16 Biodiversity

The airport site features remnant patches of grassy woodland and narrow corridors of riparian forest within extensive areas of derived grassland, cropland, and cleared and developed land. The condition of native vegetation is generally poor and there is moderate to severe weed infestation throughout the site. The main land uses are agriculture and low density rural residential development. Notwithstanding the generally poor condition of the airport site, it has high conservation significance as a result of the presence of threatened species and ecological communities and the generally limited extent and quality of similar environments in the Western Sydney region.

Construction of the Stage 1 development would result in the removal of approximately 1,153.8 hectares of vegetation. The majority of this vegetation consists of exotic grassland and cleared land or cropland dominated by exotic species and noxious and environmental weeds. About 318.5 hectares of native vegetation would be removed. The removal of vegetation at the airport site would result in the loss of fauna foraging, breeding, roosting, sheltering and/or dispersal habitat. Construction of the Stage 1 development would also result in indirect impacts on terrestrial and aquatic flora and fauna, including potential impacts associated with increased fragmentation, altered hydrology, erosion and sedimentation, dust, light, noise and vibration. Indirect impacts may also include fauna displacement, injury and mortality. Operation of the Stage 1 development would involve an increased risk of fauna strike at or near the airport site from contact with aircraft and ground transportation vehicles. Indirect impacts may include those associated with light, noise and the introduction of exotic species.

The Stage 1 development would affect threatened species, populations and ecological communities listed under both the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the *Threatened Species Conservation Act 1995* (TSC Act). Assessments of significance have been prepared for matters of national environmental significance protected under the EPBC Act in accordance with significant impact guidelines prescribed by the EPBC Act. The outcome of these assessments is that the Stage 1 development is likely to have a significant impact on Cumberland Plain Woodland, the Grey-headed Flying-fox and other plants, animals and their habitat (including a number of species, populations and ecological communities listed as threatened under NSW legislation) in an area of Commonwealth land.

Mitigation and management measures would be implemented to reduce the potential impacts on biodiversity. These measures would include: staged vegetation removal during construction, pre-clearing surveys and plans for the salvage of fauna and habitat resources, translocation programmes for threatened flora and fauna species/populations, and designing the airport to minimise its attractiveness to fauna in order to minimise bird, bat and terrestrial fauna strike. In addition, a 117.1 hectare environmental conservation zone would be established along the southern perimeter of the airport site.

Biodiversity offsets are required to compensate for significant residual impacts arising from the proposed airport. An offset package has been prepared to compensate for the removal of approximately 104.9 hectares of Cumberland Plain Woodland, the removal of about 141.8 hectares of foraging habitat for the Grey-headed Flying-fox, and on features of the natural environment including plant populations, fauna populations and several species and communities listed under NSW legislation. The offset package is intended to conserve habitat in suitable offset sites in the surrounding region in perpetuity.

Due to the scale and nature of the biodiversity offsets required for the proposed airport, the process of identifying and securing suitable offset areas will continue after the Airport Plan is determined by the Infrastructure Minister. A biodiversity offset delivery plan will be developed to set out the specific actions to be taken to meet offset requirements for the Stage 1 development and will be guided by the framework established in the offset package.

The Department of Infrastructure and Regional Development will be responsible for delivering this plan that will require approval from the Environment Minister or a Senior Executive Service officer within the Department of Environment and Energy (DoEE) prior to the commencement of Main Construction Works for the Stage 1 development, ensuring that biodiversity offsets have been identified (and secured where possible) prior to substantial impacts occurring. While conservation of offset sites through the NSW BioBanking Scheme is expected to form the primary component of the biodiversity offsets, a variety of other conservation actions will also be considered to assist in meeting overall offset requirements. This will occur in close consultation with the DoEE and relevant NSW authorities, organisations and stakeholder groups.

16.1 Introduction

This chapter provides a review of the biodiversity values that may be affected by the development of the proposed Western Sydney Airport (proposed airport). It describes terrestrial and aquatic flora and fauna, their habitats at the airport site and the presence and likelihood of occurrence of threatened and migratory species, populations and ecological communities. The potential impacts of the Stage 1 development on terrestrial and aquatic ecology are assessed and mitigation and management measures are identified to reduce potential impacts.

This chapter draws from technical studies including the biodiversity assessment in Appendix K1 (Volume 4), the offset package in Appendix K2 (Volume 4), and the bird and bat strike assessment in Appendix I (Volume 4).

The assessment has been prepared in consultation with the DoEE, previously known as the Department of the Environment, and has been carried out in accordance with the *Guidelines for the Content of a Draft Environmental Impact Statement – Western Sydney Airport* (EIS guidelines) for the proposed Western Sydney Airport.

16.2 Methodology

The terrestrial and aquatic ecological assessment included a review of databases and relevant literature, field surveys and vegetation and habitat mapping. Impact calculations and an assessment of the significance of impacts were undertaken to determine the effect of the proposed airport on terrestrial and aquatic flora and fauna.

16.2.1 Database and literature review

A desktop assessment was undertaken to identify Commonwealth and State-listed threatened and migratory species, populations and ecological communities that may be affected by the construction and operation of the proposed airport. Relevant biodiversity databases pertaining to the airport site and locality (defined as a 10 kilometre radius from the centre point of the airport site) were reviewed. The database searches included:

- Department of the Environment (DoE) Protected Matters Search Tool – for matters of national environmental significance (MNES) listed under the EPBC Act that have been recorded in the locality (DoE 2015b);
- NSW Office of Environment and Heritage (OEH) BioNet (Atlas of NSW Wildlife) – for records of threatened species, populations and endangered ecological communities listed under the TSC Act that have been recorded within the locality (OEH 2015a); and
- NSW Department of Primary Industries (DPI) Fishing and Aquaculture Threatened and Protected Species Records Viewer – for records of threatened aquatic species listed under the EPBC Act and the NSW *Fisheries Management Act 1994* (FM Act) that have been recorded within the locality (DPI 2015).

Additional databases that were reviewed to inform the terrestrial and aquatic ecological assessment are listed in Appendix K1 (Volume 4).

The results of previous ecological assessments and scientific publications were reviewed to determine the likely presence of terrestrial flora and fauna species and their habitats at the airport site. These included surveys conducted by Biosis Research for the *1997–1999 Second Sydney Airport Proposal Environmental Impact Statement* (1997–99 EIS) (PPK 1997) and the recent baseline surveys carried out for the referral (SMEC 2014). A list of the literature that was reviewed is provided in Appendix K1 (Volume 4).

The introduction of the EPBC Act following the completion of the 1997–99 EIS (PPK 1997) has provided a revised legislative framework with increased emphasis on biodiversity protection and consideration of offset requirements. The legislative description of threatened species has also broadened substantially at both the Commonwealth and State levels since 1999, reducing the currency of previous investigations.

16.2.2 Likelihood of occurrence

Following the collation of database records, species and community profiles, and the results of previous ecological assessments at the airport site and within the locality, a 'likelihood of occurrence' assessment was prepared with reference to the habitats contained at the airport site. This was further refined following field surveys and the identification and assessment of the habitats present.

16.2.3 Terrestrial flora surveys

Terrestrial flora surveys were undertaken between February and May 2015 and consisted of vegetation mapping and validation (via plot/transect surveys) and targeted threatened flora species searches. A summary of the survey effort is provided in Table 16–1. The locations of plot/transects surveys are shown on Figure 3 in Appendix K1 (Volume 4).

The surveys were designed with reference to the NSW *BioBanking Assessment Methodology (BBAM) and Credit calculator operational manual* (DECC 2009b) and the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (Working Draft) (DEC 2004b), as appropriate. The terrestrial flora field surveys were undertaken across a number of seasons and varying weather conditions. Weather conditions (minimum and maximum temperatures and total rainfall) during the survey period are presented in Appendix K1 (Volume 4).

Table 16–1 Survey effort (terrestrial flora surveys)

Survey method	Survey effort	Approximate field person-hours
Vegetation mapping, plot/transect surveys	43 plot/transects	86
Targeted threatened flora surveys	19 days	380
Wetland assessments	Seven sites	7

16.2.3.1 Vegetation surveys and mapping

A high-level vegetation assessment and map was prepared by SMEC (2014) based on the regional mapping included in *Native Vegetation Maps of the Cumberland Plain, Western Sydney* (NPWS 2006). This vegetation mapping was ground-truthed in the field through driven and walked transects across the entire survey area and by walking the boundary of vegetation units, where possible.

Vegetation types were classified according to vegetation structure, species composition, soil type and landscape position. Terrestrial vegetation types were further split into broad condition classes to yield vegetation zones as follows:

- ‘high condition’, comprising moderate/good – high or moderate/good – medium condition vegetation which featured overstorey and midstorey vegetation at benchmark levels for the equivalent vegetation type (that is, woodland or forest structure);
- ‘poor condition’, comprising moderate/good – poor condition vegetation which featured overstorey and midstorey vegetation cover substantially below benchmark levels for the equivalent vegetation type, but greater than 50 per cent of the groundcover present was native species (that is, derived native grassland, shrubland or scrub structure);
- ‘exotic grassland’, comprising low or cleared condition vegetation which was dominated by perennial plant species and featured overstorey and midstorey vegetation cover substantially below benchmark levels for the expected native vegetation type, and less than 50 per cent of the groundcover present was native species (that is, exotic grassland, shrubland or scrub structure); and
- ‘cleared land and cropland’, comprising low or cleared condition vegetation which was dominated by annual plant species, bare earth or infrastructure and featured overstorey and midstorey vegetation cover substantially below benchmark levels for the expected native vegetation type, and less than 50 per cent of the groundcover present was native species or greater than 90 per cent of the ground surface was bare earth or infrastructure.

Wetlands were mapped as a native vegetation zone if they contained greater than 10 per cent cover of native plant species and/or habitat features such as standing dead trees, shallow marginal water or mudflats. Waterbodies that were free of native plants or habitat features (such as steep sided clay lined dams, concrete lined dams or flooded quarry pits) were included in the mapped area of ‘cleared land and cropland’. Some smaller wetlands were also included in the mapped areas of woodland, forest or grassland if they could not be accurately separated and defined on an aerial photo.

16.2.3.2 Plot/transect surveys

Plot/transect surveys were conducted to confirm vegetation types and assess the condition of the airport site. The surveys were conducted in accordance with BBAM. Data recorded within each plot/transect generally included all vascular plant species present, cover abundance of each species, cover of each structural layer (canopy, midstorey, groundcover), weed abundance, presence of tree hollows, size classification length of fallen logs and a soil classification (colour and texture).

Plots were used to sample potential vegetation zones (that is, plant community types and broad condition classes) based on the initial site stratification. Forty-three plots were sampled within the airport site, as shown on Figure 3 in Appendix K1 (Volume 4).

16.2.3.3 Targeted threatened flora surveys

Targeted threatened flora surveys were undertaken for those species known or likely to occur at the survey area based on previous records (as found in the database and literature review) and the presence of suitable habitat. Areas of suitable habitat (that is, areas of near-intact native vegetation and with natural topsoil) were systematically traversed on foot and inspected for threatened plants. A targeted survey for *Marsdenia viridiflora* subsp. *viridiflora* was undertaken in April 2016 to supplement the initial surveys, following feedback in some submissions on the draft EIS.

16.2.3.4 Wetland assessments

Wetland vegetation was sampled by walking the margins of waterbodies and noting dominant plant species and percentage cover in each vegetation strata present (that is, trees, shrubs, emergent, aquatic and fringing plants). Wetlands were defined based on observed vegetation structure, species composition and whether they were natural or artificial, as inferred from geomorphic position and the presence of features such as dam walls. No natural freshwater wetlands were observed at the airport site. Artificial wetlands were matched to the closest equivalent native vegetation type.

16.2.4 Terrestrial fauna survey

Terrestrial fauna surveys were undertaken between February and June 2015 and consisted of detailed habitat assessments and targeted fauna searches. A summary of the survey effort is provided in Table 16–2. The locations of the fauna surveys are shown on Figure 3 in Appendix K1 (Volume 4).

The fauna surveys were designed with reference to the guidelines administered by the DoEE and OEH. A list of the relevant survey guidelines is provided in Appendix K1 (Volume 4).

Table 16–2 Survey effort (terrestrial fauna surveys)

Survey method	Survey effort	Approximate field person hours
Habitat assessment	18 days	360
Diurnal bird surveys	16 days	320
Early morning bird surveys	10 days	20
Microchiropteran bat surveys (Anabat)	11 nights	162.5
Frog surveys	Four afternoons and nights	80
Spotlighting (birds and mammals)	Nine nights	46
Call playback (owls)	Nine nights	11.25
Infrared cameras	Eight weeks	n/a
Cumberland Plain Land Snail searches	11 days	25
Koala scat searches	11 days	25
Opportunistic observations	18 days	360
Winter bird surveys	Two days	32

16.2.4.1 Fauna habitat assessments

Habitat assessments were conducted to describe the variety of native fauna likely to occur at the airport site. Particular attention was paid to habitat features and resources considered important for threatened species, including identification and assessment of:

- vegetation patch size, connectivity, age, disturbance and floristic and structural diversity, which is important for determining habitat suitability for many threatened birds and mammals;
- quality of substrate (including rocks, logs, peeling bark, leaf litter and native grassland) that provides foraging habitat and shelter for invertebrates, frogs, reptiles and ground-foraging birds;
- presence of feed trees important for threatened birds and mammals;
- hollow-bearing trees and logs which provide refuge, nest and den sites for a range of threatened fauna species;
- stags and other roost sites for raptors and owls; and
- wetlands, watercourses and moist grassland and other foraging or breeding habitat for waterbirds (including migratory birds), frogs, reptiles and mammals.

Evidence of animal presence was noted during the field surveys, including specific searches for mammal scats, tracks, nest/den sites, scratch marks on tree trunks, worn bark around tree hollows and animal remains.

Mapping of hollow-bearing trees was undertaken in areas within the airport site to provide an indication of the distribution and number of hollow-bearing trees, as well as sizes of hollows that would be removed by the construction of the proposed airport. Data collected included tree species, height, diameter at breast height, and number, size and location of hollows.

16.2.4.2 Targeted fauna searches

The targeted fauna searches undertaken at the airport site are summarised below with further detail provided in Appendix K1 (Volume 4). Threatened fauna surveys were undertaken for those species known or likely to occur at the airport site based on previous records (as found in the database and literature review) and the presence of suitable habitat.

Bird surveys comprised:

- diurnal surveys, which were performed in the early morning at the airport site. The surveys comprised area searches targeting larger woodland patches and wetland areas. Species were identified by sight and call. Threatened species targeted during these surveys included the Swift Parrot (*Lathamus discolor*) and Gang-gang Cockatoo (*Callocephalon fimbriatum*);
- wetlands (farm dams) surveys, which were observed during the early morning bird surveys as well as during general fauna surveys throughout the day; and
- slow driven transects, which were conducted to target Swift Parrots and Gang-gang Cockatoos. This method combined with targeted area searches ensured as much of the airport site was covered as possible.

Surveys for microchiropteran bats involved echolocation call recordings using Anabat units. Anabats were placed within the airport site and recordings were undertaken from dusk until the following morning. Calls were then analysed using specialised software (AnalookW, Version 3.8v).

Frog surveys comprised targeted and rapid surveys. Targeted surveys included both diurnal searches (searches for basking frogs and call playback) and nocturnal searches (spotlighting and call playback) in areas of suitable habitat. Rapid surveys included call playback and vocalisations broadcast at each rapid survey site. Species targeted during the frog surveys included the Green and Golden Bell Frog (*Litoria aurea*). The Green and Golden Bell Frog population at Homebush was used as a reference population for the survey to determine the level of frog activity and confirm that conditions were likely to be suitable for the detection of the targeted species.

Nocturnal bird and mammal surveys comprised call playback surveys and spotlighting surveys. The call playback surveys targeted threatened owl species in woodland areas and the spotlighting surveys targeted nocturnal birds and mammals along road reserves and in larger woodland areas. Species targeted during the nocturnal bird surveys included the Barking Owl (*Ninox connivens*), Powerful Owl (*Ninox strenua*) and Masked Owl (*Tyto novaehollandiae*).

Infrared cameras were placed in survey locations in woodland or near dams to target cryptic species. Cameras were baited and set for a minimum of three weeks. Cameras were set to take three pictures over one minute when triggered by movement, with at least five minutes between each set of photographs.

Searches for the Cumberland Plain Land Snail (*Meridolum corneovirens*) were carried out in larger patches of vegetation and along road reserves. Active searches in woodland patches were conducted in leaf litter at the base of trees and under rubbish and logs for between 30 minutes to an hour. Live snails were photographed and empty shells were collected for identification.

Koala scat searches focused on Forest Red Gum (*Eucalyptus tereticornis*), a primary feed tree for the Sydney area, and Grey Box (*Eucalyptus moluccana*), a secondary feed tree for the Sydney area (DECC 2008a). Searches were conducted in woodland patches for between 30 minutes to an hour, depending on the size of the patch.

Opportunistic and incidental observations of fauna species were recorded at all times during the field surveys. Scats, burrows and diggings were noted and mature trees were scanned for roosting birds.

16.2.5 Aquatic flora and fauna surveys

Aquatic flora and fauna surveys were undertaken in March and May 2015 and consisted of habitat assessments, water quality assessments, macroinvertebrate sampling and analysis, and fish surveys. The surveys were undertaken by two people over five days. The aquatic ecology surveys sampled stream and wetland (artificial dam) habitats within the airport site as well as upstream and downstream of the site (15 sites in total). The location of the survey sites are shown on Figure 3 in Appendix K1 (Volume 4).

16.2.5.1 Aquatic habitat assessment

An assessment of the in-stream physical habitat was conducted at all sites in accordance with the NSW Australian River Assessment System (AUSRIVAS) (Turak and Waddell 2002). This included detailed assessments of the substrata and water channels, hydraulic habitat features, and their suitability for threatened flora and fauna identified in the database searches and literature review.

16.2.5.2 Water quality assessment

Water quality parameters were measured at each survey site including temperature; electrical conductivity; dissolved oxygen; pH; turbidity; alkalinity; metals; nutrients; benzene, toluene, ethylbenzene, and xylenes (BTEX); additional hydrocarbons and other constituents. Water quality was compared to the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ 2000) and water pollution thresholds contained within the Airports (Environment Protection) Regulations 1997.

16.2.5.3 Macroinvertebrate sampling and analysis

Macroinvertebrates were collected using mesh nets from edge, pool and riffle habitats at the survey sites. Macroinvertebrate samples were live-sorted in the field (for a minimum of 40 minutes and maximum of 60 minutes). Macroinvertebrates were then preserved and transferred to a laboratory for identification. The results were used to assess the biological condition or impairment at each survey site. Impairment was calculated using both AUSRIVAS Observed to Expected Ratio (O/E50) and Stream Invertebrate Grade Number – Average Level (SIGNAL 2) scores (defined in Appendix K1 (Volume 4)). Other biological metrics used as descriptors of the surveys sites were taxa richness, Ephemeroptera-Plecoptera-Trichoptera richness and the community composition at each survey site.

16.2.5.4 Fish surveys

Fish were surveyed at each survey site using bait traps and/or fyke nets. Fish were identified and counted. Native species were released and non-native species were euthanised in accordance with ethics permit requirements. The sensitivity of key fish habitats and the functionality of waterways at the airport site were classified according to the *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI 2013). Aquatic habitats were also compared with the habitat requirements of threatened aquatic fauna known to occur in the region according to the DPI threatened species profiles (DPI 2015).

16.2.6 Rapid assessments

Additional rapid assessments were completed between March and December 2015 to supplement the initial surveys and support other assessments at the airport site. The rapid assessments were completed at a number of geotechnical investigation sites, European heritage investigation sites, the proposed high intensity approach lighting area and downstream sites. Rapid assessments involved a combination of the following survey techniques as relevant at each location:

- visual inspection of the investigation area and assessment of vegetation type and condition patch size, connectivity, age, disturbance and floristic and structural diversity;

- assessment of the conservation significance of vegetation with reference to the identification and condition criteria for listed threatened ecological communities;
- assessment of the presence and quality of fauna habitat resources such as shelter substrate for Cumberland Plain Land Snails, hollow-bearing trees and logs, stags and roost sites, wetlands and water courses;
- active searches for resident fauna in areas of suitable habitat including checking of shelter substrate for Cumberland Plain Land Snails; and
- targeted searches for threatened plants.

A summary of the survey effort is provided in Table 16–3.

Table 16–3 Rapid assessment effort

Survey method	Survey effort	Approximate field person hours
Rapid assessment – Geotechnical investigations 1	47 sites over 4 days	80
Rapid assessment – Geotechnical investigations 2	56 sites over 6 days	120
Rapid assessment – European cultural heritage	4 sites over 1 day	20
Rapid assessment – High intensity approach lighting	1 site over ½ day	10
Rapid assessment – Downstream locations	6 sites over 1 day	20

16.2.7 Impact calculations

Direct impacts on terrestrial and aquatic flora and fauna (the removal of vegetation and habitat loss) were quantified to determine the potential impacts of the airport and the necessity of biodiversity offsets. The amount of each vegetation zone and fauna habitat type directly affected by the project was recorded in a geographic information system.

16.2.8 Assessment of significance of impacts

Assessments of significance were prepared for one endangered ecological community, six flora species and two fauna species listed under the EPBC Act and for the Greater Blue Mountains World Heritage Area in accordance with the *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* (DoE 2013a). An assessment of significance was also prepared for impacts on Commonwealth Land in accordance with the *Significant Impact Guidelines 1.2 – Actions on, or Impacting upon, Commonwealth Land and Actions by Commonwealth Agencies* (DoE 2013b).

16.2.9 Offsetting impacts

Biodiversity offsets to compensate for significant residual impacts on threatened species and communities listed under the EPBC Act were calculated using the offsets assessment guide under the EPBC Act *Environmental Offsets Policy* (DSEWPaC 2012). Biodiversity offsets to compensate for significant residual impacts on other features of the natural environment on Commonwealth land, plants, animals and their habitat, including threatened species, populations and communities listed under the TSC Act, were calculated with reference to the NSW BioBanking Assessment Methodology and *Credit Calculator Operational Manual 2014* (DECC 2009b) and the NSW *Framework for Biodiversity Assessment* (OEH 2014b). The framework is used to calculate offsets for major projects in NSW. Further detail regarding the methodology for offsetting impacts is provided in Appendix K2 (Volume 4).

16.3 Existing environments

This section describes the physical environment of the airport site and the existing terrestrial and aquatic flora, fauna and fauna habitat at the airport site. Threatened and migratory species, populations and endangered ecological communities known or predicted to occur within the airport site, along with their conservation status are included in the description.

16.3.1 Physical environment

The airport site is part of an elevated ridge system dividing the Nepean River and South Creek catchments on the Cumberland Plain. The site is characterised by rolling landscapes typical of Bringelly Shale with a prominent ridge in the west of the site, reaching an elevation of about 120 metres Australian Height Datum (AHD), and smaller ridge lines in the vicinity with elevations of about 100 metres AHD. The topography of the airport site generally slopes away from the ridges in the west, with elevations between 40 and 90 metres AHD.

The airport site features remnant patches of grassy woodland and narrow corridors of riparian forest within extensive areas of derived grassland, cropland, and cleared and developed land. The main land uses are agriculture and low density rural residential development.

The airport site is contained within the ‘Cumberland Plain’ Mitchell Landscape (DECC 2008b). This landscape is noted to be approximately 30 to 120 metres above sea level, and comprises low rolling hills and valleys in a rain shadow area between the Blue Mountains and the coast, with vegetation characterised by grassy woodlands and open forests dominated by Grey Box and Forest Red Gum, and poorly drained valley floors with forests of Cabbage Gum (*Eucalyptus amplifolia*) and Swamp Oak (*Casuarina glauca*) (DECC 2008b).

The airport site is located within the Hawkesbury Nepean catchment area within the Badgerys Creek, Cosgroves Creek and Duncans Creek sub-catchments. Badgerys Creek and Cosgroves Creek are tributaries of South Creek which generally flows northward into the Hawkesbury River. Badgerys Creek flows along the southern and eastern boundary of the airport site and drains into South Creek. Oaky Creek originates in the centre of the site and flows northwards to Cosgroves Creek which drains into South Creek. There are a large number of small first and second order drainage lines across the site, many of which have been dammed and heavily modified resulting in isolated artificial freshwater wetlands. These wetlands support varying degrees of in stream and riparian vegetation.

Duncans Creek starts about three kilometres south-west of the airport site and flows north-westerly before joining the Nepean River about nine kilometres downstream from the airport site. This creek is located just outside the western end of the airport site. Duncans Creek receives flows from a number of unnamed tributaries at the airport site. The Duncans Creek catchment downstream of the site is rural and zoned for primary production (plant or animal cultivation).

Several vegetation communities that occur at the airport site are 'high probability groundwater dependent ecosystems' (SMEC 2014).

The geology of the landscape consists of Triassic shales and lithic sandstones, with a small number of volcanic vent intrusions. Tertiary river gravels and sands partially cover much of the landscape, in addition to Quaternary alluvium along the main watercourses. The soils consist of red and brown texture-contrast soils on crests, grading to yellow harsh texture-contrast soils in valleys (DECC 2008c).

16.3.2 Terrestrial flora

16.3.2.1 Flora species

A total of 280 terrestrial plant species (of which 202 were native and 78 species were exotic) from 72 families were recorded at the airport site. A list of plant species recorded at the airport site is provided in Appendix K1 (Volume 4).

Due to the existence of residential gardens and cropland, the airport site is expected to contain a considerably greater diversity of exotic plant species than are listed in Appendix K1 (Volume 4). These areas were not a focus of the terrestrial and aquatic ecological impact assessment, beyond visual inspection to confirm that they did not contain native vegetation communities. There was no formal sampling of the plant species in these areas.

The majority of the native vegetation at the airport site has been previously cleared, grazed or otherwise modified and is in moderate or poor condition.

Threatened flora species and populations recorded site or otherwise considered to potentially occur at the airport site are discussed in Section 16.3.2.5.

16.3.2.2 Weeds of national significance and noxious weeds

Of the 78 exotic species recorded at the airport site, nine are listed as weeds of national significance by the Australian Weeds Strategy (AWS 2015). Eight of the nine weeds of national significance recorded at the airport site are also listed as noxious weeds under the NSW *Noxious Weeds Act 1993* for the Liverpool Local Government Area. An additional seven noxious weeds were recorded at the airport site. These weeds are listed in Table 16–4.

As discussed above, the airport site is likely to contain additional exotic plant species to those revealed by the field surveys. The list below should be considered a guide to the most serious and widespread of the weeds at the airport site.

Weeds of national significance and noxious weeds are present across the majority of the airport site. Particularly severe or extensive infestations include:

- Madeira Vine (*Anredeira cordifolia*), Bridal Creeper (*Asparagus asparagoides*), Lantana (*Lantana camara*), African Olive (*Olea europa subsp. cuspidata*) and privet species in the riparian corridor of Badgerys Creek;
- African Olive and privet species in the riparian corridors of small drainage lines in the site's west;
- Alligator Weed (*Alternanthera philoxeroides*) in dammed sections of Oaky Creek and the adjoining floodplain in the site's north; and
- African Boxthorn (*Lycium ferocissimum*), African Olive, Common Prickly Pear (*Opuntia stricta*) and Blackberry (*Rubus fruticosus* species *aggregate*) on the margins of commercial farms in the centre of the airport site and on rural residential lots in the suburb of Badgerys Creek.

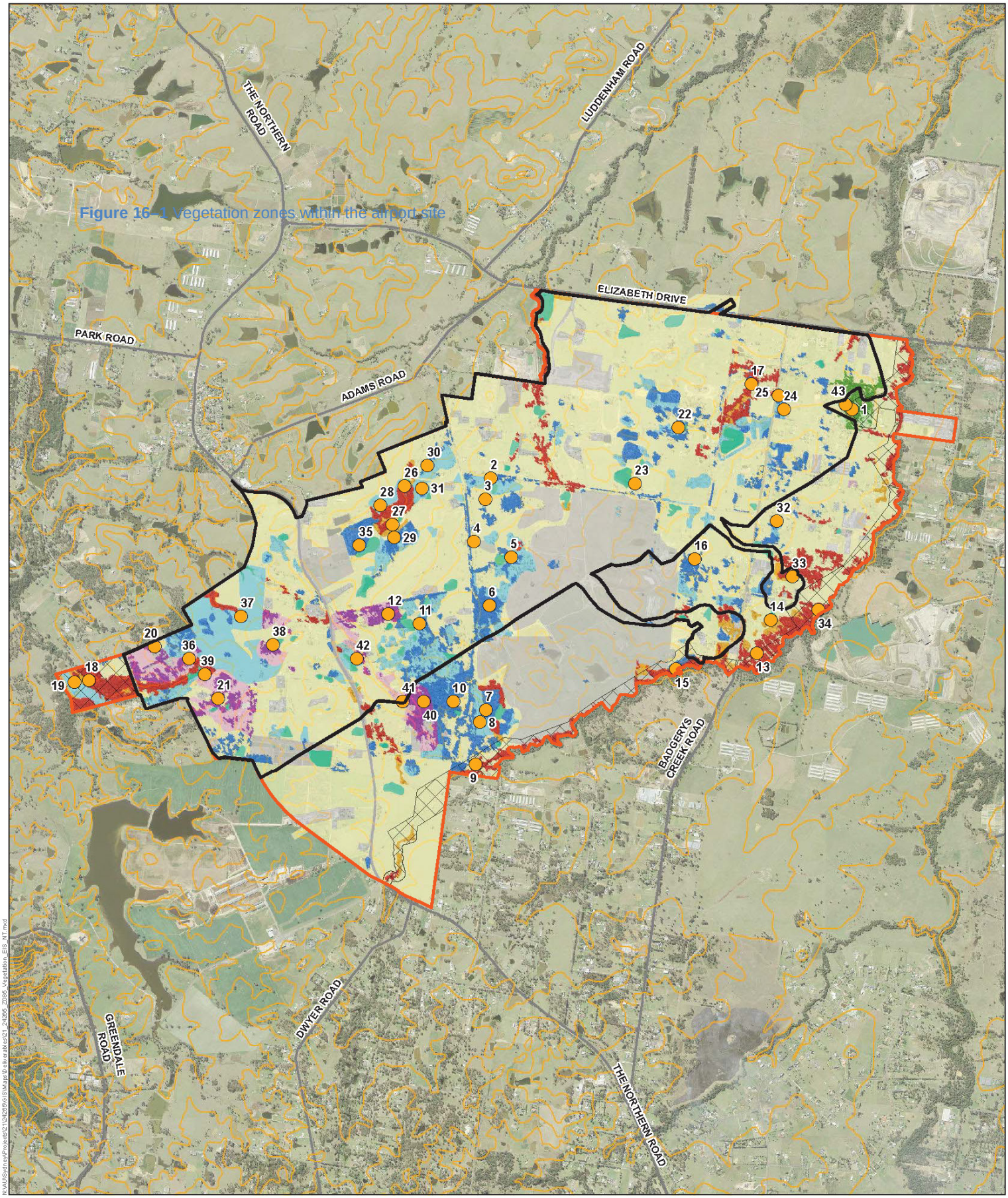
Weeds at the airport site would be managed in accordance with the mitigation measures listed in Section 16.7.2.

