Australian Government

Department of Infrastructure and Regional Development

WESTERN SYDNEY AIRPORT

DRAFT ENVIRONMENTAL IMPACT STATEMENT

VOLUME 2
STAGE 1 DEVELOPMENT

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Western Sydney Airport Draft Environmental Impact Statement

Proponent	The Australian Government Department of Infrastructure and Regional Development.
EPBC Referral	The action was referred to the Commonwealth Minister for the Environment on 4 December 2014, referral 2014-7391.
Proposed action	The proposed Western Sydney Airport would be developed over a number of stages in response to increasing demand. The proposed action is the construction and operation of the first stage of development for the proposed Western Sydney Airport at Badgerys Creek. The draft environmental impact statement (EIS) provides a detailed consideration of likely environmental impacts arising from the Stage 1 development. The Stage 1 development includes a single runway with associated aviation facilities for up approximately 10 million passengers each year and is fully described in the draft Airport Plan. This is the level of passenger demand that is expected to occur in approximately 2030.
Airport Plan	The Stage 1 development would take place under an airport plan determined under Division 4A of Part 5 of the *Airports Act 1996.*
Airport site	The airport site covers about 1,700 hectares at Badgerys Creek. The Stage 1 development impacts about 1,065 hectares within this site. The airport site currently comprises the following properties owned by the Commonwealth: - Lot 1 on DP838361 - Lot 1 on DP851626 - Lot 2 Section C on DP1451 - Lot 17 on DP258581 - Lot 22 on DP258581 - Lot 23 on DP259698 - Lot 32 on DP259698 - Lot 33 on DP259698 - Lot 7 on DP3050 - Lot 8 on DP3050 - Lot 9 on DP226448 - Lot 3 on DP611519 - Lot 11 on DP226448 - Lot 1 on DP129674 - Lot 1 on DP129675 - Lot 1 on DP996420 - Lot 2 on DP996420 - Lot 28 on DP217001 - Lot 1 on DP996379 - Lot 2 on DP996379 It is also anticipated that one or more easements and a small amount of additional land would be acquired by the Commonwealth and incorporated into the airport site for operational and safety reasons.
Draft EIS	This draft EIS has been prepared by the Department of Infrastructure and Regional Development supported by GHD Pty Ltd, RPS Manidis Roberts Pty Ltd and various specialist sub-consultants. The draft EIS has been prepared in accordance with the *Guidelines for the content of a draft environmental impact statement* for the proposed airport issued on 29 January 2015. The draft EIS is divided into four volumes. Volume 1 provides a description of the proposed Stage 1 development. Volume 1 also explains the approvals and community consultation process. Volume 2 provides a detailed impact assessment of the Stage 1 development. Volume 3 provides a strategic level assessment of environmental impacts of an indicative long term development of the airport site. The assessment has been undertaken to provide a broad understanding of the potential impacts facilitated by the Stage 1 development, given that development beyond Stage 1 would be the subject of future approvals processes. Volume 4 contains detailed technical assessments that have informed the assessment of environmental impacts in Volume 2 and Volume 3. Volume 4 also contains the further information about the proponent, the EIS study team and the *Guidelines for the content of a draft environmental impact statement*.

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Terms and abbreviations

Term	Definition
05/23	The proposed runway orientation. Refers to a generally north-east/south-west orientated runway at 50 degrees north-east and 230 degrees south-west.
1997-99 EIS	PPK 1997, Draft Environmental Impact Statement Second Sydney Airport Proposal, Commonwealth Department of Transport and Regional Development and PPK Environment and Infrastructure Pty Ltd 1999, Supplement to Environmental Impact Statement Second Sydney Airport Proposal, Volume 3 Supplement. Prepared on behalf of the Department of Transport and Regional Services, Prepared on behalf of the Department of Transport and Regional Services.
90th Percentile N60	The N60 value that is exceeded on 10 per cent of nights.
90th Percentile N70	The N70 value that is exceeded on 10 per cent of days.
ABS	Australian Bureau of Statistics
Acid sulfate soils	Naturally occurring soils or sediments containing iron sulfides, which produce sulfuric acid when exposed to air.
AHD	Australian height datum
Airport Plan	Draft plan developed in accordance with the requirements of the *Airports Act 1996*, setting out the Australian Government's requirements for the initial development of the proposed airport.
Airport site	The site for the proposed airport covering an area located at Badgerys Creek, Western Sydney.
Airports Act	*Airports Act 1996* (Commonwealth)
Airports Act amendment	Airports Amendment Bill 2015
ALC	Airport Lessee Company
ANEC	Australian noise exposure concept
ANEF	Australian noise exposure forecast
APU	Auxiliary power unit
ARI	Average recurrence interval – the average or expected value of the periods between exceedances of a given rainfall total accumulated over a given duration.
ATM	Air traffic movement
Australian Height Datum	A common reference level which is approximately equivalent to the height above sea level.
Australian Noise Exposure Concept	Scenario contours used to produce 'what if' contours, for example, in the process of examining flight path options around an airport.
Australian Noise Exposure Forecast	Official forecasts of future noise exposure patterns around an airport. They constitute the contours on which land use planning authorities base their controls.
BoM	Bureau of Meteorology

Term	Definition
Bulk earthworks	The removal, moving or adding of large quantities of soil or rock from a particular area to another.
Bund	A constructed retaining wall designed to prevent inundation or breaches from a known source.
BWSEA	Broader Western Sydney Employment Area
CASA	Civil Aviation Safety Authority
Catchment	The area drained by a stream, lake or other body of water.
CO	Carbon monoxide
Construction impact zone	The area that would be directly impacted by construction of the Stage 1 development.
Continuous descent approaches	A method by which aircraft approach airports prior to landing. Designed to reduce fuel consumption and noise compared to other conventional descents.
Controlled airspace	Airspace of defined dimensions within which air traffic control services are provided.
Criteria pollutants	Air pollutants that have been regulated and are used as indicators of air quality.
Datum	A level surface used as a reference in measuring elevations.
dB(A)	A weighted noise level – an expression of the relative loudness of sounds in air as perceived by the human ear.
DEC	NSW Department of Environment and Conservation (now Office of Environment and Heritage)
DECC	NSW Department of Environment and Climate Change (now Office of Environment and Heritage)
DECCW	NSW Department of the Environment Climate Change and Water (now Office of Environment and Heritage)
Decibel (dB)	A unit of sound.
Direct impact	Direct impacts are caused by an action and occur at the same time and place.
DP&E	NSW Department of Planning and Environment
DPI	NSW Department of Primary Industries
EEC	Endangered ecological community
EIS	Environmental Impact Statement
EIS guidelines	Guidelines for the Content of a Draft Environmental Impact Statement – Western Sydney Airport.
EMS	Environmental management system
Environmental assessment	A formal process of evaluating significant short-term and long-term effects or impacts a project will have on the environment.
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EPA	NSW Environmental Protection Agency
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
FTE	Full time equivalent

Term	Definition
Fugitive emissions	Dust derived from a mixture of sources (non-point source) or not easily defined sources. Examples of fugitive dust include dust from vehicular traffic on unpaved roads, materials transport and handling, and un-vegetated soils and surfaces.
GBAS	Ground based augmentation system
GBMWHA	Greater Blue Mountains World Heritage Area
GDE	Groundwater dependent ecosystem
GDP	Gross domestic product
General aviation	Name given to the aviation industry that is non-military (both fixed wing and helicopter) and that excludes the larger airlines operating scheduled passenger services. General aviation sector undertakes a diverse range of passenger and freight activities including charter operations, flight training, aerial agriculture, aerial work, private and business flying and sports related activities.
GPS	Global positioning system
Greenfield airport	A new airport on land which was not previously used for aviation purposes.
Grey water	Wastewater stream from all domestic wastewater sources other than the toilet (such as baths, sinks, washing machines, etc.).
Groundwater	Water found below the surface, usually in porous rock, soil or in underground aquifers.
GRP	Gross regional product
GSE	Ground support equipment
Hazard	The potential or capacity of a known or potential risk to cause adverse effects.
Hazardous material	Any item or agent that has the potential to cause harm to humans, animals or the environment.
Hazardous waste	Any waste that is classified as hazardous in accordance with the Waste Classification Guidelines (NSW EPA, 2014). Hazardous waste cannot be disposed of to landfill unless it is treated to remove or immobilise the contaminants. – including waste batteries, fertilisers, fuels, herbicides, oils pesticides, paints, solvents, cleaners, clinical and pharmaceutical waste, and waste tyres.
Heavy metal	Any metal or metalloid of environmental concern.
HIAL	High intensity approach lighting
HIPAP	NSW Hazardous Industry Planning Advisory Papers
IAP2	International Association of Public Participation
ICAO	International Civil Aviation Organisation – A specialised agency of the United Nations which codifies the principles and techniques of international air navigation and fosters the planning and development of international air transport to ensure safe and orderly growth.
ICAO Standards	Standards and recommended practices concerning air navigation, its infrastructure, flight inspection, prevention of unlawful interference and facilitation of border-crossing procedures for international civil aviation.
Impact	A change in the physical, natural or cultural environment brought about by an action. Impacts can be direct or indirect.
Impervious	Impervious surfaces are surfaces non-permeable to water.

Term	Definition
Indirect impact	As defined in the EPBC Act *Significant impact guidelines 1.2*, indirect impacts are downstream or downwind impacts, such as impacts on wetlands or ocean reef; upstream impacts, such as those associated with the extraction of raw materials; or facilitated impacts, such as urban or commercial development of an area made possible by a project.
Km/h	Kilometres per hour
L_{A90}	The L_{A90} level is the A-weighted noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.
L_{Aeq}	The equivalent continuous sound level (L_{Aeq}) is the energy average of the A-weighted noise level over a sample period, and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is sometimes used to describe aircraft noise, in which case it refers to the noise level that is due to aircraft only, excluding other noise. Variants of this measure have been defined that cover specific time periods, such as $L_{Aeq,9am-3pm}$, which is used to describe noise affecting school classrooms.
$L_{Aeq,9am-3pm}$	The impact of noise on school students and teachers.
Leachate	The liquid that passes through, or is released by, waste.
LEP	Local environmental plan
LGA	Local Government Area
$L_{night,outside}$	The equivalent-continuous noise level between 11pm and 7am, or $L_{Aeq,11pm-7am}$ (it is used to describe night time noise exposure and assess chronic health impacts associated with exposure).
Long term development	The long term development of the airport, including parallel runways and facilities for up to 82 million passengers annually (nominally occurring in 2063).
LOS	Level of service
m^2	Square metres
Manual of Standards	Standard procedures for the operation of airports issued by the Civil Aviation Safety Authority.
MAP	Million annual passengers
Master plan	Non-statutory document that outlines a vision to guide the growth and development of a place.
Maximum noise level (LA_{max})	LA_{max} over a sample period is the maximum A-weighted noise level measured during the period. In the context of aircraft noise, LA_{max} generally means the maximum A-weighted noise level recorded during a specific overflight, measured using “Slow” speed, and can therefore also be written LAS_{max}. In this report, LAmax denotes the maximum level attained during a single overflight.
MDP	Major development plan in accordance with the Airports Act.
mg/m^3	Milligrams per cubic metre
MIKE21 modelling	MIKE21 is a two dimensional hydraulic modelling software program used to simulate surface flow and estimate flood levels and flow velocities.
Minister for Infrastructure and Regional Development	Hon. Warren Truss MP

Term	Definition
Minister for the Environment	Hon. Greg Hunt MP
Mitigation	The action of reducing the severity, seriousness, or painfulness of something.
MNES	Matters of national environmental significance
MOS	Manual of standards
MUSIC modelling	MUSIC is a software program used to estimate the performance of stormwater quality management systems.
N60	N60 is a measure of noise exposure defined exactly as for N70, but representing the average number of aircraft overflights per day exceeding 60 dBA. However, N60 is generally used to describe night time noise exposure. In this report, unless otherwise noted, N60 values represent the average number of aircraft overflights per day exceeding 60 dBA during the period 10pm to 7am.
N70	N70 is a measure of noise exposure that indicates the average number of times per day (or other specified time period) that an aircraft overflight will have L_{Amax} greater than 70 dBA respectively. The numbers of overflights are graded in contour lines on a map. N70 contours can be calculated for different time periods, indicating the average number of over flights experienced per day in that period.
NASF	National Airports Safeguarding Framework
National environmental protection measure	Broad framework-setting statutory instruments which outline agreed national objectives for protecting or managing particular aspects of the environment. NEPMs are similar to environmental protection policies and may consist of any combination of goals, standards, protocols, and guidelines.
Nautical mile	A unit of distance. One nautical mile equals 1.852 kilometres.
NEPM	National Environmental Protection Measure
NGER Regulations	*National Greenhouse and Energy Reporting Regulations 2008* (Cth)
Nitrogen	Nitrogen is a colourless element that has no smell and is usually found as a gas. It forms about 78% of the earth's atmosphere, and is found in all living things.
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxide
Non-putrescible	General solid waste including waste cardboard, glass, green waste, metals, paper, plastics, wood and electronic waste.
NPWS Act	*National Parks and Wildlife Act 1974* (NSW)
Nuisance dust	Dust which reduces environmental amenity without necessarily resulting in material harm. Nuisance dust comprises particles with diameters nominally from about one millimetre to 50 micrometres (microns).
O_3	Ozone
Offset measure	A conservation action that is intended to compensate for the negative environmental impacts of an action, such as a development. Offsets can include protecting at-risk environmental assets, restoring or extending habitat for threatened species, or improving the values of a heritage place.
OLS	Obstacle limitation surface – a series of surfaces that define the limits to which structures or objects may project into the airspace to ensure the safety of aircraft.

Term	Definition
Organic	An organic compound is any member of a large class of gaseous, liquid, or solid chemical compounds whose molecules contain carbon.
PAH	Polycyclic aromatic hydrocarbon
PANS-OPS	Procedures for air navigation services – aircraft operations
Particulate	A complex mixture of extremely small particles and liquid droplets.
Pathogen	A bacterium, virus, or other microorganism that can cause disease.
Permissible use	A land use which may receive development consent under the *Environmental Planning and Assessment Act 1979* (NSW).
PM	Airborne particulate matter
PM_{10}	Airborne particulate matter with an aerodynamic diameter of less than 10 µm
$PM_{2.5}$	Airborne particulate matter with an aerodynamic diameter of less than 2.5 µm
POEO Act	*Protection of the Environment and Operations Act 1997* (NSW)
Point merge system	This is a way of synchronising arriving aircraft and directing them to the runway in a structured manner through a single final approach track. By directing aircraft though a series of predictable routes, the vertical and lateral path taken on approach is more accurate and can result in a reduction in the number of level flight segments required at a low altitude.
ppb	Parts per billion
ppm	Parts per million
Proposed airport	The proposed airport at Badgerys Creek and assessed in the Western Sydney Airport Environmental Impact Statement.
PSZ	Public safety zone
Putrescible	In relation to waste, material that may decay or putrefy.
RAAF	Royal Australian Air force
Ramsar Convention	An intergovernmental treaty that provides the framework for national action and international cooperation in wetland conservation. The treaty is named after the city of Ramsar in Iran, where it was signed.
Receivers	See sensitive receiver.
Receptors	See sensitive receiver.
Residual risk	Residual risk is the level of risk that remains after proposed mitigation and management measures are implemented.
Restricted airspace	Restricted airspace includes all airspace that has restrictions placed on its use. This is generally associated with military installations or other situations where safety is an issue, for example explosives storage facilities such as the Defence Establishment Orchard Hills.
Reticulated	In relation to water or another utility, transferred from one place to another.
Reverse thrust	A temporary redirection of aircraft engines so that the direction of exhaust is reversed, usually to provide a breaking effect during landings. Reverse thrusting generally produces an increase in noise during landing.
SACL	Sydney Airport Corporation Limited
SEIFA	Socioeconomic Indexes for Areas

Term	Definition
Sensitive receiver	A place occupied by people that is sensitive to impacts. This term is usually used in air and noise studies to refer to dwellings, businesses, schools and the like. Also termed sensitive receptor.
SEPP	NSW State Environmental Planning Policy
Significant impact	As defined in the EPBC Act *Significant impact guidelines 1.2*, a 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts.
SO_2	Sulphur dioxide
SO_x	Sulfur oxides
Stage 1 development	The initial stage in the development of the proposed airport, including a single runway and 10 million annual passengers (nominally occurring in 2030).
STM3	Strategic Travel Model (Version 3)
SWRL	South West Rail Link
Sydney Airport	Sydney (Kingsford Smith) Airport
Sydney Basin	The Sydney Basin extends over approximately 350 kilometres of coastline from Newcastle in the north, to Durras Lake in the south. To the west the boundary runs in a line through Lithgow along the Liverpool Range to about 80 kilometres north of Muswellbrook and back to the coast at Newcastle. The total land area of the basin is approximately 44,000 square kilometres and the centre lies about 30 kilometres west of the Sydney CBD at Fairfield.
Sydney CBD	Sydney Central Business District
TAPM	The Air Pollution Model
Taxiways	Defined paved areas provided for the surface movement of aircraft between runways and aprons.
The Department	Australian Government Department of Infrastructure and Regional Development
The Proponent	The proponent for the development and operation of the airport is the Australian Government Department of Infrastructure and Regional Development.
The proposed airport	The proposed Western Sydney Airport.
Threatened species	Species of animals or plants that are at risk of extinction, or becoming endangered within the next 25 years ('vulnerable species'), defined by the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999*
TSC Act	*Threatened Species Conservation Act 1995* (NSW)
TSP	Total suspended particulates
ug/m^3	Micrograms per cubic metre
UNESCO	United Nations Educational, Scientific and Cultural Organisation
USEPA	United States Environmental Protection Agency
VOC	Volatile organic compounds
Western Sydney	The proposed airport. The airport is referred to as Sydney West Airport under the *Airports Act 1996* (Commonwealth).

Term	Definition
Airport	
Western Sydney Region	Western Sydney is a major region of Sydney, New South Wales. Defined by the Western Sydney Regional Organisation of Councils (WSROC) as ranging from Auburn to the Blue Mountains and from Liverpool to Hawkesbury, with a total land area of about 5,400 square kilometres.
WHS	Work health and safety
WM Act	*Water Management Act 2000* (NSW)
WSEA	Western Sydney Employment Area
WSIP	Western Sydney Infrastructure Plan
WSU	Western Sydney Unit, Australian Government Department of Infrastructure and Regional Development

Part D – Environmental impact assessment

9. Approach to impact assessment

9.1. Introduction

The Department of Infrastructure and Regional Development is proposing the design, construction and operation of the proposed Western Sydney Airport (proposed airport) to cater for ongoing growth in demand for aviation services in the Sydney region and to support economic and employment growth in Western Sydney. This draft environmental impact statement (EIS) has been prepared in accordance with the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) to support determination of an Airport Plan under the *Airports Act 1996* (Airports Act).

A draft Airport Plan has been developed to provide the strategic direction for the proposed airport, and includes a specific proposal for Stage 1 and an indicative concept for the long term development. This draft EIS assesses the Stage 1 development, incorporating a single runway and support facilities to cater for an operational capacity of around 10 million annual passengers and approximately 63,000 air traffic movements per year, allowing for the anticipated demand until around 2030.

Volume 2 of the draft EIS has been prepared to provide a detailed consideration of environmental impacts arising from the Stage 1 development. The assessment is based on construction and operational parameters described in detail in Volume 1 of this draft EIS and included within Part 3 of the draft Airport Plan. The Stage 1 development broadly includes:

- construction activities associated with establishing a graded (level) site, which will include site clearing and major earthworks over approximately 60 per cent of the site;
- a 3,700 metre runway positioned on the northern portion of the site on an approximate north-east/south-west or 50/230 degree orientation and a single full length taxiway;
- aviation support facilities including passenger terminals, cargo and maintenance areas, car parks, car rental and navigational instrumentation;
- operational capacity to accommodate up to 10 million annual passengers (domestic and international) by 2030, along with freight services – equivalent to approximately 63,000 air traffic movements per year; and
- authorisation for some non-aeronautical commercial uses to be developed at the airport site.

The proposed airport would be developed progressively as demand increases beyond the predicted 2030 capacity of Stage 1. Additional aviation infrastructure such as taxiways, aprons, terminals, support facilities and a second runway would be progressively implemented to provide additional capacity. The need for a second runway would be triggered when the demand approaches 37 million annual passengers by around 2050. The long-term capacity of the airport to cater for 82 million passengers is expected to be required by around 2063.

All major infrastructure developments beyond the scope of the Stage 1 development would be subject to additional approvals in accordance with Part 5 of the Airports Act, and do not form part of the development for authorisation under the draft Airport Plan.

It is recognised that approval of the Stage 1 development would directly facilitate growth of the proposed airport beyond the scope of the development described in the draft Airport Plan. The progressive expansion of site operations has the potential to increase the level of impacts associated with the airport, particularly in regards to the surrounding community's exposure to aircraft noise.

A strategic level assessment has therefore been undertaken to assess the impacts arising from the long term development; these are presented in Volume 3 of this draft EIS. The strategic level assessment recognises the uncertainty in predicting impacts that may occur nearly 50 years into the future and the additional approval requirements for all future development. The approach provides flexibility in the master planning process to allow land use changes, technological improvements and changes in operational practices to be reflected in future development scenarios, while providing stakeholders and the community with greater clarity of the likely extent of future changes at the airport site to support the consideration of the Stage 1 development.

It is recognised that aircraft noise is one of the most sensitive issues associated with the development of the proposed airport and an increase in air traffic movements has the potential to increase the level of noise disturbance experienced by the surrounding community. Taking this into account, the draft EIS has assessed aircraft noise impacts for a 2050 scenario where the single runway is operating at a capacity of around 37 million annual passengers or approximately 185,000 aircraft movements per year. This scenario allows an assessment of the extent of noise exposure and associated potential impacts from the maximum capacity of the single runway that may result from the Stage 1 development.

A summary of assessment scenarios considered within the draft EIS is presented in Table 9–1. The potential impacts associated with the Stage 1 development are considered for all environmental aspects and are presented in Volume 2 of this draft EIS. The long term development is addressed separately in Volume 3.

Table 9–1 – Assessment scenarios

Development stage	Indicative year(s)	Environmental aspects considered	EIS reference
Construction	2016 to end of 2024	All relevant aspects	Volume 2 – Chapters 9 through 26
Stage 1 development (10 million annual passengers)	2030	All relevant aspects	Volume 2 – Chapters 9 through 29
Long term development Single runway at capacity (37 million annual passengers)	2050	Noise	Volume 3 – Chapter 31
Long term development Two runways operating at capacity (82 million annual passengers)	2063	Strategic assessment for all relevant aspects	Volume 3 – Chapter 31 – 40

9.2. Impact assessment process

The framework for the impact assessment has been designed to provide a structured and objective approach to identifying the proposed airport's environmental, social and economic impacts, and to developing effective mitigation, management and offset measures. The approach has generally involved:

- project definition including analysis of the need and alternatives to address the growing aviation demand in the Sydney Basin;
- identification of key issues through reviewing previous investigations, preparation of an EPBC Act referral and a gap analysis and risk assessment process;
- identifying existing environmental, social and economic baseline conditions;
- completion of impact assessments for the project based on the broad parameters presented in the draft Airport Plan having regard to the baseline conditions;
- refinement of the project having regard to the impact assessments; and
- identification of appropriate mitigation, management, monitoring measures and (where appropriate) offset measures for the identified potential impacts.

The baseline (or existing environment) conditions for the airport site and surrounding locality were derived using a combination of desktop and field investigations relevant to each environmental aspect or value. Where possible, the investigations built on previous studies that have been completed at the airport site.

The impact assessment methodology for each environmental, social and economic value was developed to meet the *Guidelines for the Content of a Draft Environmental Impact Statement – Western Sydney Airport* (EIS guidelines) issued by the Australian Government Department of the Environment (refer to Appendix C in Volume 4). The intent and objectives of the New South Wales legislative framework and assessment guidelines were also considered where appropriate for each environmental value.

Mitigation and management measures were applied to reduce the level of identified potential impacts. These measures aim to protect the identified environmental values and would be applied as required during the planning and design, construction and operation phases of the project.

A number of monitoring plans would also be developed and implemented to monitor and, in some situations, address various residual impacts associated with the development of the proposed airport.

9.3. Issues identification

9.3.1. Overview

Key issues and risks to be assessed within the draft EIS were identified using a number of related processes.

The EIS guidelines provide the overall framework of specific matters to be addressed by the EIS. A gap analysis and risk assessment process was undertaken at the start of the assessment to help prioritise key issues and develop the scope of the specialist investigations to be undertaken to support the preparation of the draft EIS.

Government and community stakeholders were also consulted to help identify their key issues, attitudes and concerns regarding the proposed airport, as outlined in Chapter 8 of Volume 1.

9.3.2. EPBC Act referral

The Department of Infrastructure and Regional Development submitted a referral under the EPBC Act for the Stage 1 development of the proposed airport on 4 December 2014. The referral was available for public comment for 12 business days.

On 23 December 2014, a delegate of the Minister for the Environment determined the proposed Western Sydney Airport to be a controlled action. The referral decision instrument identifies the following controlling provisions under the EPBC Act as being relevant for this proposal:

- world heritage properties (sections 12 & 15A);
- national heritage places (sections 15B & 15C);
- listed threatened species and communities (sections 18 & 18A); and
- Commonwealth action (section 28).

At the same time the delegate decided that the proposed airport development would be assessed by preparation of an EIS.

Tailored guidelines for the preparation of a draft EIS were issued by the Department of the Environment on 29 January 2015. The EIS guidelines detail the information about the proposed airport and its relevant impacts that must be provided in the EIS; these are presented in full in Appendix B. The EIS guidelines also include a range of general requirements for the format and style of the EIS, together with specific requirements for the content of the EIS. Table 9–2 provides a summary of the specific guideline requirements and identifies where in the draft EIS they have been addressed for Stage 1.

Table 9–2 – EIS guidelines

EIS guideline requirement	Where it is addressed
Section 1 – General information	
This should provide the background and context for the action including: a. the title of the action; b. the full name and postal address of the designated Proponent; c. a clear outline of the objective of the action; d. the location of the action; e. the background to the development of the action; f. how the action relates to any other actions (of which the Proponent should reasonably be aware) that have been, or are being, taken or that have been approved in the region affected by the action; g. the current status of the action; and h. the consequences of not proceeding with the action.	Chapters 1 and 2
Section 2 – Description of the action	
All construction, operational and (if relevant) decommissioning components of the action should be described in detail. This should include the precise location (including coordinates) of all works to be undertaken, structures to be built or elements of the action that may have impacts on matters of National Environmental Significance. The description of the action must also include details on how the works are to be undertaken (including stages of development and their timing) and design parameters for those aspects of the structures or elements of the action that may have relevant impacts.	Chapters 4 to 7
Section 3 – Feasible alternatives	
Any feasible alternatives to the action to the extent reasonably practicable, including: a. if relevant, the alternative of taking no action; b. a comparative description of the impacts of each alternative on the matters of national environmental significance and other matters protected by controlling provisions of Part 3 of the EPBC Act for the action; and c. sufficient detail to make clear why any alternative is preferred to another. Short, medium and long-term advantages and disadvantages of the options should be discussed.	Chapter 2
Section 4 – Description of the environment	
(a) Listed threatened species (including suitable habitat) and ecological communities that are or are likely to be present in all areas of potential impact. To satisfy this requirement details must be presented on the scope, timing/effort (survey season/s) and methodology for studies and surveys used to provide information on the relevant listed threatened species/ecological community/habitat (as identified in Attachment 3). This includes details of: ▪ how best practice survey guidelines have been applied; and ▪ how surveys are consistent with (or a justification for divergence from) published Australian Government guidelines and policy statements.	Chapters 16 Appendix K

EIS guideline requirement	Where it is addressed
(b) A description of the World Heritage/National Heritage values of the Greater Blue Mountains Area World Heritage property/National Heritage Place, as described in the Statement of Outstanding Universal Value and including reference to the World Heritage criteria the area is listed for as well as the integrity of the property.	Chapters 26 and 38
(c) A description of the environment in all areas of potential impact, including all components of the environment as defined in Section 528 of the EPBC Act: ▪ ecosystems and their constituent parts, including people and communities; ▪ natural and physical resources; ▪ the qualities and characteristics of locations, places and areas; ▪ heritage values of places; and ▪ the social, economic and cultural aspects of a thing mentioned in the preceding dot points.	Chapters 10 to 39 Relevant appendices
Section 5 – Relevant Impacts	
(a) The EIS must include a description of all of the relevant impacts of the action. Relevant impacts are impacts that the action will have or is likely to have on a matter protected by a controlling provision (as listed in the preamble of this document). Impacts during both the construction, operational and (if relevant) the decommissioning phases of the project should be addressed, and the following information provided: ▪ a detailed assessment of the nature and extent of the likely short-term and long-term relevant impacts (detailing direct and indirect impacts); ▪ a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible; ▪ analysis of the significance of the relevant impacts; and ▪ any technical data and other information used or needed to make a detailed assessment of the relevant impacts.	Chapters 10 to 39 Relevant appendices
(b) The EIS should identify and address cumulative impacts, where potential project impacts are in addition to existing impacts of other activities (including known potential future expansions or developments by the proponent and other proponents in the region and vicinity). The EIS should address the potential cumulative impact of the proposal on ecosystem resilience. The cumulative effects of climate change impacts on the environment must also be considered in the assessment of ecosystem resilience. Where relevant to the potential impact, a risk assessment should be conducted and documented.	Chapter 27 Volume 3
(c) The EIS should address the potential for facilitated impacts upon MNES at the local, regional, state, national and international scale.	Chapters 10 to 39
(d) If the conclusion is made that any relevant controlling provision or element of a relevant controlling provision will not be impacted by the proposed action, then justification must be provided for how this conclusion has been reached. This includes any threatened species or ecological communities that are likely to be present on site, heritage items/places likely to be on site and other relevant elements of the environment that may be impacted by the proposed action.	Chapters 10 to 39 Detailed assessment has been undertaken for all controlling provisions.
(e) To support the assessment of local historic and indigenous heritage values, the EIS must include a full heritage impact assessment and the findings of the further program of archaeological survey that was foreshadowed in the referral for this project.	Chapters 19, 20 and 39 Appendix M

EIS guideline requirement	Where it is addressed
(f) Further details of threatened species and ecological communities protected by the controlling provisions of Part 3 of the EPBC Act are provided at Attachment 3.	Chapters 16 and 39 Appendix K
▪ changes to water quality on site and downstream of the site ▪ changes to siltation ▪ hydrological changes	Chapters16, 18, 34 and 39 Appendix K and L
▪ removal and degradation of heritage items/places (historic, natural and indigenous)	Chapters 19, 20 and 39 Appendix M
▪ native flora and fauna habitat removal and degradation (on site and in surrounding areas that may be affected by the action)	Chapters 16 and 39 Appendix K
▪ aircraft noise and vibration impacts on everyday activities and on sensitive environmental receptors (all sensitive receptors within the community and natural environment). Discussion and quantification/modelling of aircraft noise impacts should include consideration of all potential flight paths, height of flights, noise exposure patterns, noise contours, the range of frequencies of the noise, cumulative exposure, peak noise, frequency of overflights and temporal variability of this (including long term trends), varying aircraft types, varying aircraft operating procedures, and variations in noise patterns due to seasonal and meteorological factors	Chapters 10 and 31 Appendix E
▪ noise and vibration from construction activities and machinery	Chapter 11 Appendix E
▪ changes to air quality during construction and operation (including consideration of seasonal and meteorological variations that influence local air quality)	Chapters 12 and 32 Appendix F
▪ potential fuel dumping impacts	Chapter 7 and 13 Appendix F
▪ changes in traffic movements during construction and operation (associated with both passenger movements and workers)	Chapters15 and 33 Appendix J
▪ bird or bat airstrike	Chapter 14 and 16 Appendix I
▪ lighting impacts on everyday activities and on sensitive environmental receptors (all sensitive receptors within the community and natural environment)	Chapters 22 and 36 Appendix O
▪ changes in recreational use and amenity of natural areas	Chapters 21, 22 and 23 Appendix N, O and P
▪ change in qualities and characteristics of the surrounding areas and associated impacts to local communities (including land values and other economic impacts)	Chapters 21, 22, 23 and 24 Appendix N, O and P
▪ creation of any risks or hazards to people or property that may be associated with any component of the action.	Chapters 14 and 39 Appendix H

EIS guideline requirement	Where it is addressed
Quantification and assessment of impacts should: • be against appropriate background/baseline levels • be prepared according to best practice guidelines and compared to best practice standards • consider seasonal and temporal variations where appropriate (including temporal changes in the sensitivity of the receptor) • be supported by maps, graphs and diagrams as appropriate to ensure information is readily understandable Guidelines and standards used to quantify baselines and impacts should be explained and justified.	Chapters 10 to 39 Relevant appendices
Section 6 – Avoidance and mitigation measures	
(a) The EIS must provide information on proposed avoidance and mitigation measures to manage the relevant impact of the action on a matter protected by a controlling provision (as listed in the preamble of this document).	Chapter 28 (consolidated) Relevant appendices
(b) The EIS must take into account relevant agreements and plans that cover impacts or known threats to a matter protected by a controlling provision (including but not necessarily limited to): (a) any recovery plan and/or conservation advice for the affected species or ecological community; (b) any threat abatement plan for a process that threatens an affected species or ecological community; (c) any wildlife conservation plan for the affected species; (d) any relevant strategic assessment undertaken in accordance with an agreement under Part 10 of the EPBC Act.; and (e) For the Greater Blue Mountains Area World Heritage property, the World Heritage Convention; the Australian World Heritage Management Principles; the Greater Blue Mountains Area World Heritage Area Strategic Plan , and relevant NSW National Parks and Wildlife Service/Office of Environment and Heritage Plans of Management..	Chapters 16 and 26 Appendix K

EIS guideline requirement	Where it is addressed
(c) The EIS must include specific and detailed descriptions of the proposed avoidance and mitigation measures based on best available practices. This must include the following elements : i. A consolidated list of mitigation measures proposed to be undertaken to prevent, minimise or compensate for the relevant impacts of the action, including: ▪ a detailed description of proposed measures; ▪ assessment of the expected or predicted effectiveness of the mitigation measures; ▪ any statutory or policy basis for the mitigation measures; and ▪ the likely cost of the mitigation measures. ii. A detailed outline of a plan for the continuing management, mitigation and monitoring of relevant matters protected by a controlling provision, including a description of the outcomes that will be achieved and any provisions for independent environmental auditing. iii. Where appropriate, each project phase (construction and operation) must be addressed separately. It must state the environmental outcomes, performance criteria, monitoring, reporting, corrective action, contingencies, responsibility and timing for each environmental issue. iv. The name of the agency responsible for endorsing or approving each mitigation measure or monitoring program.	Chapter 28
Section 7 – Residual impacts and offsets	
Residual impacts (a) The EIS must provide details of the likely residual impacts upon a matter protected by a controlling provision after the proposed avoidance and mitigation measures have been taken into account. This includes: i the reasons why avoidance or mitigation of impacts may not be reasonably achieved. ii quantification of the extent and scope of significant residual impacts.	Chapters 10 through 28
Offset package (a) The EIS must include details of an offset package to be implemented to compensate for residual significant impacts associated with the project, as well as an analysis of how the offset meets the requirements of the Department's Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy October 2012 (EPBC Act Offset Policy).	Chapter 16 and Appendix K
(b) The offset package can comprise a combination of direct offsets and other compensatory measures, as long as it meets the requirements of the EPBC Act Offset Policy. Offsets should align with conservation priorities for the impacted protected matter and be tailored specifically to the attribute of the protected matter that is impacted in order to deliver a conservation gain.	Chapter 16 and Appendix K
(c) Offsets should compensate for an impact for the full duration of the impact.	Chapter 16 and Appendix K
(d) Offsets must directly contribute to the ongoing viability of the protected matter impacted by the project and deliver an overall conservation outcome that maintains or improves the viability of the protected matter, compared to what is likely to have occurred under the 'status quo' (i.e. if the action and associated offset had not taken place).	Chapter 16 and Appendix K
(e) Note: offsets do not make an unacceptable impact acceptable and do not reduce the likely impacts of a proposed action. Instead, offsets compensate for any residual significant impact.	Chapter 16 and Appendix K

EIS guideline requirement	Where it is addressed
(f) The EIS must provide: i details of the offset package to compensate for significant residual impacts on a protected matter; and ii an analysis of how the offset package meets the requirements of the EPBC Act Offsets Policy.	Chapter 16 and Appendix K
Section 8 – Environmental Record	
(a) The information provided must include details of any past or current proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against: i the person proposing to take the action; and ii the person making the application for any related permits.	Appendix A
(b) If the person proposing to take the action is a corporation, details of the corporation's environmental policy and planning framework must also be included.	Appendix A
Section 9 – Other approvals and conditions	
The EIS must include information on any other requirements for approval or conditions that apply, or that the proponent reasonably believes are likely to apply, to the proposed action. This must include:	
(a) details of any local or State Government planning scheme, or plan or policy under any local or State Government planning system that deals with the proposed action, including: • what environmental assessment of the proposed action has been, or is being, carried out under the scheme, plan or policy; and • how the scheme provides for the prevention, minimisation and management of any relevant impacts;	Chapter 3
(b) a description of any approval that has been obtained from a State, Territory or Commonwealth agency or authority (other than an approval under the Act), including any conditions that apply to the action;	Chapter 3
(c) a statement identifying any additional approval that is required; and	Chapter 3
(d) a description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action.	Chapter 28
Section 10 – Economic and social matters	
(a) The economic and social impacts of the action, both positive and negative, must be analysed. Matters of interest may include: i details of any public consultation activities undertaken, and their outcomes; ii details of any consultation with Indigenous stakeholders; iii projected economic costs and benefits of the project, including the basis for their estimation through cost/benefit analysis or similar studies; and iv employment opportunities expected to be generated by the project (including construction and operational phases).	Chapters 24 and 37 Appendix P
(b) The economic and social impacts must include impacts at the local, regional and national level.	Chapter 23, 24 and 37 Appendix P

EIS guideline requirement	Where it is addressed
(c) Details of the relevant cost and benefits of alternative options to the proposed action, as identified in Section 3, should also be included.	Chapter 2
Section 11 – Information sources	
For information given in the EIS, the EIS must state:	
(a) the source of the information	Throughout
(b) how recent the information is	Throughout
(c) how the reliability of the information was tested	Throughout
(d) what uncertainties (if any) are in the information	Throughout
(e) what guidelines, plans and/or policies have been considered during preparation of the EIS	Throughout
Section 12 – Conclusion	
An overall conclusion as to the environmental acceptability of the proposal on protected matters must be provided, which includes:	Chapters 29 and 40
(a) a discussion on how consideration has been given to the objects of the EPBC Act, the principles of ecologically sustainable development, and the precautionary principle (as detailed at Attachment 1);	Chapter 29
(b) justification for undertaking the proposal in the manner proposed, including the acceptability of the avoidance and mitigation measures; and	Chapter 29
(c) if relevant, a discussion of residual impacts and any offsets and compensatory measures proposed or required for significant residual impacts on protected matters, and the relative degree of compensation and acceptability.	Chapter 29

9.3.3. Gap analysis

Consideration of the need for and potential location of a second Sydney airport has been ongoing for a number of decades and has included the preparation of two previous EISs, in 1985 and 1997–99. Badgerys Creek was initially assessed as the preferred second Sydney airport site in the 1985 *Second Sydney Airport Site Selection Programme Draft Environmental Impact Statement* (1985 EIS) (Kinhill Stearns 1985). The 1997–99 *Second Sydney Airport Proposal Environmental Impact Statement* (1997–99 EIS) (PPK 1997) provides the most recent comprehensive environmental assessment of the site and considered an airport concept (known as ‘Option A’) that had a similar runway configuration to the current proposal.

The previous EISs provided a substantial compilation of environmental baseline conditions and considered potential impacts associated with the development of the proposed airport at the Badgerys Creek site, in the context of the proposed operational parameters and approvals framework at the time of publication of each EIS.

A gap analysis was undertaken to determine the degree to which these previous studies could be relied or expanded upon to address the potential impacts associated with the proposal described in Part 3 of the draft Airport Plan. The length of time since previous investigations were completed was considered to limit their applicability to the current assessment.

Key observations from the gap analysis included the following:

- introduction of the EPBC Act, which has resulted in a revised Commonwealth statutory environmental assessments framework and increased stakeholder expectations about the level of assessment to be included within an EIS;
- listing of the Greater Blue Mountains Area on the United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage List;
- an increased emphasis on biodiversity protection and consideration of offset requirements;
- the broadening of the legislative description of threatened species since 1999, at both the State and Commonwealth levels, which has meant that previous mapping of Cumberland Plain Woodland and threatened species at the site would no longer be considered accurate;
- the changing context of the airport site, including the emergence of Western Sydney as a focus for economic and urban growth and the need to consider current strategic land use planning considerations for Western Sydney;
- revised operational parameters for the proposed airport, changes in forecast aircraft fleet mix and improvements in aviation technology since the previous studies, which have the potential to change the predicted environmental performance of the proposed airport; and
- revised standards and stakeholder expectations for data collection, analysis and reporting across a range of environmental disciplines, which have also limited the applicability of the previous assessments.

Despite these limitations, the previous investigations were considered useful to provide a substantial baseline for the identification of some of the key issues to inform the scope of this draft EIS. Building on the previous studies, a range of specialist investigations were undertaken to support the preparation of the draft EIS and address the requirements of the EIS guidelines. These investigations are included in Volume 4.

9.3.4. Risk assessment

A risk assessment process was undertaken to build on the identification of issues through the EPBC referral and the gap analysis. The risk assessment was undertaken to help prioritise the assessment and inform the scope of specialist studies. The risk assessment involved the following four main steps:

- identifying environmental aspects;
- identifying the source of potential risks associated with each of these aspects;
- evaluating the risks (including likelihood and severity) and applying a preliminary consideration of potential mitigation measures; and
- considering significant findings, including any residual risks after mitigation measures are applied.

The identified risks were then considered through a risk assessment workshop that involved subject matter experts and the EIS development team. A summary of key issues identified from the risk assessment, and where each risk has been assessed in detail as part of the EIS, is presented in Table 9–3.

Table 9–3 – Risk assessment outcomes (initial risk ranking 'high' or above) for Stage 1 Development

Issue	Where addressed
Noise and vibration	
Amenity and health impacts caused by exposure to excessive construction noise	Chapters 11 and 13 Appendix E and G
Amenity and health impacts caused by short term exposure to road traffic noise (construction traffic, haul, workforce etc.)	Chapters 11 and 13 Appendix E and G
Exposure to excessive vibration impacting amenity, and/ or contributing to damage to nearby buildings/ structures.	Chapters 10 and 11 Appendix E
Amenity and health impacts caused by exposure to aircraft noise beyond airport boundary	Chapters 10, 11, and 13 Appendix E and G
Amenity and health impacts associated with long term generation of road traffic noise (servicing the airport)	Chapters 11 and 13 Appendix E and G
Amenity and health impacts caused by exposure to ground running noise and vibration adjacent to airport e.g. taxiing, refuelling, engine testing, general maintenance etc.	Chapters 11 and 13 Appendix E and G
Air quality	
Generation of construction dust leading to amenity and human health impacts	Chapters 12 and 13 Appendix F and G
Generation of construction vehicle emissions leading to amenity and human health impacts	Chapters 12 and 13 Appendix F and G
Amenity and human health impacts caused by aircraft and other operational emissions (local)	Chapters 12 and 13 Appendix F and G
Community health	
Amenity and health impacts associated with potential construction impacts e.g. noise, air quality etc.	Chapter 13 Appendix G
Local health and amenity impacts associated with exposure to operational impacts e.g. noise, air quality, water quality etc. for properties and communities surrounding the airport	Chapter 13 Appendix G
Amenity and health impacts caused by reduction in regional air quality associated with aircraft operations	Chapter 13 Appendix G
Amenity and health impacts caused by noise impacts associated with aircraft operations (over flights)	Chapter 13 Appendix G
Surface transport and access	
Risk of injury or death caused by construction traffic (including haul) interacting with local traffic and pedestrians	Chapter 15 Appendix J

Issue	Where addressed
Congestion on existing transport routes caused by increased traffic volumes associated with construction	Chapter 15 Appendix J
Risk of injury or death caused by operational traffic servicing the airport interacting with local traffic and pedestrians	Chapter 15 Appendix J
Congestion on existing transport routes caused by increased operational traffic servicing the airport	Chapter 15 Appendix J
Regional accessibility insufficient to service the operation of the airport e.g. road network etc.	Chapter 15 Appendix J
Biodiversity	
Clearing of vegetation and earthworks impacting on threatened species and communities	Chapter 16 Appendix K
Habitat removal	Chapter 16 Appendix K
Construction in waterways/ crossings impacting on water quality, threatened species and aquatic habitat	Chapter 16 Appendix K
Increased erosion and sedimentation impacting on water quality, threatened species and aquatic habitat	Chapter 16 Appendix K
Potential impacts to threatened species, communities and habitat caused by indirect impacts during construction e.g. noise, dust, light	Chapter 16 Appendix K
Potential impacts to threatened species, communities and habitat caused by indirect impacts during operation e.g. noise, dust, light	Chapter 16 Appendix K
Bird and bat strike- mortality risk to threatened fauna	Chapter 16 Appendix K
Hydrology and water quality	
Alteration of local hydrology caused by earthworks and interruption of existing local flow regime	Chapter 18 Appendix L
Affectation of stream stability caused by vegetation clearing, earthworks and changes to existing flow regimes (increased flows, concentrated flows etc.)	Chapter 18 Appendix L
Increased erosion and sedimentation associated with earthworks, exposed soil surfaces etc.	Chapters 17 and 18 Appendix L
Poor on-site management of sewage effluent during construction causes overflow event/ impacts on water quality	Chapter 18 Appendix L
Poor ongoing on-site management of sewage effluent causing overflow event/ impacts on water quality	Chapter 18 Appendix L

Issue	Where addressed
Increase in nutrient/heavy metal pollutants during operation	Chapter 18 Appendix L
Reduced groundwater recharge caused by increased impervious surface area	Chapter 18 Appendix L
Hazards and risks	
Accident involving construction vehicle causing fatality or serious injury	Chapter 14 Appendix H
Incident involving the transportation and/ or storage of fuel or other substances causing injury, fatality or environmental impact	Chapter 14 Appendix H
Bird and bat strike causing aircraft accident	Chapter 14 Appendix I
Visual impact	
Presence of construction site and plant in the landscape causing impact to visual amenity	Chapter 22 Appendix O
Unacceptable light spill or visibility for closest residents causing amenity and/ or health impacts (with regard to sleep disturbance- perceived or otherwise)	Chapter 22 Appendix O
Visibility of airport infrastructure, including ancillary facilities such as advertising billboards on airport approaches etc.	Chapter 22 Appendix O
Aboriginal heritage	
Harm to registered Aboriginal artefacts, places and cultural values	Chapter 19 Appendix M
Harm to unregistered Aboriginal objects or places	Chapter 19 Appendix M
Degradation of surrounding Aboriginal objects, places and cultural values	Chapter 19 Appendix M
European and other heritage	
Harm to listed buildings, sites or artefacts	Chapter 20 Appendix M
Harm to non-listed buildings, sites or artefacts	Chapter 20 Appendix M
Socio-economic	
Significant reduction in business activity and services caused by general access and land use changes associated with construction	Chapters 23 and 24 Appendix P

Issue	Where addressed
Difficulty in sourcing of local airport workforce	Chapter 24 Appendix P
Planning and land use	
Impacts associated with change of land use on site and off site	Chapters 21 and 23 Appendix N
Loss of productive agricultural land	Chapter 21 Appendix N
Property values	
Reduction in property values	Chapter 21 Appendix P
Geology, soils and topography	
Impacts associated with change in topography e.g. hydrology, visual impact	Chapters 17 and 22 Appendix O
Waste and resources assessment	
Generation of construction waste	Chapter 25
Generation of operational waste	Chapter 25
Cumulative impacts	
Congestion on existing transport routes caused by construction traffic	Chapter 27
Cumulative impacts associated with construction of airport at the same time as other developments e.g. Northern Road deviation, Elizabeth Drive, TransGrid power line relocation etc.	Chapter 27
Congestion on existing transport routes during operation	Chapter 27
Impacts on other airport facilities during operation e.g. Sydney Airport, Bankstown, Camden	Chapters 7 and 27
Reduction/ impact on natural resources	Chapters 25 and 27

9.4. EIS Volume 2 structure

Volume 2 provides a detailed impact assessment of the Stage 1 development presented in Part 3 of the draft Airport Plan. It is in three parts:

- Part D provides a detailed consideration of all environmental aspects potentially affected by the proposed airport;
- Part E provides the environmental management framework and mitigation requirements to be implemented as part of the proposed airport; and
- Part F provides a conclusion about the assessment of impacts.

10. Noise (aircraft)

Operation of the proposed airport would result in changes to the pattern of aircraft movements above Western Sydney through the introduction of new flight paths. An increase in aircraft movements would result in potential noise emissions from aircraft during take-off, landing and when in flight. The pattern of noise impacts that would result from operation of the proposed airport is complex, and depends on time of day, season, airport operating modes, weather conditions and potentially other factors.

This assessment of the Stage 1 development is based on indicative flight paths prepared by Airservices Australia to cater for a demand of 10 million annual passengers, equivalent to approximately 63,000 aircraft movements. This level of demand is predicted to occur by around 2030. The noise impact assessment undertaken for this draft EIS has adopted a conservative approach by assuming a Stage 1 fleet mix based on current day aircraft types, without taking account of future likely reductions in noise emissions from aircraft over time. The use of continuous descent approaches (which minimises the use of engine thrust by pilots) has been assumed.

For the loudest aircraft operations (long-range departures by Boeing 747 aircraft or equivalent), maximum noise levels over 85 dBA would be experienced at a small number of rural residential locations close to the airport site in Badgerys Creek. Maximum noise levels of 70–75 dBA could be expected within built-up areas in St Marys and Erskine Park as a result of such worst case operations. The Boeing 747 is, however, being phased out of passenger services by most airlines. Maximum noise levels due to more common aircraft types such as Airbus A320 or equivalent are predicted to be lower at 60–70 dBA in built-up areas around St Marys and Erskine Park, and over 70 dBA in some adjacent areas to the south-west of the airport site, such as Greendale.

During the day, the number of residents experiencing five or more aircraft noise events per day above 70 dBA would be about 1,500. Most recreational areas would not be subject to aircraft overflight noise events exceeding 70 dBA and any exceedance of this level would occur less than once per day on average.

On an average night, aircraft approaching and departing the proposed airport in a south-west to north-east direction are predicted to result in an estimated 48,000 people experiencing more than five events above 60 dBA. With an operating strategy in the opposite direction, approximately 6,000 people are predicted to experience on average more than five events above 60 dBA per night. This number would reduce to 4,000 if a head-to-head operating mode was implemented, in which aircraft would both approach and depart at the south-west end of the runway.

Most recreational areas would not be subject to aircraft overflight noise events with maximum levels exceeding 70 dBA. In recreational areas where this level of noise exposure is predicted, the average number of events above 70 dBA would be less than one event per day. The noise impact associated with take-offs in both directions and aircraft reverse thrust during landing would primarily affect Luddenham and Greendale. Discussion of potential aircraft noise impacts in relation to community health and social impacts are discussed in Chapter 13 and Chapter 23.

Approaches to mitigating aircraft noise generally focus on reducing noise emissions from the aircraft themselves, planning flight paths and airport operating modes in a way that minimises potential noise and environmental impacts, and implementing land use planning or other controls to ensure that future noise-sensitive uses are not located in noise-affected areas. It is expected that land use planning around the proposed airport would be influenced by final Australian Noise Exposure Forecast contours, once flight paths and operating modes are finalised and approved.

The noise impact of different airport operating modes has been considered as part of the assessment and can be seen to have varied impacts on communities surrounding the airport. Future reductions in aircraft noise emission levels are difficult to predict and therefore existing aircraft types have been assumed for the purposes of assessment. In practice, new and quieter aircraft would progressively replace current day aircraft types into the future.

10.1. Introduction

This chapter provides an assessment of potential aircraft noise impacts associated with the operation of Stage 1 of the proposed airport. The chapter draws on a comprehensive aircraft noise assessment undertaken for the proposed airport which is included as Appendix E1. In considering anticipated aircraft noise impacts, the assessment takes into account the projected air traffic volumes, indicative aircraft flight paths and airport operating modes, noise emissions from different aircraft types, and future population densities in areas surrounding the airport site.

The assessment addresses the requirements of the EIS Guidelines, which specifically require consideration of aircraft noise and vibration impacts on everyday activities and on sensitive receptors. For the purposes of assessment aircraft noise has been divided into two main categories generally in line with the regulation of aircraft and airport noise:

- aircraft operation noise (overflight, take-off and landing); and
- ground based noise (including aircraft taxiing, aircraft engine ground running and airport construction).

This chapter assesses noise associated with aircraft operations which is defined as being from the start of roll on departures and until an aircraft exits the runway (e.g. enters a taxiway) on arrivals. This includes noise generated by an aircraft when it is on the ground such as elevated thrust during take-off procedures and reverse thrust during landing procedures.

Ground-based aircraft noise sources such as ground based engine runs and taxiing together with other airport sources is considered separately in Chapter 11.

Assessment of the aircraft noise associated with the longer term development of the proposed airport is included in Chapter 31 of Volume 3.

10.2. Understanding aircraft noise

10.2.1. Nature of noise

Sound is a vibration travelling as a wave of pressure through the air from a source to a receiver, such as the human ear. The frequency of a sound is what gives it a distinctive pitch or tone with the rumble of distant thunder an example of a low frequency sound and a whistle an example of a high frequency sound. The human ear is more sensitive to high frequency sounds.

The loudness of a sound depends on its sound pressure level, which is expressed in decibels. Most sounds we hear in our daily lives have sound pressure levels in the range of 30-90 decibels. A-weighted decibels (dBA) are generally used for the purposes of assessment and have been adjusted to account for the varying sensitivity of the human ear to different frequencies of sound. The main effect of the adjustment is that low and very high frequencies are given less weight.

The sound level in the average residential home is about 40 dBA, the average conversation is about 60-65 dBA. Typical levels for listening to music at home are about 85 dBA, a loud rock band about 110 dBA, and a jet engine at around 100 metres from take-off is about 130 dBA. Figure 10–1 illustrates indicative dBA noise levels in typical situations.

In terms of sound perception, 3 dBA is the minimum change that most people can detect and every 10 dBA increase in sound level is heard as a doubling of loudness. However, individuals may perceive the same sound differently.

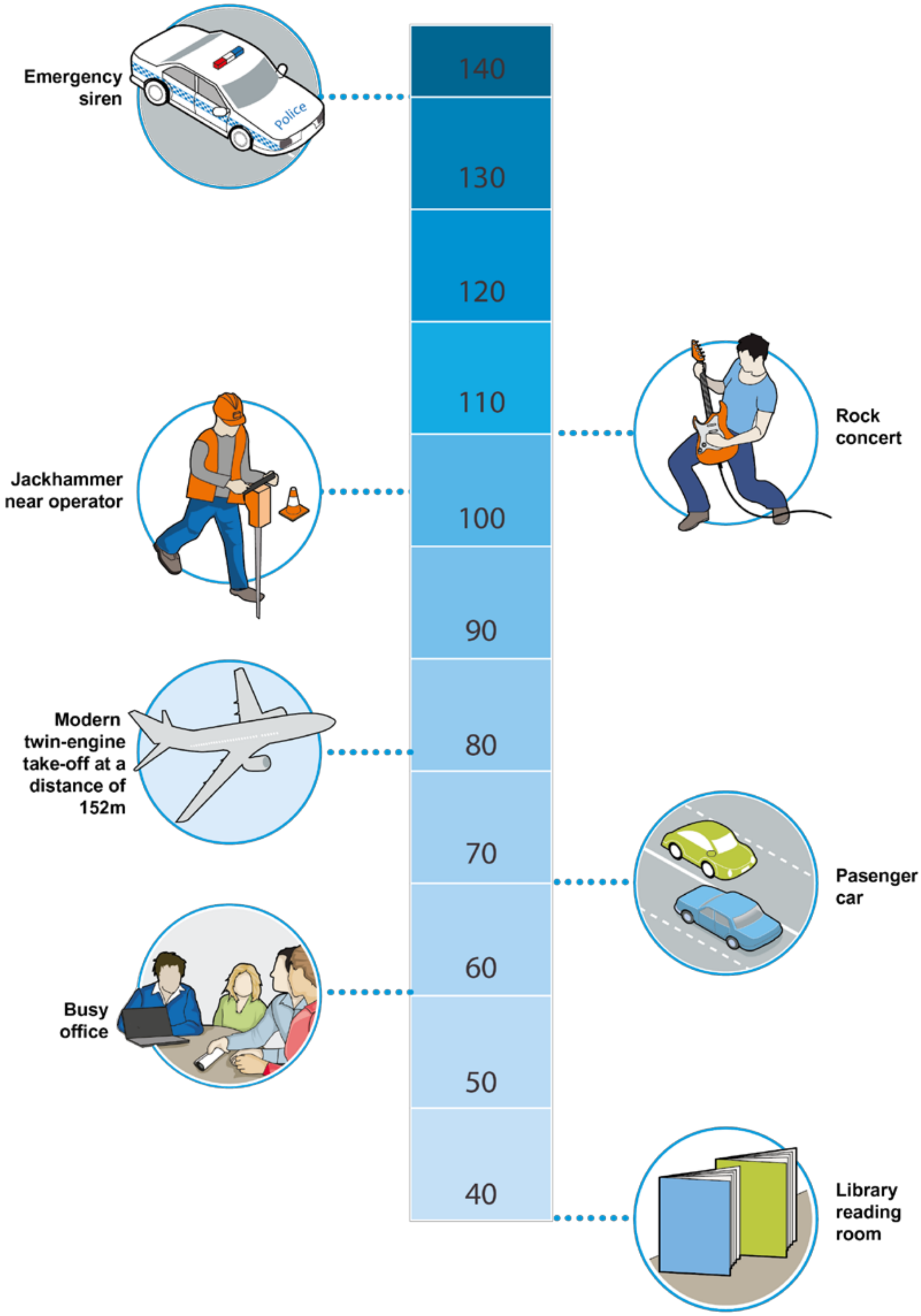


Figure 10–1 – Indicative dBA noise levels in typical situations

10.2.2. Sources of aircraft noise

Operation of the proposed airport would result in changes to the pattern of aircraft movements in the airspace above Western Sydney due to the introduction of new aircraft flight paths.

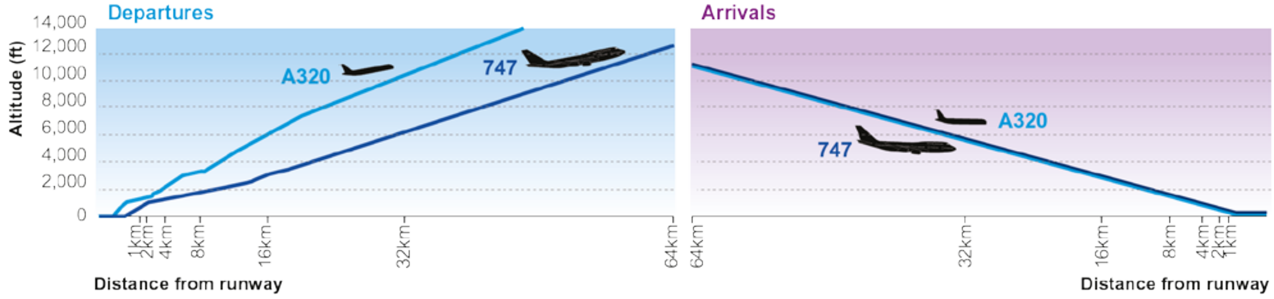
The characteristics of sound from aircraft can vary depending on a range of factors, including the type of engine, the operational stage and the height of the aircraft. While there are many sources of noise from an aircraft, it is the engines that are the dominant source for the majority of a flight cycle.

Engine noise can be particularly pronounced when aircraft are operating on the ground as a result of elevated thrust during take-off and reverse thrust during landing. Reverse thrust noise levels are typically higher than take-off noise levels as a result of the diversion of the engine exhaust to assist with deceleration, which results in a characteristic noise contour bulge surrounding a runway.

The pattern of noise impacts which would result from operation of the Stage 1 development is complex, and depends on time of day, season, airport operating mode and other factors. Each airport operating mode is also predicted to have different impacts on different areas.

The proposed airport would be developed to address aviation passenger demand and does not make specific provisions for general aviation facilities, which may include helicopter flight support and tourist flight facilities. The potential noise impacts of general aviation operations such as helicopters are not assessed in this EIS. Should such provisions be required in the future, they would be subject to separate environment and planning processes under the Airports Act.

Aircraft noise levels would decrease with distance from the proposed airport as departing and arriving aircraft are operating at greater altitudes. Indicative sound levels for Boeing 747 and Airbus A320 aircraft at gradually increasing distances (and altitude) from the runway are shown in Figure 10–2.



	Sound levels (dBA)							Sound levels (dBA)						
	1km	2km	4km	8km	16km	32km	64km	64km	32km	16km	8km	4km	2km	1km
747	96	92	86	82	75	66	56	51	61	70	79	87	94	100
A320	83	81	74	68	61	54	46	44	54	63	71	79	86	93

This figure provides information on indicative noise levels at certain distances from the end of the runway for A320 and 747 aircraft. The estimates present the height of the aircraft relative to the runway and do not account for local terrain. The indicative noise levels were calculated at the runway height.

Figure 10–2 – Indicative sound levels for B747 and A320 aircraft – departures and arrivals

10.2.3. Responsibilities for airport related noise

A number of organisations have a role in managing aircraft noise. A summary of relevant organisations and their role in managing aircraft noise is provided in Table 10–1. These include the airport lessee company (ALC), the Australian, NSW and local governments, airlines, aircraft and engine manufacturers, and regulators.

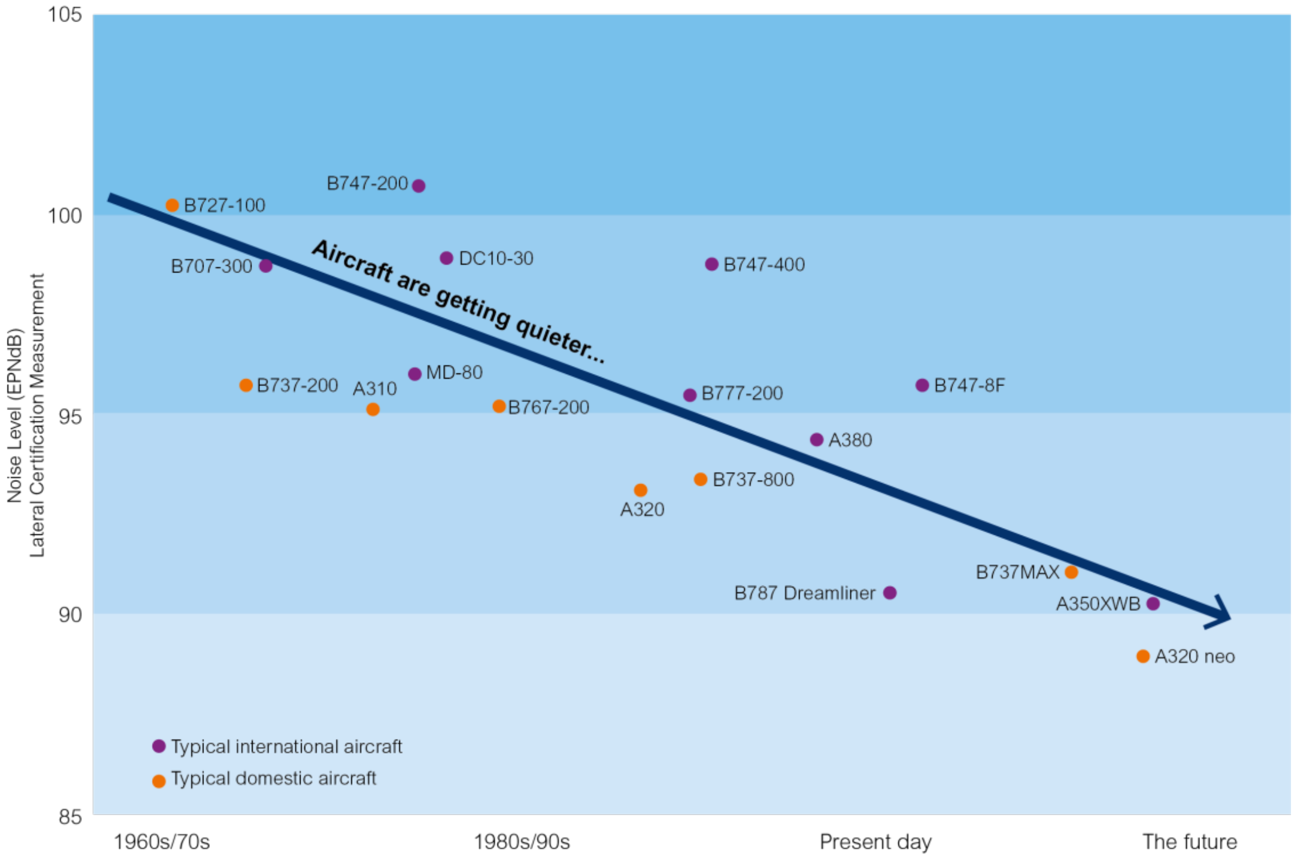
Table 10–1 – Responsibilities for managing airport related noise

Organisation	Summary of responsibilities concerning the management of aircraft noise
International Civil Aviation Organization ICAO is a United Nations specialised agency established under the Convention on International Civil Aviation (Chicago Convention) that works with member states and global aviation organisations to develop international standards and recommended practices for adoption in national civil aviation regulations.	• aircraft and helicopters built today are required to meet the ICAO's strict aircraft noise standards; and • as an ICAO member state, Australia has adopted laws and regulations to reflect these international standards at Australia's airports.
Airservices Australia Airservices Australia would be responsible for managing aircraft movements at the proposed airport.	• under the Air Services Act 1995, must exercise its powers and perform its functions in a manner that ensures that, as far as is practicable, the environment is protected from the effects of the operation and use of aircraft; • provides air traffic control management and related airside services to the aviation industry; • prepares and publishes jet noise abatement procedures; • determines aircraft flight paths and airport operating procedures; • publishes information on aircraft movements, runway and track usage and noise impacts using a range of noise descriptors; • handles aircraft noise complaints and inquiries (other than ground-based noise complaints which would be handled by the ALC); • operates flight and noise monitoring equipment the vicinity of major airports and publishes results; and • reviews and endorses for technical accuracy the ANEF noise contours for airports.
Australian Government: Aircraft Noise Ombudsman Conducts independent administrative reviews of Airservices Australia's management of aircraft noise-related activities.	• reviews the handling of complaints or inquiries made to Airservices Australia; • reviews community consultation processes related to aircraft noise; and • reviews the presentation and distribution of aircraft noise-related information.
Airport lessee company This is the airport lessee and the operator of an airport	• manages operations at the airport and ensures the effective delivery and coordination of airport-related services and facilities; • prepares an airport master plan, including publication of an ANEF and an environment strategy that identifies measures to manage noise impacts; • establishes procedures to control noise generated by engine ground running; • engages with the community; and • handles ground-based noise complaints.
Civil Aviation Safety Authority	• through the Office of Airspace Regulation, ensure that proposed changes to airspace adequately consider environmental implications.

Organisation	Summary of responsibilities concerning the management of aircraft noise
Airlines and aircraft operators	• maintains aircraft fleets and engines that meet the ICAO and Australian standards; and • implements noise-abatement principles for flight operations, where applicable.
NSW Government and local councils	• the NSW Government and local councils regulate land use planning and development in the vicinity of airports.

10.2.4. Aircraft technology

As new aviation technologies and practices are introduced, aircraft noise tends to reduce. Figure 10–3 shows how aircraft have become progressively quieter with the adoption of new models into service. It is expected that quieter aircraft like the Airbus A350XWB, A320neo, and Boeing 737MAX would be introduced during the operation of the proposed Stage 1 development. Despite the likely introduction of these next-generation aircraft, the assessment of noise impacts has been based on aircraft types that are commonplace today, including the louder Boeing 747 and the Airbus A320. The Boeing 747 is the loudest aircraft anticipated to operate at the proposed airport and airlines are already beginning to retire it from regular passenger services.



Source: ICAO and Federal Aviation Administration (USA) as included in Sydney Airport Master Plan 2033 (SACL 2014)

Figure 10–3 – Reduction in aircraft noise over time

10.3. Airport operations

10.3.1. Indicative flight paths

Airservices Australia undertook a preliminary assessment of airspace implications and air traffic management arrangements for Sydney region airspace associated with the potential commencement of operations at the proposed airport. This assessment of impacts of aircraft overflight noise is based on indicative flight paths prepared by Airservices Australia. A future airspace design process is expected to be undertaken closer to the commencement of operations at the proposed airport.

The principal objective of Airservices Australia's preliminary assessment was to establish whether safe and efficient operations could be introduced at the proposed airport through developing indicative proof-of-concept air traffic management designs. The assessment confirms the basic viability of the proposed airport for both single and parallel runway operations, and shows that the proposed Stage 1 development and Sydney Airport could safely operate independently as high capacity airports. This ensures the selection of runways or operating modes at one airport can be made to suit local conditions without considering the operating mode at the other.

It is important to note that the conceptual design did not consider potential noise abatement opportunities, which will form an essential part of the formal airspace design process. Consultation with airlines and other stakeholders would be undertaken through the design process, which would be subject to separate regulatory assessment processes (see Chapter 3, Volume 1). This process would be undertaken closer to the commencement of operations. Further information on the airspace design process is provided in Chapter 7 of Volume 1 of this EIS.

10.3.2. Operating strategies

Assessment of aircraft overflight and runway operations noise for the proposed Stage 1 development focuses on the point at which passenger demand reaches 10 million annual passenger movements, currently expected to occur around 2030. At this stage, the airport would comprise a single (northern) runway and would have been operating for approximately five years.

The approximate north-east/south-west or 50/230 degree runway orientation for the Stage 1 development resulted in three primary operating modes being considered:

- Mode 05 – aircraft arrive from the south-west and depart to the north-east;
- Mode 23 – aircraft arrive from the north-east and depart to the south-west; and
- Head-to-head – all landings and take off movements occur in opposing directions, to and from the south-west.

The availability of each operating mode (described in greater detail in Chapter 7) at any given time would depend on meteorological conditions, particularly wind direction and speed, the number of presenting aircraft and the time of day. Due to the relatively low and consistent wind speeds at Badgerys Creek (see Chapter 7) it is likely that the preferred operating mode would be in place over 80 per cent of the time. However, the assumed order for selection of the operating modes has a notable effect on the overall noise impact from the airport. In this context, the preferred operating strategies that were considered as part of the noise impact assessment are described below:

- Prefer 05 strategy – all aircraft would be directed to approach and land from the south-west and directed to take-off to the north-east. If this is not possible for meteorological or operating policy reasons, then second priority would be given to operations in the opposite direction (i.e. the 23 direction);
- Prefer 23 strategy – all aircraft would be directed to approach and land from the north-east and take-off to the south-west. If this is not possible for meteorological or operating policy reasons, then second priority would be given to operations in the opposite direction (i.e. the 05 direction);
- Prefer 05 strategy with head-to-head – as per Prefer 05, except that during the night hours of between 10.00 pm and 7.00 am, head–to-head operating mode to the south-west would be used when:
  - there are no more than a total of 20 aircraft movements in the hour following the relevant time; and
  - wind conditions allow the use of both runway directions;
- Prefer 23 strategy with head-to-head – as per Prefer 05 with head-to-head, except that when head-to-head operating mode is not in use, Prefer 23 applies rather than Prefer 05.

If Prefer 05 or Prefer 23 is in use during the night-time period, the operating mode would revert to head-to-head under the following conditions:

- the use of head-to-head has been allowed for at least two hours before the change time; and
- the use of head-to-head would be allowed for at least two hours after the change time.

10.3.3. Hours of operation

As the proposed airport would operate on a 24 hour basis, this assessment of overflight noise considers the operation of the proposed airport over a range of timeframes, including a full operating day (24-hour) and night-time hours (10.00 pm–7.00 am). This range of timeframes was intended to capture the range of potential noise impacts at sensitive receivers and on particular activities (including the potential for sleep disturbance).

These timeframes were considered in conjunction with the various operating modes discussed in Section 10.3.1 to capture a wide range of potential conditions. Consideration of seasonality was also undertaken as part of the technical paper presented in Volume E1. Minimal variation in noise impacts between summer and winter seasons was evident from this analysis.

10.4. Methodology

10.4.1. Assessing aircraft overflight noise

Aircraft overflight noise is assessed by reference to a number of measures. These measures are described below.

10.4.1.1. ANEF and ANEC

For land use planning around airports, Australia has adopted the Australian Noise Exposure Forecast (ANEF) system, which describes cumulative aircraft noise for an annual period. The ANEF system was developed on the basis of social survey data and is relatively well correlated with the proportion of people who would describe themselves as “seriously affected by noise”. The ANEF system is intended for use as a land use planning tool for controlling encroachment on airports by noise sensitive buildings and underpins *Australian Standard 2021:2015 – Acoustics—Aircraft noise intrusion—Building siting and construction* (AS2021) (Australian Standard 2015). AS2021 contains advice on the acceptability of building sites based on ANEF zones. The acceptability criteria vary depending on the type of land use as shown in Table 10–2 which identifies the recommended development types within ANEF zones, as outlined in AS2021:2015. An aircraft noise exposure level of less than 20 ANEF considered acceptable for the building of new residential dwellings.

Table 10–2 – Building Site Acceptability Based on ANEF zone (AS 2021)

Building Type	ANEF zone of site		
	Acceptable	Conditionally acceptable	Unacceptable
House, home unit, flat, caravan park	Less than 20 ANEF	20 to 25 ANEF	Greater than 25 ANEF
Hotel, motel, hostel	Less than 25 ANEF	25 to 35 ANEF	Greater than 30 ANEF
School, university	Less than 20 ANEF	20 to 25 ANEF	Greater than 25 ANEF
Hospital, nursing home	Less than 20 ANEF	20 to 25 ANEF	Greater than 25 ANEF
Public building	Less than 20 ANEF	20 to 30 ANEF	Greater than 30 ANEF
Commercial building	Less than 25 ANEF	25 to 35 ANEF	Greater than 35 ANEF
Light industrial	Less than 30 ANEF	30 to 40 ANEF	Greater than 40 ANEF
Other industrial	Acceptable in all ANEF		

An “ANEF chart” is a set of land use planning contours for a specific airport which has been formally endorsed for technical accuracy by Airservices Australia, after a period of public consultation. The production of an ANEF chart for all major airports is a requirement of the Airports Act.

An Australian Noise Exposure Concept (ANEC) is a noise exposure chart produced for a hypothetical future airport usage pattern, and is useful for considering the land use planning consequences of alternative operating strategies. ANEC noise exposure contours are calculated using the same methods as the ANEF. However, they use indicative data on aircraft types, aircraft operations and flight paths and are generally used in environmental assessments to depict and compare noise exposure levels for different flight path options.

10.4.1.2. 1985 EIS ANEC

A series of ANECs[1] were developed for the 1985 *Second Sydney Airport Site Selection Programme Draft Environmental Impact Statement* (1985 Draft EIS) (Kinhill Stearns 1985). These contours have guided subsequent planning controls implemented by the NSW Government and relevant local councils in the vicinity of the airport site.

Planning controls that are implemented based on an ANEF typically serve to limit the types of development permitted to occur within particular noise exposure zones.

The key planning decision made subsequent to the 1985 Draft EIS is the ministerial direction under section 117(2) of the *Environmental Planning and Assessment Act 1979* (NSW). The direction applies to all land within the ANEF in the local government areas of Fairfield, Liverpool, Penrith and Wollondilly and requires that planning instruments do not contain provisions enabling development which could hinder the potential for development of a Second Sydney Airport. The direction has subsequently been given effect through the *Penrith Local Environmental Plan 2010* and *Liverpool Local Environmental Plan 2008,* with the inclusion of provisions aimed at preserving noise related buffers around the airport site (see Chapter 21).

It is expected that an official ANEF would be produced and endorsed by Airservices Australia prior to the commencement of operations at the proposed airport.

10.4.1.3. 'Number Above' measures

'Number Above' measures indicate the average number of aircraft overflights per day (or other specified time period) exceeding a specified noise level. The N70 and N60 are measures commonly used in environmental impact assessments to better inform strategic planning and provide more comprehensive and understandable information on aircraft noise for communities.

- N70 – the average number of aircraft noise events per day with maximum noise levels exceeding 70 dBA. A noise level of 70 dBA outside a building would generally result in an internal noise level of approximately 60 dBA, if windows are partly open. This noise level is sufficient to disturb conversation, in that a speaker would generally need to raise their voice to be understood, or some words may be missed in speech from a television or radio. If external windows are closed, such effects would be experienced inside at an external noise level of approximately 80 dBA; and
- N60 – the average number of aircraft noise events per day with maximum noise levels exceeding 60 dBA during the night-time period 10pm-7am. An external noise level of 60 dBA approximates an internal level of 50 dBA if windows are partly open. An internal noise level of 50 dBA is commonly used as a design criterion for noise in a bedroom, to protect against sleep disturbance. A criterion of 60 dBA was considered appropriate for recreation areas, both passive and active, on the basis that at this level a person may need to raise their voice to be properly heard in conversations.

[1] *The 1985 EIS included a scenario-based noise exposure chart in the form of an "ANEF", which we would today term an "ANEC".*

Standard calculations of N70 and N60 represent an average over all days (or all days in a specified season), and may potentially not provide a representative measure if the number of events above 70 dBA or 60 dBA varies significantly between days. To overcome this potential shortcoming, this assessment has calculated modified N70 and N60 values (known as 90th percentile N70s and N60s) to identify the upper range of aircraft overflight numbers likely to be experienced. The 90th percentile is a statistical category representing noise values that would be exceeded on only 10 per cent of days. Accordingly, the 90th percentile N70 and N60 values represent days where there would be a particularly high number of movements.

10.4.1.4. Peak noise level

L_{Amax} is the maximum A-weighted noise level predicted or recorded over a period. In this assessment, L_{Amax} denotes the maximum level of noise predicted at a location during a single overflight from a particular aircraft occurring at any time.

10.4.2. Aircraft overflight noise modelling

The modelling of aircraft overflight noise uses information and projections from a number of sources, including projected air traffic volumes, aircraft flight paths, airport operating modes, assumed fleet mix and scheduling, noise emissions from representative aircraft types, and predicted future population densities in areas around the airport. A summary of the modelling process is described below and shown on Figure 10–4. Full details of the noise assessment methodology is included in Chapter 2 of Appendix E1 in Volume 4.

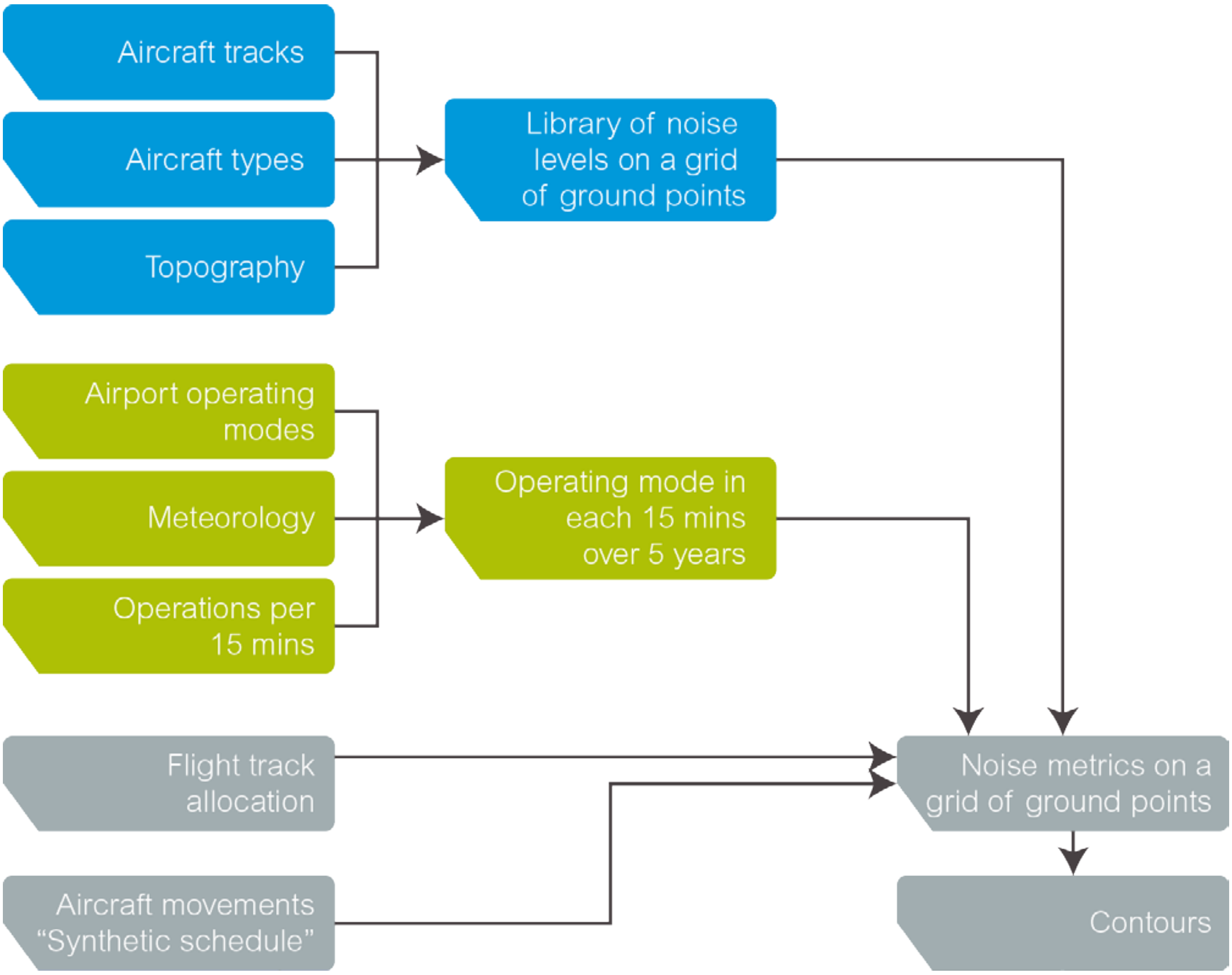


Figure 10–4 – Noise modelling process

The Integrated Noise Model (INM) aircraft noise prediction software, produced by the US Federal Aviation Administration, was used to predict noise levels from each of the 22 aircraft types on the 245 indicative flight paths for the Stage 1 development. The model includes aircraft overflight noise together with departure noise, landing and reverse thrust noise when the aircraft is on the runway.

Predicted future numbers of aircraft movements (one movement consists of an aircraft either taking off or landing) were in the form of 'synthetic schedules' which detail a list of aircraft operations for a typical day, including aircraft family, operation type (arrival or departure), time of operation and port of origin or destination for each operation.

Predicted total aircraft movements for a typical busy day for the proposed Stage 1 development (refer to Section 2.5 in Appendix E1) are summarised in Table 10–3 and the predicted number of movements for each hour of the day is shown in Figure 10–5.

Table 10–3 – Predicted daily aircraft movements in 2030 by aircraft family (busy day)

Aircraft	Daily movements
Passenger Movements	
Airbus A320	100
Airbus A330	18
Airbus A380	–
Boeing 737	28
Boeing wide-body general	–
Boeing 777	4
DeHaviland DHC8	8
Saab 340	12
Freight Movements	
Airbus A330	2
Boeing 737	2
Boeing 747	10
Boeing 767	4
Boeing 777-300	–
Small Freight	10

The aircraft types shown in Table 10–3 were used for noise level calculations in the noise modelling software. They were selected to be representative of the aircraft types expected to use the proposed airport which is considered to be conservative as aircraft are predicted to become progressively quieter with the adoption of new models into service.

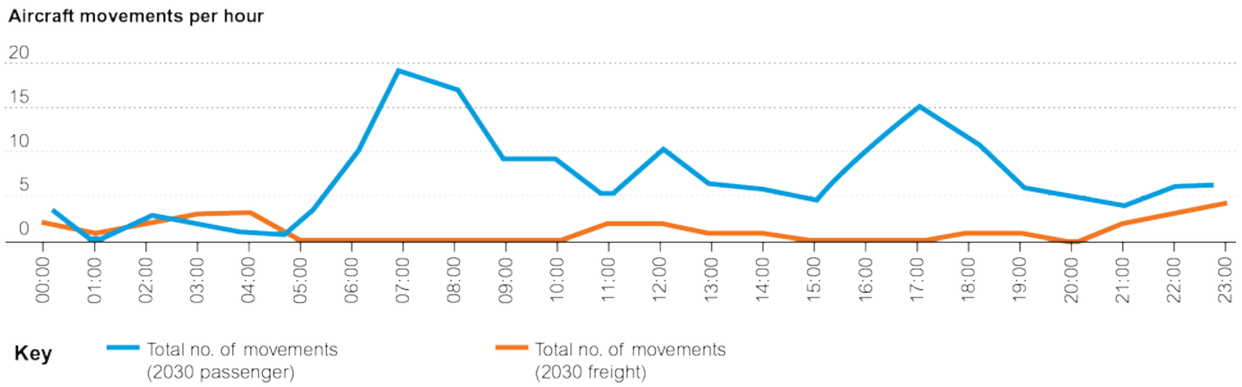


Figure 10–5 – Predicted aircraft movements per hour in 2030

An airport operating mode was assigned for each 15 minute period over the five years covered by the meteorological data, using the rules for operating mode selection described in Section 10.3.2. Aircraft operations occurring in that 15 minute period (taken from the synthetic schedule) were then assigned to flight paths according to meteorological conditions, visual or instrument landing conditions (for arrivals), aircraft type (e.g. assignment of only turboprop aircraft to certain flight paths) and the direction of the destination airport (for departures).

Arrival flight paths were assumed to follow a 'point merge' configuration where all aircraft approaching the airport pass over a single point to the north of the airport then move to a final approach in either of the two runway directions (see Chapter 7).

The point merge is a way of synchronising arriving aircraft and directing them to the runway in a structured manner. By directing aircraft though a series of predictable routes, the vertical and lateral path taken on approach is more accurate and can result in a reduction of the number of level flight segments required during decent. The system may help to reduce fuel consumption, emissions and noise impacts, as it relies on a continuous descent profile and therefore limits use of engine power settings above idle. Figure 10–6 illustrates the concept of continuous descent operation (CDO).The point merge system is discussed in further detail in Chapter 7.

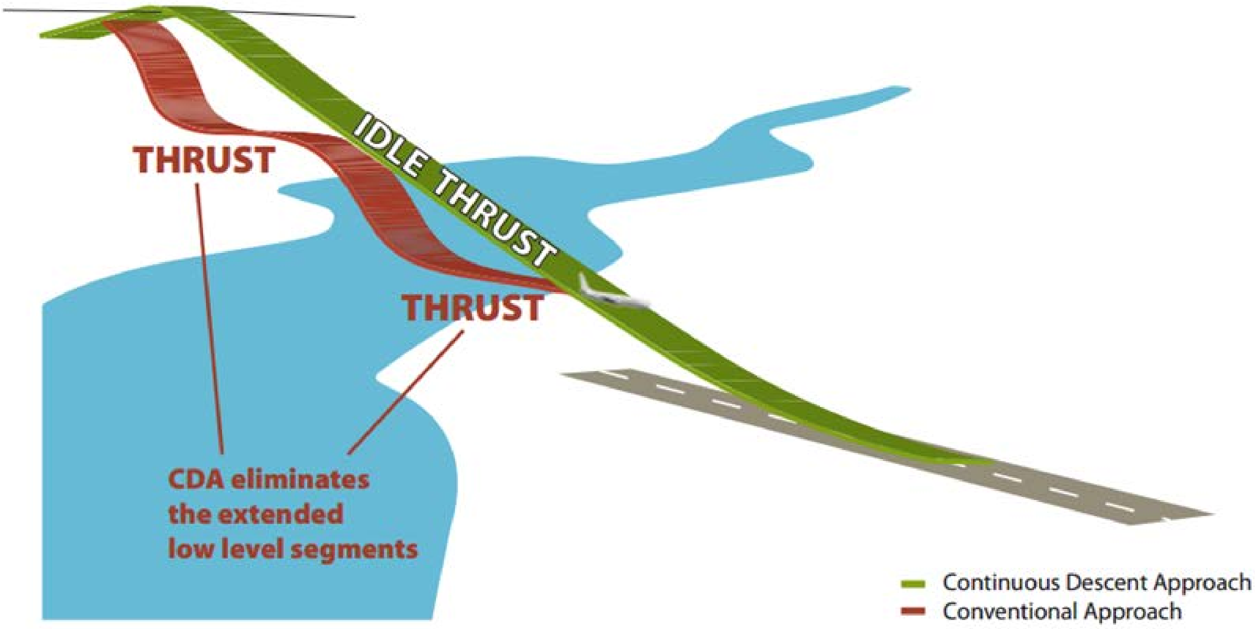


Figure 10–6 – Concept diagram of continuous descent operation

For each aircraft type, track and possible stage length (a measure of distance to destination for departing aircraft), custom-designed software was used to calculate noise levels at each point on a 185x185 metre grid. Maximum noise levels for every aircraft movement within this assessment area were used to form the 'library of noise levels' shown in Figure 10–4.

