northern expressway
environmental report
fauna technical paper

NORTHERN EXPRESSWAY

Australian Government

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Building our National Transport Future

Government of South Australia
Department for Transport, Energy and Infrastructure

FAUNA TECHNICAL PAPER

Northern Expressway

Fauna

Technical Paper

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Revision History

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List of abbreviations

ANZECC	Australian and New Zealand Environment Conservation Council
BP	before present
CAMBA	Agreement between the Government of Australia and the Government of the Peoples Republic of China for the Protection of Migratory Birds and their Environment (1986)
CEMP	construction environmental management plan
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973)
DEH (SA)	South Australian Department for Environment and Heritage
DEH (Cwlth)	Commonwealth Department of the Environment and Heritage (recently changed to Department of Environment and Water)
DTEI	Department for Transport, Energy and Infrastructure
EBS	Environmental and Biodiversity Services Pty Ltd
EMP	Environmental Management Plan
EPA	Environment Protection Authority of South Australia
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
JAMBA	Agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (1974)
NPW Act	South Australian *National Parks and Wildlife Act 1972*
NRM Act	South Australian *Natural Resources Management Act 2004*
SA Water	South Australian Water Corporation
WWTP	wastewater treatment plant

Glossary

Word	Definition
Adelaide Plains	a relatively flat area from the Northern Adelaide Plains to the Willunga basin in the south, covering about 560 km² (see also Northern Adelaide Plains)
Agriculture	the science of producing healthy plants and animals for food and other uses
AnaBat detector	a system that can permanently record and convert the echolocation signals of bats into audible electronic signals to assist in species identification
Anthropogenic	caused by humans or related to human activity
Arboreal	living in or among trees
Biodiversity	the variety of all life forms; different plants, animals and micro-organisms, the genes they contain, and the ecosystems they form part of
Brackish	slightly saline water that contains dissolved salts in the range 0.5–30 ppm, being less salty than seawater (35 ppm)
Crepuscular	species which are active just after sunset and before dawn
Ecology	the study of the interaction between living organisms, and their physical, chemical and biological environments
Ephemeral wetlands	wetlands that temporarily hold water
Floodplain	a plain bordering a river and subject to flooding
Groundstorey	see understorey
Habitat	the locality or environment where a plant, animal, population or community of interest lives; each living organism has a preferred habitat with the physical surroundings having a direct bearing on its function and survival
Horticulture	intensive cultivation of flowers, fruits, vegetables or ornamental plants
Indigenous	originating and living or occurring naturally in an area or environment
Introduced species	an animal or plant that has been introduced to an area where it normally does not occur
Invasive species	a species introduced by human action to a location, area or region where it did not previously occur naturally (i.e. is not native) where it becomes capable of establishing a breeding population, without further intervention by humans, and spreading widely
Micro-chiropteran	insectivorous bats
Migratory species	a mobile organism that changes habitat according to season, climate, food supply etc, often across vast distances and along defined paths
Native	animals or plants that originate in the region in which they are found, i.e. not introduced and naturally occurring in an area
Northern Expressway	the northern area of the project which includes the Gawler to Port Wakefield Road component of the route

Word	Definition
Northern Adelaide Plains	a relatively flat area covering approximately 750 km^2 centred 30 km north of Adelaide's central business district, and forming part of the larger St Vincent (Sedimentary) Basin.
Overstorey	the roughly horizontal uppermost layer of mature vegetation (i.e. trees) that overtops all other layers of foliage in the understorey (e.g. mallee, river red gums)
Peachey Belt	an area in the Northern Adelaide Plains that is defined by a 2km stretch of road, Peachey Road, and characteristic mallee woodland communities that were mostly cleared for primary production in the first 80 years of European settlement
Pre-European	before European settlement (1836 in South Australia)
Recent	geological time period from the present day to 10,000 years BP
Remnant	a small surviving component of an original extent; remnant vegetation includes all intact and predominantly intact indigenous vegetation communities
Riparian	relating to the banks of a watercourse or other water body
Shrubstorey	the storey of vegetation between the overstorey and understorey
Significant Tree (under Development Act 1993)	all exotic and native trees with a trunk circumference of 2 m or greater, or in the case of trees with multiple trunks, those with trunks with a total circumference of 2 m or more and an average circumference of 625 mm or more; measurements are taken at 1 m above natural ground level
Study area	within 500 m either side of the centreline of the proposed route for the Northern Expressway, and generally 100 m either side of Port Wakefield Road between Taylors Road and Salisbury Highway (expanded in some areas to include all of the area 500 m from the centreline of the alignment) other specific impact sites that may, or will, be located outside of the alignment corridor, are also part of the study area, and include areas where indirect or consequential environmental effects may occur as a result of the project
Terrestrial	living or found on land, as opposed to in water bodies or the atmosphere
Threatening process	a process that threatens, or may threaten, the survival, abundance or evolutionary development of a native species or ecological community
Trans-equatorial migration	migrating between the northern and southern hemispheres
Understorey	the small trees, shrubs, herbs and grasses which make up the lower layers of vegetation in a vegetation community. Also referred to as groundstorey
Vagrant	an individual found outside the normal range of its species
Vegetation communities	the make-up of the vegetation according to the plant species present and the relative cover of each

1 Introduction

The proposed Northern Expressway project including the Port Wakefield Road Upgrade was developed from a planning and concept design process that considered a number of options. The final configuration of the Northern Expressway proposal, its construction method, and its environmental management during construction and operation may vary from the project described, however the project constraints, design principles and standards described in the Environmental Report would remain largely the same.

1.1 Project description

The proposed Northern Expressway, and the Port Wakefield Road Upgrade, will form part of the AusLink National Network, replacing the increasingly congested Main North Road thereby providing road safety and amenity benefits. The Port Wakefield Road component involves the upgrade of the existing National Highway that connects the Northern Expressway and the Port River Expressway.

The proposed Northern Expressway between Gawler to Port Wakefield Road will provide significant State and regional benefits. It is primarily aimed at improving access to Adelaide for freight transport via the Sturt Highway, including freight for export from key areas such as the Barossa Valley wine producing area and the Riverland wine and citrus producing area. Together with the Port River Expressway, it will provide a high standard link between the Sturt Highway at Gawler and the Port of Adelaide, South Australia's main shipping port.

It will maximise the opportunity for freight transport to gain access to producers, transport hubs, freight gateways and markets, achieve better delivery times and increase cost efficiency to gain a competitive edge, while improving safety significantly. It will also improve the transport link to the regions north of Adelaide, such as Gawler and the Barossa, fringe rural communities will be more accessible to business, industry, tourists and commuters.

The Northern Expressway corridor crosses the northern Adelaide plains on the north west edge of the Adelaide metropolitan area. The Expressway links with the Gawler Bypass, south of Redbanks Road in the north, to Port Wakefield Road, approximately 500m north of Taylors Road in the south. Port Wakefield Road would be upgraded between this southern terminal junction with the expressway and the Salisbury Highway/Port River Expressway intersection.

The route passes through mainly rural and horticultural land, bypassing the township of Angle Vale on its eastern side and passing north of the Royal Australian Air Force Base Edinburgh and the land with potential for an intermodal facility at Waterloo Corner.

The proposed expressway is about 23 km long and upgrades to Port Wakefield Road extend over 12 km.

The Expressway will be constructed to rural freeway standard in a new road corridor, providing dual carriageways, grade separation of access/connecting roads and restricted road access. The horizontal alignment of the new road has been designed for a posted speed limit of 110 km/h. The road would have a wide corridor, typically about 70 m, but may vary at some locations.

Interchanges are proposed at the Gawler Bypass (partial), Curtis Road (partial), Heaslip/Womma roads and at Port Wakefield Road (signalised junction). Overpasses are proposed at Two Wells Road and Angle Vale Road.

The Expressway will have hard shoulders along both sides for emergency vehicles and breakdowns, space for services and drainage, and a 15 m wide median.

The Port Wakefield Road works would involve upgrading of the existing divided road at a number of intersections along the project length, including at Waterloo Corner Road, Bolivar Road, Ryans Road, Martins Road and the Salisbury Highway, as well as changes to service roads, traffic controls and access to properties at other locations. In most locations, Port Wakefield Road will be widened along the outside edge of the road. It is proposed that the posted speed limit on Port Wakefield Road will be typically 90 kph, but may vary at certain times to better manage safe traffic operations.

Landscaping treatment and potential noise management measures will be considered where required following detailed design development.

The proposed route of the Expressway and upgrade of Port Wakefield Road are shown on Figure 1.1.

1.2 Topic explanation

This report assesses the biological environment in relation to fauna, including constraints and effects, associated with the proposed Northern Expressway Project. It includes a review of historical accounts of the region, the literature pertaining to past and present communities, habitats and species and field surveys conducted during 2005 and 2007. Based on the background information and reviews, areas of biological importance and conservation significance were determined for both species and areas potentially impacted by the project. The assessment culminated in a summary of the actual and potential biological environmental effects of the project and mitigation measures available.

This report provides a detailed review and assessment of the biological environment issues associated with the preferred option and the region in which it will be located.

This report divides the Northern Expressway Project area into two sections. The Northern Expressway incorporates the Gawler to Port Wakefield Road component of the route. The Port Wakefield Road Upgrade extends from the Port Wakefield Road intersection with the Northern Expressway to approximately 1 km south of the Salisbury Highway overpass.

1.3 Legislative requirements and policies

1.3.1 National

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides for the protection and conservation of matters of national environmental significance and for the management of Commonwealth owned and controlled areas. The matters of national environmental significance, as they relate to fauna for the project, are:

- listed threatened species and their habitat and communities
- listed migratory species and their habitat

500m investigation corridor Study area

Figure 1.1 **Study Area**

- marine species and the general environment
- threatening processes with an impact on fauna
- recovery plans, action plans and similar documents applicable to species or groups.

The EPBC Act provides for the implementation and administration of international agreements to which Australia is a signatory, namely:

- CITES – Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973)
- JAMBA – Agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (1974)
- CAMBA – Agreement between the Government of Australia and the Government of the Peoples Republic of China for the Protection of Migratory Birds and their Environment (1986)
- Bonn Convention – Convention on the Conservation of Migratory Species of Wild Animals, for which Australia is a range state under the Convention (1979)
- Earth Summit – Convention on Biological Diversity (Rio de Janeiro, 1992).

A proponent of any proposed development that may have an adverse impact upon matters of National Environmental Significance must submit a referral under the EPBC Act to the Minister for the Environment and Water Resources. The Minister will assess the referral and determine if a formal assessment process (principally public environment report or environmental impact statement) is required.

Subsequent amendments to the EPBC Act also apply, including the *Environment and Heritage Legislation Amendment Act (No 1) 2003* and the amendments of 2006. The 2003 amendment establishes a Commonwealth heritage regime that focuses on matters of national significance and Commonwealth responsibility; and lists places of national heritage significance. The 2006 amendments aim to reduce complexity and duplication, and improve the assessment and approval process.

1.3.2 State

The South Australian *National Parks and Wildlife Act 1972* (NPW Act) provides for the conservation of wildlife in a natural environment at a state level. Schedules 7, 8 and 9 list species classified as endangered, vulnerable and rare respectively. Application to the State Government (Minister for Environment and Conservation) for activities likely to interfere with listed species and their habitat is required under the Act.

The *Native Vegetation Act 1991* as amended plus Regulations, was established to protect and control the clearance of South Australia's native vegetation. One of its provisions is that native vegetation clearance may not be approved if it provides habitat for threatened native fauna. This Act applies to the project along, and north of, Gawler River and at one site immediately adjacent to Salisbury Highway.

The *Natural Resources Management Act 2004* (NRM Act) repeals the Animal and Plant Control (Agricultural Protection and Other Purposes) Act 1986 and the Soil Conservation and Land Care Act 1997, and incorporates their functional requirements. The NRM Act establishes provisions for managing the state's natural resources, including pest plants and animals, and land and water resources.

The *Development Act 1993* contains provisions requiring approval for removal of significant trees.

The State Government policy, *No Species Loss: A Biodiversity Strategy for South Australia 2006–2016* (Draft) is undergoing public review. It will be the key policy for protecting biodiversity in the state and is applicable to the project.

1.3.3 Department for Transport, Energy and Infrastructure

The Department for Transport, Energy and Infrastructure (DTEI) has developed a comprehensive range of environmental planning, policy and management documents which will apply to all aspects of the project. For fauna habitat and species the most important management documents are:

- Care, Control and Management of Roads by the Commissioner of Highways (Section 26 of the *Highways Act 1926*) Operational Instruction 20.1
- Environmental Approval Procedures Operational Instruction 21.1
- Vegetation Removal Policy (which includes a detailed summary of legislative requirements applicable to DTEI in relation to native vegetation), Vegetation Assessment Guidelines and Vegetation Survey Guidelines
- Environmental Code of Practice for Construction
- Land Management Guidelines
- Fauna Impact Assessment Guidelines.

1.3.4 Sources

Fauna names and associated nomenclature accord with Robinson et al. (2000) unless stated otherwise.

Significance criteria were sourced from:

- National – the EPBC Act, including criteria for threatened communities and species, threatening processes and plans adopted to manage these matters
- South Australia – Department for Environment and Heritage and South Australian Museum databases, NPW Act and Schedules 7, 8 and 9
- Regional – Carpenter and Reid (2000) and the City of Playford, City of Salisbury, City of Port Adelaide Enfield, Light Regional Council and DTEI databases on the distribution of native fauna
- Local – all occurrences as all native fauna have local status in this region.

2 Methods and materials

A literature survey and accession of database records from State Government authorities generated data which was compiled to provide a comprehensive model of the former and current occurrence of communities, habitats and species.

The Protected Matters search tool of the Department of the Environment and Heritage (DEH, Cwlth) was used to provide the basis of a predictive assessment of species and habitats of areas and species of national environmental significance.

Field surveys by KBR staff over 2005 and 2006 were complemented by specialist assessments by the South Australian Museum (Terry Reardon) of insectivorous (micro-chiropteran) bat populations.

Discussions and consultation with local council officers included Light Regional Council, City of Playford, City of Salisbury and City of Port Adelaide Enfield. Specialists, especially shore, aquatic and wading bird experts and others with specialist knowledge of the region, were consulted. Specific data provided by these groups and individuals are referred to in the text.

Table 2.1 summarises the survey dates and the primary region and purpose of each assessment period. Figures 2.1, 2.2 and 2.3 record the location of assessment sites for fauna groups in the region and study areas.