Table 16–4 Weeds of national significance and noxious weeds recorded at the airport site

Scientific name	Common name	Weeds of national significance	Noxious weeds
Alternanthera philoxeroides	Alligator Weed	✓	✓
Anredeira cordifolia	Madeira Vine	✓	x
Asparagus asparagoides	Bridal Creeper	✓	✓
Bryophyllum species	Mother of Millions	x	✓
Cestrum parqui	Green Cestrum	x	✓
Cortaderia selloana	Pampas Grass	x	✓
Lantana camara	Lantana	✓	✓
Ligustrum lucidum	Small-leaved Privet	x	✓
Ligustrum sinense	Broad-leaved Privet	x	✓
Lycium ferocissimum	African Boxthorn	✓	✓
Olea europa subsp. cuspidata	African Olive	x	✓
Opuntia stricta	Common Prickly Pear	✓	✓
Ricinus communis	Castor Oil Plant	x	✓
Rubus fruticosus species aggregate	Blackberry	✓	✓
Salvinia molesta	Salvinia	✓	✓
Senecio madagascariensis	Fireweed	✓	✓

16.3.2.3 Vegetation zones

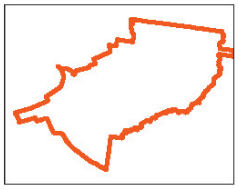
Field surveys confirmed the presence and distribution of five native and two non-native plant community types at the airport site. Stands of these plant community types include a variety of disturbance levels including near-intact vegetation in ‘moderate/good – high’ condition, partially cleared or regrowth vegetation in ‘moderate/good – poor’ condition and extensively modified areas in ‘cleared’ condition. Accordingly, nine native and two non-native vegetation zones (plant community types and broad condition classes) were identified and mapped within the airport site, as shown in Figure 16–1. The attributes of these vegetation zones are summarised in Table 16–5 with further detail provided in Appendix K1 (Volume 4).



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

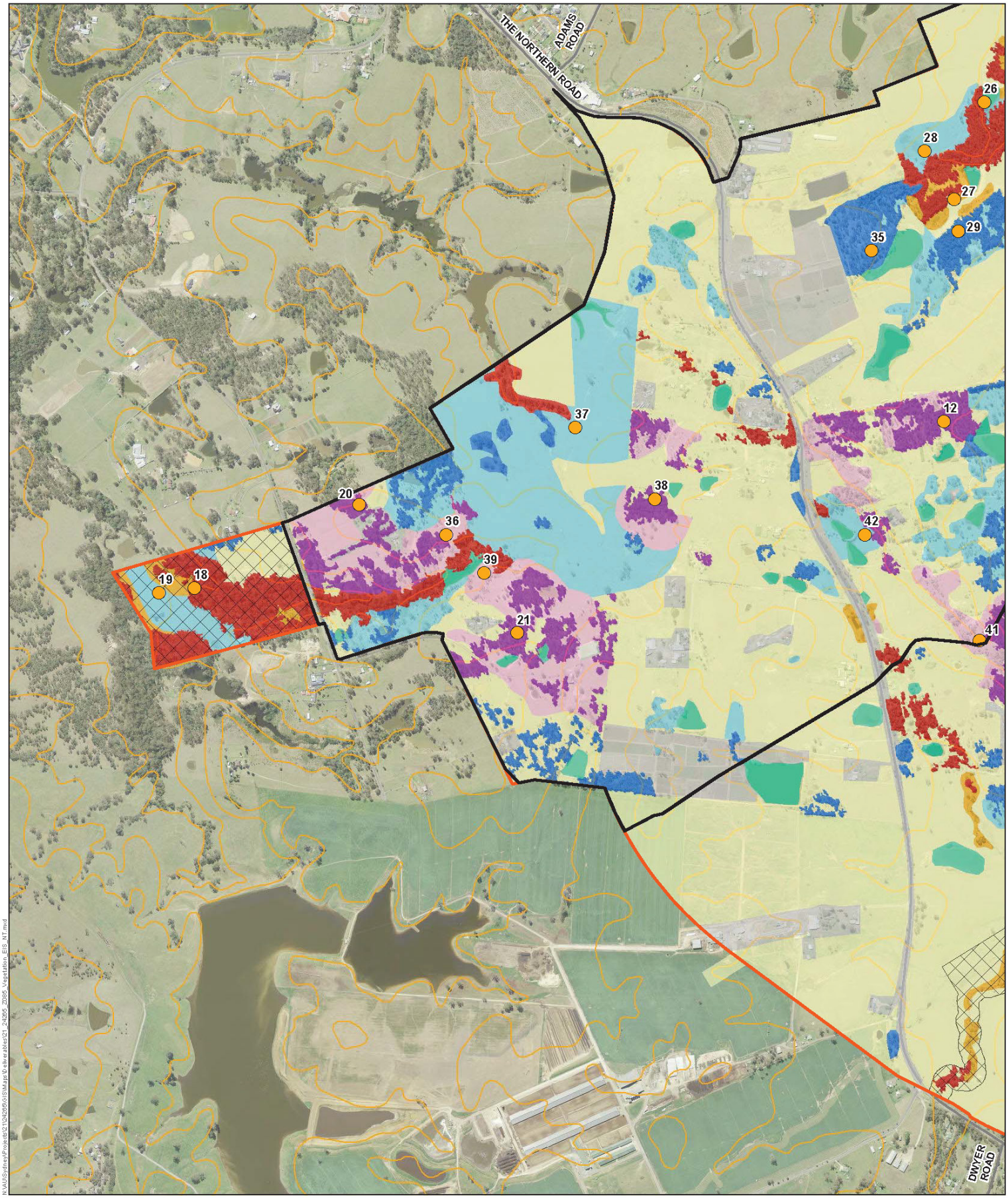
- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Contour
- Roads
- Plot/transect
- Good condition Grey Box - Forest Red Gum grassy woodland on flats (HN528)
- Poor condition Grey Box - Forest Red Gum grassy woodland on flats (HN528)
- Good condition Grey Box - Forest Red Gum grassy woodland on hills (HN529)
- Poor condition Grey Box - Forest Red Gum grassy woodland on hills (HN529)
- Good condition Forest Red Gum - Rough-barked Apple grassy woodland (HN526)
- Poor condition Forest Red Gum - Rough-barked Apple grassy woodland (HN526)
- Good condition Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest (HN512)
- Poor condition Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest (HN512)
- Good condition artficial freshwater wetland (HN630)
- Exotic grassland
- Cleared land or cropland



0 2 4 8
Kilometres

N

Figure 16-1A - Vegetation zones within the airport site



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

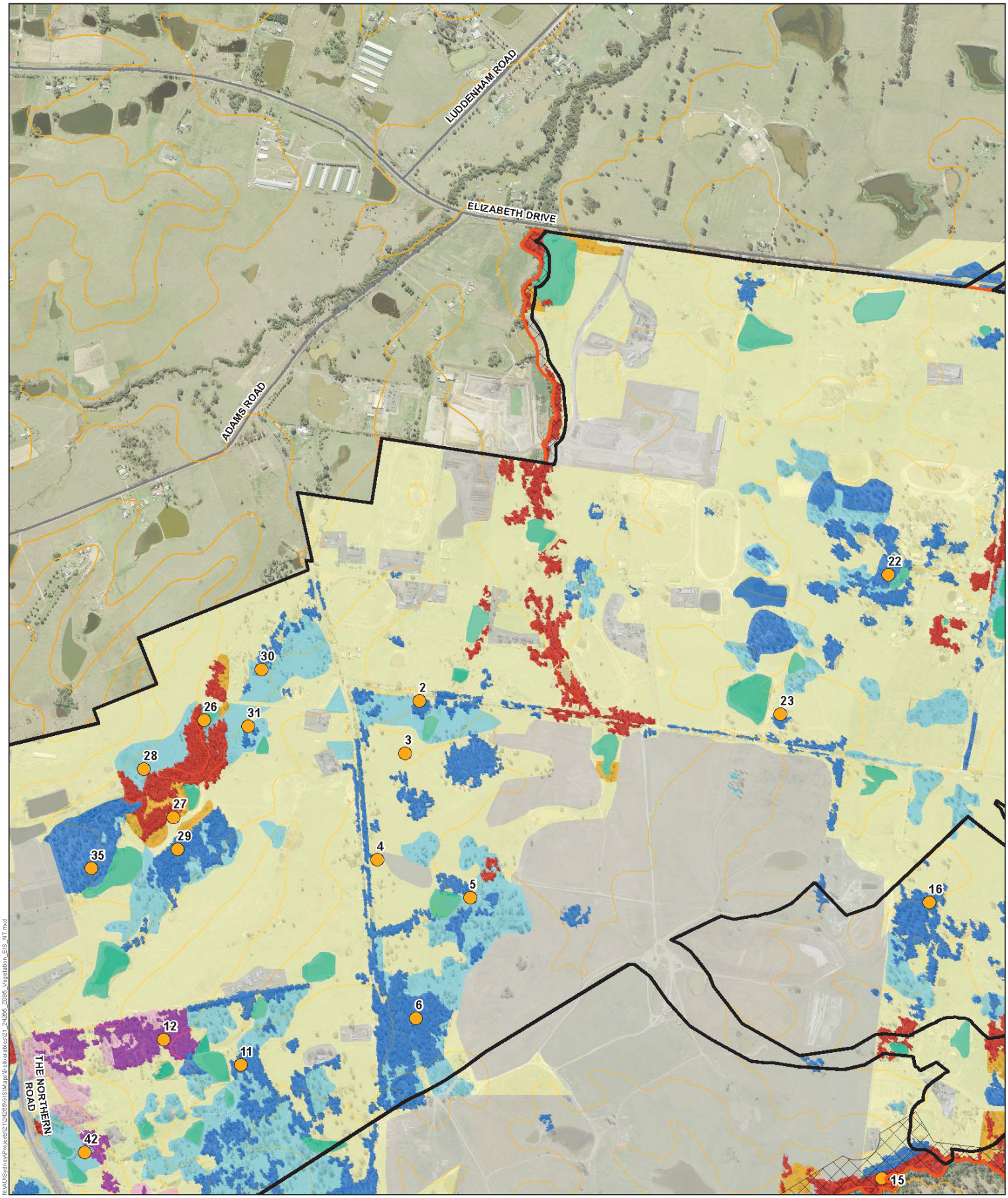
LEGEND

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Contour
- Roads
- Plot/transect
- Good condition Grey Box - Forest Red Gum grassy woodland on flats (HN528)
- Poor condition Grey Box - Forest Red Gum grassy woodland on flats (HN528)
- Good condition Grey Box - Forest Red Gum grassy woodland on hills (HN529)
- Poor condition Grey Box - Forest Red Gum grassy woodland on hills (HN529)
- Good condition Forest Red Gum - Rough-barked Apple grassy woodland (HN526)
- Poor condition Forest Red Gum - Rough-barked Apple grassy woodland (HN526)
- Good condition Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest (HN512)
- Poor condition Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest (HN512)
- Good condition artficial freshwater wetland (HN630)
- Exotic grassland
- Cleared land or cropland

0 2 4 8
Kilometres

N

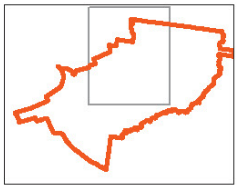
Figure 16-1B - Vegetation zones within the airport site



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

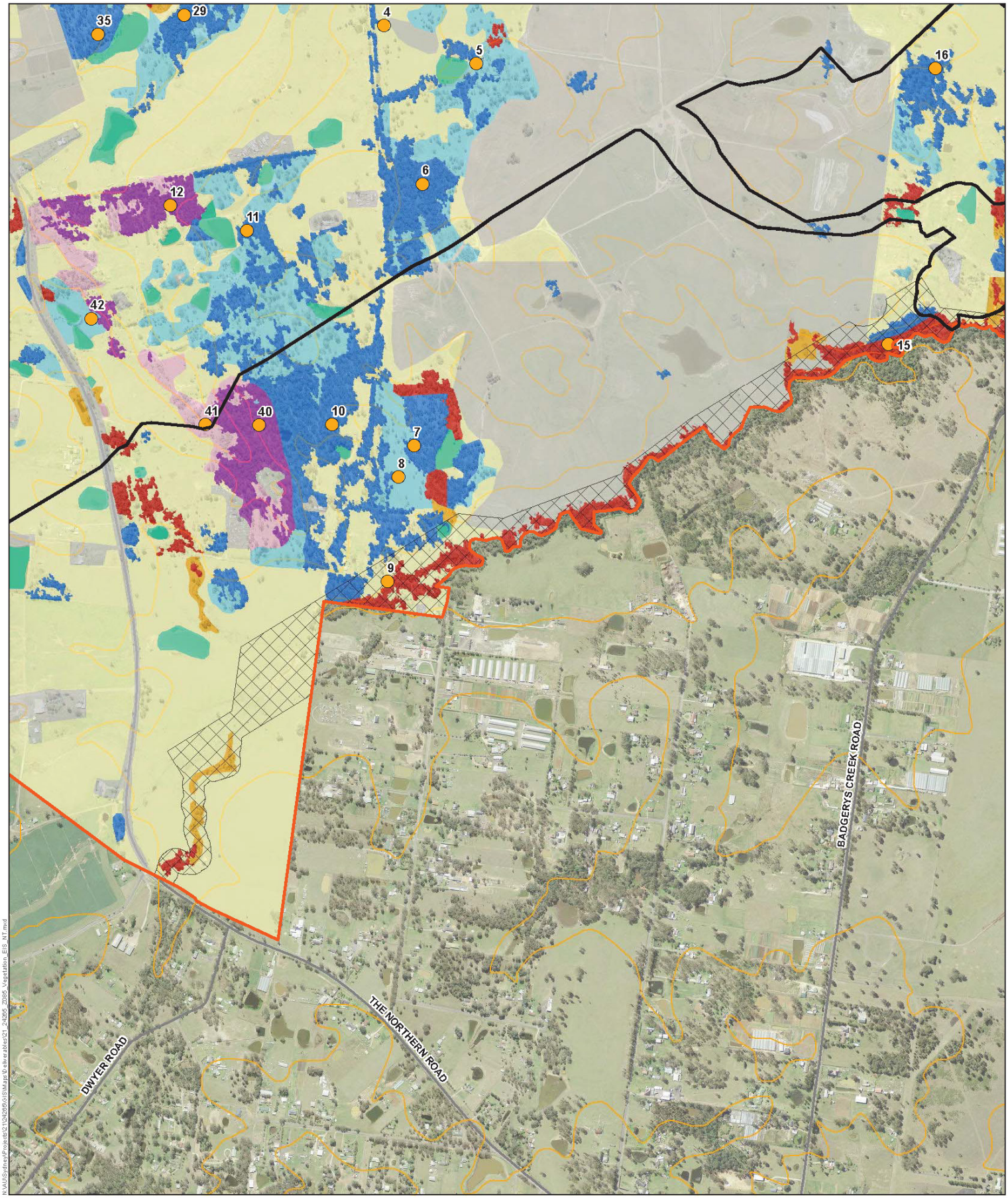
- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Contour
- Roads
- Plot/transect
- Good condition Grey Box - Forest Red Gum grassy woodland on flats (HN528)
- Poor condition Grey Box - Forest Red Gum grassy woodland on flats (HN528)
- Good condition Grey Box - Forest Red Gum grassy woodland on hills (HN529)
- Poor condition Grey Box - Forest Red Gum grassy woodland on hills (HN529)
- Good condition Forest Red Gum - Rough-barked Apple grassy woodland (HN526)
- Poor condition Forest Red Gum - Rough-barked Apple grassy woodland (HN526)
- Good condition Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest (HN512)
- Poor condition Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest (HN512)
- Good condition artficial freshwater wetland (HN630)
- Exotic grassland
- Cleared land or cropland



0 2 4 8
Kilometres

N

Figure 16-1C - Vegetation zones within the airport site



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

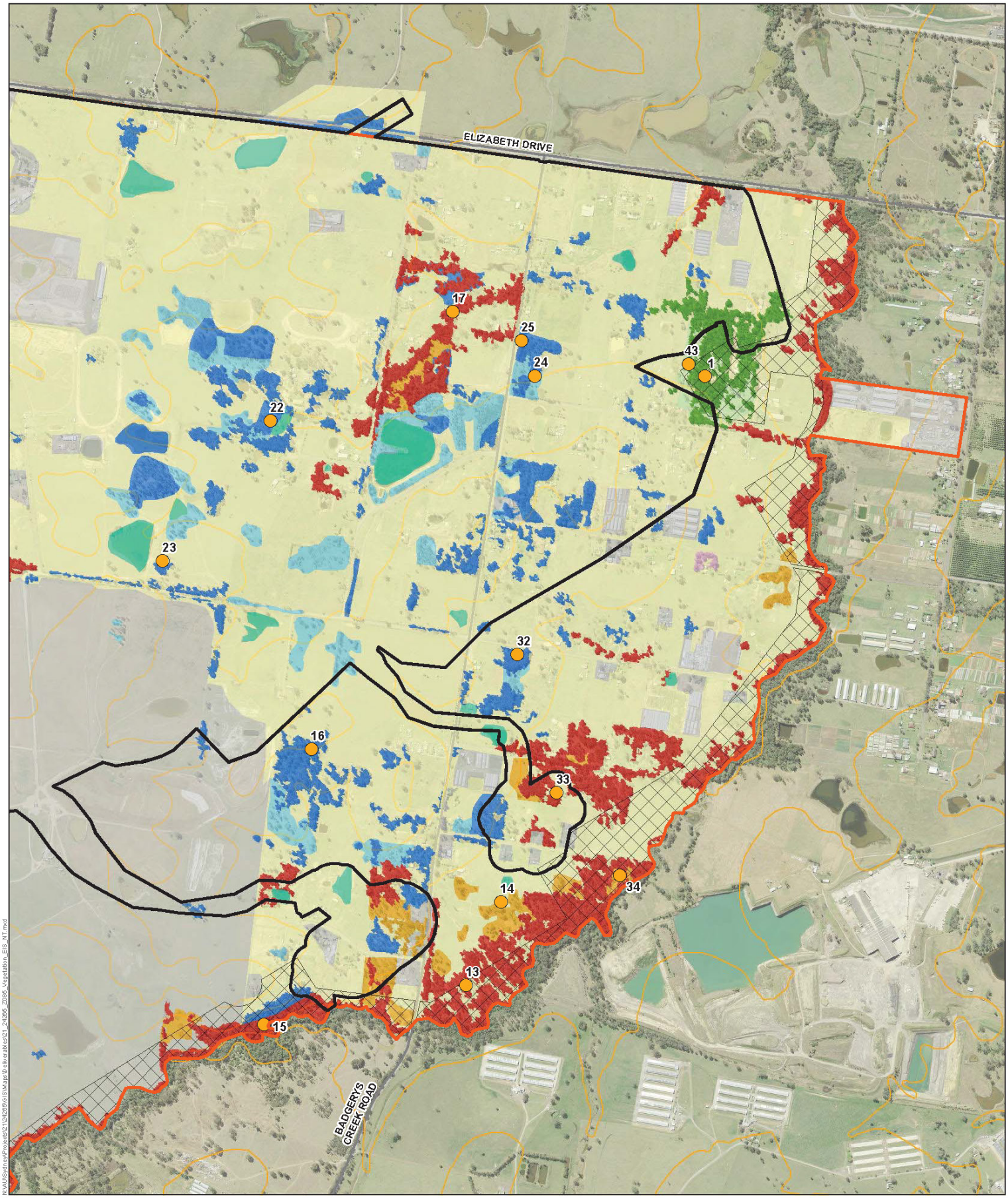
LEGEND

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Contour
- Roads
- Plot/transect
- Good condition Grey Box - Forest Red Gum grassy woodland on flats (HN528)
- Poor condition Grey Box - Forest Red Gum grassy woodland on flats (HN528)
- Good condition Grey Box - Forest Red Gum grassy woodland on hills (HN529)
- Poor condition Grey Box - Forest Red Gum grassy woodland on hills (HN529)
- Good condition Forest Red Gum - Rough-barked Apple grassy woodland (HN526)
- Poor condition Forest Red Gum - Rough-barked Apple grassy woodland (HN526)
- Good condition Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest (HN512)
- Poor condition Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest (HN512)
- Good condition artficial freshwater wetland (HN630)
- Exotic grassland
- Cleared land or cropland

0 2 4 8
Kilometres

N

Figure 16-1D - Vegetation zones within the airport site



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Contour
- Roads
- Plot/transect
- Good condition Grey Box - Forest Red Gum grassy woodland on flats (HN528)
- Poor condition Grey Box - Forest Red Gum grassy woodland on flats (HN528)
- Good condition Grey Box - Forest Red Gum grassy woodland on hills (HN529)
- Poor condition Grey Box - Forest Red Gum grassy woodland on hills (HN529)
- Good condition Forest Red Gum - Rough-barked Apple grassy woodland (HN526)
- Poor condition Forest Red Gum - Rough-barked Apple grassy woodland (HN526)
- Good condition Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest (HN512)
- Poor condition Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest (HN512)
- Good condition artficial freshwater wetland (HN630)
- Exotic grassland
- Cleared land or cropland

0 2 4 8
Kilometres

N

Figure 16-1E - Vegetation zones within the airport site

Table 16–5 Vegetation zones within the airport site

Vegetation zone	Condition	Conservation status[1]		Area at the airport site (hectares)
		EPBC Act status	TSC Act status	
Native vegetation zones				
Good condition Grey Box – Forest Red Gum grassy woodland on flats (HN528)	Moderate/good – medium or high	Cumberland Plain Woodland and Shale-gravel Transition Forest (CEEC)	Cumberland Plain Woodland (CEEC)	119.9
Poor condition Grey Box – Forest Red Gum grassy woodland on flats (HN528)	Moderate/good – poor	-	Cumberland Plain Woodland (CEEC)	131.0
Good condition Grey Box – Forest Red Gum grassy woodland on hills (HN529)	Moderate/good – medium or high	Cumberland Plain Woodland and Shale-gravel Transition Forest (CEEC)	Cumberland Plain Woodland (CEEC)	30.2
Poor condition Grey Box – Forest Red Gum grassy woodland on hills (HN529)	Moderate/good – poor	-	Cumberland Plain Woodland (CEEC)	31.0
Good condition Forest Red Gum – Rough-barked Apple grassy woodland (HN526)	Moderate/good – medium or high	-	River Flat Eucalypt Forest (EEC)	92.3
Poor condition Forest Red Gum – Rough-barked Apple grassy woodland (HN526)	Moderate/good – poor	-	River Flat Eucalypt Forest (EEC)	18.4
Good condition Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy open forest (HN512)	Moderate/good – medium or high	Cumberland Plain Woodland and Shale-gravel Transition Forest (CEEC)	Shale/gravel Transition Forest (EEC)	8.3
Poor condition Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy open forest (HN512)	Moderate/good – poor	-	Shale/gravel Transition Forest (EEC)	2.3
Good condition artificial freshwater wetland on floodplain (HN630)	Moderate/good	-	-	35.4
Non-native vegetation zones				
Exotic grassland	Cleared	-	-	956.8
Cleared land or cropland	Cleared	-	-	348.2
Total				1,773.9

The most extensive vegetation zone at the airport site is exotic grassland. This contains no native overstorey or midstorey vegetation and less than 50 per cent of the ground cover vegetation is native. Grassland areas contain occasional isolated paddock trees that are remnants of adjoining native woodland and forest. There are also extensive areas of buildings, hard stand, bare earth, cropland and waterbodies that feature minimal vegetation cover that have been collectively mapped as 'cleared land and cropland'. Exotic grassland at the airport site is shown in Photograph 16–1.

Photograph 16-1 Heavily grazed exotic grassland (left) and ungrazed exotic grassland (right) at the airport site

Grey Box – Forest Red Gum grassy woodland on flats is associated with mid and lower slopes, on shale derived soils across the airport site, and is the most extensive native plant community type. It comprises an open forest or woodland of Forest Red Gum and Grey Box with a grassy understorey and occasional dense patches of the shrub species Native Blackthorn (*Bursaria spinosa spinosa*). Grey Box – Forest Red Gum grassy woodland on flats at the airport site is shown in Photograph 16–2.

Photograph 16-2 Good condition Grey Box – Forest Red Gum grassy woodland on flats (left) and poor condition (right)

There are small areas of tertiary gravel influenced soils in the east of the airport site that support Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy open forest with a canopy of Forest Red Gum and Grey Box along with Broad-leaved Ironbark (*Eucalyptus fibrosa*), a characteristic midstorey of Honey Myrtle (*Melaleuca decora)* and a shrub and grass understorey.

There is a volcanic intrusion in the central-western portion of the site which is associated with steeper terrain, rock fragments in soil profiles and some rock outcropping. In other parts of the Cumberland Plain this geology is often associated with Moist Shale Woodland and Western Sydney Dry Rainforest (NPWS 2002; Tozer et al. 2010), however at the airport site it contains Grey Box – Forest Red Gum grassy woodland on hills with relatively few species representative of these other communities. Plot/transect data was compared with Tozer et al. (2010) diagnostic species lists to confirm the identity of this vegetation type. The observed vegetation may be because of frequent and/or recent fire and other disturbance at the airport site, which has prevented a succession towards rainforest species.

The above vegetation types transition into Forest Red Gum – Rough-barked Apple grassy woodland along the riparian corridors of Badgerys Creek and other drainage lines through the airport site. This community is a closed woodland or forest of Forest Red Gum, Grey Box and Cabbage Gum (*Eucalyptus amplifolia*) along with Swamp Oak, Broad-leaved Apple (*Angophora subvelutina*) and paperbarks (*Melaleuca* spp.). Understorey vegetation is similar to Shale Plains Woodland along with additional moisture-loving species such as rushes and sedges.

The condition of these plant community types varies across the airport site as a result of previous land use and grazing intensity. Areas that have been historically cleared and/or heavily grazed now contain regrowth vegetation in poorer condition. There is moderate to severe weed infestation throughout, with linear remnants along roads and isolated patches in agricultural land that are the most severely affected. Notwithstanding the generally moderate to poor condition of vegetation at the airport site, it has high conservation significance as a result of the presence of threatened biota and the generally limited extent and quality of similar vegetation in Western Sydney.

There are patches of derived native grassland at the airport site that comprise poor condition forms of the native vegetation communities described above. These areas contain at least 50 per cent native groundcover, mainly comprising native grasses such as Kangaroo Grass (*Themeda australis*). There is a moderate species richness, but relative low cover and an abundance of understorey herbs associated with the woodlands and forests described above. Exotic grasses and herbs are present throughout.

There are a large number of dams and flooded depressions throughout the airport site formed by the construction of barriers across small drainage lines. These waterbodies contain a moderate diversity and abundance of native wetland plants.

There are local occurrences of one threatened ecological community listed under the EPBC Act and three threatened ecological communities listed under the TSC Act at the airport site, as described below.

16.3.2.4 Groundwater dependent ecosystems

The Atlas of Groundwater Dependent Ecosystems (BoM 2015c) maps the potential for creeks and vegetation to be either groundwater dependent or inflow dependent. No waterways at the airport site are mapped as being groundwater dependent ecosystems that are reliant on the surface expression of groundwater. South Creek to the east and the Nepean River to the west are both mapped as this type of groundwater dependent ecosystem but are not anticipated to be directly influenced by groundwater aquifers at the airport site.

Most large patches of native vegetation (including riparian vegetation) at the airport site are mapped as having a high potential for groundwater interaction (that is, they are likely to be groundwater dependent ecosystems that are reliant on subsurface groundwater). Some smaller patches of native vegetation are mapped as having a low or moderate potential for groundwater interaction. Native vegetation along Badgerys Creek is also mapped as being highly likely to be an inflow dependent ecosystem (reliant on groundwater in addition to rainfall). Most other patches of native vegetation at the airport site are also mapped as being likely or highly likely to be inflow dependent (BOM 2015c). According to Kuginis et al. (2012), all native vegetation communities present at the airport site are likely to be groundwater dependent ecosystems.

16.3.2.5 Threatened flora species and populations

Twenty-eight species of threatened flora listed under the EPBC Act and/or TSC Act have been recorded or are predicted to occur within the general locality of the airport site.

Two species that are either threatened or part of an endangered population were recorded at the airport site during field surveys, while an additional seven species may occur. These species are listed in Table 16–6 and their distribution at the airport site is shown on Figure 16–2.

The remaining species predicted to occur in the general locality of the airport site are considered unlikely to occur at the airport site due to a lack of suitable habitat, and therefore would not be affected by the proposed airport. These species are discussed further in Appendix K1 (Volume 4).

Four individuals of *Pultenaea parviflora* were recorded on the southern side of Longleys Road between Ferndale Road and Taylors Road by SMEC (2014) and these records were verified during the field surveys. *Pultenaea parviflora* is listed as a vulnerable species under the EPBC Act and an endangered species under the TSC Act. This is a significant reduction from the 68 individuals previously recorded along both sides of Longleys Road in this location during the field surveys for the 1997–99 EIS (PPK 1997). The former locations of the other 64 individuals currently contain cleared, ploughed cropland or severely weed infested road edges and do not comprise occupied or potential habitat for this species.

