OLYMPIC DAM EXPANSION

DRAFT ENVIRONMENTAL IMPACT STATEMENT 2009

APPENDIX N
TERRESTRIAL ECOLOGY

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APPENDIX N

TERRESTRIAL ECOLOGY

CONTENTS

APPENDIX N1

Ecological survey of the EIS Study Area

N1 ECOLOGICAL SURVEY OF THE EIS STUDY AREA

N1.1 INTRODUCTION

Ecological Associates was engaged by ARUP ENSR on behalf of BHP Billiton to undertake an ecological survey of the areas potentially affected by the proposed expansion of the Olympic Dam mining and processing operation, including infrastructure.

RPS Ecos (with RMP Environmental) were also engaged to undertake an ecological assessment of the proposed gas pipeline from Moomba to Olympic Dam.

The scope of work was to:

- describe the existing plant associations and flora and fauna communities that would potentially be affected by the expansion project
- identify the locations of rare or threatened species under State or Commonwealth Government Acts and key habitats that may be of importance to these species within a defined study area (see Figure N1.1).

This appendix does not address potential ecological impacts or suggest mitigation measures as this assessment is provided in the main body of the Draft EIS (see Chapter 15, Terrestrial Ecology).

The study area comprises:

- the existing Olympic Dam Special Mining Lease (SML) and mining lease at Olympic Dam and the proposed expansion of this lease area to the north, west and east, hereafter called the extended SML
- the Roxby Downs Municipality, which includes the Roxby Downs township and Olympic Dam Village, extended SML and an extended area of the municipality
- the investigation area for the desalination plant site at Point Lowly and adjacent port facilities at Port Bonython
- the 10 km wide southern linear infrastructure corridor in which the proposed transmission line between the Port Augusta power station and Olympic Dam would be located, a water pipeline corridor between Point Lowly and Olympic Dam and a rail corridor between Woomera and Olympic Dam
- gas pipeline corridors (including several route options) between Moomba and Olympic Dam (see Figure N1.1).

The water pipeline, rail and transmission line corridors run parallel, and in some cases overlap along most of their length, so are addressed collectively. Where the term ‘study area’ has been used throughout this document, it refers to sites within the expanded SML, the Roxby Downs Municipality, the southern infrastructure corridor and the northern corridor gas pipeline alignment options.

The survey reported here was conducted during dry conditions. A subsequent fauna survey was conducted during more appropriate conditions in spring, following several substantial rain events (see Appendix N7). An ecological survey focusing on groundwater dependent ecosystems was also conducted (see Appendix N8).

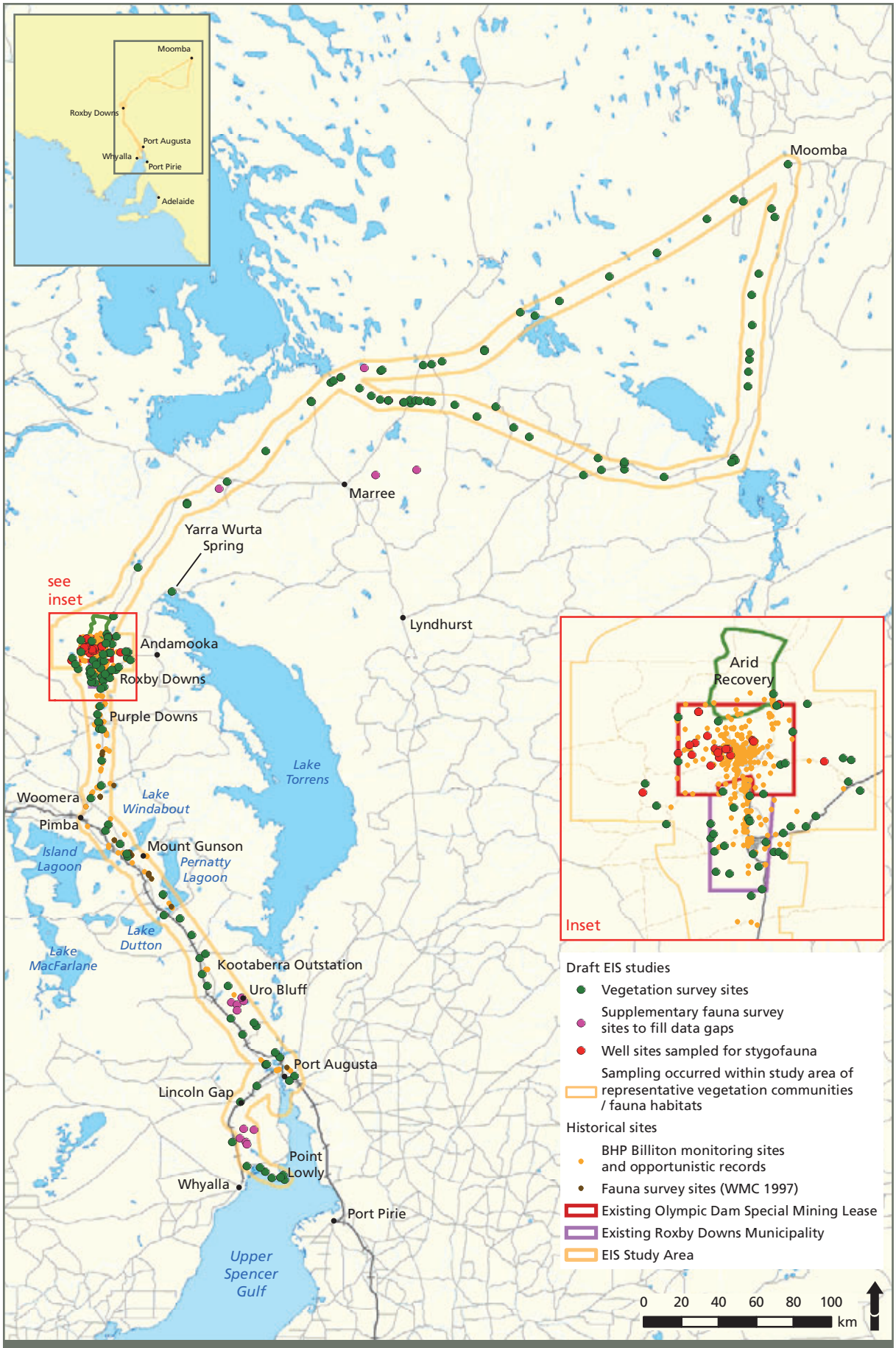

Figure N1.1 Locations of study area and sites

N1.2 METHODS

N1.2.1 Desktop review

A review of the existing records of flora, plant associations, fauna and ecological communities that occur, or are predicted to occur in the study area was compiled from the following sources:

- Australian Government Department of the Environment, Water, Heritage and the Arts Protected Matters Search Tool, extracted 8 July 2005, and again in October 2006, January and June 2007 and January 2008 (species have been progressively updated)
- previous reports of the study area (Fatchen 1981; Kinhill 1995; Kinhill 1997; WMC 1997)
- BHP Billiton Olympic Dam Weeds Database
- BHP Billiton Olympic Dam Flora Database
- BHP Billiton Olympic Dam Opportune Vertebrate Fauna Database
- Department for Environment and Heritage Biological Database of South Australia (BDSA).

The BDSA database contains records from the Department for Environment and Heritage (DEH) survey, opportunistic databases and a range of organisations including:

- Birds Australia (SA records) – 1996 to 2002
- South Australia Ornithological Association (SAOA)
- SAOA Parks Data
- Australasian Wader Study Group
- SA Museum.

Database search areas covered the full extent of the investigated study area.

N1.2.2 Vegetation mapping

Existing vegetation mapping of the study area consists of:

- 1:10,000 scale mapping of part of the SML (Fatchen 1981)
- 1:40,000 mapping of the region surrounding the SML and municipality prepared for the original environmental impact statement (Kinhill-Stearns Roger 1982)
- Arid Recovery vegetation mapping (BHP Billiton 2006)
- Department for Environment and Heritage vegetation mapping for the Stony Deserts bioregion (Brandle 1998).

The existing vegetation mapping was supplemented by further mapping of the study area based on aerial orthophotography at a scale of 1:40,000, medium resolution (15 m) satellite imagery for the gas pipeline corridors, ground-truthing of representative vegetation types in the southern infrastructure corridor (predominantly along the centre line of the existing transmission line, water pipeline and gas pipeline corridors), and additional ground-truthing in areas accessible by vehicle in other parts of the study area. Several sites on the gas pipeline corridors (e.g. in the Strzelecki Desert) were ground-truthed by helicopter. Ground-truthing in the Roxby Downs Municipality and SML occurred along tracks within representative vegetation types identified from aerial photography, and on foot in areas with no vehicle tracks.

Vegetation mapping units are based on dominant overstorey species and broad structural formations.

Vegetation mapping in the extended SML and Roxby Downs Municipality was ground-truthed from 1–8 March 2006. Vegetation mapping in the southern infrastructure corridor was ground-truthed from 27–31 March 2006 and 18–24 April 2006. Vegetation in the gas pipeline corridors was ground-truthed from 14–21 October 2006, 14–18 January 2008 and 23–25 January 2008. Additional aerial mapping of vegetation within the westerly and northerly extension of the SML, the proposed saline water borefield, the Hiltaba Village site and relocated airport site was undertaken via helicopter on 5–6 December 2007.

N1.2.3 Vegetation survey

Vegetation surveys were conducted at the same time as ground-truthing for vegetation mapping. The main purpose of these surveys was to collect data on the composition of vegetation and to provide descriptive information about the study area. Sites were chosen where a different mapping unit was identified. Forty sites were surveyed on the SML, Roxby Downs Municipality and 43 sites in the southern infrastructure corridor (see Figure N1.1). Eight additional sites were ground-truthed during the aerial mapping survey west and north of Olympic Dam. Forty-one sites were surveyed on the gas pipeline corridors, and a further 24 sites were ground-truthed by helicopter. AMG coordinates were recorded and a photograph was taken at each of these sites. One site was surveyed at the approximate location of the proposed desalination plant; the actual site was fenced and not accessible at the time of the survey.

Each survey site on the mining lease, municipality and southern infrastructure corridor comprised an area of approximately 1,000 m^2. Sites on the gas pipeline corridors comprised an area of approximately 1 ha. Each site was searched and a list was compiled of species present and identifiable. The cover of the dominant overstorey and understorey species was estimated and notes were made on vegetation condition, landform and soil types. Plant associations were classified according to the dominant overstorey species and the vegetation structural formation following the method used for the Biological Survey of South Australia (Heard and Channon 1997). Incidental records of plant species and plant associations outside the dedicated survey area were also recorded.

When the vegetation surveys were conducted in March and April 2006, the ephemeral species were largely absent from survey sites due to dry seasonal conditions and long-term drought conditions over much of the gas pipeline corridors. Records from previous surveys (and the Biological Database of South Australia for the gas pipeline) have been included in species lists to reflect the potential flora of the study area. In addition, a survey for ephemeral species was conducted in August 2006 covering the southern part of the project area (i.e. the mining lease and project area southwards), following a significant rainfall event. The results are included in the flora lists.

Species nomenclature follows the *Census of South Australian Vascular Plants* (Barker et al. 2005). An asterisk (*) in the text denotes introduced plant species.

N1.2.4 Fauna assessment

Vertebrate fauna records were imported from the DEH Biological Database of South Australia (BDSA) into the GIS software program ArcView. This spatial data along with published records in Kinhill-Stearns Roger (1982), Read (1994), Kinhill (1997) and WMC (1997) were used to compile species lists for the study area.

Field surveys, conducted at the same time as vegetation surveys, were used to describe the attributes of fauna habitat types in the study area. Opportunistic sightings of fauna were also made on these occasions.

Species nomenclature follows Robinson et al. (2000).

N1.2.5 Bat survey

Surveys for insectivorous (i.e. microchiropteran) bats were conducted over four nights near Roxby Downs from 2–5 March 2006. Recordings of bat echolocation calls were made using an AnaBat II bat detection system (Titley Electronics, Ballina, New South Wales). The AnaBat converts the ultrasonic echolocation signals of a bat species into an audible electronic signal for analysis against species voucher calls.

Both passive (i.e. a stationary detector recording over-flying bats) and active (i.e. a hand-held detector tracking bats while in flight) recordings were taken between dusk (approximately 7.30 pm) and dawn (7.30 am). Recordings were made at four sites in the following vegetation associations:

- *Acacia papyrocarpa* open woodland in interdune swales
- *Callitris glaucophylla* woodland in closely spaced dunes
- *Callitris glaucophylla* woodland adjacent to the sewage ponds
- *Atriplex vesicaria/Sclerostegia* sp. low open shrubland on open tableland.

Bat calls were analysed by Greg Ford (AnaBat call analysis specialist). Bat identifications were based on reference calls and keys published for New South Wales (Pennay et al. 2004) and Queensland (Reinhold et al. 2001).

N1.3 REGIONAL CONTEXT

The area of the proposed expansion is located predominantly within the Gawler Bioregion in South Australia, with the gas pipeline corridors crossing the Stony Plains, the Simpson-Strzelecki Dunefields and Channel Country Bioregions. These bioregions are arid to semi-arid with high summer temperatures and low rainfall.

The Gawler Bioregion extends from the Upper Eyre Peninsula to the Stony Plains Bioregion south of Lake Eyre and comprises a number of land system units (see Figure N1.2). Landforms in the south comprise gently undulating calcareous plains with quartzite uplands and zones of salt lakes. Sand dunes overlie the calcareous plains in the central part of the study area. West of Lake Torrens there is a plateau on sandstone and quartzite with an undulating surface of gibber. Sandplains and dunefields overlie a basement of old alluvial plains and basement limestone in the Olympic Dam region. Drainage is typically into dune swales, claypans, swamps or large salt lakes.

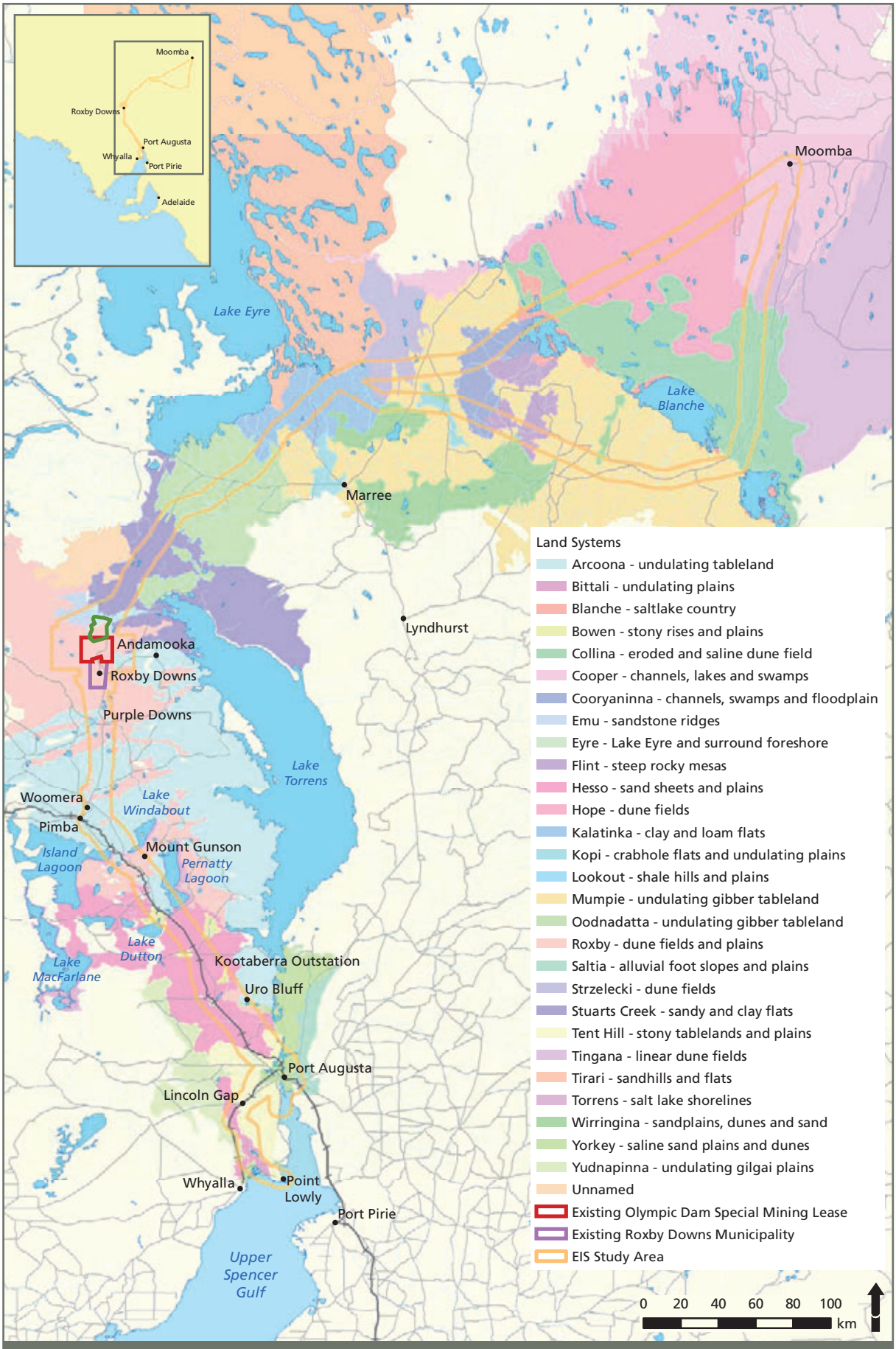

Figure N1.2 Land systems of the study area

The dominant vegetation across the study area comprises either chenopod shrublands or acacia woodlands or shrublands. Chenopod shrublands occur on plains and plateaus on skeletal soils or on loams that overlie a hardpan layer. Shrublands in the southern part of the study area are dominated by *Atriplex vesicaria, Maireana pyramidata* and *M. sedifolia*. On gibber tablelands, shrublands are dominated by *A. vesicaria* and *Sclerostegia* sp. Chenopod shrublands around Olympic Dam comprise *A. vesicaria* and *Maireana astrotricha*. On deeper loamy soils there are woodlands of *Acacia papyrocarpa* with an understorey of chenopod shrubs. Sandier soils support *Acacia aneura* woodlands with a grass-dominated understorey. Dunes support shrublands of *Acacia* sp. and *Dodonaea viscosa* ssp. *angustissima* or *Callitris glaucophylla* woodlands. Drainage areas support swamps of tall shrubs such as *Muehlenbeckia florulenta, Maireana aphylla* or *Chenopodium nitrariaceum*. Small lakes are fringed by *Melaleuca pauperiflora* ssp. *mutica* or samphire species.

The Stony Plains Bioregion is an extensive region, located primarily within South Australia. It stretches in an arc from the Northern Territory to south of Lake Eyre and east to the edges of the Strzelecki Desert and Flinders Ranges. It has gently undulating gibber and gypsum plains as its dominant feature. Breakaways, tablelands and low hills are mainly restricted to the western areas. Wetlands occur throughout this bioregion with the GAB springs being the most significant features.

The extremely extensive undulating gibber plains with gilgais in the Stony Plains Bioregion support *Astrebla pectinata*, *Sporobolus actinocladus* low open grassland with *Sclerolaena* spp. in the gilgais with very sparse chenopod shrublands between. In the sand spreads on stony plains a variety of open shrublands exist with *Acacia ligulata*, *A. cambagei*, or *A. aneura* over chenopods, *Sclerolaena* spp. and grasses. In wetter run-on areas, minor depressions and closed drainage areas, *Maireana aphylla* or *Atriplex nummularia* ssp. *nummularia* dominate with *Eragrostis setifolia*, *Astrebla pectinata* and *Sclerolaena* spp. in the ground layer. Slightly saline areas support *Sclerostegia tenuis* and other samphires.

The Simpson–Strzelecki Dunefields Bioregion is characterised by vast aeolian sand dune systems and large salt lakes. The longitudinal dune systems are generally orientated north-north-west to south-south-east. Within the bioregion are the lower reaches of two of Australia's major inland river systems, Warburton and Cooper Creeks. Dunefields typically support *Acacia ligulata* open shrubland with or without *Zygochloa paradoxa* hummock grasslands, while interdune systems support open tussock grasslands or low open chenopod shrublands.

The extreme northern end of the gas pipeline corridors falls within the Channel Country Bioregion. In South Australia, the Channel Country encompasses the Diamantina River/Goyder Lagoon/Warburton Creek river systems, Cooper Creek, Coongie Lakes and Strzelecki Creek. These major features form part of a vast flood and alluvial plains system that supplies Lake Eyre. In the vicinity of the gas pipeline in this bioregion, vegetation on broad interdune flats comprises *Atriplex spongiosa*/*Sclerolaena* spp. low shrubland, with taller shrublands of *Atriplex nummularia*, *Chenopodium auricomum*, *Eragrostris australasica* and *Muehlenbeckia florulenta*. Dunes are typically vegetated with *Acacia ligulata* shrubland.

Vegetation in drainage lines across the gas pipeline corridors is determined by the frequency and quantity of water flows and can be *Eucalyptus camaldulensis* or *E. coolabah* woodland over *Acacia salicina* or *A. stenophylla* and *Muehlenbeckia florulenta*, chenopods and ephemeral herbs. *Atriplex nummularia* ssp. *nummularia*, *Eragrostis australasica* or *Muehlenbeckia florulenta* low open shrublands are common in minor drainage lines and non-saline swamps.

N1.4 SPECIAL MINING LEASE AND ROXBY DOWNS MUNICIPALITY

N1.4.1 Introduction

The vegetation on the Special Mining Lease (SML) and Roxby Downs Municipality was first described in detail by Fatchen (1981), whose report formed the basis for the section on flora in the Terrestrial Environment chapter in the 1982 and 1997 Olympic Dam Environmental Impact Statement (EIS) (Kinhill-Stearns Roger 1982; Kinhill 1997). Fatchen (1981) based his vegetation descriptions on earlier work by Jessup (1951), who described the regional flora of the north-western pastoral zone, and surveys by Graetz and Tongway (1980) completed prior to mineral exploration work.

Fatchen (1981) produced large-scale vegetation maps of the SML and smaller scale maps of the region surrounding the lease. He described vegetation types, soils, landscape units and their characteristic species and compiled species lists for each vegetation type. Vegetation surveys associated with monitoring programs within the SML and Roxby Downs Municipality and other biological surveys in the region have increased the understanding of the flora of the region since the 1982 and 1997 EIS were compiled. A more recent survey of the vegetation of the Roxby Downs Municipality was also completed as part of the Draft EIS studies for the Draft Roxby Downs Master Plan (see Appendix F4).

Early fauna survey work in the Olympic Dam region was also undertaken prior to mineral exploration work (Fatchen and Reid 1980; Graetz and Tongway 1980). Baseline surveys of the Olympic Dam region were completed for the fauna component of the first EIS (Kinhill-Stearns Roger 1982). These surveys targeted mammals, reptiles and birds. The ongoing BHP Billiton fauna monitoring program (BHP Billiton 2005) and other fauna surveys in the region have contributed to a comprehensive understanding of the distribution, abundance and habitat preferences of many fauna species in the region (Read 1994; BHP Billiton 2005).

N1.4.2 Land systems

The leases occur predominantly within the Roxby land system, with part of the eastern section of the SML in the Arcoona land system (see Figure N1.2). The Roxby land system is an undulating plain with sand sheets, dunes and low, silcrete-capped rises overlying older alluvial plains and ancient basement limestone (Kingoonya Soil Conservation Board 2002). The dunes comprise deep red, siliceous sands and vary in height from 5 m to 10 m (averaging 6 m). Dune spacing also varies from 50 m to 700 m (Fatchen 1981), with widely spaced dunes more common in the SML and closely spaced dunes more common in the municipal lease. Sand sheets comprise a 1.5 m deep sand layer that overlays clays and loams (Jessup 1951). The interdune corridors are comprised of calcareous clay-loams overlying calcrete rubble or hard pan (Jessup 1951). In places these soils may have a thin veneer of sand with heavy clay subsoil or there may be a surface pavement of gibbers.

Drainage in the dunefields is localised with run-off accumulating in swales or small to medium-sized clay pans in dune depressions, usually at one end of a swale where dunes coalesce. The Roxby land system also includes small areas of stony plains and stony rises. These areas have calcareous clay-loam soil with calcrete rubble and a surface pavement of gibbers or firm calcareous sandy soils (Kingoonya Soil Conservation Board 2002).

The Arcoona land system is a flat to gently undulating tableland with gilgais and watercourses (Kingoonya Soil Conservation Board 2002). Soils are heavy-textured, gypseous and saline (Fatchen 1981). The soil surface has a pavement of gibbers except in gilgais where the movement of the underlying clays disperses the stones (Badman 1999). Aeolian dunes overlie the tableland surface in places.

N1.4.3 Vegetation associations

The dunefields support several vegetation associations that exhibit considerable variation at small scales but are relatively homogeneous at larger scales (Fatchen 1981). The occurrence of vegetation associations is related to soil type and land form (Table N1.1, Figure N1.3). Woodlands of *Callitris glaucophylla* and *Acacia aneura* occur frequently on closely spaced dunes. More widely spaced dunes support open woodlands or shrublands of *Acacia aneura, A. ramulosa*, *A. ligulata* and *Dodonaea viscosa* ssp. *angustissima*, although these associations may also be present on the dune ridges of closely-spaced dunes. More mobile dunes, particularly in the eastern part of the study area, have a sparse shrubby cover of *A. ligulata* and/or *Dodonaea viscosa* ssp. *angustissima* or the grass *Zygochloa paradoxa*.

Understorey vegetation on dunes is sparse and dominated by perennial grasses. Ephemeral species such as *Sclerolaena* spp. and *Atriplex* spp. may occupy the groundlayer following rains. Fatchen (1981) reported a low cover of understorey species in *Callitris glaucophylla* woodlands. However during this survey a relatively high cover (about 20%) of perennial grasses in these woodlands was found.

Vegetation in interdune corridors is influenced by soil type, which in turn is affected by dune spacing. Where there is a mantle of sand the swales have *A. aneura* woodlands with a grassy understorey. *Acacia papyrocarpa* occurs on clay-loam soils in narrow swales and at the edges of broad swales. These open to very open woodlands have an understorey of either grasses or chenopod shrubs. The underlying tablelands are exposed in the broader swales and support chenopod shrublands. These swales typically have a surface cover of gibbers.

Deaths of *Acacia papyrocarpa* trees in the Roxby Downs area have been reported (Bailey 2000). These deaths have been linked to outbreaks of the naturally occurring Western Myall Whitefly *Zaphanera paprocarpae*. Whitefly populations are normally kept in control by native predators such as native wasps. The reason for the lack of synchronicity between whitefly and native wasp numbers could not be determined, but the problem was widespread and not related to mine operations (Bailey 2000).

Silcrete capped rises are of limited occurrence in the Roxby land system. These stony areas support distinctive shrubland associations (see Table N1.1). Areas of tableland do not support large shrubs or trees. In the Roxby Downs Municipality and SML these areas have a mantle of gibbers with large gilgai. The Arcoona tablelands have a low shrub cover of *Sclerolaena* sp., although there are some areas with a good cover of *Atriplex vesicaria*. *A. vesicaria* was less frequent or absent in proximity to watering points, where it was replaced by *Sclerolaena* sp. Fatchen (1981) suggested that stock grazing has reduced the cover of *A. vesicaria* on the tableland and this is supported by the current distribution of *A. vesicaria*.

Vegetation in drainage lines and depressions in the dunefields occurs in restricted areas but there is a high diversity of vegetation associations (see Table N1.1). Most drainage is internal into small claypans in swales. Tableland areas drain along rocky watercourses into larger lagoons. Where water is held for some time after rain there may be *Eragrostis australasica* grasslands or shrublands of *Maireana aphylla* or *Chenopodium nitrariaceum*. Drainage areas in swales may also support thickets of *Acacia aneura* or *A. brachystachya, Eremophila longifolia, Senna* sp. or *Acacia tetragonophylla*. Some larger lagoons are fringed by *Melaleuca pauperiflora* ssp. *mutica*. Depressions (solution cavities) in Andamooka limestone support mixed tall shrublands of *Acacia tetragonophylla* and *A. aneura* or *A. brachystachya*. This vegetation association also occurs on sandy clays in eroded depressions (deflation basins) to the east of large claypans. Watercourses draining tablelands support tall shrublands of *Acacia tetragonophylla* and other tall shrubs. The tablelands drain into gilgai.

A full list of vegetation associations in the study area recorded during the field survey is provided in Appendix N2.

Table N1.1 Vegetation associations in the SML and Roxby Downs Municipality

Vegetation association	Landforms
Dunefields	
Callitris glaucophylla woodland to open woodland	Dune ridges and slopes of closely spaced dunes Dune crests of widely spaced dunes Dunes around lagoons or large claypans
Callitris glaucophylla/Acacia aneura woodland to open woodland	Dune ridges, slopes and swales of closely spaced dunes
Acacia ramulosa +/– *A. ligulata* +/– *Dodonaea viscosa* ssp. *angustissima* shrubland	Dune ridges and slopes of closely and widely spaced dunes
Acacia aneura open woodland	Dune ridges, slopes and swales of closely spaced dunes Lower dune slopes of widely spaced dunes Narrow interdune corridors with sandy soils
Dodonaea viscosa ssp. *angustissima* shrubland	Dune ridges and slopes of closely and widely spaced dunes
Zygochloa paradoxa grassland	Dune crests and slopes of widely spaced dunes
Atriplex vesicaria/Gunniopsis quadrifida low open shrubland	Lower dune slopes adjacent to claypans
Acacia papyrocarpa low open to very open woodland	Clay-loam soils without gibber in narrow corridors or the edges of broad interdune corridors
Sclerolaena sp. low shrubland	Clay-loam soils with or without gibber in narrow interdune corridors
Atriplex vesicaria +/– *Maireana astrotricha* low shrubland	Clay-loam soils with or without gibber in narrow or broad interdune corridors
Atriplex vesicaria/Scelrostegia tenuis low shrubland	Clay-loam soils with gibber in broad interdune corridors
Stony rises and tablelands	
Atriplex vesicaria/Sclerostegia tenuis low open shrubland	Dominant on small tableland areas in municipal lease east of Roxby Downs
Sclerolaena sp. low shrubland	Andamooka tableland
Atriplex vesicaria and/or *Maireana astrotricha* low shrubland	Andamooka tableland
Maireana sedifolia open shrubland	Low stony rises on calcareous soils
Ptilotus sp. low shrubland	Low stony rises on calcareous soils
Drainage areas	
Eragrostis australasica grassland	Gilgai on tablelands Base of dune slopes abutting tablelands Swamps in interdune corridors
Maireana aphylla shrubland	Gilgai on tablelands Swamps in interdune corridors
Chenopodium nitrariaceum shrubland	Swamps in interdune corridors
Muehlenbeckia florulenta shrubland	Swamps in interdune corridors
Acacia aneura woodland	Solution cavities in Andamooka limestone Swales
Melaleuca pauperiflora ssp. *mutica* low woodland to open woodland	Sandy watercourses Fringes of lagoons
Acacia tetragonophylla +/– *A. aneura* tall shrubland to tall open shrubland	Solution cavities in Andamooka limestone Deflation areas on eastern sides of lagoons Rocky watercourses
Atriplex vesicaria/Halosarcia sp. low shrubland	Fringing lagoons or clay pans

Listed vegetation associations

Acacia aneura low woodland on sand plains is provisionally listed as a vulnerable plant association in South Australia (Neagle 2003). These woodlands occur extensively throughout the municipal lease and in the north-western part of the SML (see Figure N1.3).

Plains Rat occurs in chenopod shrubland (17-30, 38, 42, 49-59)

Sandalwood (*Santalum spicatum*) may occur in *Acacia papyrocarpa* woodland (9, 10, 63)

joins Figure N1.6a

Gilesia biniflora occurring in *Eragrostis australasica* grassland (41)

Arid Recovery

Sandalwood

Burrowing Bettong, Greater Stick-nest Rat
Bilby, Numbat, Western Barred Bandicoot,
Australian Bustard, Blue-winged Parrot

Woma
Burrowing Bettong

Plains Rat

Bilby

Plains Rat
Burrowing Bettong

Burrowing Bettong

Relocated Borefield Road

Plains Rat

Plains Rat

Plains Rat

Freckled Duck, Musk Duck, Great Egret, Cattle Egret, Little Egret
Common Sandpiper, Eastern Curlew, Common Greenshank
Marsh Sandpiper, Sharp-tailed Sandpiper, Red-necked Stint
Grey Plover, Caspian Tern, Banded Stilt, Ruddy Turnstone
Restless Flycatcher, Darter, Banded Stilt, Black-tailed Godwit
Spotless Crake, Wood Sandpiper

Plains Rat

Plains Rat

Plains Rat

Glossy Ibis

KP335

KP325

Musk Duck, Australasian Shoveler
Major Mitchell's Cockatoo, Latham's Snipe
Blue-winged Parrot, Peregrine Falcon
Blue-billed Duck, Great Crested Grebe
Darter, Australian Bustards, Cattle Egret
Common Sandpiper, Wood Sandpiper
Banded Stilt, Glossy Ibis, Spotless Crake
Black-tailed Godwit, Plains Rat

Proposed Hiltaba Village

Relocated and expanded airport

KP320

Musk Duck, Australasian Shoveler
Latham's Snipe, Blue-billed Duck
Plains Wanderer, Banded Stilt, Darter
Freckled Duck, Grass Owl, Peregrine Falcon
Wood Sandpiper, Common Sandpiper
Major Mitchell's Cockatoo

Common Sandpiper

Thick-billed Grasswren (Eastern subspecies) occurring in *Maireana aphylla* low shrubland (49)

KP315

Roxby Downs

Acacia aneura woodland (1 - 4)

KP310

joins Figure N1.4a

▲ Kilometre point
Rare or threatened flora
Rare or threatened fauna
Gas pipeline alignment options
Water pipeline alignment
Rail alignment
Transmission line alignment
Existing Olympic Dam Special Mining Lease
Existing Roxby Downs Municipality
EIS Study Area

Vegetation associations where listed species may occur
Flora
Fauna

Vegetation associations
Acacia aneura woodland (1-4)
Acacia papyrocarpa woodland (9, 10, 63)
Acacia shrubland (5-7, 11-15, 40)
Callitris glaucophylla woodland (33, 34)
Chenopod shrubland (17-30, 38, 42, 49-59)
Claypan - no vegetation (39)
Eragrostis australasica grassland (41)
Geijera linearifolia shrubland - *Casuarina pauper* woodland (46)
Melaleuca pauperiflora ssp. *mutica* low woodland +/- *Chenopodium nitrariaceum* shrubland (61)
Muehlenbeckia florulenta +/- *Maireana aphylla* shrubland (62)
Sclerolaena spp. low shrubland (66-68)
Senna shrubland (69)
See Table N1.2 for key to numbers

0 1 2 3 4 5 km

Figure N1.3 Vegetation associations and records of listed species – Olympic Dam

Table N1.2 Key to vegetation numbers used in vegetation figures

Label	Vegetation type	Label	Vegetation type
1	*Acacia aneura/A. tetragonophylla* +/– *Maireana sedifolia* tall shrubland	41	*Eragrostis australasica* grassland
2	*Acacia aneura*/*Casuarina pauper* woodland	42	*Eremophila duttonii*/*Maireana sedifolia*/*Scaevola spinescens* shrubland – *Acacia tetragonophylla* shrubland
3	*Acacia aneura* woodland	43	*Eucalyptus camaldulensis* woodland
4	*Acacia aneura* woodland – *A. papyrocarpa* woodland	44	*Eucalyptus intertexta* woodland
5	*Acacia burkittii* +/– *A. aneura* +/– *A. ramulosa* +/– *Alectryon oleifolius* ssp. *canescens* shrubland	45	*Eucalyptus socialis* woodland
6	*Acacia ligulata* +/– *A. aneura* shrubland – *Melaleuca pauperiflora* ssp. *mutica* woodland	46	*Geijera linearifolia* shrubland – *Casuarina pauper* woodland
7	*Acacia ligulata* +/– *Maireana pyramidata* shrubland	48	*Halosarcia* spp. low shrubland
9	*Acacia papyrocarpa* woodland	49	*Maireana aphylla* low shrubland
10	*Acacia papyrocarpa* woodland – *A. ramulosa* +/– *A. aneura* +/– *A. burkittii* shrubland	50	*Maireana astrotricha* +/– *Ptilotus obovatus* low shrubland
11	*Acacia ramulosa* +/– *A. aneura* +/– *A. ligulata* +/– *Dodonaea viscosa* ssp. *angustissima* shrubland	51	*Maireana astrotricha* low shrubland +/– *M. aphylla* shrubland
12	*Acacia ramulosa* +/– *A. aneura* +/– *A. ligulata* +/– *Dodonaea viscosa* ssp. *angustissima* shrubland – *A. aneura* woodland	52	*Maireana pyramidata*/*Acacia tetragonophylla* +/– *Acacia ligulata* shrubland
13	*Acacia ramulosa* +/– *A. aneura* +/– *A. ligulata* +/– *Dodonaea viscosa* ssp. *angustissima* shrubland with emergent *Callitris glaucophylla*	53	*Maireana pyramidata/Atriplex vesicaria* low shrubland
14	*Acacia tetragonophylla* tall shrubland	54	*Maireana pyramidata*/*M. sedifolia* low shrubland
15	*Acacia victoriae* +/– *Myoporum* sp. +/– *Acacia ligulata* shrubland	55	*Maireana pyramidata* low shrubland
16	*Alectryon oleifolius* ssp. *canescens* tall shrubland	56	*Maireana pyramidata* low shrubland with emergent *A. papyrocarpa* or *A. aneura*
17	*Atriplex vesicaria*/*Halosarcia* spp. +/– *Maireana pyramidata* low shrubland	57	*Maireana sedifolia/Atriplex vesicaria* low shrubland
18	*Atriplex vesicaria/Maireana astrotricha* low shrubland	58	*Maireana sedifolia* low shrubland
19	*Atriplex vesicaria / Maireana astrotricha* low shrubland – *Acacia aneura* +/– *A. tetragonophylla* +/– *A. victoriae* tall shrubland	59	*Maireana triptera* low shrubland
20	*Atriplex vesicaria* / *Nitraria billardieri low* shrubland – *Halosarcia* spp. low shrubland	60	*Melaleuca lanceolata* shrubland
21	*Atriplex vesicaria/Sclerostegia arbuscula* +/– *Maireana sedifolia* low shrubland	61	*Melaleuca pauperiflora* ssp. *mutica* low woodland +/– *Chenopodium nitrariaceum* shrubland
22	*Atriplex vesicaria*/*Sclerostegia* sp. +/– *Maireana eriantha* low shrubland – *Acacia aneura* +/– *Casuarina pauper* woodland	62	*Muehlenbeckia florulenta* +/– *Maireana aphylla* shrubland
23	*Atriplex vesicaria*/*Sclerostegia* sp. low shrubland	63	*Acacia papyrocarpa/Myoporum platycarpum* woodland – Casuarina *pauper* woodland
24	*Atriplex vesicaria* +/– *Gunniopsis quadrifida* low shrubland +/– *Eragrostis australasica* grassland +/– *Maireana aphylla* shrubland	64	*Myoporum platycarpum* woodland
25	*Atriplex vesicaria* +/– *Maireana astrotricha* low shrubland – *Scleroleana* spp. low shrubland	65	*Olearia axillaris*/*Scaevola calendulacea* shrubland
26	*Atriplex vesicaria* +/– *Maireana astrotricha* low shrubland with emergent *Acacia anuera* +/– *A. papyrocarpa*	66	*Sclerolaena* spp. low shrubland
27	*Atriplex vesicaria* +/– *Sclerostegia* sp. low shrubland – *Eragrostis australasica* grassland	67	*Sclerolaena* spp. low shrubland – *Maireana aphylla* shrubland
28	*Atriplex vesicaria* low shrubland	68	*Sclerolaena* spp. low shrubland with emergent *Acacia aneura* +/– *A. papyrocarpa*
29	*Atriplex vesicaria* low shrubland – *Halosarcia* spp. low shrubland – *Acacia aneura/Melaleuca pauperiflora* ssp. *mutica* tall shrubland	69	*Senna* spp. shrubland +/– emergent *A. aneura* or *A. burkittii*
30	*Atriplex vesicaria* low shrubland – *Maireana aphylla* +/– *Chenopodium nitrariaceum* shrubland	70	*Astrebla pectinata* grassland

Table N1.2 Key to vegetation numbers used in vegetation figures (cont'd)

Label	Vegetation type	Label	Vegetation type
31	*Avicennia marina* forest	71	*Cyperus laevigatus, C. gymnocaulos* sedgeland
32	*Beyeria lechenaultii*/*Westringia rigida* low shrubland	72	*Dissocarpus paradoxus* shrubland
33	*Callitris glaucophylla* woodland	73	*Nitraria billardierei* shrubland
34	*Callitris glaucophylla* woodland – *Acacia aneura* woodland	74	*Sclerostegia tenuis* shrubland
36	*Casuarina pauper* woodland	75	*Zygochloa paradoxa* grassland
37	*Casuarina pauper* woodland – *Triodia irritans* grassland	76	*Eucalyptus coolabah* +/– *Acacia stenophylla woodland*
38	*Chenopodium nitrariaceum* shrubland	77	*Acacia ligulata* +/– *Zygochloa paradoxa* shrubland
39	Clay pan, salt pan – no vegetation/ephemerals	78	*Graminae* spp., *Sclerolaena* spp., *Rhodanthe* spp. +/– *Atriplex nummularia* ssp. *nummularia* grassland/herbland
40	*Dodonaea viscosa* ssp. *angustissima* +/– *Acacia ligulata* shrubland +/– *Zygochloa paradoxa* grassland	0	Mine site – no vegetation

Flora

Fatchen (1981) recorded 132 flora species during surveys for the 1982 EIS. Monitoring data has added an additional 56 species, which are mostly ephemeral species not present at the time of Fatchen's survey. During the current field surveys an additional 69 species were recorded, bringing the total number of species in the lease areas to 257 (see Appendix N3).

Listed flora

No species of national conservation significance, listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), have been recorded within the study area. The nearest record of the threatened Club Spear-grass *Austrostipa nullanulla* occurs approximately 50 km west of Pimba.

Two species listed as rare in Schedule 9 of the South Australian *National Parks and Wildlife Act 1972* (NPW Act), *Ophioglossum polyphyllum* and *Gilesia biniflora,* have been recorded within the SML (see Figure N1.3).

Gilesia biniflora was recorded from *Eragrostis australasica* grassland in the northern part of the SML and may occur in similar habitats in drainage areas throughout the SML and Roxby Downs Municipality. This species may occasionally be quite common in swales between dunes following good rainfall seasons (F Badman, pers. comm., 5 June 2006). *Ophioglossum polyphyllum* was not recorded during the current survey but was recorded in the study area during the 1981 baseline survey (Fatchen 1981) and in 1989 where the species was found on sand sheets overlying gibber following a wet season (F Badman, pers. comm., 5 June 2006).

There is an unconfirmed record for *Atriplex kochiana*, which is listed as vulnerable under Schedule 8 of the NPW Act, from the northern part of Arid Recovery. This species occurs on the slopes of stony rises in *Atriplex vesicaria*/*Sclerostegia* sp. low shrubland (J Read, pers. comm., 31 May 2006). Although this species has not been recorded in the study area, the occurrence of suitable habitat in the study area suggests that it may be present.

N1.4.4 Introduced plants

Introduced plants occur at low density throughout the SML and Roxby Downs Municipality. Woody perennial introduced species are uncommon and plants that are present occur within the Roxby Downs township, on Olympic Way and in the SML. A full list of introduced species is included in Appendix N4. The most common species in the SML and Roxby Downs Municipality (see Table N1.3) are monitored and controlled by BHP Billiton.

Table N1.3 Monitored introduced plant species in the SML and Roxby Downs Municipality

Species	Common name	Number of locations		Status[1]
		Special Mining Lease	Municipality of Roxby Downs	
Acacia saligna	Golden Wreath Wattle		4	
Acetosa vesicaria	Rosy Dock	4	26	
Asphodelus fistulosus	Onion Weed		7	Declared
Aster subulatus	Bush Starwort		2	
Avena barbata	Bearded Oat		1	
Brassica tournefortii	Wild Turnip	67	1*	
Cenchrus ciliaris	Buffel Grass	0	53	
Cenchrus incertus	Innocent Weed	0	8	Declared
Conyza bonariensis	Flax-leaf Fleabane		8	
Cucumis myriocarpus	Paddy Melon		2*	
Cynodon dactylon var. *dactylon*	Couch	1	16	
Cyperus eragrostis	Umbrella Grass		1	
Echium plantagineum	Salvation Jane	2	23	Declared
Emex australis	Three-corner Jack	1		Declared
Helianthus annuus	Sunflower		1	
Heliotropum europaeum	Potato Weed		12	
Lactuca serriola	Prickly Lettuce	5	38	
Melia azederach	White Cedar		7	
Opuntia stricta	Prickly Pear		5	Declared
Paspalum sp.	Paspalum	1	1	
Pennisetum clandestinum	Kikuyu		4*	
Pennisetum setaceum	Fountain Grass		31	
Rapistrum rugosum	Turnip Weed		2	
Schinus molle	Pepper-tree		9	
Solanum nigrum	Black Nightshade		16	
Sonchus oleraceus	Common Sow-thistle		7*	
Sorghum bicolor	Columbus Grass		1	
Tamarix aphylla	Athel Pine	14	12	Declared Weeds of national significance
Tribulus terrestris	Caltrop		1*	Declared

[1] Status: Declared – Listed under the South Australian Natural Resources Management Act 2004; Weeds of national significance – As listed in the National Weeds Strategy.
* This species is very common in the municipal lease and this figure underestimates the number of locations in which the species occurs.

Brassica tournefortii is the most common introduced species in the lease area. This species occurs on most dune crests with scattered plants on dune slopes and in sandy swales. During the current survey the cover of *B. tournefortii* on dune crests near Roxby Downs ranged from 10–30%. The cover of this species has not been associated with land disturbance. Early surveys at Olympic Dam in 1980 found that this species had 80% cover but by 1986 cover had fallen to 10% and to 1% by 1994 (Badman 1999). The decline in cover of the species was attributed to competition with native perennial species that establish in response to summer rainfall (Badman 1999).

N1.4.5 Fauna

Mammals have been well surveyed in the vicinity of Olympic Dam. Of the 49 mammal species occurring in the Gawler Bioregion (Neagle 2003), 22 native and five introduced species have been recorded in the SML and Roxby Downs Municipality, excluding Arid Recovery (Read 1994; Kinhill 1997; Appendix N5).

The most significant habitat for mammals in the Olympic Dam region is Arid Recovery, an 86 km^2 predator-proof fenced area north of the SML (see Figure N1.1). Initiated in 1997, the Arid Recovery program facilitates ecological restoration of arid ecosystems by the removal and exclusion of feral animals, the recovery of existing native vegetation and landscape function, and the re-establishment of locally extinct threatened species such as Bilby *Macrotis lagotis*, Greater Stick-nest Rat *Leporillus conditor*, Burrowing Bettong *Bettongia lesueur* and Western Barred Bandicoot *Perameles bougainville*. Since 2000, 12 mammal species have been recorded within or in the vicinity of Arid Recovery (see Appendix N5).

Reptiles form a diverse component of the vertebrate fauna in the area of the proposed expansion. Of the 113 species found in the Gawler Bioregion (Neagle 2003), 55 have been recorded in the SML and Roxby Downs Municipality (Kinhill-Stearns Roger 1982; Read 1994; BHP Billiton opportune fauna database). Since 2000, 41 reptile species have been recorded within Arid Recovery. Birds represent the most diverse vertebrate group in the area of the proposed expansion. Bird species recorded in the Olympic Dam mining area between 1980 and 1996 are reported in Kinhill (1997) and include a total of 171 species. Between 1996 and 2002, 179 species were recorded inside the SML and Roxby Downs Municipality. This comprises 71 species of migratory and wetland birds, 90 bushbirds and 18 birds of prey (see Appendix N5).

Of the four amphibian species found in the Gawler bioregion (Neagle 2003), only the Trilling Frog *Neobatrachus centralis* has been recorded in the Olympic Dam mining area (Read 1999).

Four bats were recorded from bat surveys in the Roxby Downs Municipality. Most bat activity was recorded in the *Atriplex vesicaria/Sclerostegia* sp. shrubland site, where all four species were recorded (Table N1.4). Gould's Wattled Bat *Chalinolobus gouldii* is a new record for the Olympic Dam area, although the species is common in the region (Owens and Read 1999; Neagle 2003).

Table N1.4 Bats recorded at Olympic Dam

Species	Common name	Records for each site[1]	
		***Callitris glaucophylla* woodland near sewage pond**	***Atriplex vesicaria/ Sclerostegia* sp. shrubland**
Mormopterus 'Species 4'	Southern Freetail Bat		B
Chalinolobus gouldii	Gould's Wattled Bat	B C	A B C
Nyctophilus sp.	A Long-eared Bat		A B C
Scotorepens balstoni	Inland Broad-nosed Bat		B

[1] Confidence levels for records:
A = Definite: one or more calls where absolutely no doubt about identification of bat.
B = Probable: most likely the species named; low probability of confusion with species that use similar calls.
C = Possible: one or more calls comparable with the listed species, but high probability of confusion with species that use similar calls.

Species listed under the Environment Protection and Biodiversity Conservation Act 1999

Three nationally threatened fauna species, listed as vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), have been recorded in the mining and municipal lease (see Figure N1.3). These are the Plains Rat *Pseudomys australis*, Plains-wanderer *Pedionomus torquatus* and Thick-billed Grasswren (eastern) *Amytornis textilis modestus*.

Both Plains Rat and Thick-billed Grasswren (eastern) have resident populations in the mining and municipal lease, while the Plains-wanderer is considered a vagrant visitor, with only a single record from the Roxby Township (WMC 2004). A further five nationally threatened fauna species have been introduced to Arid Recovery (Arid Recovery 2005). These are the Burrowing Bettong *Bettongia lesueur*, Bilby *Macrotis lagotis*, Greater Stick-nest Rat *Leporillus conditor*, Western Barred Bandicoot *Perameles bougainville* and Numbat *Myrmecobius fasciatus*.

State listed species

In South Australia, the Western-Barred Bandicoot, Plains-wanderer, Burrowing Bettong and Numbat are listed as endangered (E) under schedules of the NPW Act. The Bilby, Plains Rat and Greater Stick-nest Rat are listed as vulnerable (V) and the Yellow-bellied Sheathtail Bat *Saccolaimus flaviventris* is listed as rare (R).

The Woma *Aspidites ramsayi* is the only state-listed reptile recorded in the Olympic Dam area.

A number of state-listed bird species have been recorded in the Olympic Dam region. The Thick-billed Grasswren (eastern) *Amytornis textilis modestus* was the only one of these to have a resident population, in the eastern section of the expanded SML (J Read, pers. comm., 1 March 2006). However this species was removed from the NPW Act schedules in 2008 as it no longer met the criteria for rare.

State-listed nomadic and regular seasonal visitors to the Olympic Dam region are the Freckled Duck *Stictonetta naevosa* (V), Australian Bustard *Ardeotis australis* (V), Blue-winged Parrot *Neophema chrysostoma* (V), Australasian Shoveler *Anas rhynchotis* (R), Blue-billed Duck *Oxyura australis* (R), Glossy Ibis *Plegadis falcinellus* (R), Musk Duck *Biziura lobata* (R), Black-breasted Buzzard *Hamirostra melanosternon* (R), Common Sandpiper *Actitis hypoleucos* (R), Banded Stilt *Cladorhynchus leucocephalus* (V), Major Mitchell's Cockatoo *Cacatua leadbeateri* (R) and Flock Bronzewing *Phaps histrionica* (R).

Other state-listed vagrants that may visit the area include the Plains-wanderer *Pedionomus torquatus* (E), Eastern Curlew *Numenius madagascariensis* (V), Latham's Snipe *Gallinago hardwickii* (V), Darter *Anhinga melanogaster* (R), Black-tailed Godwit *Limosa limosa* (R), Wood Sandpiper *Tringa glareola* (R) and the Peregrine Falcon *Falco peregrinus* (R).

Other significant species

Many migratory bird species breed during June and July in the arctic regions of Eastern Europe, China, Alaska and parts of Japan. These birds migrate through South-East Asia to spend the non-breeding season in Australia before returning to the northern hemisphere the next year to breed. Nineteen species of migratory birds recorded in the Olympic Dam Region are protected by an international agreement between Australia and China (CAMBA), and 19 species are protected by an agreement between Australia and Japan (JAMBA) (see Appendix N5 for species lists).

N1.4.6 Introduced and over abundant fauna

The principal pest animals in the SML and Roxby Downs Municipality are the Fox *Vulpes vulpes*, Cat *Felis catus* and Rabbit *Oryctolagus cuniculus*. Red Kangaroo *Macropus rufus* is abundant. A full list of introduced vertebrate species is provided in Appendix N5.

Foxes, cats, rabbits and kangaroo numbers are regularly monitored around the Olympic Dam area (BHP Billiton 2005). Foxes were not trapped or recorded on monitoring transects during 2003 or 2004 and numbers have decreased from the long-term mean average of 0.42 animals per km^2 (WMC 2004). Cat numbers remain low although 119 cats were trapped in 2004 (WMC 2004).

Populations of rabbits and kangaroos naturally fluctuate with climatic conditions. Following the introduction of rabbit haemorrhagic disease (RHD) in 1996, rabbit numbers plummeted throughout the Olympic Dam region (Bowen and Read 1998), remaining at very low abundance until recently when numbers increased as a result of higher than average rainfall in 2004 (WMC 2004). However, local rabbit abundance remains much lower than the historical average in the Roxby Downs Municipality and SML (WMC 2004). Kangaroo abundance is up to twice the historical average near the mine and three times the historical average near Roxby Downs (WMC 2004). Reasons for the increase are possibly the lack of competition from domestic stock with the cessation of grazing on the existing SML and Municipality of Roxby Downs and the increased availability of water (WMC 2004).

N1.5 SOUTHERN INFRASTRUCTURE CORRIDOR

N1.5.1 Introduction

The ecological features of the southern infrastructure corridor (including the transmission line, water pipeline and railway) are described together as they generally occur within a single broad 10 km corridor (see Figure N1.4a–f). The disturbance footprint in each corridor would be about 30 m for each service. The northern section of the southern infrastructure corridor coincides with the Roxby Downs Municipality and SML, which has previously been described (Section N1.4). This section of the appendix describes the ecological features of the infrastructure corridors south of the leases. In most cases, the proposed infrastructure follows existing infrastructure easements, which contain a combination of roads, tracks, powerlines and pipelines.

Broad descriptions of the landforms and vegetation along the transmission line corridor were described and mapped for the first Olympic Dam Environmental Impact Statement (Kinhill-Stearns Roger 1982). Detailed vegetation surveys of the transmission line corridor between Olympic Dam and Port Augusta were completed in 1991 (WMC 1997). During these surveys vegetation communities within the corridor and their character species were described, lists were compiled of vascular plant species, and data collected on landforms, vegetation structure and vegetation condition in relation to grazing. Most of the vegetation work was based on surveys conducted in winter and spring 1991, with supplementary surveys of some areas in December 1991 and March 1992. Some changes to the original route were surveyed in 1997.

Vertebrate surveys along the transmission line corridor were conducted on several occasions in 1991 (WMC 1997). Mammal and reptile surveys included pitfall traps along two trap lines in each Environmental Association (now classified as land systems), and opportunistic observations and active searches under rocks and in leaf litter. Bird surveys comprised observations along traverses in a vehicle and on foot, and several waterbird censuses on the Arcoona Lakes.

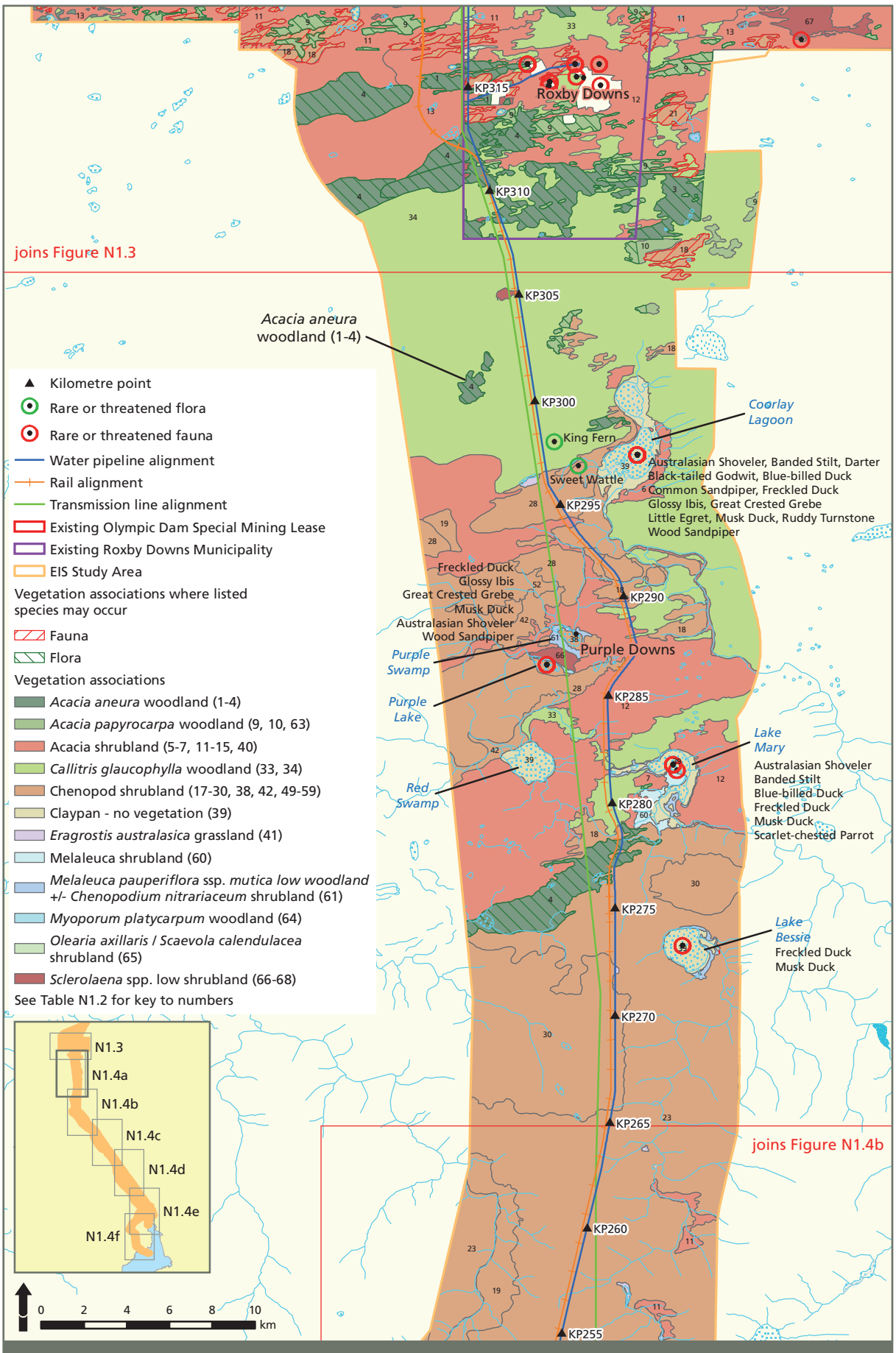

Figure N1.4a Vegetation associations and records of listed species – southern infrastructure corridor (Section a)

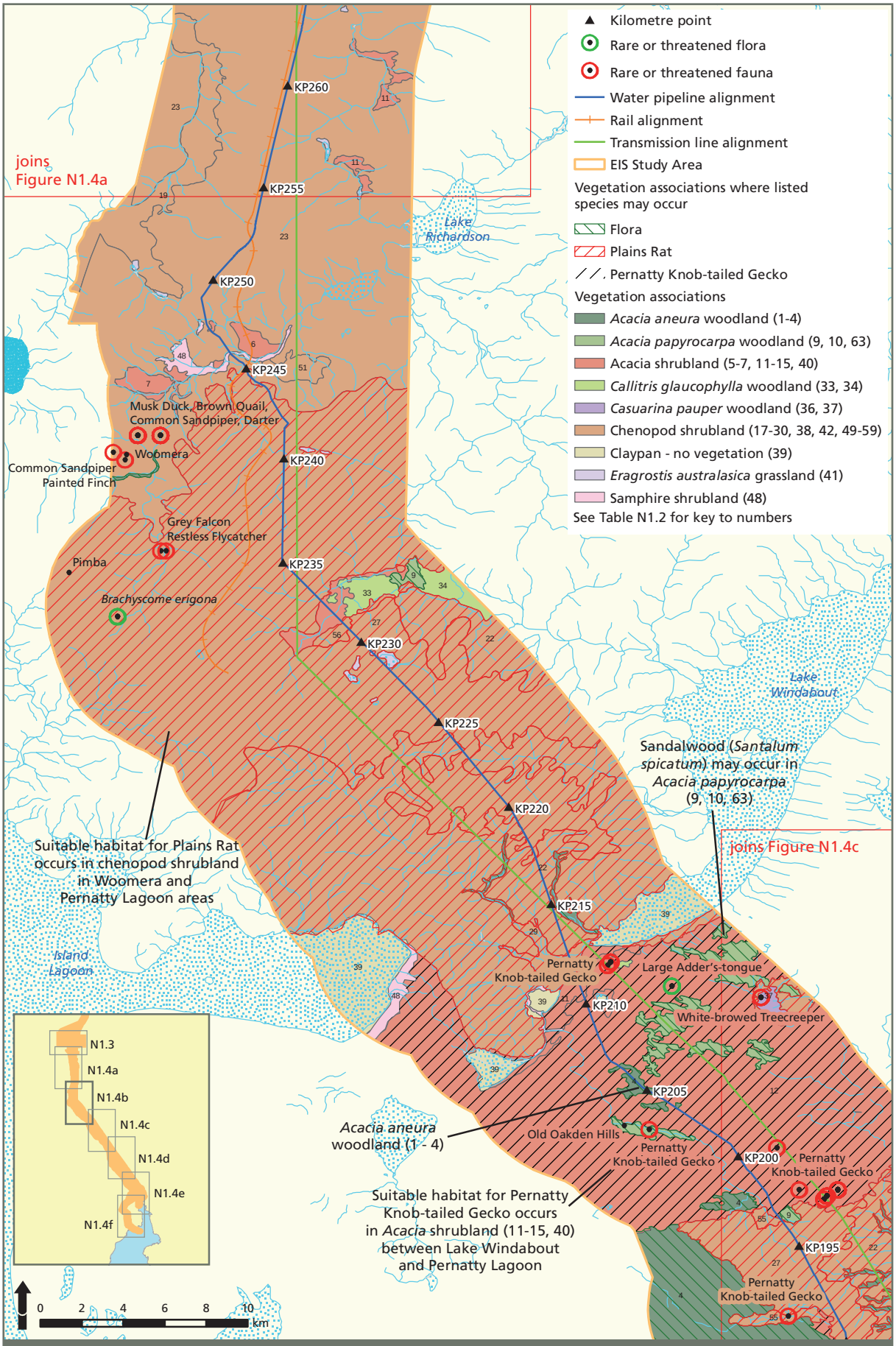

Figure N1.4b Vegetation associations and records of listed species – southern infrastructure corridor (Section b)

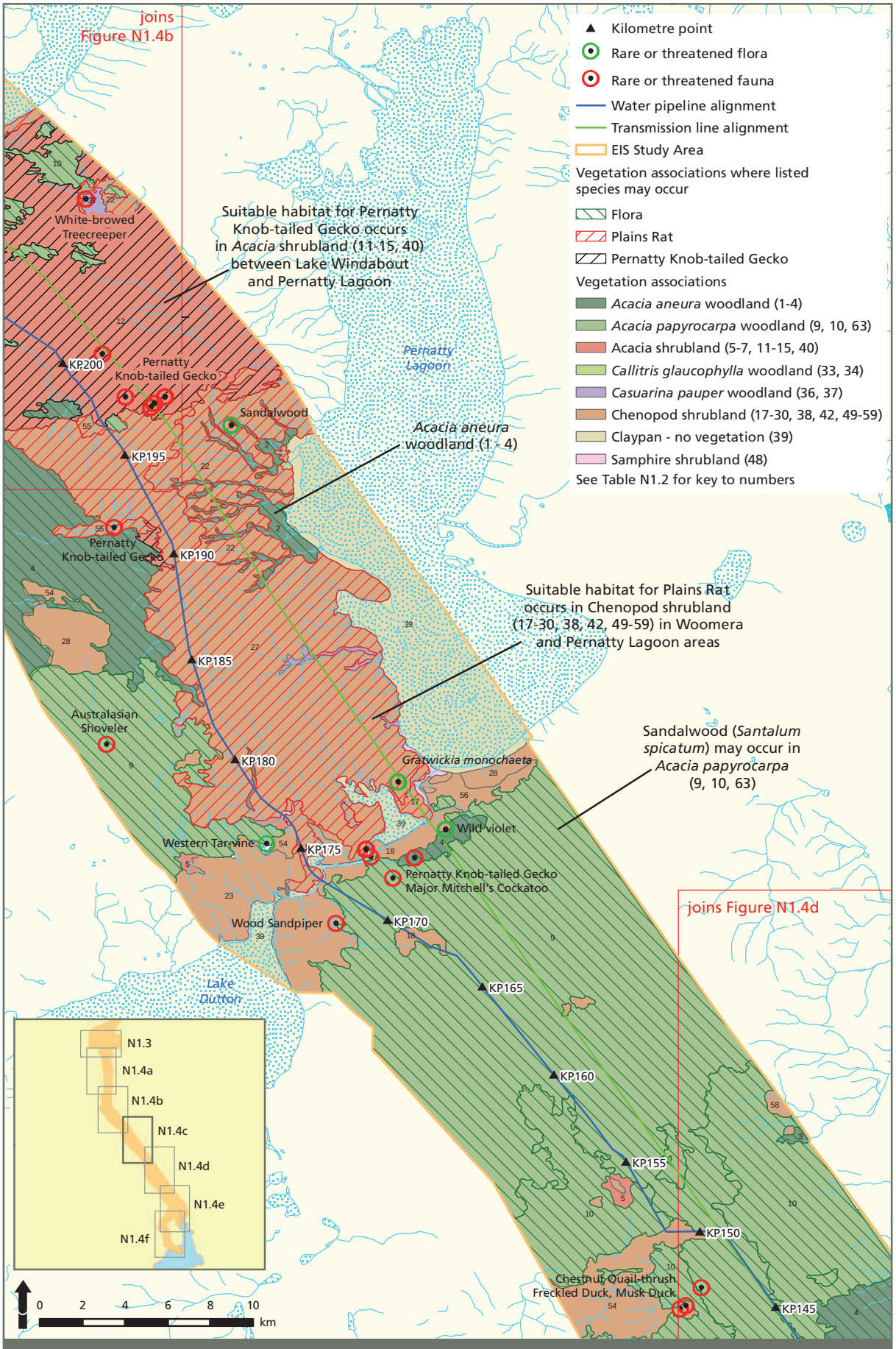

Figure N1.4c Vegetation associations and records of listed species – southern infrastructure corridor (Section c)

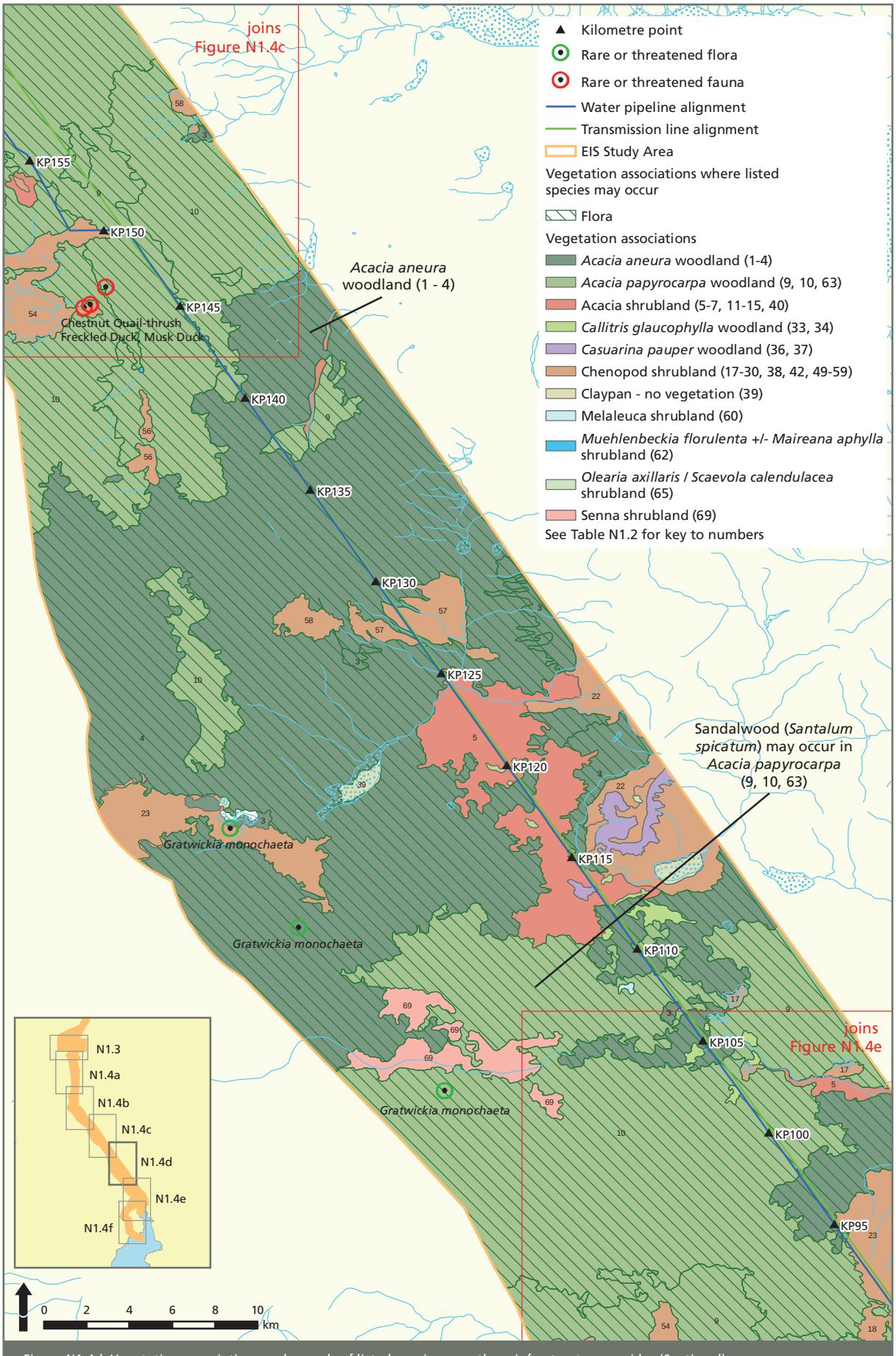

Figure N1.4d Vegetation associations and records of listed species – southern infrastructure corridor (Section d)

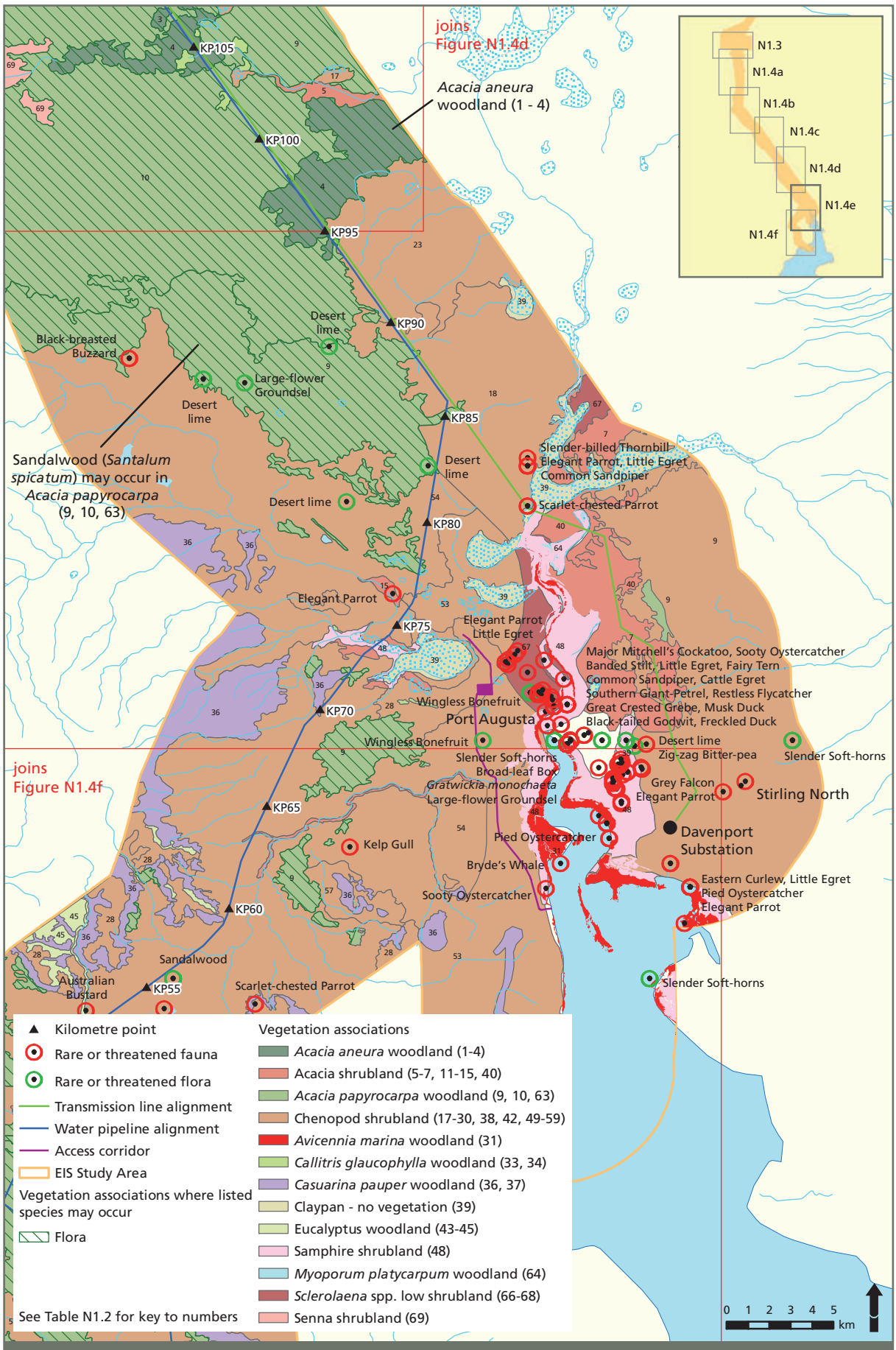

Figure N1.4e Vegetation associations and records of listed species – southern infrastructure corridor (Section e)

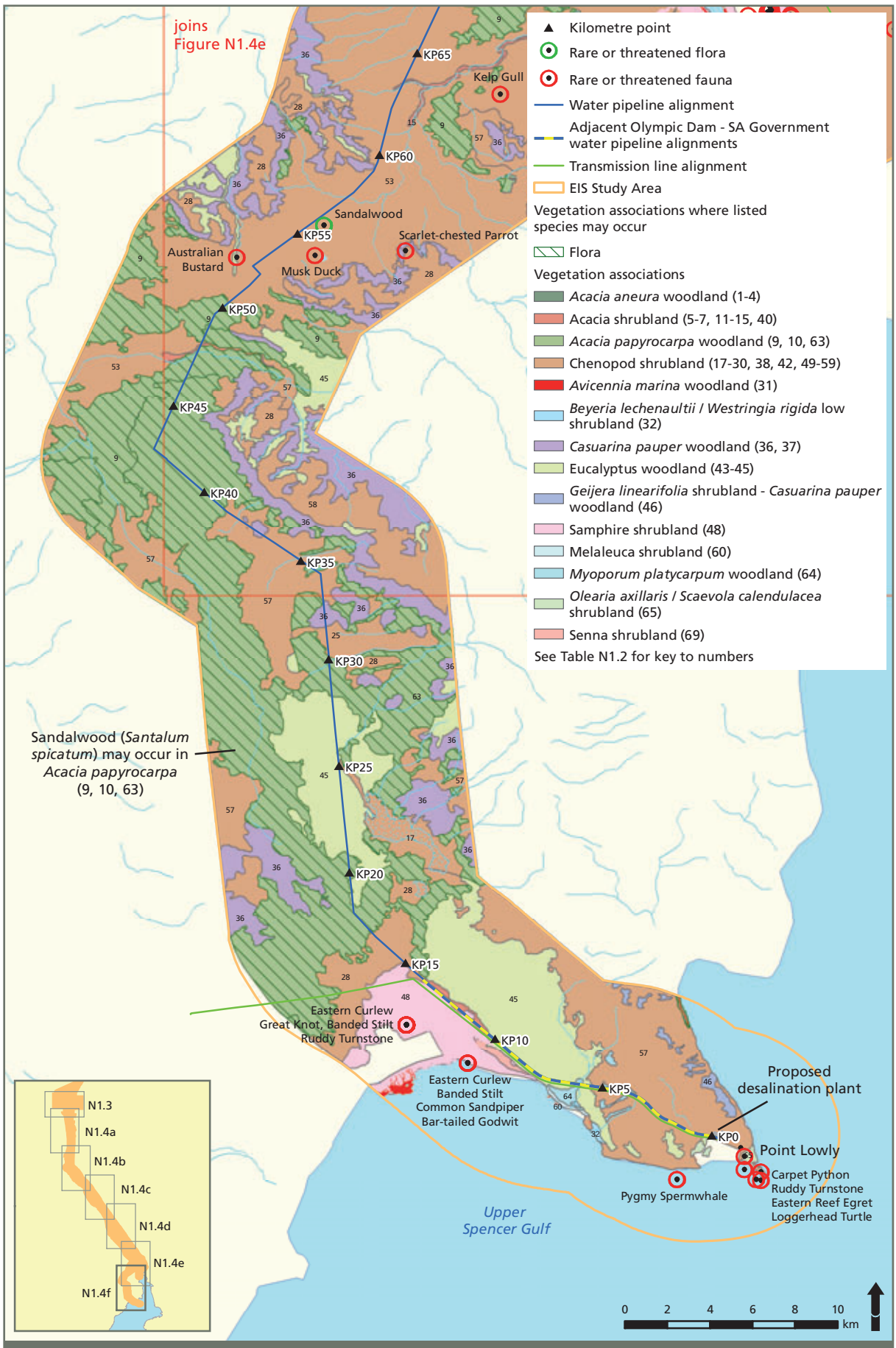

Figure N1.4f Vegetation associations and records of listed species – southern infrastructure corridor (Section f)

N1.5.2 Land systems

The southern infrastructure corridor traverses 12 land systems from north to south (see Table N1.5, Figure N1.2).