Table 2.1 Fauna field survey dates

Survey dates	Northern Expressway	Survey dates	Port Wakefield Road Upgrade
2005		**2006**	
18 November	Flora and fauna	30 August	Fauna (evening survey)
19 November	Flora and fauna	28 September	Fauna (evenings and early morning survey)
23 November	Flora and fauna	2 October	Flora and fauna
30 November	Flora and fauna	6 October	Flora and fauna (early morning survey)
6 December	Fauna	8 October	Fauna (early morning survey)
7 December	Fauna	16 - 19 October	Fauna
9December	Fauna	24 October	Fauna
16 December	Flora and fauna	25–26 September	Fauna (birds)
17 December	Flora and fauna	28 September	Fauna (birds)
27 December	Flora	2–3 October	Fauna (birds)
2006		10 October	Fauna (birds)
3 February	Fauna (birds)	12 October	Fauna (birds)
4 February	Fauna (birds)	14 October	Fauna (birds)
17 February	Flora and fauna (birds)	05 November	Fauna (birds)
2–6 March	Fauna plus bats survey	07 November	Fauna (birds)
11–12 March	Fauna plus bats survey	14 November	Fauna (birds)
24–25 March	Fauna plus bats survey	16–17 November	Fauna (birds)
4 November	Flora and fauna	19–20 November	Fauna (birds)
16 November	Flora and fauna	2–3 December	Fauna
2–3 December	Flora and fauna		

On an appraisal of past data, four faunal groups were considered to warrant more detailed survey. The relative lack of habitat for ground-dwelling species, relatively simple fauna assemblages present and abundance of pest species, indicated that assessment by pitfall traps and box and cage traps was not required. Direct observation only was used to detect these species.

2.1 Crepuscular and nocturnal fauna

Arboreal and terrestrial mammals and night birds were surveyed using spotlight surveys from last light (sun down) to first light (sun up). The most productive time for possums was the first 2 hours after sunset, while birds, such as owls and nightjars, were either seen or identified by their calls throughout the night.

Lightforce spotlights with 80 W and 100 W globes and a red filter were used (to enhance the eye shine of some species). All surveys were undertaken on foot and repeated three times in each area during October–December 2006.

Each area of woodland was assessed for 500 m east and west along Gawler River from the Wingate Road crossing and about 400 m east and west of the Port Wakefield Road crossing of Little Para River.

2.2 Insectivorous bats

Bat surveys were undertaken during March 2006 (Gawler River) and October–November 2006 (Port Wakefield Road) when weather conditions on each night were good to ideal, with warm to hot and humid conditions.

Each discrete field survey used call detection recorded by AnaBat detectors. All bat species expected to occur in the region are readily identified by their echolocation calls.

In all, 21 full detector nights were completed for the Northern Expressway section.

In the vicinity of Port Wakefield Road, restrictions prevented access to private land and lack of security for equipment generally meant that detectors could not be left out for a full night. The nine surveys in that area were therefore reduced to a period of 2.5–4 hours after sunset using accompanied detectors. Although recording for the entire night it is generally recommended, in this case recording for shorter periods during peak bat activity over four nights gave a very clear indication of activity levels and species composition.

Five 1-hour mobile surveys were undertaken for both study areas.

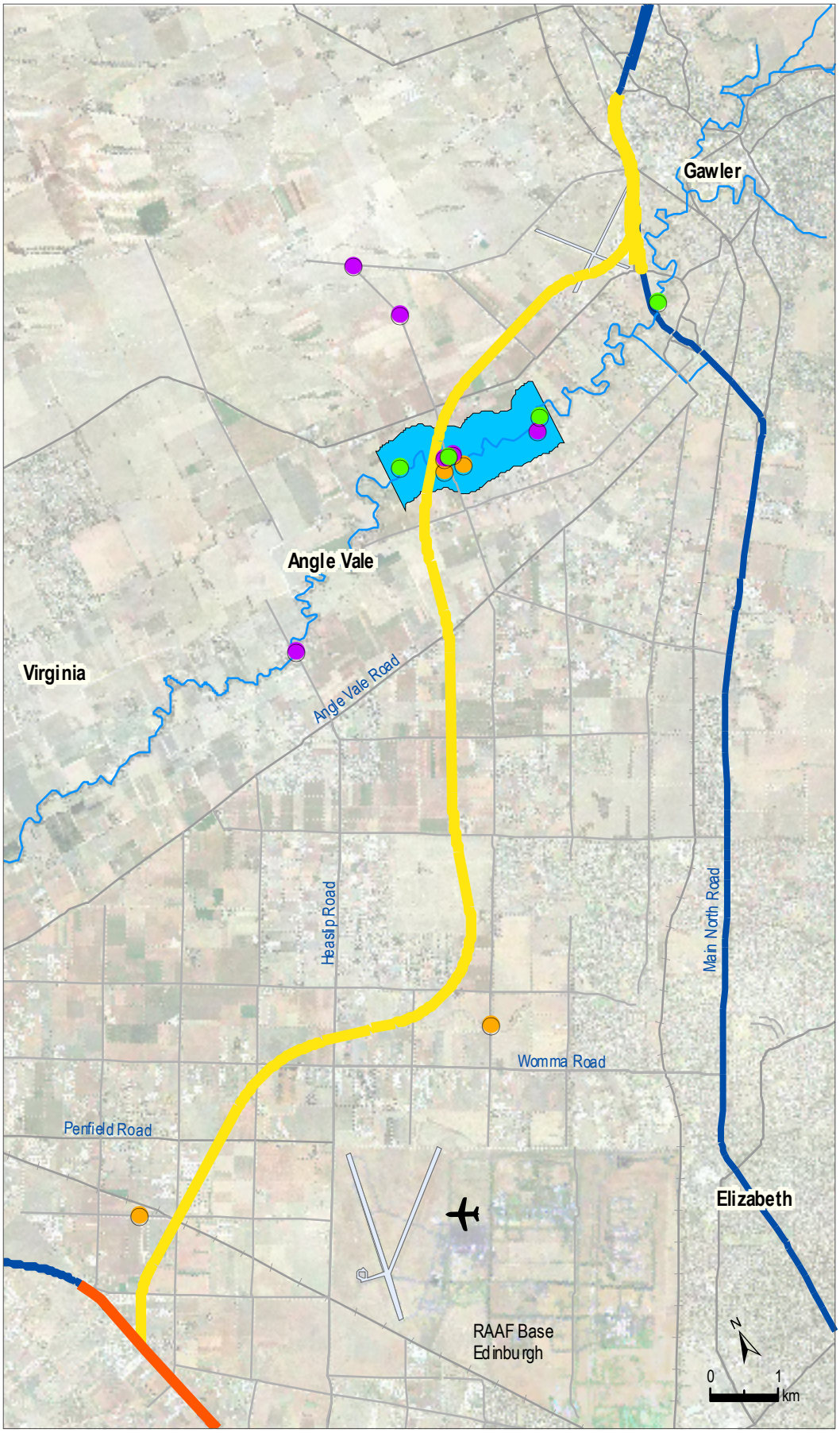

Figure 2.1 **Vertebrate fauna assessment sites Northern Expressway**

Figure 2.2 **Vertebrate fauna assessment locations along Port Wakefield Road**

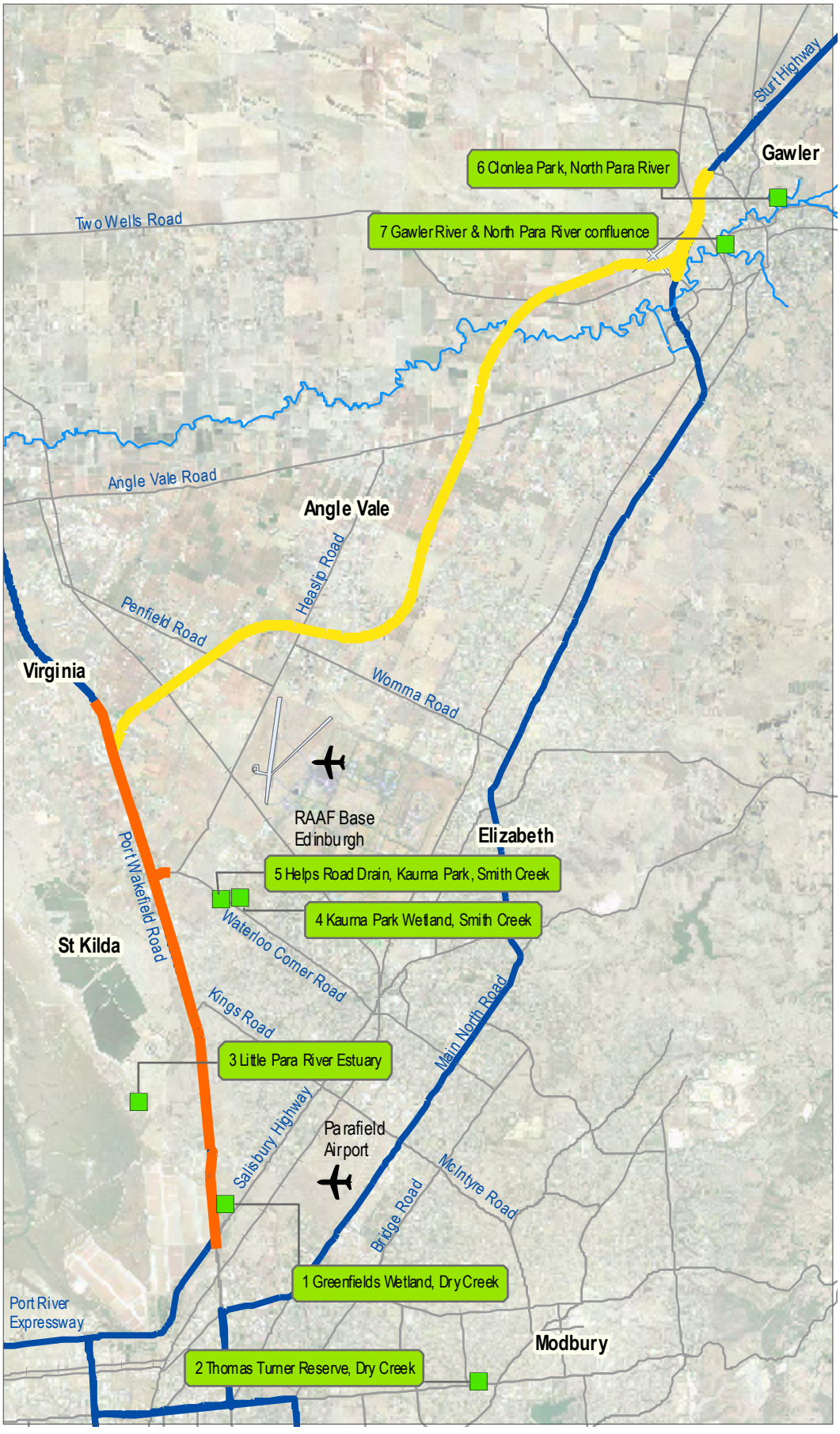

Figure 2.3 **Aquatic macro-invertebrate sampling locations**

2.3 Birds

Birds were surveyed in all known and predicted biologically significant sections of the study area and region potentially affected by the project including Gawler River, Little Para River, Dry Creek and constructed water treatment wetlands. The South Australian Water Corporation (SA Water) lagoons at Bolivar and the adjacent areas of the salt fields will not be affected by the proposal and, the sites were not considered in the field surveys.

Surveys used the '2 ha 20 minutes, or longer' procedure of Birds Australia (Barrett et al. 2003). Assessments were generally carried out for one to two hours at dawn and dusk. Comprehensive diurnal variation records were provided by surveys during the day and evening (between 1 hour after sunset and 1 a.m.). Opportunistic sightings in the study area and region, including road killed animals, were also recorded.

Bird numbers and species moving to and from survey sites were also assessed for the Port Wakefield Road Upgrade section of the study area and along Gawler River and Little Para River.

Records were kept of all bird species as per the Birds Australia procedure. Particular attention was focused on the presence or absence of: specialised wetlands species that are cryptic, such as rails, crakes and bitterns; trans-equatorial migratory shorebirds; and nationally threatened species, such as slender-billed thornbill and orange-bellied parrot.

Records for the Dry Creek saltfields and associated region are available for over 50 years, with detailed population data available since 1985 (D Close, J Cox and R Attwood, pers. comm., 2005 and 2006). These data were used to establish a baseline for bird surveys and for data analysis.

Species lists and notes about many species are also available for the Greenfields and Barker Inlet wetlands since their construction in the 1990s (Cox 1993). Additional data for the Barker Inlet wetlands, including historical information, are summarised in Brown & Root (2004) as are field observations made over November 2003 to February 2004 at this and other sites. Species lists for the Barker Inlet region and wetlands and observations of fauna in both areas were provided by the wetlands ranger for these areas (A Cowley, City of Port Adelaide Enfield, pers. comm., September 2006).

2.4 Amphibians

The South Australian EPA Frogwatch protocol was used to record the diversity and relative number of amphibian species at a site. The usual method was to sit quietly at a chosen site and note the species that were calling over 1–2 hours of the day or night. Taped calls of species that were not heard were played and responses, if any, noted.

2.5 Other groups and species

Observation during field surveys provided opportunistic records of fauna which were compiled into specific site records for certain species, including road kill statistics of native and introduced species. No other specific survey methods were used.

3 Existing conditions

For biological matters, both past and present conditions can influence the distribution of communities and species. In particular, past distribution of habitats and species available from historical accounts can help in understanding changes in native and introduced fauna populations. This section discusses both past and present information relevant to the distribution of flora and fauna.

3.1 Description of existing conditions within corridor

3.1.1 Current land use

Horticulture and intensive agriculture, and residential, retail and industrial developments characterise past and existing land use in the study area and region. Users of large land areas in the region and study area include horticulture (vegetables and flowers, rose plant production, vines and trees, and hay), livestock grazing (sheep and cattle), horse studs, housing, retail outlets and stormwater management. Less than 1% of the original native vegetation remains in the region.

However, several major revegetation schemes and many smaller areas of revegetation have been established in the region by the South Australian Government, local councils and other authorities. The SA Urban Forests One Million Trees Program is a key participant in the region. The current vegetation mostly consists of anthropogenic (introduced plant species, especially weeds, in a disturbed environment) shrubstorey and groundstorey 'communities', with occasional indigenous plants as individuals or small patches along roadsides and, more rarely, as larger areas on private land and along roadsides.