In addition, 142 stems of *Marsdenia viridiflora* subsp. *viridiflora* have been recorded at the airport site, with the majority recorded in Grey Box – Forest Red Gum grassy woodland on flats adjacent to Longleys Road and Anton Lane in the centre of the airport site (see Figure 16–2). These comprise part of the endangered *Marsdenia viridiflora* R. Br. subsp. *viridiflora* population in the Bankstown (now Canterbury-Bankstown), Blacktown, Camden, Campbelltown, Fairfield, Holroyd (now Cumberland), Liverpool and Penrith local government areas listed under the TSC Act.

Twenty-eight species of threatened flora listed under the EPBC Act and/or TSC Act have been recorded or are predicted to occur within the general locality of the airport site.

Two species that are either threatened or part of an endangered population were recorded at the airport site during field surveys, while an additional seven species may occur. These species are listed in Table 16–6 and their distribution at the airport site is shown on Figure 16–2.

The remaining species predicted to occur in the general locality of the airport site are considered unlikely to occur at the airport site due to a lack of suitable habitat, and therefore would not be affected by the proposed airport. These species are discussed further in Appendix K1 (Volume 4).

Four individuals of *Pultenaea parviflora* were recorded on the southern side of Longleys Road between Ferndale Road and Taylors Road by SMEC (2014) and these records were verified during the field surveys. *Pultenaea parviflora* is listed as a vulnerable species under the EPBC Act and an endangered species under the TSC Act. This is a significant reduction from the 68 individuals previously recorded along both sides of Longleys Road in this location during the field surveys for the 1997–99 EIS (PPK 1997). The former locations of the other 64 individuals currently contain cleared, ploughed cropland or severely weed infested road edges and do not comprise occupied or potential habitat for this species.

In addition, 142 stems of *Marsdenia viridiflora* subsp. *viridiflora* have been recorded at the airport site, with the majority recorded in Grey Box – Forest Red Gum grassy woodland on flats adjacent to Longleys Road and Anton Lane in the centre of the airport site (see Figure 16–2). These comprise part of the endangered *Marsdenia viridiflora* R. Br. subsp. *viridiflora* population in the Bankstown (now Canterbury-Bankstown), Blacktown, Camden, Campbelltown, Fairfield, Holroyd (now Cumberland), Liverpool and Penrith local government areas listed under the TSC Act.

Table 16–6 Threatened flora recorded or that may occur at the airport site

Scientific name	Common name	Conservation status		Likelihood of occurrence
		EPBC Act	TSC Act	
Pultenaea parviflora		V	E	Present
Marsdenia viridiflora subsp.			EP	Present
Cynanchum elegans	White-flowered Wax Plant	E	E	Possible
Pimelea spicata	Spiked Rice-flower	E	E	Possible
Acacia pubescens	Downy Wattle	E	V	Possible
Grevillea parviflora subsp.	Small-flower Grevillea	V	V	Possible
Grevillea juniperina subsp.	Juniper-leaved Grevillea		V	Possible
Thesium australe	Austral Toadflax	V	V	Possible
Dillwynia tenuifolia			V	Possible

Conservation status: V = Vulnerable, E = Endangered, EP = Endangered Population

16.3.2.6 Threatened ecological communities

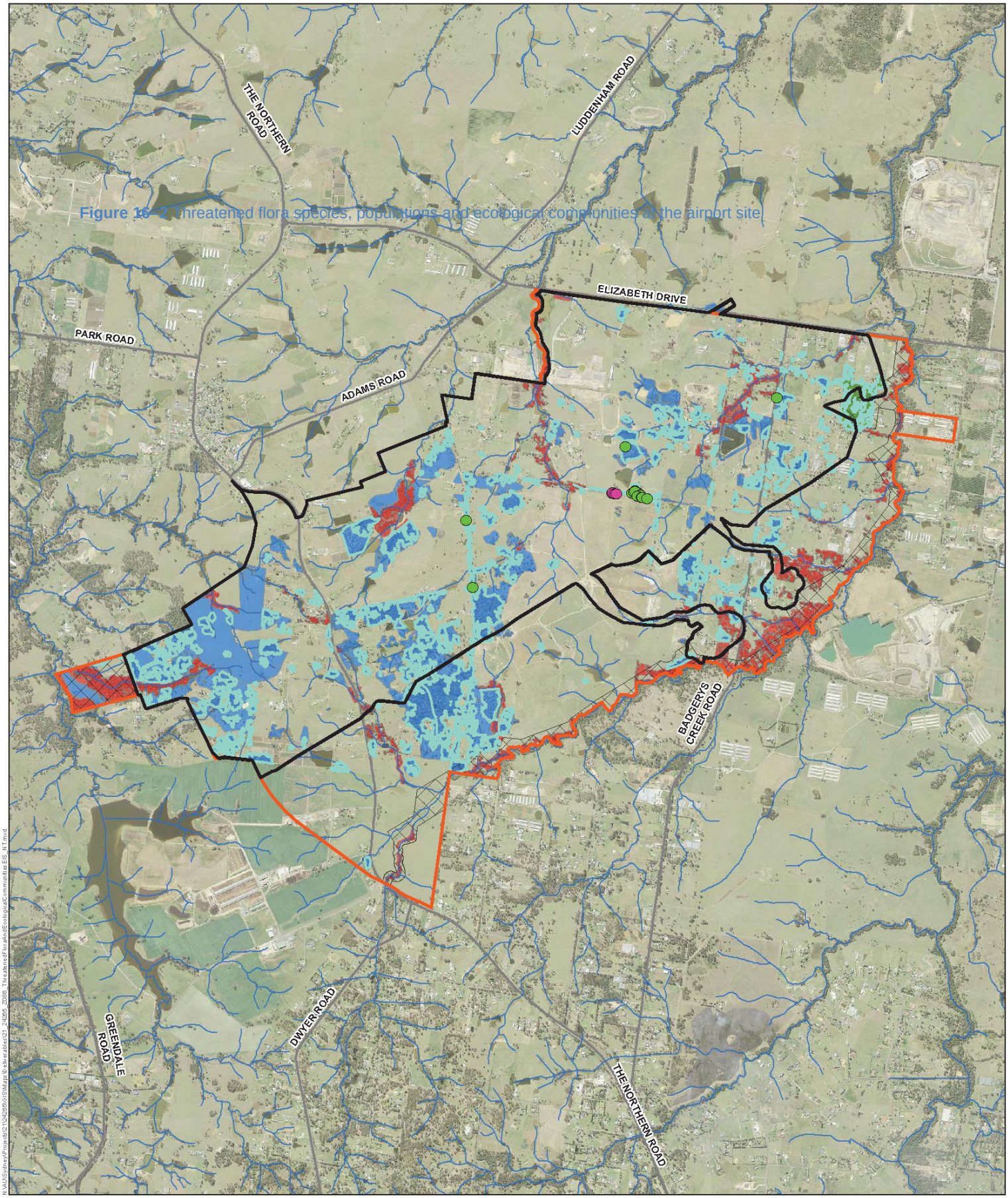
Larger and better condition patches of Grey Box – Forest Red Gum grassy woodland on flats, Grey Box – Forest Red Gum grassy woodland on hills and Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy open forest at the airport site comprise occurrences of 'Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest' (Cumberland Plain Woodland) (see Table 16–5). Cumberland Plain Woodland is listed as a critically endangered ecological community under the EPBC Act and the TSC Act.

Derived native grassland and other moderate/good – poor condition vegetation at the airport site does not meet the condition criteria for a local occurrence of Cumberland Plain Woodland as defined under the EPBC Act and associated guidelines, but does meet the definition under the TSC Act.

All of the native woodland and forest vegetation at the airport site, including derived native grasslands, comprise local occurrences of threatened ecological communities listed under the TSC Act, as follows:

- both good and poor condition patches of Grey Box – Forest Red Gum grassy woodland on flats and Grey Box – Forest Red Gum grassy woodland on hills comprise the critically endangered ecological community 'Cumberland Plain Woodland in the Sydney Basin Bioregion' (Cumberland Plain Woodland);
- both good and poor condition patches of Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy open forest comprise the endangered ecological community 'Shale/Gravel Transition Forest in the Sydney Basin Bioregion' (Shale-Gravel Transition Forest); and
- both good and poor condition patches of Forest Red Gum – Rough-barked Apple grassy woodland comprise the endangered ecological community 'River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions' (River Flat Eucalypt Forest) (see Table 16–5).

The status of vegetation zones quantified at the airport site as threatened ecological communities under the EPBC Act and TSC Act is included in Table 16–5. These threatened ecological communities are shown on Figure 16–2.



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

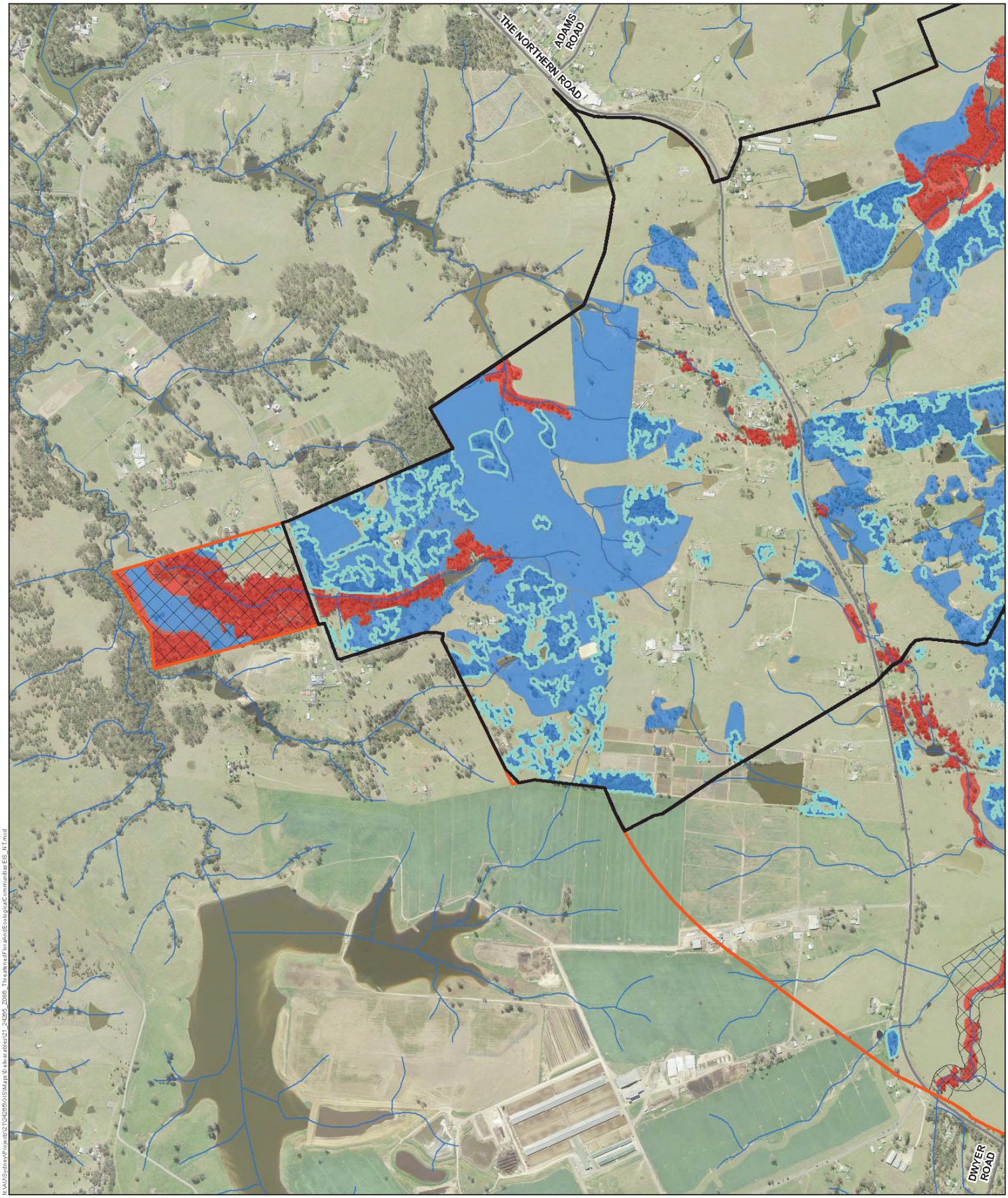
LEGEND

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Watercourses
- Roads
- Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest (CEEC under EPBC Act and TSC Act)
- Cumberland Plain Woodland (CEEC under the TSC Act)
- River Flat Eucalypt Forest (EEC under the TSC Act)
- Shale/gravel Transition Forest (EEC under the TSC Act)
- *Pultenaea parviflora* (endangered species under the EPBC Act and TSC Act)
- *Marsdenia viridiflora subsp. viridiflora* (endangered population under the TSC Act)

Threatened flora species, populations
Figure 16-2A - and ecological communities at the airport site

0 2 4 8
Kilometres

N



N:\AUS\Sydney\Projects\21\24265\GIS\Maps\Deliverables\21_24265_ZD86_ThreatenedFloraAndEcologicalCommunitiesEIS_NT.mxd

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

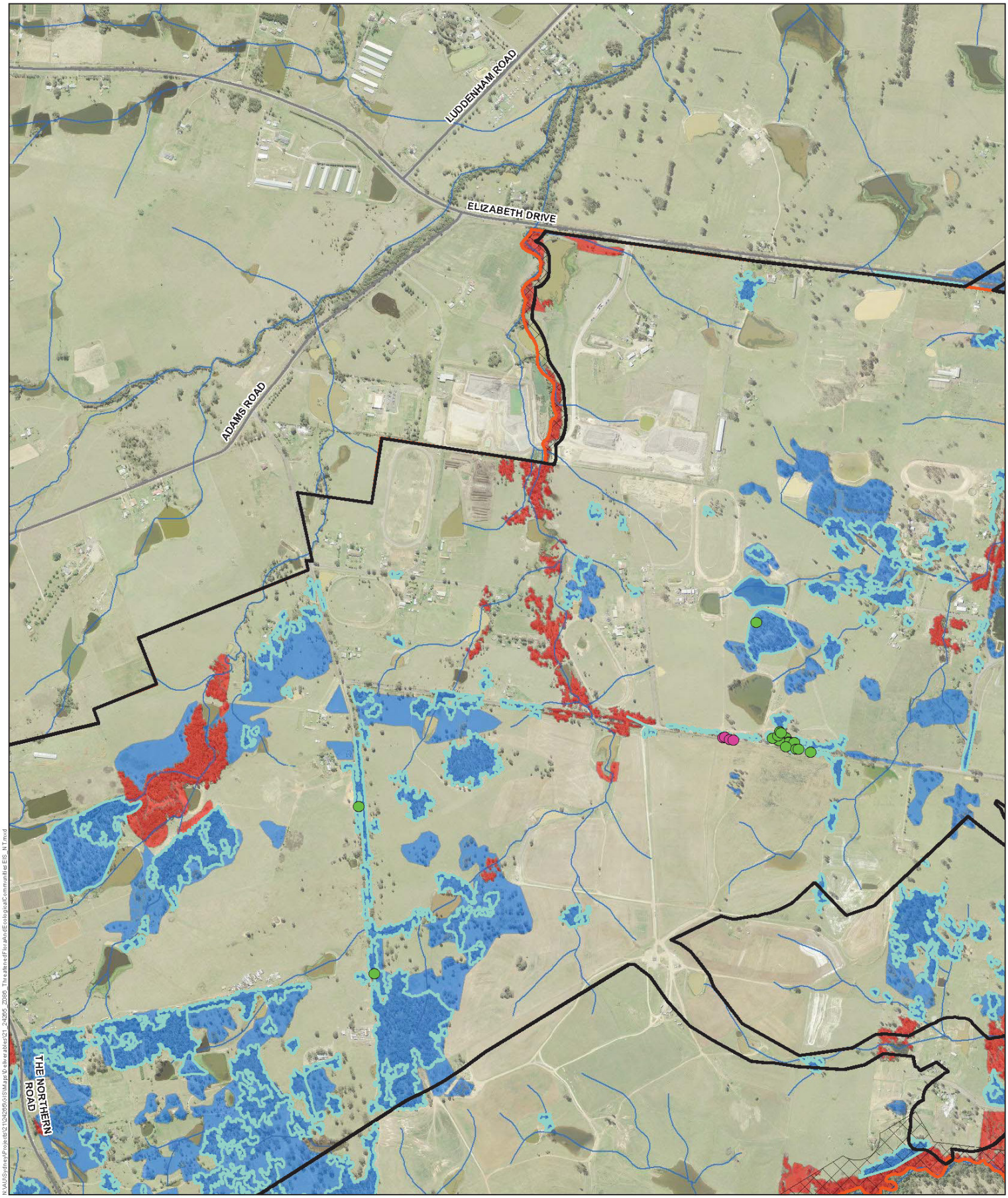
- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Watercourses
- Roads
- Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest (CEEC under EPBC Act and TSC Act)
- Cumberland Plain Woodland (CEEC under the TSC Act)
- River Flat Eucalypt Forest (EEC under the TSC Act)
- Shale/gravel Transition Forest (EEC under the TSC Act)
- *Pultenaea parviflora* (endangered species under the EPBC Act and TSC Act)
- *Marsdenia viridiflora subsp. viridiflora* (endangered population under the TSC Act)

Threatened flora species, populations and ecological communities at the airport site

Figure 16-2B

0 2 4 8
Kilometres

N

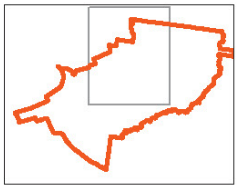


N:\AUS\Sydney\Projects\21\24295\GIS\Maps\Deliverables\21_24295_ZD86_ThreatenedFloraAndEcologicalCommunitiesEIS_NT.mxd

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

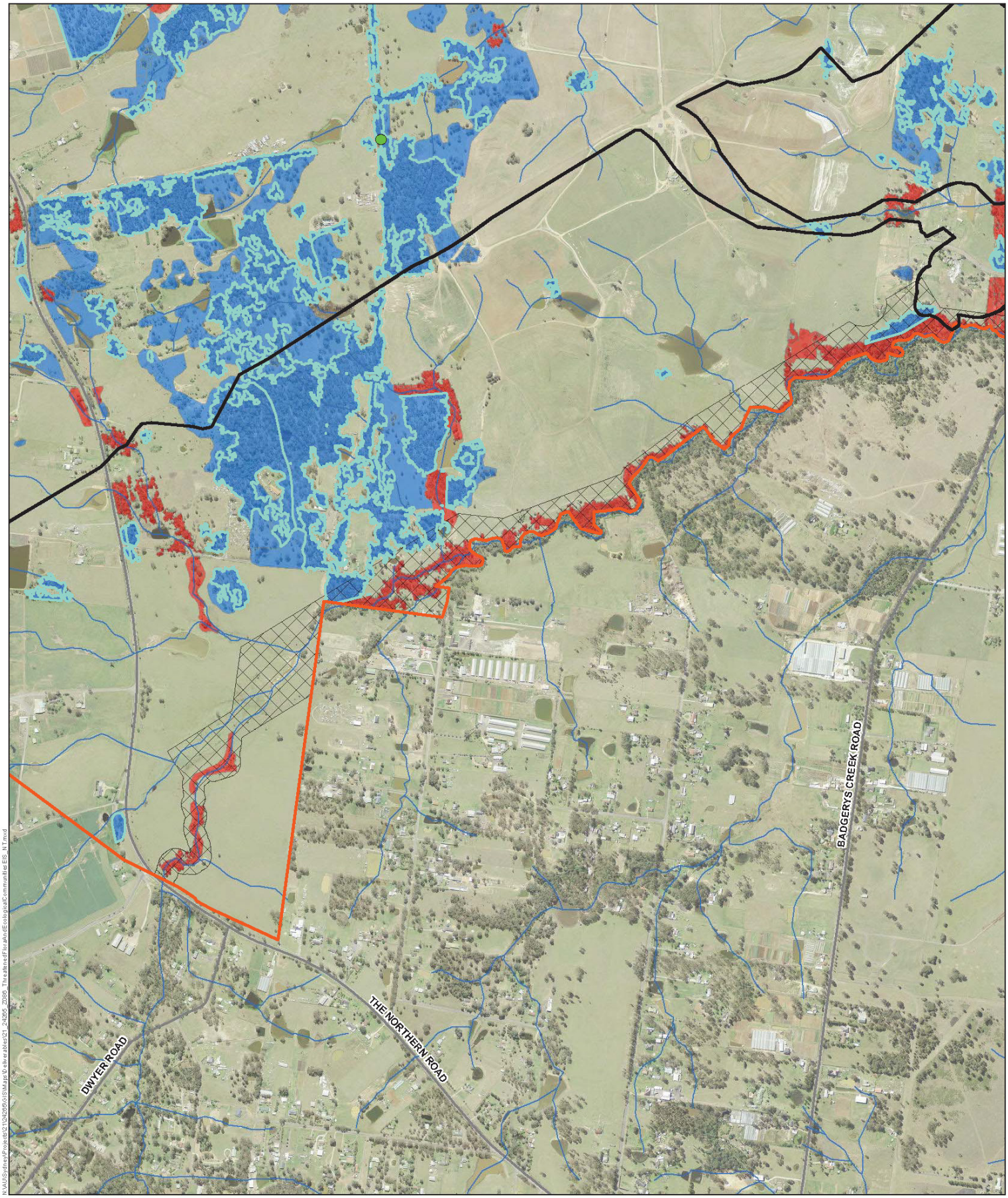
- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Watercourses
- Roads
- Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest (CEEC under EPBC Act and TSC Act)
- Cumberland Plain Woodland (CEEC under the TSC Act)
- River Flat Eucalypt Forest (EEC under the TSC Act)
- Shale/gravel Transition Forest (EEC under the TSC Act)
- *Pultenaea parviflora* (endangered species under the EPBC Act and TSC Act)
- *Marsdenia viridiflora subsp. viridiflora* (endangered population under the TSC Act)



Threatened flora species, populations
Figure 16-2C - and ecological communities at the airport site

0 2 4 8
Kilometres

N



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

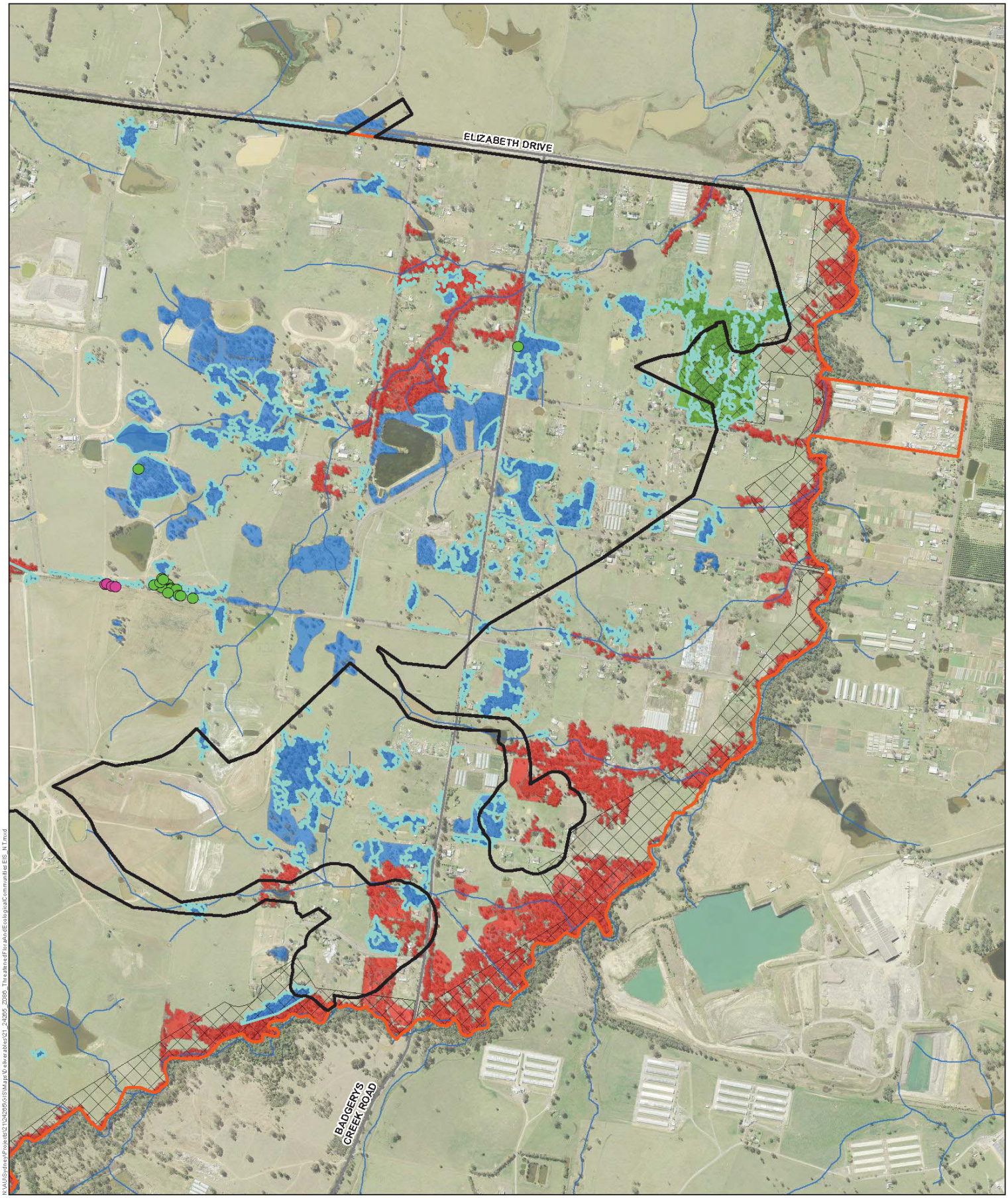
- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Watercourses
- Roads
- Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest (CEEC under EPBC Act and TSC Act)
- Cumberland Plain Woodland (CEEC under the TSC Act)
- River Flat Eucalypt Forest (EEC under the TSC Act)
- Shale/gravel Transition Forest (EEC under the TSC Act)
- *Pultenaea parviflora* (endangered species under the EPBC Act and TSC Act)
- *Marsdenia viridiflora subsp. viridiflora* (endangered population under the TSC Act)

Threatened flora species, populations and ecological communities at the airport site

Figure 16-2D

0 2 4 8
Kilometres

N



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Watercourses
- Roads
- Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest (CEEC under EPBC Act and TSC Act)
- Cumberland Plain Woodland (CEEC under the TSC Act)
- River Flat Eucalypt Forest (EEC under the TSC Act)
- Shale/gravel Transition Forest (EEC under the TSC Act)
- *Pultenaea parviflora* (endangered species under the EPBC Act and TSC Act)
- *Marsdenia viridiflora subsp. viridiflora* (endangered population under the TSC Act)

Threatened flora species, populations and ecological communities at the airport site

Figure 16-2E

0 2 4 8
Kilometres

N

16.3.3 Terrestrial fauna

16.3.3.1 Fauna species

A total of 173 terrestrial fauna species (four invertebrate species, two fish species, 10 frog species, 10 reptile species, 127 bird species and 20 mammal species) were recorded at the airport site. As many as 10 other microchiropteran bat species may also have been recorded, but poor data quality and/or interspecific call similarities precluded reliable identification of additional species. A further 20 fauna species (10 bird species, seven mammal species, two reptile species and one frog species) were recorded by Biosis Research for the 1997–99 EIS (PPK 1997) and/or by SMEC (2014). The full list of fauna species recorded at the airport site is provided in Appendix K1 (Volume 4).

Threatened fauna species recorded site or otherwise considered to potentially occur at the airport site are discussed in Section 16.3.3.4.

A number of introduced fauna species were recorded at the airport site, including seven bird species, six mammal species, one fish species, and two snail species.

16.3.3.2 Fauna habitat

Five broad fauna habitat types were recorded at the airport site: grassland and cropped areas, native woodland, riparian forest, wetlands, and buildings and other structures. These habitat types are described below.

Grassland and cropped areas

The majority of the airport site contains exotic grassland and cleared land or cropped areas. These would have historically supported native woodland vegetation but have been extensively modified by previous clearing and agriculture. Exotic grassland and cleared land contain few habitat resources of relevance to most native species due to low structural and floristic diversity. Exotic grasses and herbs would provide foraging resources for native fauna species that are relatively mobile and opportunistic.

Occasional paddock trees and shrubs (for example, Native Blackthorn or African Olive) also occur in these areas. Regrowth trees and shrubs would provide some foraging resources for native woodland birds.

Most of the species recorded in grassland areas would use these areas as an adjunct to the higher quality, more extensive areas of suitable habitat at and around the airport site. Some small fauna species such as lizards may rely on grassland habitat for their survival.

Native woodland

Native woodland at the airport site provides a moderate quality fauna habitat. Habitat resources include mature canopy trees and associated nectar, fruits and leaves as well as foraging substrate, a range of fruiting and flowering small trees and shrubs, and connectivity with wetland and aquatic habitat. Woodland and forest at the airport site forms some more extensive patches particularly where it is connected by riparian corridors, however the majority is fragmented and subject to edge effects (which are defined as changes in population or community structure that occur at the boundary of two habitats). There are roads, residences, agriculture and industry throughout the airport site creating associated noise and light disturbance as well as physical barriers to fauna movement. Grazing and the presence of exotic pest fauna would further reduce the habitat's value. There is only a moderate quantity of large, hollow-bearing trees at the airport site.

Eucalypts and other native flora species provide foraging and shelter resources for a range of birds and mammals. Foraging resources include seasonal nectar resources, seeds and insects. Winter-flowering acacias and Native Blackthorn would provide year-round foraging resources for a range of native birds, bats and mammals.

Much of the shrub and ground layer vegetation and habitat features of the woodland and forest at the airport site have been removed for grazing. Woodland at the airport site generally contains low quantities of woody debris and leaf litter. Fallen timber and leaf litter provides shelter habitat for reptiles, snakes and small mammals.