For N70 and similar units, this library was used to determine the number of events at each grid point exceeding the relevant L_{Amax} threshold, and the results used to produce contours.

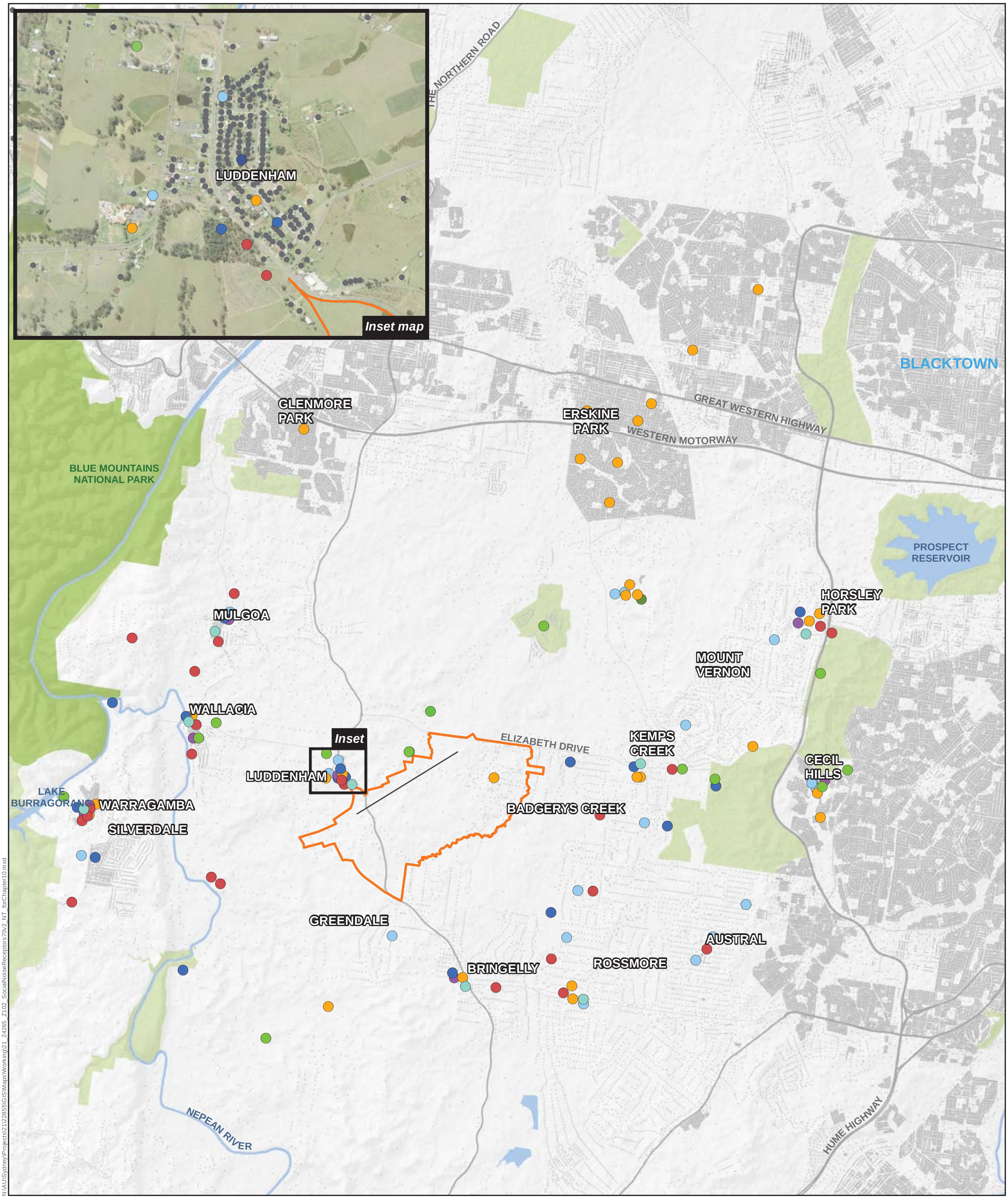
10.5. Assessment of aircraft noise impacts

10.5.1. Sensitive receivers

There is potential for aircraft noise to be experienced across a broad geographic area as a result of aircraft arrival and departures operating on the indicative flight paths presented in Chapter 7. Noise contour maps have been produced at a range of scales which represent the geographic extent of exposure for each noise assessment measure adopted as part of the analysis. For example, maximum noise levels during a single overflight from a particular aircraft have the widest potential geographic exposure and have therefore been mapped at a relatively small scale. “Number above” measures affect a comparatively smaller geographic area and therefore the noise contours have been presented in maps with larger scale showing more detailed information.

It is recognised the sensitive receivers located in close proximity to the airport generally have a higher potential to be impacted by exposure to aircraft noise. Maximum single event noise contours have therefore also been produced at a meso scale (zoomed in) to provide higher resolution mapping of noise exposure to represent sensitive receivers in close proximity to the airport site.

Noise-sensitive receivers in the area surrounding the proposed airport are also represented in Figure 10–7. Noise sensitive receivers include residences, recreational areas, schools and other educational facilities, hospitals and other health care facilities. The noise assessment has primarily focussed upon the affected population for each noise assessment measure and impact upon surrounding recreational areas. More detailed consideration of impacts to other potentially affected sensitive receivers such as schools and hospitals is provide in the social assessment in Chapter 23 of this EIS. Consideration of potential impacts upon the Greater Blue Mountains World Heritage Area is presented in Chapter 26.



LEGEND

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

- Airport site
- **Sensitive receivers**
  - Residential
  - Aged Care
  - Childcare
  - Community Centre
  - Education
  - Park
  - Recreation
  - Religious Facility
  - Shopping Centre
- Runway

0 1 2 4
Kilometres

N

Figure 10-7 - Sensitive Receivers surrounding the airport site

10.5.2. Land use planning implications

ANEC contours have been developed based upon the indicative flight tracks and operating modes to provide an indication of the likely acceptability of building types based upon ANEF zones specified in AS2021. It is expected that an endorsed ANEF noise exposure chart would be produced prior to commencement of operations at the proposed airport. Figure 10–8 and Figure 10–9 show the ANEC contours calculated for the year 2030, for the respective Prefer 05 and Prefer 23 operating modes.

Figure 10–10 and Figure 10–11 show the year 2030 ANEC 20 contour compared to the combined ANEC 20 contour presented in the 1985 Draft EIS (Kinhill Stearns 1985). The 1985 ANEC were prepared for a dual runway airport and have been used for land use planning purposes to date.

These figures show that the new 2030 ANEC contours are generally less geographically extensive than those developed for the 1985 Draft EIS (Kinhill Stearns 1985). It is important to note that the ANEC figures for the proposed Stage 1 development are not intended to guide future land use planning and are provided primarily for comparative purposes and to provide comprehensive information about predicted noise exposure. Any change to current land use planning instruments would necessarily be based on longer term forecasts of noise exposure.

While there are differences between Prefer 05 and Prefer 23 operating strategies, the introduction of head to head operations at night does not greatly influence the contours (refer to Section 3.6 of Appendix E1). This is because even with an additional 6 dBA weighting for night-time noise events, as included in the ANEF formula, overall noise exposure is still dominated by daytime events.

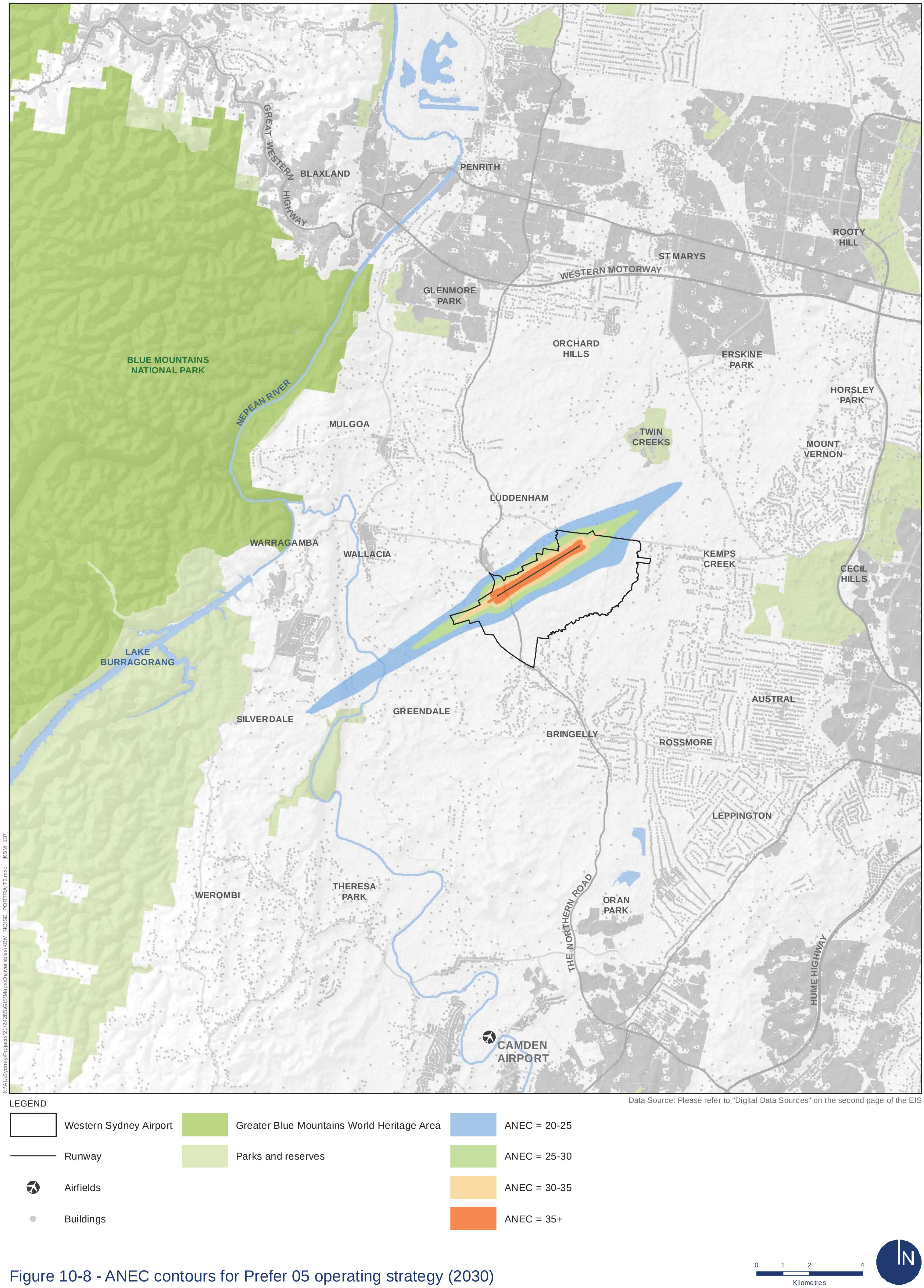
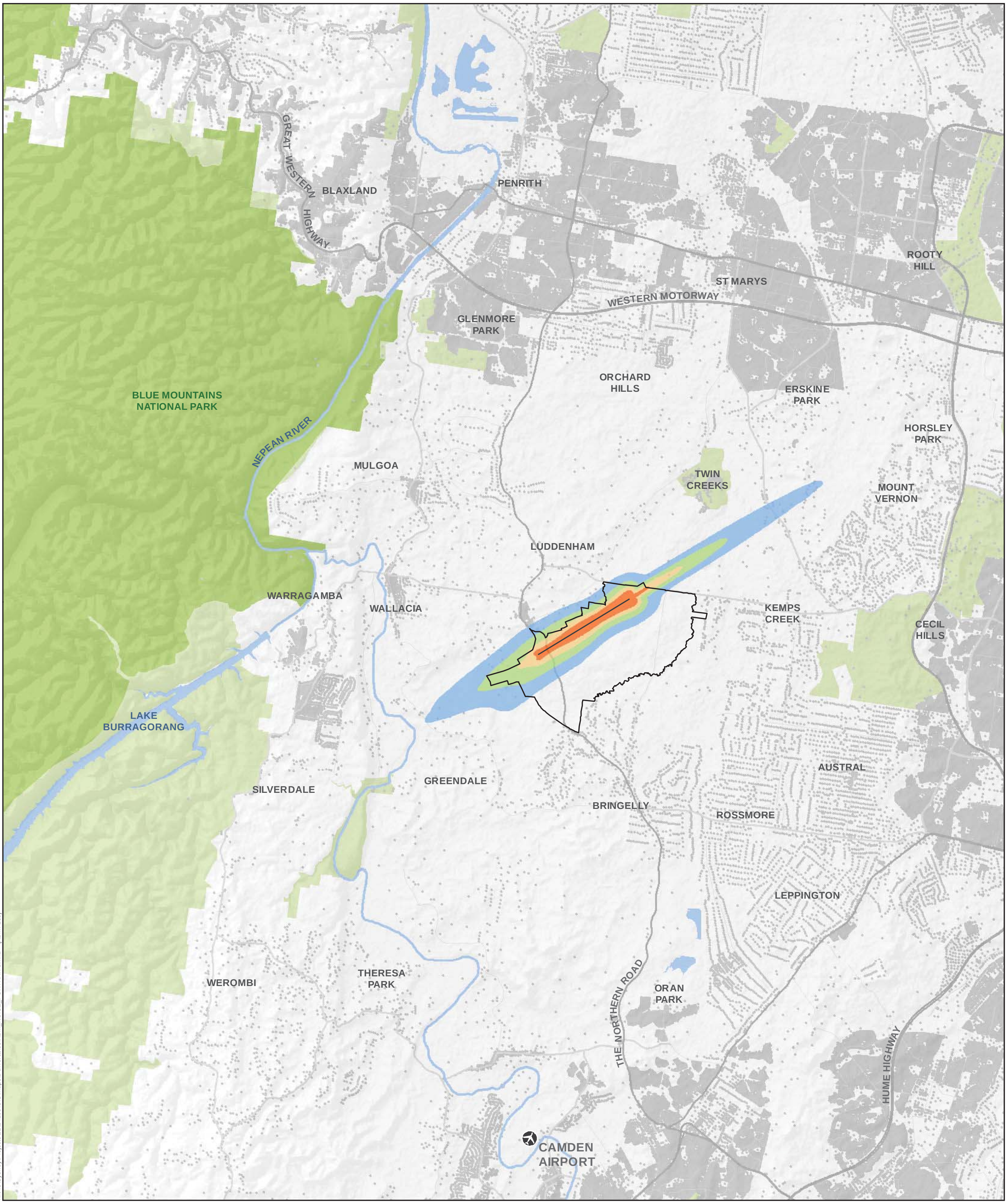


Figure 10-8 - ANEC contours for Prefer 05 operating strategy (2030)



LEGEND

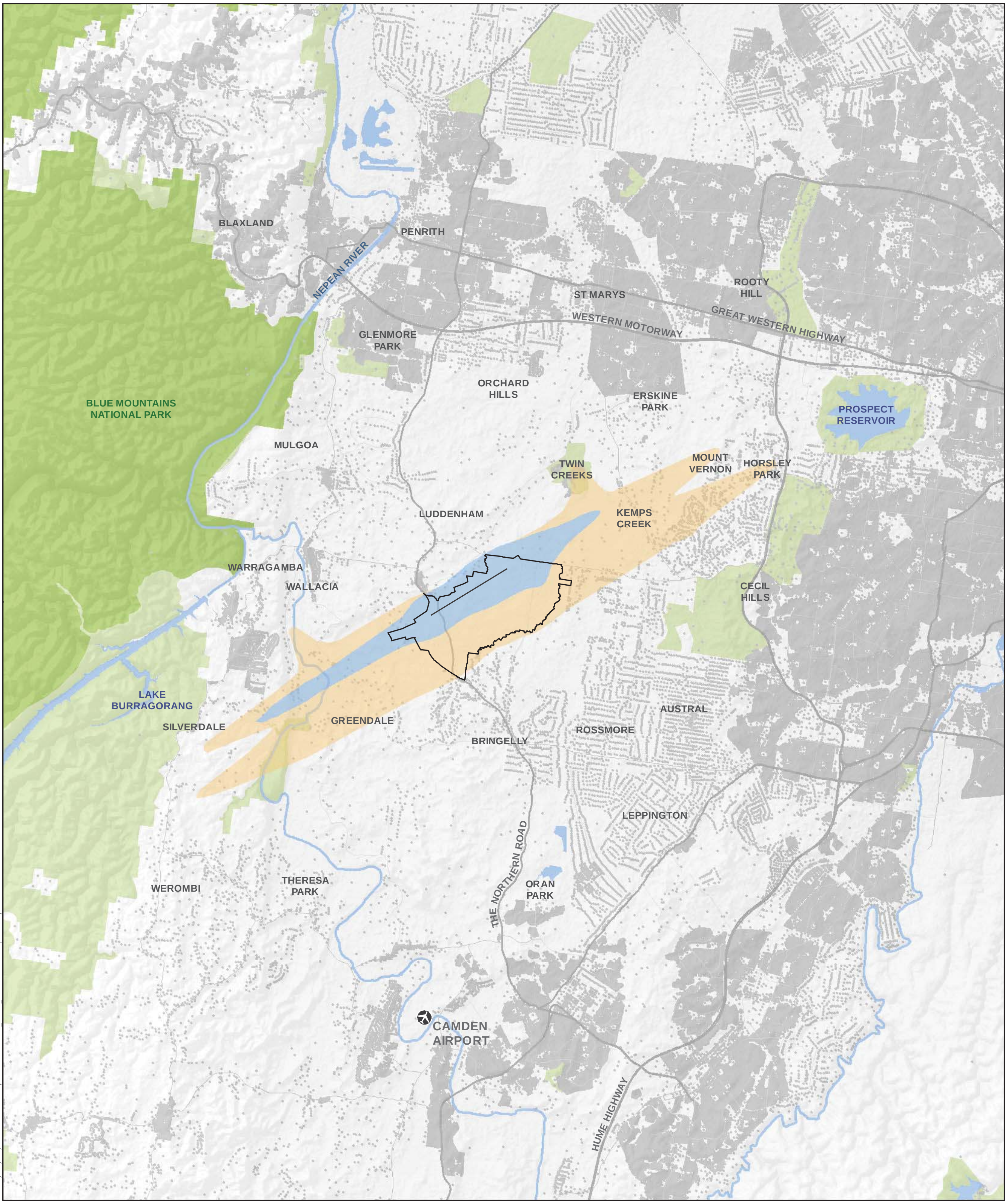
Western Sydney Airport	Greater Blue Mountains World Heritage Area	ANEC = 20-25
Runway	Parks and reserves	ANEC = 25-30
Airfields		ANEC = 30-35
Buildings		ANEC = 35+

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

0 1 2 4
Kilometres

N

Figure 10-9 - ANEC contours for Prefer 23 operating strategy (2030)



LEGEND

Western Sydney Airport	Greater Blue Mountains World Heritage Area	**ANEC Contours 2030 Prefer 05**	
Runway	Parks and reserves	20 ANEC	
Airfields		**1985 EIS ANEC Contours**	
Buildings		20 ANEC	

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

0 1.25 2.5 5
Kilometres

N

Figure 10-10 1985 Draft EIS combined ANEC contours compared to 2030 Prefer 05

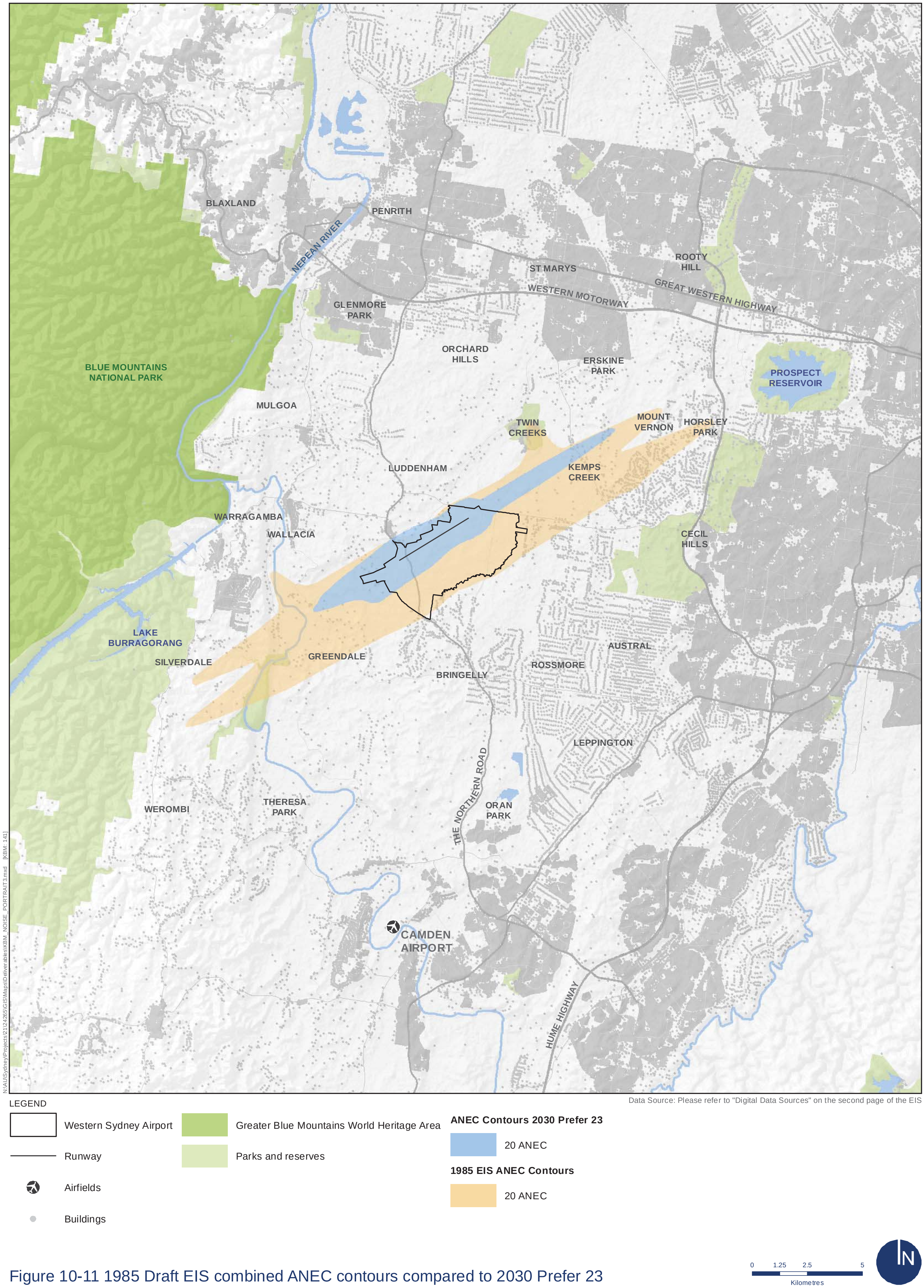


Figure 10-11 1985 Draft EIS combined ANEC contours compared to 2030 Prefer 23

10.5.3. Maximum noise levels

Single-event noise contours depict the maximum (L_{Amax}) noise levels resulting from a single operation of a specific aircraft type on all applicable arrival or departure flight paths.

In the Integrated Noise Model, departures by aircraft are defined for several stage lengths, representing different distances to the destination, and hence different assumed fuel loads. Stage 1 is the shortest stage with a length from 1,500 nautical miles, while stage 9 is the longest with a length over 6,500 nautical miles.

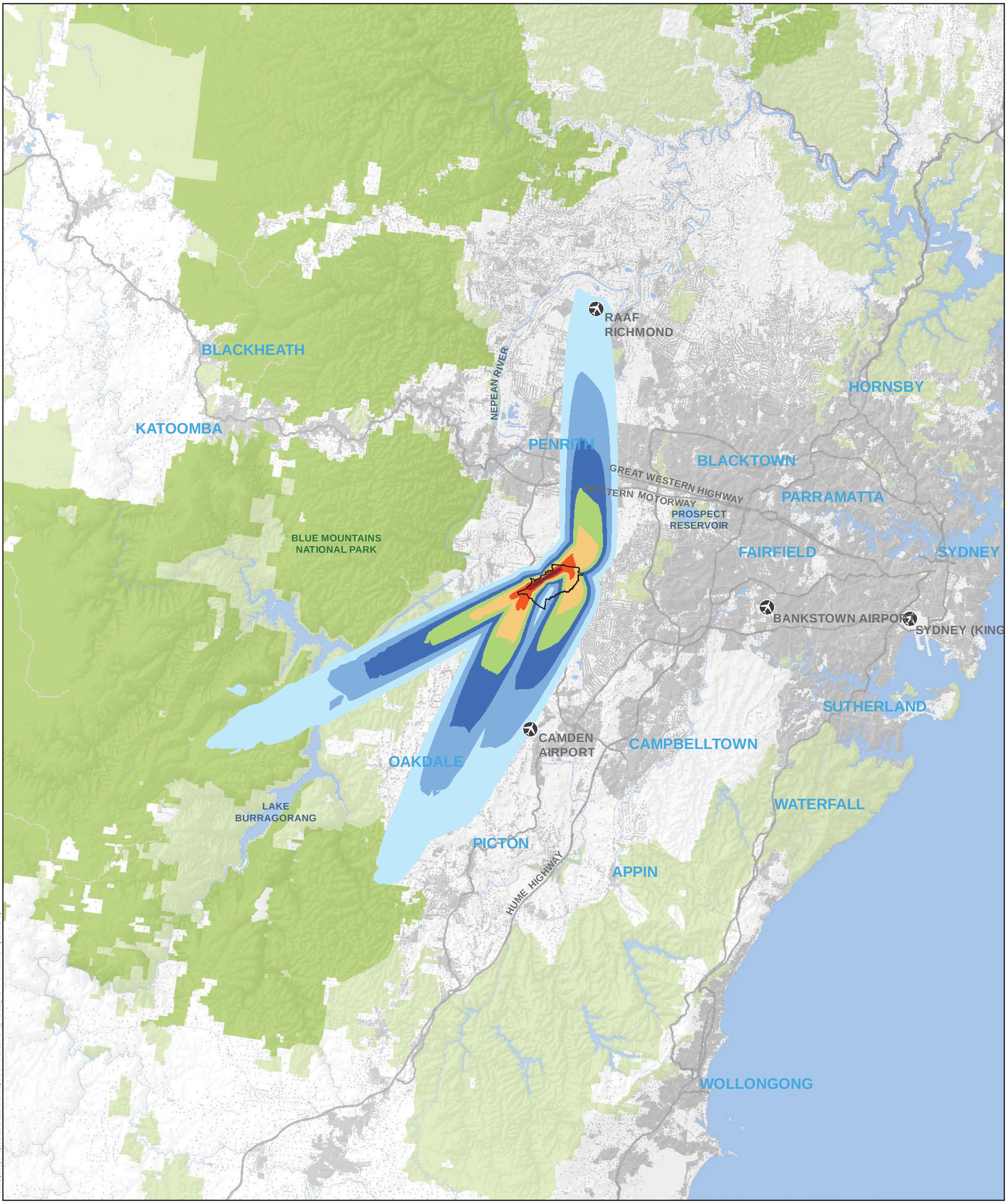
Figure 10–12 shows single-event L_{Amax} noise level contours for the loudest noise event predicted to occur at the proposed airport under this scenario – a B747 departure with stage length 5, corresponding to a departure for Singapore. These events are predicted to occur once per day on average, on any of a number of flight paths. Although contours are shown for these events on paths heading south from the airport, it is very unlikely that a stage 5 departure would occur on these paths.

At the most-affected locations close to the airport, L_{Amax} noise levels from these events would be in the range of 80 to 90 dBA. This is clearly demonstrated in the meso scale (zoomed in) version of the single-event L_{Amax} noise level contours for a B747 departure with stage length 5 as shown on Figure 10–13. There are less than 10 existing residences within the 85 dBA L_{Amax} contour for these events, located to the south-west of the proposed airport. When these events occur on the flight path leading north in the 05 operating mode (i.e. departures to the north-east), L_{Amax} noise levels exceeding 70 dBA are predicted over more densely-populated areas around St Marys, with levels above 75 dBA predicted in some parts of Erskine Park.

Figure 10–14 shows L_{Amax} noise levels from a B747 arrival on any flight path. In this case, noise levels of 60 to 70 dBA could be expected over sections of Erskine Park and St Marys, extending to parts of Blacktown as shown on the meso scale figure in Figure 10–15. Noise levels from this event would also reach 60 dBA at Blaxland, beneath the merge point for arrivals. In 2030, there are expected to be five such arrivals per day.

Figure 10–16 to Figure 10–18 show L_{Amax} noise levels for much more common events – departures (stage 4 and stage 1) and arrivals by A320 and similar aircraft types. Stage 3 or 4 departures by A320 aircraft (on any flight path) are predicted to occur 12 times per day in 2030. When these events occur to the north in the 05 operating mode, maximum noise levels in parts of St Marys would be up to 64 dBA. For Stage 1 or 2 departures (for example, to Brisbane or Melbourne), the maximum noise level over built-up areas is not predicted to exceed 60 dBA.

Arrivals by A320 aircraft, when they occur in the 23 operating mode (from the north-east), are predicted to produce L_{Amax} noise levels exceeding 60 dBA over areas between Erskine Park, St Marys and Blacktown. A320 arrivals in the 05 operating mode (from the south-west) would produce L_{Amax} levels exceeding 60 dBA over limited areas in the Blue Mountains National Park and Greater Blue Mountains World Heritage Area.



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LEGEND

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

- Western Sydney Airport
- Runway
- Airfields
- Buildings
- Greater Blue Mountains World Heritage Area
- Parks and reserves

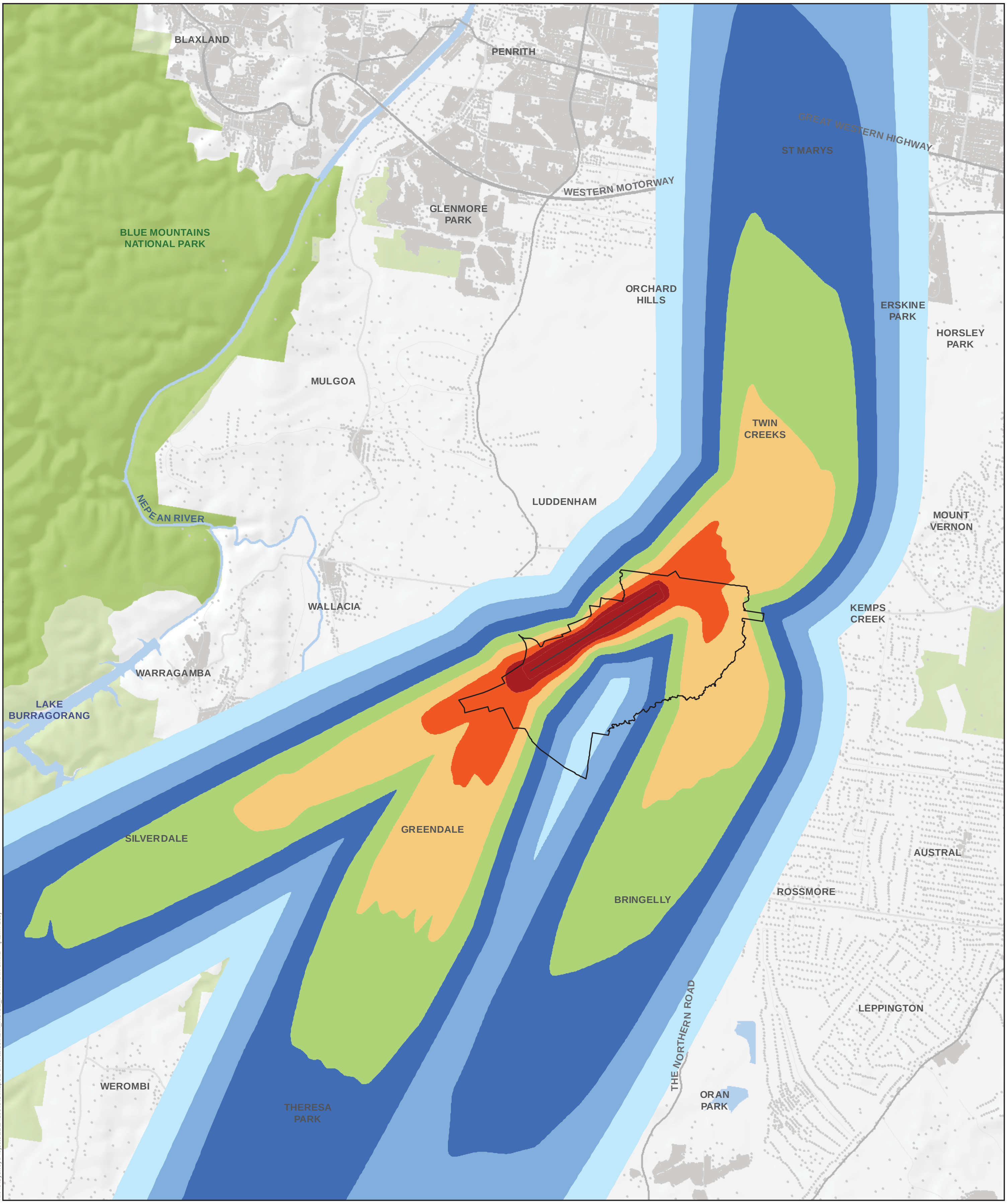
LAmax

- 60-65 dBA
- 65-70 dBA
- 70-75 dBA
- 75-80 dBA
- 80-85 dBA
- 85-90 dBA
- >90 dBA

0 3.5 7 14
Kilometres

N

Figure 10-12 - Single event B747 departure - stage 5 - on all flight paths



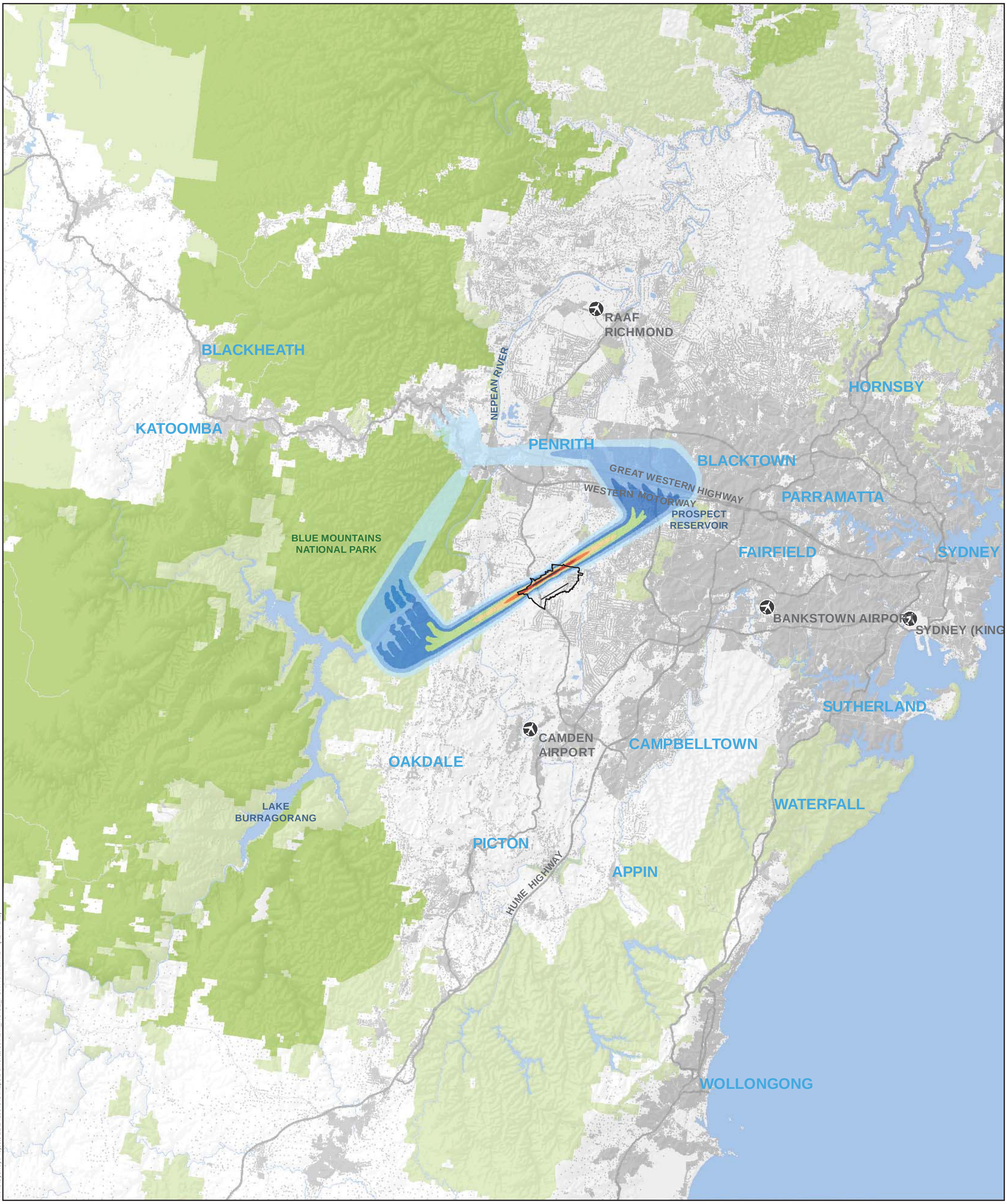
LEGEND

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

Legend		LAmax	
Western Sydney Airport	Greater Blue Mountains World Heritage Area	60-65 dBA	75-80 dBA
Runway	Parks and reserves	65-70 dBA	80-85 dBA
Buildings		70-75 dBA	85-90 dBA
			>90 dBA

0 0.75 1.5 3
Kilometres

Figure 10-13 - Single event B747 departure - stage 5 - on all flight paths (meso scale)



LEGEND

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

Western Sydney Airport
Runway
Airfields
Buildings

Greater Blue Mountains World Heritage Area
Parks and reserves

LAmax
60-65 dBA
65-70 dBA
70-75 dBA
75-80 dBA
80-85 dBA
85-90 dBA
>90 dBA

0 3.5 7 14
Kilometres

Figure 10-14 Single event B747 arrival on all flight paths

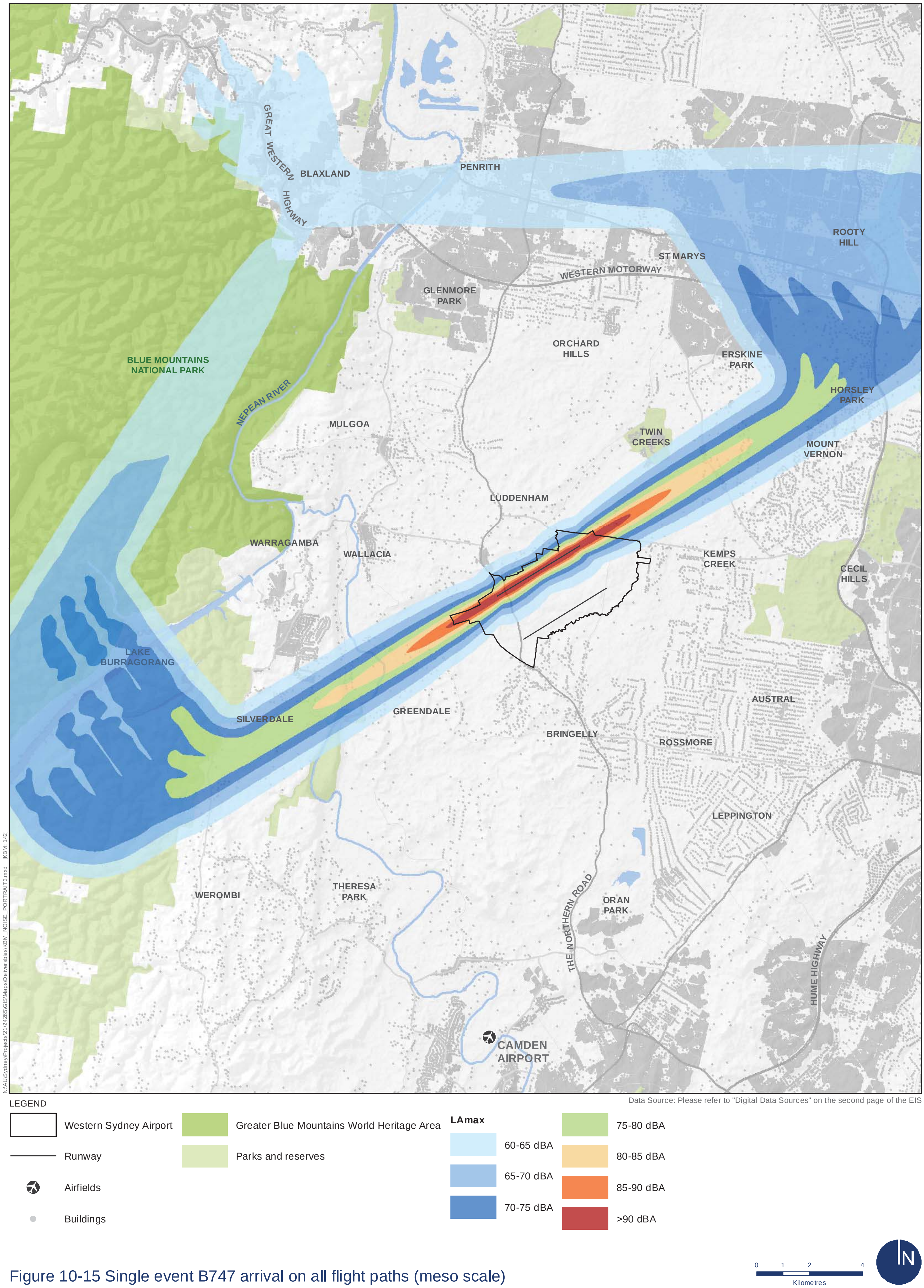


Figure 10-15 Single event B747 arrival on all flight paths (meso scale)

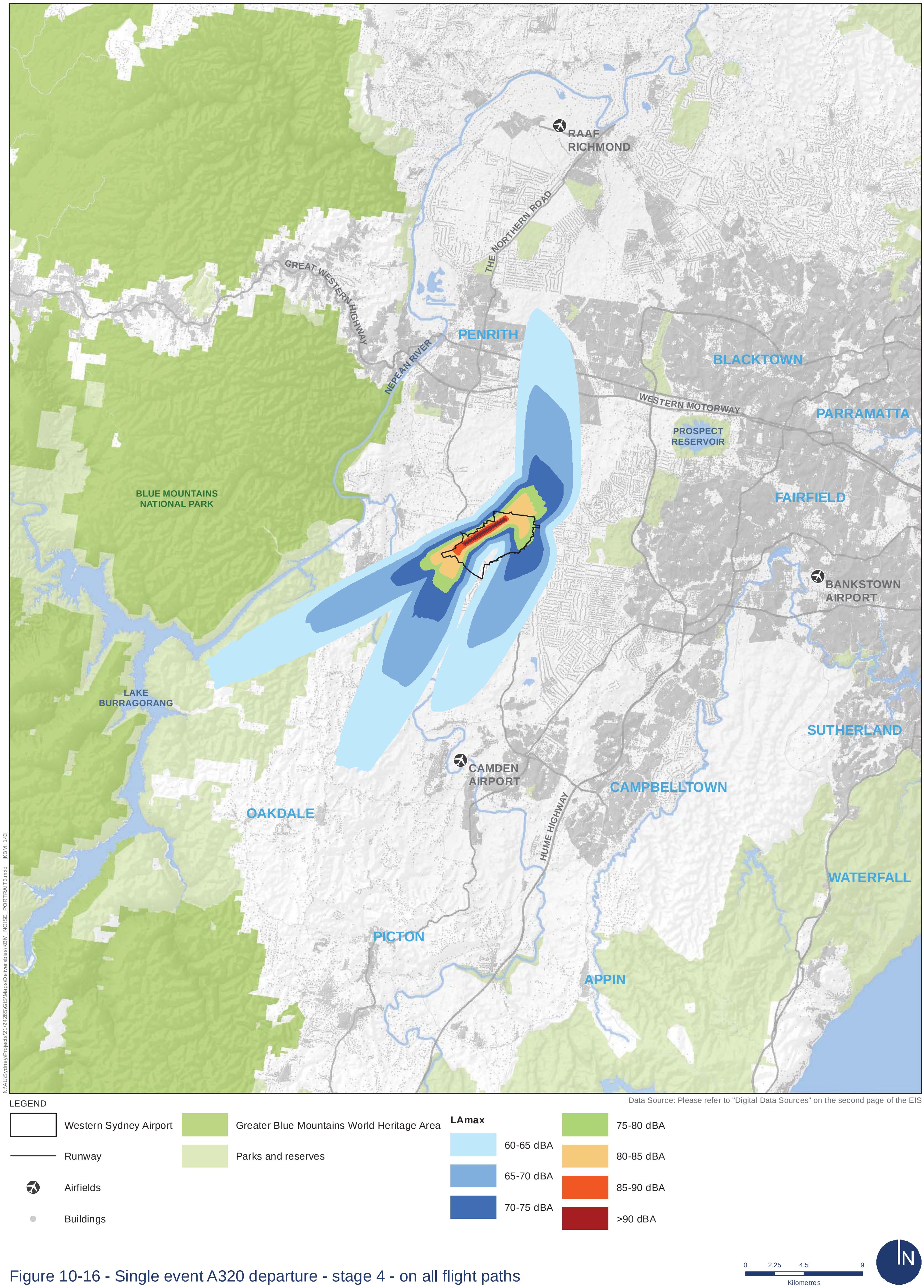
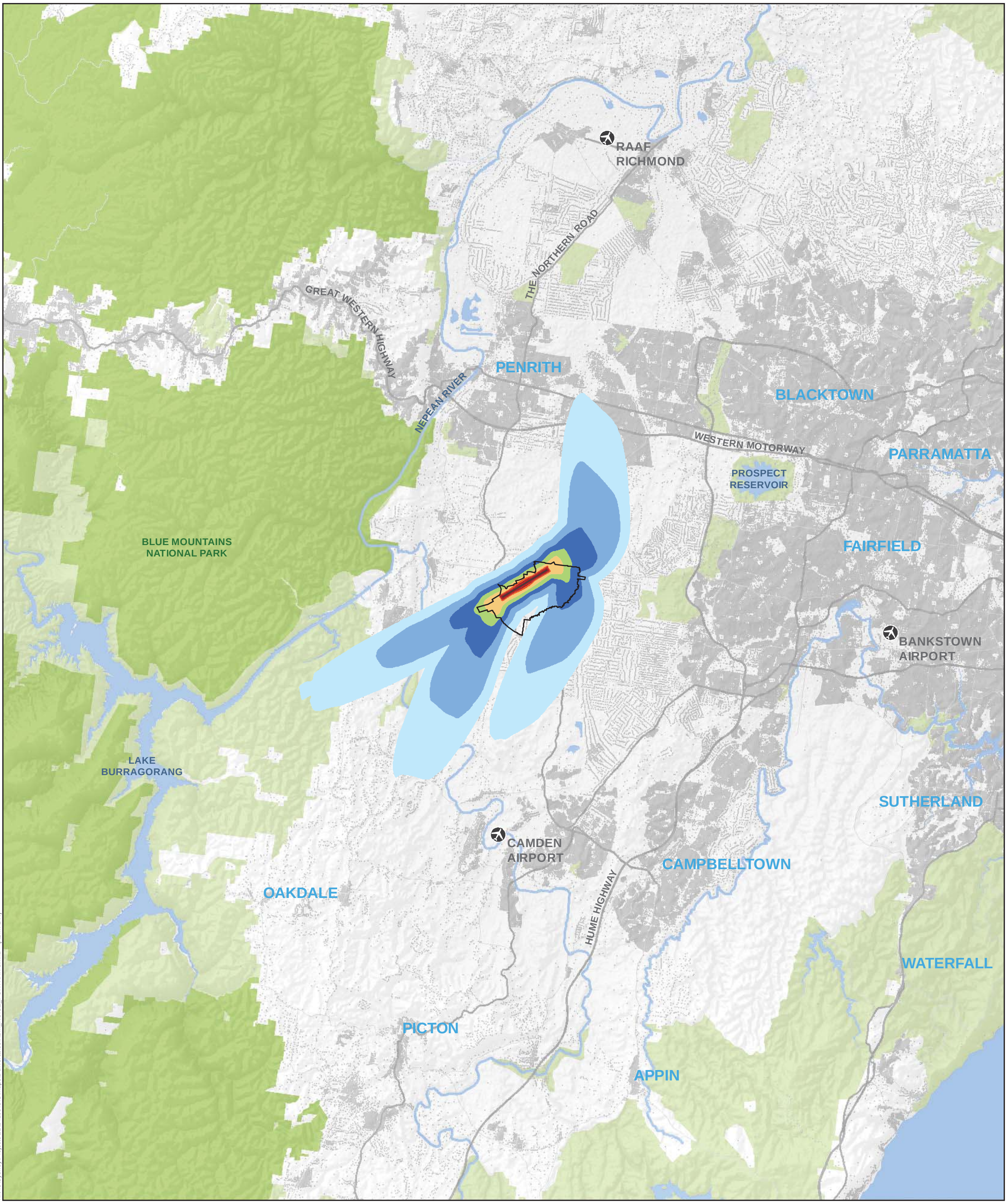


Figure 10-16 - Single event A320 departure - stage 4 - on all flight paths



LEGEND

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

- Western Sydney Airport
- Runway
- Airfields
- Buildings
- Greater Blue Mountains World Heritage Area
- Parks and reserves

LAmax

- 60-65 dBA
- 65-70 dBA
- 70-75 dBA
- 75-80 dBA
- 80-85 dBA
- 85-90 dBA
- >90 dBA

0 2.25 4.5 9
Kilometres

Figure 10-17 - Single event A320 departure - stage 1 - on all flight paths

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LEGEND

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

- Western Sydney Airport
- Runway
- Airfields
- Buildings
- Greater Blue Mountains World Heritage Area
- Parks and reserves

LAmax

- 60-65 dBA
- 65-70 dBA
- 70-75 dBA
- 75-80 dBA
- 80-85 dBA
- >85 dBA

0 2.25 4.5 9
Kilometres

N

Figure 10-18 - Single event noise level for an A320 arrival (left) and departure (right)

10.5.4. Noise over 24 hours

10.5.4.1. N70 population exposure estimates

Aircraft noise impact over a full day can be described by the number of noise events exceeding 70 dBA, or N70 (refer to Section 10.2.1). Table 10–4 shows the population estimated to be affected by noise above 70 dBA in 2030 on an average day for each operating strategy. The number of people experiencing five or more aircraft noise events per day above 70 dBA would be roughly 1,500–1,600 and would depend very little on which operating strategy is adopted. The Prefer 23 operating strategy results in fewer people being affected at lower noise levels (generally to the north of the proposed airport), but this is offset by more people being affected at higher noise levels, generally located in rural residential areas to the south and west of the airport site. Head-to-head operations are expected to only occur in favourable meteorological conditions during the night hours of 10.00 pm and 7.00 am. Because night-time movements would represent a relatively small component of the overall daily number of aircraft operations in 2030, the inclusion of a head-to-head operating mode does not affect substantially the number of residents predicted to experience noise levels above 70 dBA.

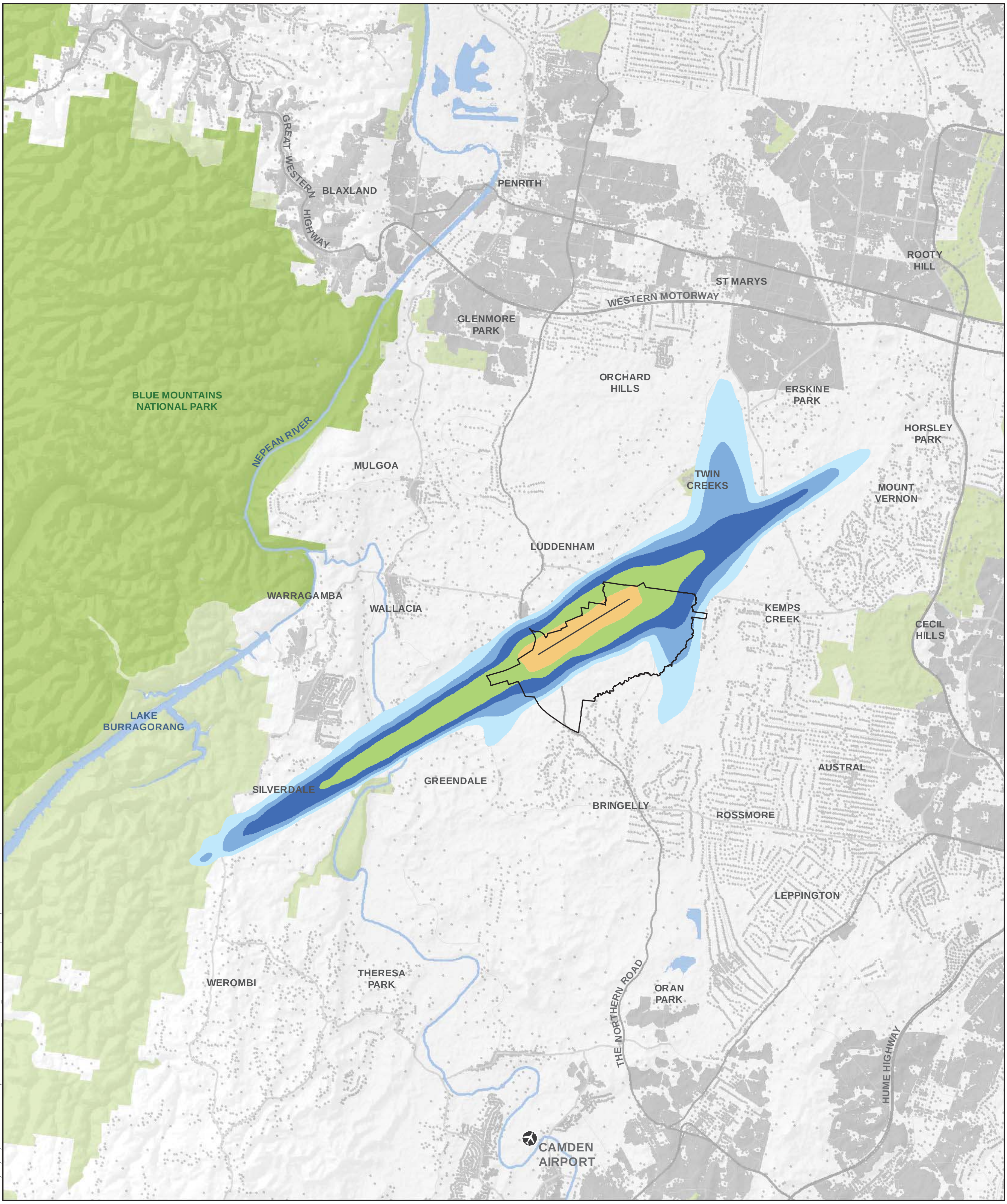
Table 10–4 – Estimated population within N70 contours (2030)

N70	Operating strategy			
	Prefer 05	Prefer 23	Prefer 05 + head-to-head	Prefer 23 + head-to-head
5–10	563	399	852	405
10–20	581	450	326	439
20–50	192	426	258	431
50–100	152	192	167	178
100–200	5	0	10	10
>200	0	0	0	0
Total	1,493	1,468	1,614	1,464

10.5.4.2. N70 contours

Calculated N70 noise contours for each of the four airport operating strategies described in Section 10.3.1 are shown on Figure 10–19 to Figure 10–22. These represent the predicted annual average number of movements per day with L_{Amax} noise levels exceeding 70 dBA.

There are significant differences in the number of residents affected between operating strategies. In particular, the Prefer 05 operating strategy results in greater impacts on residents in areas north-east of the proposed airport. However in 2030, no densely-populated residential areas are predicted to experience more than five events per day above 70 dBA (Figure 10–19).



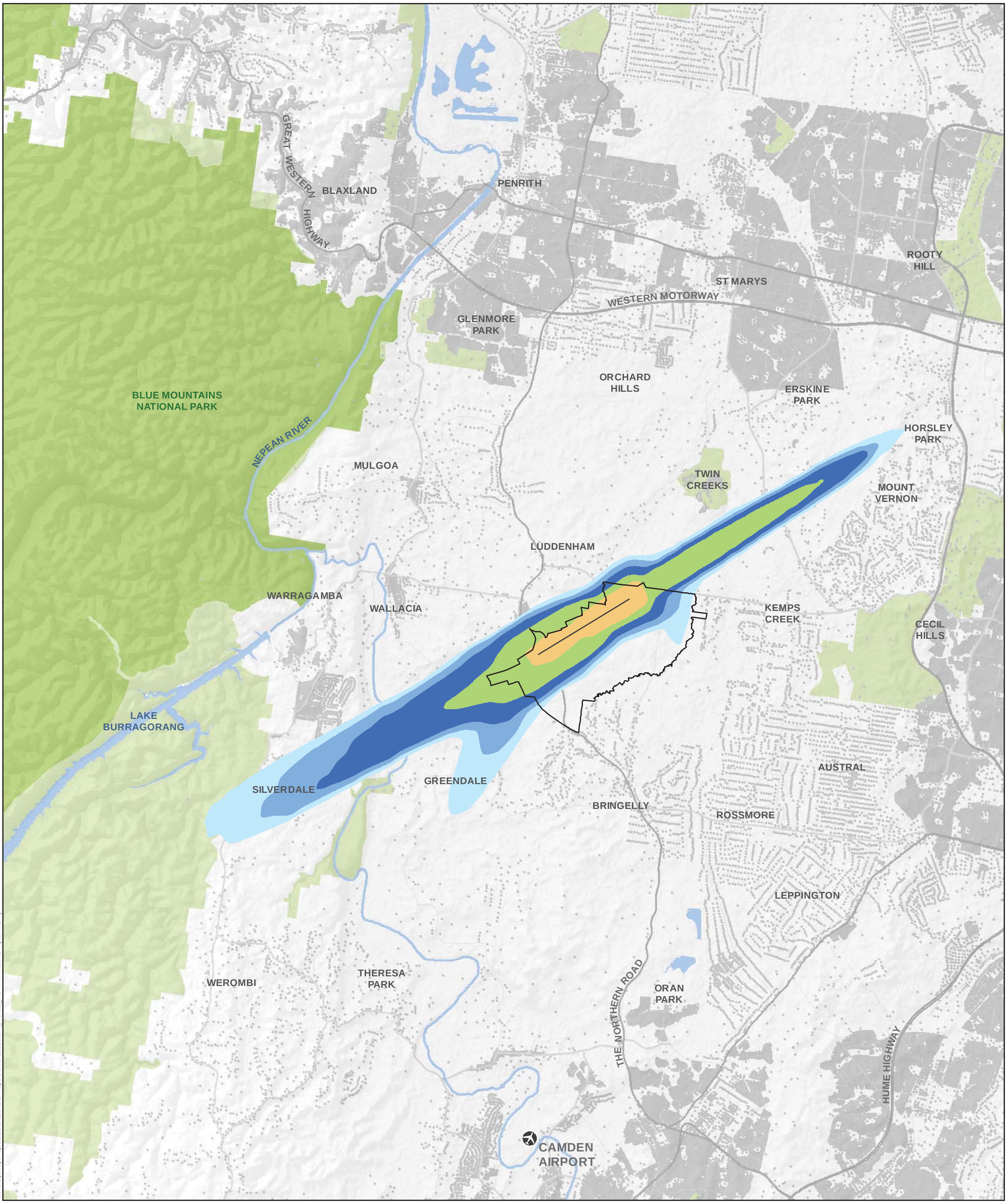
LEGEND

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

Western Sydney Airport	Greater Blue Mountains World Heritage Area	N70 = 5-10
Runway	Parks and reserves	N70 = 10-20
Airfields		N70 = 20-50
Buildings		N70 = 50-100
		N70 = 100+

0 1 2 4
Kilometres

Figure 10-19 - N70 contours - 2030 - Prefer 05



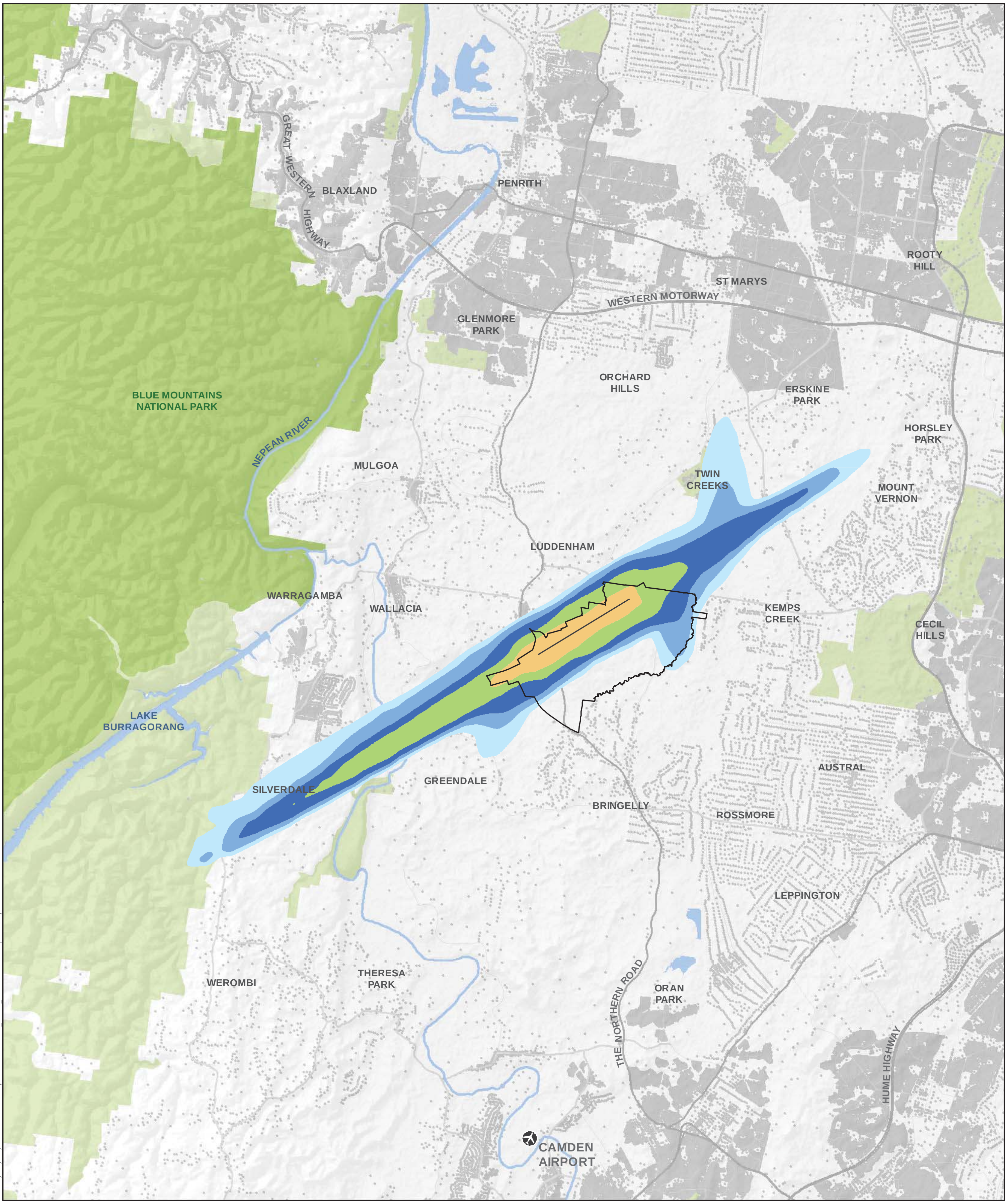
LEGEND

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

(box)	Western Sydney Airport	(box)	Greater Blue Mountains World Heritage Area	(box)	N70 = 5-10	(box)	N70 = 50-100
(line)	Runway	(box)	Parks and reserves	(box)	N70 = 10-20	(box)	N70 = 100+
(symbol)	Airfields			(box)	N70 = 20-50		
(dot)	Buildings						

0 1 2 4
Kilometres

Figure 10-20 - N70 contours - 2030 - Prefer 23



LEGEND

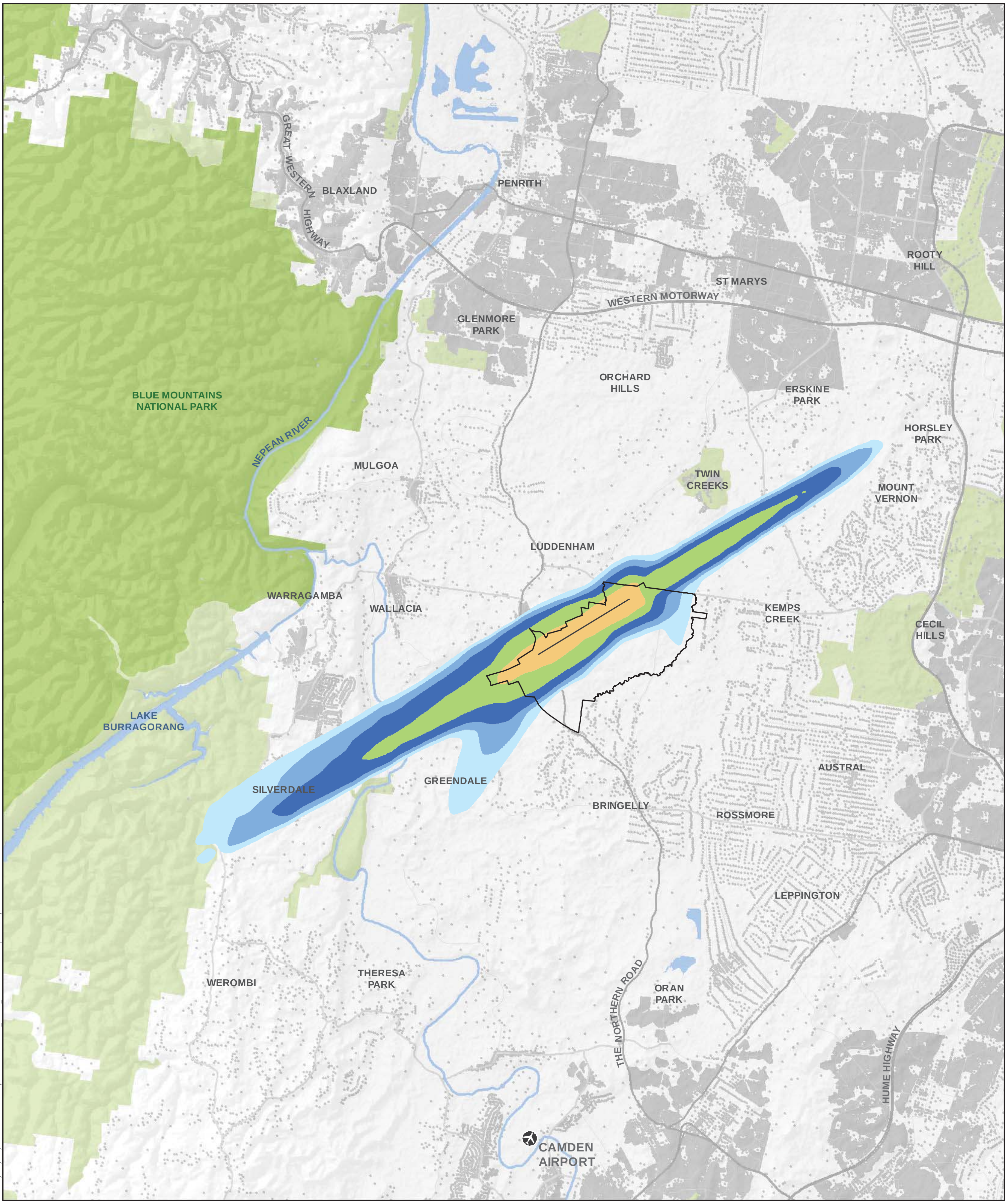
Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

Western Sydney Airport	Greater Blue Mountains World Heritage Area	N70 = 5-10	N70 = 50-100
Runway	Parks and reserves	N70 = 10-20	N70 = 100+
Airfields		N70 = 20-50	
Buildings			

0 1 2 4
Kilometres

N

Figure 10-21 - N70 contours - 2030 - Prefer 05 with head-to-head



LEGEND

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

Western Sydney Airport	Greater Blue Mountains World Heritage Area
Runway	Parks and reserves
Airfields	N70 = 5-10
Buildings	N70 = 10-20
	N70 = 20-50
	N70 = 50-100
	N70 = 100+

0 1 2 4
Kilometres

N

Figure 10-22 - N70 contours - 2030 - Prefer 23 with head-to-head

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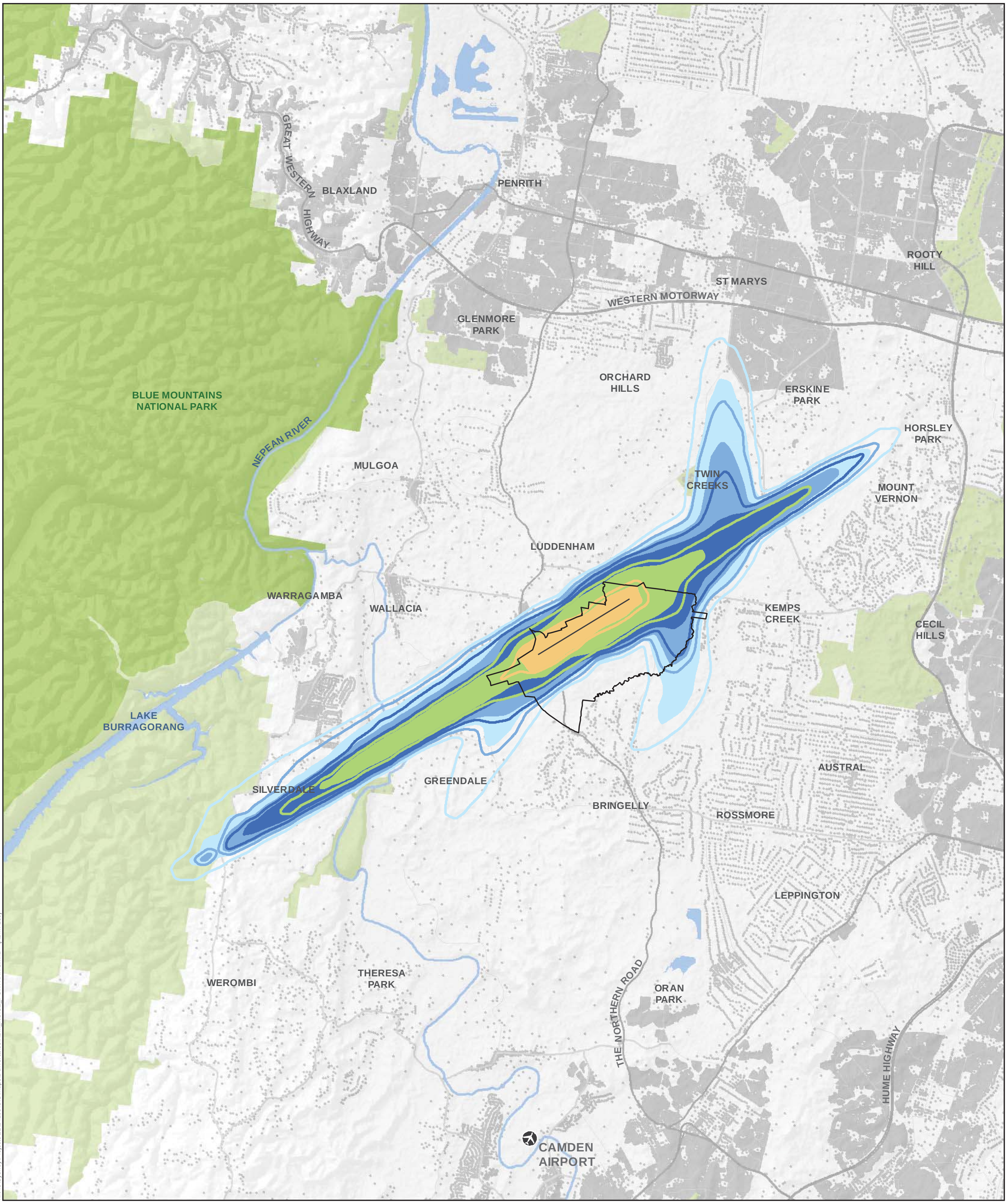
10.5.4.3. 90th percentile N70 results (worst case day)

Figure 10–23 and Figure 10–24 show 90th percentile values of N70 calculated over all days. These figures show the number of daily aircraft noise events over 70 dBA that would be exceeded on only 10 per cent of days. This can be thought of as a typical worst case day. Head-to-head operations are not shown as this operating strategy makes very little difference to the results.

The most noticeable aspect of these figures is that generally the difference between noise impact on average and typical worst case days is not large. This is due to the relatively low and consistent wind speeds at the airport site, which means that the proposed airport's preferred operating strategy could be selected over 80 per cent of the time.



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LEGEND

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

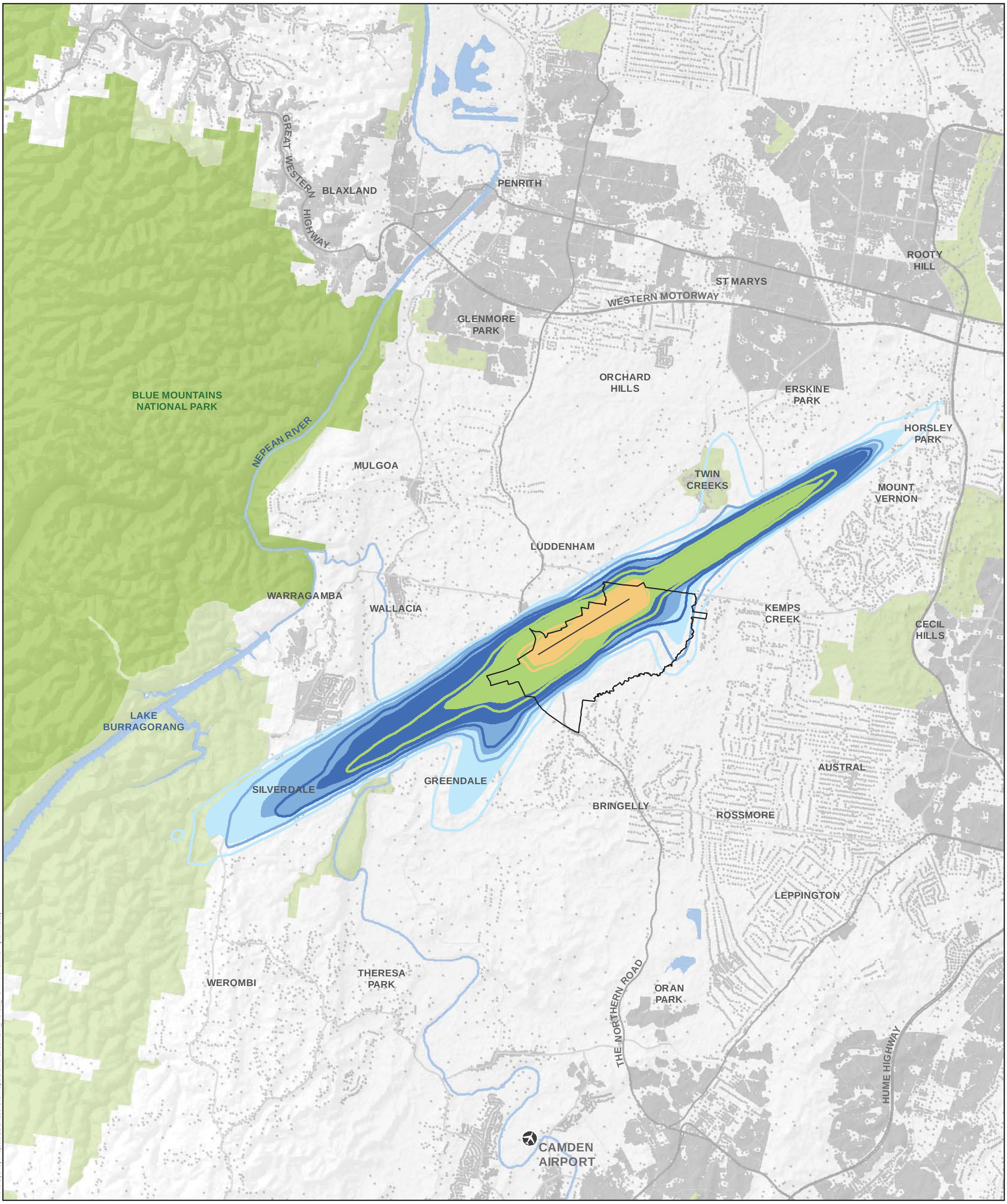
- Western Sydney Airport
- Runway
- Airfields
- Buildings
- Greater Blue Mountains World Heritage Area
- Parks and reserves
- N70 = 5-10
- N70 = 10-20
- N70 = 20-50
- N70 = 50-100
- N70 = 100+

N70 90th Percentile

- N70 = 5
- N70 = 10
- N70 = 20
- N70 = 50
- N70 = 100

0 1 2 4
Kilometres

Figure 10-23 - 90th percentile N70 contours - 2030 Prefer 05



LEGEND

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

Western Sydney Airport
Runway
Airfields
Buildings
Greater Blue Mountains World Heritage Area
Parks and reserves
N70 = 5-10
N70 = 10-20
N70 = 20-50
N70 = 50-100
N70 = 100+

N70 90th Percentile
N70 = 5
N70 = 10
N70 = 20
N70 = 50
N70 = 100

0 1 2 4
Kilometres

Figure 10-24 - 90th percentile N70 contours - 2030 Prefer 23

10.5.5. Night-time noise

10.5.5.1. N60 population exposure estimates

The number of noise events exceeding 60 dBA (N60) has been used to describe the impact of noise at night.

Table 10–5 shows the population estimated to be affected by night time noise above 60 dBA in 2030. A Prefer 05 operating strategy is predicted to result in an estimated 48,000 people experiencing more than five events above 60 dBA on an average night. This is predicted to reduce to approximately 6,000 with a Prefer 23 operating strategy, or about 4,000 if head-to-head operations are combined with either Prefer 05 or Prefer 23 operating strategies. However, a Prefer 23 or either head-to-head strategy would result in slightly more people experiencing a higher number of night time noise events in rural residential areas to the south and west of the airport site compared to the Prefer 05 strategy.

Table 10–5 – Estimated population within N60 contours (2030)

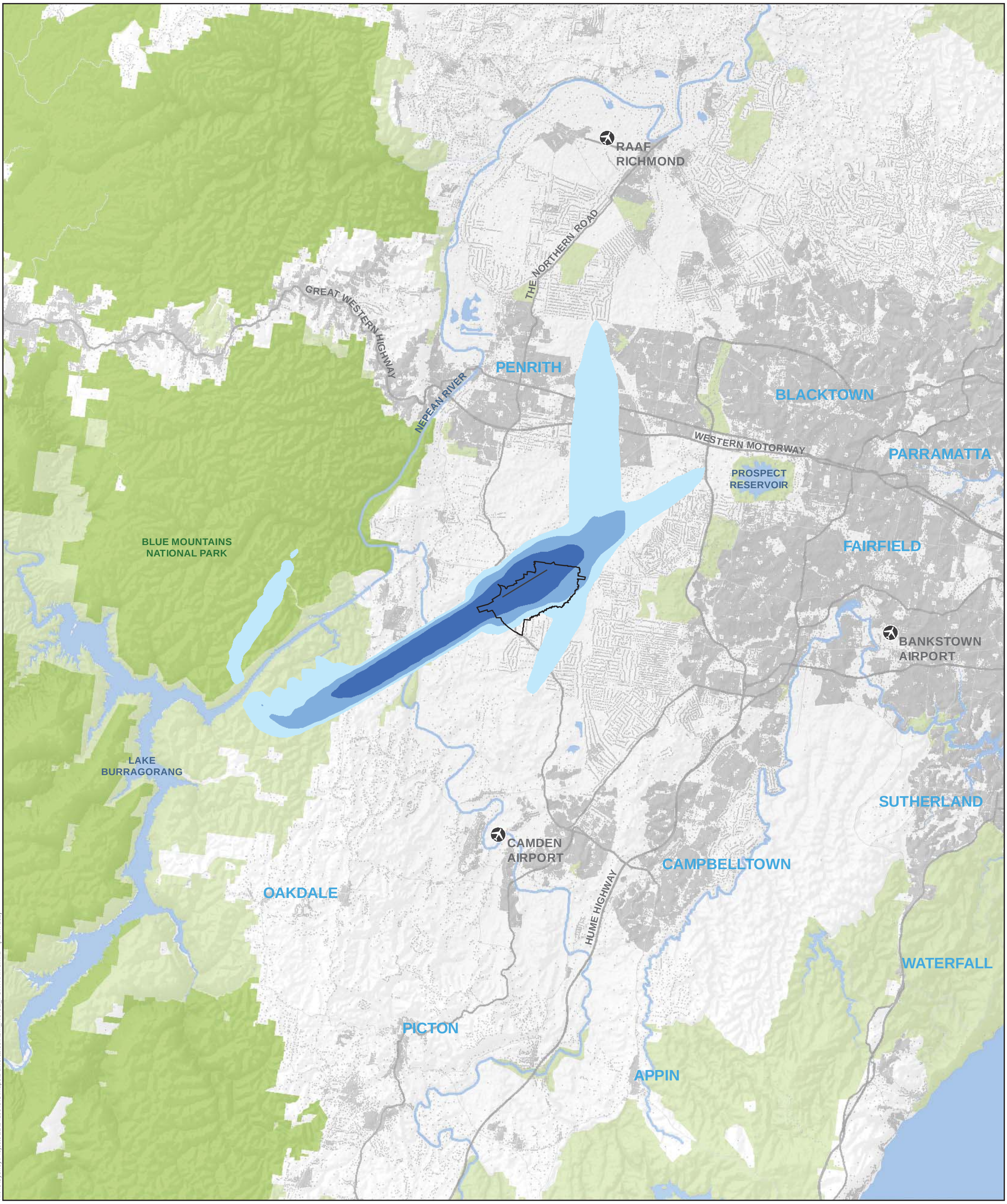
N60	Operating strategy			
	Prefer 05	Prefer 23	Prefer 05 + head-to-head	Prefer 23 + head-to-head
5-10	46,731	3,436	2,245	2,287
10-20	1,065	1,474	841	844
20-50	609	1,269	1,200	1,200
50-100	0	0	0	0
>100	0	0	0	0
Total	*48,405*	*6,179*	*4,286*	*4331*

10.5.5.2. N60 contours

N60 values have been predicted for the standard night-time period 10.00 pm–7.00 am. Figure 10–25 to Figure 10–28 show 2030 values for the four operating strategies considered.

The difference between Prefer 05 and Prefer 23 operating strategies is substantial. Prefer 05 is predicted to have a greater impact on built-up areas around St Marys, while Prefer 23 is predicted to have a greater impact on rural residential areas around Greendale and Silverdale. Under Prefer 23, this level of impact would be experienced only in rural residential areas and a small area to the south of Blacktown. Both strategies would impact Luddenham to the north of the runway; however, the Prefer 23 strategy is predicted to affect a larger area of the village.

The number of night-time noise events in densely populated areas could be reduced by use of the head-to-head operations where available. As demonstrated in Figure 10–27 and Figure 10–28, this would result in no built-up residential areas being exposed on average to more than five events per night above 60 dBA.