Table N1.5 Land systems in the southern infrastructure corridor

Land system	Brief description	Rail	Pipeline	Transmission line
Roxby	Undulating plain with sand sheets, dunes and low silcrete-capped rises overlying ancient basement limestone	✓	✓	✓
Lookout	Silicified shale hills of the Stuart Range, stony rises and plains	✓	✓	✓
Arcoona	Broad gently undulating gibber plateau grading to steep marginal slopes in the south	✓	✓	✓
Torrens	Salt crusted lake beds and shorelines		✓	✓
Hesso	Gently undulating sandy plain, calcareous rises and sand ridges		✓	✓
Bowen	Low calcareous stony rises and salt lagoons		✓	✓
Tent Hill	Quartzite plateau with steep escarpments and long footslopes		✓	✓
Yorkey	Saltmarshes, yellow and red dunefields, drainage channels and salt lagoons		✓	✓
Saltia	Alluvial footslopes and plains of stony red soils on the western flanks of the Flinders Ranges			✓
Yudnapinna	Dissected undulating plains and gilgai plain		✓	
Pandurra	Sandstone hills		✓	
Bittali	Gentle footslopes and calcareous plains		✓	

N1.5.3 Vegetation associations

Roxby land system

The Roxby land system includes an area of aeolian dunes in the northern part of the study area that extends into the area surrounding Olympic Dam. This land system also occurs in the central part of the southern infrastructure corridor where dunefields overlie the sandstone plateau of the Arcoona land system. The vegetation of this area was described in the previous section and these vegetation types continue into the infrastructure corridors within this land system. Three additional vegetation associations occur in the infrastructure corridor but not in the SML and Roxby Downs Municipality (see Table N1.6). These plant associations occur in drainage lines or are associated with drainage depressions.

Shrublands of *Atriplex ligulata* and/or *Maireana pyramidata* occur on dunes around lagoons. At lower elevations *Halosarcia* sp. become frequent and these shrublands typically have an understorey of small chenopod shrubs. Lagoons in the southern part of the land system are fringed by *Halosarcia* sp. low shrubland. Shrublands with *Acacia victoriae, A. ligulata*, and *Myoporum* sp. occur in watercourses.

Table N1.6 Additional vegetation associations in Roxby land system in the southern infrastructure corridor

Vegetation association	Land forms
Acacia victoriae, A. ligulata, and *Myoporum* sp. tall shrubland	Watercourses
Acacia ligulata/Maireana pyramidata shrubland	Low dunes around lagoons
Halosarcia sp. low open shrubland	Lagoon fringes

Lookout land system

This small land system occurs to the west of Purple Downs Station. The stony rises, lagoons and plains of the Lookout land system occupy only a small proportion of the study area but they include unique or uncommon vegetation associations (see Table N1.7). The small lagoons in this land system are vegetated with *Chenopodium nitrariaceum* with a fringe of *Melaleuca pauperiflora* ssp. *mutica* Woodland. These woodlands have many juvenile *M. pauperiflora* ssp. *mutica* plants. Stony slopes have open shrublands of *Maireana sedifolia* or mixed shrublands with *Eremophila duttonii* and *Scaevola spinescens*. A shrubland dominated by *Sclerolaena tatei* on a calcareous rise south of Purple Swamp was the only occurrence of this vegetation association in the study area.

Table N1.7 Vegetation associations in Lookout land system

Vegetation association	Land forms
Melaleuca pauperiflora ssp. *mutica* tall shrubland to low woodland	Lagoon fringes (Purple Swamp)
Sclerolaena tatei low shrubland	Calcareous rises
Acacia tetragonophylla tall shrubland	Drainage lines on stony rises
Maireana pyramidata shrubland	Sandy-clay soils on plains
Acacia ligulata shrubland	Low dunes and sandsheets
Eremophila duttonii/*Scaevola spinescens*/*Maireana sedifolia* shrubland	Stony rises
Maireana sedifolia open shrubland	Stony rises
Chenopodium nitrariaceum shrubland	Swamps (Purple Swamp)

Arcoona land system

The Arcoona land system extends from just south of Purple Downs Station to the southern extent of Pernatty Lagoon (see Figure N1.2) and is interrupted by the dunefields of the Roxby land system. The Arcoona land system comprises the Arcoona Plateau, north and south of Woomera, small areas of tableland near Purple Downs Station and tableland west of Pernatty Lagoon. The land system also includes Mount Gunson and Uro Bluff.

The steep scarp of the Arcoona Plateau rises to the north of Lake Windabout, with the drainage lines on the southern edge of the plateau draining into the lake. The tableland surface is gently undulating and has a micro-relief of gibber pavements and gilgai. The gibber pavements are typically devoid of vegetation with most vegetation occurring in the gilgai where there are chenopod shrubs and grasses. Drainage is via steep, rocky watercourses into the lake systems that surround the plateau or internally into gilgai and swamps.

Although the stony tablelands have a relatively homogeneous, vegetation cover of low chenopod shrublands there are subtle differences related to topography and grazing pressure (see Table N1.8). Flat to gently undulating stony tableland supports low shrublands of *Atriplex vesicaria* and *Sclerostegia medullosa*. *Atriplex vesicaria* is absent from plateau slopes at the northern extremity of the land system where there are shrublands of *Sclerostegia* sp. and *Sclerolaena* sp. Areas of the plateau where grazing pressure is low have shrublands of *A. vesicaria* with the grass, *Astrebla pectinata*. Steeper slopes near Pernatty Lagoon have mixed shrublands of *A. vesicaria*, *S. medullosa* and *Maireana eriantha*. This vegetation association also forms an understorey to open shrublands of *Eremophila duttonii* on steep slopes above drainage lines near Pernatty Lagoon.

Drainage lines at the southern edge of the land system, which drain into Lake Windabout, have woodlands of *Acacia aneura* or *Casuarina pauper*. The understorey of these woodlands is quite diverse and includes large shrubs such as *Prostanthera striatiflora, Eremophila* sp., *Hakea leucoptera* and *Exocarpos aphyllus*. The lower reaches of drainage lines have shrublands of *Halosarcia* sp. and *Melaleuca pauperiflora* ssp. *mutica* or *Myoporum montanum*.

Table N1.8 Vegetation associations in the Arcoona land system

Vegetation association	Land forms
Atriplex vesicaria/Astrebla pectinata low shrubland	Tablelands
Atriplex vesicaria/Maireana astrotricha low shrubland	Tablelands
Atriplex vesicaria/Sclerostegia medullosa/Maireana eriantha low shrubland	Steep to gentle tableland slopes
Atriplex vesicaria/Sclerostegia medullosa low shrubland	Tablelands
Atriplex vesicaria low shrubland	Tablelands
Casuarina pauper low open woodland	Steep slopes of drainage lines Upper escarpment slopes and plateaux (Uro Bluff)
Eremophila duttonii open to very open shrubland	Steep slopes of drainage lines
Sclerostegia sp. *and Sclerolaena* sp. low shrubland	Gentle tableland slopes
Atriplex vesicaria/Halosarcia sp. low shrubland	Footslopes near lagoons
Atriplex vesicaria low shrubland	Upper catchments of large rocky drainage lines and small rocky drainage lines
Casuarina pauper +/– Acacia aneura low open woodland	Rocky drainage lines
Eragrostis australasica grassland	Gilgai Swamps
Maireana aphylla +/– Chenopodium nitrariaceum shrubland	Gilgai
Myoporum montanum/Halosarcia sp. shrubland	Lower reaches of rocky drainage lines or sandy drainage lines

On the plateaux, drainage is typically internal into gilgai and swamps. The swamps support *Maireana aphylla* or *Chenopodium nitrariaceum* shrublands or *Eragrostis australasica* grasslands.

Torrens land system

Within the study area, the Torrens land system includes the lake bed and shores of Lake Windabout, the drainage area between Lake Windabout and Island Lagoon, Pernatty Lagoon and Ironstone Lagoon. The beds of these lagoons are devoid of vegetation. They have a narrow fringe of *Halosarcia* sp. low open shrubland. The alluvial plain of the drainage line off the Arcoona Plateau supports chenopod shrubland, and tall shrubland of *Myoporum acuminatum* and *Melaleuca pauperiflora* ssp. *mutica* (see Table N1.9).

Table N1.9 Vegetation associations in Torrens land system

Vegetation association	Land forms
Halosarcia sp. low open shrubland	Lagoon fringes
Atriplex vesicaria/*Halosarcia* sp. low open shrubland	Alluvial plain
Myoporum acuminatum/*Melaleuca pauperiflora* ssp. *mutica* tall shrubland	Alluvial plain

Hesso land system

The extensive sandplains of the Hesso land system extend from about 15 km north of Port Augusta to Ironstone Lagoon. These sandplains are dominated by *Acacia papyrocarpa* woodlands, although *Acacia aneura* woodlands are also common. Dunes overlying the sandplain have shrublands of *Acacia burkittii* and *A. ramulosa*. Dune systems with low sand ridges in the southern part of the land system have groves of *Casuarina pauper* low open woodland and *Callitris glaucophylla* woodland. There are areas of sandplain devoid of trees with shrublands of *Senna* sp. and *Acacia burkittii*. Tall understorey shrubs common in *Acacia* woodlands are *Acacia burkittii* in *A. aneura* woodlands and *Senna artemisioides* ssp. *petiolaris* in *A. papyrocarpa* woodlands. Lightly grazed sites typically have an understorey of chenopod shrubs and native grasses. Common species include *Atriplex vesicaria*, *Maireana campanulata, M. pyramidata, M. sedifolia, Aristida* sp. and *Enneapogon* sp. Grassy understorey is more common in *A. aneura* woodlands than *A. papyrocarpa* woodlands.

The woodlands are grazed by sheep, cattle and rabbits. Impacts of stock grazing are most evident within the vicinity of stock watering points and on the southern boundaries of east-west fence lines. Grazing by rabbits is widespread. Grazing results primarily in changes to understorey structure which results in the loss of palatable chenopod shrubs such as *Atriplex vesicaria* and the persistence of less palatable shrubs such as *Maireana pyramidata*. Grazing can also suppress the recruitment of trees including *Acacia papyrocarpa* and *A. aneura* (Crisp 1978; Lange and Graham 1983; Ireland 1997).

There are some small calcareous rises with shrublands of *Maireana astrotricha* and *Atriplex vesicaria* (see Table N1.10).

Table N1.10 Vegetation associations in the Hesso land system

Vegetation association	Land forms
Acacia aneura low open woodland	Sand plains and dunefields
Acacia papyrocarpa low open woodland	Sand plains on calcareous sandy loams Swales in dunefields
Acacia aneura/A. papyrocarpa low open woodland	Sand plains
Acacia aneura/Alectryon oleifolius ssp. *canescens* low open woodland	Dune crests and slopes in dunefields
Acacia burkittii low open woodland	Dunefields
Casuarina pauper low open woodland	Dunefields
Callitris glaucophylla low open woodland	Dunefields
Acacia ramulosa/A. aneura/A. burkittii tall open shrubland	Dune crests and upper dune slopes
Dodonaea viscosa ssp. *angustissima/Acacia ligulata* shrubland	Dune crests
Senna sp./*Dodonaea microzyga/Maireana sedifolia* shrubland	Stony rises
Maireana astrotricha +/– Atriplex vesicaria low open shrubland	Stony rises
Maireana sedifolia low open shrubland	Shallow sandy clay loams over limestone
Atriplex vesicaria/Maireana sedifolia low open shrubland	Sandplains on shallow sands over limestone
Maireana pyramidata low open shrubland	Sandy clay soils in drainage areas

Bowen land system

The Bowen land system occupies only a small portion of the southern infrastructure corridor within the Hesso land system, south of Kootaberra Outstation (see Figure N1.2). Low chenopod shrublands of *Atriplex vesicaria*, *Sclerostegia* sp. and/or *Maireana sedifolia* occur on calcareous stony rises. Run-on areas at the base of the stony rises and sandy-clay soils near lagoons support *Maireana pyramidata* shrublands. The margins of saline lagoons have *Halosarcia* sp. and *Gunniopsis quadrifida* shrublands. Smaller drainage areas have shrublands of *Maireana aphylla* and *Muehlenbeckia florulenta* (see Table N1.11).

Table N1.11 Vegetation associations in the Bowen land system

Vegetation association	Land forms
Acacia aneura low open woodland	On low dunes surrounding lagoon
Maireana pyramidata low open shrubland	Run-on areas at base of stony rises Sandy-clay soils near lagoons
Atriplex vesicaria/Sclerostegia sp. low open shrubland	Slopes of stony rises
Maireana sedifolia +/– Atriplex vesicaria low open shrubland	Stony rises
Halosarcia sp./*Gunniopsis quadrifida* low open shrubland	Margins of clay pans
Maireana aphylla/Muehlenbeckia florulenta shrubland	Drainage areas
Dodonaea viscosa ssp. *angustissima/Acacia ligulata* shrubland	Low dunes

Tent Hill land system

The Tent Hill land system includes plateaux and steep escarpments and footslopes from north of Port Augusta to Point Lowly (see Figure N1.2). The steep escarpments between Point Lowly and Port Augusta have woodlands of *Casuarina pauper* or open hummock grasslands of *Triodia irritans*. Near Point Lowly, small drainage lines on the plateaux support shrublands with *Eremophila* sp. or open *Myoporum platycarpum* woodland. Steep easterly facing slopes have open shrublands of *Geijera linearifolia*. Sheltered gullies have stands of *Alectryon oleifolius* ssp. *canescens* and gully slopes have *Casuarina pauper* woodlands.

Drainage lines at Lincoln Gap have open woodlands of *Eucalyptus intertexta* and drainage lines on the footslopes support *Acacia victoriae* open shrublands. Upper plateau slopes have *Eucalyptus socialis* or *Casuarina pauper* woodlands and chenopod shrublands. Chenopod shrublands also occur on the upper plateau, escarpments and footslopes. *Maireana sedifolia* and *Atriplex vesicaria* are the dominant species on the upper plateau and slopes, whereas *Maireana pyramidata* or mixed shrublands of *A. vesicaria* and *Sclerostegia tenuis* dominate the lower footslopes and plains. The plains also support open to very open woodlands of *Acacia papyrocarpa* and *Casuarina pauper* with an understorey of chenopod shrubs. Scarp slopes and plateaux north of Yorkey's Crossing have low shrublands of *Atriplex vesicaria, Maireana sedifolia* and *M. astrotricha* (see Table N1.12).

Table N1.12 Vegetation associations in the Tent Hill land system

Vegetation association	Land forms
Olearia axillaris/Scaevola calendulacea open shrubland	White calcareous coastal dunes
Beyeria lechenaultii/Westringia rigida low open shrubland	Sandy-clay soils on coastal cliff tops
Acacia papyrocarpa low open woodland	Footslopes
Casuarina pauper low woodland to open woodland	Footslopes Steep escarpments Steep quartzite slopes
Eucalyptus socialis low woodland	Tablelands
Geijera linearifolia shrubland	Steep quartzite slopes
Dodonaea viscosa ssp. *angustissima* shrubland	Low dunes
Maireana pyramidata low open shrubland	Run-on areas on footslopes and in drainage lines
Acacia victoriae tall open shrubland	Large open drainage lines
Maireana sedifolia low open shrubland	Tablelands and escarpment slopes and low rises
Atriplex vesicaria/Maireana astrotricha low open shrubland	Upper plateau slopes north of Port Augusta
Maireana sedifolia/Atriplex vesicaria low open shrubland	Plateaux Footslopes
Myoporum platycarpum open woodland	Drainage lines on plateaux
Maireana pyramidata/Maireana sedifolia low open shrubland	Footslopes
Triodia irritans hummock grassland	Steep escarpment slopes and plateaux
Avicennia marina ssp. *marina* low open woodland	Pebbly beaches at Point Lowly
Eucalyptus intertexta open to very open woodland	Rocky drainage lines on lower footslopes of tablelands

At Point Lowly, chenopod shrublands occur in places down to the shoreline. Sandy soils on Fitzgerald Bay have open *Myoporum platycarpum*/*Alectryon oleifolius* ssp. *canescens* woodland with an understorey of chenopod shrubs. Scattered mangroves occur on the pebbly beaches. Coastal dunes at Point Lowly have open shrublands of *Olearia axillaris* and *Scaevola crassifolia* or *Acacia longifolia* var. *sophorae*. These shrublands are typically disturbed and have a high proportion of introduced species. They have been previously cleared in places for housing construction.

Most of the area within the southern infrastructure corridor in this land system is disturbed by stock grazing. The groundlayer comprises the introduced annual forb, **Carrichtera annua*. Chenopod shrub density has been reduced around some stock watering points and these areas have a low groundlayer of *Sclerolaena* sp. or **Carrichtera annua*.

Yorkey land system

The Yorkey land system occurs in the transmission line corridor near Port Augusta and the pipeline corridor near Point Lowly (see Figure N1.2). The tidal flats comprise alluvial soils with grey calcareous loams and support *Avicennia marina* ssp. *marina* woodlands or forests and *Halosarcia* sp. shrublands. The alluvial plains surrounding Port Augusta have *Maireana pyramidata* shrublands with *Acacia ligulata* shrublands on short dunes. *Acacia papyrocarpa* woodlands occur patchily in swale areas and have an understorey of *Maireana pyramidata*. Salt lakes at the head of the gulf are fringed by *Halosarcia* sp. shrublands and low clayey dunes support open shrublands of *Nitraria billardieri*, *M. pyramidata* and *Acacia ligulata* (see Table N1.13).

Table N1.13 Vegetation associations in the Yorkey land system

Vegetation association	Land forms
Acacia ligulata +/– *Acacia oswaldii* +/– *Maireana pyramidata* open shrubland	Low dunes on coastal plain
Acacia papyrocarpa low open to very open woodland	Alluvial plains
Alectryon oleifolius ssp. *canescens* tall shrubland	Low dunes on alluvial plain
Atriplex vesicaria/Halosarcia sp. low open shrubland	Sands and clays around lagoons
Atriplex vesicaria low open shrubland	Alluvial plains
Avicennia marina ssp. *marina* low forest	Tidal flats
Callitris glaucophylla/Dodonaea viscosa ssp. *angustissima* low open woodland	Sand dunes
Dodonaea viscosa ssp. *angustissima/Acacia ligulata* open shrubland	Sand dunes
Halosarcia sp. low shrubland to low open shrubland	Tidal flats Fringing salt lakes
Atriplex vesicaria/Nitraria billardieri low open shrubland	Sandy-clay dunes near lagoons
Maireana pyramidata low open shrubland	Alluvial plain
Maireana pyramidata/M. sedifolia low open shrubland	Alluvial plains
Zygochloa paradoxa open grassland	Sand dunes

Extensive coastal flats between Port Bonython and Whyalla have been highly modified by the construction of salt-production evaporation pans. Tidal flats at Port Augusta are also modified at the site surrounding the power station. Other native vegetation in the Port Augusta area has been cleared or is disturbed by stock grazing and off-road vehicles. Dune areas are invaded by introduced species, particularly the woody species **Schinus molle* and **Nicotiana glauca*.

Saltia land system

The Saltia land system occurs in a small part of the transmission line corridor near Port Augusta (see Figure N1.2). In the study area, plant associations in this land system include *Maireana pyramidata* shrublands on alluvial plains and *Eucalyptus camaldulensis* woodland and *Acacia victoriae* shrubland in drainage lines. Most of this area has been disturbed as it occurs on the fringes of the townships of Port Augusta and Stirling North (see Table N1.14).

Table N1.14 Vegetation associations in the Saltia land system

Vegetation association	Land forms
Maireana pyramidata open shrubland	Alluvial plains
Eucalyptus camaldulensis open to very open woodland	Drainage lines
Acacia victoriae tall open shrubland	Drainage lines

Yudnapinna land system

The water pipeline corridor traverses the Yudnapinna land system along the Lincoln Highway between Whyalla and the Eyre Highway turn-off (see Figure N1.2). The area comprises plains with low chenopod shrublands of *Atriplex vesicaria* and *Maireana sedifolia*. This plant association occurs as understorey to open woodlands of *Acacia papyrocarpa, Myoporum platycarpum* and *Casuarina pauper*. The area is disturbed by grazing and the groundlayer is dominated by the weed **Carrichtera annua* (see Table N1.15).

Table N1.15 Vegetation associations in the Yudnapinna land system

Vegetation association	Land forms
Atriplex vesicaria and *Maireana sedifolia* open shrubland	Alluvial plains
Acacia papyrocarpa/Myoporum platycarpum/Casuarina pauper open woodland	Alluvial plains
Acacia papyrocarpa open woodland	Alluvial plains

Pandurra land system

The Pandurra land system occurs on the western boundary of the pipeline corridor north of Whyalla. There are plains with chenopod shrubland communities and open woodlands with *Acacia papyrocarpa*. Low sandstone hills in this land system also have low chenopod shrublands (see Table N1.16).

Table N1.16 Vegetation associations in the Pandurra land system

Vegetation association	Land forms
Acacia papyrocarpa open woodland	Plains and footslopes
Atriplex vesicaria low open shrubland	Alluvial plains
Maireana sedifolia open shrubland	Alluvial plains and hillslopes

Bittali land system

The Bittali land system occurs primarily to the west of Point Lowly (see Figure N1.2). Gentle footslopes on sandy loam soils near Point Lowly have mallee woodlands with an overstorey of *Eucalyptus socialis* and *E. gracilis*. The woodlands have a shrubby understorey that includes *Olearia muelleri, Westringia rigida, Atriplex stipitata*, *Rhagodia spinescens* and *Grevillea huegelii.* Mallee woodlands near Point Lowly are undisturbed beyond the road reserve and have not been recently grazed.

There is a complex of vegetation associations occurring along the coastal sands and abutting tidal flats. At the lowest elevations on the stony beaches there are scattered mangroves. The foremost low dunes behind the beach support very open *Atriplex vesicaria* shrublands with an understorey of *Carpobrotus rossii* with emergent *Melaleuca lanceolata*. Recreational beach users and shack developments have disturbed these dunes. On secondary dunes behind these there is open *Myoporum platycarpum* woodland over *Atriplex vesicaria, Beyeria lechenaultii* and *Westringia rigida* or mixed shrublands of *Melaleuca lanceolata, Alectryon oleifolius* ssp. *canescens* and *Acacia ligulata*. Rubbish dumping and off-road vehicle use have disturbed these dunes. Where mallee vegetation has been cleared along the road, there is *Dodonaea viscosa* ssp. *angustissima*/*Acacia ligulata* shrubland. *Atriplex vesicaria* shrublands occur on calcareous plains (see Table N1.17).

Table N1.17 Vegetation associations in the Bittali land system

Vegetation association	Land forms
Acacia ligulata/Dodonaea viscosa ssp. *angustissima* open shrubland	Footslopes on sandy soils
Eucalyptus socialis/E. gracilis woodland	Footslopes
Alectryon oleifolius ssp. *canescens/Melaleuca lanceolata/Acacia ligulata* tall open shrubland	Secondary coastal dunes
Atriplex vesicaria low open shrubland	Primary coastal dunes Calcareous plains
Avicennia marina ssp. *marina* open woodland	Stony beach
Myoporum platycarpum low open woodland	Secondary coastal dunes
Halosarcia sp. low shrubland to low open shrubland	Tidal flats Fringing salt lakes
Maireana pyramidata low open shrubland	Alluvial plain

Vegetation associations of conservation significance

A full list of vegetation associations recorded during the field survey in the southern infrastructure corridor is provided in Appendix N2.

Alectryon oleifolius ssp. *canescens* tall shrubland on alluvial soils of plains has been provisionally listed as a vulnerable plant association in South Australia (Neagle 2003). Although *A. oleifolius* ssp. *canescens* is common throughout the infrastructure corridor it rarely forms a distinct plant association and is usually associated with sand plain and dunefield landforms rather than alluvial plains. This plant association is not considered to occur in the study area.

The sandplains of the Hesso and Roxby land systems support extensive areas of *Acacia aneura* low woodland. This plant association is provisionally listed as a vulnerable plant association in South Australia (Neagle 2003).

N1.5.4 Flora

Badman (WMC 1997) recorded 318 indigenous vascular plant taxa during surveys of the existing transmission line route. During the current field surveys an additional 81 taxa were recorded, bringing the total number of taxa in the southern infrastructure corridor to 399. Most of these additional taxa were recorded from the pipeline corridor in the Point Lowly area, which was not included in previous surveys. Flora recorded in the southern infrastructure corridor – reported by Badman (WMC 1997) and the current survey – is presented in Appendix N3.

No species of national conservation significance have been recorded in the southern infrastructure corridor. Three state-listed species have been recorded: *Santalum spicatum, Maireana pentagona* and *Ophioglossum polyphyllum.*

Santalum spicatum is listed as vulnerable under Schedule 8 of the NPW Act. The other species are listed as rare under Schedule 9 of the Act.

Santalum spicatum occurs within the transmission line corridor in *Acacia papyrocarpa* woodland in the Hesso land system (see Figures N1.4c–f). At least 20 mature plants were counted directly beneath the existing transmission line. This species may occur elsewhere in *Acacia papyrocarpa* woodlands in the Hesso land system beyond the immediate vicinity of the transmission line.

Badman (WMC 1997) recorded *Maireana pentagona* and *Ophioglossum polyphyllum* in the transmission line corridor. These species were not found during the current survey. *Ophioglossum polyphyllum* is a perennial species with an ephemeral shoot system that becomes dormant during dry periods, so it may not have been observable during the current survey. Badman (WMC 1997) records this species from the Hesso land system, but no further information about the species is presented. *Maireana pentagona* is also listed in the Hesso land system (WMC 1997). This small perennial plant may be easily overlooked and is difficult to identify when not in fruit. It occurs on clayey soils in open woodlands associated with other chenopod shrubs (Cunningham et al. 1992).

There are herbarium collections for three other state-listed rare species in the southern infrastructure corridor: *Brachyscome eriogona, Gratwickia monochaeta and Swainsona microcalyx. Brachyscome eriogona* has previously been collected from a site near Woomera. *Gratwickia monochaeta* has been collected from sites near Ironstone Lagoon and *Swainsona microcalyx* from *Acacia papyrocarpa* woodland. These ephemeral species were not found during the current survey or during earlier surveys of the transmission line corridor conducted by Badman (WMC 1997).

N1.5.5 Introduced plants

Introduced species (denoted by *) do not comprise a high proportion of the flora in the southern infrastructure corridor. Surveys by Badman (WMC 1997) found 13% of the flora was introduced. The current survey recorded the same proportion. Introduced species recorded in the corridor are listed in Appendix N4. The majority of introduced species are ephemeral species. They are common along tracks, dams, roadsides and other areas of disturbance or where water and nutrients gather in run-off, particularly in the southern parts of the study area between Whyalla and Port Augusta. Two species have a high proportion of cover:

- **Carrichtera annua* dominate the groundlayer in chenopod shrublands and *Acacia papyrocarpa* woodlands on clay-loam soils in the southern part of the study area. This species becomes less common as soils become sandier.
- **Brassica tournefortii* is common on dunes in the northern part of the study area where it forms patches that dominate the groundlayer.

Ten declared species were recorded in the southern infrastructure corridor during surveys (see Table N1.18).

Table N1.18 Declared weeds in the southern infrastructure corridor

Species	Common name	Occurrence	Status[1]
Asparagus asparagoides	Bridal Creeper	Dunes at Point Lowly	Declared Species of national significance
Asphodelus fistulosus	Onion Weed	Dunes at Point Lowly Drainage lines and roadside on Lincoln Highway	Declared
Echium plantagineum	Salvation Jane	Transmission line corridor	Declared
Emex australis	Three-corner Jack	Transmission line corridor	Declared
Lycium ferocissimum	African Boxthorn	Dunes at Point Lowly and Port Augusta	Declared
Marrubium vulgare	Horehound	Common around stock watering points in southern part of corridor	Declared
Opuntia stricta	Prickly Pear	Chenopod shrubland north of Port Augusta	Declared
Parkinsonia aculeata	Parkinsonia	Port Augusta	Declared Weeds of national significance
Tribulus terrestris	Caltrop	Dunes near Roxby Downs	Declared
Xanthium spinosum	Bathurst Burr	Mulga woodlands in run-on areas, drainage lines and stock watering points	Declared

[1] Status: Declared – Listed under the South Australian *Natural Resources Management Act 2004*; Weeds of National Significance – As listed in the National Weeds Strategy.

Woody perennial introduced species are uncommon and typically occur in developed areas at Point Lowly, Port Augusta and Roxby Downs. Species in the Roxby Downs township are included in Section N1.4.4. Woody perennial weed species recorded from Point Lowly and Port Augusta are **Schinus molle, *Parkinsonia aculeata,*Lycium ferocissimum* and **Nicotiana glauca.* With the exception of **Parkinsonia aculeata*, these species occur on disturbed dunes. **Schinus molle* is very common on dunes with *Acacia ligulata* in the Port Augusta area.

N1.5.6 Fauna

During a previous survey of the transmission line corridor, five native and one introduced small mammal species were recorded from pitfall traps (WMC 1997). Three species of kangaroo were also recorded along with sheep, rabbits and goats. There are records for a further nine native species of mammal and five introduced mammals inside the southern infrastructure corridor (see Appendix N5).

Thirty reptile species were trapped in pitfall traps along the original proposed transmission line corridor (WMC 1997). An additional 53 reptile species have been recorded within the currently proposed corridor (see Appendix N5).

Sixty-three bird species were recorded during winter and spring bird counts along the original proposed transmission line corridor (WMC 1997). A further 143 species have been recorded inside the currently proposed corridor (see Appendix N5). This includes 112 species of bushbird, 75 species of wetland and migratory bird and 19 species of raptor.

EPBC listed species

Four nationally listed threatened fauna species have been recorded within the proposed southern infrastructure corridor. These are the Pernatty Knob-tailed Gecko *Nephrurus deleani* (V), Slender-billed Thornbill *Acanthiza iredalei* (V), Thick-billed Grasswren (eastern subspecies) *Amytornis textilis modestus* (V) and the Thick-billed Grasswren (Gawler Ranges subspecies) *Amytornis textilis myall* (V). Of these species, the distribution of the Pernatty Knob-tailed Gecko most closely coincides with the proposed infrastructure corridor (see Figure N1.5).

Based on species ranges and the presence of preferred habitat, a further four nationally listed fauna species could potentially occur in the area. These are the Plains Rat *Pseudomys australis* (V), Greater Long-eared Bat *Nyctophilus timoriensis* (V), Plains-wanderer *Pedionomus torquatus* (V) and the Night Parrot *Pezoporus occidentalis* (E).

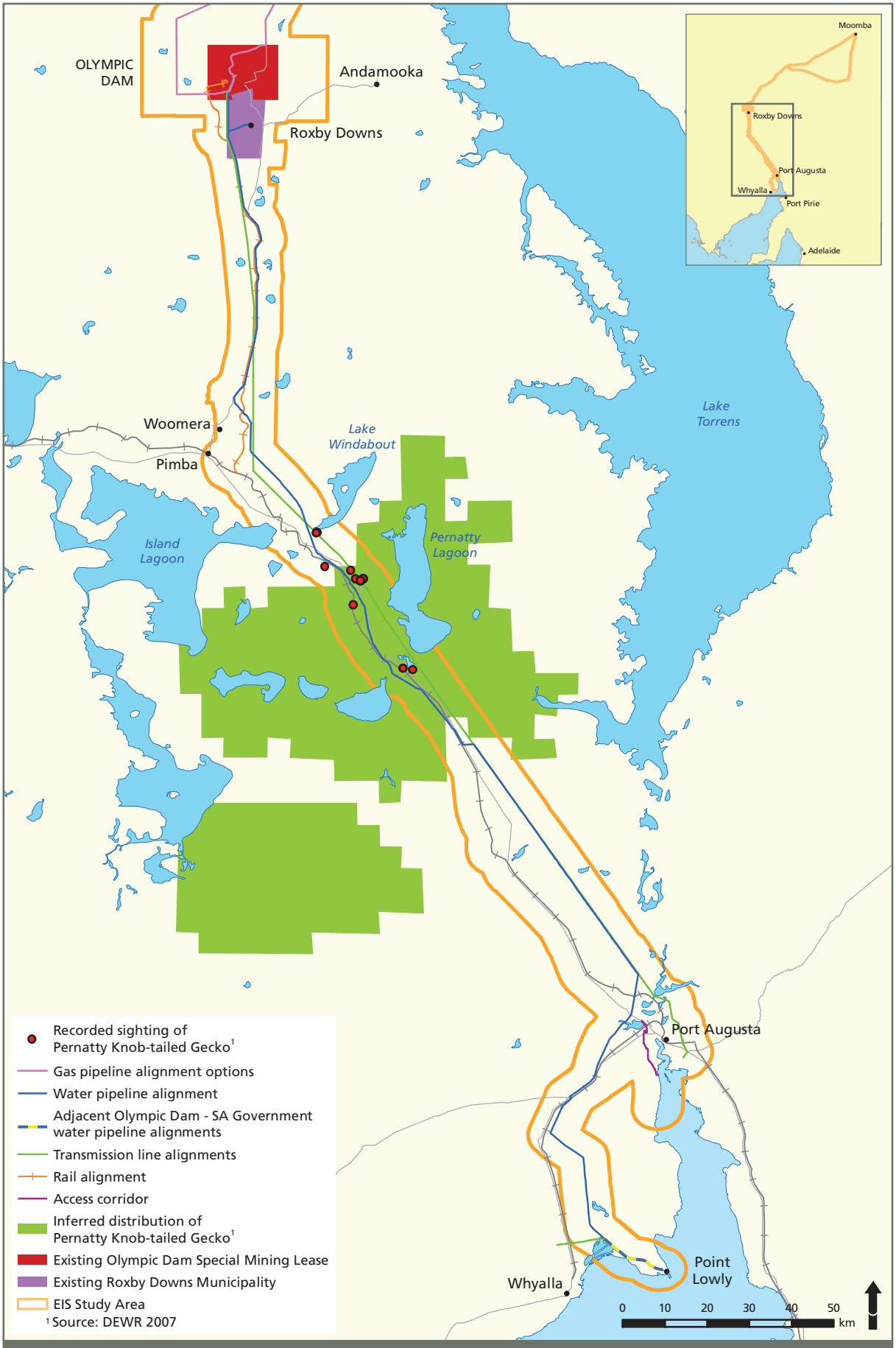

Figure N1.5 Inferred distribution of Pernatty Knob-tailed Gecko (DEWR 2007)

State-listed species

In South Australia, the Plains Wanderer and the Night Parrot are listed as endangered under schedules of the NPW Act 1972, the Plains Rat and Greater Long-eared Bat are listed as vulnerable and the Slender-billed Thornbill and Pernatty Knob-tailed Gecko are listed as rare. A further two state-listed rare reptile species, the Carpet Python *Morelia spilota* and the Common Bandy-Bandy *Vermicella annulata*, have been recorded within the proposed corridor. No additional state-listed mammals have been recorded.

Eighteen state-listed wetland and migratory waterbird species have been recorded within the proposed corridors. These are the Fairy Tern *Sterna nereis* (E), Eastern Curlew *Numenius madagascariensis* (V), Freckled Duck *Stictonetta naevosa* (V), Banded Stilt *Cladorhynchus leucocephalus* (V), Australasian Shoveler *Anas rhynchotis* (R), Musk Duck *Biziura lobata* (R), Blue-billed Duck *Oxyura australis* (R), Great Crested Grebe *Podiceps cristatus* (R), Darter *Anhinga melanogaster* (R), Little Egret *Egretta garzetta* (R), Glossy Ibis *Plegadis falcinellus* (R), Common Sandpiper *Actitis hypoleucos* (R), Ruddy Turnstone *Arenaria interpres* (R), Great Knot *Calidris tenuirostris* (R), Latham's Snipe *Gallinago hardwickii* (R), Black-tailed Godwit *Limosa limosa* (R), Sooty Oystercatcher *Haematopus fuliginosus* (R) and Pied Oystercatcher *Haematopus longirostris* (R). Two predominantly marine state-listed species are represented by single records near Port Augusta: Kelp Gull *Larus dominicanus* (R) and Southern Giant-Petrel *Macronectes giganteus* (V).

Eleven state-listed bushbird species have been recorded within the proposed corridor. These are the Chestnut Quail-thrush *Cinclosoma castanotus* (R), White-browed Treecreeper *Climacteris affinis* (R), Scarlet-chested Parrot *Neophema splendida* (R), Australian Bustard *Ardeotis australis* (V), Bush Stone-curlew *Burhinus grallarius* (R), Major Mitchell's Cockatoo *Cacatua leadbeateri* (R), Brown Quail *Coturnix ypsilophora* (V) Blue-winged Parrot *Neophema chrysostoma* (V), Elegant Parrot *Neophema elegans* (R), Shy Heathwren *Calamanthus cautus* (R) and the Restless Flycatcher *Myiagra inquieta* (R).

N1.5.7 Introduced fauna

The principal pest animals along the southern infrastructure corridor are the Fox *Vulpes vulpes*, Cat *Felis catus*, Rabbit *Oryctolagus cuniculus* and the Goat *Capra hirus*. A full list of introduced vertebrate species is provided in Appendix N5.

N1.6 GAS PIPELINE CORRIDORS

N1.6.1 Introduction

This section describes the ecological features of the gas pipeline corridors north of the mining lease. The southern section of the gas pipeline corridors coincide with the mining lease, which has previously been described (Section N1.4).

The 190 km section of the gas pipeline corridors between Olympic Dam and Borefield B parallels the existing Borefield Road and water pipelines. The landforms and vegetation on this section have been previously described in the first Environmental Impact Statement (Kinhill-Stearns Roger 1982) and the Supplementary Environmental Studies for the Borefield B development (Kinhill 1995). Limited vertebrate surveys including Elliott trapping and limited pitfall trapping, active searching and opportunistic observations were carried out for these studies. Intensive monitoring of the trench to record and release trapped fauna was carried out during construction of the Borefield B pipeline in 1997. This yielded a significant amount of data on the presence of fauna.

Fauna trapping has also been carried out across the region by the Department for Environment and Heritage (DEH) as part of the biological survey of the Stony Deserts (Brandle 1998) and the rare rodent monitoring project. Several DEH biological survey sites occur within the corridor. Fauna trapping has not been carried out specifically for the gas pipeline corridors due to a number of factors including the inaccessibility of several sections of the route, uncertainty about the final corridor option and the unfavourable conditions (both seasonal and long-term), which would limit the worth of any trapping efforts carried out in the timeframe of this report.

N1.6.2 Landforms

The gas pipeline corridors traverse 18 land systems from Olympic Dam to Moomba (see Table N1.19; Figure N1.2).

Table N1.19 Land systems in the gas pipeline corridors

Bioregion	Land system	Brief description
Gawler	Roxby	Undulating plain with sand sheets, dunes and low silcrete-capped rises overlying ancient basement limestone
	Arcoona	Broad, gently undulating gibber plateau grading to steep, marginal slopes in the south
	Emu	Low sandstone ridges with silcrete gravels on the lower slopes of the ridges and gilgai present on footslopes and plains
	Stuarts Creek	Widely-spaced, parallel sand ridges with broad clayey and sandy interdunes, superimposed on stony tableland with low downs and jump-ups, and sandplain
Stony Plains	Oodnadatta	Flat to undulating gibber tableland and plateaux with numerous gilgai
	Kalatinka	Clay-loam alluvial flats with minor occurrences of sandplain and dunes east of Lake Eyre South
	Mumpie	Flat to undulating gibber tablelands and plateaux with numerous gilgai
	Kopi	Extended areas of kopi (gypseous) soil country scattered throughout the tablelands
	Wirringina	Dunefield and sandsheets accumulated against stony hills and rises, salinas and associated lunettes, with some GAB springs in the south
	Cooryaninna	Undulating gilgai plains with creek channels, floodplains and run-on flats of Cooryaninna Creek
	Flint	Steep-sided, rocky mesas with long undulating gibber-covered slopes and plains
Simpson Strzelecki Dunefields	Strzelecki	Long, parallel sand ridges with semi-mobile crests, sandy and clayey interdunes and numerous claypans and internal soakages
	Blanche	Interconnected salt lakes with channels, gypseous shorelines and plains, and gypsum dunes on the eastern margins, running from Lake Frome to Lake Blanche
	Collina	Disorganised low dunes of light coloured gypseous sands
	Hope & Tingana	Long, parallel sand ridges, sandy and clayey interdunes and numerous claypans
	Tirari	Sandhills and flats east of Lake Eyre, including channels and floodplains of the lower Cooper, Warburton and Kallakoopah Creeks
Channel Country	Cooper	Waterholes, channels, floodplains and ephemeral lakes of the Cooper and Strzelecki Creeks, and the field of parallel sand ridges with interdune areas connected to and periodically flooded by them

N1.6.3 Vegetation associations

The vegetation associations occurring in the gas pipeline corridors are shown in Figure N1.6a–n (see Table N1.2 for key to vegetation numbers) and listed in Appendix N2. A brief overview of the vegetation associations in each land system is provided below.

Roxby and Arcoona land systems

These land systems occur in the area surrounding Olympic Dam and on the southern infrastructure corridor. The vegetation associations in these land systems have been described in the previous sections and continue in the gas pipeline corridors in this land system.

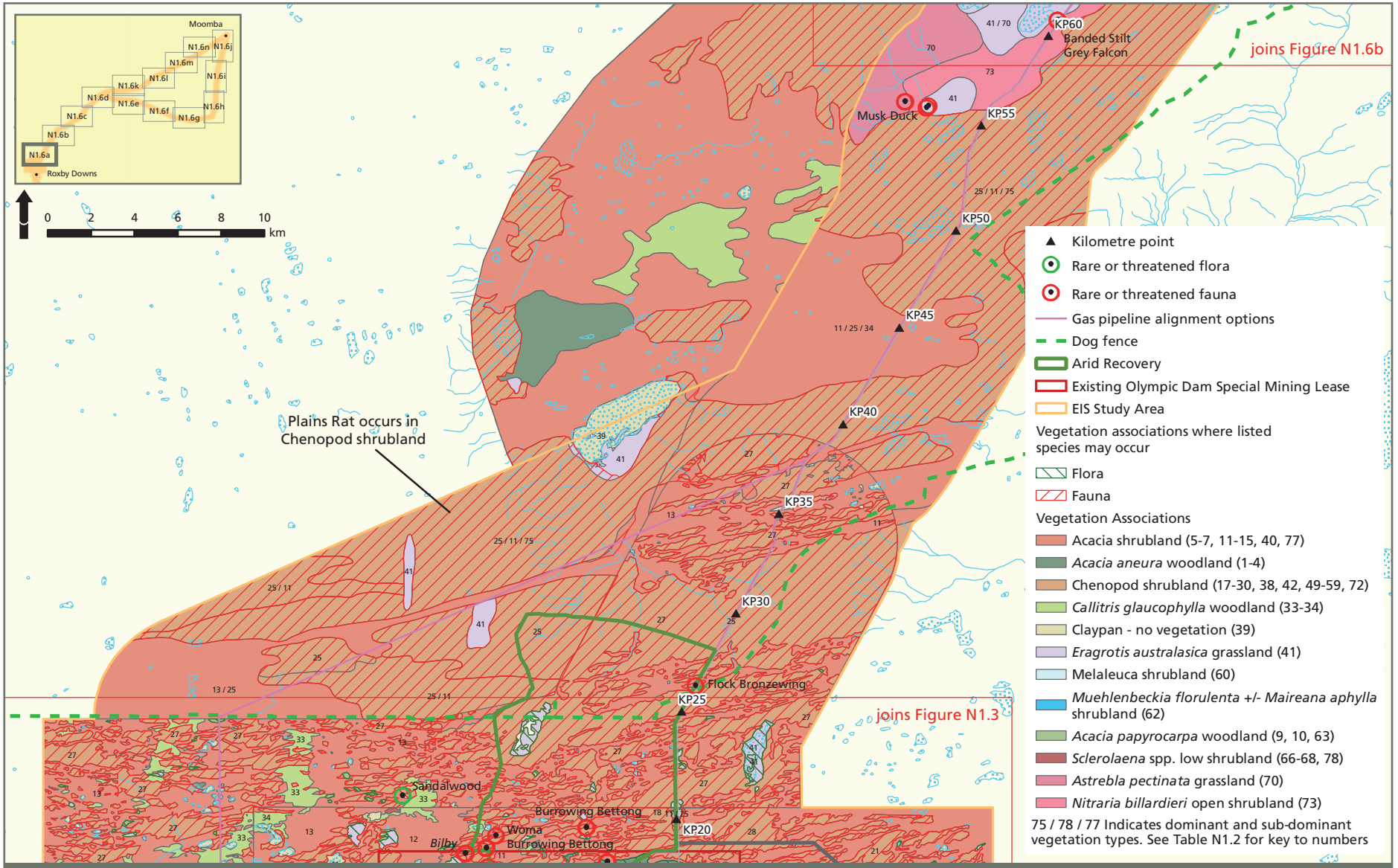

Figure N1.6a Vegetation associations and records of listed species - gas pipeline corridors (Section a)

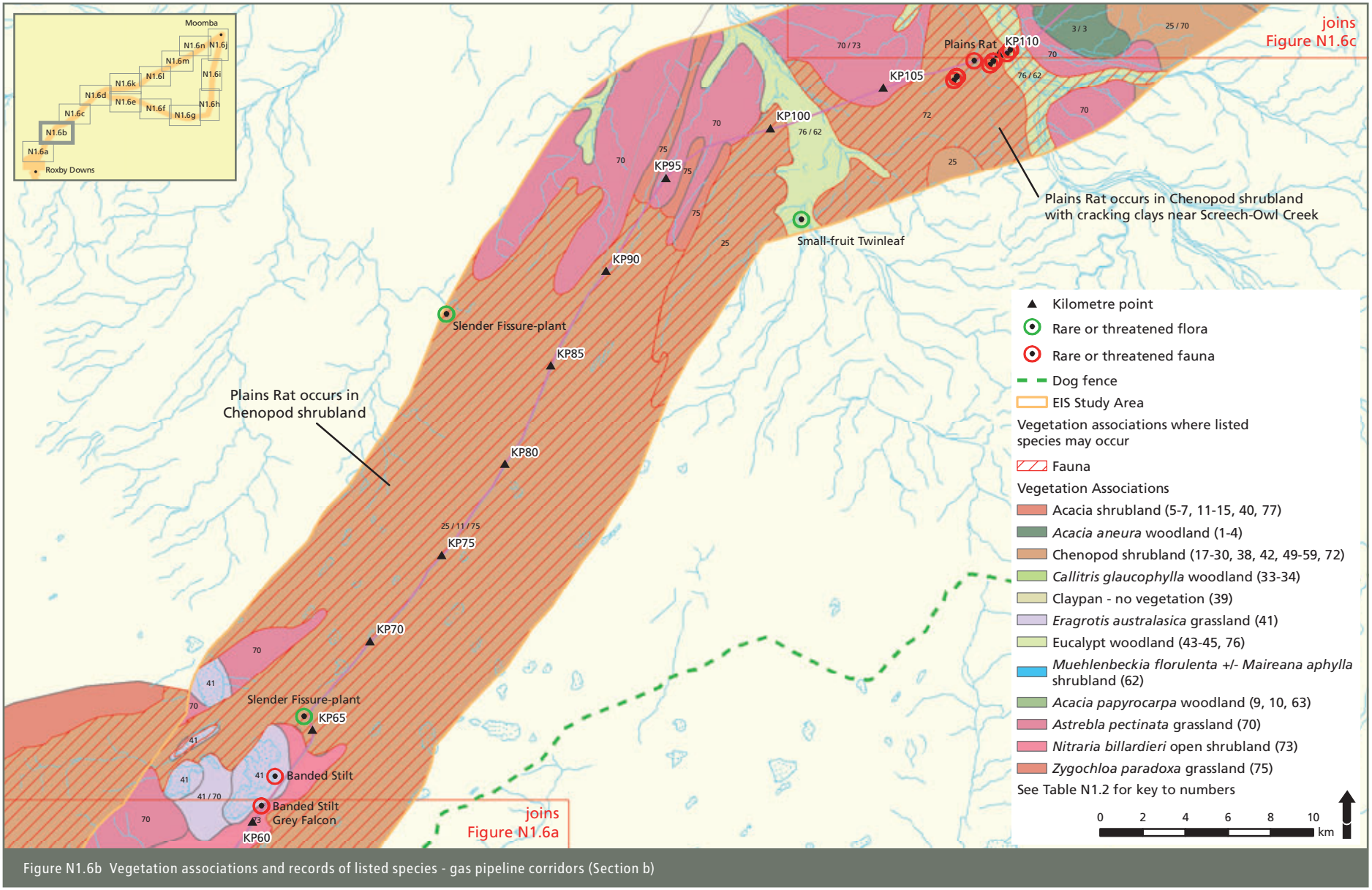

Figure N1.6b Vegetation associations and records of listed species - gas pipeline corridors (Section b)

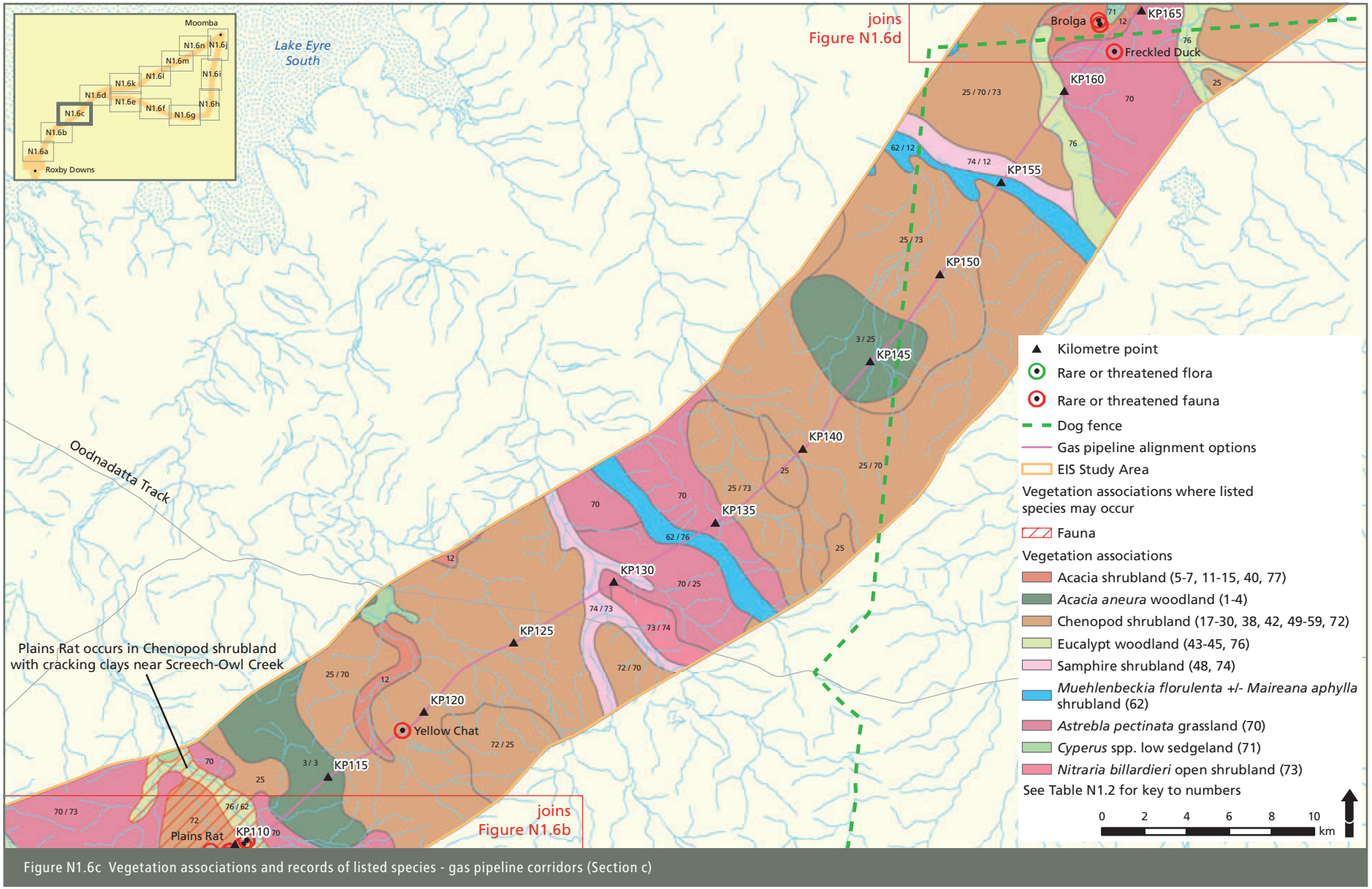

Figure N1.6c Vegetation associations and records of listed species - gas pipeline corridors (Section c)

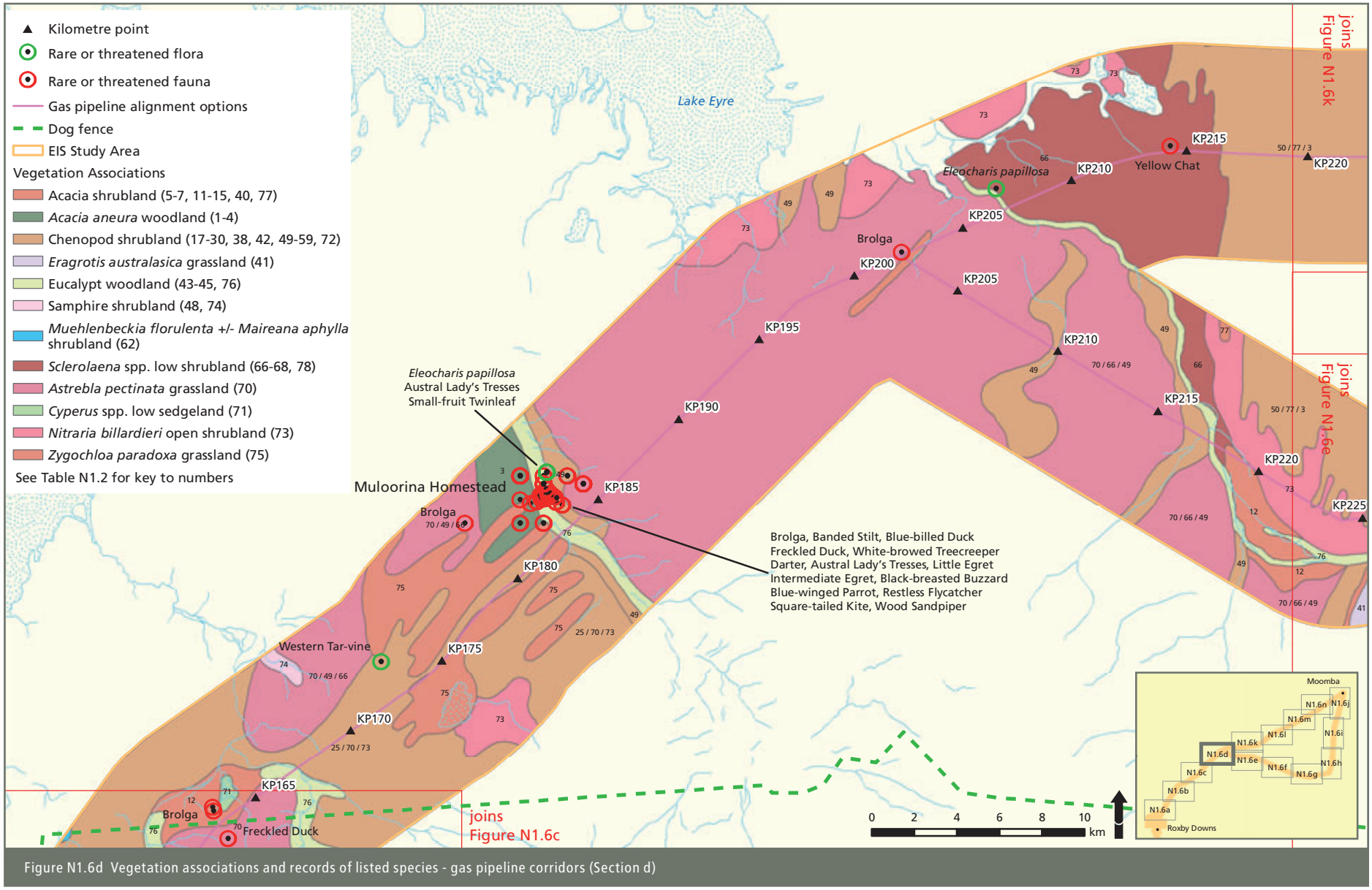

Figure N1.6d Vegetation associations and records of listed species - gas pipeline corridors (Section d)

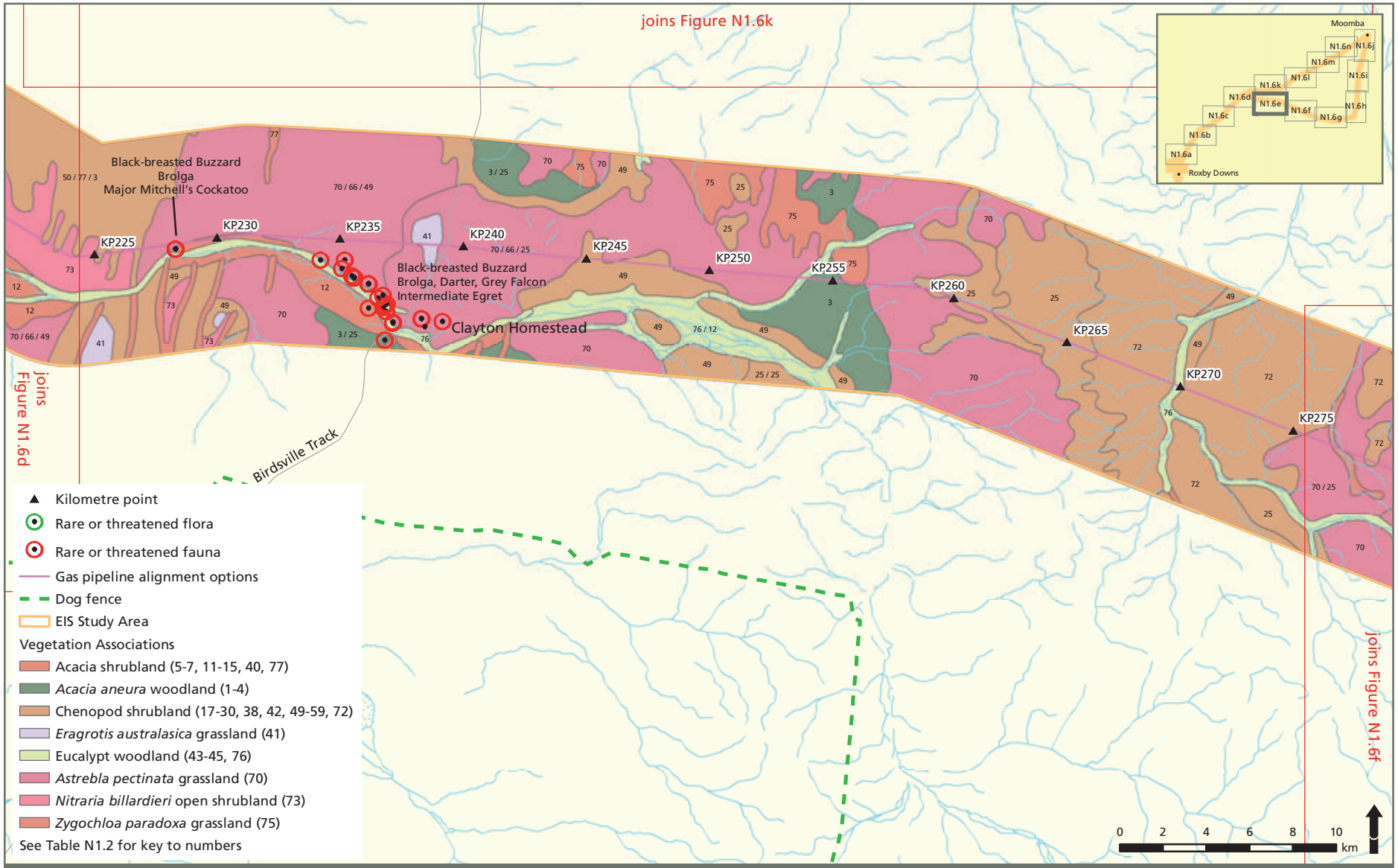

Figure N1.6e Vegetation associations and records of listed species - gas pipeline corridors (Section e)

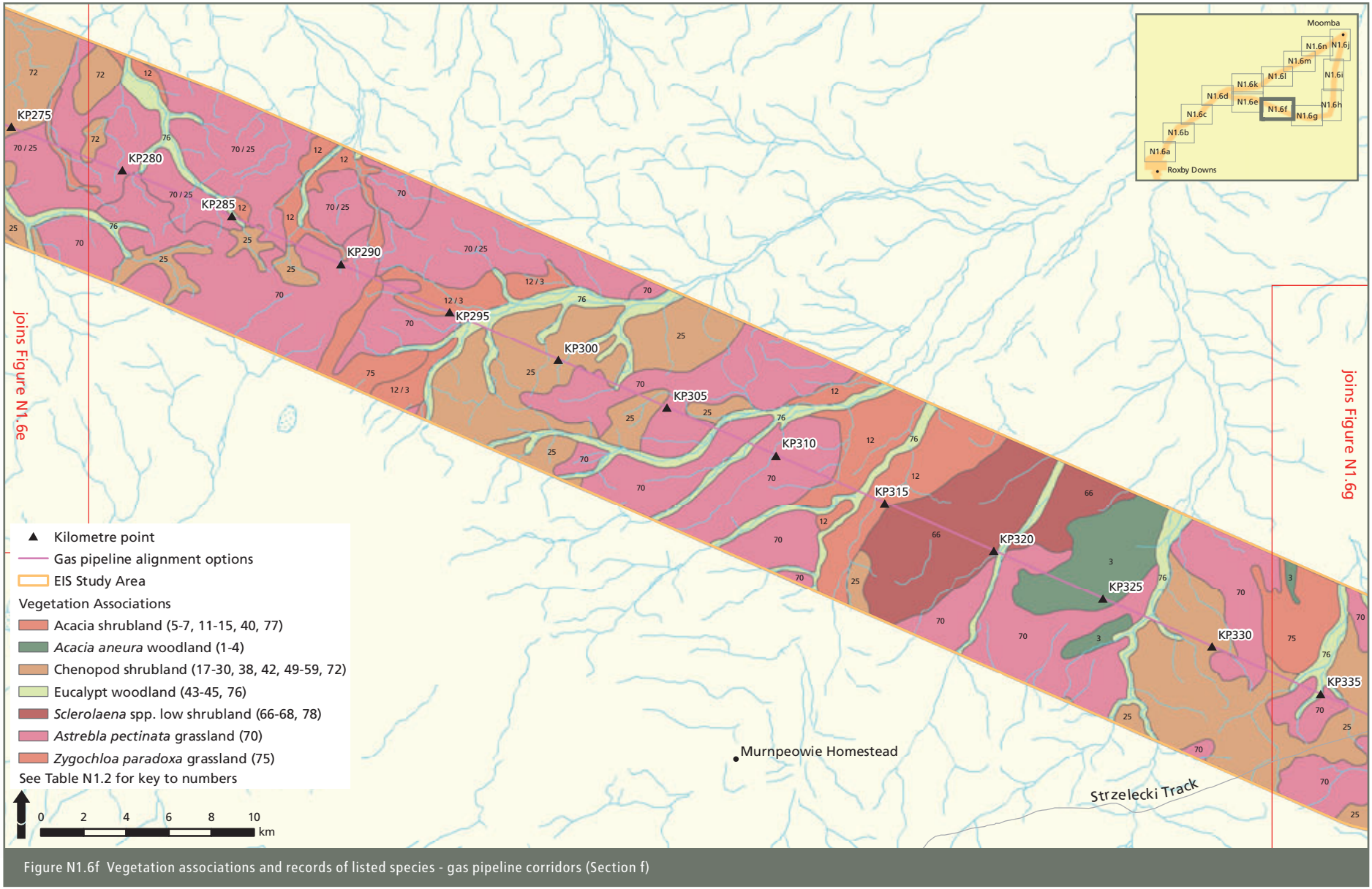

Figure N1.6f Vegetation associations and records of listed species - gas pipeline corridors (Section f)