Riparian forest

There is a relatively extensive network of drainage lines and waterbodies across the airport site. Most drainage lines are in moderate geomorphic condition and support good instream and riparian vegetation but with moderate to severe weed infestation and some evidence of degradation by cattle such as grazing, bank erosion, increased turbidity and likely also nutrient enrichment from waste.

Riparian forest at the airport site consists of a closed woodland or forest of eucalypts with Swamp Oak present along the margins of the creeks. A range of paperbarks (*Melaleuca* spp.) are also present. Understorey vegetation is similar to the adjacent native woodland along with additional moisture-loving species such as rushes and sedges. Large, hollow-bearing trees tend to occur in higher densities along the riparian corridor than in other woodland patches at the airport site.

Similar to native woodland, eucalypts and other flora species provide foraging and shelter resources for a range of birds and mammals and fallen timber and leaf litter provides shelter habitat for small reptiles and mammals.

Drainage lines provide habitat for native fish and aquatic invertebrates and breeding habitat for a number of stream-breeding frogs.

Wetlands

There are a number of dams and flooded depressions at the airport site with varying growth of native wetland and aquatic plants, including some waterbodies with extensive reed beds. These range in habitat value for native fauna depending on their size, presence of emergent or aquatic vegetation and level of use by cattle and associated disturbance. Many dams contained a variety of aquatic vegetation, including *Typha orientalis*, *Eleocharis cylindrostachys* and *Eleocharis sphacelata*.

Building and other structures

A number of sheds and buildings are present at the airport site. Some of these structures provide roosting habitat for birds and microbats. Sheds and buildings are also likely to provide shelter for rodents and snakes. Roosting microbats were observed under the Badgerys Creek bridge on Badgerys Creek Road.

These five habitats are shown on Figure 16–3. A list of species recorded in each habitat (including threatened, migratory and introduced species) is provided in Appendix K1 (Volume 4).

16.3.3.3 Habitat connectivity

Wildlife corridors are vital for the maintenance of ecological processes, including the movement of animals and the continuation of viable populations. Corridors can consist of a sequence of stepping stones across the landscape (discontinuous areas of habitat such as paddock trees, wetlands and roadside vegetation), continuous lineal strips of vegetation and habitat (such as riparian strips, ridge lines), or they may be parts of an extensive patch of vegetation (DEC 2004c).

Connectivity with vegetation outside the airport site is limited. Most vegetation in the locality occurs as small patches, with long linear patches of vegetation tending to occur along creek lines. The Badgerys Creek corridor remains generally vegetated to the north of the airport site, albeit with some gaps in vegetation cover and links to the vegetated corridors of South Creek and Cosgrove Creek. *The Western Sydney Urban Bushland Biodiversity Survey* (NPWS 1997) identified a number of riparian corridors as targets for conservation within the Liverpool Local Government Area, such as South Creek and Kemps Creek, but did not specifically include the Badgerys Creek corridor.

Most patches of native vegetation at the airport site were mapped by Ecological Australia (2012) as being linked and, therefore, having a patch size of greater than 100 hectares. There is only limited connectivity, however, with other patches of vegetation outside the airport site. Large expanses of cleared land occur along the northern edge of Elizabeth Drive and Adams Road. Small patches of vegetation to the south and west provide ‘stepping stones’ to other patches of vegetation outside the airport site.

Connectivity for fauna species is, therefore, mainly along the Badgerys Creek riparian corridor or between closely linked patches within the airport site. Species with only limited mobility, such as the Cumberland Plain Land Snail, have minimal opportunities for dispersal. The Cumberland Plain Land Snail would generally be restricted to isolated patches of vegetation in which the local population occurs, with no opportunity for movement between patches that are separated by grassland or cleared land. Small woodland birds would tend to move along the riparian corridors or along roadside vegetation to access other areas of habitat. More mobile fauna, such as the Grey-headed Flying-fox and larger birds would move easily between patches of vegetation at the airport site and other areas of habitat in the locality.

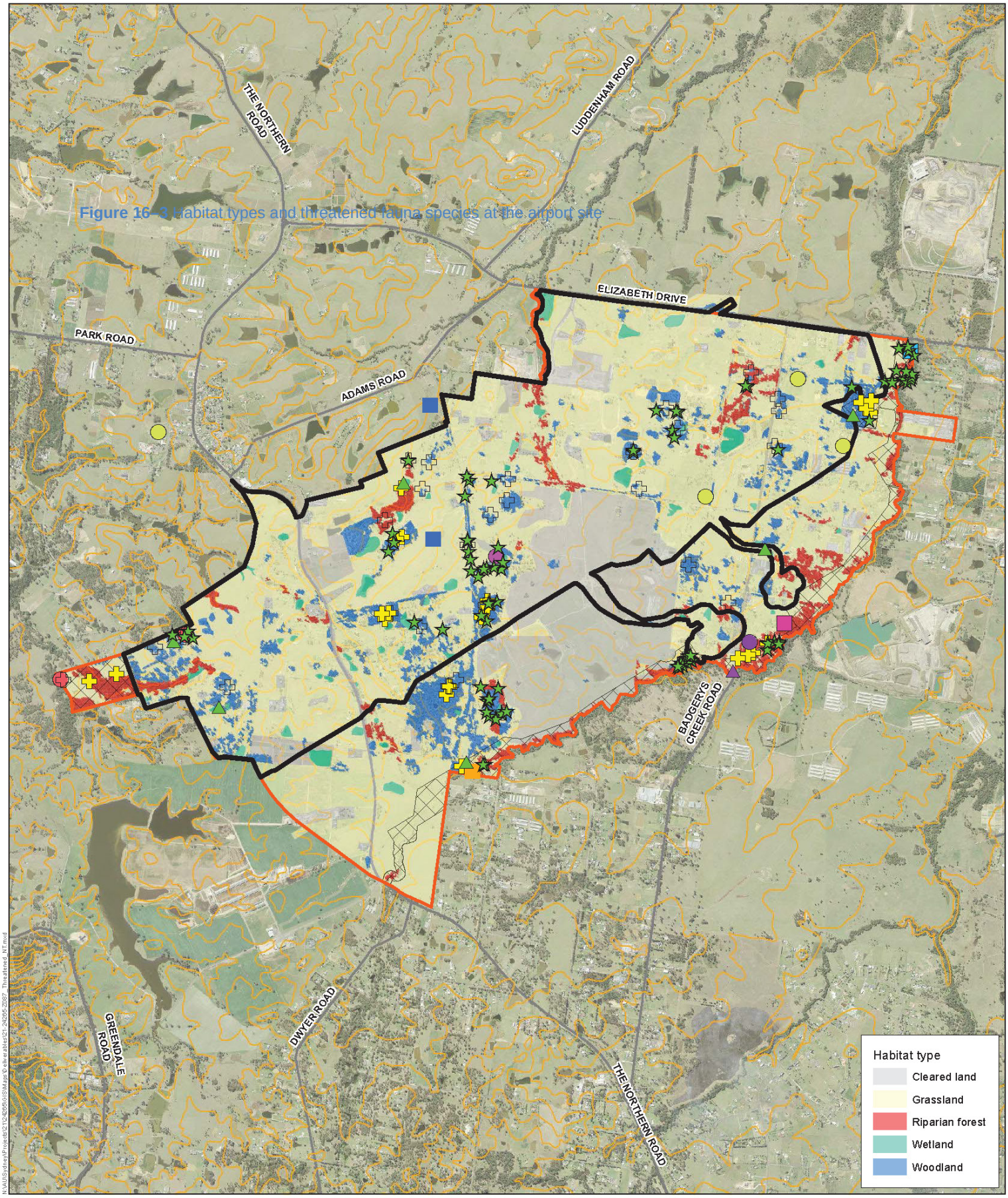


Figure 16-3 Habitat types and threatened fauna species at the airport site

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Contour
- Roads
- Habitat trees

Threatened species

- Black Bittern (V)
- Cumberland Plain Land Snail (E) (absent)
- Cumberland Plain Land Snail (E) (present)
- East Coast Freetail Bat (V)
- Grey-headed Flying-fox (V/V)
- Large-footed Myotis (V)
- Little Eagle (V)
- Scarlet Robin (V)
- Varied Sittella (V)

Migratory species

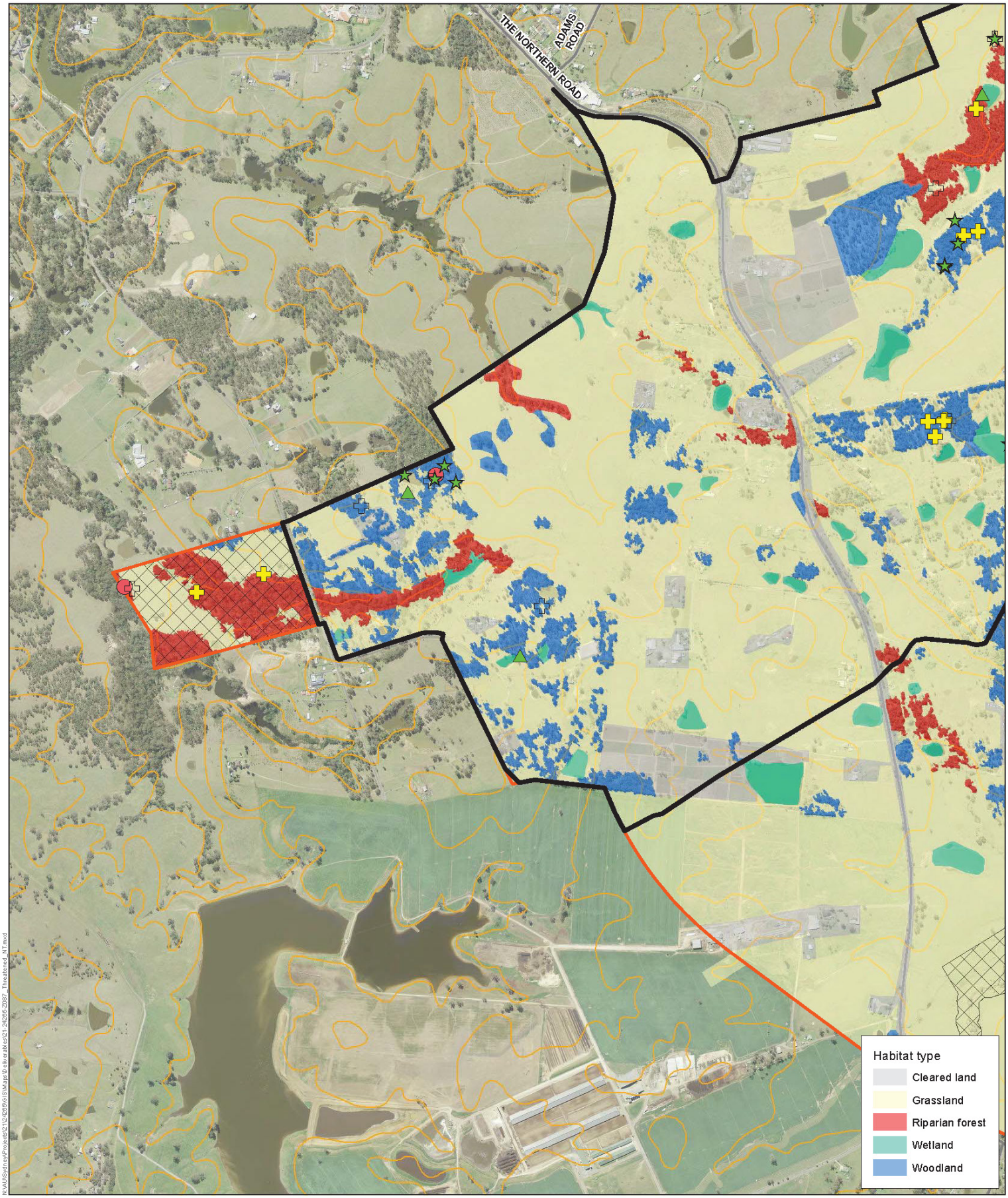
- Cattle Egret
- Latham's Snipe
- Rufous Whistler

Notes: V - vulnerable species under the TSC Act; E - endangered species under the TSC Act;
M - migratory species under the EPBC Act; V/V – vulnerable species under the TSC Act and EPBC Act

Kilometres 0 2 4 8

N

Figure 16-3A - Habitat types and threatened fauna species at the airport site



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Contour
- Roads
- Habitat trees

Threatened species

- Black Bittern (V)
- Cumberland Plain Land Snail (E) (absent)
- Cumberland Plain Land Snail (E) (present)
- East Coast Freetail Bat (V)
- Grey-headed Flying-fox (V/V)
- Large-footed Myotis (V)
- Little Eagle (V)
- Scarlet Robin (V)
- Varied Sittella (V)

Migratory species

- Cattle Egret
- Latham's Snipe
- Rufous Whistler

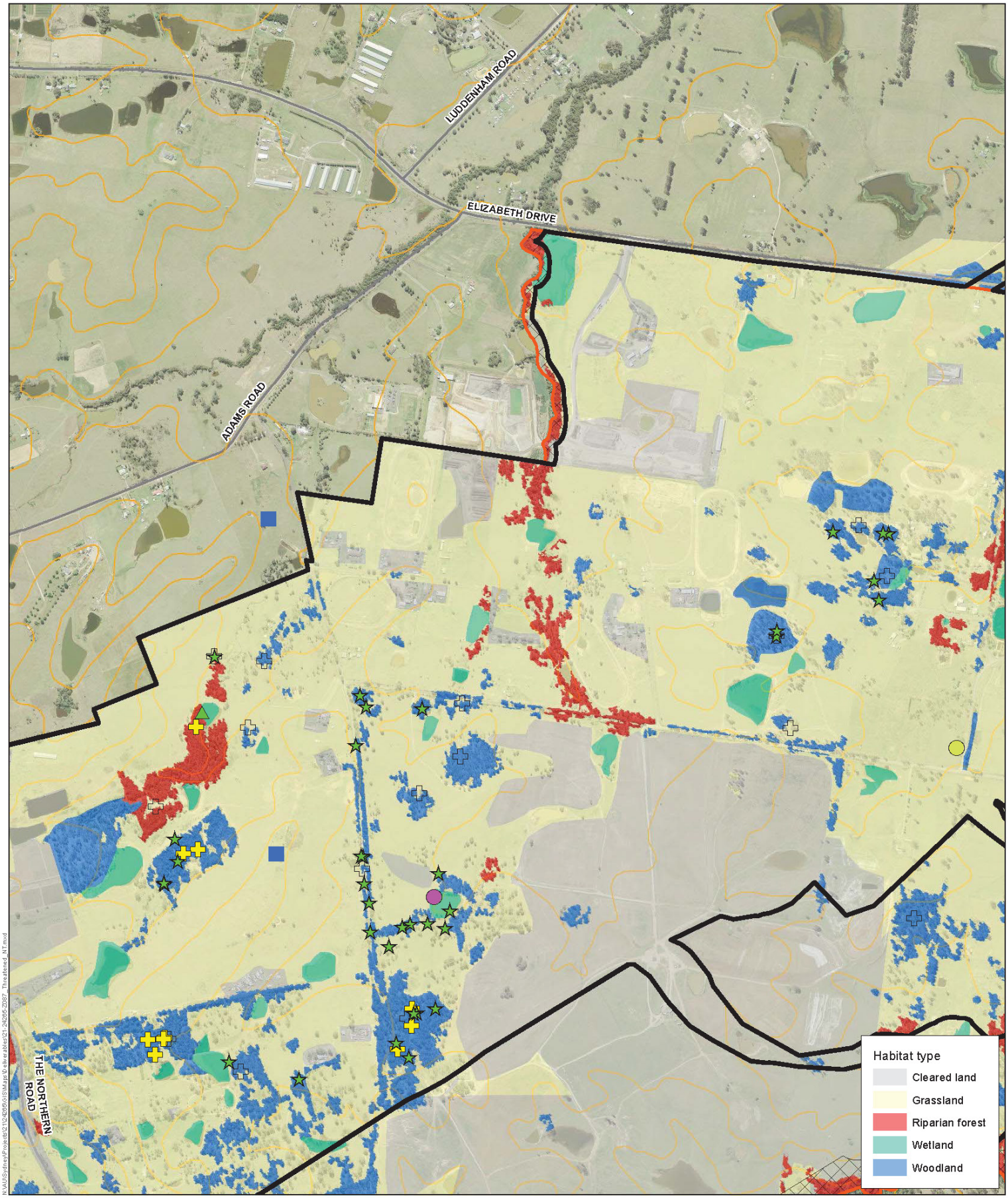
Notes: V - vulnerable species under the TSC Act; E - endangered species under the TSC Act;
M - migratory species under the EPBC Act; V/V – vulnerable species under the TSC Act and EPBC Act

N:\AUS\Sydney\Projects\21\24265\GIS\Maps\Deliverables\21_24265_GM7_Threatened_NT.mxd

Figure 16-3B - Habitat types and threatened fauna species at the airport site

0 2 4 8
Kilometres

N



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Contour
- Roads
- Habitat trees

Threatened species

- Black Bittern (V)
- Cumberland Plain Land Snail (E) (absent)
- Cumberland Plain Land Snail (E) (present)
- East Coast Freetail Bat (V)
- Grey-headed Flying-fox (V/V)
- Large-footed Myotis (V)
- Little Eagle (V)
- Scarlet Robin (V)
- Varied Sittella (V)

Migratory species

- Cattle Egret
- Latham's Snipe
- Rufous Whistler

Notes: V - vulnerable species under the TSC Act; E - endangered species under the TSC Act;
M - migratory species under the EPBC Act; V/V – vulnerable species under the TSC Act and EPBC Act

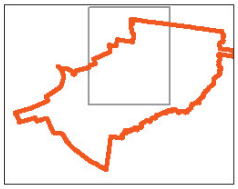
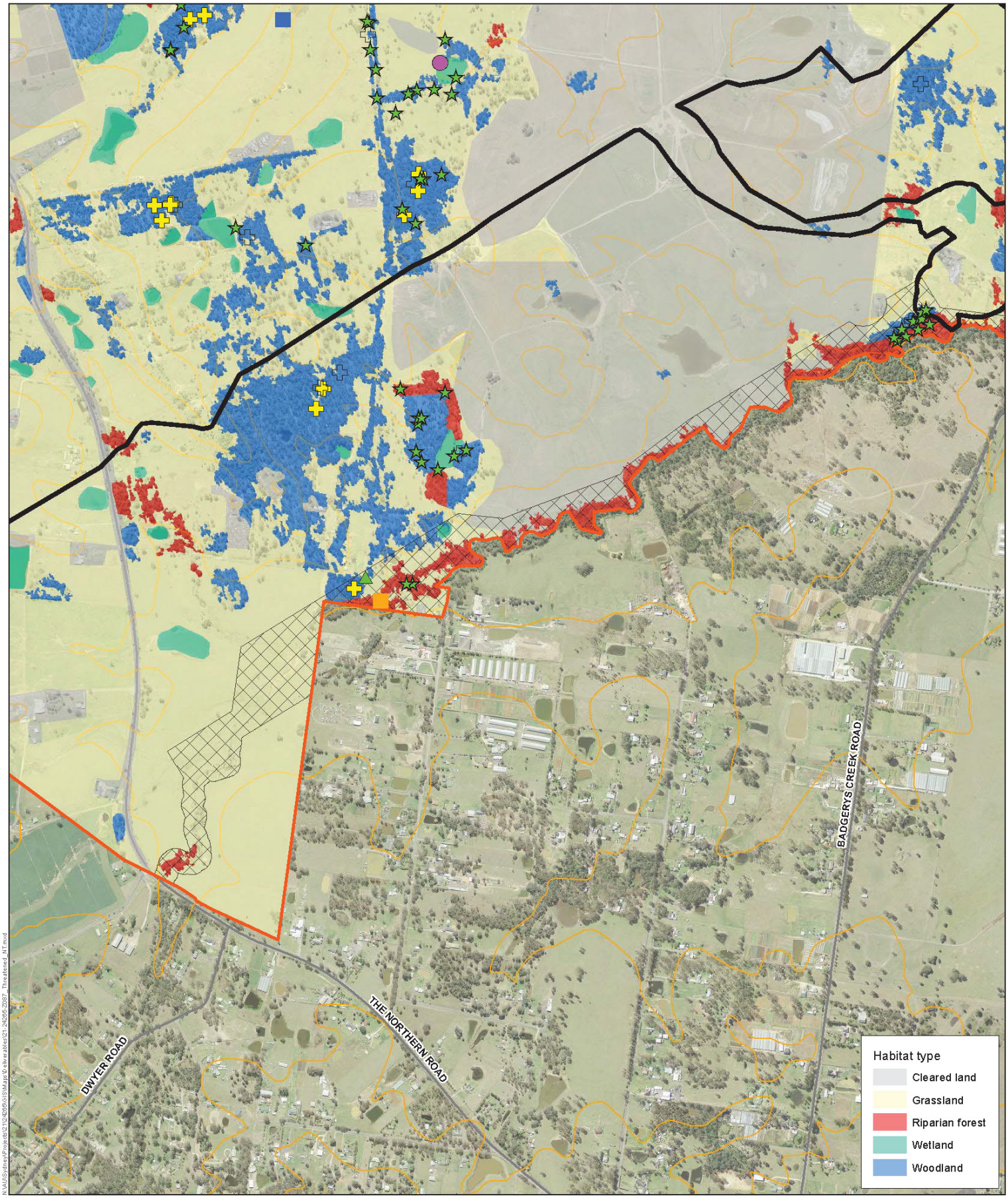


Figure 16-3C - Habitat types and threatened fauna species at the airport site

0 2 4 8
Kilometres

N



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Contour
- Roads
- Habitat trees

Threatened species

- Black Bittern (V)
- Cumberland Plain Land Snail (E) (absent)
- Cumberland Plain Land Snail (E) (present)
- East Coast Freetail Bat (V)
- Grey-headed Flying-fox (V/V)
- Large-footed Myotis (V)
- Little Eagle (V)
- Scarlet Robin (V)
- Varied Sittella (V)

Migratory species

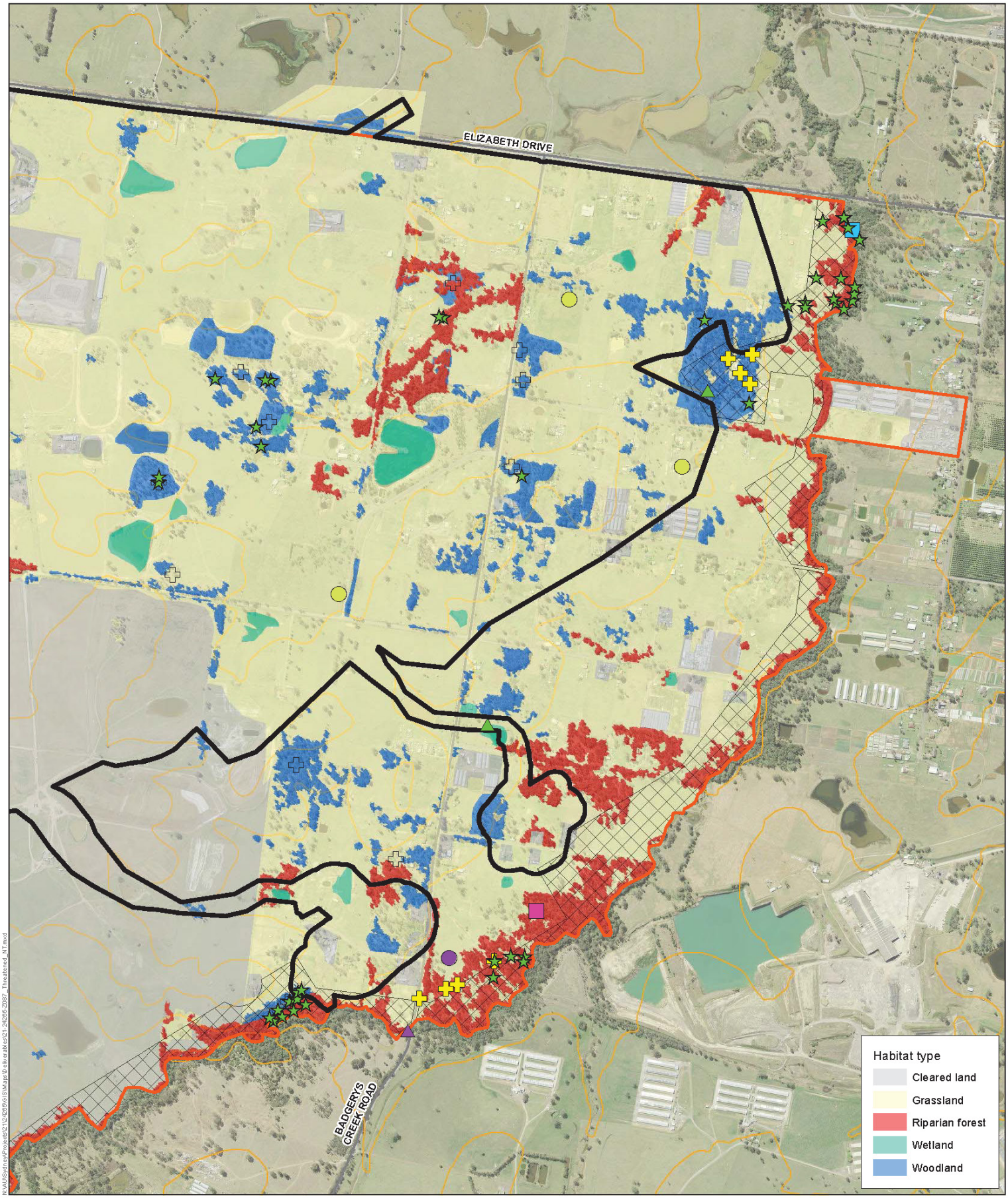
- Cattle Egret
- Latham's Snipe
- Rufous Whistler

Notes: V - vulnerable species under the TSC Act; E - endangered species under the TSC Act;
M - migratory species under the EPBC Act; V/V – vulnerable species under the TSC Act and EPBC Act

0 2 4 8
Kilometres

N

Figure 16-3D - Habitat types and threatened fauna species at the airport site



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Contour
- Roads
- Habitat trees

Threatened species

- Black Bittern (V)
- Cumberland Plain Land Snail (E) (absent)
- Cumberland Plain Land Snail (E) (present)
- East Coast Freetail Bat (V)
- Grey-headed Flying-fox (V/V)
- Large-footed Myotis (V)
- Little Eagle (V)
- Scarlet Robin (V)
- Varied Sittella (V)

Migratory species

- Cattle Egret
- Latham's Snipe
- Rufous Whistler

Notes: V - vulnerable species under the TSC Act; E - endangered species under the TSC Act;
M - migratory species under the EPBC Act; V/V – vulnerable species under the TSC Act and EPBC Act

Figure 16-3E - Habitat types and threatened fauna species at the airport site

0 2 4 8
Kilometres

N

16.3.3.4 Threatened fauna species

Threatened fauna species recorded site or otherwise considered to potentially occur at the airport site are listed in Table 16–7. The distribution of these species (where recorded) and their potential habitat at the airport site is shown on Figure 16–3. A complete list of species considered in the likelihood of occurrence assessment is provided in Appendix K1 (Volume 4).

Table 16–7 Threatened fauna recorded or that may occur at the airport site

Scientific name	Common name	Conservation status		Likelihood of Occurrence
		EPBC Act	TSC Act	
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Present
Meridolum corneovirens	Cumberland Plain Land Snail		E	Present
Hieraaetus morphnoides	Little Eagle		V	Present
Glossopsitta pusilla	Little Lorikeet		V	Present
Petroica boodang	Scarlet Robin		V	Present
Daphoenositta chrysoptera	Varied Sittella		V	Present
Ixobrychus flavicollis	Black Bittern		V	Present
Oxyura australis	Blue-billed Duck		V	Present
Mormopterus norfolkensis	East Coast Freetail Bat		V	Present
Falsistrellus tasmaniensis	Eastern False Pipistrelle		V	Present
Miniopterus schreibersii oceanensis	Eastern Bentwing Bat		V	Present
Myotis macropus	Large-footed Myotis		V	Probably recorded (anabat)
Scoteanax rueppellii	Greater Broad-nosed Bat		V	Possibly recorded (anabat)
Vespadelus troughtoni	Eastern Cave Bat		V	Possibly recorded (anabat)
Saccolaimus flaviventris	Yellow-bellied Sheath-tail Bat		V	Possible
Lathamus discolor	Swift Parrot	CE	E	Likely
Ninox strenua	Powerful Owl		V	Likely
Tyto novaehollandiae	Masked Owl		V	Likely
Petroica phoenicea	Flame Robin		V	Likely
Melanodryas cucullata	Hooded Robin		V	Possible
Stagonopleura guttata	Diamond Firetail		V	Likely
Pyrrholaemus sagittatus	Speckled Warbler		V	Possible
Melithreptus gularis	Black-chinned Honeyeater		V	Possible
Callocephalon fimbriatum	Gang-gang Cockatoo		V	Possible
Calyptorhynchus lathami	Glossy Black-cockatoo		V	Possible
Ninox connivens	Barking Owl		V	Possible
Lophoictinia isura	Square-tailed Kite		V	Possible

Scientific name	Common name	Conservation status		Likelihood of Occurrence
		EPBC Act	TSC Act	
Rostratula australis	Australian Painted Snipe	E	E	Possible
Botaurus poiciloptilus	Australasian Bittern	E	E	Possible
Stictonetta naevosa	Freckled Duck		V	Possible

Conservation status: V = Vulnerable, E = Endangered, CE = Critically Endangered

One threatened fauna species listed under the EPBC Act was recorded at the airport site during the field surveys. This species, the Grey-headed Flying-fox, is listed as vulnerable under the EPBC Act and under the TSC Act. The Grey-headed Flying-fox was also recorded at the airport site during previous surveys for the 1997–99 EIS (PPK 1997). While there are no camps located at the airport site, there are seven known colonies within 20 kilometres of the site.