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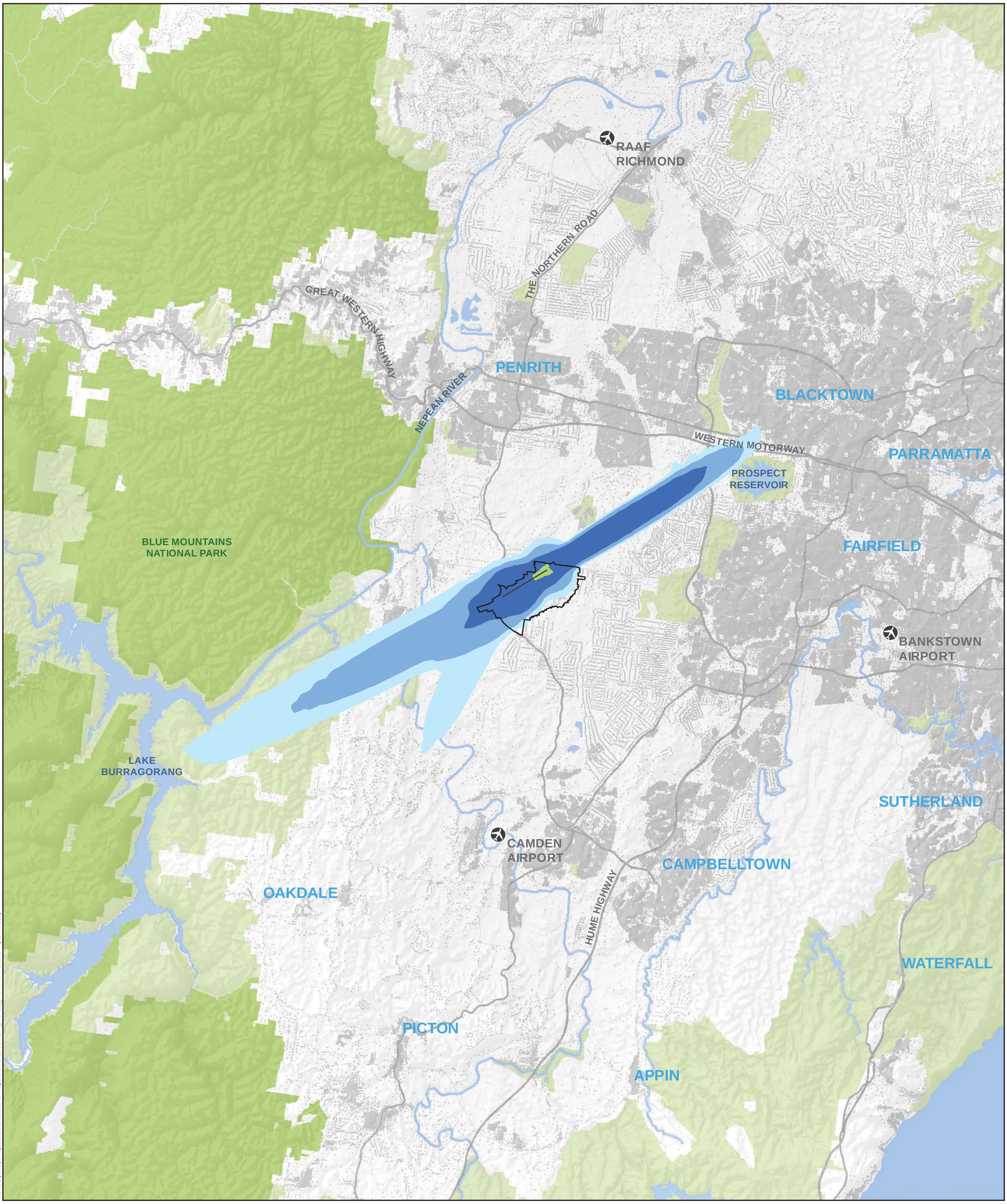
LEGEND

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

- Western Sydney Airport
- Runway
- Airfields
- Buildings
- Greater Blue Mountains World Heritage Area
- Parks and reserves
- N60 = 5-10
- N60 = 10-20
- N60 = 20+

0 2.25 4.5 9
Kilometres

Figure 10-25 - N60 contours - 2030 Prefer 05



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

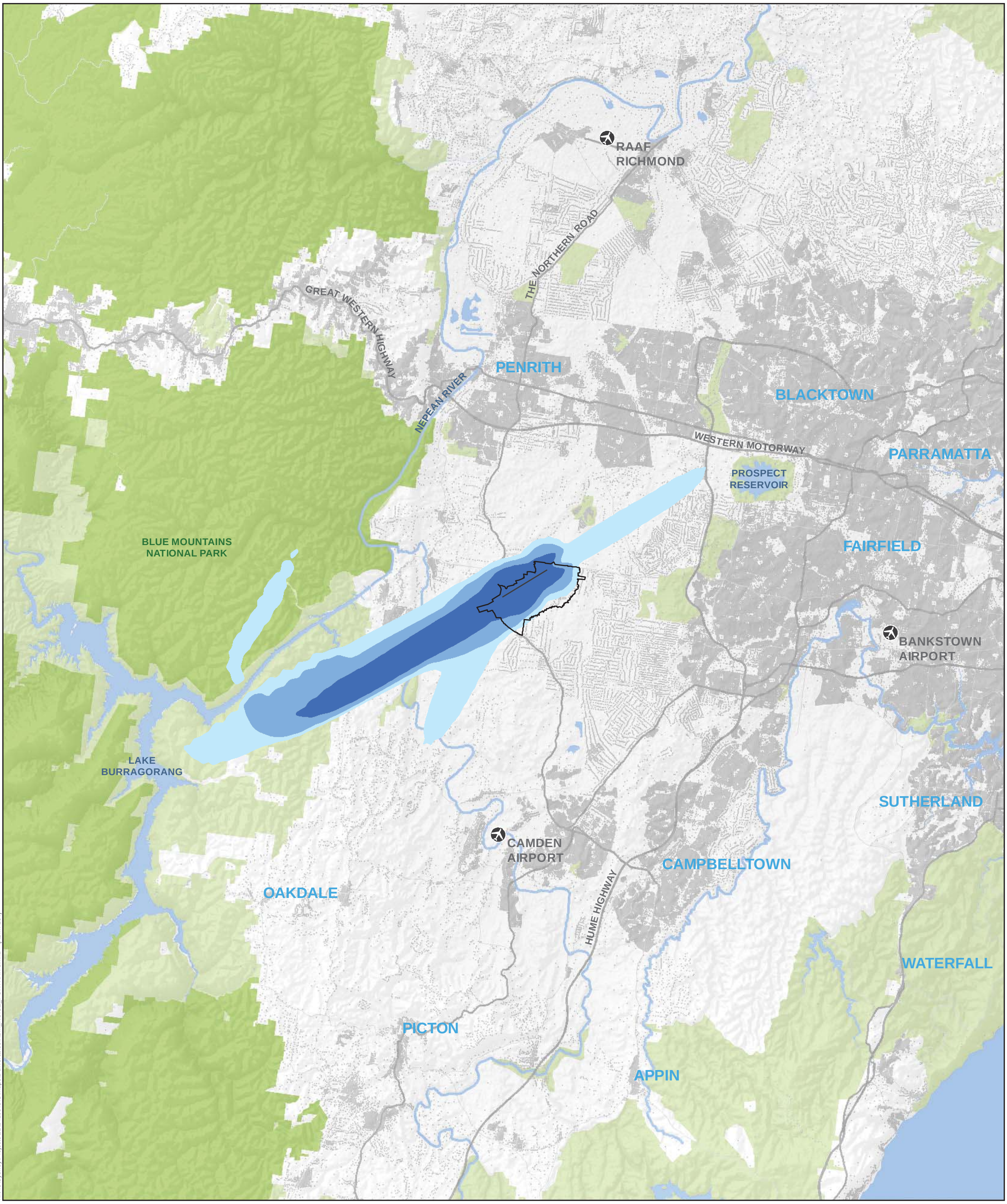
LEGEND

Western Sydney Airport	Greater Blue Mountains World Heritage Area	N60 = 5-10
Runway	Parks and reserves	N60 = 10-20
Airfields		N60 = 20-50
Buildings		N60 = 50+

0 2.25 4.5 9
Kilometres

N

Figure 10-26 - N60 contours - 2030 Prefer 23



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

LEGEND

- Western Sydney Airport
- Runway
- Airfields
- Buildings
- Greater Blue Mountains World Heritage Area
- Parks and reserves
- N60 = 5-10
- N60 = 10-20
- N60 = 20+

0 2.25 4.5 9
Kilometres

N

Figure 10-27 - N60 contours - 2030 Prefer 05 with head-to-head

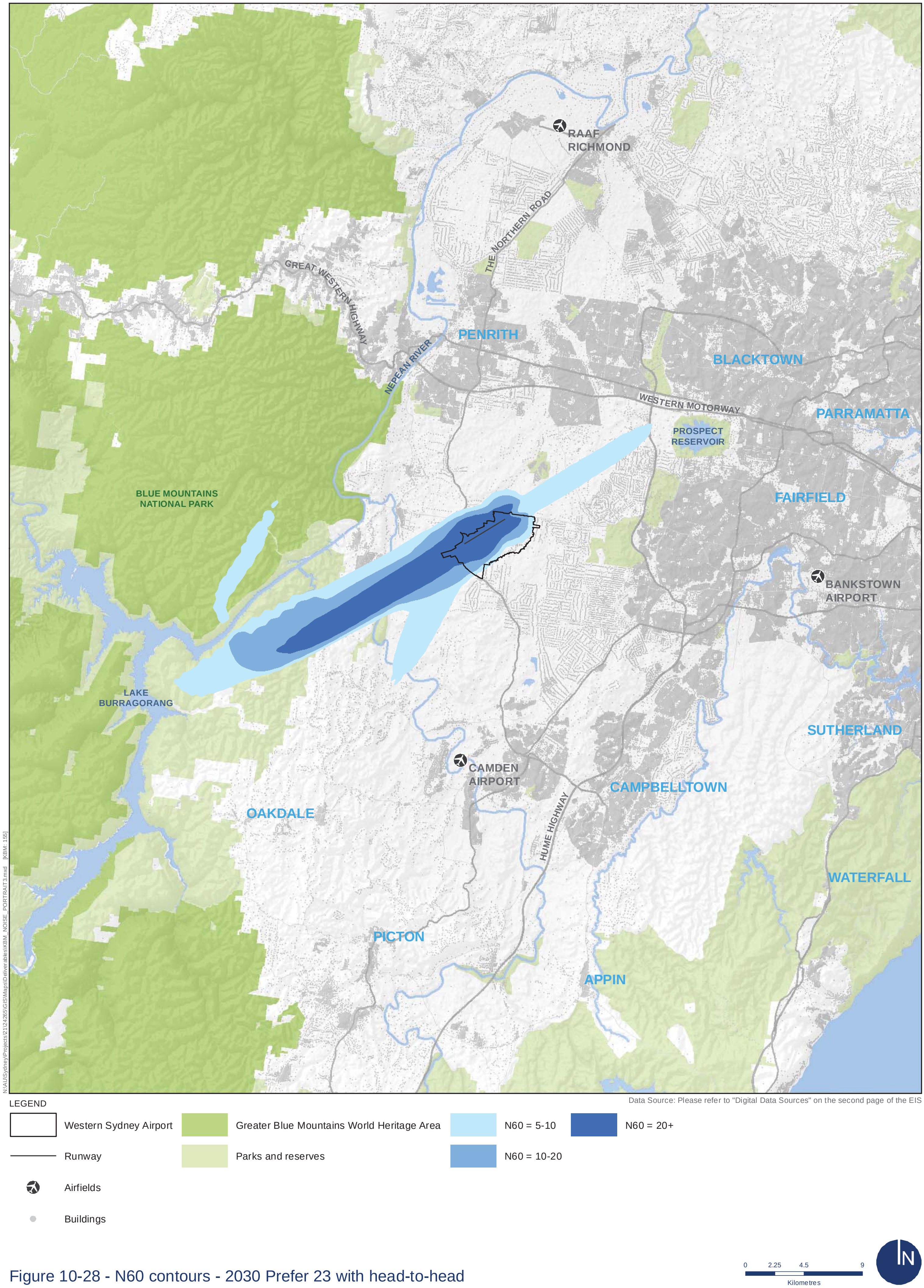
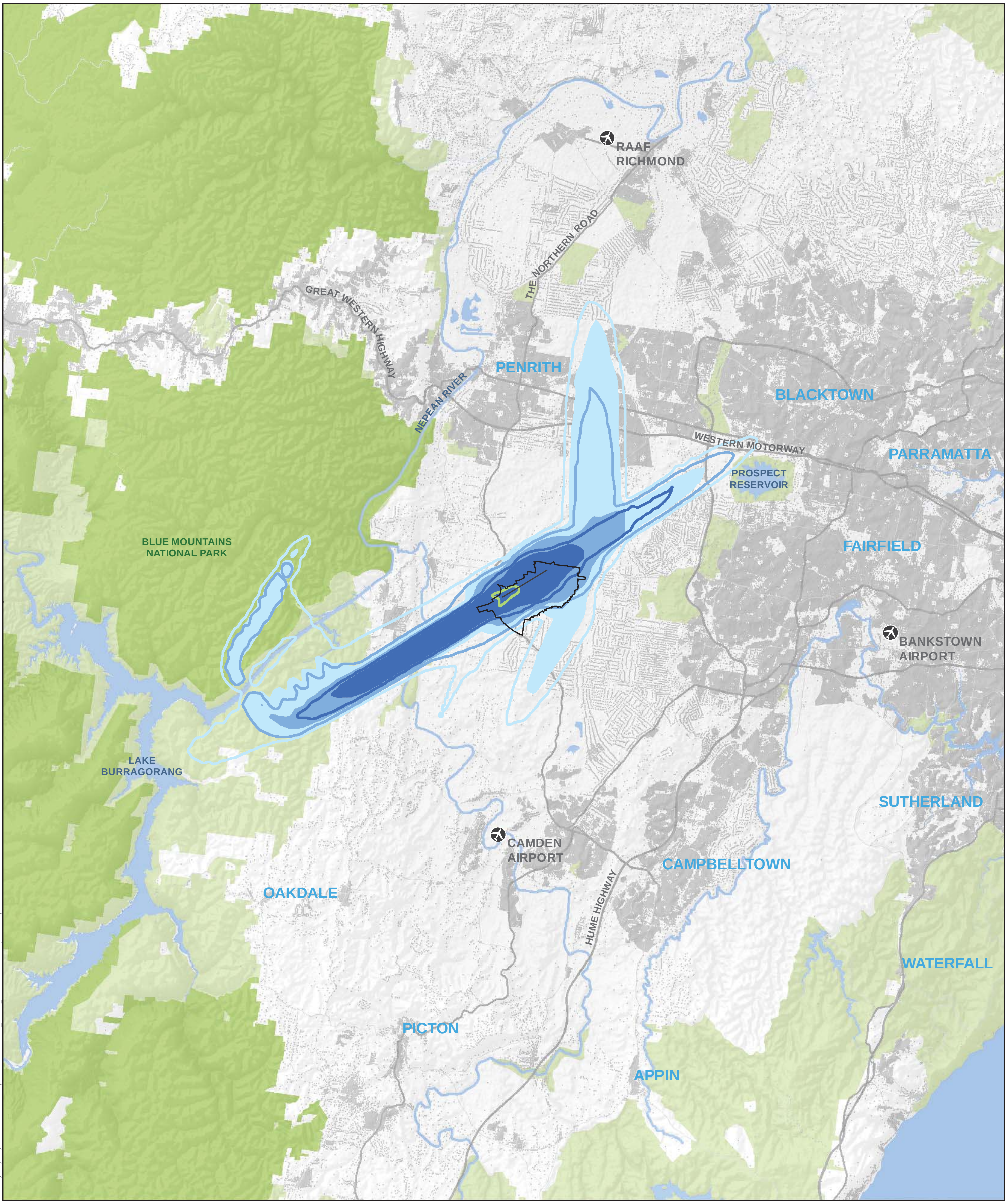


Figure 10-28 - N60 contours - 2030 Prefer 23 with head-to-head

10.5.5.3. 90th percentile N60 results (worst case)

Figure 10–29 to Figure 10–32 show 90th percentile night-time N60 values for 2030. These figures give an indication of the number of events per night exceeding 60 dBA on a typical worst case night compared to an average night. As for the N70 90th percentile results, differences between 'average' and 'typical worst-case' days are generally not large.



LEGEND

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

Western Sydney Airport	Greater Blue Mountains World Heritage Area	N60 = 5-10
Runway	Parks and reserves	N60 = 10-20
Airfields		N60 = 20+
Buildings		

N60 90th Percentile

- N60 = 5
- N60 = 10
- N60 = 20
- N60 = 50

0 2.25 4.5 9
Kilometres

Figure 10-29 - 90th percentile N60 contours - 2030 - Prefer 05

Figure 10-30 - 90th percentile N60 contours - 2030 - Prefer 23

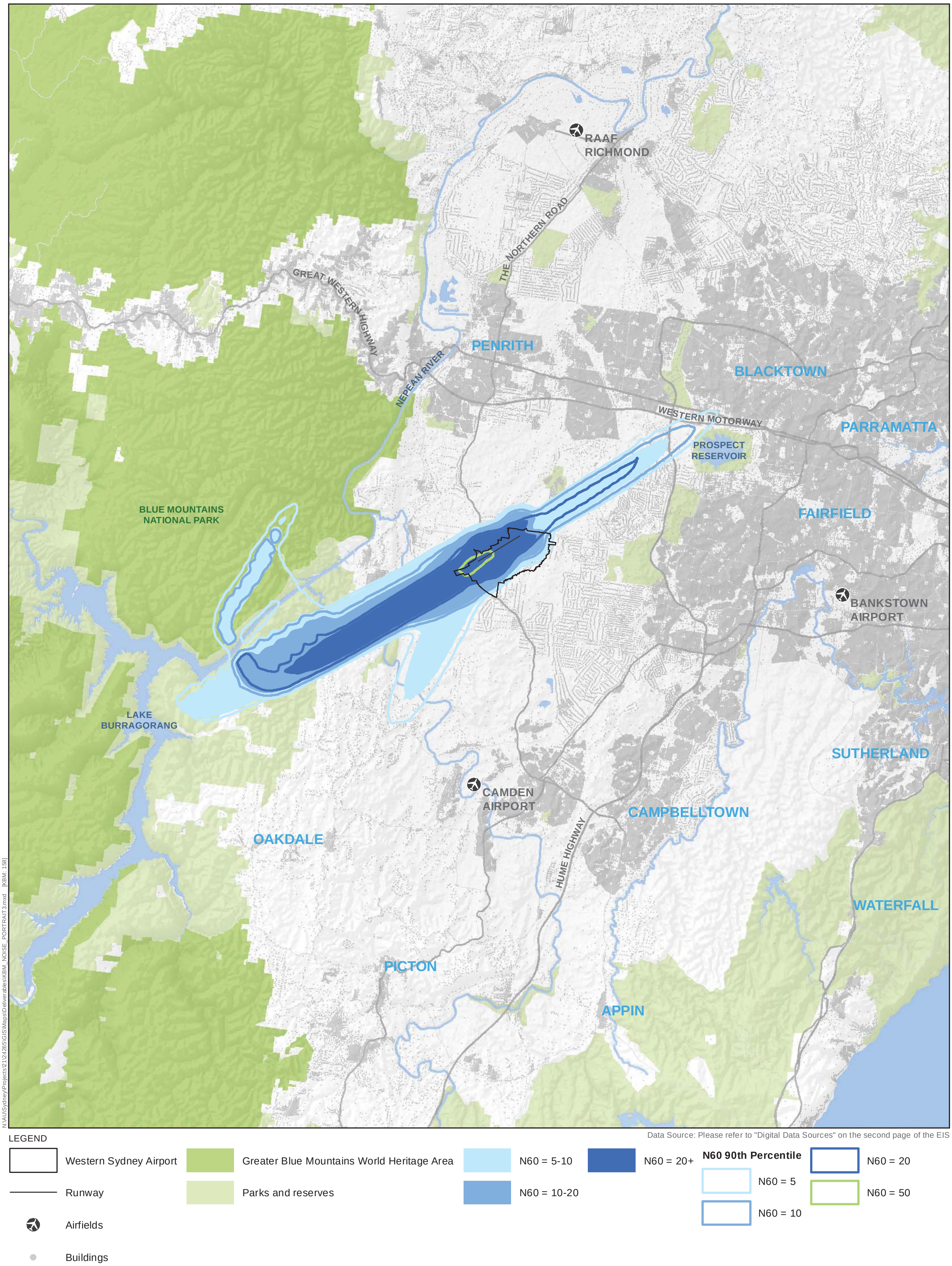
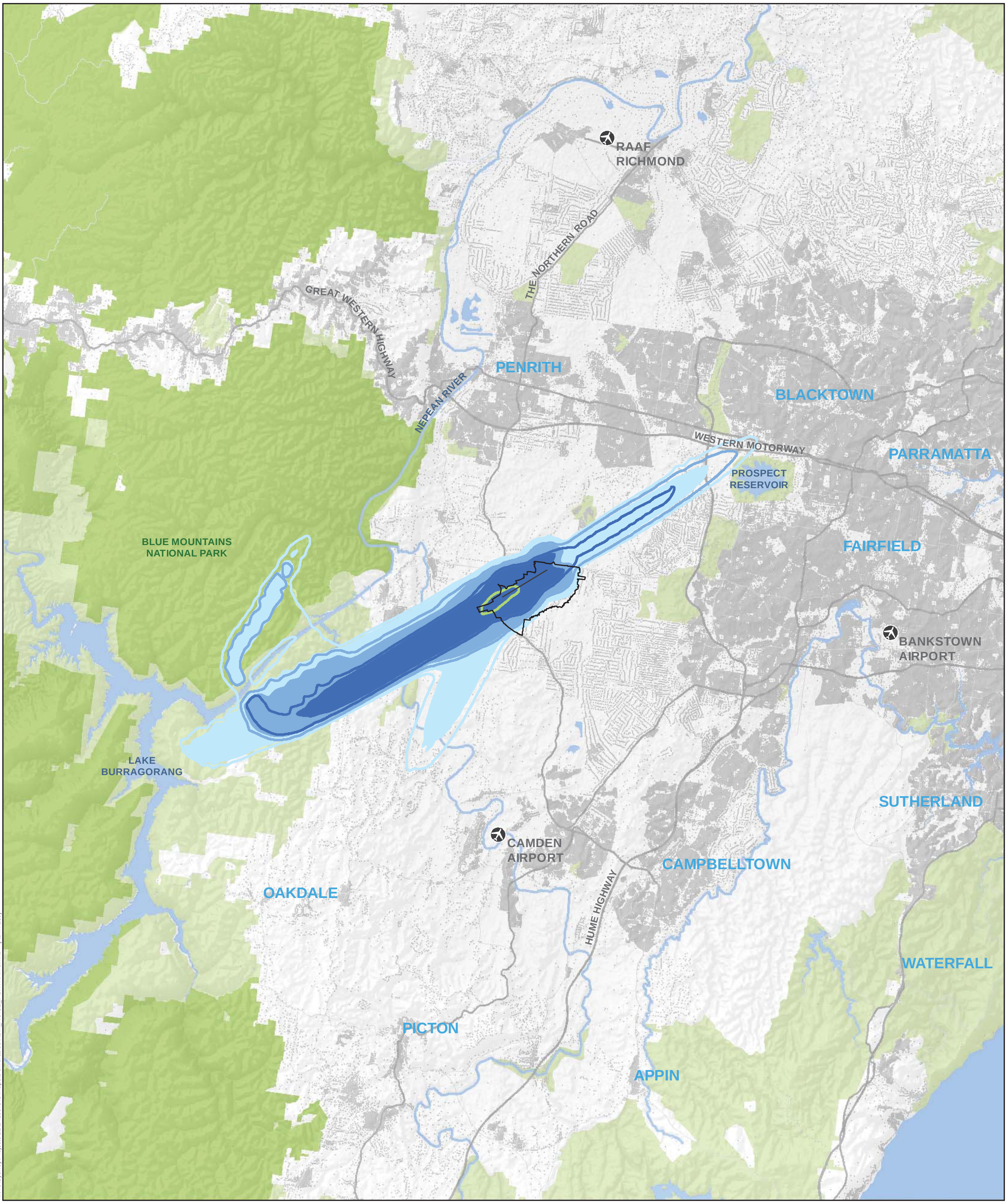


Figure 10-31 - 90th percentile N60 contours - 2030 - Prefer 05 with head-to-head



LEGEND

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

- Western Sydney Airport
- Runway
- Airfields
- Buildings
- Greater Blue Mountains World Heritage Area
- Parks and reserves
- N60 = 5-10
- N60 = 10-20
- N60 = 20+

N60 90th Percentile

- N60 = 5
- N60 = 10
- N60 = 20
- N60 = 50

0 2.25 4.5 9
Kilometres

Figure 10-32 - 90th percentile N60 contours - 2030 - Prefer 23 with head-to-head

10.5.6. Recreational areas

A number of recreational areas, located close to the proposed airport, have been identified within the area potentially affected by aircraft overflight noise. These range from sports areas used for active pursuits such as horse riding, bowling or golf to nature reserves which may be used for more passive activities.

The impact of aircraft noise in recreational areas can be quantified by calculating the number of events per day, exceeding maximum noise levels of 60 dBA and 70 dBA. Where a noise level exceeds 60 dBA, a person may need to raise their voice to be properly heard in conversation but this level would be unlikely to cause disruption to active sporting pursuits. However, it would be noticeable and could impact on the acoustic amenity of areas used for passive recreation for the duration of the aircraft overflight. Noise levels above 70 dBA would require increased voice effort (although not shouting) for conversation to be understood, and would likely be considered to be acoustically intrusive in passive recreation areas for the duration of the aircraft overflight.

Table 10–6 and Table 10–7 show the identified recreation areas and the predicted values of N60 and N70 for the Prefer 05 and Prefer 23 operating strategies. The values shown are for the period 7.00 am–6.00 pm, representing the times when these areas would most likely be used.

Table 10–6 – Average number of daily noise events with L_{Amax} exceeding 60 dBA (N60) at recreational areas

Recreational area	2030 noise events	
	Prefer 05	Prefer 23
Bents Basin State Conservation Reserve & Gulguer Nature Reserve	7	13
Kemps Creek Nature Reserve	0	0
Rossmore Grange	3	1
Horsley Park Reserve	0	0
Twin Creeks Golf & Country Club	23	6
Sydney International Equestrian Centre	0	0
Whalan Reserve, St Marys	1	2

Table 10–7 – Average number of daily noise events with L_{Amax} exceeding 70 dBA (N70) at recreational area

Recreational area	2030 noise events	
	Prefer 05	Prefer 23
Bents Basin State Conservation Reserve & Gulguer Nature Reserve	0	0
Kemps Creek Nature Reserve	0	0
Rossmore Grange	0	0
Horsley Park Reserve	0	0
Twin Creeks Golf & Country Club	5	1
Sydney International Equestrian Centre	0	0
Whalan Reserve, St Marys	0	0

The results indicate that most of the identified recreational receivers would not be subject to aircraft overflight noise events with maximum levels exceeding 70 dBA, or their exposure would be less than one event per day on average.

Aircraft noise levels at Twin Creeks Golf and Country Club would be noticeable and at times a raised voice would be required for effective communication. At this location, predicted noise exposure would be significantly reduced under a Prefer 23 operating strategy.

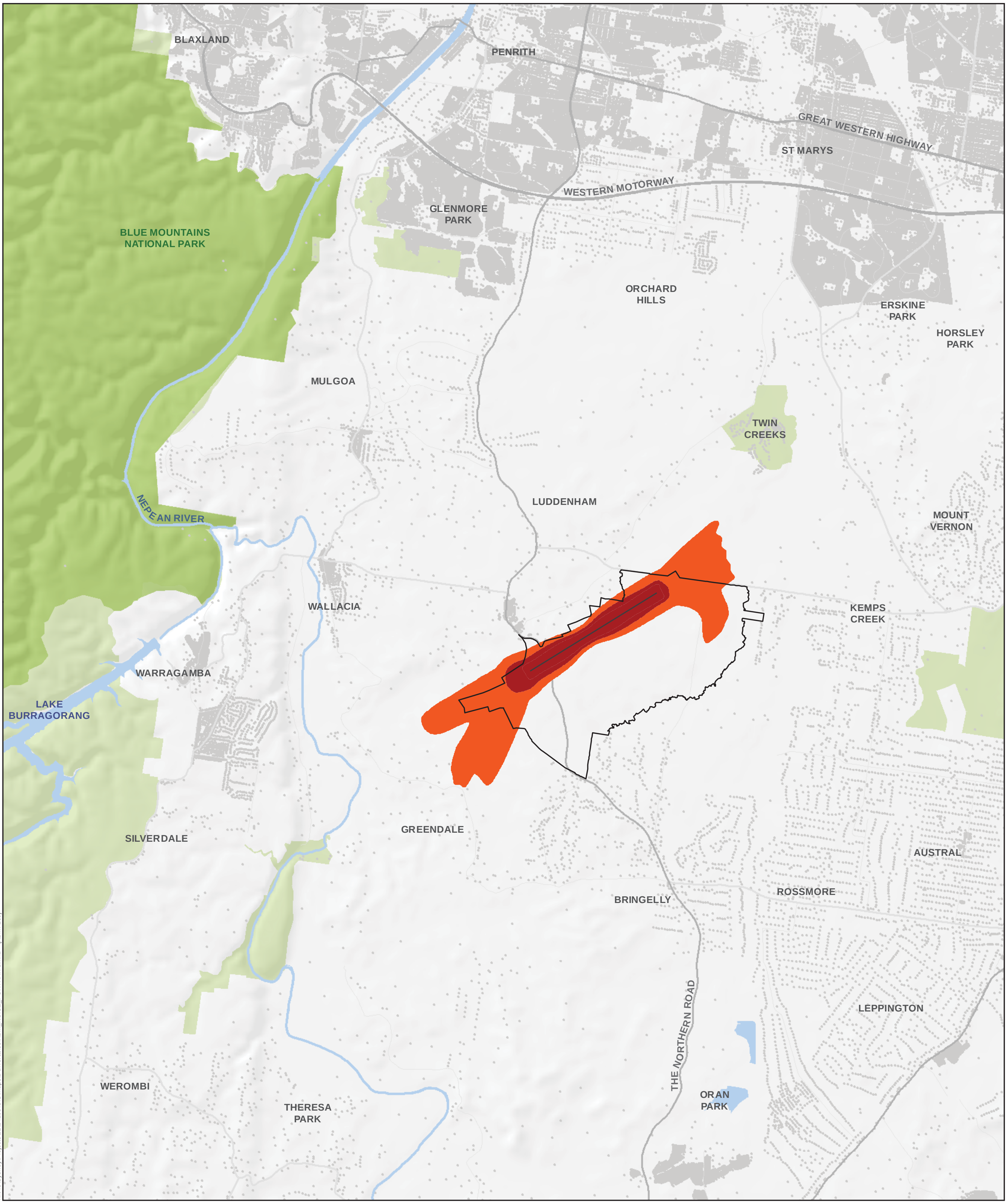
Bents Basin State Conservation Reserve and Gulguer Nature Reserve would be subject to a number of flyover event noise levels exceeding 60 dBA, which would be noticeable to passive users of these areas. Bents Basin State Conservation Reserve is used for camping, and would on average be subject to less than five night-time noise events exceeding 60 dBA per day. At this location noise exposure would be lower under a Prefer 05 operating strategy.

10.5.7. Noise induced vibration

At high noise levels, the low frequency components of aircraft noise can result in vibration of loose elements in buildings, notably windows.

Even at the highest expected noise levels, the levels of vibration due to low frequency noise would be well below those which may cause structural damage to buildings. With typical light building structures, noise induced vibration may begin to occur where the maximum external noise level reaches approximately 90 dBA. The effect is more common on take-offs than for landings because the noise spectrum for a take-off close to the airport has stronger low frequency components.

Figure 10–33 shows 85 dBA and 90 dBA noise level contours for a B747 aircraft departure (stage length 5). Only areas within the 90 dBA contour could expect to experience any noise-induced vibration of building structures, and even then only during a departure of a B747 aircraft with maximum stage length 5. For 2030, there are no existing residences within this contour.



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

LEGEND

Western Sydney Airport
Runway
Buildings
Greater Blue Mountains World Heritage Area
Parks and reserves

LAmax
85-90 dBA
>90 dBA

0 0.75 1.5 3
Kilometres

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Figure 10-33 - 85 dBA and 90 dBA LAmax contours - stage 5 B747 departure - Stage 1 development

10.6. Mitigation and management measures

10.6.1. Mitigation and management of aircraft overflight noise

There are three main options for mitigation of aircraft noise:

- reduce noise emissions from the aircraft themselves;
- plan flight paths and airport operating modes to achieve lower impacts over noise-sensitive areas; and
- develop land use planning or other controls to ensure that future noise-sensitive uses are not located in noise-affected areas.

10.6.1.1. Improvements in aircraft technology

It is difficult to predict future reductions in aircraft noise emission levels because this is primarily the role of aircraft designers and manufacturers. Even without further technological advances, it is reasonable to assume that total airport noise emissions would decrease over time as quieter new generation aircraft make up a greater share of the airport's traffic mix. For example, Singapore Airlines has already removed the Boeing 747 from passenger services. Qantas has reduced the size of its Boeing 747 fleet and is expected to retire its remaining Boeing 747s by the time operations commence at the proposed airport. Aircraft types assumed for the purposes of assessment are based on those currently in service and the approach can therefore be considered conservative. Future noise levels are expected to be lower than assumed in the modelling.

10.6.1.2. Airport operating strategies

The noise impact of different airport operating strategies has been considered as part of the assessment and it is one of the key factors affecting the pattern of noise impacts as presented in this assessment. The determination of operating strategies would be particularly important for consideration of night time noise impact and providing respite periods for affected communities. The use of continuous descent approaches (which minimises the use of engine thrust by pilots) has also been assumed as part of the noise assessment. The reduction in noise level as a result of this measure depends on the aircraft type and the location of the receiver, but is estimated to be in the order of zero to five dBA.

10.6.1.3. Land use planning

Land use planning controls around airports in Australia are based on the recommendations of AS 2021. It is expected that land use planning around the proposed airport would be based on future ANEF contours that are produced and endorsed by Airservices Australia prior to the commencement of airport operations.

It is noted that ANECs developed for the 1985 Draft EIS (Kinhill Stearns 1985) have guided interim planning controls implemented by the NSW Government and relevant local councils. These earlier ANECs are broadly consistent with the ANECs presented in this EIS. In addition to the use of these interim planning controls, the Western Sydney Employment Area being developed to the north of the airport site would also provide a buffer between the airport and residential areas.

The National Airport Safeguarding Framework (NASF) is a further initiative that addresses land use planning and aircraft noise. NASF is a national land use planning framework, agreed to by Commonwealth, State and Territory ministers in 2012 that establishes planning principles and guidelines in order to:

- improve community amenity by minimising aircraft noise-sensitive developments near airports including through the use of additional noise metrics and improved noise-disclosure mechanisms; and
- improve safety outcomes by ensuring aviation safety requirements are recognised in land use planning decisions through guidelines being adopted by jurisdictions on various safety-related issues.

Further detail on the NASF is included in Chapter 21 of Volume 2 of this EIS.

10.6.1.4. Communication and coordination

One important form of mitigation for aircraft noise impacts would be the provision of information to both existing and potential residents in areas likely to be affected by noise. For example, this would allow people to be properly informed before deciding whether or not to move into an area predicted to experience aircraft noise.

The Australian Government also expects federally leased airports to operate Community Aviation Consultation Groups (CACGs). There are guidelines for CACGs which specify that they be independently chaired and should engage broad community representation. While they are not decision making bodies, CACGs provide for effective and open discussion of airport operations and their impacts on nearby communities.

Major capital city airports are also required to establish Planning Coordination Forums. The purpose of Planning Coordination Forums is to support a strategic dialogue between the airport operator and local, state and federal government agencies responsible for town planning and infrastructure investment. Effective discussions in Planning Coordination Forums support better integration of planning for an airport and for the surrounding urban and regional community.

10.6.2. Monitoring of noise

Noise impacts associated with the proposed airport would likely be monitored using the noise and flight path monitoring system operated by Airservices Australia. Consistent with the practice at other major airports, a number of permanent monitors would be installed at locations that are representative of noise impacts at surrounding communities and monthly monitoring results would be made publicly available.

Noise monitoring is undertaken by Airservices Australia to:

- determine the contribution aircraft noise makes to the overall noise to which a community is exposed;
- provide information to the community;
- help local authorities make informed land use planning decisions;
- inform impact estimates resulting from changes in air traffic control procedures – including changes to reduce aircraft noise impacts;
- validate noise modelling;
- inform the determination of aviation policy by government; and
- assist the government in implementing legislation.

10.6.3. Mitigation and management measures

Table 10–8 outlines the broad mitigation and management measures that are proposed to address the potential aircraft noise impacts associated with the proposed Stage 1 development.

Table 10–8 – Mitigation and management measures – aircraft noise

ID	Issue	Mitigation/management measure	Timing
10.1	Noise management plan	A noise management plan would be prepared for aircraft operations prior to the commencement of airport operations. To the extent practicable, development and implementation of the noise management plan would be integrated with and draw on the outcomes of future detailed airspace and airport operations design undertaken by Airservices Australia and the Civil Aviation Safety Authority (CASA). This formal design process would provide an opportunity to optimise flight paths on the basis of safety, efficiency, noise and environmental considerations, as well as minimising changes to existing regional airspace arrangements. Establishing airspace management arrangements for the proposed airport, including the determination of flight paths, is expected to involve additional formal environmental assessment and community and stakeholder engagement. Development and implementation of the noise management plan would involve the airport lessee company, Airservices Australia, CASA, the Department of Infrastructure and Regional Development, other Australian Government agencies, State and local government, the airline industry, and community representatives. Terms of reference would be prepared for the plan. These would specify the objectives of the plan, identify the matters and actions to be considered, establish planning horizons, guide the participation of stakeholders and outline decision-making processes for determining preferred actions. Issues to be addressed in the plan would include but not be limited to: • options for flight paths and airport operating modes for day and night operations, having regard to environmental impacts, operation efficacy and safety considerations; • the number of aircraft overflights, levels of noise exposure predicted to be experienced by communities, and the impacts on amenity in conservation and recreation areas, and at other noise sensitive locations; • opportunities for the provision of periods of respite from aircraft noise; • the control of the loudness of noise events, including noise abatement departure and arrival procedures (e.g. the use of reverse thrust); • the management of noise at night; • the possible insulation or acquisition of buildings exposed to the highest noise levels having regard to Australian Standard 2021, including mechanisms for funding potential noise amelioration works and property acquisitions; • the design and installation of a noise and flight path monitoring system; • arrangements for noise enquiries and complaints; • identification of responsibilities for implementing individual actions; and • land use planning policies and instruments for areas surrounding the airport taking account of predicted noise exposure levels.	Pre-operation

10.7. Conclusion

This chapter provides an assessment of potential aircraft noise impacts associated with the operation of the proposed Stage 1 development at the point at which passenger demand reaches 10 million annual passenger movements, which is anticipated to occur around 2030.

The assessment is based on indicative flight paths prepared by AirServices Australia, as part of a preliminary assessment of airspace implications and air traffic management arrangements for Sydney region airspace associated with the potential commencement of operations at the proposed airport. A future airspace design process is expected to be undertaken closer to the commencement of operations at the proposed airport and further noise impact assessment would be carried out at that time.

The current assessment indicates that for the loudest aircraft operations (long-range departures by Boeing 747 aircraft or equivalent), maximum noise levels over 85 dBA would be experienced at a small number of residential locations close to the airport site in Badgerys Creek. Maximum noise levels of 70–75 dBA could be expected within built-up areas in St Marys and Erskine Park as a result of worst case operations. Maximum noise levels due to more common aircraft types such as Airbus A320 or equivalent are predicted to be lower at 60–70 dBA in built-up areas around St Marys and Erskine Park, and over 70 dBA in some adjacent areas to the south-west of the airport site, notably in Greendale.

On a typical busy day, about 1,500 residents are expected to experience five or more aircraft noise events per day above 70 dBA.

At night, the Prefer 05 operating strategy is predicted to result in an estimated 48,000 people experiencing more than five events above 60 dBA during the night time period. With a Prefer 23 operating strategy, approximately 6,000 people are predicted to experience more than five events above 60 dBA on an average night. This is predicted to reduce to about 4,000 residents if a head-to-head strategy (both approaches and departures to the south-west) is included.

Most recreational areas would not be subject to aircraft overflight noise events with maximum levels exceeding 70 dBA. In recreational areas where this level of noise exposure is predicted, the average number of events above 70 dBA would on average be less than one event per day.

Approaches to mitigating aircraft noise generally focus on reducing noise emissions from the aircraft themselves, planning flight paths and airport operating modes in a way that minimises potential noise and environmental impacts, and implementing land use planning or other controls to ensure that future noise-sensitive uses are not located in noise-affected areas.

In this case, the noise impact of different airport operating strategies has been considered as part of the assessment. The use of continuous descent approaches (which minimises the use of engine thrust by pilots) has been assumed. Future reductions in aircraft noise emission levels are difficult to predict and therefore existing aircraft types have been conservatively assumed for the purposes of assessment. It is expected that land use planning around the proposed airport would be influenced by the final ANEF contours once flight paths and operating modes are finalised and approved.

Noise impacts associated with the proposed airport would be monitored using a noise and flight path monitoring system.

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11. Noise (ground operations, construction, road and rail)

Ground-based noise can be generated on site from a number of potential sources, including taxiing, the ground running of aircraft engines for maintenance testing, construction activities and road traffic associated with the proposed airport.

Existing noise sources in the area around the airport site include road traffic noise and local industry, reflecting the predominantly rural residential nature of the area. Construction and operation of the proposed airport would introduce new noise sources into the area.

Noise during construction of the proposed airport would be largely confined within the airport boundary, although there would also be impacts on the Luddenham and Badgerys Creek areas. While heavy and light vehicles would need to access the airport during the construction stage, the resulting increase in traffic noise would not be significant. Vibration generated by construction activities is considered unlikely to cause building damage.

Ground-based operational noise would be generated primarily by aircraft engine runs (e.g. fixed-wing engine maintenance testing) and taxiing. Under worst case meteorological conditions, noise associated with engine run-up has the potential to affect Luddenham, Badgerys Creek, Bringelly and Greendale. The impact of noise from taxiing extends over a much smaller area and would primarily affect Luddenham.

During operation of the proposed airport, increased noise levels due to airport generated road traffic in the surrounding area are not expected to be significant.

Mitigation measures have been proposed to address noise during construction of the proposed airport. These include the implementation of a construction noise and vibration plan and the development of a strategy to manage ground-based noise during operation. Operation of the proposed airport would be subject to further detailed design including further analysis of the location of noise generating airport facilities and detailed consideration of practicable noise mitigation measures.

11.1. Introduction

This chapter provides a review of the potential construction, road traffic and ground-based operational noise and vibration impacts associated with the proposed airport. This includes consideration of:

- construction activities, including the noise generated by construction equipment and construction traffic accessing the airport site;
- ground running of aircraft engines for maintenance testing;
- taxiing of aircraft; and
- road traffic changes in the surrounding area as a result of airport operation.

This chapter draws upon a comprehensive assessment of ground-based noise undertaken for the proposed airport, included as Appendix E2 of Volume 4. It addresses the requirements of the EIS guidelines issued by the Australian Government Department of the Environment.

Aircraft overflight and runway operations noise is addressed separately in Chapter 10 and by the comprehensive assessment of aircraft overflight noise included in Appendix E1 in Volume 4.

11.2. Methodology

11.2.1. Construction noise and vibration assessment methodology

Construction activities for the proposed Stage 1 development are expected to occur in three major work phases:

- site preparation works (including major earthworks);
- aviation infrastructure; and
- site commissioning activities.

The major earthworks component of construction is expected to generate the most noise and therefore has been used as the basis of a 'worst case' construction noise assessment.

To predict construction noise levels in the surrounding area, typical sound power levels of the plant likely to be used during major earthworks were incorporated in a CadnaA noise model. Worst case weather consistent with a temperature inversion was also incorporated in the model. Temperature inversions cause sound to be deflected back toward the ground resulting in higher noise levels at receivers. Temperature inversions tend to occur in the evening and at night and can extend into the morning under calm conditions.

Vibration assessment for the construction phase included consideration of vibration generating plant proposed for use, the distance to vibration sensitive receivers and relevant guidelines values set out in German Standard DIN 4150-3 *Structural Vibration: Effects of Vibration on Structures*.

11.2.2. Ground-based operations noise assessment methodology

Ground-based operational noise levels were predicted for the proposed Stage 1 development based upon a demand of 10 million annual passenger movements in around 2030. Noise levels were reported as A-weighted decibels (dBA), which are an expression of the relative loudness of sounds as perceived by the human ear. The following noise sources were considered:

- aircraft engine run-up noise – it has been assumed that aircraft engine running would occur at a maintenance area nominally located in southern part of the airport site as shown in Figure 11–1. While the orientation of an aircraft during run-up would change depending on prevailing wind conditions, a conservative approach was adopted for this assessment by assuming that the emitted noise would be omnidirectional and at a level of 151 dBA. High power engine runs are expected to be relatively rare at the proposed Stage 1 airport and it has been conservatively assumed that no more than one run on full power would occur during any night and for no more than five minutes; and
- Taxiing noise – the proposed aircraft taxi path is shown in Figure 11–1. A sound power level for each aircraft of 138 dBA has been assumed, being the highest level measured for aircraft taxiing (B777, B747, B737, B717 and A330).

The assessment of noise impacts in this EIS has been based on aircraft types that are commonplace today, including the Boeing 747 and the Airbus A320. As indicated in Chapter 10, it is expected that quieter aircraft like the Airbus A350XWB, A320neo, and Boeing 737MAX would be introduced during the operation of the proposed Stage 1 development and consequently the ground-based noise modelling is considered conservative. The Boeing 747 is the loudest aircraft anticipated to operate at the proposed airport and airlines are already beginning to retire it from regular passenger services.

Noise contours were generated for aircraft ground running and taxiing using CadnaA noise prediction software. Certain meteorological conditions such as temperature inversions and light winds may increase noise levels at nearby receivers, by focussing sound wave paths at a single point. Worst case weather consistent with a temperature inversion was assumed in the modelling. For engine run-up noise predictions, it was also assumed that there would be shielding from a maintenance building near the run-up area as shown on Figure 11–1.

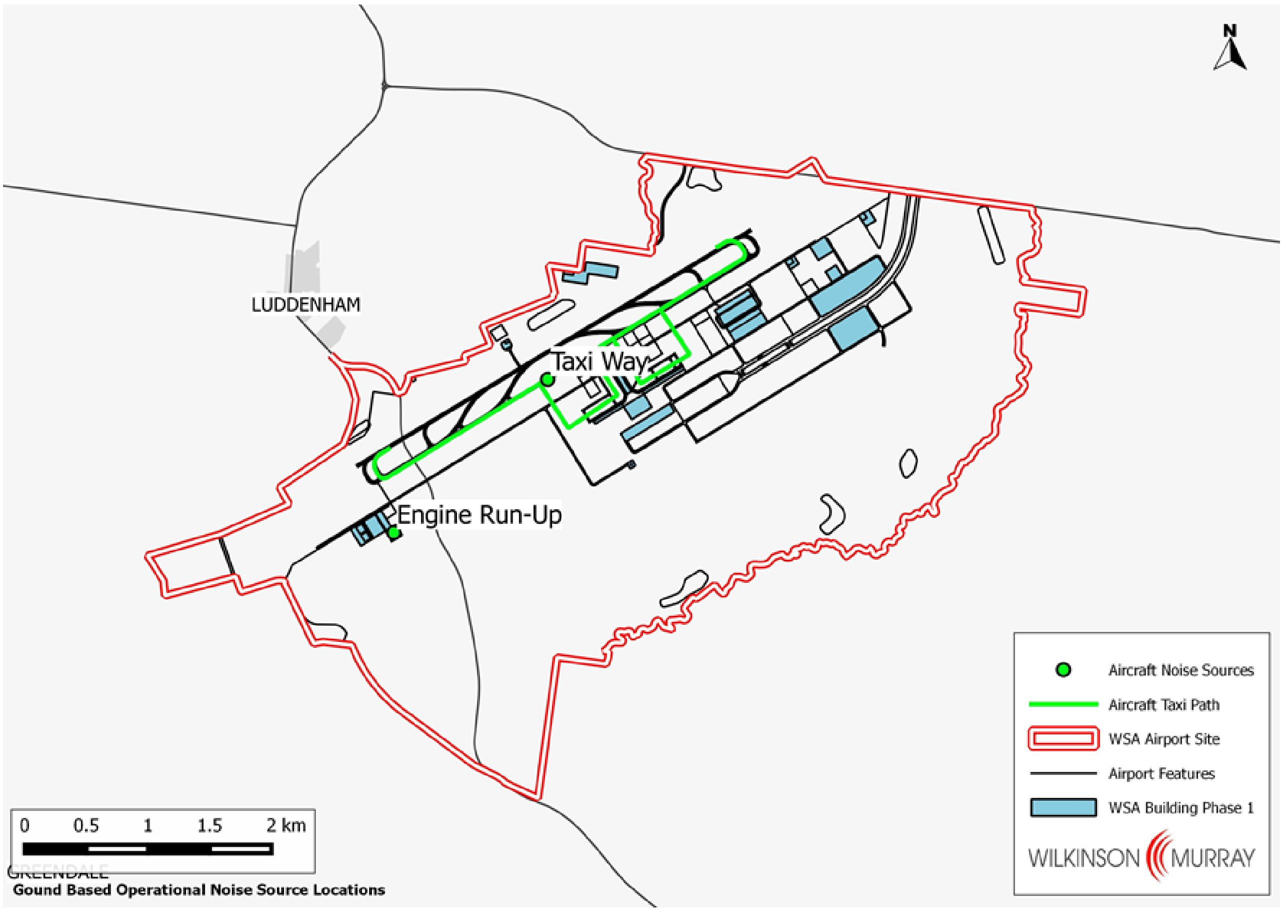


Figure 11–1 – Ground-based noise source locations

Noise from vehicle movements and mechanical plant at the airport site has not been specifically assessed because it would be at a much lower level than the above noise sources. The use of auxiliary power units on aircraft has not been assessed because they are not generally expected to be used at the proposed airport.

11.2.3. Road traffic noise assessment methodology

The traffic and transport assessment presented in Chapter 15 of Volume 2 modelled road traffic projections for major roads in the vicinity of the airport site both with and without the proposed airport. The traffic projections were used to calculate noise levels at typical distances from roads near the airport site using the 'Calculation of road traffic noise' procedure (CoRTN). CoRTN was developed by the United Kingdom Department of the Environment in 1988 and has been modified for Australian conditions and extensively tested.

11.3. Existing environment

The airport site is located in a rural and rural residential area which is reflective of the existing ambient noise environment, with existing noise sources including road traffic and industry. Understanding the background noise environment is important as this sets a benchmark against which the potential impacts associated with the construction and operation of the proposed airport can be assessed.

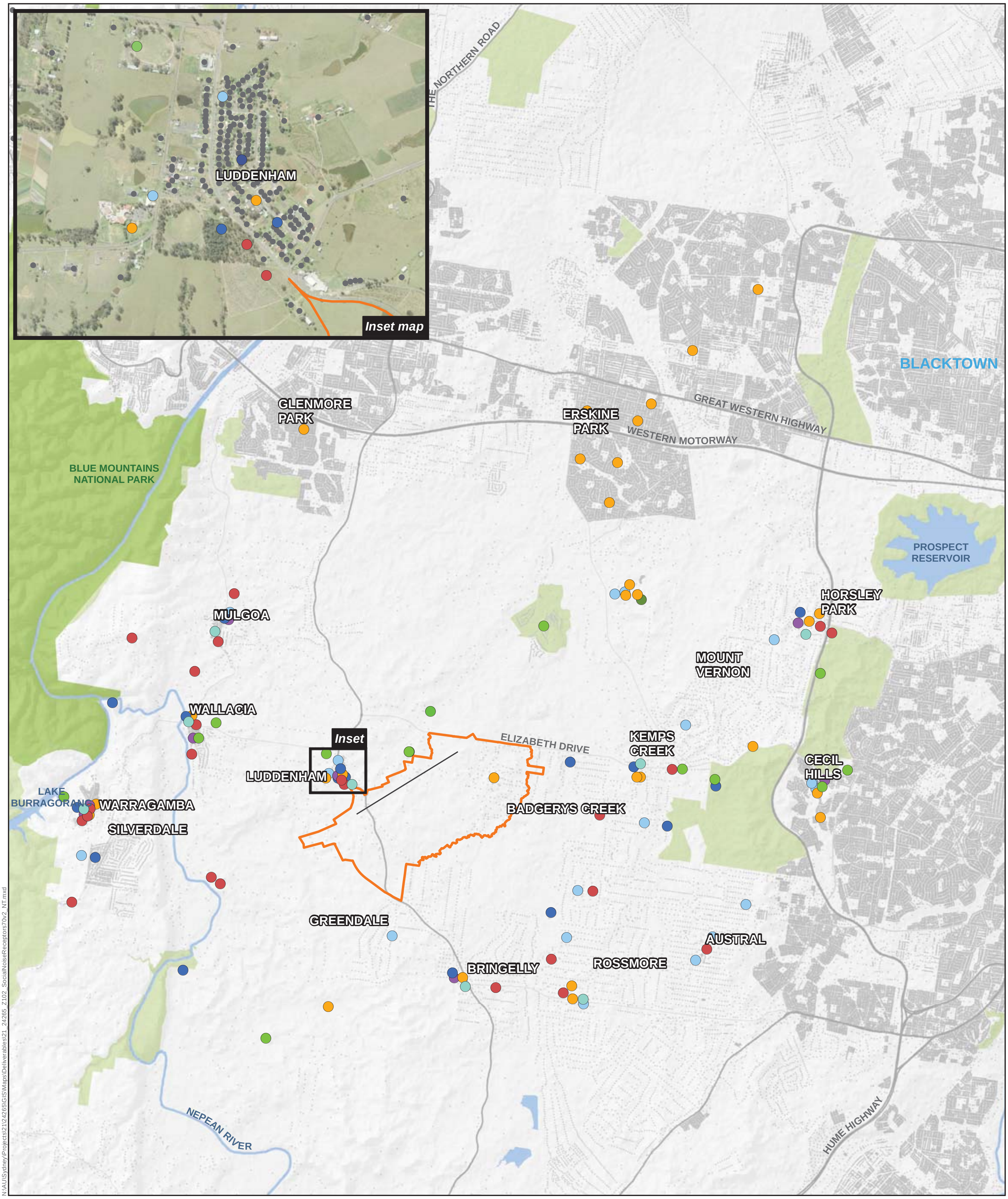
Noise measurements were carried out at 10 locations representing potentially affected areas, generally over the period Monday, 23 March to Thursday, 2 April 2015. The noise measurements were carried out in accordance with AS1055: 1997 and are presented in Appendix E2 in Volume 4.

From the measurement data, the Rating Background Level (RBL) as defined in the NSW Industrial Noise Policy has been determined and presented in Table 11–1.

Table 11–1 – Measured background noise levels

Location	Measurement duration	Rating background level (dBA)		
		Day (7am–6pm)	Evening (6pm–10pm)	Night (10pm–7am)
9 Harold Bentley Way, Glenmore Park	Mon 23/3/15 – Thu 2/4/15	39	42	38
16 Park Avenue, Springwood	Wed 25/3/15 – Thu 2/4/15	29	32	24
17 Blue Ridge Place, Orchard Hills	Mon 23/3/15 – Tue 31/3/15	34	38	36
25 Peter Pan Avenue, Wallacia	Mon 23/3/15 – Thu 2/4/15	37	34	28
27 Dwyer Road, Bringelly	Mon 23/3/15 – Thu 2/4/15	33	38	35
35 Ramsay Road, Rossmore	Fri 27/3/15 – Thu 2/4/15	35	37	35
54 Ridgehaven Road, Silverdale	Thu 26/3/15 – Thu 2/4/15	36	36	31
114 Mount Vernon Road, Mount Vernon	Mon 23/3/15 – Thu 2/4/15	34	35	33
120 Vincent Avenue, Mulgoa	Mon 23/3/15 – Tue 31/3/15	38	42	35
Twin Creeks Golf Club, 2 Twin Creeks Drive, Luddenham	Thu 26/3/15 – Thu 2/4/15	34	38	33

Noise-sensitive receivers in the area around the proposed airport include residences, schools and other educational facilities, hospitals and other health care facilities. The identified sensitive receivers are mapped in Figure 11–2.



LEGEND

Airport site

Sensitive receivers

- Residential
- Aged Care
- Childcare
- Community Centre
- Education
- Park
- Recreation
- Religious Facility
- Shopping Centre
- Runway

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

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Figure 11-2 - Sensitive Receivers surrounding the airport site

0 1 2 4
Kilometres

N

11.4. Regulatory framework, guidelines and criteria

11.4.1. Airports (Environment Protection) Regulations 1997

The *Airports (Environment Protection) Regulations 1997* (Cth) aim to promote better environmental conditions on leased Federal airports. They include standards for pollution and excessive noise and rules for monitoring, cleaning up or rectifying environmental issues.

Noise generated by an aircraft in flight, landing, taking off or taxiing is considered an operational issue. Table 11–2 includes some relevant provisions from the Regulations.

Table 11–2 – Relevant Airports (Environment Protection) Regulations 1996 provisions

Reference	Subject	Provision
2.04	What is offensive noise	1. For these Regulations, noise that is offensive occurs when noise is generated at a volume, or in a way, or under a circumstance, that, in the opinion of an airport environment officer, offensively intrudes on individual, community or commercial amenity. 2. In forming an opinion, an airport environment officer must have regard to: a. the volume, tonality and impulsive character (if any) of the noise; and b. the time of day, and duration, of the noise; and c. background noise levels at the time the noise is generated; and d. the location, in relation to the source of the noise, of: i. sensitive receptors; or ii. if there is no affected sensitive receptor — commercial receptors; and e. the excessive noise guidelines in Schedule 4.
4.06	General duty to prevent offensive noise occurring	3. The operator of an undertaking at an airport must take all reasonable and practicable measures: a. to prevent the generation of offensive noise from the undertaking; or b. if prevention is not reasonable or practicable — to minimise the generation of offensive noise from the undertaking An operator of an undertaking at an airport is complying with that duty if the noise meets the guidelines in Schedule 4 (or any local standard set by or authorisation given by the Minister).
Schedule 4 – 2.02	Noise from construction, etc	4. Noise generated from construction, maintenance or demolition of a building or other structure at an airport should not exceed 75 dB(A), calculated in accordance with subclause (2), at the site of a sensitive receptor.
Schedule 4 – 2.03	Noise from road traffic	Noise generated from road traffic on the site of an operator of an undertaking at an airport should not exceed: a. 60 dB(A), calculated as the equivalent continuous A−weighted sound pressure level for a 24 hour period of measurement; and b. 55 dB(A), calculated as the equivalent continuous A−weighted sound pressure level for an 8 hour period of measurement from 22:00 hours on a particular day to 06:00 hours on the following day.
Schedule 4 – 2.05	Noise from ground−based aircraft operations	5. For ground−based aircraft operations, there are no indicators of noise that is excessive, but the following considerations apply in determining whether noise is

Reference	Subject	Provision
		excessive. Noise from ground-based aircraft running for any reason should only be generated in a manner that is consistent with the masterplan for the airport (which is required to include a noise management plan). 6. In relation to other ground−based operations and in relation to ground−based aircraft running at times other than a time to which subclause (2) applies, matters to be considered are: a. the distance between the source of the noise and the site of the sensitive receptor; and b. the background noise level; c. the time of day when the noise occurs; d. if the noise source is an aircraft engine — the power setting of the engine; and e. anything included in the final master plan (if any) for the airport at which ground running is being conducted that is relevant to this clause. Ground based aircraft operations means operation of APU, test operation of an aircraft engine attached to an aircraft or removed from an aircraft
Schedule 4 – 2.06	Noise from other airport operations	7. This clause applies to noise generated from any of the following activities: a. aircraft refuelling; b. activities in connection with aircraft that do not involve the operating of an aircraft engine (for example, moving, maintaining or repairing aircraft); c. operation of plant or machinery; d. assembling of passengers or goods in connection with embarkation or disembarkation of aircraft; and e. operation of fixed audible alarm or warning systems. 8. Noise generated from an activity mentioned in subclause (1) should not exceed the background noise level at the sensitive receptor site: a. between the hours of 07:00 and 22:00 — by more than 5 dB(A); and b. between 22:00 hours of a day and 07:00 hours of the next day — by more than 3 dB(A).

11.4.2. Construction noise criteria

As noted in Section 11.4.1, the Airports (Environment Protection) Regulations 1997 provide a guideline level of 75 dBA for construction noise (refer to Schedule 4 – 2.02 of the Regulations).

The NSW Department of Environment and Climate Change (DECC) *Interim Construction Noise Guideline* (DECC 2009) was also used for the purposes of this assessment. The Guideline recommends noise management levels to assist the management of noise on construction sites both during and outside standard construction hours (Monday to Friday, 7.00 am to 6.00 pm and Saturday 8.00 am to 1.00 pm). Where noise at sensitive receivers is expected to exceed noise management levels implementation of reasonable and feasible noise mitigation is recommended and consultation with affected people is encouraged.

For works during standard construction hours, the noise management level is background plus 10 dBA for residential locations. For works outside of normal construction hours, the noise management level is background plus 5 dBA.

Based on the daytime background noise levels shown in Table 11–1, the residential noise management level for standard construction hours would be between 39 dBA and 49 dBA. For assessment of construction noise, a noise management level of 45 dBA may reasonably be adopted. A noise management level of 40 dBA has been adopted for weekend works and early morning works (outside standard construction hours).

11.4.3. Construction vibration criteria

To protect buildings from vibration damage the most stringent vibration standard typically used in Australia is German Standard DIN 4150-3: *Structural Vibration: Effects of Vibration on Structures*. This standard recommends frequency based guideline values and the lowest and most conservative values are normally adopted, as shown in Table 11–3.

Table 11–3 – Vibration damage guideline values (DIN 4150-3)

Type of structure	Guideline value, peak particle velocity (mm/s)
Dwellings and buildings of similar design	5
Vibration sensitive buildings (heritage)	3

11.4.4. Ground-based operations noise criteria

This section provides criteria to form the basis of consideration of potential impacts of ground-based noise from ground based operations within the airport site. It discusses general noise criteria which are applied to industrial noise in NSW as the basis for setting criteria for the relatively constant ground-based noise such as taxiing. It then sets specific noise criteria for the particular types of noise such as intermittent sources such as engine ground running and road traffic noise based upon industry standard noise assessment procedures. It is important to recognise in setting these criteria that the character of noise from ground-based activities at an airport is different from the character of noise from many other developments, such as industrial developments.

As noted in Section 11.4.1, the Airports (Environment Protection) Regulations 1997 do not apply to noise from ground-based aircraft operations (landing, taking off or taxiing). For other airport operations the Regulations provide that noise at sensitive receivers should not exceed the background noise level as indicated below:

- between 7 am and 10 pm — by no more than 5 dBA; and
- between 10 pm and 7 am of the next day — by no more than 3 dBA.

In addition to the above, the recommended criteria in the *NSW Industrial Noise Policy* (EPA 2000) and in *AS 2021: 2015 Acoustics – Aircraft Noise Intrusion – Building Siting and Construction* were also considered. These are discussed below.

11.4.4.1. Criteria for taxiing

The *NSW Industrial Noise Policy* intrusiveness criteria for residences apply to relatively continuous noise such as that produced by taxiing. The intrusiveness noise criteria used in relation to residential land uses were determined by adding 5 dBA to the measured background levels shown in Table 11–1. This is generally consistent with section 2.05(3) of Schedule 4 of the Airports (Environment Protection) Regulations, which states that background noise levels should be considered when determining if noise levels are excessive. The results are presented in Table 11–4.

Table 11–4 – Industrial Noise Policy intrusiveness noise criteria for residential locations

Location	L_{Aeq},15 min noise criteria (dBA)		
	Day (7am–6pm)	Evening (6pm–10pm)	Night (10pm–7am)
9 Harold Bentley Way, Glenmore Park	44	47	43
16 Park Avenue, Springwood	35	37	35
17 Blue Ridge Place, Orchard Hills	39	43	41
25 Peter Pan Avenue, Wallacia	42	37	35
27 Dwyer Road, Bringelly	38	43	40
35 Ramsay Road, Rossmore	40	42	40
54 Ridgehaven Road, Silverdale	41	41	36
114 Mount Vernon Road, Mount Vernon	39	40	38
120 Vincent Avenue, Mulgoa	43	47	40
Twin Creeks Golf Club, 2 Twin Creeks Drive, Luddenham	39	43	38

By the time the proposed airport becomes operational, background noise levels in the general area would have increased due to increased road traffic as well as associated residential and commercial development. This would, in turn, raise the value of the appropriate noise criteria for the assessment of airport operational noise. For this reason, and to allow easy interpretation of the operational noise contours discussed below, an overall intrusiveness noise criterion of 40 dBA averaged over 15 minute intervals ($L_{Aeq\ 15\ mins}$) can be taken as appropriate for residential locations.

For other land uses, the taxiing noise criteria were determined by reference to the amenity criteria in the *NSW Industrial Noise Policy*. Table 11–5 provides the adopted noise criteria for taxiing.

Table 11–5 – Noise criteria taxiing

Receiver type	Measure	Criterion dB(A)
Residential	$L_{Aeq,15min}$	40
School	$L_{Aeq,15min}$	50
Hospital	$L_{Aeq,15min}$	55
Place of worship	$L_{Aeq,15min}$	55
Passive recreation	$L_{Aeq,15min}$	55
Active recreation	$L_{Aeq,15min}$	60

11.4.4.2. Criteria for engine run-up

Engine run-up noise would be intermittent and subject to limitations during the night. It has been assumed that high power run-up would occur for less than five minutes on any night. In this context, the night time residential criterion for these activities has been set as five dBA over the general *NSW Industrial Noise Policy* night time criterion for residential receivers. The criteria for other land uses have been set at five dBA over the relevant amenity criteria. Table 11–6 provides the adopted noise criteria for engine run-up.

Table 11–6 – Noise criteria for aircraft engine run-up

Receiver type	Measure	Criterion dB(A)
Residential	$L_{Aeq,15min}$	45
School	$L_{Aeq,15min}$	55
Hospital	$L_{Aeq,15min}$	60
Place of worship	$L_{Aeq,15min}$	60
Passive recreation	$L_{Aeq,15min}$	60
Active recreation	$L_{Aeq,15min}$	65

11.4.5. Road traffic noise criteria

The *NSW Road Noise Policy* (DECCW 2011) recommends noise assessment criteria for residential and non-residential land uses affected by traffic generating developments. The policy indicates that an increase of up to 2 dBA represents a minor impact that is considered barely perceptible to the average person. This has been used as the reference point for the assessment of potential construction and operational road traffic noise.

11.5. Assessment of impacts during construction

11.5.1. Noise from construction works

Figure 11–3 to Figure 11–6 show worst case construction noise contours for construction sectors (east, north, north-west and south-west). These figures show the worst weather condition that may occur, representing a temperature inversion early in the morning in winter. A still, isothermal weather condition was also modelled and resulted in construction noise contours more confined to the airport site (refer to Appendix D2 in Volume 4).

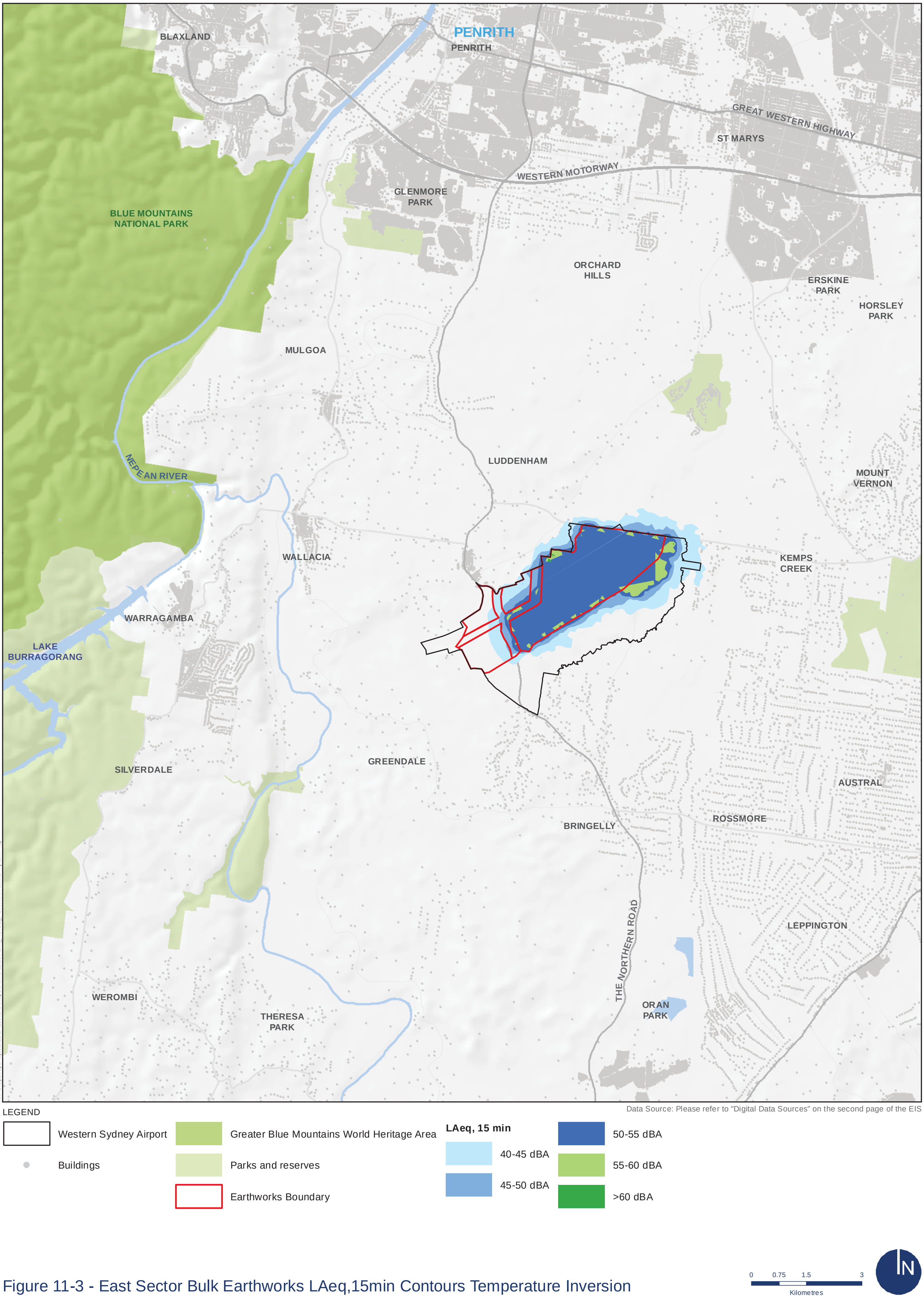
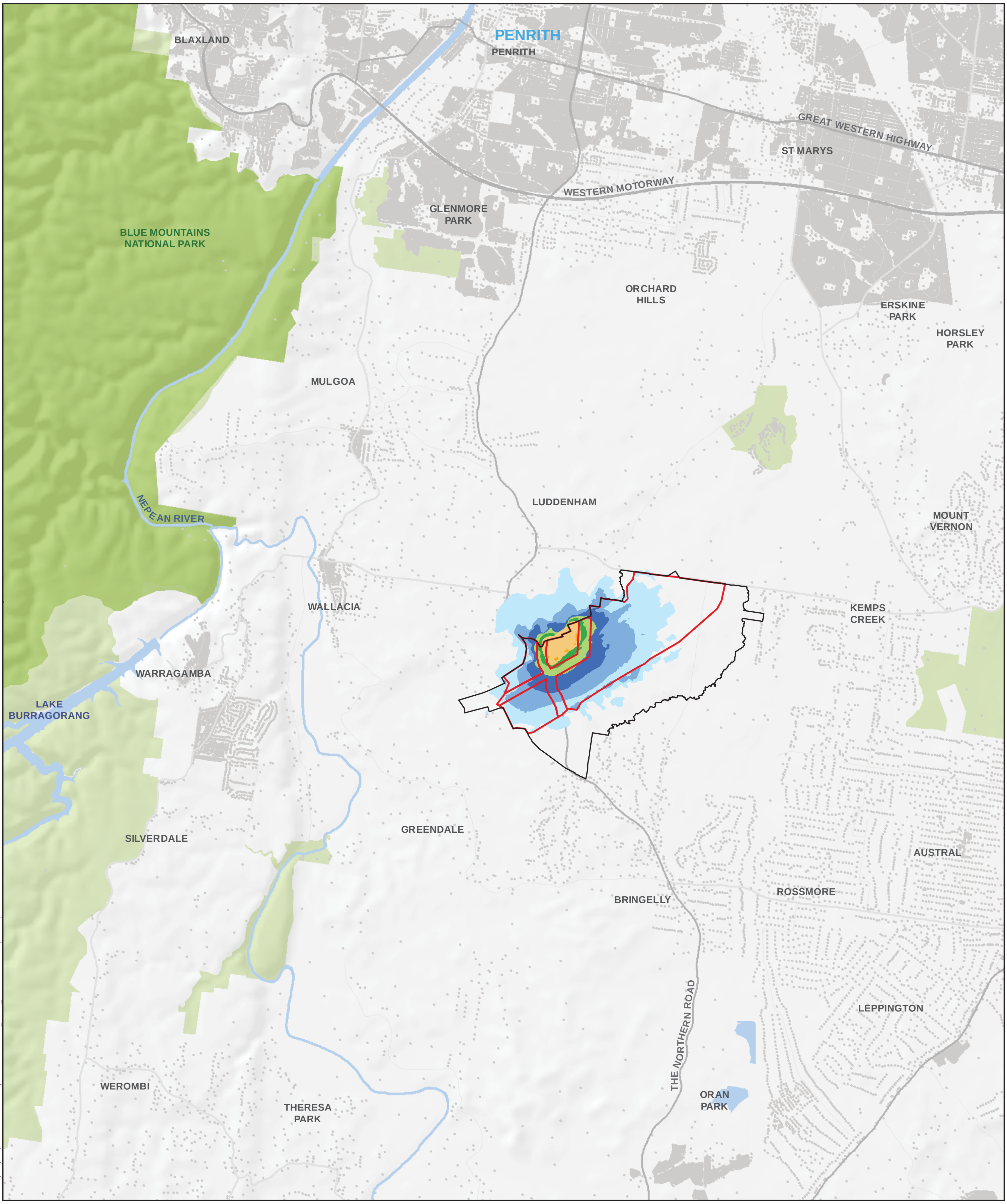


Figure 11-3 - East Sector Bulk Earthworks LAeq,15min Contours Temperature Inversion



LEGEND

Western Sydney Airport	Greater Blue Mountains World Heritage Area
Buildings	Parks and reserves
	Earthworks Boundary

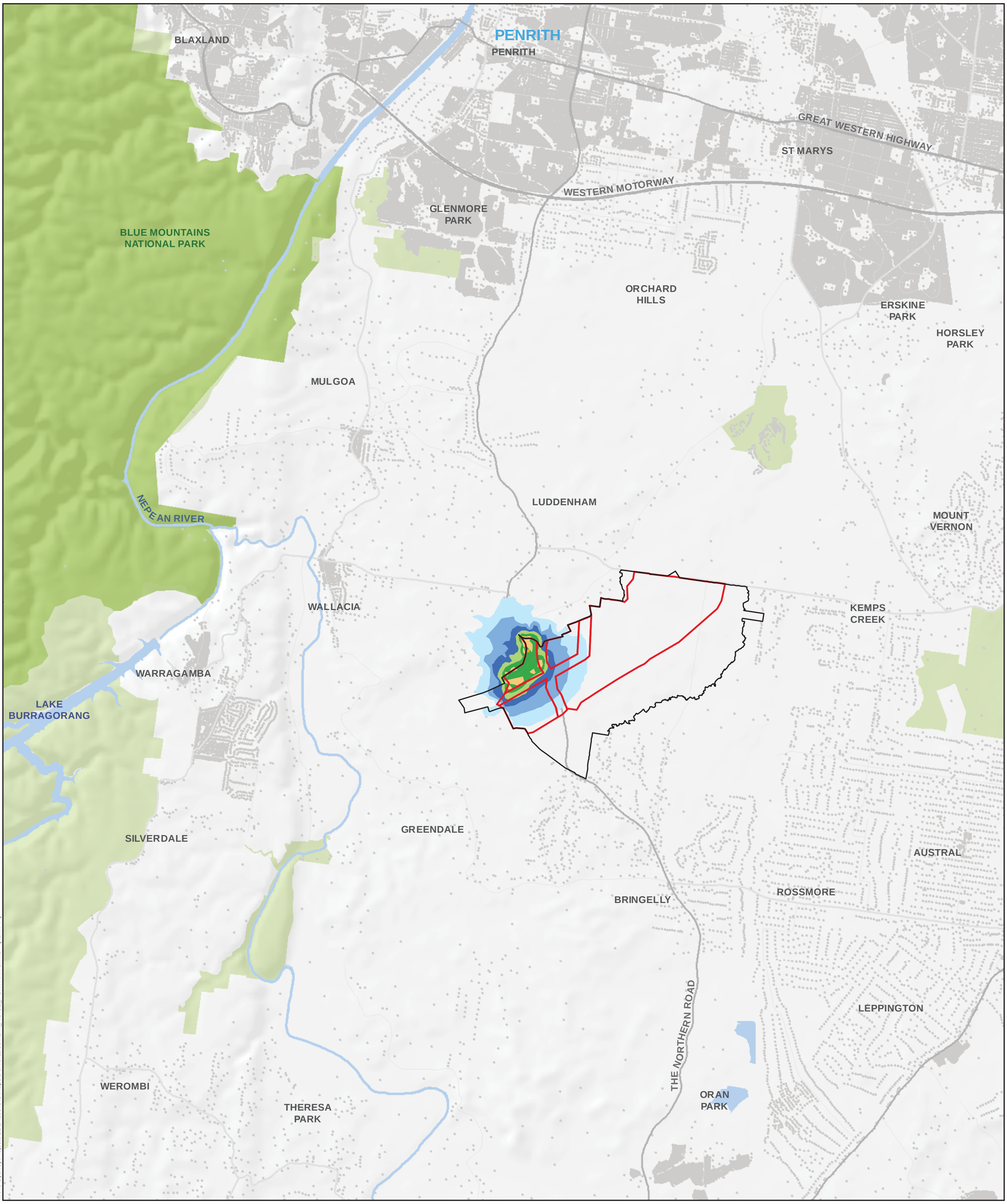
LAeq, 15 min

- 40-45 dBA
- 45-50 dBA
- 50-55 dBA
- 55-60 dBA
- 60-65 dBA
- 65-70 dBA
- >70 dBA

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

0 0.75 1.5 3
Kilometres

Figure 11-4 - North Sector Bulk Earthworks LAeq,15min Contours Temperature Inversion



LEGEND

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

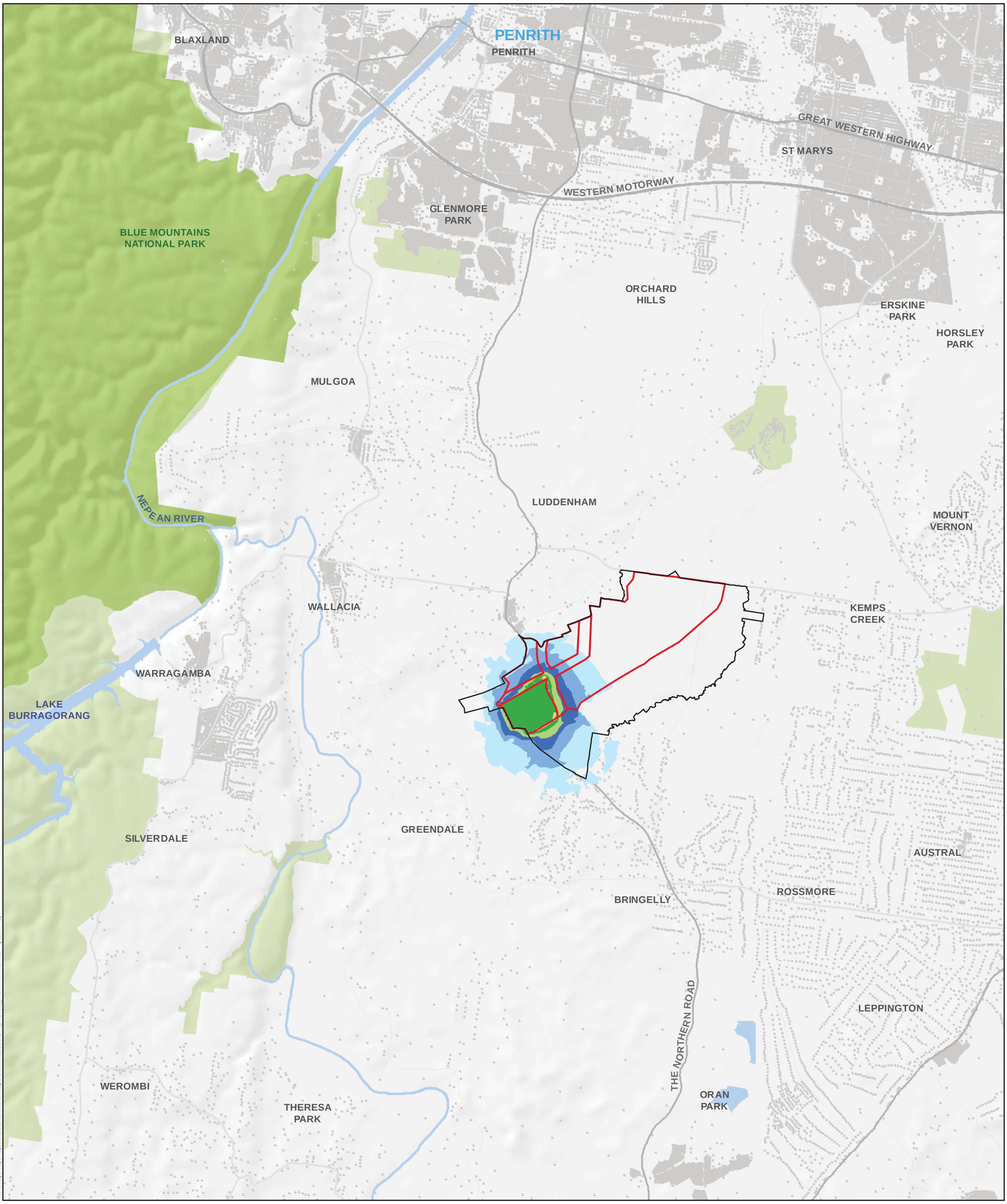
Western Sydney Airport
Buildings
Greater Blue Mountains World Heritage Area
Parks and reserves
Earthworks Boundary

LAeq, 15 min

40-45 dBA
45-50 dBA
50-55 dBA
55-60 dBA
60-65 dBA
65-70 dBA
>70 dBA

0 0.75 1.5 3
Kilometres

Figure 11-5 - North West Sector Bulk Earthworks LAeq,15min Contours Temperature Inversion



LEGEND

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

Western Sydney Airport	Greater Blue Mountains World Heritage Area	
Buildings	Parks and reserves	
	Earthworks Boundary	

LAeq, 15 min

40-45 dBA	55-60 dBA
45-50 dBA	60-65 dBA
50-55 dBA	>65 dBA

0 0.75 1.5 3
Kilometres

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Figure 11-6 - South West Sector Bulk Earthworks LAeq,15min Contours Temperature Inversion

The predicted number of residences likely to be affected by noise levels above the adopted noise management level during standard hours is shown in Table 11–7.

Table 11–7 – Residences affected by levels above noise management level – standard construction hours

Location	Noise management level	Residential buildings affected above criterion
East section	45 dBA	0
North section	45 dBA	36
North-west section	45 dBA	64
South-west section	45 dBA	44

The predicted number of residences likely to be affected by noise levels above the adopted noise management level outside standard hours is shown in Table 11–8.

Table 11–8 – Residences affected by levels above noise management level – outside standard construction hours

Location	Noise management level	Residential buildings affected above criterion
East section	40 dBA	22
North section	40 dBA	189
North-west section	40 dBA	192
South-west section	40 dBA	52

Noise emissions arising from construction activities would be predominantly limited to the airport site and immediate surrounds. The airport site covers a broad area, and a range of management measures such as the placement of temporary noise barriers or exclusion buffers within the airport site may be adopted as required to mitigate disturbance to nearby receivers, particularly for construction activity outside of standard construction hours. It should be noted that the construction noise guideline level of 75dBA in the Airports (Environment Protection) Regulations 1997 are met for all surrounding receivers.

11.5.2. Construction traffic noise

Construction traffic would use of the nearby road network, with most traffic directly accessing Elizabeth Drive. Table 11–9 presents predicted noise increases along Elizabeth Drive as a result of construction traffic. Along all sections of Elizabeth Drive the predicted increase in noise from construction traffic is less than 2 dBA. This change is unlikely to be perceptible.

Table 11–9 – Predicted construction traffic noise increases (Elizabeth Drive)

Road	Location	Noise level increase (dB)	
		Day	Night
Elizabeth Drive	West of Mamre Road	0.6	1.1
	West of Devonshire Road	0.9	0.5
	West of Lawson Road	0.9	0.6

11.5.3. Construction vibration assessment

Vibration would be generated by the proposed construction works. As a very conservative approach, the lower guideline value applying to vibration sensitive buildings (3 mm/s) has been considered to test the risk of damage from construction vibration.

Figure 11–7 shows vibration levels previously measured on construction sites at a range of distances. The vibration levels from impact piling during the construction works would likely generate the highest vibration levels.

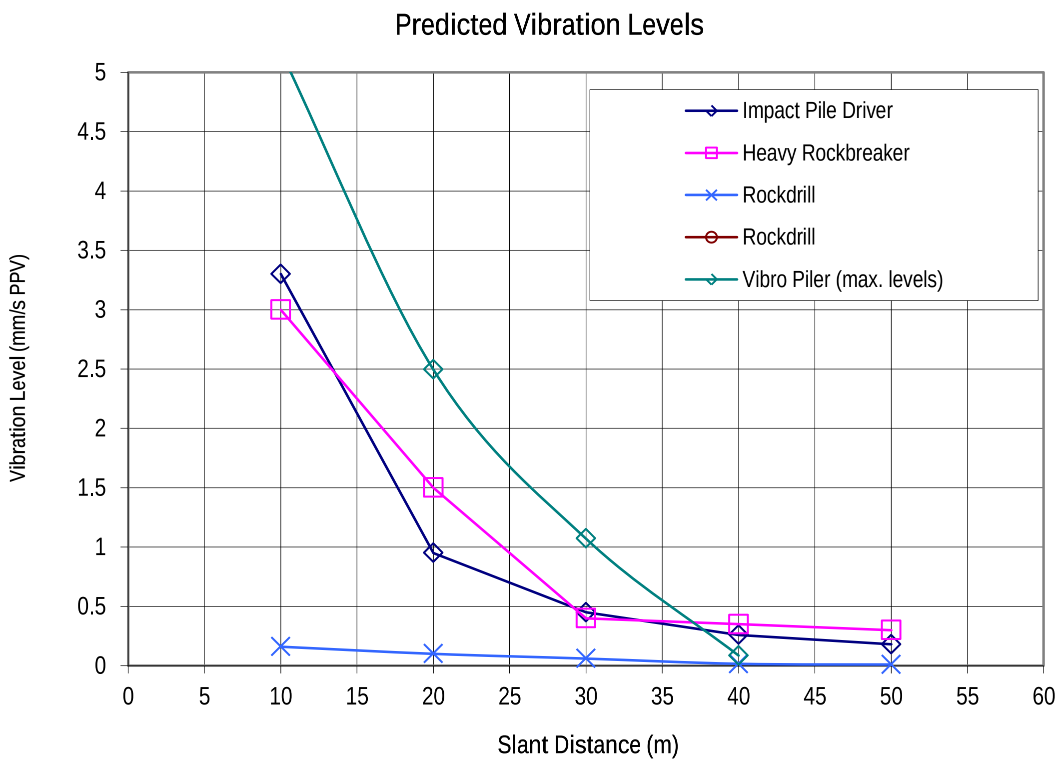


Figure 11–7 – Previously measured vibration levels

The results indicate that the 3 mm/s value would not be exceeded beyond a distance of 20 metres from a source even when using the piling method which would generate the highest vibration levels from the anticipated construction activities. Given that piling would occur well within the proposed airport boundary to construct the buildings, there would be no risk of damage to buildings from vibration outside of the proposed airport site.

Vibration may also be generated by the ripping of rock, but again the 3 mm/s guideline value is likely to be complied with inside the airport boundary and there is no risk of damage outside the airport boundary.

11.6. Assessment of impacts during operation

11.6.1. Ground-based operations noise

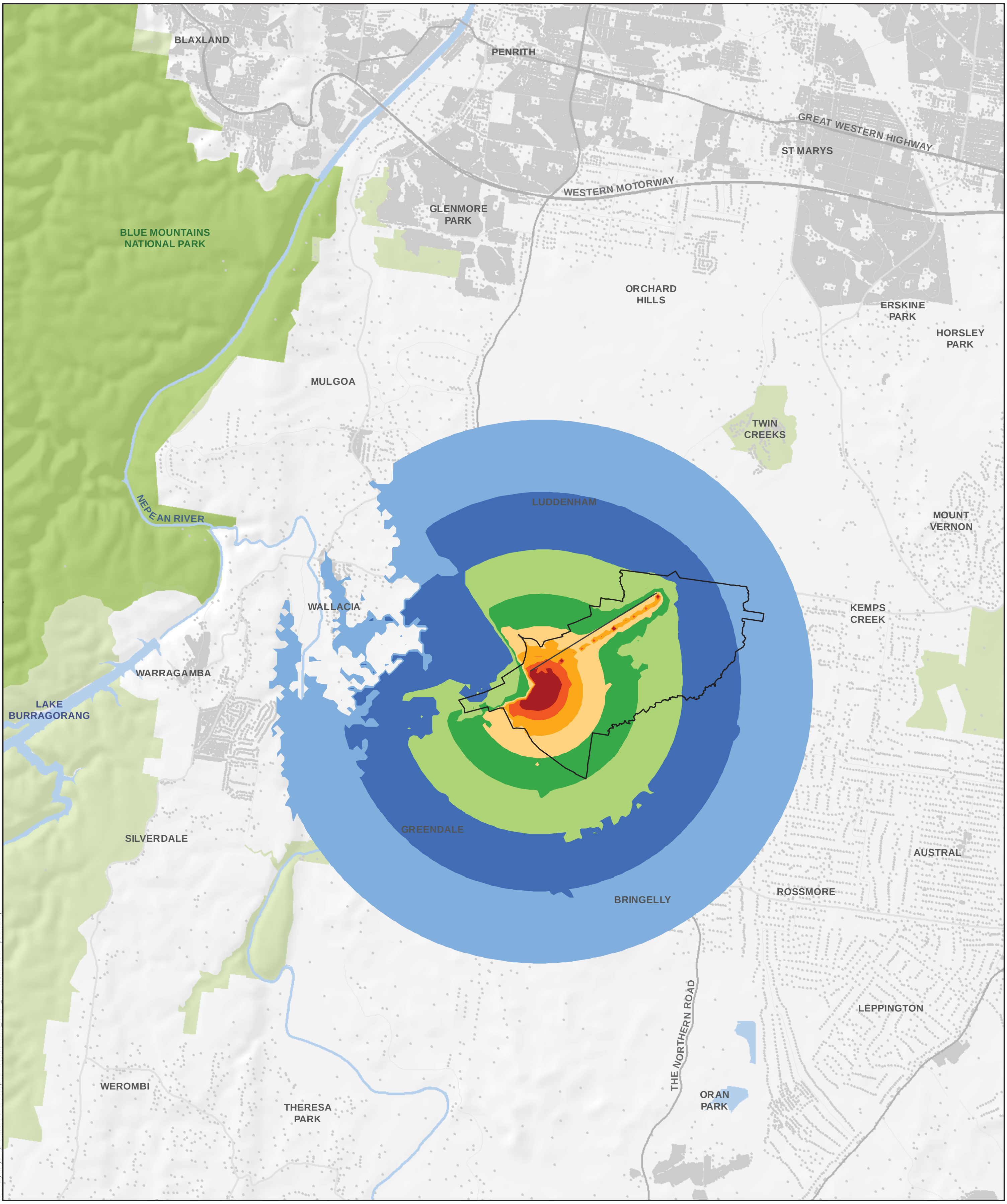
Figure 11–8 to Figure 11–9 show predicted 2030 contours for noise exposure associated with engine ground running (run-ups) and taxiing.