Little remnant overstorey vegetation remains in the southern and central sections of the study area, and when it does, it is limited to individual, isolated trees or, at the most, small copses. Areas around the Gawler River contain tall eucalypt-dominated woodland and the Reeves Plain region of plains and dunes north of the Gawler River has areas of remnant mallee scrubland–woodland and native pine woodland (Beecroft et al. 1981).

3.1.2 Pre-European settlement habitats

Before 1836, the Adelaide Plains to Reeves Plain region supported a diverse range of fauna from all faunal groups. Detailed records are available from the South Australian Museum database, Wood Jones (1923) and Waite (1929) with excerpts of historical accounts of the colony of South Australia and more recent information summarised in Twidale et al. (1976), Turner (2001) and Daniels and Tait (2005).

The original habitats of the study area were diverse, ranging from tall woodlands and forests to mallee woodlands and scrublands to open shrublands and grassland plains. Aquatic and riparian areas, especially the freshwater swamps, with a complex of woodland, shrublands and tall grasslands and sedgelands maintained a diverse and abundant assemblage of animal species. River red gum woodland and forest and areas of black box woodland were present along most of the Gawler River and its floodplain between Gawler and Port Gawler before European settlement (Kraehenbuehl 1996).

Historical accounts indicate that the region was probably one of the most biodiverse sites for fauna in South Australia (Turner 2001) but since European settlement much of the overstorey vegetation has been cleared, leaving only a 'riparian ribbon' of woodland along the rivers.

Within 20 years of white settlement, many terrestrial species were extinct or approaching extinction because of habitat destruction, and predation by or competition with introduced species. This trend continued especially for small and medium sized mammals, a wide range of which have been regionally extinct for 50 to over 100 years. Insectivorous (micro-chiropteran) bats are one of the few groups to have survived relatively unscathed.

Some bird and amphibian species had similar fates to their mammalian counterparts, although bird and reptile species assemblages have remained reasonably intact, with an occasional 'total extinction'. However, while total bird species diversity in the wider region has remained similar to that in 1836, the bird fauna composition, including species richness, has significantly changed and many woodland bird species have become locally extinct (Tait et al. 2005).

The aquatic fauna was similarly decimated, with most of the fauna assemblages and species being severely impacted and many, especially fish species and aquatic mammals, replaced by non-native species.

3.1.3 Background and regional fauna information

Environmental and Biodiversity Services (EBS 2004) reviewed and assessed fauna characteristics of the Northern Expressway region. Its information combined with a search of the Biological Databases of South Australia (DEH) and the South Australian Museum fauna databases revealed a total of 1696 records of fauna species from the vicinity of the study area. The total included 221 bird species of which 217 species are native, 25 mammal species of which 17 are native, and 40 reptile species and six amphibian species all of which are native (although one amphibian has been introduced to the region). Two other bird species were recorded in the region during the bird atlas of the Adelaide region in 1984–1985 and additional species have been recorded over the past 10 years (R Anderson pers. obs. 1995 to 2005).

Past literature assessments for the region are summarised in KBR (2006a) which provides information on the likely presence and abundance of most fauna species within the study area and the region.

The areas likely to contain the highest diversity of woodland species are the river red gum (*Eucalyptus camaldulensis*) woodlands along Gawler River and Little Para River. Many of large, mature river red gums in these woodlands contain multiple hollows and all of them have canopy characteristics suitable for use by fauna. They provide suitable habitat for roosting, resting and breeding by common fauna species, such as Australian magpie *(Gymnorhina tibicen)*, musk lorikeet *(Glossopsitta concinna),* common brushtail possum (*Trichosurus vulpecula*), Gould's wattled bat *(Chalinolobus gouldii)* and raptors (birds of prey).

Debris from the river red gums would provide microhabitats for reptile species such as snake-eyed skinks (*Morethia* spp.), dwarf skink *(Menetia greyii)* and possibly tree skink *(Egernia striolata).* Most frog species previously recorded within the region (e.g. southern bull frog, *Limnodynastes dumerili* and brown froglet, *Crinia signifera*) are likely to occur along the rivers.

The remaining small patches of mallee box woodland, mallee scrubland and native pine forest and woodland within the region and study area north of Gawler River are confined to roadsides or are small areas on private land. Most are degraded but would offer some habitat value to a variety of fauna species. It is likely that most fauna using these areas would be common species.

A large proportion of the remaining study area is extensively cleared of native vegetation, and is of low quality as habitat for native fauna. Despite this, remaining areas would still provide habitat for a range of common species including eastern bearded dragon (*Pogona barbata*), western and eastern bluetongue lizards (*Tiliqua occipitalis* and *T. scincoides* respectively), sleepy lizard (*T. rugosa*), eastern brown snake (*Pseudonaja textilis*) and a number of smaller skinks and geckoes. The diversity of the species present is predicted to be much lower than that in the Gawler River woodland area, the mallee and native pines areas to the north and the relatively intact coastal habitats along Gulf St Vincent. A number of bird species, such as birds of prey, would also use the region for feeding, roosting and breeding.

The wetlands in the region have mostly been constructed to assist in water treatment, although they occupy areas which historically contained wetlands, especially samphire shrublands and other saline wetlands. The Greenfields wetland complex, Barker Inlet wetlands and various detention basins adjacent to Port Wakefield Road and the Little Para River provide suitable habitat for a number of bird and aquatic species. Smith Creek, Dry Creek and some of the larger drains, such as Whites Road drain, contain smaller areas of habitat suited to some bird, frog, reptile and aquatic species.

Macro-invertebrates (or water bugs) can provide a good indication of overall aquatic habitat quality.

A total of 41 macro-invertebrate taxa were identified across the whole study area. The Gawler River confluence and the North Para River (both in the northern portion of the region) recorded the highest macro-invertebrate diversity. The most commonly recorded taxa throughout were non-biting midge larvae (Chironomidae), and water boatmen (Corixidae).

A disproportionate number of the macro-invertebrate species identified are known to be tolerant or very tolerant of poor water quality. This was not unexpected given the intensive agricultural practices which occur around the Gawler and North Para rivers in the northern portion of the study area.

A total of 39 species were recorded from sites within the Port Wakefield Road Upgrade project area. A high number of these were species known to be tolerant of low water quality.

3.2 Survey results for Northern Expressway

3.2.1 Habitat areas

Key fauna habitats are available within this section of the study area and adjacent sections of the region:

- Woodlands, primarily the indigenous mature river red gum woodlands associated with freshwater riparian areas, provide important habitat in these areas and also include small stormwater detention basins that have importance for some aquatic birds and amphibians.
- Grassland areas, primarily *Austrostipa* and *Austrodanthonia* spp. are also used by woodland bird species, with an occasional grassland specialist being recorded.
- Revegetation areas, primarily woodlands and tall shrublands as landscaping and amenity plantings. The sites include specific revegetation areas developed by the State Government, especially DTEI, councils, City of Salisbury and City of Port Adelaide Enfield, and private developments.

- Anthropogenic areas include areas of agriculture and horticulture, undeveloped land, buffer zones around defence sites, areas of cereal cropland, including areas that are not being cropped and some roadside areas. A few species were recorded only here or some other species were recorded using this habitat.

The value of each type of habitat varies within the region and study area depending on the quality and condition of the habitats present. The poor condition of most areas of native vegetation is considered to provide poor fauna habitat. Numerous weed species are present, particularly in the understorey where they dominate.

Table 3.1 lists the fauna habitat value of each habitat type present within the region and study area. The woodlands and forest along the Gawler River have the highest habitat value within the northern region of the study area. In particular, the presence of mature trees with large numbers of hollows increases the value of this habitat type significantly.

Areas of remnant native pine and mallee in the region also have good potential habitat, though primarily for birds and reptiles in some of larger areas. The best quality sites of these vegetation communities are north of the study area.

Relatively few native fauna species would use the other areas, and those that did would usually be the common native and introduced bird species, and, potentially, birds of prey which may feed, rest and roost in these areas.

Table 3.1 Habitat type and value observed within the study area and region

Habitat type	Habitat value
River red gum woodland (Gawler River)	Moderate to high
Mallee box woodland	Low to moderate
Remnant indigenous grasslands	Low
Mallee scrubland and native pine woodland	Moderate to high
Wetlands	Low
Cropping and grazing land and anthropogenic structures	Low
Planted vegetation	Low to moderate

The Gawler River bank fringe is one of the last remaining relatively intact areas of remnant woodland vegetation in this region. This stretch of remnant eucalypt woodland has been identified as likely to contain the highest diversity of species in the study area. The community includes mature river red gums, many of which contain multiple hollows, which have been identified as potential bat roost trees and habitat areas for local fauna. The area of remnant vegetation along the Gawler River bank is a key habitat area for common bird species of the region.

Isolated trees and small patches of large to mature river red gums are present throughout the surrounding area. Of particular note are the small areas of 1–5 ha of remnant river red gum forest or woodland adjacent to Angle Vale Road, Heaslip Road and elsewhere in the region. In general, these trees are in good condition.

Small patches of mallee woodland and native pine forest and woodland occur in the northern part of the study area. These areas were generally small, often confined to roadsides and the majority are degraded. However, they still represent habitat for some fauna species, especially birds.

Isolated stands of mallee box are located in and adjacent to the impact corridor south of the Gawler River, along most of the roads. These trees are remnants, but there is little shrubstorey or understorey vegetation present and the area is continually mown and herbicides applied. This area is of low to moderate conservation value.

Remnant vegetation of Peachey Belt woodland, which was mallee box, is now confined to roadsides, small reserves, cemeteries and occasional sites on private land.

Grassland areas and the stubble of cereal croplands still provide habitat for species such as Richard's pipit and stubble quail. These sites also provide occasional feeding sites for species such as sacred ibis.

Areas of scattered trees, here defined as woodland remnants, are common throughout this region. Gawler River and isolated patches on the Northern Expressway alignment are mixed eucalypt woodland communities. These areas provide habitat for species such as magpie-lark, wood duck, black duck, rainbow lorikeet and musk lorikeet. Species such as the peregrine falcon also use the woodlands as a feeding area and an occasional roost site. However, they are occasional visitors across a wide territory and all habitats throughout this territory during the year.

Observation during field work indicates that many river red gum trees with hollows would provide habitat for native species were it not for the intense competition with introduced species. In particular, feral pigeons and common starlings were common breeding residents in these woodlands, and some other hollows are occupied by feral European honeybee colonies.

Approximately 110 vertebrate species have been recorded as occurring in this area of which a few species are of conservation significance. There are no habitats of national significance recorded in the study area or region.

3.2.2 Fauna groups and species

Mammals

Mammal numbers throughout the study area were low. Native mammal diversity was limited to western grey kangaroo (*Macropus fuliginosus*), as an occasional vagrant annually, including two animals along Smith Creek in December 2006, common ringtail possum (*Pseudocheirus peregrinus*) and common brushtail possum (*Trichosurus vulpecula*). Water rat (*Hydromys chrysogaster*) is present along the Gawler River and echidna (*Tachyglossus aculeatus*) was recorded in the northern section of the Northern Expressway study area. Seven common bat species were recorded in sections of the proposed alignment and primarily around Gawler River woodlands (Table 3.2). All are expected to be common in the region (SA Museum 2006a).

Table 3.2 Bat species recorded in the region (SA Museum 2006a)

Common name	Scientific name
White-striped freetail bat	*Tadarida australis*
Southern freetail bat	*Mormopterus* sp.
Gould's wattled bat	*Chalinolobus gouldii*
Lesser long-eared bat	*Nyctophilus geoffroyi*
Southern forest bat	*Vespadelus regulus*
Large forest bat	*Vespadelus darlingtoni*
Chocolate wattled bat	*Chalinolobus morio*

There is minimal habitat available for larger mammals, especially south of the Gawler River. Most of the woodland in this region has been removed for agricultural purposes, leaving only isolated fragments. Placement of roads through this area has also exacerbated the effects of fragmentation by isolating habitat suitable for some mammal species. Outside of the Gawler River corridor, the remaining woodland areas occur in small fragments throughout the surrounding region and their limited size renders them unable to support mammal populations.

Many of the mammal species identified are common to the north of the proposed alignment and Gawler River, where the habitat is less fragmented, although equally disturbed by anthropogenic factors.

The introduced species, red fox (*Vulpes vulpes*) and cat (*Felis catus*), were recorded in the region. These species are predators of a range of native species. Brown hare (*Lepus capensis*), European rabbit (*Oryctolagus cuniculus*), black rat (*Rattus rattus*), brown rat (*Rattus norvegicus*) and house mouse (*Mus domesticus*) were also present or have been recently recorded for the study area. These species compete with native species for food, shelter and other resources and some are predators of some native species, especially black rat, which is a known predator of bird's eggs and nestlings.

Birds

A total of 46 bird species were identified during the survey (KBR 2006b). Database searches of recent bird observation records for the Australian Bird Atlas project (Barrett et al. 2003) indicate a likely 60–70 bird species would inhabit or use this area, primarily during spring and summer. Introduced bird species, especially feral pigeon and common starling, were the most commonly recorded species. Both species were recorded using hollows in mature river red gums for nesting.

Despite these findings, the remnant vegetation communities of the Gawler River represent an important habitat and migration corridor for local bird species. There are numerous nesting and roosting sites in the many hollows of the river red gums, the only overstorey species recorded at the sites. However, observation shows intense competition for this habitat and conservation significant bird species that are hollow-dependent are unlikely to occupy these habitat fragments. While no species of listed conservation significance was recorded, the common species that were present had reasonable sized populations and well-established feeding and nesting areas.

The shrubstorey and understorey areas in the riverine corridor are almost entirely disturbed and anthropogenic, with a number of proclaimed and environmental weed species dominant. This reduces the available habitat for birds and, therefore, the habitat in which additional species can occur.

Reptiles

Up to 16 species are likely to be present in the region, including sand goanna (monitor) (*Varanus gouldii*), which is still relatively common north of the Gawler River and common long-necked tortoise (*Chelodina longicollis*) which is still present in and along the Gawler River. Pastok et al. (1998) recorded eastern tiger snake (*Notechis scutatus)*, a species of regional significance, east of the study area.

Amphibians

Amphibian species recorded within the region were brown froglet (*Crinia signifera*), eastern pobblebonk (bull frog) (*Limnodynastes dumerilii,* southern call race), spotted marsh frog (*Limnodynastes tasmaniensis,* southern call race) and brown tree frog (*Litoria ewingi*). Painted frog (*Neobatrachus pictus*) is expected to occur and brown toadlet (*Pseudophryne bibronii*) may still be present. Brown froglet and spotted marsh frog were common and present in most drains, watercourses, ephemeral wetlands and areas which held water, such as deep pools along the roadside. Brown tree frog was relatively common in the Gawler River woodlands.