All native woodland and forest at the airport site provides foraging habitat for the Grey-headed Flying-fox. Dominant canopy species include Forest Red Gum, Grey Box and Broad-leaved Ironbark. Forest Red Gum and Grey Box are recognised as 'significant species' in the blossom diet of the Grey-headed Flying-fox (Eby and Law 2008); however, none of these species are highly productive flowering species. Forest Red Gum scores in the upper quartile of all diet plants for the region for productivity and reliability of flowering. This species flowers in late winter and spring, partly during the 'food bottleneck'. Grey Box has low productivity and reliability, flowering in late summer and early autumn. Broad-leaved Ironbark has high productivity but is an unreliable flowerer (Eby and Law 2008). This species flowers in summer and early autumn, providing foraging habitat during the breeding period.

Habitat at the airport site is thus somewhat productive during food bottlenecks, and may be habitat critical to the survival of the species, as defined in the draft recovery plan for the Grey-headed Flying-fox (DECCW 2009a). The draft recovery plan also notes that it is not possible to predict what localities would be productive in which months and, therefore, which localities would provide essential habitat for the species. All foraging habitat has the potential to be productive during general food shortages and to therefore provide a resource critical to survival (DECCW 2009a).

Three other threatened fauna species listed under the EPBC Act may occur at the airport site, although they were not detected during the field surveys:

- Swift Parrot (*Lathamus discolour*). The Swift Parrot is listed as critically endangered under the EPBC Act and endangered under the TSC Act. This species may occur at the airport site on occasion during its winter migration. Although the airport site does not provide core winter foraging resources for this species, it may provide shelter or supplementary foraging resources for migrating individuals.
- Australasian Bittern (*Botaurus poiciloptilus*). The Australasian Bittern is listed as endangered under the EPBC Act and the TSC Act. Farm dams and creeks at the airport site may provide potential foraging and breeding habitat for this species.
- Australian Painted Snipe (*Rostratula australis*). The Australian Painted Snipe is listed as endangered under the EPBC Act and the TSC Act. Wetlands and nearby flooded grasslands at the airport site may provide potential foraging and breeding habitat for this species.

Eight threatened fauna species listed under the TSC Act were recorded at the airport site during the field surveys:

- Cumberland Plain Land Snail (*Meridolum corneovirens*). The Cumberland Plain Land Snail is listed as endangered under the TSC Act. Habitat for the Cumberland Plain Land Snail occurs in larger patches with remnant trees. Live snails and shells of this species were recorded in a variety of locations where moist, deep leaf litter was present. In general, this species was recorded in locations where it had previously been recorded for the 1997–99 EIS (PPK 1997), as well as some additional locations. In some locations, including some where the species had previously been recorded, appropriate potential habitat with good leaf litter was present but no individuals were found. This may have been as a result of individuals burrowing deep into the soil and not being found, or previous local extinction of a population. Where leaf litter was shallow, woodland patches were small and no remnant trees were present, this species was not detected. It is likely the species has not been able to recolonise due to distances between patches in regrowth woodland areas.
- Little Eagle (*Hieratus morphnoides*). The Little Eagle is listed as vulnerable under the TSC Act. The Little Eagle was observed on a number of occasions flying above open grassland at the airport site. The Little Eagle would prey upon small to medium-sized mammals such as rodents and rabbits that occur in grassland habitats at the airport site. It is likely that the airport site is part of the home range of a number of breeding pairs. The species may use tall trees to nest in, although no raptor nests were observed during the field surveys.
- Little Lorikeet (*Glossopsitta pusilla*). The Little Lorikeet is listed as vulnerable under the TSC Act. A pair of Little Lorikeets was observed flying over the western portion of the airport site. This species is likely to forage throughout the airport site when eucalypts are in flower. While hollow-bearing trees are present in some locations, the species is unlikely to breed at the airport site given the level of fragmentation.
- Scarlet Robin (*Petroica boodang*). The Scarlet Robin is listed as vulnerable under the TSC Act. On individual Scarlet Robin was recorded forgaing in River-flat Eucalypt Forest near Badgerys Creek. The species may also occur in larger patches of Cumberland Plane Woodland. It may breed and forage in larger woodland patches in the airport site, but tends to breed in woodland on foothills and ridges, moving to lower more open habitats in winter'.
- Varied Sittella (*Daphoenositta chrysoptera*). The Varied Sittella is listed as vulnerable under the TSC Act. About three or so individuals were recorded foraging in River-flat Eucalypt Forest near Badgerys Creek, and may also occur in larger patches of Cumberland Plain Woodland. This species is likely to breed and forage in larger woodland patches at the airport site.
- Black Bittern (*Ixobrychus flavicollis*). The Black Bittern is listed as vulnerable under the TSC Act. One individual was observed in the northern section of Badgerys Creek. This species may breed and forage in the riparian corridor and at dams with good cover at the airport site.
- Blue-billed Duck (*Oxyura australis*). The Blue-billed Duck is listed as vulnerable under the TSC Act. Three individuals were observed on the large, deep constructed dam on Taylors Road. This species only rarely occurs east of the Great Dividing Range, occurring as vagrants generally during times of drought. This species is unlikely to rely on habitats present at the airport site.

- East Coast Freetail-bat (*Mormopterus norfolkensis*). The East Coast Freetail-bat is listed as vulnerable under the TSC Act. This species was recorded at many locations at the airport site, and was often the most common bat species recorded. This species may roost and breed in hollow-bearing trees at the airport site and would forage in woodland and open areas at the airport site.

Two additional threatened bat species listed under the TSC Act were recorded at the airport site during the surveys for the 1997–99 EIS (PPK 1997). These species were also possibly recorded at the airport site during the recent field surveys based on echolocation call analysis (though poor data quality and/or interspecific call similarities precluded the definitive identification of these species). These species are:

- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*). The Eastern False Pipistrelle is listed as vulnerable under the TSC Act. Possible calls of the species were recorded during the recent field surveys. This species prefers large tracts of vegetation, and would mainly occur along the Badgerys Creek riparian corridor and nearby large patches of vegetation; and
- Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*). The Eastern Bentwing Bat is listed as vulnerable under the TSC Act. Possible calls of the species were recorded during the recent field surveys. No breeding habitat for this species is present at the airport site, although it may roost under bridges and in buildings. This species forages in cleared and wooded areas, and could forage throughout the airport site.

Three threatened bat species were also possibly recorded at the airport site during the recent field surveys based on echolocation call analysis. These species are:

- Large-footed Myotis (*Myotis macropus*) listed as vulnerable under the TSC Act;
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) listed as vulnerable under the TSC Act; and
- Eastern Cave Bat (*Vespadelus troughtoni*), listed as vulnerable under the TSC Act.

A number of other threatened fauna species listed under the TSC Act are likely to occur at the airport site, based on a combination of recent records in the locality and the presence of suitable habitat (see Table 16–7). The airport site contains extensive areas of habitat in moderate to good condition for each of these species and is likely to support viable local populations or would provide foraging habitat for transient species.

A number of threatened fauna species are considered to have a low likelihood of occurrence at the airport site and are, therefore, unlikely to be significantly affected by the airport. These include:

- Large-eared Pied Bat (*Chalinolobus dwyeri*). The Large-eared Pied Bat is listed as vulnerable under the EPBC Act and the TSC Act. It appears to roost predominantly in caves and overhangs in sandstone cliffs and forages in nearby high-fertility forest or woodland near watercourses. It is unlikely that Large-eared Pied Bat occurs at the airport site more than occasionally. The species has not been recorded at the airport site, nor does the site host suitable habitat such as sandstone cliffs or significant patches of remnant vegetation. The Large-eared Pied Bat has been recorded at bents Basin Estate south-west of the airport site, while large expanses of suitable habitat are present west of the airport site in the Blue Mountains National Park. However, these areas are separated from the airport site by extensive urban and agricultural development;
- Green and Golden Bell Frog (*Litoria aurea*). The Green and Golden Bell Frog is listed as vulnerable under the EPBC Act and endangered under the TSC Act. No Green and Golden Bell Frogs were recorded during the recent, targeted searches, despite the presence of suitable habitat at the airport site. Similarly, none were recorded during the surveys conducted for the 1997–99 EIS (PPK 1997) and there are no other previous records of this species at the airport site (OEH 2015a). Numerous farm dams are present at the airport site and many of these appear to provide good quality potential habitat. Surrounding grassland would also provide good basking sites for frogs (if present). Mosquitofish (*Gambusia holbrooki*) were observed at many of the dams, potentially reducing the habitat quality for this species;

  Large numbers of other species of frogs were recorded during the recent field surveys at the airport site, showing that frogs in general were active at this time and suggesting that if Green and Golden Bell Frogs were present, they would have been recorded. It is likely that the Green and Golden Bell Frog does not occur at the airport site. According to Lemckert (1999) this is a typical situation for this species, as it appears to have become extinct through most of its range, despite the presence of apparently suitable habitat. Many populations in Western Sydney have become extinct over recent decades. According to White and Pyke (2008), the populations at Liverpool, Merrylands, Milperra, and Mount Druitt, also in Western Sydney, are extinct or probably extinct;
- The Giant Burrowing Frog (*Heleioporus australiacus*), listed as vulnerable under the EPBC Act and the TSC Act, was identified in the assessment process notice following determination of the airport as a controlled action as potentially being significantly affected by the proposed airport (DoE 2015c). This species has a strong habitat association with sandstone geology, especially the Hawkesbury Sandstone plateaus surrounding Sydney where it occurs on sandy soils supporting heath, woodland or open forest. It does not occur on the shale and alluvium substrates of the Cumberland Plain and would not occur at the airport site;
- Spotted-tail Quoll (*Dasyurus maculatus*) is listed as endangered under the EPBC Act and vulnerable under the TSC Act. There are no records of Spotted-tail Quoll at the airport site and very few records on the Cumberland Plain. No evidence of the species was found during field surveys at the airport site. The species tends to occupy wet forest habitats that are not present near the airport site. As such, it is considered unlikely to occur; and

- The Koala (*Phascolarctos cinereus*) is listed as vulnerable under the EPBC Act and the TSC Act. There are few records of the species in the locality. It has been recorded to the west in the Blue Mountains National Park, and to the east in the Western Sydney Parklands, however there is minimal connectivity between these areas and the airport site. Koalas were not observed at the airport site, and no scats were recorded during the recent, targeted searches for the species. Potential habitat at the airport site does not constitute 'habitat critical to the survival of the species', as defined in the referral guidelines (DoE 2014c).

16.3.3.5 Migratory species

Seven migratory bird species listed under the EPBC Act have been recorded or are predicted to occur at the airport site or within the locality and may be affected by the proposed airport. These species are described in Appendix K1 (Volume 4) and are listed in Table 16–8. Their distribution at the airport site is shown on Figure 16–3.

Table 16–8 Migratory species known or likely occur at the airport site

Scientific name	Common name	Conservation status		Likelihood of occurrence
		TSC Act	EPBC Act	
Apus pacificus	Fork-tailed Swift	-	M,C,J,K	Likely
Ardea alba	Great Egret	-	M,C,J	Present
Ardea ibis	Cattle Egret	-	M,C,J	Present
Gallinago hardwickii	Latham's Snipe	-	M,C,J,K	Present
Hirundapus caudacutus	White-throated Needletail	-	M,C,J,K	Present
Merops ornatus	Rainbow Bee-eater	-	M,J	Present
Rhipidura rufifrons	Rufous fantail	-	-	Present

Conservation status: M = Migratory; C = China-Australia Migratory Bird Agreement (CAMBA), J = Japan-Australian Migratory Bird Agreement (JAMBA) and K = Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)

Six migratory of the migratory bird species listed in Table 16–8 were recorded at the airport site during the field surveys for the EIS. Cattle Egrets (*Ardea ibis*) were observed at a number of locations in paddocks and near dams, and on several occasions flocks of about 30 individuals were recorded. Occasional individual Great Egrets (*Ardea alba*) were observed at dams and one Latham's Snipe (*Gallinago hardwickii*) was disturbed from exotic grassland adjacent to a dam.

A flock of White-throated Needletails (*Hirundapus caudacudatus*) was also recorded foraging high above the airport site. The Rainbow Bee-eater (*Merops ornatus*) was heard on a number of occasions in patchy woodland remnants in the vicinity of Badgerys Creek. The Rufous Fantail (*Rhipidura rufifrons*) was observed foraging in grassy woodland at a number of locations across the airport site. Fork-tailed swift, while not recorded in the surveys, was considered likely to occur.

In addition to the seven migratory bird species identified in Table 16–8, a flock of shorebirds was observed during the field surveys. While these were not able to be identified, they were likely to be a type of sandpiper. Potential species include the Marsh Sandpiper (*Tringa stagnatilis*) and the Sharp-tailed Sandpiper (*Calidris acuminata*), which are known to occur on farm dams or the Common Greenshank (*Tringa nebularia*), previously recorded in the locality.

The EPBC Act lists families of birds (such as ducks, waders, eagles and hawks) that are also known to be migratory but are not listed under international agreements. A range of such waterfowl and waders have been recorded at the airport site. Other seasonally migratory or nomadic species would also be likely to occasionally use habitats at the airport site.

The airport site is not considered important habitat for any of these migratory species, according to the relevant significant impact criteria. The airport site would not support an ecologically significant proportion of the population of migratory species, is not of critical importance to these species at particular life-cycle stages, is not at the limit of these species ranges, and is not within an area where these species are declining (DEWHA 2009).

16.3.4 Aquatic flora, fauna and habitat

16.3.4.1 Aquatic flora

Thirteen aquatic plant species were recorded within the waterbodies (wetlands and creeks) sampled at the airport site and in the locality. This included 10 native species and three exotic species (two of which are declared noxious weeds – Salvinia (*Salvinia molesta*) and Water Hyacinth (*Eichhornia crassipes*)). The list of aquatic plant species recorded within waterbodies at the airport site is provided in Appendix K1 (Volume 4). Where exotic or declared noxious weed species were found, they tended to dominate the waterbody.

16.3.4.2 Aquatic fauna

Eight fish species were recorded within the waterbodies sampled at the airport site and in the locality. Native species included Long Finned Eel (*Anguilla reinhardtii*), Australian Smelt (*Retropinna semoni*), Firetail Gudgeon (*Hypseleotris galii*), Western Carp Gudgeon,(*Hypseleotris klunzingerii*) and other unidentified Gudgeon species. Of the native fish species collected, the Firetail Gudgeon (*Hypseleotris galii*) was the most widespread. Exotic species were present at almost all survey sites and accounted for the majority of the species sampled. These included Eastern Gambusia (*Gambusia holbrooki*), Common Carp (*Cyprinus carpio*) and Goldfish (*Carassius auratus*). Eastern Gambusia and Common Carp are both listed as noxious fish under the FM Act. The presence and overwhelming abundance of exotic fish species recorded during the field surveys indicates that aquatic habitat at the airport site and in the locality is highly modified and degraded.

A total of 1,075 individual macroinvertebrates from 15 taxonomic groups were identified within the waterbodies sampled at the airport site and in the locality. The macroinvertebrate communities were dominated by Dipterans (true flies) (31 per cent), Acarina (water mites) (25 per cent) and Odonata (dragonflies) (10 per cent). The taxonomic groups recorded during the field surveys were generally made up of groups that have a high tolerance to moderate to severe pollution.

All survey sites had very low SIGNAL 2 scores (ranging from 1.31 to 3.75). These scores indicate that waterbodies at the airport site and in the locality have been subject to or are consistently exposed to severe pollution.

The survey sites had AUSRIVAS classifications indicating the waterbody is significantly to extremely impaired and highly degraded with very low water quality and habitat quality.

No threatened fish species listed under the EPBC Act and/or the FM Act identified in the database searches as potentially occurring in the locality were collected during the surveys. No suitable habitat for these species was observed during the site visits, which is in agreement with the findings of the SMEC study (2014).

16.3.4.3 Aquatic habitat

As discussed above, the presence and abundance of exotic fish species and the variety of macroinvertebrates recorded during the field surveys indicates that aquatic habitat at the airport site and in the locality is severely modified and degraded.

The results from of the fish habitat assessment indicates that 22 per cent of sites are classified as Class 2 (moderate habitat), 71 per cent of sites are classified as Class 3 (minimal fish habitat), and seven per cent as Class 4 (unlikely habitat) (DPI 2013). The majority of the survey sites were intermittent in nature with some indication of semi-permanent pools existing throughout the reaches surveyed, which may provide refuge during periods of stress for some fish species. The intermittent nature of these systems also suggests that they are unlikely to be suitable habitat for the listed threatened species recorded in the database search.

The results of the water quality assessment also indicate that aquatic habitats at the airport site and in the locality are affected by poor water quality. Electrical conductivity was high at all survey sites (factors that contributed to this could include the influence of local geology, groundwater input during periods of low flow, salinity issues due to agricultural practices, or a combination of these factors). Dissolved oxygen levels were generally low, likely due to a combination of low flow conditions and nutrient enrichment. Alkalinity levels indicated moderate to very hard waters. Survey sites with high alkalinity were also those with elevated electrical conductivity, so some of the high electrical conductivity at those sites relates to elevated calcium and carbonate ion levels.

High levels of zinc, nickel and copper were recorded at the survey sites. While these metals occur naturally, high levels of each can indicate specific catchment-related impacts such as industry, fertilisers and runoff from roads. Total nitrogen and total phosphorous concentrations were high at all survey sites, consistent with the agricultural land use at the airport site and in the locality.

16.3.4.4 Threatened species, populations and ecological communities

No threatened aquatic flora or fauna species, populations or ecological communities listed under the EPBC Act or the FM Act were recorded at the airport site or in adjoining downstream areas and none are likely to occur given known distributions and the absence of suitable habitat.

16.3.5 Additional matters of national environmental significance

There are several matters of national environmental significance (MNES) that are protected under the EPBC Act. Among these are threatened species, populations and ecological communities plus migratory species protected under international agreements (addressed in Section 16.3.2, Section 16.3.3 and Section 16.3.4). Other MNES include world heritage areas.

The Greater Blue Mountains World Heritage Area is located approximately eight kilometres to the west of the airport site and is separated from the airport site by extensive areas of residential and agricultural land, fragmented patches of native vegetation, roads and the Nepean River.

The Greater Blue Mountains World Heritage Area consists of approximately 1.03 million hectares of sandstone plateaus, escarpments and gorges dominated by temperate eucalypt forest. The area is noted for its diversity of eucalypts, which are associated with its wide range of habitats as well as significant numbers of rare or threatened species, including endemic and evolutionary relict species. A significant proportion of the Australian continent's biodiversity occurs in the area (UNESCO 2015). The Greater Blue Mountains World Heritage Area protects a large number of pristine and relatively undisturbed catchment areas, some of which make a substantial contribution to maintaining high water quality in a series of water storage reservoirs supplying Sydney and adjacent rural areas (DECC 2009c). The Greater Blue Mountains Area is listed as a declared World Heritage property and a National Heritage place under the EPBC Act.

There are no other MNES (for example wetlands of international importance, marine areas, nuclear actions, etc.) at the airport site or in the locality.

16.4 Assessment of impacts during construction

This section presents the anticipated impacts of the Stage 1 development on terrestrial and aquatic flora and fauna at the airport site and in the locality during construction. Construction of the Stage 1 development would result in both direct and indirect impacts on terrestrial and aquatic flora and fauna. Mitigation measures to avoid or reduce these impacts are discussed in Section 16.7.

16.4.1 Direct impacts

Direct impacts on terrestrial and aquatic flora and fauna during construction of the Stage 1 development include the removal of vegetation and the loss of terrestrial, wetland and aquatic fauna habitat.

16.4.1.1 Removal of vegetation

Construction of the Stage 1 development would result in the removal of approximately 1,153.8 hectares of vegetation. The majority of this vegetation consists of exotic grassland and cleared land or cropland, dominated by exotic species and noxious and environmental weeds. Vegetation removal by vegetation zone is summarised in Table 16–9.

Approximately 835.3 hectares of exotic grassland and cleared land or cropland would be removed. These vegetation zones contain little native vegetation cover and have limited habitat value for native plants. Vegetation clearing in these areas would remove a small number of non-threatened native plants, and noxious and environmental weeds.

Approximately 318.5 hectares of native vegetation would be removed, comprising around 169.9 hectares of good condition native vegetation (occurring in small, fragmented patches with moderate weed infestation) and a further 148.6 hectares of poor condition native vegetation (occurring as derived native grassland or scrub with moderate to severe weed infestation).

As discussed in Section 16.3.2, native vegetation at the airport site constitutes a local occurrence of Cumberland Plain Woodland, patches of which are commensurate with the EPBC Act listed form of this threatened ecological community. Native vegetation at the airport site also constitutes a number of threatened ecological communities listed under the TSC Act. Populations of threatened plants listed under the EPBC Act and/or TSC Act also occur at the airport site. The impacts of vegetation removal on threatened species, populations and ecological communities are discussed in Section 16.6.

Vegetation clearance would include the loss of woodland and forest vegetation that contains an overstorey of mature trees (approximately 141.8 hectares). Mature trees have particular value within plant populations because they take longer to replace and are sources of pollen and seed. There are moderate areas of these vegetation types and plant species in the locality, including around 12,569 hectares of similar woodland and forest on shale or alluvial substrates within a 10 kilometre radius of the airport site. Around 56.8 hectares of native vegetation would also be retained in the environmental conservation zone at the airport site, as shown in the revised draft Airport Plan.

These zones contain representative areas of each of the vegetation types at the airport site and would support many of the plant species in the construction impact zone. The environmental conservation zone is located around Badgerys Creek along the southern perimeter of the airport site, around Oaky Creek along the north-western perimeter of the airport site and along the south-western part of the airport site. These would help maintain vegetation connectivity and allow pollination, seed fall and other ecological processes that are necessary to maintain plant populations. Flora populations are also likely to persist within adjoining areas of alternative habitat beyond the airport site.

Plant species with a limited distribution in the locality would be most affected by the removal of vegetation. Notably, the population of *Marsdenia viridiflora* subsp. *viridflora* at the airport site would be removed, which would comprise a significant impact at the local scale (see Section 16.6).

The removal of native vegetation at the airport site is less significant at the regional scale and is unlikely to threaten the persistence of any populations of native plants or vegetation communities. It is unlikely that an ecologically significant proportion of any regional plant population would be located entirely within the airport site. At the regional scale, flora populations would persist in habitat that is conserved in Kemps Creek Nature Reserve, Mulgoa Nature Reserve, existing and proposed BioBank sites at Mulgoa and in the Ropes and South Creek riparian corridors, the Western Sydney Parklands and other offset sites linked to the North and South West Growth Centres. Notably, there is a parcel of land with shale/gravel transition habitat located at Kemps Creek around three kilometres to the east of the airport site that will be set aside as an offset for the South West Growth Centres. This site contains local populations of *Pultenaea parviflora* and other threatened plant species that may be affected by the construction of the Stage 1 development.

Table 16–9 Estimated vegetation removal by vegetation zone (Stage 1 development)

Vegetation zone	Conservation status		Direct impact (hectares)
	EPBC Act	TSC Act	
Native vegetation zones			
Good condition Grey Box – Forest Red Gum grassy woodland on flats (HN528)	CEEC	CEEC	79.8
Poor condition Grey Box – Forest Red Gum grassy woodland on flats (HN528)		CEEC	112.5
Good condition Grey Box – Forest Red Gum grassy woodland on hills (HN529)	CEEC	CEEC	22.9
Poor condition Grey Box – Forest Red Gum grassy woodland on hills (HN529)		CEEC	27.6
Good condition Forest Red Gum – Rough-barked Apple grassy woodland (HN526)		EEC	34.2
Poor condition Forest Red Gum – Rough-barked Apple grassy woodland (HN526)		EEC	7.9
Good condition Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy open forest (HN512)	CEEC	EEC	4.4
Poor condition Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy open forest (HN512)		EEC	0.6
Good condition artificial freshwater wetland on floodplain (HN630)			28.6
Total removal native vegetation			318.5
Non-native vegetation zones			
Exotic grassland			663.2
Cleared land or cropland			172.1
Total removal non-native vegetation			835.3
Total vegetation removal			1,153.8

Conservation status: CEEC = Critically endangered ecological community, EEC = Endangered ecological community.

16.4.1.2 Loss of terrestrial and wetland fauna habitat

The airport site provides habitat for a range of fauna groups including species of macropods, flying-foxes and bats, a wide variety of birds, reptiles (including goannas, snakes and lizards), frogs and small fish. The removal of vegetation at the airport site would result in the loss of fauna foraging, breeding, roosting, sheltering and/or dispersal habitat. The loss of terrestrial and wetland fauna habitat is summarised in Table 16–10 and is shown on Figure 16–3. The impacts of vegetation removal on threatened and migratory fauna habitat are discussed in Section 16.6.

Fauna species that would be most affected during construction of the Stage 1 development include those that occur in grassland areas, artificial wetlands (in the form of farm dams) and those that can use fragmented patches of woodland vegetation, as the airport site does not provide habitat for species that need extensive patches of vegetation. Exotic grassland and cleared land or cropland provides only limited habitat values for fauna. The loss of these areas would remove foraging, breeding and shelter habitat for small grassland animals such as skinks, and would potentially result in the loss of local populations of these species. The loss of this habitat would also remove foraging habitat for macropods, open-country microchiropteran bats, and bird species such as the Australian Magpie (*Gymnorhina tibicen*), Australian Raven (*Corvus coronoides*), Magpie-lark (*Grallina cyanoleuca*), Straw-necked Ibis (*Threskiornis spinicollis*) and Cattle Egret (*Ardea ibis*), in particular.

Artificial wetlands, minor drainage lines and associated damp soaks would be removed. This would potentially result in the loss of local populations of frog species and the loss of habitat for waterbirds and microchiropteran bat species. Construction would also require the removal of woodland and riparian forest habitat. Clearing this vegetation would permanently remove foraging and breeding resources for native fauna, including birds and arboreal mammal species including bats.

Construction of the Stage 1 development would result in the loss of about 50 hollow-bearing trees, which occur as scattered trees across the airport site. The loss of hollow-bearing trees at the airport site would result in a loss of roosting and nesting habitat for birds and arboreal mammals such as possums and bats.

Shrub layers and leaf litter would also be removed during construction of the Stage 1 development. This would result in the loss of habitat for small woodland birds that rely on these resources for foraging and breeding. In addition, the loss of leaf litter would remove habitat for small reptiles and invertebrates that rely on this feature for shelter, breeding and foraging.

Table 16–10 Estimated loss of terrestrial and wetland fauna habitat (Stage 1 development)

Habitat type	Area in Stage 1 construction impact zone (hectares)	Estimated extent in the locality (hectares)[1]	Percentage of the estimated extent in the locality
Woodland	107.6	10,014	1.08%
Riparian forest	34.2	2,555	1.34%
Sandstone woodland, forest and scrub	-	4,825	-
Total woodland and forest	141.8	17,393	0.82%
Artificial wetlands (farm dams)[2]	28.6	-	-
Grassland[2]	811.2	-	-
Cleared land and cropland	172.1	-	-

Notes:
1. Based on mapping within the airport site and on a composite of Tozer et al. (2010) and NPWS (2002) mapping in the locality.
2. Wetland and grassland vegetation has not been mapped by Tozer et al. (2010) or NPWS (2002).

16.4.1.3 Loss of aquatic fauna habitat

Construction of the Stage 1 development would involve the infilling of stream reaches, including the upper reaches of Oaky Creek and smaller drainage lines that feed into Badgerys, Cosgroves and Duncans creeks within the construction impact zone, and the permanent loss of riparian and aquatic habitats associated with these features. All of the affected reaches are small and largely intermittent. All are highly modified and in poor condition as a result of historical and current land use and disturbance. Water quality is poor and the macroinvertebrate and fish communities are dominated by species indicative of disturbed habitats. Fish habitat is moderate or minimal at most sites and the habitats present are not suitable for threatened fish or invertebrate species (dragonflies) known or predicted to occur in the locality.

Badgerys Creek, which comprises the largest watercourse at the airport site, would be retained within an environmental conservation zone, as outlined in the revised draft Airport Plan.

A large number of artificial wetlands (farm dams) would be removed. In total, approximately 28.6 hectares of artificial wetland habitat would be removed. These provide only limited habitat for native fish species, with most dams dominated by the exotic Eastern Gambusia. Farm dams are not key fish habitat and do not provide habitat for threatened species listed under the EPBC Act or the FM Act.

It is noted that around 2.1 hectares of vegetation in the proposed environmental conservation zone would require clearing for the establishment of detention basins outlets. Vegetation in these areas would be allowed to naturally regenerate and be protected in the environmental conservation zone but have nonetheless been included in the construction impact calculations.

16.4.2 Indirect impacts

Construction of the Stage 1 development may result in indirect impacts such as habitat fragmentation; fauna displacement, injury or mortality; edge effects; altered hydrology; erosion, increased sedimentation and contamination; dust; increased light, noise and vibration; the spread of pests and pathogens; and an increased incidence of fire at the airport site. These impacts are discussed below.

16.4.2.1 Habitat fragmentation

Habitat fragmentation would increase at the airport site and in the locality as a result of the proposed airport. Habitat fragmentation can result in reduced dispersal and reproductive success of biota, a decline in populations resulting from increased predation by introduced species or native species that do not normally occur in the community, and an increased probability that stochastic events (for example, fire) may reduce some population numbers below critical levels required for their survival at the airport site. Past land use, including clearing for agriculture, rural-residential buildings and linear infrastructure such as transmission lines and roads, has resulted in a highly fragmented rural landscape at the airport site. This fragmentation has created barriers for some fauna species, particularly those that have limited dispersal capability and habitat preferences.

More mobile species such as birds and bats can readily traverse the landscape, which is reflected in the variety of fauna species recorded in field surveys. The proposed environmental conservation zone would retain woodland along Badgerys Creek, Oaky Creek and Duncans Creek riparian corridors and would assist in maintaining vegetated fauna movement corridors and habitat stepping stones around the airport site.