The contours show that under worst case conditions and in the absence of operational controls (e.g. restriction of engine run-ups), ground-based operational noise has the potential to extend over a large area surrounding the airport site. Table 11–10 shows the number of residential buildings likely to be affected by noise above adopted criteria.

Table 11–10 – Residential noise impact of ground-based operational noise

Noise type	Noise criterion	Residential buildings affected above criterion
Engine run-up	45 dBA	1,356 residences
Taxiing	40 dBA	659 residences

Under worst case meteorological conditions, noise associated with engine run-ups has the potential to affect Luddenham, Badgerys Creek, Bringelly, Wallacia and Greendale. The predicted noise exposure from aircraft taxiing extends over a much smaller area and would primarily affect Luddenham.



LEGEND

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

Western Sydney Airport

Runway

Buildings

Greater Blue Mountains World Heritage Area

Parks and reserves

LAeq, 15min

45-50 dBA

50-55 dBA

55-60 dBA

60-65 dBA

65-70 dBA

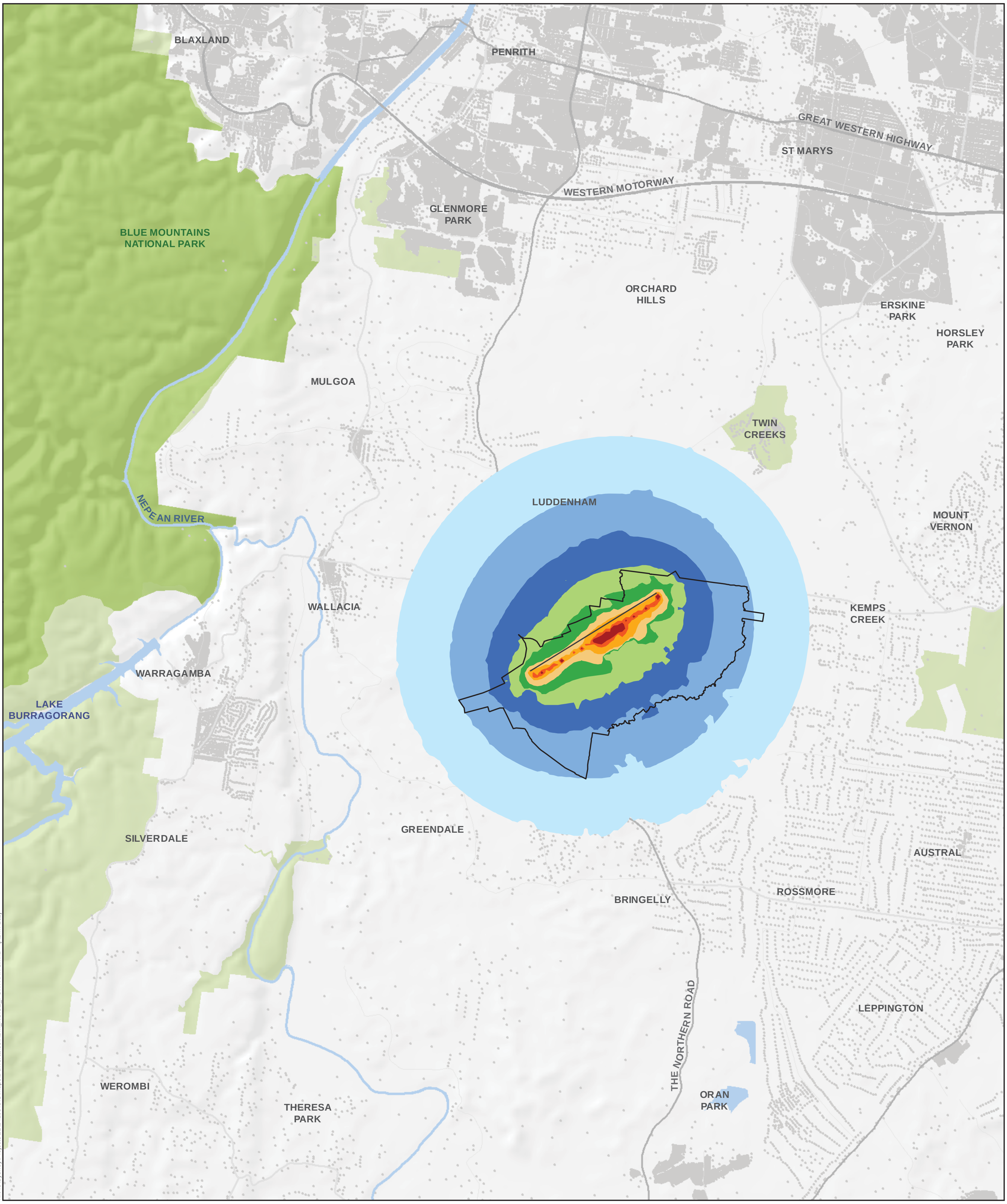
70-75 dBA

75-80 dBA

>80 dBA

0 0.75 1.5 3
Kilometres

Figure 11-8 - Engine run-up noise contours - worst case (2030)



LEGEND

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

Western Sydney Airport	Greater Blue Mountains World Heritage Area
Runway	Parks and reserves
Buildings	

LAeq, 15min

40-45 dBA	60-65 dBA
45-50 dBA	65-70 dBA
50-55 dBA	70-75 dBA
55-60 dBA	75-80 dBA
	>80 dBA

0 0.75 1.5 3
Kilometres

Figure 11-9 - Taxiing noise contours - worst case (2030)

The predicted impact of ground-based operational noise on other noise sensitive uses surrounding the airport site is summarised in Table 11–11.

Table 11–11 – Noise impact of ground-based operational noise on other uses

Noise type	Building/land use type	Criterion	Number affected (above criterion)
Engine run-up	Educational institution	55 dBA	5
	Hospitals	60 dBA	0
	Place of worship	60 dBA	2
	Passive recreation	60 dBA	2
	Active recreation	65 dBA	0
Taxiing	Educational institution	50 dBA	1
	Hospitals	55 dBA	0
	Place of worship	55 dBA	0
	Passive recreation	55 dBA	0
	Active recreation	60 dBA	0

11.6.2. Road traffic noise

As explained in Section 10.2.3, road traffic noise levels for roads near the airport site were calculated using the traffic projections discussed in Chapter 15 and the CoRTN procedure.

Table 11–12 shows the change in noise level expected as a result of the proposed airport on the major roads that airport related traffic is expected to use. There would be a decrease in road traffic noise on some roads due to the proposed M12 motorway. The highest noise level increase expected is less than 2 dBA and would be unlikely to be perceptible at the nearest sensitive receivers.

Table 11–12 – Road traffic noise level increases due to proposed airport (2030)

Road	Location	Noise level increase (dB)	
		Day	Night
Elizabeth Drive	West of Mamre Road	0.8	0.5
	West of Devonshire Road	1.3	0.8
	West of Lawson Road	-0.4	-1.8
	West of Badgerys Creek Road	1.6	0.0
	West of Luddenham Road	1.3	-0.1
Luddenham Road	South of South Creek	-0.4	-0.6
	South of Twin Creeks Golf Club	-0.8	-1.4
Mamre Road	North of Elizabeth Drive	-0.1	-0.1
	North of Bakers Lane	0.5	0.4

Road	Location	Noise level increase (dB)	
		Day	Night
	North of Banks Drive	0.0	0.0
The Northern Road	North of Homestead Road	-0.4	-0.6
	South of Glenmore Parkway	-0.6	-1.1
	North of Littlefields Road	-0.9	-1.3
	North of Adams Road	-0.6	-0.9
	North of Northern Road	-0.1	-0.4
	North of Cobbitty Road	-0.2	-0.3
	North of Camden Valley Way	-0.1	-0.2

11.7. Mitigation and management measures

Table 11–13 outlines the broad mitigation and management measures that are proposed to address noise associated with ground operations, construction and airport generated road traffic. All major airports have procedures in relation to engine runs, which restrict the time and location for ground running to limit noise impacts. The proposed airport is expected to have similar procedures which would limit the circumstances and manner in which night time engine runs would be conducted. Restricting the amount of high power engine runs at night would substantially reduce the impact of engine ground running noise.

It may also be practical to construct buildings, mounds or barriers near the run-up area to provide greater noise shielding. It is possible that reductions of around 10 dBA could be achieved with provision of a purpose-built ground running enclosure, mounds or buildings at least 10 metres high, but moderate residual impacts would still occur under worst case meteorological conditions. Alternate locations for the run-up facility may also be considered during detailed design.

Table 11–13 – Mitigation and management measures – ground operations, construction and road traffic

ID	Issue	Mitigation/management measure	Timing
11.1	Construction noise and vibration	A noise and vibration management plan would be developed prior to construction of the proposed airport as part of the construction environmental management framework. The plan would: • assist in ensuring that the noise during construction complies where feasible with the construction noise management levels set for the project including Schedule 4 of the Airports (Protection of the Environment) Regulations where relevant; • determine noise and vibration monitoring, reporting and response procedures. • describe specific mitigation treatments, management methods and procedures to be implemented to control noise and vibration during construction; • describe construction timetabling to minimise noise impacts including time and duration restrictions, respite periods and frequency; • describe procedures for notifying residents of construction activities likely to affect their amenity through noise and vibration; and • define contingency procedure to be implemented in the event of noncompliance and/or noise complaints.	Pre-construction
11.2	Operational ground-based noise	The airport-lessee company would establish and operate a community aviation consultation forum and a planning coordination forum consistent with practice at other airports.	Pre-construction Construction Pre-operation Operation

ID	Issue	Mitigation/management measure	Timing
11.3	Operational ground-based noise	A ground-based noise amelioration management strategy would be developed that identifies reasonable and feasible noise mitigation measures. The Issues to be addressed in the strategy would include but not be limited to: • the identification of reasonable and feasible noise mitigation measures for on-ground noise generating activities, including: ▪ aircraft ground running operating procedures; ▪ opportunities to refine the location and design of airport features to reduce noise impact; ▪ aircraft taxiing operating procedures; and ▪ other measures to address excessive noise where noise mitigation by physical features (e.g. noise barriers) is deemed ineffective. • additional noise modelling and assessment conducted during the detailed airport design phase to examine with the objective of examining the effectiveness of any proposed noise amelioration mitigation measures and identifying any residual excessive noise levels in areas surrounding the airport site; • if off-site noise exposure cannot be managed appropriately by operational and other on-site mitigation measures, a detailed noise amelioration plan for affected residences and other sensitive receivers surrounding the airport site should be developed for consideration by the Australian Government and any reasonable and feasible noise mitigation measures; • stakeholder engagement with affected residences and other stakeholders regarding potential noise impacts, and potential mitigation and amelioration measures; • similar to other airports, implementation of aircraft ground running operating procedures including investigations of feasible measures to reduce the impact of noise; • other specific measures to address noise exceedances where physical noise mitigation is ineffective; and • noise monitoring and reporting arrangements.	Pre-operation Operation
11.4	Operational ground-based noise	The airport-lessee company would incorporate noise monitoring and reporting into any future master plan in accordance with the *Airports Act 1996*.	Operation

11.8. Conclusion

Noise during the construction of the proposed airport would be largely confined within the airport boundary, although there would be some impacts on the Luddenham and Badgerys Creek areas. While heavy and light vehicles would need to access the airport site during the construction stage, the increase in traffic noise as a result would not be significant. Vibration generated by construction activities is considered unlikely to cause building damage.

Ground-based operational noise would be generated primarily by aircraft engine ground running and taxiing. Under worst case meteorological conditions, noise associated with engine runs has the potential to affect residences and other sensitive receivers in Luddenham, Badgerys Creek, Bringelly, Wallacia and Greendale. The impact of noise from taxiing is predicted to extend over a much smaller area and would primarily affect Luddenham.

During operation of the proposed airport, noise level increases in the surrounding area due to airport generated road traffic are not expected to be significant.

Mitigation and management measures have been proposed to address noise associated with ground operations, construction and airport generated road traffic.

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12. Air quality and greenhouse gases

The air quality and greenhouse gas assessment included a review of climatic data obtained from the airport site and an analysis of ambient air quality from data collected from monitoring stations in the vicinity of the airport site. Air quality impacts associated with the construction of the proposed airport (particularly construction dust) were modelled as were emissions and air quality impacts associated with the operation of the proposed airport. Other air quality parameters that were assessed included odour (from aircraft exhaust and the on-site waste water treatment plant), regional air quality impacts (ozone) and greenhouse gas emissions.

Construction would result in dust emissions generated during both the bulk earthworks and the aviation infrastructure works and the asphalt batching plant would generate some odour during construction. The results of the air dispersion modelling show that the predicted dust impacts during construction would be below the air quality assessment criteria at all sensitive residential receptors. Odour from the asphalt plant is also predicted to be below the relevant criteria at all sensitive residential receptors and would be largely contained within the airport site.

Operation of the proposed Stage 1 development would result in an increase in emissions of nitrogen dioxide (NO2), particulate matter (as PM_{10} and $PM_{2.5}$), carbon monoxide (CO), sulfur dioxide (SO_2) and air toxics. There would also be odour emissions from exhaust and from the on-site wastewater treatment plant. The highest off-site concentrations of the air quality metrics evaluated were generally predicted to occur at the receptors located to the north and northeast of the proposed airport. Airport traffic on surrounding road infrastructure was found to be a significant contributor to off-site ground level concentrations, particularly for those receptors located close to proposed roadways. Despite this, there were almost no predicted exceedances of the air quality assessment criteria at any of the sensitive residential receptors investigated as part of the assessment of the Stage 1 development. The exception was the maximum (99.9th percentile) one hour concentration of formaldehyde with an exceedance shown at an on-site receptor. This exceedance is principally governed by the contribution from external roads as opposed to activities at the airport itself. Predicted off-site odour concentrations were expected to be below detection limits for both aircraft exhaust emissions and odours from the on-site wastewater treatment plant.

Only marginal ozone impacts would result from the operation of the Stage 1 development. These emissions would be managed using best available techniques and/or emission offsets.

Greenhouse gas emissions from the Stage 1 development have been estimated to comprise 0.11 Mt CO2-e/annum, with the majority of emissions associated with the consumption of purchased electricity. The Scope 1, Scope 2 and Scope 3 greenhouse gas emissions estimated for the proposed Stage 1 development would represent approximately 0.1 per cent of Australia's projected 2030 transport-related greenhouse gas emission inventory. For this reason, it can be concluded that the greenhouse gas emissions from the proposed airport would not be material in terms of the national inventory.

Mitigation and management measures would be implemented to reduce potential air quality impacts during both construction and operation of the Stage 1 development. In particular, a dust management plan would be developed and implemented to address potential impacts from dust generated during construction. Air quality monitoring would also be undertaken at the airport site during operations. Even though greenhouse gas emissions from the proposed airport would not be material in terms of the national inventory, a number of mitigation measures would also be implemented during operations to reduce these emissions.

In acknowledgement that the National Environment Protection Council is currently in the process of revising its criteria for particles, updated air quality modelling would be undertaken and documented in the Final EIS.

12.1. Introduction

This chapter provides a review of the local and regional air quality impacts of the proposed airport. This chapter draws on a comprehensive local air quality and greenhouse gas assessment (included as Appendix F1 in Volume 4) and a regional air quality assessment (included as Appendix F2 in Volume 4).

For the purpose of the assessment, local air quality was defined as being within a five kilometre radius of the airport site and regional air quality refers to the wider Sydney basin. Regional air quality considers the formation of secondary pollutants (such as ozone (O_3) through photochemical reactions from primary emissions from the proposed airport.

The potential impacts of the proposed Stage 1 development on local and regional air quality and the anticipated greenhouse gas emissions from the construction and operation of the Stage 1 development are considered and appropriate mitigation and management measures have been identified to reduce potential impacts.

The local air quality and greenhouse gas assessment and the regional air quality assessment have been prepared in consultation with the Australian Government 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).

12.2. Methodology

The assessment of air quality and greenhouse gases included a review of climatic data obtained from the airport site and an analysis of ambient air quality based on data collected from monitoring stations in the vicinity of the airport site. Air quality impacts associated with the construction and operation of the proposed airport were modelled using representative sensitive receivers located in the vicinity of the airport site. Other air quality parameters assessed include odour (from aircraft exhaust and the on-site wastewater treatment plant), regional air quality impacts (ozone) and greenhouse gas emissions. The potential for impacts arising from the proposed airport to be exacerbated by climate change was considered as part of the assessment.

12.2.1. Meteorology and existing air quality

Climatic data (wind speed and direction, temperature, rainfall and humidity) was obtained from the automatic weather station operated by the Bureau of Meteorology at the airport site. Data measured over the past five years (2010–14) were used to characterise the prevailing weather conditions at the airport site.

Air quality monitoring data collected between 2005 and 2014 from the NSW Office of Environment and Heritage (OEH) monitoring stations in Bringelly, Macarthur/Campbelltown West, Liverpool and Richmond were used to describe the existing air quality in the vicinity of Badgerys Creek.

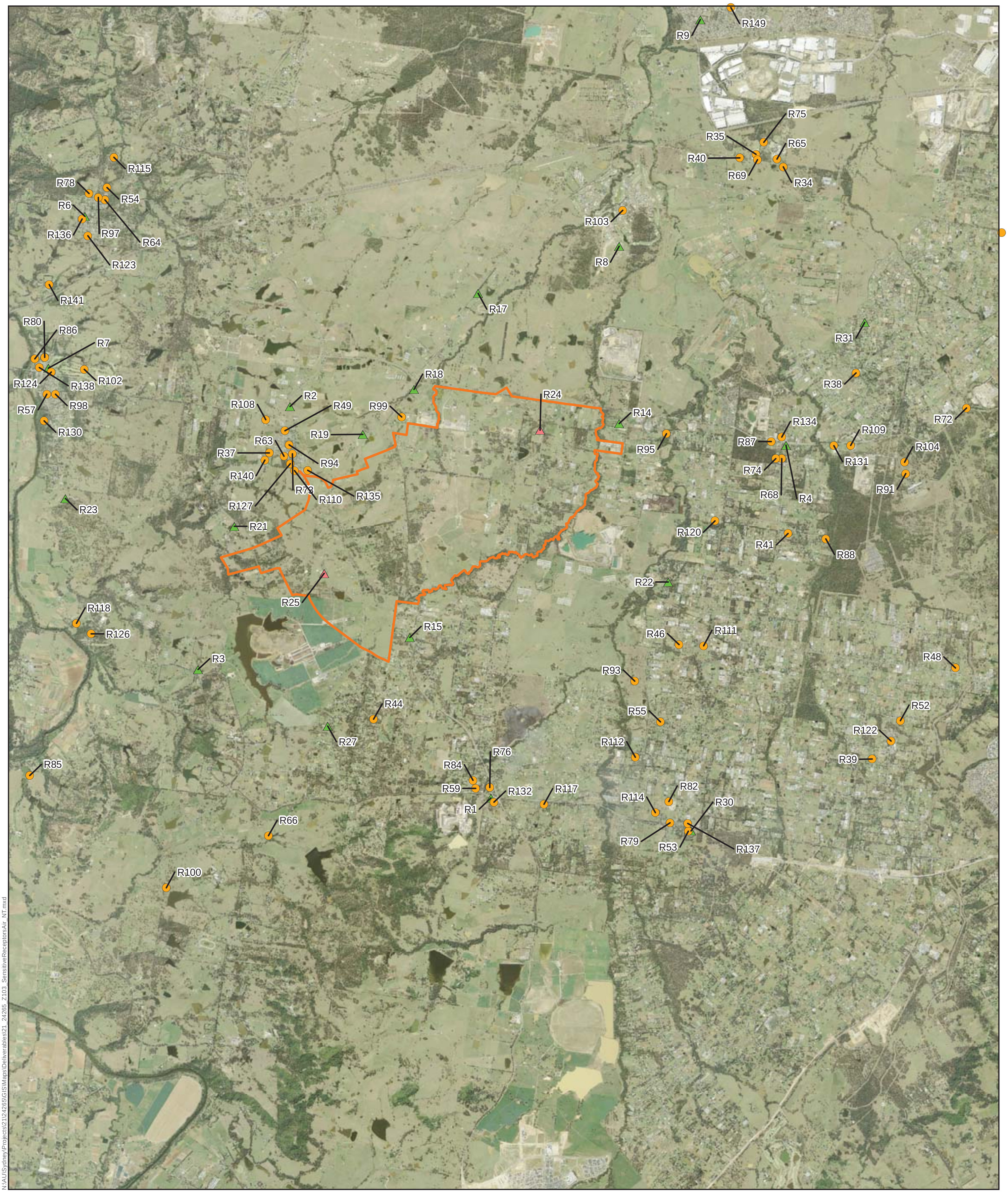
12.2.2. Sensitive receptors

It is standard practice in air quality assessments to estimate pollutant concentrations at discrete locations which are considered to be broadly representative of exposure in the area of interest. The concentrations at these locations are then compared with the relevant air quality assessment criteria in the legislation (refer to Section 12.3). The locations are known as ‘receptors’. Receptors should reflect locations where the general public is likely to have access on a regular basis as well as sensitive locations where people are likely to work or reside. Examples of sensitive receptors include schools, day care centres and hospitals.

The airport site is located in an area with a high density of sensitive receptors. To assess each individual receptor was not practicable. Therefore, a series of receptors were selected on the basis that they would be representative of residential suburbs and individual residences close to the airport site. In addition, a number of community receptors, such as schools, churches, shopping centres and recreational areas, were also identified within the local area. On-site receptors were selected to evaluate the potential exposures of airport staff and passengers.

A total of 152 sensitive receptors were identified. The approach taken for this assessment was to identify a sub-set of receptors to represent individual residences and clusters of residences located within approximately five kilometres of the airport site. This subset included 18 residential receptors, two on-site receptors and 75 community receptors. On-site receptors were selected to evaluate the potential exposures of airport staff and passengers at the facility, noting that airport terminal staff are likely to have a much longer exposure. The on-site receptors have been assessed during operations only as during construction the relevant uses for assessment would not yet exist. The locations of the receptors are shown in Figure 12–1.

The regional model was run using three dimensional nested grids to determine impacts over the Sydney basin and the broader NSW Greater Metropolitan encompassing Newcastle, Wollongong and Lithgow with 25 vertical levels up to 8,000 metres.



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

LEGEND

- Airport site
- Community
- Residential
- Airport site

0 0.5 1 2
Kilometres

N

Figure 12-1 - Location of sensitive receptors in the vicinity of the airport site

12.2.3. Construction

A quantitative assessment of construction impacts was undertaken using the United States Environmental Protection Agency (USEPA) dispersion model AERMOD (USEPA 2004). A detailed description of the model configuration and meteorological file is provided in Appendix F1.

Construction of the Stage 1 development would result in dust emissions generated during both the bulk earthworks and the aviation infrastructure works. Total suspended particulate, PM_{10} and $PM_{2.5}$ emission rates were calculated using emission factors developed both locally and from the USEPA (1995). Key emission sources during bulk earthworks include the operation of dozers, vehicle haulage on unpaved roads, grading of roads and scrapers loading and transporting topsoil for rehabilitation. Hauling of gravel and subgrade material and the movement of cement and asphalt trucks will be the primary emission sources during the aviation infrastructure works. There would also be diesel particulate matter emissions (comprising $PM_{2.5}$ only) from the on-site equipment as well as odour emissions from the asphalt plant.

It is acknowledged that some construction activities would overlap. To provide a conservative basis for assessment, the worst case emissions scenario was identified for the bulk earthworks and the construction of aviation infrastructure.

12.2.4. Operation

The proposed airport has the potential to generate emissions in the form of nitrogen dioxide, particulate matter (PM_{10} and $PM_{2.5}$), carbon monoxide, sulfur dioxide, air toxics, odour and greenhouse gases. These emissions have the ability to affect human health, reduce amenity and contribute to climate change.

Modelling of emissions and air pollution associated with the proposed airport was undertaken using the United States Federal Aviation Administration (FAA) Emissions and Dispersion Modelling System (EDMS) (Version 5.1.4 from June 2013). The EDMS is a combined emissions and dispersion model used for assessing air quality at civilian airports and military air bases. It has been used for several recent airport assessments in Australia including at Sydney Airport and Adelaide Airport.

The operational air quality assessment has adopted the NSW EPA *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (Approved Methods) (DEC 2005) as the primary basis of the impact assessment and in some cases other relevant legislation and guidelines including the draft NEPM-AAQ (refer to Section 12.3).

The detailed methodology for the assessment is presented in Appendix F1 in Volume 4. A brief description of the air quality modelling is provided later in this section. An overview of the air quality assessment is provided in Figure 12–2.

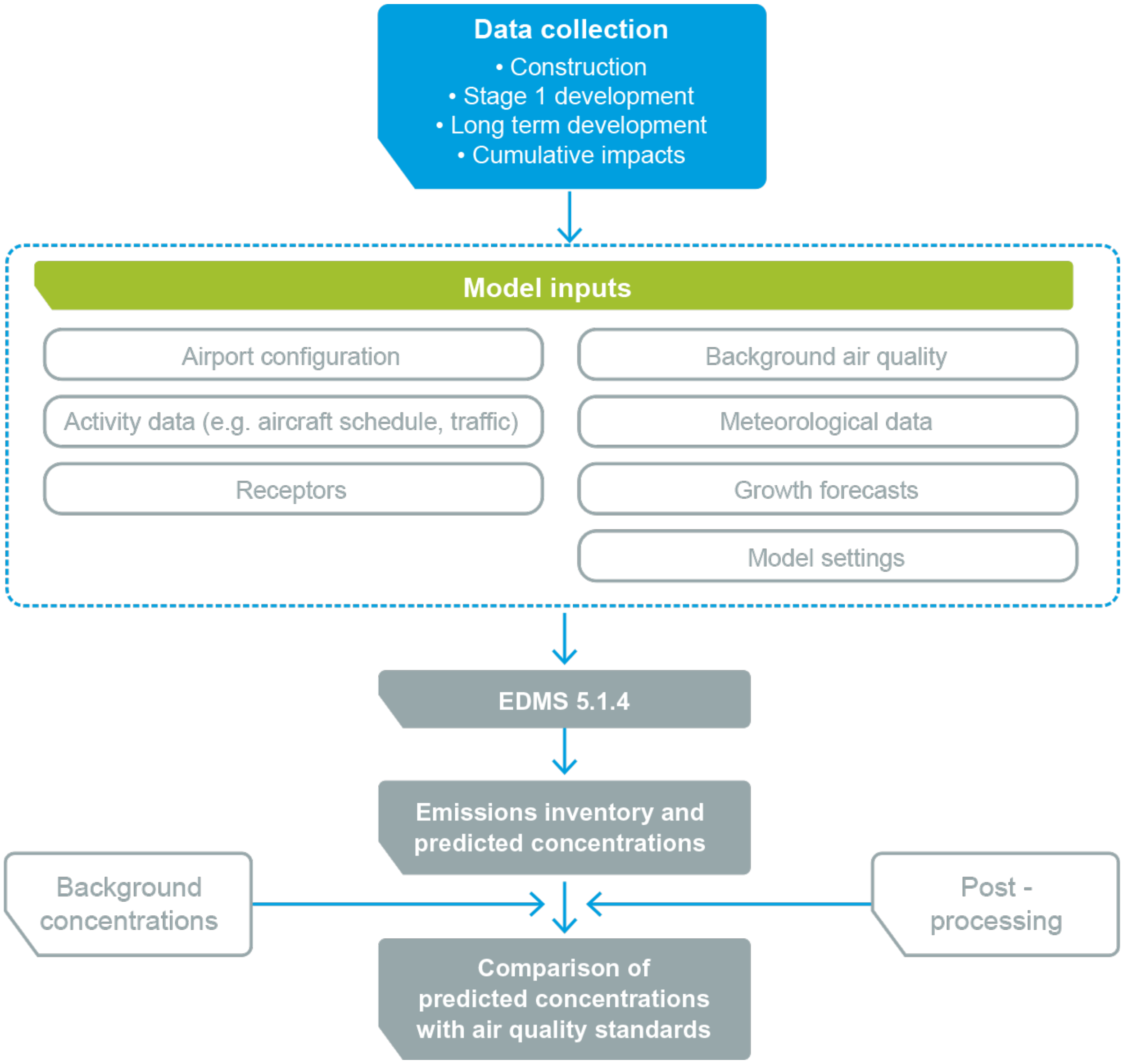


Figure 12–2 – Overview of air quality assessment

Emissions inventories and dispersion model predictions for the proposed Stage 1 and long term developments were obtained using EDMS based on activity data and growth projections for all emission sources. The types of activity that result in atmospheric emissions at airports are identified in the relevant DoE National Pollutant Inventory (NPI) emission estimation technique manual (DEWHA, 2008). These activities (which generate emissions through either combustion or evaporation) are listed in Table 12–1.

Table 12–1 – Summary of activities generating atmospheric emissions at the airport

NPI source type		Description
Emissions directly from aircraft	Aircraft main engine	Main engines of aircraft ranging from start-up to shut-down.
	Auxiliary power unit	Auxiliary power unit located on-board aircraft providing electricity and pre-conditioned air while on the ground and bleed air for main engine start.
Aircraft handling emissions	Ground support equipment	Ground support equipment necessary to handle the aircraft during the turnaround at the stand, including ground power units, air climate units, aircraft tugs, conveyor belts, passenger stairs, fork lifts, tractors, cargo loaders, etc.
	Airside traffic	Service vehicle and machinery traffic, including sweepers, trucks (catering, fuel, sewage), cars, vans, buses etc. that circulate on service roads within the airport perimeter and typically within the restricted area.
	Aircraft refuelling	Evaporation through aircraft fuel tanks (vents) and from fuel trucks or pipeline systems during fuelling operations.
Stationary/ infrastructure sources	Power/heat generating plant	Facilities that produce energy for the airport infrastructure, namely boiler houses, heating/cooling plants, co-generators.
	Emergency power generator	Diesel or other generators for emergency operations (e.g. for buildings or for runway lights).
	Aircraft maintenance	All activities and facilities for maintenance of aircraft, i.e. washing, cleaning, paint shop, engine test beds, etc.
	Airport maintenance	All activities and facilities for maintenance of airport facilities, including cleaning operations.
	Fuel	Fuel storage, distribution and handling.
	Construction and demolition activities	All construction and demolition activities involved in airport operation and development, including the resurfacing of roads and runways.
	Fire training	Activities for fire training with different fuels (e.g. kerosene, butane, propane, wood).
	Wastewater treatment	All activities and facilities for the collection, storage and treatment of wastewater on-site.
Landside traffic	Vehicle traffic	Cars, vans, trucks, buses, motorbikes etc. associated with the proposed airport on access roads, drop-off areas and parking lots. Emissions include tailpipe and evaporative releases.

EDMS incorporates a comprehensive database of emission factors for aircraft engines, ground support equipment, auxiliary power units, vehicles and stationary sources. The emission factors are taken from a range of sources, including the International Civil Aviation Organization, the FAA and the USEPA.

The pollutants currently included in the EDMS emission calculations are:

- carbon dioxide (CO_2);
- carbon monoxide (CO);
- nitrogen oxides (NO_x)
- sulfur oxides (SO_x)

- particulate matter ($PM_{2.5}$ and PM_{10});
- total hydrocarbons (THC);
- non-methane hydrocarbons (NMHC);
- volatile organic compounds (VOC);
- total organic gases (TOG); and
- 394 speciated organic gases (including benzene, toluene, xylenes and formaldehyde).

Model post-processing was undertaken to determine the relative contribution of nitrogen dioxide to nitrogen oxides, sulfur dioxide to sulfur oxides and volatile organic compounds speciation.

The EDMS dispersion analysis undertaken in this assessment uses AERMOD (USEPA 2004). Detailed spatial information on aircraft movements, other emission sources (for example, engine testing and auxiliary power units), the proposed airport layout, and meteorological data were employed within EDMS to determine the proposed airport's contribution to concentrations of criteria pollutants at discrete receptor locations and across the model domain.

Aircraft movements are calculated in EDMS using the schedule, gate locations, runway locations and the taxi paths between the gates and runways. For this assessment, gates were allocated in groups and more than 30 different taxiway sections were entered utilising the proposed runway system.

Emissions from vehicles on roadways are calculated in EDMS and include terminal traffic and external roadways. The terminal traffic comprises traffic that would be travelling to and from the airport and accounts for vehicles using parking facilities or vehicles dropping off or collecting passengers. The traffic emissions from the external roads included all roadways outside of the proposed airport site, extending as far north as the M4 and as far east as the M7. Future emissions from the proposed M12 roadways were also included.

The results from the dispersion modelling were then used in combination with the data on existing air quality (used to define background concentrations) to determine the likely impact of airport operations.

12.2.5. Cumulative impacts

There is potential for cumulative impacts during the operation of the proposed airport. For the purpose of this assessment cumulative impacts are defined as 'existing' (background) air quality, combined with the airport activities within the airport site (incremental) for each development stage and other projects which are current or reasonably foreseeable at the time of this project and would give rise to combined impacts. For the Stage 1 development, cumulative impacts would be the emissions from the proposed airport operating with the single runway and the external roadways combined with background pollutant measurements from other sources. For the long term development, this would also be the case except that the proposed airport's emissions would comprise emissions from the airport operating with both runways at full capacity.

Within the Western Sydney airshed, there are a number of other industrial emitters with the potential to affect local air quality. These include:

- major roadways (for example, M4 and M7);
- Camden Airport;
- Bankstown Airport;
- the Elizabeth Drive landfill facility;
- Boral Bricks Bringelly;
- Erskine Park Quarry;
- the Western Sydney Service Centre (metal manufacturing); and
- the Western Sydney Employment Area.

With the exception of the major roadways, the sources are all located at a sufficient distance from the airport site that potential cumulative impacts at the local scale are considered negligible. The adopted background air quality values would effectively account for potential emissions from these other sources.

To address the potential cumulative impacts of the proposed airport in combination with the major roadways, emissions from both sources were included in the modelling.

There would be potential cumulative emissions from operation of the proposed Stage 1 development in combination with the construction activities pertaining to the long term development. It is anticipated that dust emissions generated during construction of the second runway would be effectively managed. This assumption is supported by the fact that there are significant safety issues associated with dust generation in the vicinity of an operational airport that would be of much greater risk (and so receive more careful management) than conventional nuisance dust issues from other construction activities. The additional combustion emissions from on-site equipment during the long term development construction activities are also assumed to be insignificant in comparison to the emissions from the airport in isolation and on that basis, have not been considered further in this chapter.

Regional ozone impacts were also considered in terms of cumulative emissions within the Sydney basin.

12.2.6. Odour

12.2.6.1. Odour from aircraft exhaust

Studies by Winther et al. (2005) established that, at the point of emission, there is a relationship of 57 odour units (OU) per milligram per cubic metre of total organic compounds released by aircraft. This relationship has been referenced within other local air quality assessments recently published, such as the assessment for London Luton Airport (Air Quality Consultants 2012).

This approach (mass emission of TOC multiplied by 57 to establish the OU emission rate) has been adopted within the current assessment. Total organic compound emissions were quantified by EDMS from aircraft operations in start-up mode in combination with total organic compound emissions from auxiliary power units and ground support equipment. These total organic compound emissions were then scaled accordingly to represent odour emission rates in OU/s.

Subsequently, odour impacts of the proposed airport were assessed referencing an odour detection threshold (one OU) corresponding to 34 milligrams per cubic metre of total organic compounds. This relationship was based on odour measurements conducted by the CSIRO in 1997 at Sydney Airport (PPK 1997), and effectively provides an odour performance criterion for nearby sensitive receptors in terms of total organic compounds.

12.2.6.2. Odour from the on-site wastewater treatment plant

To characterise the potential odour impacts of the on-site wastewater treatment plant, odour sampling was completed at two similar wastewater treatment plant facilities located at Pitt Town and central Sydney. The purpose of the monitoring was to characterise the odour from these existing facilities and to use the data to derive odour emission rates for use in the dispersion modelling. The odour emissions used in this assessment are provided in Table 12–2.

Table 12–2 – Adopted waste water treatment plant odour monitoring inputs

Sample	Odour concentration (OU)	Specific odour emission rate (OU m/s)
MBR tank – membrane chamber	1,970	0.68
MBR tank – aerobic chamber	3,620	1.19
MBR tank – anoxic chamber	4,310	1.42
Activated carbon filter outlet (treated air)	3,320	n/a

12.2.6.3. Regional air quality (ozone)

Ozone air quality impacts were evaluated using the Comprehensive Air Quality Model with extensions (CAMx) Version 6.2 developed by Rambol Environ (ENVIRON 2015). CAMx is a three-dimensional, gridded, atmospheric dispersion model with photochemistry that allows for assessments of gaseous and particulate air pollution (for example, ozone, $PM_{2.5}$, PM_{10} and air toxics) over spatial scales ranging from suburban to continental. CAMx was used to assess ozone impacts in the Sydney Greater Metropolitan Region in a study for the NSW Environmental Protection Authority (EPA) to develop the tiered assessment procedure for ozone (ENVIRON 2011). CAMx is used around the world and is one of two models used by the USEPA to develop air quality regulations for ozone and particulate matter (USEPA 2011).

CAMx requires meteorological input data for: wind, temperature, pressure, vertical diffusivity, water vapour, clouds, rainfall and layer interface height. CSIRO's three-dimensional meteorological and air pollution model 'The Air Pollution Model' (TAPM) was used to simulate meteorology within the study area. Surface observation data from numerous meteorological stations located in the Sydney region were used for calibration and a statistical evaluation shows good correlation for wind speed and temperature with reasonably low bias and error.

The ozone modelling assessment considered emissions data for the following scenarios:

- 2008 base case for model evaluation;
- 2030 future base case for comparison with future airport operations;
- 2030 airport case for Stage 1 development emissions; and
- 2063 airport case for long term airport emissions (refer to Chapter 32 of Volume 3).

The 2008 base case scenario was used to assess model performance, by comparing predicted ozone concentrations against ambient monitoring data for the same period. Scatter plots presented for the evaluation demonstrated that modelled-observed data pairs are clustered around the 1:1 line, showing that the model tends to correctly predict ozone variability. The model exhibits little bias at Bringelly and St Marys, with the normalised mean bias less than two per cent for one hour ozone and less than seven per cent for four hour ozone.

To assess the impact from the addition of airport emissions, a number of days were selected for detailed analysis. Twelve days with high observed ozone (one hour ozone concentrations greater than 70 parts per billion and four hour ozone concentrations greater than 65 parts per billion) and good model performance (bias within plus or minus 15 per cent in peak values) were selected for analysis. Historical dates in January and February 2009 were selected to represent the meteorological conditions that have historically led to peak ozone formation and which the model has effectively captured for peak ozone formation with the addition of future emissions.

12.2.7. Greenhouse gases

Quantification of greenhouse gas emissions (in tonnes of carbon dioxide equivalent (t CO_2-e)) associated with each greenhouse gas source was made in accordance with the *Greenhouse Gas Protocol* (WRI & WBCSD 2004), the Intergovernmental Panel on Climate Change (IPCC) and the Australian Government greenhouse gas accounting/classification systems.

The greenhouse gas assessment is guided by the *National Greenhouse and Energy Reporting Regulations 2008* (NGER Regulations). These describe the detailed requirements for reporting under the *National Greenhouse and Energy Reporting Act 2007* (Cth) (NGER Act). Calculations are consistent with the *National Greenhouse and Energy Reporting (Measurement) Determination 2008* (the “NGER Measurement Determination”).

To streamline the quantification process, greenhouse gas emissions were calculated within the EDMS model used for the local air quality assessment. Any deviations in the calculation approaches between the NGER Technical Guidelines and the EDMS model are acknowledged and their material impact quantified.

Greenhouse gas emission calculations are generally of the form:

$$\mathrm{Emission_i} = \mathrm{Activity\ data} \times \mathrm{EF_i}$$

Where:

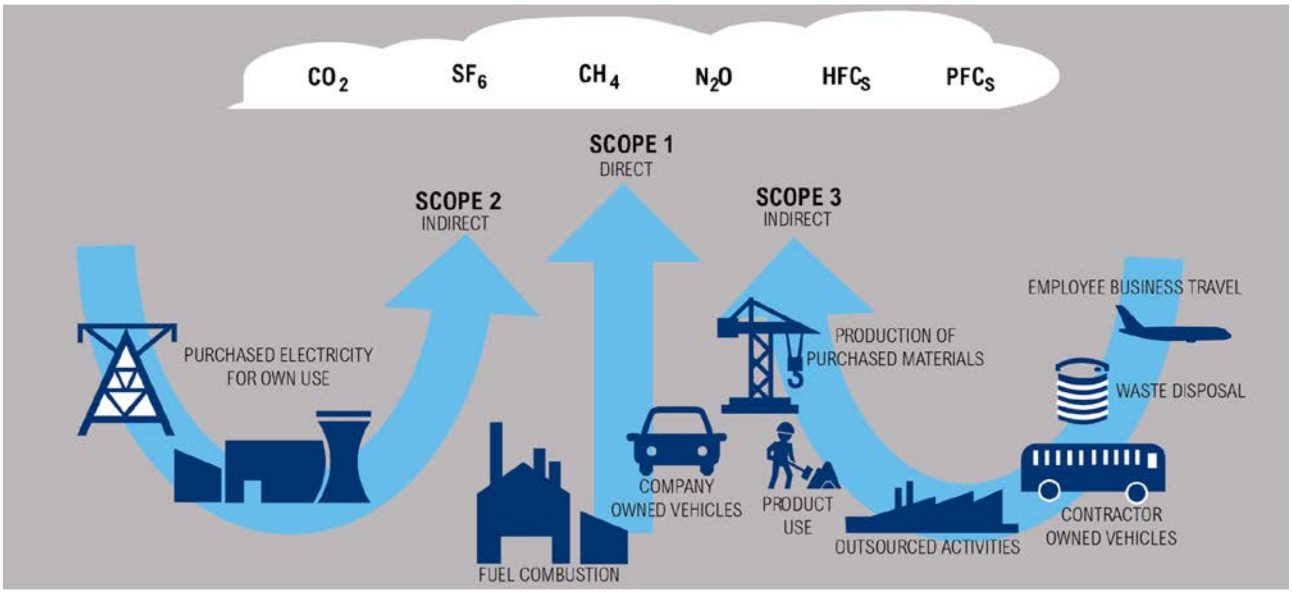
$Emission_i$	=	Estimated emissions of greenhouse gas $_i$	(t CO_2-e)
$Activity\ data$	=	Basis of emission estimate (for example, amount of fuel combusted for energy generation)	(generally in gigajoules for fuel combustion)
EF_i	=	Emission factor for greenhouse gas $_i$	(t CO_2-e/activity)

Greenhouse gas emissions were estimated based upon the methods outlined in the following documents:

- the *Greenhouse Gas Protocol* (World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD) 2004);
- the *National Greenhouse and Energy Reporting (Measurement) Amendment Determination 2015 (No.2)* (DoE 2015a) produced from the *National Greenhouse and Energy Reporting (Measurement) Determination 2008* (DCCEE 2008); and
- *Technical Guidelines for the Estimation of Greenhouse Gas Emissions by Facilities in Australia* (DoE, 2014a).

The *Greenhouse Gas Protocol* establishes an international standard for accounting and reporting greenhouse gas emissions (WRI & WBCSD 2004). The Protocol has been adopted by the International Organization for Standardization, endorsed by greenhouse gas initiatives (such as the Carbon Disclosure Project) and is compatible with existing greenhouse gas trading schemes.

Under this Protocol, three emissions “scopes” (Scope 1, Scope 2 and Scope 3) are defined for greenhouse gas accounting and reporting purposes. This terminology has been adopted in Australian greenhouse gas reporting and measurement methods and has been employed in this assessment. Scope 1 emissions are direct greenhouse emissions from sources owned or controlled by the reporting entity such as airport owned vehicles and equipment. Scope 2 emissions are indirect greenhouse gas emissions from the generation of purchased energy by the proposed airport. Scope 3 emissions are defined as those emissions that are a consequence of the activities of an entity, but arise from sources not owned or controlled by that entity such as the activities of individual airlines (that is, aircraft movements). A visual representation of Scope 1, 2 and 3 emissions is presented in Figure 12–3.



Source: WRI & WBCSD 2004.

Figure 12–3 – Overview of the three scopes and emissions sources across a reporting entity

12.3. Air quality criteria

Gaseous pollutants and particulate matter performance criteria

Legislation, guidelines and standards governing air pollutant emissions and ambient air quality have been introduced at the Commonwealth and State government levels. Legislation, guidelines and other standards which have been considered for this assessment are summarised in Table 12–3.

Regulated air pollutants are divided into 'criteria' pollutants and 'air toxics'. Criteria pollutants tend to be ubiquitous and emitted in relatively large quantities, and their health effects have been studied in some detail. Air toxics are gaseous or particulate organic pollutants that are present in the air in low concentrations and have characteristics hazardous to human, plant or animal life. The health effects and main sources of pollutants investigated in the local air quality and greenhouse gas assessment are summarised in Appendix F1.

Table 12–3 – Emissions and air quality legislation

Legislating body	Legislation/measures	Summary
Ambient air quality		
Australian Government	*Airports Act 1996*	Promotes the sound development of civil aviation in Australia. It contains an obligation on airport lessee companies to develop a master plan every five years including a detailed environmental strategy which is required to address amongst other things continuous improvement in the environmental consequences of activities at the airport; progressive reduction in extant pollution at the airport and development and adoption of a comprehensive environmental management system for the proposed airport that maintains consistency with relevant Australian and international standards. The Airports Act also contains a number of offences related to pollution at airports. An Airport Plan is required to authorise the construction and operation of the Stage 1 development.
	Airports (Environment Protection) Regulations 1997	Imposes a general duty to prevent or minimise environmental pollution once an airport lease is granted. Promotes improved environmental management practices at airports. Includes provisions setting out definitions, acceptable limits and objectives for air quality, as well as monitoring and reporting requirements.
	Air Navigation (Aircraft Engine Emissions) Regulations /Chicago Convention Annex 16	The regulations make it an offence to fly certain aircraft if they do not meet relevant emissions standards including the standards set out in Annex 16 to the Chicago Convention.
	National Environment Protection (Ambient Air Quality) Measure (NEPM-AAQ)	Sets the national health-based air quality standards for six air pollutants (carbon monoxide, nitrogen dioxide, sulfur doxide, lead, ozone and PM_{10}) and includes advisory reporting standards for $PM_{2.5}$.
	National Environment Protection (Air Toxics) Measure (Air Toxics NEPM)	Sets a nationally consistent approach to monitoring (by reference to 'investigation levels') for five air toxics: benzene, formaldehyde, toluene, xylenes and benzo(a)pyrene (as a marker for polycyclic aromatic hydrocarbons). These are not compliance standards but are for use in assessing the significance of the monitored levels of air toxics with respect to the protection of human health.

Legislating body	Legislation/measures	Summary
NSW Government	*Protection of the Environment Operations Act 1997* (POEO Act), and the Protection of the Environment Operations (General) Regulation 2009	The POEO Act provides a range of controls with regard to air quality including requirements to maintain plant and equipment in proper and efficient condition and to operate plant and equipment in a proper and efficient manner. This includes the means of processing, handling, moving, storage and disposal of materials.
Emissions of air quality criteria pollutants		
Australian Government	National Environment Protection (National Pollutant Inventory) Measure	The primary goals are to: (a) collect a broad base of information on emissions and transfers of substances and (b) disseminate information to all sectors of the community. This NEPM covers a variety of air pollutants.
NSW Government	*Protection of the Environment Operations Act* (2007) (POEO Act) and Protection of the Environment Operations (Clean Air) Regulation (2010) (Clean Air Regulation)	The object of the POEO Act is to achieve the protection, restoration and enhancement of the quality of the NSW environment having regard to the need to maintain ecologically sustainable development. The Clean Air Regulation prescribe standards for certain groups of plant and premises to regulate industry's air emissions and impose requirements on the control, storage and transport of volatile organic liquids.
	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW	This policy document lists the statutory methods that are to be used to model and assess emissions of air pollutants from stationary sources in NSW. It is referred to in Part 5: Air impurities from emitted activities and plant of the Clean Air Regulation. It also prescribes the air pollutants and averaging periods that an airport's emissions are to be assessed against.
Emissions of greenhouse gases		
Australian Government	*National Greenhouse and Energy Reporting Act (2007)*	An airport lessee company (ALC) is required to register and report its operational greenhouse gas emissions attributable to the activities over which it has operational control. This is because it is expected that its emissions will exceed relevant thresholds. This may also apply to the construction contractor and other contractors or users of the airport (e.g. airlines).
Ozone-depleting substances		
Australian Government	*Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* and the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995	This Act and these Regulations impose controls on the manufacture, import, export and management of substances that deplete ozone in the atmosphere including CFCs 11, 12, 113, 114 and halons 1211, 1301 and 2402.
NSW Government	*Ozone Protection Act 1989*	This Act regulates or prohibits the manufacture, sale, distribution, conveyance, storage, possession and use of ozone-depleting substances in NSW.

The air quality criteria adopted for use in the air quality assessment are principally those defined in the NSW Approved Methods (DEC 2005). The Approved Methods take account of various pollutant criteria and averaging periods from multiple sources, including the Commonwealth's National Environment Protection (Ambient Air Quality) Measure (NEPM-AAQ). In some cases, the Approved Methods mirror the NEPM-AAQ. In other cases, where no similar criteria are stated in the Approved Methods, criteria outlined in the NEPM-AAQ have been adopted in this study. Examples of the latter are average annual PM_{10} and $PM_{2.5}$. A summary of the adopted air quality assessment criteria and their source is provided in Table 12–4. In each case, where several performance criteria are available, the more stringent criterion has been used.

Table 12–4 – Air quality criteria applicable to the airport

Pollutant	Criterion[a]	Averaging period	Source[b]
Carbon monoxide (CO)	87 ppm or 100 mg/m3	15 minutes	NSW EPA
	25 ppm or 30 mg/m3	1 hour	NSW EPA
	9 ppm or 10 mg/m3	8 hours	NSW EPA, AEPR (b)
Nitrogen dioxide (NO_2)	16 pphm or 320 µg/m3	1 hour	AEPR
	12 pphm or 246 µg/m3	1 hour	NSW EPA
	3 pphm or 62 µg/m3	1 year	NSW EPA
Total suspended particulate matter (TSP)	90 µg/m3	1 year	NSW EPA, AEPR
Particulate matter < 10 µm (PM_{10})	50 µg/m3	24 hours(c)	NSW EPA
	30 µg/m3	1 year	NSW EPA
Particulate matter < 2.5 µm ($PM_{2.5}$)	25 µg/m3	24 hours	NEPM-AAQ advisory reporting standard
	8 µg/m3	1 year	NEPM-AAQ advisory reporting standard
Deposited dust – Incremental	2 g/m2/month	Annual	NERDDC
Deposited dust – Cumulative	4 g/m2/month	Annual	NERDDC
Lead (Pb)	1.5 ppm	3 months	AEPR
	0.5 µg/m3	1 year	NSW EPA
Photochemical oxidants (as ozone (O_3))	0.10 ppm or 210 µg/m3	1 hour	NSW EPA(d), AEPR
	0.08 ppm or 170 µg/m3	4 hours	NSW EPA(e), AEPR
Sulfur dioxide (SO_2)	25 pphm or 710 µg/m3	10 minutes	NSW EPA(f), AEPR
	20 pphm or 570 µg/m3	1 hour	NSW EPA, AEPR
	8 pphm or 228 µg/m3	1 day	NSW EPA
	2 pphm or 60 µg/m3	1 year	NSW EPA, AEPR
Benzene	0.009 ppm or 29 µg/m3	99.9^{th} one hour max	NSW EPA
Toluene	0.09 ppm or 360 µg/m3	99.9^{th} one hour max	NSW EPA
Xylene	0.004 ppm or 180 µg/m3	99.9^{th} one hour max	NSW EPA
Formaldehyde	0.18 ppm or 20 µg/m3	99.9^{th} one hour max	NSW EPA
Benzo[a]pyrene	0.4 µg/m3	99.9^{th} one hour max	NSW EPA

Notes:
(a) ppm = parts per million; pphm = parts per hundred million; µg/m^3 = micrograms per cubic metre; mg/m^3 = milligrams per cubic metre
(b) NSW EPA = NSW EPA 'Approved Methods'; AEPR = *Airports (Environment Protection) Regulations 1997*
(c) Up to 5 exceedances allowed per year in NEPM-AAQ
(d) Given as 214 µg/m^3 in Approved Methods
(e) Given as 171 µg/m^3 in Approved Methods
(f) Given as 712 µg/m^3 in Approved Methods

It is noted that in 2014, the National Environment Protection Council released an Impact Statement and draft variation to the AAQ NEPM in relation to the standards for airborne particles. The NSW EPA, which has managed the NEPM variation, has subsequently requested NSW Cabinet approval for a number of changes to the particle standards. It is understood that Australian Environment Ministers have agreed to finalise their consideration of the draft variation to the NEPM-AAQ by the end of 2015. These changes may be subsequently adopted by the NSW EPA into an update to the NSW Approved Methods.

In consideration of potential future changes to the air quality standards for particulates, the Department will seek further guidance from the National Environment Protection Council during exhibition of the draft EIS and revise the modelling and assessment of local air quality in accordance with any revised criteria proposed in the draft NEPM.

In recognition of the potential health problems arising from exposure to air toxics, 'investigation levels' have been set for five pollutants in ambient air under the *National Environment Protection (Air Toxics) Measure* (Air Toxics NEPM). These investigation levels are listed in Table 12–5**.**

Table 12–5 – Advisory standard air toxic investigation levels applicable to the airport

Pollutant	Criterion(a)		Averaging period	Source
Benzene	0.003	ppm	1 year(d)	Air Toxics NEPM, investigation levels
PAHs(b) (as B[a]P)(c)	0.3	ng/m^3	1 year(d)	Air Toxics NEPM, investigation levels
Formaldehyde	0.04	ppm	24 hours	Air Toxics NEPM, investigation levels
Toluene	1.0	ppm	24 hours	Air Toxics NEPM, investigation levels
	0.1	ppm	1 year(d)	
Xylenes	0.25	ppm	24 hours	Air Toxics NEPM, investigation levels
	0.20	ppm	1 year(d)	

Notes:

(a) ng/m^3 – nanograms per cubic metre

(b) PAH – polycyclic aromatic hydrocarbons

(c) B[a]P – benzo[a]pyrene, the most widely studied PAH and used as an indicator compound

(d) Arithmetic mean of concentrations of 24 hour monitoring results

12.3.1.1. Odour performance criteria

The Approved Methods also include ground-level concentration criteria for complex mixtures of odorous air pollutants, taking account of population density in a given area. Table 12–6 lists the odour criteria to be exceeded not more than one per cent of the time, across different population densities. The airport site falls within an urban area, so a criterion of two OU applies.

Table 12–6 –Odour performance criteria for the assessment of odour

Population of affected community	Criterion for complex mixtures of odorous air pollutants 99th percentile (OU)
≤ ~2	7
~10	6
~30	5
~125	4
~500	3
Urban (2000) and/or schools and hospitals	2

12.3.1.2. Greenhouse gases

The NGER Act establishes a mandatory obligation on corporations which exceed defined thresholds to report greenhouse gas emissions, energy consumption and other related information.

Corporate and facility reporting thresholds for greenhouse gas emissions and energy consumption are provided in Table 12–7. Emissions are measured in terms of tonnes of carbon dioxide equivalent which is a value representing the normalisation of different types of greenhouse gases to their equivalent global warming potential of carbon dioxide.

Table 12–7 –NGER reporting thresholds

Corporate threshold		Facility threshold	
Greenhouse gas emissions (kt CO_2-e)	Energy usage (TJ)	Greenhouse gas emissions (kt CO_2-e)	Energy usage (TJ)
50	200	25	100

Source: DCCEE, 2007.

As the proposed airport (once operational) is anticipated to have combined Scope 1 and Scope 2 emissions greater than 25 kilotonnes carbon dioxide equivalent in a financial year, emissions are expected to be required to be reported under the NGER scheme.

If a corporation has operational control over facilities whose greenhouse gas emissions or energy use in a given reporting year:

- individually exceed the relevant facilities threshold; or
- when combined with other facilities under the corporation's operational control, exceed the relevant corporate thresholds, that corporation must report its greenhouse gas emissions or energy use (as the case may be) for that year under the NGER Act.

This definition may encompass the ALC, a construction company, various other contractors and airlines. A preliminary assessment of greenhouse emissions and energy use for the Stage 1 development is presented in Section 12.7.

12.3.1.3. Regional air quality (ozone)

The National Environment Protection Measures (NEPM) for ambient air quality standards for ozone are summarised in Table 12–8 and expressed as parts per million by volume. The NEPM standards are identical to the impact assessment criteria prescribed by the NSW EPA in the Approved Methods, although the impact assessment criteria are expressed as parts per hundred million and in micrograms per cubic metre of air (refer to Table 12–9). The NEPM standard, like the NSW EPA criteria, also allows for the goal to be exceeded for one day a year.

Table 12–8 – National standards for ozone (NEPM)

Averaging period	Maximum concentration	Maximum allowable exceedances
1 hour	0.10 ppm	1 day a year
4 hours	0.08 ppm	1 day a year

Table 12–9 – Impact Assessment criteria for ozone (NSW EPA)

Averaging period	Concentration	
	pphm	µg/m³a
1 hour	10	214
4 hours	8	171

The ambient ozone monitoring data and ozone modelling results presented in this chapter use parts per billion as the preferred reporting unit. A concentration of 100 parts per billion for one hour ozone is equivalent to the NEPM standard of 0.10 parts per million and the NSW EPA criterion of 10 parts per hundred million, while a concentration of 80 parts per billion for four hour ozone is equivalent to the NEPM standard of 0.08 parts per million and the EPA criterion of eight parts per hundred million.

Ozone standards for vegetation are not prescribed by the NSW EPA, however under the Queensland Environment Protection (Air) Policy 2008 (EPP (Air)), air quality objectives are listed for both human health and ecosystems damage. The EPP (Air) adopts the NEPM health based standards referenced in Table 12–8.

12.4. Existing environment

This section describes the meteorological conditions (wind speed and direction, temperature, rainfall and humidity) at the airport site. The existing, ambient air quality in the vicinity of the airport site is also described.

12.4.1. Meteorology

Air quality is influenced by meteorological conditions. Wind speed, wind direction, temperature and relative humidity all affect the potential dispersion and transport of emissions and are basic input requirements for dispersion modelling.

Climatic data was reviewed for five consecutive years (2010-14). Summary statistics are provided in Appendix F1. These data were used to describe the local meteorology at Badgerys Creek.

12.4.1.1. Wind speed and direction

The average wind speed across the five year period was 2.6 metres per second. The percentage of winds less than 0.5 metres per second across the period was nine per cent.

An analysis of the climatic data suggests that there is no strong relationship between the time of year and the monthly average wind speed, although the monthly average wind speeds are generally less during autumn as shown on Figure 12–4. There is little variation in average wind speed between years. The highest average wind speed of 2.9 metres per second was recorded in 2010 and the lowest average wind speed of 2.5 metres per second was recorded in 2012.

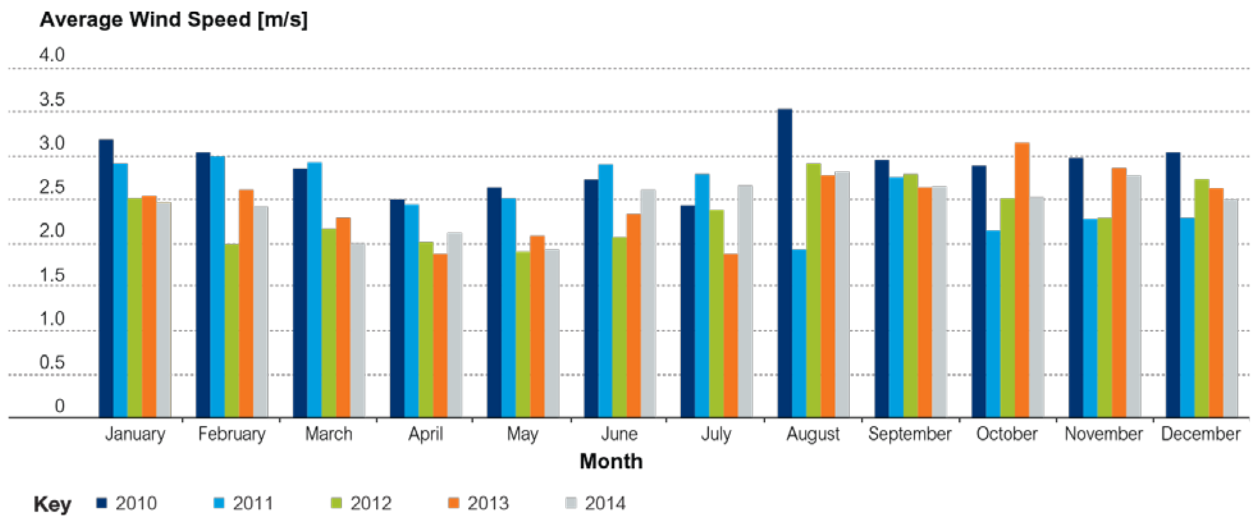


Figure 12–4 – Monthly average wind speed at Badgerys Creek (2010-2014)

Annual and seasonal wind roses for the years 2010-14 are presented in Appendix F1. Wind roses show the frequency of occurrence of winds by direction and strength. The bars correspond to the 16 compass points – north, north-north-east, north-east, etc. The bar at the top of each wind rose diagram represents northerly winds, and so on. The length of the bar represents the frequency of occurrence of winds from that direction, and the width of the bar corresponds to wind speed categories, the narrowest representing the lightest winds.

On an annual basis, the predominant winds at Badgerys Creek originate from the south-west, followed by the south-south-west and north. Very few winds originate from the north-west. The prevailing winds vary across the seasons with the characteristic south-westerly wind less prominent during summer where winds from the north-east become more frequent. During winter, the majority of winds originate from the south-west. There is a consistent seasonal pattern across all years.

12.4.1.2. Temperature, rainfall and humidity

There is a strong seasonal variation in temperature at Badgerys Creek. The annual average temperature between 2010 and 2014 was 17 degrees Celsius. On average, January was the hottest month, with an average monthly temperature of 23 degrees Celsius and maximum of 45 degrees Celsius. June and July were the coldest months for the five year period, with average temperatures of 11 degrees Celsius and 10 degrees Celsius, respectively. The minimum temperatures for these months were -2 degrees Celsius and -1 degrees Celsius, respectively.

Total annual rainfall data measured over the 2010-14 period indicates an annual average total rainfall of 814 millimetres. The wettest year was 2013 with 912 millimetres of rainfall. The driest year was 2014 with 693 millimetres of rainfall. The rainfall data collected at Badgerys Creek indicate that February is the wettest month, with an average rainfall of 114 millimetres while July is the driest month, with an average rainfall of 30 millimetres. The average monthly rainfall for all years was 68 millimetres.

The annual average relative humidity reading at Badgerys Creek was 73 per cent. The month with the highest relative humidity on average was June, with an average of 79 per cent. The months with the lowest relative humidity were September and October.

12.4.1.3. Vertical profile

Measurements of the vertical profile of the lower atmosphere are made daily at Sydney Airport. No other regular measurements of this kind are made within the Sydney region. The wind speed and wind direction measurements are made using a radiosonde, typically up to 7,000 metres above ground level. The vertical profile measurements of wind speed between 2010 and 2014 are shown in Figure 12–5.

The measurements of wind speed indicate that in the lower few hundred metres of the atmosphere, the wind speeds are generally relatively low, up to eight metres per second. Layers of high wind speeds are observed between 800 metres and 1,000 metres and again between 3,500 metres and 4,500 metres. The highest observed wind speed was 116 metres per second.

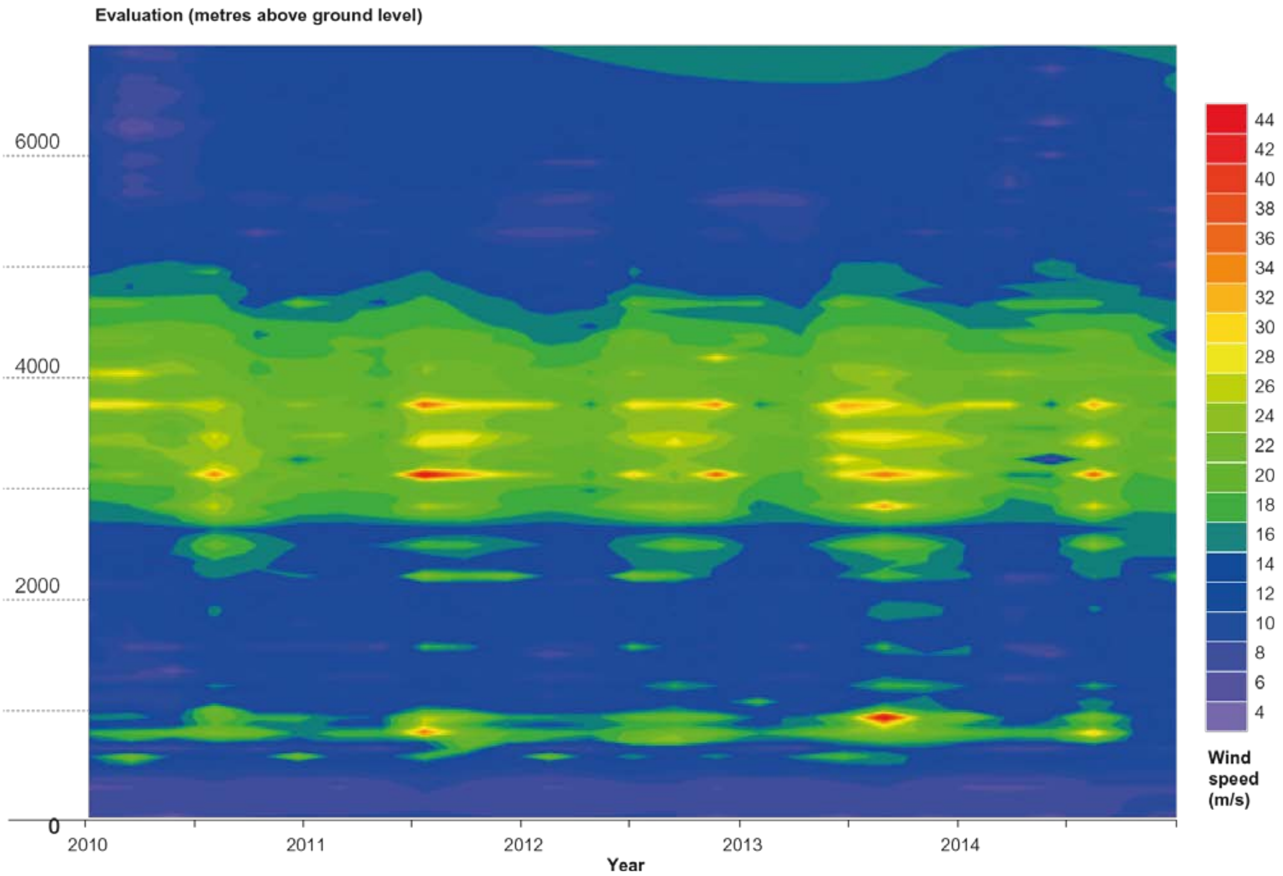


Figure 12–5 – Vertical profile of wind speed at Sydney Airport (2010-14)

12.4.2. Local ambient air quality

To assess the potential impacts of the proposed airport against the relevant air quality assessment criteria described in Section 12.3, it is necessary to have information on existing concentrations of pollutants for the study area so that the cumulative (ambient conditions plus project incremental emissions) impact may be evaluated.

Air quality monitoring data collected between 2005 and 2014 from the OEH monitoring stations in Bringelly, Macarthur/Campbelltown West, Liverpool and Richmond was used to describe the existing air quality in Badgerys Creek. The data was compared with the criteria given in Table 12–4 and Table 12–5.

A summary of the available air quality data is provided below with further information provided in Appendix F1. Generally, air quality for the local area is good, with the exception of isolated high pollution days or extreme events such as dust storms and bushfires. Uncontrolled combustion events such as bushfires will influence regional observations of PM_{10} and $PM_{2.5}$, and to a lesser extent, nitrogen oxides.

12.4.2.1. Nitrogen dioxide (NO_2)

The main oxides of nitrogen present in the atmosphere are nitric oxide, nitrogen dioxide and nitrous oxide. The major human activity which generates oxides of nitrogen is fuel combustion, especially in motor vehicles. Oxides of nitrogen form in the air when fuel is burnt at high temperatures. This is mostly in the form of nitric oxide with usually less than 10 per cent in the form of nitrogen dioxide. Once emitted, nitric oxide combines with oxygen ('oxidises') to form nitrogen dioxide, especially in warm sunny conditions. These oxides of nitrogen may remain in the atmosphere for several days, during this time chemical processes may generate nitric acid, and nitrates and nitrites as particles. These oxides of nitrogen play a major role in the chemical reactions that generate photochemical smog (OEH 2014a).

Data for nitrogen dioxide were obtained from the monitoring station at Bringelly. The data is presented in Table 12–10. There were no exceedances of the nitrogen dioxide one hour average criteria of 246 micrograms per cubic metre (the one hour maximum concentration ranged between 51 micrograms per cubic metre and 92 micrograms per cubic metre). There were also no exceedances of the annual average criteria of 62 micrograms per cubic metre (the annual average concentrations ranged between 9 micrograms per cubic metre and 13 micrograms per cubic metre).

Analysis of the data shows a clear downward trend in nitrogen dioxide concentrations most substantially between 2006 and 2009 and then again after 2012. In addition, there is a strong seasonal influence on nitrogen dioxide concentrations, peaking during the winter months. This trend is attributed to the more stable atmospheric conditions during winter that leads to reduced dispersion as well as the limited photochemical processes that react with nitrogen dioxide during the summer months.

Further analysis of the data shows that the greatest concentrations of nitrogen dioxide originate from the east and are associated with the key local nitrogen oxides sources, such as vehicle emissions from the M7 which is located to the east of the Bringelly monitoring station.

Table 12–10 – Maximum one hour and annual average nitrogen dioxide concentrations at Bringelly

Year	One hour maximum ($\mu g/m^3$)	Annual average ($\mu g/m^3$)	Exceedances of one hour standard (days per year)
EPA criterion	*246*	*62*	*n/a*
2005	92	13	No exceedances
2006	82	13	No exceedances
2007	90	12	No exceedances
2008	68	10	No exceedances
2009	70	9	No exceedances
2010	76	12	No exceedances
2011	60	10	No exceedances
2012	78	11	No exceedances
2013	76	10	No exceedances
2014	51	10	No exceedances

12.4.2.2. Particulate matter

Particulate matter is solid or liquid particles that are suspended in air that may reduce visual amenity or adversely impact health. It is measured as PM_{10} (particles less than 10 micrometres in diameter) and $PM_{2.5}$ (particles less than 2.5 micrometres in diameter). Examples of particles in the air include dust, smoke, plant spores, bacteria and salt. Particulate matter may be a primary pollutant, such as smoke particles, or a secondary pollutant formed from the chemical reaction of gaseous pollutants. Human activities resulting in particulate matter in the air include mining; burning of fossil fuels; transportation; agricultural and hazard reduction burning; the use of incinerators; and the use of solid fuel for cooking and heating (OEH 2014a).

Data for PM_{10} was obtained from the monitoring station at Bringelly. The data are presented in Table 12–11. The maximum concentrations of 24 hour average PM_{10} have been fairly constant over the last 10 years, generally ranging between 40 micrograms per cubic metre and 97 micrograms per cubic metre (the exception is 2009, where elevated 24 hour average PM_{10} concentrations were measured on a number of occasions as a result of a series of dust storms). There have been several exceedances of the 24 hour average criterion of 50 micrograms per cubic metre. Aside from 2009, the annual average concentrations appear to be generally decreasing with no exceedances of the criterion of 30 micrograms per cubic metre (the annual average concentrations ranged between 25 micrograms per cubic metre and 15 micrograms per cubic metre).

Further analysis of the data suggests that the greatest concentrations originate from the north-west, and to a lesser extent, from the east, west and south-east. The dominant north-west source is likely to be a function of natural events such as bushfires and dust storms that tend to be associated with the hot dry prevailing winds originating from this direction. To the east and south-west are the densely populated precincts of Liverpool and Campbelltown which encompass a multitude of potential particulate matter sources.

Table 12–11 –Maximum 24 hour and annual average PM_{10} concentrations at Bringelly

Year	24 hour maximum (µg/m³)	Annual average (µg/m³)	No. of exceedances of 24 hour standard
EPA criterion	*50*	*30*	*n/a*
2005	55	19	2
2006	72	20	3
2007	51	18	1
2008	63	16	1
2009	1,684	25	6
2010	41	15	No exceedances
2011	86	16	2
2012	40	16	No exceedances
2013	97	17	3
2014	43	17	No exceedances

Data for $PM_{2.5}$ was obtained from the monitoring station at Liverpool and Richmond. The data are presented in Table 12–12. The data indicates that $PM_{2.5}$ concentrations are higher at Liverpool than Richmond, with combustion emissions from urbanisation anticipated to be a major source of the measured differences. There are a number of days across the monitoring period where the 24 hour average measurements are above the NEPM goal of 25 micrograms per cubic metre. As with the PM_{10} monitoring data, the dust storms from 2009 have also been captured in the data set, recording up to 268 micrograms per cubic metre at Liverpool.

Table 12–12 – Maximum 24 hour and annual average $PM_{2.5}$ concentrations at Liverpool and Richmond

Year	24 hour max (µg/m³)		Annual average (µg/m³)		No. of exceedances of 24 hour standard	
	Liverpool	Richmond	Liverpool	Richmond	Liverpool	Richmond
NEPM advisory goal	*25*		*8*		*n/a*	
2005	31	23	8	6	2	0
2006	48	78	9	6	3	1
2007	23	21 [(a)]	7	6 [(a)]	0	0
2008	32	18	6	7	1	0
2009	268	149	8	6	5	2
2010	22	21	6	4	0	0
2011	38	43	6	5	2	2
2012	25	117	9	5	0	2
2013	74	83	9	8	2	14
2014	24	25	9	7	0	0

Notes: (a) Less than 75% data retrieval for year

12.4.2.3. Carbon monoxide (CO)

Carbon monoxide is an odourless, colourless gas produced by incomplete oxidation (burning). As well as wildfires, carbon monoxide is produced naturally by oxidation of the oceans and organic decomposition. In cities, the motor vehicle is by far the largest human source, although any combustion process may produce it (OEH 2014a).

Data for carbon monoxide was obtained from the monitoring station at Macarthur and Campbelltown West, though only a short data set is available from the monitoring station at Campbelltown West. The data is presented in Table 12–13. The one hour maximum concentrations of carbon monoxide show a reasonably stable trend through the years with a slight decrease after 2006. The eight hour maximum concentrations also show a slight decrease that occurred after 2007. There have been no exceedances of one hour or eight hour carbon monoxide criteria at Macarthur.

Table 12–13 – Minute, one hour and eight hour average carbon monoxide concentrations at Macarthur and Campbelltown West

Year	15 minute maximum (mg/m^3)		One hour maximum (mg/m^3)		Eight hour maximum (mg/m^3)	
	Macarthur	Campbelltown West	Macarthur	Campbelltown West	Macarthur	Campbelltown West
EPA criterion	*100*	*100*	*30*	*30*	*10*	*10*
2005	-	-	2.3 [(a)]	-	1.2 [(a)]	-
2006	-	-	2.5	-	2.3	-
2007	-	-	2.4	-	2.2	-
2008	-	-	1.5	-	1.1	-
2009	-	-	1.6	-	0.9	-
2010	-	-	2.0	-	1.1	-
2011	-	-	2.1	-	1.3	-
2012	-	-	1.1 [(a)]	1.1 [(a)]	0.8 [(a)]	0.8 [(a)]
2013	-	-	-	10.5	-	8.6
2014	-	2.1	-	1.5	-	1.2

Notes: (a) Less than 75 per cent data retrieval for year

12.4.2.4. Sulfur dioxide (SO_2)

Sulfur dioxide in the atmosphere arises from both natural and human activities. Natural processes which release sulfur compounds include decomposition and combustion of organic matter; spray from the sea; and volcanic eruptions. The main human activities producing sulfur dioxide are the smelting of mineral ores containing sulfur and the combustion of fossil fuels (OEH 2014a).

Data for sulfur dioxide were obtained from the monitoring station at Bringelly and Campbelltown West, though only a short data set is available from the monitoring station at Campbelltown West. The data is presented in Table 12–14. There have been fluctuating one hour maximum concentrations of sulfur dioxide over the past 10 years. In 2007 and 2008, one hour maximum concentrations of sulfur dioxide rose by 50 per cent from the 2006 level. Concentrations decreased during 2010 and 2011 and subsequently rose again in 2011. The 24 hour concentrations follow a similar trend to the one hour maximums with a significant drop in 2010 and subsequent increase in 2011. Annual average sulfur dioxide concentrations appear to have decreased from 2010 to 2011 but then increased again in 2012 and 2013. There have been no exceedances of the criteria for any of the required averaging periods.

Further analysis of the data suggests that the greatest concentrations of sulfur dioxide originate from the east, and are most likely associated with vehicle emissions and industry located in this direction.

Table 12–14 – Maximum 15-minute, one hour, eight hour and annual average sulfur dioxide concentrations at Bringelly and Campbelltown West

Year	10 minute maximum ($\mu g/m^3$)	One hour maximum ($\mu g/m^3$)		24 hour maximum ($\mu g/m^3$)		Annual average ($\mu g/m^3$)	
	Campbelltown West	Bringelly	Campbelltown West	Bringelly	Campbelltown West	Bringelly	Campbelltown West
EPA criterion	*712*	*570*	*570*	*228*	*228*	*60*	*60*
2004	-	43	-	6.8	-	0.6	-
2005	-	26	-	7.5	-	0.7	-
2006	-	26	-	6.3	-	1.0	-
2007	-	49	-	8.2	-	1.2	-
2008	-	54	-	7.5	-	0.3	-
2009	-	34	-	9.2	-	-0.8	-
2010	-	23	-	5.7	-	0.7	-
2011	-	31	-	5.2	-	0.3	-
2012	-	43	23 (a)	5.1	5.7 (a)	0.5	1.4 (a)
2013	-	31	26	7.0	6.8	0.7	1.3
2014 (b)	80(c)	26	34	8.5	9.9	0.7	1.2

Notes: (a) Less than 75 per cent data retrieval for year.

(b) Calibration issue with instrument between January and May 2014. The data have been included for completeness.

(c) High resolution data was available for Campbelltown West only.

12.4.2.5. Air toxics

Air toxics include benzene, dioxins, lead and other metals. Major sources of these toxics include motor vehicle exhaust and some commercial and industrial processes. Knowledge of the health effects of air toxics is far from complete, but studies are showing that very small amounts of air toxics may present a risk to human health and the environment (OEH 2014a).

Continuous monitoring of air toxics is not measured as part of the OEH air quality monitoring network or under any other program at present. However, between 1996 and 2001, the NSW Environment Protection Authority (EPA) (then Department of Environment and Conservation (DEC)) conducted the Air Toxics Monitoring Project which investigated concentrations of the NEPM air toxics (benzene, toluene, xylene and polyaromatic hydrocarbons such as benzo[a]pyrene) for 24 hour periods at numerous locations across Sydney and NSW (DEC 2004a, DEC 2004b). In addition, the Ambient Air Quality Monitoring and Fuel Quality Testing Project collected 24 hour concentrations of formaldehyde at Rozelle and Turella for a one year period from October 2008 to October 2009. The results of this monitoring have been published as part of the EPA's *Current Air Quality in New South Wales* technical paper (DECCW 2010).

The Air Toxics Monitoring Project found ambient concentrations of most tested substances were well below international ambient air quality goals at the time. The Ambient Air Quality Monitoring and Fuel Quality Testing Project also found low concentrations of all chemical pollutants, with many observations below the detection limit of the method.

12.4.2.6. Ozone (O_3)

Near the ground, ozone is a colourless, gaseous secondary pollutant. It is formed by chemical reactions between reactive organic gases and oxides of nitrogen in the presence of sunlight. Ozone is one of the irritant secondary pollutants in photochemical smog and is often used as a measure of it (OEH 2014a).

Data for ozone in the vicinity of the airport site was obtained from the monitoring station at Bringelly. The data are presented in Table 12–15 and further analysis of regional ozone is presented in Section 12.4.5. There have been multiple exceedances of both the one hour maximum criteria of 214 micrograms per cubic metre and the four hour maximum criteria of 171 micrograms per cubic metre over the past 10 years. The one hour maximum concentrations ranged between 188 micrograms per cubic metre and 268 micrograms per cubic metre and the four hour maximum concentrations ranged between 149 micrograms per cubic metre and 235 micrograms per cubic metre.

Ozone concentrations vary based on the time of day and also time of year, with peak ozone concentrations occurring in the mid-afternoon and also during the summer months. The seasonal variability is associated with the availability of sunlight, with the increase in sunlight in the summer months driving the photochemical activity that generates ozone.

Table 12–15 – Maximum one hour and four hour average ozone concentrations at Bringelly

Year	One hour maximum ($\mu g/m^3$)	Four hour maximum ($\mu g/m^3$)	Exceedances of one hour standard (days per year)	Exceedances of four hour standard (days per year)
EPA criterion (NEPM goal)	*214*	*171*	*(1)*	*(1)*
2005	261	235	8	5
2006	240	218	6	3
2007	255	219	10	5
2008	199	155	0	0
2009	257	232	7	3
2010	223	179	2	1
2011	268	226	5	2
2012	188	149	0	0
2013	231	207	3	1
2014	265	237	4	3

12.4.3. Odour

The airport site is mostly isolated from other industry that has the potential to be odorous. The exception is the poultry industry with a number of broiler and egg-laying farms in the vicinity, particularly to the east of the airport site. Multiple sources of odour are typically only treated cumulatively when similar in character and, as such, consideration of background odour has not been included as part of this assessment.

12.4.4. Adopted local background concentrations

The background concentrations adopted for the local air quality assessment are presented in Table 12–16.

Table 12–16 – Summary of assumed background concentrations

Pollutant	Averaging period	Year	Value used for background		Location
Carbon monoxide (CO)	15 minutes	2014	2.1	mg/m³	Campbelltown West
	One hour	2014	1.5	mg/m³	Campbelltown West
	Eight hours	2014	1.2	mg/m³	Campbelltown West
Nitrogen dioxide (NO_2)	One hour	2014	Varying	-	Bringelly
	One year	2014	10	µg/m³	Bringelly
Particulate matter < 10 µm (PM_{10})	24 hours	2014	Varying	-	Bringelly
	One year	2014	17	µg/m³	Bringelly
Particulate matter < 2.5 µm ($PM_{2.5}$)	24 hours	2014	Varying		Bringelly [(b)]
	One year	2014	7	µg/m³	Bringelly [(b)]
Deposited dust	One year	n/a	2	g/m²/month	n/a
Sulfur dioxide (SO_2)	10 minutes	2014	80	µg/m³	Campbelltown West
	One hour	2014	34	µg/m³	Campbelltown West
	24 hours	2014	9.9	µg/m³	Campbelltown West
	One year	2014	1.2	µg/m³	Campbelltown West
Benzene	One year	2008-09	1.0	µg/m³	Rozelle
Toluene[(a)]	24 hours	2008-09	15.3	µg/m³	Rozelle
	One year	2008-09	3.7	µg/m³	Rozelle
Xylenes [(a)]	24 hours	2008-09	16.6	µg/m³	Rozelle
	One year	2008-09	2.4	µg/m³	Rozelle
Formaldehyde	24 hours	2008-09	4.3	µg/m³	Rozelle
B[a]p	One year	2008-09	0.2	ng/m³	Blacktown

Notes: (a) 24 hour average value has been pro-rated based on the 1996-2001 data from Table 4-10 in Appendix F1.
(b) Based on 2014 $PM_{2.5}$ / PM_{10} ratio of 0.31 at Liverpool and Richmond.

12.4.5. Regional air quality (ozone)

Regional air quality considers the formation of secondary pollutants (such as ozone (O_3)) through photochemical reactions from primary emissions of precursor gases including nitrogen oxides, volatile organic compounds and carbon monoxide.

Regional ozone is affected both by local formation and the transport of ozone and its precursor gases from upwind areas. As a secondary pollutant, ozone concentrations are generally more regionally homogeneous than concentrations of primary pollutants (USEPA 2013).

Meteorology and seasonality also play an important role in ozone formation. Peak ozone concentrations in Sydney tend to occur in the afternoon and during summer months due to the availability of sunlight and higher temperatures.

Elevated ground-level ozone concentrations are also associated with slow moving high pressure systems during the warmer seasons, associated with generally cloudless skies, light winds and the development of stable conditions near the surface that reduce the vertical mixing of the precursor gases. The combination of reduced mixing and light winds minimises the dispersal of pollutants, allowing their concentrations to build up (USEPA 2014).

There are a range of precursor gas emission sources which contribute to regional ozone generation. Sources include industrial, commercial, off-road mobile and on-road mobile emissions together with biogenic sources such as emission of volatile organic compounds from areas of existing vegetation such as the Blue Mountains.

The relationship between ozone formation and emissions of precursor gases is not linear, for example nitrogen oxides emissions can lead to both formation and destruction of ozone, depending on the local quantities of nitrogen oxides, volatile organic compounds and sunlight (USEPA 2014).

The NSW EPA tiered procedure for ozone assessment requires classification of areas of Sydney as “attainment” or “non-attainment”, based on meeting or exceeding an “acceptance limit” expressed as 82 per cent of the NEPM goal (NEPC 2007).

Ozone is currently measured at 15 Sydney monitoring sites, operated by the OEH. The maximum one hour and four hour average ozone concentrations for the most recent five years of monitoring data at these sites are presented in Table 12–17 and Table 12–18. The average across the five years is taken and the maximum five year average is compared against the acceptance limits of 82 parts per billion (one hour) and 65.2 parts per billion (four hour). It is clear from the analysis that all areas of the Sydney region are currently classified as non-attainment.

Table 12–17 – Classification of ozone nonattainment based on one hour average ozone concentrations

Station	Maximum ozone concentration (parts per billion)					Average
	2010	2011	2012	2013	2014	
Randwick	84	73	66	75	66	73
Rozelle	73	93	69	73	67	75
Lindfield	82	86	73	81	85	81
Chullora	83	114	80	105	79	92
Earlwood	85	99	82	101	69	87
Maximum five year average – Sydney central-east (nonattainment)						92
Richmond	89	116	85	95	90	95
St Marys	95	136	85	110	100	105
Vineyard	90	94	80	105	112	96
Prospect	104	126	80	111	103	105
Maximum five year average – Sydney north-west (nonattainment)						105
Liverpool	91	103	79	117	103	99
Bringelly	104	125	88	108	124	110
Bargo	110	126	91	95	105	105
Macarthur	119	131				
Oakdale	99	126	89	95	110	104
Campbelltown west				94	124	
Camden				110	123	
Maximum five year average – Sydney south-west (nonattainment)						110

Table 12–18 – Classification of ozone nonattainment based on four hour average ozone concentrations

Station	Maximum ozone concentration (parts per billion)					Average
	2010	2011	2012	2013	2014	
Randwick	77	69	63	67	61	67
Rozelle	67	80	54	63	60	65
Lindfield	79	84	71	74	75	77
Chullora	72	96	68	94	73	81
Earlwood	74	88	68	82	65	75
Maximum – Sydney central-east (nonattainment)						**81**
Richmond	82	88	70	76	73	78
St Marys	83	121	72	101	85	92
Vineyard	79	75	70	90	75	78
Prospect	97	114	73	104	97	97
Maximum – Sydney north-west (nonattainment)						**97**
Liverpool	81	95	71	110	87	89
Bringelly	89	118	72	102	113	99
Bargo	86	98	83	82	93	88
Macarthur	103	122				
Oakdale	88	98	81	81	88	87
Campbelltown west				82	111	
Camden				90	110	
Maximum – Sydney south-west (nonattainment)						**99**

All areas of the Sydney region are currently classified as non-attainment, meaning they are not meeting an ‘acceptance limit’ expressed as 82 per cent of the NEPM standards (ENVIRON 2011). Exceedances of the ambient ozone standards in Sydney are generally limited to the summer months (December to February). In some years, exceedances occur in the months of October, November and March, however outside the core summer periods, exceedances often coincide with bushfires events (for example November 2009 and October 2013).