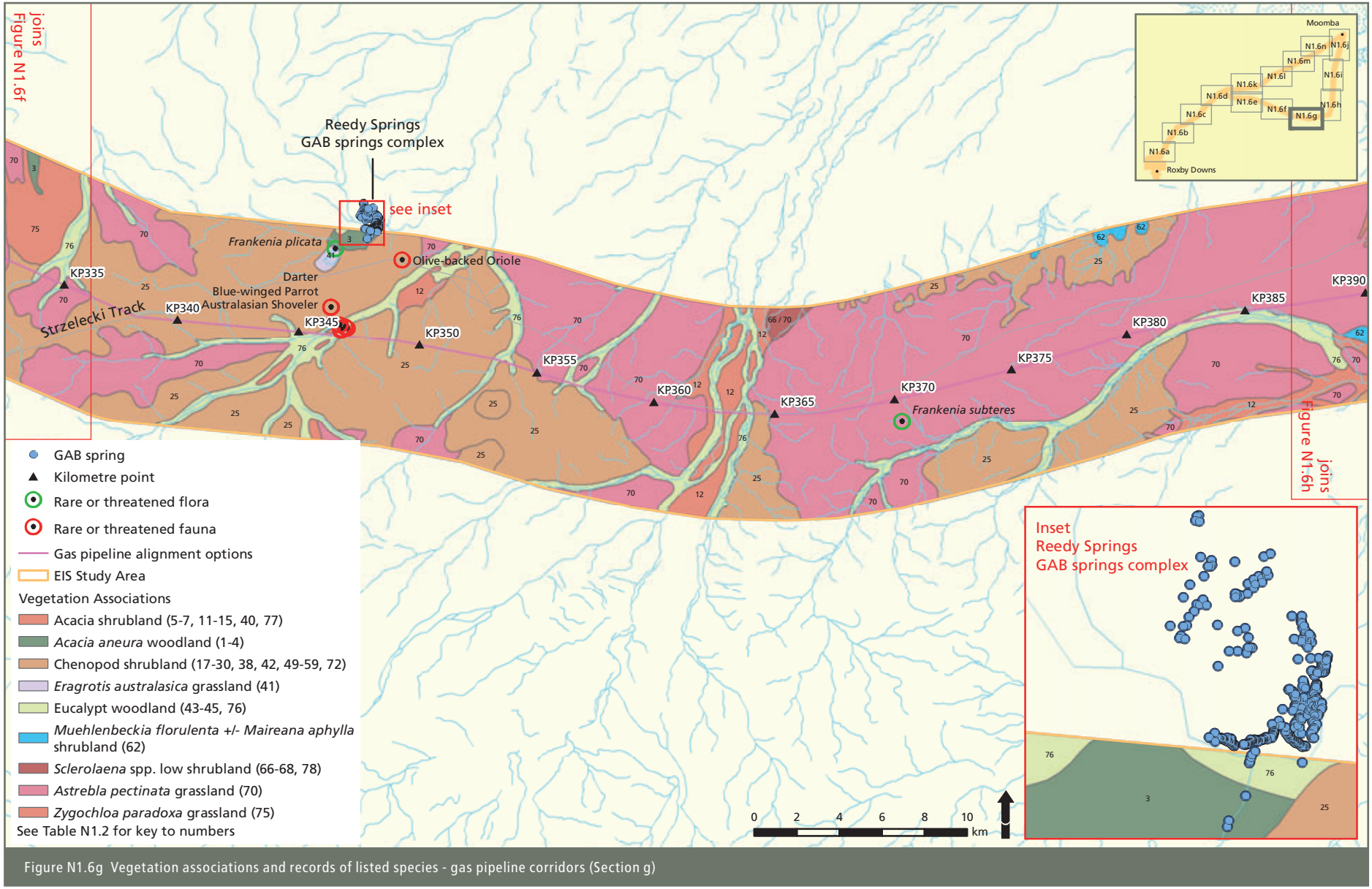

Figure N1.6g Vegetation associations and records of listed species - gas pipeline corridors (Section g)

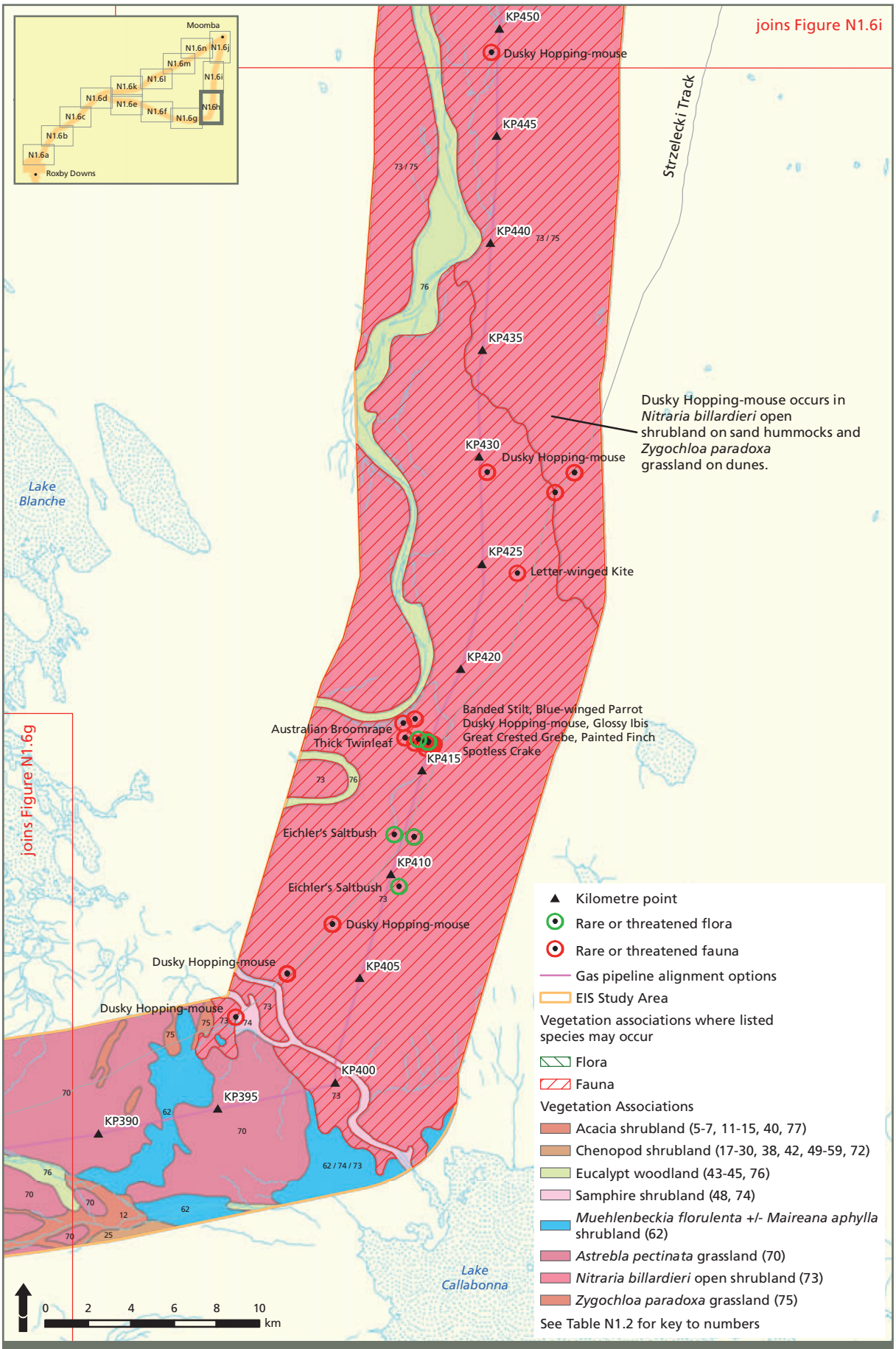

Figure N1.6h Vegetation associations and records of listed species - gas pipeline corridors (Section h)

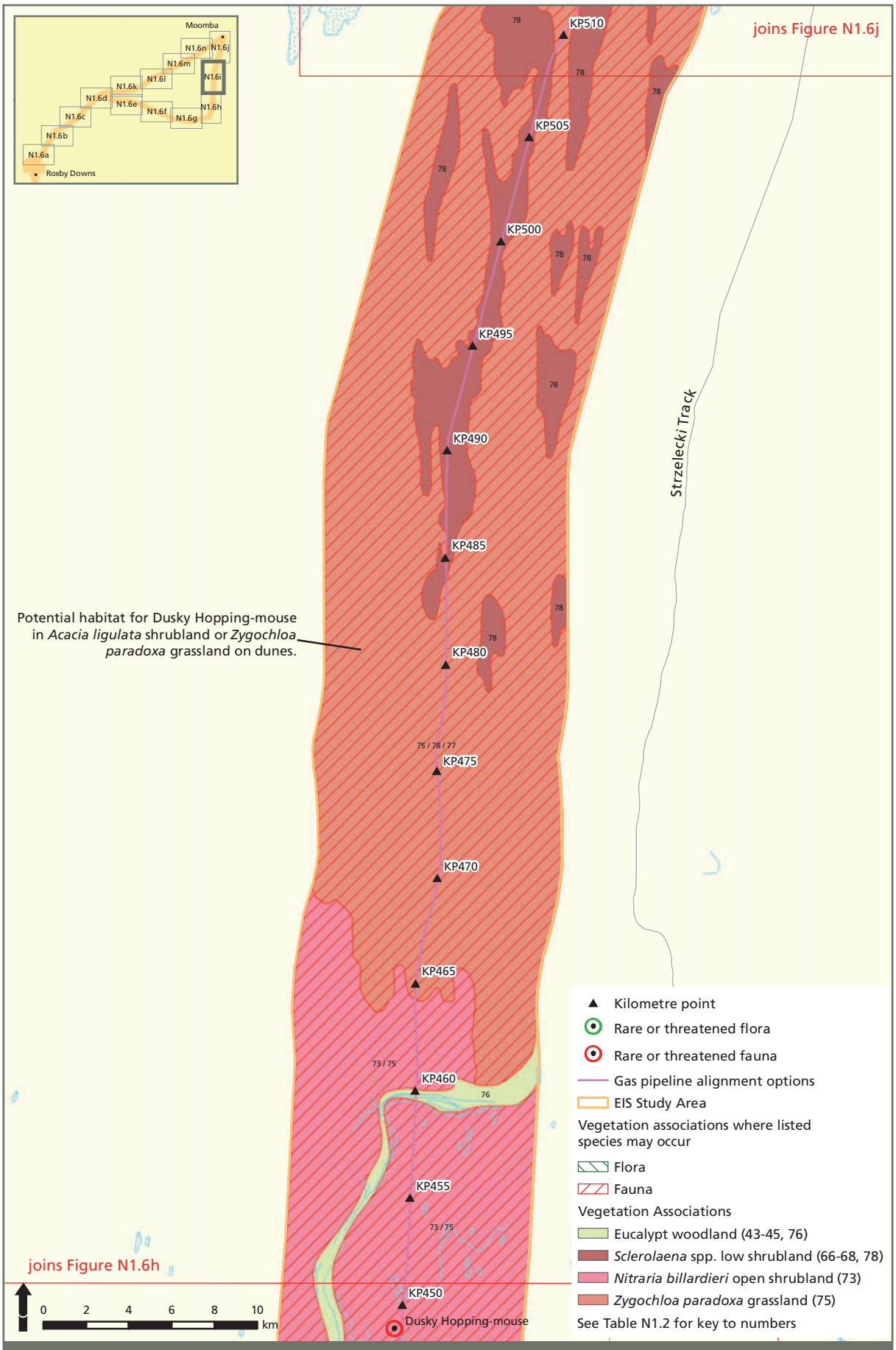

Figure N1.6i Vegetation associations and records of listed species - gas pipeline corridors (Section i)

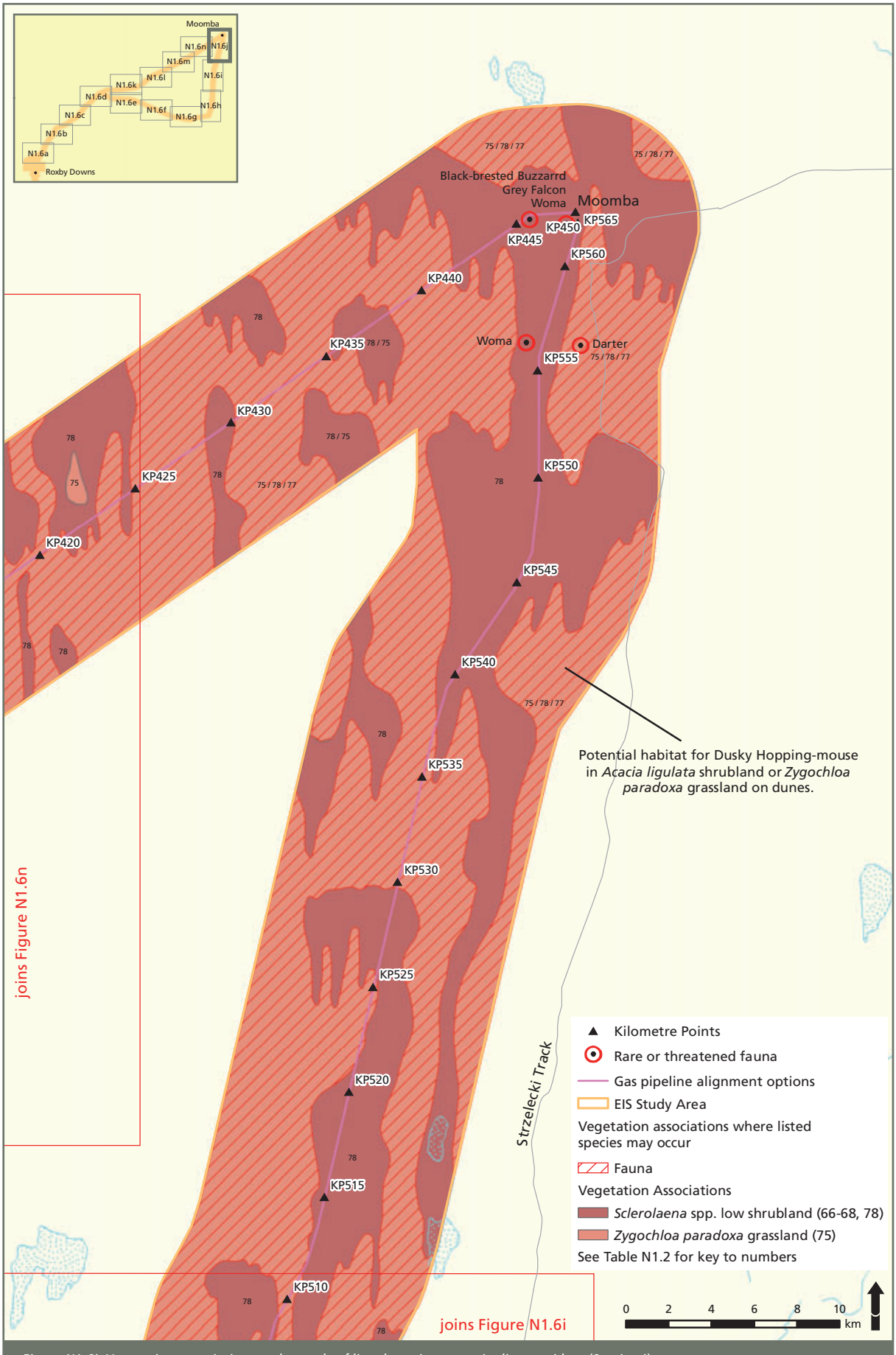

Figure N1.6j Vegetation associations and records of listed species - gas pipeline corridors (Section j)

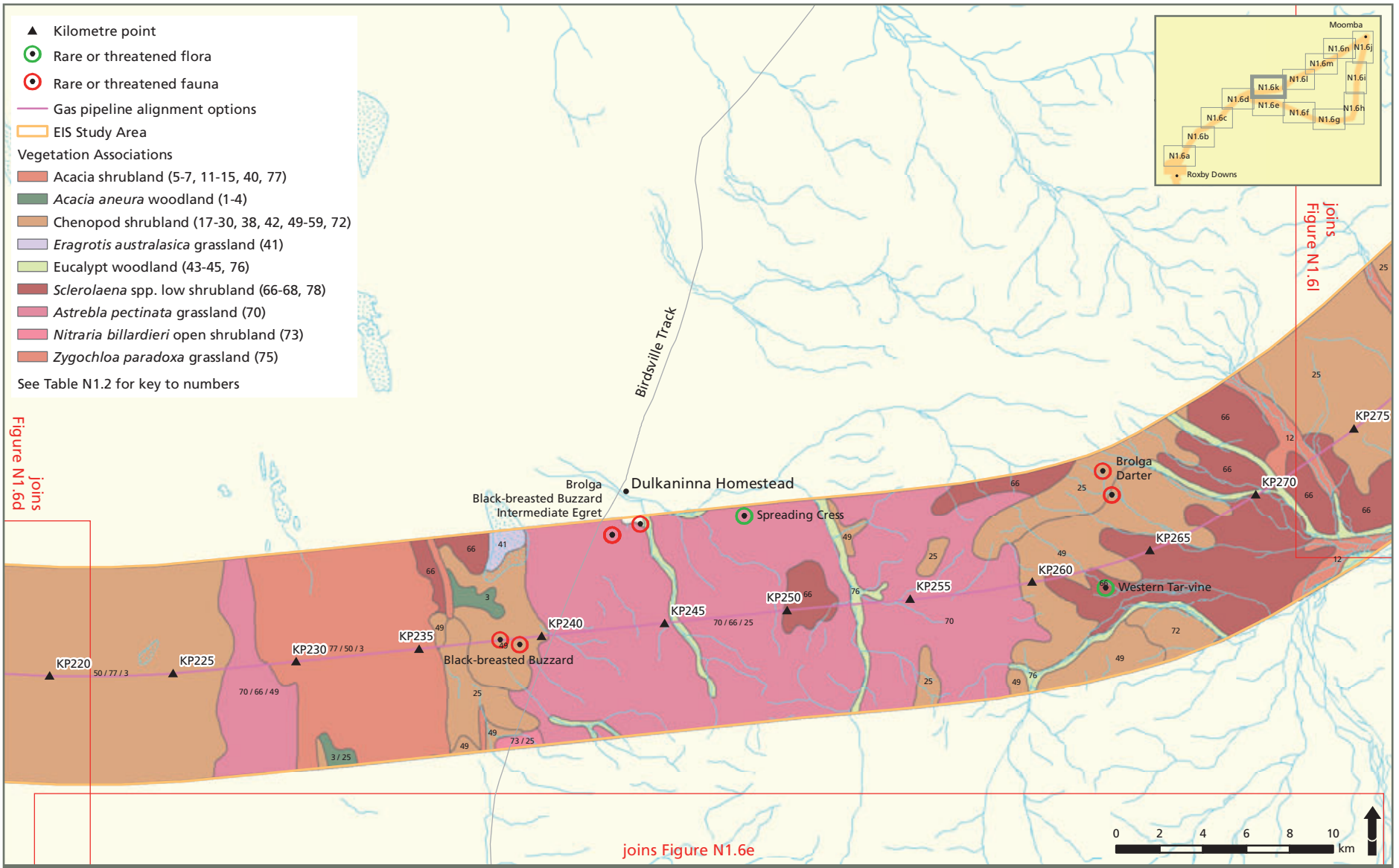

Figure N1.6k Vegetation associations and records of listed species - gas pipeline corridors (Section k)

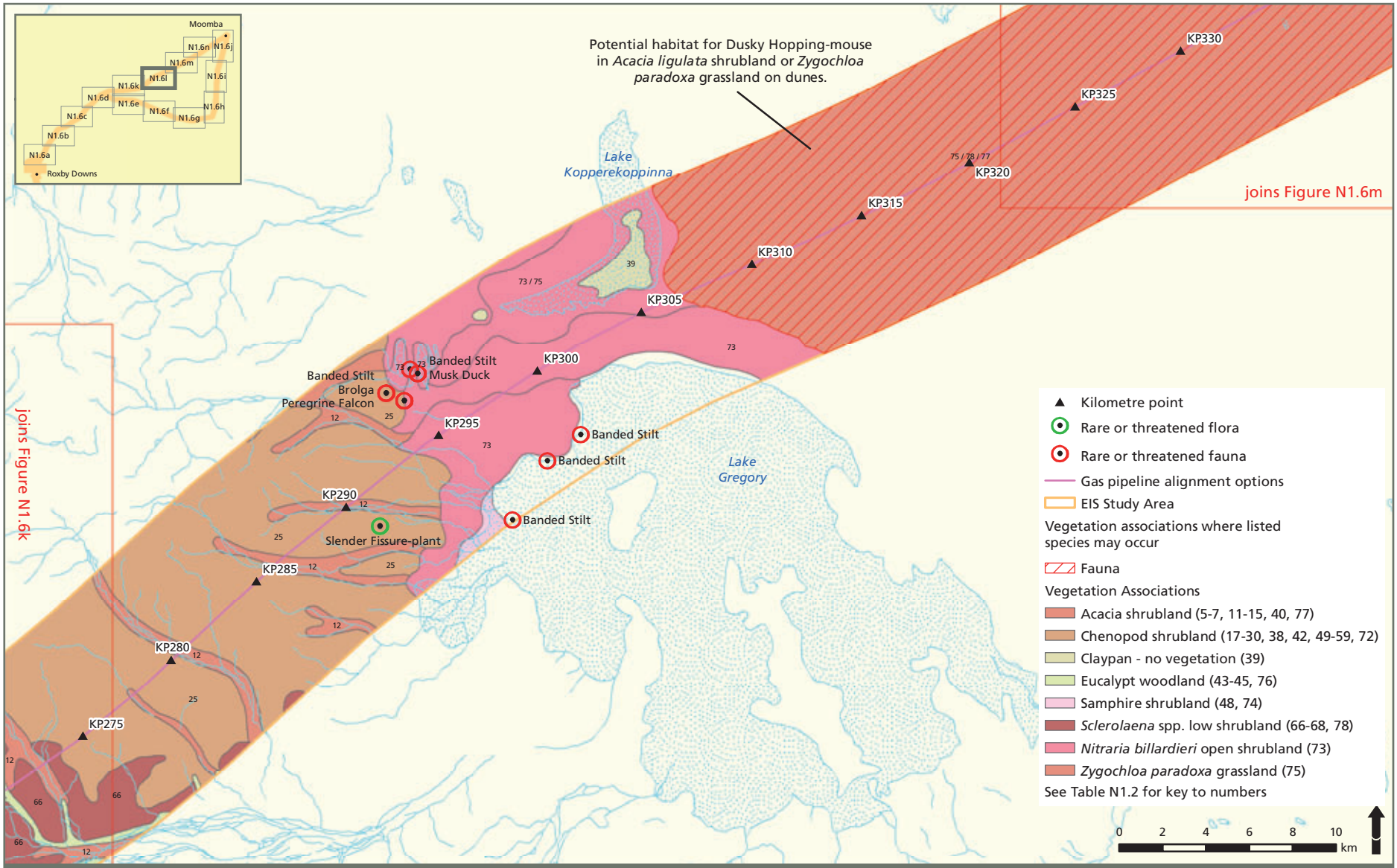

Figure N1.6l Vegetation associations and records of listed species - gas pipeline corridors (Section I)

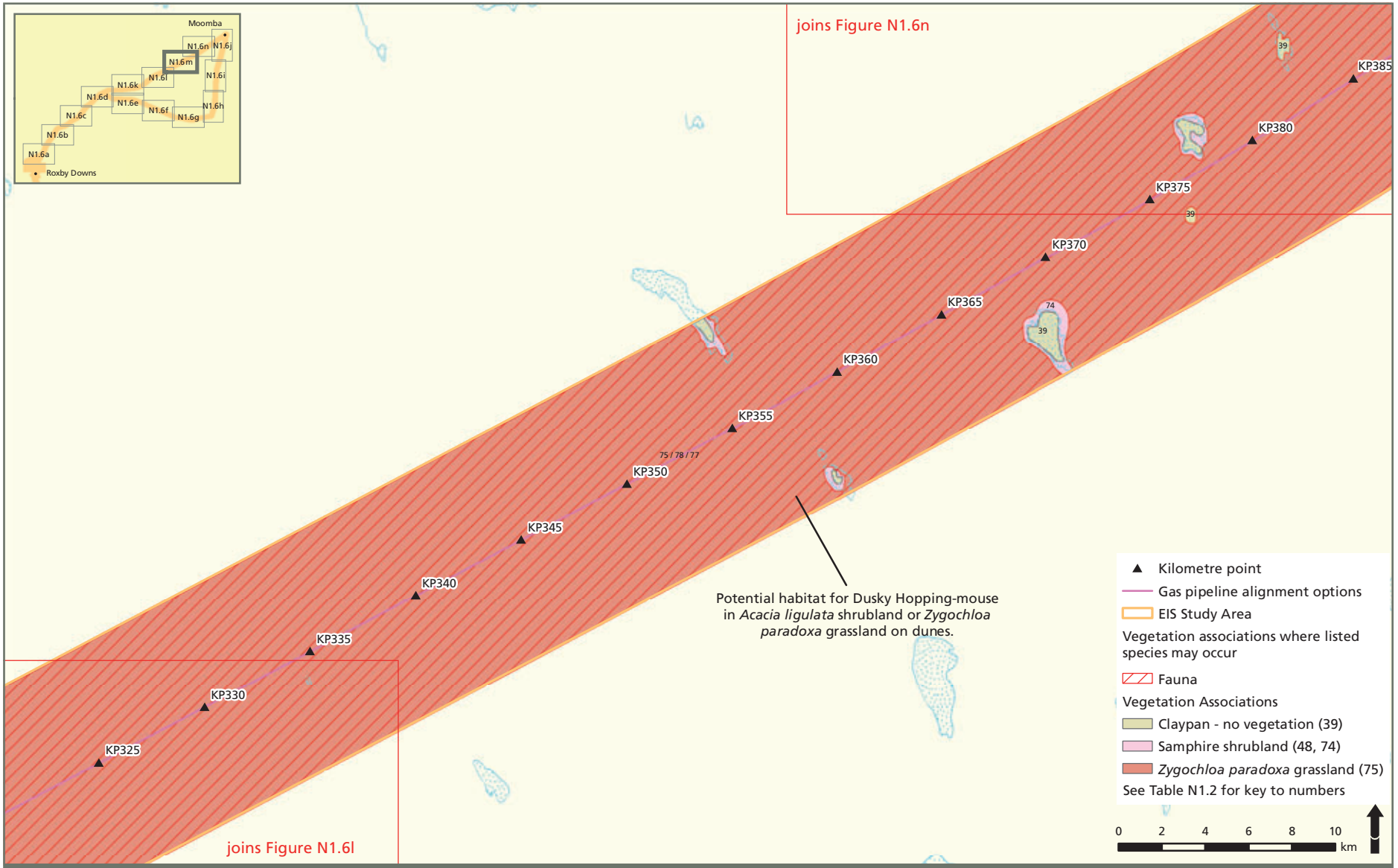

Figure N1.6m Vegetation associations and records of listed species - gas pipeline corridors (Section m)

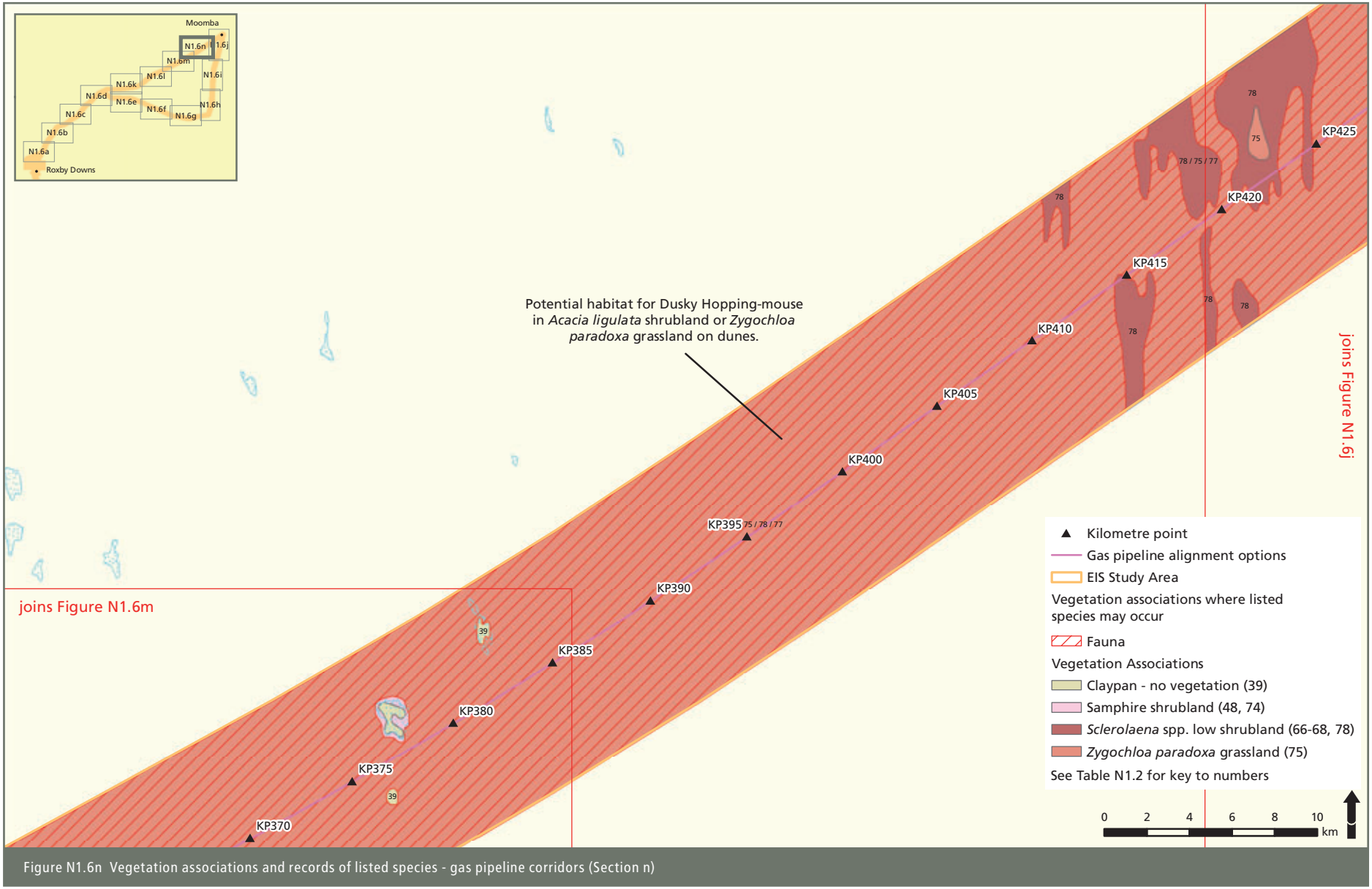

Figure N1.6n Vegetation associations and records of listed species - gas pipeline corridors (Section n)

Emu land system

This land system occurs in a small area to the north-west of Olympic Dam. The dunes support open shrublands of *Acacia ligulata*, *A. aneura* and/or *A. ramulosa* with some *Zygochloa paradoxa* and scattered *Callitris glaucophylla* where it is close to the Roxby land system. Swales support *Atriplex vesicaria* shrubland, with *Aristida contorta* grassland on swales where few shrubs are present and *Eragrostris australasica* hummock grassland or *Muehlenbeckia florulenta* shrubland in the occasional claypans and swamps.

Stuarts Creek land system

This land system occurs to the north of Olympic Dam. The dunes support open woodlands or shrublands of *Acacia aneura*, *A. ligulata*, *A. ramulosa* and *Dodonaea viscosa* ssp. *angustissima*, with some *Zygochloa paradoxa.* The swales and sandy plains support open *Acacia aneura* woodland or a low chenopod shrubland with *Maireana* spp. and *Atriplex vesicaria* dominating. *Muehlenbeckia florulenta* shrubland and *Eragrostris australasica* hummock grassland dominate the occasional swamps.

Oodnadatta land system

The Oodnadatta land system is extensive in the region west and south of Lake Eyre, and is crossed by the gas pipeline corridors south of Lake Eyre South. Gilgai are the most productive component of this landscape and are vegetated with *Atriplex nummularia* ssp. *omissa* and samphire shrubland or *Astrebla pectinata* grassland. Gibber areas between gilgai are almost unvegetated, but support ephemeral species after heavy rains. Shrublands of *Atriplex vesicaria*, *Maireana pyramidata* and *Eremophila duttonii* occur on occasional low, rocky hills and escarpments (jump-ups). Larger watercourses support *Eucalyptus coolabah* woodland, sometimes with *Eucalyptus camaldulensis*. *Acacia aneura* woodland occurs on smaller watercourses. *Sclerostegia tenuis* shrubland can be found fringing small salt lakes.

Kalatinka land system

Plant cover on the clay-loam alluvial flats is a mix of sparse *Astrebla pectinata* grassland or low *Atriplex vesicaria* shrubland. Ephemeral herbs and shrubs appear in quantity after rain. *Acacia ligulata* open shrubland occurs on minor sand spreads. Clay flats, subject to inundation, have an open shrubland of *Maireana aphylla* with patches of *Atriplex nummularia* and *Eragrostris australasica* or a low shrubland of *Atriplex spongiosa* and *Sclerolaena* spp. Low dunes and sand plains have open *Zygochloa paradoxa* grassland and *Acacia ligulata* shrubland.

Mumpie land system

This gibber tableland land system is extensive and dominates the southern option of the gas pipeline corridors between Borefield B and the Moomba–Adelaide pipeline. Gilgai and run-on flats are vegetated with *Atriplex nummularia/A. vesicaria* shrublands, *Astrebla pectinata* grasslands or *Atriplex spongiosa* and *Sclerolaena* spp. low shrubland. On slightly saline flats the gilgais comprise *Sclerostegia tenuis* and annual *Atriplex* spp. Tableland jump-ups have low, open shrubland of *Maireana* spp. and scattered *Acacia aneura*. Major drainage lines have linear woodland, which may be *Eucalyptus camaldulensis* but more frequently *E. coolabah*, *Acacia salicina* and *A. stenophylla* sometimes over *Muehlenbeckia florulenta*. Minor drainage develops a fringing tall shrubland of *Acacia tetragonophylla*, *Santalum lanceolatum* and *Eremophila duttonii*. *Eragrostris australasica* hummock grassland dominates less saline run-ons, with *Sclerolaena* spp. and *Nitraria billardierei* shrubland on the more saline run-on areas. GAB springs on the edge of, and adjacent to the gas pipeline corridors on Murnpeowie Station are heavily covered with *Cyperus laevigatus* sedgeland.

Kopi land system

Vegetation in the Kopi land system is very sparse because of the gypsum in the soil, which binds most soil water. Most plants are ephemerals, appearing briefly when there is sufficient rainfall. Vegetation includes *Dissocarpus paradoxus*, *Atriplex* spp. and *Sclerolaena* spp. low shrubland. Non-kopi areas (i.e. non-gypseous soils) are stony tableland soils with gilgai and run-on areas that may carry *Astrebla pectinata* grasslands.

Wirringina land system

Vegetation cover is a mixture of *Zygochloa paradoxa* grassland on dune upper slopes and tall open *Acacia ligulata* shrubland on flanks and sandsheets. Stony rises with accumulations of wind blown sand are dominated by *Senna* spp. and *Acacia ligulata* very open shrubland.

Cooryaninna land system

Vegetation cover is greatest in gilgai and is dominated by *Atriplex vesicaria* or *Sclerolaena* spp. shrubland. Outwash flats have a dense cover with low shrublands of *Atriplex vesicaria*/*Rhagodia spinescens, Dissocarpus paradoxus*/*Sclerolaena* spp., *Atriplex spongiosa* and grasses. Larger creeks are sandy, with open woodland of *Eucalyptus coolabah* or *Acacia stenophylla.*

Flint land system

Mesa tops have a dense cover of large silcrete gibber and rock outcrops and are vegetated with open shrubland or low open shrubland of *Eremophila freelingii* and *Atriplex vesicaria* or *Astrebla pectinata* grassland. The steepest slopes below the silcrete or other rock outcrops on the edge of mesas are minimally vegetated. The plains and downs have a dense gibber cover and the stone-free gilgai have the greatest perennial vegetation cover. Vegetation includes *Atriplex vesicaria* shrubland and *Astrebla pectinata* grassland.

Strzelecki, Tingana, Hope and Tirari land systems

The Strzelecki, Tingana and Hope land systems of longitudinal dunefields are extensive in the north-east of the project area. The Tirari land system lies predominantly north of the gas pipeline corridors, and in the area where it intersects the margin of the northern gas pipeline corridor, it can be considered to be equivalent to the Strzelecki land system. Dune upper and mid-slopes typically support open *Acacia ligulata* shrubland, *Triodia basedowii* open hummock grassland or *Zygochloa paradoxa* grassland where crests are semi-mobile, with a groundcover of ephemerals and short-lived perennials. Narrow interdunes typically support *Acacia ligulata, A. aneura* or *A. victoriae* open shrubland or low woodland or low chenopod shrubland. Wider interdunes are generally treeless, with low shrubland of *Sclerolaena* spp. and grasses sometimes with areas of *Atripex nummularia* ssp. *nummularia*. Claypan swamps (which can be present in any interdune but are larger and more frequent in the wider interdunes with only internal drainage) support shrublands of *Muehlenbeckia florulenta*, *Eragrostris australasica* and *Chenopodium auricomum*. *Sclerostegia tenuis* shrubland can be found fringing small salt lakes.

Blanche land system

Vegetation on the major unit, the salt lakes themselves, is limited to saline and gypseous shores, with low open shrublands of *Nitraria billardierei* and samphires. The whitish, gypseous dunes are mobile and *Acacia ligulata* and *Hakea leucoptera* tall shrublands occur where the gypsum content allows. Elsewhere, sparse ephemeral herbs and grasses are present. Interdunes and some plain areas have a sparse shrubland of *Atriplex vesicaria* and *Maireana astrotricha*. More saline and heavier soils in interdunes have *Nitraria billardierei* and samphire shrubland, and there is some *Muehlenbeckia florulenta* shrubland in run-on areas.

Collina land system

This transition area between the gypseous lakes system (Blanche) and the longitudinal dunes (Hope) system is typified by the Cobblers Desert with *Nitraria billardierei* dominating and stabilising the dunes and sandy knolls. *Acacia ligulata* shrubland and *Zygochloa paradoxa* or *Triodia basedowii* hummock grasslands grow on some of the larger dunes. Flat areas between and around the dunes have clayey sand that supports chenopod shrubland and extensive ephemeral growth of annual saltbushes, forbs and herbs after minor rains. Claypans can be quite extensive with *Muehlenbeckia florulenta* shrubland or *Eragrostris australasica* tall open hummock grassland. *Eucalyptus coolabah* woodland occurs on the Strzelecki Creek.

Cooper land system

The larger dunes support tall shrubland of *Acacia ligulata* and/or *Hakea leucoptera*. Pale dunes are recent depositions from the floodplains, and are more mobile. Perennial cover may be *Acacia ligulata* shrubland sandhill wattle and *Zygochloa paradoxa* or *Triodia basedowii* hummock grasslands. Flats support *Atriplex spongiosa*/*Sclerolaena* spp. low shrubland, with taller shrublands of *Atriplex nummularia*, *Chenopodium auricomum*, *Eragrostris australasica* and *Muehlenbeckia florulenta* occurring. Responses to rain in dunes and swales usually result in prolific growth of ephemeral herbs and grasses.

Vegetation associations of conservation significance

The nationally endangered '*community of native species dependent on natural discharge of groundwater from the Great Artesian Basin*' is present at one location, where the northern edge of the gas pipeline corridors intercepts the Reedy Springs complex on Murnpeowie Station. The sandplains of several land systems including Stuarts Creek, Oodnadatta, Kalatinka and Strzelecki support areas of *Acacia aneura* low woodland. This plant association is provisionally listed as vulnerable in South Australia (Neagle 2003).

N1.6.4 Flora

The Biological Database of South Australia has records for 520 indigenous vascular plant species in the pipeline corridors, and the current surveys detected 162, including 14 additional species. Flora species recorded in the gas pipeline corridors on the Biological Database of South Australia and in the current survey are presented in Appendix N3.

No plant species with a conservation rating at state or national level were found during the field survey, nor were they found during the previous survey of the route for the water pipeline for Borefield B development (WMC 1995). Eight species of state conservation significance and one species of national conservation significance occur within the corridor (Biological Database of South Australia). Of those species, many are very old single records and some may be misidentifications.

The nationally listed species, *Frankenia plicata*, has been recorded at one location on the edge of the gas pipeline corridors, and at two locations within 12 km of the corridor, but was not detected near the historical locations during the survey. As noted in Appendix N6, it is understood that it is not likely to occur in the study area, as there are numerous incorrect and unvouchered records of this species. All confirmed records of this species are from the Breakaways (outside the study area). The majority of the state listed species are ephemeral species and are all listed as rare.

N1.6.5 Introduced plants

Introduced species comprise a low proportion of the flora in the gas pipeline corridors. Woody, perennial introduced species are very rare. Most species are ephemeral, such as **Brassica tournefortii*, which commonly occurs on dunes throughout the gas pipeline corridors. One declared weed species is recorded in databases for the corridor, **Tribulus terrestris*. Introduced species recorded in databases and in the current survey are listed in Appendix N4.

N1.6.6 Fauna

The gas pipeline corridors support a range of fauna that is adapted to arid and semi-arid conditions. A diversity of habitat types is present, including gibber plains with areas of cracking clay, drainage lines, dunefields and sandplains. Results of studies undertaken in the region (Brandle 1998; Slaytor 1999) suggest that each of these habitat types supports relatively specific faunal communities, particularly terrestrial vertebrates such as small mammals and reptiles.

Eleven native and one introduced small mammal species have been recorded in the pipeline corridors, including Dunnarts *Sminthopsis* sp., Planigales *Planigale* sp., Forrest's Mouse *Leggadina forresti*, several species of *Pseudomys,* and two bat species. Three larger native mammal species have been recorded – the Red Kangaroo *Macropus rufus*, the Short-beaked Echidna *Tachyglossus aculeatus* and the Dingo *Canis lupus familiaris* (see Appendix N5). A number of other native species have been reintroduced to Arid Recovery (as discussed in Section N1.4.5), which is adjacent to the gas pipeline corridors.

Fifty-one reptiles have been recorded in the gas pipeline corridors (see Appendix N5). Species of note include the Woma *Aspidites ramsayi*. This large snake is known to occur in the north-east of South Australia but is rarely encountered and was listed as rare in the 2008 revision of the NPW Act schedules.

Sixty-five native bird species were recorded during the field survey, and an additional 104 have been recorded in the gas pipeline corridors (see Appendix N5). This included 95 species of bushbird, 57 species of wetland and migratory bird and 17 species of raptor.

Four amphibians have been recorded on the gas pipeline corridors, including the widespread Trilling Frog *Neobatrachus centralis* and two species of tree frog *Litoria* spp. recorded in the Cooper Creek floodplain near Moomba.

EPBC-listed species

Three nationally listed, threatened fauna species have been recorded inside the gas pipeline corridors (excluding those that have been reintroduced to the Arid Recovery discussed in Section N1.4.6). These are the Thick-billed Grasswren (eastern subspecies) *Amytornis textilis modestus* (V), Dusky Hopping-mouse *Notomys fuscus* (V) and Plains Rat *Pseudomys australis* (V). One additional species, Ampurta *Dascycercus hillieri* (E) has been recorded to the north of the gas pipeline corridors east of Lake Eyre. Although this represents the most southern and recent record of this species, it is possible that it may occur in the gas pipeline corridors in this region.

State-listed species

In South Australia, the Plains Rat and Dusky Hopping-mouse are listed as vulnerable under schedules of the NPW Act. No other state-listed mammals have been recorded.

The Woma *Aspidites ramsayi* (R) is the only state-listed reptile recorded.

Thirteen state-listed wetland and migratory waterbird species have been recorded inside the gas pipeline corridors. These are the Australasian Shoveler *Anas rhynchotis* (R), Musk Duck *Biziura lobata* (R), Blue-billed Duck *Oxyura australis* (R), Freckled Duck *Stictonetta naevosa* (V), Glossy Ibis *Plegadis falcinellus* (R), Intermediate Egret *Ardea intermedia* (R), Little Egret *Egretta garzetta* (R), Brolga *Grus rubicunda* (V), Great Crested Grebe *Podiceps cristatus* (R), Darter *Anhinga melanogaster* (R), Spotless Crake *Porzana tabuensis* (R), Wood Sandpiper *Tringa glareola* (R) and the Banded Stilt *Cladorhynchus leucocephalus* (V).

Twelve state-listed bushbird and raptor species have been recorded inside the gas pipeline corridors. These are the Letter-winged Kite *Elanus scriptus* (R), Black-breasted Buzzard *Hamirostra melanosternon* (R), Square-tailed Kite *Lophoictinia isura* (E), Grey Falcon *Falco hypoleucos* (R), Peregrine Falcon *Falco peregrinus* (R), Major Mitchell's Cockatoo *Cacatua leadbeateri* (R), Blue-winged Parrot *Neophema chrysostoma* (V), White-browed Treecreeper *Climacteris affinis* (R), Yellow chat *Epthianura crocea* (E), Painted Finch *Emblema pictum* (R), Restless Flycatcher *Myiagra inquieta* (R) and the Olive-backed Oriole *Oriolus sagittatus* (R).

N1.6.7 Introduced fauna

Eight introduced mammal species and two introduced bird species have been recorded in the gas pipeline corridors (Appendix N5). The main pest species are the Cat *Felis catus*, Fox *Vulpes vulpes*, Rabbit *Oryctolagus cuniculus* and House Mouse *Mus musculus*. Domestic animals are associated with pastoral stations (sheep, cattle and dogs).

N1.7 DESALINATION PLANT

N1.7.1 Introduction

A desalination plant is proposed at Point Lowly. The proposed site occurs on the upper part of the peninsula, approximately 1 km from the shoreline (see Figure N1.4f).

Point Lowly consists of platy fragments of bedrock backed by a narrow strip of low dunes. Soils are calcareous clay loams. The tip of the peninsula extends to an offshore reef which grades to a shingle beach. Two sandy beaches and intertidal areas (Weerona Bay and the embayment between it and Lowly Point) front more extensive dune systems. The two bays act as sediment sinks, and are replenished by sediments from the beach (Laut et al. 1977).

N1.7.2 Vegetation associations

The vegetation at the proposed desalination plant site is *Atriplex vesicaria*/*Maireana sedifolia* low shrubland (see Figure N1.4f). Shrub cover of the dominant overstorey species is about 30%. *Minuria cunninghamii* forms a sparse understorey with a cover of 5%. The groundlayer is dominated by the introduced annual species, **Carrichtera annua*, which has a cover of 20%.

Atriplex vesicaria low shrubland occurs between the desalination plant site and Port Bonython.

N1.7.3 Flora

A total of 26 native species and 13 introduced species were recorded in the vicinity of the proposed desalination plant site (see Appendix N3). These species occurred in the roadside reserve adjacent to the site (access to the site was not possible due to exclusion fencing) although this vegetation is continuous with that at the site. Most of the introduced species occurred on the road verge.

No species of state or national conservation significance were recorded from the areas surveyed.

N1.7.4 Fauna

Fauna information for the proposed desalination plant site was compiled from the Environmental Impact Statement for the Port and Terminal Facilities at Port Bonython (SEA 1981 and 1998) and the Biological Database of South Australia (BDSA) records. Fauna records within a 20 km radius of the site were chosen to represent the diversity of fauna that may be present at the site. This includes 10 native and six introduced mammal species, 34 reptile and 136 bird species (see Appendix N5). Bird species are further divided into 74 bushbirds, 54 waterbirds and migratory birds and eight birds of prey (see Appendix N5).

Threatened fauna

The Thick-billed Grasswren *Amytornis textilis myall*, a nationally vulnerable species, has been recorded in *Atriplex vesicaria*/*Maireana sedifolia* shrublands within 20 km of the desalination plant site. The nationally vulnerable Slender-billed Thornbill *Acanthiza iredalei* is also known to use the habitat types present at the site. An additional two state-listed birds (not including migratory and waterbirds) have been recorded in the vicinity of the proposed desalination plant site. These are the Bush Stone-curlew *Burhinus grallarius* (R), and the White-bellied Sea-Eagle *Haliaeetus leucogaster* (E).

No mammals of conservation significance have been recorded in the vicinity of the site. One reptile, the Carpet Python *Morelia spilota*, is listed as rare under the NPW Act. Although there are historical records for Carpet Python in the Point Lowly area, the chenopod shrublands at the site are not likely to provide suitable habitat for this species. As the chenopod shrublands at the site are widespread, the reptiles recorded from the region are likely to have wide-ranging distributions and are not likely to be restricted to the desalination plant site.

Waterbirds

Results of Australia-wide counts indicate that the Upper Spencer Gulf region has international, national and state significance as a habitat for waders, and is one of the most important sites in South Australia (Watkins 1993). The nearest significance habitats to the desalination plant site are Ward Spit, 15 km to the east, and False Bay, 10 km to the west. Wader counts indicate that the Upper Spencer Gulf area can support up to 50,000 migratory waders over the summer period (see Appendix O3). These feed mostly on invertebrates obtained from tidal mud and sand flats at low tide, and roost on spits, islands and saltfields at high tide. Upper Spencer Gulf also supports significant waterbird breeding colonies. This includes about a third of the state's Pied Cormorants, 20% of Fairy Terns and 7% of Caspian Terns.

The Upper Spencer Gulf supports many waterbirds of state conservation significance and migratory waterbirds listed under the EPBC Act (see Appendix O3). Of these, the region has significant numbers of Eastern Curlew and Fairy Tern, the latter with possibly the largest breeding colony in South Australia at Ward Spit. The national and state conservation status of the Banded Stilt has been under reassessment on the basis of significantly reduced breeding success in recent years, due to predation of eggs and young by Silver Gulls, and it was state-listed as vulnerable in 2008. The Upper Spencer Gulf region provides a staging area for movements to and from breeding sites at Lakes Torrens and Lake Eyre.

The Southern Giant-Petrel *Macronectes giganteus* occurs throughout the Southern Ocean and breeds in Antarctica, including the Australian Antarctic Territory, and on sub-Antarctic islands including Macquarie Island, Heard Island, McDonald Island and the Australian Antarctic Territory (Parker et al. 1979). The Australian population is listed as endangered (EPBC Act), primarily due to long-line fishing by catch and in part by the impact of feral predators at nesting sites.

In South Australia, the Southern Giant-Petrel is primarily a winter visitor (May–October) to coastal waters, where it feeds mainly on moribund cuttlefish and offal (Parker et al. 1979; Copley 1996). In summer the species occurs predominantly in sub-Antarctic to Antarctic waters, usually below 60 degrees south in the South Pacific and south-east Indian Oceans or 53 degrees south around Heard or Macquarie Islands (Blakers et al. 1984).

Most sightings of Southern Giant-Petrels in South Australia are from Gulf St Vincent, Encounter Bay, Kangaroo Island, the South-East, the west coast of Eyre Peninsula and the Great Australian Bight (Parker et al. 1979; Blakers et al. 1984). There is one published record from Upper Spencer Gulf at Port Augusta on 30 January 2000 (SAOA 2000). This would suggest that the species is a vagrant or irregular visitor to Spencer Gulf in low numbers.

A full report of waterbirds in Upper Spencer Gulf is presented in Appendix O3.

N1.8 SIGNIFICANT WILDLIFE HABITATS

N1.8.1 Arcoona Lakes

The proposed southern infrastructure corridor occurs in close proximity to several large, ephemeral lakes between Roxby Downs and Woomera, collectively known as the Arcoona Lakes. These lakes are fed by drainage from the Arcoona plateau after significant rainfall events. The last significant flood event was in 1989, with recharge in 1992, when the deeper lakes remained flooded until 1994 (Read and Ebdon 1998).

The lakes support large populations of water birds when flooded, including the threatened or rare species, Freckled Duck (V) and Musk Duck (R) (Read and Ebdon 1998). The lakes provide a feeding and nesting habitat for waterbirds and other bird species such as the Budgerigar *Melopsittacus undulatus*, Cockatiel *Nymphicus hollandicus*, Bourke's Parrot *Neopsephotus bourkii*, Magpie-lark *Grallina cyanoleuca* and the Wedge-tailed Eagle *Aquila audax*.

The gas pipeline corridors also abut the edge of, or pass close to, a number of very large salt lakes (Lake Eyre, Lake Gregory and Lake Blanche). These fill infrequently as a result of inflow from rainfall on large catchments outside the project area and also provide feeding and nesting habitats for large populations of waterbirds when flooded.

N1.8.2 Cracking clay soils on gibber tablelands

Regions of localised drainage on gibber tablelands are characterised by cracking clay soils that support a high diversity of fauna. Within the study area, these habitats occur in the southern infrastructure corridor on the Arcoona Tableland and in the SML, on the Andamooka Tableland in the eastern expansion area and in several land systems in the gas pipeline corridors, particularly the Oodnadatta, Mumpie, Cooryaninna and Flint land systems.

Small mammals such as the Forrest's Mouse *Leggadina forresti*, Dunnart *Sminthopsis* sp. and Planigale *Planigale* sp. are found predominantly in this habitat (Owens and Read 1999). Cracks provide shelter and sites for seed storage that are relatively inaccessible to other vertebrates (Brandle et al. 1999). Cracking soils also provide shelter for reptiles. *Lerista dorsalis* appears to be concentrated in these run-on areas on the Arcoona Tableland (WMC 1997). Low-lying patches of deep-cracking clays provide important refugia for the threatened Plains Rat (Brandle et al. 1999). When the population size increases following significant rainfall events the species may occupy smaller depressions in gilgais.

Cracking clay soils are vulnerable to disturbance by stock. Trampling by hoofed animals can compact soils, or destroy shallow burrow systems (Ehmann 2005).

N1.8.3 Low-lying areas with enhanced water availability or retention

Other areas where water and nutrients accumulate and create periodically waterlogged conditions support tall shrublands of *Maireana aphylla*, *Chenopodium nitrariaceum, Muehlenbeckia florulenta* or *Eragrostis australasica* grasslands. These habitats are widespread throughout the project area from Olympic Dam northwards and become common in the dunefield land systems in the north-east. In the Olympic Dam region, they occur in the Arcoona and Roxby land systems. They occur in depressions on tablelands and where dunes abut gibber plateaux. In the Roxby land system, these habitats occur in dune swales and are common in the western and eastern parts of the SML.

These sites provide drought refuges for fauna and when dry, the cracking clay soils support small mammal species, as discussed above. *Maireana aphylla* shrublands in depressions on gibber tablelands provide habitat for the threatened Thick-billed Grass-wren (Neagle 2003).

These areas are vulnerable to grazing by stock that may compact or pug soils and selectively graze herbaceous species (Ehmann 2005).

N1.8.4 Waterholes, GAB springs and bore drains

The region supports few natural, permanent waterbodies with drinkable water, although the springs of the Great Artesian Basin (including the Reedy Springs group in the gas pipeline corridors) are notable. Waterholes are present on the larger rivers in the north-east of the region (such as Clayton and Frome Rivers and Strzelecki Creek) and can persist for months after the infrequent occurrence of large flows. Permanent water also occurs at Saint Mary Pool in the gas pipeline corridors. Flowing bores in the gas pipeline corridors provide very scattered sources of surface water. On the Clayton River a flowing bore has created an extensive permanent wetland within the gas pipeline corridors.

These sources of permanent water are generally vegetated with a relatively dense layer of shrubs and sedges and eucalypt woodland is usually present (except at GAB springs). The available water and structurally diverse habitats support a wide range of fauna, particularly native birds. These areas are generally subject to high levels of grazing and trampling by stock.

N1.8.5 Rocky watercourses

Rocky watercourses draining plateau surfaces receive nutrients and have higher water availability than surrounding areas. These habitats are not common in the SML and Roxby Downs Municipality, occurring only in the eastern part of the municipality where a small stony rise drains into Coorlay Lagoon. They occur most frequently in the infrastructure corridor in the Arcoona land system, and carry drainage waters from the tablelands into large salt lakes or small freshwater lagoons. Few of the watercourses in the gas pipeline corridors are rocky, with Kootyaninna Creek on Murnpeowie Station a notable exception.

Rocky watercourses support diverse plant assemblages and are structurally diverse habitats. Large rocks, leaf litter and woody debris, and trees and shrubs provide shelter for reptiles. Grasses and shrubs provide food sources for birds, mammals and reptiles. These areas may also be subject to greater grazing pressure, as they may be the only source of feed during drought periods.

N1.8.6 Tree-lined watercourses

Vegetated watercourses with clayey or sandy channels are widespread in the stony plain land systems in the gas pipeline corridors. Watercourses with tall *Acacia* shrubland or woodlands of *Eucalyptus coolabah* or *E. camaldulensis* in these land systems provide a diversity of habitats for many vertebrates. These habitats are particularly significant as they are often not present in surrounding areas, which are generally dominated by low shrublands or grasslands. As with woodland vegetation (discussed below), tree hollows, leaf litter and trees and shrubs along watercourses provide important habitat components for birds, mammals and terrestrial and arboreal reptiles.

Vegetated watercourses are noted refuges for fauna (Owens and Read 1999). Strzelecki Creek is a noted refuge for a variety of birds, including bushbirds that utilise the *Eucalyptus coolabah* woodlands and wetland and migratory birds that are abundant when the creek is flooded by infrequent, large Cooper Creek flows (Morton et al. 1995). The Strzelecki Creek is also listed in the Directory of Important Wetlands in Australia (ANCA 1996).

N1.8.7 Woodland vegetation with a complex understorey structure

Acacia woodlands with an understorey of tall woody shrubs, low chenopod shrubs and native grasses are common throughout the Olympic Dam region and southern part of the project area, and dominate the Roxby and Hesso land systems. These areas include a diversity and abundance of resources for many vertebrates including food, shelter and nesting sites. Woodlands that provide tree hollows for birds, mammals (especially bats) and reptiles are particularly important for fauna. Habitat components such as leaf litter and woody debris are important for reptiles. Trees and large shrubs are important for arboreal reptiles that climb to thermoregulate or to avoid predators (Read and Owens 1999). Although *Callitris glaucophylla* woodlands often have a simple understorey structure, they provide feeding and nesting habitat for Major Mitchell's Cockatoo *Cacatua leadbeateri* (Ehmann 2005).

These habitats are particularly vulnerable to grazing by stock and rabbits. Grazing can eliminate palatable understorey species and suppress the recruitment of woody shrubs and trees. Stock may trample and disperse litter layers and destroy soil crusts. *Acacia* woodlands are also vulnerable to fire, especially when grazing inhibits regeneration. Woodlands near developed areas may be threatened by timber collection and may be more vulnerable to fires.

N1.8.8 Lunette dunes

These habitats typically occur on the eastern and southern fringes of salt lakes and larger clay pans. Extensive lunette dunes occur in the southern infrastructure corridor in the Hesso and Roxby land system, on the southern fringes of the Arcoona Lakes, Lake Windabout, Pernatty Lagoon and Ironstone Lagoon. Hummocky lunette dunes also occur in the Yorkey land system near Port Augusta on the southern side of Yorkey's Crossing and in the Blanche land system near Lake Gregory on the gas pipeline corridors. The slightly elevated humidity of burrows in the salty soils can allow humidity dependent species to persist during drought (Ehmann 2005). These habitats are important for Pernatty Knob-tailed Gecko (Ehmann 2005).

N1.8.9 Dune crests stabilised with perennial vegetation

Roots of perennial trees, shrubs and grasses stabilise dune sands, preventing erosion of sands by wind and water. Common shrubs include *Acacia ligulata, A. ramulosa, A. burkittii, Dodonaea viscosa* ssp. *angustissima* and *Duboisia hopwoodi*. Grasses include *Zygochloa paradoxa, Aristida* sp., *Eragrostis* sp. and *Monachather paradoxa*. These habitats are common in the SML and Roxby Downs Municipality and occur throughout the southern infrastructure corridor, particularly in the Roxby, Hesso, Stuarts Creek, Strzelecki, Collina and Hope land systems.

The habitats provide easy burrowing and an abundance of invertebrate food for many animals. This habitat type is particularly important for the Pernatty Knob-tailed Gecko south of Woomera (Ehmann 2005). Dunes also support small mammals such as the Spinifex Hopping-mouse *Notomys alexis* and Sandy Inland Mouse *Pseudomys hermansburgensis* (Read and Owen 1999). The vulnerable Dusky Hopping-mouse *Notomys fuscs* occurs in sand dune habitats in the Strzelecki Desert in the gas pipeline corridors. The Marsupial Mole *Notoryctes typhlops* has not been recorded in the region but this species is very elusive. This burrowing mammal favours sand dune habitats (Corbett 1975).

Removal of vegetation by either grazing animals or clearance is the most significant threat to these habitats. Loss of sand by either wind or water erosion creates blow-outs, where the inner clay core of the dunes is exposed. These areas are generally impermeable to water and regeneration of plant cover is inhibited.

N1.8.10 Upper Spencer Gulf

The Upper Spencer Gulf supports numerous coastal wetlands of importance to waterbirds. These include extensive areas of mangrove and samphire communities, tidal flats and estuaries (see Draft EIS Chapter 16, Marine Environment, Figure 16.4). Many of these wetlands are recognised as being of national importance in the Directory of Important Wetlands in Australia (ANCA 1996). On the eastern side of the Gulf these include the wetlands around the head of the Gulf at Port Augusta, especially Chinaman Creek, Yatala Harbour, Redcliff Point, Ward Spit, Weeroona Island and the tidal creeks and flats between Port Pirie and Point Jarrold. On the western side of the Gulf the most significant wetlands occur around False Bay near Whyalla and along the Whyalla foreshore.

DEH (2003) suggests that some of these wetlands may be of sufficient value to warrant inclusion on the Ramsar Convention as wetlands of international significance, although none are yet listed.

The key areas for waders are shown in Figure 16.4 in Chapter 16, Marine Environment of the Draft EIS. The eastern shore of Spencer Gulf from Ward Spit to Point Jarrold is considered to be the most important habitat for waders (DEH 2003). Ward Spit is considered one of the most important nesting locations for waterbirds. The principal species known to breed in the region include the Pied Cormorant *Phalacrocorax varius*, Little Tern *Sterna albifrons*, Crested Tern *Sterna bergii* and Caspian Tern *Sterna* (also known as *Hydroprogne*) *caspia* (DEH 2003). None of these species is listed as a migratory wader under the EPBC Act.

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APPENDIX N2

Vegetation associations recorded in the EIS Study Area

N2 VEGETATION ASSOCIATIONS RECORDED IN THE EIS STUDY AREA

Dr Jane Prider of Ecological Associates mapped the vegetation associations within the EIS Study Area using a combination of aerial photographs (1:40,000 and 1:80,000) and ground-truthing. Roger Playfair of RMP Environmental mapped the vegetation associations for the gas pipeline corridors using existing DEH mapping, medium-resolution satellite imagery and ground-truthing. Unless otherwise indicated, the EIS Study A rea included the expanded Special Mining Lease and the Municipality of Roxby Downs, a 10 km wide southern corridor for infrastructure, a 20 km radius around the desalination plant site, a landing facility near Port Augusta and the 10 km northern corridor gas pipeline alignment options.