16.4.2.2 Fauna displacement, injury or mortality

The removal of vegetation has potential to result in fauna displacement, injury or mortality. This would be particularly the case for less mobile species such as invertebrates (snails), amphibians, small reptiles and terrestrial mammals. More mobile species such as birds, macropods and larger terrestrial mammals would be able to avoid vegetation removal and other construction activities, seeking refuge in nearby alternative habitat outside the airport site. Fauna displacement to nearby habitat may result in increased competition for resources with existing resident fauna. Breeding success may also be disrupted for one or more seasons. There would be mortality of aquatic fauna (including fish, eels, turtles and frogs) associated with the infilling of streams and artificial wetlands (farm dams).

16.4.2.3 Edge effects

'Edge effects' refer to factors including weed invasion, increased noise and light, and erosion and sedimentation at the interface of intact vegetation and cleared areas. Edge effects may result in impacts such as changes to plant community type and structure, increased growth of exotic plants, increased predation of native fauna or avoidance of habitat by native fauna. Construction activities could result in the dispersal of weed propagules into areas of native vegetation through vegetation clearing, erosion and from the movement of workers and vehicles. The effects of erosion and sedimentation and increased light and noise are discussed below.

Given the fragmented nature of habitat in the locality and the extent of exotic plant cover, construction activities would have a minor effect on the extent and seriousness of edge effects in the locality and would be unlikely to introduce any new weed species or increase the prevalence of weed infestations.

16.4.2.4 Altered surface water hydrology

The existing landform and hydrology within the construction impact zone would be altered at the airport site. These alterations have the potential to affect the hydrological regime downstream of the airport site, impacting aquatic and riparian communities.

The water management system included in the Stage 1 development would include a series of detention basins on the periphery of the airport site to retain stormwater runoff prior to discharge into nearby creeks. The detention basins provide controlled release to the receiving waters in a way that mimics the natural flows as closely as possible over a range of storm durations and magnitudes. The airport site comprises approximately 4 per cent of the total catchment area for South Creek and any minor alteration to the hydrological regime is anticipated to have negligible influence on downstream flows in the catchment. The airport site also comprises about 9 per cent of the catchment area for Duncans Creek (draining to Nepean River) and is predicted to have negligible influence on downstream flows in that catchment.

16.4.2.5 Altered groundwater

There is a potential for a minor reduction in groundwater recharge associated with the increase in paved surfaces with the establishment of the Stage 1 development. Overall, minimal change to local groundwater recharge would be expected, as the existing shale derived clay soils have low permeability and the majority of rainfall is therefore released as stormwater runoff rather than infiltrating to groundwater. It is not expected that a reduction in recharge would affect any sensitive ecological receptors or beneficial uses of the groundwater system.

Groundwater drawdown is also expected during construction as a result of reprofiling the airport site and deeper excavations for the establishment of basements in the terminal complex. The re-profiling would result in a lowering of groundwater elevations in areas that currently have higher topographical elevation, and is expected to result in reduced groundwater flow rates and hence reduced discharge to surrounding surface features. The re-profiling would not result in dewatering of the groundwater system below the level of the surrounding creeks and there would be no potential for drying up of the creeks from this activity.

Groundwater drawdown and reduced groundwater infiltration are expected to be limited due to the generally low hydraulic conductivity of the soils and geology at the airport site. Although several vegetation communities in or around the airport site are likely to have some level of groundwater dependence, potential impacts would be limited by this low hydraulic conductivity.

Particularly sensitive vegetation in the riparian area of Duncans Creek, Oaky Creek and Badgerys Creek intersect alluvial deposits that have limited hydraulic connectivity with the shale aquifers and are not likely to be directly impacted by construction activities.

No creek waterways at the airport site are mapped as being reliant on the surface expression of groundwater, supported by historic water quality data that indicate groundwater expression as a very small proportion of surface water flow. Downstream impacts in terms of surface water and groundwater interaction would be mitigated through the operation of the water management system included in the Stage 1 development.

16.4.2.6 Erosion, sedimentation and contamination

As described in Section 16.3.4.3, existing water quality in the project area is poor with elevated nutrients, suspended sediments and salinity. Erosion, sedimentation and potential contamination may occur from activities such as vegetation removal, excavations and earthworks, and the accidental release of fuel, oil or other chemicals. This could result in further reduced habitat quality and the potential mortality of aquatic flora and fauna downstream of the airport site. The water management system included in the Stage 1 development would include a system of vegetated swales and bio-retention basins that would improve water quality prior to discharge under normal flow conditions.

16.4.2.7 Dust

Dust from vegetation removal, excavation and earthworks could reduce plant and animal health. Dust may affect photosynthesis, respiration and transpiration in plants, and allow the penetration of gaseous pollutants. This could then lead to decreased productivity and in the long term could alter community structure. Dust could also impact the health of fauna, such as through respiratory disease, and the reduction in health of animals could be exacerbated by changes to plant health and community structure.

16.4.2.8 Light, noise and vibration

An increase in light at the airport site from vehicles and machinery could affect nocturnal fauna, potentially disrupting movement and behaviour. Construction activities would also result in an increase in noise levels at the airport site, which may affect fauna species. Some fauna species would likely tolerate an increase in noise, while others may not, causing them to leave the affected area or making the area less desirable for foraging, nesting and breeding.

Vibration from construction activities, such as heavy vehicle movements, may deter native fauna from using the area near vibration sources. This may potentially interrupt dispersal within the locality if an individual is unwilling to travel through an area where vibration is detectable, or may cause some species to abandon an area in search of areas where vibration is not detectable.

16.4.2.9 Spread of pests and pathogens

There is the potential to introduce or spread pathogens such as Phytophthora (*Phytophthora cinnamomi*), Myrtle Rust (*Uredo rangelii*) and Chytrid fungus (*Batrachochytrium dendrobatidis*) into adjacent native vegetation through vegetation disturbance and increased visitation. Phytophthora and Myrtle Rust may result in the dieback or modification of native vegetation and damage to fauna habitats. Chytrid fungus affects both tadpoles and adult frogs and can cause mortality in some populations once introduced into an area.

16.4.2.10 Fire

There may be an increase in the incidence of fire at the airport site from the accidental ignition of combustible fuels. An increase of fire could result in the injury or mortality of flora and fauna at the airport site or locality.

16.5 Assessments of impact during operation

This section presents the anticipated impacts of the Stage 1 development on terrestrial and aquatic flora and fauna at the airport site and in the locality during operation. Similar to construction, operation of the Stage 1 development would result in both direct and indirect impacts on terrestrial and aquatic flora and fauna, as discussed below. Mitigation measures to avoid, reduce or minimise these impacts are discussed in Section 16.7.

16.5.1 Direct impacts

Direct impacts on terrestrial and aquatic flora and fauna during operation of the Stage 1 development include bird and bat strike and terrestrial fauna strike from aircraft and ground transportation vehicles.

16.5.1.1 Bird and bat strike

Operation of the Stage 1 development would create a risk of mortality for birds and bats at or near the airport site. It is noted that most bird and bat strikes occur during take-off and landing below 3,500 feet. As such, bird and bad strikes tend to involve birds occupying habitats close to airports rather than migratory species moving across the landscape at higher altitudes.

Birds are often attracted to airports because of the presence of grass, lights, water, feeding trees, or roosts, while bats (particularly flying-foxes) tend to come in contact with aircraft while transiting between roosting sites (camps) and foraging areas (Parsons et al. 2009). Features in and around the airport site with the potential to attract birds and bats include farm dams, nearby landfills and flying-fox camps. Seven flying-fox camps have been identified in the region of the airport (see Appendix I (Volume 4)).

A high diversity of bird species were recorded at the airport site, including many that occur in large flocks or that would fly at heights where aircraft strike is a risk. A small number of large raptors were observed at the airport site, including Wedge-tailed Eagles (*Aquila audax*), White-bellied Sea-eagles (*Haliaeetus leucogaster*), Little Eagles (*Hieraaetus morphnoides*), Black Kites (*Milvus migrans*) and Whistling Kites (*Haliastur sphenurus*). It is most likely that one or two pairs of each species occur at or near the airport site. Large flocks of ibis and herons occur at or in the vicinity of the airport site, due to the large number of farm dams and fertilised crop fields, as do a wide variety of ducks and other waterbirds. Few migratory wader species are likely to occur at or in the vicinity of the airport site, although at least two species were recorded. A wide range of other bird species is also likely to be at risk of aircraft strike, including magpies, swallows, ducks and ravens.

Although potentially moderate and high risk species were recorded during the field surveys, their numbers were not unusually large and there were limited transits through the air. The bird and bat strike risk assessment summarised in Chapter 14, and included as Appendix I (Volume 4), found that there would be a moderate risk of strike during operation. While birds are likely to be struck on occasion, management measures would minimise the risk of this occurring and, as such, the viability of populations in the local area is not likely to be threatened. This finding is supported by data from existing airports provided in the bird and bat strike risk assessment, which shows that strikes are too infrequent to affect the viability of bird and bat populations.

16.5.1.2 Ground vehicle strike

Movement of aircraft and ground support vehicles on the tarmac has the potential to result in the injury or mortality of fauna that reside or forage in cleared areas alongside the tarmac. These fauna species may attempt to cross the tarmac and be struck by aircraft and ground support vehicles. The final design of the proposed airport would consider deterrence measures such as fencing of the airport site, which would likely prevent large mammals such as kangaroos and wallabies entering the airport site, thus minimising the potential for impact.

There would be an increase in general traffic in the area surrounding the airport site that could result in an increased risk of fauna injury or mortality on surrounding roads. Vehicle strike on surrounding roads is already likely to be high, given the presence of vegetated and agricultural areas. As Western Sydney continues to grow and more areas of agricultural and forested land are removed, fauna mortality from vehicle strike would reduce.

16.5.2 Indirect impacts

Operation of the Stage 1 development may result in indirect impacts such as increased light, noise and vibration; an increased incidence of fire; contamination of aquatic habitats; decreased water quality and changes to the hydrology of waterbodies; and the introduction of exotic species. These impacts are discussed below.

16.5.2.1 Light, noise and vibration

Increased light associated with tarmac and terminal lighting and from aircraft and ground transportation vehicles could affect fauna species at the airport site and in the locality. Many fauna individuals and species that are currently resident at the airport site would already be accustomed to existing residential and road lighting. The increased light may, however, result in the displacement of less tolerant species, but could also attract some birds and bats that forage on insects attracted to light. These species may then be susceptible to aircraft strike in the absence of mitigation.

Aircraft and vehicle movements at the airport site would result in increased noise and vibration. Fauna most at risk would be those residing in close proximity to the airport site. Most fauna species are likely to become accustomed to increased noise and vibration, as many species that occur in the surrounding area are already accustomed to noise from roads and agricultural areas. Increased noise and vibration, however, may result in impacts to foraging and breeding behaviours and/or the displacement of less tolerant species.

16.5.2.2 Fire

There may be an increase in the incidence of fire at the airport site from the accidental ignition of combustible fuels or from aircraft incidents. An increase of fire could result in the injury or mortality of flora and fauna at the airport site or in the locality.

16.5.2.3 Contamination

Spills of fuel, oil or other chemicals such as pesticides and/or herbicides could reduce habitat quality and potentially harm or kill aquatic flora and fauna downstream of the airport site.

16.5.2.4 Hydrology and water quality

As described in Section 16.3.4.3, existing water quality in the project area is poor with elevated nutrients, suspended sediments and salinity. The operation of the Stage 1 development has the potential to affect water quality and hydrology at the airport site and downstream. The Stage 1 development includes a water management system that would capture and treat surface water runoff prior to release to the surrounding environment.

The water management system would be designed to avoid substantial alteration to the timing, duration, volume and velocity of flows leaving the airport site and at downstream locations. The operation of the water management system is unlikely to have a substantial impact on downstream hydrology or dependant ecological values. The water management system would also be designed to capture and treat runoff in order to reduce entrained pollutants prior to release to the surrounding environment.

Given the existing poor water quality downstream of the site and the design of the water management system, it is expected that the proposed airport would have no adverse impact on downstream water quality and aquatic health. As such, the airport is unlikely to have an adverse impact on downstream key fish habitat and other aquatic or riparian habitat, or on threatened species that may occur downstream of the airport site.

The performance of the water management system with regard to surface water hydrology and water quality is discussed in Chapter 18 and assessed in detail in Appendix L1 and Appendix L2 (Volume 4).

16.5.2.5 Groundwater dependent ecosystems

The impermeable surface of the Stage 1 development at the airport site would have the potential to reduce groundwater infiltration, leading to impacts on groundwater resources, groundwater dependant ecosystems and groundwater dependant waterways.

Groundwater drawdown and reduced groundwater infiltration are expected to be limited due to the generally low hydraulic conductivity of the soils and geology at the airport site. Although several vegetation communities in or around the airport site are likely to have some level of groundwater dependence, potential impacts would be limited.

Sensitive vegetation in the riparian area of Duncans Creek, Oaky Creek and Badgerys Creek intersect alluvial areas which have minimal potential to be impacted by the Stage 1 development.

No creek waterways at the airport site are mapped as being reliant on the surface expression of groundwater, supported by historic water quality data that indicate groundwater expression as a very small proportion of surface water flow. Downstream impacts in terms of surface water and groundwater interaction would be mitigated through the operation of the water management system included in the Stage 1 development.

The operation of the proposed airport would involve the use of a range of fuels and chemicals. These substances may be released to the environment in the event of a mishap during refuelling, maintenance or general storage and handling. Releases would be avoided with the implementation of Australian Standards for the storage and handling of hazardous materials. Remediation would be implemented as soon as practicable in the unlikely event of a significant leak or spill of contaminants.

16.5.2.6 Introduction of exotic species

As with any international airport, there is the potential for the introduction of exotic species as a result of the transport of goods on aircraft. Any escaped exotic species could potentially establish in nearby vegetated areas, or be unintentionally transported to other areas of native vegetation and impact the local native flora and fauna. These risks are managed through the biosecurity regulatory framework.

16.5.2.7 *Fuel jettisoning*

As discussed in Chapter 7 (Volume 1), fuel jettisoning is extremely rare worldwide and is a procedure used in certain emergency situations to reduce an aircraft's weight to allow it to land safely. Aircraft do not jettison fuel as a standard procedure when landing. Indeed, most aircraft are unable to jettison fuel. In Australian airspace, where there is mandatory reporting of fuel jettisoning events, there were 10 reported instances of civilian fuel jettisoning in 2014 from 698,856 domestic air traffic movements and 31,345 international movements. This equates to emergency fuel jettisoning occurring in approximately 0.001 per cent of all aircraft movements.

There are specific procedures in place, published by Airservices Australia, to regulate fuel jettisoning in Australia. For example, pilots must obtain authority from air traffic control before commencing a fuel jettison and must receive instruction on where the fuel jettison is to be performed. Fuel jettisons are required to occur in clear air at an altitude of above 6,000 feet (approximately 1.8 kilometres) and in an area nominated by air traffic control. Reasonable precautions must also be taken to ensure the safety of persons or property in the air and on the ground. Most of the fuel evaporates rapidly within the first few hundred metres as it falls.

The effects of fuel jettisoning on local air quality would be limited due to the rarity of such events, the inability of many aircraft to perform fuel jettisons, the rapid vaporisation and wide dispersion of jettisoned fuel and the strict regulations on fuel jettisoning altitudes and locations.

16.6 Assessments of significance

This section lists key threatening processes of relevance to the Stage 1 development and discusses impacts on MNES and on State-listed threatened species, populations and ecological communities from the construction and operation of the Stage 1 development. Impacts of the long term development are also discussed.

16.6.1 Key threatening processes

Key threatening processes threaten, or have the potential to threaten, the survival or evolutionary development of a species, population or ecological community. They are listed under the EPBC Act, TSC Act and/or FM Act. The key threatening processes of relevance to the Stage 1 development are listed in Table 16–11. Key threatening processes have been considered in the assessment of impacts and tests of significance for the listed species, populations and ecological communities potentially present at the airport site. Mitigation measures to limit the potential impacts are discussed in Section 16.7.

Table 16–11 Key threatening processes

Key threatening process	Status
EPBC Act key threatening processes	
Clearing of native vegetation	EPBC Act/TSC Act
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	EPBC Act/TSC Act
Novel biota and their impact on biodiversity	EPBC Act

Key threatening process	Status
Infection of native plants by *Phytophthora cinnamomi*	EPBC Act/TSC Act
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	EPBC Act/TSC Act
Aggressive exclusion of birds from potential woodland and forest habitat by over-abundant Noisy Miners (*Manorina melanocephala*)	EPBC Act/TSC Act
Predation by the European red fox	EPBC Act/TSC Act
Predation by feral cats	EPBC Act/TSC Act
Competition and land degradation by rabbits	EPBC Act/TSC Act
Human-caused climate change	EPBC Act/TSC Act
TSC Act and FM Act key threatening processes	
Clearing of hollow-bearing trees	TSC Act
Removal of dead wood and dead trees	TSC Act
Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act
Invasion of plant communities by perennial exotic grasses	TSC Act
Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners	TSC Act
Invasion of native plant communities by African Olive Olea *europaea subsp. cuspidata* (Wall. ex G. Don) Cif.	TSC Act
Invasion of the Yellow Crazy Ant *Anoplolepis gracilipes* (Fr. Smith) into NSW	TSC Act
Predation by the Plague Minnow (*Gambusia holbrooki*)	TSC Act
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	TSC Act/FM Act
The degradation of native riparian vegetation along NSW water courses	FM Act
The removal of large woody debris from NSW rivers and streams	FM Act

16.6.2 Impacts on matters of national environmental significance

Assessments of significance for MNES have been prepared in accordance with the *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* (DoE 2013a) and the *Significant Impact Guidelines 1.2 – Actions on, or Impacting upon, Commonwealth Land and Actions by Commonwealth Agencies* (DoE 2013b). The assessments of significance are included in Appendix K1 (Volume 4).

This assessment was based on the Stage 1 development but also considered cumulative impacts that would occur with the long term development.

A significant impact was determined for Cumberland Plain Woodland and the Grey-headed Flying-fox. Construction and operation of the proposed airport would also have a significant impact on other plants, animals and their habitat on Commonwealth land. The key findings of the assessments are summarised below.

16.6.2.1 Threatened flora species

One threatened flora species listed under the EPBC Act was recorded at the airport site during the field surveys – *Pultenaea parviflora*. An additional five species listed under the EPBC Act are considered likely to occur at the airport site: Downy Wattle (*Acacia pubescens*), White-flowered Wax Plant (*Cynanchum elegans*), Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*), Spiked Rice-flower (*Pimelea spicata*) and Austral Toadflax (*Thesium australe*) (see Table 16–6). Assessments of significance were prepared for these threatened flora species, the results of which are summarised below with further detail provided in Appendix K1 (Volume 4).

Pultenaea parviflora

Construction of the Stage 1 development would require the removal of four *Pultenaea parviflora* individuals which would be the entire known local population at the airport site. Construction of the airport would also require the removal of approximately 107.1 hectares of better quality potential habitat for the Stage 1 development and up to approximately 45.3 hectares of additional better quality potential habitat for the long term development. The *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* (DoE 2013a) include specific criteria for assessing impacts on a vulnerable species, which primarily relate to impacts on an important population.

The population of *Pultenaea parviflora* at the airport site is not an important population because:

- it is not identified in a recovery plan;
- it would not be important for breeding or dispersal as it includes only four plants and it is in a comparatively isolated and poor quality patch of habitat surrounded by extensive areas of cleared cropland or grazing country;
- it is not important for maintaining genetic diversity because it comprises only four plants that are in close proximity and as such would be unlikely to contain much genetic diversity. Further, this genetic material has already been retained via the Royal Botanic Gardens Trust sampling and propagation programme (RBGS 1992); and
- this population is near the limit of the species range as it is at the western extent of recognised outlier populations near Kemps Creek (OEH 2015b). The majority of the known population at Kemps Creek is associated with a parcel of land within tertiary gravel and shale/gravel transition habitat located around three kilometres to the east of the site (OEH 2015a). This land parcel is to be set aside as an offset for the South West Growth Centres. The population at the airport site would probably make a very minor contribution to the viability of this population.

Therefore, construction of the proposed airport would not result in any direct impacts on an important population of the species and would not substantially interfere with the recovery of *Pultenaea parviflora*. The proposed airport would not result in a significant impact on *Pultenaea parviflora*.

Other threatened flora species

Construction and operation of the airport would not affect any known populations of the endangered White-flowered Wax Plant or Spiked Rice-flower, nor would it affect the vulnerable species Downy Wattle, Small-flower Grevillea or Austral Toadflax. Despite targeted surveys for these species, there is no evidence that the airport site or any adjoining areas of vegetation contain populations of these threatened plants (PPK 1997; SMEC 2014; OEH 2015a). Any populations of these threatened plant species at the airport site are likely to have relatively low viability since they are not abundant or extensive enough to have been detected by surveys. The airport site is also extensively degraded and modified and there is limited potential for either recruitment or population expansion given the extent of habitat fragmentation.

Any local populations of these species (if present) would probably make a minor contribution to the maintenance or recovery of these species. Given these considerations, the proposed airport is unlikely to interfere with the recovery of any of these threatened plant species. The airport would not result in a significant impact on Downy Wattle, White-flowered Wax Plant, Small-flower Grevillea, Spiked Rice-flower or Austral Toadflax.

16.6.2.2 Threatened ecological communities

Cumberland Plain Woodland has been recorded at the airport site (see Section 16.3.2.6). As shown in Section 16.4.1.1, construction of the Stage 1 development would involve the removal of around 1,153.8 hectares of native vegetation including woodland of varying condition.

Assessment of this woodland found that 104.9 hectares of this vegetation would classify as the Cumberland Plain Woodland threatened ecological community under the EPBC Act.

An additional 46.4 hectares of vegetation cleared for construction of the long term development would also classify as this threatened ecological community.

In accordance with the relevant guidelines and listing advice, these totals exclude certain areas of vegetation based on a range of criteria. The criteria include requirements that the vegetation is in good condition and of sufficient patch size. The criteria are explained further in Appendix K1 (Volume 4).

The removal of the vegetation is considered to constitute a significant impact on the local and regional occurrence of the threatened ecological community. A biodiversity offset package has been prepared to compensate for this significant impact through the protection of other areas of Cumberland Plain Woodland in perpetuity. The offset package is discussed in Section 16.7.

16.6.2.3 Threatened fauna species

Threatened fauna species recorded site or otherwise considered to potentially occur at the airport site are discussed in Section 16.3.3.4. As discussed, the Grey-headed flying fox was recorded at the airport site while the Swift Parrot was considered likely to occur. As such, an assessment of significance has been undertaken for potential impacts to these species.

The Australasian Bittern and Australian Painted Snipe may occur at the airport site on a transient basis with only low quality potential habitat present at the airport site for these species. The construction and operation of the airport is highly unlikely to have a significant impact on these species and, as such, assessments of significance were not prepared for these species.

Grey-headed Flying-fox

The airport site may provide foraging habitat during food bottlenecks for the Grey-headed Flying-fox. Much of the foraging habitat in the locality would be of a similar nature and may comprise habitat critical to the survival of the species, as defined in the draft recovery plan for the Grey-headed Flying-fox (DECCW 2009). Construction of the Stage 1 development would require the removal of approximately 141.8 hectares of foraging habitat and 64.4 hectares of foraging habitat for the long term development. This amounts to a large area of foraging habitat in a fragmented rural landscape.

These areas of habitat contribute to the availability of foraging resources for local camps when resources are scarce and at critical life stages. In addition, development of the locality would likely follow as a result of the construction of the airport, resulting in additional clearing of foraging habitat for the species. Furthermore, individuals may be at risk of mortality from aircraft strike during operation, though this is unlikely to substantially impact the population as a whole. For these reasons, the airport may interfere with the recovery of the species and is likely to have a significant impact on the Grey-headed Flying-fox.

A biodiversity offset package has been prepared for the airport to compensate for these significant impacts (see Section 16.8). This would include the protection and management of Grey-headed Flying-fox habitat at offset sites in perpetuity. It is also noted that about 46.8 hectares of potential habitat for Grey-headed Flying-fox would be retained within the environmental conservation zone along Badgerys Creek.

Swift Parrot

Dominant canopy species at the airport site include Grey Box and Forest Red Gum, which may provide foraging resources for migrating Swift Parrots. However, much of the airport site is vegetated with relatively young regrowth, which is not the preferred foraging habitat of the species. A range of aggressive competitors such as the Noisy Miner (*Manorina melanocephala*) and the Bell Miner (*Manorina melanophrys*) are common at the airport site, potentially further reducing habitat suitability for the Swift Parrot. The construction of the airport would require the removal of approximately 141.8 hectares of highly fragmented, relatively low quality potential foraging habitat for the Stage 1 development and an additional 64.4 hectares of foraging habitat for the long term development. Approximately 46.8 hectares of potential habitat would be retained within the environmental conservation zone along Badgerys Creek. A total of about 17,393 hectares of potential foraging habitat (woody native vegetation) is mapped in the locality, although not all of this vegetation is likely to be suitable for the species. There is a low risk of aircraft strike for this species given the low numbers that may forage in the area, and lack of good quality foraging habitat in surrounding areas. The proposed airport is unlikely to result in a significant impact on the Swift Parrot.

16.6.2.4 Migratory species

Seven migratory species have been recorded or are predicted to occur at the airport site (see Table 16–8). The Stage 1 development would require the removal of approximately 28.6 hectares of artificial wetlands (farm dams) (habitat for the Great Egret, Cattle Egret, Latham's Snipe and White-bellied Sea-eagle), 141.8 hectares of woodland and forest vegetation (habitat for the Rufous Fantail and Rainbow Bee-eater), and 663.2 hectares of exotic grassland (habitat for the Cattle Egret). No habitat for the White-throated Needletail would be removed as this species forages in the air, well above the ground.

The long term development would require the removal of a further 6.3 hectares of artificial wetlands, 87.3 hectares of woodland and forest and 243.1 hectares of exotic grassland. While birds are likely to be struck by aircraft on occasion during operation, management measures would minimise the risk of this occurring and, as such, the viability of populations in the local area are not likely to be threatened.

The airport site is not considered important habitat for any of these species, according to the significant impact criteria for migratory species (DEWHA 2009). Construction and operation of the proposed airport is, therefore, unlikely to result in significant impacts on these migratory fauna species. No assessments of significance have been prepared for these species.

16.6.2.5 Greater Blue Mountains World Heritage Area

An assessment of significance has been prepared in accordance with the *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* (DoE 2013a) for impacts on the Greater Blue Mountains World Heritage Area. The results of this assessment are summarised below with further detail provided in Appendix K1 (Volume 4). The assessment focused on biodiversity values, in particular.

It is unlikely that construction and subsequent operation of the proposed airport would have a significant impact on biodiversity values of the Greater Blue Mountains World Heritage Area for the following reasons:

- there would be no direct impact on the Greater Blue Mountains World Heritage Area;
- the construction and operation of the proposed airport is unlikely to result in the loss of biological diversity or biological processes within the Greater Blue Mountains World Heritage Area;
- potential impacts on the Greater Blue Mountains World Heritage Area as a result of changes to air quality are likely to be negligible given the distance to the Greater Blue Mountains World Heritage Area and prevailing wind conditions;
- the airport design and land use plan includes measures to manage surface water that have been purposefully designed to capture water on-site and to avoid substantial alteration of surface water drainage patterns outside of the airport site; and
- while greenhouse gas emissions would increase as a result of the construction and operation of the proposed airport, this is unlikely to directly result in the loss of biological diversity or biological processes within the Greater Blue Mountains World Heritage Area.

Impacts on the Greater Blue Mountains World Heritage Area are discussed further in Chapter 26 (Greater Blue Mountains World Heritage Area).

16.6.2.6 Commonwealth land

An assessment of significance was prepared for impacts on other plants, animals and their habitat in an area of Commonwealth land. The outcome of this assessment is that the proposed airport would likely have a significant impact on:

- flora – through large-scale native vegetation clearance, especially of vegetation containing an endangered population of *Marsdenia viridiflora* subsp. *viridiflora* that would threaten the viability of the regional population of the species; and
- fauna – by displacing animals, reducing or fragmenting available habitat and causing a long term decrease or extinction of local populations of small, less mobile animals such as frogs, reptiles and the Cumberland Plain Land Snail.

16.6.3 Impacts on State-listed threatened species, populations and ecological communities

An assessment of impacts was undertaken for threatened species, populations and ecological communities listed under the TSC Act. This assessment was based on the Stage 1 development but also considered cumulative impacts that would occur with the long term development.

A significant impact was determined for one threatened flora population (*Marsdenia viridiflora* subsp. *viridiflora*) and for three threatened ecological communities (Cumberland Plain Woodland, River Flat Eucalypt Forest and Shale-Gravel Transition Forest).

In addition, a significant impact was determined for one threatened invertebrate (the Cumberland Plain Land Snail) and four threatened bat species (the Eastern False Pipistrelle, East Coast Freetail-bat, Greater Broad-nosed Bat and Yellow-bellied Sheathtail-bat). The key findings of the assessment are summarised below.

16.6.3.1 Threatened flora species and populations

The majority of the flora species listed as a threatened under the TSC Act that may occur at the airport site are also listed as threatened species under the EPBC Act. Impacts on these species have been assessed in Section 16.6.2. There is potential habitat at the airport site for two additional threatened plant species (*Dillwynia tenuifolia* and *Grevillea juniperina* subsp. *juniperina*) and one threatened population (*Marsdenia viridiflora* subsp. *viridiflora*) listed under the TSC Act.

There is no evidence of a viable local population of *Grevillea juniperina* subsp. *juniperina* or *Dillwynia tenuifolia* at the airport site or in nearby vegetation despite weeks of targeted surveys in multiple seasons (PPK 1997; SMEC 2014; OEH 2015a). There is a possibility that these species may be present at the airport site in low numbers in areas that were not directly observed or in the soil seed bank. There is also a chance that these species could colonise this habitat at some point in the future. As such, there is a risk of affecting a possible local population of these threatened plants through the removal, modification or fragmentation of potential habitat at the airport site.

Construction of the Stage 1 development would remove up to 289.8 hectares of potential habitat for *Grevillea juniperina* subsp *juniperina*. There is no evidence that this habitat is of particular value or significance to the species and there are around 10,014 hectares of similar shale woodland habitat and relatively abundant populations in the locality (NPWS 2006, Tozer 2010, OEH 2015a).