A review of the most recent 10 years of monitoring data reveals exceedances of the one hour and four hour ozone standard in eight of the previous 10 years at Bringelly. Analysis of long term trends indicates that there is some evidence of decreasing monthly maximum ozone concentrations at Bringelly, near the airport site, as well as in other areas of Sydney.

12.5. Assessment of impacts during construction

12.5.1. Overview

Construction of the proposed Stage 1 development would result in dust emissions being generated during both the bulk earthworks and the aviation infrastructure works. Dust emissions during the bulk earthworks would result from:

- dozers;
- scrapers;
- the loading and unloading of material;
- hauling on paved and unpaved roads;
- wind erosion; and
- grading.

Dust emissions during the aviation infrastructure works would be generated by:

- the working crew (similar to the equipment used during bulk earthworks);
- the asphalt plant; and
- the concrete batching plant.

In addition to the above, there would also be diesel particulate matter emissions (comprising $PM_{2.5}$ only) from the on-site equipment as well as odour emissions from the asphalt plant.

This section describes the results of the air dispersion modelling for the construction of the Stage 1 development. The concentrations of PM_{10}, $PM_{2.5}$, dust deposition and odour were determined for 18 residential receptors and 75 community receptors in the vicinity of the airport site. Only the residential receptors are discussed below as they were considered representative of the community receptors. The tabulated results for all receptors, including the community receptors, are provided in Appendix F1.

Contour plots for each of the pollutants and relevant averaging periods are also provided in Appendix F1.

12.5.2. Bulk earthworks

Table 12–19 presents a summary of the maximum 24 hour average and annual average particulate matter and dust deposition concentrations due to the on-site construction activities. Table 12–20 summarises the cumulative results including other sources/background predictions. The predicted dust impacts at the community receptors are provided in Appendix F1.
The results show that the predicted dust impacts during the bulk earthworks would be below the air quality assessment criteria for each of the reported air quality parameters both incrementally as a result of the project and cumulatively when assessed with background concentrations and modelled inputs of other projects.

The contour plots show the spatial extent of particulate matter and the predicted concentrations across the local area (refer to Appendix F1). While the predicted concentrations remain low at all off-site residential receptors, the nature of the plume spread for the 24 hour and annual averaging periods is highest to the north-east and south-west of the airport site, consistent with the prevailing winds measured at Badgerys Creek (refer to Section 12.4.1).

Table 12–19 – Predicted incremental particulate matter and dust deposition results during bulk earthworks

Receptor	Receptor description	PM_{10} (µg/m^3)		$PM_{2.5}$ (µg/m^3)		Dust deposition (g/m^2/month)
		24 hour	Annual	24 hour	Annual	Annual
Assessment criteria		*n/a*	*n/a*	*n/a*	*n/a*	*2*
R1	Bringelly	1.0	0.1	0.4	<0.1	1 x10^{-5}
R2	Luddenham	2.1	0.3	0.5	0.1	7 x10^{-5}
R3	Greendale, Greendale Road	2.7	0.1	1.4	0.1	2 x10^{-5}
R4	Kemps Creek	1.3	0.1	0.8	<0.1	2 x10^{-5}
R6	Mulgoa	0.4	0.1	0.2	<0.1	1 x10^{-5}
R7	Wallacia	0.6	0.1	0.3	<0.1	1 x10^{-5}
R8	Twin Creeks, corner of Twin Creeks Drive and Humewood Place	2.0	0.3	0.7	0.1	5 x10^{-5}
R14	Badgerys Creek, Lawson Road	4.8	0.6	2.0	0.2	1 x10^{-4}
R15	Greendale, Mersey Road	3.3	0.4	1.2	0.1	5 x10^{-5}
R17	Luddenham Road	2.2	0.3	0.6	0.1	6 x10^{-5}
R18	Corner of Adams and Elizabeth Drive	6.5	1.0	1.8	0.2	2 x10^{-4}
R19	Corner of Adams and Anton Road	7.2	0.9	2.1	0.2	2 x10^{-4}
R21	Corner of Willowdene Avenue and Vicar Park Lane	2.9	0.5	0.7	0.1	1 x10^{-4}
R22	Rossmore, Victor Avenue	1.4	0.1	0.7	<0.1	2 x10^{-5}
R23	Wallacia, Greendale Road	0.8	0.1	0.3	<0.1	2 x10^{-5}
R27	Greendale, Dwyer Road	1.2	0.2	0.4	<0.1	3 x10^{-5}
R30	Rossmore residential	0.7	0.1	0.3	<0.1	7 x10^{-6}
R31	Mount Vernon residential	1.8	0.1	1.0	<0.1	2 x10^{-5}

Table 12–20 – Predicted cumulative particulate matter and dust deposition results during bulk earthworks

Receptor	Receptor description	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)		Dust deposition (g/m²/month)
		24 hour	Annual	24 hour	Annual	Annual
Assessment criteria		*50*	*30*	*25*	*8*	*4*
R1	Bringelly	43.0	17.1	13.5	7.0	2.0
R2	Luddenham	42.7	17.3	13.3	7.1	2.0
R3	Greendale, Greendale Road	42.7	17.1	13.3	7.1	2.0
R4	Kemps Creek	42.6	17.1	13.3	7.0	2.0
R6	Mulgoa	42.6	17.1	13.3	7.0	2.0
R7	Wallacia	42.6	17.1	13.3	7.0	2.0
R8	Twin Creeks, corner of Twin Creeks Drive and Humewood Place	43.4	17.3	13.5	7.1	2.0
R14	Badgerys Creek, Lawson Road	43.0	17.6	13.4	7.2	2.0
R15	Greendale, Mersey Rd	44.6	17.4	14.0	7.1	2.0
R17	Luddenham Road	44.2	17.3	13.7	7.1	2.0
R18	Corner Adams and Elizabeth Drive	44.2	18.0	13.7	7.2	2.0
R19	Corner of Adams and Anton Road	43.9	17.9	13.6	7.2	2.0
R21	Corner of Willowdene Avenue and Vicar Park Lane	42.9	17.5	13.4	7.1	2.0
R22	Rossmore, Victor Avenue	42.7	17.1	13.3	7.0	2.0
R23	Wallacia, Greendale Road	42.6	17.1	13.3	7.0	2.0
R27	Greendale, Dwyer Road	43.0	17.2	13.4	7.0	2.0
R30	Rossmore residential	42.7	17.1	13.4	7.0	2.0
R31	Mt Vernon residential	42.6	17.1	13.3	7.0	2.0

12.5.3. Aviation infrastructure works

Table 12–21 presents a summary of the maximum 24 hour average and annual average particulate matter and dust deposition concentrations at each of the 20 residential receptors, due to the aviation infrastructure works. Table 12–22 summarises the results cumulatively with other sources/background predictions. The predicted dust impacts at the community receptors are provided in Appendix F1.

The results show that the predicted dust impacts during the aviation infrastructure works are forecast to be below the air quality assessment criteria for each of the reported air quality parameters both incrementally as a result of the project and cumulatively when assessed with the background concentrations and modelled inputs of other projects.

The contour plots show a similar trend to those described for the bulk earthworks, with maximum off-site concentrations predicted to the north-east and south-west of the airport site (refer to Appendix F1).

Table 12–21 – Predicted incremental results during aviation infrastructure works

Receptor	Receptor description	PM_{10} (µg/m^3)		$PM_{2.5}$ (µg/m^3)		Dust deposition (g/m^2/month)
		24 hour	Annual	24 hour	Annual	Annual
Assessment criteria		*n/a*	*n/a*	*n/a*	*n/a*	*2*
R1	Bringelly	2.7	0.2	2.3	0.2	7 x10^{-6}
R2	Luddenham	2.7	0.4	2.4	0.3	4 x10^{-5}
R3	Greendale, Greendale Road	8.0	0.3	5.4	0.2	2 x10^{-5}
R4	Kemps Creek	11.0	0.2	2.8	0.2	1 x10^{-5}
R6	Mulgoa	1.3	0.1	0.7	0.1	7 x10^{-6}
R7	Wallacia	1.7	0.1	0.9	0.1	1 x10^{-5}
R8	Twin Creeks, corner of Twin Creek Drive and Humewood Place	4.0	0.4	3.3	0.3	2 x10^{-5}
R14	Badgerys Creek, Lawson Road	25.4	1.2	6.6	0.7	5 x10^{-5}
R15	Greendale, Mersey Road	7.3	0.6	5.9	0.5	3 x10^{-5}
R17	Luddenham Road	5.3	0.4	2.4	0.3	3 x10^{-5}
R18	Corner of Adams and Elizabeth Drive	11.0	1.1	7.8	1.0	1 x10^{-4}
R19	Corner of Adams and Anton Road	8.7	1.1	7.0	1.1	1 x10^{-4}
R21	Corner of Willowdene Avenue and Vicar Park Lane	4.6	0.7	3.9	0.7	1 x10^{-4}
R22	Rossmore, Victor Avenue	6.6	0.3	2.2	0.2	1 x10^{-5}
R23	Wallacia, Greendale Road	2.1	0.2	1.2	0.2	1 x10^{-5}
R27	Greendale, Dwyer Road	2.6	0.2	2.9	0.2	2 x10^{-5}
R30	Rossmore residential	2.3	0.1	1.5	0.1	4 x10^{-6}
R31	Mt Vernon residential	5.9	0.2	2.9	0.2	1 x10^{-5}

Table 12–22 – Predicted cumulative results during aviation infrastructure works

Receptor	Receptor description	PM_{10} (µg/m^3)		$PM_{2.5}$ (µg/m^3)		Dust deposition (g/m^2/month)
		24 hour	Annual	24 hour	Annual	Annual
Assessment criteria		*50*	*30*	*25*	*8*	*4*
R1	Bringelly	45	17	14	7	2
R2	Luddenham	43	17	13	7	2
R3	Greendale, Greendale Road	43	17	13	7	2
R4	Kemps Creek	43	17	13	7	2
R6	Mulgoa	43	17	13	7	2
R7	Wallacia	43	17	13	7	2
R8	Twin Creeks, corner of Twin Creek Drive and Humewood Place	47	17	14	7	2
R14	Badgerys Creek, Lawson Road,	50	18	14	8	2
R15	Greendale, Mersey Road	46	18	17	8	2
R17	Luddenham Road	44	17	15	7	2
R18	Corner of Adams and Elizabeth Drive	45	18	15	8	2
R19	Corner of Adams and Anton Road	44	18	15	8	2
R21	Corner of Willowdene Avenue and Vicar Park Lane	43	18	14	8	2
R22	Rossmore, Victor Avenue	43	17	13	7	2
R23	Wallacia, Greendale Road	43	17	13	7	2
R27	Greendale, Dwyer Road	43	17	14	7	2
R30	Rossmore residential	43	17	14	7	2
R31	Mt Vernon residential	43	17	13	7	2

12.5.4. Asphalt batching plant

The 99th percentile one hour odour predictions for emissions from the asphalt batching plant are presented in Table 12–23. Odour from the asphalt plant would be below the relevant criteria at all sensitive residential receptors. The contour plot shows that the highest odour concentrations would be largely limited to within the airport site (refer to Appendix F1). The two OU contour (the adopted impact assessment criterion) spreads outside of the airport site a relatively short distance to the north. This area is currently unoccupied and, therefore, there would be no adverse odour impacts to sensitive receptors from the asphalt batching plant.

Table 12–23 – Predicted 99th percentile odour concentration from asphalt batching plant

Receptor	Receptor description	One hour 99th percentile odour (OU)
Assessment criteria		*2*
R1	Bringelly	<0.1
R2	Luddenham	<0.1
R3	Greendale, Greendale Road	<0.1
R4	Kemps Creek	0.1
R6	Mulgoa	<0.1
R7	Wallacia	<0.1
R8	Twin Creeks, corner of Twin Creek Drive and Humewood Place	0.3
R14	Badgerys Creek, Lawson Road	1.7
R15	Greendale, Mersey Road	0.1
R17	Luddenham Road	0.4
R18	Corner of Adams and Elizabeth Drive	0.5
R19	Corner of Adams and Anton Road	0.1
R21	Corner of Willowdene Avenue and Vicar Park Lane	<0.1
R22	Rossmore, Victor Avenue	0.2
R23	Wallacia, Greendale Road	<0.1
R27	Greendale, Dwyer Road	<0.1
R30	Rossmore residential	<0.1
R31	Mt Vernon residential	0.2

12.6. Assessment of impacts during operation

This section describes the results of the emission calculations and air dispersion modelling for the operation of the proposed Stage 1 development.

12.6.1. Emissions

The emissions of criteria pollutants from the Stage 1 development are presented in Figure 12–6. Incremental emissions are generated by sources associated with the airport operations alone including emissions from aircraft, auxiliary power units, ground support equipment, parking facilities, terminal traffic, stationary sources and training fires. Cumulative emissions include the respective airport sources in addition to emissions from vehicles on external roadways, as characterised within the surface transport and access technical report (refer to Chapter 15 and Appendix J in Volume 4).

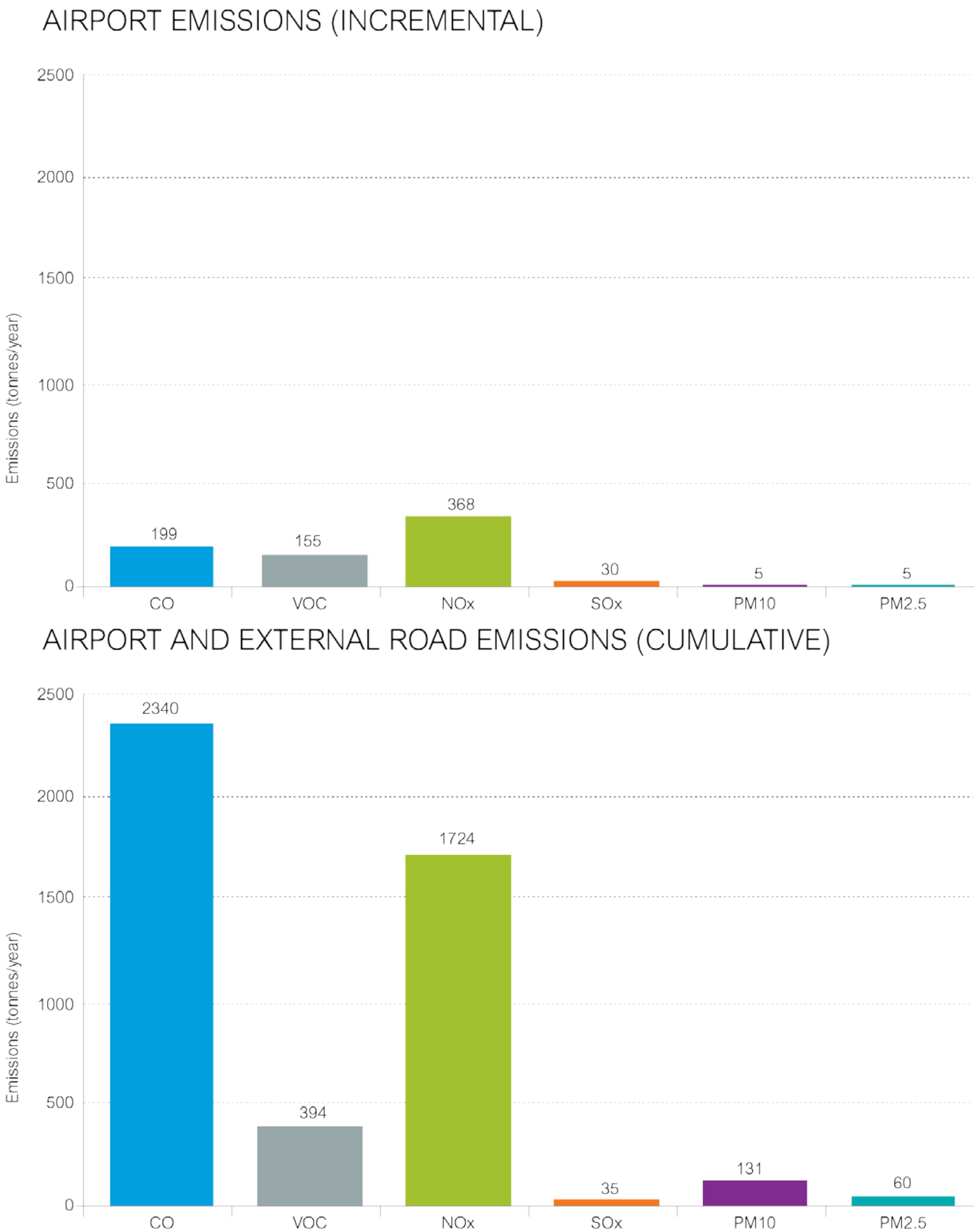


Figure 12–6 – Total estimated emissions for criteria pollutants

The emission inventory for the Stage 1 development is presented by source type in Table 12–24. The percentage contribution of each source is shown alongside the emission value. Emission totals have been provided with and without the cumulative contributions from external roadways. The external roadways are estimated to be the largest source of emissions during the Stage 1 development, as shown on Figure 12–7. This is attributed to the extent of the road network, the number of vehicles using the road network and the associated emissions that have been included in the modelling (refer to Appendix F1). Review of the incremental emissions (that is, those emissions from within the airport site only) shows the emissions from aircraft engines are the most significant source.

Emissions from auxiliary power units, ground support equipment, parking facilities and terminal traffic were also significant emission sources. In the case of carbon monoxide, the largest single source was ground support equipment (24 per cent), while for nitrogen oxides, auxiliary power units were the next largest source (five per cent). Stationary sources, in particular fuel tanks, are a significant contributor to volatile organic compounds emissions. Evaporative losses from jet fuel at the on-site fuel farm is calculated to account for over 99 per cent of losses compared with those from diesel and petroleum, reflecting this fuel source’s volatility.

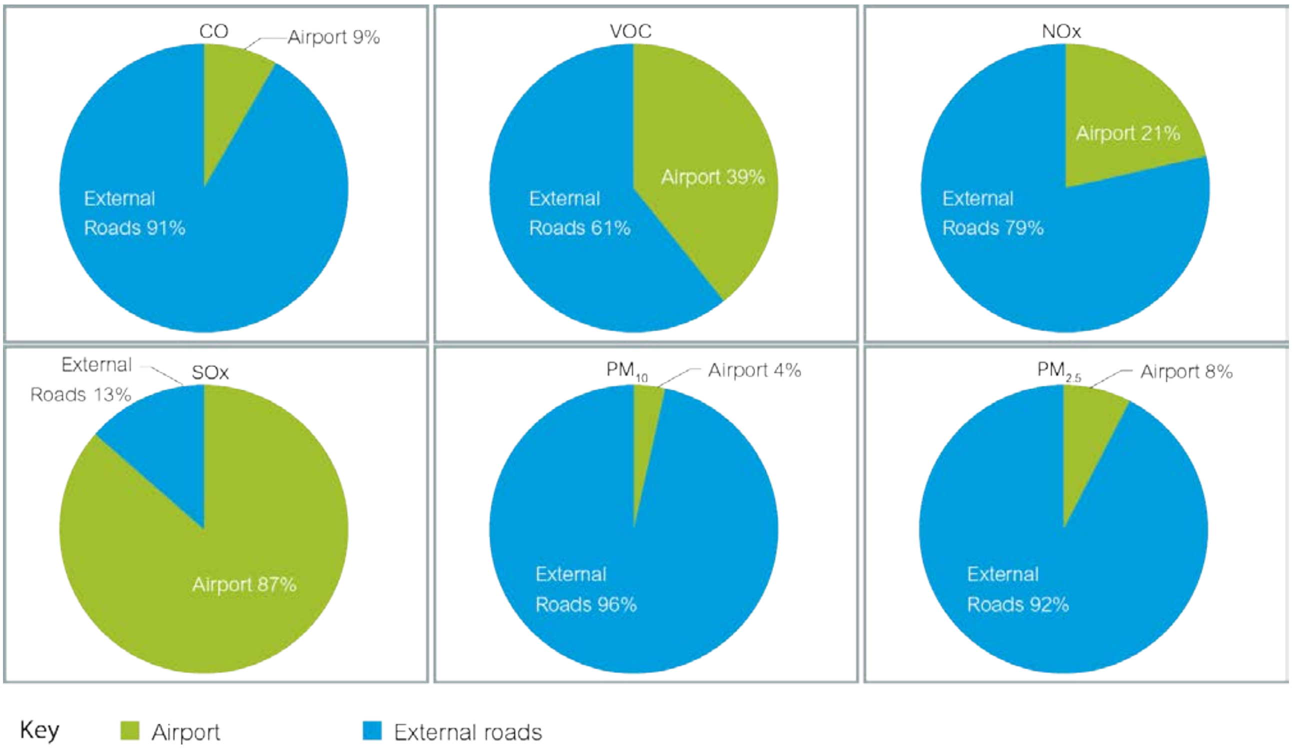
When the cumulative contributions from the external roadways in the study area are considered, they account for an estimated 97 per cent of PM_{10}, 93 per cent of $PM_{2.5}$ and 79 per cent of nitrogen oxides emissions with the remaining emissions comprising those from the proposed airport.

Table 12–24 – Airport emission inventory for criteria pollutants

Category	Emissions (tonnes per year)											
	CO		VOC		NOx		SO_2		PM_{10}		$PM_{2.5}$	
Aircraft engines	126.5	64%	26.5	17%	335.9	91%	23.3	77%	1.8	39%	1.8	39%
Ground support equipment	48.6	24%	2.0	1%	4.5	1%	0.5	2%	0.3	6%	0.3	6%
Auxiliary power units	4.7	2%	0.5	0%	17.3	5%	1.6	5%	1.1	23%	1.1	23%
Parking facilities	9.4	5%	1.0	1%	0.4	0%	0.0	0%	0.0	1%	0.0	0%
Terminal traffic	4.9	2%	0.5	0%	1.2	0%	0.0	0%	0.2	4%	0.1	2%
Stationary sources	2.4	1%	62.0	40%	4.4	1%	4.7	16%	0.3	7%	0.3	7%
Boilers	1.9	1%	0.1	0%	2.4	1%	0.0	0%	0.2	4%	0.2	4%
Engine tests	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Fuel tanks	-	-	54.5	35%	-	-	-	-	-	-	-	-
Generators	0.4	0%	0.1	0%	2.0	1%	0.1	0%	0.1	3%	0.1	3%
Paint and Solvent	-	-	7.2	5%	-	-	-	-	-	-	-	-
Training Fires	0.0	0%	0.1	0%	0.0	0%	0.0	0%	0.7	15%	0.7	15%
Total (airport)	199	100%	155	100%	368	100%	30	100%	5	100%	5	100%
External roadways	2131	91%	238	72%	1353	79%	4.7	13%	126	96%	54.9	92%
Airport	199	9%	155	28%	368	21%	30	87%	5	4%	5	8%
Total including external roadways	2,331	100%	331	100%	1,717	100%	30	100%	130	100%	59	100%

Notes: (a) Includes contribution from airport traffic on roadways outside the airport site.

CO = Carbon monoxide, VOC = Volatile organic compounds, NO_x = Nitrogen oxides, SO_2 = Sulfur dioxide, PM_{10} and $PM_{2.5}$ = Particulate matter



Notes: CO = Carbon monoxide, VOC = Volatile organic compounds, NO_x = Nitrogen oxides, SO_x = Sulfur oxides, PM_{10} and $PM_{2.5}$ = Particulate matter

Figure 12–7 – Estimated airport and external roads emissions as a percentage of total modelled for criteria pollutants

Forecast emissions from the proposed airport have also been considered in the context of the Sydney airshed. Projected emissions data for the Sydney airshed were prepared by the NSW EPA (2012) for the years 2016, 2021, 2026, 2031 and 2036. The projected emissions for 2031 have been compared with the total emissions from the proposed airport and are shown in Table 12–25. As the Sydney airshed forecast emissions are not available for 2030, it has been assumed that they will be the same as 2031. The emissions from the airport represent up to 0.7 per cent of the total anthropogenic emissions of nitrogen oxides within the Sydney airshed.

Table 12–25 – Forecast Sydney airshed emissions compared with forecast airport emissions

Pollutant	Forecast Sydney airshed emissions in 2031 (tonnes/year)	Forecast airport emissions in 2030 (tonnes/year)	Forecast airport emissions compared with Sydney airshed in 2030 (%)
CO	166,802	199	0.1%
VOC	98,369	155	0.2%
NOx	51,452	368	0.7%
SO_2	18,522	30	0.2%
PM_{10}	10,446	5	<0.1%
$PM_{2.5}$	12,834	5	<0.1%

Source: Forecast 2031 Sydney Airshed emissions from EPA 2012a.
Note: Forecast airport emissions do not include contributions from external roadways. CO = Carbon monoxide, VOC = Volatile organic compounds, NOx = Nitrogen oxides, SO_2 = Sulfur dioxide, PM_{10} and PM2.5 = Particulate matter

12.6.2. Dispersion modelling results

The concentrations of the criteria pollutants (carbon monoxide, nitrogen dioxide, sulfur dioxide, PM_{10}, $PM_{2.5}$ and volatile organic compounds) were determined for residential, on-site and community receptors in the local area. As the residential receptors are generally located in the similar areas as the community receptors, only the residential and on-site receptors are discussed below. The results for all receptors, including the community receptors, are provided in Appendix F1.

Contour plots that show the spatial distribution of each pollutant are provided in Appendix F1.

The incremental emissions comprise emissions from aircraft, auxiliary power units, ground support equipment, parking facilities, terminal traffic, stationary sources and training fires. Cumulative predictions include the respective airport sources and emissions from the external roadways and background contributions.

12.6.2.1. Nitrogen dioxide (NO_2)

The dispersion modelling results for maximum one hour and annual average nitrogen dioxide are presented in Table 12–26. The results of the dispersion modelling show predicted nitrogen dioxide concentrations to be below the air quality assessment criteria at all residential receptors when considering the airport both in isolation (incremental) and combined with the external roadways and background sources (cumulative).

The maximum one hour nitrogen dioxide concentration is predicted to occur at receptor R3, located to the south-west of the airport site. The incremental and cumulative contributions are predicted to be 60 per cent and 70 per cent of the air quality assessment criteria of 320 micrograms per cubic metre. The cumulative contributions from external roadways are shown to have negligible effects for some receptors and greater effects for others such as R22 at Rossmore.

Table 12–26 – Predicted incremental and cumulative NO_2 concentrations

Receptor	Receptor description	Airport (µg/m3)		Cumulative (µg/m3)	
		One hour	Annual	One hour	Annual
Assessment criteria		*320*	*62*	*320*	*62*
R1	Bringelly	84	11	139	18
R2	Luddenham	91	13	91	15
R3	Greendale, Greendale Road	194	12	227	14
R4	Kemps Creek	76	11	160	25
R6	Mulgoa	84	12	90	14
R7	Wallacia	90	11	92	13
R8	Twin Creeks, corner Twin Creeks Drive & Humewood Place	86	13	105	19
R14	Badgerys Creek, Lawson Road	147	13	160	22
R15	Greendale, Mersey Road	130	13	138	17
R17	Luddenham Road	96	13	115	18
R18	Corner Adams and Elizabeth Drive	107	17	110	22
R19	Corner Adams and Anton Road	111	19	121	23
R21	Corner Willowdene Avenue and Vicar Park Lane	171	13	179	16
R22	Rossmore, Victor Avenue	68	11	145	17
R23	Wallacia, Greendale Road	87	11	101	13
R24	Badgerys Creek 1 NE	166	18	169	25
R25	Badgerys Creek 2 SW	104	12	108	16
R27	Greendale, Dwyer Road	80	11	86	12
R30	Rossmore residential	66	11	131	20
R31	Mt Vernon residential	142	12	143	19

12.6.2.2. Particulate matter (PM_{10})

The dispersion modelling results for maximum 24 hour average and annual average PM_{10} are presented in Table 12–27. The results of the dispersion modelling show predicted PM_{10} concentrations to be below the air quality assessment criteria at all residential receptors. For both averaging periods, the background PM_{10} contributes more than half of the respective criterion.

The contour plots show that the contribution from roadways plays a significant role in the ground level concentrations of PM_{10} (refer to Appendix F1).

Table 12–27 – Predicted incremental and cumulative PM_{10} concentrations

Receptor	Receptor description	Airport (µg/m3)		Airport + external roadways (µg/m3)		Cumulative – Airport + external roadways + existing background (µg/m3)	
		24 hour	Annual	24 hour	Annual	24 hour	Annual
Assessment criteria		*n/a*	*n/a*	*n/a*	*n/a*	*50*	*30*
R1	Bringelly	0.5	<0.1	7.8	1.1	44	18
R2	Luddenham	0.5	<0.1	2.0	0.3	43	17
R3	Greendale, Greendale Road	1.0	<0.1	3.3	0.2	43	17
R4	Kemps Creek	0.6	<0.1	15.8	1.7	46	19
R6	Mulgoa	0.5	<0.1	1.9	0.2	43	17
R7	Wallacia	0.4	<0.1	2.0	0.2	43	17
R8	Twin Creeks, corner Twin Creeks Drive and Humewood Place	0.6	<0.1	3.8	0.6	44	18
R14	Badgerys Creek, Lawson Road	1.5	0.1	7.1	1.1	44	18
R15	Greendale, Mersey Road	1.1	0.1	2.5	0.5	44	18
R17	Luddenham Road	0.7	<0.1	3.5	0.6	43	18
R18	Corner Adams and Elizabeth Drive	0.7	0.1	3.7	0.7	44	18
R19	Corner Adams and Anton Road	2.0	0.2	3.0	0.6	44	18
R21	Corner Willowdene Avenue and Vicar Park Lane	0.9	<0.1	3.3	0.4	43	17
R22	Rossmore, Victor Avenue	0.9	<0.1	4.5	0.6	44	18
R23	Wallacia, Greendale Road	0.6	<0.1	3.0	0.2	43	17
R24	Badgerys Creek 1 NE	4.1	0.4	6.0	1.2	44	18
R25	Badgerys Creek 2 SW	0.6	<0.1	2.8	0.6	43	18
R27	Greendale, Dwyer Road	0.1	<0.1	1.7	0.2	43	17
R30	Rossmore residential	0.3	<0.1	7.5	1.4	45	18
R31	Mt Vernon residential	0.9	<0.1	5.6	0.6	43	18

12.6.2.3. Particulate matter ($PM_{2.5}$)

The dispersion modelling results for maximum 24 hour average and annual average $PM_{2.5}$ are presented in Table 12–28. The dispersion modelling shows predicted $PM_{2.5}$ concentrations to be below the air quality assessment criteria at all residential receptors. For both averaging periods, the background is anticipated to contribute more than half of the respective criterion.

As with PM_{10}, the contour plots show the contribution from roadways plays a significant role in the ground level concentrations of $PM_{2.5}$ (refer to Appendix F1).

Table 12–28 – Predicted incremental and cumulative $PM_{2.5}$ concentrations

Receptor	Receptor description	Airport (µg/m3)		Airport + external roadways (µg/m3)		Cumulative – Airport + external roadways + existing background (µg/m3)	
		24 hour	Annual	24 hour	Annual	24 hour	Annual
Assessment criteria		*n/a*	*n/a*	*n/a*	*n/a*	*25*	*8*
R1	Bringelly	0.5	<0.1	3.6	0.5	14	8
R2	Luddenham	0.5	<0.1	1.0	0.2	14	7
R3	Greendale, Greendale Road	1.0	<0.1	2.0	0.1	13	7
R4	Kemps Creek	0.6	<0.1	6.5	0.8	15	8
R6	Mulgoa	0.5	<0.1	1.0	0.1	13	7
R7	Wallacia	0.4	<0.1	0.9	0.1	13	7
R8	Twin Creeks, corner Twin Creeks Drive and Humewood Place	0.6	<0.1	1.6	0.3	14	7
R14	Badgerys Creek, Lawson Road	1.4	0.1	4.0	0.6	14	8
R15	Greendale, Mersey Road	1.0	0.1	1.4	0.3	14	7
R17	Luddenham Road	0.7	<0.1	1.5	0.3	14	7
R18	Corner Adams and Elizabeth Drive	0.7	0.1	1.8	0.4	14	7
R19	Corner Adams and Anton Road	1.9	0.2	2.4	0.4	14	7
R21	Corner Willowdene Avenue and Vicar Park Lane	0.8	<0.1	1.5	0.2	14	7
R22	Rossmore, Victor Avenue	0.9	<0.1	2.0	0.3	14	7
R23	Wallacia, Greendale Road	0.6	<0.1	1.3	0.1	13	7
R24	Badgerys Creek 1 NE	3.9	0.3	4.3	0.7	14	8
R25	Badgerys Creek 2 SW	0.6	<0.1	1.3	0.3	13	7
R27	Greendale, Dwyer Road	0.1	<0.1	0.7	0.1	13	7
R30	Rossmore residential	0.3	<0.1	3.5	0.7	14	8
R31	Mt Vernon residential	0.9	<0.1	2.2	0.3	14	7

12.6.2.4. Carbon monoxide (CO)

The dispersion modelling results for maximum 15-minute, one hour and eight hour carbon monoxide are presented in Table 12–29. The results of the dispersion modelling show predicted carbon monoxide concentrations to be well below the air quality assessment criteria at all residential receptors for all averaging periods.

The contour plots show higher concentrations centred over the proposed airport and along roadways (refer to Appendix F1).

Table 12–29 –Predicted incremental and cumulative CO concentrations

Receptor	Receptor description	Airport (µg/m3)			Airport + external roadways (µg/m3)			Cumulative – Airport + external roadways + existing background (µg/m3)		
		15-min	1-hour	8-hour	15-min	1-hour	8-hour	15-min	1-hour	8-hour
Assessment criteria		*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*100*	*30*	*10*
R1	Bringelly	0.6	0.4	0.1	3.2	2.4	0.3	5.3	3.9	1.5
R2	Luddenham	0.5	0.4	0.1	0.5	0.4	0.1	2.6	1.9	1.3
R3	Greendale, Greendale Road	0.9	0.7	0.1	1.6	1.2	0.2	3.7	2.7	1.4
R4	Kemps Creek	0.7	0.5	0.1	2.0	1.5	0.5	4.1	3.0	1.7
R6	Mulgoa	0.7	0.5	0.1	0.9	0.7	0.1	3.0	2.2	1.3
R7	Wallacia	0.3	0.2	0.0	0.9	0.7	0.1	3.0	2.2	1.3
R8	Twin Creeks, corner Twin Creeks Drive and Humewood Place	0.9	0.7	0.1	1.5	1.1	0.2	3.6	2.6	1.4
R14	Badgerys Creek, Lawson Road	1.8	1.4	0.2	3.1	2.3	0.3	5.2	3.8	1.5
R15	Greendale, Mersey Road	1.1	0.8	0.2	1.4	1.0	0.2	3.5	2.5	1.4
R17	Luddenham Road	0.5	0.4	0.1	1.1	0.8	0.2	3.2	2.3	1.4
R18	Corner Adams and Elizabeth Drive	0.7	0.5	0.1	1.8	1.4	0.2	3.9	2.9	1.4
R19	Corner Adams and Anton Road	2.3	1.7	0.3	2.4	1.8	0.3	4.5	3.3	1.5
R21	Corner Willowdene Avenue and Vicar Park Lane	1.1	0.8	0.2	1.7	1.3	0.2	3.8	2.8	1.4
R22	Rossmore, Victor Avenue	1.0	0.8	0.1	1.1	0.9	0.2	3.2	2.4	1.4

Receptor	Receptor description	Airport (µg/m3)			Airport + external roadways (µg/m3)			Cumulative – Airport + external roadways + existing background (µg/m3)		
		15-min	1-hour	8-hour	15-min	1-hour	8-hour	15-min	1-hour	8-hour
R23	Wallacia, Greendale Road	0.4	0.3	0.1	0.7	0.5	0.1	2.8	2.0	1.3
R24	Badgerys Creek 1 NE	3.1	2.3	0.5	3.1	2.3	0.5	5.2	3.8	1.7
R25	Badgerys Creek 2 SW	0.5	0.4	0.1	1.0	0.8	0.1	3.1	2.3	1.3
R27	Greendale, Dwyer Road	0.2	0.1	0.0	0.3	0.2	0.1	2.4	1.7	1.3
R30	Rossmore residential	0.4	0.3	0.1	2.6	1.9	0.4	4.7	3.4	1.6
R31	Mt Vernon residential	0.8	0.6	0.1	0.9	0.6	0.2	3.0	2.1	1.4

12.6.2.5. Sulfur dioxide (SO_2)

The dispersion modelling results for maximum 10-minute, one hour, 24 hour and annual average sulfur dioxide, are presented in Table 12–30 (10-minute and one hour averaging periods) and Table 12–31 (24 hour and annual averaging periods). The results of the dispersion modelling show predicted sulfur dioxide concentrations to be well below the air quality assessment criteria at all residential receptors for all averaging periods.

The contour plots show higher concentrations in the north and north-east of the airport site, consistent with the annual prevailing winds (refer to Appendix F1).

Table 12–30 –Predicted incremental and cumulative maximum 10 minute and one hour sulfur dioxide concentrations

Receptor	Receptor description	Airport (µg/m3)		Airport + external roadways (µg/m3)		Cumulative – Airport + external roadways + existing background (µg/m3)	
		10-min	1-hour	10-min	1-hour	10-min	1-hour
Assessment criteria		*n/a*	*n/a*	*n/a*	*n/a*	*700*	*570*
R1	Bringelly	28	19	29	19	109	53
R2	Luddenham	18	12	19	12	99	46
R3	Greendale, Greendale Road	63	42	65	43	145	77
R4	Kemps Creek	24	16	24	16	104	50
R6	Mulgoa	122	81	122	81	202	115
R7	Wallacia	66	44	66	44	146	78
R8	Twin Creeks, corner Twin Creeks Drive and Humewood Place	64	42	64	43	144	77
R14	Badgerys Creek, Lawson Road	85	56	86	57	166	91
R15	Greendale, Mersey Road	49	32	49	32	129	66
R17	Luddenham Road	133	88	133	88	213	122
R18	Corner Adams and Elizabeth Drive	39	26	41	27	121	61
R19	Corner Adams and Anton Road	102	67	102	68	182	102
R21	Corner Willowdene Avenue and Vicar Park Lane	51	34	52	34	132	68
R22	Rossmore, Victor Avenue	25	16	25	16	105	50
R23	Wallacia, Greendale Road	83	55	84	56	164	90
R24	Badgerys Creek 1 NE	87	57	87	57	167	91
R25	Badgerys Creek 2 SW	84	56	85	56	165	90
R27	Greendale, Dwyer Road	16	11	16	11	96	45
R30	Rossmore residential	24	16	24	16	104	50
R31	Mt Vernon residential	90	59	90	59	170	93

Table 12–31 – Predicted incremental and cumulative maximum 24 hour and annual average SO_2 concentrations

Receptor	Receptor description	Airport (µg/m3)		Airport + external roadways (µg/m3)		Cumulative – Airport + external roadways + existing background (µg/m3)	
		24 hour	Annual	24 hour	Annual	24 hour	Annual
Assessment criteria		*n/a*	*n/a*	*n/a*	*n/a*	*228*	*60*
R1	Bringelly	1.8	0.1	2.0	0.1	11.9	1.3
R2	Luddenham	1.4	0.2	1.4	0.2	11.3	1.4
R3	Greendale, Greendale Road	4.6	0.2	4.7	0.2	14.6	1.4
R4	Kemps Creek	2.2	0.1	2.3	0.1	12.2	1.3
R6	Mulgoa	2.4	0.1	2.4	0.1	12.3	1.3
R7	Wallacia	1.5	0.1	1.5	0.1	11.4	1.3
R8	Twin Creeks, Corner Twin Creeks Drive and Humewood Place	2.2	0.2	2.2	0.3	12.1	1.5
R14	Badgerys Creek, Lawson Road	4.6	0.3	4.9	0.3	14.8	1.5
R15	Greendale, Mersey Road	3.9	0.3	3.9	0.3	13.8	1.5
R17	Luddenham Road	2.7	0.2	2.8	0.2	12.7	1.4
R18	Corner Adams and Elizabeth Drive	2.5	0.6	2.5	0.6	12.4	1.8
R19	Corner Adams and Anton Road	4.4	0.8	4.5	0.8	14.4	2.0
R21	Corner Willowdene Avenue and Vicar Park Lane	3.8	0.2	3.8	0.2	13.7	1.4
R22	Rossmore, Victor Avenue	2.4	0.1	2.5	0.1	12.4	1.3
R23	Wallacia, Greendale Road	2.8	0.1	2.9	0.1	12.8	1.3
R24	Badgerys Creek 1 NE	7.4	0.7	7.4	0.7	17.3	1.9
R25	Badgerys Creek 2 SW	2.2	0.1	2.2	0.2	12.1	1.4
R27	Greendale, Dwyer Road	0.6	0.1	0.7	0.1	10.6	1.3
R30	Rossmore residential	1.7	0.1	1.9	0.1	11.8	1.3
R31	Mt Vernon residential	4.2	0.1	4.3	0.2	14.2	1.4

12.6.2.6. Air toxics

The dispersion modelling results for the four air toxics evaluated in this assessment (benzene, toluene, xylene and formaldehyde) are presented in Table 12–32 (99.9th percentile), Table 12–33 (24 hour averaging period) and Table 12–34 (annual averaging period). The results of the dispersion modelling show the predicted concentrations of air toxics to be well below the air quality assessment criteria for the 99.9th percentile. The exception was formaldehyde with an exceedance shown at on-site receptor R24 (highlighted in bold text in Table 12–32).

The 24 hour and annual average concentrations of benzene, toluene and xylenes were predicted to be orders of magnitude lower than the air quality assessment criteria. The concentration of formaldehyde was also less than 20 per cent of the investigation level (refer to Table 12–32 and Table 12–33).

Table 12–32 –Predicted incremental and cumulative 99.9th percentile one hour average air toxic concentrations

Receptor	Receptor description	Airport (µg/m³)				Airport + external roadways (µg/m³)			
		Benzene	Toluene	Xylene	Formaldehyde	Benzene	Toluene	Xylene	Formaldehyde
Assessment criteria		*29*	*360*	*180*	*20*	*29*	*360*	*180*	*20*
R1	Bringelly	0.1	<0.1	<0.1	0.7	2.0	0.8	0.5	14.9
R2	Luddenham	0.2	0.1	0.1	1.5	1.3	0.5	0.3	9.3
R3	Greendale, Greendale Road	0.2	0.1	<0.1	1.2	1.2	0.5	0.3	8.8
R4	Kemps Creek	0.1	<0.1	<0.1	0.9	2.3	0.9	0.6	17.1
R6	Mulgoa	0.1	<0.1	<0.1	0.7	0.8	0.3	0.2	5.6
R7	Wallacia	0.1	<0.1	<0.1	0.7	0.6	0.2	0.2	4.3
R8	Twin Creeks, Corner Twin Creeks Drive and Humewood Place	0.1	<0.1	<0.1	0.8	1.0	0.4	0.3	7.4
R14	Badgerys Creek, Lawson Road	0.3	0.1	0.1	2.2	1.3	0.5	0.3	9.3
R15	Greendale, Mersey Road	0.3	0.1	0.1	1.8	1.5	0.6	0.4	11.0
R17	Luddenham Road	0.1	0.1	<0.1	1.0	0.9	0.3	0.2	6.2
R18	Corner Adams and Elizabeth Drive	0.2	0.1	<0.1	1.4	1.3	0.5	0.4	9.8
R19	Corner Adams and Anton Road	0.4	0.1	0.1	2.6	2.2	0.8	0.6	16.1
R21	Corner Willowdene Avenue and Vicar Park Lane	0.2	0.1	0.1	1.5	1.1	0.4	0.3	8.1

Receptor	Receptor description	Airport (µg/m³)				Airport + external roadways (µg/m³)			
		Benzene	Toluene	Xylene	Formaldehyde	Benzene	Toluene	Xylene	Formaldehyde
R22	Rossmore, Victor Avenue	0.2	0.1	<0.1	1.1	0.8	0.3	0.2	5.8
R23	Wallacia, Greendale Road	0.1	<0.1	<0.1	0.9	0.6	0.2	0.2	4.6
R24	Badgerys Creek 1 NE	0.6	0.2	0.2	4.2	3.1	1.2	0.8	22.6
R25	Badgerys Creek 2 SW	0.3	0.1	0.1	2.0	1.8	0.7	0.5	13.5
R27	Greendale, Dwyer Road	0.1	0.1	<0.1	1.0	0.9	0.4	0.2	6.8
R30	Rossmore residential	0.1	<0.1	<0.1	0.5	1.6	0.6	0.4	11.8
R31	Mt Vernon residential	0.2	0.1	0.1	1.4	1.0	0.4	0.3	7.0

Table 12–33 – Predicted incremental and cumulative 24 hour average air toxic concentrations

Receptor	Receptor description	Airport (µg/m³)			Airport + external roadways (µg/m³)			Cumulative – Airport + external roadways + existing background (µg/m³)		
		Toluene	Xylene	Formald-ehyde	Toluene	Xylene	Formald-ehyde	Toluene	Xylene	Formald-ehyde
Assessment criteria		*4,160*	*1,170*	*53*	*4,160*	*1,170*	*53*	*4,160*	*1,170*	*53*
R1	Bringelly	<0.1	<0.1	0.9	0.1	0.1	2.1	15.4	16.7	6.4
R2	Luddenham	0.1	0.1	1.6	0.1	0.1	1.5	15.4	16.7	5.8
R3	Greendale, Greendale Road	0.1	0.1	1.5	0.1	0.1	1.6	15.4	16.7	5.9
R4	Kemps Creek	0.1	<0.1	1.1	0.2	0.1	3.4	15.5	16.7	7.7
R6	Mulgoa	<0.1	<0.1	0.8	0.1	<0.1	1.0	15.4	16.6	5.3
R7	Wallacia	<0.1	<0.1	0.8	<0.1	<0.1	0.9	15.3	16.6	5.2
R8	Twin Creeks, Corner Twin Creeks Drive and Humewood Place	<0.1	<0.1	0.8	0.1	<0.1	1.2	15.4	16.6	5.5
R14	Badgerys Creek, Lawson Road	0.1	0.1	2.4	0.1	0.1	2.7	15.4	16.7	7.0
R15	Greendale, Mersey	0.1	0.1	2.0	0.1	0.1	1.8	15.4	16.7	6.1

Receptor	Receptor description	Airport (µg/m³)			Airport + external roadways (µg/m³)			Cumulative – Airport + external roadways + existing background (µg/m³)		
		Toluene	Xylene	Formald-ehyde	Toluene	Xylene	Formald-ehyde	Toluene	Xylene	Formald-ehyde
	Road									
R17	Luddenham Road	0.1	<0.1	1.1	0.1	<0.1	1.1	15.4	16.6	5.4
R18	Corner Adams and Elizabeth Drive	0.1	0.1	1.5	0.1	0.1	1.4	15.4	16.7	5.7
R19	Corner Adams and Anton Road	0.1	0.1	2.7	0.2	0.1	3.0	15.5	16.7	7.3
R21	Corner Willowdene Avenue and Vicar Park Lane	0.1	0.1	1.7	0.1	0.1	1.5	15.4	16.7	5.8
R22	Rossmore, Victor Avenue	0.1	<0.1	1.2	0.1	0.1	1.4	15.4	16.7	5.7
R23	Wallacia, Greendale Road	0.1	<0.1	1.1	0.1	<0.1	1.1	15.4	16.6	5.4
R24	Badgerys Creek 1 NE	0.2	0.2	4.6	0.3	0.2	5.1	15.6	16.8	9.4
R25	Badgerys Creek 2 SW	0.1	0.1	2.1	0.1	0.1	2.4	15.4	16.7	6.7
R27	Greendale, Dwyer Road	0.1	<0.1	1.0	0.1	<0.1	1.3	15.4	16.6	5.6
R30	Rossmore residential	<0.1	<0.1	0.5	0.1	0.1	2.4	15.4	16.7	6.7
R31	Mt Vernon residential	0.1	0.1	1.4	0.1	0.1	1.5	15.4	16.7	5.8

Table 12–34 – Predicted incremental and cumulative annual average air toxic concentrations

Receptor	Receptor description	Airport (µg/m³)			Airport + external roadways (µg/m³)			Cumulative – Airport + external roadways + existing background (µg/m³)		
		Toluene	Xylene	Formald-ehyde	Toluene	Xylene	Formald-ehyde	Toluene	Xylene	Formald-ehyde
Assessment criteria		*10*	*406*	*935*	*10*	*406*	*935*	*10*	*406*	*935*
R1	Bringelly	0.01	<0.01	<0.01	0.02	0.01	1.0	3.7	2.4	6.4
R2	Luddenham	0.02	0.01	0.01	0.01	0.01	1.0	3.7	2.4	5.8
R3	Greendale, Greendale Road	0.01	<0.01	<0.01	0.01	<0.01	1.0	3.7	2.4	5.9
R4	Kemps Creek	0.01	<0.01	<0.01	0.03	0.02	1.1	3.7	2.4	7.7
R6	Mulgoa	0.01	<0.01	<0.01	0.01	<0.01	1.0	3.7	2.4	5.3
R7	Wallacia	0.01	<0.01	<0.01	0.01	<0.01	1.0	3.7	2.4	5.2
R8	Twin Creeks, Corner Twin Creeks Drive and Humewood Place	0.01	0.01	<0.01	0.01	0.01	1.0	3.7	2.4	5.5
R14	Badgerys Creek, Lawson Road	0.02	0.01	<0.01	0.02	0.02	1.1	3.7	2.4	7.0
R15	Greendale, Mersey Road	0.01	0.01	<0.01	0.01	0.01	1.0	3.7	2.4	6.1
R17	Luddenham Road	0.01	0.01	<0.01	0.01	0.01	1.0	3.7	2.4	5.4
R18	Corner Adams and Elizabeth Drive	0.03	0.01	0.01	0.02	0.01	1.1	3.7	2.4	5.7
R19	Corner Adams and Anton Road	0.04	0.02	0.01	0.02	0.02	1.1	3.7	2.4	7.3
R21	Corner Willowdene Avenue and Vicar Park Lane	0.01	<0.01	<0.01	0.01	0.01	1.0	3.7	2.4	5.8
R22	Rossmore, Victor Avenue	0.01	<0.01	<0.01	0.01	0.01	1.0	3.7	2.4	5.7
R23	Wallacia, Greendale Road	<0.01	<0.01	<0.01	<0.01	<0.01	1.0	3.7	2.4	5.4
R24	Badgerys Creek 1 NE	0.06	0.02	0.02	0.04	0.03	1.1	3.7	2.4	9.4
R25	Badgerys Creek 2 SW	0.02	0.01	<0.01	0.02	0.01	1.0	3.7	2.4	6.7

Receptor	Receptor description	Airport (µg/m³)			Airport + external roadways (µg/m³)			Cumulative – Airport + external roadways + existing background (µg/m³)		
		Toluene	Xylene	Formald-ehyde	Toluene	Xylene	Formald-ehyde	Toluene	Xylene	Formald-ehyde
R27	Greendale, Dwyer Road	0.01	<0.01	<0.01	0.01	<0.01	1.0	3.7	2.4	5.6
R30	Rossmore residential	<0.01	<0.01	<0.01	0.02	0.02	1.1	3.7	2.4	6.7
R31	Mt Vernon residential	0.01	<0.01	<0.01	0.01	0.01	1.0	3.7	2.4	5.8

12.6.3. Odour

12.6.3.1. Aircraft exhaust

The modelling results for the 99th percentile one hour odour emissions from aircraft exhaust are presented in Table 12–35. The modelling shows predicted odour concentrations to be below the threshold detection level of one OU at all but one of the residential receptors. At R24, the predicted odour concentration is one OU, indicating when a receptor is located in this area, they may detect odour from aircraft exhausts. This is, however, less than the NSW EPA odour performance criterion of two OU.

The contour plots show that the highest odour concentrations would be largely limited to within the airport site (refer to Appendix F1).

Table 12–35 – Predicted 99th percentile odour concentrations from aircraft exhaust

Receptor	Receptor description	One hour 99th percentile
Assessment criteria		*2*
R1	Bringelly	<1
R2	Luddenham	<1
R3	Greendale, Greendale Road	<1
R4	Kemps Creek	<1
R6	Mulgoa	<1
R7	Wallacia	<1
R8	Twin Creeks, Corner Twin Creeks Drive and Humewood Place	<1
R14	Badgerys Creek, Lawson Road	<1
R15	Greendale, Mersey Road	<1
R17	Luddenham Road	<1
R18	Corner Adams and Elizabeth Drive	1
R19	Corner Adams and Anton Road	1
R21	Corner Willowdene Avenue and Vicar Park Lane	<1
R22	Rossmore, Victor Avenue	<1
R23	Wallacia, Greendale Road	<1
R24	Badgerys Creek 1 NE	1
R25	Badgerys Creek 2 SW	<1
R27	Greendale, Dwyer Road	<1
R30	Rossmore residential	<1
R31	Mt Vernon residential	<1

12.6.3.2. Wastewater treatment plant

The modelling results for the 99th percentile one hour odour emissions from the on-site wastewater treatment plant are presented in Table 12–36. The modelling shows predicted odour concentrations to be below the threshold detection level of one OU at all residential receptors.

The contour plots show that the highest odour concentrations would be largely limited to within the airport site (refer to Appendix F1).

Table 12–36 – Predicted 99th percentile odour concentrations from wastewater treatment plant

Receptor	Receptor description	One hour 99th percentile
Assessment criteria		*2*
R1	Bringelly	<1
R2	Luddenham	<1
R3	Greendale, Greendale Road	<1
R4	Kemps Creek	<1
R6	Mulgoa	<1
R7	Wallacia	<1
R8	Twin Creeks, Corner Twin Creeks Drive and Humewood Place	<1
R14	Badgerys Creek, Lawson Road	<1
R15	Greendale, Mersey Road	<1
R17	Luddenham Road	<1
R18	Corner Adams and Elizabeth Drive	<1
R19	Corner Adams and Anton Road	<1
R21	Corner Willowdene Avenue and Vicar Park Lane	<1
R22	Rossmore, Victor Avenue	<1
R23	Wallacia, Greendale Road	<1
R24	Badgerys Creek 1 NE	<1
R25	Badgerys Creek 2 SW	<1
R27	Greendale, Dwyer Road	<1
R30	Rossmore residential	<1
R31	Mt Vernon residential	<1

12.6.4. Fuel jettisoning

As discussed in Chapter 7, fuel jettisoning is extremely rare worldwide and generally only occurs during an emergency, as a safety precaution when a plane must land prematurely. In Australia, there are specific protocols in place to regulate fuel jettisoning in accordance with the Air Navigation (Fuel Spillage) Regulations 1999. For example, pilots must obtain authority from air traffic control before jettisoning fuel and must receive instruction on where the operation is to be performed. Fuel jettisoning is required to occur in an area nominated by air traffic control in clear air at 6,000 feet (approximately 2,000 metres) above ground level such that all fuel is vaporised before reaching the ground. Reasonable precautions must be taken to promote the safety of persons and property in the air and on the ground.

Due to improvements in fuel efficiency and lightweight aircraft material, the amount of fuel jettisoned from aircraft in emergency situations has decreased substantially, with this trend anticipated to continue. As fuel efficiency, technology and airspace management continue to improve, volumes of fuel required to be carried on planes will steadily decline in the future. Major Australian airlines already have goals in place to implement these improvements. Qantas, for example, is currently aiming to improve its fuel efficiency by 1.5 per cent per year until 2020 (Department of Resources, Energy and Tourism 2013). The Qantas Group Fuel Optimisation Program also has strategies in place to reduce travel distance and unnecessary aircraft weight. These strategies will help to reduce the volume of fuel carried by aircraft and reduce the amount of fuel released in event of an emergency.

The effects of fuel jettisoning on local air quality would be limited due to the inability of many aircraft to perform fuel dumps, the rapid vaporisation and wide dispersion of jettisoned fuel, the strict guidelines on fuel jettison altitudes and locations and the anticipated reduction in events and volumes in the future. For these reasons, fuel dumping is not considered likely to have a significant immediate or future impact on local air quality or human health.

12.6.5. Regional air quality

International studies have shown that emissions from airport operations are small when viewed in the context of regional emissions inventories (Ratliff et al. 2009). This is supported by data presented in the *Air Emissions Inventory for the Greater Metropolitan Region in New South Wales* (EPA 2012) which shows that emissions from existing airport operations in Sydney are less than three per cent of total emissions for the Sydney region.

The daily maximum predicted one hour ozone concentrations are presented in Table 12–37. Results are presented as peak concentrations for the 2030 future base case (no airport), the 2030 airport Case (airport emissions plus 2030 future base case) and the largest difference in daily maximums (the 2030 airport case – 2030 future base case). The largest difference represents the maximum change in daily maximum ozone concentration, as a result of the additional emissions from the airport.

Table 12–37 – Maximum daily predicted one hour ozone concentration (parts per billion)

Date	2030 future base case peak value	2030 airport case peak value	2030 airport case – 2030 future base case largest difference
06/01/2009	149.1	149.1	0.4
07/01/2009	129.8	129.8	5.5
14/01/2009	106.6	106.6	1.3
29/01/2009	124.1	124.1	0.3
30/01/2009	107.4	107.4	0.6
31/01/2009	109.4	109.4	0.6
04/02/2009	103.8	103.8	1.1
05/02/2009	119.6	119.6	0.3
06/02/2009	112.5	112.5	0.8
07/02/2009	133.7	133.7	0.3
08/02/2009	148.6	148.6	0.6
20/02/2009	98.3	98.3	1.0

The results of the regional air quality analysis show that for each day of analysis, the peak predicted one hour ozone concentrations were unchanged between the 2030 future base case and the 2030 airport case. This is because the predicted ozone concentrations from the proposed airport occur in different locations to where ozone peaks occur. Both the 2030 future base case and the 2030 airport case were above the NEPM criterion of 100 parts per billion for all but one day of analysis.

To provide context, the predicted peak ozone concentrations presented in Table 12–37 can be compared with measured peak one hour ozone concentrations at Bringelly. During 2014, there were two days when the maximum daily one hour ozone concentration was above the NEPM standard, with a peak concentration of 124 parts per billion measured in November 2014. It is noted that the modelled peak values are expected to be higher than observed peak values because monitoring networks never achieve full coverage of an airshed. In other words, modelling can predict higher peak ozone for areas not covered by monitoring networks.

The largest difference in daily maximum one hour ozone concentration, from the addition of airport emissions, was 5.5 parts per billion, however the second highest was significantly lower at 1.3parts per billion. This highlights that reliance on a single model result (for example, focussing on the largest ozone change) could accentuate the influence of uncertainties in the model's input data or model formulation. Therefore, the average of the 2nd to 4th highest ozone change (1.1 parts per billion) is used to describe ozone impacts. This approach is similar to the use of a 99th percentile to describe maximum ozone impacts. When compared to the maximum allowable increment level of one part per billion, prescribed by the NSW tiered procedure for ozone assessment, a marginal impact is predicted from the 2030 airport case.

The peak predicted four hour ozone concentration were unchanged between the 2030 airport case and the 2030 future base case on ten days and increased on two days, by a maximum of 0.1 parts per billion as shown in Table 12–38

Table 12–38 – Maximum daily predicted four hour ozone concentration (parts per billion)

Date	2030 future base case peak value	2030 airport case peak value	2030 airport case – 2030 future base case largest difference
06/01/2009	126.2	126.3	0.3
07/01/2009	115.3	115.4	2.4
14/01/2009	98.7	98.8	0.7
29/01/2009	95.9	95.9	0.5
30/01/2009	78.2	78.2	0.6
31/01/2009	99.9	99.9	0.5
04/02/2009	97.3	97.3	0.7
05/02/2009	108.7	108.7	0.4
06/02/2009	92.4	92.4	0.4
07/02/2009	121.0	121.0	0.6
08/02/2009	129.9	129.9	0.6
20/02/2009	83.9	84.0	1.2

The highest change in daily maximum four hour ozone concentration, from the addition of airport emissions, was 2.4 parts per billion, while the second highest was 1.2 parts per billion. The average of the 2^{nd} to 4^{th} highest change in daily maximum four hour ozone was 0.9 parts per billion, which is below the maximum allowable increment of one part per billion.

Locations of ozone differences between the 2030 airport case and the 2030 base case – that is, ozone due to airport emissions –are shown in the spatial plots of the daily maximum predicted one hour and four hour ozone concentrations (refer to Appendix F2 in Volume 4). Decreases in daily maximum ozone occur only in the vicinity of the airport for the 2030 airport case and are attributable to ozone suppression by nitrogen oxides emissions. Increases in ozone occur downwind of the airport site which, on most days, is to the south.

12.7. Greenhouse gas assessment

Consensus within the scientific community is that anthropogenic (man-made) activities, including aviation, increase atmospheric concentrations of greenhouse gases which lead to climate change. The IPCC estimated in 2007 that aviation accounts for two per cent of global carbon dioxide emissions. However, with airline travel becoming more popular in Australia and around the world, this contribution could reach five per cent by 2050 (SACL 2014).

This section presents the results of the greenhouse gas assessment which quantifies the greenhouse gas emissions (in tonnes of carbon dioxide equivalent (tCO_2-e)) for construction and the Scope 1, Scope 2 and Scope 3 emissions associated with the operation of the Stage 1 development.

12.7.1. Construction emission estimates

Greenhouse gas emissions generated during construction of the proposed Stage 1 development are presented in Table 12–39. The two main sources of greenhouse gas emissions would be the operation of construction equipment and vegetation clearing. A conservative approach was applied when calculating the emissions. For example, it was assumed that the equipment used during construction of the aviation infrastructure would use as much fuel as the equipment used during the bulk earthworks. It was also assumed that construction equipment would be used for six working days a week. Public holidays and bad weather were also factored into the calculations. In addition, it was assumed that 50 per cent of the vegetation cleared was carbon and that 3.67 tonnes of carbon dioxide equivalent is generated per tonne of carbon cleared (AGO 1999, 2000, 2002 and 2003).

Table 12–39 – Summary of greenhouse gas emissions during construction

Scope	Source	Fuel type	Quantity	Units	Emissions ($t CO_2$-e)
1	Equipment	Transport diesel oil	162	ML	286
1	Vegetation clearing	N/A	39	kt	71,565
				Total	71,851

12.7.2. Operations emission estimates

Greenhouse gas emissions forecast to be generated during operation of the proposed Stage 1 development are presented in Table 12–40. As shown in Table 12–40, electricity consumption would account for the vast majority of greenhouse gas emissions (83 per cent). Electricity is a Scope 2 emission. Scope 1 emissions would account for the remaining 17 percent of greenhouse gas emissions from the airport site. Within the Scope 1 emissions, greenhouse gas emissions from auxiliary power units would be the greatest source of emissions.

Table 12–40 – Summary of estimated annual Scope 1 and 2 greenhouse gas emissions

Scope	Source	Fuel type	Annual quantity	Units	Annual emissions ($t\ CO_2$-e)
1	Ground support equipment	Transport diesel oil	0.85	ML	2,292
		Transport gasoline	2	ML	4,776
1	Auxiliary power unit	Stationary gasoline (jet fuel)	5	ML	10,975
1	Boilers	Stationary natural gas	1,489,809	m^3	3,005
1	Generators	Stationary diesel oil	0.04	ML	113
1	Fire training	Stationary Kerosene (jet fuel)	0.01	ML	14
1	Wastewater treatment plant	N/A	1,935	ML	1204
1	Fugitive emissions	Transport gasoline (jet fuel)	985	ML	104
1	Fugitive emissions	Transport diesel oil	0.85	ML	0.1
1	Fugitive emissions	Transport gasoline	2	ML	0.2
2	Electricity	N/A	124,392,000	kWh	106,977
				TOTAL	129,462

Note: Fuel Type reflects the categories in DoE (2014b)
Assumptions made within the greenhouse gas calculations are provided within Appendix F1.
Emissions factor was not available for jet fuel, emissions have been assumed to be the same as Avgas.

As mentioned in Section 12.2.7, it is not commonplace to report Scope 3 emissions due to the potential of double counting greenhouse gas emissions. Nevertheless, as they are considered significant for the proposed airport, the most probable primary contributor (jet fuel) has been quantified in Table 12–41. It must be noted that this assessment accounts for the greenhouse gas emissions being emitted during the entire flight of departing planes only. This method assumes the arriving planes' emissions are accounted for by the airport from which the planes departed. This method is common overseas and has been recommended by the Airport Cooperative Research Program (ACRP) (ACRP 2009).

Table 12–41 – Summary of estimated annual Scope 3 greenhouse gas emissions

Scope	Source	Fuel type	Annual quantity	Annual emissions ($t\ CO_2$-e)
3	In flight aviation fuel	Transport gasoline (jet fuel)	986	2,524,504

Note: Emissions factor was not available for jet fuel, emissions have been assumed to be the same as Avgas.

Table 12–42 compares the Stage 1 development's estimated greenhouse gas emissions to NSW's total anthropogenic emissions in 2011–12. It concludes that the Stage 1 development would contribute to less than 0.1 per cent of NSW's total emissions for 2011–12.

Table 12–42 – Comparison of greenhouse gas emissions

Location	Source coverage	Reference year	Emissions Mt CO_2-e
Western Sydney Airport (Stage 1 development)	Scope 1 and 2	2030	0.13
NSW	Total	2011-12	154.7

Source: DoE (2014) and CER (2015).

Table 12–43 summarises Australia's current and forecast sectoral breakdown of greenhouse gas emissions. As aviation is considered a part of 'transport' it can be concluded that the Stage 1 development would account for approximately 0.1 per cent of the total 'transport' greenhouse gas emissions throughout Australia.

Table 12–43 – Australian sectoral breakdown of 2014-15 projection results to 2029-30

Sector	2013-14 Mt CO_2-e	2029-30 Mt CO_2-e
Electricity	180	224
Direct combustion	93	129
Transport	92	115
Fugitives	41	68
Industrial processes	32	39
Agriculture	82	92
Waste	13	16
Land use, land use change and forestry	14	41
Total	548	724

Source: DoE (2015)

12.8. Mitigation and management measures

Mitigation and management measures proposed to minimise the impacts on local and regional air quality are listed in Table 12–44. Measures to reduce greenhouse gas emissions during the operation of the proposed airport are also listed in Table 12–44. These measures would be incorporated into the environmental management plan for the proposed airport.

Table 12–44 – Mitigation and management measures (air quality and greenhouse gases)

ID	Issue	Mitigation/management measure	Timing
12.1	Dust management Plan	A dust management plan would be developed prior to construction of the proposed airport as part of the construction environmental management framework. The plan would collate measures to mitigate and manage potential impacts on air quality. The plan should include standard measures such as watering of exposed surfaces and covering of stockpiled material. The plan may also include monitoring of dust deposition, dust flux, real time PM_{10} continuous monitoring and/or visual inspections.	Pre-Construction
12.2	Community engagement	Develop and implement a stakeholder communications plan that specifically addresses construction and includes community engagement before work commences on-site.	Pre-Construction
12.3		Display the name and contact details of person(s) accountable for environmental management at the airport site boundary.	Construction
12.4	Dust management	Record all dust and air quality complaints, identify cause(s), and record the response to the complaint, including any further mitigation measures taken.	Construction
12.5		Make the complaints log available to the relevant authority when asked.	Construction
12.6		Record in a log book any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation.	Construction
12.7		Carry out regular site inspections to monitor compliance with the dust management plan, record inspection results, and make an inspection log available to the relevant authority when asked.	Construction
12.8		Increase the frequency of site inspections by the person accountable for air quality and dust issues on-site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.	Construction
12.9		Determine dust deposition, dust flux, or real-time PM_{10} continuous monitoring locations in consultation with the relevant authorities. Where possible commence baseline monitoring at least three months before work commences on site or before work on a construction phase commences.	Pre-Construction
12.10		Avoid site runoff of water or mud. This will reduce the potential for track-out dust emissions.	Construction
12.11	Vehicle and equipment emissions	Vehicle operators would be required to switch off engines when not in use.	Construction
12.12		Avoid the use of diesel or petrol powered generators and use mains electricity or battery powered equipment where practicable.	Construction
12.13		Appropriate vehicle speeds on sealed and unsealed roads would be considered as part of the dust management plan.	Construction
12.14		Produce a construction logistics plan to manage the sustainable delivery of goods and materials.	Pre-Construction

ID	Issue	Mitigation/management measure	Timing
12.15		Prepare a travel plan that supports and encourages sustainable travel for construction workers (public transport, cycling, walking, and car-sharing).	Construction
12.16		Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays.	Construction
12.17		Adequate water would be made available on the site for effective dust and particulate matter suppression and mitigation, using non-potable water where possible and appropriate.	Construction
12.18		Use enclosed chutes and conveyors and covered skips.	Construction
12.19		Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment. Use fine water sprays on such equipment wherever appropriate.	Construction
12.20		Equipment would be readily available on-site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.	Construction
12.21	Demolition	Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible), to provide a screen against dust.	Construction
12.22		Ensure effective water suppression methods are used during demolition operations. Hand held sprays are more effective than hoses attached to equipment as the water can be directed to where it is needed. In addition high volume water suppression systems, manually controlled, can produce fine water droplets that effectively bring the dust particles to the ground.	Construction
12.23		Avoid use of explosive blasting in demolition building works, using appropriate manual or mechanical alternatives.	Construction
12.24		Bag and remove any biological debris or damp down such material before demolition.	Construction
12.25	Earthworks	Re-vegetate earthworks and exposed areas or soil stockpiles to stabilise surfaces as soon as practicable.	Construction
12.26		Use hessian, mulches or tackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.	Construction
12.27		Minimise exposed areas as far as is practical.	Construction
12.28	Aviation Infrastructure	Avoid scrabbling (roughening of concrete surfaces) if possible.	Construction
12.29		Sand and other aggregates would be stored in bunded areas and not allowed to dry out, unless required for particular processes. If so, appropriate additional control measures would be in place.	Construction
12.30		Bulk cement and other fine powder materials would be delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	Construction
12.31		Seal and appropriately store bags of any fine powder materials to prevent dust generation.	Construction
12.32	Track out dust	Use water-assisted dust sweeper(s) on the access and local roads to remove, as necessary, any material tracked out of the site. This may require the sweeper to be continuously in use.	Construction
12.33		Avoid dry sweeping of large areas.	Construction
12.34		Vehicles should be covered to prevent escape of material during transport.	Construction
12.35		Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	Construction

ID	Issue	Mitigation/management measure	Timing
12.36		Record all inspections of haul routes and any subsequent action in a site log book.	Construction
12.37		Hard surfaced haul routes would be regularly cleaned and damped down with fixed or mobile sprinkler systems or mobile water bowsers.	Construction
12.38		Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).	Construction
12.39		An adequate area of hard surfaced road between the wheel wash facility and the site exit would be provided, wherever site size and layout permits.	Construction
12.40		Site access points would be located as far as practicable from sensitive receptors.	Construction
12.41	Greenhouse gases – Scope 2 emissions	Consideration will be given to designing, constructing and operating the Stage 1 development to achieve the following where appropriate: • 5 Star Green Star – Design & As Built; • 5 Star NABERS Office Energy Rating; and • 4 Star Green Star – Performance	Pre-construction
12.42	Demolition	Avoid use of explosive blasting in demolition works, using appropriate manual or mechanical alternatives.	Construction
12.43	Earthworks	Minimise exposed areas as far as practical.	Construction
12.44	Management of air quality and odour	Develop and implement an operational air quality and odour management plan for the proposed airport.	Operation
12.45	Air quality monitoring	Install an air quality monitoring station at the airport site to monitor NO_x, NO, NO_2, CO, O_3, PM_{10}, $PM_{2.5}$ and VOCs.	Pre-operation Operation
12.46		Conduct ambient air quality monitoring prior to operation to record baseline air quality conditions prior to operation activities.	Pre-operation
12.47	Emissions	Consider best available techniques to reduce the potential for ground level ozone formation, which may include: • replacing conventionally fuelled ground support equipment with electric or hydrogen powered belt loaders, pushback tractors, bag tugs, and cargo loaders; • using remote ground power for remote aircraft parking positions; • installing co-generation or tri-generation in-lieu of traditional gas fired boilers or solar hot water systems to replace gas fired boilers; • avoiding certain activities, such as training fires, maintenance (spray painting) during the ozone seasons; • using underground fuel hydrant systems and/or vapour recovery systems for refuelling and fuel storage; and • promoting the use of public transport to the airport.	Operation
12.48	Greenhouse gases – Scope 1 emissions	Support alternatively fuelled and 'modernised' ground support equipment – including compressed natural gas, hydrogen, electric, compressed air and hybrid vehicles.	Operation

ID	Issue	Mitigation/management measure	Timing
12.49		Educate ground support equipment drivers in techniques to conserve fuel and implement a no-idling policy	Operation
12.50		Design runways, taxiways, gates and terminals to minimise aircraft and ground support equipment travel distances where practical.	Operation
12.51		Aircraft management procedures would consider the reduction of fuel use as far as practical.	Operation
12.52		Reduce the use of auxiliary power units by using fixed electrical ground power and preconditioned air supply to aircraft where possible.	Operation
12.53		Specify high efficiency power, heating and cooling plants.	Operation
12.54		Make use of renewable energy sources where practical for the generation, use or purchase of electricity, heating and cooling.	Operation
12.55	Greenhouse gases – Scope 3 emissions	Consider the use of high capacity public transport to and from the proposed airport as part of the ground transport plan. Support the use of the low emission vehicles to and from the proposed airport, including the provision of recharging stations.	Operation
12.56		Develop an integrated solid waste management plan to implement waste saving initiatives such as composting and recycling.	Operation
12.57		Install tenant energy sub-metering systems.	Operation

12.9. Conclusion

Construction of the proposed Stage 1 development would generate dust emissions during both the bulk earthworks and the aviation infrastructure works. The asphalt batching plant would also generate some odour during construction. The results of the air dispersion modelling show that the dust impacts during construction are expected to be below the air quality assessment criteria at all sensitive residential receptors. Odour from the asphalt plant would also be below the relevant criteria at all sensitive residential receptors and largely contained within the airport site. Some odour may be detected outside of the airport boundary to the north, however, this area is currently unoccupied and, as such, there would be no impacts on sensitive receptors.

Operation of the proposed Stage 1 development would result in an increase in emissions of nitrogen dioxide, PM_{10}, $PM_{2.5}$, carbon monoxide, sulfur dioxide and air toxics. There would also be odour emissions from exhaust and from the on-site wastewater treatment plant. The highest off-site concentrations of the air quality metrics evaluated were generally predicted to occur at the receptors located to the north and north-east of the proposed airport. This is anticipated to be a function of the prevalence of south-westerly winds and the proximity of these receptors to activities at the proposed airport. Airport traffic on surrounding road infrastructure was found to be a significant contributor to predicted off-site ground level concentrations, particularly for those receptors located close to proposed roadways. Despite this, there were almost no predicted exceedances of the air quality assessment criteria at any of the sensitive residential receptors investigated as part of the assessment of the Stage 1 development. The exception was the 99.9^{th} percentile one hour maximum for formaldehyde with an exceedance shown at an on-site receptor. Predicted off-site odour concentrations were below odour detection limits for both aircraft exhaust emissions and odours from the on-site wastewater treatment plant.

The local effects of fuel jettisoning at the airport site would be limited due to the inability of many aircraft to jettison fuel, the quick vaporisation and dispersion of aircraft fuel, the strict guidelines on fuel dumping altitudes and locations, and the anticipated reduction in fuel dumping events and volumes in the future. For these reasons, fuel jettisoning is not considered likely to have a significant future impact on local air quality or human health.

The maximum predicted one hour ozone concentration remained unchanged following the implementation of the airport and four hour ozone concentrations increased by a maximum of 0.1 parts per billion. Both predicted base case and the long term development were generally above the NEPM criteria. The average change in daily maximum four hour ozone was 0.9 parts per billion, which is below the maximum allowable increment of one parts per billion.

Greenhouse gas emissions from the Stage 1 development have been estimated to comprise 0.11 Mt CO_2-e/annum, with the majority of emissions associated with purchased electricity. The Scope 1, Scope 2 and Scope 3 greenhouse gas emissions estimated for the proposed Stage 1 development represent approximately 0.1 per cent of Australia's projected 2030 transport-related greenhouse gas emission inventory. For this reason, it can be concluded the greenhouse gas emissions from the proposed airport would not be material in terms of the national inventory, however a number of mitigation measures have been suggested to reduce these emissions.

Mitigation and management measures would be implemented to reduce potential air quality impacts during both construction and operation of the proposed Stage 1 development. In particular, a dust management plan would be developed and implemented to address potential impacts from dust generated during construction. Air quality monitoring would also be undertaken at the airport site during operations. Even through greenhouse gas emissions from the proposed airport would not be material in terms of the national inventory, a number of mitigation measures would also be implemented during operations to reduce these emissions.

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The risk assessment process comprises five stages: issue identification, hazard (or toxicity) assessment, exposure assessment, risk characterisation and uncertainty assessment. Through the issues identification stage, it was determined that the primary pathways by which the proposed airport could pose a risk to human health were exposure to air pollutants, noise, and surface and groundwater pollutants.

The health risk assessment is based upon the findings of the local and regional air quality, noise and water technical studies undertaken as part of the preparation of the draft EIS. The potential health effects of local air quality, including emissions from aircraft overflights, ground based activity and traffic associated with the proposed airport are considerations in the assessment. The potential health risk from construction activities has also been assessed.

The results of the risk assessment are presented and discussed in terms of the number of 'attributable cases' relevant to each aspect considered. For example, health risk assessments for pollutants draw on population studies typically undertaken across an entire society or a specified section of society. Accordingly, references to the number of hospital admissions for respiratory disease are intended to identify a change in the number of hospital admissions across a specified population resulting from exposure to the pollutant compared to the baseline level.

13.3. Air quality

13.3.1. Pollutants

The health effects resulting from exposure to 10 µm (or less) particulate matter (PM_{10}), 2.5 µm (or less) particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and carbon monoxide (CO) have been assessed in this health risk assessment. These pollutants have been considered for the potential for any increases in mortality, hospital admissions for respiratory and cardiovascular disease, and emergency department visits for asthma in children, that may be attributable to emissions from the proposed airport.

Baseline health statistics for Sydney have been used in the assessment and the risk has been assessed for localities within five kilometres of the airport boundary. These include Bringelly, Luddenham, Greendale, Kemps Creek, Mulgoa, Wallacia, Badgerys Creek, Rossmore and Mount Vernon.

13.3.2. Ozone

The regional air quality assessment follows the NSW EPA guidelines and identifies peak ozone periods with potential exceedances of air quality standards. The assessment has considered the potential risk that ozone may have on mortality and emergency department visits for asthma in children that may be attributable to emissions from the proposed airport.

13. Human health

The health risk assessment has considered the risks associated with construction and operation of Stage 1 of the proposed airport on the health of the local community.

The assessment was undertaken in five stages: issue identification, hazard assessment, exposure assessment, risk characterisation, and uncertainty assessment. The assessment focuses on the potential health risks from air, noise, and surface and groundwater pollutant exposure through a comparison with the baseline (existing) situation. These pathways were identified as the likely primary means of potential impact to human health from the development of the proposed airport. The health impact assessment considers impacts from atmospheric particulates, nitrogen dioxide, sulphur dioxide, air toxics (benzene, toluene, xylenes and formaldehydes), diesel, and ozone. Water contaminants considered include petroleum hydrocarbons, heavy metals, polyaromatic hydrocarbons, chlorinated hydrocarbons and perflourinated compounds.

Overall, the assessment found that potential risks to human health are low. This is consistent with the fact pollution from the proposed airport is expected to be within acceptable limits. Having regard to the potential risks, the assessment identifies measures to further reduce the likely human health impacts of the proposed airport, with reference to other chapters in the draft EIS. Following the implementation of the measures proposed in this draft EIS, the human health impacts of the Stage 1 development are likely to be minimal.

13.1. Introduction

This chapter considers the risks associated with the construction and operation of the proposed airport on the health of the local community. It draws upon the specialist health risk assessment (see Appendix G) undertaken during the preparation of the draft EIS which considered the risks associated with noise, air and surface/ground water emissions from the proposed airport.

The assessment considers the baseline health profile of the region, identifies key health risks of the construction and operation of the proposed airport, and identifies mitigation measures to minimise impacts to human health.

Overall, the assessment found that the predicted health risk associated with the proposed airport would be in line with national and international standards of acceptability. The implementation of mitigation measures associated with noise, air quality and surface water described in the relevant chapters of this draft EIS would further reduce the predicted risk.

13.2. Methodology

The health risk assessment was undertaken in accordance with the Australian Government *Guidelines for Health Risk Assessment* (enHealth 2012) and the National Health and Medical Research Council *Approach to Hazard Assessment for Air Quality* (NHMRC 2006). The health risk assessment uses information about pollutants to estimate a theoretical level of risk for people who might be exposed to defined levels. Health statistics for Sydney have been used as a baseline in the assessment, with information on the health risks of pollutants being drawn from scientific studies. Data on existing pollutant levels come from ambient monitoring stations in Western Sydney operated by the NSW Office of Environment and Heritage and the NSW Environment Protection Authority.

The assessment is based on a small sample of days when exceedances of the standards are predicted and when there is a good correlation between the model outputs and existing monitoring data obtained from NSW EPA monitoring stations. Given there is only a limited ozone prediction dataset available, a full risk characterisation is not possible. The approach adopted focuses on the potential increase in risk due to changes in ozone only on the days where exceedances are predicted. However, this is considered to be a reasonable approach because the likelihood of health impacts arising in circumstances where there are no or very few relevant exceedances of ozone is very small.

13.3.3. Air toxics

A number of air toxics will be emitted during airport operations. Air dispersion modelling has been conducted for benzene, toluene, xylenes and formaldehyde. The most significant potential health risk is cancer from exposure to benzene. The predicted data for benzene has been used in the human health risk assessment for operations of the Stage 1 development in 2030.

To enable the potential increased risk of cancer arising from the airport operations to be evaluated, annual average concentrations of benzene have been modelled. The maximum concentration predicted at any location was 0.1µg/m^3. This value has been used to calculate the maximum cancer risk from benzene in the surrounding area.

13.3.4. Diesel

Diesel emissions associated with the proposed airport would arise from machinery used during construction activities as well as truck movements to, from and on the site. Diesel emission would also be generated through the use of diesel powered equipment on site during operations.

In recent years there has been increased community concern about the health effects of diesel. Exposure to diesel exhaust can have immediate health effects. Diesel exhaust can irritate the eyes, nose, throat and lungs, and it can cause coughs, headaches, light headedness and nausea. In studies with human volunteers, exposure to diesel exhaust particles at certain intensities made people with allergies more susceptible to the materials to which they are allergic, such as dust and pollen. Exposure to diesel exhaust at certain intensities also causes inflammation in the lungs, which may aggravate chronic respiratory symptoms and increase the frequency or intensity of asthma attacks. Diesel exhaust and many individual substances contained in it (including arsenic, benzene, formaldehyde and nickel) have the potential to contribute to mutations in cells that can lead to cancer.

13.4. Noise

Epidemiological studies have found that exposure to environmental noise is consistently associated with cardiovascular diseases. The main health effects associated with environmental noise are:

- sleep disturbance;
- cardiovascular disease;
- cognitive impairment;

- tinnitus;
- annoyance; and
- hearing impairment.

Noise and vibration exposure data for the health risk assessment includes consideration of aircraft overflights as well as ground based noise. Residential areas and schools were identified as sensitive noise receivers in the draft EIS (see Appendix E) and are listed in Table 13–1 and shown in Figure 13–1.

Although the schools have been identified primarily for assessment of the potential impacts on child learning and cognitive development, they are also located in residential areas. Accordingly, the noise levels predicted at these locations would be representative of the exposure to noise for the local community, and have also been used in the assessment of sleep disturbance.

Table 13–1 – Representative sensitive noise receivers

Residential areas	
Kemps Creek	Silverdale
Rossmore	Rooty Hill
Schools	
Emmaus Catholic College (Kemps Creek)	Mount Druitt Public School
Luddenham Public School	Colyton High School
St Clair High School	Plumpton High School

Following the enHealth *Health Effects of Environmental Noise other than Hearing Loss* (2004) and World Health Organisation (WHO) guidelines (2009; 1999), the assessment of the potential impacts of aircraft noise considers the following noise metrics:

- L_{Aeq}: a measure of noise which represents the equivalent-continuous noise level averaged over a specified period;
- $L_{Aeq,11pm\text{-}7am}$ or $L_{night,outside}$: the equivalent-continuous noise level between 11pm and 7am. This metric is used to describe night time noise exposure and assess chronic health impacts associated with noise exposure;
- $L_{Aeq,9am\text{-}3pm}$: the equivalent-continuous noise level between 9am and 3pm. This metric is used to assess the impact of noise on school students and teachers; and

- L_{Amax}: a measure of the maximum noise level during a specified period. This metric is used to assess of night time noise impacts from aircraft overflights.

Using the findings from the noise impact assessments, the health risk assessment used these metrics to identify the potential for annoyance, sleep disturbance, increased likelihood of cardiovascular disease, and impacts on children's learning and cognitive development. In all cases, noise levels were calculated at an external point of the building. The noise level within a building would be significantly lower, depending on the building fabric and whether windows and doors are opened.

The predicted noise levels were calculated at specific locations (see Figure 13–1), using assumptions and procedures that are described in detail in the noise assessment reports in Appendix E.

13.5. Ground and surface water

Groundwater data from samples collected in 1995 and 1998 were compared to groundwater investigation levels from relevant guideline sources. A qualitative evaluation of the risk potential to identified waterbodies under current conditions at the site and in surrounding areas has been conducted.

The ANZECC (2000) guidelines set out key indicators which can be used to measure whether there is a potential risk to each environmental value. Indicators have been selected based on the appropriate level of protection for the waterways at and surrounding the site. These indicators provide a risk-based approach to assessing the potential for impacts to environmental values.

13.6. Existing environment

13.6.1. Airport site

The airport site covers an area of approximately 1,700 hectares located at Badgerys Creek in Western Sydney. The site is located approximately 50 kilometres west of Sydney's central business district and 15 to 20 kilometres from major population centres such as Liverpool, Fairfield, Campbelltown and Penrith.

The Northern Road transects the western end of the airport site and Elizabeth Drive borders the site to the north. Badgerys Creek flows in a north-easterly direction and forms the south eastern boundary of the airport site. The airport site is located on undulating topography that has been extensively cleared with the exception of stands of remnant vegetation located predominantly along Badgerys Creek and the south western portion of the site.