Vegetation associations (refer Appendix N1, Figures N1.4a–f)	Variants	Land system (see Figure N1.2)											
		Roxby	Lookout	Arcoona	Torrens	Hesso	Bowen	Tent Hill	Yorkey	Bittali	Yudnapinna	Saltia	Pandurra
Woodlands													
Sandplains and dunefields													
Callitris glaucophylla woodland to open woodland	*Callitris glaucophylla/Acacia aneura +/– A. ramulosa* open woodland with grassy understorey	+											
	Callitris glaucophylla woodland over *Dodonaea viscosa* ssp. *angustissima*								+				
	Callitris glaucophylla woodland over *Sida ammophila*	+											
	Callitris glaucophylla woodland with grassy understorey	+				+							
Acacia aneura open woodland	*Acacia aneura/A. ramulosa* very open woodland over *Dodonaea viscosa* ssp. *angustissima*	+											
	Acacia aeura open woodland over *Maireana* sp.					+							
	Acacia aneura/A. burkittii low open woodland over *Austrostipa nitida*					+							
	Acacia aneura/Alectryon oleifolius ssp. *canescens* low open woodland					+	+						
	Acacia aneura open woodland over *Dissocarpus paradoxus* and *Sclerolaena* spp.	+											
	Acacia aneura open woodland over *Dodonaea viscosa* ssp. *angustissima* and *Chenopodium gaudichaudianum*	+											
	Acacia aneura open woodland with ephemeral understorey	+											
	Acacia aneura open woodland with grassy understorey	+											
	Acacia aneura very open woodland over *A. ligulata*	+											
	Acacia aneura very open woodland over *Maireana pyramidata*						+						
Acacia papyrocarpa low open to very open woodland	*Acacia papyrocarpa/A. aneura* low open woodland over *Atriplex vesicaria*					+							
	Acacia papyrocarpa/A. aneura low open woodland over *Maireana campanulata*					+							
	Acacia papyrocarpa/Myoporum platycarpum low open woodland over *Maireana sedifolia*/*M. pyramidata* and *Atriplex vesicaria*					+							
	Acacia papyrocarpa low open woodland over *Maireana astrotricha*	+											
	Acacia papyrocarpa low open woodland over *Maireana pyramidata +/– Atriplex vesicaria*	+				+			+		+		
	Acacia papyrocarpa low open woodland over *Maireana sedifolia*					+							

Table N2.1 Vegetation associations of the southern infrastructure corridor (cont'd)

Vegetation associations (refer Appendix N1, Figures N1.4a–f)	Variants	Land system (see Figure N1.2)											
		Roxby	Lookout	Arcoona	Torrens	Hesso	Bowen	Tent Hill	Yorkey	Bittali	Yudnapinna	Saltia	Pandurra
	Acacia papyrocarpa low open woodland over *Senna artemisioides* ssp. *petiolaris* and *Atriplex vesicaria*					+							
	Acacia papyrocarpa low open woodland with grassy understorey	+											
Casuarina pauper low open woodland	*Casuarina pauper* low open woodland over *grasses*					+			+				
	Casuarina pauper low open woodland over M*aireana sedifolia* and *Atriplex vesicaria*					+							
Plains or footslopes													
Acacia papyrocarpa low open to very open woodland	*Acacia papyrocarpa* low open woodland over *Eremophila scoparia*									+			
	Acacia papyrocarpa low open woodland over *Maireana pyramidata* and grasses							+			+		
	Acacia papyrocarpa/Myoporum platycarpum low open woodland over *Maireana sedifolia*					+				+			
	Acacia papyrocarpa low open woodland over *Maireana sedifolia +/– Atriplex vesicaria*					+				+			+
Casuarina pauper low open woodland	*Casuarina pauper* low open woodland							+					
Myoporum platycarpum open woodland	*Myoporum platycarpum* open woodland over *Atriplex vesicaria*									+			
Eucalyptus socialis woodland	*Eucalyptus socialis/E. gracilis* woodland over *Maireana sedifolia* and *Rhagodia ulicina*									+			
	Eucalyptus socialis woodland over *Beyeria opaca, Senna* sp. and *Eremophila* sp.									+			
Drainage areas													
Acacia aneura woodland	*Acacia aneura/A. tetragonophylla* woodland over *Dissocarpus paradoxus*	+											
	Acacia aneura Casuarina pauper woodland			+									
	Acacia aneura woodland over *Eremophila duttonii*			+									
Melaleuca pauperiflora ssp. *mutica* low woodland to open woodland	*Melaleuca pauperiflora* ssp. *mutica* low open woodland over *Atriplex spongiosa*	+											
	Melaleuca pauperiflora ssp. *mutica* low open woodland over *Halosarcia* sp.	+											
	Melaleuca pauperiflora ssp. *mutica* low open woodland with abundant juveniles	+	+										

Table N2.1 Vegetation associations of the southern infrastructure corridor (cont'd)

Vegetation associations (refer Appendix N1, Figures N1.4a–f)	Variants	Land system (see Figure N1.2)											
		Roxby	Lookout	Arcoona	Torrens	Hesso	Bowen	Tent Hill	Yorkey	Bittali	Yudnapinna	Saltia	Pandurra
Casuarina pauper low open woodland	*Casuarina pauper* low open woodland over *Eremophila* spp. and +/– *Prostanthera striatiflora*			+				+					
Eucalyptus intertexta very open woodland	*Eucalyptus intertexta* very open woodland							+					
Eucalyptus camaldulensis woodland	*Eucalyptus camaldulensis* woodland											+	
Tablelands													
Casuarina pauper low open woodland	*Casuarina pauper* low open woodland over *Geijera linearifolia*								+				
	Casuarina pauper low open woodland over *Triodia irritans*							+					
Myoporum platycarpum open woodland	*Myoporum platycarpum* open woodland							+	+				
Eucalyptus socialis woodland	*Eucalyptus socialis* woodland over *Maireana sedifolia*							+					
Tidal flats													
Avicennia marina ssp. *marina* low forest to open woodland	*Avicennia marina* ssp. *marina* low forest								+				
	Avicennia marina ssp. *marina* open woodland							+					
Shrublands													
Sandplains and dunefields													
Acacia ramulosa open shrubland	*Acacia ramulosa* tall open shrubland	+											
	Acacia ramulosa/A. aneura /A. burkittii tall open shrubland					+							
	Acacia ramulosa/A. aneura /A. ligulata tall open shrubland	+											
	Acacia ramulosa/A. ligulata +/– Dodonaea viscosa ssp. *angustissima* tall open shrubland	+		+									
Acacia ligulata open shrubland	*Acacia ligulata/A. oswaldii* open shrubland								+				
	Acacia ligulata/Dodonaea viscosa ssp. *angustissima* shrubland	+		+		+	+		+				
	Acacia ligulata/Duboisia hopwoodi tall open shrubland					+							
	Acacia ligulata/Maireana pyramidata +/– Lycium australe open shrubland	+							+				
	Acacia ligulata/Melaleuca glomerata shrubland												
	*Acacia ligulata +/– *Schinus molle* shrubland								+				
	Acacia ligulata shrubland over *Atriplex velutinella*	+											
	Acacia ligulata shrubland over *Atriplex vesicaria +/– Maireana apressa*	+							+				

Table N2.1 Vegetation associations of the southern infrastructure corridor (cont'd)

Vegetation associations (refer Appendix N1, Figures N1.4a–f)	Variants	Land system (see Figure N1.2)											
		Roxby	Lookout	Arcoona	Torrens	Hesso	Bowen	Tent Hill	Yorkey	Bittali	Yudnapinna	Saltia	Pandurra
	Acacia ligulata shrubland over *Zygophyllum aurantiacum* and *Sclerolaena obliquicuspis*	+											
Senna spp. shrubland	*Senna artemisioides* ssp. *petiolaris/Acacia burkittii* shrubland					+							
Dodonaea viscosa ssp. *angustissima* open shrubland	*Dodonaea viscosa* ssp. *angustissima* open shrubland	+						+					
	Dodonaea viscosa ssp. *angustissima* open shrubland over *Brassica tournefortii*	+											
Acacia burkittii open shrubland	*Acacia burkittii/Acacia ligulata/Dodonaea viscosa* ssp. *angustissima* open shrubland					+							
	Acacia burkittii/Maireana pyramidata open shrubland					+							
	Acacia burkittii/Senna spp. open shrubland					+							
Nitraria billardieri low open shrubland	*Nitraria billardieri* low open shrubland over *Atriplex vesicaria*								+				
Melaleuca lanceolata tall open shrubland	*Melaleuca lanceolata* tall open shrubland over *Atriplex vesicaria* and *Geijera linearifolia*					+							
Interdune corridors or plains													
Atriplex vesicaria low open shrubland	*Atriplex vesicaria/Gunniopsis quadrifida* low open shrubland	+											
	Atriplex vesicaria/Maireana astrotricha low shrubland	+						+					
	Atriplex vesicaria +/– *Halosarcia* sp. low open shrubland								+				
	Atriplex vesicaria low open shrubland over *Disphyma crassifolium* ssp. *clavellatum* and *Sclerolaena ventricosa*								+				
	Atriplex vesicaria low open shrubland over *Sclerolaena* spp.	+											
Atriplex vesicaria/Sclerostegia tenuis low shrubland	*Atriplex vesicaria/Sclerostegia tenuis* low shrubland	+											
Alectryon oleifolius ssp. *canescens* tall shrubland	*Alectryon oleifolius* ssp. *canescens* tall shrubland over *Maireana pyramidata*								+				
Atriplex vesicaria/ Maireana sedifolia low open shrubland	*Atriplex vesicaria/Maireana sedifolia* low open shrubland					+					+		+
Maireana pyramidata shrubland	*Maireana pyramidata* shrubland						+		+	+		+	
Maireana sedifolia low open shrubland	*Maireana sedifolia/Sida petrophila* low open shrubland					+							
Sclerolaena spp. low open to very open shrubland	*Sclerolaena* spp. low open shrubland over grasses	+											

Table N2.1 Vegetation associations of the southern infrastructure corridor (cont'd)

Vegetation associations (refer Appendix N1, Figures N1.4a–f)	Variants	Land system (see Figure N1.2)											
		Roxby	Lookout	Arcoona	Torrens	Hesso	Bowen	Tent Hill	Yorkey	Bittali	Yudnapinna	Saltia	Pandurra
Stony rises and tablelands													
Maireana sedifolia open shrubland	*Maireana sedifolia*/*M. astrotricha* open shrubland					+		+					
	Maireana sedifolia open shrubland over *Sclerolaena* spp.	+											
Maireana sedifolia open shrubland	*Maireana sedifolia* open shrubland with emergent *Acacia tetragonophylla*	+											
Maireana astrotricha low open shrubland	*Maireana astrotricha* low open shrubland	+		+									
Eremophila duttonii open to very open shrubland	*Eremophila duttonii*/*Scaevola spinescens*/*Maireana sedifolia* open shrubland		+										
	Eremophila duttonii very open shrubland			+									
Ptilotus obovatus low shrubland	*Ptilotus obovatus* low shrubland with ephemeral understorey	+											
Atriplex vesicaria/*Sclerostegia* sp. low open shrubland	*Atriplex vesicaria*/*Sclerostegia medullosa*/*Maireana eriantha* low open shrubland			+									
	Atriplex vesicaria/*Sclerostegia tenuis* +/– *Maireana astrotricha* low open shrubland	+					+						
	Atriplex vesicaria/*Sclerostegia tenuis* +/– *Maireana sedifolia* low open shrubland						+	+					
Sclerolaena sp. low shrubland to low open shrubland	*Sclerolaena tatei* low shrubland		+										
	Sclerolaena brachyptera low open shrubland			+									
	Sclerolaena ventricosa/*S. brachyptera* low open shrubland			+									
	Sclerolaena spp. low open shrubland with emergent *Sclerostegia* sp.			+									
Atriplex vesicaria/*Maireana astrotricha* low shrubland	*Atriplex vesicaria*/*Maireana astrotricha* low shrubland	+		+		+		+					
Atriplex vesicaria low open shrubland	*Atriplex vesicaria*/*Maireana sedifolia* low shrubland							+	+		+		+
	Atriplex vesicaria low shrubland			+									+
	Atriplex vesicaria low shrubland over *Sclerolaena* spp.			+									
	Atriplex vesicaria low shrubland with *Astrebla pectinata*			+									
Geijera linearifolia shrubland	*Geijera linearifolia* shrubland over *Atriplex vesicaria*								+				
Senna spp. open shrubland	*Senna* spp./*Dodonaea microzyga* var. *microzyga*/*Maireana sedifolia* open shrubland						+						
	Senna spp. open shrubland			+									

Table N2.1 Vegetation associations of the southern infrastructure corridor (cont'd)

Vegetation associations (refer Appendix N1, Figures N1.4a–f)	Variants	Land system (see Figure N1.2)											
		Roxby	Lookout	Arcoona	Torrens	Hesso	Bowen	Tent Hill	Yorkey	Bittali	Yudnapinna	Saltia	Pandurra
Acacia tetragonophylla open shrubland	*Acacia tetragonophylla* open shrubland	+		+									
Maireana triptera low open shrubland	*Maireana triptera* low open shrubland	+											
Drainage areas													
Maireana aphylla shrubland	*Maireana aphylla*/*Muehlenbeckia florulenta* shrubland						+						
	Maireana aphylla shrubland over *Dissocarpus paradoxus*	+											
	Maireana aphylla shrubland with emergent *Acacia oswaldii* and *Alectryon oleifolius* ssp. *canescens*	+											
	Maireana aphylla shrubland with ephemeral understorey	+		+									
Chenopodium nitrariaceum shrubland	*Chenopodium nitrariaceum* shrubland over *Atriplex spongiosa* and *Eragrostis setifolia*	+		+									
	Chenopodium nitrariaceum shrubland with ephemeral understorey	+	+	+		+							
Muehlenbeckia florulenta shrubland	*Muehlenbeckia florulenta*/*Chenopodium nitrariaceum* shrubland over *Centipeda thespidioides*					+							
	Muehlenbeckia florulenta shrubland over *Osteocarpum* sp.	+											
Acacia tetragonophylla tall shrubland to tall open shrubland	*Acacia tetragonophylla* tall shrubland	+											
	Acacia tetragonophylla tall shrubland over *Maireana pyramidata*		+										
	Acacia tetragonophylla/Dodonaea lobulata tall shrubland	+											
	Acacia tetragonophylla/Eremophila scoparia +/– *A. aneura/A. victoariae* tall shrubland			+									
Atriplex vesicaria/Halosarcia spp. low shrubland	*Atriplex vesicaria/Halosarcia* spp. low shrubland over *Sclerolaena ventricosa*	+											
	Atriplex vesicaria/Maireana pyramidata/Halosarcia spp. low shrubland over *Sclerolaena decurrens*					+							
Myoporum acuminatum shrubland	Mosaic of *Myoporum acuminatum* shrubland and *Halosarcia* sp. low open shrubland			+	+								
Atriplex vesicaria low shrubland	*Atriplex vesicaria/Gunniopsis quadrifida* low open shrubland	+											
	Atriplex vesicaria/Halosarcia sp. low shrubland			+									
	Atriplex vesicaria/Nitraria billardieri low open shrubland								+				
	Atriplex vesicaria low shrubland		+										

Table N2.1 Vegetation associations of the southern infrastructure corridor (cont'd)

Vegetation associations (refer Appendix N1, Figures N1.4a–f)	Variants	Land system (see Figure N1.2)											
		Roxby	Lookout	Arcoona	Torrens	Hesso	Bowen	Tent Hill	Yorkey	Bittali	Yudnapinna	Saltia	Pandurra
Halosarcia sp. low open shrubland	*Halosarcia halocnemoides* low open shrubland				+								
	Halosarcia sp. low open shrubland	+			+				+				
	Halosarcia spp./*Gunniopsis quadrifida* low open shrubland						+						
Alectryon oleifolius ssp. *canescens* tall shrubland	*Alectryon oleifolius* ssp. *canescens* tall shrubland over *Geijera linearifolia*								+				
Acacia victoriae tall open shrubland	*Acacia victoriae/A. ligulata* shrubland	+											
	Acacia victoriae +/– *Chenopodium nitrariaceum* tall open shrubland								+			+	
	Acacia victoriae tall open shrubland over *Cymbopogon ambiguus*							+					
Maireana pyramidata low open shrubland	*Maireana pyramidata* low open shrubland over *Halosarcia* spp.					+							
Melaleuca spp. shrubland	*Melaleuca glomerata* +/– *Maireana pyramidata* shrubland					+							
Eremophila duttonii open shrubland	*Eremophila duttonii/Dodonaea lobulata/Hakea leucoptera* open shrubland			+									
Gunniopsis quadrifida low open shrubland	*Gunniopsis quadrifida* low open shrubland	+											
Coastal dunes and cliffs													
Olearia axillaris/*Scaevola crassifolia* open shrubland	*Olearia axillaris*/*Scaevola crassifolia* open shrubland								+				
Beyeria lechenaultii/Westringia rigida low open shrubland	*Beyeria lechenaultii/Westringia rigida* low open shrubland								+				
Melaleuca lanceolata shrubland	*Melaleuca lanceolata/Alectryon oleifolius* ssp. *canescens/Acacia ligulata* open shrubland									+			
Tidal flats													
Halosarcia sp. low open to very open shrubland	*Halosarcia* sp. low open shrubland								+				
	Halosarcia sp. low open shrubland over **Sueada aegyptiaca*								+				
Grasslands													
Sandplains and dunefields													
Zygochloa paradoxa grassland	*Zygochloa paradoxa* grassland								+				
	Zygochloa paradoxa grassland with *Crotolaria eremaea* ssp. *eremaea*	+		+									
Aristida spp. open tussock grassland	*Aristida contorta* +/– *A. holathera* var. *holathera* open tussock grassland	+				+							
	Enneapogon spp. open tussock grassland	+											

Table N2.1 Vegetation associations of the southern infrastructure corridor (cont'd)

Vegetation associations (refer Appendix N1, Figures N1.4a–f)	Variants	Land system (see Figure N1.2)											
		Roxby	Lookout	Arcoona	Torrens	Hesso	Bowen	Tent Hill	Yorkey	Bittali	Yudnapinna	Saltia	Pandurra
Drainage areas													
Eragrostis australasica grassland	*Eragrostis australasica* open grassland	+		+									
	Eragrostis australasica open grassland over *Trianthema triquetra*	+											
Tablelands and stony rises													
Triodia irritans hummock grassland	*Triodia irritans* hummock grassland							+					

Table N2.2 Vegetation associations of the gas pipeline corridor

Vegetation associations (see Appendix N1, Figures N1.6a–n)	Variants	Land system (see Figure N1.2)																	
		Roxby	Collina	Hope	Stuarts Creek	Tingana	Emu	Arcoona	Flint	Kalatinka	Kopi	Mumpie	Oodnadatta	Cooper	Cooryaninna	Blanche	Strzelecki	Wirringina
Woodlands																			
Sandplains and dunefields																			
Callitris glaucophylla woodland to open woodland	*Callitris glaucophylla / Acacia aneura* +/– *A. ramulosa* open woodland with grassy understorey	+			+		+												
	Callitris glaucophylla woodland over *Sida ammophila*	+			+														
	Callitris glaucophylla woodland with grassy understorey	+			+														
Acacia aneura open woodland	*Acacia aneura/A. ramulosa* very open woodland over *Dodonaea viscosa* ssp. *angustissima*	+			+														
	Acacia aneura open woodland over *Dissocarpus paradoxus* and *Sclerolaena* spp.	+							+	+	+		+				+		
	Acacia aneura open woodland over *Dodonaea viscosa* ssp. *anugustissima* and *Chenopodium gaudichaudianum*	+			+														
	Acacia aneura open woodland with ephemeral understorey	+									+		+				+	+	
	Acacia aneura open woodland with grassy understorey	+			+						+		+				+	+	
	Acacia aneura very open woodland over *A. ligulata*	+							+	+							+	+	
Acacia papyrcocarpa low open to very open woodland	*Acacia papyrocarpa* low open woodland over *Maireana astrotricha*	+																	
	Acacia papyrocarpa low open woodland over *Maireana pyramidata* +/– *Atriplex vesicaria*	+																	
	Acacia papyroocarpa low open woodland with grassy understorey	+																	
Drainage areas																			
Acacia aneura woodland	*Acacia aneura*/A. tetragonophylla woodland over *Dissocarpus paradoxus*	+																	
Melaleuca pauperiflora ssp. *mutica* low woodland to open woodland	*Melaleuca pauperiflora* ssp. *mutica* low open woodland over *Atriplex spongiosa*	+																	
	Melaleuca pauperiflora ssp. *mutica* low open woodland over *Halosarcia* sp.	+																	
	Melaleuca pauperiflora ssp. *mutica* low open woodland with abundant juveniles	+																	
Eucalyptus camaldulensis woodland	*Eucalyptus camaldulensis* woodland																		

Table N2.2 Vegetation associations of the gas pipeline corridor (cont'd)

Vegetation associations (see Appendix N1, Figures N1.6a–n)	Variants	Land system (see Figure N1.2)																	
		Roxby	Collina	Hope	Stuarts Creek	Tingana	Emu	Arcoona	Flint	Kalatinka	Kopi	Mumpie	Oodnadatta	Cooper	Cooryaninna	Blanche	Strzelecki	Wirringina
Eucalyptus coolabah, Acacia stenophylla woodland	*Eucalyptus coolabah, Acacia stenophylla* woodland		+					+	+	+	+	+	+		+			
	Eucalyptus coolabah, Acacia stenophylla +/– Muehlenbeckia florulenta woodland										+	+						
	Eucalyptus coolabah, Acacia stenophylla +/– Acacia salicina woodland							+	+	+	+	+						
	Eucalyptus coolabah, Acacia stenophylla +/– Eucalyptus camaldulensis woodland		+								+							
Shrublands																			
Sandplains and dunefields																			
Acacia ramulosa open shrubland	*Acacia ramulosa* tall open shrubland	+																	
	Acacia ramulosa/A. aneura/A. ligulata tall open shrubland	+			+		+	+											
	Acacia ramulosa/A. ligulata +/– Dodonaea viscosa ssp. *angustissima* tall open shrubland	+							+	+		+	+		+				
Acacia ligulata open shrubland	*Acacia ligulata / Dodonaea viscosa* ssp. *angustissima* shrubland	+																	
	Acacia ligulata/Maireana pyramidata +/– Lycium australe open shrubland	+																	
	Acacia ligulata shrubland over *Atriplex velutinella*	+																	
	Acacia ligulata shrubland over *Atriplex vesicaria +/– Maireana apressa*	+																	
	Acacia ligulata shrubland over *Zygophyllum aurantiacum* and *Sclerolaena obliquicuspis*	+																	
	Acacia ligulata shrubland over *Zygochloa paradoxa*		+	+		+							+				+		
Dodonaea viscosa ssp. *angustissima* open shrubland	*Dodonaea viscosa* ssp. *angustissima* open shrubland	+																	
	Dodonaea viscosa ssp. *angustissima* open shrubland over *Brassica tournefortii*	+																	
Nitraria billardieri low open shrubland	*Nitraria billardieri* low open shrubland over *Atriplex vesicaria*		+		+				+	+			+			+		+	
	Nitraria billardieri low open shrubland over *Zygophyllum* spp.		+		+				+	+			+			+		+	
Interdune corridors or plains																			
Atriplex vesicaria low open shrubland	*Atriplex vesicaria/Gunniopsis quadrifida* low open shrubland	+			+														
	Atriplex vesicaria/Maireana astrotricha low shrubland	+			+		+	+	+	+	+	+	+		+		+	+	

Table N2.2 Vegetation associations of the gas pipeline corridor (cont'd)

Vegetation associations (see Appendix N1, Figures N1.6a–n)	Variants	Land system (see Figure N1.2)																	
		Roxby	Collina	Hope	Stuarts Creek	Tingana	Emu	Arcoona	Flint	Kalatinka	Kopi	Mumpie	Oodnadatta	Cooper	Cooryaninna	Blanche	Strzelecki	Wirringina
	Atriplex vesicaria low open shrubland over *Sclerolaena* spp.	+			+		+	+	+	+	+	+	+		+			+
Atriplex vesicaria/Sclerostegia tenuis low shrubland	*Atriplex vesicaria/Scelrostegia tenuis* low shrubland	+																
Sclerolaena spp. low open to very open shrubland	*Sclerolaena* spp. low open shrubland over grasses	+								+	+	+			+			
	Sclerolaena spp. low open shrubland with *Atriplex nummularia* ssp. *nummularia* over grasses					+								+				
	Sclerolaena spp., *Atriplex spongiosa* low open shrubland with grasses		+							+	+	+						
Dissocarpus paradoxus low open shrubland	*Dissocarpus paradoxus, Sclerolaena* spp. low open shrubland												+		+			
Stony rises and tablelands																		
Maireana sedifolia open shrubland	*Maireana sedifolia* open shrubland over *Sclerolaena* spp.	+																
	Maireana sedifolia open shrubland with emergent *Acacia tetragonophylla*	+																
Maireana astrotricha low open shrubland	*Maireana astrotricha* low open shrubland	+																
Ptilotus obovatus low shrubland	*Ptilotus obovatus* low shrubland with ephemeral understorey	+																
Atriplex vesicaria/ Sclerostegia sp. low open shrubland	*Atriplex vesicaria/Sclerostegia tenuis +/– Maireana astrotricha* low open shrubland	+																
Sclerostegia tenuis low open shrubland	*Sclerostegia tenuis +/– Atriplex vesicaria* low open shrubland		+	+						+			+					
Atriplex vesicaria/ Maireana astrotricha low shrubland	*Atriplex vesicaria/Maireana astrotricha* low shrubland	+																
Acacia tetragonophylla open shrubland	*Acacia tetragonophylla o*pen shrubland	+																
Maireana triptera low open shrubland	*Maireana triptera* low open shrubland	+																
Drainage areas																		
Maireana aphylla shrubland	*Maireana aphylla*/*Muehlenbeckia florulenta* shrubland									+		+	+					+
	Maireana aphylla shrubland over *Dissocarpus paradoxus*	+								+			+					
	Maireana aphylla shrubland with emergent *Acacia oswaldii* and *Alectryon oleifolius* ssp. *canescens*	+																
	Maireana aphylla shrubland with ephemeral understorey	+								+	+	+			+			+
Chenopodium nitrariaceum shrubland	*Chenopodium nitrariaceum* shrubland over *Atriplex spongiosa* and *Eragrostis setifolia*	+																

Table N2.2 Vegetation associations of the gas pipeline corridor (cont'd)

Vegetation associations (see Appendix N1, Figures N1.6a–n)	Variants	Land system (see Figure N1.2)																	
		Roxby	Collina	Hope	Stuarts Creek	Tingana	Emu	Arcoona	Flint	Kalatinka	Kopi	Mumpie	Oodnadatta	Cooper	Cooryaninna	Blanche	Strzelecki	Wirringina
	Chenopodium nitrariaceum shrubland with ephemeral understorey	+																
Muehlenbeckia florulenta shrubland	*Muehlenbeckia florulenta* shrubland over *Osteocarpum* sp.	+			+		+											
Acacia tetragonophylla tall shrubland to tall open shrubland	*Acacia tetragonophylla* tall shrubland	+																
	Acacia tetragonophylla/Dodonaea lobulata tall shrubland	+																
Atriplex vesicaria/ Halosarcia spp. low shrubland	*Atriplex vesicaria/Halosarcia* spp. low shrubland over *Sclerolaena ventricosa*	+																
Atriplex vesicaria low shrubland	*Atriplex vesicaria/Gunniopsis quadrifida* low open shrubland	+																
Halosarcia sp. low open shrubland	*Halosarcia* sp. low open shrubland	+			+				+					+		+		
Acacia victoriae tall open shrubland	*Acacia victoriae/A. ligulata* shrubland	+			+	+												
Gunniopsis quadrifida low open shrubland	*Gunniopsis quadrifida* low open shrubland	+																
Grasslands/Sedgelands																		
Sandplains and dunefields																		
Zygochloa paradoxa grassland	*Zygochloa paradoxa* grassland		+	+		+	+		+	+	+			+		+	+	+
	Zygochloa paradoxa grassland with *Crotalaria eremaea* ssp. *eremaea*	+	+	+	+	+	+			+				+		+	+	+
	Zygochloa paradoxa +/– *Triodia basedowii* grassland			+														
Aristida spp. open tussock grassland	*Aristida contorta* +/– *A. holathera* var. *holathera* open tussock grassland	+				+												
Stony rises and tablelands																		
Astrebla pectinata grassland	*Astrebla pectinata, Sclerolaena* spp. grassland				+				+	+	+	+	+					+
Cyperus laevigatus sedgeland	*Cyperus laevigatus* +/– *C. gymnocaulos* sedgeland											+						
	Cyperus laevigatus +/– *C. gymnocaulos* +/– *Typha* sp. sedgeland											+						
	Cyperus laevigatus +/– *C. gymnocaulos* +/– *Acacia salicina* sedgeland											+						
Drainage areas																		
Enneapogon spp. open tussock grassland	*Enneapogon* spp. open tussock grassland	+																
Eragrostis australasica grassland	*Eragrostis australasica* open grassland	+		+	+		+											+
	Eragrostis australasica open grassland over *Trianthema triquetra*	+			+		+											
	Eragrostis australasica/*Muehlenbeckia florulenta* open grassland				+		+											+

APPENDIX N3

Indigenous plant species recorded within the EIS Study Area

N3 INDIGENOUS PLANT SPECIES RECORDED WITHIN THE EIS STUDY AREA

Unless otherwise indicated in Table N3.1, the search area included the expanded SML and Municipality of Roxby Downs (SML/RD), a 10 km wide corridor for infrastructure (Corridors), a 20 km radius around the desalination plant site (DP), the landing facility (LF) near Port Augusta and Yarra Wurta Spring (YW).

The sources of indigenous plant information were:

- southern corridor: (1) transmission line survey by WMC (1997); (2) Ecological Associates survey (2006)
- gas pipeline corridors: (3) Biological database of SA; (4) three field trips by RMP Environmental and EBS in association with RPS Ecos (2006–8)
- expanded SML and Municipality of Roxby Downs: (5) previous surveys and monitoring as reported by Kinhill (1997); (6) Ecological Associates survey (2006)
- desalination plant (DP): Ecological Associates survey (2006)
- Yarrawurta Spring (YW): Ecological Associates survey (2006)
- landing facility near Port Augusta (LF): Environmental and Biodiversity Services survey (2007).

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
ACANTHACEAE												
Rostellularia adscendens var. *pogonanthera*	Pink Tongues			X	X							
ADIANTACEAE												
Cheilanthes lasiophylla	Woolly Cloak-fern			X	X							
Cheilanthes sieberi ssp. *sieberi*	Narrow Rock-fern			X								
AIZOACEAE												
Carpobrotus rossii	Native Pigface				X			X				
Disphyma crassifolium ssp. *clavellatum*	Round-leaf Pigface			X	X							
Glinus lotoides	Hairy Carpet-weed			X		X						
Gunniopsis papillata	Twin-leaf Pigface			X		X						
Gunniopsis quadrifida	Sturt's Pigface			X	X	X	X	X	X			
Gunniopsis zygophylloides	Twin-leaf Pigface			X	X	X						
Mollugo cerviana	Wire-stem Chickweed					X						
Sarcozona praecox	Sarcozona			X	X	X	X		X			
Tetragonia eremaea	Desert Spinach			X	X	X	X	X	X			
Tetragonia implexicoma	Bower Spinach				X							
Tetragonia tetragonioides	New Zealand Spinach			X	X							
Trianthema triquetra	Red Spinach			X		X		X	X			
Zaleya galericulata ssp. *australis*	Hogweed					X						
AMARANTHACEAE												
Alternanthera denticulata	Lesser Joyweed					X						
Alternanthera nodiflora	Common Joyweed					X						
Alternanthera sp.	Joyweed					X						
Amaranthus grandiflorus	Large-flower Amaranth					X		X	X			
Amaranthus mitchellii	Boggabri Weed					X						
Amaranthus sp.	Amaranth					X						
Hemichroa diandra	Mallee Hemichroa				X	X						X
Ptilotus gaudichaudii var. *gaudichaudii*	Paper Fox-tail					X						
Ptilotus latifolius var. *latifolius*	Tangled Mulla Mulla					X						
Ptilotus nobilis var. *nobilis*	Yellow-tails					X						
Ptilotus obovatus var. *obovatus*	Silver Mulla Mulla			X	X	X	X	X	X			
Ptilotus parvifolius var. *laetus*	Small-leaf Mulla Mulla			X	X							

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
Ptilotus polystachyus var. *polystachyus*	Long-tails			X	X	X	X	X	X			
Ptilotus sessilifolius var. *sessilifolius*	Crimson-tails			X		X	X					
AMARYLLIDACEAE												
Calostemma luteum	Yellow Garland-lily					X						
Calostemma purpureum	Pink Garland-lily					X						
Crinum flaccidum	Murray Lily			X	X	X	X		X			
ASCLEPIADACEAE												
Cynanchum floribundum	Desert Cynanchum					X	X					
Marsdenia australis	Native Pear				X							
Sarcostemma viminale ssp. *australe*	Caustic Bush			X	X				X			
AVICENNIACEAE												
Avicennia marina ssp. *marina*	Grey Mangrove				X						X	
BORAGINACEAE												
Halgania cyanea	Rough Halgania				X							
Heliotropium pachyphyllum							X					
Omphalolappula concava	Burr Stickseed			X				X	X			
Trichodesma zeylanicum	Camel Bush			X	X	X		X	X			
CAMPANULACEAE												
Isotoma petraea	Rock Isotome			X	X	X						
Wahlenbergia communis	Tufted Bluebell			X	X	X						
Wahlenbergia sp.	Native Bluebell				X			X				
Wahlenbergia tumidifructa	Swollen-fruit Bluebell			X		X						
CASUARINACEAE												
Casuarina pauper	Black Oak			X	X						X	
CHENOPODIACEAE												
Atriplex acutibractea ssp. *acutibractea*	Pointed Saltbush				X							
Atriplex angulata	Fan Saltbush					X	X	X				
Atriplex cordifolia						X						
Atriplex crassipes var. *crassipes*									X			
Atriplex eardleyae	Eardley's Saltbush					X						
Atriplex eichleri	Eichler's Saltbush		R			X						
Atriplex fissivalvis	Gibber Saltbush			X								

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
Atriplex holocarpa	Pop Saltbush			X		X	X					
Atriplex incrassata						X	X					
Atriplex intermedia									X			
Atriplex kochiana			V					X				
Atriplex limbata						X		X				
Atriplex lindleyi	Baldoo			X	X			X				
Atriplex lindleyi ssp. *conduplicata*	Baldoo					X						
Atriplex lindleyi ssp. *inflata*								X				
Atriplex lindleyi ssp. *lindleyi*	Baldoo				X	X			X			
Atriplex lindleyi ssp. *quadripartita*	Baldoo					X						
Atriplex lobativalvis						X						
Atriplex macropterocarpa				X								
Atriplex nummularia ssp. *nummularia*	Old-man Saltbush					X	X					
Atriplex nummularia ssp. *omissa*	Old-man Saltbush					X						
Atriplex obconica						X						
Atriplex pseudocampanulata	Spreading Saltbush				X							
Atriplex quadrivalvata var. *quadrivalvata*												
Atriplex sp.	Saltbush					X						
Atriplex spongiosa	Pop Saltbush			X	X	X	X	X	X			X
Atriplex stipitata	Bitter Saltbush				X							
Atriplex velutinella	Sandhill Saltbush			X	X	X	X	X	X			
Atriplex vesicaria	Bladder Saltbush			X	X	X	X	X	X	X	X	
Chenopodium auricomum	Golden Goosefoot					X	X					
Chenopodium cristatum	Crested Goosefoot			X	X	X						
Chenopodium desertorum	Desert Goosefoot			X	X							
Chenopodium desertorum ssp. *desertorum*	Frosted Goosefoot				X							
Chenopodium desertorum ssp. *rectum*	Erect Goosefoot				X							
Chenopodium gaudichaudianum	Scrambling Goosefoot			X	X				X			
Chenopodium nitrariaceum	Nitre Bush				X	X	X	X	X			
Chenopodium pumilio	Clammy Goosefoot							X				
Dissocarpus biflorus	Two-horn Saltbush			X								
Dissocarpus biflorus var. *biflorus*	Two-horn Saltbush					X						

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
Dissocarpus biflorus var. *villosus*	Woolly Two-horn Saltbush					X						
Dissocarpus fontinalis				X		X						
Dissocarpus paradoxus	Ball Bindyi			X	X	X		X	X			
Dysphania kalpari	Rats' Tails					X						
Dysphania plantaginella	Plantain Crumbweed					X						
Dysphania platycarpa	Flat-fruit Crumbweed					X						
Dysphania simulans	Erect Crumbweed					X						
Einadia nutans ssp. *eremaea*	Dryland Climbing Saltbush					X	X					
Einadia nutans ssp. *nutans*	Climbing Saltbush			X	X			X	X			
Enchylaena tomentosa	Ruby Saltbush					X	X					
Enchylaena tomentosa var. *glabra*	Smooth Ruby Saltbush					X						
Enchylaena tomentosa var. *tomentosa*	Ruby Saltbush			X	X	X		X	X			
Eriochiton sclerolaenoides	Woolly-fruit Bluebush			X	X	X		X	X			
Halosarcia halocnemoides				X	X				X	X		X
Halosarcia halocnemoides ssp. *halocnemoides*	Grey Samphire					X						
Halosarcia halocnemoides ssp. *longispicata*						X						X
Halosarcia indica	Brown-head Samphire			X	X				X			
Halosarcia indica ssp. *leiostachya*						X	X	X				
Halosarcia pergranulata ssp. *divaricata*	Black-seed Samphire			X		X						
Halosarcia pergranulata ssp. *pergranulata*	Black-seed Samphire					X						
Halosarcia pruinosa	Bluish Samphire			X								
Halosarcia sp.					X	X					X	
Maireana aphylla	Cotton-bush			X	X	X	X	X	X			
Maireana appressa	Pale-fruit Bluebush			X	X	X	X		X			X
Maireana astrotricha	Low Bluebush			X	X	X	X	X	X		X	
Maireana brevifolia	Short-leaf Bluebush				X							
Maireana campanulata	Bell-fruit Bluebush			X	X							
Maireana cannonii	Cannon's Bluebush			X	X					X		
Maireana carnosa	Cottony Bluebush								X			
Maireana ciliata	Hairy Fissure-plant					X						
Maireana coronata	Crown Fissure-plant					X	X					
Maireana eriantha	Woolly Bluebush			X	X	X						X

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
Maireana erioclada	Rosy Bluebush			X	X	X		X	X			
Maireana georgei	Satiny Bluebush			X	X	X	X			X		
Maireana integra	Entire-wing Bluebush			X	X	X						
Maireana microcarpa	Swamp Bluebush					X	X					
Maireana pentagona	Slender Fissure-plant		R			X						
Maireana pentatropis						X		X				
Maireana pyramidata	Black Bluebush			X	X	X	X	X	X			
Maireana scleroptera	Hard-wing Bluebush								X			
Maireana sedifolia	Bluebush			X	X			X	X	X		
Maireana sp.	Bluebush/Fissure-plant					X			X			
Maireana spongiocarpa	Spongy-fruit Bluebush			X								
Maireana tomentosa ssp. *urceolata*						X						
Maireana trichoptera	Hairy-fruit Bluebush			X	X							
Maireana triptera	Three-wing Bluebush				X				X			
Maireana turbinata	Top-fruit Bluebush				X	X						
Malacocera albolanata	Woolly Soft-horns			X		X						
Malacocera tricornis	Goat-head Soft-horns				X	X	X	X				
Neobassia proceriflora	Desert Glasswort					X						
Osteocarpum acropterum var. *acropterum*	Tuberculate Bonefruit			X	X	X		X				
Osteocarpum dipterocarpum	Two-wing Bonefruit			X	X	X	X					X
Osteocarpum salsuginosum	Inland Bonefruit				X							
Osteocarpum sp.					X	X	X		X			
Rhagodia candolleana ssp. *candolleana*	Sea-berry Saltbush				X							
Rhagodia parabolica	Mealy Saltbush				X	X						
Rhagodia spinescens	Spiny Saltbush			X	X	X		X	X			
Rhagodia ulicina	Intricate Saltbush				X				X			
Salsola tragus	Buckbush			X	X	X	X	X	X	X		
Sclerolaena bicornis	Goat-head Bindyi					X	X					
Sclerolaena brachyptera	Short-wing Bindyi			X	X	X	X	X	X			
Sclerolaena brevifolia	Small-leaf Bindyi								X			
Sclerolaena calcarata	Redburr Bindyi					X						
Sclerolaena constricta						X						

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
Sclerolaena cuneata	Tangled Bindyi			X		X			X			
Sclerolaena decurrens	Green Bindyi			X	X	X		X	X			
Sclerolaena diacantha	Grey Bindyi			X	X	X	X	X	X			
Sclerolaena divaricata	Tangled Bindyi			X	X	X	X	X	X		X	
Sclerolaena eriacantha	Silky Bindyi			X								
Sclerolaena glabra	Smooth Bindyi				X							
Sclerolaena holtiana	Holt's Bindyi			X		X	X					
Sclerolaena intricata	Tangled Bindyi			X		X	X	X				
Sclerolaena lanicuspis	Spinach Bindyi			X		X	X	X	X			
Sclerolaena limbata	Pearl Bindyi					X						
Sclerolaena longicuspis	Long-spine Bindyi					X						
Sclerolaena muricata var. *muricata*	Five-spine Bindyi					X						
Sclerolaena obliquicuspis	Oblique-spined Bindyi			X	X	X	X	X	X	X		
Sclerolaena parallelicuspis	Western Bindyi					X			X			
Sclerolaena patenticuspis	Spear-fruit Bindyi				X	X		X	X			
Sclerolaena sp.	Bindyi					X						
Sclerolaena sp.				X								
Sclerolaena tatei	Tate's Bindyi			X	X	X						
Sclerolaena uniflora	Small-spine Bindyi			X	X							
Sclerolaena ventricosa	Salt Bindyi			X	X	X		X	X			
Sclerostegia arbuscula					X							
Sclerostegia medullosa					X	X						
Sclerostegia sp.	Samphire					X						
Sclerostegia tenuis	Slender Samphire			X	X	X	X	X	X		X	
Suaeda australis	Austral Seablite				X							
COMPOSITAE												
Actinobole uliginosum	Flannel Cudweed			X	X	X	X		X			
Anemocarpa podolepidium	Rock Everlasting			X		X						
Angianthus brachypappus	Spreading Angianthus					X						
Angianthus glabratus	Smooth Angianthus				X							
Brachyscome ciliaris	Variable Daisy							X			X	
Brachyscome ciliaris var. *ciliaris*	Variable Daisy			X								

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
Brachyscome ciliaris var. *lanuginosa*	Woolly Variable Daisy			X	X	X	X		X			
Brachyscome dichromosomatica var. *dichromosomatica*	Large Hard-head Daisy			X								
Brachyscome iberidifolia	Swan River Daisy				X							
Brachyscome lineariloba	Hard-head Daisy			X	X			X	X			
Calocephalus platycephalus	Western Beauty-heads					X		X	X			
Calocephalus sp.	Beauty-heads					X						
Calotis cymbacantha	Showy Burr-daisy			X	X	X		X				
Calotis erinacea	Tangled Burr-daisy				X	X						
Calotis hispidula	Hairy Burr-daisy			X	X	X	X	X	X			
Calotis kempei	Kemp's Burr-daisy			X								
Calotis latiuscula	Leafy Burr-daisy			X		X						
Calotis multicaulis	Woolly-headed Burr-daisy					X		X				
Calotis plumulifera	Woolly-headed Burr-daisy					X						
Calotis porphyroglossa	Channel Burr-daisy			X		X						
Cassinia laevis	Curry Bush				X							
Centipeda cunninghamii	Common Sneezeweed					X						
Centipeda sp.	Sneezeweed				X							
Centipeda thespidioides	Desert Sneezeweed			X	X	X			X			
Chrysocephalum apiculatum	Common Everlasting					X			X			
Chrysocephalum eremaeum	Sand Button-bush					X						
Chthonocephalus pseudevax	Ground-heads			X				X				
Compositae sp.	Daisy Family					X						
Cratystylis conocephala	Bluebush Daisy				X							
Dichromochlamys dentatifolia							X					
Epaltes australis	Spreading Nut-heads			X		X						
Epaltes cunninghamii	Tall Nut-heads					X						
Eriochlamys behrii	Woolly Mantle			X	X	X	X					
Erodiophyllum elderi	Koonamore Daisy				X							
Gnephosis arachnoidea	Spidery Button-flower			X	X	X	X	X	X			
Gnephosis drummondii	Slender Golden-tip						X					
Gnephosis eriocarpa	Native Camomile					X						
Gnephosis tenuissima	Dwarf Golden-tip			X	X	X		X	X			

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
Hyalosperma glutinosum ssp. *glutinosum*	Golden Sunray			X								
Hyalosperma semisterile	Orange Sunray			X	X							
Isoetopsis graminifolia	Grass Cushion			X	X							
Ixiochlamys cuneifolia	Silverton Daisy					X						
Ixiochlamys nana	Small Fuzzweed				X	X						
Kippistia suaedifolia	Fleshy Kippistia					X						
Lawrencella davenportii	Davenport Daisy			X								
Leiocarpa leptolepis	Pale Plover-daisy			X	X	X	X	X				
Leiocarpa tomentosa	Woolly Plover-daisy				X							
Leiocarpa websteri	Narrow Plover-daisy					X						
Lemooria burkittii	Wires-and-wool			X			X					
Leptorhynchos baileyi	Bailey's Buttons			X								
Leucochrysum molle	Hoary Sunray			X								
Microseris lanceolata	Yam Daisy			X								
Millotia macrocarpa	Large-fruit Millotia			X								
Minuria annua	Annual Minuria					X						
Minuria cunninghamii	Bush Minuria			X	X	X	X	X	X	X		X
Minuria denticulata						X		X				
Minuria integerrima	Smooth Minuria						X					
Minuria leptophylla	Minnie Daisy			X		X		X	X			
Minuria rigida						X						
Myriocephalus sp.						X						
Olearia axillaris	Coast Daisy-bush				X					X		
Olearia muelleri	Mueller's Daisy-bush				X							
Olearia pimeleoides ssp. *pimeleoides*	Pimelea Daisy-bush				X							
Pluchea rubelliflora						X						
Podolepis capillaris	Wiry Podolepis			X	X	X	X		X			
Podolepis davisiana	Button Podolepis			X								
Polycalymma stuartii	Poached-egg Daisy			X	X	X	X	X	X			
Pseudognaphalium luteoalbum	Jersey Cudweed			X		X		X				
Pterocaulon sphacelatum	Apple-bush			X	X	X	X		X			
Pycnosorus pleiocephalus	Soft Billy-buttons			X		X		X				

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
Pycnosorus sp.						X		X				
Rhodanthe charsleyae						X						
Rhodanthe corymbiflora	Paper Everlasting									X		
Rhodanthe floribunda	White Everlasting			X		X	X	X	X			
Rhodanthe microglossa	Clustered Everlasting			X		X		X				
Rhodanthe moschata	Musk Daisy			X	X	X	X	X				
Rhodanthe pygmaea	Pigmy Daisy			X		X	X	X				
Rhodanthe stricta	Slender Everlasting			X		X	X	X	X			
Rhodanthe stuartiana	Clay Everlasting					X						
Rhodanthe troedelii	Small Paper-everlasting					X						
Rhodanthe uniflora	Woolly Daisy			X		X	X					
Rutidosis helichrysoides ssp. *helichrysoides*	Grey Wrinklewort					X						
Schoenia ramosissima	Dainty Everlasting			X		X						
Senecio cunninghamii var. *cunninghamii*	Shrubby Groundsel					X						
Senecio glossanthus	Annual Groundsel			X	X	X						
Senecio gregorii	Fleshy Groundsel			X		X	X	X				
Senecio lanibracteus	Inland Shrubby Groundsel				X	X	X		X			
Senecio magnificus	Showy Groundsel			X		X	X					
Senecio pinnatifolius	Variable Groundsel			X	X	X		X		X		
Senecio runcinifolius	Thistle-leaf Groundsel					X						
Senecio sp.	Groundsel				X	X						
Sigesbeckia orientalis ssp. *orientalis*	Oriental Sigesbeckia				X							
Streptoglossa adscendens	Desert Daisy					X						
Streptoglossa cylindriceps						X						
Streptoglossa liatroides	Wertaloona Daisy					X						
Trichanthodium skirrophorum	Woolly Yellow-heads				X	X			X			
Vittadinia arida									X			
Vittadinia cervicularis var. *cervicularis*	Waisted New Holland Daisy				X					X		
Vittadinia eremaea	Desert New Holland Daisy			X		X		X				
Vittadinia sp.	New Holland Daisy					X	X		X			
Waitzia acuminata var. *acuminata*	Orange Immortelle			X								
Xerochrysum bracteatum	Golden Everlasting								X			

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
CONVOLVULACEAE												
Convolvulaceae sp.	Bindweed Family					X						
Convolvulus erubescens					X	X	X	X				
Convolvulus eyreanus	Silver Bindweed					X						
Convolvulus remotus	Grassy Bindweed			X	X	X			X			
Cressa cretica	Rosinweed			X	X							
Cuscuta victoriana						X						
Ipomoea lonchophylla	Cow-vine					X						
CRASSULACEAE												
Crassula colorata	Dense Crassula			X				X				
Crassula colorata var. *acuminata*	Dense Crassula					X						
Crassula sieberiana complex	Australian Stonecrop			X	X	X						
Crassula sp.	Crassula/Stonecrop				X				X			
Crassula tetramera	Australian Stonecrop					X						
CRUCIFERAE												
Arabidella nasturtium	Yellow Cress			X		X						
Arabidella sp.					X							
Arabidella trisecta	Shrubby Cress			X		X						
Blennodia canescens	Native Stock			X		X						
Blennodia pterosperma	Wild Stock					X		X				
Blennodia sp.						X						
Harmsiodoxa brevipes var. *brevipes*	Short Cress					X						
Harmsiodoxa puberula	Scented Cress					X						
Lepidium muelleri-ferdinandi	Mueller's Peppercress					X						
Lepidium oxytrichum	Green Peppercress			X		X	X	X				
Lepidium papillosum	Warty Peppercress					X						
Lepidium phlebopetalum	Veined Peppercress			X	X	X	X	X	X			
Lepidium rotundum	Veined Peppercress				X							
Lepidium sagittulatum	Fine-leaf Peppercress					X						
Lepidium sp.	Peppercress								X			
Menkea crassa	Fat Spectacles			X	X	X		X				
Pachymitus cardaminoides	Sand Cress			X								

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
Phlegmatospermum cochlearinum	Downy Cress			X	X	X						
Phlegmatospermum eremaeum	Spreading Cress		R			X						
Stenopetalum anfractum	Inland Thread-petal								X			
Stenopetalum lineare	Narrow Thread-petal			X		X		X				
Stenopetalum sp.	Thread-petal				X							
CUPRESSACEAE												
Callitris glaucophylla	White Cypress-pine			X	X	X	X	X	X			
CYPERACEAE												
Bolboschoenus caldwellii	Salt Club-rush					X						
Cyperus bulbosus	Bulbous Flat-sedge					X						
Cyperus difformis	Variable Flat-sedge					X						
Cyperus gymnocaulos	Spiny Flat-sedge			X	X	X	X					
Cyperus iria						X						
Cyperus laevigatus	Bore-drain Sedge					X	X					
Cyperus pygmaeus	Pygmy Flat-sedge					X						
Cyperus rigidellus	Dwarf Flat-sedge					X						
Cyperus squarrosus	Bearded Flat-sedge					X						
Cyperus victoriensis	Yelka					X						
Eleocharis pallens	Pale Spike-rush					X	X					
Eleocharis papillosa	Dwarf Desert Spike-rush	V	R			X						
Fimbristylis dichotoma	Common Fringe-rush					X						
Isolepis australiensis	Southern Club-rush					X						
Lipocarpha microcephala	Button Rush					X						
Schoenoplectus dissachanthus	Inland Club-rush					X						
Schoenoplectus litoralis	Shore Club-rush					X						
ELATINACEAE												
Bergia trimera	Three-part Water-fire			X								
EUPHORBIACEAE												
Beyeria lechenaultii	Pale Turpentine Bush				X							
Beyeria opaca	Dark Turpentine Bush				X							
Chamaesyce australis				X								
Chamaesyce sp.						X						

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
Chamaesyce drummondii				X		X		X	X			
Chamaesyce wheeleri				X				X	X			
Euphorbia stevenii	Bottletree Spurge			X	X							
Euphorbia parvicaruncula	Rough-seeded Spurge					X						
Euphorbia sp.	Spurge					X						
Euphorbia tannensis ssp. *eremophila*	Desert Spurge			X		X		X	X	X		
Euphorbiaceae sp.	Spurge Family					X						
Phyllanthus fuernrohrii	Sand Spurge			X		X		X	X			
Phyllanthus lacunellus	Lagoon Spurge					X	X					
Phyllanthus sp.	Spurge					X						
Sauropus trachyspermus	Rough-seed Spurge			X		X						
FRANKENIACEAE												
Frankenia pauciflora	Southern Sea-heath				X							
Frankenia foliosa	Leafy Sea-heath				X	X			X		X	
Frankenia pauciflora var. *gunnii*	Southern Sea-heath					X						
Frankenia plicata		E	V			X						
Frankenia serpyllifolia	Thyme Sea-heath			X	X	X	X	X	X			X
Frankenia sp.	Sea-heath					X						
Frankenia subteres			R			X	X					
GENTIANACEAE												
Centaurium spicatum	Spike Centaury			X		X	X	X				
GERANIACEAE												
Erodium crinitum	Blue Heron's-bill					X						
Erodium cygnorum	Blue Heron's-bill			X		X		X				
Erodium sp.	Heron's-bill/Crowfoot				X	X	X		X			
Geranium retrorsum	Grassland Geranium				X							
GOODENIACEAE												
Goodenia berardiana	Split-end Goodenia			X								
Goodenia cycloptera	Serrated Goodenia			X		X						
Goodenia fascicularis	Silky Goodenia			X		X						
Goodenia glauca	Pale Goodenia					X						
Goodenia lunata	Stiff Goodenia			X	X	X		X	X			

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
Goodenia pinnatifida	Cut-leaf Goodenia			X	X	X	X					
Goodenia pusilliflora	Small-flower Goodenia			X								
Goodenia triodiophila						X						
Lechenaultia divaricata	Tangled Lechenaultia					X	X					
Scaevola bursariifolia	Bursaria Fanflower					X						
Scaevola collaris				X	X	X	X					X
Scaevola crassifolia	Cushion Fanflower				X							
Scaevola linearis ssp. *confertifolia*	Bundled Fanflower					X						
Scaevola parvibarbata	Small-beard Fanflower					X	X					
Scaevola spinescens	Spiny Fanflower			X	X	X	X					
HALORAGACEAE												
Haloragis aspera	Rough Raspwort					X	X					
Haloragis sp.	Raspwort								X			
Myriophyllum verrucosum	Red Milfoil					X						
JUNCACEAE												
Juncus bufonius	Toad Rush					X						
JUNCAGINACEAE												
Triglochin calcitrapum				X								
LABIATAE												
Mentha australis	River Mint					X	X					
Prostanthera striatiflora	Striated Mintbush				X							
Teucrium racemosum	Grey Germander			X	X		X		X			
Westringia rigida	Stiff Westringia				X							
LAURACEAE												
Cassytha glabella forma *dispar*	Slender Dodder-laurel				X							
LEGUMINOSAE												
Acacia aneura				X	X	X	X	X	X			
Acacia aneura var. *aneura*	Mulga					X						
Acacia ayersiana	Blue Mulga			X								
Acacia brachystachya	Turpentine Mulga							X	X			
Acacia burkittii	Pin-bush Wattle			X	X							
Acacia calamifolia	Wallowa				X							

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
Acacia cambagei	Stinking Wattle						X					
Acacia dictyophleba	Net-veined Wattle					X						
Acacia farnesiana	Sweet Acacia					X	X					
Acacia kempeana	Witchetty Bush				X			X				
Acacia ligulata	Umbrella Bush			X	X	X	X	X	X			
Acacia longifolia ssp. *sophorae*	Coastal Wattle				X							
Acacia murrayana	Colony Wattle					X	X					
Acacia oswaldii	Umbrella Wattle			X		X	X	X	X		X	
Acacia papyrocarpa	Western Myall			X	X			X	X			
Acacia ramulosa				X	X	X	X	X	X			
Acacia salicina	Willow Wattle				X	X	X					
Acacia sibirica	Bastard Mulga					X						
Acacia sp.	Wattle					X						
Acacia stenophylla	River Cooba					X	X					
Acacia tetragonophylla	Dead Finish			X	X	X	X	X	X			
Acacia victoriae	Elegant Wattle					X	X					
Acacia victoriae ssp. *arida*	Downy Elegant Wattle					X						
Acacia victoriae ssp. *victoriae*	Elegant Wattle			X	X	X						
Aeschynomene indica	Budda Pea					X						
Bauhinia gilva	Bauhinia					X	X					
Crotalaria cunninghamii	Bird-flower							X				
Crotalaria cunninghamii ssp. *sturtii*	Bird-flower Rattle-pod					X			X			
Crotalaria eremaea	Loose-flowered Rattle-pod			X		X	X					
Crotalaria eremaea ssp. *eremaea*	Downy Loose-flowered Rattle-pod					X		X	X			
Crotalaria smithiana	Low Rattle-pod					X						
Cullen australasicum	Tall Scurf-pea				X	X	X					
Cullen cinereum	Annual Scurf-pea					X						
Cullen discolor	Prostrate Scurf-pea					X						
Cullen graveolens	Native Lucerne			X		X						
Cullen pallidum	White Scurf-pea					X						
Cullen patens	Spreading Scurf-pea					X						
Cullen sp.	Scurf-pea					X						

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
Glycine canescens	Silky Glycine			X		X						
Glycine rubiginosa	Twining Glycine						X					
Indigofera colutea	Sticky Indigo					X						
Indigofera helmsii								X				
Indigofera psammophila	Sand Indigo					X						
Leguminosae sp.						X						
Lotus cruentus	Red-flower Lotus			X	X	X		X				
Senna artemisioides ssp. *alicia*	Desert Senna					X						
Senna artemisioides ssp. *artemisioides*	Silver Senna				X				X			
Senna artemisioides ssp. *coriacea*	Broad-leaf Desert Senna			X	X	X		X	X			
Senna artemisioides ssp. *filifolia*	Fine-leaf Desert Senna			X		X	X		X			
Senna artemisioides ssp. *helmsii*	Blunt-leaf Senna			X		X						
Senna artemisioides ssp. *oligophylla*	Limestone Senna			X		X	X					
Senna artemisioides ssp. *petiolaris*				X	X	X		X	X			
Senna artemisioides ssp. *quadrifolia*	Four-leaf Desert Senna					X	X					
Senna artemisioides ssp. *sturtii*	Grey Senna			X								
Senna artemisioides ssp. *zygophylla*	Twin-leaf Desert Senna					X						
Senna pleurocarpa var. *pleurocarpa*	Stripe-pod Senna					X						
Swainsona adenophylla	Wild Violet					X		X				
Swainsona affinis	Small-leaf Swainson-pea					X						
Swainsona campylantha						X						
Swainsona eremaea						X						
Swainsona extrajacens						X						
Swainsona flavicarinata	Yellow-keel Swainson-pea					X						
Swainsona formosa	Sturt Pea			X		X		X				
Swainsona microphylla	Small-leaf Swainson-pea					X						
Swainsona oliveri				X				X				
Swainsona oroboides	Variable Swainson-pea					X						
Swainsona phacoides	Dwarf Swainson-pea					X						
Swainsona purpurea	Purple Swainson-pea					X						
Swainsona sp.	Swainson-pea				X	X						
Swainsona stipularis	Orange Swainson-pea			X	X	X						

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
Tephrosia sphaerospora	Mulga Trefoil			X		X	X	X				
Trigonella suavissima	Sweet Fenugreek			X		X			X			
LILIACEAE												
Arthropodium fimbriatum	Nodding Vanilla-lily			X								
Arthropodium minus	Small Vanilla-lily			X								
Arthropodium strictum	Common Vanilla-lily			X								
Bulbine alata	Winged Bulbine-lily					X						
Bulbine semibarbata	Small Leek-lily			X	X							
Dianella brevicaulis	Short-stem Flax-lily				X							
Dianella revoluta var. *revoluta*	Black-anther Flax-lily				X							
Murchisonia volubilis				X								
Thysanotus baueri	Mallee Fringe-lily					X						
Thysanotus exiliflorus	Inland Fringe-lily							X				
Thysanotus sp.	Fringe-lily			X					X			
Wurmbea centralis ssp. *australis*	Inland Nancy			X								
Wurmbea dioica				X								
Wurmbea dioica ssp. *citrina*	Green-flower Nancy					X						
LORANTHACEAE												
Amyema maidenii ssp. *maidenii*	Pale-leaf Mistletoe			X	X	X			X			
Amyema miquelii	Box Mistletoe				X							
Amyema miraculosa ssp. *boormanii*	Fleshy Mistletoe			X		X			X			
Amyema preissii	Wire-leaf Mistletoe			X		X	X		X			
Amyema quandang var. *quandang*	Grey Mistletoe			X	X							
Diplatia grandibractea	Coolibah Mistletoe					X						
Lysiana exocarpi ssp. *exocarpi*	Harlequin Mistletoe			X	X	X		X	X			
Lysiana murrayi	Mulga Mistletoe			X	X			X	X			
LYTHRACEAE												
Ammannia multiflora	Jerry-jerry					X						
Lythrum hyssopifolia	Lesser Loosestrife			X								
Lythrum wilsonii	Wilson's Loosestrife					X						
MALVACEAE												
Abutilon cryptopetalum ssp. *cryptopetalum*	Hill Lantern-bush			X	X							

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
Abutilon fraseri				X	X		X					
Abutilon halophilum	Plains Lantern-bush			X	X	X						
Abutilon leucopetalum	Desert Lantern-bush					X						
Abutilon malvaefolium	Scrambling Lantern-bush					X						
Abutilon otocarpum	Desert Lantern-bush			X	X	X		X	X			
Hibiscus krichauffianus	Velvet-leaf Hibiscus			X	X	X		X	X			
Lawrencia glomerata	Clustered Lawrencia				X	X	X					
Lawrencia squamata	Thorny Lawrencia				X					X		X
Malva behriana	Australian Hollyhock				X	X						
Malvastrum americanum var. *americanum*	Malvastrum			X		X	X	X	X			
Sida ammophila	Sand Sida			X	X	X	X	X	X			
Sida calyxhymenia	Tall Sida			X	X							
Sida corrugata	Corrugated Sida			X				X				
Sida cunninghamii				X		X						
Sida fibulifera	Pin Sida			X	X	X	X	X	X			
Sida filiformis	Fine Sida					X						
Sida goniocarpa	Angled Sida					X						
Sida intricata	Twiggy Sida			X		X			X			
Sida petrophila	Rock Sida			X		X						
Sida sp.	Sida					X						
Sida trichopoda	High Sida			X	X	X			X			
MARSILEACEAE												
Marsilea costulifera	Narrow-leaf Nardoo					X						
Marsilea drummondii	Common Nardoo			X	X	X	X	X	X			
Marsilea exarata	Swayback Nardoo			X		X						
Marsilea hirsuta	Short-fruit Nardoo					X						
Marsilea sp.	Nardoo					X						
MYOPORACEAE												
Eremophila alternifolia	Narrow-leaf Emubush			X	X							
Eremophila bignoniiflora	Bignonia Emubush					X						
Eremophila deserti	Turkey-bush			X			X					
Eremophila duttonii	Harlequin Emubush			X	X	X	X	X	X			

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
Eremophila freelingii	Rock Emubush			X		X	X		X			
Eremophila glabra ssp. *glabra*	Tar Bush			X	X	X	X	X	X			
Eremophila latrobei	Crimson Emubush			X				X				
Eremophila latrobei ssp. *glabra*	Crimson Emubush				X				X			
Eremophila longifolia	Weeping Emubush			X	X	X	X	X	X			
Eremophila macdonnellii	Macdonnell's Emubush					X						
Eremophila macgillivrayi	Dog-bush					X						
Eremophila maculata ssp. *maculata*	Spotted Emubush				X							
Eremophila oppositifolia ssp. *oppositifolia*	Opposite-leaved Emubush			X	X							
Eremophila paisleyi	Paisley's Emubush							X	X			
Eremophila rotundifolia	Round-leaf Emubush								X			
Eremophila scoparia	Broom Emubush			X	X				X			
Eremophila serrulata	Green Emubush			X					X			
Eremophila sturtii	Turpentine Bush							X				
Myoporum brevipes	Warty Boobialla					X						
Myoporum insulare	Common Boobialla				X	X						
Myoporum montanum	Native Myrtle			X	X	X	X		X			
Myoporum platycarpum ssp. *platycarpum*	False Sandalwood			X	X	X	X			X		
Myoporum sp. *petiolatum* (R.Taylor 484)	Sticky Boobialla					X						
MYRTACEAE												
Eucalyptus calycogona	Square-fruit Mallee			X								
Eucalyptus camaldulensis var. *camaldulensis*	River Red Gum			X	X							
Eucalyptus camaldulensis var. *obtusa*	Northern River Red Gum					X	X					
Eucalyptus coolabah	Coolibah					X	X					
Eucalyptus gracilis	Yorrell				X							
Eucalyptus socialis					X	X						
Melaleuca dissitiflora						X						
Melaleuca glomerata	Inland Paper-bark					X	X		X			
Melaleuca lanceolata	Dryland Tea-tree				X							
Melaleuca xerophila	Boree			X	X			X	X			
Melaleuca uncinata	Broom Bush							X				

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
NYCTAGINACEAE												
Boerhavia coccinea	Tar-vine					X						
Boerhavia dominii	Tar-vine			X	X	X	X	X	X			
Boerhavia schomburgkiana	Schomburgk's Tar-vine					X						
Commicarpus australis	Pink Gum-fruit					X						
OPHIOGLOSSACEAE												
Ophioglossum polyphyllum	Large Adder's-tongue		R	X				X				
OROBANCHACEAE												
Orobanche cernua var. *australiana*	Australian Broomrape		R			X						
OXALIDACEAE												
Oxalis perennans	Native Sorrel			X	X							
POACEAE												
Agrostis avenacea var. *avenacea*	Common Blown-grass				X							
Aristida anthoxanthoides	Yellow Three-awn					X	X					
Aristida contorta	Curly Wire-grass			X	X	X	X	X	X			
Aristida holathera var. *holathera*	Tall Kerosene Grass			X	X	X	X	X	X			
Aristida nitidula	Brush Three-awn			X								
Aristida sp.	Three-awn/Wire-grass							X				
Astrebla lappacea	Curly Mitchell-grass					X						
Astrebla pectinata	Barley Mitchell-grass			X	X	X	X	X	X			
Austrodanthonia caespitosa	Common Wallaby-grass			X	X					X		
Austrodanthonia sp.					X				X			
Austrostipa elegantissima	Feather Spear-grass			X	X					X		
Austrostipa eremophila	Rusty Spear-grass									X		
Austrostipa nitida	Balcarra Spear-grass			X	X			X				
Austrostipa platychaeta	Flat-awn Spear-grass				X							
Austrostipa scabra ssp. *falcata*	Rough Spear-grass				X							
Austrostipa stipoides	Coast Spear-grass				X							
Austrostipa trichophylla				X	X							
Bothriochloa ewartiana	Desert Blue-grass					X						
Brachiaria praetervisa	Large Arm-grass			X				X				
Brachiaria sp.						X						

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
Bromus arenarius	Sand Brome			X								
Chloris pectinata	Comb Windmill Grass					X						
Chloris truncata	Windmill Grass				X	X						
Cymbopogon ambiguus	Lemon-grass			X	X	X						
Dactyloctenium radulans	Button-grass			X	X	X	X	X	X			
Dichanthium sericeum ssp. *humilius*	Annual Silky Blue-grass					X						
Dichanthium sericeum ssp. *sericeum*	Silky Blue-grass			X	X	X						
Digitaria ammophila	Spider Grass					X						
Digitaria brownii	Cotton Panic-grass			X	X	X						
Digitaria coenicola	Spider Grass				X	X						
Enneapogon avenaceus	Common Bottle-washers			X	X	X	X	X	X			
Enneapogon caerulescens var. *caerulescens*	Blue Bottle-washers			X								
Enneapogon cylindricus	Jointed Bottle-washers			X	X	X	X	X				
Enneapogon intermedius	Tall Bottle-washers				X							
Enneapogon nigricans	Black-head Grass				X							
Enneapogon polyphyllus	Leafy Bottle-washers			X		X	X	X				
Enneapogon sp.	Bottle-washers/Nineawn							X	X			
Enteropogon acicularis	Umbrella Grass			X	X	X	X		X			
Enteropogon ramosus	Umbrella Grass					X						
Eragrostis australasica	Cane-grass			X	X	X	X	X	X			
Eragrostis basedowii	Neat Love-grass					X						
Eragrostis dielsii var. *dielsii*	Mulka			X	X	X	X	X				
Eragrostis eriopoda	Woollybutt			X		X	X		X			
Eragrostis falcata						X		X				
Eragrostis laniflora	Hairy-flower Woollybutt			X				X				
Eragrostis leptocarpa	Drooping Love-grass					X						
Eragrostis setifolia	Bristly Love-grass			X	X	X	X	X	X			
Eragrostis xerophila	Knotty-butt Neverfail			X		X		X				
Eriachne aristidea	Three-awn Wanderrie					X						
Eriachne helmsii	Woollybutt Wanderrie			X				X				
Eriachne ovata	Swamp Wanderrie					X						
Eriochloa australiensis	Australian Cupgrass			X		X						

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
Eriochloa pseudoacrotricha	Perennial Cupgrass					X						
Eulalia aurea	Silky Brown-top					X						
Gramineae sp.	Grass Family					X						
Iseilema eremaeum						X						
Iseilema membranaceum	Small Flinders-grass					X						
Iseilema sp.	Flinders-grass					X						
Iseilema vaginiflorum	Red Flinders-grass					X						
Lachnagrostis filiformis	Perennial Blown-grass					X						
Leptochloa digitata	Umbrella Cane-grass					X						
Monachather paradoxus	Bandicoot Grass			X	X				X			
Neurachne munroi	Window Mulga-grass							X				
Panicum decompositum var. *decompositum*	Native Millet					X	X		X			
Panicum laevinode						X						
Panicum sp.						X		X				
Paractaenum novae-hollandiae ssp. *reversum*	Barbed-wire Grass			X	X	X		X	X			
Paractaenum refractum	Bristle-brush Grass			X		X		X				
Phragmites australis	Common Reed					X						
Poa poiformis var. poiformis	Coast Tussock-grass				X							
Setaria clementii	Clement's Paspalidium				X							
Setaria constricta	Knotty-butt Paspalidium			X				X				
Setaria dielsii	Diel's Pigeon-grass					X						
Sporobolus actinocladus	Ray Grass			X	X	X		X	X			
Sporobolus mitchellii	Rat-tail Couch					X						
Themeda avenacea	Tall Oat-grass					X						
Themeda triandra	Kangaroo Grass					X						
Tragus australianus	Small Burr-grass			X	X	X		X	X			
Triodia irritans	Spinifex			X	X							
Tripogon loliiformis	Five-minute Grass			X		X		X				
Triraphis mollis	Purple Plume Grass			X		X		X	X			
Zygochloa paradoxa	Sandhill Cane-grass			X	X	X	X	X	X			X
PITTOSPORACEAE												
Pittosporum angustifolium	Native Apricot			X	X	X	X	X	X		X	

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
PLANTAGINACEAE												
Plantago cunninghamii	Clay Plantain					X						
Plantago drummondii	Dark Plantain			X	X	X	X	X	X			
Plantago sp.	Plantain					X						
POLYGONACEAE												
Muehlenbeckia coccoloboides	Sandhill Lignum					X						
Muehlenbeckia florulenta	Lignum			X	X	X	X	X	X			
Rumex crystallinus	Glistening Dock			X		X						
PORTULACACEAE												
Anacampseros australiana	Australian Anacampseros			X	X							
Calandrinia eremaea	Dryland Purslane			X	X			X	X			
Calandrinia remota	Round-leaf Parakeelya			X				X				
Calandrinia volubilis	Twining Purslane				X					X		
Portulaca oleracea	Common Purslane			X	X	X	X		X			
POTAMOGETONACEAE												
Ruppia sp.	Water-tassel					X						
PROTEACEAE												
Grevillea huegelii	Comb Grevillea				X							
Hakea leucoptera ssp. *leucoptera*	Silver Needlewood			X	X	X	X	X	X			
RANUNCULACEAE												
Ranunculus pentandrus var. *pentandrus*	Smooth Buttercup			X								
Myosurus minimus var. *australis*	Mousetail					X						
Ranunculus pentandrus var. *platycarpus*	Smooth Buttercup			X		X						
Ranunculus pumilio var. *pumilio*	Ferny Buttercup					X						
RUBIACEAE												
Dentella pulvinata							X					
RUTACEAE												
Geijera linearifolia	Sheep Bush				X					X		
SANTALACEAE												
Exocarpos aphyllus	Leafless Cherry			X	X			X	X	X		
Santalum acuminatum	Quandong			X	X			X	X			
Santalum lanceolatum	Plumbush			X		X	X	X	X			

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
Santalum spicatum	Sandalwood		V	X	X							
SAPINDACEAE												
Atalaya hemiglauca	Whitewood					X						
Alectryon oleifolius ssp. *canescens*	Bullock Bush			X	X			X	X		X	
Dodonaea lobulata	Lobed-leaf Hop-bush			X	X							
Dodonaea microzyga var. *microzyga*	Brilliant Hop-bush			X	X	X			X			
Dodonaea viscosa ssp. *angustissima*	Narrow-leaf Hop-bush			X	X	X	X	X	X			
SCROPHULARIACEAE												
Glossostigma diandrum	Two-anther Mud-mat					X						
Stemodia florulenta	Bluerod			X	X	X	X	X	X			
Stemodia glabella	Smooth Bluerod					X						
SOLANACEAE												
Duboisia hopwoodi	Pituri			X								
Lycium australe	Australian Boxthorn			X	X			X	X	X		X
Nicotiana excelsior	Native Tobacco					X						
Nicotiana goodspeedii	Small-flower Tobacco				X							
Nicotiana occidentalis ssp. *obliqua*	Western Tobacco					X						
Nicotiana simulans	Native Tobacco			X		X						
Nicotiana velutina	Velvet Tobacco			X	X	X			X			
Solanum coactiliferum	Tomato-bush				X				X			
Solanum chenopodinum	Goosefoot Potato-bush					X						
Solanum ellipticum	Velvet Potato-bush			X	X	X		X	X			
Solanum ellipticum/quadriloculatum						X	X					
Solanum esuriale	Quena					X			X			
Solanum lacunarium	Lagoon Nightshade			X								
Solanum lasiophyllum	Flannel Bush				X							
Solanum petrophilum	Rock Nightshade			X	X							
Solanum quadriloculatum	Plains Nightshade			X	X							
Solanum sp.						X		X				
STACKHOUSIACEAE												
Stackhousia clementii	Limestone Candles			X								
Stackhousia muricata ssp.	Yellow Candles			X								

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
STERCULIACEAE												
Gilesia biniflora	Western Tar-vine		R			X		X	X			
Melhania oblongifolia	Velvet Hibiscus				X				X			
THYMELAEACEAE												
Pimelea microcephala ssp. *microcephala*	Shrubby Riceflower			X	X				X			
Pimelea simplex	Desert Riceflower			X	X							
Pimelea simplex ssp. *continua*	Desert Riceflower					X						
Pimelea simplex ssp. *simplex*	Desert Riceflower					X	X					
Pimelea trichostachya	Spiked Riceflower					X						
TYPHACEAE												
Typha domingensis	Narrow-leaf Bulrush					X	X					
UMBELLIFERAE												
Daucus glochidiatus	Native Carrot			X		X	X	X	X			
Trachymene glaucifolia	Blue Parsnip			X		X			X			
URTICACEAE												
Parietaria debilis	Smooth-nettle			X								
ZYGOPHYLLACEAE												
Nitraria billardierei	Nitre-bush			X	X	X	X			X	X	
Tribulus astrocarpus	Star-fruit Caltrop							X				
Tribulus eichlerianus	Eichler's Caltrop					X	X		X			
Tribulus hystrix	Spiky Caltrop					X	X					
Tribulus minutus						X						
Tribulus sp.	Caltrop				X							
Zygophyllum ammophilum	Sand Twinleaf			X				X	X			
Zygophyllum apiculatum	Pointed Twinleaf				X					X		
Zygophyllum aurantiacum	Shrubby Twinleaf			X	X	X		X	X			
Zygophyllum aurantiacum ssp.	Shrubby Twinleaf					X						
Zygophyllum aurantiacum ssp. *cuneatum*						X						
Zygophyllum aurantiacum ssp. *verticillatum*	Shrubby Twinleaf					X						
Zygophyllum billardierei	Coast Twinleaf				X							
Zygophyllum compressum	Rabbit-ears Twinleaf				X	X						
Zygophyllum confluens	Forked Twinleaf					X						

Species	Common name	Status[1]		Corridors				SML / RD		DP	LF	YW
		AUS	SA	1	2	3	4	5	6			
Zygophyllum crenatum	Notched Twinleaf			X							X	
Zygophyllum crassissimum	Thick Twinleaf		R			X						
Zygophyllum emarginatum	Notched Twinleaf			X								
Zygophyllum eremaeum	Climbing Twinleaf			X	X			X	X			
Zygophyllum howittii	Clasping Twinleaf			X	X	X		X				
ygophyllum humillimum	Small-fruit Twinleaf		R		X							
Zygophyllum iodocarpum	Violet Twinleaf			X	X							
Zygophyllum ovatum	Dwarf Twinleaf				X							
Zygophyllum prismatothecum	Square-fruit Twinleaf			X								
Zygophyllum simile	White Twinleaf			X		X						
Zygophyllum sp.	Twinleaf					X	X		X			

[1] Status: Species conservation status is indicated by SA = Conservation status schedules of the *National Parks and Wildlife Act 1972*, AUS = Conservation Status under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*, (E = endangered, V= vulnerable, R = rare).

N3.1 REFERENCES

Kinhill Engineers Pty Ltd 1997, *Olympic Dam Expansion Project: Environmental Impact Statement*, May, Report to WMC (Olympic Dam Corporation) Pty Ltd, Adelaide.

WMC 1997, *Olympic Dam to Port Augusta 275 kV powerline survey environmental report*, WMC (Olympic Dam Corporation) Pty Ltd, Adelaide.

APPENDIX N4

Non-Indigenous plant species recorded within the EIS Study Area

N4 NON-INDIGENOUS PLANT SPECIES RECORDED WITHIN THE EIS STUDY AREA

Several declared and environmental weed species have been recorded within the search area of the expanded SML and Municipality of Roxby Downs (SML/RD), a 10 km wide corridor for infrastructure (Corridors), a 20 km radius around the desalination plant site (DP), at the proposed landing facility near Port Augusta (LF) and a 10 km wide corridor for the gas pipeline alignment options (Gas P).

Sources of non-indigenous plant information were as follows:

- previous surveys (Fatchen 1981, WMC 1997)
- BHP Billiton Weeds Database
- several field surveys by Ecological Associates (2006)
- three field trips by RMP Environmental and EBS in association with RPS Ecos (2006–8).