Other groups

Fish records are sparse for the region, although recent data indicate that three native fish species have been recorded in the Gawler River near Virginia.

There is no definitive list of invertebrates for the region. Many of the species recorded in Turner (2001) would be expected to occur here.

3.2.3 Fauna species of national conservation significance

A search of the DEH (Cwlth) database revealed a total of 26 fauna species of national conservation significance (listed under the EPBC Act) which may occur in the survey area and region (Table 3.3). (A further 30 fauna species of state conservation significance have been previously recorded within the vicinity of the study area.)

Table 3.3 Fauna species with conservation ratings

Common name	Species	AUS	SA
Spotted quail-thrush (Mt Lofty Ranges)	*Cinclosoma punctatum anachoreta*	E critically	E
Orange-bellied parrot	*Neophema chrysogaster*	E critically	E
Southern giant-petrel	*Macronectes giganteus*	E, M	
Regent honeyeater	*Xanthomyza phrygia*	E	E
Northern giant-petrel	*Macronectes halli*	V, M	
Buller's albatross	*Thalassarche bulleri*	V, M	V
Shy albatross	*Thalassarche cauta*	V, M	V
Campbell albatross	*Thalassarche impavida*	V, M	
Mallee fowl	*Leipoa ocellata*	V	V
Plains-wanderer	*Pedionomus torquatus*	V	V
Australian painted snipe	*Rostratula australis*	V	R
Gibson's albatross	*Diomedea gibsoni*	V	

Common name	Species	AUS	SA
Sharp-tailed sandpiper	*Calidris acuminata*	M	
Curlew sandpiper	*Calidris ferruginea*	M	
Red-necked stint	*Calidris ruficollis*	M	
Latham's snipe	*Gallinago hardwickii*	M	
White-bellied sea-eagle	*Haliaeetus leucogaster*	M	
White-throated needletail	*Hirundapus caudacutus*	M	
Rainbow bee-eater	*Merops ornatus*	M	
Painted snipe	*Rostratula benghalensis* s. lat.	M	
Common greenshank	*Tringa nebularia*	M	
Marsh sandpiper	*Tringa stagnatilis*	M	
Slender-billed thornbill	*Acanthiza iredalei rosinae*	V	V
Australasian bittern	*Botaurus poiciloptilus*		V
Crested shrike-tit	*Falcunculus frontatus*		V
Eastern curlew	*Numenius madagascariensis*		V
Regent parrot	*Polytelis anthopeplus anthopeplus*		V
Diamond firetail	*Stagonopleura guttata*		V
Fairy tern	*Sterna nereis*		V
Painted button-quail	*Turnix varia*		V
Intermediate egret	*Ardea intermedia*		R
Shining bronze-cuckoo	*Chrysococcyx lucidus plagosus*		R
Light-mantled sooty albatross	*Diomedea palpebrata*		R
Peregrine falcon	*Falco peregrinus*		R
Little bittern	*Ixobrychus minutus*		R
Blue-billed duck	*Oxyura australis*		R
Flame robin	*Petroica phoenicea*		R
Striped honeyeater	*Plectorhyncha lanceolata*		R
Glossy ibis	*Plegadis falcinellus*		R
Redthroat	*Pyrrholaemus brunneus*		R
Common tern	*Sterna hirundo*		R
Bassian thrush	*Zoothera lunulata*		R
Azure kingfisher	*Alcedo azurea*		EX
Southern brown bandicoot	*Isoodon obesulus obesulus*	E	V
Burrowing bettong	*Bettongia lesueur*	E	E
Southern freetail bat	*Mormopterus planiceps*		R
Koala	*Phascolarctos cinereus*		R
Yellow-bellied sheathtail bat	*Saccolaimus flaviventris*		R
Flinders worm-lizard	*Aprasia pseudopulchella*	V	
Cunningham's skink	*Egernia cunninghami*		V
Heath goanna	*Varanus rosenbergi*		R

Birds

Thirteen bird species of national conservation significance possibly occur within the region (Table 3.3). Nine of them have a rating of vulnerable (four are also listed as migratory), and four bird species have a rating of endangered (one is also listed as migratory). A further 10 species are listed under the EPBC Act as migratory bird species. Of the 13 bird species of national conservation significance and 10 migratory bird species, only six species have been previously recorded within the region: the nationally vulnerable species, shy albatross *(Thalassarche cauta*), mallee fowl (*Leipoa ocellata*) and plains-wanderer (*Pedionomus torquatus*), the nationally endangered species, spotted quail-thrush (*Cinclosoma punctatum*) and regent honeyeater (*Xanthomyza phrygia)*, and the migratory rainbow bee-eater (*Merops ornatus*).

Migratory bird species

Fifteen of the bird species listed as of national conservation significance, are migratory species. Six of the migratory species are marine birds, five of which – Gibson's albatross (*Diomedea gibsonii*), northern giant petrel (*Macronectes halli*), Buller's albatross (*Thalassarche bulleri*), shy albatross (*Thalassarche cauta*), and the Campbell albatross (*Thalassarche impavida*) – are also listed as vulnerable. The sixth marine species, the southern giant petrel (*Macronectes giganteus*) is listed as endangered. As they are generally restricted to coastal areas, it is unlikely that any of these species would use the study area, and therefore are unlikely to be adversely affected by the project. Only one of these marine species, the shy albatross, has been recorded in the region (coastal area only).

A further seven of the migratory species are wetland specialists that are present within Australia from about September to April each year: sharp-tailed sandpiper (*Calidris acuminata*), curlew sandpiper (*Calidris ferruginea*), red-necked stint (*Calidris ruficollis*), Latham's snipe (*Gallinago hardwickii*), painted snipe (*Rostralatula benghalensis*), common greenshank (*Tringa nebularia*) and marsh sandpiper (*Tringa stagnatilis*). Most of these wetland species are found along shorelines, but they are occasionally also found inland using wetlands, tidal flats and salt marshes. It is unlikely that these species would use the study area but they occur within the St Kilda mangroves and Penrice saltfields. There are no previous records of these wetland birds within the proposed area and no suitable habitat was observed within the study area during the field inspection. Therefore, it is unlikely that the proposed project would have a significant impact on these waterbirds.

The remaining three migratory species – white-bellied sea-eagle (*Haliaeetus leucogaster*), white-throated needletail (*Hirundapus caudacutus*) and rainbow bee-eater – are listed as terrestrial migratory species. The white-throated needletail is a migrant to Australia during October–April and there are only scattered records of this species in South Australia. For some time it was believed that this species remained aerial during its stay in Australia, but it is now known to roost in rock crevices and trees for short periods. It might fly over the proposed site during its months in Australia but there are no records of this species for the study area. The white-bellied sea-eagle usually flies along coast lines, and the only breeding pair in the region nests south of Adelaide. One or other of these birds (or their progeny) is occasionally recorded along the Gawler River west of the study area. However, the Northern Expressway Project is unlikely to have an adverse impact on these birds.

The rainbow bee-eater is a migrant to the region over about September–April and inhabits woodland plains and riparian areas. This species is known to breed on the Adelaide Plains, mainly north of the Gawler River and west along the coastline. A bird survey of the Gawler River (KBR 2006b) did not record the species. No nesting sites were recorded and no vagrant birds were recorded at the time of the survey.

Additionally, 16 bird species, which belong to families listed as migratory under the EPBC Act, have been recorded or may occur within the vicinity of the alignment.

Nine species have not been recorded in the area since late 1950s but it is likely that this is a result of limited observation or recording of observations, rather than an absence of the species. Most of these species are expected to occur in the area at some time of the year. These species and their last date of 'official record' are: grey teal (*Anas gracilis*, 1918), wedge-tailed eagle (*Aquila audax*, 1937), swamp harrier (*Circus approximans*, 1917), brown falcon (*Falco berigora*, 1957), black falcon (*Falco subniger*, 1958), whistling kite (*Haliastur sphenurus*, 1928), black kite (*Milvus migrans*, 1952), Australian hobby (*Falco longipennis*, 1957) and spotted harrier (*Circus assimilis*, 1918).

Anderson (pers. obs. 2000–2005) confirms that grey teal, wedge-tailed eagle, brown falcon, whistling kite, black kite and Australian hobby are present in the region and have been occasionally recorded in the study area. Black falcon is still present in the wider region, with sightings of the species made about 20 km north of the study area.

The remaining seven species have been recorded in the region more recently (since the 1980s), and potentially would utilise the study area.

Hardhead (*Aythya australis*) has been recorded as recently as 2000 within the region. It is a wetland species that may use areas of the Gawler River, Little Para River and Greenfields complex. The Australian wood duck (*Chenonetta jubata*) is increasing in numbers and considered to be becoming a pest (Turner 2001). Brown goshawk (*Accipiter fasciatus*), collared sparrowhawk (*Accipiter cirrhocephalus*), black-shouldered kite (*Elanus axillaris*), little eagle (*Hieraaetus morphnoides*) and nankeen (Australasian) kestrel (*Falco cenchroides*) may all utilise the area predominantly for feeding. Personal observation (R Anderson, 2000–2005) indicates that wood duck, little eagle, brown goshawk, black-shouldered kite and nankeen kestrel are breeding in the region (primarily north of the Gawler River).

Other birds previously recorded in the region

*Spotted quail thrush (Mt Lofty ranges) (*Cinclosoma punctatum anachoreta*) (critically endangered)*

Spotted quail thrush is listed as critically endangered under the EPBC Act and is one of Australia's most endangered bird species. This species is found only in the Mount Lofty Ranges, and has not been recorded north of Angaston. The last confirmed sighting was in 1984 (Armstrong et al. 2003). It prefers sclerophyll forest habitat, ideally on leaf-littered rocky ridges with short tussock grass (Turner 2001). This habitat type does not occur within the study and region and therefore it is unlikely that this species would occur here. The project would not impact this species.

Orange-bellied parrot (Neophema chrysogaster*) (critically endangered)*

The orange-bellied parrot is listed as critically endangered under the EPBC Act with an estimated 180 mature birds only remaining in the wild (Garnett and Crowley 2000). The species was last recorded in samphire along Gulf St Vincent west of the study area in the 1970s, and potential habitat for the species remains there. The orange-bellied parrot is unlikely to occur within the study area, nor be affected given the location of potential habitat away from the proposed route.

*Regent honeyeater (*Xanthomyza phrygia*) (endangered)*

This species once regularly visited and bred in the wetter parts of South Australia, from the Mount Lofty Ranges north to the southern Flinders Ranges, mostly in woodlands. The last record within the wider region was a single bird in Golden Grove in the 1930s. Today it is thought to only occur in fragmented populations in New South Wales and Victoria (Garnett and Crowley 2000). The regent honeyeater is very unlikely to occur within the study area.

*Letter-winged kite (*Elanus scriptus*)*

The letter-winged kite was not listed under the EPBC Act protected matters search or the NPW Act. However, the species is a rare visitor to the region, usually as a result of southerly migrations during drought years in the pastoral zone. It was recorded in 2002 at Dublin, about 20 km north of the study area (R. Anderson, pers. obs. March 2002). This is the second record of the species this far south in 40 years. Based on the limited occurrence of this species, the project is unlikely to encounter, let alone affect, the letter-winged kite.

*Australian painted snipe (*Rostratula australis*) (vulnerable)*

Australian painted snipe has not been previously recorded within the region around the proposed project site. It is a highly nomadic and cryptic species that usually occurs in coastal areas but also frequents inland wetland areas. The Australian painted snipe prefers shallow ephemeral wetlands, such as flooded lignum, samphire or tussock grasses. No suitable habitat was observed within the study area and it is unlikely that the project would have an adverse effect on this species.

*Malleefowl (*Leipoa ocellata*) (vulnerable)*

Malleefowl is a species that occupies large territories (up to hundreds of hectares) within mallee woodland. This species was identified as being previously recorded in the region from the database search but the most recent recording was in 1922 in Humbug Scrub, Mount Lofty Ranges, (approx. 5 km away).The lack of suitable habitat within the study area and the requirements for the species indicate that it would not occur within the project site.

*Plains-wanderer (*Pedionomus torquatus*) (vulnerable)*

Plains-wanderer is rarely reported but is probably sparsely widespread throughout the grassed areas of South Australia. The latest record of this species in the vicinity of the study area was in 1925 at Virginia. Agricultural and housing development since then has removed almost all of the native grasslands that would have occurred in the area in 1925. No suitable habitat was observed within the study area for this species.

*Slender-billed thornbill (*Acanthiza iredalei rosinae*) (vulnerable)*

The slender-billed thornbill (western) has a distribution across Western and Southern Australia and is considered vulnerable in the Gulf St Vincent region (Garnett and Crowley 2000). Last recorded in 1957 in the vicinity of the development, the slender-billed thornbill occupies treeless chenopod shrubland with a preference for glasswort (*Halosarcia*) habitat to the west of the proposed road works. It was not recorded during recent surveys of samphire, and with the last sighting now 50 years ago, is not considered to be an issue for this project.

None of the species described above were recorded in the study area or region during the bird surveys.

Mammals

Two mammal species, the burrowing bettong (*Bettongia lesueur*) and the southern brown bandicoot (*Isoodon obesulus obesulus*) with a national conservation rating of endangered (under the EPBC Act) possibly occurred within the region. One of these species, the burrowing bettong has previously been recorded within the region.

Additionally, three mammal species with a state rating of rare have been recorded in the area. These are the yellow-bellied sheathtail bat *(Saccolaimus flaviventris)*, the southern free-tail bat *(Mormopterus planiceps)* and the koala *(Phascolarctos cinereus)*. All of these species have previously been recorded within the vicinity of the study area.

Burrowing bettong

Database searches indicated that the burrowing bettong was last recorded within the region of the project site in 1904 on the Gawler Plains. Once having one of the largest geographic ranges of any Australian mammal, the burrowing bettong is now presumed extinct on the mainland (except where re-introduced), due primarily to predation by foxes and feral cats and from competition with rabbits (Strahan 1995; Maxwell et al. 1996). This species is not considered to be an issue for the project.

Southern brown bandicoot

The endangered southern brown bandicoot is currently only known to occupy areas within the Mount Lofty Ranges, Kangaroo Island and South East and there are no previous records for this species in close proximity to the study area. The bandicoot prefers areas of heath, shrubland and woodland where there is thick undergrowth (Maxwell et al. 1996), habitat not known within the study area. The species does not occur within the study area.

The yellow-bellied sheathtail bat is rare in South Australia (a total of 20 records only of the species in all of the State) and it appears to be an occasional migrant only. The species was not observed or recorded during the survey. The southern free-tail bat was recorded during a bat survey of the Gawler River and surrounds in 2005.