Construction of the Stage 1 development would remove up to 5.0 hectares of potential habitat for *Dillwynia tenuifolia* which is likely to have minor value compared to the relatively extensive areas of shale/gravel transition and alluvial habitat supporting thousands of individuals at Kemps Creek, around three kilometres to the east of the airport site (OEH 2015b). The long term development would remove additional areas of lower quality potential habitat but the removal of any known individuals of these threatened plants is not likely. The proposed airport is, therefore, not likely to result in a significant impact on a local population of these threatened plant species (if present at the airport site).

Construction of the Stage 1 development would completely remove the known local population of *Marsdenia viridiflora* subsp. *viridiflora* and its occupied and potential habitat. No stems of *Marsdenia viridiflora* subsp. *viridiflora* were recorded in the environmental conservation zone or in the area potentially impacted by the long term development. The closest known records of the species are around five kilometres away near Bringelly and Mulgoa (OEH 2015a). Construction of the Stage 1 development would result in a significant impact on the local population of *Marsdenia viridiflora* subsp. *viridiflora*. Impacts to the population may be partially mitigated by the proposed translocation programme and the retention of some potential habitat in the environmental conservation zone (see Section 16.7). It is acknowledged translocation may not provide assurance of survival and in recognition of this, the impact assessment and offset calculations conservatively assume the loss of all individuals in the construction impact zone.

Offsets for threatened flora listed under the TSC Act have been calculated using the BioBanking methodology for a major project as part of the assessment of offsets for impacts on the environment (see Section 16.8).

16.6.3.2 Threatened ecological communities

All of the native woodland and forest vegetation at the airport site, including derived native grasslands, comprise local occurrences of threatened ecological communities listed under the TSC Act (Cumberland Plain Woodland, River Flat Eucalypt Forest and Shale-Gravel Transition Forest).

Construction of the Stage 1 development would comprise a significant reduction in the extent and increase in the degree of fragmentation of Cumberland Plain Woodland, River Flat Eucalypt Forest and Shale-Gravel Transition Forest. The Stage 1 development would result in the removal of approximately 242.8 hectares of Cumberland Plain Woodland, 42.1 hectares of River Flat Eucalypt Forest and 5.0 hectares of Shale-Gravel Transition Forest. The Stage 1 development would, therefore, likely result in a significant impact on these threatened ecological communities. The long term development would further reduce the extent and increase the degree of fragmentation of Cumberland Plain Woodland and River Flat Eucalypt Forest. The long term development would not result in any direct impacts on Shale-Gravel Transition Forest.

Offsets for threatened ecological communities listed under the TSC Act have been calculated using the BioBanking methodology for a major project as part of the assessment of offsets for impacts on the environment (see Section 16.8).

16.6.3.3 Threatened fauna species

Threatened fauna species recorded site or otherwise considered to potentially occur at the airport site are discussed in Section 16.3.3.4.

As shown, eleven species listed under the TSC Act were considered present. It was considered that another 19 species listed under the TSC Act may occur at the airport site.

Four of these species – Grey-headed flying fox, the Swift Parrot, Australian Painted Snipe and Australasian Bittern – are also listed under the EPBC Act and are discussed in Section 16.6.2.

The loss of approximately 141.8 hectares of woodland and forest habitat for construction of the Stage 1 development would have a significant impact on the Cumberland Plain Land Snail. The removal of good quality occupied patches of vegetation would remove local populations and subpopulations and would reduce the genetic diversity in the locality of the airport site.

Construction of the Stage 1 development would not result in a significant impact on any of the threatened bird species recorded or considered likely to occur at the airport site. The loss of approximately 141.8 hectares of woodland and forest vegetation would reduce the total area of habitat for threatened woodland bird species in the locality (for example, the Scarlet Robin and Varied Sittella). However, many of these species require large patches of intact vegetation for their survival and may only occur at the airport site on a transient basis (if at all). These woodland bird species are also highly unlikely to breed at the airport site.

The construction of the Stage 1 development would remove approximately 981.6 hectares of potential foraging and breeding habitat for the Little Eagle. This species may continue to forage above the southern portion of the airport site prior to this area being developed as part of the long term development. Given the large home range of this species and the large area of potential habitat present in the locality, the loss of this habitat is unlikely to have a significant impact on the species. Individuals would be at risk of mortality from aircraft strike during operation, however, this is unlikely to significantly affect the population of this species in the locality.

The Blue-Billed Duck would be a rare visitor to the airport site, and would not breed there. The construction of the proposed airport would remove approximately 28.6 hectares of artificial wetlands (farm dams) that provide only occasional foraging habitat for a few individuals. No breeding habitat would be removed.

There is a very low risk of mortality from aircraft strike given the low numbers of individuals that may occur in the area. Due to this, the construction and operation of the proposed airport is unlikely to have a significant impact on this species.

Threatened owls may forage at the airport site on occasion. These include the Powerful Owl, Masked Owl and Barking Owl. Given the large areas of cleared land in the area, the airport site is not likely to contain core habitat for these species. Large, hollow-bearing trees are present that would be suitable for breeding, however, given the lack of good quality foraging habitat, breeding is unlikely to occur at the airport site. Construction of the proposed airport is unlikely to have a significant impact on these species.

The Gang-gang Cockatoo was not recorded during targeted surveys, but may forage at the airport site. Most local records of this species are associated with well vegetated areas such as the Blue Mountains. This species often moves to lower altitudes during autumn and winter, occurring in drier, more open eucalypt forests and woodlands and is often recorded in urban areas. During spring and summer it moves to tall mountain forests and woodlands for breeding. As such, it is unlikely to breed at the airport site. The proposed airport would remove around 141.8 hectares of woodland and forest which is potential foraging habitat for the species. Approximately 46.8 hectares of potential habitat would be retained within the environmental conservation zone along Badgerys Creek. Given the lack of evidence of this species at the airport site, the patchy nature of the vegetation to be removed, and that breeding at the airport site is unlikely, construction of the proposed airport is unlikely to have a significant impact on this species.

The Little Lorikeet was recorded flying over woodland at the airport site. The airport site is likely to provide foraging habitat for occasional transient individuals. The Little Lorikeet is unlikely to breed at the airport site given the patchy nature of the vegetation, low density of hollow-bearing trees, and because most breeding occurs west of the Great Dividing Range. Construction of the proposed airport would remove about 141.8 hectares of woodland and forest, which is potential foraging habitat for the species. Approximately 46.8 hectares of potential habitat would be retained within the environmental conservation zone along Badgerys Creek. Given the lack of evidence of this species at the airport site, the patchy nature of the vegetation to be removed, and that breeding at the site is unlikely, construction of the proposed airport is unlikely to have a significant impact on this species.

The Black Bittern was recorded within the riparian corridor of Badgerys Creek, near Elizabeth Drive. Preferred habitat for this species at the airport site is primarily located along this riparian corridor, which would mostly be retained within the environmental conservation zone. Habitat for this species could also occur at artificial wetlands (farm dams) at the airport site where there is suitable cover and the riparian corridors of Duncans Creek and Oaky Creek. Approximately 62.7 hectares of artificial wetland and riparian vegetation would be removed for the Stage 1 development. Not all of this area would be suitable for the species, as it requires dense vegetation for cover. About 46.8 hectares of potential habitat would be retained within the environmental conservation zone along Badgerys Creek. Given the protection of the riparian corridor along Badgerys Creek and the large numbers of artificial wetlands present in the locality, construction of the proposed airport is unlikely to have a significant impact on this species.

The construction of the proposed airport is likely to result in a significant impact on four obligate hollow-breeding bat species (the Eastern False Pipistrelle, East Coast Freetail-bat, Greater Broad-nosed Bat and Yellow-bellied Sheathtail-bat) through direct impacts on individual bats and from the removal of a substantial area of foraging and roosting habitat (approximately 141.8 hectares of woodland and forest vegetation and hollow-bearing trees). The proposed airport may also have a significant impact on the Large-footed Myotis if it uses tree hollows in the airport site for breeding. This species mainly breeds in caves and man-made structures. The construction of the proposed airport is unlikely to impact the Eastern Bentwing Bat and Eastern Cave Bat because it would only remove foraging resources and less valuable roost sites such as buildings and culverts. While individuals may be at risk of mortality from aircraft strike during operation, this is unlikely to substantially impact any populations of threatened bats.

Offsets for threatened fauna listed under the TSC Act have been calculated using the BioBanking methodology for a major project as part of the assessment of offsets for impacts on the environment (see Section 16.7).

16.7 Mitigation and management measures

Measures to mitigate impacts on terrestrial and aquatic flora and fauna (including threatened and migratory species, threatened populations and threatened ecological communities) from the construction and operation of the proposed airport are presented below, according to the hierarchy of avoidance, minimisation and mitigation of impacts.

A Biodiversity Construction Environmental Management Plan (CEMP) and Biodiversity, Land and Safety Operational Environmental Management Plan (OEMP) will be prepared and submitted for approval prior to Main Construction Works and operation of the Stage 1 development respectively. The plans would collate the mitigation and management measures discussed in this section and itemised in Table 16–12. These and other environmental management plans are discussed in further detail in Chapter 28 (Volume 2b).

Offsetting of impacts is discussed in Section 16.8. Mitigation measures and biodiversity offsets would be further developed with reference to relevant conservation advice and recovery plans for threatened biota potentially affected by the proposed airport.

16.7.1 Avoidance of minimisation of impacts

A number of avoidance and minimisation measures would be included in the design of the proposed airport in order to minimise the potential impacts on flora and fauna at the airport site and in the locality, where practicable. These measures would include:

- designing the airport to minimise its attractiveness to fauna, minimising bird and bat strike risk and other terrestrial fauna strike risk, including measures such as:
  - designing and building the airfield, drains and water basins to reduce the availability of water;
  - installing fencing to restrict terrestrial animal access to the airfield; and
  - designing airside access roads to facilitate wildlife management;
- designing the surface water management system to minimise the potential for adverse impacts on downstream environments, including measures such as:
  - separating ‘clean’ and ‘dirty’ water and retaining and treating any surface water generated on hard stand areas before discharge from the airport site;
  - avoiding substantial alteration of surface water drainage patterns and the volume of downstream flows;
  - designing and locating new waterway crossings or upgrades of existing crossings (if required) to minimise impacts on riparian and aquatic habitats. Crossings would be designed to minimise potential impacts on watercourse functionality, in particular impacts on aquatic and riparian habitats and fish passage; and

- designing airport lighting to avoid unnecessary light spill into adjoining areas of retained vegetation (such as in the environmental conservation area) as far as practicable given operational and security requirements.

Approximately 117.1 hectares of land in the environmental conservation zone would be protected. The environmental conservation zone includes around 56.8 hectares of native vegetation and representative areas of each of the vegetation types at the airport site. The 60.3 hectares of land within the environmental conservation zone that does not currently contain native vegetation would be revegetated. It is noted that around 2.1 hectares of vegetation in the proposed environmental conservation zone would require clearing for the establishment of detention basins outlets. Vegetation in these areas would be allowed to naturally regenerate and be protected in the environmental conservation zone. The environmental conservation zone is well placed, primarily around the southern perimeter of the airport site, to maintain vegetation connectivity and to provide opportunity for fauna movement and other ecological processes that are necessary to maintain biodiversity values.

The parts of the airport site outside the construction impact zone of the Stage 1 development but potentially impacted by the long term development would not be cleared until required for construction of the second runway or other infrastructure, except to the extent necessary or relevant for Stage 1 (for example, drainage and services lines, fire protection and other ancillary purposes), or subsequent development of the airport site. This approach means that impacts on biodiversity values would be avoided for as long as is practicable. Where practical, biodiversity values would be maintained in the long term development area through:

- retention of native vegetation and flora and fauna populations in areas not subject to development. This would help maintain the viability of populations outside the airport site by providing source populations for ecological processes such as pollination, reproduction and recruitment as well as helping to maintain genetic variability;
- retention of habitat resources, including potential refuge habitat and resources such as tree-hollows in areas not subject to development for fauna displaced by clearing for the Stage 1 development; and
- maintenance of habitat connectivity, including locally important vegetated corridors linking larger patches of Cumberland Plain Woodland at the airport site with riparian corridors extending away from the airport site.

A staged vegetation clearing process would be implemented during construction of the Stage 1 development. This would provide the opportunity for fauna that are resident in the construction impact zone to seek refuge in alternative habitat in the environmental conservation zone, long term development area or outside the airport site. Vegetation clearing would commence in the north-east of the airport site and proceed south and west. Subject to safety and security requirements, this clearing would be undertaken before the construction of the southern perimeter fence to allow fauna to relocate towards the environmental conservation zone and off-site. This approach would be taken to maximise the opportunity for resident fauna to vacate the clearing footprint via vegetated remnants and move toward alternative habitat.

16.7.2 Mitigation and management of impacts

Mitigation and management measures proposed to minimise the impacts on terrestrial flora and fauna are listed in Table 16–12.

The mitigation and management measures listed in Chapter 12, Chapter 17 and Chapter 18 would be implemented, as far as practicable, to minimise the impacts associated with dust, erosion and sedimentation on terrestrial and aquatic flora and fauna at the airport site.

Table 16–12 Mitigation and management measures

Issue	Mitigation/management measure	Timing
Worker induction	All workers are to be provided with an environmental induction prior to starting onsite construction activities. This would include information on: • the ecological values of the airport site; and • protection measures and site procedures to be implemented to protect biodiversity during construction.	Pre-construction
Waterway crossings	New waterway crossings or upgrades of existing crossings, if required on the airport site, will be designed and constructed to minimise potential impacts on watercourse functionality, in particular impacts on riparian and aquatic habitats and fish passage.	Pre-construction Construction
Pre-clearance surveys for threatened species	Pre-clearance surveys for threatened species will be undertaken by a qualified ecologist. Specific management plans will be prepared to manage impacts on each threatened flora and fauna species. These plans would include: • additional targeted searches of the airport site for the Green and Golden Bell Frog (in suitable conditions) to confirm that they are not present at the site. Should this species be located during targeted surveys, a management plan would be prepared to provide detail on Green and Golden Bell Frog relocation and habitat management. Frog collection and relocation would need to be conducted by appropriately experienced ecologists; • targeted searches of the airport site for the Cumberland Plain Land Snail (in suitable conditions) and salvage and relocation of any snails and/or suitable shelter sites that are detected. A management plan would be prepared to provide more detail on Cumberland Plain Land Snail relocation and habitat management. Snails and/or suitable shelter sites would be relocated to appropriate habitat near the airport site. Snail collection and relocation would need to be conducted by appropriately experienced ecologists; • searches for roosting bats at any bridges or culverts that need removal; • pre-clearing surveys for larger birds' nests, particularly the White-bellied Sea-Eagle and Little Eagle; and • targeted searches for threatened flora species in areas of appropriate habitat with particular attention to the vicinity of known populations of *Marsdenia virdiflora* subsp. *viridiflora* and *Pultenaea parviflora*. Any unexpected finds would be communicated to the Department of Infrastructure and Regional Development and addressed in the translocation plan and/or offset delivery plan as appropriate.	Pre-construction

Issue	Mitigation/management measure	Timing
Habitat clearing and fauna removal plan	A habitat clearing and fauna removal plan will be developed as part of the Biodiversity CEMP for the management of impacts on fauna species during clearing activities. The plan will include the following measures: • preparing a nest box strategy, including provisions for the: ▪ installation of nest-boxes within the Environmental Conservation Zone prior to clearing areas of native vegetation. This would provide a safe location for hollow-dwelling fauna to be transferred to during clearing operations; ▪ reuse of hollows and fallen debris within conversation areas; and ▪ salvage of native fauna from existing nest boxes in the construction impact zone prior to their removal and translocation. • providing for pre-clearing surveys to be undertaken by a suitably qualified ecologist to mark and map hollow-bearing trees, logs and existing nest boxes that would require fauna management during removal; • establishing protocols for the staged clearing of vegetation and safe tree felling and log removal to reduce the risk of fauna mortality; • measures outlined in the threatened species translocation plan; • establishing protocols for the capture and relocation of less mobile fauna (such as nestling birds and nocturnal fauna) by a trained fauna handler; and • establishing protocols for the appropriate management of injured or deceased individuals.	Pre-construction
Weed management plan	A weed management plan will be developed as part of the Biodiversity CEMP and will include the following measures: • implementing soil erosion and sediment control measures; • mapping of weed infestations; • removing and controlling noxious weed species; • appropriate disposal of weeds and weed-infested soils; • stabilising disturbed areas following clearing to prevent weed spread; • monitoring and adaptive management of weeds; and • reporting on the extent, composition and severity of weed infestations and adaptive management measures.	Pre-construction

Issue	Mitigation/management measure	Timing
Dam decommissioning and repurposing protocol	A protocol for the decommissioning of dams, or repurposing of dams for storage and use of water during construction, will be developed as part of the Biodiversity CEMP, in consultation with relevant agencies. The measures to be implemented through the protocol include: • any requirements of a Green and Golden Bell Frog management plan; • eradication of the Alligator Weed infestation on the dammed section of Oaky Creek near Elizabeth Drive prior to any works in the vicinity; • progressively emptying dams over a number of days to allow fauna to relocate; • avoiding the nesting season of waterbirds, where possible. A pre-removal survey would be conducted to identify bird breeding locations; • salvaging and relocating aquatic vertebrate fauna, including frogs, turtles and eels, to areas of suitable habitat retained at the airport site or nearby habitats, with regard to numbers and identification of suitable release sites; • preventing the release of Eastern Gambusia (*Gambusia holbrooki*) and other noxious fish into local waterways as a result of the draining of farm dams. Eastern Gambusia will be eradicated from dams using humane methods; and • establishing protocols for the humane euthanasia of aquatic fauna, including fish.	Pre-construction
Bushfire management	As part of ongoing site management activities, the Department of Infrastructure and Regional Development has prepared and implemented a bushfire management plan for the Commonwealth owned land at Badgerys Creek. This plan addresses current bushfire risk and identifies response actions. The existing bushfire management plan will be reviewed and updated in consultation with NSW Rural Fire Service to minimise the risk of bushfire and associated impacts on adjoining areas of native vegetation during construction and operation of the proposed airport, including the proposed environmental conservation area. This would include: • identifying activities likely to generate sparks and putting in place appropriate restrictions based on the forecast fire danger; • preparing pre-planned fire response action plans. The action plans would be issued as part of the site induction for all site personnel; • developing limitations on relevant construction procedures which would be applied during the fire season based on specific fire danger ratings. An example of such restrictions would include the halting of all construction works during extreme or catastrophic fire danger days; • managing the airport site to maintain a low overall fuel hazard. Measures to achieve this would include a combination of herbicide application, slashing, low intensity burning and hand removal; and • ensuring that fuel-reduction measures are appropriate to biodiversity values in each area, e.g. low intensity burns rather than slashing would be used in native woodland and forest.	Pre-construction
Natural environments adjacent to and downstream from the airport site	Measures to minimise the potential hydrological and contamination impacts on natural environments adjacent to and downstream of the airport site which will be implemented through the Soil and Water CEMP as discussed in Chapter 28 (Volume 2b). Measures to minimise the generation of dust and associated impacts on natural environments adjacent and downstream of the airport will be implemented through the Air Quality CEMP as discussed in Chapter 28 (Volume 2b).	Pre-construction Construction

Issue	Mitigation/management measure	Timing
Threatened flora translocation plan	A threatened flora salvage and translocation plan will be developed as part of the Biodiversity CEMP, in consultation with relevant agencies and the Australian Botanic Garden at Mount Annan and with consideration of the *Guidelines for the Translocation of Threatened Plants* (Vallee et al 2004). The plan will specify measures for the salvage and translocation of threatened flora species. In particular, it will include: • the salvage and propagation or transplanting of the known local populations of Pultenaea parviflora and Marsdenia viridiflora subsp. viridiflora and any other threatened flora detected at the airport site; and • consideration of the suitability of sites within the Environmental Conservation Zone in order to maintain populations of these species as close to their original location as is possible.	Pre-construction Construction
Threatened species management plans	Threatened species management plans will be prepared and implemented as part of the Biodiversity CEMP to reduce the potential for impacts on threatened species known to occur on the airport site, both inside and outside of the construction impact zone. These plans will include: • maps identifying locations of threatened species; • the scope and requirements for targeted surveys and pre-clearing surveys; including an unexpected finds protocol; • vegetation and habitat clearing protocols; and • reporting and adaptive management measures.	Pre-construction Construction
Vegetation clearance and habitat loss	The following measures will be taken to reduce the potential for adverse impacts on ecologically sensitive areas due to vegetation clearance and habitat loss: • deferring vegetation removal until necessary; • locating site offices and stockpiles in already cleared and disturbed areas where possible, to avoid further unnecessary removal or disturbance of native vegetation and hollow-bearing trees; • providing maps to construction staff engaged in Main Construction Works clearly showing vegetation clearing boundaries and exclusion/no-go zones; • engaging a suitably qualified ecologist or environmental officer prior to any clearing works that form part of Main Construction Works to clearly demarcate vegetation protection areas; and • establishing an unexpected finds protocol to detail measures to be undertaken if threatened flora and fauna not previously recorded at the airport site are detected during Main Construction Works.	Preparatory Activities Construction
Disease management protocol	A disease management protocol will be developed as part of the Biodiversity CEMP to minimise the potential for the spread of diseases. The protocol will include procedures for the management of plant diseases (such as Phytophthora, Myrtle Rust and Chytrid fungus), as well as any other likely diseases.	Construction

Issue	Mitigation/management measure	Timing
Management of vegetation areas outside the construction impact zone	A vegetation management plan will be developed as part of the Biodiversity CEMP to guide the activities for managing areas of vegetation outside the Stage 1 construction impact zone. The plan will identify how environment protection objectives for the Environmental Conservation Zone shown in the Land Use Plan in the Airport Plan will be met. The plan will detail specific measures to: • avoid unnecessary disturbance in nearby areas of retained vegetation outside of the construction impact zone such as avoiding unnecessary light spill; • replace exotic grasslands with suitable native vegetation in the Environmental Conservation Zones; • rehabilitate existing remnant and native vegetation within the Environmental Conservation Zones; and • protect environmental values within the Environmental Conservation Zone.	Pre-construction Construction
Landscaping	Landscaping on the airport site will utilise predominantly native vegetation endemic to the region, sourced from the local area where possible. This will include: • planting of native grasses in open areas around airport infrastructure; and • the use of native vegetation in decorative gardens and plant screenings used to minimise visual impacts.	Construction
Biodiversity and Vegetation (Environmental Conservation Zone)	A vegetation management plan will be prepared and implemented as part of the Biodiversity Land and Safety OEMP to guide the activities for managing areas of endemic native vegetation with the Environmental Conservation Zone outlined in the Land Use Plan in the Airport Plan. The vegetation management plan will include the following measures: • retaining endemic vegetation and/or supplementary replanting with local native species; • slashing of grassland to manage fuel loads and bushfire risk; • identifying threatened flora populations and measures to avoid impacts from activities such as weed control or bushfire hazard reduction; • identifying measures for the management of weeds; • planting schedules; and • monitoring and reporting the success of revegetation, weed control and adaptive management.	Pre-operation Operation

Issue	Mitigation/management measure	Timing
Biodiversity and Vegetation (Other areas outside the Stage 1 construction impact zone)	A vegetation management plan will be prepared and implemented as part of the Biodiversity, Land and Safety OEMP to protect those areas of significant vegetation outside the Stage 1 construction impact zone and the Environmental Conservation Zone, where the vegetation: • comprises a threatened ecological community under the EPBC Act; or • provides important or critical habitat for a listed threatened species under the EPBC Act. The vegetation management plan will: • map and identify those areas of significant vegetation within the airport site to which the plan applies; • identify measures to ensure that no clearance of significant vegetation occurs without prior approval under the Airports Act; • identify measures to protect significant vegetation from impacts associated with land management activities and development activities; and • detail any other measures necessary to retain significant vegetation and protect it from accidental or inadvertent disturbance.	Pre-operation/ Operation
Wildlife hazard management plan	To manage the risk of fauna hazard and bird and bat strike a wildlife hazard management plan will be developed and implemented. The plan will include the following measures: • the conduct of additional surveys to study and monitor for changes in species and movement patterns. The surveys will be conducted in accordance with relevant Commonwealth and State guidelines and standards including any recovery plans for threatened species; • the review of detailed design documentation to identify potential bird and bat attractants; • liaison with local government in relation to plans for proposed developments within 13 kilometres of the airport site that are likely to increase the bird and bat strike risk; • active management of bird and bat presence at the airport site six months prior to the commencement of airport operations; and • the outcomes of bird and bat strike monitoring will be reviewed by a wildlife strike expert and the results taken into account in any audit of the airport's impacts on wildlife in and around the airport site.	Pre-operation Operation
Fauna hazard	To minimise bird and bat strike risk and terrestrial fauna strike risk, the design of the proposed airport will seek to minimise the attractiveness of the airport site to fauna. To achieve this, the following measures will be incorporated into the detailed design process: • drains, water basins and other airfield components that minimise the availability and attractiveness of water and other potential roosting, nesting or foraging habitat; • an appropriate fence to restrict terrestrial animal access to the airfield; and • airside access roads to facilitate active wildlife management.	Pre-operation
Fire	Review, update and implement the Bushfire Management Plan developed for the airport site in response to the transition to the airport operation phase, including in response to changes to locations of building envelopes, fuel loads, ignition sources etc.	Operation

16.8 Offsetting impacts

Biodiversity offsets are required to compensate for the significant residual impacts arising from the proposed airport in accordance with the EPBC Act Offsets Policy and the EIS guidelines. Biodiversity offsets to compensate for significant residual impacts on threatened species and communities listed under the EPBC Act were calculated using the offsets assessment guide under the EPBC Act *Environmental Offsets Policy* (DSEWPaC 2012).

Biodiversity offsets to compensate for significant residual impacts on other features of the natural environment on Commonwealth land, plants, animals and their habitat, including threatened species, populations and communities listed under the TSC Act, were calculated with reference to the NSW BioBanking Assessment Methodology*, Credit Calculator Operational Manual 2014* (DECC 2009b) and the NSW *Framework for Biodiversity Assessment* (OEH 2014b). The framework is used to calculate offsets for major projects in NSW. Further detail regarding the methodology for offsetting impacts is provided in Appendix K2 (Volume 4).

The Department of Infrastructure and Regional Development will be responsible for delivering offsets for the Stage 1 development.

The biodiversity offset package discussed here comprises the first stages in the process of delivery of biodiversity offsets for the proposed airport. The process involving offset identification, securing and delivery is shown schematically in Figure 16–4.

An offset package has been prepared to compensate for the removal of approximately 104.9 hectares of Cumberland Plain Woodland; the removal of about 141.8 hectares of foraging habitat for the Grey-headed Flying-fox; and on features of the natural environment including plant populations, fauna populations and several species and communities listed under NSW legislation and TSC Act (collectively referred to as plants, animals and their habitat).

The offset package is intended to conserve habitat as offsets for affected biota at suitable offset sites in the surrounding region in perpetuity. The details of the offset package are described below. Further information on the offset package is provided in Appendix K2 (Volume 4).

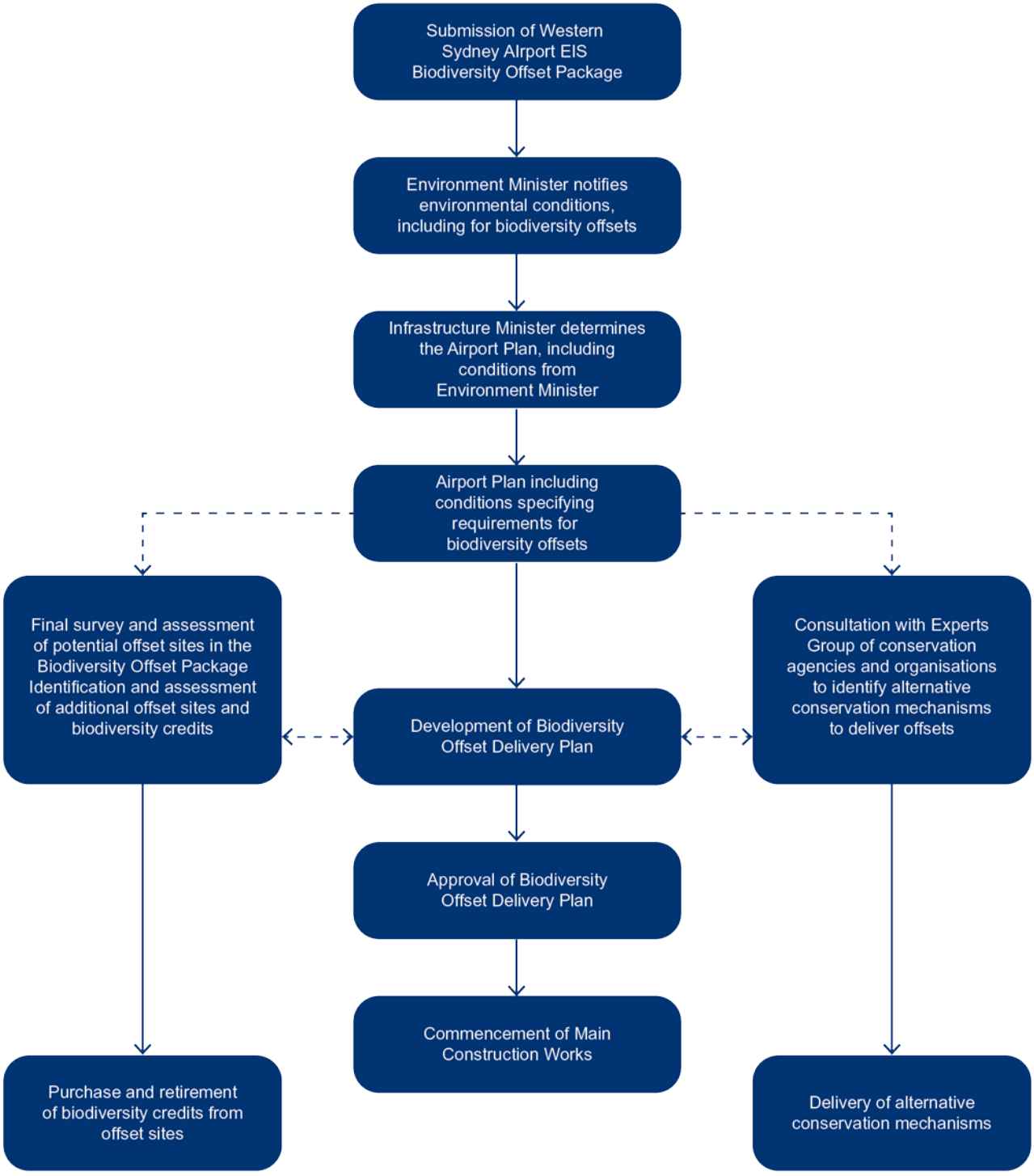


Figure 16–4 Overview of offset delivery process

16.8.1 Overview of the offset proposal

The EIS guidelines state that the proposed airport will require biodiversity offsets calculated with reference to the EPBC Act Offsets Policy. The key considerations included in the policy are that:

- offsets are described as measures that compensate for significant residual adverse impacts on the environment and the policy applies to all matters that are protected under the EPBC Act;
- the 'offsets assessment guide' spreadsheet is a tool that has been developed to help assess the suitability of offset proposals. The offsets assessment guide uses a balance sheet approach to measure impacts and offsets;
- at least 90 per cent of a project's impacts should be directly offset (subject to exceptions outlined in the EPBC Act Offsets Policy) and any offsets should be implemented prior to or at the time of the impact occurring; and
- up to 10 per cent (or more if an appropriate exception applies) of a project's impacts may be indirectly offset through compensatory measures such as contributions to a research fund or an educational programme.