Table N4.1 Non-indigenous flora

Species	Common name	Status[1]	SML / RD	Corridors	DP	LF	Gas P
Acacia salicina	Broughton Wattle		X				
Acacia saligna	Golden Wreath Wattle	E	X				
Acetosa vesicaria	Rosy Dock			X			X
Adonis microcarpa	Pheasant's Eye			X			
Agave americana	Century plant			X			
Alternanthera pungens	Khaki Weed	D		X			
Anagallis arvensis	Pimpernel			X			
Arctotheca calendula	Capeweed	E	X				
Asparagus asparagoides	Bridal Creeper	D		X			
Asphodelus fistulosus	Onion Weed	D	X	X	X		
Aster subulatus	Wild aster		X				
Avena barbata	Bearded Oat	E	X	X			
Avena fatua	Wild Oat	E		X			
Brassica tournefortii	Wild Turnip or Mustard	E	X	X			X
Bromus diandrus	Great Brome			X			
Bromus rubens	Red Brome			X			
Calendula arvensis	Field Marigold			X			
Calotropis procera	Rubber bush		X				
Carrichtera annua	Ward's Weed	E	X	X	X	X	X
Carthamus lanatus	Saffron Thistle	E		X	X		
Cenchrus ciliaris	Buffel Grass	E	X	X			X
Cenchrus longispinus	Innocent Weed	D	X				X
Centaurea melitensis	Malta Thistle			X			
Centaurium spicatum	Spike century			X			
Chenopodium album	Fat Hen		X	X			
Chenopodium murale	Nettle-leaf Goosefoot						X
Chloris virgata	Feather-top Rhodes Grass	E		X			X
Citrullus colocynthis	Paddy Melon			X			X
Citrullus lanatus	Bitter Melon		X	X			X
Conyza bonariensis	FlaX-leaf Fleabane	E	X	X			
Cucumis myriocarpus	Paddy Melon		X	X			X
Cynodon dactylon var. *dactylon.*	Couch	E	X	X			
Cyperus eragrostis	Umbrella Grass		X				
Datura inoXia	Downy Thorn-apple			X			
Datura leichhardtii	Native Thorn-apple						X
DiplotaXis muralis var. *muralis*	Wall Rocket			X	X		
Dittrichia graveolens	Stinkweed	E		X	X		
Echinochloa crus-galli	Common Barnyard Grass			X			
Echium plantagineum	Salvation Jane	D	X	X			

Table N4.1 Non-indigenous flora (cont'd)

Species	Common name	Status[1]	SML / RD	Corridors	DP	LF	Gas P
EmeX australis	Three-corner Jack	D	X	X			
Eragrostis barrelieri	Pitted Love-grass		X				X
Eragrostis pergracilis	Small Love-grass						X
Erodium aureum			X	X			X
Erodium cicutarium	Cut-leaf Heron's-bill			X	X		X
Eucalyptus torquata	Coral gum			X			
Gazania linearis	Gazania	E		X			
Hedypnois rhagadioloides	Cretan Weed			X			
Helianthus annuus	Sunflower		X	X			
Heliotropium curassavicum	Smooth Heliotrope			X			
Heliotropium europaeum	Common Heliotrope		X	X			
Heliotropium supinum	Creeping Heliotrope		X				
Holcus lanatus	Yorkshire Fog			X	X		
Hordeum glaucum	Blue Barley-grass			X			
Hypochaeris glabra	Smooth Cat's Ear			X			
Hypochoeris radicata	Deep-rooted Cat's Ear			X			
Lactuca serriola	Prickly Lettuce		X	X			
Lamarckia aurea	Goldentop			X			
Limonium companyonis	Sea-lavender			X			
Limonium lobatum	Winged Sea-lavender			X			
Lolium rigidum	Wimmera Ryegrass			X			
Lycium ferocissimum	African BoXthorn	D		X			
Malva parviflora	Small-flower Marshmallow			X			X
Marrubium vulgare	Horehound	D		X	X		
Medicago littoralis	Strand Medic			X			
Medicago minima var. *minima*	Little Medic			X	X		
Medicago polymorpha var. *polymorpha*	Burr-medic			X			
Melia azederach	White Cedar		X				
Mesembryanthemum crystallinum	Common Iceplant			X			
Mesembryanthemum nodiflorum	Slender Iceplant			X			
Nicotiana glauca	Tree Tobacco			X			
Ocimum basilicum	Basil						X
Opuntia ficus-indica	Indian Fig			X			
Opuntia stricta	Prickly Pear	D	X	X			
Panicum miliaceum ssp. *miliaceum*	Broom Millet			X			
Parkinsonia aculeata	Jerusalem Thorn	D		X			
Paspalum sp.	Paspalum		X				
Pennisetum clandestinum	Kikuyu	E	X	X			
Pennisetum setaceum	Fountain Grass	E	X	X			
Pentaschistis airoides	False Hair-grass			X			
Polygonum aviculare (NC)	Wireweed			X			X
Polypogon monspeliensis	Annual Beard-grass			X			
Potamogeton crispus	Curly Pondweed						X
Proboscidea louisianica	Purple-flower Devil's Claw			X			
Prosopis juliflora	Mesquite			X			
Raphanus raphanistrum	Wild Radish						X
Rapistrum rugosum	Short-fruited Wild Turnip		X				
Rostraria cristata	Annual Cat's-tail			X			
Rostraria pumila	Tiny Bristle-grass		X	X			X

Table N4.1 Non-indigenous flora (cont'd)

Species	Common name	Status[1]	SML / RD	Corridors	DP	LF	Gas P
Salvia verbenaca	Wild Sage			X			
Scabiosa atropurpurea	Pincushion			X			
Schinus molle	Pepper-tree		X	X			
Schismus barbatus	Arabian Grass		X	X			X
Sisymbrium erysimoides	Smooth Mustard			X	X		X
Sisymbrium irio	London Mustard or Rocket		X	X			X
Sisymbrium orientale	Indian Hedge			X			X
Solanum nigrum	Black Nightshade		X	X			X
Sonchus oleraceus	Common Sow-thistle		X	X	X		X
Sonchus tenerrimus	Clammy Sow-thistle		X	X			
Sorghum bicolor	Sorghum		X				
Sorghum halepense	Johnson Grass			X			
Spergularia diandra (NC)	Lesser Sand-spurrey		X	X			
Suaeda aegyptiaca				X			
TamariX aphylla	Athel Pine	D	X				
Tribulus terrestris	Caltrop	D	X	X	X		X
Verbena officinalis	Common Verbena			X			
Verbena supina var. supina	Trailing Verbena		X	X			
Xanthium spinosum	Bathurst Burr	D		X			
Xanthium strumarium	Noogoora Burr	D	X				

NC = non-current.
[1]Status: D = declared species under the *SA Natural Resource Management Act 2004*; E = environmental weed.

Note: if a weed is not a declared species under the SA NRM Act, it will not have a class designation and landholders are not obliged to control the species. However, environmental weeds are considered to have the potential to cause significant economic, social and environmental impacts. Although environmental weed species are not listed under the Act, NRM Boards can and do consider the impact of such species (and others) when undertaking risk assessment and can provide advice to landholders for undertaking control of such weeds.

N4.1 REFERENCES

Fatchen, TJ 1981, Olympic Dam Project Environmental Studies: Vegetation Baseline Survey, Report for Dames and Moore, Sydney.

WMC 1997, *Olympic Dam to Port Augusta 275 kV powerline survey environmental report*, WMC (Olympic Dam Corporation) Pty Ltd, Adelaide.

APPENDIX N5

Fauna recorded in the EIS Study Area

N5 FAUNA RECORDED IN THE EIS STUDY AREA

Species records from state databases (Biological Database of South Australia), published literature and BHP Billiton databases were searched to establish species lists for the EIS Study Area. The Biological Database of South Australia includes records from a range of organisations including Birds Australia (SA records 1996–2002), the South Australian Ornithological Association (SAOA), SAOA Parks Database, Australasian Wader Studies Group and the South Australian Museum. Species nomenclature follows Robinson and others (2000).

Locations: unless otherwise indicated, the search area included the expanded Special Mining Lease and Municipality of Roxby Downs (SML/RD), a 10 km wide corridor for infrastructure (Corridors), and a 20 km radius around the desalination plant site (DP).

Sources: sources for species presence are indicated by 1 = BHP Billiton databases; 2 = Biological Database of South Australia (SML and southern infrastructure corridor); 3 = Fauna survey of the southern infrastructure corridor by Ecological Associates (September 2007); 4 = Biological Database of South Australia (gas pipeline corridors); 5 = Fauna survey of the gas pipeline corridors by RPS Ecos (October 2006); 6 = Arid Recovery database.

Status: species conservation status is indicated by SA = conservation status schedules of the *National Parks and Wildlife Act 1972*; AUS = conservation status under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) (E = endangered, V= vulnerable, R = rare, Mi = migratory, Ma = marine); and C/J/B = international migratory bird agreements (C = CAMBA or China–Australia Migratory Birds Agreement, J = JAMBA or Japan–Australia Migratory Birds Agreement, B = Bonn Convention). The International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species status has not been listed, as the South Australian and Commonwealth status assessments are more up to date and are considered to be appropriate indication of the status of terrestrial species. *Indicates introduced species.

Mobility: Re = resident, N = nomadic, S = seasonal visitor, Va = vagrant.

Home range size: S = small (<10ha), M = medium (10-20 ha), L = large (<20 ha).

Shelter: B = burrows, N = nest made of vegetation, H = hollow, S = shade under vegetation.

Birds are listed in Table N5.1, mammals in Table N5.2 and reptiles and amphibians in Table N5.3. No invertebrates were listed in the EIS Study Area.

Species name	Common name	SML/ RD	Corridors	DP	Status			Mobility
					AUS	SA	C/J/B	
CASUARIIDAE	**Cassowaries and Emus**							
Dromaius novaehollandiae	Emu	1,2	2,3,4,5					N / Re
STRUTHIONIDAE	**Ostriches**							
*Struthio camelus**	Ostrich		2					N
PHASIANIDAE	**Pheasants, Quails and allies**							
Coturnix pectoralis	Stubble Quail	1,2	2,4		Ma			N
Coturnix ypsilophora	Brown Quail		2			V		N
ANATIDAE	**Geese, Swans and Ducks**							
Oxyura australis	Blue-billed Duck	1,2	4			R		N
Biziura lobata	Musk Duck	1,2	2,4,5	2	Ma	R		N
Stictonetta naevosa	Freckled Duck	1	2,4			V		N
Cygnus atratus	Black Swan	1,2	2,3,4					N
Tadorna tadornoides	Australian Shelduck	1,2	2,4					N
Anas castanea	Chestnut Teal	1,2	2,4					N
Anas gracilis	Grey Teal	1,2	2,3,4,5	2				N
*Anas platyrhynchos**	Mallard	1						N
Anas rhynchotis	Australasian Shoveler	1,2	4			R		N
Anas superciliosa	Pacific Black Duck	1,2	2,4					N
Aythya australis	Hardhead	1,2	2,4					N
Chenonetta jubata	Australian Wood Duck	1,2	2,4					N
Malacorhynchus membranaceus	Pink-eared Duck	1,2	2,4					N
PODICIPEDIDAE	**Grebes**							
Podiceps cristatus	Great Crested Grebe	2	4			R		N / Va
Poliocephalus poliocephalus	Hoary-headed Grebe	1,2	2,3,4	2				N / Re
Tachybaptus novaehollandiae	Australasian Grebe	1,2	2,4					N / Re
PROCELLARIIDAE	**Shearwaters, Petrels and Diving-Petrels**							
Macronectes giganteus	Southern Giant-Petrel		2		E, Mi, Ma	V	B	Va
ANHINGIDAE	**Darters**							
Anhinga melanogaster	Darter	1,2	2,4			R		N
PHALACRO-CORACIDAE	**Cormorants**							
Phalacrocorax carbo	Great Cormorant	1,2	2,4,5					N

Species name	Common name	SML/ RD	Corridors	DP	Status			Mobility
					AUS	SA	C/J/B	
Phalacrocorax fuscescens	Black-faced Cormorant			2	Ma			S
Phalacrocorax melanoleucos	Little Pied Cormorant	1,2	2,4,5					N
Phalacrocorax sulcirostris	Little Black Cormorant	1,2	2,4					N
Phalacrocorax varius	Pied Cormorant	1,2	2,4	2				N
PELECANIDAE	**Pelicans**							
Pelecanus conspicillatus	Australian Pelican	1,2	2,4	2				N
ARDEIDAE	**Herons and Bitterns**							
Ardea alba	Great Egret	1,2	2,4		Mi, Ma		CJ	N
Ardea ibis	Cattle Egret	1			Mi, Ma	R	CJ	N / Va
Ardea intermedia	Intermediate Egret	1	4		Ma	R		N
Ardea pacifica	White-necked Heron	1,2	2,3,4					N
Egretta garzetta	Little Egret	1	2,4	2		R		N
Egretta novaehollandiae	White-faced Heron	1,2	2,4,5	2				N
Egretta sacra	Eastern Reef Egret			2	Mi, Ma	R	C	N
Nycticorax caledonicus	Nankeen Night Heron	1,2	4		Ma			N / Va
THRESKIORNITHIDAE	**Ibises and Spoonbills**							
Platalea flavipes	Yellow-billed Spoonbill	1	2,4					N
Platalea regia	Royal Spoonbill	1	4					S / Va
Plegadis falcinellus	Glossy Ibis	1,2	4		Mi, Ma	R	CB	N
Threskiornis molucca	Sacred Ibis	1	4		Ma			N
Threskiornis spinicollis	Straw-necked Ibis	1,2	2,4		Ma			N
ACCIPITRIDAE	**Osprey, Hawks, Eagles and allies**							
Accipiter cirrhocephalus	Collared Sparrowhawk	1,2	2,4					N
Accipiter fasciatus	Brown Goshawk	1	2,4		Ma			N
Aquila audax	Wedge-tailed Eagle	1,2	2,3,4,5					Re
Circus approximans	Swamp Harrier	1	2,4		Ma			N
Circus assimilis	Spotted Harrier	1,2	4					N
Elanus axillaris	Black-shouldered Kite	1,2	2,4					N
Elanus scriptus	Letter-winged Kite		4			R		N
Haliaeetus leucogaster	White-bellied Sea-eagle		2	2	Mi, Ma	E	C	N
Haliastur sphenurus	Whistling Kite	1,2	2,4,5		Ma			Re

Table N5.1 Birds (cont'd)

Species name	Common name	SML/ RD	Corridors	DP	Status			Mobility
					AUS	SA	C/J/B	
Hamirostra melanosternon	Black-breasted Buzzard	1				R		N
Hieraaetus morphnoides	Little Eagle	1,2	2,4					Re
Lophoictinia isura	Square-tailed Kite		4			E		N
Milvus migrans	Black Kite	1,2	2,4,5					S / Re
FALCONIDAE	**Falcons**							
Falco berigora	Brown Falcon	1,2	2,3,4,5	2				Re
Falco cenchroides	Nankeen Kestrel	1,2	2,3,4,5	2				Re
Falco hypoleucos	Grey Falcon	1	2,4			R		N
Falco longipennis	Australian Hobby	1,2	2,4	2				N
Falco peregrinus	Peregrine Falcon	1,2	4			R		Va
Falco subniger	Black Falcon	1,2	2,4					N
GRUIDAE	**Cranes**							
Grus rubicunda	Brolga	1	4,5			V		Va
CICONIIDAE								
Ephippiorhynchus asiaticus	Black-neck stork		5					Va
RALLIDAE	**Rails, Crakes and allies**							
Fulica atra	Eurasian Coot	1,2	2,4,5					N
Gallinula tenebrosa	Dusky Moorhen	1,2	4					N
Gallinula ventralis	Black-tailed Native-hen	1,2	2,4,5					N
Gallirallus philippensis	Buff-banded Rail	1,2	2					N
Porphyrio porphyrio	Purple Swamphen	1,2	2,4					N
Porzana fluminea	Australian Spotted Crake	1,2	2,4					N
Porzana pusilla	Baillon's Crake	1,2	2,4		Ma			N / Va
Porzana tabuensis	Spotless Crake	1,2	4		Ma	R		N / Va
OTIDIDAE	**Bustards**							
Ardeotis australis	Australian Bustard	1,2				V		N
TURNICIDAE	**Button-quails**							
Turnix velox	Little Button-quail	1,2	2,3,4					N
PEDIONOMIDAE	**Plains-wanderer**							
Pedionomus torquatus	Plains-wanderer	1			V	E		Va
SCOLOPACIDAE	**Sandpipers and allies**							
Actitis hypoleucos	Common Sandpiper	1,2	2	2	Mi, Ma	R	CJB	S

Species name	Common name	SML/ RD	Corridors	DP	Status			Mobility
					AUS	SA	C/J/B	
Arenaria interpres	Ruddy Turnstone	1		2	Mi, Ma	R	CJB	S / Va
Calidris acuminata	Sharp-tailed Sandpiper	1,2	2,4	2	Mi, Ma		CJB	S
Calidris canutus	Red Knot	1	2	2	Mi, Ma		CJB	S / Va
Calidris ferruginea	Curlew Sandpiper		2	2	Mi, Ma		CJB	S
Calidris ruficollis	Red-necked Stint	1,2	2	2	Mi, Ma		CJB	S
Calidris tenuirostris	Great Knot			2	Mi, Ma	R	CJB	S / Va
Gallinago hardwickii	Latham's Snipe	1,2			Mi, Ma	R	CJB	S / Va
Limosa lapponica	Bar-tailed Godwit			2	Mi, Ma	R	CJB	S / Va
Limosa limosa	Black-tailed Godwit	1,2	2		Mi, Ma	R	CJB	S / Va
Numenius madagascariensis	Eastern Curlew	1	2	2	Mi, Ma	V	CJB	S / Va
Philomachus pugnax	Ruff			2	Mi, Ma	R	CJB	S / Va
Tringa glareola	Wood Sandpiper	1,2	4		Mi, Ma	R	CJB	S
Tringa nebularia	Common Greenshank	1,2	2	2	Mi, Ma		CJB	S / Va
Tringa stagnatilis	Marsh Sandpiper	1,2	2	2	Mi, Ma		CJB	S
BURHINIDAE	**Stone-curlews**							
Burhinus grallarius	Bush Stone-curlew			2		R		Re
HAEMATOPODIDAE	**Oystercatchers**							
Haematopus fuliginosus	Sooty Oystercatcher		2			R		S / Va
Haematopus longirostris	Pied Oystercatcher		2	2		R		S / Va
RECURVIROSTRIDAE	**Avocets and Stilts**							
Cladorhynchus leucocephalus	Banded Stilt	1,2	2,4	2		V		N
Himantopus himantopus	Black-winged Stilt	1,2	2,4,5	2	Ma			N / Re
Recurvirostra novaehollandiae	Red-necked Avocet	1,2	2,4	2	Ma			N
CHARADRIIDAE	**Plovers and Dotterels**							
Charadrius australis	Inland Dotterel	1,2	2,4,5					N / S
Charadrius leschenaultii	Greater Sand Plover			2	Mi, Ma	R	CJB	S / Va
Charadrius ruficapillus	Red-capped Plover	1,2	2,4,5	2	Ma			N
Charadrius veredus	Oriental Plover	1			Mi, Ma		JB	S / Va
Elseyornis melanops	Black-fronted Dotterel	1,2	2,4,5					S / Re
Erythrogonys cinctus	Red-kneed Dotterel	1,2	2,4,5	2				N
Pluvialis squatarola	Grey Plover	1	2	2	Mi, Ma		CJB	S / Va
Vanellus miles	Masked Lapwing	1,2	2,4,5	2				Re

Table N5.1 Birds (cont'd)

Species name	Common name	SML/ RD	Corridors	DP	Status			Mobility
					AUS	SA	C/J/B	
Vanellus tricolor	Banded Lapwing	1,2	4					N
GLAREOLIDAE	**Pratincoles and Coursers**							
Stiltia isabella	Australian Pratincole	1,2	4		Ma			S / Va
LARIDAE	**Gulls, Skuas and allies**							
Larus novaehollandiae	Silver Gull	1,2	2,4	2	Ma			N / Re
Larus dominicanus	Kelp Gull		2		Ma	R		S / N
Larus pacificus	Pacific Gull		2	2	Ma			S / Va
Chlidonias hybridus	Whiskered Tern	1,2	2,4	2	Ma			N
Sterna bergii	Crested Tern		2	2	Ma			S / Va
Sterna caspia	Caspian Tern	1,2	2,4	2	Mi, Ma		C	N
Sterna nereis	Fairy Tern		2		Ma	E		S / Va
Sterna nilotica	Gull-billed Tern	1,2	4		Ma			N
COLUMBIDAE	**Pigeons and Doves**							
*Columba livia**	Rock Dove	1,2	2	2				N
Geopelia cuneata	Diamond Dove	1,2	2,4					N
Geopelia placida	Peaceful Dove	1,2	2,4					N
Ocyphaps lophotes	Crested Pigeon	1,2	2,4,5	2				Re
Phaps chalcoptera	Common Bronzewing	1,2	2,4					N
Phaps histrionica	Flock Bronzewing	1				R		N / Va
*Streptopelia chinensis**	Spotted Turtle-dove	1,2	2					Er
CACATUIDAE	**Cockatoos and Cockatiel**							
Cacatua leadbeateri	Major Mitchell's Cockatoo	1,2	2,5			R		N
Cacatua roseicapilla	Galah	1,2	2,3,4,5	2				Re
Cacatua sanguinea	Little Corella	1,2	2,4,5					N
Nymphicus hollandicus	Cockatiel	1,2	2,4					N
PSITTACIDAE	**Parrots**							
Barnardius zonarius	Australian Ringneck	1	2,3,4,5	2				N
Glossopsitta porphyrocephala	Purple-crowned Lorikeet	1	2					N
Melopsittacus undulatus	Budgerigar	1,2	2,4	2				N
Neophema chrysostoma	Blue-winged Parrot	1,2	4		Ma	V		N / S
Neophema elegans	Elegant Parrot		2			R		N
Neophema splendida	Scarlet-chested Parrot	1	2			R		Va

Species name	Common name	SML/ RD	Corridors	DP	Status			Mobility
					AUS	SA	C/J/B	
Neopsephotus bourkii	Bourke's Parrot	1,2	2,3,4					Re
Northiella haematogaster	Blue Bonnet	1,2	2,3,4,5					Re
Psephotus haematonotus	Red-rumped Parrot		2,4					N
Psephotus varius	Mulga Parrot	1,2	2,3,4,5	2				N
CUCULIDAE	**Cuckoos**							
Cacomantis flabelliformis	Fan-tailed Cuckoo		2		Ma			N
Chrysococcyx basalis	Horsfield's Bronze-cuckoo	1,2	2,3,4,5	2	Ma			N
Chrysococcyx osculans	Black-eared Cuckoo	1,2	2,4	2	Ma			N
Cuculus pallidus	Pallid Cuckoo	1,2	2,4	2	Mi, Ma		CJ	N
Cuculus saturatus	Oriential Cuckoo	1						N / S
STRIGIDAE	**Typical Owls**							
Ninox connivens	Barking Owl		2			R		N
Ninox novaeseelandiae	Southern Boobook	1,2	2,3,4		Ma			N
TYTONIDAE	**Barn Owls**							
Tyto alba	Barn Owl	1,2	4					N
Tyto capensis	Grass Owl	2				R		N
PODARGIDAE	**Frogmouths**							
Podargus strigoides	Tawny Frogmouth	1,2	3,4					Re
CAPRIMULGIDAE	**Nightjars**							
Eurostopodus argus	Spotted Nightjar	1,2	2,4		Ma			N
AEGOTHELIDAE	**Owlet-nightjars**							
Aegotheles cristatus	Australian Owlet-nightjar	1,2	4					Re
APODIDAE	**Swifts**							
Apus pacificus	Fork-tailed Swift	1,2	4		Mi, Ma		CJ	Va
ALCEDINIDAE	**Kingfishers**							
Todiramphus pyrrhopygia	Red-backed Kingfisher	1,2	2,4,5					S
Todiramphus sanctus	Sacred Kingfisher	1,2	4,5		Ma			N
MEROPIDAE	**Bee-eaters**							
Merops ornatus	Rainbow Bee-eater	1,2	2,4,5		Mi, Ma		J	S
CLIMACTERIDAE	**Australopapuan Treecreepers**							
Climacteris affinis	White-browed Treecreeper		2,4			R		Re

Table N5.1 Birds (cont'd)

Species name	Common name	SML/ RD	Corridors	DP	Status			Mobility
					AUS	SA	C/J/B	
MALURIDAE	**Fairy-wrens, Emu-wrens and Grasswrens**							
Amytornis goyderi	Eyrean Grasswren		4					Re
Amytornis textilis modestus	Thick-billed Grasswren (Eastern subspecies)	1	4		V			Re
Amytornis textilis myall	Thick-billed Grasswren (Gawler Ranges subspecies			2	V			Re
Malurus cyaneus	Superb Fairy-wren			2				Re
Malurus lamberti	Variegated Fairy-wren	1,2	2,3,4,5	2				Re
Malurus leucopterus	White-winged Fairy-wren	1,2	2,3,4,5	2				Re
Malurus pulcherrimus	Blue-breasted Fairy-wren		4	2				Re
Malurus splendens	Splendid Fairy-wren	1,2	2,3,4	2				Re
PARDALOTIDAE	**Pardalotes**							
Pardalotus rubricatus	Red-browed Pardalote	1,2	4					N
Pardalotus striatus	Striated Pardalote	1,2	2,3,4					N / S
ACANTHIZIDAE	**Bristlebirds, Thornbills, Scrubwrens and allies**							
Acanthiza apicalis	Inland Thornbill	1,2	2,4	2				Re
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	1,2	2,4	2				N
Acanthiza iredalei iredalei	Slender-billed Thornbill		2		V	R		Re
Acanthiza uropygialis	Chestnut-rumped Thornbill	1,2	2,3,4	2				Re
Aphelocephala leucopsis	Southern Whiteface	1,2	2,3,4	2				Re
Aphelocephala nigricincta	Banded Whiteface		4					Re
Calamanthus campestris	Rufous Fieldwren	1	2,4					Re
Calamanthus cautus	Shy Heathwren		2			R		Re
Gerygone olivacaea	White-throated Gerygone	1						
Pyrrholaemus brunneus	Redthroat		2,4					Re
Smicrornis brevirostris	Weebill		3,4,5					Re
MELIPHAGIDAE	**Honeyeaters and Australian Chats**							
Acanthagenys rufogularis	Spiny-cheeked Honeyeater	1,2	2,4,5	2				Re
Anthochaera carunculata	Red Wattlebird		2	2				Re
Certhionyx niger	Black Honeyeater		2,4					Re
Certhionyx variegatus	Pied Honeyeater	1,2	2,4					N
Lichenostomus chrysops	Yellow-faced Honeyeater		2					Re
Lichenostomus leucotis	White-eared Honeyeater			2				Re
Lichenostomus ornatus	Yellow-plumed Honeyeater	2	3					Re

Species name	Common name	SML/ RD	Corridors	DP	Status			Mobility
					AUS	SA	C/J/B	
Lichenostomus penicillatus	White-plumed Honeyeater	1,2	2,4,5					Re
Lichenostomus plumulus	Grey-fronted Honeyeater	1	2,4					Va
Lichenostomus virescens	Singing Honeyeater	1,2	2,3,4,5	2				Re
Manorina flavigula	Yellow-throated Miner	1,2	2,3,4,5					Re
Melithreptus brevirostris	Brown-headed Honeyeater							Re
Phylidonyris albifrons	White-fronted Honeyeater	1,2	2,3,4					N
Phylidonyris novaehollandiae	New Holland Honeyeater							Re
Epthianura albifrons	White-fronted Chat	1	2,3	2				N
Epthianura aurifrons	Orange Chat	1,2	2,3,4					N
Epthianura crocea	Yellow Chat		5			E		
Epthianura tricolor	Crimson Chat	1,2	2,3,4					N
Ashbyia lovensis	Gibberbird	1	4,5					N / Re
PETROICIDAE	**Australopapuan Robins and allies**							
Drymodes brunneopygia	Southern Scrub-robin		2,4					Re
Melanodryas cucullata	Hooded Robin	1	2,3,4					Re
Microeca fascinans	Jacky Winter	1	2,3					Re
Petroica goodenovii	Red-capped Robin	1,2	2,3,4	2				S
POMATOSTOMIDAE	**Australopapuan Babblers**							
Pomatostomus ruficeps	Chestnut-crowned Babbler		4					Re
Pomatostomus superciliosus	White-browed Babbler	1,2	2,3,4,5	2				Re
EUPETIDAE	**Whipbirds, Quail-thrushes and allies**							
Cinclosoma castanotus	Chestnut Quail-thrush		2			R		Re
Cinclosoma cinnamomeum	Cinnamon Quail-thrush	1,2	2,4,5					Re
Psophodes cristatus	Chirruping Wedgebill	1,2	2,4,5					Re
Psophodes occidentalis	Chiming Wedgebill							Re
NEOSITTIDAE	**Sittellas**							
Daphoenositta chrysoptera	Varied Sittella	1,2	2,4					N
PACHYCEPHALIDAE	**Whistlers, Shrike-tits and allies**							
Colluricincla harmonica	Grey Shrike-thrush	1,2	2,4	2				Re
Oreoica gutturalis	Crested Bellbird	1,2	2,4,5	2				Re
Pachycephala pectoralis	Golden Whistler		2					Re
Pachycephala rufiventris	Rufous Whistler	1,2	2,4,5					S / Va

Table N5.1 Birds (cont'd)

Species name	Common name	SML/ RD	Corridors	DP	Status			Mobility
					AUS	SA	C/J/B	
DICRURIDAE	**Monarchs, Drongos, Magpie-larks and allies**							
Grallina cyanoleuca	Magpie-lark	1,2	2,4,5					Re
Myiagra inquieta	Restless Flycatcher	1	2,4			R		N
Rhipidura albiscapa	Grey Fantail	1,2	2	2				Re
Rhipidura leucophrys	Willie Wagtail	1,2	2,3,4,5					Re
ARTAMIDAE	**Woodswallows, Butcherbirds and allies**							
Artamus cinereus	Black-faced Woodswallow	1,2	2,3,4,5					Re
Artamus cyanopterus	Dusky Woodswallow		2,3,4					N
Artamus leucorhynchus	White-breasted Woodswallow	1,2	4					Re
Artamus personatus	Masked Woodswallow	1,2	2,4,5					N
Artamus superciliosus	White-browed Woodswallow	1,2	2,4	2				N
Cracticus nigrogularis	Pied Butcherbird		2					N
Cracticus torquatus	Grey Butcherbird	1,2	2,3,4	2				Re
Gymnorhina tibicen	Australian Magpie	1,2	2,3,4,5	2				Re
Strepera versicolor	Grey Currawong		2,3					Re
CAMPEPHAGIDAE	**Cuckoo-shrikes and allies**							
Coracina maxima	Ground Cuckoo-shrike	1,2	2,4					N
Coracina novaehollandiae	Black-faced Cuckoo-shrike	1,2	2,3,4,5	2	Ma			Re
Lalage tricolor	White-winged Triller	1,2	2,3,4,5					S
ORIOLIDAE	**Orioles**							
Oriolus sagittatus	Olive-backed Oriole		4			R		N
CORVIDAE	**Crows**							
Corvus bennetti	Little Crow	1,2	2,3,4,5	2				Re
Corvus coronoides	Australian Raven	1,2	2,4,5	2				Re
Corvus mellori	Little Raven		2,4	2	Ma			Re
MUSCICAPIDAE	**Thrushes and Old World Flycatchers**							
*Turdus merula**	Eurasian Blackbird	1,2	2					Re
STURNIDAE	**Starlings**							
*Sturnus vulgaris**	Common Starling	1,2	2,4	2				Re
ALAUDIDAE	Larks							
*Alauda arvensis**	Skylark		3					
Mirafra javanica	Horsfield's Bushlark		4					N / Re

Species name	Common name	SML/ RD	Corridors	DP	Status			Mobility
					AUS	SA	C/J/B	
HIRUNDINIDAE	**Swallows and Martins**							
Cheramoeca leucosternus	White-backed Swallow	1,2	2,4,5	2				Re
Hirundo neoxena	Welcome Swallow	1,2	2,4,5	2				Re
Hirundo rustica	Barn Swallow	1,2			Mi, Ma		CJ	Re
Petrochelidon ariel	Fairy Martin	1,2	2,4,5					S
Petrochelidon nigricans	Tree Martin	1,2	2,4,5	2				S
ZOSTEROPIDAE	**White-eyes**							
Zosterops lateralis	Silvereye		2	2	Ma			Re
SYLVIIDAE	**Warblers**							
Acrocephalus australis	Australian Reed Warbler	1,2	2,4,5					N / Re
Cincloramphus cruralis	Brown Songlark	1,2	2,4					N
Cincloramphus mathewsi	Rufous Songlark	1	2,4					N
Megalurus gramineus	Little Grassbird	1,2	4					N / Re
DICAEIDAE	**Flowerpeckers**							
Dicaeum hirundinaceum	Mistletoebird	1,2	2,3,4,5	2				N / S
PASSERIDAE	**Old World Sparrows**							
*Passer domesticus**	House Sparrow	1,2	2,4,5	2				Re
MOTACILLIDAE	**Wagtails and Pipits**							
Anthus novaeseelandiae	Richard's Pipit	1,2	2,3,4,5	2	Ma			Re
ESTRILDIDAE	**Grass-finches (Waxbills)**							
Emblema pictum	Painted Finch		4			R		N / Re
Taeniopygia guttata	Zebra Finch	1,2	2,3,4,5					Re
Total	**239**	**184**	**216**	**83**	**64**	**49**	**27**	

Information as above, plus:
Mobility: Re = resident, N = nomadic, S = seasonal visitor, Va = vagrant
* Indicates introduced species

Species name	Common name	SML/ RD	Corridors	DP	Status		Home range size	Shelter
					AUS	SA		
TACHYGLOSSIDAE	**Echidnas**							
Tachyglossus aculeatus	Short-beaked Echidna	1,2	4				L	S
MYRMECOBIIDAE	**Numbat**							
Myrmecobius fasciatus	Numbat	6			V	E	L	H,B
DASYURIDAE	**Dasyurids**							
Planigale gilesi	Giles' Planigale	1	2,4				S	B
Planigale tenuirostris	Narrow-nosed Planigale		4				S	B
Antechinomys laniger	Kultarr	1						
Sminthopsis crassicaudata	Fat-tailed Dunnart	1,2	1,2,3,4	2			S	B
Sminthopsis macroura	Stripe-faced Dunnart	1	1,2,3,4				S	B
PERAMELIDAE	**Bandicoots and Bilbies**							
Perameles bougainville	Western Barred Bandicoot	6			E	E	M	B,N
Macrotis lagotis	Bilby	6			V	V	M	B,N
POTOROIDAE	**Potoroos, Bettongs and Musky Rat-kangaroos**							
Bettongia lesueur	Burrowing Bettong	6			V	E	M	B
MACROPODIDAE	**Wallabies, Kangaroos and Tree Kangaroos**							
Macropus fuliginosus	Western Grey Kangaroo	1	3				L	S
Macropus robustus	Euro	1	3				L	S
Macropus rufus	Red Kangaroo	1	3,4,5				L	S
MOLOSSIDAE	**Freetail-bats**							
Mormopterus planiceps	Southern Freetail-bat	2	2				L	H
Tadarida australis	White-striped Freetail-bat	2	2	2			L	H
EMBALLONURIDAE	**Sheathtail-bats**							
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	2				R	L	H
VESPERTILION-IDAE	**Ordinary bats**							
Nyctophilus geoffroyi	Lesser Long-eared Bat	2	2,5	2			L	H
Chalinolobus gouldii	Gould's Wattled Bat	2	2	2			L	H
Scotorepens balstoni	Inland Broad-nosed Bat	2	2				S	H
Vespadelus baverstocki	Inland Forest Bat	2	2,4				L	H
CANIDAE	**Dogs, Foxes and relatives**							
Canis lupus dingo	Dingo	1	4,5				L	S

Species name	Common name	SML/ RD	Corridors	DP	Status		Home range size	Shelter
					AUS	SA		
**Canis lupus familiaris*	Dog (domestic or feral)	1	4,5					
**Vulpes vulpes*	Fox	1	3,4,5					
FELIDAE	**Cats and relatives**							
**Felis catus*	Cat	1	3,4,5					
EQUIDAE	**Horses, Donkeys and relatives**							
**Equus caballus*	Horse		2,4,5					
**Equus asinus*	Donkey		5					
BOVIDAE	**Horned Ruminants**							
**Bos taurus*	Cattle	1	2,4,5					
**Capra hircus*	Goat		1,2					
**Ovis aries*	Sheep		1,2,3,5					
MURIDAE	**Murids**							
Leggadina forresti	Forrest's Mouse	1	4				S	B
Leporillus conditor	Greater Stick-nest Rat	6			V	V	S	N
Notomys alexis	Spinifex Hopping-mouse	1,2					S	B
Notomys fuscus	Dusky Hopping-mouse		4		V	V	S	B
Pseudomys australis	Plains Rat	1	4		V	V	S	B
Pseudomys bolami	Bolam's Mouse	1	3,4	2			S	B
Pseudomys hermannsburgensis	Sandy Inland Mouse	1	4	2			S	B
Pseudomys desertor	Desert Mouse	1	4				S	B
**Mus musculus*	House Mouse	1	1,2,3,4					
**Rattus rattus*	Black Rat	1		2				
LEPORIDAE	**Rabbits and Hares**							
**Oryctolagus cuniculus*	Rabbit	1	3,4,5					
Total	**40**	**29**	**31**	**7**	**7**	**8**		

Information as above, plus:
Home range size: S = small (◂10 ha), M = medium (10–20 ha), L = large (▸20 ha)
Shelter: B = burrows, N = nest made of vegetation, H = hollow, S = shade under vegetation.

Scientific name	Common name	SML	Corridors	DP	Status		Size (cm)[1]
					AUS	SA	
REPTILES							
AGAMIDAE	**Dragons**						
Ctenophorus cristatus	Crested Dragon		1,2,3				11
Ctenophorus fionni	Peninsula Dragon		1,2,3				9
Ctenophorus fordi	Mallee Dragon	1,2	1,2,4				5
Ctenophorus gibba	Gibber Dragon		4				8
Ctenophorus nuchalis	Central Netted Dragon	1,2	1,2,3,4, 5				11
Ctenophorus pictus	Painted Dragon	1,2	2,4,5	2			6
Ctenophorus vadnappa	Red-barred Dragon		4,5				8
Diporiphora winneckei	Canegrass Dragon		4				7
Pogona vitticeps	Central Bearded Dragon	1,2	1,2,3,4,5				25
Tympanocryptis intima	Smooth-snouted Earless Dragon	1,2	1,2,4				10
Tympanocryptis lineata	Five-lined Earless Dragon	1,2	1,2				10
Tympanocryptis tetraporophora	Eyrean Earless Dragon	1,2	1,2,3,4				10
GEKKONIDAE	**Geckos and Legless Lizards**						
Diplodactylus byrnei	Pink-blotched Gecko		4				6
Diplodactylus conspicillatus	Fat-tailed Gecko	1,2	4				6
Diplodactylus damaeus (recently changed to Lucasium damaeum)	Beaded Gecko	1,2	1,2,3,4				5
Diplodactylus stenodactylus	Sandplain Gecko	1,2	1,2,4				6
Diplodactylus tessellatus	Tessellated Gecko	1,2	1,2,3,4				5
Diplodactylus vittatus	Eastern Stone Gecko		2	2			5
Nephrurus deleani	Pernatty Knob-tailed Gecko		1,2		V	R	10
Nephrurus levis	Smooth Knob-tailed Gecko	1,2	1,2,4				8
Nephrurus milii	Barking Gecko	1,2	1,2,4				8
Rhynchoedura ornata	Beaked Gecko	1,2	1,2,4				5
Strophurus ciliaris	Northern Spiny-tailed Gecko	1,2					8
Strophurus intermedius	Southern Spiny-tailed Gecko		1,2,3	2			8
Gehyra purpurascens	Purple Dtella	1,2	4				6
Gehyra sp. '2n=44'	Southern Rock Dtella	1	4				6
Gehyra variegata	Tree Dtella	1,2	2,3,4,5	2			5

Scientific name	Common name	SML	Corridors	DP	Status		Size (cm)[1]
					AUS	SA	
Heteronotia binoei	Bynoe's Gecko	1,2	1,2,3,4,5	2			5
Aprasia inaurita	Red-tailed Worm-lizard		2	2			12
Delma australis	Barred Snake-lizard		2,4				8
Delma butleri	Spinifex Snake-lizard		2				9
Delma molleri	Adelaide Snake-lizard		2				10
Lialis burtonis	Burton's Legless Lizard		4				25
Pygopus lepidopodus	Common Scaly-foot			2			20
Pygopus nigriceps	Black-headed Scaly-foot	1,2	1,2,4				18
SCINCIDAE	**Skinks**						
Cryptoblepharus plagiocephalus / carnabyi	Desert Wall Skink		1,2,3,4				4
Ctenotus brooksi	Sandhill Ctenotus	1,2	1,2,4				5
Ctenotus leae	Centralian Coppertail	1,2	1,2,4				6
Ctenotus leonhardii	Common Desert Ctenotus	1					7
Ctenotus olympicus	Saltbush Ctenotus	1	1,2,3,4				9
Ctenotus orientalis	Eastern Spotted Ctenotus		2,4	2			8
Ctenotus pantherinus	Leopard Skink		2				11
Ctenotus regius	Eastern Desert Ctenotus	1,2	1,2,3,5				7
Ctenotus robustus	Eastern Striped Skink		2				11
Ctenotus saxatilis	Centralian Striped Skink		2				10
Ctenotus schomburgkii	Sandplain Ctenotus	1,2		2			5
Ctenotus strauchii	Short-legged Ctenotus	1,2	2,4				5
Ctenotus taeniatus	Eyrean Ctenotus		4				
Cyclodomorphus melanops	Spinifex Slender Bluetongue		2				12
Egernia inornata	Desert Skink		4				8
Egernia stokesii	Gidgee Skink		4				18
Eremiascincus fasciolatus	Narrow-banded Sandswimmer		4				8
Eremiascincus richardsonii	Broad-banded Sandswimmer	1,2	1,2,4				11
Hemiergis millewae	Rusty Earless Skink		2				5
Lerista aericeps	Yellow-tailed Slider		4				5
Lerista bougainvillii	Bougainville's Skink		1,2				7
Lerista desertorum	Great Desert Slider	1,2					9
Lerista edwardsae	Myall Slider		2,3	2			9

Scientific name	Common name	SML	Corridors	DP	Status		Size (cm)[1]
					AUS	SA	
Lerista labialis	Eastern Two-toed Slider	1,2	1,2,3,4				6
Lerista muelleri	Dwarf Three-toed Slider	1	1,2,3,4	2			5
Lerista terdigitata	Southern Three-toed Slider		1,2				6
Menetia greyii	Dwarf Skink	1,2	1,2,3,4	2			3
Morethia adelaidensis	Adelaide Snake-eye	1,2	1,2,4	2			5
Morethia boulengeri	Common Snake-eye	1,2	1,2,3,4	2			4
Tiliqua occipitalis	Western Bluetongue	1,2	4				30
Tiliqua rugosa	Sleepy Lizard	1,2	1,2,3,4,5				30
VARANIDAE	**Goannas**						
Varanus gilleni	Pygmy Mulga Goanna	1,2	2				30
Varanus gouldii	Sand Goanna	1,2	1,2,3,4,5				160
BOIDAE	**Boas and Pythons**						
Antaresia stimsoni	Stimson's Python		1,2,4				90
Aspidites ramsayi	Woma	1,2	4			R	200
Morelia spilota	Carpet Python			2		R	250
ELAPIDAE	**Elapid Snakes**						
Demansia reticulata	Desert Whipsnake		1,2	2			100
Furina diadema	Red-naped Snake		2				35
Pseudechis australis	Mulga Snake	1,2	1,2,4				200
Pseudonaja inframacula	Peninsula Brown Snake			2			150
Pseudonaja modesta	Five-ringed Snake	1,2	1,2,4				50
Pseudonaja nuchalis	Western Brown Snake	1,2	1,2,4				145
Simoselaps bertholdi	Desert Banded Snake	1,2	1,2,3	2			30
Simoselaps fasciolatus	Narrow-banded Snake	1,2					30
Simoselaps semifasciatus	Half-girdled Snake		2				
Suta spectabilis	Mallee Black-headed Snake		2	2			40
Suta suta	Curl Snake	1,2	1,2,3,4	2			40
Vermicella annulata	Common Bandy-bandy		2			R	60
TYPHLOPIDAE	**Blind snakes**						
Ramphotyphlops australis	Southern Blind Snake		2				25
Ramphotyphlops bituberculatus	Rough-nosed Blind Snake	1,2	2,3,4				30
Ramphotyphlops endoterus	Centralian Blind Snake	1,2	1,2,4				25

Scientific name	Common name	SML	Corridors	DP	Status		Size (cm)[1]
					AUS	SA	
HYLIDAE	**Tree Frogs**						
Litoria caerulea	Green Tree Frog		4				
Litoria latopalmata	Broad-palmed Frog		4				
Litoria rubella	Red Tree Frog		4				
MYOBATRACHIDAE	**Southern Frogs**						
Neobactrachus centralis	Trilling Frog	1,2	4				
Total	**90**	**48**	**82**	**20**		4	

Information as above, plus:
Size = total body length (head to tail).

N5.1 REFERENCES

Robinson, AC, Casperson KD & Hutchinson, MN 2000, *A List of the Vertebrates of South Australia*, 3rd edn, Department for Environment and Heritage, Adelaide.

APPENDIX N6

Priority species list

N6 PRIORITY SPECIES LIST

Priority flora and fauna species include species recognised by state, national and international legislation as being rare, threatened and/or migratory. A total of 34 plant and 101 animal species were identified as being priority species, but only some would be at risk as a consequence of the proposed expansion and/or mine operation.

Those species at credible risk of being affected by the project have been determined using a matrix combining species distribution and ecology/resilience (see Table N6.1 for flora and Table N6.3 for fauna). The species identified as having a credible risk of being affected by the proposed mine expansion were consolidated into a table for inclusion in the Draft EIS Chapter 15, Terrestrial Ecology, and subjected to an additional level of assessment.

Flora is presented in Table N6.2 and fauna in Table N6.4.

Flora species have been screened using Table N6.1. Risk to plants has been determined by the likelihood of the plant occurring in the study area and the ecology of the species (i.e. the longevity of the species, its resilience to disturbance and the availability of alternative habitat in the region). By default, any plant species listed as vulnerable or endangered, with a confirmed record in or near the study area, was considered to be at credible risk.

Table N6.1 Risk matrix defining whether plant species are at credible risk of being adversely affected by the mine expansion

		Ecology/resilience		
		a	b	c
Distribution		Long-lived tree or shrub (>20 years)	Short-lived shrub or grass (lives 2–20 years); any plant species with limited habitat in the region	Ephemeral species (lives <1–2 years) with abundant similar habitat in region
1	Regularly recorded in the study area	Yes	Yes	No
2	Occasional records in or near the study area	Yes	Yes	No
3	Never recorded in or near the study area	No	No	No

Status

Letters under columns AUS and SA represent the category listed in the *Environment Protection and Biodiversity Conservation Act 1999* and the *National Parks and Wildlife Conservation Act 1972* (E = endangered, V = vulnerable, R = rare).

Principal Sources

BD = recorded in Biological Database of South Australia; P = predicted to occur in the study area as per the EPBC Act Protected Matters Search Tool; PS = have been found in the study area during previous surveys; S = have been found in the study area during the current surveys.

Additional specific sources are included as footnotes at the end of the table.

Species name	Common name	Status		Source	Distribution	Ecology	Susceptibility to potential impact (see table N6.1)		Credible risk to species
		AUS	SA				Dist.	Ecol.	
Atriplex eichleri	Eichler's Saltbush		R	BD	Widely distributed from the Mid North through to Cowarie Station, most records in Flinders and Olary Ranges.	Small, annual to 30 cm tall, usually on heavier soils and associated with drainage lines or floodplains. Can be in disturbed areas near dams and water points.	3	b	No
Atriplex kochiana	Koch's saltbush		V	PS	Northern regions of the state[1]. There are many records from around Andamooka[1] and from north of Olympic Dam.[12]	Small, short-lived perennial to 40 cm tall. Occurs on gibber slopes with other chenopod shrubs.[1]	1	b	Yes
Austrostipa nullanulla	Club Spear-grass	V		P	Murray, Eyre Peninsula and Gairdner–Torrens botanic regions[1]. A DEH Species Profiles and Threats (SPRAT) assessment of this species has recently been completed and its main distribution is well to the west of study area[2]. The closest SA Herbarium record to the study area is 50 km west (west of Pimba).	Perennial grass to 50 cm. Three collections have been made from gypsum rises and gypseous sands and from *Sclerostegia tenuis* and *Acacia papyrocarpa* communities near a salt lake[1]. Almost always found on calcareous soils at or near salt lakes.[2]	3	b	No
Brachyscome eriogona			R	BD	Woomera area in the Gairdner–Torrens botanic region, Lake Eyre botanic region[1]. However, a recently completed SPRAT assessment of this species has recommended that it no longer warrants any conservation rating in South Australia.	Small ephemeral herb to 25 cm occurring on sandy clay soils to cracking clays in chenopod shrublands on gibber plains or herblands in run-off or floodplain areas.[1]	2	c	No
Brachyscome muelleri	Corunna Daisy	E	E	P	Currently known from only one location in the Baxter Hills, 5 km north of Iron Knob.[4]	Small annual herb to 20 cm tall. One occurs on steep south-facing cliff-slopes.[3]	3	b	No

Table N6.2 Priority plant species occurring or likely to occur in the proposed expansion area (cont'd)

Species name	Common name	Status		Source	Distribution	Ecology	Susceptibility to potential impact (see table N6.1)		Credible risk to species
		AUS	SA				Dist.	Ecol.	
Caladenia tensa	Greencomb Spider-orchid	E		P	Eyre Peninsula, southern Flinders Ranges and northern Mount Lofty Ranges and the South-East[1]. There are no herbarium records from the western side of northern Spencer Gulf and it is unlikely that it would be found in the study area.	Deciduous terrestrial orchid that occurs in pine and mallee woodlands on sands to sandy loams.[5]	3	b	No
Citrus glauca	Desert Lime		V	BD	Native to Queensland and New South Wales, west of a line running from Rockhampton to Dubbo, with some isolated occurrences in central South Australia. In South Australia, common in the southern Flinders Ranges and surrounding areas from Mambray Creek in the south to 50 km south-east of Olympic Dam in the north. Four SA Herbarium records are within the southern infrastructure corridor 10-20 km north of Port Augusta.	Shrub to small tree that suckers prolifically, forming dense groves, usually restricted to heavy brown clays, desert loams or red earths.	2	a	Yes
Daviesia pectinata			R	BD	Occurs in lower Eyre Peninsula and the southern Mount Lofty Ranges[1]. There is a single 1941 herbarium record of this species from Port Augusta, which is disjunct from all other vouchered herbarium collections. All other nearby records are from southern Eyre Peninsula[1] and the database record.	Woody perennial shrub to 1.5 m tall.	3	a	No
Eleocharis papillosa	Dwarf Desert Spike-rush	V	R	BD	Known from eight remote locations in NT, from the northern Tanami Desert to the Finke bioregion and Simpson Desert.[15] Recorded within gas pipeline corridors at two locations on Frome Creek and another minor drainage line feeding into Lake Eyre South[1] both more than 2 km north of corridor centre line.	Small, erect perennial sedge, grows to less than 10cm high. All records are from temporary wetlands; predominantly freshwater and semi-saline swamps with one record from the edge of a temporary riverine waterhole.[15]	2	b	Yes
Eriocaulon carsonii	Salt Pipewort	E	E	P	Restricted and endemic to certain GAB mound springs in Queensland, northern South Australia and north-western NSW.[15] Recorded at Gosse, Hermit Hill, Finniss and Mount Hopeless Springs groups all more than 10 km from gas pipeline corridors centreline.[1]	Small, hairless herb associated with vegetated mounds that have formed organic alkaline boggy soils. Appears to prefer areas of shallow standing water with slow flow.[15]	3	b	No

Species name	Common name	Status		Source	Distribution	Ecology	Susceptibility to potential impact (see table N6.1)		Credible risk to species
		AUS	SA				Dist.	Ecol.	
Eucalyptus behriana			R	BD	Northern Mount Lofty Ranges, lower Eyre Peninsula and South-East.[1] There is a 1941 record from Port Augusta, but this is not shown in EUCLID (the electronic version of Eucalypts of Southern Australia). There is also a record from the Wirrabara Forest on the eastern side of Spencer Gulf. The database record for this species in the study area is probably erroneous.	Mallee tree in low flat areas.[11]	3	a	No
Frankenia plicata		E	V	BD, P	All confirmed records of this species are from the Breakaways[2]. The 2003 review of threatened species in South Australia[13] recommended that this species was sufficiently common to not warrant a conservation rating, but a more recent DEH SPRAT assessment found that this judgment was based on incorrect and unvouchered records and it was considered that a new state rating of Vulnerable may be more appropriate. There is one unvouchered record in the gas pipeline corridors near the Reedy Springs complex on Murnpeowie Station.[1]	Low, mat-forming perennial shrub on lower slopes of hills and in small run-off channels.[6]	2	b	Yes
Frankenia subteres			R	BD	South Australian distribution is mainly in the northern Flinders Ranges with very few records further north in the Lake Eyre botanical region. There is one vouchered record in the gas pipeline corridors on Murnpeowie Station in open gibber/gilgai undulating plains.	Small perennial shrub.	2	a	Yes
Gilesia biniflora	Western Tar-vine		R	BD, S	Located mainly in the northern regions of the state[1] Two vouchered records exist in the gas pipeline corridors in open undulating chenopod shrublands.[1]	Prostrate perennial herb that occurs in run-on areas in swamps or interdune corridors.	2	a	Yes

Species name	Common name	Status		Source	Distribution	Ecology	Susceptibility to potential impact (see table N6.1)		Credible risk to species
		AUS	SA				Dist.	Ecol.	
Gratwickia monochaeta			R	BD	Upper Eyre Peninsula, Nullarbor and Gairdner–Torrens botanic regions.[1]	Ephemeral herb usually on sandy soils[3] or sandy loam and clay soils in swales and near claypans[1]. The two main habitats of this species are red and yellow sandy soils of sand plains, swales and sand ridges, where it is often common; and clay, often calcareous, soils of plains and hillsides, where it is usually less common. It has also been recorded on sandy soils around salt lakes and on clay soils in association with granite outcrops and in a rocky creek bed, but was not common in any of these habitats.[1]	3	c	No
Halosarcia flabelliformis	Bead Glasswort	V		P	Near the coast on southern Eyre Peninsula, Yorke Peninsula and the Port Wakefield area[1]. There are no herbarium records from the western side of upper Spencer Gulf.[1]	Herbaceous perennial to 20 cm tall. Two records on salt lakes or on tidal flats near the coast.[1]	3	b	No
Maireana melanocarpa	Black-fruit Bluebush	V		P	North-western and north-eastern edges of the Flinders Ranges and more recently has been collected from the Arckaringa Hills and Moon Plain near Coober Pedy, the Simpson Desert and in the Northern Territory.[7] There are no herbarium records from south of Beltana, between Hawker and Leigh Creek.[1]	Short-lived perennial shrub to 50 cm tall that occurs in a variety of habitats in chenopod shrublands on rocky hillslopes, plains and floodplains.[6]	3	b	No
Maireana pentagona	Slender Fissure-plant		R	PS	Lake Eyre, Murray and Gairdner–Torrens botanical regions[1]. There are no herbarium records from the project area, with the closest vouchered record being from a canegrass swamp to the north of Olympic Dam near the Borefield Road[1]. The 1992 transmission line corridor record (WMC 1997) now appears to have been based on a misidentification, with the specimen since redetermined by State Herbarium of South Australia.[14] Also recorded (unvouchered) in gas pipeline corridors near Lake Gregory in open stony gilgai country.[1]	Small short-lived woody perennial. Heavy, often saline clay soils on floodplain of River Murray and on clay soils at the margins of claypans.[1]	2	c	No

Table N6.2 Priority plant species occurring or likely to occur in the proposed expansion area (cont'd)

Species name	Common name	Status		Source	Distribution	Ecology	Susceptibility to potential impact (see table N6.1)		Credible risk to species
		AUS	SA				Dist.	Ecol.	
Malacocera gracilis	Slender Soft-horns		V	BD	Eyre Peninsula and Eastern botanic regions[3]. Collected from the transmission line area near Port Augusta. There is a herbarium record from Port Augusta and many records from south of this city on the eastern side of Spencer Gulf (Red Cliffs, Winninowie)[1]. The other Eyre Peninsula record is well to the east of the study area.	Annual or short-lived perennial herb that occurs on clay soils or on gypseous mounds.[3]	2	b	Yes
Ophioglossum polyphyllum	Large Adder's-tongue		R	PS	Gairdner–Torrens, North-Western, Lake Eyre and Eastern botanic regions[1]. There are several herbarium records from the Lake Windabout area[1]. Records of this species from the SML and Municipality of RD (Kinhill 1997) are not supported by herbarium records[1], although an *Ophioglossum* sp. was definitely present in this area in 1989.[14]	Perennial rhizomatous fern with large leathery leaves[3]. Has been collected from swales in mulga woodland and also from tussock grassland on gibber plains.	2	a	Yes
Orobanche cernua var. australiana	Australian Broomrape		R	BD	Spread over a large number of coastal and inland environments from the West Coast to Riverland and north to Lake Eyre. There are two vouchered specimens from Motecollina Bore in the gas pipeline corridors.	Brown parasitic herb 15–45 cm high. Grows in dry sandy creekbeds. Parasitic on native *Senecio* spp., including *S. cunninghamii*, but data on host range are poor.	2	b	Yes
Osteocarpum acropterum var. *deminutum*	Wingless Bonefruit		R	BD	Lake Eyre, Gairdner–Torrens, Eastern and Murray botanic regions.[1] There are herbarium records from the Port Augusta area and from west of Upper Spencer Gulf on Eyre Peninsula.[1]	Small short-lived perennial shrub found in heavy periodically waterlogged soil.[3]	2	c	No
Phlegmatospermum eremaeum	Spreading Cress		R	BD	Spread very widely throughout the State, with specimens in the SA Herbarium from every botanical region except the South East. Recorded as *P. cochlearinum,* locally seems quite common with four records in the gas pipeline corridors near Moomba, Compressor Station 2, Pumping Station 6 and just north of Olympic Dam.[1]	Annual herb, mostly prostrate to spreading, stems slender, 2–10 (rarely to 20) cm long. Usually found on heavier soils.[1]	1	c	No
Prasophyllum pallidum	Pale Leek-orchid	V	R	P	Mount Lofty Ranges to southern Flinders Ranges. The closest populations to the study area are at Quorn[1] and there are many other records from the east of Spencer Gulf.[1]	Deciduous terrestrial orchid in fertile soils in grassy open forest in high rainfall areas[8]. In the Flinders Ranges the species has been collected from *Allocasuarina* woodlands with a grassy understorey.[1]	3	b	No

Species name	Common name	Status		Source	Distribution	Ecology	Susceptibility to potential impact (see table N6.1)		Credible risk to species
		AUS	SA				Dist.	Ecol.	
Pterostylis sp. (Eyre Peninsula R. Bates 19474)		V	V	P	Has only been recorded from the Mount Olympus area on upper Eyre Peninsula.[9]	Deciduous terrestrial orchid.	3	b	No
Pterostylis xerophila	Desert Greenhood	V	V	P	Northern Eyre Peninsula west to the edge of the Great Sandy Desert.[7] There are no herbarium records from the study area.[1]	Deciduous terrestrial orchid on fertile red loamy soils in dry woodland and on rocky outcrops.[7]	3	b	No
Santalum spicatum	Sandalwood		V	S, BD	Throughout the arid to semi-arid zone of South Australia, north to about the Dog Fence north of Olympic Dam, further north in the Great Victoria Desert, but not in the far north of the state.[1]	Shrub or small tree in woodland or shrubland. In the eastern parts of its range in South Australia, this species occurs in clayey soils on stony hillsides and flats, in gullies and along watercourses. Further west it also occurs on sandy swales and on sand dunes and on the limestone of the Nullarbor Plain[1]. (This information is contained in a SPRAT sheet, but the original source was herbarium collection labels).	1	a	Yes
Senecio megaglossus	Superb or Large-flower Groundsel	V	E	BD	Northern Mount Lofty Ranges and southern Flinders Ranges.[10]	Long-lived perennial shrub to 1 m high.[8] Mostly occurs on rocky creek banks and rocky gorge or valley slopes. Old herbarium records from sand dunes[8] are incorrect.[2]	3	a	No
Spiranthes australis (NC)	Austral Lady's Tresses		R	BD	One vouchered specimen is recorded on Frome Creek in the gas pipeline corridors. Taxonomy has been split for this species name. SA Census lists this species as only occurring in the South East, Kangaroo Island and Southern Lofty botanical regions. This specimen collected in 1974 has a location accuracy exceeding 25 km and is probably a mis-identification.	An uncommon small marsh orchid usually occurring in small clumps in boggy swamps.	3	b	No
Swainsona microcalyx	Wild Violet		R	BD	Eyre Peninsula, Gairdner–Torrens, Lake Eyre and North-West botanic regions[1]. There are herbarium records from the vicinity of the transmission line corridor.[1]	Small ephemeral herb with prostrate then later ascending stems 10–30 cm long.[3] Occurs on shallow sands at margins of clay pans or salt lakes.[1]	1	c	No
Swainsona pyrophila	Yellow Swainson-pea	V	R	P	Eyre Peninsula and Yorke Peninsula botanic regions.[1] All Eyre Peninsula records are from south or west of the study area, with the closest being from near Kimba.	Small herb with prostrate then descending stems 10–30 cm long.[3] In the southern part of its range the species occurs on sandy or sandy-clay loams in mallee scrub[5]. It usually occurs after fire or other soil disturbance and will persist for several years.[5]	3	b	No

Table N6.2 Priority plant species occurring or likely to occur in the proposed expansion area (cont'd)

Species name	Common name	Status		Source	Distribution	Ecology	Susceptibility to potential impact (see table N6.1)		Credible risk to species
		AUS	SA				Dist.	Ecol.	
Todea barbata	King Fern		E	BD	Mount Lofty Ranges. All herbarium records are from this area[1] and the database record for this species in the study area is most probably erroneous.	Large fern that occurs in moist gullies with high rainfall.	3	a	No
Zygophyllum crassissimum	Thick Twinleaf		R	BD	Distributed in the Lake Eyre, North-West and Gairdner–Torrens botanical regions of South Australia, and southern NT. One mainly north and west of the project area. There is one vouchered record from 1957 in the gas pipeline corridors at Montecollina Bore.	Fleshy perennial shrub to 60 cm high with ascending spreading branches.	2	a	Yes
Zygophyllum humillimum	Small-fruit Twinleaf		R	BD	Distributed throughout the Lake Eyre, North-West and Flinders Ranges botanical regions of South Australia, and in the north-west of NSW, this species is recorded widely across the arid areas. There are two vouchered records in the gas pipeline corridors on drainage lines south of Lake Eyre South.	Small prostrate annual that grows on red-brown cracking clay and sandy loam with gypsum.	2	c	No

[1] = State Herbarium of South Australia; [2] = F Badman, Badman Environmental, pers. comm., 5 June 2006; [3] = Jessop and Toelken 1986; [4] = Jusaitis et al. 1998; [5] = Todd 2000; [6] = Neagle 2003; [7] = DEH 2005; [8] = Bates and Weber 1990; [9] = K. Pobke, Threatened Flora Officer, DEH Port Lincoln; [10] = DEH 2006; [11] = Nicolle 1997; [12] = KBR (2005) Cultana Army Training Area (CATA) flora and fauna assessment 2004; [12] = Read and Kilpatrick (in preparation 2007); [13] = National Parks and Wildlife Council and Department for Environment and Heritage 2003 Review of the Status of Threatened Species in South Australia. Proposed schedules under the South Australian *National Parks and Wildlife Act 1972*, discussion paper, SA Department for Environment and Heritage, Adelaide; [14] = F Badman, Badman Environmental, pers. comm., 10 October 2006; [15] = Dept of Environment, Water, Heritage and the Arts SPRAT Database 2007; [16] = Botanic Gardens Trust (20/2/08). PlantNET – The Plant Information Network System of Botanic Gardens Trust, Sydney, Australia. http://plantnet.rbgsyd.nsw.gov.au; [17] = Neagle 2002.

Table N6.3 Risk matrix defining the susceptibility of fauna to potential impact

The ecology rating of credible risk for fauna is based mainly on the risk of fauna interacting with the project, which includes the risk of fauna being attracted to the hazardous habitat provided by the tailings storage facility, and the ability of fauna to actively avoid project related impacts. The rating also takes into account the likely abundance of habitat for particular species in the region, which would affect the percentage of the regional population potentially impacted.

Distribution		Ecology		
		a	b	c
		Attracted to hazardous project generated habitat	Sedentary or not particularly mobile, or mobile, but with limited alternative habitat in the area	Highly mobile with extensive alternative habitat and no population critical habitat in the study area
1	Regularly recorded in the study area	Yes	Yes	No
2	Occasional records in or near the study area	Yes	Yes	No
3	Never recorded in or near the study area	No	No	No

Status

Letters under columns AUS and SA represent the category listed in the *Environment Protection and Biodiversity Conservation Act 1999* and the *National Parks and Wildlife Conservation Act 1972* (E = endangered, V = vulnerable, R = rare, Mi = migratory, Ma = marine).
Letters under column C/J/B represent allocation of species to international migratory bird agreements (C = China–Australia Migratory Birds Agreement, J = Japan–Australia Migratory Birds Agreement, B = Bonn Convention).

Sources

PS = have been found in the study area during previous surveys/reports; S = have been found in the study area during the current surveys; 1 = BHP Billiton database records; 2 = Biological Database of South Australia records; 3 = predicted to occur in the study area as per the EPBC Act Protected Matters Search Tool; AR = occurs only in Arid Recovery; SAM = South Australian Museum; BA = New Atlas of Australian Birds (Barrett et al. 2003);
AWSG = Australian Wader Studies Group; CATA = Cultana Army Training Area flora and fauna assessment 2004 (KBR 2005).