Reptiles

One reptile species, the Flinders worm-lizard *(Aprasia pseudopulchella*) that has a national rating of vulnerable under the EPBC Act, has been recorded within the Cobbler Creek Conservation Park. The latest record for this species is 1993.

The pygmy bluetongue lizard (*Tiliqua adelaidensis*), listed as critically endangered under the EPBC Act, originally occurred in the region. The last record of the species in Adelaide was 1959.

Flinders Ranges worm-lizard

The Flinders worm-lizard is listed as nationally vulnerable under the EPBC Act. This species is endemic to South Australia and although it has a national conservation rating, it does not have a state conservation rating. At the time (approximately 1993) when the national conservation rating was

assigned to this species, little was known about its habitat, habits and abundance (M Hutchinson, SA Museum, cited in EBS 2004).

Since then, this species has been found at numerous sites. The state conservation ratings have been updated more recently than the national rating, which has resulted in the different classifications.

This species was recorded in the early 1990s at Cobbler Creek Conservation Park (more than 9 km away) and there have been no sightings closer to the Northern Expressway corridor. It is possible that it occurs within the study area as habitat which may be suitable for the species is present along the Gawler River and in patches of native vegetation north of the river. It is highly unlikely that this species would occur in areas utilised for high density housing or for regular cropping or intensive farming. This species was not recorded during current fauna surveys of the study area or region.

3.2.4 Fauna species of state conservation significance

Fauna species of state conservation significance are listed under the *National Parks and Wildlife Act 1972*.

A search of the fauna databases maintained by DEH (SA) and the South Australian Museum by EBS and for this current report indicated that 26 fauna species with a state conservation rating have been previously recorded in the general area of the site. A further two species of state conservation significance recorded during a survey of the Adelaide region in 1984–1995 may occur within the proposed area.

Birds

A total of 23 bird species of state conservation significance were identified from the database searches and literature review as possibly occurring within the area.

Nine of the previously recorded bird species of state conservation significance have not been recorded within the region of the Northern Expressway corridor since the early–mid 1900s: little bittern (*Ixobrychus minutus* (rare), 1940), Australasian bittern (*Botaurus poiciloptilus* (vulnerable), 1936), flame robin (*Petroica phoenicea* (rare) 1930), common tern (*Sterna hirundo* (rare) 1962), slender-billed thornbill (*Acanthiza iredalei rosinae* (vulnerable) 1957), diamond firetail (*Stagonopleura guttata* (vulnerable) 1936), painted button quail (*Turnix varia* (vulnerable) 1911), regent parrot (*Polytelis anthopeplus anthopeplus* (vulnerable) 1927) and crested shrike-tit (*Falcunculus frontatus* (vulnerable), 1933). In addition, the azure kingfisher (*Alcedo azurea*) is now believed to be extinct here. Therefore, with the exception of the Australasian bittern that occurs in Greenfields wetland complex, it is unlikely that any of these species would occur within the proposed site.

The fairy tern (*Sterna nereis*, vulnerable) and the light-mantled sooty albatross (*Diomedea palpebrata*), rare) are entirely coastal species. The intermediate egret (*Ardea intermedia*, rare), occurs in fresh water and mangrove swamps, the glossy ibis (*Plegadis falcinellus*, rare) utilises marshes, estuaries, coastal bays and swamps, and the eastern curlew (*Numenius madagascariensis*, vulnerable) is a migrant species that inhabits coastal mudflats, mangroves and estuaries. The blue-billed duck (*Oxyura australis*, rare) usually inhabits wetlands with dense vegetation.

Previous records for these species in the wider region have all been within the coastal edge of Gulf St Vincent, including the Barker Inlet wetlands, St Kilda mangroves and northern saltfields. These species were not observed during bird surveys of the Northern Expressway corridor and Port Wakefield Road alignment. However, the blue-billed duck is believed to be an occasional visitor to the Greenfields and

Barker Inlet wetlands and the saltfields during the autumn months (Cox 1993). The glossy ibis is also known to visit this area during the autumn and winter months (Cox 1993).

The shining bronze-cuckoo (*Chrysococcyx lucidus plagosus*, rare), a summer visitor to Australia, and the bassian thrush (*Zoothera lunulata*, rare) prefer moist forest habitats, which were not observed within the proposed study area. The former species is a very rare visitor to this region, with one bird only being recorded in the 1970s. The latter species has not been recorded in the region.

The state rare redthroat (*Pyrrholaemus brunneus*) inhabits mulga, mallee and bluebush (EBS 2004), and it will not be found in the study area due to the lack of suitable habitat.

The black-chinned honeyeater (*Melithreptus gularis*, vulnerable) was recorded in the region during the 1984–85 bird atlas survey (Armstrong et al. 2003). However, with the last sightings in the mid-1990s this species is possibly extinct in the northern Adelaide region (Turner 2001) and is unlikely to be adversely effected by the proposed project.

The remaining three bird species of state conservation significance (all classified as rare) have been recorded in the study area or could possibly utilise areas within the study area.

Peregrine falcon (*Falco peregrinus*) usually nests on cliff and rock faces but can utilise breeding habitat in tall trees and on buildings. It is known to use open areas for hunting rodents, reptiles and, especially, small to medium sized birds. The species was recorded in the wider region as a breeding pair on RAAF Edinburgh over 2002–2005 and as individual birds feeding on racing pigeons, including along Angle Vale Road. It is unlikely that the proposal will adversely effect this species.

Striped honeyeater (*Plectorhyncha lanceolata*) prefers woodland and forest, including mallee, habitat, therefore it may utilise the river red gum woodland along the Gawler River or the mallee box woodland and native pine woodland areas in the northern section of the study area. This species has not been observed in the area since 1984.

Musk duck (*Biziura lobata*) prefers permanent deep water aquatic environments (Turner 2001). Some small, though deep, pools of water form in the Gawler River downstream from Gawler but are not permanent and not likely to be suitable habitat for this species for all of the year. No deep permanent pools were recorded in the reach of the Gawler River potentially effected by the proposal.

Mammals

Three state rare mammals have previously been recorded within the vicinity of the study area.

Yellow-bellied sheathtail bat *(Saccolaimus flaviventris)* has been recorded as recently as 2000 (corner of White Road and Lovelock Road, Parafield Gardens).

Fewer than 20 specimens of this species have been recorded over scattered localities in South Australia. The apparent low number here and elsewhere indicates that the project is unlikely to have a significant effect on this species (KBR 2006b).

The southern free-tail bat *(Mormopterus planiceps)* potentially occurs within the study area, where it is most likely to occur near the Gawler River roosting in river red gums and feeding on insects over the river and other water sources. Drinking water would be available from the same sources. However, the latest recording of the southern free-tail bat was in 1984 at Fauna Dam, Roseworthy College.

Koala *(Phascolarctos cinereus)* may be present in the river red gum woodlands, although there is considerable debate as to whether the koala occurred in the Adelaide region before European

settlement. It is possible that this species would utilise the river red gum woodland areas within the study area.

Reptiles

Records of the nationally critically endangered pygmy bluetongue lizard show that it was originally present in the Virginia region. It has not been recorded from the Adelaide Plains since the late 1950s and the closest population is about 100 km north of the study area.

Two reptile species with a state conservation rating have been recorded within the region of the project site. The state rare heath goanna *(Varanus rosenbergi)* inhabits coastal heaths, woodlands, mallee and both wet and dry sclerophyll forests (Cogger 1994). The species is more likely to occur within the conservation parks east and south the study area than in the Northern Expressway corridor or Port Wakefield Road Upgrade area due to the lack of suitable habitat. Sand (Gould's) goanna is recorded, and still present, in the northern section of the study area.

Cunningham's skink occurs in rock crevices or under large rock slabs. In South Australia, it is limited to the Mount Lofty Ranges and has not been recorded in the wider area surrounding the project site (upstream of Gawler) since the 1940s. No suitable habitat is present within the study area. Therefore, the proposal will not have an effect on this species.

Fish

Three native and one pest fish species have been recorded in the region. None is of particular conservation significance.

Pest animal species, pathogens and national threatening processes

Introduced and pest animals recorded in the region include nine mammal species, up to 11 bird species, of which four are abundant, one fish species and a number of invertebrate species, especially insects and land snails (KBR 2006a). From an ecological and conservation perspective, these species occur throughout the region and all have contributed to the degradation of the natural history.

No significant animal pathogens have been recorded in the region although a number of diseases of livestock occur seasonally. Mosquitoes, house fly and non-biting midges may be seasonally abundant.

Predation by red fox and cat are listed as national threatening processes, as is the impact of European rabbit. These activities occur throughout the region.

3.3 Survey results for the Port Wakefield Road Upgrade

3.3.1 Fauna habitat areas

The habitats available within the region and study area were documented in Brown & Root (2004) and KBR (2006a):

- Artificial wetlands, such as saline wetlands and associated environments occupy the largest area and include the Cheetham saltfield complex, Barker Inlet wetlands and Greenfields wetlands.

- Samphire shrubland sits along the western fringe of the mangrove woodland and along low lying, saline areas throughout the region and project area.
- Mangrove woodlands generally occur west of the project area, but some of the resident and migratory fauna species move between the woodlands and areas inland, which will include the project area.
- Woodlands, primarily the indigenous mature river red gum woodlands associated with freshwater riparian areas, provide important habitat in these areas and also include small stormwater detention basins that have importance for some aquatic birds and amphibians.
- Watercourses and drains are often weed infested but provide some values for reptiles, amphibians and a few birds. The largest of these sites is Dry Creek, although several smaller stormwater drains may be of use to fauna that cross Port Wakefield Road.
- Fragmentary, high value habitats, such as sedgelands, are usually tiny remnants of native vegetation, such as the *Gahnia* sedgelands at Bolivar and St Kilda which are being restored. They have limited value as major faunal group habitat but which may, in future, provide critical habitat for one or a few threatened invertebrate species, such as butterflies.
- Revegetation sites, primarily woodlands and tall shrublands including landscaping and amenity plantings, include specific revegetation areas developed by South Australian Government groups, the City of Salisbury, the City of Playford, the City of Port Adelaide-Enfield, Light Regional Council and private developments.
- Anthropogenic areas include agriculture and horticulture, undeveloped land, buffer zones around defence sites, areas of cropland that are not being cropped, some roadside areas, and buildings and other structures.

An isolated stand of remnant vegetation, primarily eucalypt woodland, is located along the Little Para River to the west and east of Port Wakefield Road, and is one of few large areas of terrestrial habitat areas left in the region. Unfortunately, many of the hollow bearing trees along the Little Para River provide habitat for pest species such as feral pigeons, starlings, noisy miner and colonies of the introduced European honeybee. Other common native species such as rainbow lorikeet, galah and Adelaide rosella use this area but are subject to intense competition with pest species for roosting and breeding hollows.

Another large habitat along Port Wakefield Road is constructed wetlands. Greenfields wetlands, Dry Creek saltfields, and Barker Inlet wetlands provide habitat for many species of common aquatic birds such as Australian white ibis, common coot and silver gull, which use the wetlands for nesting and as a food source.

Some species of conservation significance, such as buff banded rail, Australasian bittern and various wading bird species have been recorded in these wetlands.

Birds of prey often use wetlands, as well as woodland areas, as a source of food. Australian hobby, peregrine falcon, black-shouldered kite and nankeen kestrel use the wetland complex for that purpose. These species are common visitors or vagrant throughout this area and have not been recorded as nesting or breeding in these areas.

The presence of conservation significant species and the proliferation of common bird species within the wetlands suggest these areas play an important role in maximising biodiversity in the fragmented surrounds of the region. In this respect the constructed wetlands are of key conservation significance as habitat areas.

3.3.2 Fauna groups and species

Mammals

A desktop search of the Biological Databases of SA (DEH), South Australian Museum fauna database and the EPBC Act Protected Matters database, identified four species within the study area, namely house mouse (*Mus musculus*), fox (*Vulpes vulpes*), yellow-bellied sheathtail bat (*Saccoclaimus flaviventris*), and New Zealand fur seal (*Arctocephalus forsteri*).

Based on information for the adjacent region, an additional five species are predicted to occur in the study area, of which most are micro-chiropteran (insectivorous) bats.

PPK Consultants (1992), Brown & Root (2001, 2004) and KBR (2006a) have recorded the mammals listed in Table 3.4 as occurring in the region.

Table 3.4 Mammal species in the study area

Common name	Scientific name	Conservation status		
		AUS	SA	R
Water rat	*Hydromys chrysogaster*			C
White-striped mastiff bat	*Tadarida australis*			C
Yellow-bellied sheath-tail bat	*Saccolaimus flaviventris*		R	
Gould's wattled bat	*Chalinolobus goudii*			
Chocolate wattled bat	*Chalinolobus morio*			
Lesser long-eared bat	*Nyctophilus geoffroyi*			
Large forest bat	*Vespadelus darlingtoni*			
Southern forest bat	*Vespadelus regulus*			
Southern freetail bat	*Mormopterus* sp.			
Common brushtail possum	*Trichosurus vulpecula*			
Common ringtail possum	*Pseudocheirus peregrinus*			
Euro	*Macropus robustus*			
Western grey kangaroo	*Macropus fuliginosus*			
New Zealand fur seal	*Arctocephalus forsteri*			
*House mouse	*Mus domesticus*			
*Black rat	*Rattus rattus*			
*Brown hare	*Lepus capensis*			
*European rabbit	*Oryctolagus cuniculus*			
*Red fox	*Vulpes vulpes*			
*Cat	*Felis catus*			
*Fallow deer	*Cervus dama*			
*Goat	*Capra hircus*			
*Sheep	*Ovis aries*			

* *Introduced species; AUS Australia; SA South Australia; R region.*

The SA Museum conducted a bat survey of the Little Para River west from Port Wakefield Road and the Greenfields wetlands during 2006 (SA Museum 2006b). The number of calls recorded during the survey were fewer than expected given the optimal weather conditions at the time. It was concluded that the limited roosting habitat in the area was a major limiting resource. Hollows are abundant within the river red gums along the banks of the Little Para and the southern corner of SA Water land, but little native vegetation remains in the surrounding area.

The survey suggests that, providing as many hollow-bearing trees as possible are protected, roadworks associated with the Port Wakefield Road Upgrade are likely to have little or no effect upon local bat populations. Further, given the low abundance and apparently low species richness of bats at the sites survey it is likely that adverse effects to local populations across the whole of Northern Expressway Project study area will be minimal.