A deviation from the 90 per cent direct offset requirement may be considered where it can be demonstrated that a greater benefit to the protected matter is likely to be achieved through increasing the proportion of other compensatory measures.

Following consultation with the DoEE, it was determined that the estimate of offsets for significant residual impacts on other features of the natural environment plants, animals and their habitat, including threatened biota listed under the TSC Act, would be calculated with reference to the NSW *Framework for Biodiversity Assessment* (OEH 2014b). The framework is based on the NSW Biodiversity Banking and Offsets Scheme (BioBanking) credit calculator and assessment methodology and is used to calculate offsets for major projects in NSW.

The EPBC Act Offsets Policy requires biodiversity offset sites to be securely titled under a legally binding conservation covenant and actively managed under a fully funded plan. There are a variety of mechanisms for achieving this, including BioBanking, Voluntary Conservation Agreements or dedication of land to the National Parks estate.

Due to a variety of factors, most notably the scale and nature of the biodiversity offsets required for the proposed airport, it will not be possible to identify and secure all of the proposed biodiversity offsets as part of this final EIS. The Department of Infrastructure and Regional Development has also identified strategic offsetting opportunities which involve working with the NSW Government and local stakeholders to source and manage suitable biodiversity offsets, but some of these opportunities cannot be realised immediately. The process of identifying and securing suitable offset areas will continue after the Airport Plan is determined by the Infrastructure Minister for the proposed airport and will comprise the following main stages:

- The biodiversity offset package (the package provided in this EIS), which outlines the approach to the delivery of biodiversity offsets for the proposed airport, including an estimate of the quantum of offsets required, options to deliver these offsets, an estimate of the costs involved and the additional steps required to finalise their delivery.

- The biodiversity offset delivery plan which will set out the specific actions to be taken to meet the offset conditions for the Stage 1 development as set out in the Airport Plan. Development of the plan will be guided by the framework established in this biodiversity offset package. The delivery plan will include further information such as:
    - the final quantum of impacts arising from the Stage 1 development, including refinements to impact calculations based on detailed design, pre-clearing surveys of the Stage 1 construction impact zone and any necessary modifications to vegetation and habitat mapping;
    - identification of additional offset areas to address the shortfall in the offset areas for EPBC Act Cumberland Plain Woodland and biodiversity credits for impacts on plants, animals and their habitat;
    - location details and fine scale mapping of individual offset sites;
    - current tenure arrangements, land uses, risk of loss of offsets and legal mechanisms proposed to avert the risk of loss at individual offset sites;
    - confirmed presence of threatened biota and assessment of the extent and quality of habitat at individual offset sites and details of studies and surveys used to inform offset calculations;
    - the final number and type of biodiversity credits to be purchased, or other action to be taken in relation to alternative offset mechanisms;
    - a detailed description of the specific management actions that will be undertaken to improve the quality of the offset sites; and
    - the overall cost of the proposed offset package.
- The biodiversity offset delivery plan will be submitted and require approval from the Environment Minister or an SES officer in DoEE prior to the commencement of Main Construction Works for the Stage 1 development, ensuring that biodiversity offsets have been identified (and secured where possible) prior to the substantial impacts occurring.

At this stage of the planning and assessment for the proposed airport, the intent is to deliver biodiversity offsets through conservation of suitable offset sites. The offset sites would be secured by registration of a BioBanking agreement on title to the sites. A BioBanking agreement is recognised as a practical and secure way of delivering biodiversity offsets and is endorsed by the DoEE as well as OEH and the NSW Department of Planning and Environment (DPE) for this purpose. This approach would require purchase of the number and type of biodiversity credits that match the proposal's impacts as calculated in accordance with the EPBC Act Offsets Policy.

While conservation of offset sites through the NSW BioBanking Scheme is expected to form the primary component of the biodiversity offsets, a variety of other alternative mechanisms to offset impacts will also be considered, especially where they would be more readily implemented or achieve better conservation outcomes in the region. These other compensatory measures could include actions such as:

- contributing to the Cumberland Conservation Corridor programme to enhance efforts to acquire and protect priority conservation lands within the Cumberland Conservation Corridor;
- contributing to Cumberland Plain restoration projects such as funding of revegetation programmes in the Western Sydney Parklands or expanding the 20 Million Trees programme;
- contributing to landholders such as local councils to fund bush regeneration or revegetation programmes;
- funding a seed collection and propagation programme to support bush regeneration or revegetation programmes;
- translocation of threatened flora from within the Stage 1 construction impact zone and monitoring of translocated populations in a way that will contribute to the long term conservation of the species; and
- payments into the NSW Biodiversity Conservation Fund, noting that it has not yet been established but could be before offsets need to be implemented.

Continued consultation with agencies and bodies such as the DoEE Biodiversity Conservation Division, NSW OEH, NSW Department of Planning and the Environment, Penrith City Council, Greater Sydney Local Land Services, the Western Sydney Parklands Trust, and members of the Cumberland Conservation Corridor Reference Group may identify options that are more suitable.

As a coordinated approach to consulting on the development of alternative conservation mechanisms, the Department of Infrastructure and Regional Development will establish an Experts Group including DoEE, other relevant NSW authorities, organisations and stakeholder groups as determined by the Department. Key considerations, with reference to the EPBC Act Offsets Policy, will include that any offsets must directly benefit the protected matter to be affected, must be based on sound ecological survey and assessment, and must be additional to any existing or proposed government funding for conservation programmes.

16.8.2 Summary of impacts requiring offsets

According to the EPBC Act Offsets Policy, biodiversity offsets are required for significant residual impacts on matters protected by the EPBC Act after any proposed avoidance and mitigation measures have been taken into account. The proposed airport is likely to have an impact on:

- Cumberland Plain Woodland, which is listed as a critically endangered ecological community under the EPBC Act and occurs at the airport site. Offsets are required for the removal of approximately 104.9 hectares of vegetation within the local occurrence of the community;
- the Grey-headed Flying-fox which is listed as a vulnerable species under the EPBC Act and which has been observed at the airport site. Offsets are required for the removal of approximately 141.8 hectares of foraging habitat; and
- plants, animals and their habitat including several species and communities listed under NSW legislation.

Impacts on EPBC Act-listed biota have been entered in the EPBC Act offset assessment guide. The offset assessment guide can only be used to calculate offsets for threatened biota listed under the EPBC Act and so an alternative approach is required for impacts on other protected matters. The EPBC Act Offsets Policy requires that the approach to calculating offsets must be in proportion to the level of statutory protection that applies to the protected matter, be of a size and scale proportionate to the residual impacts on the protected matter and be scientifically robust and reasonable (DSEWPC 2012). The NSW *Framework for Biodiversity Assessment* (OEH 2014b) has been used to calculate required offsets for significant residual impacts to plants, animals and their habitat as it meets each of these criteria and is supported by DoEE for this purpose. The calculated offsets are summarised in Table 16–13 and Table 16–14.

Table 16–13 Ecosystem credits required to offset impacts of the proposed airport

Plant community type name	Condition	Conservation status		Management zone area	Ecosystem credit requirement	Offset options – Plant community types
		EPBC Act Status	TSC Act Status			
Good condition Grey Box – Forest Red Gum grassy woodland on flats (HN528)	Moderate/ Good	CEEC	CEEC	79.8	4,220	HN528, HH526[1]
Poor condition Grey Box – Forest Red Gum grassy woodland on flats (HN528)	Moderate/ Good_Poor		CEEC	112.5	3,686	HN528, HH526
Good condition Grey Box – Forest Red Gum grassy woodland on hills (HN529)	Moderate/ Good	CEEC	CEEC	22.9	1,062	HN529, HN528, HN526[1]
Poor condition Grey Box – Forest Red Gum grassy woodland on hills (HN529)	Moderate/ Good_Poor		CEEC	27.6	884	HN529, HN528, HN526
Good condition Forest Red Gum – Rough-barked Apple grassy woodland (HN526)	Moderate/ Good		EEC	34.2	1,878	HN526, HN528
Poor condition Forest Red Gum – Rough-barked Apple grassy woodland (HN526)	Moderate/ Good_Poor		EEC	7.9	262	HN526, HN528
Good condition Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy open forest (HN512)	Moderate/ Good	CEEC	EEC	4.4	337	HN512, HN513, HN604, HN556[1]
Poor condition Broad-leaved Ironbark – Grey Box – Melaleuca decora grassy open forest (HN512)	Moderate/ Good_Poor		EEC	0.6	21	HN512, HN513, HN604, HN556
Good condition artificial freshwater wetland on floodplain (HN630)	Moderate/ Good			28.6	873	HN630, HN520

Notes: 1) Ecosystem credits that are used to offset impacts on EPBC Act Cumberland Plain Woodland would need to be plant community types HN528, HN529 or HN512 and associated with better quality vegetation in order to comply with the EPBC Act offset policy (DSEWPaC 2012).

Table 16–14 Species credits required to offset impacts of the proposed airport

Common name	Scientific name	Threatened species multiplier	Species credits required
Black Bittern	*Ixobrychus flavicollis*	1.3	815
Cumberland Plain Land Snail	*Meridolum corneovirens*	1.3	1,843
Marsdenia viridiflora subsp. *viridiflora* in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas	*Marsdenia viridiflora* subsp. *viridiflora* – endangered population	4.0	5,800
Pultenaea parviflora	*Pultenaea parviflora*	1.5	60
Southern Myotis	*Myotis macropus*	2.2	752

16.8.3 Potential offset sites

The biodiversity offset package sets out the overarching framework and strategy for how biodiversity offsets will be identified and secured for the proposed airport. Offsets for the proposed airport would mainly comprise the conservation of habitat for the affected protected matters in suitable offset sites. This section of the report outlines potential offset sites that the Department of Infrastructure and Regional Development intends to secure and has been used to estimate the quantum and cost of biodiversity offsets for the Stage 1 development of the proposed airport. Most of the offset sites would be secured by registration of a BioBanking agreement on title that will ensure that they are securely conserved and managed in perpetuity.

A desktop assessment was performed to identify and describe potential offset sites for the proposed airport. Candidate sites would be secured under a BioBanking agreement that would ensure that the offset sites would be securely titled for conservation as a biobank in perpetuity. The sources that were considered in the desktop assessment include BioBanking online registers administered by OEH, BioBanking assessment reports for existing and potential biobank sites and consultation with private landowners and agencies.

The desktop assessment revealed suitable offset sites that contain Cumberland Plain Woodland and/or Grey-headed Flying-fox habitat. Potential offset sites that contain habitat for the affected threatened biota and that could be included in the offset package are detailed in Table 16–15. Portions of four of these potential offset sites (Williamswood, Montpelier Stages 1 and 2 and Durham biobanks), are located in Cumberland Plain Priority Conservation Lands identified in the recovery plan for Cumberland Plain Woodland (DECC 2010).

Table 16–15 Potential offset sites

Potential offset site	Location	Total area (hectares)	Status and ownership
Williamswood biobank	Mount Hunter	104.5	Established biobank, private owner.
Durham biobank	Oxley Park (Ropes Creek riparian corridor)	46.85	Potential biobank, DPE.
Mamre biobank	Mamre Park (South Creek riparian corridor)	98.1	Potential biobank, DPE.

Potential offset site	Location	Total area (hectares)	Status and ownership
Luddenham biobank	Mamre Park (South Creek riparian corridor)	42	Potential biobank, DPE.
Roper biobank	Minchinbury (Ropes Creek riparian corridor)	14.05	Potential biobank, DPE.
Caddens biobank	Claremont Meadows (South Creek riparian corridor)	36.08	Potential biobank, DPE.
Dunheved biobank	Werrington County (South Creek riparian corridor)	90.17	Potential biobank, DPE.
Forrester biobank	Tregear (Ropes Creek riparian corridor)	30.43	Potential biobank, DPE.
Stage 1 Montpelier biobank	The Oaks	76.24	Potential biobank, private owner.
Stage 2 Montpelier biobank	The Oaks	79.5	Potential biobank, private owner
Menangle Road biobank	The Oaks	57.07	Potential biobank, private owner
Bruelle biobank	Mulgoa	27.5	Potential biobank, private owner
The Oaks	Mowbray Park	40	Established biobank, private owner
Western Sydney Parklands ID 120	Cecil Park	19.4	Established biobank, Western Sydney Parklands Trust
Western Sydney Parklands ID 70	Cecil Park and Chandos West	40.5	Established biobank, Western Sydney Parklands Trust
Hampden Vale biobank	Razorback	101	Potential biobank, private owner

At the offset sites, there are local occurrences of each of the threatened ecological communities that would be removed for construction of the proposed airport and known or potential habitat for many of the threatened species that would be affected at the offset sites.

The potential offset sites described above contain some areas of native vegetation and habitat that is not an appropriate ‘like for like’ match for impacts on the EPBC Act listed affected threatened biota or is associated with biodiversity credits that have already been sold. A subset of the habitat available at the potential offset sites has been selected that would directly offset impacts on the affected threatened biota. DoEE would require these specific areas to be clearly documented and mapped in the biodiversity offset delivery plan.

The criteria for selecting the proposed offset areas are:

- areas that are linked to biodiversity credits that area available for sale at established biobanks or that would be available for sale at proposed biobanks;
- presence of EPBC Act Cumberland Plain Woodland; and
- presence of habitat for the Grey-headed Flying-fox.

The ‘proposed offset areas’ (that is, the specific areas of habitat at potential offset sites that would look to be included in the offset delivery plan to offset impacts on the affected threatened biota) are summarised in Table 16–16. This table presents the potential offset areas that are available at the time of publication (i.e. September 2016). Biodiversity credits linked to these areas may be sold to other parties prior to the finalisation of the biodiversity offset delivery plan. Additional or alternative offset areas as other compensatory measures will also be identified and considered to assist in meeting overall offset requirements for the offset delivery plan.

The area of Grey-headed Flying-fox habitat available in the proposed offset areas (at least 451 hectares) is greater than the estimated area required to meet this species’ offset requirement (410 hectares). This area would also offset impacts to plants, animals and their habitat.

Table 16–16 Proposed offset areas

Potential offset site	Total area (hectares)	Extent of available EPBC Act Cumberland Plain Woodland (hectares)[1]	Extent of available poorer quality Cumberland Plain Woodland (hectares)[2]	Grey-headed Flying fox habitat (hectares) [3]	Notes
Williamswood biobank	104.5	31.9	28.0	50.4	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Additional poorer quality Cumberland Plain Woodland.
The Oaks	40.0	10.0	3.0	10.4	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Additional poorer quality Cumberland Plain Woodland.
Durham biobank	42.7	2.9	0.0	24.1	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Additional Grey-headed Flying-fox habitat associated with River Flat Eucalypt Forest and close to a known roost camp.
Mamre Biobank	98.1	0.0	0.0	52.5	Grey-headed Flying-fox habitat associated with River Flat Eucalypt Forest and linked to biodiversity credits that area available for sale.
Luddenham biobank	40.0	4.1	0.7	34.6	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Additional Grey-headed Flying-fox habitat associated with River Flat Eucalypt Forest. Additional poorer quality Cumberland Plain Woodland.
Roper biobank	13.3	3.0	1.7	6.7	EPBC Act Cumberland Plain Woodland and poorer quality Cumberland Plain Woodland linked to credits that are available for sale.
Caddens biobank	33.3	4.8	1.2	17.3	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Additional poorer quality Cumberland Plain Woodland. Biodiversity credits for other impacts on the environment.

Potential offset site	Total area (hectares)	Extent of available EPBC Act Cumberland Plain Woodland (hectares)[1]	Extent of available poorer quality Cumberland Plain Woodland (hectares)[2]	Grey-headed Flying fox habitat (hectares) [3]	Notes
Dunheved biobank	65.0	3.8	8.7	23.0	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Additional poorer quality Cumberland Plain Woodland. Biodiversity credits for other impacts on the environment.
Forrester biobank	30.4	11.6	0.0	26.7	Grey-headed Flying-fox habitat associated with River Flat Eucalypt Forest and linked to biodiversity credits that area available for sale.
Stage 1 Montpelier biobank	76.2	34.1	11.4	40.9	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Additional poorer quality Cumberland Plain Woodland. Biodiversity credits for other impacts on the environment.
Stage 2 Montpelier biobank	79.5	20.9	9.2	48.5	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Additional poorer quality Cumberland Plain Woodland. Biodiversity credits for other impacts on the environment.
Menangle Road biobank	57.1	27.0	21.1	36.0	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Additional poorer quality Cumberland Plain Woodland. Biodiversity credits for other impacts on the environment.
Bruelle biobank	26.8	14.4	0.0	27.5	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Biodiversity credits for other impacts on the environment.
Western Sydney Parklands ID 120	19.4	18.2	0.0	18.2	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Biodiversity credits for other impacts on the environment.
Western Sydney Parklands ID 70	40.5	5.2	0.0	5.2	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox

Potential offset site	Total area (hectares)	Extent of available EPBC Act Cumberland Plain Woodland (hectares)[1]	Extent of available poorer quality Cumberland Plain Woodland (hectares)[2]	Grey-headed Flying fox habitat (hectares) [3]	Notes
					habitat. Biodiversity credits for other impacts on the environment.
Hampden Vale biobank	101.0	16.0	50.1	28.7	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Biodiversity credits for other impacts on the environment.
Total	867.8	207.9	135.0	450.6	

16.8.4 Preliminary offset calculations

16.8.4.1 Overview

The EPBC Act Offsets Policy requires a formal assessment of impacts and offset contributions for EPBC Act-listed species and communities using the 'offsets assessment guide'.

The Offsets Assessment Guide utilises a balance sheet approach to measure impacts and offsets. According to the EPBC Act Offsets Policy, controlled actions requiring offsets must achieve a minimum 90 per cent 'direct offset' (subject to exceptions outlined in the EPBC Act Offsets Policy). The EPBC Act offset policy requires 'like for like' biodiversity offsets and the site must be able to reach the same site quality score as the development site.

Offset Assessment Guide calculations have been performed based on the significant residual impacts documented in this chapter and the likely conservation and management of the potential offset sites. The 'area of offset' has been treated as a variable in these preliminary offset assessment guide calculations to estimate the total area of habitat at offset sites that would be required to directly offset 100 per cent of the proposed airport's impacts. The calculator inputs associated with the other attributes of the offset areas is an aggregate based on the assessment of the potential offset sites. This approach has been used to demonstrate that suitable offset areas are available having regard to the EPBC Act Offset Policy and that these potential offset areas would substantially meet the offset requirements for the proposed airport as direct offsets. A detailed description of the calculations is provided in the Biodiversity Offset Package (see Appendix K2 (Volume 4)).

The NSW *Framework for Biodiversity Assessment* (OEH 2014b) has also been used to estimate offset requirements for impacts on plants, animals and their habitat, as ecosystem credits and species credits respectively.

Potential offset sites would be subject to targeted surveys to confirm their like for like qualities and their value in terms of ecosystem credits and species credits.

16.8.4.2 Preliminary calculations

Preliminary offset guide calculations were made based on the summary of impacts requiring offsets in Section 16.8.2 and the potential offset sites in Section 16.8.3. In summary:

- impacts to 104.9 hectares of Cumberland Plain Woodland require around 355 hectares in offset area. Potential offset sites contain around 207.9 hectares in comparable condition and another 135 hectares in poor condition that could be actively managed to achieve equivalence.
- impacts to 141.8 hectares of Grey-headed flying fox habitat require around 410 hectares in offset area. Potential offset sites contain around 451 hectares in comparable condition.

The preliminary offset guide calculations indicate that the additional Cumberland Plain Woodland offset area must be identified to meet the requirements of the EPBC Act Offsets Policy.

Ecosystem credits for impacts to the environment are quantified in Table 16–17, while species credits for impacts to species protected under NSW legislation are quantified in Table 16–18.

Table 16–17 Ecosystem credits for impacts on the natural environment

Potential offset site	Total area (hectares)	Available HN528 credits	Available HN529 credits	Available HN526 credits	Available HN512 credits	Available HN630 credits	Available HN524 credits
Williamswood biobank	104.5	0	694	280	0	0	38
Durham biobank	42.7	31	0	246	0	0	0
Mamre biobank	98.1	0	0	680	0	7	0
Luddenham biobank	40.0	34	0	246	0	0	0
Roper biobank	13.3	48	0	20	25	0	0
Caddens biobank	33.3	47	0	181	0	5	0
Dunheved biobank	65.0	93	0	362	0	0	0
Forrester biobank	30.4	81	0	127	0	0	0
Stage 1 Montpelier biobank	76.2	119	442	0	0	0	153
Stage 2 Montpelier biobank	79.5	0	363	0	0	0	118
Menangle Road biobank	57.1	0	454	36	0	0	29
Bruelle biobank	26.8	0	141	0	0	0	0
The Oaks	40.0	0	261	11	0	0	69
Western Sydney Parklands ID 120	19.4	120	0	61	0	0	0
Western Sydney Parklands ID 70	40.5	49	0	10	0	0	0
Hampden Vale biobank	101	185	417	52	0	0	36
Total	867.8	807	2,772	2,312	25	12	443
Ecosystem credit requirement		7,906	1,946	2,140	358	873	0
Credit balance		-7,099	826	172	-333	-861	443
Total including trading of matching credits		979					
Credit balance including trading of matching credits		-6,927	826	0	-333	-861	443

Notes: 1) includes 531 HN526 credits which may be traded with HN528.

Table 16–18 Species credits potentially available at offset sites

Common name	Scientific name	Species credits required	Individuals / area required in offset site	Individuals / area available in offset site(s)
Black Bittern	*Ixobrychus flavicollis*	815	115 ha	Up to around 314 hectares of potential habitat in Forest Red Gum – Rough-barked Apple grassy woodland (HN526) and Coastal freshwater wetland (HN630) at proposed offset sites.
Cumberland Plain Land Snail	*Meridolum corneovirens*	1,843	260 ha	Up to around 414 hectares of potential habitat in Grey Box – Forest Red Gum grassy woodland on shale (HN529) and Grey Box – Forest Red Gum grassy woodland on plains (HN528). The species has been recorded at the Forrester and Caddens biobank sites.
Marsdenia viridiflora subsp. *viridiflora* in endangered population	*Marsdenia viridiflora* subsp. *viridiflora* – endangered population	5,800	817 stems	Up to around 476 hectares of potential habitat in Grey Box – Forest Red Gum grassy woodland on shale (HN529), Grey Box – Forest Red Gum grassy woodland on plains (HN528) and Grey Box – Forest Red Gum shrubby woodland (HN524). Around 75 stems of the species have been recorded as a result of partial survey of around 80 hectares of habitat at the Hampden Vale biobank site. The species has also been recorded at Ninth Ave. Penrith.
Pultenaea parviflora	*Pultenaea parviflora*	60	8 individuals	100 individuals recorded at the Dunheved biobank site.
Southern Myotis	*Myotis macropus*	750	106 ha	Up to around 313 hectares of potential habitat in Forest Red Gum – Rough-barked Apple grassy woodland (HN526) at proposed off set sites. The species has been recorded at the Mamre biobank site.

16.8.5 Delivery of offsets

Biodiversity offsets will be delivered through procurement of biodiversity credits to match the proposed airport's impacts on affected EPBC Act-listed biota as calculated by the offsets assessment guide. Additional biodiversity credits would be purchased to offset impacts on plants, animals and their habitat. This would secure the conservation covenant over the area of land that is linked to the biodiversity credits and provide funds for management in perpetuity.

The process of identifying and securing suitable offset areas will continue through the development of a biodiversity offset delivery plan, with work to commence on this plan after the Infrastructure Minister's determination of the Airport Plan for the proposed airport. Further information for completing this delivery plan, as the next stage of the offset delivery process, would include the steps identified in Section 16.8.1. These steps comprise the identification of further offset areas for Cumberland Plain Woodland in addition to the areas which have been identified at the time of this EIS. Potential offset sites would be subject to targeted surveys to confirm their like for like qualities and their value in terms of biodiversity credits or other offsetting potential.

Delivery of offsets may also include other compensatory measures such as the examples discussed in Section 16.8.1 or other options identified through consultation with an Experts Group to be established by the Department of Infrastructure and Regional Development.

A biodiversity offset delivery plan will be developed to set out the specific actions to be taken to meet offset requirements for the Stage 1 development and will be guided by the framework established in the offset package. The Department of Infrastructure and Regional Development will be responsible for delivering this plan.

The plan will be submitted and require approval from the Environment Minister or an SES officer in DoEE prior to the commencement of Main Construction Works for the Stage 1 development of the proposed airport, ensuring that biodiversity offsets have been identified (and secured where possible) prior to the substantial impacts occurring.

16.9 Conclusion

Construction of the Stage 1 development would result in the removal of approximately 1,153.8 hectares of vegetation. The majority of this vegetation consists of exotic grassland and cleared land or cropland dominated by exotic species and noxious and environmental weeds. Approximately 318.5 hectares of native vegetation would be removed. The removal of vegetation at the airport site would result in the loss of fauna foraging, breeding, roosting, sheltering and dispersal habitat. Construction of the Stage 1 development would also result in potential for indirect impacts on terrestrial and aquatic flora and fauna including impacts associated with increased fragmentation, altered hydrology, erosion and sedimentation, dust, light, noise and vibration. Indirect impacts may also include fauna displacement, injury and/or mortality.

Operation of the proposed airport would involve an increased risk of fauna strike from contact with aircraft and ground transportation vehicles. Indirect impacts may include those associated with light, noise and vibration, the increased incidence of fire and the introduction of exotic species.

The Stage 1 development would affect threatened species, populations and ecological communities listed under both the EPBC Act and the TSC Act. Assessments of significance have been prepared in accordance with the Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (DoE 2013a) for impacts on threatened biota and other MNES, and the Significant Impact Guidelines 1.2 – Actions on, or Impacting upon, Commonwealth Land and Actions by Commonwealth Agencies (DoE 2013b) for impacts on the natural environment. The outcome of these assessments is that the Stage 1 development is likely to have a significant impact on Cumberland Plain Woodland, the Grey-headed Flying-fox and other plants, animals and their habitat (including a number of species populations and ecological communities listed as threatened under the TSC Act) in an area of Commonwealth land.

Mitigation and management measures would be implemented to reduce the potential impacts on biodiversity. These measures would include staged vegetation removal during construction, pre-clearing surveys and measures for the salvage of resident fauna and habitat resources, translocation programmes for threatened flora and fauna species and populations, and designing the airport to minimise its attractiveness to fauna and thus minimising bird and bat strike and terrestrial fauna strike. In addition, an environmental conservation zone would be established along the southern perimeter of the airport site where approximately 117.1 hectares of land would be protected.

Biodiversity offsets are required to compensate for significant residual impacts arising from the proposed airport. An offset package has been prepared to compensate for the removal of approximately 104.9 hectares of Cumberland Plain Woodland, the removal of about 141.8 hectares of foraging habitat for the Grey-headed Flying-fox and impacts on plants, animals and their habitat including species and communities listed under NSW legislation. The offset package provides the strategic framework for the conservation of habitat for the affected threatened biota in suitable offset sites in the surrounding region in perpetuity.

Due to the scale and nature of the biodiversity offsets required for the proposed airport, the process of identifying and securing suitable offset areas will continue after the Airport Plan is determined by the Infrastructure Minister. A biodiversity offset delivery plan will be developed to set out the specific actions to be taken to meet offset requirements for the Stage 1 development and will be guided by the framework established in the offset package. The Department of Infrastructure and Regional Development will be responsible for delivering this plan that will require approval from the Environment Minister or an SES officer in DoEE prior to the commencement of Main Construction Works for the Stage 1 development, ensuring that biodiversity offsets have been identified (and secured where possible) prior to substantial impacts occurring.

While conservation of offset sites through the NSW BioBanking Scheme is expected to form the primary component of the biodiversity offsets, a variety of other conservation actions will also be considered that would assist in meeting overall offset requirements. These other conservation mechanisms which could be used to deliver offsets, such as the Cumberland Conservation Corridor programme and proposed NSW Biodiversity Conservation Fund, among others, may achieve greater strategic benefits for biodiversity conservation in the region. The Department of Infrastructure and Regional Development will consult closely with the DoEE and other relevant NSW authorities, organisations and stakeholder groups on these and other potential offsetting opportunities.

When implemented, the biodiversity offset delivery plan would improve or maintain the viability of the protected matters that would be affected by the proposed airport.