Species name	Common name	Status			Source	Distribution	Ecology	Susceptibility to impact (see Table N6.3)		Credible risk to species
		AUS	SA	C/J/B				Dist.	Ecol.	
Mammals										
Bettongia lesueur lesueur	Boodie, Burrowing Bettong (Shark Bay)	V	E		AR	Species reintroduced to Arid Recovery in 1999. Once widespread across much of continent (except areas of dense vegetation and high rainfall), but now extinct on Australian mainland. Records from Gawler Bioregion include an 1880 specimen from Port Augusta and an undated specimen from Lake Phillipson, south of Coober Pedy.	Only macropod to inhabit burrows on regular basis. Diet consists mainly of tubers, bulbs, seeds and the green (succulent) parts of some plants.	2	b	Yes

Species name	Common name	Status			Source	Distribution	Ecology	Susceptibility to impact (see Table N6.3)		Credible risk to species
		AUS	SA	C/J/B				Dist.	Ecol.	
Dasycercus hillieri	Ampurta	E				Southern half of the Simpson Desert, including parts of South Australia, Northern Territory and Queensland, plus the northern Tirari Desert and western edge of the Strzelecki Desert in South Australia. Recorded both east and west of Lake Eyre by Southgate in 2006. Gas pipeline corridors pass within 3.5 km of most southerly records of this species (at the southern end of Lake Eyre), but it was not recorded by Southgate (2006) at Ampurta survey sites in the corridor in this area. Removed from SA NPW Act schedules in the 2008 update (i.e. no longer listed as Rare or threatened in South Australia). Note: Woolley (2005) has argued that, using taxonomic precedence, Ampurta *D. hillieri* should be named *D. cristicauda* and referred to as the Crest-tailed Mulgara, and the Mulgara *D. cristicauda* should be named *D. blythi* and referred to as the Brush-tailed Mulgara. However, Ampurta *D. hillieri* has been used in this report to meet current state and Commonwealth listings.	Inhabits sand dunes with *Zygochloa paradoxa* and areas around salt lakes with *Nitraria billardieri*. Diet comprises mainly invertebrates, supplemented with small reptiles and rodents.	2	b	Yes
Dasycercus cristicauda	Mulgara	V	E		3	Western Australia, southern half of Northern Territory and western Queensland. No recent records of this species in South Australia (see *D. hillieri* for taxonomic discussion).	Inhabits sand plains and dune swales with *Triodia*. Eats small rodents, spiders, reptiles. Breeds during winter.	3	b	No
Leporillus conditor	Wopilkara, Greater Stick-nest Rat	V	V		AR	Species reintroduced to Arid Recovery in 1998. Once common across southern semi-arid Australia. Although there are no records of the species in the Gawler Bioregion, it is believed to have once been part of the extensive range of the species. Nests at Coorlay Lagoon (kp 290) and in the gas pipeline corridors on Murnpeowie Station.	Perennial shrublands of succulent and semi-succulent chenopod species. Also in the vicinity of hills, breakaways, escarpments and rocky outcrops. Builds large (1 m × 1.5 m) nests of sticks with an interior nest of soft grass and other vegetation. Diet strictly herbivorous consisting of the leaves and fruits of succulent plants.	1	b	Yes

Table N6.4 Priority fauna occurring or likely to occur in the study area (cont'd)

Species name	Common name	Status			Source	Distribution	Ecology	Susceptibility to impact (see Table N6.3)		Credible risk to species
		AUS	SA	C/J/B				Dist.	Ecol.	
Macrotis lagotis	Bilby	V	V		AR	Species reintroduced to Arid Recovery in 2000 and has been recorded breeding outside Arid Recovery on the SML and surrounding pastoral properties. Once inhabited arid and semi-arid regions throughout most of the Australian mainland. Now restricted to Great Sandy and Gibson Deserts and an outlying population in south-west Queensland. Recorded on Purple Downs Station in 1930s. Has also been reintroduced to Thistle Island, Yookamurra Sanctuary and Venus Bay Conservation Park.	Inhabits shrublands, hummock grasslands, forblands and open woodlands in semi-arid areas. Forages on insects, seeds, tubers, fruits and green (succulent) plant material.	1	b	Yes
Myrmecobius fasciatus	Numbat	V	E		AR	Species reintroduced to Arid Recovery in 2005. A number of released animals were taken by predators following their release. By January 2007 only two males were known to remain. Historical distribution included western New South Wales, through South Australia and across much of the southern half of Western Australia. Although there are no records of the species from the Gawler Bioregion, the area is believed to have once been part of the extensive range of the species.	Formerly inhabited *Acacia aneura* woodland in central Australia.	1	b	Yes
Notomys fuscus	Dusky Hopping-mouse, Wilkiniti	V	V		2,3,S	Known from scattered records in south-west Queensland and the south-eastern Strzelecki Desert, predominantly south and east of Strzelecki Creek. Recent records from Waraninna Creek and Mulka and Etadunna stations on the western edge of the Strzelecki Desert and Quinyambie pastoral lease, east of Lake Frome. Recorded in the gas pipeline corridors 100–160 km south of Moomba, near Montecollina Bore.	Inhabits dune and sand plain systems. The presence of consolidated dunes and perennial vegetation are thought to be important for the maintenance of stable populations (Moseby et al. 1999). Diet consists of seeds, green plants (when available) and occasionally insects.	2	b	Yes

Species name	Common name	Status			Source	Distribution	Ecology	Susceptibility to impact (see Table N6.3)		Credible risk to species
		AUS	SA	C/J/B				Dist.	Ecol.	
Notoryctes typhlops	Marsupial Mole, Itjari Itjari	E	V			Occurs in central Australia. No records within region. Recent unconfirmed sighting on Etadunna Station on the western edge of Strzelecki Desert, but it is considered likely that the sighting was an Ampurta (R Pedler, SAAL NRM, pers. comm., 7 August 2008). Considered unlikely to occur in Strzelecki Desert and 2005 survey detected no signs of this species (J Benshemesh, pers. comm., 20 December 2006).	Lives underground in sand dunes, swales, sand plains and sandy soils along inland river flats.	3	b	No
Nyctophilus timoriensis	Greater Long-eared Bat	V	V		2,3 SAM	Semi-arid environments across southern Australia and Tasmania. In South Australia, species occurs in two main areas – South Olary Plains and Eyre Peninsula. Species is known from several widely disjunct localities in the Gawler Bioregion: Yellabinna Regional Reserve, Gawler Ranges National Park and Lake Gilles Conservation Park. The south-eastern form, which is the taxon listed as Vulnerable, occurs to the east of (and outside) the study area.	Inhabits various mallee woodlands, *Acacia papyrocarpa* woodland, *Acacia* spp. shrubland and *Casuarina pauper* woodland. Also inhabits tree-lined watercourses with a well-developed shrubby or grassy understorey. Roosts in tree hollows, loose separated bark and large trunk splits. Feeds on large moths and beetles taken in the air, or in bark and foliage on the ground.	2	c	No
Perameles bougainville	Western Barred Bandicoot	E	E		AR	Species reintroduced to Arid Recovery in 2001. Previously extinct in South Australia. Historically occurred across much of arid and semi-arid regions of the southern half of Australia. Although there are no records of the species from the Gawler Bioregion, the area is believed to have once been part of the extensive range of the species.	Formerly inhabited *Atriplex* spp. and *Maireana* spp. plains in South Australia. Forages for insects and other small animals, seeds, roots, tubers and green (succulent) plant material.	1	b	Yes

Species name	Common name	Status			Source	Distribution	Ecology	Susceptibility to impact (see Table N6.3)		Credible risk to species
		AUS	SA	C/J/B				Dist.	Ecol.	
Pseudomys australis	Plains Rat	V	V		1, 2, 3	Widespread in western Lake Eyre Basin from Northern Territory border to Lake Eyre South, gibber tableland west of Lake Torrens (Arcoona Plateau). Populations in conservation reserves include Witjira National Park, Simpson Desert Regional Reserve. Recorded in SML, Arid Recovery and Arcoona Tableland and gas pipeline corridors near Lake Eyre South.	Inhabits low-lying patches of deep cracking clay common on gibber plains and gentle slopes supporting sparse chenopod shrublands and other ephemeral vegetation that appears after rain. Feeds on seeds, leaves (particularly of chenopods) and insects.	1	b	Yes
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat		R		PS CATA	Occurs in Australia and Papua New Guinea. Recorded from Adelaide Hills and plains. Common in the far north of South Australia.	Has a large home range and is likely to be migratory passing through Australia between March and June. Shelters in hollows.	2	c	No
Reptiles										
Aspidites ramsayi	Woma		R		1,2	Arid areas of central Australia. Sparse records in the gas pipeline corridors north of the SML and near Moomba.	Inhabits dunefields and sandy plains with a variety of vegetation. Shelters in animal burrows, or under dense bushes or hummock grasses.	2	b	Yes
Morelia spilota imbricata	Carpet Python		R		2 SAM	Found on the Eyre Peninsula between Port Augusta and Ceduna. One SA Museum record from 1950 near proposed desalination plant.	Inhabits complex mallee scrub areas that receive run-off water from nearby outcrops or rocky hills. Also in extensive rock outcrops, ravines, escarpments, rivers, creeks and floodplains lined with Red Gum. Carpet Pythons shelter in hollows or deep rock and soil crevices, in large rock piles, in leaf litter or in rabbit warrens.	2	b	Yes
Nephrurus deleani	Pernatty Knob-tail Gecko	V	R		1,2,3 PS	Restricted to pastoral leases in the vicinity of Pernatty Lagoon and Lake MacFarlane, intersected by southern infrastructure corridor. The species has not been recorded from any conservation reserve.	Inhabits crests and slopes of red dunes and nearby sandy swales and rises. Also on whitish lunette dunes associated with salt lakes and nearby flats. Dominant plants may include *Acacia* spp., *Alectroyn oleifolius, Duboisia hopwoodi, Dodonea viscosa* and *Zygochloa paradoxa*. Feeds on medium-sized insects, spiders and scorpions.	1	b	Yes

Species name	Common name	Status			Source	Distribution	Ecology	Susceptibility to impact (see Table N6.3)		Credible risk to species
		AUS	SA	C/J/B				Dist.	Ecol.	
Vermicella annulata	Common Bandy-Bandy		R		SAM 2	Distributed mainly in northern Western Australia and throughout most other mainland states except south-eastern Australia. One SA Museum record from 1950 near Port Augusta.	Nocturnal burrowing snake found in wide range of habitats including mallee and mulga woodland, acacia scrubs and spinifex-covered sandhills.	2	b	Yes
Terrestrial Birds										
Acanthiza iredalei iredalei	Slender-billed Thornbill (Western subspecies)	V	R		2,3 BA	Sparsely distributed across southern Western Australia and western South Australia from the coast south of Carnarvon to the eastern side of the Spencer Gulf. Present in southern half of Gawler Bioregion, from the Kingoonya area, through the Gawler Ranges to Port Augusta. Populations in conservation reserves include Nullarbor National Park, Yellabinna Regional Reserve and Gawler Ranges National Park.	Inhabits chenopod and samphire shrublands and saline flats around salt lakes. Forages on insects, spiders and other small prey.	2	c	No
Amytornis textilis modestus	Thick-billed Grasswren (Eastern subspecies)	V			2,3 PS	Northern Territory and catchments of Lake Frome and western Lake Eyre Basin in South Australia. Much of the range of this species is in the Stony Plains Bioregion and the Gawler Bioregion is on the periphery of species range. Recently recorded just north of Arid Recovery and near Andamooka (J Read, Ecological Horizons, pers. comm., 12 February 2008). Scattered records north and east of SML. Recorded in gas pipeline corridors on Murnpeowie Station near Montecollina Bore. There are no records in any conservation reserves. However it is possible that populations occur in the Witjira National Park in the Stony Plains Bioregion.	Inhabits chenopod shrublands dominated by *Atriplex* spp. and *Maireana* spp. Sedentary species.	1	b	Yes

Table N6.4 Priority fauna occurring or likely to occur in the study area (cont'd)

Species name	Common name	Status			Source	Distribution	Ecology	Susceptibility to impact (see Table N6.3)		Credible risk to species
		AUS	SA	C/J/B				Dist.	Ecol.	
Amytornis textilis myall	Thick-billed Grasswren (Gawler Ranges subspecies)	V			2,3 BA SAM	Recorded in desalination plant area. Subspecies is restricted to the Gawler Ranges in South Australia between Lake Gairdner and the west coast of Spencer Gulf. There are no records in any conservation reserves. However suitable habitat exists in Lake Gilles Conservation Park and Lake Gilles Conservation Reserve (Kenny and Graham 2001, cited in Neagle 2003).	Inhabits chenopod shrublands dominated by *Atriplex* spp. and *Maireana* spp. often with scattered tall shrubs and low trees, samphire flats in coastal areas with Nitraria billardieri. Also associated with *Acacia payrocarpa,* particularly along drainage lines. Forages on ground for fruits, seeds, insects and spiders.	2	c	No
Ardeotis australis	Australian Bustard		V		1,2 BA SAM PS CATA	Formerly throughout inland Australia, extending to coastal areas north of the Tropic of Capricorn. Now rare or absent from most of southern Australia. Recorded in the SML, Municipality of RD, Arid Recovery. Also in study area near Port Augusta in 2000. Recorded in CATA in 2004 – first record in 10 years.	Open grassy woodland, grassland including pastoral land and crops.	1	c	No
Burhinus grallarius	Bush Stone-curlew		R		AWSG 2	Woodland and dry inland plains throughout Australia and Tasmania except coastal and near-coastal south-eastern Australia. One record reported from Whyalla in 1982 by the Australian Wader Studies Group. Recorded in CATA in 2004.	Open forests, samphire flats near timber, plains intersected with belts of trees. Singly or in pairs, but also in small groups outside the breeding season. Not particularly mobile but not many records in area.	2	c	No
Cacatua leadbeateri	Major Mitchell's Cockatoo		R		1,2 BA SAM PS, S	From north-western Australia through Central Australia to south-western Queensland, western New South Wales, western Victoria and inland parts of South Australia. Four records for species in study area: sites near Roxby Downs (within the Municipality of RD), Pernatty Lagoon and Port Augusta and Clayton River in gas pipeline corridors.	Often near water on timbered watercourses, surrounding grasslands, gibber and saltbush. Mulga and other acacias, stands of native cypress, casuarina, larger mallee, eucalypts with suitable nest hollows and mallee associated with riverine woodlands.	1	c	No

Species name	Common name	Status			Source	Distribution	Ecology	Susceptibility to impact (see Table N6.3)		Credible risk to species
		AUS	SA	C/J/B				Dist.	Ecol.	
Calamanthus cautus	Shy Heathwren		R		2	Southern Australia, from western New South Wales to south-western Western Australia. Recorded in the southern infrastructure corridor.	Inhabits understorey in mallee woodland.	2	c	No
Cinclosoma castanotus	Chestnut Quail-thrush		R		1,2 BA SAM	Western Queensland and north-western New South Wales to central Western Australia. One SA Museum record for species in study area in 1979 near Bookaloo. The eastern subspecies, which is the taxon listed as Rare, occurs predominantly to the east of the study area.	Dry stony mulga woodlands. Prefers stony ridges.	2	c	No
Climacteris affinis	White-browed Treecreeper		R		2 BA SAM	Inland Southern Australia. Last recorded sighting in 1965 near Port Augusta. Several records in early 1900s near Pernatty Lagoon. Recorded in CATA in 2004. One Birds Australia record in 2000 in gas pipeline corridors south of Lake Eyre.	Dry woodland, especially mulga and sheoak.	2	c	No
Coturnix ypsilophora	Brown Quail		V		2 BA	Mainly coastal lowlands of northern, eastern and south-western Australia. One Birds Australia record near Woomera in 2000.	Grassland, heavy pastures and marshy grounds, usually in flocks.	2	c	No
Emblema pictum	Painted finch		R		2	Arid Australia from western Queensland to north-western coast, south to northern Flinders Ranges in South Australia. Very sparse scattered records across north-eastern South Australia. One record in the gas pipeline corridors at Montecollina Bore.	Usually inhabits rocky hills, outcrops and gorges with hummock grasses. Resident near water, nomadic elsewhere.	2	c	No
Epthianura crocea	Yellow chat		E		S	Coastal Northern Territory and Queensland, inland to the far north-east of South Australia. Uncorroborated record in gas pipeline corridors south of Lake Eyre in 2006.	Inhabits the margins of ephemeral wetlands, swamps, bore drains and saltbush flats but may forage in other adjacent low vegetation.	2	c	No

Table N6.4 Priority fauna occurring or likely to occur in the study area (cont'd)

Species name	Common name	Status			Source	Distribution	Ecology	Susceptibility to impact (see Table N6.3)		Credible risk to species
		AUS	SA	C/J/B				Dist.	Ecol.	
Falco hypoleucos	Grey Falcon		R		1,2 BA	Inland Australia generally, but extending to coastal areas in parts of Western Australia. Records in study area near Woomera in 2000 and in wellfields region and gas pipeline corridors.	Open plains, semi-desert and lightly timbered country or mountain ranges, singly or in pairs. Generally confined to arid regions.	2	c	No
Falco peregrinus	Peregrine Falcon		R		1,2 BA CATA	Most of Australia, except central Australia, western South Australia, and Tasmania. Recorded in Special Mining Lease, Municipality of Roxby Downs, Arid Recovery and gas pipeline corridors. One BDSA record near Roxby Downs and Birds Australia record in gas pipeline corridors near Lake Gregory. Recorded in CATA in 2004.1	Inland and coastal areas, with a preference for heavily timbered and rugged mountainous country.	1	c	No
Hamirostra melanosternon	Black-breasted Buzzard		R		1,2 BA PS S	Widespread in semi-arid and arid regions of Australia. Absent from eastern and southern coastal regions. Previously sighted in the Special Mining Lease. Recorded within the gas pipeline corridors.	Inhabits open woodlands, floodplains, avoids forests and other dense vegetation. Feeds on lizards, mammals, nesting birds and eggs.	2	c	No
Leipoa ocellata	Malleefowl	V,Mi	V	J	3 BA	Scattered locations through semi-arid rangelands and dryland cropping zones across southern Australia. Populations in conservation reserves include Gawler Ranges National Park, Lake Gilles Conservation Park, and Munyaroo Conservation Park. Never recorded from CATA – closest populations 100 km south.	Inhabits semi-arid to arid shrublands and low woodlands dominated by mallee eucalypts and/or acacias. Soil in nesting areas needs to be sandy with a good accumulation of leaf litter for mound building. Forages on flowers, green shoots, fruits, wattle seeds, insects, lizards and frogs.	3	c	No
Myiagra inquieta	Restless Flycatcher		R		2	Eastern, south-eastern, south-western and northern Australia. Recorded in the southern infrastructure corridor and gas pipeline corridors.	Open forests and woodlands. Migrant or nomadic in much of its range.	2	c	No

Species name	Common name	Status			Source	Distribution	Ecology	Susceptibility to impact (see Table N6.3)		Credible risk to species
		AUS	SA	C/J/B				Dist.	Ecol.	
Neophema chrysostoma	Blue-winged Parrot	Ma	V		1,2 BA SAM PS CATA	Victoria, southern and eastern South Australia, western New South Wales and south-western Queensland. Has been recorded in the Roxby Downs region since 1991. Recorded in CATA in 2004 and gas pipeline corridors.	Inhabits chenopod shrublands, grasslands, grassy woodlands and sand dunes with Sandhill Cane Grass and coastal dunes. Forages mostly on the ground for grass seeds and herbaceous seeds (including chenopods), flowers and fruits.	1	c	No
Neophema elegans	Elegant Parrot		R		2	Southern South Australia, western Victoria and New South Wales, south-western Western Australia. Recorded in the southern infrastructure corridor.	Open woodland, lightly timbered grasslands and partly cleared farmland. Nomadic.	2	c	No
Neophema petrophila	Rock Parrot	Ma	R		2 BA CATA	Coast and islands of south-western and southern Australia, from Shark Bay to south-eastern South Australia. One record of species near Port Augusta in 1998. Recorded in CATA in 2004.	Coastal, including shorelines, dunes, heaths, offshore islands, swamps, seldom venturing more than a few hundred metres from the sea, in pairs or small flocks.	2	c	No
Neophema splendida	Scarlet-chested Parrot		R		1,2 BA	Western NSW, through northern South Australia to the coastal areas of the Great Australian Bight and the inland of Western Australia. Recorded in Arid Recovery in 2001. Recorded near Woomera (Barrett et al. 2003).	Open woodlands of eucalypt, sheoak, mulga with spinifex, saltbush, often far from water.	2	c	No
Ninox connivens	Barking Owl		R		2 SAM	Most of northern, eastern and south-eastern Australia to Eyre Peninsula, also south-western Western Australia. One SA Museum record from 1930 near Port Augusta.	Forests and woodland.	2	c	No
Oriolus sagittatus	Olive-backed Oriole		R		2 BA	Northern and eastern Australia, from Broome to Adelaide. One BA record within gas pipeline corridors area near Blanchewater ruins.	Inhabits woodlands and forests.	2	c	No

Table N6.4 Priority fauna occurring or likely to occur in the study area (cont'd)

Species name	Common name	Status			Source	Distribution	Ecology	Susceptibility to impact (see Table N6.3)		Credible risk to species
		AUS	SA	C/J/B				Dist.	Ecol.	
Pachycephala rufogularis	Red-lored Whistler	V	R		3	Patchily distributed over a restricted area in eastern South Australia and north-western Victoria, with outlying populations in south-western NSW.	Mallee communities that contain low, dense cover and mixed plant communities. Feeds mainly on the ground, eating airborne and ground-dwelling invertebrates. Nests located in the top of spinifex under overhanging mallee foliage or in a low fork of a mallee.	3	c	No
Pedionomus torquatus	Plains-wanderer	V	E		1 PS BA	Recorded in Roxby Downs in 1990 (BHP Billiton data). Sparse and patchy distribution throughout inland south-eastern Australia from southern Queensland to Eyre Peninsula. Records scarce in Gawler Bioregion. No records from within any conservation reserve in South Australia.	Inhabits natural sparse grasslands and mixed grasslands/herblands. Forages on seeds and arthropods.	2	c	No
Phaps histrionica	Flock Bronzewing		R		1 SAM PS	Flocks or scattered individuals may occur almost anywhere across the arid north and west of the continent. Previously sighted in Special Mining Lease. Recorded on numerous occasions. No BDSA records.	Mainly open grassy treeless plains.	1	c	No
Stagonopleura guttata	Diamond Firetail		V		BA	South-central Queensland to South Australia and Kangaroo Island, west to Eyre Peninsula. Not recorded in study area. However, the nearest record is 15 km north-east of Port Augusta.	Grasslands with open spaces with tall trees, in pairs or small flocks.	3	c	No
Tyto capensis	Grass Owl		R		2	Mainly northern and north-eastern Australia. Record in SML.	Grasslands, lignum, canegrass and heaths, often in swampy areas.	2	c	No
Migratory / Water / Marine Birds										
Actitis hypoleucos	Common Sandpiper	Mi,Ma	R	C,J,B	1,2	Recorded in SML, southern infrastructure corridor and desalination plant area.	Inhabits coastal and inland wetlands. It breeds in Eurasia and migrates to Australia. Records of being a visitor to TRS and recorded mortality.	1	a	Yes

Species name	Common name	Status			Source	Distribution	Ecology	Susceptibility to impact (see Table N6.3)		Credible risk to species
		AUS	SA	C/J/B				Dist.	Ecol.	
Anas rhynchotis	Australasian Shoveler		R		1,2	Large range in Australia, New Zealand and New Caledonia. Recorded in SML and gas pipeline corridors.	Occurs in all kinds of wetlands, but prefers heavily vegetated freshwater swamps. No TRS records.	2	c	No
Anhinga melanogaster	Darter		R		2	Found across most of mainland Australia. Recorded in the southern infrastructure corridor and gas pipeline corridors.	Lakes, rivers, swamps and estuaries. No TRS records.	2	c	No
Apus pacificus	Fork-tailed Swift	Mi,Ma		C,J	1,2,3	Recorded in SML and gas pipeline corridors.		2	c	No
Ardea alba	Great Egret	Mi,Ma		C,J	2,3	Irrregular visitor to region. Prefers shores of lakes, ponds, and rivers; freshwater and saltwater marshes, mudflats, shallow lagoons, estuaries. Requires trees or shrubs near the water for nesting. Recorded in SML, southern infrastructure corridor and gas pipeline corridors.	Found in most of the tropical and warmer temperate parts of the world, although it is very local in southern Europe and Asia. Records of being a visitor of TRS and recorded mortality.	3	a	Yes
Ardea ibis	Cattle Egret	Mi,Ma	R	C,J	3, S	Found on most continents and across most of Australia. Common and widespread throughout northern and eastern Australia. Recorded in SML and gas pipeline corridors.	Found in grasslands, woodlands and wetlands and also uses pastures and croplands. Commonly forages in wetland areas. Mobile species, no records or likelihood of being found within TRS.	2	c	No
Ardea intermedia	Intermediate Egret	Ma	R		1,2	Recorded in SML and gas pipeline corridors. Africa through Asia to Japan and Australia.	Prefers to hunt in fresh water (marshes, cultivated fields), but is also found in mangroves, mudflats and estuaries. Mobile species, no records or likelihood of being found within TRS.	2	c	No
Arenaria interpres	Ruddy Turnstone	Mi,Ma	R	C,J,B	1	Recorded in SML and desalination plant area.	Mobile species, no records or likelihood of being found within TRS.	1	c	No
Biziura lobata	Musk Duck	Ma	R		1,2, S	Found only in Australia. It ranges from north-western WA, through the south and east to southern Queensland, and can be found several hundred kilometres inland in some areas. Recorded in SML, southern infrastructure corridor, desalination plant area and gas pipeline corridors.	Deep freshwater lagoons, with dense reed beds. Records of being a visitor to TRS and recorded mortality.	1	a	Yes

Table N6.4 Priority fauna occurring or likely to occur in the study area (cont'd)

Species name	Common name	Status			Source	Distribution	Ecology	Susceptibility to impact (see Table N6.3)		Credible risk to species
		AUS	SA	C/J/B				Dist.	Ecol.	
Calidris acuminata	Sharp-tailed Sandpiper	Mi,Ma		C,J,B	1,2,3	Breeds in the boggy tundra of North-East Asia and is strongly migratory, wintering in South-East Asia and Australasia. Recorded in SML, infrastructure corridors and desalination plant area.	It occurs as a rare autumn migrant to North America, but in western Europe only as a very rare vagrant. Records of being a visitor to TRS and recorded mortality.	2	a	Yes
Calidris alba	Sanderling	Mi,Ma	R	C,J,B	3	Migrates from Siberia to sandy beaches and coastal sand lagoons around Australia.	No records of species within study area.	3	c	No
Calidris canutus	Red Knot	Mi,Ma		C,J,B	1,3	Recorded at SML.	No TRS records.	2	c	No
Calidris ferruginea	Curlew Sandpiper	Mi,Ma		C,J,B	2,3	Recorded in southern infrastructure corridor and desalination plant area.	No TRS records.	1	c	No
Calidris ruficollis	Red-necked Stint	Mi,Ma		C,J,B	1,2,3	Recorded in SML, southern infrastructure corridor and desalination plant area. Forages in wet grassland and soft mud. Widespread in small flocks; likely to be found wintering with flocks of the endemic Wrybill in areas where they are present.	Breeds in Arctic. Winters in South-East Asia and Australasia as far south as Tasmania. It is a very rare vagrant to western Europe. It is often seen in western Alaska and occasionally elsewhere in the Americas. Records of being a visitor to TRS and recorded mortality.	1	a	Yes
Calidris tenuirostris	Great Knot	Mi,Ma	R	C,J,B	2	Recorded in desalination plant area.	Mobile species. Mainly inhabits coastal area. No TRS records.	2	c	No
Charadrius leschenaultii	Greater Sand-plover	Mi,Ma	R	C,J,B	2	Summer migrant to Australia, mainly to the north-west and less common in the east and south. Recorded in desalination plant area	Sandy beaches and coastal mudflats. No TRS records.	2	c	No
Charadrius veredus	Oriental Plover	Mi,Ma		J,B	1,3	Recorded at Olympic Dam in 2006.	Mobile species, mainly inhabits coastal area. No TRS records.	2	c	No
Cladorhynchus leucocephalus	Banded Stilt		V		1,2	Recorded in SML, southern infrastructure corridor and desalination plant area.	Breeds on islands in inland salt lakes on rare occasions when they are inundated. Breeding events threatened by predation from Silver Gulls. Records of being a visitor to TRS and recorded mortality.	2	a	Yes

Species name	Common name	Status			Source	Distribution	Ecology	Susceptibility to impact (see Table N6.3)		Credible risk to species
		AUS	SA	C/J/B				Dist.	Ecol.	
Cuculus saturatus	Oriental Cuckoo	Mi,Ma		C,J	1	Migrant to northern Australia. Recorded in the SML.	Forests and woodlands.	2	c	No
Diomedea exulans gibsoni	Gibson's Albatross	V,Mi, Ma	V	B	3	Endemic to the Auckland Islands. The non-breeding range probably disperses across the southern Pacific. No records in study area.	Breeds biennially in colonies on isolated sub-Antarctic islands, using the wind to travel great distances both during and between breeding seasons. This species feeds pelagically on squid, fish and crustaceans.	3	c	No
Egretta garzetta	Little Egret		R		1,2	Coastal and inland areas, mainly northern, eastern and south-eastern Australia. Also occurs in Africa, Europe, Asia and New Guinea. Recorded in the SML, southern infrastructure corridor, gas pipeline corridor and desalination plant area.	Tidal mudflats, saltwater and freshwater wetlands and mangroves. Records of being a visitor to TRS.	2	c	No
Egretta sacra	Eastern Reef Egret	Mi, Ma	R	C	2	Coastal areas of mainland Australia and Asia. Record in the desalination plant area.	Intertidal zone, including rocks, coral reefs, mangroves and mudflats.	2	c	No
Elanus scriptus	Letter-winged Kite		R		2	Arid regions of inland Australia, occasional irruptions across mainland after rodent plagues. Recorded in the gas pipeline corridors.	Desert grasslands and timbered watercourses.	2	c	No
Gallinago hardwickii	Latham's Snipe	Mi	V	C,J,B	1,2,3	Recorded in SML. Large global range.	No TRS records, mobile species.	2	c	No
Grus rubicunda	Brolga		V		1,2 S	Large range. Recorded in SML and Arcoona Tableland and gas pipeline corridors.	No TRS records, mobile species.	2	c	No
Haemotopus fuliginosus	Sooty Oystercatcher		R		2	Coastal Australia. Recorded in the southern infrastructure corridor.	Coastal areas; prefers rocky shores.	2	c	No
Haemotopus longirostris	Pied Oystercatcher		R		2	Coastal Australia. Recorded in the southern infrastructure corridor and desalination plant area.	Coastal areas; prefers sandy beaches, mudflats and estuaries.	2	c	No

Species name	Common name	Status			Source	Distribution	Ecology	Susceptibility to impact (see Table N6.3)		Credible risk to species
		AUS	SA	C/J/B				Dist.	Ecol.	
Haliaeetus leucogaster	White-bellied Sea-eagle	Mi,Ma	E	C	2,3 BA SAM	Coast and near coastal areas across Australia. Recorded in southern infrastructure corridor and desalination plant area.	Mainly coastal but is also found in large rivers and lakes. Feeds mainly on aquatic animals such as fish, turtles and sea snakes, but takes birds and mammals as well. No TRS records.	2	c	No
Hirundapus caudacutus	White-throated Needletail	Mi,Ma		C,J	3	Occurs in large numbers over eastern Australia. No records in study area.	An aerial species that feeds on the wing that is rarely seen on the ground. It breeds in northern Asia and migrates to Australia each October.	3	c	No
Hirundo rustica	Barn Swallow	Mi,Ma		C,J	1,2	Uncommon visitor to the far north and north-east of Australia, rare vagrant to eastern New South Wales, eastern South Australia and northern Victoria. Recorded in the SML.	Open country, agricultural land, urban areas.	2	c	No
Larus dominicanus	Kelp Gull	Ma	R		2	Coastal southern Australia and much of the southern hemisphere. Recorded in the southern infrastructure corridor.	Sheltered parts of coasts such as bays, nlets and estuaries; also beaches and reefs on off-shore islands.	2	c	No
Limosa lapponica	Bar-tailed Godwit	Mi,Ma	R	C,J,B	2	Recorded in desalination plant area.	No TRS records.	2	c	No
Limosa limosa	Black-tailed Godwit	Mi,Ma	R	C,J,B	1,2	Recorded in SML and southern infrastructure corridor.	No TRS records.	2	c	No
Lophoictinia isura	Square-tailed Kite		E		2	Eastern, northern and south western Australia. Recorded in the gas pipeline corridor.	Open forests, woodlands, mallee and adjacent heath and low scrubby habitats.	2	c	No
Macronectes giganteus	Southern Giant-petrel	E,Mi, Ma	V	B	2,3	Circumpolar pelagic range from Antarctica to approximately 20 degrees south. SA sightings are mostly from Gulf St Vincent, Encounter Bay, Kangaroo Island, the South-East, west coast of Eyre Peninsula and the Great Australian Bight (Parker et al. 1979; Blakers et al. 1984). One published record from northern Spencer Gulf, at Port Augusta on 30 January, 2000 (SAOA 2000). This suggests that the species is a vagrant or irregular visitor to northern Spencer Gulf.	An opportunistic scavenger and predator, feeding mainly on moribund cuttlefish and offal (Parker et al. 1979; Copley 1996). Scavenges from fishing vessels and animal carcasses on land. Susceptible to long-line fishing bycatch and predation on nesting sites by feral animals.	2	c	No

Table N6.4 Priority fauna occurring or likely to occur in the study area (cont'd)

Species name	Common name	Status			Source	Distribution	Ecology	Susceptibility to impact (see Table N6.3)		Credible risk to species
		AUS	SA	C/J/B				Dist.	Ecol.	
Macronectes halli	Northern Giant-petrel	V,Mi, Ma		B	3	Circumpolar resident of the southern oceans, usually between 40–64°S in open oceans. Their range extends into subtropical waters (to 28°S) in winter and early spring. No records in study area.	Breeding in Australian territory is limited to Macquarie Island and occurs during spring and summer. Females obtain most of their prey live from the sea, while males also scavenge from the carcases of penguins and seals on land.	3	c	No
Merops ornatus	Rainbow Bee-eater	Mi,Ma		J	2,3,S	Widely distributed across Australia except in desert areas. Recorded in gas pipeline corridors.	Commonly found in woodland and timbered plains throughout Australia. Breeds throughout most of its range. Southern populations move to northern Australia, New Guinea and Indonesia over winter. No TRS records.	2	c	No
Numenius madagascariensis	Eastern Curlew	Mi,Ma	V	C,J,B	2,3	Large global range. Several records from region and SML.	Breeds in Russia. Occupies coastal habitat especially with seagrass. Visitor to TRS.	2	c	No
Oxyura australis	Blue-billed Duck		R		1,2	Recorded in SML and gas pipeline corridors. Occupies deep permanent water bodies in southern Australia.	Aggregates in large flocks in autumn and winter, dispersing to smaller water bodies when feeding. Records of being a visitor to TRS and recorded mortality.	2	a	Yes
Pandion haliaetus	Osprey	Mi,Ma	E	B	2	Worldwide distribution. Irregular visitor to Spencer Gulf, occurring in reasonable numbers.	Usually mate for life. Breeds by freshwater lakes, and sometimes on coastal brackish waters. Feeds on fish. Irregular visitor. No TRS records.	2	c	No
Philomachus pugnax	Ruff	Mi,Ma	R	C,J,B	2	Recorded in desalination plant area.	No TRS records.	2	c	No
Plegadis falcinellus	Glossy Ibis	Mi,Ma	R	C,B	1,2	Recorded in SML and gas pipeline corridors. Large global range.	Inhabits forests, wetlands, floodplains, mangroves and rice fields. No TRS records.	2	c	No

Table N6.4 Priority fauna occurring or likely to occur in the study area (cont'd)

Species name	Common name	Status			Source	Distribution	Ecology	Susceptibility to impact (see Table N6.3)		Credible risk to species
		AUS	SA	C/J/B				Dist.	Ecol.	
Pluvialis squatarola	Grey Plover	Mi,Ma		C,J,B	1,2,3	Recorded in SML, southern infrastructure corridor and desalination plant area.	Records of being a visitor to TRS and recorded mortality.	1	a	Yes
Podiceps cristatus	Great Crested Grebe		R		2	Recorded in SML. Large global range.	No TRS records.	2	c	No
Porzana tabuensis	Spotless Crake	Ma	R		1,2	South-eastern, south-western and northern Australia with patchy distribution inland. Recorded in the SML and gas pipeline corridors.	Reedy and grassy freshwater swamps. No TRS records.	2	c	No
Puffinus carneipes	Flesh-footed Shearwater	Mi,Ma	R	J	2	Breeding and non-breeding visitor to the coastal and pelagic waters of southern Australia. Occurring in small numbers predominantly in summer.	Recorded mainly in subtropical waters, over continental shelves and slopes. Nests are made in burrows on gentle to steep slopes. Feeds by pursuit-plunging after fish and squid. Mainly coastal species. No TRS records.	2	c	No
Rostratula benghalensis	Painted Snipe	V,Mi, Ma	V	C	3	Eastern and southern Australia, with sporadic reports from northern Western Australia, inland Northern Territory and inland and sub-coastal Queensland. No records in region.	Recorded from infrequently filled freshwater wetlands, predominantly August to March. No sites where the species is in residence or regular occurrences have been detected.	3	b	No
Sterna albifrons	Little Tern	Mi,Ma	E	C,J,B	2	Migrating from eastern Asia, found on the north, east and south-east Australian coasts. Occurring in Spencer Gulf in small numbers in summer.	Coastal, preferring sheltered environments, although it may occur several kilometres from the sea in harbours, inlets and rivers. Nests in small, scattered colonies in low dunes or on sandy beaches just above high tide mark near estuary mouths or adjacent to coastal lakes and islands. Mainly coastal species. No TRS records.	2	c	No

Table N6.4 Priority fauna occurring or likely to occur in the study area (cont'd)

Species name	Common name	Status			Source	Distribution	Ecology	Susceptibility to impact (see Table N6.3)		Credible risk to species
		AUS	SA	C/J/B				Dist.	Ecol.	
Sterna caspia	Caspian Tern	Mi,Ma		C,J	1,2,3	Recorded in SML, southern infrastructure corridor and desalination plant area. Usually nests on ground among debris or sometimes on floating material.	Large lakes and ocean coasts in North America including the Great Lakes and locally across much of Europe, Asia, Africa, Australia and New Zealand. Records of being a visitor to TRS and recorded mortality.	1	a	Yes
Sterna nereis	Fairy Tern	Ma	E		2	Large range in Australia, New Zealand and New Caledonia. Recorded in southern infrastructure corridor.	Hunts over shallow estuaries, and just beyond the surf zone. Constructs nests on exposed, low-lying areas of shell-covered sand. Feeds on small fish, gastropods, crustaceans and plant matter. Mainly coastal species. No TRS records.	2	c	No
Stictonetta naevosa	Freckled Duck		V		1,2	Recorded in SML, southern infrastructure corridor and gas pipeline corridors. Wetlands across southern Australia.	Records of being a visitor to TRS.	2	a	Yes
Thalassarche bulleri	Buller's Albatross	V,Mi, Ma	V	B	3	Endemic to New Zealand. Adults forage between 40 and 50°S from Tasmania eastwards to the Chatham Rise. No records of species in study area.	Breeds annually in a variety of habitats including grassy meadows, tussock-covered slopes and cliffs, scrub and under forest canopy. It feeds mostly on fish, squid and tunicates, also octopus and crustaceans.	3	c	No
Thalassarche cauta	Shy Albatross	V,Mi, Ma		B	3	Breeds off Australia and New Zealand's sub-Antarctic islands and ranges extensively across the Southern Ocean. No records of species in study area.	Feeds by a combination of surface-seizing and some pursuit diving.	3	c	No
Thalassarche impavida	Campbell Albatross	V,Mi, Ma		B	3	Confined to southern Australian waters, the Tasman Sea and the south Pacific Ocean. Breeding adults forage from the South Island and Chatham Rise southwards to the Ross Sea. No records of species in study area.	Breeds only on the northern and western coastline of Campbell Island and Jeanette Marie islet. Nests on ledges and steep slopes covered in low native grasses, tussocks and mud. Feeds mainly on fish, also on squid, crustaceans, gelatinous organisms and carrion.	3	c	No

Species name	Common name	Status			Source	Distribution	Ecology	Susceptibility to impact (see Table N6.3)		Credible risk to species
		AUS	SA	C/J/B				Dist.	Ecol.	
Tringa glareola	Wood Sandpiper	Mi,Ma	R	C,J,B	1,2	Recorded in SML and gas pipeline corridors.	No TRS records.	2	c	No
Tringa nebularia	Common Greenshank	Mi,Ma		C,J,B	1,2,3	Recorded in SML, southern infrastructure corridor and desalination plant area. Breeds on wet moorland and upland bogs. Winters on estuaries and coastal creeks. On passage, can turn up on any wetland habitat including inland marshes.	Throughout the Old World including Australia and New Zealand. No TRS records.	1	c	No
Tringa stagnatilis	Marsh Sandpiper	Mi,Ma		C,J,B	1,2	Recorded in SML, southern infrastructure corridor and desalination plant area.	No TRS records.	1	c	No

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APPENDIX N7

Fauna surveys

N7 FAUNA SURVEYS

N7.1 FAUNA SURVEY OF THE SOUTHERN INFRASTRUCTURE CORRIDOR FOLLOWING A RAIN EVENT

N7.1.1 Introduction

ARUP ENSR, on behalf of BHP Billiton, engaged Ecological Associates to carry out a fauna survey within the proposed infrastructure corridor between Whyalla, Port Augusta and Olympic Dam.

The survey was undertaken following periods of significant rainfall to supplement the existing data and to demonstrate compliance with the joint governments' guidelines for the Olympic Dam EIS by undertaking fauna surveys at the time appropriate to maximise the detection of significant species. Discussions held with Rob Brandle (Department for Environment and Heritage) and Darryl Harvey (Department of Water, Land and Biodiversity Conservation) on 21 August 2007 established a compliant scope of works for the assessment required a survey of:

- land systems and vegetation communities that presently lack biological information
- two sites in a more intensive manner in areas that would complement the existing DEH datasets by filling existing data gaps
- five sites in both areas in a variety of habitat types in order to maximise the diversity of fauna detected.

N7.1.2 Background

Relevant components of the proposed expansion

The proposed expansion would require the provision of additional supplies and facilities through the development of a range of linear infrastructure. A 10 km wide corridor between Whyalla and Port Augusta in the south, and Olympic Dam in the north has been assessed.

The components of the infrastructure corridor relevant to this fauna study are (see Figure N7.1):

- a water supply pipeline from a seawater desalination plant at Point Lowly in Upper Spencer Gulf to Olympic Dam
- a transmission line from the existing state electricity grid at Port Augusta to Olympic Dam.

Description of survey sites

Two locations were chosen for fauna surveys within the proposed infrastructure corridor: the first on Kootaberra Station near Uro Bluff approximately 40 km north-north-west of Port Augusta, and the second on Tregalana Station between 25 and 30 km north of Whyalla (see Figure N7.1).

The Kootaberra location is situated in the eastern side of the Western Pastoral environmental province of South Australia, in the Central Salt Lakes and Plateaux environmental region (Laut et al. 1977). Survey sites were located on two environmental associations (EA): the Hesso EA to the west and the Uro EA to the east. The Uro EA consists of rocky quartzite hills with colluvial footslopes. The vegetation cover is low mixed chenopod shrubland, tall shrubland and low open woodland with a chenopod shrub understorey. The Hesso EA is characterised as an undulating sandy plain with isolated silcrete-capped rises and salt lakes. There is a complex cover of low open woodland, tall shrubland, tall open shrubland and open woodland, all with an understorey of chenopod shrubs, and low chenopod shrubland. All are used for extensive livestock grazing.

The Tregalana location is in the south-east corner of the Western Pastoral environmental province of South Australia, in the Gawler Uplands environmental region (Laut et al. 1977). Survey sites were located in two EAs: the Simmens EA and the Tregolana (sic) EA. The long footslope along the western edge of the plateau in the Simmens EA is partly mantled by Aeolian sand. The Tregolana EA is characterised as an undulating plain, with occasional low sand dunes and pans and some samphire flats. Livestock extensively grazes the cover of low chenopod shrubland and low open woodlands with a chenopod understorey across the area.

Figure N7.1 Location of fauna survey sites

Existing data

Flora and fauna studies have previously been undertaken within the proposed infrastructure corridor (see Appendix N1). Detailed vegetation mapping of the infrastructure corridors has been undertaken as part of the studies for the EIS and was used as the basis for quadrant positioning in this study. Fauna surveys of the Port Augusta to Olympic Dam transmission line corridor, using pitfall trapping, were conducted during October–November 1991, and opportunistic surveys of mammals, reptiles and birds have been undertaken (WMC 1997). General bird surveys in June and November 1991, and bird surveys of ephemeral lakes (when they were flooded) were undertaken in June 1991, July 1991, September 1991, May 1992, October 1992 and March 1993 (WMC 1997).

During these surveys the Pernatty Knob-tailed Gecko *Nephrurus deleani* and Plains Rat *Pseudomys australis* were identified as species of conservation significance occupying habitat found along the corridor. Both of these species are classified as vulnerable under both national and state legislation.

N7.1.3 Fauna survey

Introduction

This survey applied a modified version of the methods of the Biological Survey of South Australia (Owens 2000). Both localities in which fauna were surveyed were situated north of the Agricultural Region and as such would normally require two sets of trap-lines set within each vegetation type to be surveyed. Under the protocol adopted in this study only one trap-line was established at each site. This variation in protocol allowed trap-lines to be established within five vegetation types at each site, maximising the number of vegetation types surveyed.

The first set of five sites was located on Kootaberra Station near Uro Bluff approximately 40 km north-north-west of Port Augusta (see Figure N7.1). The second set of five sites was located on Tregalana Station between 25 and 30 km N of Whyalla (see Figure N7.1).

The survey was carried out under:

- the Wildlife Ethics Committee Approval of a Project Involving Animals – Application Number 28/2007
- a Permit to Undertake Scientific Research – Permit Number Y25516 1
- a Licence to Use Animals for Teaching, Research or Experimental Purposes – Licence No 202.

Methods

Trap-lines

Trap-lines consisted of a pitfall trap-line (six pitfalls, 10 m apart, with 300 mm high drift fencing covering 70 m), one Elliot trap-line (15 size A traps, 10 m apart), and two cage traps at either end of the line. Traps were installed and opened on Monday 10 September 2007; they were removed on Friday 14 September 2007. Traps were checked and cleared in the late evening (5 pm to 7 pm) and early morning (7 am to 9 am) each day. Trapping effort at each of the 10 sites surveyed was Elliot traps = 60 trap nights, pitfall traps = 24 trap nights and cage traps = 8 trap nights.

LOCALITY 1 – KOOTABERRA STATION

On Kootaberra Station, five trap-lines were set within four vegetation associations (see Figure N7.2):

- Site 1: *Acacia burkitti* ± *A. aneura* ± *A. ramulosa* ± *Alectryon oleifolius* ssp. *canescens* shrubland (GDA 94 53H 0740192E 6442497S)
- Site 2: *Callitris glaucophylla* woodland (GDA 94 53H 0741877E 6437693S)
- Site 3: *Acacia aneura* woodland – *A. papyrocarpa* woodland (GDA 94 53H 0739115E 6442361S)
- Site 4: *Atriplex vesicaria* / *Sclerostegia* sp. ± *Maireana eriantha* low shrubland – *A. aneura* ± *A. burkitti* shrubland (GDA 94 53H 0743614E 6442022S)
- Site 5: *Callitris glaucophylla* woodland (GDA 94 53H 0741972E 6439591S).

LOCALITY 2 – TREGALANA STATION

On Tregalana Station, five trap-lines were set within four vegetation associations (see Figure N7.3):

- Site 1: *Eucalyptus socialis* woodland (see Plate N7.1) (GDA 94 53H 0744380E 6361735S)
- Site 2: *Eucalyptus socialis* woodland (see Plate N7.2) (GDA 94 53H 0744076E 6366230S)
- Site 3: *Maireana sedifolia*/*Atriplex vesicaria* low shrubland (see Plate N7.3) (GDA 94 53H 0742390E 6370863S)
- Site 4: *Acacia papyrocarpa*/*Myoporum platycarpum* woodland – *Casuarina pauper* woodland (see Plate N7.4) (GDA 94 53H 0740985E 6370657S)
- Site 5: *Casuarina pauper* Woodland (see Plate N7.5) (GDA 94 53H 0740985E 6370657S).

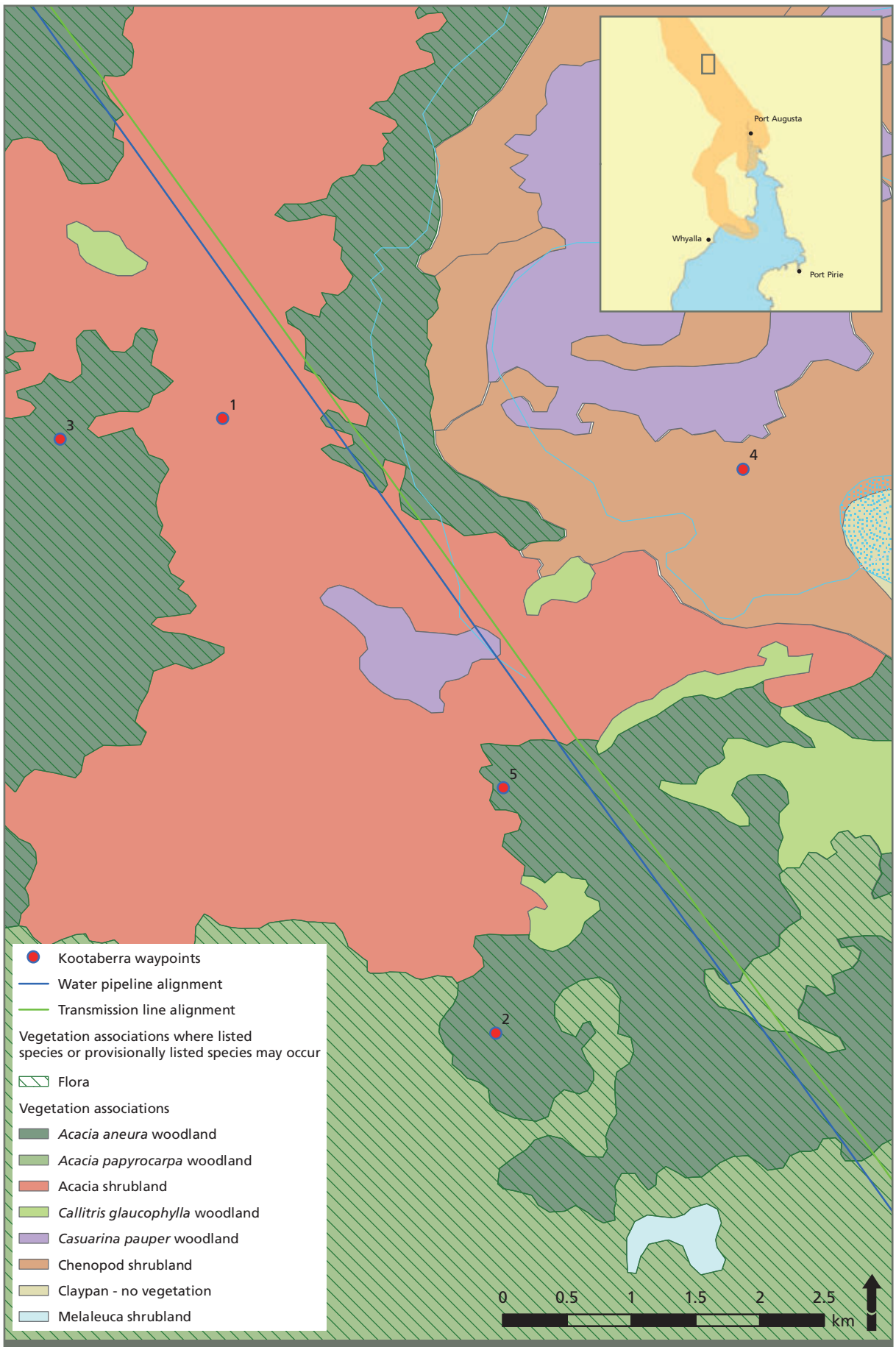

Figure N7.2 Trap-line positions and vegetation associations at Location 1 on Kootaberra Station

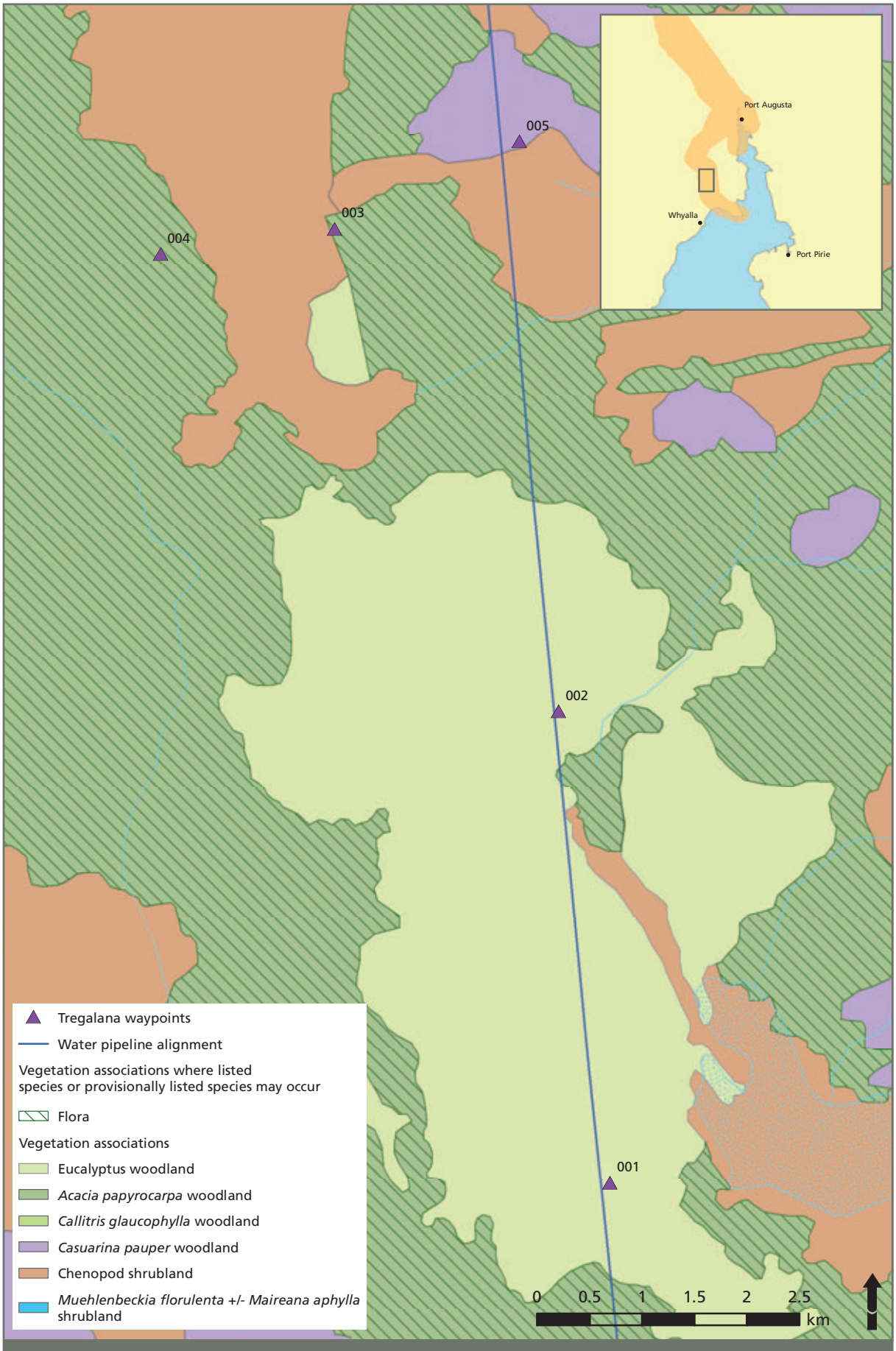

Figure N7.3 Trap-line positions and vegetation associations at Location 2 on Tregalana Station

Plate N7.1 *Eucalyptus socialis* woodland

Plate N7.2 *Eucalyptus socialis* woodland

Plate N7.3 *Maireana sedifolia/Atriplex vesicaria* low shrubland

Plate N7.4 *Acacia papyrocarpa/Myoporum platycarpum* woodland

Plate N7.5 *Casuarina pauper* woodland

Roaming surveys

Two observers carried out roaming surveys for at least two hours total duration each day over four days. Each of the habitat types were surveyed once.

Physical search

Physical searches were conducted on each day during roaming surveys. Physical searches involved the lifting of rocks and logs, looking under bark on tree trunks, digging up burrows and raking of leaf litter. Observations were made of animals active at the time, or for signs of animals, including tracks, scats, scratchings, burrows and skulls. Active animals were, where possible, hand caught and identified.

Spotlighting

Spotlighting for nocturnal mammals, birds and reptiles was carried out on two evenings (25 September 2007 and 26 September 2007) between 8 pm and 11 pm. Efforts to spotlight were abandoned on 27 September 2007 due to the cold and extremely windy weather. Under these conditions the likelihood of animal movement was low and the probability of detecting animals either visually or by sound was also low.

During a spotlighting survey two observers walked a predetermined route around a site, using a portable spotlight to detect animals by eye shine or movement. Spotlighting was also carried out from the vehicle while moving among sites. All sightings, audible movement, and calls were investigated and identified.

Micro-pitfall traps

Small plastic vials (80 mm x 25 mm) full of 75% alcohol were placed in the ground flush to the surface, within one metre of each pitfall trap. These vials act as traps for invertebrates moving around on the surface. The vials were left open for the duration of the survey. At the completion of the survey they were returned to the South Australian Museum for analysis.

Results

Weather

Surveys were carried out over five days (four nights) from 10 September 2007 to 14 September 2007. On the first two days the weather conditions, being relatively cool and overcast (see Table N7.1), were poor for animal activity at both sites. Warmer conditions on the next two days, particularly following rainfall on Tregalana Station, resulted in a marked increase in animal activity and capture rates.

Climate records at both sites show a marked variation in rainfall over the last year. Mean annual rainfall at Yudnapinna, 50 km west of Kootaberra Station is 210.4 mm (N = 121 years: 1884–2007 BOM 2007). Mean annual rainfall at Port Augusta Airport, 40 km south of Kootaberra Station is 255.7 mm (N = 38 years: 1958–1997 BOM 2007). Total rainfall at Port Augusta Airport in the previous 12-month (1 October 2006–31 September 2007) period was 194.8 mm. These data are not definitive, but suggest that while rainfall for Kootaberra Station over the last 12 months may have been around the average, local fauna populations would not have experienced a particularly productive season and may not have had high growth rates at the time of the survey.

Mean annual rainfall at Whyalla is 271.5 mm (N = 63 years: 1945–2007 BOM 2007). Total rainfall at Whyalla in the previous 12-month (1 October 2006–31 September 2007) period was 307.6 mm, being above average. Rainfall on Tregalana Station was significantly above average over the last year (N Bouly, Tregalana Station, pers. comm., 11 September 2007). Two very heavy rainfall events (91.8 mm 19–20 January 2007 and 50 mm 20 March 2007) caused localised flooding on Tregalana Station, and resulted in subsequent extensive vegetation growth particularly at Site 3 (N Bouly, pers. comm., 11 September 2007). In contrast to Kootaberra Station these data suggest that local fauna populations on Tregalana Station may have increased following declines in the severe drought during 2006.

Table N7.1 Weather during survey period

Date	Whyalla (Tregalana Station)			Port Augusta (Kootaberra Station)		
	Temperature (°C)		Rainfall (mm)	Temperature (°C)		Rainfall (mm)
	Maximum	Minimum		Maximum	Minimum	
10/09/07	20.1	10.4	0.0	22.0	9.9	0.0
11/09/07	16.8	11.0	0.6	18.6	10.2	0.0
12/09/07	24.5	3.4	0.0	24.9	2.4	0.0
13/09/07	27.8	15.1	0.0	28.5	12.5	0.0
14/09/07	17.6	8.3	0.0	19.8	9.8	0.0

Vouchered specimens

Vertebrate voucher specimens were collected for the South Australian Museum. Eighteen specimens from 15 species were collected from Kootaberra Station (Voucher number 590-1-001 to 590-1-018), and 15 specimens from 12 species were collected from Tregalana Station (Voucher number 590-2-001 to 590-2-015).

Amphibians

No amphibians were recorded at either site during this survey.

Reptiles

Reptiles from 23 species (13 species at Tregalana Station, 17 species at Kootaberra Station) were recorded during this fauna survey (see Table N7.2). No species of conservation significance were found at either location. All species identified had previously been observed in the infrastructure corridor.

At both survey locations there was low reptile activity and low capture rates, which were attributed to cool weather conditions, particularly on the first two days of the survey. Activity increased on the third day and over the warmer third night.

On Kootaberra Station the highest reptile species diversity (seven species) was associated with the *Atriplex vesicaria*/*Sclerostegia* sp. shrubland (Site 4). Four species were captured in the *Callitris glaucophylla* woodland (Sites 2 and 5), three species were associated with the *Acacia aneura – A. papyrocarpa* woodland (Site 3), and only two species were recorded in the *Acacia burkitti* shrubland (Site 1).

Reptile species diversity (two species) was low in the *Eucalyptus socialis* woodland (Sites 1 and 2) at Tregalana Station. Highest diversity (seven species) was associated with the *Acacia papyrocarpa*/*Myoporum platycarpum* woodland (Site 4). Three species were recorded in both the *Maireana sedifolia*/*Atriplex vesicaria* woodland (Site 3) and the *Casuarina pauper* woodland (Site 5).

Table N7.2 Reptiles recorded during the fauna survey

Family Scientific name	Common name	Survey site		Status	
		Tregalana Station	Kootaberra Station		
		Quadrants		AUS	SA
AGAMIDAE	**Dragons**				
Ctenophorus cristatus	Crested Dragon	4	3,5		
Ctenophorus fionni	Peninsula Dragon		4		
Ctenophorus nuchalis	Central Netted Dragon		0		
Pogona vitticeps	Central Bearded Dragon	0	0		
Tympanocryptis tetraporophora	Eyrean Earless Dragon	3	4		
GEKKONIDAE	**Geckos and Legless Lizards**				
Diplodactylus damaeus (recently changes to *Lucasium damaeum*)	Beaded Gecko	4	0		
Diplodactylus tessellates	Tessellated Gecko	3			
Strophurus intermedius	Southern Spiny-tailed Gecko		4		
Gehyra variegata	Tree Dtella	4	3,4,5		
Heteronotia binoei	Bynoe's Gecko		0		
SCINCIDAE	**Skinks**				
Cryptoblepharus plagiocephalus Icarnabyi	Desert Wall Skink	1			
Ctenotus olympicus	Saltbush Ctenotus		4		
Ctenotus regius	Eastern Desert Ctenotus		1,3,4		
Lerista edwardsae	Myall Slider	1			
Lerista labialis	Eastern Two-toed Slider		0		
Lerista muelleri	Dwarf Three-toed Slider	1,3,5	0		
Menetia greyii	Dwarf Skink		2		
Morethia boulengeri	Common Snake-eye	2			
Tiliqua rugosa	Sleepy Lizard	4,5,0	4,5		
VARANIDAE	**Goannas**				
Varanus gouldii	Sand Goanna		1		
ELAPIDAE	**Elapid snakes**				
Simoselaps bertholdi	Desert Banded Snake		0		
Suta suta	Curl Snake	3			
TYPHLOPIDAE	**Blind snakes**				
Ramphotyphlops bituberculatus	Rough-nosed Blind Snake	4			
Total species	**23**	**13**	**17**	**0**	**0**

AUS: National conservation rating (EPBC Act).
SA: State conservation rating (NPW Act).
O: Recorded in the survey locality, but outside the quadrants.

Birds

A survey of birds was not specifically included in this protocol, but incidental observations were made at both locations during the study. Birds from 62 species were recorded (44 species at Tregalana Station, and 43 species at Kootaberra Station; see Table N7.3). No species of conservation significance were recorded at either location. All species identified had previously been observed in the infrastructure corridor.

Table N7.3 Birds recorded during the fauna survey

Family Scientific name	Common name	Survey site		Status		
		Tregalana Station	Kootaberra Station			
		Quadrants	Quadrants	AUS	SA	CAMBA JAMBA
CASUARIIDAE	**Cassowaries and emus**					
Dromaius novaehollandiae	Emu	0	2,3			
ANATIDAE	**Geese, swans and ducks**					
Cygnus atratus	Black Swan		4			
Anas gracilis	Grey Teal	0	4			
PODICIPEDIDAE	**Grebes**					
Poliocephalus poliocephalus	Hoary-headed Grebe		4			
ARDEIDAE	Herons and bitterns					
Ardea pacifica	White-necked Heron	5				
ACCIPITRIDAE	**Osprey, hawks, eagles and allies**					
Aquila audax	Wedge-tailed Eagle	0	5			
FALCONIDAE	**Falcons**					
Falco berigora	Brown Falcon		1			
Falco cenchroides	Nankeen Kestrel	0	1			
TURNICIDAE	**Button-quails**					
Turnix velox	Little Button-quail	3				
COLUMBIDAE	**Pigeons and doves**					
Ocyphaps lophotes	Crested Pigeon	5	2			
Phaps chalcoptera	Common Bronzewing		1,2,5			
CACATUIDAE	**Cockatoos and cockatiel**					
Cacatua roseicapilla	Galah	2,3,5	1,2			
PSITTACIDAE	**Parrots**					
Barnardius zonarius	Australian Ringneck	1,0	1			
Neopsephotus bourkii	Bourke's Parrot		2			
Northiella haematogaster	Blue Bonnet		1,2,3			
Psephotus varius	Mulga Parrot		2,3			
CUCULIDAE	**Cuckoos**					
Chrysococcyx basalis	Horsfield's Bronze-cuckoo		3,0			
STRIGIDAE	**Typical owls**					
Ninox novaeseelandiae	Southern Boobook	0				
PODARGIDAE	**Frogmouths**					
Podargus strigoides	Tawny Frogmouth		5			
AEGOTHELIDAE	Owlet-nightjars					
Aegotheles cristatus	Australian Owlet-nightjar	1	5			
MALURIDAE	**Fairy-wrens, emu-wrens and grasswrens**					
Malurus lamberti	Variegated Fairy-wren	0				
Malurus leucopterus	White-winged Fairy-wren	3,0	4			
Malurus splendens	Splendid Fairy-wren	0	1			
PARDALOTIDAE	**Pardalotes**					
Pardalotus striatus	Striated Pardalote	1,2,0				
ACANTHIZIDAE	**Bristlebirds, thornbills, scrubwrens and allies**					
Acanthiza uropygialis	Chestnut-rumped Thornbill	5	1,5			

Table N7.3 Birds recorded during the fauna survey (cont'd)

Family Scientific name	Common name	Survey site		Status		
		Tregalana Station	Kootaberra Station			
		Quadrants	Quadrants	AUS	SA	CAMBA JAMBA
Aphelocephala leucopsis	Southern Whiteface	5,0	2			
Smicrornis brevirostris	Weebill	2				
MELIPHAGIDAE	**Honeyeaters and Australian chats**					
Acanthagenys rufogularis	Spiny-cheeked Honeyeater	2,4,5,0	2,3,5			
Anthochaera carunculata	Red Wattlebird	1				
Lichenostomus ornatus	Yellow-plumed Honeyeater	2, 0				
Lichenostomus virescens	Singing Honeyeater	4,0	1,3,4			
Manorina flavigula	Yellow-throated Miner		2,3,5			
Phylidonyris albifrons	White-fronted Honeyeater	0				
Epthianura albifrons	White-fronted Chat	0				
Epthianura aurifrons	Orange Chat	3,0				
Epthianura tricolor	Crimson Chat	0	4			
PETROICIDAE	**Australopapuan robins and allies**					
Melanodryas cucullata	Hooded Robin	5				
Microeca fascinans	Jacky Winter	1,2,5,0				
Petroica goodenovii	Red-capped Robin	1,5				
POMATOSTOMIDAE	**Australopapuan Babblers**					
Pomatostomus superciliosus	White-browed Babbler	2,5	1,2,3,5			
PACHYCEPHALIDAE	**Whistlers, shrike-tits and allies**					
Colluricincla harmonica	Grey Shrike-thrush	1,2	2,3,5			
Oreoica gutturalis	Crested Bellbird	2,4,5,0	2,3,5			
Pachycephala rufiventris	Rufous Whistler		3,5			
DICRURIDAE	**Monarchs, drongos, magpie-larks and allies**					
Rhipidura leucophrys	Willie Wagtail		2,4			
ARTAMIDAE	**Woodswallows, butcherbirds and allies**					
Artamus cinereus	Black-faced Woodswallow	3,0	1,3,4			
Artamus cyanopterus	Dusky Woodswallow		3			
Cracticus torquatus	Grey Butcherbird	1,4,0	1,3,5			
Gymnorhina tibicen	Australian Magpie	3,5	2,3,5			
Strepera versicolor	Grey Currawong	1, 0				
CAMPEPHAGIDAE	**Cuckoo-shrikes and allies**					
Coracina maxima	Ground Cuckoo-shrike		5,0			
Coracina novaehollandiae	Black-faced Cuckoo-shrike	1	3,5			
Lalage tricolor	White-winged Triller	0	1			
CORVIDAE	**Crows**					
Corvus bennetti	Little Crow					
Corvus mellori	Little Raven	1				
STURNIDAE	**Starlings**					
*Sturnus vulgaris**	Common Starling		0			
ALAUDIDAE	**Larks**					
*Alauda arvensis**	Skylark	3				

Table N7.3 Birds recorded during the fauna survey (cont'd)

Family Scientific name	Common name	Survey site		Status		
		Tregalana Station	Kootaberra Station			
		Quadrants	Quadrants	AUS	SA	CAMBA JAMBA
HIRUNDINIDAE	**Swallows and martins**					
Cheramoeca leucosternus	White-backed Swallow		0			
Hirundo neoxena	Welcome Swallow	0	1,4,0			
SYLVIIDAE	**Warblers**					
Cincloramphus cruralis	Brown Songlark	0				
DICAEIDAE	**Flowerpeckers**					
Dicaeum hirundinaceum	Mistletoebird	4	3,4			
MOTACILLIDAE	**Wagtails and pipits**					
Anthus novaeseelandiae	Richard's Pipit	0	1			
ESTRILDIDAE	**Grass-finches (waxbills)**					
Taeniopygia guttata	Zebra Finch		4			
Total species	Both sites: 62	44	43	0	0	0

AUS: National conservation rating (EPBC Act).
SA: State conservation rating (NPW Act).
* Feral animal.
O: Recorded in the survey locality, but outside the quadrants.

Mammals

Mammals from 11 species were recorded (six species at Tregalana Station, 11 species at Kootaberra Station; see Table N7.4). Five of the species recorded were introduced feral mammals. No species of conservation significance were recorded at either location, and there were no new species records for the infrastructure corridor.

On Kootaberra Station the highest mammal species diversity (seven species) was associated with the *Callitris glaucophylla* woodland (Sites 2 and 5), with three native species recorded (*Macropus fuliginosus*, *Macropus rufus* and *Pseudomys bolami*). Four species (including two native mammals: *Sminthopsis crassicaudata* and *Pseudomys bolami*) were captured in the *Acacia burkitti* shrubland (Site 1). Only one species (*Pseudomys bolami*) was captured in the *Acacia aneura – A. papyrocarpa* woodland (Site 3), and three species (two native: *Pseudomys bolami* and *Sminthopsis macroura*) were recorded in the *Atriplex vesicaria/ Sclerostegia* sp. shrubland (Site 4). *Pseudomys bolami* was captured at all sites.

Mammal species diversity was low at Tregalana Station. No native mammal species were recorded in the *Eucalyptus socialis* woodland (Sites 1 and 2). The most productive site was the *Maireana sedifolia/Atriplex vesicaria* woodland (Site 3), with multiple captures of the Stripe-faced Dunnart *Sminthopsis macroura* and the introduced House Mouse *Mus musculus*. One Stripe-faced Dunnart was captured at Site 4 (*Acacia papyrocarpa/Myoporum platycarpum* woodland). The *Casuarina pauper* woodland (Site 5) had very low capture rates, but a group of Western Grey Kangaroos *Macropus fuliginosus* were recorded grazing on the site.

Table N7.4 Mammals recorded during the fauna survey

Family Scientific name	Common name	Survey site		Status	
		Tregalana Station	Kootaberra Station		
		Quadrants		AUS	SA
DASYURIDAE	**Dasyurids**				
Sminthopsis crassicaudata	Fat-tailed Dunnart		1		
Sminthopsis macroura	Stripe-faced Dunnart	3,4	4		
MACROPODIDAE	**Wallabies, kangaroos and tree kangaroos**				
Macropus fuliginosus	Western Grey Kangaroo	5,0	5		
Macropus robustus	Euro		0		
Macropus rufus	Red Kangaroo		2,0		
CANIDAE	**Dogs, foxes and relatives**				
Vulpes vulpes[1]	Fox		1,0		
FELIDAE	**Cats and relatives**				
Felis catus[1]	Cat	2	2		
BOVIDAE	**Horned ruminants**				
Ovis aries[1]	Sheep	0	2		
MURIDAE	**Murids**				
Pseudomys bolami	Bolam's Mouse		1,2,3,4,5		
Mus musculus[1]	House Mouse	2,3	1,2		
LEPORIDAE	**Rabbits and hares**				
Oryctolagus cuniculus[1]	Rabbit	4	2,4,5		
Total species	**11**	**6**	**11**	**0**	**0**

AUS: National conservation rating (EPBC Act).
SA: State conservation rating (NPW Act).
[1] Introduced feral.

N7.1.4 Discussion of results

Cold, cloudy and windy weather conditions during the first half of the survey resulted in low levels of animal activity at both survey locations. Warmer weather on the last two days of the survey resulted in an increase of animal activity, with a corresponding increase in the number and diversity of fauna captured. Overall the diversity of species caught was good, but generally low capture rates, particularly in some habitat types (e.g. *Eucalyptus socialis* woodland) suggests that rare animals and fauna active only at relatively high ambient temperatures were under represented in the surveys.

No amphibians were captured during the survey. These animals are generally active for limited periods following relatively heavy rainfall events. Such an event did not occur immediately prior to, or during, the survey. A range of amphibian species have distributions across the survey sites and their presence in the areas surveyed could be anticipated. Given the transient nature of their activity, targeted surveys would be required to ensure detection of the full range of species at the study site.

Survey sites were positioned to address known gaps in DEH database and South Australian Museum records of animal distribution. To this end, records of birds, reptiles and mammals have been substantively improved at both sites. At Tregalana Station 63 new vertebrate fauna records (13 reptiles, 44 birds and six mammals) were made for the area, with 18 new specimens lodged with the SA Museum. At Kootaberra Station 71 new vertebrate fauna records (17 reptiles, 43 birds and 11 mammals) were made for the area, with 15 new specimens lodged with the SA Museum. A range of invertebrate samples was also obtained from both survey locations, but these have yet to be sorted and identified by the museum.

Eight vegetation associations were surveyed, with differences in diversity and capture rate among these sites. The timing of the survey and the timing of peak periods of productivity specific to each of these habitat types overlapped to varying degrees. Consequently it is inappropriate to draw conclusions on which habitat types constitute the best environment in terms of total biomass or highest species diversity. More long-term studies would be required to address this question.

No species of conservation concern, or species new to the infrastructure corridor, were detected during this survey.

N7.1.5 References

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Owens, H (ed) 2000, *Guidelines for Vertebrate Surveys in South Australia Using the Biological Survey of South Australia*, National Parks and Wildlife SA, Department for Environment and Heritage, Adelaide.

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N7.2 SURVEY OF THE PROPOSED HILTABA VILLAGE AND AIRPORT SITES FOR THICK-BILLED GRASSWRENS, PLAINS RATS AND KOCH'S SALTBUSH

N7.2.1 Introduction

ARUP ENSR has been contracted by BHP Billiton to investigate environmental consequences associated with the proposed expansion of the Olympic Dam mine and associated infrastructure. A component of these studies includes determination of the likelihood of occurrence and potential impacts on plant and animal species of conservation concern.

Ecological Horizons Pty Ltd (namely John Read) survey was commissioned to survey for Thick-billed Grasswrens *Amytornis textilis textilis*, Plains Rats *Pseudomys australis* and Koch's Saltbush *Atriplex kochiana* in the Horn Ridge region of Andamooka Station, the site of the proposed Hiltaba Village and airport. The study area, bounded by 136 59' 30"E, 30 28'15"S and 137 03' 15"E 30 30'50"S is an undulating gibber plain overlain by widely separated linear sand dunes.