All wetland, riparian and floodplain areas will provide habitat for many of the native and introduced species recorded in the study area. Bat species may be more obvious around the more densely vegetated areas. Many of the other zones have been cleared of native trees and therefore are unlikely to provide key habitat for bat species.

Water rats use both saline and freshwater wetlands in the region and are therefore likely to be present in most wetland areas. The species was recorded in Greenfields and Barker Inlet wetlands during the current survey.

Birds

Over 140 bird species have been recorded in the region. Many of these are threatened and the group as a whole is discussed under Section 3.3.3.

Reptiles

Much of the area for the Port Wakefield Road Upgrade is immediately adjacent to the existing road corridor, which is cleared of native vegetation and is of low quality as habitat for reptiles. Despite this, the remaining areas of native vegetation, as well as introduced vegetation and the debris and habitats used by people, provide suitable habitat for a number of species. No reptiles of conservation significance listed under legislation are believed to occur in the area. All species recorded are listed in Table 3.5.

The project may cause temporary displacement of some reptile species during construction. However, reptiles do not represent a significant environmental constraint to the project.

Amphibians

Similar to the findings for the Northern Expressway, five common and widespread frog species have been or were recorded in the study area.

Fish

Five common native fish species have been recorded in the Greenfields wetlands.

Table 3.5 Reptile species within the study area

Common name	Scientific name
Western bluetongue lizard	*Tiliqua occipitalis*
Eastern bluetongue lizard	*Tiliqua scincoides*
Stumpy tail lizard	*Tiliqua rugosus*
Eastern brown snake	*Pseudonaja textilis*
Marbled gecko	*Christinus marmoratus*
Eastern bearded dragon	*Pogona barbatus*
Painted dragon	*Ctenophorus pictus*
Five-lined earless dragon	*Tympanocryptis lineata*
Barking gecko	*Underwoodisaurus milli*
Southern spiny-tailed gecko	*Strophurus intermedius*
Red-tailed worm-lizard	*Aprasia inaurita*
Lined worm-lizard	*Aprasia striolata*
Eastern spotted ctenotus	*Ctenotus orientalis*
Three-toed earless skink	*Hemiergis decresiensis*
Four-toed earless skink	*Hemiergis peronii*
Common long-necked tortoise	*Chelodina longicollis*

3.3.3 Birds of national and state conservation significance

Apart from one mammal species, all of the species of national and state conservation significance known to occur within the region and study area are birds.

- Three species are listed as nationally vulnerable under the EPBC Act of which two have been recently recorded as occurring in the region and study area.
- About 25 species listed under the EPBC Act under the National Wildlife Conservation Plan for Migratory Shorebirds (DEH 2006) occur within the region and parts of the study area. These bird species are also listed under various international treaties or conventions to which Australia is a co-signatory. This represents 70% of all of the species listed under DEH (2006).
- Some 10 to 15 other species listed under international conventions or treaties to which Australia is a co-signatory and which are listed as being migratory, have habitat within the region and/or study area or are conservation-dependent species.
- About 30 species are also listed under SA legislation (Schedules 7, 8 or 9 of the NPW Act). Many of these species are also listed under the EPBC Act.

Native aquatic bird species

Aquatic species as defined in this report are those species that rely on aquatic habitat, for example some ducks, crakes, rails and bitterns associated with freshwater. In addition, cormorants, gulls, terns

and similar species are also considered to be aquatic birds, although they are primarily marine species.

A number of these species are also migratory, both within the region and in the wider area of South Australia and Australia. However, migratory species are defined as being those that are trans-equatorial wading or similar bird species protected under one or other of international treaties and listed in one category or another under the EPBC Act. Table 3.6 lists the location of threatened aquatic bird species within the study area based on desktop reviews of existing literature.

Bird surveys during October–December 2006 were targeted at aquatic species using the wetland areas to determine the movement patterns of birds in wetland areas (Figure 2.3 shows the location of wetland areas surveyed). Several well known ornithologists and bird experts, John Cox, City of Salisbury and Dr Jeremy Robertson, Flinders University, were consulted to provide additional information and historical data.

Table 3.6 Threatened aquatic bird species of the study area

Common name	Scientific name	Bird survey Greenfields & Barker Inlet wetlands[1]	Saltfields[2]	Greenfields & Barker Inlet wetlands[3]
Blue-billed duck	*Oxyura australis*	–	+	+
Freckled duck	*Stictonetta naevosa*	–	–	+
Great crested grebe	*Podiceps cristatus*	–	+	+
Musk duck	*Biziura lobata*	–	+	+
Cape Barren goose	*Cereopsis novaehollandie*	–	+	+
Australasian shoveler	*Anas rhynchotis*	–	+	+
Ballion's crake	*Porzana pusilla*	–	–	+
Spotless crake	*Porzana tabuensis*	–	–	+
Lewins rail	*Rallus pectoralis*	–	+	+
Buff-banded rail	*Gallirallus philippensis*	+	+	+
Pied oystercatcher	*Haematopus longirostris*	–	+	–
Sooty oystercatcher	*Haematopus fuliginosus*	–	+	–
Little egret	*Egretta garzetta*	+	+	+
Intermediate egret	*Ardea intermedia*	–	+	+
Cattle egret	*Ardea ibis*	–	+	+
Nankeen night-heron	*Nycticorax caledonicus*	+	–	+
Australasian bittern	*Botaurus poiciloptilus*	+	–	+
Glossy ibis	*Plegadis falcinellus*	–	–	+
White-bellied sea-eagle	*Haliaeetus leucogaster*	+	–	–
Royal spoonbill	*Platalea regia*	+	–	+

1. Bird survey of Greenfields & Barker Inlet wetlands, October–December 2006 (this project).
2. Saltfields (Brown & Root 2004).
3. Greenfields & Barker Inlet wetlands (Cox 1993, Brown & Root 2004).

Bird movement patterns were observed as being north, south or east between Greenfield wetlands, the connector wetlands and Dry Creek saltfields. Some migratory waders such as sharp-tailed sandpiper (*Calidris acuminata*) and wood sandpiper (*Tringa glareola*) arrive from the west. Based on survey results the current road alignment of Port Wakefield Road (south–north alignment) does not appear to impede movement and migration patterns of bird species which use the area. Further, there is no evidence that the presence or absence of an arterial road would have any effect on the passage of birds to and from the sites studied (Dr Jeremy Robertson, Flinders University, pers. comm., October 2006). Attachment A includes species lists for different sites in the region.

Relatively few bird species use the Greenfields and surrounding wetlands as a permanent 'residence'; many arrive as vagrants or migrants, and species diversity is seasonally dependent. However, there are populations of resident bird species The Greenfields wetland is a particularly well established and important freshwater wetland. Bird life in the general area is prolific and the habitat is known to be a breeding ground for many species. Birds such as Australasian bittern, which are rare in south-eastern Australia, have found refuge at the wetlands during the current drought and may breed in this area. Other Greenfields sites such as the Connector wetlands and Dry Creek saltfields have salt or brackish water and attract and maintain migratory waders and other shorebird species. There is little doubt that the region as a whole has the potential to be a wetland community of state, if not national, importance.

The upgrade of Port Wakefield Road will not affect the Greenfields Connector wetlands. (Subject to the final design details). The final design details would need to be reviewed to assess whether any habitat loss occurs during the detailed design phase.

The Little Para River to the west of Port Wakefield Road was also surveyed. Of particular note was the presence of a white-bellied sea-eagle and nankeen night-heron (*Nycticorax caledonicus)* at the Little Para River. Both species are classified as nationally important. Other aquatic species observed at this location include white-faced heron (*Egretta novaehollandiae*) and white-necked heron (*Ardea pacifica*).

Note that the critical habitat areas for migratory shorebirds in the saltfields and along the tidal shoreline of Gulf St Vincent are north of St Kilda, distant from the study area.

Under the EPBC Act both the species and its habitat is protected. If an action is proposed to be undertaken which will have any sort of adverse impact on the species or its habitat, then the action must be referred to DEH (Cwlth). Based on detailed observations, birds of international significance and other shorebirds do not heavily use the surveyed sites in the region and study area. It is considered that adverse impacts on these species as a result of upgrading the road will be minimal and referral under Commonwealth legislation is unlikely to be required.

Native terrestrial bird species

In the region, 71 native terrestrial bird species have been recorded and many of them are expected to occur in the study area.

The largest group of these are raptors (birds of prey), of which 15 species are present in varying numbers. Some, such as wedge-tailed eagle, white-bellied sea-eagle and peregrine falcon are represented by one pair, or rarely two pairs of breeding birds in the region or within a wider area. The habitat of these species includes the study area.

Some raptors are relatively common species but are non-breeding visitors to the region, for example swamp harrier, brown goshawk, collared sparrowhawk and little eagle.

Other species are occasional to rare seasonal migrants or visitors, such as black kite, black falcon, spotted harrier and letter-winged kite. These species may be resident further to the north of the region

or the state and they may be recorded around St Kilda, Bolivar and Dry Creek occasionally or under exceptional circumstances. Most usually they are seeking food.

Still others are breeding residents, including black-shouldered kite, whistling kite, brown falcon and nankeen kestrel.

The key attractant to the region is the potential for food, especially the large numbers of aquatic and shorebird species. Table 3.7 lists the general location of threatened native terrestrial bird species within the study area.

Table 3.7 Threatened native terrestrial bird species of the study area

Common name	Scientific name	Bolivar STP	Saltfields	Greenfields and Barker Inlet wetlands
Letter-winged kite	*Elanus scriptus*	+	+	-
Whistling kite	*Haliastur sphenurus*	+	+	+
White-bellied sea-eagle	*Haliaeetus leucogaster*	-	+	+
Little eagle	*Hieraaetus morphnoides*	+	+	+
Australian hobby	*Falco longipennis*	+	+	+
Black falcon	*Falco subniger*	-	+	+
Peregrine falcon	*Falco peregrinus*	+	+	+
Brown quail	*Coturnix australis*	+	-	-
Brush bronzewing	*Phaps elegans*	-	+	-
Rainbow bee-eater	*Merops ornatus*	-	+	-
Orange-bellied parrot	*Neophema chrysogaster*	-	+	-
Elegant parrot	*Neophema elegans*	-	+	+
Blue-winged parrot	*Neophema chrysostoma*	-	+	-
Rock parrot	*Neophema petrophila*	-	+	+
White-throated needletail	*Hirundapus caudacutus*	-	+	-
Fork-tailed swift	*Apus pacificus*	-	+	+
Dollarbird	*Eurystomus orientalis*	-	+	-
White-browed scrubwren	*Sericornis frontalis*	-	+	-
Slender-billed thornbill	*Acanthiza iredalei*	-	+	-

Fringing river red gum woodland along the banks of the Little Para River also provide habitat for some terrestrial bird species. Superb fairywren, rainbow lorikeet, striated pardalote and Australian reed-warbler were noted in this area along with several other woodland species. Species lists are available in Attachment A.

International migratory shorebirds and other shorebirds

The region including the saltfields, Gulf St Vincent, Barker Inlet wetlands and the Greenfields wetlands supports 119 bird species, some of which are listed under the EPBC Act and/or Schedules of the NPW Act.

Shorebirds make extensive use of the region. This second-most important site for these species in South Australia (WWF 2002) has seen 35 species of international migratory (20 species listed under the EPBC Act) and other native shorebirds (also known as wading birds or waders) recorded in the region. Farrelly (1998, cited in WWF 2002), Cox (1993 and unpublished) and Crowley (pers. comm., 2004) indicate that over 60,000 migratory shorebirds and up to 100,000 other shorebirds have been recorded in the region, but not the study area, on occasions.

The key regional attraction for these bird species is the diversity of habitats for resting, roosting, feeding, and, for a few species, breeding. The study area forms a very important component of the avifaunal habitat in the region.

The birds move about extensively, for example from feeding areas along the coast to resting and roosting areas inland (although some retain high tide roost sites along the margin of the gulf). Consequently, migration along the east coast of Gulf St Vincent and inland from the coast to the wetlands along Salisbury Highway and Port Wakefield Road occurs regularly. Continued access to an array of habitats is critically important to the ecology of these species.

This use of the northern Gulf St Vincent by shorebird species has been responsible for recent discussions about the potential to establish a new Ramsar wetland for the Northern Gulf St Vincent, which is ranked as being one of the 10 most important sites for shorebirds in Australia (WWF 2002; DEH 2006).

Table 3.8 lists the location of migratory shorebirds within the study area.

3.3.4 Introduced and pest species and threatening processes

Nine mammal, seven bird and a number of invertebrate species have been introduced into the region. This is similar to the diversity recorded in the Northern Expressway study area. The adverse effects of rabbits, cats and foxes are listed as threatening processes under the EPBC Act and threat abatement plans have been prepared to address these issues.

Animal pathogens and disease vectors also occur here, of which biting insects, primarily mosquitoes, are present in the region and study area.

Phylloxera, an insect which infests grape vine roots, has not been recorded in the region. A number of new pest invertebrates, notably ant species, have recently been found in Australia. It is essential that these species are not introduced during the project.

Table 3.8 Migratory shorebirds and other shorebirds of the study area

Common name	Scientific name	Saltfields	Greenfields and Barker Inlet wetlands
Migratory shorebirds and other shorebirds			
Lathams snipe	*Gallinago hardwickii*	+	+
Double-banded plover	*Charadrius bicinctus*	+	–
Pacific gull	*Larus pacificus*	+	–
Gull-billed tern	*Sterna nilotica*	+	–
Common tern	*Sterna hirundo*	+	–
Little tern	*Sterna albifrons*	+	–
Fairy tern	*Sterna nereis*	+	–
White-winged black tern	*Chlidonias leucopterus*	+	+
Wildlife Conservation Plan for Migratory Shorebirds (EPBC Act), listed species			
Black-tailed godwit	*Limosa limosa*	+	+
Bar-tailed godwit	*Limosa lapponica*	+	–
Little curlew	*Numenius minutus*	+	–
Whimbrel	*Numenius phaeopus*	+	–
Eastern curlew	*Numenius madagascariensis*	+	–
Common redshank	*Tringa nebularia*	+	–
Common greenshank	*Tringa nebularia*	+	+
Wood sandpiper	*Tringa glareola*	+	+
Terek sandpiper	*Xenus cinereus*	+	+
Common sandpiper	*Actitis hypoleucos*	+	+
Grey-tailed tattler	*Tringa brevipes*	+	-
Ruddy turnstone	*Arenaria interpres*	+	+
Great knot	*Calidris tenuirostris*	+	+
Sanderling	*Calidris alba*	+	–
Red necked-stint	*Calidris ruficollis*	+	+
Long-toed stint	*Calidris subminuta*	+	+
Pectoral sandpiper	*Calidris melanotos*	+	+
Sharp-tailed sandpiper	*Calidris acuminata*	+	+
Curlew sandpiper	*Calidris ferruginea*	+	–
Broad-billed sandpiper	*Limicola falcinellus*	+	+
Ruff	*Philomachus pugnax*	+	+
Pacific golden plover	*Pluvialis fulva*	+	+
Grey plover	*Pluvialis squatarola*	+	–
Greater sand plover	*Charadrius ruficapillus*	+	–
Greater sand plover	*Charadrius ruficapillus*	+	–
Oriental plover	*Charadrius veredus*	+	–
Oriental pratincole	*Glareola maldivarum*	+	–
Red-necked phalarope	*Phalaropus lobatus*	+	–

4 Effects of project upon existing conditions

4.1 Northern Expressway

The survey area and the region in which it is located is a highly disturbed and degraded environment. The environmental effects on fauna of the proposed corridor alignment are thus predominantly low with potential moderate effects around a small section of the Gawler River, where the extent of effects will largely depend on the construction methodology chosen during the planning and design phase. An environmentally sensitive construction approach is needed to minimise the construction footprint left in this area.