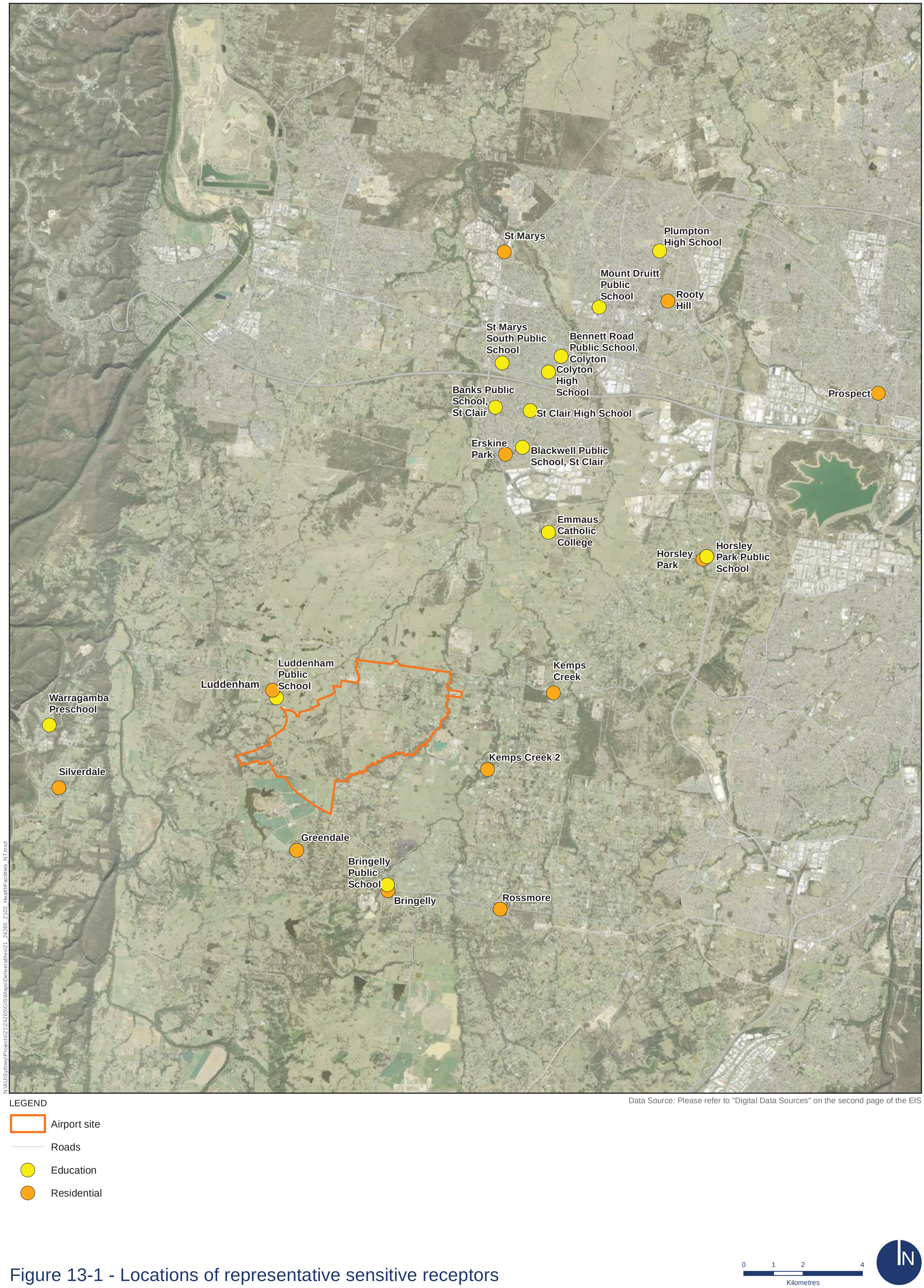


Figure 13-1 - Locations of representative sensitive receptors

13.7. Population profile

13.7.1. Demography

The airport site is located within the Liverpool local government area (LGA). The Liverpool LGA is bounded by Fairfield, Penrith, Camden, Wollondilly and Bankstown LGAs (see Figure 13–2).

Population statistics for the 2011 Census have been obtained from the Australian Bureau of Statistics for each of the localities surrounding the airport which have been considered in the health risk assessment. These statistics are shown in Table 13–2, with the localities sorted in order of increasing population size. It is noted that the stated population of Badgerys Creek would have included tenants on the airport site, however as the majority of these tenants have relocated, the current population would now be much lower.

The South West Sydney Local Health District forecasts in its Liverpool Community Health Profile (2014) that the population of Liverpool LGA will increase significantly from 188,088 people in 2011 to 288,959 in 2031. The highest rate of growth is anticipated in the age cohort 45-69.

13.7.2. Socioeconomic status

Consistent with assumptions found generally in epidemiological studies, people who are of a low socioeconomic status have been identified as a vulnerable group for the effects of air, noise and water pollution for the purposes of the health impact assessment. This is largely due to the fact that people within these groups usually have a poorer health status, may have limited access to medical care, and may live in more affordable areas which generally experience higher rates of pollution (e.g. near major roads or industry).

The health risk assessment adopts the Socioeconomic Indexes for Areas (SEIFA) as a measure of relative social disadvantage. This measure takes into account 20 variables (including income levels, educational attainment, unemployment, vocational skills).

SEIFA scores in Table 13–2 indicate that there are areas within the vicinity of the proposed airport with a lower socioeconomic status than the Australian average (SEIFA score of 1,000) or Sydney as a whole (SEIFA score of 1,025). The localities of Badgerys Creek, St Marys, Mount Druitt, Rooty Hill, Colyton and Warragamba all have low SEIFA scores indicating that the populations in these localities may be vulnerable to the effects of air, noise and water pollution from the proposed airport.

13.7.3. Health baseline

A baseline health status of the Liverpool LGA was prepared by the South West Sydney Local Health District as part of their 2014 Community Health Profile (see Table 13–3). This table summarises the key indicators for hospitalisations and mortality in the Liverpool LGA, compared to the average for NSW over the same period. Whilst Liverpool experiences a relatively higher number of coronary heart disease, diabetes, and fall related hospitalisations, it is generally comparable to the NSW health profile, having regard to the full range of measured health indicators for the population.

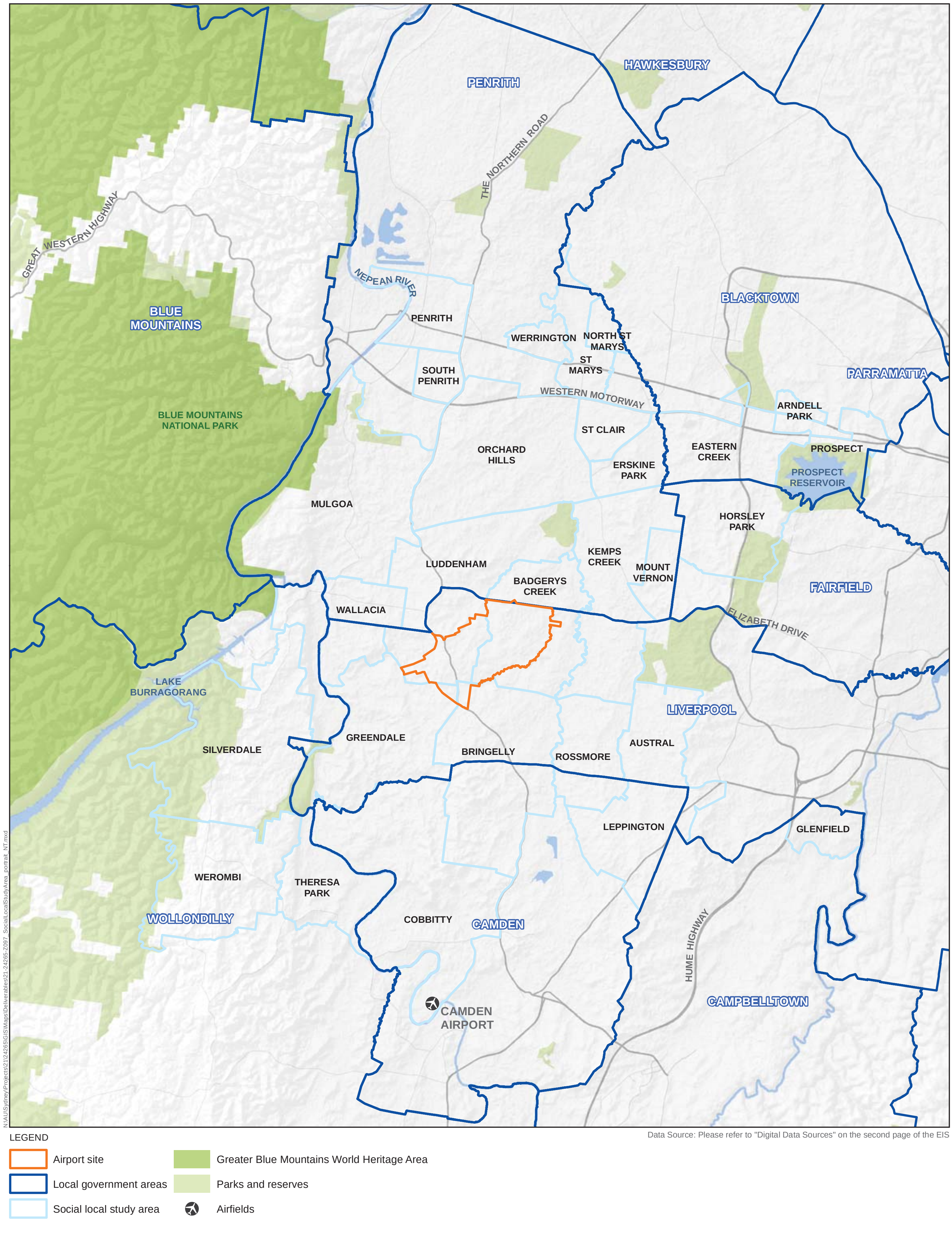


Figure 13-2 - Airport site and social local study area

Table 13–2 – Demographic profile of localities surrounding the airport site (ABS 2011)

Locality	Approximate distance to the airport (km)	Total population	Proportion of population older than 65 years of age (%)	Proportion of population younger than 15 years of age (%)	SEIFA index
Sydney (average)	–	–	13	19	1,025
Badgerys Creek*	3	455*	12	20	913
Warragamba	11	1,236	12	22	914
Wallacia	8	1,700	10	21	1,032
Horsley Park	13	1,936	16	18	1,007
Bringelly	6	2,387	10	21	1,036
Silverdale	11	3,439	7	24	1,077
Erskine Park	11.5	6,668	4	23	1,041
Plumpton	18.5	8,244	6	25	999
Mt Druitt	16	15,794	8	26	895
St Clair	12	19,837	6	21	1,013

*The population of Badgerys Creek includes tenants on the proposed airport site, however at the time the airport becomes operational, these tenants will no longer be occupying the site and therefore the population would be expected to be much lower.

Table 13–3 – Liverpool LGA baseline health status

Indicator	Liverpool	Proportion of NSW average (%)
Hospitalisations (2009/10 to 2010/11) per year	58,010	99.9
Alcohol attributable hospitalisations per year (2010/11 to 2011/12)	934	81.8
High body mass index attributable hospitalisations per year (2010/11 to 2011/12)	719	101
Chronic obstructive pulmonary disease hospitalisations (persons aged over 65) per year (2009/10 to 2010/11)	262	112.9
Fall-related injury overnight hospitalisations (persons aged 65 years and over) per year (2010/2011 to 2011/12)	572	116.9
Deaths		
Potentially avoidable deaths from preventable causes (persons aged under 75 years) (2006 to 2007)	122	96.6
High body mass index attributable deaths (2006 to 2007)	46	91.1
Smoking attributable deaths per year (2006 to 2007)	79	99.2

Over the period 2005 to 2007, Liverpool LGA had a higher mortality ratio of 107.3 (NSW baselined at 100). The life expectancy for both males (79.5) and females (83.4) was less than the NSW averages (males 79.6 and females 84.3).

According to the Liverpool Community Health Profile (SWSLHD), the asthma prevalence rate in people over 16 years of age in the area is 6.3 per cent. This is lower than the NSW average for the same age group.

13.7.4. Existing air quality

Air quality monitoring data collected between 2005 and 2014 from the NSW Office of Environment and Heritage monitoring stations in Bringelly, Macarthur/Campbelltown West, Liverpool and Richmond was used to describe the existing air quality in Badgerys Creek. A detailed outline of the available air quality data is provided in Appendix F1. Generally, air quality for the local area is good, with the exception of isolated high pollution days or extreme events such as dust storms and bushfires.

13.7.5. Existing hydrogeology

There are two principal local aquifers present beneath the airport site:

- a shallow alluvial aquifer which is considered to be localised around the main creeks which drain the site and is generally encountered at depths of approximately 0.7-4.7 metres below ground level; and
- a confined aquifer within the Bringelly Shale which is present at approximately 20 metres below ground level.

Perched groundwater may be intermittently encountered within the weathered shale profile, however it is not considered to be a continuous aquifer. In addition, a deep regional aquifer may be present at depths of greater than 100 metres below ground level within the Hawkesbury Sandstone.

It is unlikely the aquifers are interconnected based on geological information, water strike observations and groundwater elevation data. Both of the main aquifers present beneath the site are reported to have low hydraulic conductivity (0.0027-0.14 m/day).

Standing water level elevations (in surrounding registered bores) suggest that there is a strong downward head gradient between the Bringelly Shale aquifer and the underlying Hawkesbury Sandstone aquifer, which suggests that there is limited prospect of any hydraulic connectivity between the aquifers.

The Luddenham Dyke (which runs south-east to north-west in the south-west area of the site) is observed to create a divide in the Bringelly Shale aquifer with flow on the eastern side towards Badgerys Creek and on the western side towards Duncans Creek.

There are 42 registered groundwater bores within a five kilometre radius of the airport site. Twelve of these bores are registered as being used for domestic, stock, industrial, farming and irrigation purposes; these wells range in depth from 61-337 metres below ground level. The depth of registered extraction bores indicates that groundwater users extract water from the Hawkesbury Sandstone aquifer. This aquifer is known to be of higher value than the groundwater from the Bringelly Shale, which is of relatively poor quality.

13.7.6. Existing surface water conditions

Two main catchments drain the site: the South Creek Catchment and the Nepean River Catchment. There are several waterways that are within, or in the vicinity of, the airport site:

- Duncans Creek is located to the south-west of the site and drains to the Nepean River west of the airport site;
- Oaky Creek flows through the central and northern area of the airport site and then drains to Cosgroves Creek;
- Cosgroves Creek flows along to the north-west and north of the airport site, before draining into South Creek to north east of the site;
- Badgerys Creek flows along the southern and south-eastern boundary of the airport site and then drains to South Creek to the north east of the airport site; and
- Thompsons Creek is located to the south-east of the airport site and drains to South Creek to the south-east of the airport site.

Each of the above listed waterways has a number of small tributaries which drain the airport site and areas in the vicinity. Many of the creeks which drain the airport site and surrounding area may not flow continuously. During dry periods, only intermittent pools of water may remain along the creek beds.

Warragamba Dam is located approximately eleven kilometres west of the airport site and is one of Sydney's major drinking water supply dams. Prospect Reservoir is located approximately 18 kilometres north-east of the site. Prospect Reservoir is a potable water supply which is used during periods of high demand. The airport site is not located within the catchment area for either the dam or the reservoir. There are also numerous farm storage dams on and surrounding the airport site, as well as rain water tanks on properties around the site used for potable water.

The following uses of surface water have been identified on the airport site and surrounding areas:

- agricultural use, such as farm dams used for stock water and irrigation, and ecological habitat;
- potable untreated/pre-treatment domestic supply (Warragamba Dam and Prospect Reservoir);
- non-potable domestic use; and
- industrial use, with a few large scale industrial operations in the area observed to have large dams adjacent to their facilities, indicating that this water may be used for industrial purposes.

13.8. Assessment of impacts during construction

13.8.1. Air quality

Air quality modelling conducted for the construction phase has provided annual average and 24-hour average PM_{10} and $PM_{2.5}$ for the following activities:

- bulk earthworks; and
- construction of aviation infrastructure, including:
  - construction plant
  - concrete batching plant.

Details of the modelling and sources considered are provided in the local air quality assessment (see Chapter 12).

13.8.2. Particulates

Air quality modelling shows that 24 hour average PM_{10} levels from bulk earthworks would be below the current National Environmental Protection Measure (NEPM) standard of 50µg/m^3 at all residential locations assessed. The highest concentration is predicted at Badgerys Creek.

The highest predicted risk is for all-cause mortality from long-term exposures with between one additional death per 1000 years and one additional death per 100 years that are attributable to PM_{10}. All other risks would be lower than that predicted for long-term mortality.

As with PM_{10}, the predicted $PM_{2.5}$ concentrations are low and below the NEPM advisory reporting standard of 25µg/m^3. The highest concentrations are predicted for Greendale and Badgerys Creek.

The highest predicted risk attributable to $PM_{2.5}$ is for all-cause mortality and cardiopulmonary mortality from long-term exposures with between seven additional deaths per 10,000 years and four additional deaths per 1,000 years.

The predicted PM_{10} concentrations are higher than those during bulk earthworks but are still below the NEPM standard. The highest concentration is at Badgerys Creek. As with PM_{10}, the predicted $PM_{2.5}$ concentrations are higher than those predicted for bulk earthworks but still in compliance with the NEPM advisory reporting standard. The highest concentrations are predicted for Badgerys Creek, Greendale and Rossmore.

The highest predicted risks attributable to PM_{10} are for all-cause mortality from long-term exposures with between two additional deaths per 1000 years and one additional death per 100 years. The highest impacts are predicted at Luddenham, Bringelly, Kemps Creek and Badgerys Creek.

The highest predicted risks attributable to $PM_{2.5}$ are for all-cause mortality from long-term exposures with between three additional deaths per 1,000 years and two additional deaths per 100 years. All other risks are lower than that predicted for these outcomes. The highest predicted impacts are at Bringelly and Luddenham.

It should be noted that the construction of Stage 1 development would occur for a period of less than 10 years. Therefore the predicted risk levels associated with the construction phase are unlikely to be realised as they are predicted to occur over much longer timeframes (100 to 10,000 years).

13.8.3. Diesel

The increase in cancer risk has been calculated for the diesel particle inhalation pathway. International agencies have published unit risk factors (URF) for diesel. The URF is an estimate of the increase in risk with exposure to 1 µg/m^3 of the pollutant over a lifetime. For the purposes of this assessment, a lifetime is assumed to be 70 years. To calculate the lifetime cancer risk associated with the concentrations of diesel predicted to arise from emissions from the airport operations, the following equation has been used:

Increase in lifetime cancer risk = annual average concentration x URF

A review of the available unit risk factors has been undertaken as part of the health risk assessment. The URF from a guideline produced by the Californian Environment Protection Authority (California EPA) has been used in this study. The URF used to calculate the increased risk of cancer is 3×10^{-4} per 1µg/m^3 for the operations of the airport in 2030.

The health risk assessment predicts an increase in cancer risk attributable to diesel particles ranging from 1.3×10^{-6} to 8.4×10^{-6} per 1µg/m^3. Accordingly, the resultant cancer risk estimates are demonstrated to fall within levels for risk generally considered acceptable to regulators (by two orders of magnitude).

13.8.4. Noise

Construction noise impacts have been assessed in Chapter 11 and Appendix E2. Construction noise has the potential to result in minor exceedances to adopted criteria during earthworks undertaken in the north western sector of the site. Noise levels during construction fall within the ground based noise levels predicted for the airport operations. As such, construction noise is not anticipated to result in significant health risks to the surrounding community.

The airport site covers a broad area, and a range of management measures such as the placement of temporary noise barriers or exclusion buffers within the airport site could be considered with a view to mitigating disturbance to nearby receivers from construction activity.

13.9. Water

13.9.1. Local surface water catchment

The following activities during construction of the airport have the potential to result in impacts on surface water bodies:

- earthmoving activities and/or vegetation clearance resulting in potentially increased sediment loading in surface run-off;
- accidental spills of fuels or chemicals from construction vehicles which may discharge into surface water environments; and
- discharge of collected groundwater to surface water bodies which may contain potential contaminants that have not been adequately assessed prior to discharge.

These risks are typical of most major construction projects and standard precautionary measures are considered to be appropriate to address these issues. The recommended monitoring, management and mitigation measures identified in Chapter 18 are expected to reduce the potential for these risks to be realised during airport construction.

13.9.2. Sydney's drinking water catchment

Construction of the proposed airport is not located within the catchments for Warragamba Dam or Prospect Reservoir. However, there is potential that airborne particles from construction may be deposited within these two waterbodies through dispersion of airborne dust, potentially affecting water quality.

Warragamba Dam is approximately eleven kilometres from the airport site. Dispersion modelling forecasts an annual average deposition rate of 0.02µg/m^3 from the airport construction at Warragamba. This is unlikely to represent a significant risk to water quality. Prospect Reservoir is located further away, approximately 18 kilometres from the site. Airborne particle deposition is therefore also unlikely to be a significant risk for this site, given the separation distance.

Dust suppression mitigation measures outlined for air quality in Chapter 12 would further reduce the risk of these impacts.

13.10. Assessment of impacts during operation

13.10.1. Air quality

Overall, the analysis found that the health impacts associated with air quality impacts from the operation of the proposed airport would be in line with national and international standards of acceptability. This is consistent with the air quality assessments which found that emissions from the proposed airport would be within the relevant standards.

The analysis presented in this section should be viewed in the context of overall health in the Sydney basin. In particular, evidence provided by NSW Health to a Parliamentary Inquiry into health effects of pollution showed that in 2006 it was estimated that between 600 and 1,400 deaths per year were attributed to air pollution in the Sydney basin (NSW Parliament 2006). Based on these figures, the health impacts associated with emissions from the operation of the proposed airport are expected to represent a small increase in current rates of long-term mortality associated with air pollution.

13.10.2. Particulates

Annual average and 24-hour emissions for particulate matter (PM_{10} and $PM_{2.5}$) have been modelled as part of the air quality assessment. The average 24 hour NEPM ambient air quality standard for PM_{10} and $PM_{2.5}$ are 50µg/m^3 and 25µg/m^3 respectively and all predictions for emissions from operations of the proposed airport are below these levels.

The highest predicted 24 hour average PM_{10} concentration for airport operations is predicted at Kemps Creek and Rossmore, with a maximum level of less than 16µg/m^3. The highest predicted 24 hour average $PM_{2.5}$ concentration for airport operations is predicted for Kemps Creek, Badgerys Creek, Rossmore and Mulgoa, with a maximum level of less than 7µg/m^3.

Noting the predicted levels are within the relevant standards, the highest risk is for all-cause mortality from long-term exposures with between one additional death per 1,000 years and one additional death per 10 years attributable to PM_{10}. The highest risk is predicted for Kemps Creek with an additional one death per 10 years predicted in a population of 2,309.

Similar to $PM_{10,}$ the numbers of cases attributable to PM2.5 are low. The highest risk is for all-cause mortality and cardiopulmonary mortality from long-term exposures with between one additional death per 1,000 years and six additional deaths per 100 years. The highest risks are predicted for Kemps Creek and Rossmore which have a total population of 4,721. This increase in deaths is relative to the current health baseline in these areas. All other risks are lower than that predicted for these outcomes.

13.10.3. Nitrogen dioxide

The daily 24-hour nitrogen dioxide concentrations at residential receivers are predicted to be low. The air quality assessment identified that for all relevant averaging periods, the nitrogen dioxide levels due to the airport operations would be well below the current NEPM air quality standards. The levels predicted at all residential locations are similar, with slightly higher levels at Kemps Creek.

Based on the modelling data, the highest risk is for long-term mortality in people over 30 years of age with between six additional deaths every 100 years and six additional deaths in 10 years predicted. This risk relates to the combined emissions from the airport as well as airport-generated traffic on roads external to the airport.

Although the predicted air pollution levels meet the NEPM standards, it is recognised in epidemiological studies that there is no threshold for nitrogen dioxide below which adverse health effects are not observed. This means that even meeting the air quality standards means that there is a level of risk associated with exposure to nitrogen dioxide.

To enable an assessment of the risk posed by nitrogen dioxide emissions from airport operations in isolation, additional air dispersion modelling was conducted in the absence of traffic on roads outside the airport site. This enabled an assessment of the contribution of airport operations to the overall risk from exposure to nitrogen dioxide and helped to identify what mitigation could be implemented to reduce the overall risk. Without traffic emissions, airport operations alone may lead to four additional deaths every 10 years due to nitrogen dioxide.

It should be noted that the health risk assessment predictions do not take into account the implementation of any mitigation measures proposed in the draft EIS to reduce nitrous oxide emissions. The implementation of these mitigation measures identified in Chapter 12 and 15 would reduce the predicted health risks associated with air quality emissions.

13.10.4. Sulphur dioxide

Air dispersion modelling has predicted maximum 1-hour, 24-hour average and annual average sulphur dioxide concentrations for a range of receivers in the vicinity of the airport site. The daily 24-hour sulphur dioxide concentrations at the most affected receivers show that all levels are below the current NEPM air quality standard of 228µg/m^3. The levels are similar across most locations but higher at the receivers in Badgerys Creek, Greendale and Mount Vernon.

The results of the air quality assessment show that the risk from exposure to sulphur dioxide from the airport operations in 2030 is very low. Based on the modelling data, the highest risk is for hospital admissions from respiratory causes, with approximately three additional admissions per 1,000 years. Other risks associated with sulphur dioxide exposure are lower than this.

13.10.5. Carbon monoxide

The air dispersion modelling conducted as part of the local air quality assessment provided daily 8 hour maximum carbon monoxide levels for the worst affected locations in the vicinity of the airport site. The data indicates that the predicted carbon monoxide levels are higher at Kemps Creek, Bringelly, Rossmore and Badgerys Creek, however all predicted carbon monoxide concentrations are well below the NEPM standard of 10 mg/m^3.

The modelling results indicate that the predicted health effects associated with the proposed airport are very low. The highest risk is for hospital admissions for cardiovascular disease in people 65 years of age and older with a maximum of an additional five hospital admissions in 1,000 years. This risk is negligible.

13.10.6. Air toxics

The maximum predicted cancer risk was estimated using a unit risk factor adopted by the California EPA. The modelled maximum annual average concentration was 0.1 µg/m^3, resulting in an increase in cancer risk of 2.9 x 10^{-6}.

It is generally accepted by national and international regulatory agencies that an increase in risk between 1 x 10^{-6} (one in a million) and 1 x 10^{-5} (one in 100,000) is considered to be a low risk and therefore acceptable. The maximum predicted increase in cancer risk from exposure to benzene is very small and is well within the acceptable range.

13.10.7. Ozone

Peak daily ozone concentrations have been predicted for a number of days of airport operations in 2030 and the largest changes in ozone concentration have been calculated. Increases in ozone occur downwind of the airport site which, on most days, is to the south and southwest. Decreases in daily maximum ozone occur only in the vicinity of the airport site and are attributable to ozone suppression by fresh nitrous oxide emissions.

For the base year of 2009, the resulting risk for the outcomes assessed is between two in a million (respiratory mortality) and 1.8 in 100,000. For Stage 1 operations, the increase in risk ranges from one in a million for respiratory mortality to nine in a million for emergency department attendances for asthma in children. The largest predicted ozone concentration changes from the airport occur in a different location to the predicted daily peak ozone concentrations.

There is general agreement by international agencies including the World Health Organisation and the US EPA that acceptable risk levels fall between one in a million and one in 100,000. The increases in risk for the days assessed in the regional air quality assessment, fall well within these limits.

13.10.8. Noise

The assessment of health risks associated with aircraft noise and ground-based noise from the operation of the Stage 1 development are based on the findings of noise exposure presented in Chapter 10 and Chapter 11 of this draft EIS. The predicted risks associated with aircraft noise consider the differences associated with potential operating modes at the proposed airport (i.e. Prefer 05, Prefer 23 and head to head). Further information on these operating modes can be found at Chapter 10 of this draft EIS.

For night-time aircraft noise during Stage 1, under all potential airport operating modes, the results indicate that the highest noise levels are predicted at Luddenham. All other areas assessed would be below the WHO 40 dB criterion, which is the level of lowest observed adverse effects to public health. Regarding daytime noise levels during Stage 1, the highest noise levels of between 44-46 dB are also predicted at Luddenham. The noise levels at all other locations are predicted to be below 40 dB.

As outlined in Section 13.4, the health risk assessment considered three health outcomes for exposure to noise:

- sleep disturbance;
- increase in myocardial infarction; and
- effects on learning and cognitive development in children.

Dose-response relationships were adopted from the WHO for myocardial infarctions and induced awakenings. The dose-response relationships are derived from empirical studies and measure the risk relative to a change of an underlying variable, which in this case is noise.

Regarding the potential for sleep disturbance, the relevant metric used is EEG awakenings. An EEG awakening is a measure of disturbed sleep that is less than a fully awakened state. The European Environment Agency (2010) noted that per person, there are usually 24 awakenings per night, even during an undisturbed 8-hour sleep. For most operating modes the aircraft noise associated with aircraft traffic from the proposed airport would not increase this number. $L_{night\ outside}$ noise results indicate that the Prefer 05 mode results in more EEG awakenings across more localities than the Prefer 23 mode. The use of the head to head mode could reduce the number of EEG awakenings in some instances compared to both the Prefer 05 mode and the Prefer 23 mode.

The areas with the highest number of EEG awakenings are Luddenham (which has the highest number of awakenings overall no matter which operating mode is selected) and Silverdale. In both these cases, the use of head to head operating mode does not reduce the potential incidence of EEG awakenings as at other localities. The number of additional EEG awakenings per person per year due to aircraft noise is estimated to be between 0 and 40 (i.e. a 0-0.4 per cent increase) across all operating mode options. When the predicted additional EEG awakenings are considered in relation to the European Environment Agency (2010) findings above, the number of predicted additional EEG awakenings is very low.

To identify the potential for noise impacts on the learning and cognitive development of children, the WHO hazard quotient method was applied to daytime noise levels. A hazard quotient is the ratio of the potential exposure to a substance and the level at which no adverse effects are expected. If the forecast hazard quotient is less than 1, then no adverse health effects are expected as a result of exposure to the hazard. If the hazard quotient is greater than 1, then adverse health effects are possible. It should be noted that a hazard quotient exceeding 1 does not necessarily mean that adverse effects will occur.

The WHO has identified that the noise level for potential increases for myocardial infarction (heart attacks) is 55 dB $L_{night,\ outside}$. For all receivers assessed for overflight noise impacts, the $L_{night,\ outside}$ predicted levels were below 55 dB. This was observed for all years assessed and all operating modes. On the basis of these results, it can be concluded that aircraft noise would not lead to any increased risk in myocardial infarction in communities in the vicinity of the airport site.

Having regard to the airport proposal, most hazard quotients are less than one, indicating that the risk from the aircraft overflight noise from each of the proposed modes of operation generally do not pose an unacceptable risk (enHealth 2012).

In some cases there are marginal exceedances of one. This does not mean that there will be an impact on children's learning and cognitive development but that there is an increased risk, albeit very low.

Noise mitigation measures proposed in Chapter 10 of the EIS would reduce this potential risk.

13.10.9. Ground based operations

Noise from ground based operations (airport operational noise on the ground) has the most impact on the localities closest to the proposed airport, in particular Luddenham. The combined effects of aircraft overflight and ground based operations noise is predicted to lead to an additional 13 to 15 EEG awakenings (i.e. a 0.15 to 0.17 per cent increase) per year per person, depending on the operational mode adopted.

For ground based sources, the $L_{night\ outside}$ levels predicted for Luddenham exceeded the 55dB threshold. Based on the WHO exposure response curve, the levels predicted for Luddenham may result in an increase in myocardial infarction of approximately two per cent. In terms of children's learning and cognitive development from ground based operational noise, the hazard quotients experienced at Luddenham exceed one.

Noise mitigation measures proposed in Chapter 11 of this EIS may reduce this potential risk.

13.10.10. Water

A number of activities undertaken during the operation of the proposed Western Sydney Airport have the potential to result in the contamination of ground and surface water. These activities include chemical and fuel storage, equipment operation, equipment maintenance and firefighting. Potential contaminants include petroleum hydrocarbons, heavy metals, polyaromatic hydrocarbons, perflourinated compounds and chlorinated hydrocarbons.

Aqueous film-forming foams (AFFF) have historically been used for firefighting purposes at airports, at fuel depots, hangars and for aviation rescue and fire-fighting (for both operational and training purposes). AFFF products historically used on airport sites contain perfluorinated or polyfluorinated compounds, or fluorosurfactants (PFCs). Depending on the type of AFFF used, the principal PFC constituents could have included perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) and fluorotelomers such as 6:2 fluorotelomer sulfonate (6:2FtS) and 8:2 fluorotelomer sulfonate (8:2FtS).

AFFF has not been used for aviation rescue and fire-fighting by Airservices Australia since 2010, but continues to be used around fuel depots and hangars at many airports (GHD 2015 b).

13.10.11. Groundwater

Based on available information relating to the types of activities which will be conducted during construction and operation of the airport, there is considered to be minor potential for risks to the environmental values of groundwater in the alluvial and Bringelly Shale aquifers.

Groundwater bores are recorded as being constructed to significant depths and are understood to target the underlying Hawkesbury Sandstone aquifer.

The management and mitigation measures identified in Chapter 18 would be implemented to reduce the potential for these risks to occur. It is noted however that the potential for exposure to groundwater contaminants by off-site users of extracted groundwater is minimal as bores draw from the Hawkesbury Sandstone aquifer.

13.10.12. Surface water

The indicative flight paths for the proposed Stage 1 development are located above the catchment areas for Warragamba Dam and Prospect Reservoir. In addition, through consultations there have been concerns raised by parts of the community about the potential for aircraft emissions to impact on the quality of tank water in the area close to the airport site.

A qualitative evaluation was conducted to understand the potential for these activities, and activities at the airport site, to impact on surface water bodies in and around the airport site. The following operational activities were considered for their potential to impact on surface water:

- the accidental spill of stored chemicals or fuels from vehicles, which may be released to nearby surface water environments;
- the release of stored groundwater, which has not been adequately characterised with regard to contamination concentrations, to surface water bodies;
- the deposit of aircraft emissions to nearby surface water bodies which may result in increased contaminant loading to waterways; and
- the very rare event of aircraft jettisoning fuel during emergency incidents as aircraft approach the site.

Based on available information there is considered to be a low risk for operation of the proposed airport to impact on the environmental values of surface water.

In relation to accidental spills and stored groundwater, the health risk assessment found that there was very low risk of airport operations impacting on nearby surface water bodies. In addition, the mitigation measures outlined in Chapter 17 (topography, geology and soils) Chapter 18 (Surface water and groundwater) would be implemented to reduce the potential for surface water risks.

For aircraft emissions, there are currently no data available which can be used to assess whether emissions from aircraft operations would result in increased loading of contaminants to surface waters. However, air dispersion modelling was conducted as part of the air quality assessment (see Chapter 12) to predict ground level concentrations of volatile organic compounds (VOCs) and PM_{10} in areas close to the airport site. The maximum predicted concentration of benzene within five kilometres of the airport site is 0.1 $\mu g/m^3$ and diesel particles 0.8 ng/m^3. These concentrations are very low and would not impact on the quality of tank water.

As discussed in Chapter 7, fuel jettisoning for commercial aircraft is very rare and only occurs during emergency circumstances where an unscheduled landing is required. Based on the information presented in Chapter 7, it is considered unlikely that the jettisoning of fuel will result in impacts to surface water bodies surrounding the proposed airport site.

13.11. Mitigation and management measures

Potential impacts to human health associated with the construction and operation of the proposed airport would be directly related to potential noise, air quality and water quality impacts that are described in the relevant sections of this draft EIS. The mitigation measures described to manage potential issues associated with these other disciplines would be expected to reduce the potential impacts to human health. These mitigation measures are described in Chapters 10, 11, 12, 17 and 18 of this EIS.

13.12. Conclusion

The health risk assessment considers the likely health impacts of construction and operation of Stage 1 of the proposed airport. The assessment considers the predicted risk associated the proposed airport on human health from the most likely contaminant exposure pathways: air, noise and surface water risks.

Overall, the assessment found that the predicted health risk associated with the proposed airport would be in line with national and international standards of acceptability. The implementation of mitigation measures associated with noise, air quality and surface water described in the relevant chapters of this draft EIS would further reduce the predicted risk.

14. Hazard and risk

This assessment considers the key hazards and risks that may arise from the construction and operation of the proposed Western Sydney Airport.

The analysis was based on a review of relevant project documentation including a number of studies conducted for the EIS and local and international aircraft safety data, a conceptual airspace risk model and a series of workshops with key project stakeholders.

Many aspects of the airport design are preliminary and a number of important considerations will only be resolved close to the commencement of operations. While this may be the case, certification of the aerodrome by the Civil Aviation Safety Authority will be required before operations can commence, as well as implementation of the requirements of the existing regulatory framework. Satisfying these regulatory requirements will necessitate detailed design studies.

Based on the design information currently available, no insurmountable risks associated with the proposed Stage 1 airport development are considered likely. Key issues that need to be finalised prior to the operation of the proposed airport include:

- resolution of potential offsite risks associated with jet fuel storage;
- reservation of a pipeline corridor to secure future fuel supply by means other than road transport;
- additional bird and bat surveys to confirm the preliminary low risk identified to date;
- completion of a study to identify stack emissions in the proposed airspace; and
- implementation of development controls on public safety zones outside Commonwealth land.

Prior to operations commencing at the airport, a safety review would need to be undertaken in accordance with the requirements of the applicable work, health and safety legislation.

14.1. Introduction

As part of the development of this environmental impact statement, a hazard and risk review of the Western Sydney Airport proposal was undertaken (refer to Volume 4, Appendix H).

The assessment of key risks associated with the construction and operation of the proposed airport adopted a precautionary approach, consistent with the provisions of the *Work Health and Safety Act 2011* (Cth) and *Work, Health and Safety Act 2011* (NSW). Due to the preliminary nature of the design, including indicative flight tracks and limited other relevant airspace and terminal design information, a comprehensive due diligence assessment of the proposed airport was not possible.

A review was therefore considered appropriate for the purposes of the EIS, given that a safety assessment to demonstrate due diligence in accordance with WHS legislation would be required before the start of Stage 1 operations. This chapter draws on that study and other work by the Australian Government agencies (such as Airservices Australia), as described in Chapter 7.

14.2. Methodology

The study methodology comprised:

- documentation review – including the findings of the 1997–99 EIS risk study, current project design documentation, and national and international aviation safety statistics;
- legislative context – to establish the legislative context for the proposed airspace and ground operations at the proposed airport;
- development of a conceptual airspace risk model – to provide a framework for a systematic process to identify possible hazards and risks; and
- stakeholder workshops – to discuss identified risks and seek expert opinion on these and any other risks and treatments that should be considered for the proposed airport.

14.2.1. Document review

A number of background documents were reviewed as part of the hazard and risk assessment process, including:

- 1997–1999 Environmental Impact Statement: Technical Paper 10 – Hazards and Risks (PPK 1997);
- Western Sydney Airport: Preliminary Airspace Management Analysis (Airservices Australia 2015);
- Western Sydney Airport Climatological Review (Bureau of Meteorology 2015a);
- Western Sydney Airport Usability Report – Meteorological Impacts (Bureau of Meteorology 2015b); and
- Western Sydney Airport indicative airport layouts.

14.2.2. Legislative context

The following Commonwealth legislation applies to airports and aviation:

- *Civil Aviation Act 1988;*
- *Civil Aviation Regulations 1988;*
- *Civil Aviation Safety Regulations 1998;*
- *Air Navigation Act 1920;*
- *Airspace Regulations 2007;*
- *Airports Act 1996*;
- *Airports (Protection of Airspace) Regulations 1996;*
- *Air Navigation Regulations 1947;*
- *Airport (Building Control) Regulations 1996;*
- *Airport (Environment Protection) Regulations 1997;*

- *Airports Regulations 1997;*
- *Airports (Control of On-Airports Activities) Regulations 1997;*
- *Airports (Ownership and Interests in Shares) Regulations 1996;*
- *Aviation Transport Security Act 2004; and*
- *Aviation Transport Security Regulations 2005.*

The Civil Aviation Safety Authority (CASA) has primary responsibility for the safety regulation of civil air operations in Australia. The Civil Aviation Regulations 1988 and the Civil Aviation Safety Regulations 1998 provide the general regulatory controls for the safety of air navigation. The regulations empower CASA to issue Manuals of Standards with detailed technical material, which support the regulations. The following Manuals of Standards are relevant to the proposed Western Sydney Airport:

- Manual of Standards Part 139 – Aerodromes;
- Manual of Standards Part 139H – Standards Applicable to the Provision of Aerodrome Rescue and Fire Fighting Services;
- Manual of Standards Part 172 – Air Traffic Services;
- Manual of Standards Part 171 – Aeronautical Telecommunication and Radio Navigation Services; and
- Manual of Standards Part 173 – Standards Applicable to Instrument Flight Procedure Design.

Prior to the proposed airport commencing operations, CASA would need to be satisfied that appropriate operating procedures, and necessary infrastructure and personnel are in place to ensure the safety of aircraft operations in accordance with the Civil Aviation Act and the CASRs. Aircraft operations around the proposed airport would be controlled by the range of aviation-specific Commonwealth Acts and Regulations outlined above.

14.2.2.1. Airspace protection

The airspace at and around airports is protected under Part 12 of the Airports Act and the *Airports (Protection of Airspace) Regulations 1996* (APAR). The protected airspace is defined using international standards as the space above two sets of operational surfaces above the ground around an airport, namely the:

- Obstacle limitation surface (OLS); and
- Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS) surfaces.

The OLS is intended to provide protection for aircraft flying into or out of the airport when the pilot is flying by sight. The PANS-OPS surfaces are intended to safeguard an aircraft from collision with obstacles when the aircraft's flight may be guided solely by instruments, in conditions of reduced visibility.

The Airports Act defines any activity resulting in an intrusion into an airport's prescribed airspace to be a 'controlled activity', and requires that controlled activities cannot be carried out without approval. The APAR provide for the Secretary of the Department Infrastructure and Regional Development to assess and approve applications to carry out controlled activities, and to impose conditions of approval. A controlled activity which results in an intrusion into the airspace above the OLS may be permitted if assessed as acceptable by CASA. CASA may require the approved obstacle to be marked and/or lit.

Long term intrusions into the airspace above a PANS-OPS surface are not permitted as these have a direct impact on the safety of aircraft flying an instrument approach or departure procedure. Buildings and other structures are considered to be controlled activities within the meaning of the Airports Act and the APAR and are dealt with accordingly.

14.2.2.2. Control of development in the vicinity of airports

The National Airports Safeguarding Framework (NASF) is a national land use planning framework, agreed to by Commonwealth, State and Territory Ministers in 2012. The NASF recognises that responsibility for land use planning rests with State and local governments, but that a national approach can assist in improving planning outcomes on and near airports and flight paths.

The NASF guidelines provide comprehensive information and recommendations relating to six airport safeguarding matters. The NASF guidelines are:

- Guideline A: Measures for Managing Impacts of Aircraft Noise;
- Guideline B: Managing the Risk of Building Generated Windshear and Turbulence at Airports;
- Guideline C: Managing the Risk of Wildlife Strikes in the Vicinity of Airports;
- Guideline D: Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation;
- Guideline E: Managing the Risk of Distractions to Pilots from Lighting in the Vicinity of Airports; and
- Guideline F: Managing the Risk of Intrusions into the Protected Airspace of Airports.

Additional guidelines for the protection of public safety zones and communication, navigation and surveillance infrastructure are proposed to be developed by National Airports Safeguarding Advisory Group in the near future.

The assessment of proposed development in the vicinity of airports is primarily the responsibility of local government, based on declared airspace arrangements. Once the airspace has been declared for the proposed airport, surrounding councils would be notified and OLS and PANS-OPS requirements would be incorporated into local planning instruments. Development with the potential to exceed the OLS must be referred to the airport operator and the Department of Infrastructure and Regional Development for review prior to development proceeding. The OLS applies to both building obstacles (e.g. antennae, masts or tall buildings) as well as hot or high velocity air emissions which may cause a potential hazard to aircraft. In addition to OLS, civil aviation regulations also require approval from CASA for the installation of lighting which might cause a distraction, glare or confusion for pilots.

14.2.2.3. Dangerous goods

There is specific legislation related to the management of dangerous goods. For the storage and handling of dangerous goods (which includes jet fuel), the responsible authority in NSW is WorkCover. Australian Standard *AS 1940-2004 – The storage and handling of flammable and combustible liquids* deals with flammable liquids of dangerous goods classified as Class 3 substances (flammable liquids) in the UN *Recommendations on the Transport of Dangerous Goods – Model Regulations.* The objective of AS 1940-2004 is to promote the safety of persons and property where flammable or combustible liquids are stored or handled, by providing requirements and recommendations that are based on industry best practices.

The authority with regard for the transport of dangerous goods is the NSW Environment Protection Authority (EPA) under the provisions of the *Dangerous Goods (Road and Rail Transport) Act 2008* (NSW). The approval authority for a fuel pipeline would be the NSW Department of Trade and Investment (Resources and Energy) under the provisions of the *Pipelines Act 1967* (NSW).

14.2.2.4. Hazardous industries

The NSW Department of Planning and Environment also provides guidelines for the planning and development of hazardous industry in NSW which applies to land outside of the airport site. Relevant guidelines include the NSW *Hazardous Industry Planning and Advisory Paper* (HIPAP) series of guidelines:

- HIPAP 4 – Risk Criteria for Land Use Safety Planning (January 2011); and
- HIPAP 10 – Land Use Safety Planning (January 2011).

14.2.3. Conceptual airspace risk model

In conceptual terms, the airport airspace risk analysis approach considers risks in three parts: the entry (arrival and landing), exit (departure and take-off) and transit through the relevant airport airspace. There are a number of factors that add complexity to an airport airspace, including:

- terrain and weather;
- the number and variety of airspace activities;
- multiple runway operations (where applicable);
- possible airspaces resulting in increased traffic density;
- potential runway intrusions including animals;
- public and other environmentally sensitive facilities and activities adjacent to the airport that may affect operations (e.g. population centres, especially schools and hospitals);
- speed differentials between aircraft at the airport; and
- pilot experience differentials.

These issues were tested in stakeholder workshops in order to systematically consider possible airspace risks at the proposed airport and identify, in a preliminary manner, existing regulatory and potential other risk treatments.

14.2.4. Stakeholder workshops

Workshops with representative key stakeholders were completed to identify credible risk issues that should be addressed by the hazard and risk assessment.

Workshops or meetings were undertaken with the following stakeholders:

- Department of Infrastructure and Regional Development;
- Civil Aviation Safety Authority, Office of Airspace Regulation;
- Airservices Australia;
- NSW Department of Planning and Environment;
- Australia Federal Police; and
- NSW Rural Fire Service.

14.3. Identified key risks

The risk review process identified a list of key credible hazards that were the subject of analysis and discussion with stakeholders. These can be broadly considered as either airspace or ground-based risks and are outlined in Table 14–1. It should be noted that while each of these risks has a different likelihood of occurrence, they were identified on the basis that each could potentially result in either injury or loss of life to members of the public, airport workers or airline staff.

Table 14–1 – Identifed key risks

Airspace	Ground-based
Bat and bird strike	Aircraft fire (on the ground)
Drone and model aircraft strike	Building fire
Airspace obstruction	Fuelling fire
Mid-air collision with other aircraft	Grass fire
Military and emergency services operations	Fuel storage fire
High velocity air discharge	Contaminated land (during construction)
Adverse meteorology	Transport of dangerous goods
Aircraft crashes into critical infrastructure	Site flooding
Falling aircraft	Railway safety
Terrorism incidents	Bushfire

For the purposes of the hazard and risk assessment process, these risks were considered separately, as they may have different causes, and mitigation measures would be specific to each risk. For the purposes of the summary below, they have been grouped into broad categories for more general discussion.

14.4. Airspace risk overview

Australia has a good aviation safety record, comparable to other developed countries such as the United States, Canada and the United Kingdom. Statistics collected by the Australian Transport Safety Bureau (ATSB) indicate that the number of reported safety incidents in Australia has risen significantly over the past decade. However, not all incidents result in a physical accident and the growth in incidents reported needs to be considered in light of the continuing increase in aircraft movements. In 2013, among 3.3 million departures of high capacity public transport aircraft, there were 23 serious incidents (occurrences nearly leading to an accident) and two accidents in which serious injury or damage to an aircraft or person occurred.

The 23 aircraft involved in serious incidents in 2013 was the highest rate for this operation type in more than 10 years (ATSB 2014). The most common occurrences reported were wildlife strikes, adverse weather and aircraft system problems. Most accidents and serious incidents involved reduced aircraft separation distance, engine malfunction, or runway excursions.

No fatalities involving high capacity commercial aircraft operations similar to the type proposed at Western Sydney Airport have occurred since 1975 and the number of reported fatal accidents and fatalities declined significantly between 1990 and 2005 to a level considered to be very low (ATSB 2006a).

14.4.1. Flight tracks

Indicative flight tracks have been developed by Airservices Australia for use in the EIS. The indicative design demonstrates that in 2030, it would be possible to independently manage the operations of Sydney Airport and the proposed airport. The indicative airspace design did not consider potential noise or other environmental considerations. A future formal airspace design process is expected to be undertaken closer to the commencement of operations at the proposed airport. Chapter 7 provides further detail on the indicative flight path design, however it is noted that these flight tracks would avoid key infrastructure locations such as Defence Establishment Orchard Hills, the Warragamba Dam wall and Prospect Reservoir.

Commencement of operations of the second runway at the proposed airport would introduce additional complexity to airspace arrangements. Current analysis suggests that a broader reconfiguration of the Sydney Basin airspace would likely be required. However, changes in land and improved navigation technology over time would have some influence over the extent of future reconfigurations.

Similar to the indicative Stage 1 flight paths, a rigorous process of airspace design and approval would need to be undertaken prior to commissioning of a second runway. This two runway scenario at the proposed airport is discussed in Chapter 34.

14.4.2. Navigation systems and air traffic management procedures

A variety of satellite and ground-based navigational aids would provide necessary safety for aircraft approaches and departures in reduced visibility conditions. The required accuracy, operation and availability of these facilities are strictly controlled under the CASR. All aircraft that would operate at the proposed airport in reduced visibility conditions would need to be suitably equipped to use the available navigational aids. Radar services would assist air traffic control to manage air traffic in the controlled airspace surrounding the proposed airport under the CASR.

A satellite assisted precision landing system, known as a ground based augmentation system (GBAS) is proposed for the airport. The system uses GPS signals to provide aircraft with very precise positioning guidance during the final stages of an approach and landing. Airservices Australia and ICAO recognise GBAS as a potential future replacement for current instrument landing systems and adoption of this technology is considered to be a critical component of next-generation air traffic management infrastructure. Each GBAS can precisely guide up to 26 approach flight paths simultaneously from up to 42 kilometres from the runway. The proposed airport would likely include two GBAS – one for each runway.

Another example of emerging technology in the aviation sector is the adoption of automatic dependent surveillance-broadcast for all instrument flight rules (IFR) aircraft. This system allows aircraft to broadcast their position, velocity and other flight details in real time for flight tracking. The technology is being rolled out in the Sydney basin. It is anticipated that the proposed airport would similarly adopt emerging technology and that future incidents would decrease.

As discussed in Chapter 7, the indicative airspace design includes adoption of a ‘point merge’ for aircraft approaches. The point merge method of sequencing arriving traffic was introduced in Norway in 2011 and has been gaining popularity in European and Asian airports such as Seoul and Kuala Lumpur. One of the cited benefits of this new concept is safety improvements through a reduction of tactical vectoring, increased situational awareness in pilots and a lower workload for air traffic control staff.

14.4.3. Bat and bird strike

Birds are attracted to large, open grassed areas which are often found on an airports. Such areas provide feeding, resting and nesting areas for many types of birds. Short grass provides protection against predators such as snakes, cats and foxes but may also attract predatory birds in search of rodents and other food sources. Water lying in drains and dams on the airport site may also provide suitable habitat for ibis and ducks. Large open hangars and other flat roofed buildings can also provide nesting areas for small birds.

The environment surrounding airports can also attract birds. These may be natural habitat areas (e.g. wetlands) or urban features such as landfills. Birds and flying foxes can transit across airports and flight paths while travelling between nesting, roosting and feeding sites.

Modern aircraft engines are designed to deal with bird or bat strike. The key issue is the size and flocking habits of the species in and around an airport. While in the worst case bird or bat strike can lead to serious aircraft incidents, the more likely consequence is damage to aircraft and inconvenience to the travelling public.

A preliminary bird and bat strike report (refer to Appendix I) identifies the type and number of species that would likely to be in the vicinity of the proposed airport. It concludes that, unlike many other Australian airports that are situated in coastal areas where birds are more likely to exist, the risk at the proposed airport is comparably low. A range of standard activities and procedures throughout the design, construction and operational phases are would be undertaken to confirm the preliminary results and reduce the areas for potential habitats of various species before airport operations begin. This would include measures to be adopted both on- and off-site, in accordance with the requirements of applicable regulations such as NASF, CASA Advisory Circular 139-26(0) and ICAO requirements.

14.4.4. Airspace obstructions

Airspace obstructions and distractions (e.g. lighting and glare) can be a threat to navigation, but these are controlled through CASA standards and guidelines and through development control assessments of local developments.

A preliminary survey for obstacles in the proposed airport is being conducted to identify any necessary changes to surrounding areas. It should be noted that not all identified obstacles may need to be removed or demolished. Depending on the level of risk posed to aircraft operations, other options such as notifying pilots may be an acceptable resolution. Typical obstructions may include radio masts and transmission towers as well as natural features.

Another type of hazard is hot air discharges such as industrial emissions (stack discharge). Emissions above certain velocities, or chimneys above specified heights, are considered potential hazards in accordance with the Airports (Protection of Airspace) Regulations 1996.

Before the start of airport operations, a survey would be required to identify existing industrial emissions that may pose a hazard to aircraft. Any future industrial developments within the declared airspace would need to be referred to the Department of Infrastructure and Regional Development and the airport-lessee company for comment prior to the development proceeding.

14.4.5. Adverse meteorology

In aviation terms, adverse meteorology refers to the following conditions:

- aircraft icing (freezing fog);
- crosswind (especially gusts);
- cyclones/tornados;
- fog (visibility);
- lightning (thunderstorm); and
- windshear (especially in the vicinity of the runway threshold).

The likely occurrence of these meteorological conditions at the airport site was investigated by the Bureau of Meteorology (refer Appendix D) and the outcomes are summarised in Chapter 7. No unusual conditions are likely to exist at the site that would routinely interfere with safe operation at the proposed airport site. A site automatic weather station would collect a comprehensive baseline of local weather conditions before the start of operations to support further analysis. Provided that appropriate airport operating parameters are established and complied with, operational safety concerns associated with adverse meteorology at the airport would be satisfactorily managed.

14.4.6. Aircraft accidents

Australia has a good aviation safety record, comparable to other developed countries. No fatalities involving high capacity commercial aircraft operations similar to the type proposed at Western Sydney Airport have occurred since 1975, and the number of reported fatal accidents and fatalities declined significantly between 1990 and 2005 to a level considered to be very low (ATSB 2006a).

The Civil Aviation Safety Authority (CASA) recently completed an aeronautical study of the airspace arrangements in the Sydney Basin within 45 nautical miles of Sydney Airport. One of the findings of the report was that the Sydney Basin has shown a decreasing rate of total airspace related incidents over the past six years. Most incidents related to airspace involved operational non-compliance or navigation problems resulting in airspace infringements by visual flight rule (VFR) aircraft and did not result in significant safety hazards. This supports the overall findings of the ATSB review.

Aircraft accidents involving multiple fatalities are a rare occurrence in Australia and worldwide (ATSB 2006b). Figure 14–1 provides a summary of commercial jet aeroplane operations between 1959 and 2013 and indicates that over the 54 years of analysis, the annual fatal accident rate has reduced from 40 (1959) to less than 0.5 (2013) per million departures (Boeing 2014).

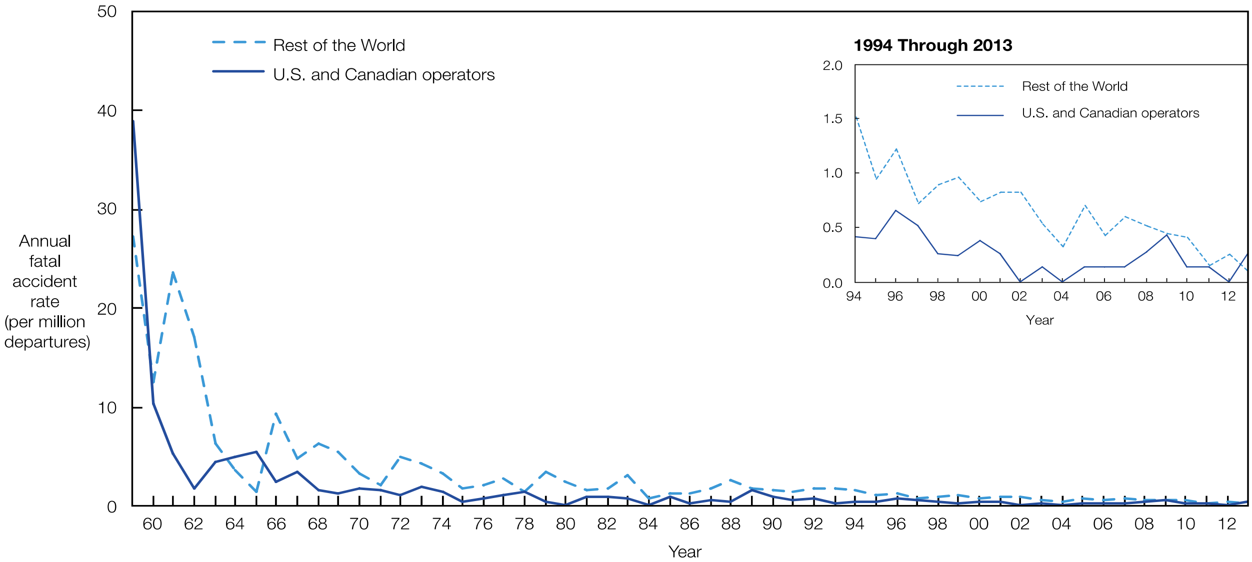


Figure 14–1 – Summary of annual fatal accident rate between 1959 and 2013.

Figure 14–2 summarises the percentage of fatal accidents by stage of flight which indicates that:

- 10 per cent are likely to occur on the ground during taxiing, loading/unloading, when the plane is being parked or towed;
- 14 per cent are during take-off or initial climb to cruising altitude;
- 10 per cent are during level flight at cruising altitude;
- 11 per cent are during descent and on initial approach to landing; and
- 47 per cent are during final approach or landing.

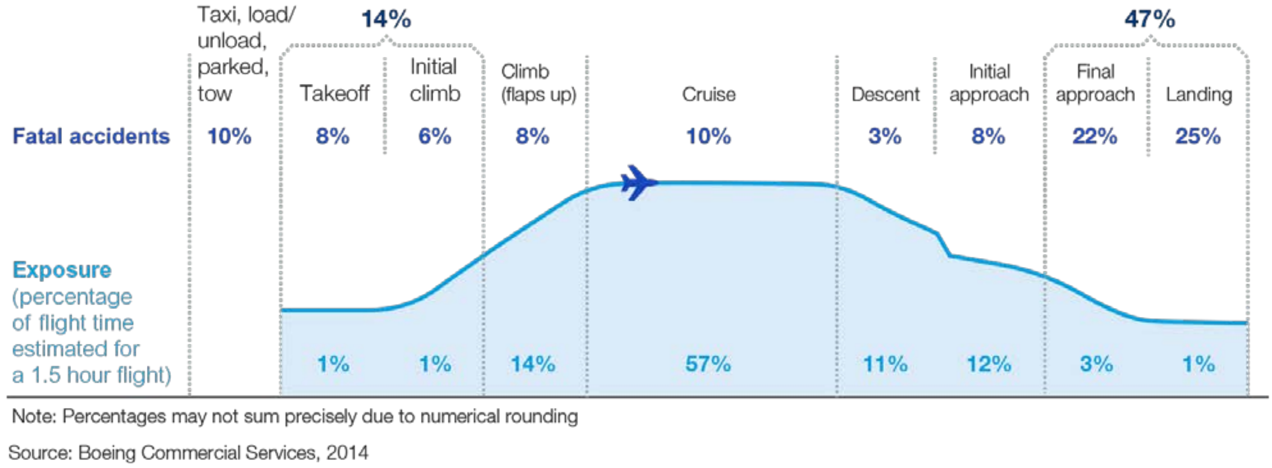


Figure 14–2 – Percentage of fatal accidents by flight stage

ICAO reports that most aircraft crashes occur within 1,000 metres of landing and 500 metres of take-off (ICAO 2014). The Australian Government is working with the states and territory governments on the development of a national standard for public safety zones (PSZ) to be incorporated into the NASF. PSZ are areas of land at the ends of runways within which development may be restricted in order to control the number of people on the ground at risk of injury or death in the event of an aircraft accident on take-off or landing. While Australia has an excellent aviation safety record there will always be an inherent risk associated with flying and operation of aircraft at or around airports. The use of PSZs can further reduce the already low risk of an air transport accident affecting people near airport runways. In the absence of any nationally agreed guidance, a nominal 1,000 metre trapezoid-shaped clearance off the end of the proposed runway threshold has been provided in the 2030 airport concept.

An estimate of the likely risk of plane crashes resulting from the proposed airport has been undertaken based on the most recent year of accident data available. In 2013, Boeing reported five major accidents occurred worldwide in their fleet as a result of 25 million departures that year. This equates to an accident likelihood of 2×10^{-7} per departure. Table 14–2 shows the likelihood of an accident for the proposed Stage 1 development based on forecast total annual air traffic movements and the 2013 accident statistics.

Table 14–2 – Predicted likelihood of an accident for Stage 1 airport development

	Total annual air traffic movements (passenger and freight)	Departures (per year)	Likelihood of major accident per departure	Major accidents per year	Years between major accidents	Years between major accidents on final approach or runway
Stage 1 (2030)	63,000	31,500	0.0000002	0.0063	159	317

As indicated in the table, the accident rate for aircraft operating at the proposed Western Sydney Airport in 2030 would be in the order of 1 in 150 years for all stages of flight. It should be noted that this estimate is based on forecast air traffic movements at the airport and an accident rate based on current aviation technology and practices around the world. As outlined in Section 1.4.2, aviation procedures and technology are continually improving, particularly in response to ongoing incident investigations, and therefore it is likely that improved safety performance would be achieved over time.

14.4.7. Terrorism

At this preliminary design stage, no specific issues or precautions beyond those in use at Sydney Airport or other similar international facilities are envisaged for the proposed airport. The detailed design of the proposed airport facilities would be reviewed by security experts to ensure that adequate space for security facilities and personnel is provided and additionally, that the design minimises potential vulnerabilities. Terrorism response considerations could include including provision of aircraft stand-off bays.

14.5. Ground based issues

14.5.1. Transport of dangerous goods

It is expected that jet fuel would initially be transported to the airport site by B-double road tankers to the airport site. In 2030 (approximately five years after opening), the expected fuel demand would require approximately 43 B-double fuel deliveries per day. This number of deliveries would continue to rise in line with the increased aircraft movements at the airport.

It is not currently possible to identify what traffic routes are likely to be used for fuel deliveries, although it is expected the majority of the trip would be by high capacity, arterial roads or motorways, and locally via the M7 and future M12 motorway. This is not a large number of trucks, relative to road capacity or existing heavy vehicle volumes.

At a future point, likely before the operation of the second runway, a fuel supply pipeline would replace the need for supply by a large numbers of road tankers. A route for a fuel pipeline will be determined by the entity or organisation responsible for providing fuel to the airport. Arrangements for access to the fuel pipeline, which may involve an easement, would be required along the pipeline corridor alignment to ensure maintenance access and as a public safety measure. This may include planning controls restricting development on, and adjacent to, the pipeline.

14.5.2. Fuel storage and other fires

The concept design for jet fuel storage as part of the Stage 1 development includes four by 2.5 megalitre storage tanks in a two-by-two configuration, each within a 100 by 100 metre bunded area near the northern boundary of the site. The current buffer from the closest tank to the airport site perimeter is approximately 80 metres.

For the purposes of investigating potential off-site risks resulting from a fire in the fuel storage area, a worst case scenario was assessed involving ignition of a 100 by 100 metre bunded area of jet fuel was considered in conjunction with 20 knot winds blowing towards off-site areas. Based on meteorological investigations, winds exceeding 20 knots are rare at Badgerys Creek (BOM 2015a).

A fire dynamics simulation model for a kerosene fire with 20 knot winds was undertaken and the results shown in Figure 14–3. The vertical coloured bar on the right hand side indicates the different heat flux levels resulting at different distances from the fire.

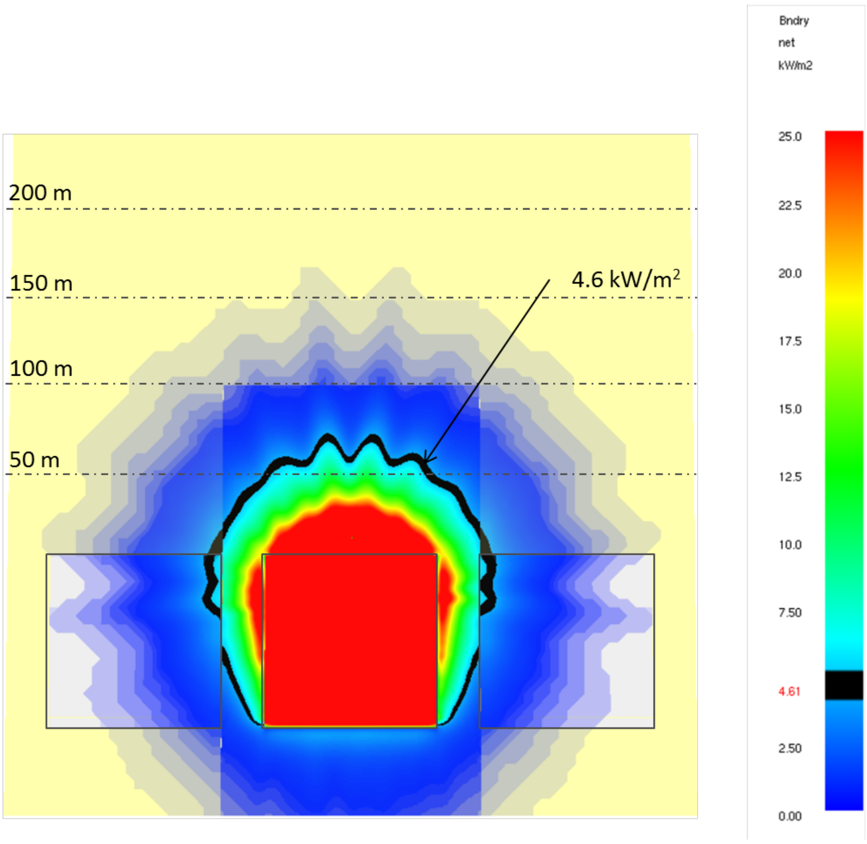


Figure 14–3 – Fire dynamic simulation model for a kerosene fire with 20 knot winds

HIPAP 4 (Department of Planning and Environment 2011a) outlines the potential consequences of varying levels of heat flux on structures and people, noting that the ultimate effect would depend on the duration of exposure. In general terms, buildings should be located outside of a heat flux level of 12.6 kilowatts per square metre which is the point at which timber can ignite after prolonged heat exposure and insulated steel can buckle. Buildings outside the 2.1 kW/m^2 heat flux level would not typically require special fire protection measures to be adopted.

The preliminary fire modelling shows that a buffer of at least 50 metres is required from the edge of the storage bund to all airport site boundaries would be required to avoid a heat flux level of 12.6 kW/m^2. The current conceptual design of the fuel storage facility at the proposed airport would satisfy this requirement by incorporating an 80 metre buffer to the airport site boundary.

The land use zoning of property neighbouring the fuel storage allows for the development of residential dwellings. In consideration of potential injury to people in these locations, HIPAP 4 specifies a heat flux level of 4.7 kilowatts per square metre. This level is considered high enough to trigger the possibility of injury for people who are exposed for more than 30 seconds and are unable to be evacuated or seek shelter.

As shown in Figure 14–3, this heat flux level would only be achieved within approximately 75 metres from the edge of the storage bund and also with the 80 metre buffer provided to the site boundary. Accordingly, it considered that the HIPAP 4 risk criteria are satisfied.

Other fires associated with tanker truck discharge, fires in terminal buildings or other areas or aircraft are also possible, but would likely to be smaller. Standard design precautions would be adopted for all infrastructure. Also, an aviation rescue fire-fighting station is proposed for the Stage 1 development. A mutual aid agreement with the NSW Rural Fire Service would also be in place before airport operations commence.

14.5.3. Flooding

The potential for flooding at the proposed airport is assessed in detail in Chapter 18 of the EIS. The concept design for the proposed airport includes a drainage strategy for the site. The airport infrastructure is located outside the 100 year average recurrence interval flood extent of Badgerys Creek, Duncans Creek and Oaky Creek. The existing creeks on the airport site would be removed and replaced with an extensive stormwater drainage network including a series of detention basins which would be created during the construction stage and remain in use during airport operation.

The airport infrastructure has been designed in accordance with the *Stormwater Drainage Design Manual*, which identifies standards for aerodromes and is consistent with current industry practice. The manual sets minimum flood immunity requirements for airport infrastructure as shown in Table 14–3. Consideration has also been given to *Australian Rainfall and Runoff* (Engineers Australia 1987) recommendations, including the need to make appropriate allowances in the design for blockage of stormwater structures.

The table shows that, for key infrastructure such as runways and taxiways, flood immunity would be required at least a 50 year ARI event, with additional restrictions on the duration for which any water can pond nearby.

During construction, the effects of changes to the site topography would be mitigated by a network of flood detention basins. A detailed surface water management plan would be developed to manage the impacts of on-site flooding during the construction period.

Table 14–3 – Typical flood criteria for aerodromes

Aerodrome Area	Criterion	Annual recurrence interval
Pavements		
Runways	No ponding	50 years
Taxiways	No ponding	50 years
Apron	No ponding	10 years
Other paved areas	No ponding within 30 metres of buildings	50 years
Grassed areas		
Runway strip	Ponding within 75 metres of runway centreline not to exceed 12 hours	5 years
Taxiway strip and apron flanks	Ponding within 15 metres of pavement edge not to exceed 12 hours	5 years

14.5.4. Railway safety

The Stage 1 Development does not currently include a rail service because the recently approved road network upgrades have been assessed as adequate to support anticipated airport demand for at least a decade after opening. Depending on the alignment and preferred timing to develop rail services, some enabling work may be required during the proposed Stage 1 development to future-proof the corridor. Any such work is expected to be subject to a separate approval process.

Underground trains and stations have special safety and operational considerations which would be taken into account in the railway design and approvals process. Railway safety is managed by independent regulators at both the State and Federal levels working in partnership to improve rail safety.

14.5.5. Bushfire

A bushfire risk assessment was conducted as part of the design development of the proposed airport. The proposed airport would be a significant commercial asset, located in a landscape that contains vegetation and landscape features that may represent a bushfire risk.

The most likely scenario for fire at the airport site would be from a large grass fire starting to the west of the site under hot, dry north-westerly, westerly or south-westerly winds. Construction and operation of the proposed airport also has the potential to provide sources of ignition that, under adverse winds, could allow a fire to escape off site.

A Bushfire Management Plan is being prepared for the site to manage current bushfire risk. A revised plan would be prepared for the construction and operation of the airport and would contain procedures for how site personnel should respond in the event of a bushfire occurring within or threatening the site. The plans would be prepared in consultation with the NSW Rural Fire Service.

14.5.6. Contaminated land

A preliminary contamination assessment was conducted during the preparation of the EIS. The scope of work included a desktop study of available documentation, a limited site inspection and preparation of a preliminary conceptual site model which facilitated classification of the site into broad risk categories. Information available for the desktop review included aerial photography, council land zoning, searches of regulatory databases, and information from previous environmental reports and details from a contamination register maintained by the Department of Infrastructure and Regional Development.

The site has historically comprised a variety of land uses including rural residential, agricultural, poultry farming and light commercial activities. These uses can potentially result in contamination including asbestos, scrap metal, agricultural chemicals and fuel storage.

Mitigation measures included priority actions for the further assessment and management of asbestos and lead based paint in identified high risk areas. Before the start of construction, an unexpected finds protocol would be prepared that would detail measures to be undertaken to safeguard potential risks to workers and the environment if contamination not previously recorded is encountered.

14.6. Mitigation and management measures

While a number of potential risk issues were identified and analysed by the hazards and risk study, the majority:

- could be satisfactorily resolved through further design and regulatory processes or studies already underway;
- would not require the adoption of project-specific measures or measures that are not already required by existing industry legislation and standards; or
- would be the responsibility of other statutory authorities to implement, in consultation with the Department of Infrastructure and Regional Development and the future airport lessee company.

These issues and the responsible parties are summarised in Table 14–4.

Table 14–4 – Identified issues and responsible parties

Responsible organisation	Identified risk	Considerations
Airservices Australia	Future formal flight path design process	• avoidance of military and emergency services operations from surrounding airfields, existing airspace obstacles, surrounding critical infrastructure and site-specific meteorology; and • consideration of possible future, long term flight paths associated with the proposed second runway so that changes in surrounding land use over the intervening period can be appropriately managed.
Civil Aviation Safety Authority	Safe operation of aircraft	• aerodrome certification of the proposed airport facilities and equipment are in accordance with the applicable standards and operating procedures make satisfactory provision for the safety of aircraft operations; • regulation of drone and model aircraft; and • specification of new technology/procedures as demonstrated to be effective.
Airport lessee company	Appropriate design and safe operation of the proposed airport and facilities	• preparation of an aerodrome manual; • installation and operation of automatic weather station in consultation with the Bureau of Meteorology; • compliance/adoption of new technology/ procedures specified by CASA; • detailed design of the proposed airport and facilities in accordance with industry standards and regulations e.g. terminal, railway and fuel storage; • provision of necessary safety and contingency procedures and facilities in accordance with guidelines; • ongoing management of wildlife at the airport in accordance with CASA Manuals of Standards and operational management plan; • preparation of an airport master plan in accordance with the Airports Act; • participate in planning coordination forums and community aviation consultation groups; and • conduct a risk and safety study prior to Stage 1 operations in accordance with the requirements of WHS legislation.
Aircraft manufacturers and airline operators	Fuel exhaustion Mechanical failure Pilot error Inflight fire	• continuous improvement and response to identified issues
Local councils	Airspace intrusion	• refer potential conflicts to the airport-lessee company and Department of Infrastructure and Regional Development.

The key remaining issues to be resolved in future design stages are provided in Table 14–5.

Table 14–5 – Mitigation measures to be resolved in future design stages

ID	Issue	Mitigation/management measure	Timing
14.1	Bird and bat strike	Conduct additional surveys to confirm the findings of the preliminary strike risk study.	Pre-construction
14.2	Bird and bat strike	Actively manage bird and bat presence at the airport site six months prior to the commencement of runway operations.	Pre-operation
14.3	Bird and bat strike	Develop a Wildlife Hazard Management Plan to include: • conduct of additional surveys to study and monitor for changes in species and movement patterns. The surveys would be conducted in accordance with relevant Commonwealth and State guidelines and standards including any recovery plans for threatened species; • review of detailed design documentation to identify potential bird and bat attractants; and • liaise 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.	Pre-operation
14.4	Bird and bat strike	The outcomes of bird and bat strike monitoring would 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	Operation
14.5	Public safety zones	Consider whether any planning measures are required for areas not currently Commonwealth-owned.	Pre-construction

14.7. Conclusion

At this preliminary design stage for the proposed Western Sydney Airport, adequate precautions have been identified to resolve safety and risk issues. Ongoing design processes would further consider these issues and future regulatory approvals would also need to be achieved before operations could commence. This would include the future formal airspace design process by Airservices Australia, the detailed design of the airport in accordance with the approved Airport Plan (including any conditions in the Airport Plan arising out of the EIS and made by the Minister for the Environment) and the aerodrome certificate from CASA.

The recommended mitigation measures would reduce hazards and risk during construction and operation of the airport, both for airspace and ground based activities.

15. Traffic, transport and access

The road network in the vicinity of the airport site is currently relatively uncongested, with only sections of Narellan Road and Camden Valley Way experiencing congested conditions in peak periods. While there is currently spare capacity on much of the network near the airport site, there is congestion on the broader strategic network including the M4 Motorway, M5 Motorway, M7 Motorway and M31 Hume Highway.

The construction of Stage 1 would generate an estimated 1,254 additional vehicle movements per day on the surrounding road network during the construction period. This includes 314 peak hour vehicle movements during the AM peak period. In the context of the broader Western Sydney region, this would not be considered a significant increase. A community awareness programme would be implemented during construction, to ensure that the local community and road users are kept informed about any construction activities and expected delays. A traffic and access management plan would also be implemented to ensure that construction traffic (including any oversize vehicles) is appropriately managed.

The operation of Stage 1 is expected to result in approximately 41,858 vehicles entering and leaving the airport site each day by 2030. With the introduction of the M12 Motorway, this additional traffic is not likely to significantly affect the operation of the surrounding road network but is expected to result in:

- a small increase in congestion at The Northern Road / M4 intersection; and
- a small increase in congestion on Mamre Road.

Significant road improvement works are proposed as part of the Western Sydney Infrastructure Plan, in addition to those identified in the Broader Western Sydney Employment Area and South West Priority Growth Area. These are expected to provide sufficient capacity to cater for the forecast passenger and employee traffic demand associated with the proposed airport in 2030.

The public transport, walking and cycling systems proposed by the NSW Government and local councils in the region would also have sufficient capacity to cater for the expected airport passenger and employee demand at the proposed airport. An assessment of the surface traffic impacts of the longer term development is presented in Chapter 35. It considers the possible extension of the South West Rail Link to the airport site in response to increasing demand.

15.1. Introduction

This chapter provides a review of the expected traffic and transport impacts associated with the construction and operation of the proposed airport. The chapter draws on a comprehensive Surface Transport and Access Study (included at Appendix I), summarising its main findings and identifying mitigation measures to address potential impacts.

The assessment addresses the requirements of the *Guidelines for the Content of a Draft Environmental Impact Statement – Western Sydney Airport* (EIS guidelines) issued by the Commonwealth Department of the Environment. The EIS Guidelines include a requirement to assess all relevant impacts including specific consideration of changes in traffic movements during construction and operation (associated with both passenger movements and workers).

15.2. Methodology

15.2.1. Assessment approach

Assessment of the potential traffic, transport and access impacts has involved a consideration of both the construction and operation of the proposed Stage 1 airport development.

For the construction phase, the assessment focuses on traffic impacts that would be associated with the haulage of materials, plant and equipment, as well as the traffic generated by construction workers. For the purpose of analysing the potential construction impacts, 2021 was selected as representative of the peak construction year, during which the highest number of construction vehicle movements are likely to be generated.

For the operation phase, the assessment focuses on the impact of the proposed airport, operating at its intended capacity of 10 million annual passengers, operating at its intended capacity of 10 million annual passengers, on wider transport networks in the Western Sydney region. Two modelling 'scenarios' were developed for the purpose of this assessment:

- 'Do minimum' which represents the minimum transport network improvements required to maintain status quo, without consideration of the expected additional demand generated by the proposed airport; and
- 'With airport' which includes consideration of the expected additional demand generated by the proposed airport.

The operational assessment involved:

- determination of the trips expected to be generated by the proposed airport;
- analysis of how those trips are likely to be distributed across the transport system;
- assessment of the resulting impacts on the transport system; and
- identification of appropriate mitigation measures to alleviate the impacts.

Assessment of the road traffic impacts of the long term development is included in Chapter 35 (Volume 3).

15.2.2. Transport modelling and analysis

15.2.2.1. Strategic Travel Model

The potential impacts of constructing and operating the proposed Stage 1 airport were assessed using the Strategic Travel Model (Version 3). The Strategic Travel Model is a best practice tool, operated by the NSW Bureau of Transport Statistics and is used for projecting travel patterns in Sydney, Newcastle and Wollongong under different land use, transport and pricing scenarios. The model is typically used to test alternative settlement, employment and transport policies, to identify likely future capacity constraints, or to determine potential usage levels of proposed new transport infrastructure or services. The Strategic Travel Model is programmed to model the years 2011, 2016, 2021, 2026, 2031 and 2036. The 2031 model year was therefore adopted for the assessment of the potential impacts of the Stage 1 development.

15.2.2.2. Modelling process

Transport modelling typically comprises four main stages:

1. determination of trip generation, or travel frequency (how many trips would occur to and from a nominated travel zone with regard to the demographics and land uses of that zone);
2. trip distribution (where these trips are likely to go);
3. assignment of travel mode choice (car, bus, rail, ferry or a combination); and
4. assignment of route (chosen for each trip and mode, and between each origin and destination). This stage provides the detail for the number of vehicles on each road and people on each public transport service.

For the purposes of this assessment the following adjustments to the model were necessary:

- removal of trips destined for airport travel zones in the Strategic Travel Model. This allows assessment of a scenario that does not include the proposed airport (the 'do minimum' scenario), which can then be used to identify the specific impact of the proposed airport in addition to other development forecasts for Western Sydney;
- changes to the number of trips to and from the airport site for cars, light goods, rigid and articulated vehicles. This represents construction traffic in 2021 and Stage 1 operational traffic in 2031;
- inclusion of additional road infrastructure in the form of the proposed M12 Motorway and associated connections. This project is currently in the planning phase. The proposed motorway is expected to run generally parallel to Elizabeth Drive and provide direct motorway-grade access to the proposed airport. The project and any associated environmental assessment and approval requirements are the responsibility of NSW Roads and Maritime Services (Roads and Maritime). It is assumed that the proposed M12 would be operational when the proposed airport opens and it is therefore included in all 'with airport' model scenarios, but excluded from the 'do minimum' scenarios; and
- inclusion of a railway extension from Leppington in the east, linking the airport with St Marys, to the north for the long term assessment scenario.

The proposed corridor for the Outer Sydney Orbital has not yet been defined and was not included in the modelling undertaken for this assessment.

Following these model alterations, the revised travel demand was reassigned to the road network. This was done for the AM peak (7:00 am to 9:00 am), the PM peak (3:00 pm to 6:00 pm), the period between these peaks (9:00 am to 3:00 pm), and the evening period (6:00 pm to 7:00 am). Only the AM peak and PM peak are reported here because these are the periods during which the capacity of the road network is most constrained. The assignment occurred in two stages:

- assignment of heavy vehicle demand; and
- assignment of the car demand. This was divided into toll-paying trips and non-toll-paying trips on the motorway network.

15.2.2.3. Trip generation and modelling assumptions

For the assessment of construction impacts, daily light vehicle numbers were estimated using the assumption that 80 per cent of construction personnel would drive to and from the airport site on any given day, and that the remainder would either use public transport or car-pooling. Heavy vehicle volumes were estimated following an analysis of the indicative construction schedule described in Section 6.2.1.

Trip generation and traffic generation associated with the operation of the proposed Stage 1 airport were estimated using the Sydney Airport Land Transport Model. This model describes the types of trips to Sydney Airport and is based on surveys completed in 2008.

The modelling process has also taken into account recent developments in airport operation, such as self-check-in and notification of customers and security clearance times, which generally allow people to arrive at the airport closer to their flight departure time and depart from the airport more quickly.

It was also assumed that the main airport access road would be limited to three traffic lanes and one bus lane in each direction. This would act as a capacity constraint over the longer term, resulting in a shift away from cars towards public transport.

15.2.2.4. Assessment criteria

Assessment of the potential traffic, transport and access impacts has been undertaken with reference to the *Guide to Traffic Generating Developments* (RTA 2002). This guideline suggests a process and methodology for assessment which is familiar to NSW stakeholders and the community. The operational traffic assessment process outlined in the guidelines stipulates that the operating characteristics need to be compared with agreed performance criteria as described below.

Midblock capacity

The capacity of urban roads is generally determined by the capacity of the intersections or the ‘mid-block’ capacity (the sections of roads between intersections). The mid-block capacities for roads can be estimated and compared to the existing traffic volumes in terms of volume to capacity ratios.

The volume/capacity ratio (VCR) is a measure of the amount of traffic carried by a section of road compared to its nominal capacity. As VCR nears one, the speed on the link decreases and both the likelihood and the duration of flow breakdowns increase.

The Austroads *Guide to Traffic Management*[2] outlines Level of Service (LoS) criteria for mid-block sections of road based on the VCR. A summary of LoS criteria is presented in Table 15–1.

[2] *Part 3: Traffic Studies and Analysis (2009)*

Table 15–1 – Level of Service descriptions for roads

Level of Service (LoS)	Uninterrupted flow facilities (motorways)	Uninterrupted flow facilities (arterial and collector roads)	Volume/capacity ratio
A	Free flow conditions in which individual drivers are unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent.	Primarily free flow operations at average travel speeds, usually about 90% of the free flow speed (FFS) for the given street class. Vehicles are completely unimpeded in their ability to manoeuvre within the traffic stream. Control delay at signalised intersections is minimal.	0.00 to 0.34
B	Zone of stable flow and drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream, although the general level of comfort and convenience is less than with LoS A.	Reasonably unimpeded operations at average travel speeds, usually about 70% of the FFS for the street class. The ability to manoeuvre within the traffic stream is only slightly restricted and control delays at signalised intersections are not significant.	0.35 to 0.50
C	Also in the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level.	Stable operations; however ability to manoeuvre and change lanes in mid-block locations may be more restricted than at LoS B, and longer queues, adverse signal coordination or both may contribute to lower average travel speeds of about 50% of the FFS for the street class.	0.51 to 0.74
D	Close to the limit of stable flow and is approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow will generally cause operational problems.	A range in which small increases in flow may cause substantial increases in delay and decreases in travel speed. LoS D may be due to adverse signal progression, inappropriate signal timing, high volumes or a combination of these factors. Average travel speeds are about 40% of FFS.	0.75 to 0.89
E	Occurs when traffic volumes are at or close to capacity, and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream will cause breakdown.	Characterised by significant delays and average travel speeds of 33% of the FFS or less. Such operations are caused by a combination of adverse progression, high signal density, high volumes, extensive delays at critical intersections and inappropriate signal timing.	0.90 to 0.99
F	In the zone of forced flow. With LoS F, the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow breakdown occurs and queuing and delays result.	Characterised by urban street flow at extremely low speeds, typically 25% to 33% of the FFS. Intersection congestion is likely at critical signalised locations, with high delays, high volumes and extensive queuing.	1.0 or greater

Source: Adapted from Austroads Guide to Traffic Management – Part 3: Traffic Studies and Analysis.

15.3. Existing environment

15.3.1. Existing road network

Roads and Maritime define four levels in a typical functional road hierarchy, ranging from high mobility and low accessibility, to high accessibility and low mobility. These road classes are:

- Arterial Roads – controlled by Roads and Maritime typically no limit in flow and designed to carry vehicles long distances between regional centres;
- Sub-Arterial Roads – can be managed either by council or by Roads and Maritime under a joint agreement. Typically, their operating capacity ranges between 10,000 and 20,000 vehicles per day, and their aim is to carry through-traffic between specific areas in a sub region, or provide connectivity from arterial road routes (regional links);
- Collector Roads – provide connectivity between local sites and the arterial road network, and typically carry between 2,000 and 10,000 vehicles per day; and
- Local Roads – provide direct access to properties and the collector road system and typically carry between 500 and 4,000 vehicles per day.

A description of the roads within and servicing the airport site, including their functional category is provided in Table 15–1. The location of these roads and the broader land use context are shown in Figure 15–1.

Table 15–2 – Existing roads servicing the airport site

Road	Functional category	Description
Westlink M7 Motorway	Arterial	The M7 Motorway connects Western Sydney with the broader road network and Sydney CBD by providing an uninterrupted journey between the M2, M4 and M5 motorways. It is a fully electronic toll road with no toll booths that uses a distance based tolling system. In the vicinity of Elizabeth Drive, the M7 has two lanes in each direction separated by a grass median around 14 metres wide. The M7 provides for travel at variable speeds up to 100 kilometres per hour. An off-road shared cycle / pedestrian pathway traverses the motorway and connects with the Sydney Cycleway network.
The Northern Road	Arterial	The Northern Road connects Narellan in the south west to the Great Western Highway in Penrith. In the vicinity of Luddenham, The Northern Road has an undivided carriageway with one lane in each direction and a sign posted speed limit of 80 kilometres per hour.
Elizabeth Drive	Arterial	Elizabeth Drive connects The Northern Road at its western end, and the M7 Motorway to the Hume Highway at Liverpool. Between The Northern Road and the Mamre Road roundabout, Elizabeth Drive has an undivided carriageway with one lane in each direction and a sign posted speed limit of 80 kilometres per hour. Elizabeth Drive between Mamre Road and the M7 has two eastbound lanes and one westbound lane. In the vicinity of Wallgrove Road, Elizabeth Drive carries around 26,000 vehicles per day.
Bringelly Road	Collector	Bringelly Road connects to The Northern Road at Bringelly and to Camden Valley Way at Horningsea Park. Bringelly Road is around 10 kilometres in length and has

Road	Functional category	Description
		an undivided carriageway with one lane in each direction, unsealed shoulders and a sign posted speed limit of 80 kilometres per hour for the majority of its length.
Badgerys Creek Road	Collector	Badgerys Creek Road connects The Northern Road at a roundabout to the north of Bringelly to Elizabeth Drive, and is around seven kilometres in length. The carriageway is undivided with one lane in each direction, unsealed shoulders and a sign posted speed limit of 80 kilometres per hour. The on-site component of Badgerys Creek Road was compulsorily acquired by the Australian Government.
Adams Road	Collector	Adams Road connects The Northern Road at Luddenham to Elizabeth Drive. The carriageway is undivided with one lane in each direction and a sign posted speed limit of 70 kilometres per hour.
Mamre Road	Arterial	Mamre Road connects the Great Western Highway in St Marys to Elizabeth Drive. Mamre Road has an undivided carriageway with one lane in each direction and has a sign posted speed limit of 80 kilometres per hour.
Local roads within the airport site	Local	The following local roads are located within the airport site: Ferndale Road; Fuller Street; Gardiner Road; Jackson Road; Jagelman Road; Leggo Street; Longleys Road; Pitt Street; Taylors Road; Vicar Park Lane; and Winston Close. These roads were compulsorily acquired, in part or in full, by the Australian Government in July 1991 and are currently maintained by Liverpool City Council under an agreement with the Australian Government.