Thick-billed Grasswrens in the region typically occupy gibber plains vegetated with emergent chenopod shrubs including *Atriplex nummularia omissa*, *Maireana aphylla* or *M. pyramidata.* Although reasonably common further north in the Lake Eyre catchment (Read and Badman 1999), there have been few Thick-billed Grasswren records south of the Dog Fence or the Roxby–Andamooka region (J Read unpub. data, Read et al. 2000).

Plains Rats typically occupy cracking clay ephemeral swamps or gilgais on gibber plains in central northern South Australia. The known distribution and abundance of Plains Rats in the Roxby Downs region has increased considerably since the mid-1990s (Read 1994) with several recent records from the Olympic Dam mine lease (BHP Billiton unpub. data). Since 2006, Plains Rat numbers have increased dramatically within the predator-free reserve of Arid Recovery, with dozens of captures and tracks frequently recorded on sand dunes (Arid Recovery 2007), which are not considered typical habitat for the species.

Koch's Saltbush is listed as vulnerable in South Australia under Schedule 8 of the South Australian *National Parks and Wildlife Act 1972*. Koch's Saltbush has historically been recorded from four broad localities in northern South Australia, although the confirmed distribution since 1987 is restricted to the vicinity of Andamooka township. Recent discoveries elsewhere in the Andamooka–Roxby Downs region have considerably increased the known distribution of this species, which is typically found on well-drained stony rises with patchy cover of *Maireana astrotricha* and samphires (Read and Kilpatrick in prep.)

N7.2.2 Methods

At high densities Plains Rats can be detected through their 'runways' and scats in gypseous soil and spoor on sand dunes, yet at low densities they are more efficiently surveyed using Elliot traps. Thick-billed Grasswrens are also trappable in Elliot traps (Read and Badman 1999).

Lines of 15 Elliot traps baited with peanut paste and oats were set in four cracking clay swamps within the study region for four consecutive nights (see Figure N7.4). Traps were opened and baited each evening and checked, closed and bait removed within two hours of dawn each morning.

Thick-billed Grasswrens are typically unobtrusive birds that are sometimes difficult to detect but may be flushed from tall bushes or respond to call playbacks. The study area was traversed on foot to search for Thick-billed Grasswrens and Koch's Saltbush. At 34 locations supporting emergent chenopod shrubs, a recording of a Thick-billed Grasswren was played and a search made for any birds seen or heard in the vicinity. All bird searches were made before midday in low wind conditions. Birds were also recorded opportunistically while checking Elliot trap sites and walking or driving through the region.

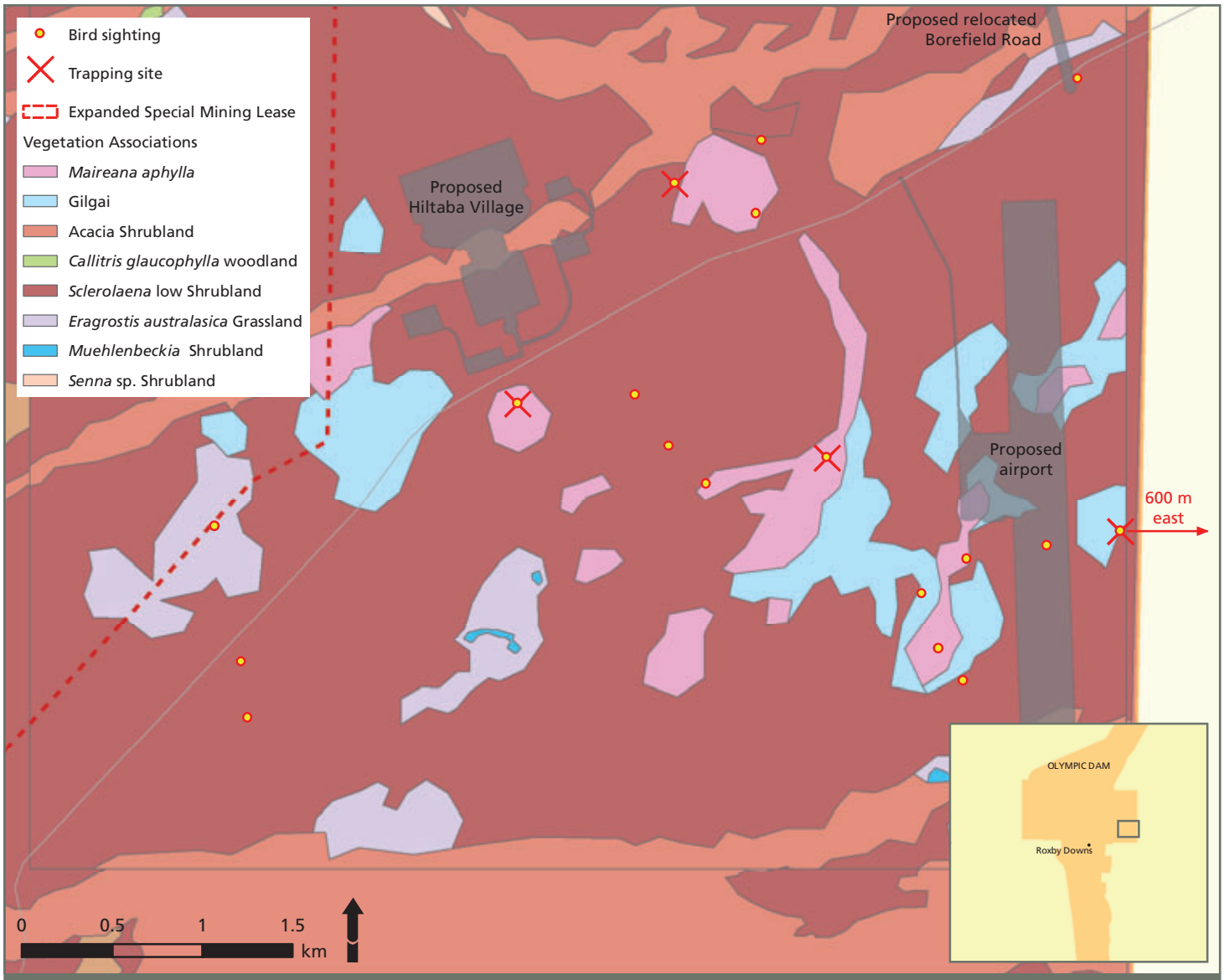

Figure N7.4 Trapping sites and bird observation locations superimposed on vegetation associations of the study area near Hiltaba Village and the proposed airport

N7.2.3 Results

No Plains Rats, Thick-billed Grasswrens or Koch's Saltbush were recorded from the study region.

A total of 16 bird species, including five groups of Calamanthus and seven White-winged Fairywren flocks that occupy similar habitat to Thick-billed Grasswrens, were recorded from swamps and sparser *Maireana aphylla* patches (see Table N7.5).

Three mammal species, *Sminthopsis macroura, Leggadina forresti* and *Mus musculus,* were trapped at low capture rates (see Table N7.6). Red Kangaroos and horses were regularly recorded on the gibber plains and cats, rabbits and dingoes recorded from the sand dunes.

No prime habitat for Koch's Saltbush, or plants outside their prime habitat, was located within the study area.

Table N7.5 Localities, habitats and birds recorded at opportunistic sites of the Thick-billed Grasswren

Site	Easting	Northing	Habitat	Birds
CAL1			patchy *M. aphylla*	Cal x 2
MAPH1			*M. aphylla* elongated patch	WWW
CAL2			patchy *M. aphylla*	Cal x 2
CAL3			patchy *M. aphylla*	Cal x 2
WW2			patchy *M. aphylla*	WWW and Pipit
MAPH2			*M.aphylla* deep crabholes	CQT x 2, Pipit
MAPH3			*M.aphylla* deep crabholes	none
LIG1			Lignum and *M.aphylla* big swamp	CQT x 7, WTE
MAPH4			Lignum and *M. aphylla* big swamp	CQT x 2
CAL4			patchy *M. aphylla*	Cal heard
MAPH5			patchy *M. aphylla*	none
WW1			large *M. aphylla* swamp	WWW, CPig
MA1	695228	6625968	patchy *M. aphylla*	none
MA3	686733	6623416	patchy *M. aphylla*	none
MA4	696375	6623381	patchy *M. aphylla*	IDot
MA5	696145	6623864	patchy *M. aphylla*	none
MA6	696395	6624055	patchy *M. aphylla*	CQT
MA7	696836	6624130	patchy *M. aphylla*	none
MA8	692413	6623176	patchy *M. aphylla*	CQT
EV 138	692377	6623486	patchy *M. aphylla*	BLap
LIG3	696239	6623560	lignum and *M. aphylla* big swamp	no birds
ERA1	695257	6626372	canegrass swamp	CQT
ERA2	692230	6624237	canegrass swamp	CQT
E1	695620	6624617	*M. aphylla* swamp	Cal x 2
E2	697907	6624206	patchy *M. aphylla*	Emu, BLap, OChat
E3	694776	6626134	canegrass swamp	OChat, BLap
E4	693907	6624916	*M. aphylla* swamp	Pipit, WWW, BrFalc
ERA3			canegrass swamp	WWW
ERA4	692721	6932570	canegrass and *M. aphylla* swamp	WWW, VFW, A Rav, CWedg, RBE, SHE, CPig, Lfalc
ERA5	697010	6626712	canegrass swamp	OChat, WWW, Bbnt
MA9	694556	6624964	patchy *M. aphylla*	nil
MA10	694745	6624679	patchy *M. aphylla*	CQT
MA11	694953	6624472	patchy *M. aphylla*	CQT

Cal = Calamanthus, WWW = White-winged Fairywren, CQT = Cinnamon Quailthrush, Pipit = Richard's Pipit, WTE = Wedge-tailed Eagle, IDot = Inland Dotterel, BLap = Banded Lapwing, OChat = Orange Chat, BrFalc = Brown Falcon, CWedge = Chirupping Wedgebill, ARav = Australian Raven, RBE = Rainbow Bee-eater, CPig = Crested Pigeon, LFalc = Little Falcon, Bbnt – Bluebonnet.

Table N7.6 Localities, habitats and captures of traplines

Site	Easting	Northing	Habitat	Captures
E1	695620	6624617	*M. aphylla*, lignum swamp	1 *Mus musculus*, 1 *Sminthopsis macroura*
E2	697907	6624206	patchy *M. aphylla* to canegrass swamp	1 *M. musculus*
E3	694776	6626134	canegrass and *M. aphylla* swamp	Nil
E4	693907	6624916	*M. aphylla* cracking clay swamp	5 *M. musculus*, 1 *Leggadina forresti*, 1 *S. macroura* (with pouched young)

N7.2.4 Discussion

This survey suggests that the Horn Ridge region is unlikely to provide core or significant habitat for the Thick-billed Grasswren, Plains Rat or Koch's Saltbush, and that the proposed establishment of the Hiltaba Village and airport would not have a significant impact on the conservation status of these species.

However, confirming the presence, and particularly the absence, of cryptic uncommon animal and plant species is difficult. It is possible that the Thick-billed Grasswren, and probable that the Plains Rat, occur at low densities within the study area. Both species occur in very similar habitats in the region and have been recorded from localities where considerable previous monitoring has failed to detect them. Plains Rats colonise patches of suitable habitat when seasonal conditions or low predator numbers permit, then contract back to persistent refugia at other times (Brandle and Moseby 1999).

Native fauna inhabitants of swamps or gilgai in the region are likely to benefit from reduction in cat and fox numbers and grazing pressure and be threatened by changes in surface water flow or quality that inundate, desiccate or pollute their habitats. Minimising clearance of perennial chenopods, particularly *Maireana aphylla*, will minimise impacts of the proposed expansion on Thick-billed Grasswrens and other chenopod shrubland birds.

N7.2.5 References

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Read, JL 1994, 'A retrospective view of the quality of the fauna component of the Olympic Dam Environmental Impact Statement', *Journal of Environmental Management*, vol. 41, pp. 167–185.

Read, JL, Ebdon, FR & Donohoe, P 2000, 'The terrestrial birds of the Roxby Downs Area: A ten year history', *South Australian Ornithologist*, vol. 33, pp. 71–83.

Read, JL & Kilpatrick, AD (forthcoming) 'Improved conservation status of *Atriplex kochiana',* submitted to *Transactions of the Royal Society of South Australia*.

N7.3 BAT SURVEY USING AN ANABAT II DETECTION DEVICE AT ROXBY DOWNS

N7.3.1 Introduction

A survey for insectivorous (i.e. microchiropteran) bats was conducted near Roxby Downs to identify species in the area.

N7.3.2 Methods

The survey was undertaken using an Anabat II bat detection system. The survey was conducted over four nights near Roxby Downs in March 2006 by Ecological Associates. Recorded echolocation calls were subsequently assigned to species by Greg Ford, an Anabat call-analysis specialist. Weather conditions during the survey were fine with clear skies, little if any wind, and a new moon.

N7.3.3 Results and discussion

A summary of the results are given in Table N7.7.

No reference calls were available for the survey area; so species identification was based on reference calls and keys published for New South Wales (Pennay et al. 2004) and Queensland (Reinhold et al. 2001). The species likely to occur in the survey area are unlikely to exhibit much variation in call characteristics from their east-coast counterparts.

Table N7.7 Bats recorded at Olympic Dam, 2–3 March 2006

Species	Common name	Session date – 2–3 March 2006	
Mormopterus 'species 4'	Southern Freetail Bat		1b
Chalinolobus gouldii	Gould's Wattled Bat	2b, 1c	2a, 17b, 2c
Nyctophilus species	Unidentified Long-eared Bat		1a, 6b, 1c
Scotorepens balstoni	Inland Broad-nosed Bat		2b

Species presence during each recording session is recorded as number of calls identified at three levels of confidence.
Confidence levels for identification are coded as follows:
a) Definite one or more calls where absolutely no doubt about identification of bat
b) Probable most likely the species named; low probability of confusion with species that use similar calls
c) Possible one or more calls comparable with the listed species, but high probability of confusion with species that use similar calls.

Notes on species recorded are given below.

Mormopterus species 4

A single call on 3 March 2006 was definitely attributable to a *Mormopterus* species bat, but it was not possible to be certain of species identity. Based on survey locality and call frequency (c. 26 kHz) it is most likely that the call was made by *M.* 'species 4', the Southern Freetail Bat.

Chalinolobus gouldii

Calls are usually highly distinguishable, but few of the calls attributed to the species in this survey exhibited the characteristic alternating frequency between consecutive pulses. There is some overlap in frequency and pulse-shape with *Scotorepens balstoni* (see below), with low probability that some calls attributed as 'probable' *C. gouldii* may actually have come from *S. balstoni*.

Nyctophilus species

One call definitely from a long-eared bat on 3 March 2006, plus a number of other calls most likely attributable to the group. It is not possible to identify *Nyctophilus* to species using Anabat data. Most likely species, given survey location, is *N. geoffroyi* (Lesser Long-eared Bat), however *N. timoriensis* (central Australian form) may also occur in the area (Churchill 1998).

Scotorepens balstoni

Two calls rated as probable for this species on 3 March 2006. These calls were at higher frequency (c. 34 kHz) than all calls attributed to *C. gouldii* (28–32 kHz), so were considered more likely to be *S. balstoni*.

N7.3.4 References

Churchill, S 1998, *Australian Bats*, Reed New Holland, Sydney.

Pennay, M, Law, B & Reinhold, L 2004, *Bat Calls of New South Wales*, Department of Environment and Conservation, Hurstville, NSW.

Reinhold, L, Law, B, Ford, G & Pennay, M 2001, *Key to the Bat Calls of South-East Queensland and North-East New South Wales*, Forest Ecosystem Research and Assessment Technical Paper 2001–2007, Department of Natural Resources and Mines, Brisbane.

APPENDIX N8

Ecological assessment of groundwater dependent ecosystems

N8 ECOLOGICAL ASSESSMENT OF GROUNDWATER DEPENDENT ECOSYSTEMS

N8.1 INTRODUCTION

The proposed open pit at Olympic Dam would create a groundwater 'sink' (or drawdown cone), which would draw local groundwater towards the open pit. Although preliminary modelling suggests that lateral movement of groundwater would be extremely slow (i.e. over centuries), it would move towards the pit, lowering the groundwater levels in a zone of influence around the mine that may extend about 30 km north-east, 20 km north and 45 km south of the open pit (see Appendix K1 for details).

Searches were undertaken to identify groundwater dependent ecosystems within 50 km of the proposed open pit (i.e. a conservative approach was taken to defining the area potentially affected by groundwater drawdown). Figure N8.1 shows the search area and the springs potentially affected. An ecological assessment of these springs found that a single spring, Yarra Wurta Spring (located about 45 km north-east of the open pit), supports a population of a native fish, the Lake Eyre Hardyhead *Craterocephalus eyresii*. The search area for springs was subsequently extended to identify additional springs that contain Lake Eyre Hardyheads and potentially connect with Lake Torrens, but which are outside the zone of influence of groundwater drawdown. These springs may provide permanent refuge habitat, from which colonisation of Lake Torrens by the Lake Eyre Hardyhead may occur.

This appendix provides the findings of an investigation to determine:

- if any groundwater dependent ecosystems (springs) occur within the area potentially affected by groundwater drawdown from the proposed open pit
- the presence of Lake Eyre Hardyheads in other springs and waterholes, particularly in the Lake Torrens region
- the significance of the Lake Eyre Hardyhead population in Yarra Wurta Spring in relation to the ecology of Lake Torrens
- if the Lake Eyre Hardyhead population in Yarra Wurta Spring consists of a genetically distinct species or subspecies of hardyheads
- the significance of stromatolite-like rock and algae formations that were recorded from Yarra Wurta Spring
- the ecological consequences if the Yarra Wurta Spring ceased to flow.

N8.2 REGIONAL CONTEXT OF LAKE TORRENS SPRINGS

N8.2.1 Physical

Lake Torrens is a large (about 5,900 km^2) ephemeral salt lake to the west of the Flinders Ranges in South Australia (Williams et al. 1998). The lake and its catchment form a distinct river basin of the South Australian Gulf Drainage Division (Figure N8.2). Its catchment includes the Andamooka Ranges to the west and the Flinders Ranges to the east. The lake is generally dry, but occasionally floods when heavy rainfall occurs in the catchment. It was last filled in 1989.

Lake Torrens and associated physiographic features comprise the Lake Torrens Sunklands. Significant features include several small saline or freshwater springs in and around the lake, including Yarra Wurta Spring on its north-western edge (see Figure N8.2).

Springs on the northern boundary and north-east of Lake Torrens are fed by a shallow, highly saline aquifer that is distinct from the Great Artesian Basin, the southern boundary of which is about 50–70 km to the north.

The region's groundwater is a dual aquifer system consisting of the Andamooka Limestone aquifer and the underlying Arcoona Quartzite aquifer, the flow of which converges north of Olympic Dam and flows eastward toward the northern end of Lake Torrens (Waterhouse et al. 2002). While the aquifer boundaries are unclear, groundwater flow does not extend to either Lake Eyre or the Great Artesian Basin (Waterhouse et al. 2002: see Draft EIS Chapter 12, Groundwater, Section 12.3 for details).

N8.2.2 Ecology

This section does not intend to provide a detailed overview of the ecology of Lake Torrens. Rather, it provides a background to the use of the lake by waterbirds following flooding events to provide a context for the Lake Eyre Hardyhead.

During flooding events in northern South Australia, the Lake Eyre Hardyhead is thought to be a food resource for waterbirds, including the Pelican *Pelecanus conspicillatus*, Cormorant *Phalacrocorax* sp. and Whiskered Tern *Chlidonias hybridus* (Ivantsoff and Crowley 1996).

During the 1989 flood in Lake Torrens, waterbirds and aquatic fauna were surveyed as part of a study of the breeding of the Banded Stilt *Cladorhynchus leucocephalus* (Bellchambers and Carpenter 1990; Williams et al. 1998). Samples of aquatic fauna were collected at several sites in Lake Torrens during the survey and are reported by Williams and others (1998). Salinity was typically in the range 15–30 g/l. Aquatic fauna were dominated by the brine shrimp, *Parartemia minuta* (growing up to several centimetres in length), and the small cladocerans, *Daphniopsis queenslandensis* and *Moina baylyi*, and several species of ostracods. Other less commonly recorded fauna were chironomids, rotifers and the Lake Eyre Hardyhead. The latter was recorded in small numbers at the northern end of the lake, and was not noted in the vicinity of Banded Stilt colonies (Bellchambers and Carpenter 1990). No aquatic vegetation was recorded in the lake.

The waterbirds were surveyed at Lake Torrens during a period when extensive fresh and saline wetlands were present across inland Australia. Consequently many of the waterbirds (e.g. ducks, swans and pelicans) recorded were probably en route to other wetlands and not dependent on the lake for feeding. Similarly, the lake provided suitable nesting sites for some species that probably did not feed at the lake (e.g. Gull-billed Tern *Sterna nilotica*).

Common birds closely associated with the lake were the Red-capped Plover *Charadrius ruficollis*, Banded Stilt *Cladorhynchus leucocephalus*, Red-necked Avocet *Recurvirostra novaehollandiae*, Silver Gull *Larus novaehollandiae*, Red-necked Stint *Calidris ruficollis* and the Curlew Sandpiper *Calidris ferruginea*. Aquatic fauna, particularly the brine shrimp, formed a major part of the diet of the Banded Stilt, Silver Gull and probably Red-necked Avocet, and these are considered the critical component of the aquatic ecosystem (Bellchambers and Carpenter 1990). Although recorded at the northern end of Lake Torrens, the Lake Eyre Hardyhead was probably not widely distributed or abundant in the lake and would not have formed an important prey item for the bird species recorded (Bellchambers and Carpenter 1990).

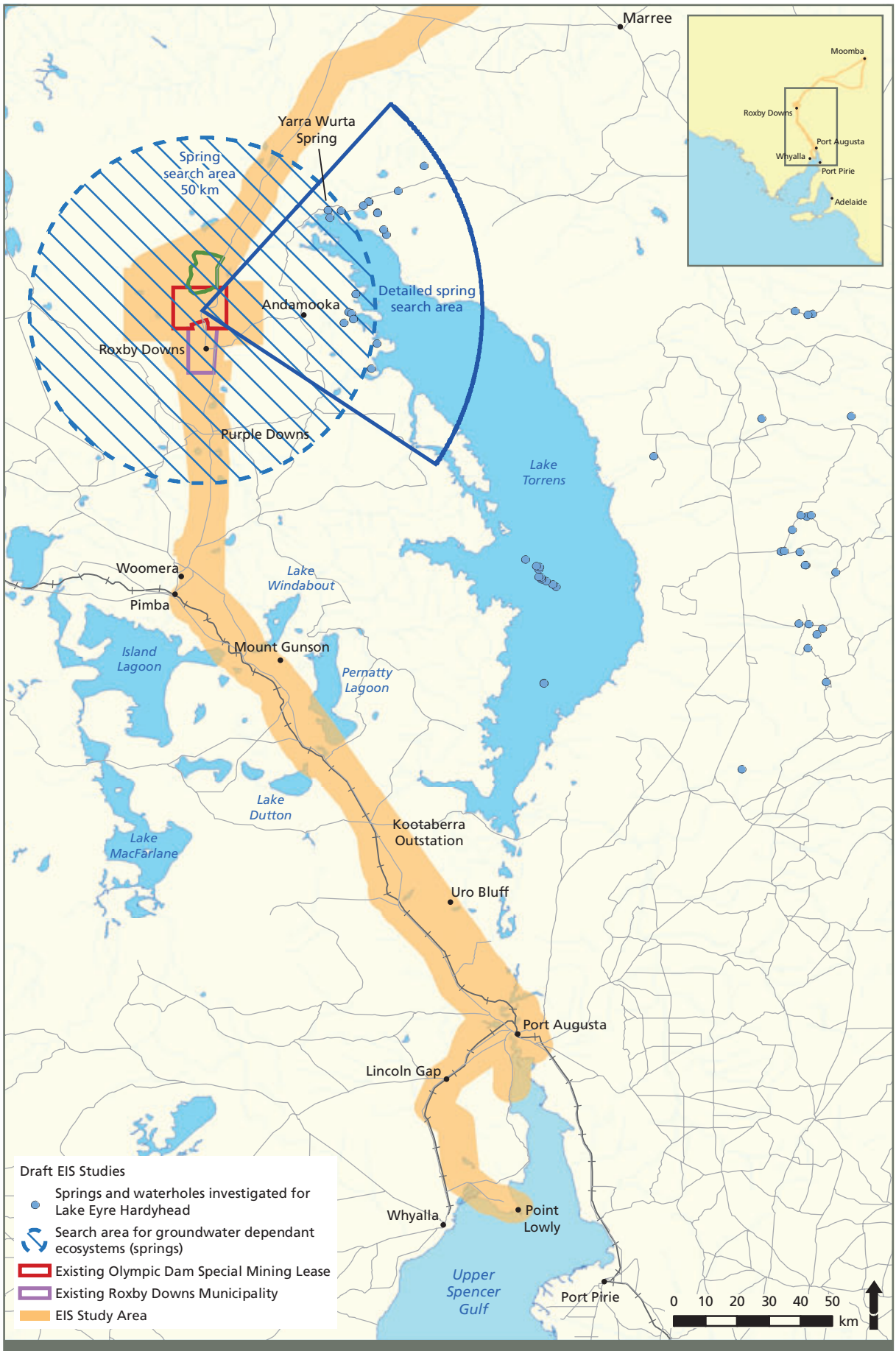

Figure N8.1 The study area showing springs surveyed

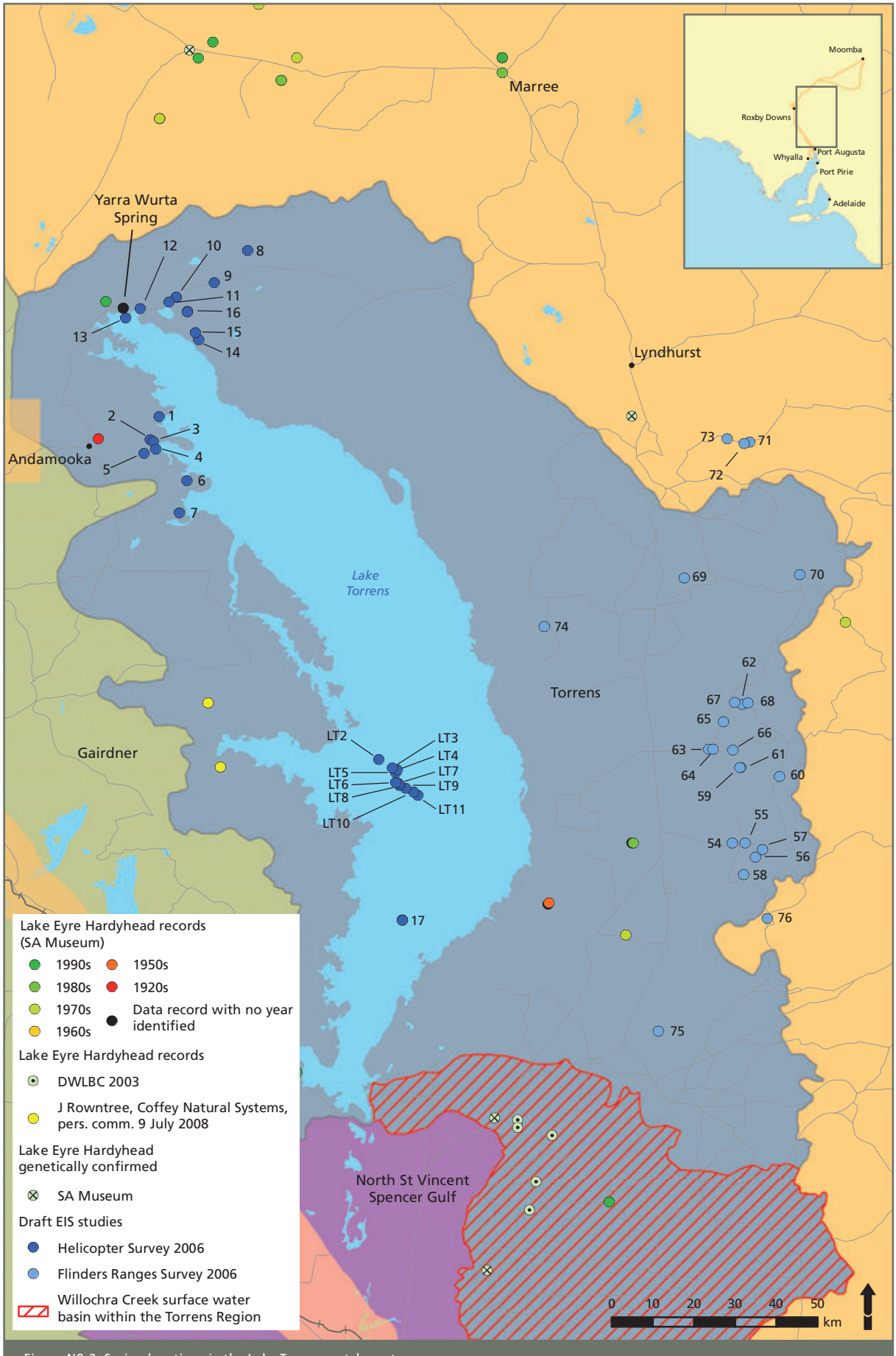

Figure N8.2 Spring locations in the Lake Torrens catchment

N8.3 LAKE EYRE HARDYHEAD – ECOLOGY AND DISTRIBUTION

The Lake Eyre Hardyhead is a small (<10 cm) native fish (see Plate N8.1) occurring widely in fresh and saline waterbodies in the Lake Eyre Basin of South Australia, including artesian springs, waterholes in creeks and man-made bores (Ivantsoff and Crowley 1996; Niejalke 1998; Allan et al. 2002). Populations of the fish are known to occur in the Yarra Wurta Spring and in the neighbouring Willochra Creek catchment (Wagner and Unmack 2000; DWLBC 2003a). During the 1989 flooding of Lake Torrens, small numbers of Lake Eyre Hardyheads were recorded in the northern end of the lake (Williams et al. 1998).

Plate N8.1 Lake Eyre Hardyhead from Yarra Wurta Spring

It is thought that isolated waterbodies in the arid zone, such as Yarra Wurta Spring, provide key refuge habitat for some aquatic species. Aquatic fauna may disperse into ephemeral waterbodies such as Lake Torrens during periods of floods (DWLBC 2003a). This is confirmed to some extent by genetic investigations that have shown that the two Lake Torrens populations of Lake Eyre Hardyhead are subtly different from each other, and from populations in the adjoining regions of the Lake Eyre Basin (Adams 2004). This demonstrates the isolated nature of the refuges, and the fact that random mating does not occur among these isolated populations. Genetic investigations have shown that each of the populations indicated on Figure N8.1 is the same species of Lake Eyre Hardyhead (Adams 2004) despite the geographical separation.

The Lake Eyre Hardyhead can tolerate high salinities (three times that of seawater) and a range of temperatures (Merrick and Schmida 1984; Ivantsoff and Crowley 1996). Consequently it is able to survive in highly saline permanent pools during drought conditions. Maintenance of aquatic biodiversity in arid ecosystems is highly dependent on the presence of permanent refuge habitats such as Yarra Wurta Spring, and periodic connectivity of these refuges during flooding to enable gene flow between populations (Costelloe et al. 2003; Costelloe et al. 2004; CRL 2004).

N8.3.1 Assessment methods

During three springs surveys within the Lake Torrens region, 45 waterbodies (springs, dams, streams and channels) were investigated (Figure N8.2). Waterbodies on the northern and western side of Lake Torrens, where fish had previously been recorded, were surveyed from 19–22 April 2006. A second survey to locate and examine additional springs in a 50 km radius east of Olympic Dam and in Lake Torrens occurred between 27–29 September 2006, using a helicopter to visit springs inaccessible by road. The second survey occurred after heavy rain in the region in June 2006. A third survey, from 26 November – 2 December 2006, investigated springs accessible by road on the eastern side of Lake Torrens (see Table N8.1). In addition, pastoralists around the perimeter of the lake were consulted regarding the presence of fish in the area.

Aquatic habitats were surveyed opportunistically in pools with clear water and by using a range of sampling equipment including dip nets, seine nets, baited traps and fyke nets. Sampling was done under a PIRSA Section 59 Fisheries Exemption (9901914) and a DEH Permit to Undertake Scientific Research (permit number Z25315).

During the second survey, water sampling and site assessments were completed by Resource and Environment Management (REM). During the third survey basic water quality parameters were sampled by Aquasave Consultants.

Table N8.1 Spring field trips by subcontractors

Date	Subcontractors	Region sampled
19–22 April 2006	Ecological Associates, Access Macquarie, Aquatic Photographics	Yarra Wurta Spring and western Lake Torrens
27–29 September 2006	REM, Aquasave Consultants	North-western, far north-eastern and central Lake Torrens
26 November–2 December 2006	Aquasave Consultants and BHP Billiton environment section	Western Lake Torrens

N8.3.2 Results

Of the 45 waterbodies investigated, only Yarra Wurta Spring contained fish. A brief overview of the springs investigated is provided below, followed by a detailed account of Yarra Wurta. The springs assessed, their location and notes on any previous South Australian Museum records of fish from the springs are shown in Attachment N8.1.

Lake Torrens Springs

Of the two waterbodies on the western side of Lake Torrens where fish had previously been recorded, one was dry and the other had no fish present, indicating that the fish populations in these springs are only temporary. Several pastoralists reported previously seeing fish (likely to be the Lake Eyre Hardyhead) in springs that were dry at the time of the current surveys (see Attachment N8.1).

Of the 17 springs visited during the second survey, 11 were sampled for fish, with the remainder being either dry, or with insufficient water to justify sampling for fish other than by visual means.

Of the 23 springs investigated during the third survey, four were dry (Sites 58, 61, 65 and 74: see Figure N8.2). Information from station owners identified a further six sites that were investigated, but actually had no springs or the existing springs were dry.

Water quality and ecology

A summary of the results are provided in Table N8.2.

During the second survey, habitat conditions at most sites were hypersaline (three to four times saltier than marine), with little aquatic cover or water depth for shelter. The exceptions were springs 8 and 9, two larger waterholes to the north-east of Lake Torrens, which recorded much lower water conductivities (0.48 and 2.52 $mScm^{-1}$ respectively).

Opportunistic samples of fauna were collected at four of the 11 springs. Invertebrates were found at spring 1 (two brine shrimp/cm^2, five chironomids (red)/10 cm^2), spring 6 (zooplankton and snail shells), spring 8 (fairy and shield shrimp, clam shrimp) and spring 9 (shield shrimp and small mussel). A large tadpole was also observed in spring 8.

Springs in the third survey were typically fresh to moderately saline water and consisted of isolated small pools with no flow (with the exception of Sites 55, 66, 64, 72 and 73, which comprised a series of pools with low flow). Springs were typically found in a river or gorge channel and were moderately shaded by eucalypts (see Plate N8.2).

Plate N8.2 Puttapa Springs in the western Flinders Ranges

Opportunistically observed aquatic fauna included yabbies, snails, boatmen, frogs, beetles, Orthoptera larvae, tadpoles, diving beetles, notonectides, mayfly larvae, copeopods and Hymenoptera.

Table N8.2 Spring physical parameters

Spring	Depth	Pool condition	Flow	Subsurface biological %	Emergent %	Edge veg. %	Shade %	pH	Cond. (mS)	Transparency (m)	Temp. (˚C)
1	0.3	Concentrated[1]	Seep	0	0	n.a.	0	7.6	201.6	n.a.	31
2	0.25	Concentrated	None	0	0	n.a.	0	7.8	200.5	n.a.	32.8
4	0.1	Concentrated	None	0	0	n.a.	0	7.5	202.2	n.a.	30.2
6	0.2	Concentrated	None	85 *Ruppia*	0	n.a.	0	9.3	51.3	n.a.	27.6
7	1.5	Concentrated	Seep	0	0	n.a.	0	7.2	181.1	n.a.	26
8	1.8	Low level	None	0	0	n.a.	2	7.8	0.48	n.a.	19.2
9	1.5	Concentrated	None	60 algae	0	n.a.	1	7.5	2.52	n.a.	23.4
10	0.4	Concentrated	Seep	0	0	n.a.	0	7.9	145.3	n.a.	32.1
14	0.2	Concentrated	Seep	0	0	n.a.	0	8.7	134.8	n.a.	30.7
15	0.25	Concentrated	Seep	85 algae	0	n.a.	0	7.2	209	n.a.	41
17	1.0	Low level	Seep	30 algae	0	n.a.	0	6.9	34	n.a.	22.8
54	0.15	Concentrated	None	2	0	0	0		3800	0.15	
55	1.2	Low level	Seep	10	20	20	40		1700	0.5	
56	0.3	Concentrated	Seep	30	0	15	40		2300	0.3	
57	0.3	Concentrated	None	30	0	15	40		2390	0.3	
58	0	Dry	None	0	70	0	50		n.a.	n.a.	
59	0.3	Concentrated	None	20	2	10	50		1332	0.2	
60	2	Bank level	None	2	30	10	30		1980	0.2	
61	0	Dry	None	0	0	0	0		n.a.	n.a.	
62	0.8	Concentrated	None	75	0	10	50		1741	20	
63	0.6	Low level	None	30	0	0	20		2298	0.5	
64	0.3	Concentrated	Low	50	10	80	10		2300	0.02	
65	0	Dry	None	0	0	0	0		n.a.	n.a.	
66	1	Low level	Low	1	10	30	40		2760	1	
67	1.3	Concentrated	None	10	5	100	40		2700	0.1	
68	0.2	Concentrated	Seep	60	5	2	40		1790	0.1	
69	1.3	Low level	Seep	15	5	10	5		4300	10	
70	1.2	Concentrated	Seep	10	0	10	20		3600	0.6	
71	1	Concentrated	Seep	0	0	1	10		15700	0.8	
72	0.3	Low level	Seep	10	5	30	40		6400	30	
73	1	Concentrated	Seep	10	5	10	5		8300	0.9	
74	0.02	Dry	None	0	0	0	0		n.a.	n.a.	
75	2	Bank level	Seep	10	40	65	5		7800	0.2	
76	2	Bank level	None	0	0	0	20		652	1	

[1] 'Concentrated' refers to a waterhole with limited habitat.

N8.4 YARRA WURTA SPRING

N8.4.1 Water quality

Water samples were taken from Yarra Wurta Spring by Macquarie University. Three 250 ml water samples were collected for analysis: one untreated, one filtered (0.2 m) and the other filtered (0.2 m) and acidified (five drops hydrochloric acid). At the time of sampling, the water temperature ranged between 21.5 °C and 25 °C. The water samples were analysed by Ecowise Environmental, a NATA accredited laboratory in Sydney, and the results are presented in Table N8.3.

Table N8.3 Yarra Wurta Spring water quality

Test	Unit	Result
pH	pH units	7.6
Bicarbonate	mg/L	300
Carbonate	mg/L	<2
Hydrox	mg/L	<2
Total alkalinity	mg/L	300
Phosphate	mg/L P	<1
Sp. conductance	µS/cm	74,000
Total dissolved solids	mg/L	54,000
Total organic carbon (as NPOC)	mg/L	<2
Total aluminium	mg/L	0.05
Total calcium	mg/L	970
Total iron	mg/L	0.76
Total potassium	mg/L	190
Total magnesium	mg/L	1,300
Total sodium	mg/L	17,000
Ammonia (as N)	mg/L N	0.37
Anions		
Chloride	mg/L	28,000
Bromide	mg/L	36
Sulphate	mg/L	5,000
Fluoride	mg/L	1.9
Nitrate	mg/L	<0.2
Nitrite	mg/L	<0.01

N8.4.2 Vegetation

Vegetation was surveyed by Dr Jane Prider of Ecological Associates.

Yarra Wurta Spring consists of two vents, with water flowing into a pool approximately 50 m long and 3–4 m wide, with silts and anaerobic muds overlying rock (see Plate N8.3). The spring is located in a broad watercourse, which is fed by run-off from a range of hills to the north of the lake. This drainage line is underlain by sandstone that outcrops in places. Most of the vegetation in the drainage line occurs on patches of alluvium. There are large areas of salt-encrusted bare ground, particularly adjacent to the spring. Soils on the surrounding high ground are gypseous clays, with a patchy overlay of sands and gravels.

The pools support large bacterial mats and filamentous green algae. One of the vents was surrounded by rock and the other by alluvial sands. The sands had an open shrub layer dominated by *Halosarcia halocnemoides longispicata*, along with *Hemichroa diandra* and another *Halosarcia* sp. These plants occurred approximately 0.5 m above the surface water level of the spring vents and pool on damp soils. At the southern end of the pool there are large, scattered *Halosarcia* species.

Within the drainage line surrounding the spring were patches of vegetation that appeared to be fed by groundwater seeps. They were different to surrounding vegetation, having greater leaf cover that indicated some dependence on groundwater. The vegetation consists of a low shrubland of *Lawrencia squamata, Frankenia foliosa, Maireana cannonii* and *Halosarcia halocnemoides longispicata.* This vegetation continues for about 400 m north of the springs.

Plate N8.3 Yarra Wurta Spring

To the immediate west of the spring there is a low open shrubland of *Lawrencia squamata* and *Sclerostegia* sp. on gypseous clay soils at high elevations. Other species include *Lycium australe, Frankenia foliosa, Maireana appressa* and *M. eriantha*. Where there are shallow sands overlying the gypseous clays, species include *Sarcozona praecox, Frankenia serpyllifolia, Osteocarpum dipterocarpum* and *Atriplex* species. This vegetation does not appear to be dependent on groundwater and occurs at elevations more than two metres above the spring.

Sand dunes between the spring and Lake Torrens have a sparse cover of *Zygochloa paradoxa*, *Lycium australe, Sclerostegia* sp. and *Scaevola collaris* with emergent *Pittosporum angustifolium*. This vegetation is about 500 m from the spring and is not considered to be dependent on groundwater discharge.

The vegetation in the spring and environs is in relatively good condition, although large, salt-tolerant shrubs to the immediate south of the spring are senescent and the cause of this is not clear. The surrounding shrublands are grazed but although cattle have been trampling the spring, the disturbance appears minor.

No introduced flora was recorded from the spring or the immediate surrounding vegetation.

No flora or plant associations of conservation significance were recorded at the spring or surrounding areas. A list of species occurring at the site is provided in Table N8.4.

Table N8.4 Vegetation recorded at Yarra Wurta Spring (19 April 2006)

Species	Common name
Hemichroa diandra	Mallee Hemichroa
Atriplex spongiosa	Pop Saltbush
Halosarcia halocnemoides	No common name
Halosarcia halocnemoides longispicata	No common name
Halosarcia sp.	No common name
Maireana appressa	Pale-fruit Bluebush
Maireana eriantha	Woolly Bluebush
Osteocarpum dipterocarpum	Two-wing Bonefruit
Minuria cunninghamii	Bush Minuria
Frankenia foliosa	Leafy Sea-heath
Frankenia serpyllifolia	Thyme Sea-heath
Scaevola collaris	No common name
Zygochloa paradoxa	Sandhill Cane-grass
Lawrencia squamata	Thorny Lawrencia
Lycium australe	Australian Boxthorn

N8.4.3 Stromatolites

Stromatolite fossils have been dated at up to 3.5 billion years old, and are therefore considered to be the oldest evidence of life on Earth. They consist of layers of sediment-formed rock built by a form of blue-green algae known as cyanobacteria, which is the simplest single-celled life-form known. Stromatolites generally occur only as fossils, but sometimes occur as living organisms. The presence of living stromatolites in Shark Bay in Western Australia was a major factor in this area being declared a World Heritage Area.

Methods

The presence of stromatolites in Yarra Wurta Spring was investigated during a field visit to the spring on 19 April 2006, by Dr Roberto Anitori of Macquarie University.

A 50 ml Falcon tube was used to collect five core samples of algal material from several locations in the spring (under permit number Z25315). Several rock samples that had a stromatolite-like appearance were taken from the spring for analysis. All samples were taken to Macquarie University for analysis by Professor Malcolm Walter, a renowned authority on stromatolites.

Nine rock samples were examined for sedimentary features that would provide evidence of their origin. The initial examination was with the naked eye and a hand lens. Five samples that had a well-developed laminar structure (samples 2006-04 B, C, D, E and G) were selected for detailed analysis. Two thin sections perpendicular to lamination were made from each sample, one 30 µm thick and the other 60 µm. The thinner sections were half-stained with Alizarin Red S and potassium ferricyanide to determine carbonate mineralogy. The thicker sections were taken to study lamination details.

Results and discussion

At and under the water surface, layered, mat-like algal structures of varying colours were present lying above a black, hydrogen-sulphide-emitting mud (see Plate N8.4). The spring was largely covered in benthic orangey/brownish growth, consisting of layered structures with green and orange or white colouration, varying from soft to extremely rubbery in consistency.

Plate N8.4 Stromatolite-like rock and algal formations in Yarra Wurta Spring

All the samples stained positive for calcite. All were laminated on a millimetric scale. The laminae form convex-up small domical features. Most laminae were continuous between adjacent domes, but in samples D and G some domes were separated by poorly laminated sediment and the domes had ragged margins.

All thin sections revealed what are called palimpsest microbial structures. These are faint remnants of filamentous microbes. They were abundant and, where visible, most were perpendicular to the lamination. They were tubular and about 20 µm in diameter and were most clearly visible in samples D and G.

Sample E was highly fenestrate (i.e. there were numerous voids, probably resulting from the decomposition of organic matter). This sample also had round voids that might be cross-sections of large tubular structures, perhaps from a large alga such as *Chara*.

The evidence suggests that all the rocks are stromatolites. That is, they originally were laminated microbial mats built by filamentous microbes. Calcium carbonate precipitated in the mats, lithifying them.

Such stromatolites are common around springs worldwide.

In addition, the living microbial mats in the Yarra Wurta Spring appear to be the precursors of stromatolites. Such microbial mats are also common around springs worldwide.

It is interesting that the observations indicate two periods of stromatolite formation separated by a time gap of unknown duration. Possibly the springs were dry for a long period and then began to flow again.

Other than this discontinuity, the stromatolites and mats at Yarra Wurta appear to be of only minor scientific interest (M Walter, Macquarie University, pers. comm., 1 June 2006).

N8.4.4 Lake Eyre Hardyhead genetics

Methods

Live fish from the Yarra Wurta Spring were transported to Adelaide for enzyme analysis at the South Australian Museum (under Section 59 Fisheries exemption number 9901914). The live fish were sedated with clove oil and frozen for allozyme analysis.

Genetic profiles for 25 Hardyhead fish were determined at 52 allozyme loci using the molecular genetic technique of allozyme electrophoresis. The fish from Yarra Wurta included seven individuals collected from the April 2006 survey, and five collected in 2004, but which had died prior to delivery to the museum. The remaining 13 fish were sampled from seven additional sites, including two sites from which the fish had previously been genetically analysed (see Figure N8.2). To determine the genetic relationships among populations of *C. eyresii*, principal co-ordinate analysis (PCoA) of fish with complete or near-complete allozyme profiles was undertaken (see Figure N8.3).

Results

Analysis of allozyme electrophoresis of the 25 fish clearly identified the 12 fish collected from Yarra Wurta Spring as *Craterocephalus eyresii* (Adams 2006). Genetic variability of all populations and species of Hardyhead examined, as determined by allozyme variation, was lowest in the Yarra Wurta population (heterozygosity = 0.003 ± 0.003), closely followed by the Willochra Creek population (0.01± 0.01) (Adams 2006).

Allozyme analysis of Lake Eyre Hardyheads from several sites in the Lake Eyre and Willochra Basins identified five genetically definable sub-populations, which correlated with their geographical locations (see Figures N8.2 and N8.3) (Adams 2004). The genetic PCoA placed the Yarra Wurta population between the Willochra Creek and the Lake Eyre South populations, which reflects the geographical position of these populations. The fish from each location have statistically significant differences in allele frequencies; the Yarra Wurta population being different at one locus compared with the Lake Eyre South population, and at two loci compared with the Willochra Creek population.

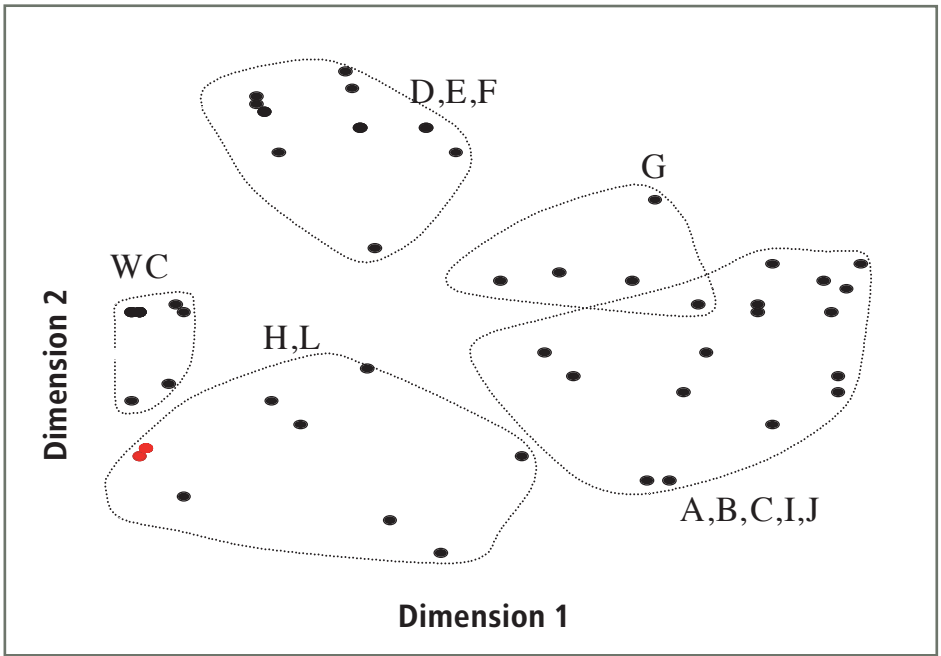

Figure N8.3 Principal coordinate analysis of the allozyme data from *C. eyresii,* showing major groupings based on geographically-based clusters

Discussion

Allozyme electrophoresis has identified the Yarra Wurta Lake Eyre Hardyhead population as subtly different from the other fish populations sampled. The lack of genetic allozyme variation evident in the Yarra Wurta (and Willochra Creek) populations identified them as comparatively inbred compared with the *C. eyresii* elsewhere. Inbreeding may result from founder effects, genetic drift and/or selection. Despite the lack of allozyme variation, the Yarra Wurta population does not display any alleles at high frequency that are absent elsewhere across the geographic range of *C. eyresii*. This is in contrast to the Willochra Creek population where an otherwise rare allele occurs at a frequency of 50%.

The eco-geographical uniqueness of the Willochra Creek population considerably increased its ecological significance, leading to the recognition of the Willochra Creek population as a 'management unit' (DLWBC 2003a). Both 'management units' (MUs) and 'evolutionarily significant units' (ESUs) can be assigned to a population and define a special status that aids in the management of the population (Moritz et al. 1995). Management of vulnerable species with fragmented distribution requires the identification of the smallest number of regional populations that harbour the major proportion of the 'evolutionary potential' or genetic and ecological parameters of the species (Adams 2004). 'Management units' take a regional approach and place less reliance on genetic data, whereas 'evolutionarily significant units' take a species level perspective on evolutionary potential and identify the primary sources of historical genetic diversity. While there are no legislative implications following the identification of a population as a 'management unit', the allocation of this status is aimed at raising awareness of the significance of the population and to assist with conservation management.

While the Yarra Wurta population of *C. eyresii* has been identified as distinctly different to other sampled *C. eyresii* populations, the differences are not great enough for the population to be recognised as a different species or subspecies, or to warrant any special consideration as a 'management unit' (Adams 2006).

The ecological significance of the Yarra Wurta population of the Lake Eyre Hardyhead depends on the presence of other permanent populations of the species in the Lake Torrens catchment. If Yarra Wurta Spring provided the only permanent refuge habitat, its significance would be enhanced as it would provide the only population from which colonisation of Lake Torrens would occur during floods. However, it appears that there are several other refuge habitats for the Lake Eyre Hardyhead in the catchment. The Willochra Creek population of the Lake Eyre Hardyhead occurs in waterbodies in gorges, rolling hills and lowlands before the creek exits the Flinders Ranges on to the Lake Torrens plain (DWLBC 2003a). Although none of these pools is greater than 1.5 metres, many are groundwater dependent and therefore relatively permanent (DWLBC 2003b). During floods, Lake Eyre Hardyheads would probably disperse from these pools down Willochra Creek into Lake Torrens.

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Attachment N8.1 Spring locations in and around Lake Torrens

Site	Spring number	Location	Survey[1]	Waterway	Museum fish record date	Pastoral property	Comments
Yarra Wurta Spring	–	53J, 715493, 6660892	S1		1996, 2006	Mulgaria	Fish collected
Mirrabuckia Waterhole	8	53J, 742012, 6674259	S2	Isolated	–	Mulgaria	No fish
Flagstaff Waterhole	9	53J, 734782, 6666637	S2	Rocky Creek	–	Mulgaria	No fish
Spring NE Lake Torrens	10	53J, 726512, 6663191	S2	Rocky Creek	–	Mulgaria	No fish
	11		S2		–	Mulgaria	Too little water
	12		S2		–	Mulgaria	Too little water
	13		S2		–	Mulgaria	Too little water
Spring NE Lake Torrens	14	53J, 731170, 6652833	S2	Unnamed	–	Mulgaria	No fish
Spring NE Lake Torrens	15	53J, 728985, 6659762	S2	Unnamed	–	Mulgaria	No fish
	16		S2		–	Mulgaria	Too little water
Spring in middle of southern Lake Torrens	17	53J, 770461, 6511296	S2	Lake Torrens	–		No fish
Springs in central Lake Torrens	LT1–9		S2		–		Group of nine springs in central Lake Torrens, all dry
Spring at Andamooka	–	53J, 709626.87, 629383.38	S1		1905	Andamooka	Spring is dry
Spring NW Lake Torrens	1	53J, 722565, 6634483	S2	Lake Torrens		Andamooka	
Spring NW Lake Torrens	2	53J, 720572, 6628926	S2	Trig Creek		Andamooka	
	3		S2			Andamooka	Too little water

Attachment N8.1 Spring locations in and around Lake Torrens (cont'd)

Site	Spring number	Location	Survey[1]	Waterway	Museum fish record date	Pastoral property	Comments
Western edge of Lake Torrens	4	53J, 721674, 6626599	S2	Crozier Creek		Andamooka	
	5		S2			Andamooka	Too little water
Western Lake Torrens	6	53J, 728006, 6618822	S2	Lake Torrens		Andamooka	
Spring Western Lake Torrens	7	53J, 726258, 6611069	S2	Andamooka Creek		Andamooka	
			S1			Bosworth	Spring on property is dry Spring on lake is inaccessible
			T			Arcoona	Spring is dry
			T			Pernatty	Spring is dry
West Beda Hill (spring at southern end of Lake Torrens)		53J, 747589.7, 6475143.52	S1		1990	South Gap	Spring site completely dry Two small dams nearby with water, plants and bivalves, but no fish
			T			Kootaberra	Dam about half full, mullet-like fish present No connection to Lake Torrens
			T			Yadlamulka	Permanent salt-water hole on Lake Torrens from the Willochra Creek system
Moralana (Spring on south-eastern shoreline of Lake Torrens)		54J, 230597.23, 6515224.48	T		no date	Wintabat-inyana	Springs are dry Fish in springs previously
Brachina (Spring south-east of Lake Torrens)		54J, 247862.42, 6530507.69	T		no date	Motpena	Springs are always slightly wet, but no fish presently Fish in springs previously Spring 5 km west of property on Lake Torrens Predicts eggs remain dormant in springs/creeks until conditions are ideal
			T			Beltana	Two springs on property, both dry No fish present
Brachina Gap, Brachina Gorge	54	54J, 268682, 653961	S3	Brachina Creek			Spring pool
Lubra waterhole, Brachina Gorge	55	54J, 271351, 6530974	S3	Brachina Creek			Waterhole
Elatina Water, Brachina Gorge	56	54J, 273620, 6527660	S3	Elatina Creek			Spring pool
Elatina Middle site spring, Brachina Gorge	57	54J, 275088, 6529534	S3	Brachina Creek			Spring pool
Bunyeroo Gorge	58	54J, 271233, 6523318	S3	Bunyeroo Creek			Dry spring
Little Wurta Spring	59	54J, 270136, 6549319	S3	Parachilna Gorge creek trib.		Gum Creek	Spring pool
Dam	60	54J, 278172, 6547339	S3	Patterton Creek		Gum Creek	Dam

Attachment N8.1 Spring locations in and around Lake Torrens (cont'd)

Site	Spring number	Location	Survey[1]	Waterway	Museum fish record date	Pastoral property	Comments
Winna Winna Spring	61	269900, 54J, 6549333	S3	Parachilna Gorge creek trib.		Gum Creek	Spring pool
Second Spring	62	54J, 270096, 6564606	S3	Oratunga Creek		Oratunga	Spring pool
Parachilna Gorge	63	54J, 263303, 6553545	S3	Parachilna Creek		Mt Falkland	Spring pool/dam
Oratunga/ Parachilna Creek junction	64	54J, 264237, 6553587	S3	Parachilna Creek		Alpana	Spring pool
Third Spring	65	54J, 266251, 6560330	S3	Oratunga River		Oratunga	River channel
Beliman pools	66	54J, 268377, 6553481	S3	Wocker-awira River		Alpana	Stream
First Spring	67	54J, 268455, 6564979	S3	Oratunga Creek		Oratunga	Spring pool
Forth Spring	68	54J, 271262, 6564979	S3	Oratunga Creek		Mooloolo	Spring pool
Puttapa Spring	69	54J, 257213, 6594980	S3	Warruiita Creek		Beltana	Spring pool
Blinmans camp	70	54J, 281390, 6596316	S3	Sandy Camp Creek		Warra-weena private conservation reserve	Spring pool
Mundy Spring	71	54J, 270226, 6628190	S3	Mundy Creek		Depot Spring	Spring pool
Jeremiah Spring	72	54J, 269053, 6627774	S3	Jeremiah Creek		Depot Spring	Spring pool
Patsy Spring	73	54J, 265533, 6628886	S3	Mundy Creek		Depot Spring	Spring pool
Norina	74	54J, 228257, 6582490	S3	Warrioota Creek		Beltana	Spring pool
Mayo Gorge Spring	75	54J, 254372, 6485005	S3	Hookina Creek		Wonoka	Spring pool/dam
Wilpena Pound, approximately 3 km south of township	76	54J, 276397, 6512865	S3	Wood Duck Dam			Dam

[1] Survey: T = telephone survey of pastoralist; S1 = survey 1; S2 = survey 2; S3 = survey 3.

APPENDIX N9

Significant environmental benefit proposal

N9 SIGNIFICANT ENVIRONMENTAL BENEFIT PROPOSAL

N9.1 BACKGROUND

All native vegetation in South Australia is protected under the provisions of the *Native Vegetation Act 1991*. Clearance of vegetation is prohibited unless it is approved by the Native Vegetation Council (NVC) or the activity requiring the clearance is exempted by the regulations under the Act. In most circumstances, including exemptions, the clearance of vegetation is to be accompanied by an approved management plan that describes a significant environmental benefit (SEB).

Under Regulation 5(1)(c) of the Native Vegetation Act, the proposed Olympic Dam expansion is exempt from the provisions of the Act, but is required to prepare a management plan approved by the NVC that results in a SEB.

The goal of a SEB is to achieve a net gain that contributes to improving the condition of the environment and biodiversity of the region, rather than to simply replace the immediate environmental values lost through clearing.

The SEB may be in the form of either:

(1) a payment to the Native Vegetation Fund as established under the Native Vegetation Act

(2) an appropriate offset through the identification of land that can be protected and managed as a set-aside area

(3) alternative offset activities.

Options (2) and (3) require the preparation of a native vegetation management plan by the proponent that describes how the native vegetation is to be managed to achieve the SEB.

A combination of (1), (2) and (3) may also be considered by the NVC.

The purpose of this appendix is to present BHP Billiton's proposal to meet its SEB obligations, and to assist in the subsequent development of a native vegetation management plan.

N9.2 SEB RATIO

The SEB ratio is used to determine the size of the SEB payment or set-aside area. It is used in the following way:

- the SEB area is calculated as the area of native vegetation to be cleared, multiplied by a set-aside ratio. The ratio varies from 2:1 (weed dominated with only scattered areas or patches of native vegetation) to 10:1 (intact vegetation) as determined by established indicators of vegetation condition
- the SEB ratio may be reduced by half for any area that is to be restored to as near as practicable to original condition following the clearance
- a further 50% reduction in the ratio can be achieved with additional mitigation measures. However, this involves mitigation and conservation of key criteria based on principles described in the Native Vegetation Act and is to be additional to onsite restoration (e.g. mitigation measures beyond restoration of clearance of threatened flora)
- for cleared areas that are not restored (e.g. the open pit mines and rock storage facility), the SEB ratio may be reduced by half if specific ecological restoration activities are undertaken offsite. Such activities would need to address the conservation of significant flora and fauna affected by the clearance.

N9.3 OFFSET OPTIONS

There are three ways in which the vegetation clearance offset may be made.

Option 1 SEB payment

The SEB payment is calculated as the SEB area multiplied by land value, plus a one-off management fee multiplied by the area cleared. Currently a standard one-off management fee of $800/ha has been endorsed by the NVC.

Any payments into the Native Vegetation Fund are to be used by the NVC to achieve an environmental benefit in the same region where the clearance occurs.

Option 2 Set-aside area

The SEB set-aside area is equivalent to the SEB area calculated above. The aim of the set-aside area is to provide an offset to the clearance through the long-term conservation of flora and fauna in the district. This may be in the form of protecting and managing existing native vegetation (preferred) or by restoring previously cleared areas. When establishing the location of the set-aside area, consideration should be given to providing sufficient buffer areas between the proposed development and conservation areas.
A management plan is required that identifies the location of the set-aside area and its management. Management requirements may include fencing to exclude stock, and control of weeds and introduced fauna. For larger areas, the allocation of environmental staff to undertake the actions identified in the management plan would also be required. The plan must be endorsed by the NVC and comply with Regulation 7 of the Native Vegetation Act.

Option 3 Other offset activities

Other activities that result in the conservation of flora and fauna in the district may be considered by the NVC to provide a sufficient SEB. These may include providing funding or other assistance to local organisations to manage environmental problems in the region. Again, a management plan that details the actions and costings to be undertaken is required.

BHP Billiton's preferred approach

BHP Billiton proposes a combination of Option 1 (SEB payment) and Option 2 (set-aside area) to provide a SEB to offset vegetation clearance associated with the proposed Olympic Dam expansion.

N9.4 VEGETATION CLEARANCE

N9.4.1 Areas of vegetation clearance

The proposed expansion would result in the clearance of native vegetation during construction and mining activities (see Figures N9.1a and N9.1b). Most vegetation clearance would occur in the South Australia Arid Lands Natural Resources Management (NRM) region in the vicinity of the mine, but smaller areas associated with the desalination plant and infrastructure corridors fall in the Northern and Yorke and Eyre Peninsula NRM regions (see Figure N9.2).

The proposed expansion would result in the clearance of about 13,108 ha of native vegetation at the mine site and about 3,818–4,161 ha for associated infrastructure, including the expanded township of Roxby Downs, rail line from Pimba to Olympic Dam, transmission line from Port Augusta to Olympic Dam, water pipeline from Point Lowly to Olympic Dam and gas pipeline from Moomba to Olympic Dam. The clearance figure within the special mining lease includes about 528 ha of vegetation around the rim of the open pit and 90 ha in the access corridor through the rock storage facility, where the vegetation would be cleared in some areas and highly degraded in others. A further 20 ha has been included for clearance associated with ancillary infrastructure that may be required during expansion operations (see Table N9.1).

The effect of emissions on vegetation is difficult to quantify as the areas at greatest potential risk from dust and sulphur dioxide would already have been totally cleared of vegetation during construction of the open pit, rock storage facility and tailings storage facility (12,131 ha), which would therefore buffer impacts on vegetation to some degree.

The total area of vegetation clearance would be 16,926–17,269 ha (depending on the gas pipeline route chosen).

Progressive areas of vegetation clearance associated with each component of the proposed expansion are shown in Table N9.1. The area of each vegetation association that would be cleared is shown in Table N9.2. The area of each vegetation association cleared is also expressed as a percentage of the total area of each association within the EIS Study Area (thus representing the percentage within the local area).

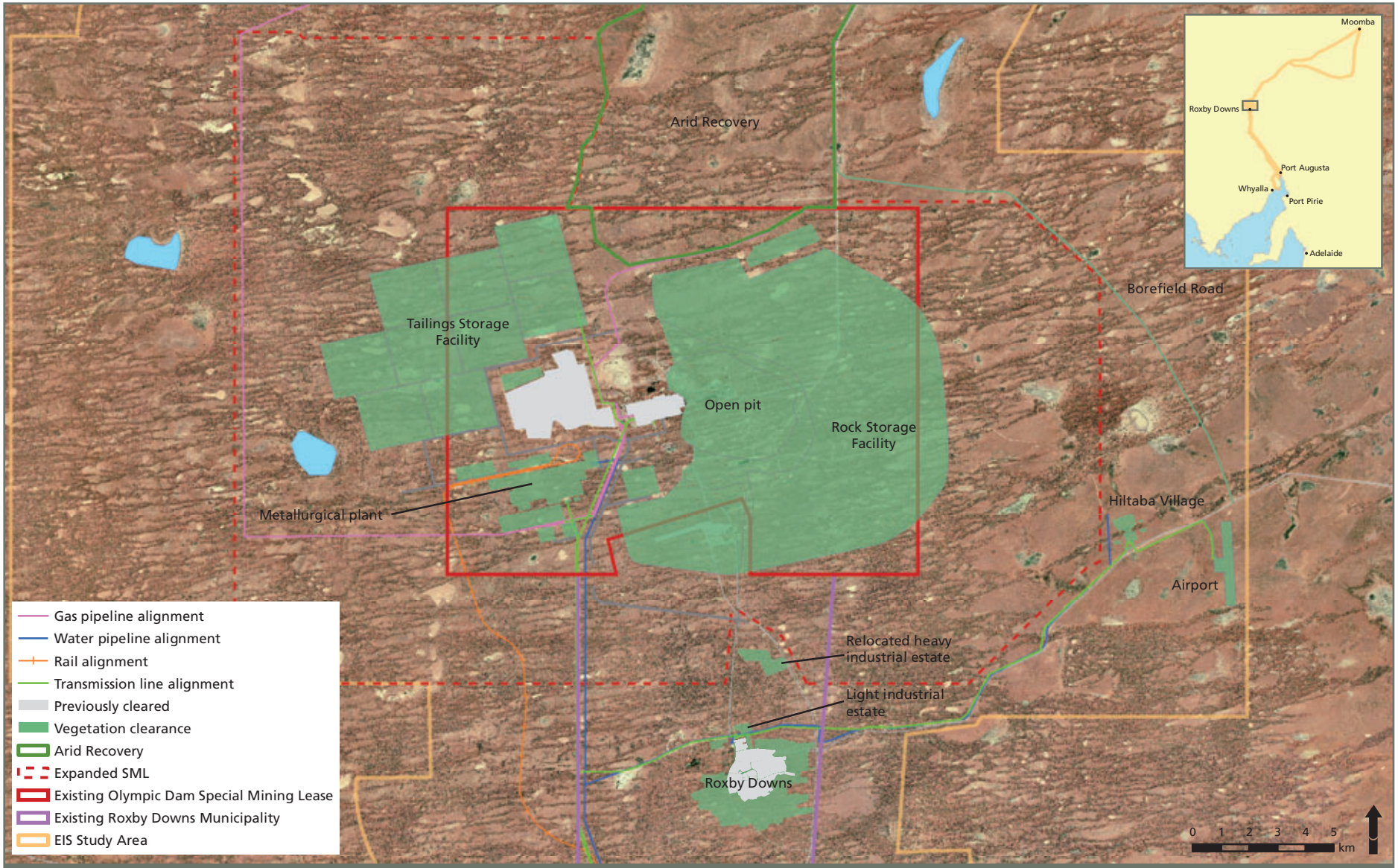

Figure N9.1a Areas of vegetation clearance (Olympic Dam area)

Figure N9.1b Areas of vegetation clearance (infrastructure corridors)

Figure N9.2 Location of Natural Resource Management regions

Table N9.1 Progressive areas of vegetation clearance associated with each component of the proposed expansion

Project site	Cumulative total (ha)		
	Predicted construction period (Year 10)	Year 20	Total vegetation cleared (Year 40)
Open pit and perimeter	173.0	264.0	1,009.5
Rock storage facility and haul roads	4,791.0	6,443.0	6,721.4
Tailings storage facility	2,467.0	4,399.6	4,399.6
Metallurgical plant and associated facilities	977.7	977.7	977.7
Roxby Downs and heavy industrial estate	515.0	515.0	515.0
Hiltaba Village and airport	160.1	160.1	160.1
Rail (30 m) and intermodal facility	443.9	443.9	443.9
Gas pipeline and facilities (30 m)	1,342.2–1,684.7[1]	1,342.2–1,684.7	1,342.2–1,684.7
Water pipeline (30 m)	992.9	992.9	992.9
Electrical transmission line and substation (15 m)	166.5	166.5	166.5
Access corridor (15 m), landing facility and Port Augusta pre-assembly yard	73.2	73.2	73.2
Desalination plant and associated facilities	28.7	28.7	28.7
Marine facilities (landing pier and intake/outfall pipelines)	2.7	2.7	2.7
Borefield Road (60 m)	41.4	41.4	41.4
Passing bays and borrow pits	32.0	32.0	32.0
Miscellaneous (e.g. mobile camps, rest areas and ancillary infrastructure)	20.0	20.0	20.0
Totals	12,227–12,570	15,902–16,246	16,926–17,269[1]

[1] Range reflects the shortest and longest alternative gas pipeline routes; totals include clearance within three NRM regions.