Trees and habitat along the Gawler River will be removed as part of this project and revegetation works will be required to reconstruct the habitat areas lost as a result of this proposal. There is also the potential for positive outcomes; the river bed and its banks are densely infested with weeds such as African boxthorn, castor oil plant and Noogoora burr plus fennel and olive, which are proclaimed or major environmental weeds in South Australia. Weed management works in the construction zone of the study area could provide an environmental benefit to the Gawler River. However, the infestations do continue along the whole length of this river and a combined management program with local council and landholders is recommended to ensure the environmental benefit is effective.

4.1.1 Threatening processes

The impacts of cats, foxes and rabbits are listed as national threatening processes under the EPBC Act. All species are common throughout or in parts of the region, and appropriate management precautions will be required to ensure that the project does not facilitate their spread. The management of these issues should occur at the regional landscape scale and be coordinated with local councils and other major landholders so as to maximise potential benefits.

Land clearance and loss of habitat due to anthropogenic climate change are two other threatening processes listed under the EPBC Act. Extensive survey work and consultation with local experts has enabled the identification of significant, though limited, biodiversity assets in the area. The alignment of the Northern Expressway section has been carefully chosen to avoid or minimise adverse effects on these few remaining biodiversity assets, which are of also of importance to native fauna. Very few areas of native vegetation will be cleared and an extensive revegetation and restoration program is proposed. With the potential to enhance, rather than hinder, local biodiversity, the revegetation associated with this development may also help to counter greenhouse gas emissions.

Various diseases and fungi may be present in the region. Dieback from root-rot fungus (*Phytophthora cinnamomi*), infection of amphibians with chytrid fungus, and infection of endangered parrots and related species with psittacine circoviral disease are listed as key threatening processes under the EPBC Act. None of these pathogens have been identified as occurring in the region.

4.1.2 Birds

The northern area of the proposed alignment on the Gawler River floodplain has several isolated small patches of woodland which are habitat areas for many common bird species, native and introduced. The limited size of these woodland areas is such that it is highly unlikely that they support any species of conservation significance. Of particular note was the presence of nesting nankeen kestrel and black-shouldered kite in isolated woodland areas in the study area. This is an example of the use or potential use of these areas of woodland and their importance at a regional level.

A large portion of the alignment is open paddocks and introduced grassland which provides habitat for many common and introduced species. Species of conservation significance were not observed in these areas during field assessments. Following harvest, cereal and other horticultural crops are used by a number of bird species as feeding sites. All species recorded in these locations were common, with the most interesting species being stubble quail and sacred ibis.

Patches of fruit trees, such as almonds and stone fruits, and grape vines are common throughout the alignment. These trees represent a food source for common bird species such as lorikeets, galahs, noisy miners and introduced pest species.

Roadside revegetation areas managed by various local councils provide an important habitat refuge for common bird species. Some areas are lacking in understorey species and subsequently are not expected to support a large number of bird species.

4.1.3 Reptiles

Due to the small populations of common species the project is likely to have negligible adverse effects on this group.

4.1.4 Amphibians

Due to the small populations of common species only in the study area the project is likely to have negligible adverse effects on this group.

4.1.5 Summary

Most of the study area is likely to experience minimal adverse environmental effects given its disturbed nature. Further habitat fragmentation from both a flora and fauna perspective is likely to occur with the clearance of some areas of vegetation. Given the already degraded nature of the environment it is unlikely to seriously impact on flora and fauna of the region, particularly if revegetation with local indigenous seed occurs along the length of this section. No significant adverse effect on fauna in the region is anticipated as a result of the project.

Monitoring of disturbance in the few key construction areas is recommended. The impact of European rabbit, red fox and feral cat (key threatening processes under the EPBC Act) on local fauna should be monitored closely and mediated as necessary through the life of this development.

4.2 Port Wakefield Road Upgrade

4.2.1 Threatening processes

The threatening processes discussed for the Northern Expressway section are assumed to apply to the Port Wakefield Road Upgrade also, but to a lesser extent in line with the reduced works schedule and limited area.

The adverse effects of cats, foxes and rabbits are listed as national threatening processes, and are most relevant to the region. All species are common in the study area, and appropriate management precautions will be required to ensure that the project does not facilitate their spread. The management of these issues should occur at the landscape scale and be coordinated with local councils and other major landholders to maximise potential benefits.

Land clearance is expected to be minimal and associated with road widening and the construction of side roads. Anthropogenic induced climate change through increased greenhouse gas emissions (i.e. additional traffic) is an issue that must be tackled internationally. Locally, revegetation with indigenous species will assist by absorbing and processing some emissions through photosynthetic pathways in green plants.

Various pathogens, diseases and fungi may be present in the region. Dieback from root-rot fungus (*Phytophthora cinnamomi*), infection of amphibians with chytrid fungus, and infection of parrots and related species with psittacine circoviral disease are also listed as key threatening processes. None of these pathogens have been identified in the region.

4.2.2 Birds

The Greenfields wetland region including the Barker Inlet wetlands is a particularly well established and important freshwater wetland (despite it being an 'artificial' environment). Bird life in the general area is prolific and the habitat is known to be a breeding ground for many species. Birds (such as Australasian bitterns) that are rare in south-eastern Australia have found refuge at the wetlands during the current drought and may also use the resource for breeding purposes. Other regional and study area sites such as Dry Creek saltfields and Dry Creek have salt or brackish water and attract and maintain migratory waders and other shorebird species. There is little doubt that the region as a whole has the potential to be a wetland community of state if not national importance.

Observation during this assessment and elsewhere, including for the Port Adelaide Expressway project, in general, indicates that birds are not 'worried' by the presence of a transport corridor (road or rail) passing through their territory (although a number of roadkills will always occur). The main effect from the Northern Expressway will be habitat loss. Large trees, understorey, reedbeds and open water channels are key habitat areas. If the widening of Port Wakefield Road appropriates land in Greenfields wetlands, Dry Creek and Connector wetlands then habitat loss may have short term effects on some species of aquatic birds.

In general, effects from the widening of Port Wakefield Road are expected to be minimal and short term. 'There is no evidence that the presence or absence of an arterial road would have any effect on the passage of birds to and from the sites studied' (Dr Jeremy Robertson, Flinders University, pers. comm., October 2006).

The wider region is covered by extensive infrastructure corridors for both rail and road transport and land use ranging from light industrial to heavy industrial. Given the nature of the surrounding landscape it is unlikely that bird species which use these wetland areas throughout the year will be heavily affected by widening or upgrading of the roadway.

Since the wetlands development in the early 1990s, bird diversity and population numbers have increased steadily while the surrounding land use has changed and intensified. It is reasonable to suggest that these species are highly adaptable to a changing environment and unlikely to be affected in the long term by small scale habitat loss and disruption.

All samphire and associated habitat in the study area were thoroughly searched for slender-billed (samphire) thornbill. This species was not recorded and therefore it is concluded that the species is not currently present here.

4.2.3 Reptiles

The small populations of common species in the study area are likely to have negligible adverse effects from the project.

4.2.4 Amphibians

The greatest potential effect on amphibians is likely to be in the wetlands complexes around Salisbury Highway. All species recorded are common and widespread. The minimal works are unlikely to have any major adverse effects following restoration of the construction sites. Monitoring of the effects is recommended so as to test this prediction.

4.2.5 Summary

The majority of the study area is likely to experience minimal environmental impacts given the disturbed nature of the region and minimal works associated with the minor upgrade of the road. Some additional habitat fragmentation from both a flora and fauna perspective will be associated with road widening and the construction of side entry and exit points. Given the already degraded nature of the environment it is unlikely to seriously affect flora and fauna of the region, particularly if the length of this section is revegetated with local indigenous seed. No significant adverse effect on fauna in the region is anticipated as a result of the project.

Monitoring of disturbance in the few key construction areas is recommended. The adverse effects of the European rabbit, red fox and feral cat (key threatening processes under the EPBC Act) on local fauna should be monitored closely and mediated as necessary through the life of this development.

5 Safeguards and mitigation measures

5.1 Environmental management

Environmental management measures for both the Northern Expressway and the Port Wakefield Road Upgrade are an integral consideration for the project. Specific measures will be developed as part of the project Environmental Management Plan (EMP) following project approval.

5.1.1 Principles adopted to minimise effects

An EMP will be prepared by DTEI before construction begins and a contractor environmental management plan (CEMP) will be developed by the contractor to address requirements of the EMP.

The EMP will outline all potential environmental impacts of the works and describe proposed mitigation measures and techniques to be adopted during construction.

The final EMP will be developed and managed by the contractor undertaking the works and it will be subject to DTEI approval.

The goal of the EMP will be to avoid or minimise the environmental effects of activities associated with the planning, pre-construction, construction and post-construction phases of the project. DTEI has a legal and moral obligation to limit its adverse effects on the environment and the contractor has the same obligations.

The general principles of an EMP are to:

- manage the processes and activities to ensure that adverse environmental effects are avoided or minimised during all phases of the project
- establish monitoring protocols as a means of evaluating the success of the management practices and strategies developed
- review the EMP and its management strategies at regular and appropriate intervals against a set of benchmark criteria, to determine areas requiring additional attention, and success areas
- ensure that all environmental management aspects are fully documented and subject to review.

5.1.2 Measures to minimise effects during planning, design, construction and post-construction

In addition to DTEI's operational and construction policies and guidelines, the management measures listed in Table 5.1 will be included in the project EMP and CEMP.

Table 5.1 Management measures for Northern Expressway and Port Wakefield Road Upgrade

Issue	Management strategy	Key result area
Removal of vegetation	Effect on vegetation (i.e. habitat) must be avoided (where possible) and minimised at all other places to that necessary to complete works	No evidence of adverse effects outside of the construction corridor
	Undertake further fauna assessments prior to construction in any area of important habitat	Supplementary fauna reports completed and outcomes actioned
	Specific mitigation measures will be developed and incorporated into the CEMP based upon the outcomes of the assessment and DTEI's environmental management policies	Mitigation measures incorporated into the CEMP and implemented on site through the CEMP
Threatened species	The contractor is to employ a suitably qualified and competent person (as agreed to by DTEI) for environmental management of the project	Person employed and data available, especially in relation to management of bird populations and their habitat
	The CEMP is to detail proposed contingency measures for sightings of conservation significant species and national threatening processes within the construction area(s)	No disturbance to populations or individuals of conservation significant species observed in the construction area
		Contractor to appoint trained biologist to ensure accurate measures and monitoring is in place
	Management of woodland habitat and wetland will begin before construction to provide suitable alternative habitat for existing fauna populations	Fauna species populations are unaffected in the long term
	The construction corridor/site will be limited to that necessary to complete works	No evidence of disturbance to areas outside of the construction corridor
	The manner of construction activities will ensure that major disturbance-producing activities are within approved areas and efficiently completed	Approved works plans produced Construction precincts defined
	Strategies will be stringently developed and implemented to ensure water is not polluted	No evidence of water pollution in construction corridor; any water testing meets ANZECC requirements
Low risk species	Low risk species will be listed in the EMP and contingency actions be available for each if it is encountered	EMP includes contingency mitigation measures for each low risk species of conservation significance
Pest animals	Wastes (particularly food) will be appropriately managed and disposed of so as to avoid increasing pest animal populations	No visible waste No increase in habitat and populations as a result of the works
	No increase in breeding habitat for pest invertebrates, especially mosquitoes No introduction of new pest invertebrates, especially ant species and Phylloxera	No new pest species introduced

6 Conclusion

Little to nil remnant native vegetation remains in this developed landscape, restricting fauna to scattered trees and remnant habitats along creek lines, roadsides, revegetation sites, and constructed wetlands. Remnant habitat is generally of poor quality with a weed-dominated understorey providing suboptimal resources to local fauna. Despite this, a few notable native species and most common species rely on the remnant and reconstructed habitats for feeding, resting, roosting and breeding. The river red gum woodlands along the Gawler and Little Para rivers provide an important local and regional habitat for birds, bats and reptiles, with hollows in mature trees critical for breeding. The Greenfields wetlands and Dry Creek saltfields provide habitat for common aquatic birds and significant species such as the Australasian bittern and buff-banded rail.

The effect of the development on local and migratory fauna is likely to be minimal, with a route selected to avoid and/or minimise the disturbance to critical habitats. A lack of habitat and associated local fauna across the majority of the landscape will place an increasing emphasis on the integrity of remaining assets. The extent of effects on the Gawler River will largely depend on the construction methodology, but will be mitigated by careful planning and design and revegetation/restoration works. Birds along Port Wakefield Road are generally undeterred by the current transport corridor although the number of road kills will likely increase with the upgrade (i.e. heavier traffic). Wetland species may be temporarily affected by the small loss of habitat (subject to final design) but given their adaptation to the existing urban landscape, are unlikely to be affected in the long term. The possible effects on nationally and state significant species are summarised in more detail below.

Not all sites have been able to be investigated in detail. Wherever possible, site assessments have been combined with a review of existing databases and consultation with environmental planners and officers of local councils to provide a broader indication of environmental conditions. The result of this approach indicates a low to negligible risk of causing a major or significant adverse effect to flora and fauna within the few areas not subject to a detailed assessment.