Existing land use in the vicinity of the proposed airport is shown in Figure 15–1. The areas surrounding the airport site are mostly rural properties with a few residential areas adjacent to The Northern Road and Park Road intersection and further south of The Northern Road.

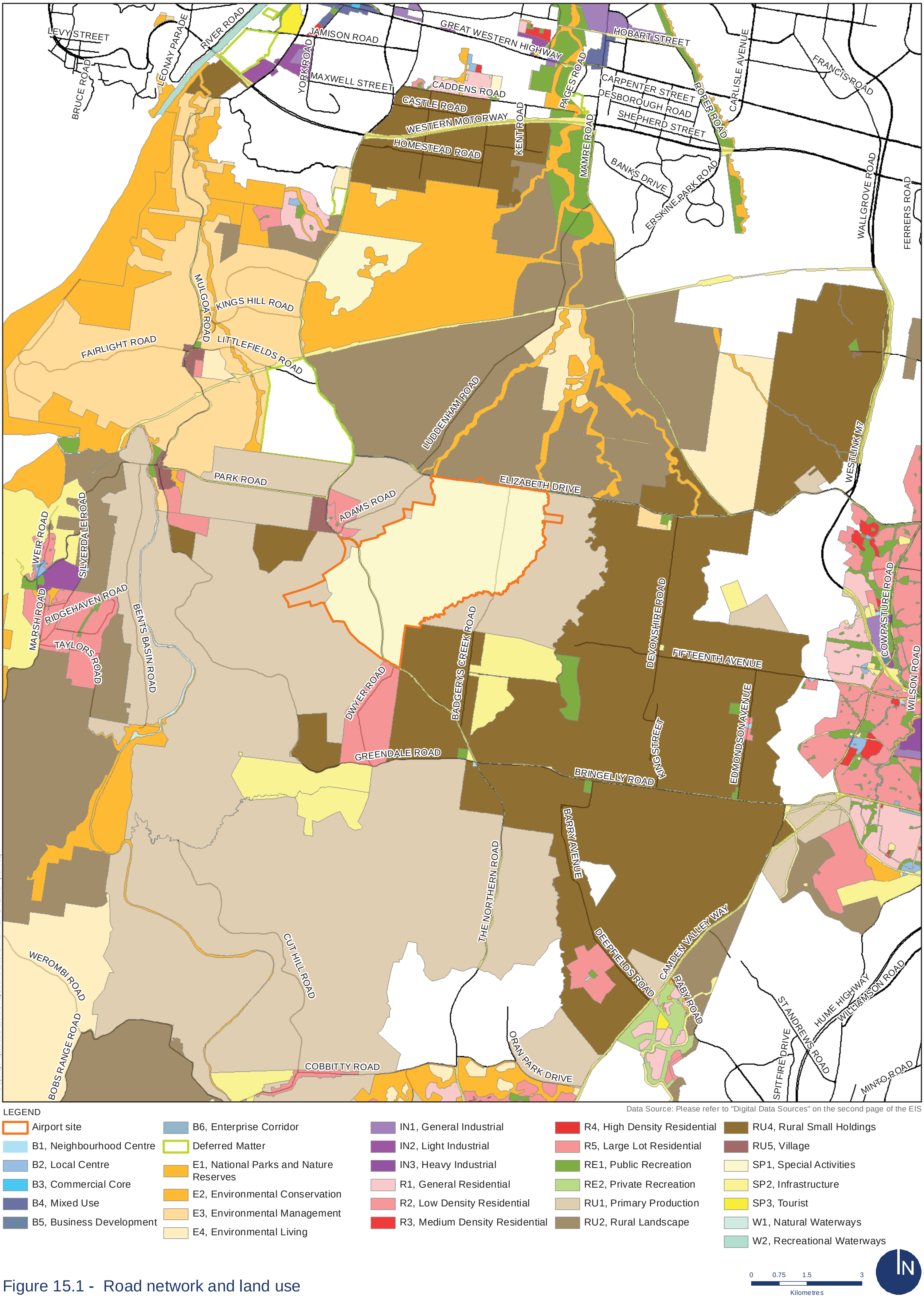


Figure 15.1 - Road network and land use

15.3.2. Traffic volumes and profile

Daily traffic volumes recorded for roads within the vicinity of the proposed airport are provided in Table 15–3. Data presented are for 2005 (the last year these counters were in operation) and represent a combination of vehicle counts and axle pair counts. An axle pair is the equivalent of a passenger car (passenger car unit) with two axles and is a standard method of determining the volume of traffic passing a counting location. A correction factor is applied to the axle spacing to determine a volume for heavy vehicles.

Table 15–3 – Average annual daily traffic 2005

Location	Average annual daily traffic	Count type
The Northern Road north of Bringelly Road	16,944	Vehicle
The Northern Road north of Elizabeth Drive	16,654	Vehicle
Elizabeth Drive east of The Northern Road	7,311	Axle pairs
Mamre Road south of Erskine Park Road	13,793	Vehicle
Bringelly Road west of Camden Valley Way	8,900	Axle pairs
Bringelly Road east of The Northern Road	6,212	Axle pairs

Roads and Maritime have permanent counting stations on Elizabeth Drive at Cecil Hills and Bonnyrigg. Recent results from these counters and the percentage growth per annum are presented in Table 15–4.

Table 15–4 – Elizabeth Drive traffic volumes and growth rate

Location	Direction	2008	2008 combined	2014	2014 combined	% growth per annum compounding
Elizabeth Drive at Cecil Hills	Westbound	10.927	22,523	12,923	26,598	2.8%
	Eastbound	11,596		13,675		
Elizabeth Drive at Bonnyrigg	Westbound	16,726	35,600	17,989	38,121	1.2%
	Eastbound	18,874		20,132		

Table 15–5 provides a summary of the 2015 traffic counts undertaken by Roads and Maritime for The Northern Road and Bringelly Road.

Table 15–5 – Existing daily traffic volumes 2015

Location	Vehicles per day (weekday)	Vehicles per day (weekend)	Vehicles per day (7 day average)
The Northern Road north of Bringelly Road	16,916	12,286	15,593
The Northern Road south of Bringelly Road	14,745	11,100	13,704
Bringelly Road east of The Northern Road	6,462	4,908	6,018

15.3.3. Existing road network performance

The Sydney Strategic Travel Model provides a mechanism for assessing the impact of land use and transport infrastructure changes. In order to provide an understanding of the current transport system, the 2011 base year model has been analysed to provide an insight into the prevailing peak period performance in the area surrounding the proposed airport site. No changes were made to the 2011 model for this analysis.

Modelling indicates that the road network in the vicinity of the airport site is currently relatively uncongested (2011 base model), with only sections of Narellan Road and Camden Valley Way showing a level of service (LoS) of D or worse in either the AM or PM peak periods.

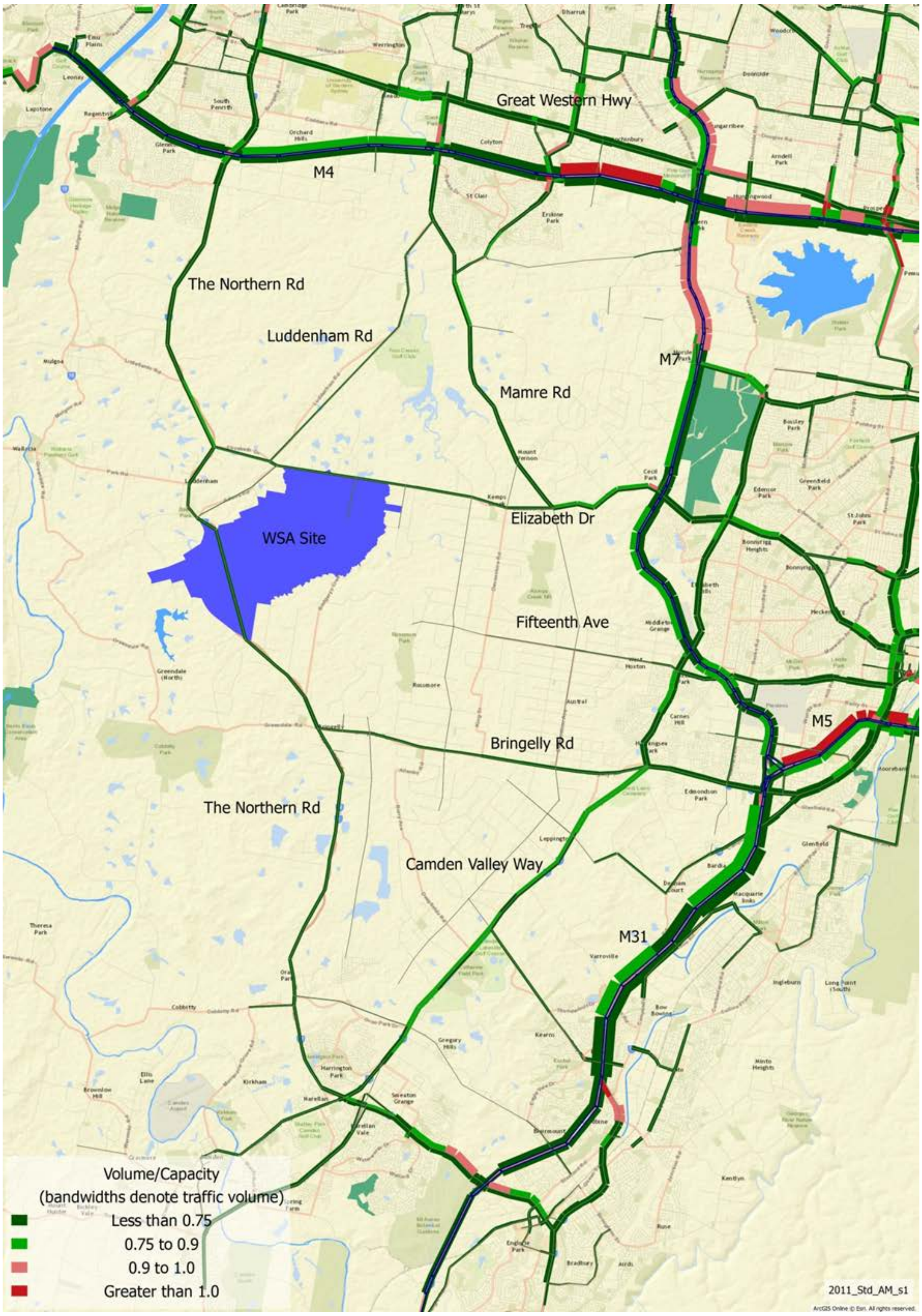
While there has been development in the area since 2011, including the Broader Western Sydney Employment Area and the South West Priority Growth Area, there remains spare capacity on much of the network near the airport site. Figure 15–2 and Figure 15–3 show the existing (2011) network conditions.

While roads near the airport site are relatively unconstrained, there are constraints on the broader strategic motorway network for the 2011 scenario. For the AM peak, the model shows capacity constraints on the following components of the network:

- M4 Motorway:
  - LoS F eastbound to the west of the M7; and
  - LoS E eastbound to the east of the M7;
- M7 Motorway:
  - LoS E in both directions south of the M4; and
  - LoS E southbound to the north of the M4;
- M5 Motorway:
  - LoS F eastbound, east of the M7; and
- Narellan Road:
  - LoS E southeast-bound towards the M31 Hume Motorway.

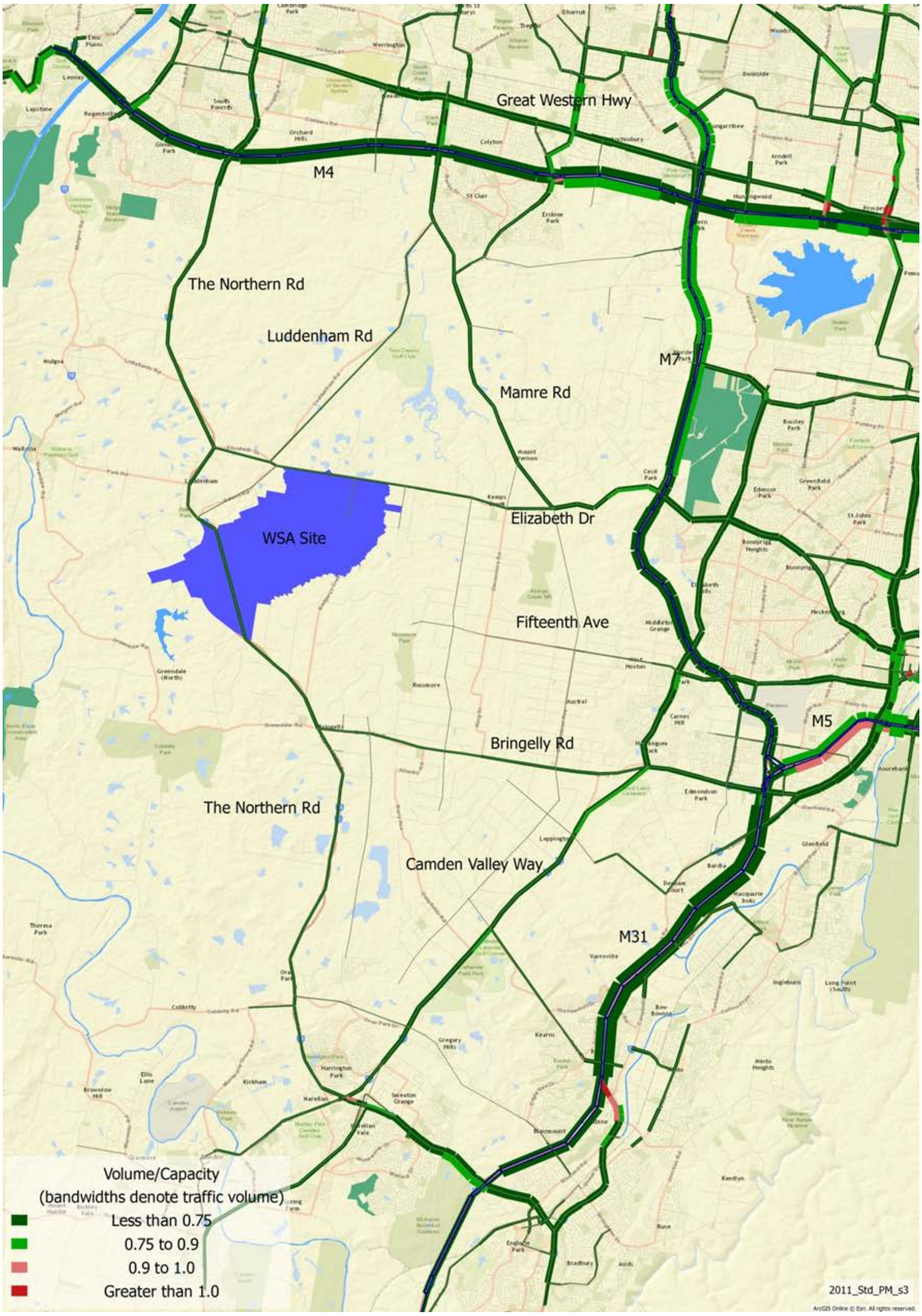
In the PM peak, capacity constraints are generally less acute, but the model still shows constraint for the following motorway locations:

- M5 Motorway:
  - LoS E, westbound, east of the M7.
- M4 Motorway:
  - LoS D, westbound along much of the length of the M4; and
- M7 Motorway:
  - LoS D in both directions, particularly close to the M4 intersection.



Note: Volume/capacity ratio bandwidth definitions are outlined in Table 15–1

Figure 15–2 – 2011 AM peak volume/capacity – existing conditions



Note: Volume/capacity ratio bandwidth definitions are outlined in Table 15–1

Figure 15–3 – 2011 PM peak volume/capacity – existing conditions

15.3.4. Road safety and crash history

Roads and Maritime crash data were available for the major roads in the vicinity of the proposed airport. The data are summarised in Table 15–6. Crash rates are generally consistent with the traffic volumes carried by these roads.

Table 15–6 – Crash data for key roads near the airport site

Location	Period	Crashes	% resulting in injury (fatality)
The Northern Road – between Maxwell Street and Mersey Street	January 2009 to December 2013	304	43% (1%)
The Northern Road – between Badgerys Creek Road and Mersey Street	July 2009 to June 2014	16	38% (6%)
Bringelly Road – between The Northern Road and Camden Valley Way	July 2009 to June 2014	113	54% (2%)
Elizabeth Drive – between The Northern Road and M7 Motorway	July 2009 to June 2014	157	48% (1%)
Mamre Road – between Elizabeth Drive and M4 Motorway	July 2009 to June 2014	159	50% (1%)
Badgerys Creek Road – between Elizabeth Drive and The Northern Road	July 2009 to June 2014	24	9% (0%)
Adams Road – between Elizabeth Drive and The Northern Road.	July 2009 to June 2014	6	67% (0%)

15.3.5. Public transport

There are currently four bus routes that traverse the airport site and/or service the immediate surrounds:

- Route 789 Penrith Interchange to Luddenham;
- Route 801 Liverpool Interchange to Badgerys Creek Road;
- Route 855 Austral to Liverpool via Prestons and Churchill Gardens; and
- Route 856 Bringelly to Liverpool via Prestons and Churchill Gardens.

The following train interchanges are closest to the airport site:

- T1 Western Line – Penrith Interchange;
- T2 Inner West and South Line – Liverpool Interchange; and
- South West Rail Link – Leppington.

Penrith and Leppington railway stations are around 15 kilometres from the site and Liverpool is around 21 kilometres from the site.

15.3.6. Pedestrians and cyclists

Pedestrian and cycling infrastructure in the area is currently limited, reflecting the predominantly rural character of the area.

As the South West Priority Growth Area lands develop, additional cycleway links will be provided and integrated within the Liverpool cycleway network. By 2018, the expected Bringelly Road Stage 1 and Stage 2 upgrades described in the Western Sydney Infrastructure Plan will deliver more than 10 kilometres of shared pedestrian and cyclist paths between Leppington and The Northern Road.

According to the Western Sydney Infrastructure Plan, The Northern Road is expected to have shared pedestrian and cyclist paths between Narellan and the M4 Motorway by 2019.

15.4. Assessment of impacts during construction

15.4.1. Construction traffic volumes and distribution

Construction vehicles would access the site via Elizabeth Drive, Anton Road, The Northern Road and Badgerys Creek Road. Construction vehicle generation would be expected to reach its peak in 2021. Table 15–7 provides the expected traffic volumes by period and vehicle type.

Table 15–7 – Peak construction vehicle generation

Vehicles	Direction	AM peak	Inter-peak	PM peak	Evening	Total (vtpd)
Light vehicles	In	264	88	0	88	440
	Out	0	66	220	154	440
Semi-trailers	In	4	11	5	2	22
	Out	4	11	5	2	22
B-Double and Truck and Dog	In	21	63	31	50	165
	Out	21	63	31	50	165
Total		314	302	292	346	1,254

The following vehicle distribution assumptions were made for the purposes of assessment:

- the majority of light vehicles would arrive and depart the site between 5.00 am and 7.00 pm; and
- heavy vehicles would operate to and from the site 24 hours per day during aviation infrastructure works.

The geographic distribution of light vehicles was assumed to be consistent with existing vehicle movements in this area derived from the existing 2021 Strategic Travel Model.

Detailed information on a probable distribution for heavy vehicles was not available; however the following assumptions are considered reasonable:

- 50 per cent of trips to and from the M31 Hume Motorway;
- 20 per cent of trips to and from the M5;

- 10 per cent of trips to and from the M4 (east);
- 10 per cent of trips to and from the M4 (west); and
- 10 per cent of trips to and from the M7 (north).

15.4.2. Effect on road network performance

The expected distribution and volume of construction traffic discussed in Section 15.4.1 suggests there would be approximately 160 additional vehicle movements (to and from the airport site) on Elizabeth Drive during the AM peak and 150 additional vehicle movements (to and from the airport site) on Elizabeth Drive during the PM peak.

Modelling indicates that this level of additional traffic volume would not result in operating conditions worse than LoS C on Elizabeth Drive in the vicinity of the airport site.

There would be capacity constraints on the wider network, principally on the M4, M5 and M7 motorways; however:

- these constraints currently exist;
- the LoS does not deteriorate when construction traffic is included; and
- the proportion of construction traffic compared to overall traffic, reduces with distance from the airport site and therefore the impact of construction is reduced with distance from the site.

The types of vehicle movements associated with the construction of the proposed airport would not significantly impact on the surrounding transport system, with the exception of potential oversized vehicle movements required for the delivery of equipment. These movements may require temporary road closures or suitable escorts.

15.5. Assessment of impacts during operation

To assess the potential transport network impacts of the proposed Stage 1 airport operation, consideration was given to the travel demand associated with passengers, employees and freight. The expected trip generation for each of these groups is considered in Section 15.5.1, Section 15.5.2 and Section 15.5.3 respectively. The consequential transport network impacts are discussed in Section 15.5.6. Road infrastructure providing access to the proposed airport is described in Chapter 5 (Section 5.9).

The assessment has not considered traffic associated with future commercial development. While the proposed airport includes authorisation for future non-aeronautical commercial development, the details of such development would be developed by the ALC and would be subject to authorisation under the Airports Act.

15.5.1. Future transport network

15.5.1.1. Road network

As part of the Western Sydney Infrastructure Plan the Commonwealth and New South Wales governments have committed $3.6 billion over 10 years in major road infrastructure upgrades in Western Sydney. These upgrades would relieve pressure on existing infrastructure and provide connectivity to the new airport and surrounding areas before the proposed airport begins operation. The key projects which comprise the Western Sydney Infrastructure Plan are listed in Table 15–8.

Table 15–8 – Key Western Sydney Infrastructure Plan projects

Initiative	Description
The Northern Road	Upgrade to a minimum of four lanes from Narellan to the M4 Motorway.
M12 Motorway	Construction of a new four-lane motorway between the M7 Motorway and The Northern Road.
Bringelly Road	Upgrade to a minimum of four lanes from Camden Valley Way to The Northern Road.
Werrington Arterial	Construction of the Werrington Arterial by upgrading Kent Road and Gipps Street to four lanes between the Great Western Highway and the M4 Motorway.
Ross Street, Glenbrook	Upgrade of the intersection of Ross Street and the Great Western Highway to reduce congestion.
Local roads	$200 million package for local roads upgrades.

15.5.1.2. Public transport network

There are three additional bus routes identified by Transport for NSW to services the proposed airport. These routes are:

- Liverpool-Badgerys Creek-Penrith (suburban);
- Campbelltown-Oran Park-Badgerys Creek (suburban); and
- Leppington-Badgerys Creek-Mt Druitt (local).

The service frequencies would be determined based on the demand for travel to the proposed airport.

15.5.1.3. Rail

While no rail connection to the proposed airport is currently expected until after 2031, planning for the proposed airport preserves flexibility for several possible rail alignments including a potential express service. Potential rail corridors are shown by Figure 15–4. A final alignment would be determined in consultation with the New South Wales Government and some enabling work may be required during Stage 1 to future-proof the corridor.

Figure 15–4 – Potential future rail corridors

15.5.2. Passenger trip generation

In 2031, it is estimated that the proposed airport would be handling up to 10 million passengers per year. In order to understand the transport impact these passenger movements may have, they need to be translated into 'trips' and assigned to the surrounding road network using the Strategic Transport Model. This process is illustrated in Figure 15–5.

While this figure shows rail as a mode of transport, the proposed Stage 1 development does not currently include a rail service. Planning for the proposed airport preserves flexibility for several possible rail alignments including a potential express service. A final alignment will be determined in consultation with the New South Wales Government.

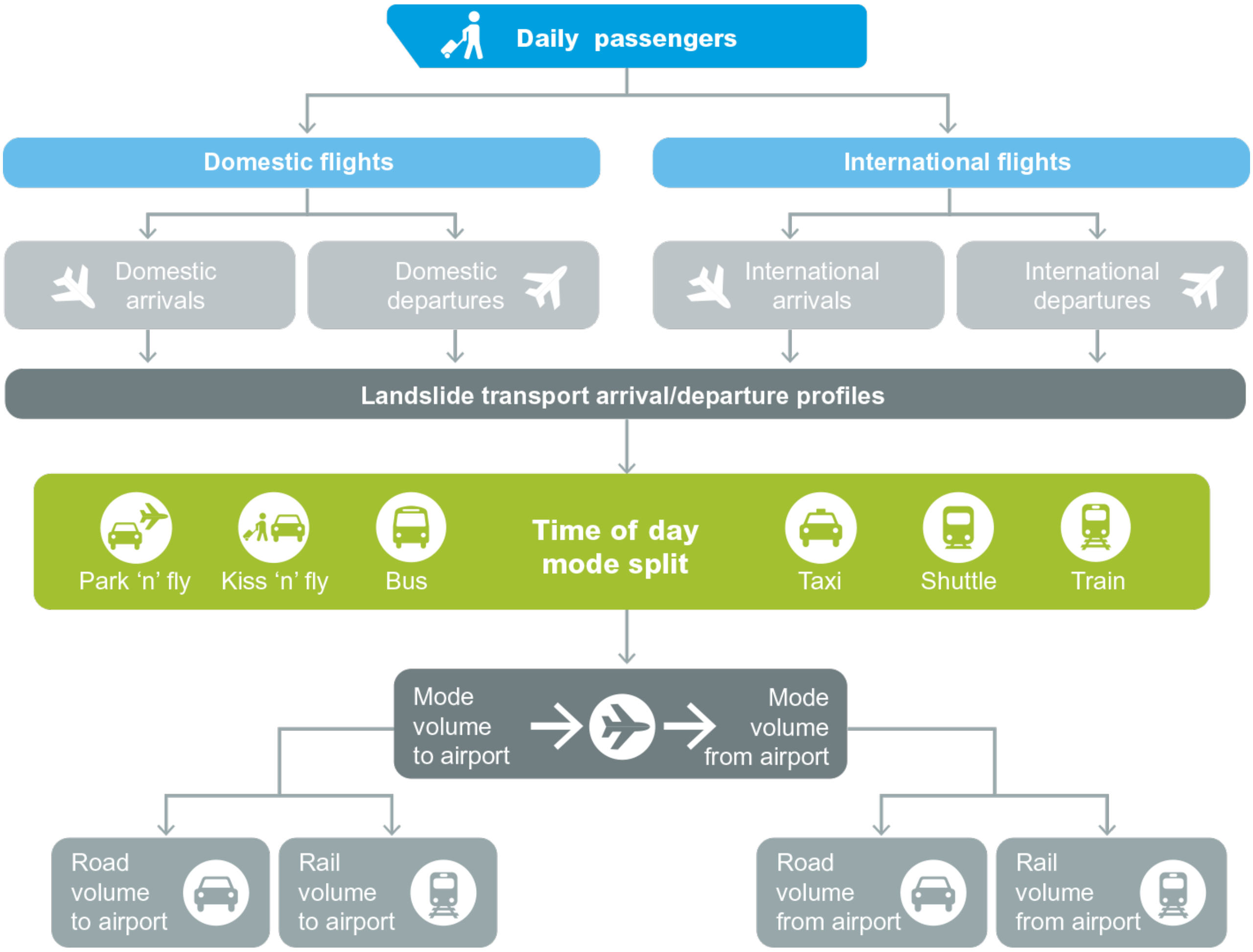


Figure 15–5 – Process for determining passenger trip generation

15.5.2.1. Flight movements

A passenger flight profile for Stage 1 was developed based on the number of daily and peak hour passenger flights. The profile for 2031 is shown in Figure 15–6.

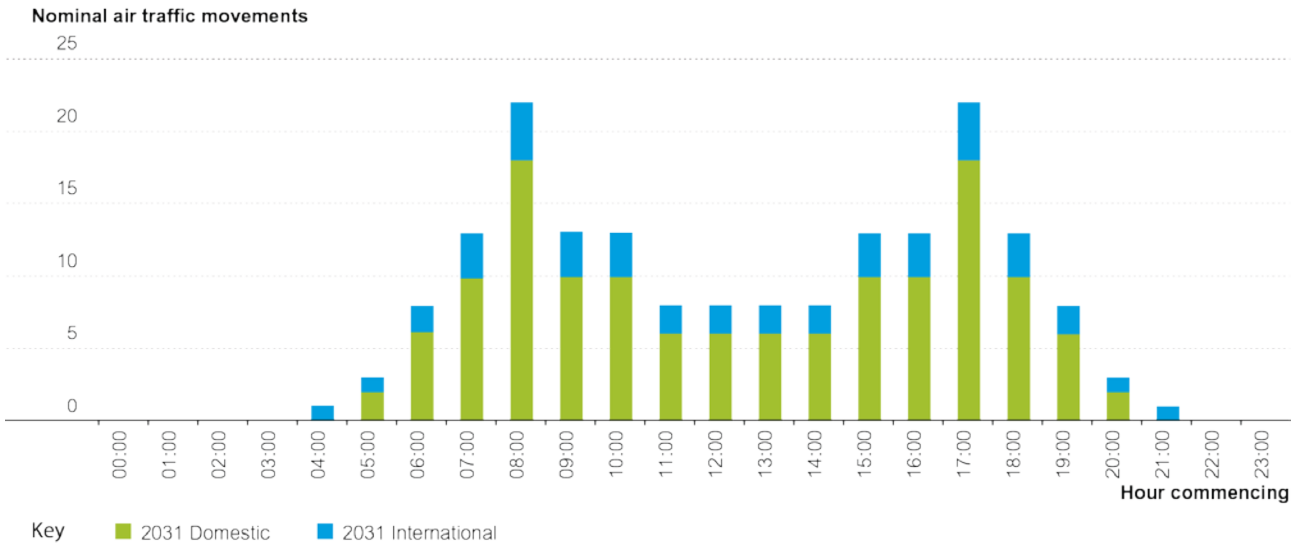


Figure 15–6 – Flight arrivals/departures profile 2031

In 2031 a total of 170 passenger flights per day would be expected, of which 149 flights are assumed to be domestic and 21 international. During the peak hour, anticipated to be between 7 am and 8 am, there is predicted to be 22 passenger flights, split evenly between arrivals and departures (for both domestic and international sectors).

15.5.2.2. Passenger movements

For each domestic and international flight, a profile for the passengers entering and exiting the airport was determined based on the Sydney Airport Land Transport Model, as explained in Section 15.2.2. The following assumptions were made for the purposes of calculating passenger volumes:

- for each domestic aircraft, an average capacity of 180 passengers with an average flight occupancy of 90 percent; and
- for each international aircraft, an average capacity of 420 passengers with an average flight occupancy of 90 percent.

Using the passenger profile and the above assumptions, a passenger arrival/departure profile was developed in order to determine the associated demand for ground transport services. The resulting profile is illustrated in Figure 15–7.

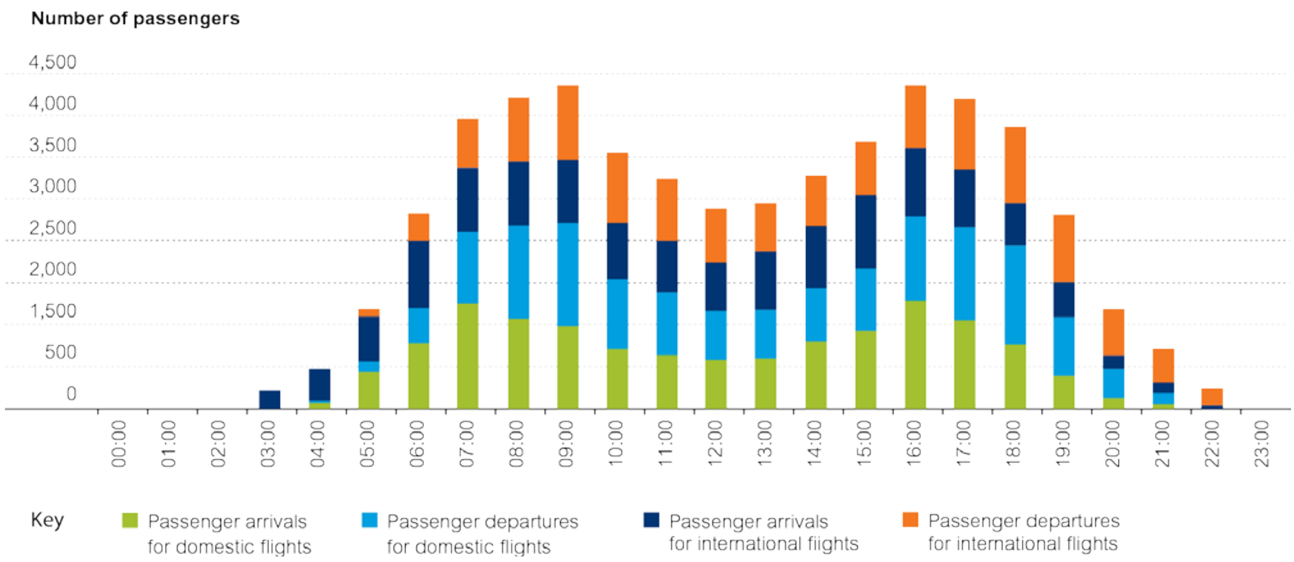


Figure 15–7 – 2031 Ground transport demand per hour (2031)

15.5.2.3. Transport mode split

The Sydney Airport Land Transport Model (and its assumed mode split) was used to assign the calculated ground transport demand to the modes listed in Table 15–9.

Table 15–9 – 2031 assumed mode split

Mode	2031 assumed mode split			
	Domestic		International	
	Drop-off	Pick-up	Drop-off	Pick-up
Kiss and fly	30%	30%	40%	40%
Park and fly	35%	35%	30%	30%
Taxi	20%	20%	20%	20%
Shuttles	5%	5%	5%	5%
Bus	10%	10%	5%	5%

Rail was not considered because no rail connection to the proposed airport is currently expected until after 2031. Walking and cycling to the airport (as passengers) was assumed to be minimal.

Suitable dwell times for each mode were then applied (with, for example, longer times assumed for international kiss and fly passengers when compared to their domestic counterparts).

Figure 15–8 shows the number of expected passenger arrivals via ground transport at the proposed airport. Figure 15–9 shows the total departures expected via ground transport from the proposed airport.

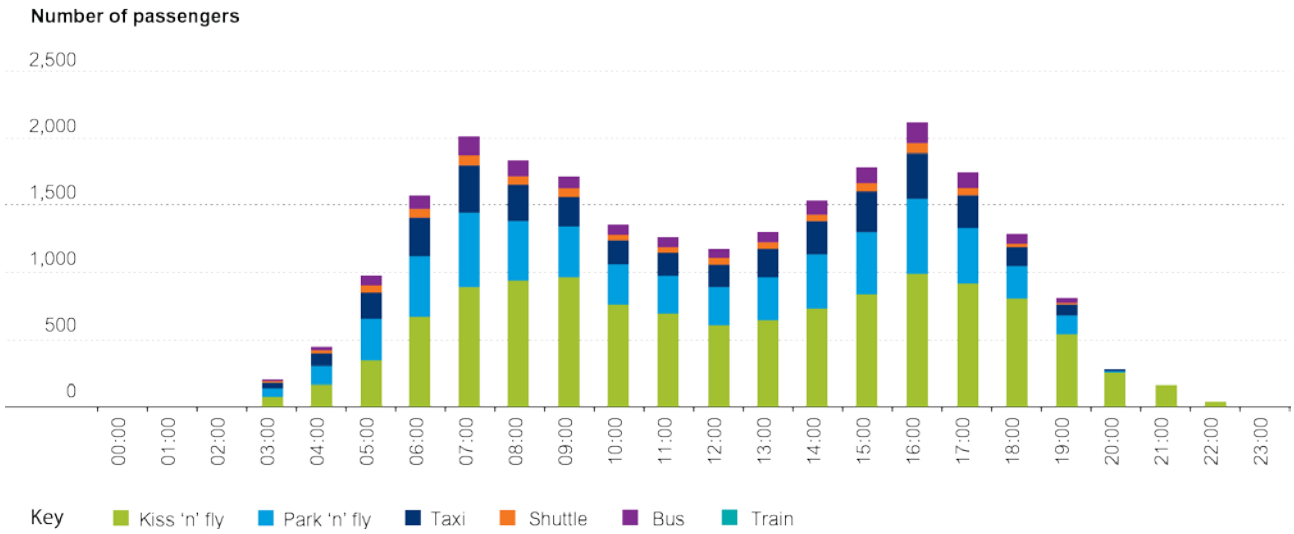


Figure 15–8 – Total passenger arrivals at the proposed airport via ground transport

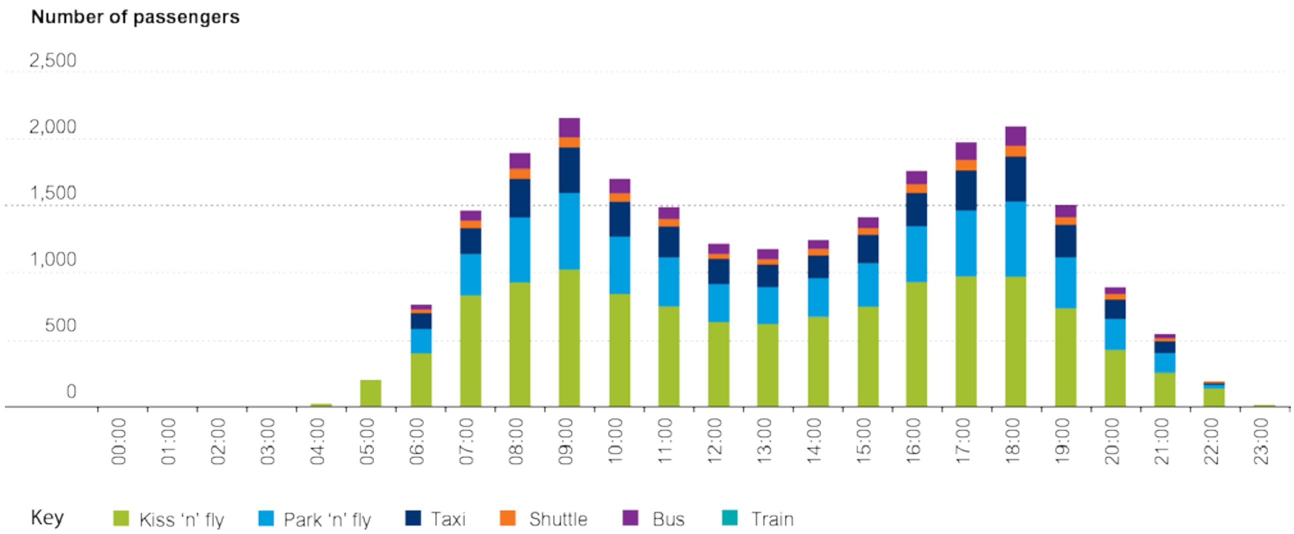


Figure 15–9 – Total passenger departures from the proposed airport via ground transport

15.5.2.4. Traffic generation

The trips (by mode) shown in Figure 15–8 and Figure 15–9 were assigned to vehicles entering and exiting the airport site to determine the passenger related traffic generation (excluding vehicle movements that only circulate internally within the airport site, such as some taxi movements).

Figure 15–10 shows that in 2031, 1,359 vehicles would be expected to enter the airport site during the AM peak period and 1,425 vehicles would be expected to enter the airport site during the PM peak period.

Figure 15–11 shows that in 2031, 1,453 vehicles would be expected to leave the airport during the AM peak and 1,388 would be expected to leave the airport during the PM peak.

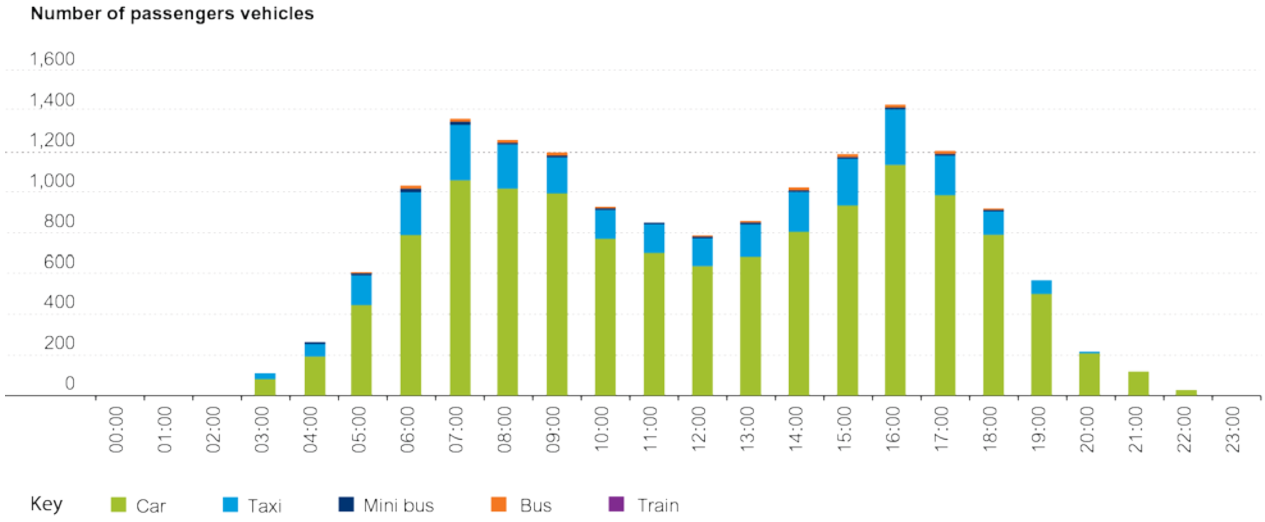


Figure 15–10 – Passenger vehicles entering the proposed airport site

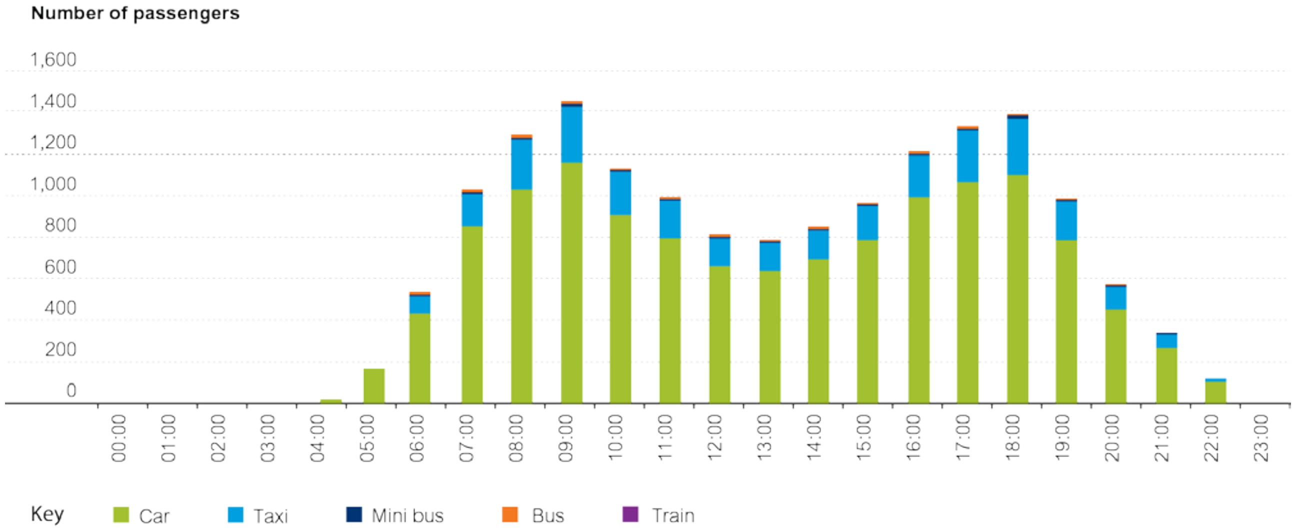


Figure 15–11 – Passenger vehicles leaving the proposed airport site

15.5.3. Employee trips

Airfield, terminal and airside employment estimates are directly related to the volume of passengers expected to pass through the proposed airport. A ratio of 750 workers per one million annual passengers has been used as a reasonable basis on which to estimate the number of full time employees at the airport.

In order to determine the expected number of trips generated by these employees; they were allocated into shifts across the proposed 24-hour operation of the airport and then assigned to a transport mode. Figure 15–12 illustrates the process.

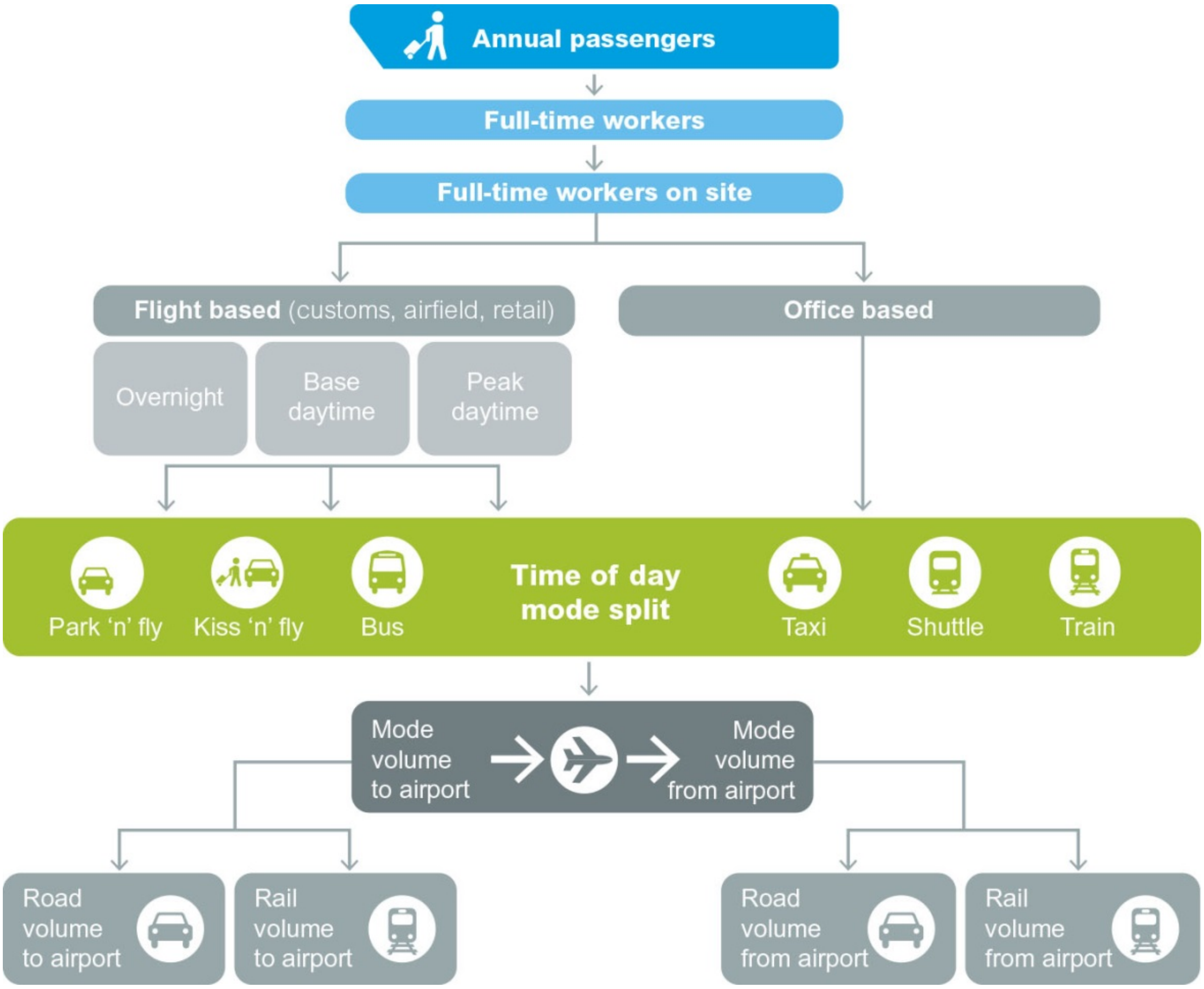


Figure 15–12 – Employee trip generation

15.5.3.1. Employees and shifts

Up to 7,600 employees would likely be required to service the proposed airport in 2031. Consistent with the experiences at Sydney Airport and other international airports, it was assumed that up 80 per cent of employees (6,158) would be on-site during Stage 1 on any given day.

The airport employees were categorised as follows:

- airfield operations (three shifts of 8.5 hours);
- terminal support (two shifts of 7 hours plus two split-shifts of four hours); and
- office workers (two shifts of nine hours, offset by one hour).

15.5.3.2. Employee arrival and departure profiles

A profile for employee arrivals and departures prior to and after their shifts was developed and is shown in Figure 15–13. The profile acknowledges that some employees would arrive in the hour before their shift starts and/or leave in the hour after their shift finishes.

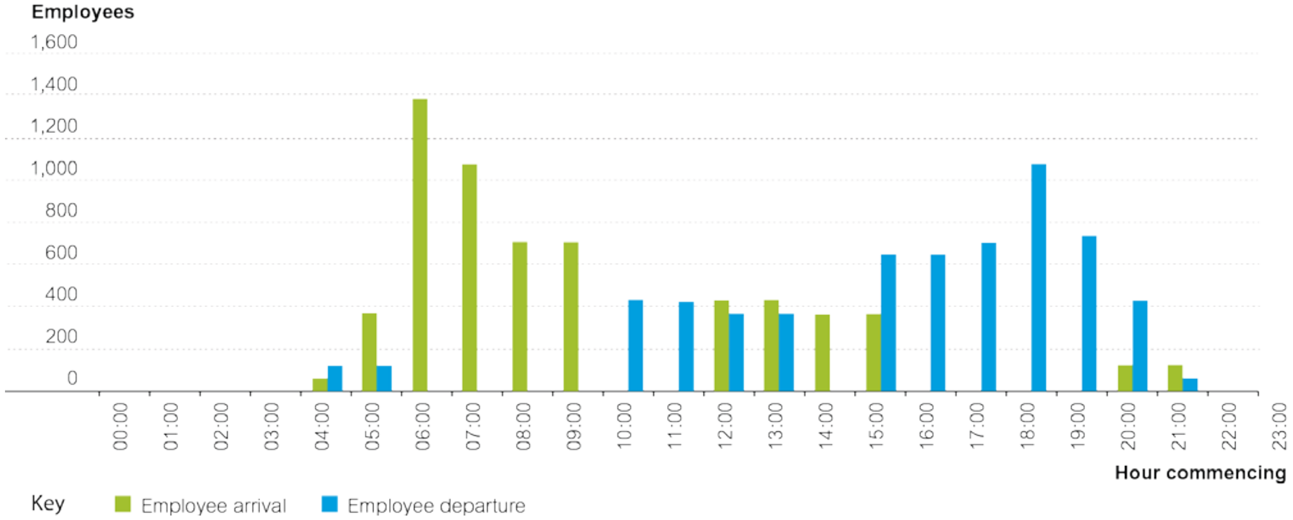


Figure 15–13 – Employee arrival and departure profile (2031)

Figure 15–13 shows that the peak arrival for the AM peak period is expected to be around 1,386 employees and the PM peak departure for employees (between 7.00 pm and 8.00 pm) is 1,086 employees.

15.5.3.3. Mode split

The employee mode split has been determined using the Sydney Airport overall mode splits for journey to work, but reassigning the 11 per cent of trips taken by train (to Sydney Airport) to car based modes for the proposed airport. This recognises that the proposed airport is not expected to have a railway line until after 2031.

Additionally, it was assumed that no employees would use public transport during early morning hours due to service limitations.

Figure 15–14 and Figure 15–15 show the expected distribution of arrivals and departures. It can be seen that the AM arrival volume for employees is expected to be 1,345 employees during the AM traffic peak hour (7.00 am to 8.00 am), with the majority arriving by car. The departure volume for employees is predicted to be greater than 1,300 during the PM traffic peak hour.

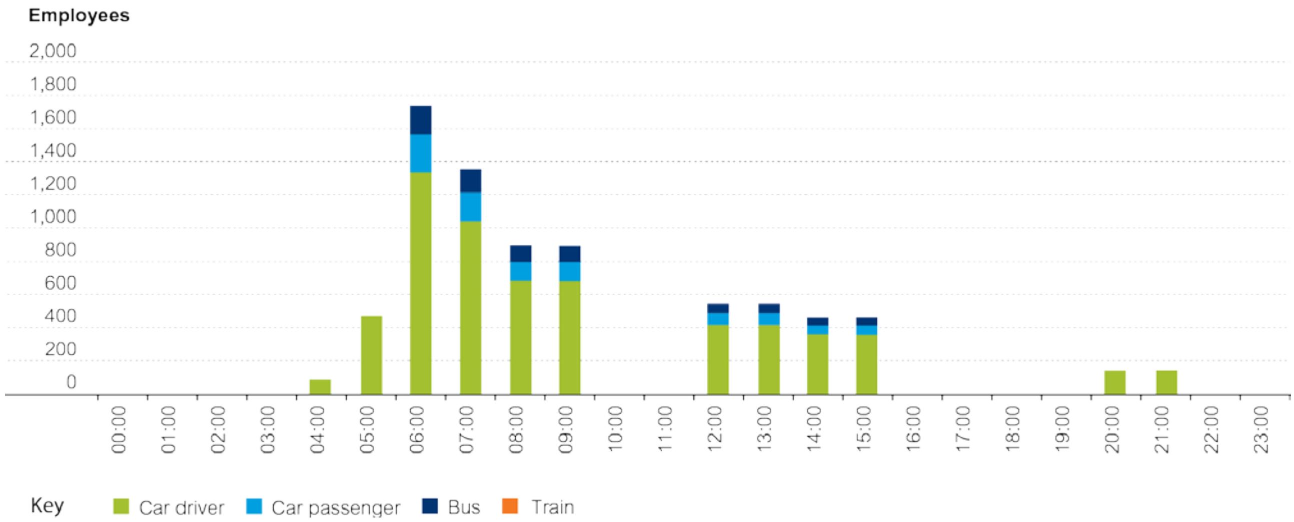


Figure 15–14 – Employee arrivals by mode and time of day

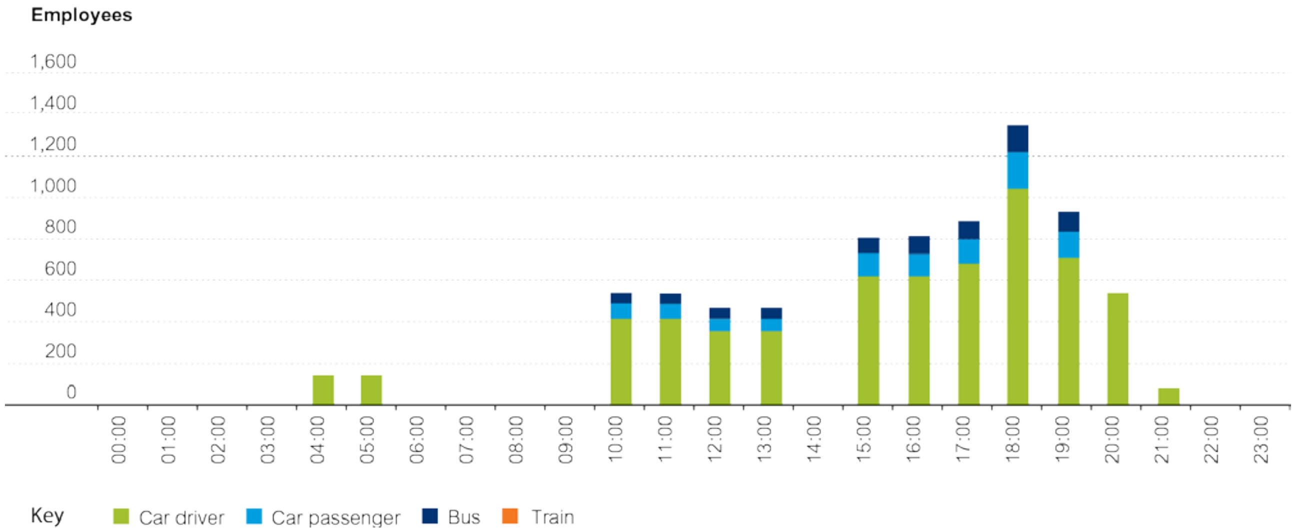


Figure 15–15 – Employee departures by mode and time of day

15.5.3.4. Traffic generation

The calculated employee arrivals and departures were assigned to vehicles to determine the number of vehicles entering and leaving the airport site throughout the 24-hour operational period. The results are shown in Figure 15–16 for arrivals and Figure 15–17 for departures. Employee traffic generation peaks would be expected to be outside the main traffic peak periods of 7−9 am and 4−6 pm.

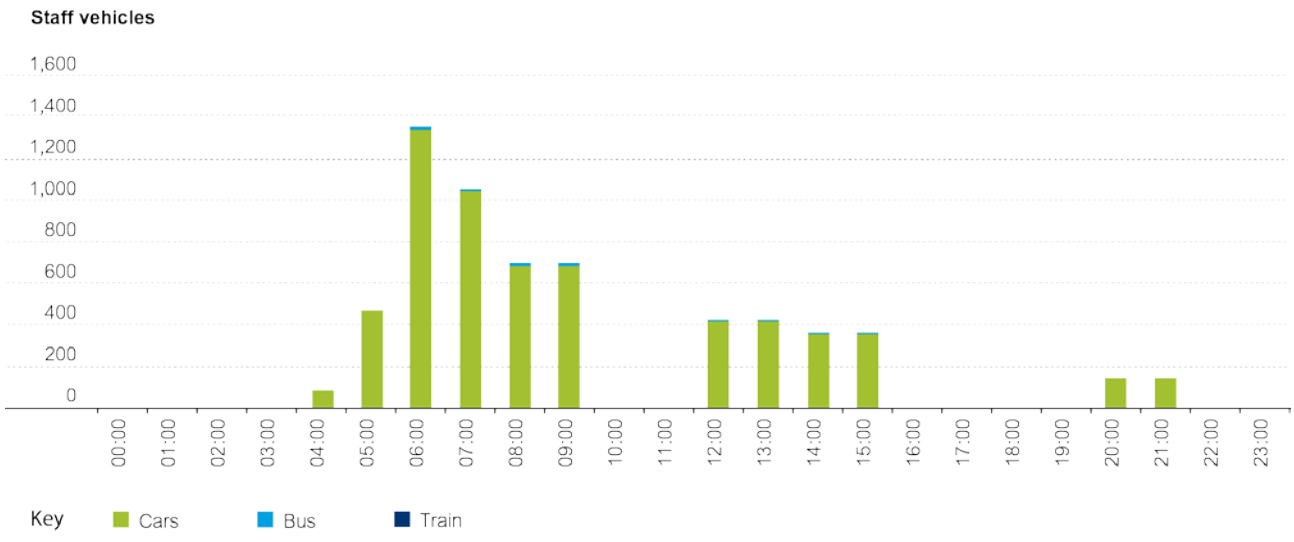


Figure 15–16 – Employee vehicle arrivals by mode (2031)

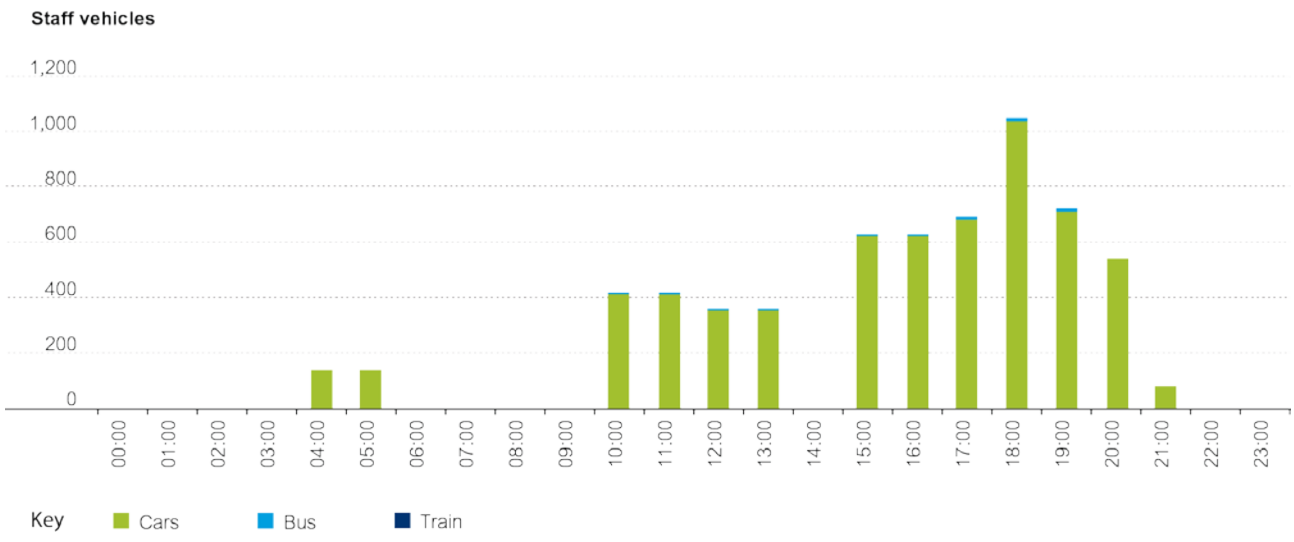


Figure 15–17 – Employee vehicle departures by mode (2031)

15.5.4. Freight trips

Freight demand has been identified for air freight cargo and for the delivery of aviation fuel to the fuel farm. Demand estimates for airport consumables (e.g. food, retail items) or waste removal cannot be calculated before a detailed terminal plan is developed and have therefore been excluded from the assessment.

The freight demand for air cargo is estimated to be 190,793 tonnes in 2031. It has been assumed that the cargo freight arrives at and departs from the airport on heavy rigid trucks, semi-trailers and B-doubles. Table 15–10 gives the estimated heavy vehicle volumes (and car equivalents).

Table 15–10 – 2031 two-way truck movements

Vehicle type	2031 annual movements	2031 daily movements	2031 hourly movements	2031 car equivalents per hour
Heavy Rigid Truck (12.5 metres long)	53,051	152	6	13
Semi-Trailer (19 metres long)	6,376	17	1	2
B-Double (23 -26 metres long)	1,822	10.59	0	1

15.5.4.1. Fuel deliveries

Assuming a fuel supply pipeline is not available to service the proposed airport, it has been estimated that in 2031 approximately 43 B-doubles of fuel per day would be required to meet Stage 1 fuel use requirements. This would be equivalent to about two B-doubles per hour, or 35 passenger car units (pcus) per hour on average entering and leaving the airport site.

15.5.5. Total airport traffic generation estimate

A total airport trip generation estimate has been calculated using the totals for passengers, employees and freight provided in the previous sections. Table 15–11 presents the results divided into representative two-hour periods, with a 24-hour total.

Table 15–11 – Total modelled traffic to / from the proposed airport in 2031

	AM peak 2 hour	Interpeak 2 hour	PM peak 2 hour	Evening 2 hour	24 hour
Arriving at airport					
Passengers	2,582	1,862	2,518	1,276	15,774
Airport workers	1,375	498	190	573	4,871
Freight (TNR)	9	26	13	57	277
Total (arriving)	3,966	2,386	2,721	1,905	20,922

	AM peak 2 hour	Interpeak 2 hour	PM peak 2 hour	Evening 2 hour	24 hour
Departing from Airport					
Passengers	2,286	1,983	2,312	1,357	15,774
Airport workers	0	411	1,027	704	4,885
Freight (TNR)	9	26	13	57	277
Total (departing)	2,295	2,420	3,353	2,117	20,936

15.5.6. Effect on network performance

As noted in Section 15.5.4, operation of the proposed Stage 1 development is expected to result in 20,992 vehicles accessing the site and 20,936 vehicles leaving the site each day. This would increase traffic on nearby north−south routes in the area including The Northern Road. At the same time, the opening of the M12 Motorway would attract traffic from the M4 corridor, Elizabeth Drive, Bringelly Road and Fifteenth Avenue, reducing the volumes on these east−west routes.

There are two drivers of the changes in volumes. Firstly, the proposed airport would introduce more trips on the network in this area. Secondly the M12, which would provide primary access to the airport, would have a diversionary effect on traffic movements in the wider area, attracting vehicles to the M12 corridor that would otherwise have used Elizabeth Drive, Bringelly Road or the M4 Motorway. This would have the effect of:

- reducing volumes on the M4;
- reducing volumes on Bringelly Road and Elizabeth Drive; and
- increasing volumes on The Northern Road.

Table 15–12, Figure 15–18 and Figure 15–19 show the 2031 network conditions for the 'do minimum and 'with airport' assessment scenarios, for the respective AM and PM peak periods.

The following specific network effects would be expected:

- improved LoS on Elizabeth Drive as a result of the diversion of trips on to the M12;
- a deterioration in LoS on The Northern Road:
  - to LoS D on sections of The Northern Road between the M12 and M4 (AM/PM peaks);
  - to LoS E just north of Elizabeth Drive (AM peak); and
  - to LoS F just south of the M4 (AM/PM peaks);
- increase in LoS on sections of Mamre Road near the M12;
- reduction in LoS on Mamre Road north of Erskine Park Road; and
- the M12 motorway maintains a LoS no worse than B.

Having regard to the proposed road developments in the vicinity of the airport site, by 2031 it is predicted that the proposed airport would not generate the level of traffic required to significantly impact the operation of the surrounding road network.

15.5.7. Public transport, walking and cycling

The public transport, walking and cycling networks proposed by the NSW Government and local councils are expected to have sufficient capacity to cater to the expected airport passenger and employee demand.

Bus routes 789 and 801 currently traverse the airport site and would therefore need to be appropriately altered in consultation with the bus operator and Transport for NSW.

15.5.8. Access

Ground transport infrastructure to service the proposed airport is discussed in Section 5.9 (Chapter 5 in Volume 1).

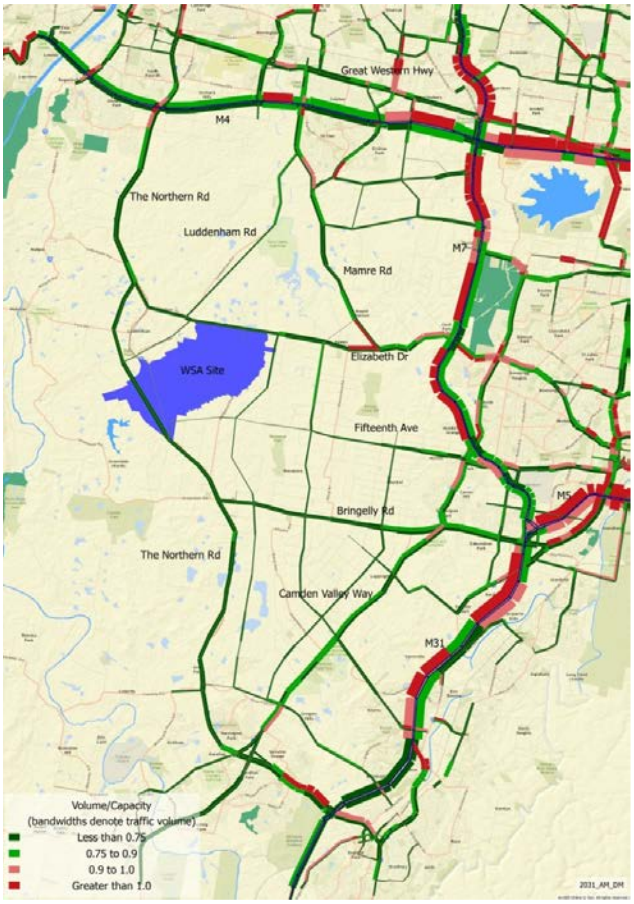
Local traffic originating in Bringelly which currently travels north to Elizabeth Drive via Badgerys Creek Road would no longer be able to do so. A high standard alternative route (via The Northern Road and the proposed M12 Motorway) is expected to be available to service this traffic.

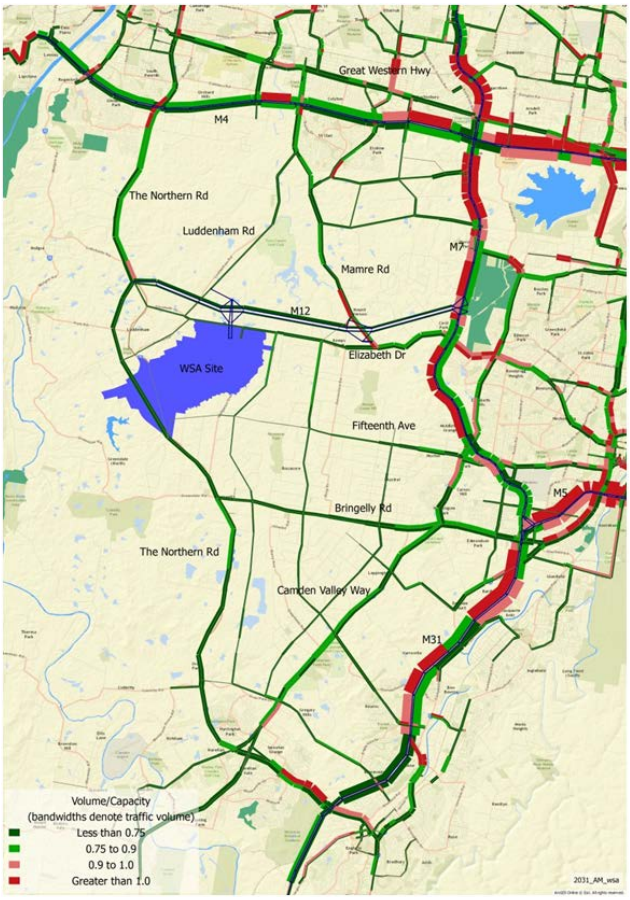
Table 15–12 – Level of Service for 2031 with and without the proposed airport

Id	Road	Location	Without the airport				With the airport			
			AM Peak		PM Peak		AM Peak		PM Peak	
			Nbd/Ebd	Sbd/Wbd	Nbd/Ebd	Sbd/Wbd	Nbd/Ebd	Sbd/Wbd	Nbd/Ebd	Sbd/Wbd
1	The Northern Road	North of Elizabeth Drive	C	D	C	C	C	E	D	C
2	The Northern Road	South of M4	F	C	D	F	F	D	D	F
3	The Northern Road	South of Bringelly Road	C	B	B	C	D	B	B	C
4	M4	West of Mamre Road	F	D	D	F	F	D	D	F
5	M4	West of M7	F	D	D	E	F	D	D	E
6	M7	South of M4	F	F	F	E	F	F	F	E
7	M7	South of Elizabeth Drive	F	D	D	D	F	D	D	E
8	M5	East of M7	F	E	E	F	F	E	E	F
9	M31	South of Campbelltown Road	F	E	D	E	F	E	D	E
10	Narellan Road	North of Tramway Drive	D	F	D	D	D	F	D	D
11	Bringelly Road	West of Cowpasture Road	D	C	C	C	D	C	C	C
12	Cowpasture Road	At M7	F	E	D	F	F	E	D	F
13	Elizabeth Drive	East of M7	D	F	D	C	E	F	E	D
14	Elizabeth Drive	West of M7	E	D	C	D	D	C	C	C
15	Elizabeth Drive	West of Mamre Road	F	B	B	D	C	B	B	C
16	Elizabeth Drive	East of the Northern Road	C	A	A	B	A	A	A	A
17	Mamre Road	North of Elizabeth Drive	F	C	C	F	F	E	D	F
18	Mamre Road	South of M4	D	F	E	D	D	F	E	D

Id	Road	Location	Without the airport				With the airport			
			AM Peak		PM Peak		AM Peak		PM Peak	
			Nbd/Ebd	Sbd/Wbd	Nbd/Ebd	Sbd/Wbd	Nbd/Ebd	Sbd/Wbd	Nbd/Ebd	Sbd/Wbd
19	Luddenham Drive	West of Mamre Road	D	C	C	C	**C**	C	C	**D**
20	Lawson Road	South of Elizabeth Drive	C	A	A	C	**D**	A	A	C
21	Western Road	South of Elizabeth Drive	D	A	B	C	D	**B**	B	**D**
22	Fifteenth Avenue	West of Cowpasture Road	C	A	A	C	C	A	A	C
23	M12	West of M7	-	-	-	-	A	A	A	A
24	M12	West of Mamre Road	-	-	-	-	B	A	A	A

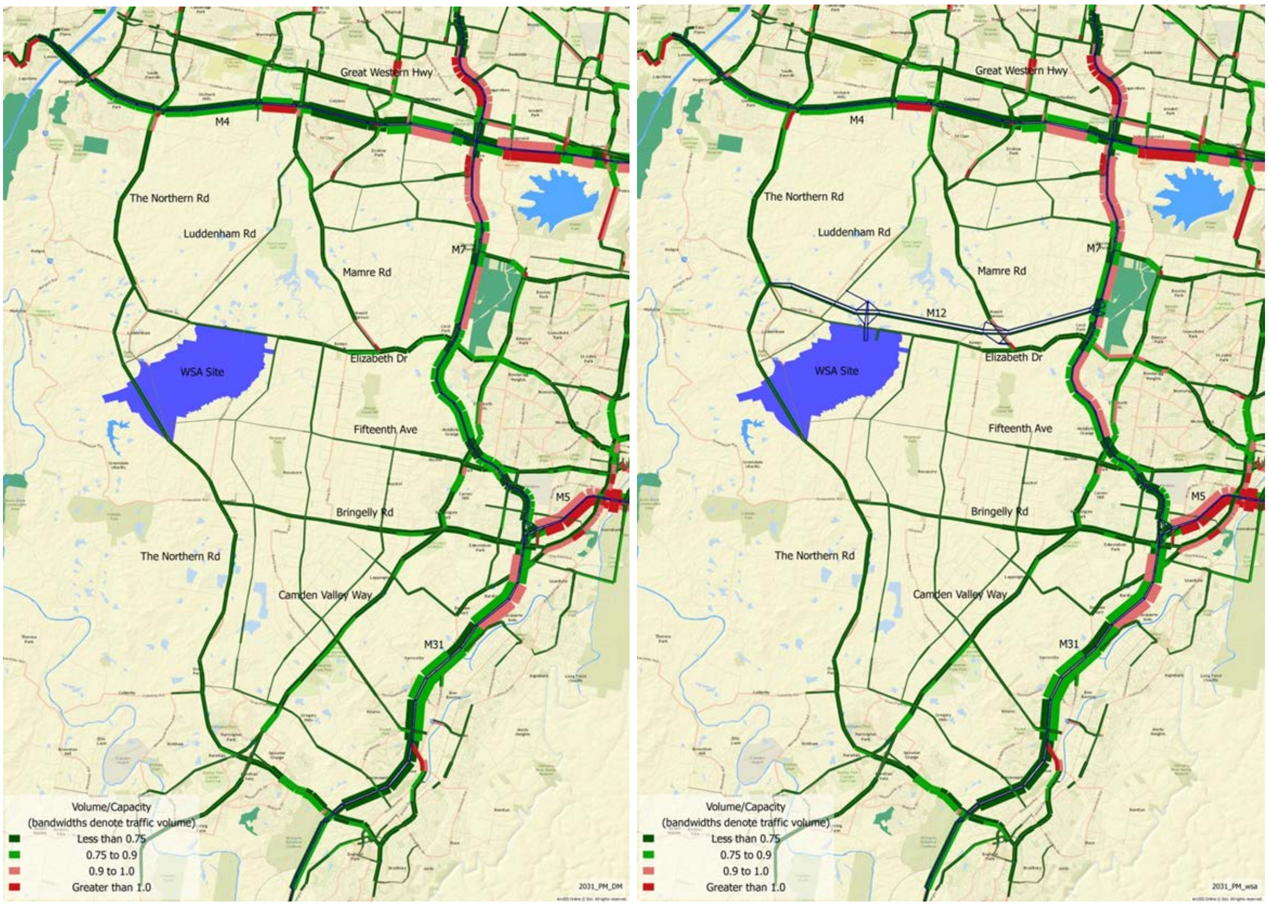
Note: Improvements are indicated in **green bold**. Deteriorations are indicated in **red bold**.





Note: Volume/capacity ratio bandwidth definitions are outlined in Table 15–1

Figure 15–18 – AM peak Volume/Capacity − Do minimum (left), with proposed airport (right)(2031)



Note: Volume/capacity ratio bandwidth definitions are outlined in Table 15–1

Figure 15–19 – PM peak volume/capacity − Do minimum (left), with proposed airport (right) (2031)

15.6. Mitigation and management measures

Table 15–13 outlines the broad mitigation and management measures that are proposed to address the expected traffic and transport effects associated with the proposed Stage 1 development.

Table 15–13 – Mitigation and management measures – surface traffic and access

ID	Issue	Mitigation/management measure	Timing
15.1	Construction related traffic and transport impacts	A community awareness programme would be implemented prior to construction commencing and would continue throughout the entire construction period. The programme would aim to make road users (including local residents) aware of construction traffic and safety issues, such as diversions, temporary road closures, traffic signalling and speed limits.	Pre-Construction
15.2	Construction related traffic and transport impacts	A traffic and access management plan would be developed prior to construction of the proposed airport as part of the construction environmental management framework. The plan would collate measures to mitigate and manage potential traffic impacts. The plan would consider the following elements: • management for the temporary and permanent closures of roads within the airport site; • a community engagement strategy; • ongoing consultation with Roads and Maritime, local councils as appropriate and emergency services; • induction for drivers working on the project to cover safety measures particularly for night works; • review of speed environments along transport corridors; • restriction of construction related traffic within the AM and PM peak periods where required; • management of the transportation of construction materials to optimise vehicle loads in order to minimise vehicle movements; • traffic control measures to manage and regulate traffic movements during construction; • identification of potential disruption to road users; • identification of any road closures and/or road upgrades that may be required; • construction vehicle routes, including the use of arterial roads, haulage routes, access to the airport site and procedures for oversize and heavy vehicles; and • parking facilities for construction workers. The plan would be developed in consultation with relevant stakeholders prior to the commencement of construction. The plan would provide the overall plan and staging for managing traffic through and around each work site. This would be in accordance with the Roads and Maritime's *Road Design Guide*, the Roads and Maritime Services *Traffic Control at Work Sites* manual and AS1742.3 *Manual of Uniform Traffic Control Devices – Traffic control for works on roads*, and any other relevant standard, guide or manual. The draft plan would be reviewed by relevant stakeholders including NSW Police, Transport for NSW, Road and Maritime Services and affected local councils.	Pre-Construction

ID	Issue	Mitigation/management measure	Timing
15.3	Operational traffic and transport impacts	A ground transport plan would be prepared as part of the detailed design of Stage 1 and before the proposed airport begins operating. The plan would address: • road design speeds; • security issues; • traffic loads from airport and other developments on site; • connections with off-site/external roads, including matching capacity, speeds and road geometry; • forecast traffic flows, including public transport requirements; • car parking; • commercial and operational vehicles and storage; • terminal interface; • passenger pick-up and drop-off by private and commercial vehicles; • pedestrian linkages between terminals and all transport drop-off/pick-up areas; • pedestrian, cycle or road networks for movement around the Airport Site; • use of dedicated busways; • ability to continue to provide access to and from the Airport when key intersections are unavailable; and • the ability to expand, with minimal disruption, to meet future airport and business development requirements.	Pre-operations

15.7. Conclusion

The construction phase of the proposed Stage 1 development is expected to generate an additional 1,254 vehicle movements per day on the surrounding road network. This equates to around 314 peak hour vehicle movements during the AM peak period. The predicted construction traffic would be dispersed throughout broader road network and would not be significant in the context of the broader Western Sydney region.

Elizabeth Drive would receive the greatest impact of the major roads during construction, due to its proximity to the site. The forecast AM peak traffic equates to about an 8% increase in traffic on this road. This increase would not be expected to lower the level of service on Elizabeth Drive.

A community awareness programme and traffic and access management plan would be implemented to provide information to road uses and manage construction traffic, including oversize vehicles.

During operation, Stage 1 would be expected to result in 20,922 vehicles accessing the site each day, with 20,936 leaving the site. With the introduction of the M12 Motorway, this additional traffic is not likely significantly to affect the operation of the surrounding road network but would be expected to result in:

- small increases in congestion at The Northern Road/M4 intersection; and
- small increases in congestion on Mamre Road.

A significant amount of road improvement works is proposed as part of the Western Sydney Infrastructure Plan, in addition to those identified in the Broader Western Sydney Employment Area and South West Priority Growth Area. These upgraded roads are expected to provide sufficient capacity to cater for the expected passenger and employee traffic demand associated with the proposed airport in 2031.

The public transport, walking and cycling systems proposed by the NSW Government and local councils would also have sufficient capacity to cater to the expected airport passenger and employee demand at the proposed airport.

An assessment of the surface traffic impacts of the longer term development is presented in Chapter 35. It considers the possible extension of the South West Rail Link to the airport site in response to increasing demand.

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16. Biodiversity

The airport site comprises gently undulating, low hills on shale and broad flats on alluvium on the Cumberland Plain. It 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 at the airport site 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 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 1,065 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 280.8 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 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 proposed Western Sydney Airport (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 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* (Cth) (EPBC Act) and the *Threatened Species Conservation Act 1995* (NSW) (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 and animals (including a number of species and populations 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 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, an environmental conservation zone would be established along the southern perimeter of the airport site where approximately 122 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 90.8 hectares of Cumberland Plain Woodland, the removal of about 120.6 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 for the affected threatened biota in suitable offset sites in the surrounding region in perpetuity.

16.1. Introduction

This chapter provides a review of the biodiversity values that may be potentially affected by the development of the proposed Western Sydney Airport (proposed airport). This chapter draws on a comprehensive terrestrial and aquatic ecological impact assessment, which is included as Appendix K1 in Volume 4 and on the offset strategy, which is included as Appendix K2 in Volume 4. The assessment 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.

The assessment has been prepared in consultation with the Australian Government Department of the Environment (DoE) 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 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:

- 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 Fisheries Management Act 1994 (NSW) (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 in 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 in 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 in Volume 4.

The surveys were designed with reference to the *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 in 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	18 days	360
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 airport site 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 in 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 airport site 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.

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 surveys

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 in Volume 4.

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

Table 16–2 – Survey effort (terrestrial fauna surveys)

Survey method	Survey effort	Approximate field person hours
Habitat assessment	18 days	360
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)	Eight nights	30
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 in 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 in 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 (Cth).

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 in 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. 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.

16.2.7. 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).

16.2.8. 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* (DSEWPC 2012). Biodiversity offsets to compensate for significant residual impacts on the natural environment on Commonwealth land, including threatened species and communities listed under the TSC Act, were calculated with the *BioBanking Assessment Methodology and Credit Calculator Operational Manual 2014* (DECC 2009b) and the *Framework for Biodiversity Assessment* (OEH 2014b). Further detail regarding the methodology for offsetting impacts is provided in Appendix K2 in Volume 4.

16.3. Existing environment

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 described.

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 within the catchment 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 and then also 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 freshwater wetlands. These wetlands support varying degrees of in stream and riparian vegetation.

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 in 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 in 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. One threatened plant species and one endangered population was recorded at the airport site and these are discussed in further detail below.

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 Noxious Weeds Act 1993 (NSW) for the Liverpool Local Government Area. An additional seven noxious weeds were recorded at the airport site. These weeds are listed in Table 16–3.

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 feroccissimum*), 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.

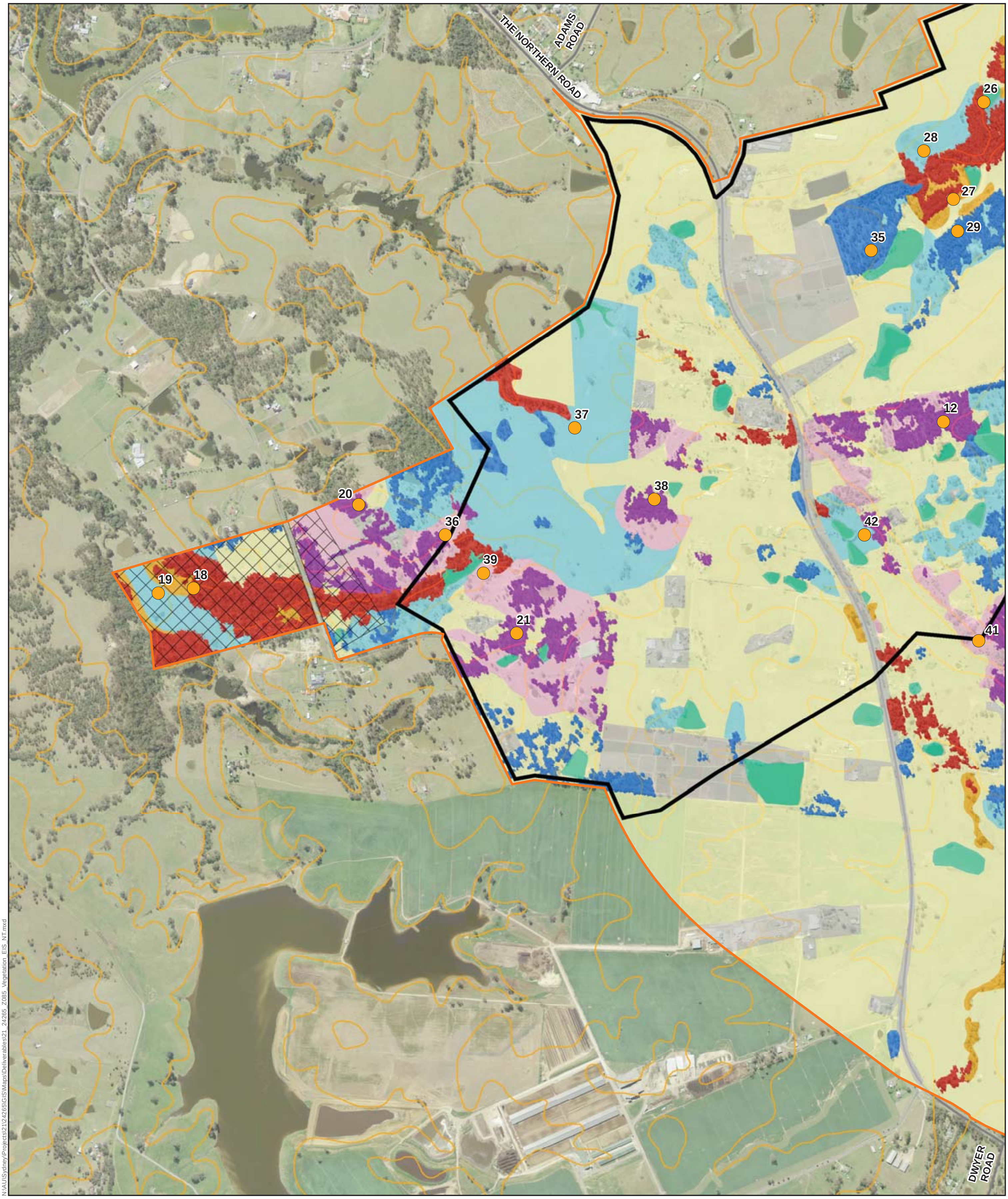
Weeds at the airport site would be managed in accordance with the mitigation measures listed in Section 16.7.2.

Table 16–3 – 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 feroccissimum	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 16–4 with further detail provided in Appendix K1 in Volume 4.