Table N9.2 Area of each vegetation association to be cleared (hectares)

Vegetation associations	Open pit and perimeter	RSF and haul roads	TSF	Metallurgical plant and associated facilities	Roxby Downs and heavy industrial estate	Hiltaba Village and airport	Rail line and intermodal facility	Gas pipeline	Water pipeline	Transmission line	Access corridor and Port Augusta laydown	Desalination plant and associated facilities	Marine facilities (landing and pipelines)	Borefield Road	Passing bays and borrow pits	Total cleared	Vegetation in EIS Study Area	% loss
Acacia aneura woodland (1–4)		100.6	1.0	25.7			18.3	50.8	100.4	19.2					3.4	319.4	70,235.7	0.5
Acacia papyrocarpa woodland (9, 10, 63)		11.6	131.4		94.1		1.8		173.9	23.7					2.2	438.7	96,213.5	0.5
Acacia shrubland (5–7, 11–15, 40, 77)	722.1	3,877	2,315	492.3	351.8	5.5	99.6	100.1	126.6	34.8				15.6	2.6	8,142.9	144,586.0	5.6
Amphibolis antarctica													0.3			0.3	30.0	1.0
Astrebla pectinata grassland (70)								408.4								408.4	152,764.2	0.3
Avicennia marina forest (31)													0.1			0.1	856.0	0.0
Beyeria lechenaultii/Westringia rigida low shrubland (32)																0.0	30.3	0.0
Callitris glaucophylla woodland (33–34)	9.6	482.3			60.5		50.1		56.7	8.9					3.1	671.1	26,010.0	2.6
Casuarina pauper woodland (36–37)									7.4	0.1						7.5	10,521.8	0.1
Chenopod shrubland (17–30, 38, 42, 49–59, 72)	249.9	2,051	1,826	452.8	8.6	0.0	271.0	453.8	476.1	63.7	73.2	27.0		23.7	19.7	5,997.2	422,688.9	1.4
Claypan – ephemerals (39)	28.0	88.7	83.1	6.9			0.9		1.6	0.7						209.8	15,987.2	1.3
Cyperus spp. low sedgeland (71)																0.0	322.6	0.0
Eragrotis australasica grassland (41)		14.5	29.8				1.0	10.4	1.2	0.1				1.3		58.4	4,787.7	1.2
Eucalypt woodland (43–45, 76)								64.6	38.8	2.4						105.7	33,378.2	0.3
Geijera linearifolia, shrubland – *Casuarina pauper* woodland (46)		5.1														5.1	199.1	2.6
Maireana aphylla (49)		11.3				9.5		19.3		0.1						40.2	14,297.7	0.3
Melaleuca shrubland (60)																0.0	234.7	0.0
Melaleuca xerophila woodland (61)									0.6	0.4						0.9	371.4	0.2
Muehlenbeckia florulenta +/– *Maireana aphylla* shrubland (62)								7.8								7.8	4,783.9	0.2
Myoporum platycarpum woodland (64)									2.3	0.3						2.6	352.2	0.7

Table N9.2 Area of each vegetation association to be cleared (hectares) (cont'd)

Vegetation associations	Open pit and perimeter	RSF and haul roads	TSF	Metallurgical plant and associated facilities	Roxby Downs and heavy industrial estate	Hiltaba Village and airport	Rail line and intermodal facility	Gas pipeline	Water pipeline	Transmission line	Access corridor and Port Augusta laydown	Desalination plant and associated facilities	Marine facilities (landing and pipelines)	Borefield Road	Passing bays and borrow pits	Total cleared	Vegetation in EIS Study Area	% loss
Nitraria billardieri open shrubland (73)								232.0								232.0	79,070.3	0.3
Olearia axillaris/Scaevola crassifolia shrubland (65)												1.7				1.7	84.1	2.0
Posidonia spp.													2.4			2.4	1,250.0	0.2
Samphire shrubland (48, 74)							0.7	7.5	6.9	3.1						18.2	8,425.4	0.2
Sclerolaena spp. low shrubland (66–68, 78)		78.7	13.0			145.1	0.6	196.0	0.5	9.1				0.8		443.8	65,877.7	0.7
Senna shrubland (69)															1.1	1.1	1,505.8	0.1
Zostera spp.													0.3			0.3	25.0	1.2
Zygochloa paradoxa grassland (75)								134.2								134.2	203,854.0	0.1
Total	1,010	6,721	4,400	978	515	160	444	1,685	993	167	73	29	3	41	32	17,249	1,358,743	

[1] Total does not include miscellaneous clearance of 20 ha from Table N9.1 (vegetation types are unknown); assumes longest gas pipeline route.

N9.4.2 SEB area

The SEB area is calculated by multiplying the area cleared by the SEB ratio, which is based on vegetation condition. Ecological surveys of the disturbance footprints suggest that the vegetation in the study area is generally in good condition and that a SEB ratio of 8:1 provides an appropriate reflection of virtually all the disturbance areas (Ecological Associates 2006).

It is assumed that 75% of the infrastructure corridors would revegetate reasonably quickly and therefore that a halving of the SEB ratio to 4:1 for 75% of the disturbed area of these corridors is justified. The calculation of the SEB areas for the Arid Lands, Northern and Yorke, and Eyre Peninsula NRM regions is shown in Tables N9.3, N9.4 and N9.5, respectively. The SEB areas for vegetation clearance in each of the three NRM regions affected by the expansion are summarised in Table N9.6. The SEB area for the loss of seagrass associated with construction of the landing facility and the intake and outfall pipelines for the desalination plant are shown in Table N9.7.

Table N9.3 SEB area for the Arid Lands NRM region

Project site	Areas (ha)			SEB area (ha)	
	Total area cleared[1]	Area with revegetation	Area with no revegetation	Area with revegetation x 4	Area with no revegetation x 8
Open pit	1,009.5	0.0	1,009.5	0.0	8,076.0
Rock storage facility	6,721.4	0.0	6,721.4	0.0	5,3771.2
Tailings storage facility	4399.6	0.0	4,399.6	0.0	35,196.8
Metallurgical plant	977.7	0.0	977.7	0.0	7,821.6
Roxby Downs	515.0	0.0	515.0	0.0	4,120.0
Hiltaba Village and airport	160.1	0.0	160.1	0.0	1,280.8
Rail (30 m) and intermodal facility	443.9	332.9	111.0	1331.7	887.8
Gas pipeline (30 m)	1,341.2–1,684.7[2]	1,005.9–1,263.5	353.3–421.2	4,023.6–5,054.1	2,682.4–3,369.4
Water pipeline (30 m)	852.4	639.3	213.1	2,557.2	1,704.8
Transmission line (10 m)	144.5	108.4	36.1	433.5	289.0
Borefield Road (60 m)	41.4	0.0	41.4	0.0	331.2
Passing bays and borrow pits	32.0	0.0	32.0	0.0	256.0
Miscellaneous	20.0	0.0	20.0	0.0	160.0
				8,341.1–9,376.5	+ 116,577.8–117,264.6
Totals	16,659–17,002[2]				= 124,924–126,641[2]

[1] Does not include clearance in Eyre and Northern and Yorke NRM regions.
[2] Range reflects the two alternative gas pipeline routes.

Table N9.4 SEB area for Northern and Yorke NRM region

Project site	Areas (ha)			SEB area (ha)	
	Total area cleared	Area with revegetation	Area with no revegetation	Area with revegetation x 4	Area with no revegetation x 8
Water pipeline (30 m)	81.2	60.9	20.3	243.6	162.4
Transmission line (10 m)	10.1	7.6	2.5	30.3	20.2
Access corridor (60 m) and Port Augusta pre-assembly yard	73.2	0.0	73.2	0.0	585.6
				273.9	+ 768.2
Totals	165				= 1,042

Table N9.5 SEB area for the Eyre Peninsula NRM region

Project site	Areas (ha)			SEB area (ha)	
	Total area cleared	Area with revegetation	Area with no revegetation	Area with revegetation x 4	Area with no revegetation x 8
Water pipeline (30 m)	59.3	44.5	14.8	177.9	118.6
Transmission line (10 m)	11.9	8.9	3.0	35.7	23.8
Desalination plant	28.7	0.0	28.7	0.0	229.6
				213.6	+ 372.0
Totals	100				= 586

Table N9.6 SEB areas to compensate for vegetation clearance in each NRM region

NRM region	Area of vegetation cleared (ha)	SEB area (ha) (SEB ratios = 4:1 and 8:1)
Arid Lands	16,659–17,002	124,924–126,641[1]
Northern and Yorke	165	1042
Eyre Peninsula	100	586

[1] Range reflects the shortest and longest gas pipeline routes

Table N9.7 SEB areas to compensate for clearance of seagrass

Project component	Area of seagrass loss (ha)	SEB area (ha) (SEB ratio = 10:1)
Intake pipeline	1.5	15
Outfall pipeline	1.0	10
Landing facility	0.5	5

N9.5 BHP BILLITON PROPOSALS

BHP Billiton proposes a combination of set-aside areas (see Section N9.5.1) and payment into the Native Vegetation Fund (see Section N9.5.2) to comply with the *Native Vegetation Act 1991*.

N9.5.1 Set-aside areas – Arid Lands NRM region

BHP Billiton proposes to use the set-aside option to compensate for vegetation clearance in the Arid Lands NRM region. BHP Billiton owns several pastoral stations in the vicinity of Olympic Dam, sections of which would be set aside to meet the requirements of a SEB under the Regulations to the Native Vegetation Act.

Criteria for selection

The International Council for Mining and Metallurgy (ICMM) recently published the *Good Practice Guidance for Mining and Biodiversity* (ICMM 2006). The ICMM guide and background studies provide the principles by which native vegetation suitable for achieving a SEB was identified (ten Kate et al. 2004).

Specifically set-aside areas and priorities were identified using the following key principles. The area:

a) should be larger than disturbance to compensate for direct and indirect impacts

b) should complement other programs and conservation priorities

c) net gain should be achieved for biodiversity over time

d) should be quantifiable

e) should apply a 'like for like or better' basis

f) ideally should be in the same area

g) should be similar to original habitat disturbed

h) should be supplementary – not already established under a separate program.

Set-aside options

Five areas located on BHP Billiton stations (Stuarts Creek, Andamooka, Roxby Downs and Purple Downs) were identified as potential options for establishing a SEB. These areas are Gosse/Emerald Springs, McCormack Reserve, Wood Duck and Black Swan Wimbrina East and Kookaburra (see Figure N9.3). Areas were selected that historically experienced light grazing pressure by domestic stock and contained unique or important habitat types, away from the potential influence of infrastructure corridors and mining operations. Areas on BHP Billiton stations previously set aside for conservation purposes (e.g. Arid Recovery and Wabma Kadarbu Conservation Park: see Figure N9.3) were not considered as they were already established under separate programs, making them inconsistent with principle (h) listed above.

Gosse/Emerald Springs is located in the north-eastern area of Stuarts Creek Station and covers an area of 45,300 ha. The northern side adjoins Lake Eyre National Park and is unfenced. The eastern boundary follows Finniss Springs Aboriginal Lands. The southern boundary follows the Oodnadatta Track and is unfenced. Sections of this boundary may need fencing to prevent the ingress of wandering stock. The area includes the only access to view Lake Eyre along a major tourist route in northern South Australia. Four Great Artesian Basin spring groups are located in the area, all of which are listed as endangered ecosystems under the EPBC Act. The Gosse/Emerald Springs area is located in the Wattiwarriganna and Oodnadatta land systems (Badman 1999; Kingoonya Soil Conservation Board 2002). The area is predominantly low Cobbler, or parallel sand dunes with low Nitre Bush *Nitraria billardierei* or Sandhill Cane Grass *Zygochloa paradoxa*. Samphire communities are also present along the lake edge and following drainage lines. Clay plains between the dunes are often covered with gibber and sparse chenopods (e.g. *Atriplex* sp. and *Maireana* sp.). During good seasons the dunes have a dense understorey of wild flowers, including *Polycalymma* sp., *Othonna* sp. and *Crotalaria* species.

McCormack Reserve is an area of 2,750 ha that predominantly supports a chenopod scrubland with an overstorey of Western Myall and Mulga, which is representative of much of the Roxby land system, and the area of the proposed expansion. The reserve also supports a *Melaleuca*-lined Lignum swamp, a rocky ridge and stands of both Quandong *Santalum acuminatum* and *Acacia burkittii,* which are regionally uncommon. Formerly Sisters Ram paddock on Roxby Downs Station, it has not been grazed since 1997 and was selected as a regional reference site by PIRSA's Pastoral Management Branch in 2000. Three sites in the reserve were repeatedly monitored for the *Birds Australia Atlas* and revealed a range of birds, representative of the regional avifauna. Limited fencing is required to protect the area from grazing by domestic stock.

Wood Duck/Black Swan are two large fenced areas of 159,000 ha incorporating the central and eastern parts of Stuarts Creek Station, with sections of the eastern boundary adjoining Billa Kalina Station. The areas are within the Oodnadatta land system (Kingoonya Soil Conservation Board, 2002). Lying in the Lake Eyre South region this system consists of undulating gibber tableland with plateaux and numerous watercourses lined with Eucalyptus (Badman 1999). The plains are dominated by chenopods and low grasses following rain. The plateaux or mesas often have gypseous clay soils and support bladder saltbush with areas of emubush *Eromophila* sp. and *Senna* sp.

Wimbrina East is an area of 19,000 ha located in a narrow easterly section of Stuarts Creek Station. The area is bounded to the north by Finniss Springs Aboriginal Land, to the east by Witchelina Station and to the south by Mulgaria Station. A section along the western boundary of the area may need fencing to exclude wandering stock. This area is located in the same land system as Stuarts Creek and Lees and the terrain is similar, but with a greater density of mesas, with characteristically coloured soils such as the well-known Painted Desert near Coober Pedy. The Willouran Ranges adjoin this area to the east and several drainage lines flow out of the ranges. Grazing pressure in the area has historically been limited as there is no permanent water.

Kookaburra is an area of 30,200 ha containing almost equal proportions of Roxby land system to the north and Arcoona Tableland land system to the south (Kingoonya Soil Conservation Board 2002). These land systems include gently undulating stony tablelands supporting bladder saltbush-dominant low chenopod shrublands; some trees are found along watercourses and tall shrublands on isolated dunes. The area of the proposed expansion occurs in both of these land systems. Kookaburra incorporates four paddocks (Kookaburra, Big Marjory, Boundary and Pan) of Roxby Station and adjoins Parakylia and Wirraminna Stations. These paddocks have not been grazed for nearly 10 years following heavy grazing pressure around Kookaburra Tank in the centre of the region. The periphery of this region has retained good vegetation cover due to its remoteness from water. Access to this region is restricted periodically due to its proximity to the weapons and rocket testing facilities of the Woomera Prohibited Area.

Each of the areas was assessed against the principles outlined above to determine their suitability and to identify constraints (see Table N9.8). It is considered that each of the options identified is suitable as a set-aside to achieve a SEB under the Native Vegetation Act.

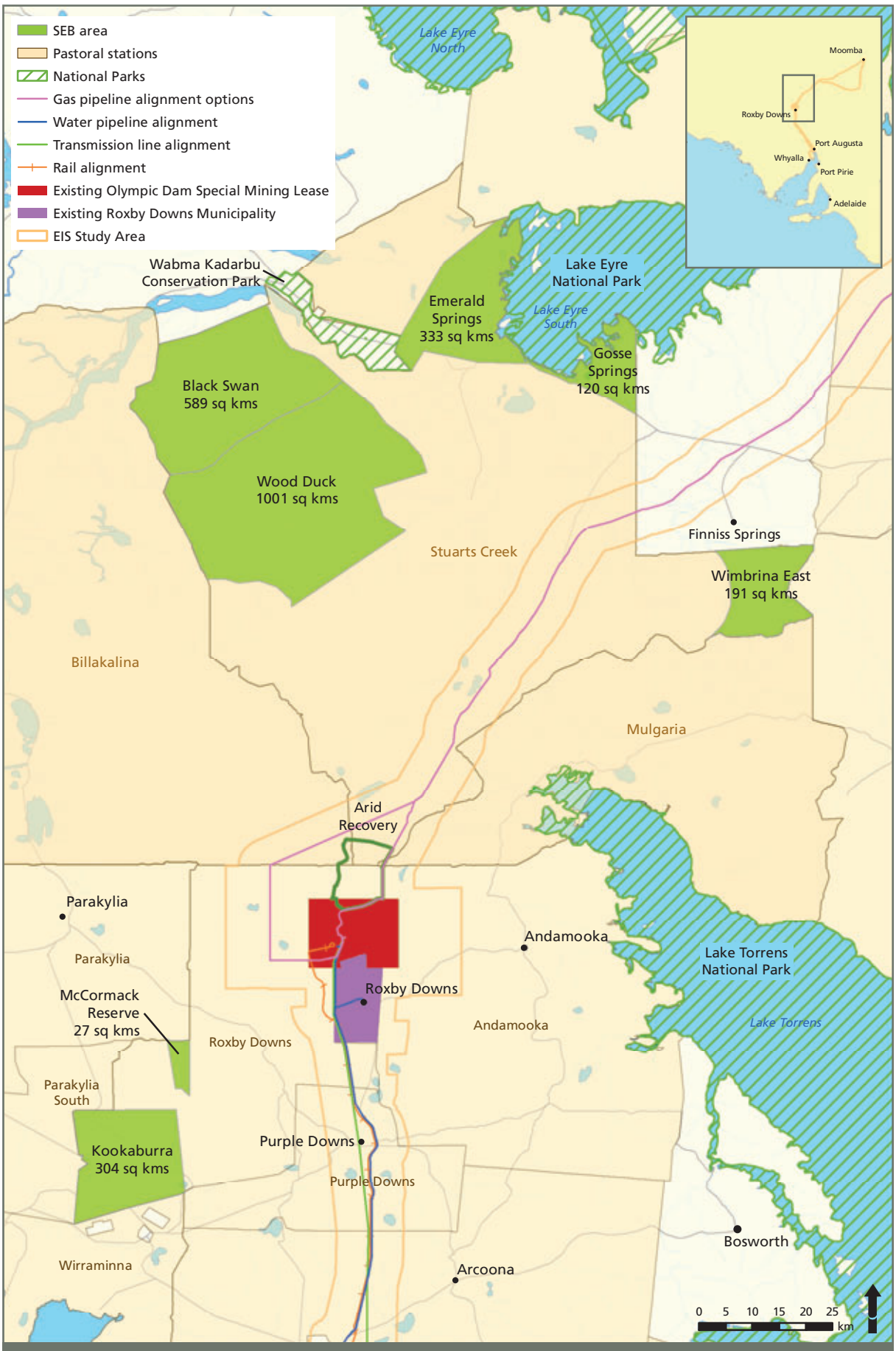

Figure N9.3 Proposed set aside area to provide a SEB to compensate for vegetation clearance

Table N9.8 Summary of assessment against selection criteria for each set-aside option

	Selection criteria[1]							
	Tourism interest	Adjacent to conservation area	Listed present	Unique habitat/ terrain types	Quantifiable area – km²	In same NRM region as vegetation loss	In same land system as vegetation loss	Habitat similar to disturbed areas
Set-aside options	b	b	c	c	c	e	f	g
Gosse/Emerald Springs	✓	✓	✓	✓	453	✓		
Wimbrina East		✓	✓	✓	191	✓		✓
McCormack Reserve					27	✓	✓	✓
Wood Duck and Black Swan			✓	✓	1,590	✓		✓
Kookaburra					304	✓	✓	✓

[1] Set-aside principles identified by ICMM (2005) and ten Kate et al. (2004) listed in Section N9.5.1 above.

Proposed set-aside strategy

All of the set-aside options identified total 2,565 km² (256,500 ha), which exceeds the estimated requirement of about 1,249–1,266 km² (124,924–126,641 ha) to compensate for the clearance of 16,659–17,002 ha of vegetation associated with the Olympic Dam expansion in the Arid Lands NRM region. The allocation of the SEB may be staged to reflect the project phases and the relatively long period over which vegetation disturbance would occur. Most clearance (about 75%), however, would occur in first 10 years of the expansion commencing.

BHP Billiton proposes to set aside 1,266 km² (126,650 ha) of rangeland in the Arid Lands NRM region to offset vegetation clearance associated with the proposed expansion. It is considered that the offset would provide a significant environmental benefit to the Arid Lands NRM region.

N9.5.2 Set-aside areas – Northern and Yorke and Eyre Peninsula NRM regions

To offset clearance of 165 ha and 100 ha in the Northern and Yorke and Eyre Peninsula NRM regions respectively, BHP Billiton proposes to retain the services of a third party to facilitate the required set-asides and achievement of the SEB(s) in compliance with the Native Vegetation Act.

The SEB areas used to determine the size of the offset are 1,042 ha for the Northern and Yorke NRM region, and 586 ha for the Eyre Peninsula NRM region. These areas of land would be set aside and protected under a Heritage Agreement with a management plan to create a SEB, approved by the Native Vegetation Council.

The set-asides would occur either in the Northern and Yorke and Eyre Peninsula NRM regions, or in an equivalent region, as agreed with the Native Vegetation Council and other stakeholders.

N9.5.3 SEB payment

To offset the loss of seagrass in Spencer Gulf, BHP Billiton proposes to make a monetary payment to the Native Vegetation Fund, which would achieve the SEB in compliance with the Native Vegetation Act.

Using the formula provided in the NVC guidelines, the SEB payment is calculated as: (SEB area x land value) + (area cleared x management fee). Within Spencer Gulf it is assumed that the value of the seagrass is $50/ha, and the management costs are $800/ha. The SEB payment would therefore be: (30 ha x $50/ha) + (3 ha x $800/ha) = $3,900.

N9.6 REFERENCES

Badman, FJ 1999, *The Lake Eyre South Study: Vegetation*, Lake Eyre South Monograph Series, vol. 2, ed. WJH Slaytor, Royal Geographical Society of South Australia, Adelaide, pp 176–200.

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ten Kate, K, Bishop, J & Bayon, R 2004, *Biodiversity Offsets: Views, Experience, and the Business Case*, The International Union for the Conservation of Nature (IUCN), Gland, Switzerland & Cambridge, UK, in assoc. with Insight Investment, London.

APPENDIX N10

Review of the existing effect of the tailings retention system on fauna

N10 REVIEW OF THE EXISTING EFFECT OF THE TAILINGS RETENTION SYSTEM ON FAUNA

N10.1 INTRODUCTION

A review of the effect of the existing tailings retention system (TRS) at Olympic Dam on fauna, with a particular focus on birds, has been undertaken to guide the assessment of potential impacts of the expanded facilities.

The findings presented in this appendix draw on published and unpublished data on fauna mortalities from monitoring studies conducted by BHP Billiton environmental personnel and private consultants, and literature reviews.

Fauna species in this appendix are identified by common name only, with the corresponding scientific name provided in an attachment to the appendix (Attachment N10.1).

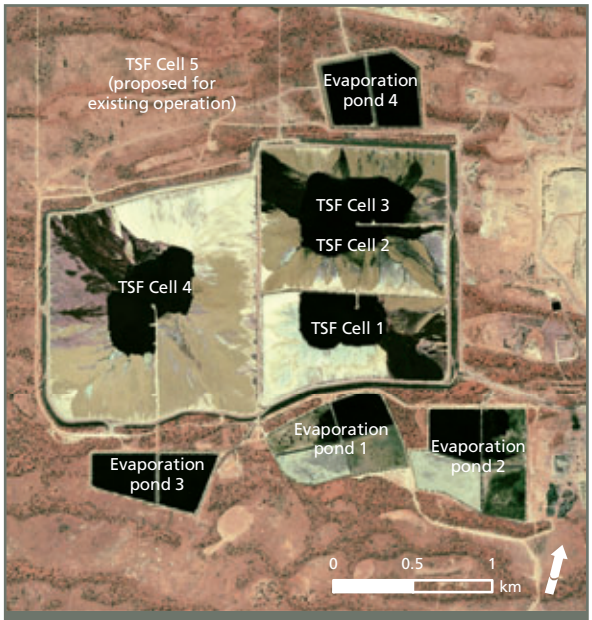

Figure N10.1 Existing TRS

N10.2 DESCRIPTION OF THE TRS

The existing TRS is located on the western side of the Olympic Dam plant in arid South Australia (see Figure N10.1). The TRS consists of open ponds (tailings cells and evaporation ponds) of acidic liquor and wet beach environments, presently covering 530 ha.

The first three tailings cells were constructed during the late 1980s and early 1990s, with a fourth cell added in 1999. The cells receive waste slurry from the minerals processing plant. Slurry is discharged around the perimeter of the cells where the tailings solids settle (forming areas called 'beaches') and the tailings liquor is evaporated. Excess liquor that has not yet evaporated flows to the centre of the tailings cell where it is reclaimed to evaporation ponds (some is also recycled back into the processing plant). These four cells currently cover about 400 ha, and the evaporation ponds cover about 130 ha.

Originally constructed in 1995, the evaporation ponds consist predominantly of 1–3 m deep acid liquor. They have relatively steep banks with up to several metres of variously coloured, precipitated surface crust ('jarosite') around the margins that are attractive to fauna (particularly waders).

The TRS is surrounded by 3m high mesh fences to exclude people and larger ground-dwelling vertebrates. The waste liquid is acidic (pH <2–3.5 depending on the age of the liquor) and contains a range of metals, metalloids and chemicals (see Draft EIS Appendix K4 for details).

N10.3 CAUSE OF BIRD INJURIES AND DEATHS

Liquid in the TRS contains acid (pH <2–3.5) and a range of metals. Birds may be killed or injured following contact with this liquor from a number of causes:

- ingesting acid causing burns to internal organs
- acid contacting (either through spray or immersion) sensory organs such as eyes or nostrils, causing burns
- acid contacting plumage thus reducing its ability to repel water, resulting in waterlogging of plumage and drowning. Birdavert (2006) noted that waterbirds can drown in ponds which have heavy salts and low pH values, due to waterlogging of plumage and subsequent encrusting by salt crystals
- ingesting metals that cause organ damage.

The first three causes (above) have an immediate effect, while the last may take some time until sufficient levels of metals accumulate in the body. It is most likely the bird would die from the acid prior to metals causing organ damage.

Observations at the TRS suggest that the first three causes are the main causes of injury and mortality in birds. However, it is difficult to develop a monitoring system that detects injured birds that move offsite. No elevated levels of metals in dead birds recovered from the TRS have been detected, suggesting that this is not a significant cause of mortality at the TRS.

N10.4 WATERBIRDS IN THE REGION

Intensive surveys by BHP Billiton (and the previous WMC Resources) staff provide a detailed assessment of waterbirds in the region since 1988. These assessments included a very wet period (1989–92) when both Lake Eyre and smaller ephemeral wetlands were filled (Read and Ebdon 1998, Waterman and Read 1992). At least 64 waterbird species have been recorded (Read 1994) (see Attachment N10.2). The surveys show great fluctuations in species and numbers of individuals using the artificial waterbodies in the Olympic Dam region. Larger numbers correlate loosely with both wet conditions in the region, or during extended dry periods when other waterbodies are dry.

A comparison of the waterbirds in the region indicates that only a small proportion of species and individuals visit the TRS. However, the TRS appears to be more attractive to some species that favour more saline habitats elsewhere (e.g. Banded Stilt).

N10.5 BIRD USE OF THE TRS

Night-flying species that roost on open water (e.g. grebes, ducks, swans) are probably attracted to the reflective surface of the evaporation ponds. The bare, open margins and 'jarosite crusts' of the TRS create roosting habitat for wading birds such as stilts, avocets, gulls, terns and egrets.

Three main groups of birds frequent the TRS: (1) waterbirds, (2) scavengers and (3) insectivores that feed on the wing. The sporadic rainfall of the arid environment of the Olympic Dam region means that species' occurrence and abundance on the TRS over time is unpredictable.

N10.5.1 Waterbirds

Waterbirds do not feed within the TRS because the acid liquor in the TRS precludes the establishment of aquatic flora or fauna. However, it is thought that the TRS appears similar to wetlands that are used by waterbirds, and so attract waterbirds that are flying over. The features of the TRS that appear similar to natural wetlands include bare, open margins, an extensive and complex shoreline and areas of extensive shallow substrate.

Some species land directly on the open ponds (ducks, swans, grebes, gulls) while others settle on the precipitated shoreline or pond banks (waders – especially stilts and avocets; gulls, terns). Most waterbirds arrive at the TRS overnight or early morning and do not depart until the following night, if able (BHP Billiton staff, pers. comm., 17 May 2006). As observed on other inland waterbodies (Carpenter pers. obs.), it is likely that still nights are most attractive, either because the surface is more reflective or because more birds are in flight and therefore passing over. If one of a group of birds becomes disabled, often the rest will remain at the TRS.

Many northern hemisphere breeding waders are thought to migrate across central Australia in September–October, at which time a large shallow water body would be an attractive stopover.

Waterbird species recorded as injured or mortalities at the TRS, or are considered to be at risk, are listed in Attachment N10.2.

N10.5.2 Scavengers

Birds and other vertebrates that are disabled or die at the TRS are attractive prey for other birds. Australian Ravens are a common scavenger in the region, and will drag or fly off with smaller carcasses. Little Crows also occur in the region, but feed less on carrion. Ravens often feed before daybreak and may completely remove smaller carcasses from the vicinity of the TRS. The internal organs of larger carcasses are often the part eaten. Raptors, especially the Wedge-tailed Eagle, Black Kite and Whistling Kite also scavenge dead or injured vertebrates. Wedge-tailed Eagles are relatively numerous in the area, while Black Kites migrate seasonally and are common at Olympic Dam during summer. These species may remove carcasses from the TRS in the early morning and feed on them elsewhere. The removal of carcasses suggests that counts of waterbird mortalities at the TRS underestimate the actual incidence.

N10.5.3 Aerial insectivores

Although no insects breed in the TRS, many fly over the open liquid, land and become disabled on the surface, or wash up on TRS margins. These insects are attractive to insectivorous birds that feed mostly while flying, or perch briefly to consume caught prey. These include swallows, martins and woodswallows. The most common species around the TRS are Welcome Swallows and Black-faced Woodswallows, although other species may be numerous at times. Some aerial insectivores may be incapacitated by consuming dead insects from the TRS while on the wing, as observed by BHP Billiton staff with the Whiskered Tern.

N10.6 BIRD MONITORING

BHP Billiton TRS technicians monitored birds on the TRS daily while undertaking other tasks from 1996 to 1999. There are limitations with this information given the variable effort undertaken to locate birds and the ability of unqualified staff to identify bird species. Many of these bird records are of a generic nature (e.g. waterbird, stilt, duck). Since 1999, qualified environmental personnel from BHP Billiton have conducted monthly counts of waterbirds on the TRS and other water bodies around the mine (e.g. sewage works, mine water ponds).

TRS staff reported a marked increase in the number of wildlife deaths during 2004. This corresponded with an increase in the numbers of waterbirds in the region (BHP Billiton 2005). An independent environmental consultant (David Donato) was subsequently engaged to assess the risks to wildlife posed by the TRS. Intensive observations over three four-day periods were made in December 2004, February 2005 and March–April 2005 (Donato Environmental Services 2007).

Qualified environmental personnel have also monitored birds on the TRS for about five hours, once each week, since the start of June 2005 (usually 7 am to midday). This involves driving slowly along the embankments around each evaporation pond and noting those birds seen (species, numbers, dead or alive). Dead birds are retrieved if possible for identification purposes and bagged for later disposal. Monitoring is not conducted during wet or windy conditions due to safety regulations.

N10.7 NUMBER OF FAUNA MORTALITIES

Between 1996 and 2003, from 30 to 180 birds per year were observed at the TRS by TRS technicians, and 30 dead birds per year were recorded. During 2004, TRS staff noted an increase in the numbers of birds and mortalities at the TRS with over 200 deaths recorded (WMC 2004).

In August 2005 a full time project officer was engaged to study fauna interactions with the TRS. A weekly monitoring program was implemented in June 2005 and is continued by qualified environmental staff. Monitoring results (both standardised and opportunistic) have shown the following:

- 2005–6: 895 fauna mortalities (BHP Billiton 2006)
- 2006–7: 311 fauna mortalities (BHP Billiton 2007)
- 2007–8: 282 fauna mortalities (BHP Billiton 2008).

Numbers reported are likely to be underestimates due to removal of carcasses by scavengers and the probable sinking of some carcasses before they were able to be counted.

The data suggests a seasonal pattern with a three-fold increase in the rate of bird mortality over summer–autumn compared to winter–spring. The data also suggests a widely fluctuating trend in bird mortalities from year to year.

About four times more bird mortalities have been reported from the evaporation ponds compared with the tailings cells, despite being less than half the size. Reasons are likely to be that:

- the evaporation ponds typically have larger areas of available liquor
- birds that die within the evaporation ponds are more likely to wash up on the edge of the pond where they are easily identified and counted
- most birds that die within the TRS cells are difficult to see as they are generally close to the tailings liquor hundreds of metres from the edge of the cells, and are not therefore included in monitoring counts.

Fauna species affected

Twenty-six waterbird species and 11 species of other birds have been recorded as mortalities or injured at the Olympic Dam TRS (see Attachment N10.1). The species with the highest mortalities are the Banded Stilt, Red-necked Avocet, Whiskered Tern, Grey Teal, Black Swan, Hoary-headed Grebe, Little Pied Cormorant and the Silver Gull. Of these, the Banded Stilt is rarely reported from other water bodies monitored in the region.

Mortalities at the TRS include five species listed in international agreements (i.e. the Great Egret, Common Greenshank, Red-necked Stint, Sharp-tailed Sandpiper and Caspian Tern) and two species (Musk Duck and Banded Stilt) listed as rare or threatened under the schedules of the South Australian National Parks and Wildlife Act. It is likely that only small numbers of these species have been affected.

Monitoring data has recorded mortalities of 6 mammal and at least eight reptile species from the TRS (see Attachment N10.2). Most deaths associated with the TRS are small vertebrate species. These species are able to gain access to the site through fences. Only a small number of bat deaths have been associated with the TRS. Rabbits are the most common mammal and snakes the most common reptile death associated with the TRS (see Attachment N10.2).

N10.8 DISCUSSION AND CONCLUSIONS

The Olympic Dam TRS is the largest permanent 'water' body in north-western South Australia and lies within about 100 km of Lake Eyre and Lake Torrens. As such it is attractive to passing waterbirds. Unlike overseas, Australia has few well-defined waterbird migration routes. In central Australia, waterbirds have the ability to locate and use ephemeral wetlands within a short period of filling (e.g. Read and Ebdon 1999). How they do this is unclear. Read and Badman (1999) have hypothesised that some species have scouts that periodically leave established feeding areas to engage in reconnaissance flights, probably at high altitude, occasionally landing at small wetlands to rest. The large 'waterbodies' comprising the TRS at Olympic Dam would be easily seen by high-flying waterbirds, so it follows that the TRS will receive ongoing visits by passing birds.

The evidence from other artificial wetlands in arid Australia shows an increasing number and diversity of waterbirds visit each year for several years after construction, before the number of visitors levels off (e.g. Alice Springs Sewage Ponds – Braithwaite and Stewart 1975, cf. Roberts 1981). If the habitat is modified or increases in area, the number and diversity of species increases accordingly (e.g. St Kilda saltfields, Adelaide – Rix 1978). Depending on the future TRS design, the numbers and diversity of certain bird species is likely to increase further if the availability of habitat (i.e. roosting sites and food – insects and carrion) increases.

Weekly monitoring at the existing Olympic Dam TRS has recorded up to 895 fauna mortalities annually in 2005–6, reducing to 311 and 282 in 2006–7 and 2007–8, respectively. Numbers reported are likely to be underestimates due to removal of carcasses by scavengers and the probable sinking of some carcasses before they were able to be counted.

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List is arranged in taxonomic order.

Status = likely status in study area: Sum = mainly spring–summer migrant (lesser numbers over winter); Res = resident (presumed to breed locally); Irr = irregular visitor (may occasionally breed locally); Win = mainly winter visitor

Abundance = abundance in study area: R = rare; usually small numbers only; U = uncommon; C = common – usually present in reasonable numbers. Vag = considered as vagrants to the area, usually involving single birds

Camba = listed in China – Australia Migratory Birds Agreement

Jamba = listed in Japan – Australia Migratory Birds Agreement

CMS = listed under the convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)

EPBC = listed under Schedules of the Commonwealth Environment Protection and Biodiversity Conservation Act, 1999 (EPBC Act): E = Endangered; V = Vulnerable; Mi = Migratory; Ma = Marine Listed

SA (2000) = listed under schedules of the South Australian National Parks and Wildlife Act 1972: E = Endangered, V = Vulnerable, R = Rare

SA (update) = listed within draft changes to NPW schedules

Common name	Scientific name	Status	Abundance	Likely visitor to TRS	Visitor to TRS	Mortality recorded	Camba	Jamba	CMS	EPBC	SA (2000)	SA (updated)
Blue-billed Duck	*Oxyura australis*	Irr	R	X	X	X					R	R
Musk Duck	*Biziura lobata*	Irr	R	X	X	X					R	R
Freckled Duck	*Stictonetta naevosa*	Irr	R	X							R	V
Black Swan	*Cygnus atratus*	Irr		X	X	X						
Australian Shelduck	*Tadorna tadornoides*	Irr		X								
Australian Wood Duck	*Chenonetta jubata*	Irr										
Pacific Black Duck	*Anas superciliosa*	Irr		X	X	X						
Australasian Shoveler	*Anas rhynchotis*	Irr		X							R	R
Grey Teal	*Anas gracilis*	Irr		X	X	X						
Chestnut Teal	*Anas castanea*	Irr		X								
Pink-eared Duck	*Malacorhynchus membranaceus*	Irr		X								
Hardhead	*Aythya australis*	Irr		X	X	X						

Common name	Scientific name	Status	Abundance	Likely visitor to TRS	Visitor to TRS	Mortality recorded	Camba	Jamba	CMS	EPBC	SA (2000)	SA (updated)
Australasian Grebe	*Tachybaptus novaehollandiae*	Irr		X	X	?						
Hoary-headed Grebe	*Poliocephalus poliocephalus*	Irr		X	X	X						
Great Crested Grebe	*Podiceps cristatus*	Vag		X							R	R
Darter	*Anhinga melanogaster*	Irr										R
Little Pied Cormorant	*Phalacrocorax melanoleucos*	Irr		X	X	X						
Pied Cormorant	*Phalacrocorax varius*	Irr		X	X	X						
Little Black Cormorant	*Phalacrocorax sulcirostris*	Irr		X	X	X						
Great Cormorant	*Phalacrocorax carbo*	Irr		X	X	X						
Australian Pelican	*Pelecanus conspicillatus*	Irr		X	X							
White-faced Heron	*Egretta novaehollandiae*	Irr		X	X	X						
Little Egret	*Egretta garzetta*	Irr		X								R
White-necked Heron	*Ardea pacifica*	Irr										
Great Egret	*Ardea alba*	Irr		X	X	X	X	X		Mi		
Intermediate Egret	*Ardea intermedia*	Irr									R	R
Cattle Egret	*Ardea ibis*	Vag					X	X		Mi		R
Nankeen Night Heron	*Nycticorax caledonicus*	Vag		X	X	X						
Glossy Ibis	*Plegadis falcinellus*	Irr					X		X	Mi	R	R
Australian White Ibis	*Threskiornis aethiopicus*	Irr		X								
Straw-necked Ibis	*Threskiornis spinicollis*	Irr										
Royal Spoonbill	*Platalea regia*	Irr										
Yellow-billed Spoonbill	*Platalea flavipes*	Irr										
Brolga	*Grus rubicundus*	Vag									V	V
Buff-banded Rail	*Gallirallus philippensis*	Irr										
Baillon's Crake	*Porzana pusilla*	Vag									R	
Australian Spotted Crake	*Porzana fluminea*	Irr										
Purple Swamphen	*Porphyrio porphyrio*	Irr										
Dusky Moorhen	*Gallinula tenebrosa*	Irr										
Black-tailed Native-hen	*Gallinula ventralis*	Irr		X								
Eurasian Coot	*Fulica atra*	Irr		X	X	X						
Latham's Snipe	*Gallinago hardwickii*	Vag					X	X	X	Mi	V	V

Common name	Scientific name	Status	Abundance	Likely visitor to TRS	Visitor to TRS	Mortality recorded	Camba	Jamba	CMS	EPBC	SA (2000)	SA (updated)
Black-tailed Godwit	*Limosa limosa*	Vag					X	X	X	Mi		R
Bar-tailed Godwit	*Limosa lapponica*	Vag		X			X	X	X	Mi		R
Eastern Curlew	*Numenius madagascariensis*	Vag			X		X	X	X	Mi	V	V
Marsh Sandpiper	*Tringa stagnatilis*	Sum		X	X		X	X	X	Mi		
Common Greenshank	*Tringa nebularia*	Sum		X	X	?	X	X	X	Mi		
Wood Sandpiper	*Tringa glareola*	Sum					X	X	X	Mi		R
Common Sandpiper	*Actitis hypoleucos*	Sum		X	X	X	X	X	X	Mi		R
Ruddy Turnstone	*Arenaria interpres*	Vag					X	X	X	Mi		R
Red Knot	*Calidris canutus*	Vag		X			X	X	X	Mi		
Red-necked Stint	*Calidris ruficollis*	Sum		X	X	X	X	X	X	Mi		
Sharp-tailed Sandpiper	*Calidris acuminata*	Sum		X	X	X	X	X	X	Mi		
Curlew Sandpiper	*Calidris ferruginea*	Sum		X			X	X	X	Mi		
Black-winged Stilt	*Himantopus himantopus*	Res/Irr		X	X	X						
Banded Stilt	*Cladorhynchus leucocephalus*	Irr		X	X	X						V
Red-necked Avocet	*Recurvirostra novaehollandiae*	Irr		X	X	X						
Pacific Golden Plover	*Pluvialis fulva*	Vag		X			X	X	X	Mi		
Grey Plover	*Pluvialis squatarola*	Vag		X	X	X	X	X	X	Mi		
Red-capped Plover	*Charadrius ruficapillus*	Irr		X	X							
Black-fronted Dotterel	*Elseyornis melanops*	Res										
Red-kneed Dotterel	*Erythrogonys cinctus*	Irr		X	X	X						
Banded Lapwing	*Vanellus tricolor*	Irr		X								
Masked Lapwing	*Vanellus miles*	Res		X								
Oriental Pratincole	*Glareola maldivarum*	Vag					X	X		Mi		
Australian Pratincole	*Stiltia isabella*	Sum		X								
Silver Gull	*Larus novaehollandiae*	Res		X	X	X				Ma		
Gull-billed Tern	*Sterna nilotica*	Irr		X	X	X						
Caspian Tern	*Sterna caspia*	Irr		X	X	X	X			Mi		
Whiskered Tern	*Chlidonias hybridus*	Irr		X	X	X						
TOTAL	70 species			48	28	26						

Common name	Scientific name	Status	Abundance	Likely visitor to TRS	Visitor to TRS	Mortality recorded	Camba	Jamba	CMS	EPBC	SA (2000)	SA (updated)
Black Kite	*Milvus migrans*			X	X							
Whistling Kite	*Haliastur sphenurus*			X	X							
Wedge-tailed Eagle	*Aquila audax*			X	X	X						
Brown Falcon	*Falco berigora*			X	X							
Australian Hobby	*Falco longipennis*			X								
Grey Falcon	*Falco hypoleucos*	R		X								R
Black Falcon	*Falco subniger*			X								
Peregrine Falcon	*Falco peregrinus*	R		X								R
Nankeen Kestrel	*Falco cenchroides*			X	X							
Little Button-quail	*Turnix velox*			X	X	X						
Crested Pigeon	*Ocyphaps lophotes*			X	X							
Blue Bonnet	*Northiella haematogaster*			X	X							
Budgerigar	*Melopsittacus undulatus*			X	X							
Barn Owl	*Tyto alba*			X	X	X						
Fork-tailed Swift	*Apus pacificus*			X			X	X		Mi		
White-winged Fairy-wren	*Malurus leucopterus*			X	X	X						
Yellow-throated Miner	*Manorina flavigula*			X	X							
Singing Honeyeater	*Lichenostomus virescens*			X	X	X						
Orange Chat	*Epthianura aurifrons*			X	X	X						
Red-capped Robin	*Petroica goodenovii*			X	X							
Willie Wagtail	*Rhipidura leucophrys*			X	X							
White-breasted Woodswallow	*Artamus leucorhynchus*			X	X							
Black-faced Woodswallow	*Artamus cinereus*			X	X	X						
Australian Magpie	*Gymnorhina tibicen*			X	X	X						
Australian Raven	*Corvus coronoides*			X	X	X						
Richard's Pipit	*Anthus australis*			X	X							
House Sparrow	*Passer domesticus*			X	X	X						
Zebra Finch	*Taeniopygia guttata*			X	X							
White-backed Swallow	*Chermoeca leucosternus*			X	X	X						
Welcome Swallow	*Hirundo neoxena*			X	X							

Common name	Scientific name	Status	Abundance	Likely visitor to TRS	Visitor to TRS	Mortality recorded	Camba	Jamba	CMS	EPBC	SA (2000)	SA (updated)
Tree Martin	*Hirundo nigricans*			X	X							
Fairy Martin	*Hirundo aeriel*			X	X							
TOTAL				32	27	11						

Attachment N10.2 Mammal and reptile species recorded from the TRS
(Source: TRS Fauna Database, records 1 September 2004 to 15 March 2006)

Taxa	Number of mortalities	Number recorded alive
Bat	3	0
Feral Cat	2	0
Fox	0	1
Mouse (unidentified)	4	0
Red Kangaroo (or Kangaroo)	12	3
Rabbit	40	2
Spinifex Hopping-mouse	11	0
Bearded Dragon	4	9
Desert Banded Snake	6	0
Trilling Frog	5	0
Lizard (unidentified species)	4	1
Netted Dragon	1	0
Sand Goanna	2	0
Sleepy Lizard	5	0
Snake (unidentified species)	21	1
Western Brown Snake	7	0

APPENDIX N11

Review of potential effects of the expanded tailings retention system on shorebirds

N11 REVIEW OF POTENTIAL EFFECTS OF THE EXPANDED TAILINGS RETENTION SYSTEM ON SHOREBIRDS

N11.1 INTRODUCTION

Arup, on behalf of BHP Billiton Ltd, engaged Brett Lane & Associates Pty Ltd to undertake a risk assessment of the proposed tailings retention system for the expanded Olympic Dam mine in northern South Australia.

This investigation was commissioned to provide information on the potential risks to birds from landing on and using the temporary wet slopes of the enlarged tailings storage facilities that would be required for expanded mine operations. The species of greatest concern is the Banded Stilt *Cladorhynchus leucocephalus*, a gregarious Australian native shorebird that inhabits hypersaline wetlands, including the large salt lakes of inland southern Australia. It gathers in large flocks of up to 250,000 individuals.

Specifically, the scope of the investigation included:

- document the occurrence in the wider region around the Olympic Dam site of shorebirds, and in particular the Banded Stilt
- review past occurrences of the species (and other shorebirds) in the region to ascertain how often they may occur in the area in significant numbers
- review the usage of wetlands within the mine area by waterbirds
- ascertain if the proposed expanded tailings storage facilities (TSF) at Olympic Dam would have a significant impact on shorebirds, and in particular the Banded Stilt.

This investigation was undertaken by Peter Lansley (Zoologist) and Brett Lane (Principal Consultant) of Brett Lane & Associates Pty Ltd.

N11.2 SHOREBIRDS OF THE REGION

This section summarises information on the status and occurrence of shorebirds, and in particular Banded Stilts, in the region around the Olympic Dam mine site.

N11.2.1 Overview of the Banded Stilt

The Banded Stilt is a medium sized shorebird endemic to Australia. The species was first described in 1816 but breeding was not confirmed until 1930 (Marchant and Higgins 1993). This species gathers in large flocks (tens to hundreds of thousands) on open saline lakes and breeds colonially. There have been just over 30 breeding events reported (see below), 25 of them in Western Australia.

Banded Stilts occur in open shallow saline waters in southern and inland Australia from Melbourne, Victoria, to Port Hedland, north-western Australia. Non-breeding Banded Stilts gather in flocks, often attaining immense numbers when food resources are concentrated. In 2008, for example, data indicate that most of the population was gathered at The Coorong, South Australia, where flocks totalling 250,000 birds were counted in February 2008 by at least two independent shorebird experts during the annual summer count for the Australasian Wader Studies Group (I Veltheim, pers. comm., 3 March 2008). A count of 10,000 birds was simultaneously estimated from Western Australia, increasing the estimated population to around 260,000 birds, an increase on previous estimates of 206,000 (Watkins 1993; Delaney and Scott 2006).

Non-breeding flocks generally number from a few hundred to approximately 50,000. The 2008 Coorong observation of 250,000 comprised four separate flocks (I Veltheim, pers. comm., 3 March 2008). In some areas, such as the Natimuk-Douglas Lakes in western Victoria, the Banded Stilt may be seasonal and is present usually in winter and spring, when the lakes are inundated (Alcorn and Alcorn 2000). Key non-breeding sites include coastal saline lakes of south-west Western Australia and the saltworks at Port Hedland, The Coorong and salt evaporation basins of coastal South Australia around Gulf St Vincent and Spencer Gulf and salt lakes of the Wimmera and western districts of Victoria (Lane 1987; Baxter 2003). Vagrants have occurred as far afield as Tasmania, south-east Queensland and Darwin (Baxter 2003).

Adult stilts mostly feed on brine shrimps (branchipods). Juveniles are reported as feeding on Chironomid midge larvae (Gosbell and Christie 2006) and the diet at times includes other invertebrates (Marchant and Higgins 1993).

N11.2.2 Breeding of the Banded Stilt

The species breeds on large ephemeral salt lakes, mostly in inland Western Australia and South Australia, with a recent breeding event from The Coorong, in coastal South Australia (Gosbell and Christie 2006) and an earlier record from Esperance, WA (Marchant and Higgins 1993). The bird breeds colonially after heavy local rainfall events fill the usually dry saline lakes that they prefer. Typically, years or even decades may pass between reports of breeding events, although recently such events are more commonly observed, due probably to more interest in the birds and easier access to the interior with four wheel drive vehicles.

A summary of breeding events is presented in Table N11.1.

Table N11.1 Documented breeding record of the Banded Stilt.

Year	State	Location	No. of pairs or nests	Comments
1904	WA	Lake Cowan	Not known	Large colony but unconfirmed
1923	WA	Quinns Find, 64 km SW of Nannine	Not known	Unconfirmed
1929–1930	WA	Near Menzies	Not known	Hundreds of thousands of dead chicks
1930	WA	Lake Grace	40,000	
1930	WA	Lake King	n.a.	Tens of thousands of adults and countless chicks
1930–1931	SA	Lake Callabonna	27,000	
1936	SA	Lake Callabonna	n.a.	
1945	WA	Lake Grace	n.a.	
1946	WA	Lake Grace	500	
1960	WA	Lake Wagga Wagga	40–50	
1963	WA	Lake Ballard–Menzies district	n.a.	Chicks walking through town
1971	WA	Lake Disappointment	Not known	Probable colony
1973	WA	Lake Ballard–Menzies district	60	
1974	WA	Lake Ballard–Menzies district	n.a.	
1975	WA	Lake Ballard–Menzies district	Several thousand	
1975	WA	Lake Marmion	50,000	March figure quoted; 2,500 still nesting in May
1980	WA	Lake Barlee	179,000	
1980	WA	Lake Goongarrie	n.a.	
1980	WA	Esperance	n.a.	
1981	WA	Lake Ballard–Menzies district	n.a.	Chicks on road
1984	SA	Lake Eyre North	n.a.	One chick observed
1986	WA	Lake Ballard–Menzies district	n.a.	Chicks walking through town
1988	WA	Lake King	6,000–8,000	21,000–28,000 chicks
1989	SA	Lake Torrens	50,000	Breeding failed due to silver gull predation
1992	WA	Lake Barlee	n.a.	10,000–15,000 adults observed also flightless young
1992	WA	Lake Giles	n.a.	Small flock of flightless young
1995	WA	Lake Ballard	n.a.	
1997	SA	Lake Eyre North	n.a.	
2000	SA	Lake Eyre North	18,000	Mostly successful after culling of silver gulls; recruited 50,000 young
2003	WA	Lake Disappointment	n.a.	500 dead juveniles found
2005–2006	SA	The Coorong	n.a.	1,006 juveniles of total of 92,500 counted; difficult to find nesting scrapes

Sources: McGilp and Morgan 1931; Burbidge and Fuller 1982; Marchant and Higgins 1993; Chapman and Lane 1997; Baxter 2003; Clarke et al. 2004; Gosbell and Christie 2006.
Note: n.a. = not available.

These data indicate the key sites for breeding are the large ephemeral salt lakes of the Goldfields region of Western Australia (particularly Lakes Grace, King, Ballard, Barlee and Marmion) and less frequently (but perhaps no less importantly) those in the Lake Eyre Basin of South Australia (Lakes Eyre, Torrens and Callabonna are known sites to date). Sites outside of these two key regions, such as The Coorong (SA), Esperance area (WA) and Lake Disappointment (WA) are used less frequently.

N11.2.3 Movements of the Banded Stilt

The Banded Stilt is dispersive and is known to move widely and quickly in response to changes in rainfall that affect food availability. Until recently, it was believed that there were two largely separate populations of Banded Stilt – one breeding in South Australia and the other in Western Australia (Minton et al. 2000). In 2000, a bird marked with a coloured flag in Western Australia in 1995 was observed at Lake Eyre North, South Australia (Baxter 2003). Recently a bird originating from South Australia was seen in Western Australia (I Veltheim, pers. comm., 3 March 2008). Therefore, there is some interchange of birds between eastern and western Australia but the extent of this interchange is not yet known.

N11.2.4 Habitats of the Banded Stilt

Banded Stilts are primarily birds of large, open, shallow (10–60 cm deep), saline waters, both when breeding and not breeding. Large numbers also may congregate on seashores and other sheltered marine waters, especially when salinities increase due to evaporation (e.g. in Spencer Gulf, South Australia). Brackish and freshwater wetlands such as sewage farms are used less often (Marchant and Higgins 1993) and usually by smaller numbers of birds (PS Lansley, pers. comm., 9 March 2008). The range of salinities at which stilts have been recorded varies from 20 to 145 parts per thousand (Marchant and Higgins 1993). Since 1975, an increase in numbers of Banded Stilts in the Sunraysia district centred on Mildura, Victoria, has occurred (Sonter 1987). This increase is likely a result of increased salinities in the River Murray catchment and associated salt diversion works into lakes such as Lake Woorinen and Lake Tutchewop near Swan Hill (Lane 1987).

N11.2.5 Occurrence of the Banded Stilt near Olympic Dam

From Table N11.1, it can be seen that a number of lakes within easy stilt flight range (i.e. several hundred kilometres) of Olympic Dam are occasionally used by the Banded Stilt for breeding. These include:

- Lake Torrens
- Lake Eyre North
- Lake Callabonna.

It also seems likely that if suitable water levels were attained, the following large salt lakes within a similar distance might also be used for breeding:

- Lake Gairdiner
- Lake Eyre South
- Island Lagoon
- Lake MacFarlane
- Lake Gregory
- Lake Blanche
- Lake Frome.

Where the Banded Stilt has bred in the region, it bred in the following years (numbers in brackets, if known):

- 1984
- 1989 (100,000 birds)
- 1997
- 2000 (36,000 birds).

This is four times in 24 years or an average of once every six years.

Lakes where breeding occurs need to fill sufficiently to isolate sandy islands on which the species can breed. When the lakes are full enough, Banded Stilts move into the region and probably stay within their chosen lake for the duration of the breeding event.

Observations of breeding events (e.g. Minton et al. 2000) show that they continue breeding until water levels decline and/or predation by gulls and raptors reaches a high level and they depart the site.

The period soon after heavy inland rainfall and lake filling, and the point in the breeding event when activity winds down, may be periods when large numbers of Banded Stilts wander more widely within the region. As breeding occurs, on average, every six years, there would be two periods (arrival and departure) when large numbers of Banded Stilts may move across the mine site every six years.

Although it is not known what size flocks Banded Stilts move in, observations in the Victorian Wimmera (Alcorn and Alcorn 2000) show that 50,000 birds can move into an area in a very short time, suggesting that at times they move in very large flocks.

To summarise:

- Banded Stilts may move to the larger salt lakes in the wider region around the Olympic Dam mine on average once every six years (although more frequent visits may characterise wetter periods).
- At the beginning and end of the lake filling cycle and stilt breeding event, large numbers of Banded Stilts would move into and out of the region and, at times, may fly over the Olympic Dam mine site.
- When lakes fill in the area, Banded Stilts would spend most of their time at the lakes where they are breeding and would
- not move far.
- Mobile flocks of tens of thousands of birds are likely to be a regular feature of the movements of this species.

N11.2.6 Other shorebirds

Observations at inland sites suggest that migratory shorebirds moving across the continent from north to south in the period from September to November largely over-fly the inland but from time to time, small flocks of migratory shorebirds (numbering several hundred) occur on inland wetlands for short periods before moving on (Lane 1987). The species recorded most often in inland Australia at this time are:

- Red-necked Stint *Calidris ruficollis*
- Sharp-tailed Sandpiper *C. acuminata*
- Greenshank *Tringa nebularia*
- Marsh Sandpiper *Tringa stagnatilis*.

These species probably routinely use inland wetlands as part of their migration across the continent. During the migration from south to north again (March–April), very few birds occur in inland wetlands in southern Australia, probably because they depart the south coast in good condition and are able to overfly this part of the continent (Lane 1987). It is also likely that at this time, getting to the breeding grounds in the higher latitudes of the northern hemisphere when seasonal conditions are right for breeding places a greater imperative on the birds migrating more rapidly and in fewer hops, so inland occurrence is rare at this time (Lane 1987).

Large numbers (several thousand) of the first two species listed above in particular can at times occur on larger inland salt lakes when they hold water, notwithstanding the unpredictable nature of this habitat. However, the most attractive habitat is provided by large lakes with long shorelines, such as Lake Eyre. Fewer migratory species are found on smaller wetlands that are routinely encountered during migration. Consequently, the smaller water bodies associated with the Olympic Dam mine site are unlikely to hold or attract significant numbers of these birds.

In addition to these species, resident Red-necked Avocets *Recurvirostra novaehollandiae* also move to inland salt lakes in large numbers. For example, when Lake Eyre filled in 1984, over 130,000 Red-necked Avocets moved to forage on the abundant insect larvae that the lake held (Lane 1987). Elsewhere in the eastern part of the continent, very few avocets were observed at this time, suggesting that the entire eastern Australian population may have moved there. At such times in future, this species may also fly over the Olympic Dam mine site. It is probable that this would occur as often as breeding events by the Banded Stilt.

N11.3 DESCRIPTION OF THE PROPOSED TAILINGS STORAGE FACILITY

The proposed tailings storage facility (TSF) cells would increase in area from about 400 ha to over 4,000 ha. No additional evaporation ponds would be established. Each new tailings cell (9) would contain a small central decant pond (300 m x 300 m) within a flow-through rock filter wall to maximise operational control of free liquor. The central decant facility would have rock edges rather than beaches and would provide the opportunity to cover or net the free liquor to minimise fauna interaction with the TSF. Tailings would be deposited into the TSF via spigots around the edge of each cell. The liquor would separate from the tailings and flow toward the central decant ponds, forming large areas of wet beaches dissected by small rivulets.

A number of balance ponds would be constructed, allowing supernatant liquor to be decanted from the TSF cells and redistributed, either returned to the metallurgical process, forwarded to the existing evaporation ponds, or recirculated over the TSF cell beaches. The balance ponds would be about 60 ha in area, and would be covered to restrict fauna access, particularly by birds.

N11.4 IMPACTS ON SHOREBIRDS FROM THE EXPANDED TAILINGS STORAGE FACILITY

This section of the report provides information on the use by birds of the tailings retention system. This is followed by an assessment of the consequences and likelihood of the proposed expanded tailings storage facilities having a significant impact on shorebirds.

N11.4.1 Bird use of the tailings facilities and its consequences

The principal concern for wildlife at tailings storage facilities is their attractiveness as a source of drinking water or wetland habitat at dry times of the year or in dry regions. The decant water in tailings cells is usually toxic, depending on the mineral being processed at the mine, and this can cause bird deaths.

There have been several instances of bird deaths due to tailings liquor in Australia. Documented cases mostly involve tailings for gold mines that use cyanide for processing ore. Birds generally die of cyanide poisoning through drinking tailings liquor (Northern Territory Government 1998). These examples involved tailings storage facilities with an open liquor pond at their centre.

Bird mortalities are also known to occur from the existing Olympic Dam tailings retention system and a summary of existing information is provided in Appendix N10.

N11.5 IMPACTS OF THE EXPANDED TAILINGS STORAGE FACILITY ON SHOREBIRDS

The design of the proposed tailings storage facility for the expanded mine has been significantly modified to reduce seepage to the groundwater and to minimise bird access to tailings liquor, including:

- no new evaporation ponds and covered balance ponds
- providing a central decant pond which also enables the free liquor in the tailings cell to be covered (or similar).

The liquor pond in the centre of each cell would be covered or netted and not visible or accessible to waterbirds. Therefore, unlike at the existing tailings storage facility where birds are attracted to areas of free liquor, the part of the proposed tailings storage facility that may attract shorebirds is the tailings beaches (or slope), when it is wet with liquor flowing over it. At any one time only 15–20%, or up to approximately 100 ha, of 'mudflat-like' environment would occur in each active tailings cell.

Significantly, from a distance, a large, open water body in an otherwise dry landscape would not be visible and therefore the attractiveness of the wet muddy surface to waterbirds would be potentially less than an open water body, but this remains to be tested.

Banded Stilts have been heard flying over the Olympic Dam area at night (John Read, pers. comm. August 2007). The species may occur in large numbers at the proposed expanded tailings storage facility during its pre- and post-breeding dispersal, after heavy rains bring it inland to the Lake Eyre Basin. These events are rare in the Lake Eyre Basin, with six events recorded in the past 80 years, although it is likely that some events have been missed (e.g. in 1974: Robinson and Minton 1989).

Given that the largest flocks of non-breeding birds are in the vicinity of 5,000 birds (although several such flocks may sometimes occur close to each other), and the bulk of breeding events occur in Western Australia, it is considered unlikely that a significant proportion of the Banded Stilt population would arrive on the tailings ponds at Olympic Dam in a single event or regularly. However, there is a remote chance that a large flock may land on the wet mudflats of the expanded TSF, in which case a significant one-off impact on the species' population may occur. The likelihood of this is considered low but the consequences are potentially significant, with a worst-case estimate of a potential loss of 15% of the population (occurring when a large flock is attracted to the TSF during an inland breeding event).

If such an event occurred after a series of dry years where no breeding had taken place, it would affect the adult breeding population, particularly if it occurred before a breeding event after heavy inland rains had filled an inland salt lake or lakes. If such an event occurred after a breeding event and affected more juvenile birds, then the consequences for the population would be less serious.

It is not possible to predict accurately when, or if, such a mortality event might occur. However, based on the predicted likelihood and consequence of such an event for the Banded Stilt, it has been categorised as a high risk (see Appendix C for details of the risk assessment method).

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APPENDIX N12

Potential ecological effects of noise emissions

N12 POTENTIAL ECOLOGICAL EFFECTS OF NOISE EMISSIONS

N12.1 SOURCE

The major sources of noise associated with the proposed expansion of works include vehicular traffic, particularly trucks driving on haul roads and unloading mine rock at the rock storage facility (RSF), blasting and excavation and ore processing.

N12.2 EFFECTS/SYMPTOMS

High noise levels are known to decrease species diversity, numbers, and breeding success in birds (Forman and Alexander 1998; Habib et al. 2007). Reijnen et al. (1995) studied the effect of road noise on birds in deciduous and coniferous woodlands in Holland. Of the 43 species analysed, 18 species had reduced density near roads. The threshold noise levels, above which a significant effect on bird density was recorded ranged between 23–58 dB(A) (Reijnen et al. 1995). Many possible reasons are proposed for the effects of traffic noise on birds. Likely hypotheses include hearing loss, increase in stress hormones, altered behaviours, interference with communications during breeding activities, differential sensitivity to different frequencies, deleterious effects on food supply or other habitat parameters (Forman and Alexander 1998), and predator avoidance communication during nesting and fledging phase (Forman et al. 2002). Birds with higher pitched songs are less susceptible to the effect of noise pollution than those with lower pitched songs (Reindt 2003), suggesting that acoustic masking is one of the mechanisms by which noise negatively affects density of passerine birds (i.e. perching birds).

As noise levels within a habitat component increase above critical minimums, both the number of species and the population of each species present in the area will decrease. The louder the noise and the longer its duration, the greater the impact on species present in the area (Foreman and Alexander 1998).

N12.3 IMPACTS OF PAST AND CURRENT OPERATIONS

Read et al. (2000) investigated the bio-indicator value of birds for a number of factors, including noise, from 14 sites in vegetation types at a range of distances from the existing mine site. Heavily developed regions of the mine and processing plant were avoided in the site selection. Surveys were conducted at the same sites each year from 1992 to 1995. At each site a transect was surveyed in chenopod shrubland swale and open woodland, or tall shrubland on an adjacent sand dune. While the highest bird abundances were consistently recorded at mining transects, the total bird numbers were positively associated primarily with woodland and shrubland cover (Read et al. 2000). Crested Bellbirds and mixed-feeding flocks of small insectivorous birds such as the Southern-whiteface, Chestnut-rumped Thornbill, Inland Thornbill and Red-capped Robin were significantly less common in mine transects (Read et al. 2000). Instantaneous noise levels recorded from the sites were typically lower than 70 dB(A) (Read et al. 2000). By way of comparison, the noise levels seven metres away from average street traffic travelling at 40 km/h is 75 dB(A) (EPA 1999). Noise as a single factor was considered unlikely to be important at the Olympic Dam mine site for most bird species (Read et al. 2000).

N12.4 POTENTIAL IMPACTS OF THE EXPANDED OPERATION

Sources of noise for the existing and expanded operation have been identified and the total noise levels for the expanded project have been modelled with the program SoundPLAN using the CONCAWE noise propagation model (see Draft EIS Chapter 14, Noise and Vibration). Separate modelling has been done for three meteorological scenarios (i.e. neutral conditions, adverse conditions and temperature inversion). These were modelled to represent neutral and likely worst-case conditions for transmitting noise from the operation to the Roxby Downs township and proposed accommodation village, and they take into consideration the effect of significant winds and winter inversion conditions.

Under the Draft Environment Protection (Industrial Noise) Policy 2003, industrial external noise during the night is limited to 40 dBL_{Aeq} (40 dBL_{Aeq} is the equivalent of a continuous A-weighted sound pressure of 40 dB(A)). This limit of 40 dBL_{Aeq} would also appear to be an appropriate conservative limit when assessing the likely impact of noise on the environment due to the expanded operations at Olympic Dam. Modelling of neutral, adverse and temperature inversion meteorological conditions suggests that the 40 dB(A) contour would be at a distance of approximately 10, 12 and 16 km respectively from the centre of the open pit (see Figure N12.1). For the expanded operations and under all meteorological scenarios, the 40 dB(A) contour penetrates the Arid Recovery area, the closest area of sensitive fauna habitat.

It is predicted that songbirds such as Chestnut-rumped Thornbill, Inland Thornbill and Red Capped Robin, and shy birds such as Crested Bellbirds and Southern-whiteface are likely to be impacted where noise levels exceed 40 dBL_{Aeq}. Most of the effects of the noise impact are likely to be contained within the expanded SML, although adverse effects would extend into the southern section of Arid Recovery.

N12.5 POTENTIAL IMPACTS ON SPECIES OF CONSERVATION SIGNIFICANCE

Noise is likely to impact on species of conservation significance. It may impact, for example, on species that are shy rely on song for communication or rely on sound for detection of prey. Examples of species that may be affected include:

- Thick-billed Grasswren (several resident populations have been recorded north of the extended SML)
- Greater Stick-nest Rat (reintroduced to Arid Recovery)
- Greater Bilby (reintroduced to Arid Recovery)
- Western Barred Bandicoot (reintroduced to Arid Recovery)
- Burrowing Bettong (reintroduced to Arid Recovery).

Although some degree of habituation to noise would occur, some species may no longer utilise the habitat in the southern section of Arid Recovery. The area of potential effect (i.e. >40 dB(A)) represents about 25–30% of Arid Recovery. The recent northerly extension of Arid Recovery provides an opportunity for fauna movement to the north and therefore lessen the impact to some degree.

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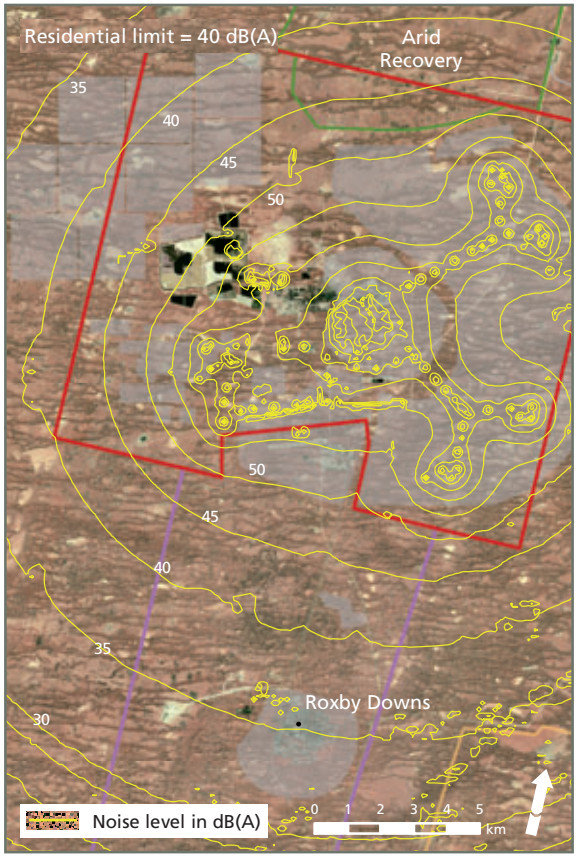
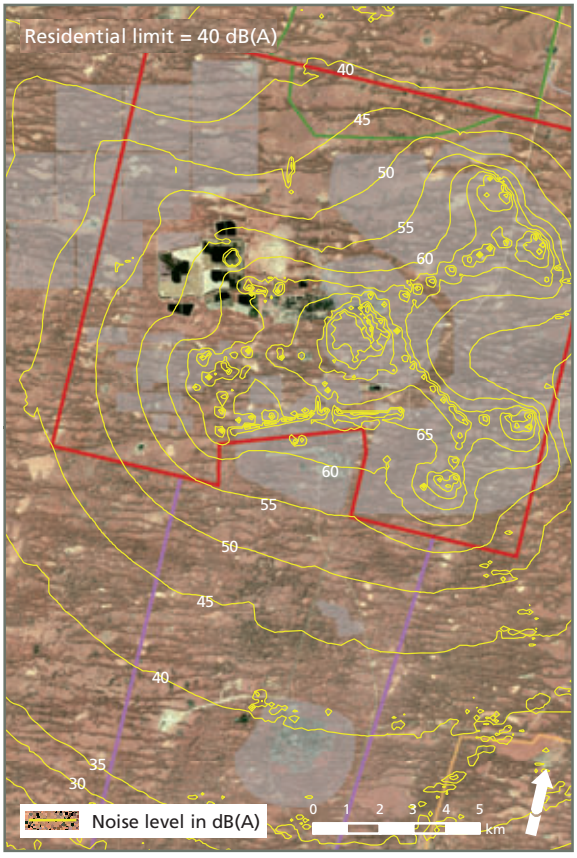
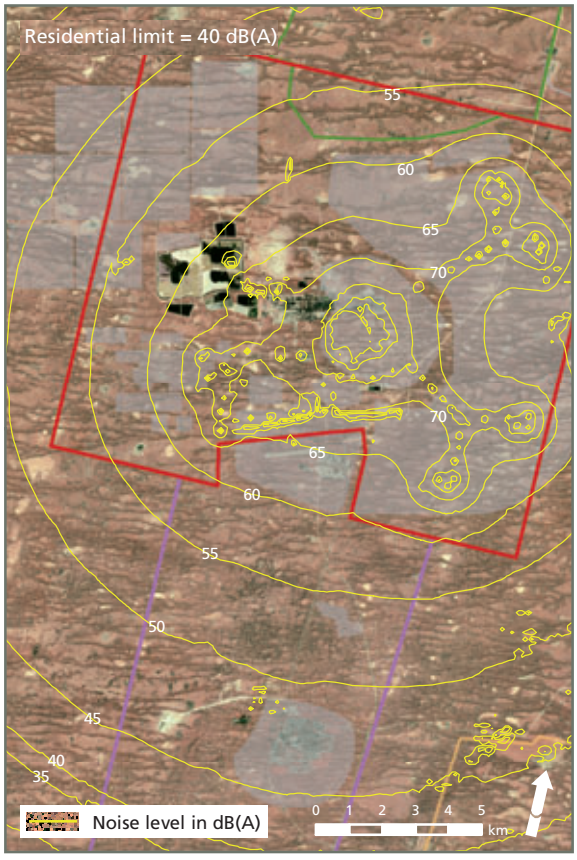


Neutral conditions



Adverse conditions



Temperature inversion

Figure N12.1 Predicted noise contours for the construction phase