Given the lack of habitat and predicted minimal effects on local fauna, there are relatively few biological constraints to the alignment of the Northern Expressway as currently proposed. Most of the issues will thus relate to ‘fine tuning’ the alignment around important resources including Gawler River, Little Para River and the wetland areas. All areas of remnant native vegetation in this district are of value because they are so few; they require protection wherever practicable. Active management of the native flora elsewhere along the route will be required to minimise the effects to sections of remnant woodland scattered within the alignment corridor. Disturbance of all habitats will be avoided as a first preference, and/or appropriately managed in accordance with an Environmental Management Plan. Along with other information, this plan will detail proposed contingency measures for sightings of conservation significant fauna within the construction zone.

Revegetation of new embankments, mounds and swales with local indigenous species will in fact significantly enhance local biodiversity, and thus the resources and habitats available to native fauna. Collection of named propagating material from all species has already begun and should continue to ensure that as many species and biotypes as possible are represented in collections to be used for landscaping and revegetation. Care will need to be taken to ensure enough understorey is replanted, thus encouraging use by native fauna while deterring introduced cats and foxes. Appropriate waste management (particularly food) will also deter increases in pest animal populations.

Within the constraints imposed by weather, time and land access conditions over 2005–2006, several sections of the study area were not assessed in detail under ideal conditions. These sections remain to be reviewed during spring and summer following a year with average or above average rainfall.

6.1 Environment Protection and Biodiversity Conservation Act 1999

Many species listed as being of national conservation significance under the EPBC Act, have not been recorded in the region for many years and/or are unlikely to occur due to the absence of suitable habitat. The rainbow bee-eater was not recorded at the time of the surveys in either the study area or the immediately adjacent region. During both 2005 and 2006 the species was present along the eastern edge of Gulf St Vincent and at Buckland Park but it is considered unlikely that it will occur in the study area in the future. Review of the Gawler River surrounds for potential and actual nest sites in its banks indicated that the likelihood of this species occurring is very low. Rainbow bee-eater nests were not present in the riverbank over 2005 and 2006 (KBR 2006b), probably because of the prevalence of pest species which would prey on the birds and their eggs, such as red fox, domestic and feral cat and black rat.

Two additional bird species are worthy of note. The critically endangered orange-bellied parrot was last recorded in the 1970s in samphire habitat to the north-west of the proposed development. It has not been recorded during recent surveys, and is unlikely to occur or be affected given the location of potential habitat for the species away from the proposed route. The vulnerable slender-billed (samphire) thornbill was not recorded in the study area or the immediate region. Therefore, no adverse effect on these species is predicted to occur.

It appears extremely unlikely that the proposal will undertake actions that will enhance any of the nationally listed threatening processes, such as the adverse effects of red fox, cat or European rabbit, each of which is abundant in either the region or parts of the region. Nonetheless, specific management measures will be in place to avoid any positive effects on these species and, where practicable, control measures will be put in place.

Overall, the project is unlikely to significantly affect national matters of biological significance.

6.2 National Parks and Wildlife Act 1972

Many species of state significance, as listed by the NPW Act schedules, have either not been recorded within the region for some time and appear to be regionally extinct, or are unlikely to occur due to a lack of suitable habitat. Those that have been recently sighted include a number of migratory and vagrant birds and two species of bat.

Wetlands, saltfields and major watercourses provide habitat and resources for a variety of state listed species, including ducks, crakes, rails, egrets and oystercatchers, and a number of raptor species. Many arrive as vagrants or migrants but large populations of resident bird species may be present, and consequently attract up to 15 raptor species that prey upon them. Few of these birds use the wetlands and surrounding landscape as a permanent residence, meaning that there is little likelihood of adverse effects.

The local bat populations were found to be lower in numbers and species richness than expected. The incorporation of protection measures for hollow trees into the EMP will ensure that roost sites are retained, meaning that the roadworks will be likely to have little or no effect upon the local populations. Enhancement of the native plant species as part of the landscape works may assist in providing more invertebrates for the bats to feed on in future.

Species of conservation significance under State legislation are unlikely to be affected by the project, primarily due to the small area of land used by these species or habitat used by these species affected by the proposal. Consequently, there do not appear to be any adverse implications for the project under the NPW Act.

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Attachment A

Birds observed during bird surveys of the Port Wakefield Upgrade region and areas

Birds observed during bird surveys of the Port Wakefield Upgrade region and areas

Southern wetlands	Dry Creek	Central wetlands (Whites Rd)	Little Para	No.	Survey	Common name	Sp	Su	A	W	Notes
						Stubble quail	O	O	R	R	
✓		✓		M-	●	Black swan	C	C	U	C	B
						Cape Barren goose	O	O	O	R	
					○	Australian shelduck	C	C	C	C	B
		✓		M+	●	Maned duck	U	U	U	U	B
✓			✓	L	●	Grey teal	C	C	C	C	B
		✓	✓	M+	●	Chestnut teal	C	C	C	C	B
✓		✓	✓	S	●	Pacific black duck	C	C	U	C	B
✓			✓	S	●	Mallard	U	U	U	U	*
					○	Australasian shoveler	C	C	U	C	B
						Pink-eared duck	U	U	O	U	
✓		✓	✓	M+	●	Hardhead	C	C	U	C	B
						Blue-billed duck	U	U	O	R	B
						Musk duck	O	U	O		
						Freckled duck	O	O	R	R	
						Great crested grebe	O	O			
					○	Hoary-headed grebe	C	C	C	C	B
✓		✓		S	●	Australasian grebe	C	C	C	C	B
						Kerguelen petrel				V	
						Short-tailed shearwater			O		
						Australian darter			O	O	
✓			✓	S	●	Little pied cormorant	C	C	C	C	
						Black-faced cormorant	V				
						Pied cormorant	R		R	R	
✓		✓		M-	●	Little black cormorant	C	C	C	C	
						Great cormorant	U	U	U	U	
✓					●	Australian pelican	C	C	C	C	
✓			✓	S	○	White-faced heron	C	C	C	C	
	✓	✓		M-	●	Little egret	C	C	C	U	
✓			✓	S	●	White-necked heron	O		O	R	
		✓		S	●	Great egret	C	C	C	C	
						Cattle egret	O	O	O	U	
		✓	✓	S		Nankeen night-heron	O	U	U	O	
✓				S	●	Australasian bittern	U	R	U	U	
						Glossy ibis	U	U	O	O	

Southern wetlands	Dry Creek	Central wetlands (Whites Rd)	Little Para	No.	Survey	Common name	Sp	Su	A	W	Notes
✓	✓	✓		L	●	Australian white ibis	C	C	C	C	
✓				S		Straw-necked ibis	O	O	O	O	
✓		✓		M-	●	Royal spoonbill	U	C	C	U	
✓		✓		M-	●	Yellow-billed spoonbill	U	C	C	U	
✓			✓	S	●	Black-shouldered kite	C	C	C	C	B
			✓	S		Black kite	O	O	O		
	✓			S	○	Whistling kite	C	C	C	C	
		✓		S		White-bellied sea-eagle	O	O	O	R	
		✓		S		Spotted harrier	R	R	O	O	
					○●	Swamp harrier	C	C	C	C	
						Brown goshawk	U	U	U	U	
						Collared sparrowhawk	U	U	U	U	
			✓	S		Wedge-tailed eagle	O	O	O	O	
			✓			Little eagle	U	U	U	U	
		✓				Brown falcon	U	U	U	U	
	✓			S		Australian hobby	C	U	U	U	
						Black falcon	O	O	O	U	
✓	✓			S		Peregrine falcon	U	U	U	U	
✓				S	○	Nankeen kestrel	C	C	C	C	B
✓				S	●	Buff-banded rail	U	U	O	U	B
						Lewins rail			R	R	
					○	Baillons crake	C	C		U	B
✓		✓		S	●	Australian spotted crake	C	C	C	U	B
						Spotless crake	R	O	O		
✓		✓		M-	●	Purple swamphen	C	C	O	C	B
		✓		M-	●	Dusky moorhen	C	C	C	C	B
✓	✓			M+	●	Black-tailed native-hen	C	C	C	C	B
✓	✓	✓	✓	L		Common coot	C	C	C	C	B
						Little buttonquail	R				
						Lathams snipe	U	U		R	M
						Black-tailed godwit		U		O	M
						Little curlew	R	R	R		M
						Marsh sandpiper	U	C	C	O	M
						Common greenshank	U	C	C	U	M
						Wood sandpiper	U	C	C	U	M
						Terek sandpiper		R			M
	✓			S	●	Common sandpiper	U	U	U	O	M
						Ruddy turnstone	O				M

Southern wetlands	Dry Creek	Central wetlands (Whites Rd)	Little Para	No.	Survey	Common name	Sp	Su	A	W	Notes
						Red knot				R	M
						Red-necked stint	U	C	U	O	M
						Long-toed stint	U	U	O		M
						Pectoral sandpiper	U	U	O		M
✓	✓			S	●	Sharp-tailed sandpiper	C	C	C	O	M
						Curlew sandpiper	U	U	O	O	M
						Broad-billed sandpiper	R	R			M
						Ruff		R			M
						Painted snipe	R	O	R	R	
	✓	✓		S	●	Black-winged stilt	C	C	C	C	B
						Banded stilt	U	U	U	O	
						Red-necked avocet	U	U	U	O	
						Pacific golden plover	R	O			M
						Red-capped plover	U	C	C	C	B
	✓			S	○	Black-fronted plover	C	C	C	C	B
	✓	✓		S	●	Red-kneed dotterel	C	C	C	C	B
						Banded lapwing	O	O	O	O	
✓	✓			S	●	Masked lapwing	C	C	C	C	B
✓	✓	✓	✓	L	●	Silver gull	C	C	C	C	B
						Franklins gull	V				
						Gull-billed tern	O	O		R	
						Caspian tern	U	U	U	U	
✓	✓			M-	●	Whiskered tern	C	C	C	U	
						White-winged black tern		R			M
✓	✓	✓	✓	L	●	Feral pigeon	C	C	C	C	
						Barbary dove			R		*
✓	✓		✓	L	●	Spotted turtle-dove	C	C	C	C	B*
	✓			S		Common bronzewing				R	
	✓		✓	L	●	Crested pigeon	C	C	C	C	B
						Peaceful dove			R		
						Yellow-tailed black-cockatoo	R				
		✓	✓	L	●	Galah	C	C	C	C	
		✓		S		Little corella	O	O	O	O	B
			✓	M-	●	Sulphur-crested cockatoo	O	R	O	O	
						Cockatiel	O		O	O	
		✓	✓	M+	●	Rainbow lorikeet	O	O	U	U	
			✓	M-	●	Musk lorikeet	O	U	U	U	

Southern wetlands	Dry Creek	Central wetlands (Whites Rd)	Little Para	No.	Survey	Common name	Sp	Su	A	W	Notes
						Purple-crowned lorikeet	U	U	U	U	
			✓	M+	●	Adelaide rosella	O	O	O	U	
						Blue bonnet		R			
		✓	✓	M-		Red-rumped parrot	O	O	O	O	
						Budgerigar	O	R			
	✓			S		Elegant parrot	U	U	R	R	
						Rock parrot	R	R		R	
						Pallid cuckoo	U	R		O	
					○	Horsfield's bronze cuckoo	C	U	O	U	b
						Shining bronze-cuckoo	O				
		✓		S		Southern boobook	R		O	O	
			✓	S		Barn owl	U	U	U	O	
	✓			M-		Fork-tailed swift		O	O		M
						Red-backed kingfisher	R				
						Sacred kingfisher	U	O	O		
✓	✓		✓	S	●	Superb fairywren	U	U	U	U	
✓						White-winged fairywren	U	U	U	U	b
						Spotted pardalote				R	b
		✓	✓	M-	●	Striated pardalote	R			O	
						Brown thornbill			R	O	
	✓	✓		S		Yellow-rumped thornbill	U	U	U	U	
						Orange chat	R				
✓				S		White-fronted chat	C	C	C	C	B
		✓	✓	M-	●	Red wattlebird	U	U	U	C	
						Brush wattlebird	O	O	U	O	
						Spiny-cheeked honeyeater	O		O	R	
		✓	✓	L	●	Noisy miner	O		O	O	
						Yellow-faced honeyeater			R		
✓	✓	✓	✓	M-	●	Singing honeyeater	C	C	C	C	B
						Yellow-plumed honeyeater				R	
		✓	✓	M+	●	White-plumed honeyeater	C	C	C	C	B
						White-naped honeyeater			O		
✓			✓	S	●	New Holland honeyeater	C	C	C	C	B
						Red-capped robin	R		O	O	
			✓	S	●	Golden whistler	O		R	O	
						Rufous whistler	O	R	O	O	

Southern wetlands	Dry Creek	Central wetlands (Whites Rd)	Little Para	No.	Survey	Common name	Sp	Su	A	W	Notes
✓			✓	S	●	Grey shrikethrush	U	U	U	U	b
✓	✓	✓	✓	M+	●	Magpie-lark	C	C	C	C	B
			✓	S	●	Grey fantail	U	O	U	U	
✓	✓	✓	✓	M+	●	Willie wagtail	C	C	C	C	B
			✓	S	●	Black-faced cuckooshrike	U	U	C	C	
						White-winged triller	O	O		O	
✓			✓	M+	●	Australian magpie	C	C	C	C	
			✓	M-	●	Little raven	C	C	C	C	B
✓			✓	M-	●	Skylark	C	C	C	C	B*
✓				S		Richard's pipit	U	U	U	U	b
✓	✓	✓	✓	L	●	House sparrow	C	C	C	C	B*
						European greenfinch	U	O	U	U	*
						European goldfinch	O	O	O	O	*
						Mistletoebird			O	O	
✓	✓	✓	✓	M+	●	Welcome swallow	C	C	C	C	B
	✓	✓		M+	●	Tree martin	C	C	C	O	
	✓			M-	●	Fairy martin	C	C	C	O	B
✓			✓	M+	●	Australian reed-warbler	C	C	C	U	B
✓				M-	●	Little grassbird	C	C	C	C	B
						Rufous songlark	U		R		
						Brown songlark	U	U	O	U	b
						Golden-headed cisticola	R		R	R	
			✓	S		Silvereye	U	U	O	U	b
✓	✓		✓	M+	●	Common blackbird	C	U	U	C	B*
✓	✓	✓	✓	L	●	Common starling	C	C	C	C	B*

S – small <20
M – medium M+ >50, M- <50
L – large >100

● – observed
○ – likely to be present

Sp – spring
Su – summer
Au – autumn
W – winter

C – common
O – occasional
R – rare
U – uncommon

B – breeding
b – potentially breeding
* – introduced