</b>	Brown sandy loam, shallow soils; scattered surface gravel present								
<b>Other site notes</b>	Land unit consistent with existing, except a few species composition leaf litter cover not dense, only thing layer. No weeds recorded within this land unit.								
<b>Site photos and location</b>									
									
<b>Land unit</b>	6a - creek channel ranging in width and depths forming large pools	<b>Survey sites</b>	Q29SVS6, Q29SP, Riparianlike6a			<b>Slope</b>	1 – 4 %	<b>Area (ha)</b>	9.9
<b>Vegetation type</b>	<i>Corymbia bella</i> , <i>Corymbia polycarpa</i> , <i>Ficus racemosa</i> and occasional <i>Melaleuca leucadendra</i> (V14), <i>Alstonia actinophylla</i> , <i>Barringtonia acutangula</i> and Banyan trees mid high woodland to open forest, over <i>Erythrophleum chlorostachys</i> , <i>Terminalia</i> sp., and <i>Acacia auriculiformis</i> and occasional <i>Planchonia careya</i> open shrubland, over <i>Aristida</i> sp., and Hyptis mid high open tussock grassland.								
<b>Vegetation</b>	<b>Upper stratum</b>	<b>Mid stratum</b>	<b>Ground stratum</b>						
% cover	55	35	1						
Height range (m)	12 – 14	6 – 10	0.6						
Average height (m)	13	8	0.6						
Dominant species	<i>Corymbia bella</i> <i>Corymbia polycarpa</i> <i>Ficus racemosa</i> <i>Melaleuca leucadendra</i> <i>Alstonia actinophylla</i> <i>Barringtonia acutangula</i>	<i>Erythrophleum chlorostachys</i> <i>Terminalia</i> sp. <i>Acacia auriculiformis</i> <i>Acacia</i> sp. <i>Planchonia careya</i>	<i>Aristida</i> sp. Hyptis						





<b>Soil description</b>	Yellowish/brown sandy clay soils						
<b>Other site notes</b>	Largely disturbed land unit with large Hyptis patches						
<b>Site photos and location</b>							
							
Q29SVS6		Riparianlike6a		Hyptis (disturbance) recorded at Q29SP			
<b>Land unit</b>	6a1 - minor creek lines and broad drainage systems	<b>Survey sites</b>	Q29NVS4, RRS-sty	<b>Slope</b>	1-6 %	<b>Area (ha)</b>	9.1
<b>Vegetation type</b>	Mixed <i>Corymbia</i> species; <i>Corymbia bella</i> , <i>Corymbia polycarpa</i> and <i>Corymbia grandiflora</i> mid high (10 -15 m tall) and occasional <i>Eucalypt bigalerita</i> and <i>Eucalyptus tectifca</i> woodland over shrubland of mixed species over <i>Eriachne</i> sp. and <i>Mnesithea</i> sp. (V11) sparse tussock grassland.						
<b>Vegetation</b>	<b>Upper stratum</b>	<b>Mid stratum</b>	<b>Ground stratum</b>				
% cover	15	15	3				
Height range (m)	10	2 – 7	0.5				
Average height (m)	10	4	0.5				
<b>Dominant species</b>	<i>Corymbia bella</i> <i>Corymbia polycarpa</i> <i>Corymbia grandiflora</i>  <i>Eucalypt bigalerita</i> <i>Eucalyptus tectifca</i>	<i>Erythrophleum chlorostachys</i> <i>Buchanania obovata</i>	<i>Eriachne</i> sp <i>Mnesithea</i> sp. (V11)				
<b>Soil description</b>	Soils vary between sites; reddish/brown sandy clay within creek bed at Rustlers Roost, and more skeletal on the upper bank and yellow/brown sandy clay at Q29						



RRS-sty Surface soil (in creek bed at Rustlers Roost)



Q29NVS4 Surface soil

	with less surface gravel		
<b>Other site notes</b>			
<b>Site photos and location</b>			
			
	Q29NVS4	RRS-sty	RRS-sty
<b>Land unit</b>	2a - hills and ridges with some steep slopes	<b>Survey sites</b>	Q29SVS5, Q29NP3 Q29SP1, Q29SP2, Q29SP3, Q29SP4, Q29SP5, Q29SP6, Q29SP7
		<b>Slope</b>	>10 %
		<b>Area (ha)</b>	18.3
<b>Vegetation type</b>	<i>Eucalyptus miniata</i> , <i>Corymbia polysciada</i> (V4), <i>Corymbia dichromophloia</i> (V1) and occasional <i>Corymbia clavegeria</i> low to mid high open woodland, over <i>Erythrophleum chlorostachys</i> , <i>Corymbia dichromophloia</i> open shrubland, over <i>Eriachne</i> sp., and <i>Triodia bitextura</i> tussock grassland.		
<b>Vegetation</b>	<b>Upper stratum</b>	<b>Mid stratum</b>	<b>Ground stratum</b>
% cover	20	30	40
Height range (m)	8 – 10	2 – 8	0.2 – 0.6
Average height (m)	9	5	0.3
Dominant species	<i>Eucalyptus miniata</i> <i>Corymbia polysciada</i> <i>Corymbia dichromophloia</i> <i>Corymbia clavegeria</i>	<i>Erythrophleum chlorostachys</i> <i>Corymbia dichromophloia</i>	<i>Eriachne</i> sp. <i>Triodia bitextura</i>
			
	29SVS5 Surface soil		

<b>Soil description</b>	Skeletal soils; greyish/brown sandy clay loam
<b>Other site notes</b>	Hyptis in dense stands at Q29

**Site photos and location**

Q29SVS5



Q29NP3



Q29SP4



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