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

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

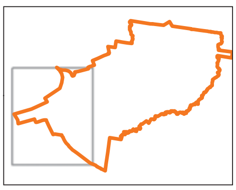


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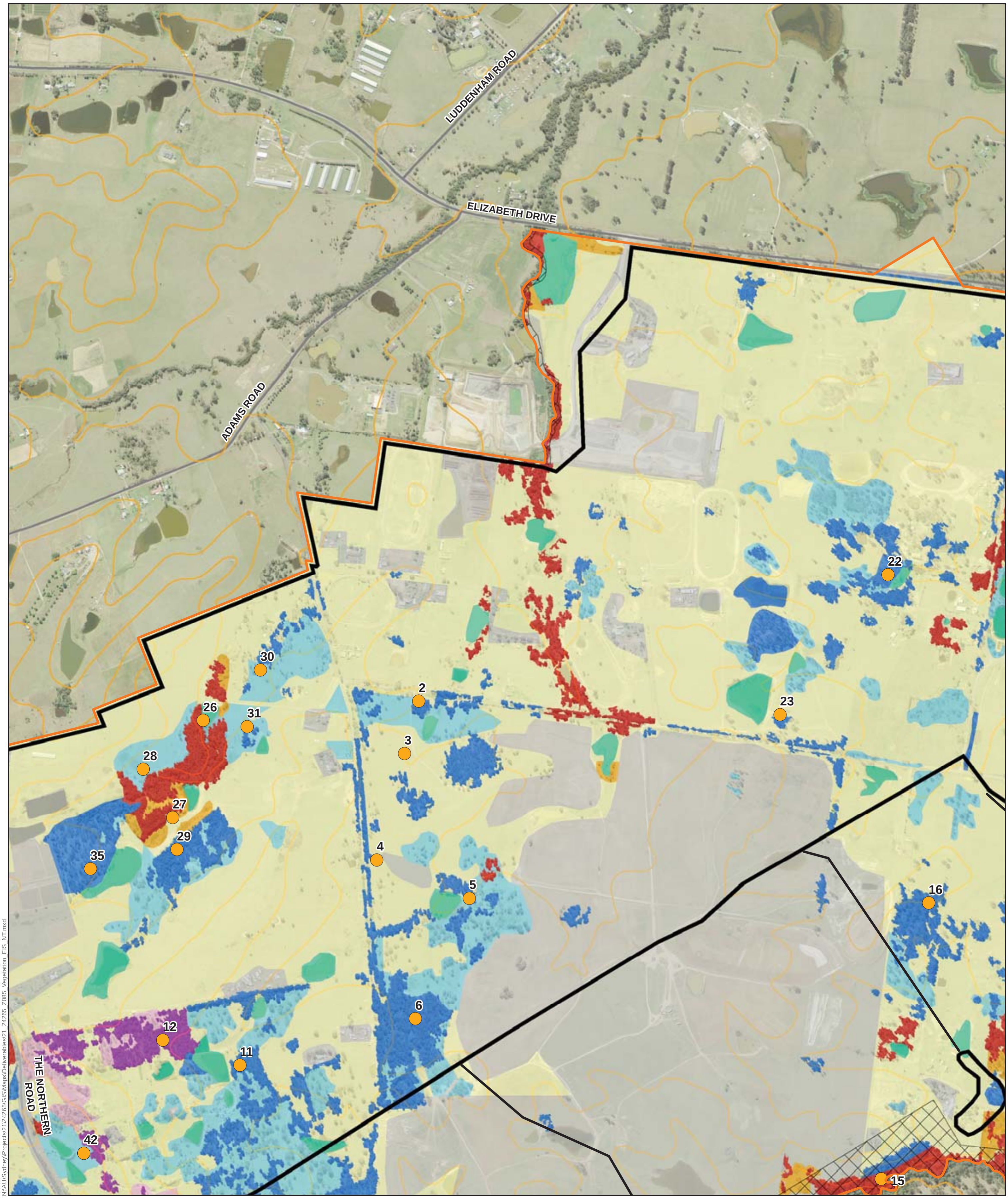
Figure 16-1A - Vegetation zones within the airport site



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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

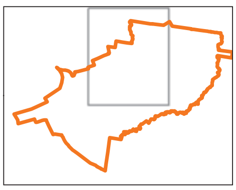

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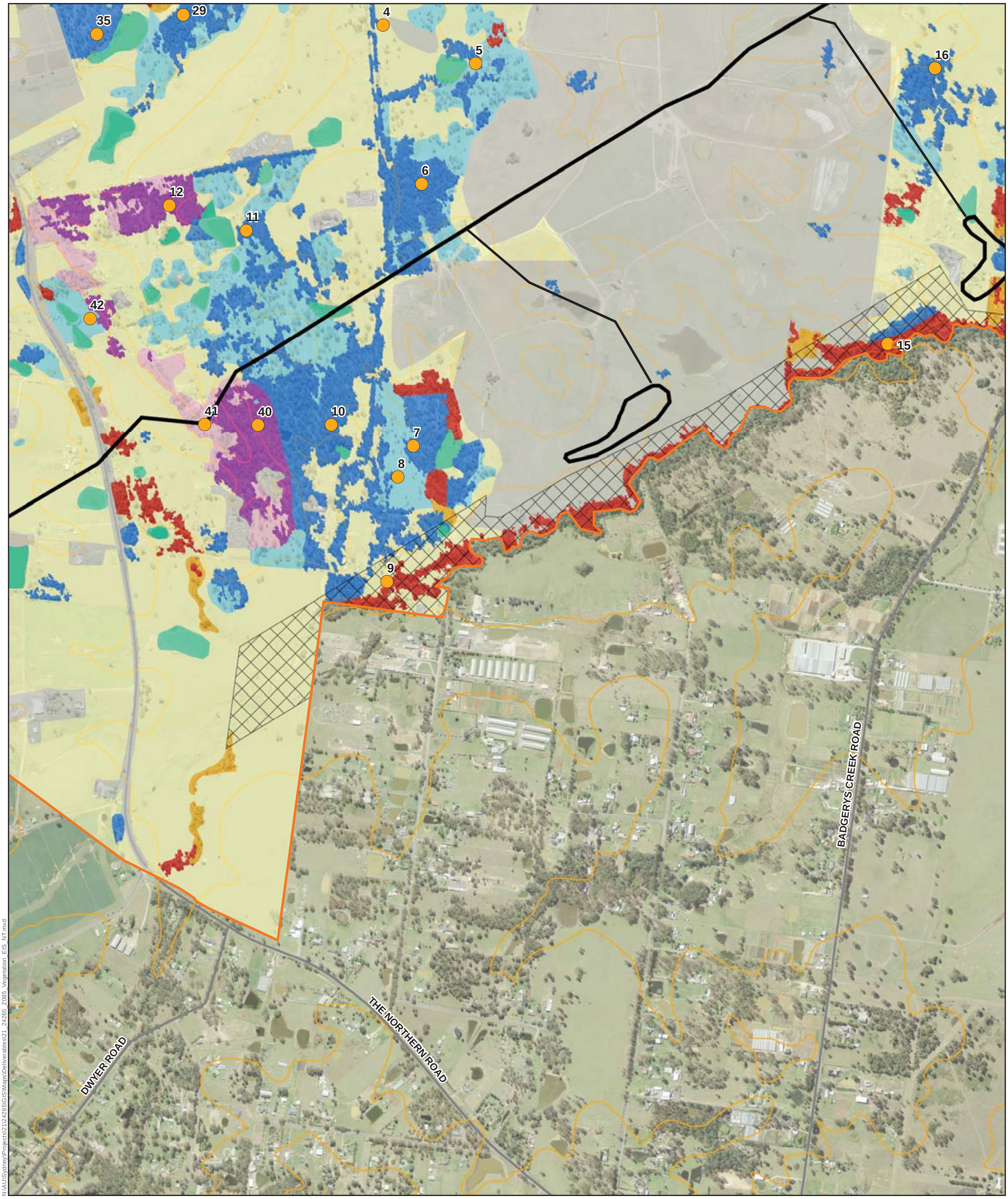
Figure 16-1B - Vegetation zones within the airport site



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

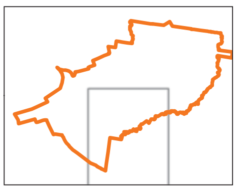


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Figure 16-1C - Vegetation zones within the airport site

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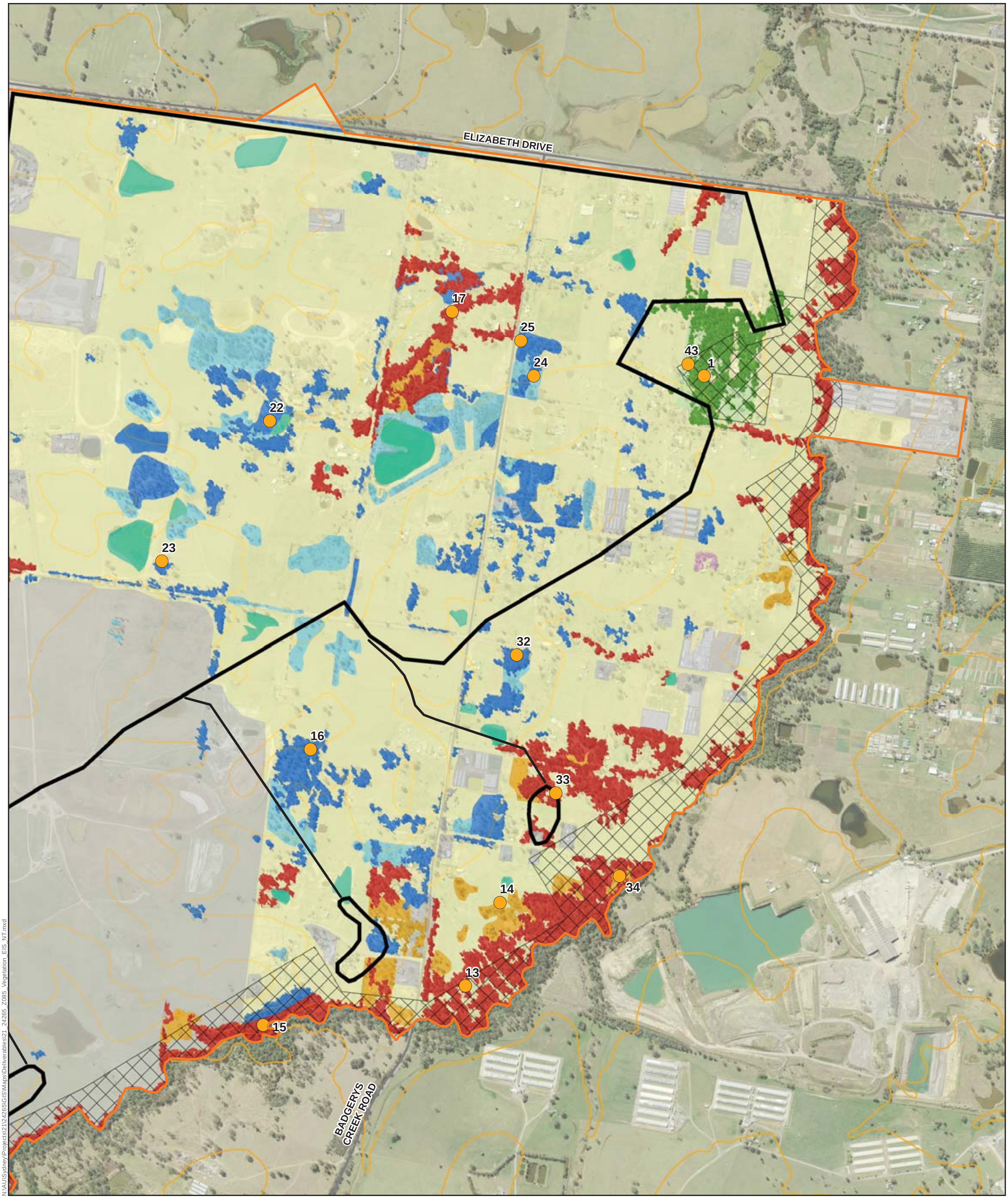

LEGEND

- 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

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

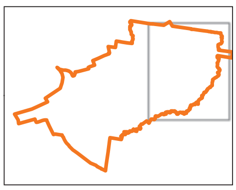

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Figure 16-1D - Vegetation zones within the airport site

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Table 16–4 – 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)	177.2
Poor condition Grey Box – Forest Red Gum grassy woodland on flats (HN528)	Moderate/good – poor	-	Cumberland Plain Woodland (CEEC)	134.0
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

Vegetation zone	Condition	Conservation status[1]		Area at the airport site (hectares)
		EPBC Act status	TSC Act status	
Non-native vegetation zones				
Exotic grassland	Cleared	-	-	956.4
Cleared land or cropland	Cleared	-	-	348.7
Total				1,774.3

Notes: 1. CEEC = Critically endangered ecological community, EEC = Endangered ecological community

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 creeks at the airport site are mapped as being groundwater dependent ecosystems that are reliant on the surface expression of groundwater (rivers, springs, wetlands). 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 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 2015). 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 at the airport site or within the locality. These species are described in Appendix K1 in Volume 4. Only one species was recorded at the airport site during field surveys and an additional seven species are considered likely to occur at the airport site and may be affected by the proposed airport. These species are listed in Table 16–5 and their distribution at the airport site is shown on Figure 16–2. The species recorded during the field surveys are highlighted in bold text in Table 16–5. The remaining 20 species 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 (refer to Appendix K1 in 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, 93 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 in the centre of the airport site (refer to Figure 16–2). These comprise part of the endangered *Marsdenia viridiflora* R. Br. subsp. *viridiflora* population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas listed under the TSC Act.

Table 16–5 – Threatened flora known or likely to occur at the airport site (terrestrial)

Scientific name	Common name	Conservation status[1]	
		EPBC Act	TSC Act
Acacia pubescens	Downy Wattle	V	V
Cynanchum elegans	White-flowered Wax Plant	E	E
Dillwynia tenuifolia	-	-	V
Grevillea juniperina subsp. juniperina	Juniper-leaved Grevillea	-	V

Scientific name	Common name	Conservation status[1]	
		EPBC Act	TSC Act
Grevillea parviflora subsp. parviflora	Small-flower Grevillea	V	V
Pimelea spicata	Spiked Rice-flower	E	E
Pultenaea parviflora	**-**	**V**	**E**
Thesium australe	Austral Toadflax	V	V

Notes: 1. Conservation status: V = Vulnerable, E = Endangered, **Bold** = recorded during field surveys

16.3.2.6. Threatened ecological communities

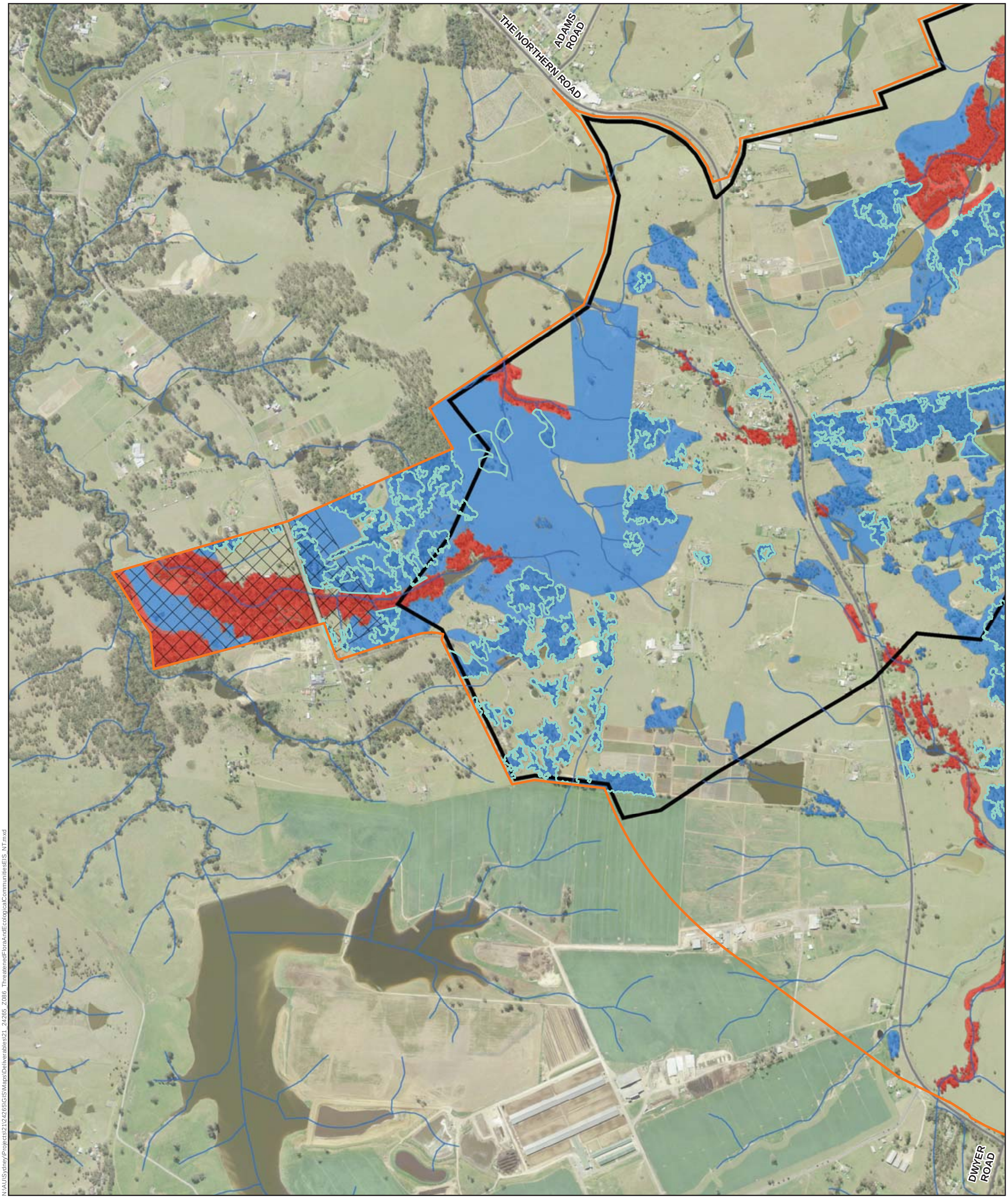
Larger and better condition patches of Grey Box – Forest Red Gum grassy woodland on flats, Grey Box – Forest Red Gum grassy woodland on hills and Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy open forest at the airport site comprise occurrences of 'Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest' (Cumberland Plain Woodland) (refer to Table 16–4). Cumberland Plain Woodland is listed as a critically endangered ecological community under the EPBC Act and the TSC Act. There are approximately 155.7 hectares of Cumberland Plain Woodland as defined under the EPBC Act at the airport site, as shown on Figure 16–2.

Derived native grassland and 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) (refer to Table 16–4).

These 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)

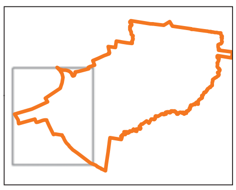


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Figure 16-2A - Threatened flora species, populations and ecological communities at the airport site

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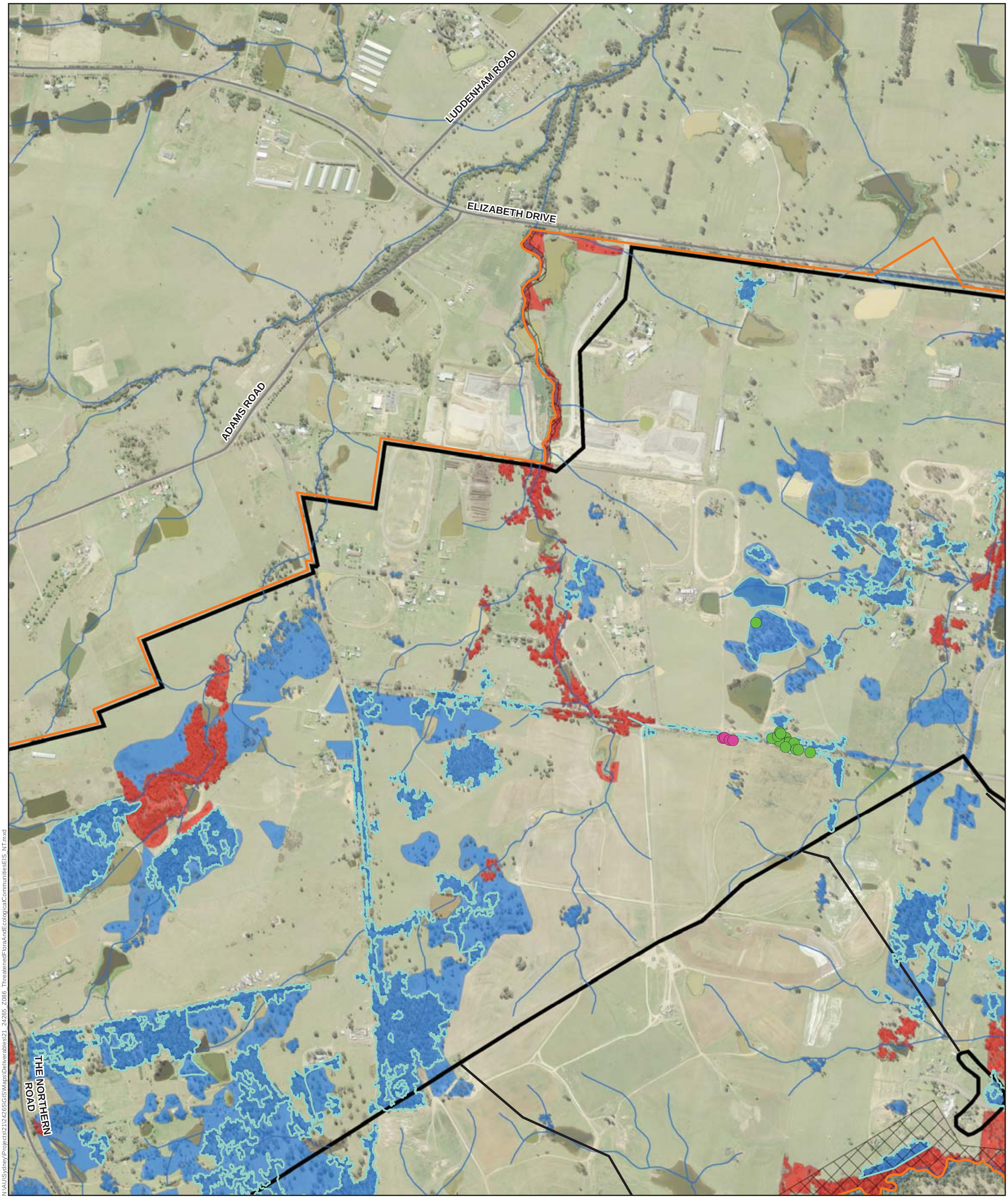


Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

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)

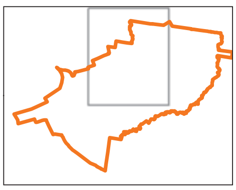
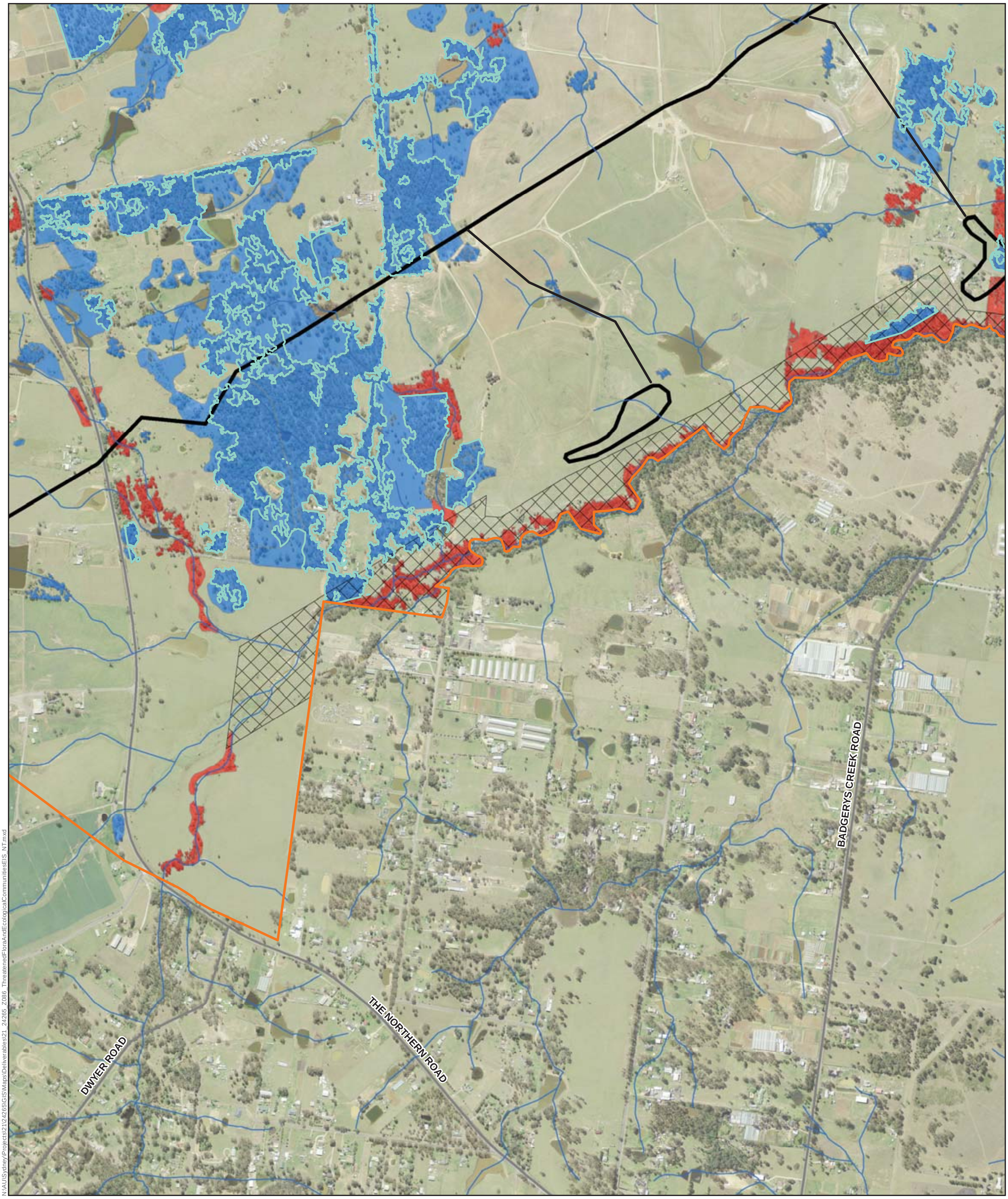


Figure 16-2B - Threatened flora species, populations and ecological communities at the airport site



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
- 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)

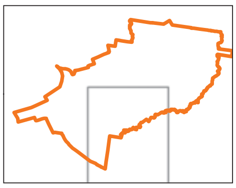
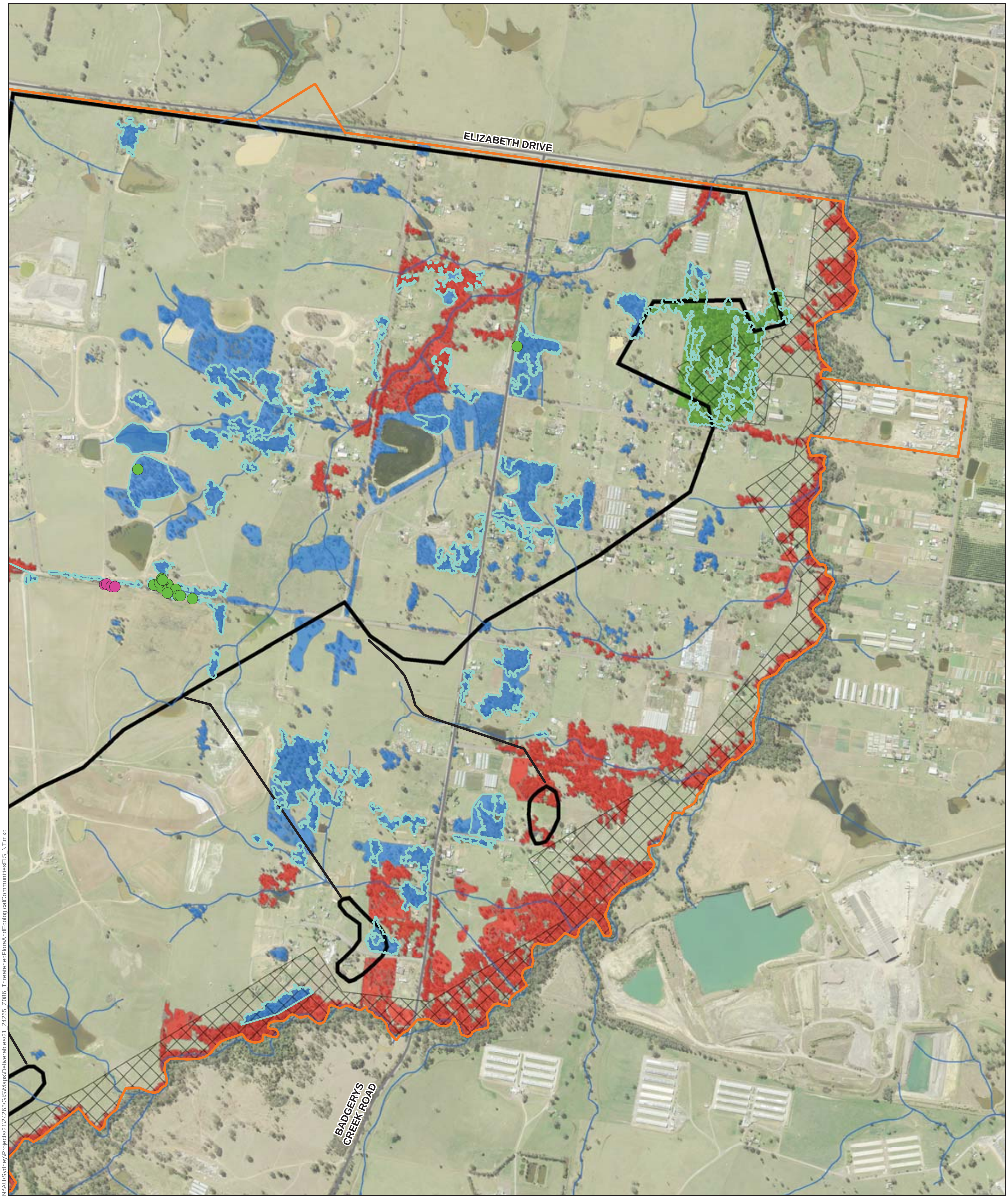


Figure 16-2C - Threatened flora species, populations and ecological communities at the airport site



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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)

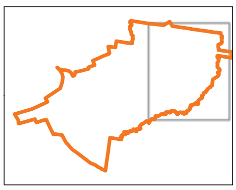

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Figure 16-2D - Threatened flora species, populations and ecological communities at the airport site

16.3.3. Terrestrial fauna

16.3.3.1. Fauna species

A total of 172 terrestrial fauna species (four invertebrate species, two fish species, 10 frog species, 10 reptile species, 126 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 animal species recorded at the airport site is provided in Appendix K1 in Volume 4.

One threatened fauna species listed under the EPBC Act was recorded at the airport site. The Grey-headed Flying-fox (*Pteropus poliocephalus*) was recorded during the recent surveys and the surveys for the 1997–99 EIS (PPK 1997). An additional eight threatened fauna species listed under the TSC Act have also been recorded at the airport site during both the recent surveys and the surveys for the 1997–99 EIS (PPK 1997). These are discussed in further detail below.

A number of introduced fauna species were recorded at the airport site. These included five bird species, six mammal species (including the Red Fox (*Vulpes vulpes*), Goat (*Capra hircus*) and Rabbit (*Oryctolagus cuniculus*)), one fish species (Mosquitofish (*Gambusia holbrooki*)), 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

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 feature near-intact geomorphology and 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*.

Buildings and other structures

A number of sheds and buildings are present at the airport site. These 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 in Volume 4.

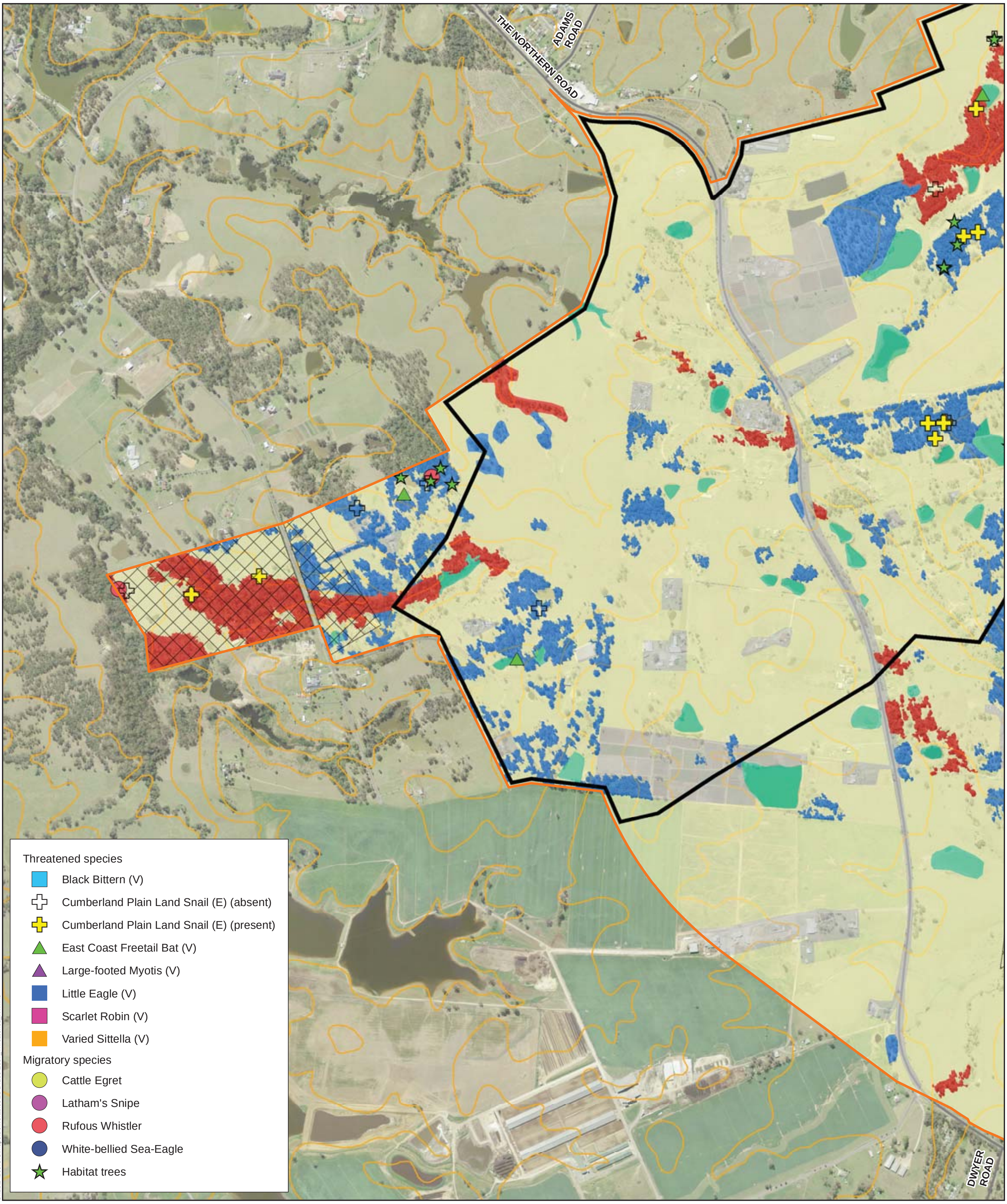
16.3.3.3. Habitat connectivity

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 Adam’s 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.



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LEGEND

Airport site
Stage 1 construction impact zone
Environmental conservation
Contour
Roads

Habitat type
Cleared land
Grassland
Riparian forest
Wetland
Woodland

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

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

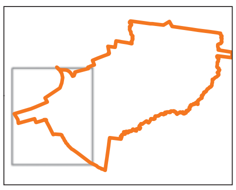

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Figure 16-3A - Habitat types and threatened fauna species at the airport site

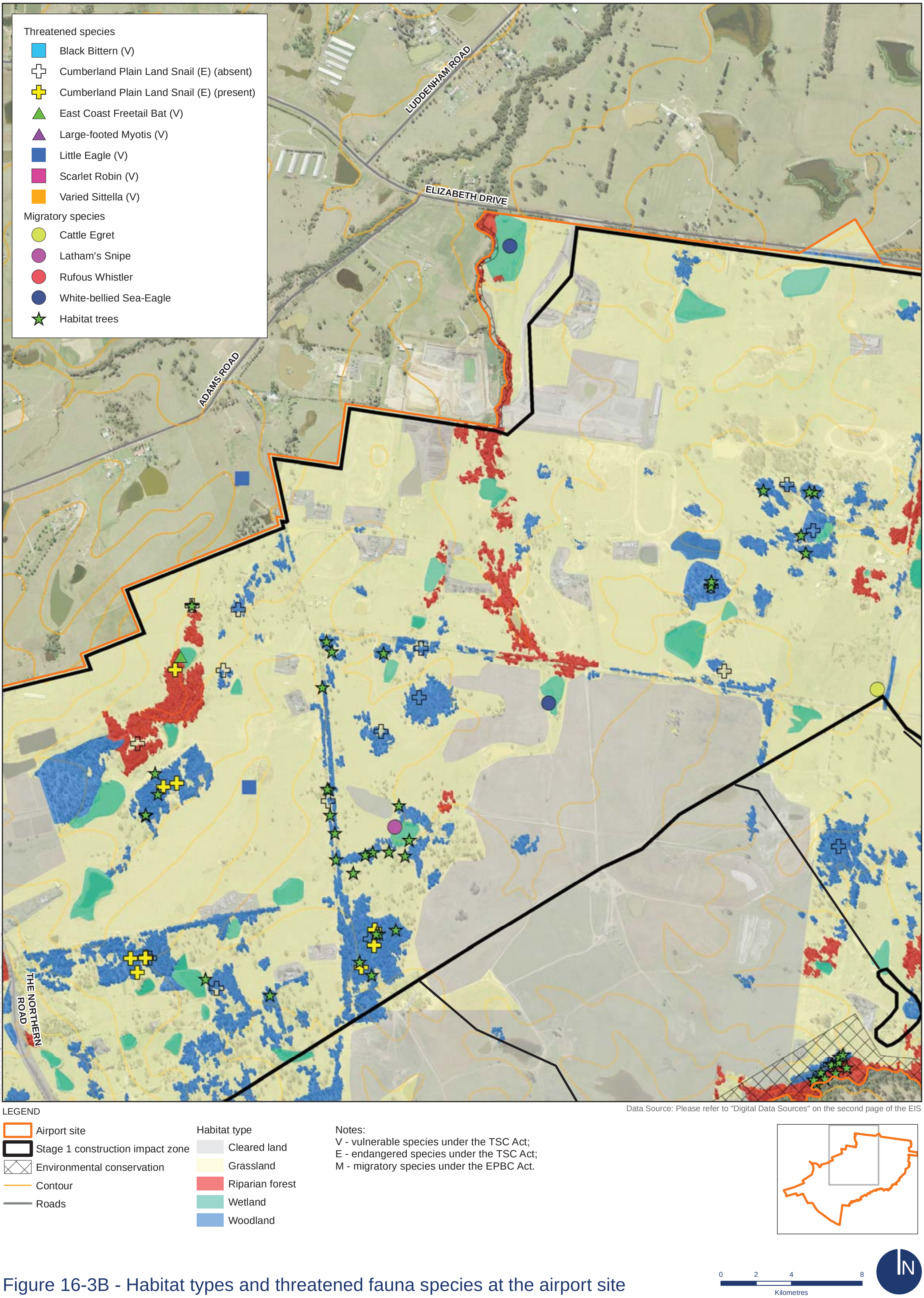
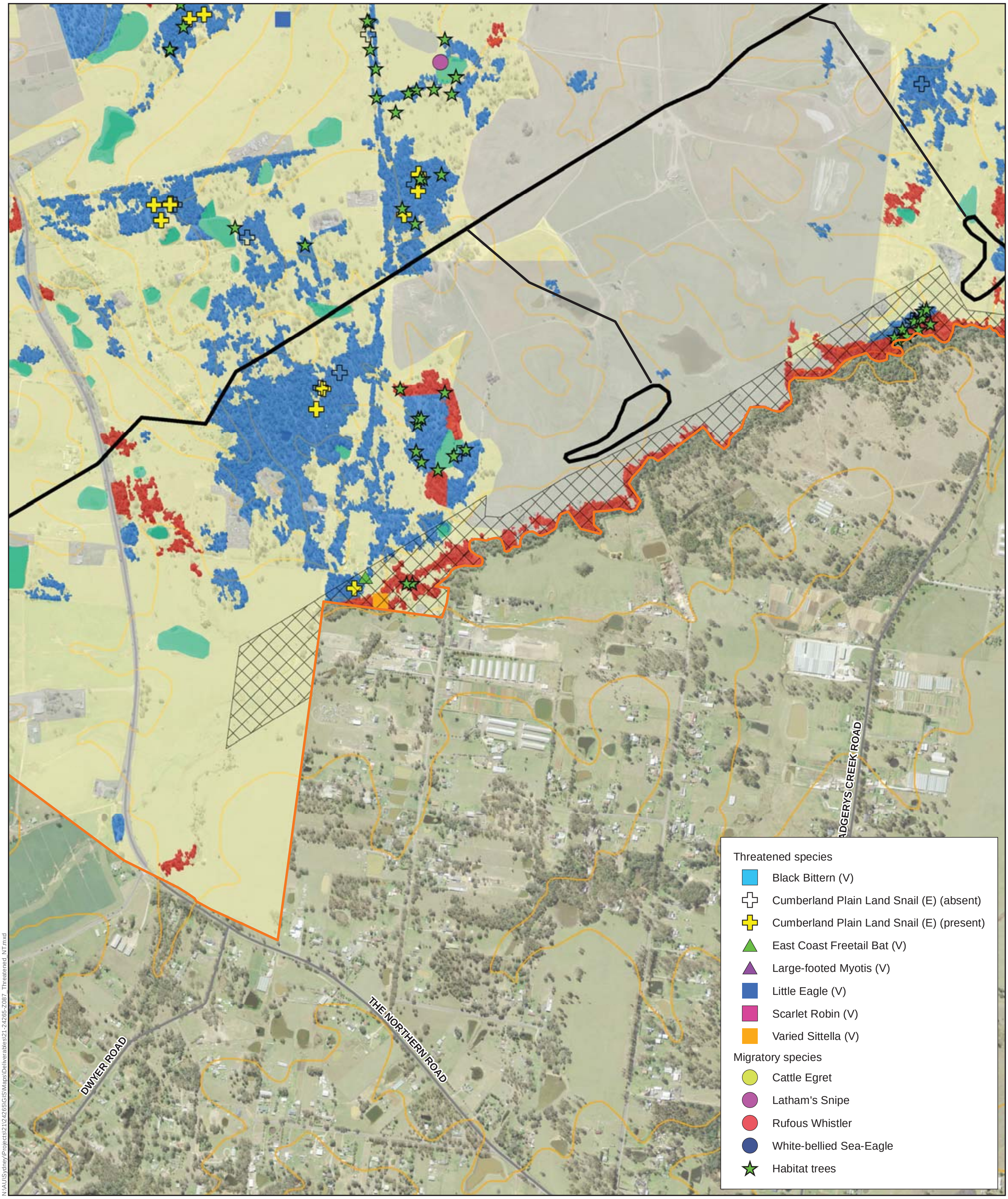


Figure 16-3B - Habitat types and threatened fauna species at the airport site



LEGEND

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

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

Habitat type

- Cleared land
- Grassland
- Riparian forest
- Wetland
- Woodland

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

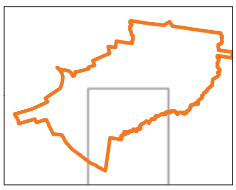


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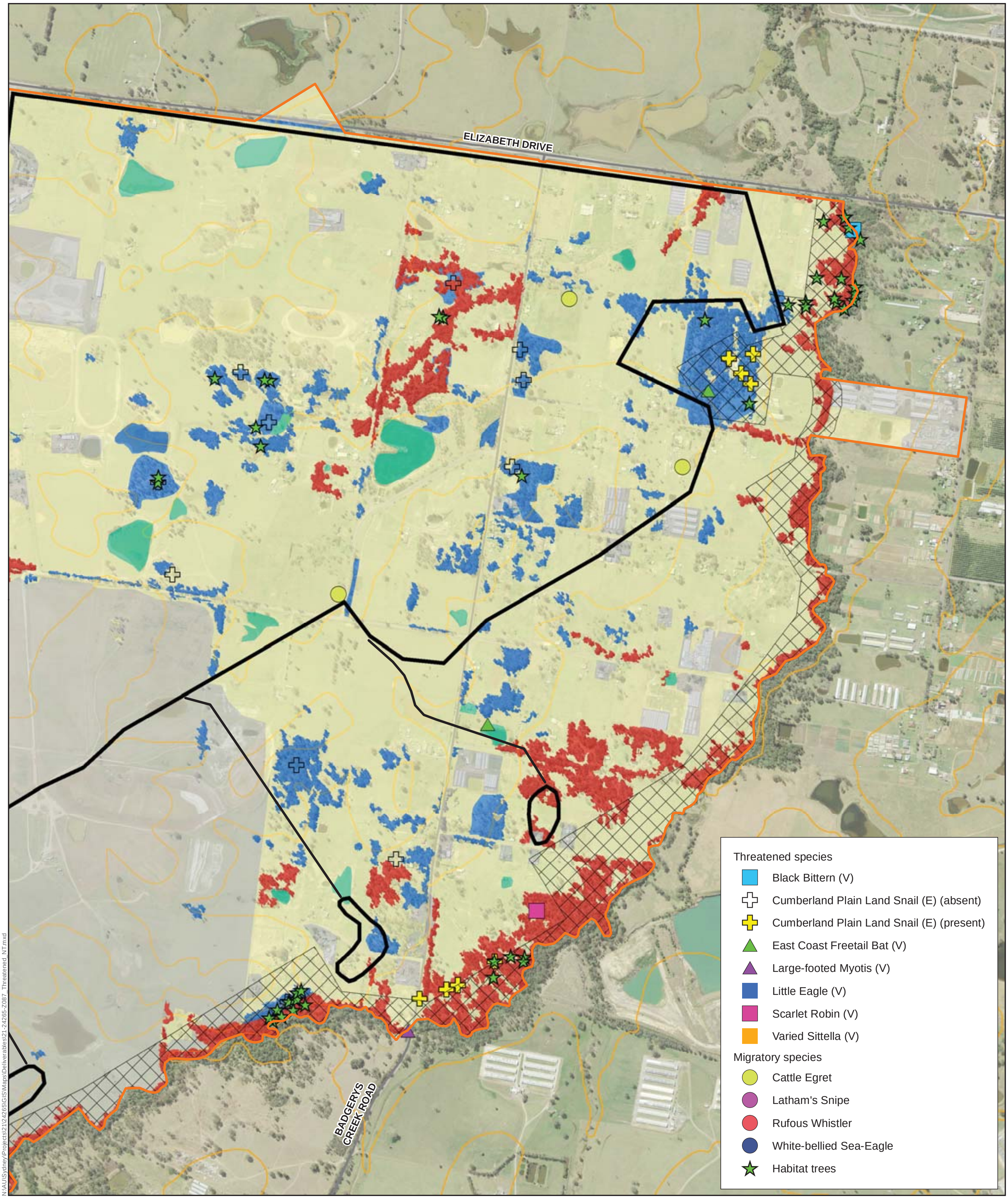
Figure 16-3C - Habitat types and threatened fauna species at the airport site



LEGEND

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

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

Habitat type

- Cleared land
- Grassland
- Riparian forest
- Wetland
- Woodland

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

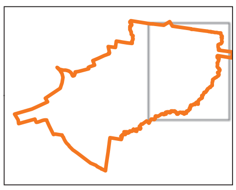


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Figure 16-3D - Habitat types and threatened fauna species at the airport site

16.3.3.4. Threatened fauna species

Fifty-one species of threatened fauna (listed under the EPBC Act and/or TSC Act) have been recorded or are predicted to occur at the airport site or within the locality. This includes three invertebrates, three fish, four amphibians, one reptile, 26 birds and 14 mammals. These species are described in Appendix K1 in Volume 4. Of these, nine species (one invertebrate, six birds and two mammals) were recorded at the airport site during the field surveys and an additional 21 species (15 birds and six mammals) are considered likely to occur at the airport site and may be affected by the proposed airport. These species are listed in Table 16–6 and their distribution at the airport site is shown on Figure 16–3. Those species recorded during the field surveys are highlighted in bold text in Table 16–6. The remaining 21 species are considered unlikely to occur at the airport site and, therefore, would not be affected by the proposed airport (refer to Appendix K1 in Volume 4).

Table 16–6 – Threatened fauna known or likely occur at the airport site (terrestrial)

Scientific name	Common name	Conservation status1	
		EPBC Act	TSC Act
Invertebrates			
Meridolum corneovirens	**Cumberland Plain Land Snail**	**-**	**E**
Birds			
Botaurus poiciloptilus	Australasian Bittern	E	E
Callocephalon fimbriatum	Gang-gang Cockatoo	-	V
Calyptorhynchus lathami	Glossy Black-Cockatoo	-	V
Chthonicola sagittata	Speckled Warbler	-	V
Daphoenositta chrysoptera	**Varied Sittella**	**-**	**V**
Glossopsitta pusilla	**Little Lorikeet**	**-**	**V**
Hieraaetus morphnoides	**Little Eagle**	**-**	**V**
Ixobrychus flavicollis	**Black Bittern**	**-**	**V**
Lathamus discolor	Swift Parrot	E	E
Lophoictinia isura	Square-tailed Kite	-	V
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	-	V
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	-	V
Ninox connivens	Barking Owl	-	V
Ninox strenua	Powerful Owl	-	V
Oxyura australis	**Blue-billed Duck**	**-**	**V**
Petroica boodang	**Scarlet Robin**	**-**	**V**
Petroica phoenicea	Flame Robin	-	V
Rostratula australis	Australian Painted Snipe	E	E

Scientific name	Common name	Conservation status1	
		EPBC Act	TSC Act
Stagonopleura guttata	Diamond Firetail	-	V
Stictonetta naevosa	Freckled Duck	-	V
Tyto novaehollandiae	Masked Owl	-	V
Mammals			
Falsistrellus tasmaniensis	Eastern False Pipistrelle	-	V
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	-	V
Mormopterus norfolkensis	**Eastern Freetail-bat**	-	V
Myotis macropus	Southern Myotis	-	V
Pteropus poliocephalus	**Grey-headed Flying-fox**	V	V
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	-	V
Scoteanax rueppellii	Greater Broad-nosed Bat	-	V
Vespadelus troughtoni	Eastern Cave Bat	-	V

Notes: 1. Conservation status: V = Vulnerable, E = Endangered, **Bold** = recorded during field surveys

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 (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. These species include:

- 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;
- Swift Parrot (*Lathamus discolour*). The Swift Parrot is listed as endangered under the EPBC Act and 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; and
- 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;
- 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;
- 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;
- 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;

- 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;
- Scarlet Robin (*Petroica boodang*). The Scarlet Robin is listed as vulnerable under the TSC Act. One individual was recorded foraging in River-flat Eucalypt Forest near Badgerys Creek and may also occur in larger patches of Cumberland Plain Woodland. This species may breed and forage in larger woodland patches at the airport site, although it tends to breed in woodland on foothills and ridges, moving to lower more open habitats in winter;
- 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; and
- Eastern Freetail-bat (*Mormopterus norfolkensis*). The Eastern 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 included:

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

- Southern 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 (refer to Table 16–6). 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.

Two threatened fauna species were identified as potentially being significantly affected by the proposed airport in the EIS guidelines. However, these 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 species 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. This species was not recorded at the airport site during the recent field surveys, nor has it been recorded during previous field surveys undertaken at the airport site. The species has been recorded at Bents Basin State Conservation Area to the south-west of the site. Large expanses of suitable habitat are present to the west in the Blue Mountains National Park, however, extensive areas of cleared agricultural land between these areas and the airport site make it unlikely that this species would occur at the airport site other than on a very occasional basis. In addition, there is no suitable roosting habitat at the airport site or in the immediate vicinity; and
- 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.

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

Eight 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 in Volume 4 and are listed in Table 16–7. Their distribution at the airport site is shown on Figure 16–3. Those species recorded during the field surveys are highlighted in bold text in Table 16–7.

Table 16–7 – Migratory species known or likely occur at the airport site

Scientific name	Common name	Conservation status[1]	
		TSC Act	EPBC Act
Apus pacificus	Fork-tailed Swift	-	M,C,J,K
Ardea alba	Great Egret	-	M,C,J
Ardea ibis	Cattle Egret	-	M,C,J
Gallinago hardwickii	Latham's Snipe	-	M,C,J,K
Haliaeetus leucogaster	White-bellied Sea-Eagle	-	M,C
Hirundapus caudacutus	White-throated Needletail	-	M,C,J,K
Merops ornatus	Rainbow Bee-eater	-	M,J
Rhipidura rufifrons	Rufous fantail	-	M

Notes: 1. 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), **Bold** = recorded during field surveys

Seven migratory bird species listed under the EPBC Act were recorded at the airport site during the field surveys. 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.

The White-bellied Sea-eagle (*Haliaeetus leucogaster*) was observed either flying over dams or perching on large trees near dams. 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.

In addition to the seven migratory bird species recorded at the airport site, a flock of about 40 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 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 significant impact criteria for migratory species. The airport site would not support an ecologically significant proportion of the population of these 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 in 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. These included five native species and three exotic 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 (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 Area is listed as a declared World Heritage Area and a National Heritage Place under the EPBC Act. The Greater Blue Mountains 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 forests. 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).

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, as discussed below. 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 1,065 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 16–8.

Approximately 784.2 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 280.8 hectares of native vegetation would be removed, comprising around 146.1 hectares of good condition native vegetation (occurring in small, fragmented patches with moderate weed infestation) and a further 134.7 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 120.6 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 12,568 hectares of similar woodland and forest on shale or alluvial substrates within a 10 kilometre radius of the airport site. Around 61 hectares of native vegetation would also be retained in the environmental conservation zone at the airport site, as shown in the 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 (refer to 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 16–8 – Estimated vegetation removal by vegetation zone (Stage 1 development)

Vegetation zone	Conservation status[1]		Direct impact (hectares)
	EPBC Act	TSC Act	
Native vegetation zones			
Good condition Grey Box – Forest Red Gum grassy woodland on flats (HN528)	CEEC	CEEC	71.3
Poor condition Grey Box – Forest Red Gum grassy woodland on flats (HN528)		CEEC	107.8
Good condition Grey Box – Forest Red Gum grassy woodland on hills (HN529)	CEEC	CEEC	17.3
Poor condition Grey Box – Forest Red Gum grassy woodland on hills (HN529)		CEEC	22.3
Good condition Forest Red Gum – Rough-barked Apple grassy woodland (HN526)		EEC	29.8
Poor condition Forest Red Gum – Rough-barked Apple grassy woodland (HN526)		EEC	4.2
Good condition Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy open forest (HN512)	CEEC	EEC	2.2
Poor condition Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy open forest (HN512)		EEC	0.4
Good condition artificial freshwater wetland on floodplain (HN630)			25.4
Total removal native vegetation			280.8
Non-native vegetation zones			
Exotic grassland			628.8
Cleared land or cropland			155.4
Total removal non-native vegetation			784.2
Total vegetation removal			1,064.9

Notes: 1. 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 16–9 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 (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 16–9 – 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	90.8	10,014	0.91%
Riparian forest	29.8	2,555	1.16%
Total woodland and forest	120.6	17,393	0.69%
Artificial wetlands (farm dams)[2]	25.4	-	-
Grassland[2]	763.5	-	-
Cleared land and cropland	155.4	-	-
Total	1,064.9	-	-

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 draft Airport Plan.

A large number of artificial wetlands (farm dams) would be removed. In total, approximately 25.4 hectares of 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.

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.

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 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. A water management system has been developed for the Stage 1 development, which would include establishing a series of seven detention basins on the periphery of the airport site to retain stormwater runoff prior to discharge into nearby creeks. The basins have been sized to manage post-development flows to pre-development levels, and would be sited to allow discharge points consistent with existing drainage lines to minimise impacts on downstream hydrology.

16.4.2.5. Erosion, sedimentation and contamination

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 reduced habitat quality and the potential mortality of aquatic flora and fauna downstream of the airport site.

16.4.2.6. 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.

16.4.2.7. 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.

16.4.2.8. 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.

16.4.2.9. 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. Assessment of impacts 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 or reduce 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. 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).

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. 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.

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.

The bird and bat strike risk assessment found these bird species would present at least a moderate strike risk during operation of the Stage 1 development. Farm dams are common in the surrounding area and present the greatest bird hazard for the airport. Nearby landfills also support high numbers of large birds, which may result in birds transiting the operational airspace.

There are at least seven flying-fox camps located within 20 kilometres of the airport site. Bats travelling from local camps to foraging areas may fly across the airport site and approaches and be at risk from aircraft strike. While occasional bats may be killed by aircraft strike, this is not likely to substantially change the population numbers in nearby camps.

16.5.1.2. Other terrestrial fauna strike

Movement of aircraft and 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 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. Water quality and hydrology

Water quality at the airport site is poor, with high levels of nutrients and suspended solids and elevated electrical conductivity levels due to salinity issues. Dissolved oxygen levels are also low. It is likely that water released downstream of the airport site during operation would be improved compared to current catchment discharges. This should have a net beneficial effect on aquatic flora and fauna in waterbodies close to the airport site.

Operation of the Stage 1 development would likely affect flows in receiving waterbodies both upstream and downstream of the airport site. Hydrologic and hydraulic modelling indicates that duration, volume and velocity of surface water flows in watercourses would generally be similar or reduced when compared to existing flow conditions (refer to Chapter 18 Surface water and groundwater). Impacts on aquatic habitat and key fish habitat may, therefore, occur as a result of this changed hydrology. These impacts are likely to be restricted to reaches close to the airport site. Further downstream, inflow from other creeks would dissipate these changes. Few native species (gudgeons) were recorded at the airport site, and these were generally located in the Oaky Creek sites. Eels were recorded at dams and in Badgerys Creek. Given the generally poor quality of aquatic habitats in and downstream of the airport site, it is unlikely that the proposed airport would have a substantial impact on fish habitat in downstream areas.

Further resolution of appropriate management and mitigation measures would be provided in the final EIS having regards to the potential for impacts upon any downstream threatened species.

16.5.2.5. 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.

16.5.2.6. Fuel jettisoning

As discussed in Chapter 7, fuel jettisoning is extremely rare worldwide and generally only occurs during an emergency, as a safety precaution when a plane must land prematurely. Airservices Australia indicates that of the 730,201 aircraft movements in Australia in 2014, there were only 10 instances of fuel jettisoning. There are currently no recorded cases of fuel from civilian aircraft reaching the ground.

There are specific protocols in place 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 6,000 feet (approximately 2,000 metres) above ground level, and in an area nominated by air traffic control to ensure that all fuel is vaporised before reaching the ground. Reasonable precautions must also be taken to ensure the safety of persons and property in the air and on the ground.

Due to improvements in fuel efficiency and lightweight aircraft material, the amount of fuel jettisoned from an aircraft under emergency situations has decreased substantially, with this trend anticipated to continue. As fuel efficiency, technology and airspace management continue to improve, volumes of fuel required to be carried on planes will steadily decline in the future. This will, in turn, reduce the amount of fuel jettisoned in the event of an emergency.

The effects of fuel jettisoning on local air quality would be limited due to the inability of many aircraft to perform fuel jettisons, the rapid vaporisation and wide dispersion of jettisoned fuel, the strict guidelines on fuel jettisoning altitudes and locations, and the anticipated reduction in fuel jettisoning events and volumes in the future. For these reasons, fuel jettisoning is not considered likely to have a significant immediate or future impact on local air quality or on biodiversity values.

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 16–10. 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 and mitigation measures to limit the potential impacts are discussed in Section 16.7.

Table 16–10 – 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
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

Key threatening process	Status
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 in 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 plants and animals 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 and include 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*) (refer to Table 16–5). Assessments of significance were prepared for these threatened flora species, the results of which are summarised below with further detail provided in Appendix K1 in 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 90.8 hectares of potential habitat for the Stage 1 development and up to approximately 57 hectares of additional 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.

Since the proposed airport is not likely to result in a significant impact on these threatened species, there is no requirement to calculate or deliver direct biodiversity offsets in accordance with the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPaC 2012) (EPBC Act Offsets Policy). However, any potential impacts on these threatened plant species would be substantially offset through the biodiversity offset package for the proposed airport (refer to Section 16.8).

16.6.2.2. Threatened ecological communities

One threatened ecological community listed under the EPBC Act was recorded at the airport site – Cumberland Plain Woodland (refer to Section 16.3.2). An assessment of significance was undertaken for Cumberland Plain Woodland. Construction of the proposed airport would require the removal of approximately 90.8 hectares of this community for the Stage 1 development and an additional 57 hectares for the long term development. Construction of the proposed airport is likely to have a significant impact on the local and regional occurrence of Cumberland Plain Woodland. A significant impact would occur through a substantial reduction in the extent of the community and increase in the degree of fragmentation which would in turn result in a negative effect on the potential for recovery of the community.

A biodiversity offset package has been prepared to compensate for these significant impacts (refer to Section 16.8). This includes the protection and management of Cumberland Plain Woodland at offset sites in perpetuity.

16.6.2.3. Threatened fauna species

One threatened fauna species listed under the EPBC Act was recorded at the airport site during the field surveys – the Grey-headed Flying-fox. Three additional species listed under the EPBC Act are considered likely to occur at the airport site and include the Australasian Bittern, Swift Parrot and Australian Painted Snipe (refer to Table 16–6). Assessments of significance were prepared for the Grey-headed Flying-fox and the Swift Parrot, the results of which are provided below. The Australasian Bittern and Australian Painted Snipe may occur at the airport site on a transient basis and only low quality potential habitat is 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 120.6 hectares of foraging habitat and 78.6 hectares of foraging habitat for the long term development, which is 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 strategy has been prepared for the airport to compensate for these significant impacts (refer to Section 16.8). This would include the protection and management of Grey-headed Flying-fox habitat at offset sites in perpetuity.

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 120.6 hectares of highly fragmented, relatively low quality potential foraging habitat for the Stage 1 development and an additional 78.6 hectares of foraging habitat for the long term development. Approximately 61 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

Eight migratory species listed under the EPBC Act have been recorded or are predicted to occur at the airport site (refer to Table 16–7). The Stage 1 development would require the removal of approximately 25.4 hectares of artificial wetlands (habitat for the Great Egret, Cattle Egret, Latham's Snipe and White-bellied Sea-eagle), 120.6 hectares of woodland and forest vegetation (habitat for the Rufous Fantail and Rainbow Bee-eater), and 628.8 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 9.6 hectares of artificial wetland, 78.5 hectares of woodland and forest and 279.2 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 in 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 'plants' and 'animals' 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, Eastern 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 221 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 2.6 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 long term development area. 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 (refer to Section 16.8).

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 (refer to 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 221.3 hectares of Cumberland Plain Woodland, 34 hectares of River Flat Eucalypt Forest and 2.6 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 at the airport site 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 (refer to Section 16.8).

16.6.3.3. Threatened fauna species

The Australasian Bittern, Swift Parrot and Grey-headed Flying-fox are listed under both the EPBC Act and the TSC Act. Impacts on these species have been assessed in Section 16.6.2. Eight species listed under the TSC Act have been recorded at the airport site. There is also potential habitat for an additional 18 species listed under the TSC Act (refer to Table 16–6). The potential impacts on these threatened species are summarised below.

The loss of approximately 120.6 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/subpopulations and would reduce the genetic diversity of the species 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 120.6 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 882.5 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 (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.

Three Blue-billed Ducks were observed at a large artificial dam at the airport site. 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 25.4 hectares of artificial wetlands 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 give the low numbers of individuals that may occur in the area. Given these points, 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 120.6 hectares of woodland and forest, which is potential foraging habitat for the species. Approximately 61 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 120.6 hectares of woodland and forest, which is potential foraging habitat for the species. Approximately 61 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 wetlands at the airport site where there is suitable cover and the riparian corridors of Duncans Creek and Oaky Creek. Approximately 55.3 hectares of 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 61 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, Eastern 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 120.6 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 (refer to Section 16.8).

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. 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 and 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 122 hectares of land in the environmental conservation zone would be protected. The environmental conservation zone includes around 61 hectares of native vegetation and representative areas of each of the vegetation types at the airport site. The 61 hectares of land within the environmental conservation zone that does not currently contain native vegetation would be revegetated. 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 long term development area (that is, the parts of the airport site outside the construction impact zone of the Stage 1 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 16–11. These measures would be incorporated into a biodiversity management plan for the proposed airport and implemented as far as practicable.

The mitigation and management measures listed in Chapter 12 (Air quality and greenhouse gases), Chapter 17 (Topography, geology and soils) and Chapter 18 (Surface water, groundwater and water quality) 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 16–11 – Mitigation and management measures (biodiversity)

ID	Issue	Mitigation/management measure	Timing
16.1	Biodiversity management plan	A biodiversity management plan would be developed prior to construction of the proposed airport as part of the construction environmental management framework. The plan would collate measures to mitigate and manage potential impacts on biodiversity.	Pre-construction
16.2	Worker inductions	All workers are to be provided with an environmental induction prior to starting construction activities on site. This would include information on the ecological values of the airport site and protection measures to be implemented to protect biodiversity during construction.	Pre-construction Construction
16.3	Vegetation clearance and habitat loss	Reduce the potential for adverse impacts on ecologically sensitive areas by: • deferring vegetation removal until necessary; • locating site offices and stockpiles in already cleared and disturbed areas, to avoid further unnecessary removal or disturbance of native vegetation and hollow-bearing trees, where possible; • providing maps to construction staff clearly showing vegetation clearing boundaries and exclusion/no-go zones; and • engaging a suitably qualified ecologist or environmental officer prior to any clearing works to clearly demarcate vegetation protection areas.	Pre-construction Construction
16.4	Disease management	Management of plant disease (such as Phytophthora, Myrtle Rust and Chytrid fungus) would be a principal consideration in the development of the construction environmental management plans, with particular regard to protection of environmental conservation zones.	Pre-construction Construction
16.5	Threatened fauna management plans	Prepare and implement a threatened fauna species management plans to reduce the potential for impacts on relevant species. These would include maps identifying locations of threatened species, scope and requirements for targeted surveys and pre-clearing surveys, unexpected finds protocol, salvage and translocation of threatened species as per the measures recommended below, clearing protocols, and reporting and adaptive management measures.	Pre-construction Construction
16.6	Threatened flora translocation plan	Prepare and implement a threatened flora salvage and/or translocation plan in consultation with the Australian Botanic Garden Mount Annan. This would include the salvage and propagation or transplanting of the known local populations of *Pultenaea parviflora* and *Marsdenia viridiflora* subsp. *viridiflora* and any other threatened plants detected at the airport site. The translocation plan will build upon conservation activities previously undertaken for *Pultenaea parviflora* following the 1997-99 EIS. The plan would consider the suitability of sites within the environmental conservation zone and any biodiversity offset sites that are within the vicinity of the airport site in order to maintain populations of these species as close to their original location as is possible.	Pre-construction Construction

ID	Issue	Mitigation/management measure	Timing
16.7	Pre-clearance surveys for threatened species	Undertake pre-clearance surveys for threatened species by a qualified ecologist. Specific management plans would be prepared to manage impacts on threatened flora and fauna species. Surveys 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; • surveying any bridges or culverts that need removal to search for roosting bats; • 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.	Pre-construction
16.8	Habitat clearing and fauna management protocol	Develop measures for the management of impacts on fauna species during clearing activities. Measures would include: • preparing a nest box strategy, including provisions for the: ▪ installation of nest-boxes within conservation areas prior to clearing areas of native vegetation on the airport site to provide a safe location for hollow-dwelling fauna to be transferred to during clearing operations; and ▪ salvage of native fauna from existing nest boxes on the airport site prior to their removal and translocation of fauna to newly established nest box sites; • pre-clearing surveys 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 vegetation and safe tree felling and log remove to reduce the risk of fauna mortality; • 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

ID	Issue	Mitigation/management measure	Timing
16.9	Weeds	Prepare and implement a weed management plan that would include: • 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 Construction
16.10	Unexpected finds	Establish 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 clearing or construction activities.	Pre-construction
16.11	Dam decommissioning	Establish a protocol for the decommissioning of dams in consultation with relevant agencies, to include: • dam removal following any requirements of a Green and Golden Bell Frog management plan; • eradication of 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 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 where practicable, 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 draining of farm dams. Eastern Gambusia would be eradicated from dams using humane methods; and • establishing protocols for the humane euthanasia of aquatic fauna, including fish.	Pre-construction

ID	Issue	Mitigation/management measure	Timing
16.12	Fire	Prepare a bushfire management plan in consultation with NSW Rural Fire Service to minimise the risk of bushfire and associated impacts on adjoining areas of native vegetation, including the proposed environmental conservation area. This would include: • identifying activities likely to generate sparks and putting in place appropriate restrictions based on the forecasted 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; and • 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 prescribed burning and hand removal; and • ensuring that fuel-reduction measures are appropriate to biodiversity values in each area e.g. low intensity prescribed burns rather than slashing would be used in native woodland and forest.	Pre-construction
16.13	Lighting	Avoid unnecessary light spill into nearby areas of retained vegetation (such as in the environmental conservation areas) as much as possible.	Construction
16.14	Fauna management	Subject to safety and security, implement measures for the management of impacts on fauna species during clearing activities, including: • implementing a staged vegetation clearing process. This would provide opportunity for fauna that are resident in the Stage 1 development construction impact zone to seek refuge in alternative habitat in the environmental conservation zone, long term development impact zone or outside the airport site. Clearing would commence in the north-east of the site and proceed south and west. Subject to safety and security requirements, the clearing would be undertaken before the construction of the southern perimeter fence to allow fauna to relocate offsite and towards the environmental conservation zones. This approach has been identified to maximise the opportunity for resident fauna to vacate the clearing footprint via vegetated remnants and move toward alternative habitat; • identifying and assessing potential habitat trees and logs through a fauna spotter, prior to the commencement of clearing. These would be clearly identified with spray paint. A dozer would then clear the undergrowth and trees not identified as potential habitat trees. An excavator would follow several days behind the dozer to give resident fauna the opportunity to vacate habitat trees. The excavator would drop trees in a manner to increase the likelihood of survival of any fauna present; and • engaging an experienced fauna spotter-catcher, licenced wildlife carer or ecologist to supervise native vegetation clearing or removal/disturbance of other habitat features (e.g. culverts), and to capture and relocate fauna, if required. Any injured native fauna would be transferred to the care of a licenced wildlife carer.	Construction

ID	Issue	Mitigation/management measure	Timing
16.15	Vegetation	Prepare and implement a vegetation management plan. The vegetation management plan would apply to open space within the airport site and the environmental conservation zone and would include: • retaining native 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; • monitoring of the success of revegetation, weed control and adaptive management; and • reporting.	Construction Operation
16.16	Fire	Review, update and implement the bushfire management plan in response to the transition to the airport operation phase, including in response to changes to changes to locations of building envelopes, fuel loads, ignition sources etc.	Operation

16.8. Offsetting impacts

Biodiversity offsets are required to compensate for significant residual impacts arising from the proposed airport in accordance with the EPBC Act Offsets Policy and the EIS guidelines. An offset package has been prepared to compensate for the removal of approximately 90.8 hectares of Cumberland Plain Woodland; the removal of about 120.6 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 details of the offset package are described below. Further information is provided in Appendix K2 in Volume 4.

16.8.1. Overview

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 required for significant residual impacts on matters protected by the EPBC Act including (as relevant for this report), threatened species and communities listed under the EPBC Act and the environment, where Commonwealth agencies are proposing to take an action;
- the amount of offset required for threatened species and communities listed under the EPBC Act must be calculated using the 'offset assessment guide' spreadsheet. The Offset Assessment Guide uses a balance sheet approach to calculate the percentage of the proposal's impacts that would be directly offset;
- at least 90 per cent of the proposed airport's impacts must be directly offset and the offset site must be identified, assessed and securely conserved under a covenant and management plan, preferably prior to the impact occurring; and
- up to 10 per cent of the proposed airport's impacts may be indirectly offset through contribution to a research fund or a conservation program.

Following consultation with the DoE, it is considered appropriate that the estimate of offsets for residual impacts on the environment, including threatened biota and their habitats listed under the TSC Act, should be calculated using the NSW Biodiversity Banking and Offsets Scheme (BioBanking) assessment methodology.

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.

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 DoE 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.

This biodiversity offset package report has been prepared using the EPBC Act Offsets Policy, the offsets assessment guide and BioBanking assessment methodology and is included as Appendix K2 in Volume 4. The biodiversity offset package comprises the first stages in the delivery of biodiversity offsets for the proposed airport.

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 a significant 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 90 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 120 hectares of foraging habitat; and
- on features of the natural environment including plant populations, fauna populations and several species and communities listed under NSW legislation. Offset requirements have been estimated using the BioBanking assessment methodology for a major project.

Impacts on EPBC Act-listed biota have been entered in the EPBC Act offset assessment guide (refer to Section 16.8.4). 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 BioBanking assessment methodology meets each of these criteria and is supported by DoE for this purpose.

BioBanking credit calculations using the assessment methodology for a major project in NSW have been used to estimate offsets for impacts on the environment, including species and communities listed under NSW legislation. The outcome of the BioBanking credit calculations is that the ecosystem credits summarised in Table 16–12 and the species credits summarised in Table 16–13 would be required to offset significant residual impacts of the proposed airport on the natural environment.

Table 16–12 – 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	71.27	3,555	HN528, HH526[1]
Poor condition Grey Box – Forest Red Gum grassy woodland on flats (HN528)	Moderate/ Good_Poor		CEEC	107.79	3,208	HN528, HH526
Good condition Grey Box – Forest Red Gum grassy woodland on hills (HN529)	Moderate/ Good	CEEC	CEEC	17.32	751	HN529, HN528, HN526[1]
Poor condition Grey Box – Forest Red Gum grassy woodland on hills (HN529)	Moderate/ Good_Poor		CEEC	22.29	647	HN529, HN528, HN526
Good condition Forest Red Gum – Rough-barked Apple grassy woodland (HN526)	Moderate/ Good		EEC	29.83	1,530	HN526, HN528
Poor condition Forest Red Gum – Rough-barked Apple grassy woodland (HN526)	Moderate/ Good_Poor		EEC	4.22	127	HN526, HN528
Good condition Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy open forest (HN512)	Moderate/ Good	CEEC	EEC	2.19	161	HN512, HN513, HN604, HN556[1]
Poor condition Broad-leaved Ironbark – Grey Box – Melaleuca decora grassy open forest (HN512)	Moderate/ Good_Poor		EEC	0.39	20	HN512, HN513, HN604, HN556
Good condition artificial freshwater wetland on floodplain (HN630)	Moderate/ Good			25.44	700	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 16–13 – 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	719
Cumberland Plain Land Snail	*Meridolum corneovirens*	1.3	1,568
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	3,720
Pultenaea parviflora	*Pultenaea parviflora*	1.5	60
Southern Myotis	*Myotis macropus*	2.2	656

16.8.3. Proposed offsets

16.8.3.1. Proposed offset strategy

The proposed biodiversity offset strategy for the airport is to conserve habitat for the affected threatened biota in suitable offset sites. The offsets would be secured by ensuring that they would be securely titled and managed for conservation in perpetuity.

Biobanking provides a market-based biodiversity offset scheme in Australia. It is established under the TSC Act. Biobanking enables a project proponent to deliver biodiversity offsets for its project by purchasing and then retiring (that is, delivering to the OEH) biodiversity credits of a sufficient number and type to offset the impacts of that project. Biodiversity credits are generated under the Biobanking scheme, by owners of land committing to management actions which will enhance biodiversity values on their land, under a binding BioBanking agreement with the NSW Minister for the Environment. That agreement establishes the land as a biobank site. The BioBanking agreement is registered on the title to the land and operates in perpetuity.

The number and type of biodiversity credits required to offset the proposed airport's impacts as calculated by the offset assessment guide would be purchased and retired from offset sites. Additional biodiversity credits would be purchased to offset impacts on the natural environment.

The land use plan for the airport site contained within the draft Airport Plan includes around 122 hectares of land that is zoned 'EC 1 Environmental conservation' and that would be managed for biodiversity conservation. While the present intent is to allow only environmental conservation activities within the environmental conservation zone, it would not be securely titled for conservation purposes and so has not been included as a formal offset site within the offset package. The likely increase in biodiversity value that would be achieved through management of the environmental conservation zone may be recognised through a reduction in the quantum of offset that would otherwise be required for the proposed airport.

The EPBC Act Offsets Policy requires that a minimum of 90 per cent of the airport's impacts must be directly offset as calculated with the Offset Assessment Guide. Depending on the project, DoE may require more than 90 per cent direct offsets. Therefore, the remaining offset requirement, which may be up to 10 per cent, is able to be met by alternative contributions such as a financial contribution to research or conservation.

16.8.3.2. Potential offset sites

A desktop assessment was performed to identify and describe potential offset sites for the proposed airport. Candidate sites would be secured by 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 16–14. 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 16–14 – Potential offset sites

Potential offset site	Location	Total area (hectares)	Status and ownership
Williamswood biobank	Mount Hunter	104.4	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.
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)	9.16	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

Potential offset site	Location	Total area (hectares)	Status and ownership
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

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. The DoE would require these specific areas to be clearly documented and mapped in the final offset package.

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 be included in the offset package to offset impacts on the affected threatened biota) are summarised in Table 16–15.

The area of Grey-headed Flying-fox habitat available in the proposed offset areas (around 401 hectares) is substantially greater than the estimated area required to meet this species' offset requirement. This area would also contribute offsets for impacts on the environment and so the full area has been included in the Offset assessment guide calculations.

Table 16–15 – 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	9.2	0.0	0.0	5.9	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.

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
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 habitat. Biodiversity credits for other impacts on the environment.
	786.2	180.3	78.6	401.2	

16.8.4. Preliminary Offset Assessment Guide 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'.

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. A detailed description of the calculations is provided in the Biodiversity Offsets Package (refer to Appendix K2 in Volume 4). The output of this preliminary assessment is an estimate of the percentage of the proposed airport impacts that would be 'directly offset' by the potential offset sites.

Once the final offset sites have been identified, a 90 per cent direct offset may be acceptable under the EPBC Act Offsets Policy with up to 10 per cent of the offset able to be achieved through 'other compensatory measures'. These measures are defined as actions that are anticipated to lead to benefits for the impacted protected matter, for example funding for research or educational programs.

16.8.4.2. Preliminary Offset Assessment Guide calculations

Preliminary Offset Assessment Guide calculations were performed for the affected threatened biota based on the following:

- removal of approximately 90 hectares of EPBC Act Cumberland Plain Woodland with a site quality score of 6/10;
- removal of approximately 120.8 hectares of habitat for the Grey-headed Flying-fox with a site quality score of 7/10; and
- the conservation and management of offset sites to achieve increased site quality, containing:
  - EPBC Act Cumberland Plain Woodland;
  - poorer quality Cumberland Plain Woodland; and
  - Grey-headed Flying-fox habitat.

The outcome of these preliminary Offset Assessment Guide calculations is that:

- The proposed offset areas contain around 180 hectares of EPBC Act Cumberland Plain Woodland and an additional 79 hectares in poor condition that would collectively offset approximately 74 per cent of the impact of the proposed airport on the community;
- The proposed offset areas containing up to 401 hectares of habitat for the Grey-headed Flying-fox would offset around 136 per cent of the proposed airport's impacts on this vulnerable species.

16.8.5. Delivery of offsets

16.8.5.1. Biodiversity credits

Biodiversity credits would be purchased to secure the proposed offset areas for EPBC Act-listed biota. Subject to confirmation of the overall offset requirement for the proposed airport, additional biodiversity credits would be purchased to offset the proposal's impacts on the environment.

The EPBC Act Offsets Policy and the BioBanking assessment methodology include different rules that govern the biodiversity offsets that can be delivered for a development's impacts. The EPBC Act offset policy requires 'like for like' biodiversity offsets and the offset site must be able to reach the same site quality score as the development site. Therefore, only EPBC Act Cumberland Plain Woodland, poorer quality Cumberland Plain Woodland that could reach this standard and Grey-headed Flying-fox habitat have been included in the proposed offset areas. The suite of biodiversity credits that are associated with the proposed offset areas would be purchased and retired in order to secure the offsets for EPBC Act-listed biota.

The BioBanking assessment methodology includes greater flexibility with respect to some criteria. This flexibility allows trading of ecosystem credits for closely related vegetation types if they are in the same vegetation class and are at least as extensively cleared (that is, have the same or greater conservation significance). BioBanking also allows trading of ecosystem credits associated with low condition vegetation at a Biobank site, including vegetation that could not meet the standard of EPBC Act Cumberland Plain Woodland. This flexibility should be considered along with the fact that BioBanking requires the calculation of biodiversity offsets for poorer condition vegetation. A substantial area of poor condition vegetation at the airport site has contributed to the amount of offset required for residual significant impacts on the environment. Species credits should be traded on a like for like basis.

The number and type of biodiversity credits that would be required to offset the proposed airport's impacts on the environment are specified in the BioBanking credit report (refer to Appendix K2 in Volume 4). Table 16–16 includes a comparison of the credits available at the proposed offset sites and the ecosystem credit requirement to offset the proposed airport's impacts on the natural environment as estimated with BioBanking credit calculations. There would be sufficient ecosystem credits available to offset impacts on Grey Box – Forest Red Gum grassy woodland on shale (HN529) and Forest Red Gum – Rough-barked Apple grassy woodland (HN526). The 'Credit balance' in Table 16–16 shows that additional ecosystem credits would be required to offset impacts on other vegetation types and associated predicted threatened species. The credit shortfall for Grey Box – Forest Red Gum grassy woodland on flats (HN528) could be partially met by trading surplus HN526 credits, which is permitted by the BioBanking credit trading rules.

Table 16–16 – 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	9.2	0	0	56	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
Total	892.8	542	2355	2188	25	12	407
Ecosystem credit requirement		6763	1398	1657	181	700	0
Credit balance		-6221	957	531	-156	-688	407
Total including trading of matching credits		1074[1]		1657			
Credit balance including trading of matching credits		-5689	957	0	-156	-688	407

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

No species credits have been calculated at any of the existing or proposed biobank sites included in the offset package. Species credits may be generated once targeted surveys have been undertaken to confirm the presence of threatened species and the numbers of individuals of plants and area of habitat for fauna. Based on the assessments undertaken to date, the proposed offset sites contain known or potential habitat for each of the species credit-type threatened species affected by the proposed airport. Table 16–17 summarises the species credits required to offset the impacts of the proposed airport, the equivalent area of fauna habitat or number of plants required to generate these credits at an offset site and a summary of the potential habitat available at offset sites.

Sufficient *Pultenaea parviflora* has already been recorded at the Dunheved biobank site to generate the required number of species credits. Based on the site surveys and habitat assessments undertaken, it is likely that supplementary surveys would confirm the presence of the species at these offset sites and allow the calculation of species credits. *Marsdenia viridiflora* subsp. *viridiflora* is very sparsely and sporadically distributed within its range and so it is likely to be difficult to locate a population of the required size at offset sites. The proposed translocation program would be important in avoiding or minimising impacts on this endangered population and should be coordinated with the offset package.

Table 16–17 – 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*	719	101	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 off set sites.
Cumberland Plain Land Snail	*Meridolum corneovirens*	1568	221	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	3720	524	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).
Pultenaea parviflora	*Pultenaea parviflora*	60	8	100 individuals recorded at the Dunheved biobank site.
Southern Myotis	*Myotis macropus*	656	92	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.

16.8.5.2. Identification of additional offsets

Based on the preliminary offset assessment guide calculations and BioBanking calculations, the proposed offset sites could not meet all of the proposed airport's EPBC Act offsetting requirements as direct offsets. Additional offset sites containing Cumberland Plain Woodland would be identified throughout the environmental assessment process for the proposed airport and would be included in the final offset package. Any additional offset sites would be identified to ensure that they are an appropriate 'like for like' match for the airport's impacts and meet the other requirements of the EPBC Act Offsets Policy and consider the OEH principles for biodiversity offsets.

A similar approach would be taken in the event that any credits which have been identified for purchase from BioBanking sites identified in this draft EIS are sold to third parties, or otherwise become unavailable, before they can be secured as offsets for the proposed airport.

16.8.5.3. Finalisation of the offset package

The offset package would be finalised in accordance with any conditions required by the Minister for the Environment. The Minister for the Environment would advise the final quantum of biodiversity offsets required for the proposed airport. This may include the requirement for additional site specific information such as proposed management, current risk of development and the security of titling proposed for individual offset sites. These additional data would be considered the DoE and the final calculations and details regarding data and assumptions underlying the results would be compiled and collectively comprise the EPBC Act offset package for the proposed airport.

16.9. Conclusion

Construction of the Stage 1 development would result in the removal of approximately 1,065 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 280.8 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 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 and animals (including a number of species and populations 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 122 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 90.8 hectares of Cumberland Plain Woodland, the removal of about 120.6 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 for the affected threatened biota in suitable offset sites in the surrounding region in perpetuity.

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17. Topography, geology and soils

The airport site comprises about 1,700 hectares of undulating terrain. Soils at the airport site are primarily firm residual clays with areas of alluvial gravels, sands, silts and clays associated with Badgerys Creek.

A major bulk earthworks programme would be carried out for the construction of the Stage 1 development. The programme would essentially involve the redistribution of about 22 million cubic metres of soil across a construction impact zone covering about 60 per cent of the airport site, to achieve a level surface suitable for the construction of airport facilities. Construction and operation would involve the controlled storage, treatment and handling of fuel, sewage and other chemicals with potential to contaminate land.

Measures including erosion control structures, sediment basins and stockpile management are proposed to mitigate and manage potential soil erosion and degradation associated with earthworks. Fuel and other chemicals would be responsibly stored and handled, minimising the potential for contamination to occur.

Prior activities at the airport site including agriculture, light commercial and building demolition mean there is potential for contaminated land to be present. Any contamination discovered during construction would be managed and mitigated to make the land suitable for its intended use and to prevent impacts on human health and the environment.

The potential impacts of the operation of the proposed airport are typical of a large scale infrastructure project and would be managed with the implementation of stormwater, erosion and dust controls and adherence to industry standards for the storage and handling of chemicals. Sewage effluent would be treated and irrigated on site in accordance with an irrigation scheme that maintains the receiving soil in a stable and productive state.

17.1. Introduction

This chapter provides an analysis of the existing topography, geology and soils that would be affected by the development of the proposed airport. It draws on a number of field assessments including geotechnical investigations and contamination assessment. Potential impacts of the construction and operation of the airport are characterised, and measures to mitigate and manage these impacts are identified.

17.2. Methodology

The following tasks were undertaken to describe the existing environmental values of the airport site and to assess the impact of the airport with regard to topography, geology and soils:

- desktop reviews of prior reporting, mapping and databases;
- review of surface water and groundwater assessments of the airport site;
- geotechnical investigation of the airport site to characterise soils and geology;
- contamination assessment of the airport site to identify potentially contaminated land;
- identification of potential impacts on topography, geology and soils; and
- development of mitigation and management measures.

17.2.1. Geotechnical investigation

The purpose of the geotechnical investigation was to determine the constructability of soils at the airport site. The geotechnical investigation involved sampling at 137 boreholes, 11 test pits and 10 kilometres of seismic survey across the airport site. This sampling distribution and density was selected to provide confidence in planning of bulk earthworks, particularly hard rock excavation. The samples underwent laboratory testing for their geotechnical properties. Further geotechnical investigations would be undertaken before construction to supplement the investigations to date.

17.2.2. Contamination investigation

The purpose of the contamination investigation was to identify potential sources of land contamination at the airport site. The investigation involved a desktop analysis and visual inspection of all properties at the airport site. Properties of potential concern due to their registered uses were visited, while remaining properties were inspected from neighbouring roads. Samples gathered during the geotechnical investigations underwent laboratory testing for potential contamination indicators. The identified potential sources of land contamination were assessed for their impacts on human health or the environment.

17.3. Existing environment

17.3.1. Topography

The topography of the airport site is depicted in Figure 17–1. The airport site is part of an elevated ridge system dividing the Nepean River and South Creek catchments. The site is characterised by rolling landscapes typical of the Bringelly Shale (see Section 17.3.2) 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, at elevations between 40 metres and 90 metres AHD, with the lower elevations toward Badgerys Creek.

17.3.2. Geology

As outlined in Figure 17–1 the dominant geological formations beneath the airport site are Bringelly Shale, the Luddenham Dyke and alluvium.

Bringelly Shale is a Triassic geological unit mainly comprising claystone and siltstone, with some areas of sandstone. This unit underlies most of the airport site (Coffey Partners International 1990). Bringelly Shale is the top unit of the Wianamatta Group and is about 150 metres thick beneath the airport site, with overlying weathered material.

Luddenham Dyke is a Jurassic groundmass of olivine basalt, analcite, augite, feldspar and magnetite in the west of the airport site (Bannerman and Hazelton 1990). The dyke outcrops toward the peak of the ridge in the west of the airport site (see Section 17.3.1).

Alluvium at the airport site comprises of Quaternary sedimentary deposits along Cosgrove Creek and Badgerys Creek. These sedimentary deposits can be up to five metres thick and are made up of fine sands, silts and clays with some areas of gravelly clay (Coffey Partners International 1990).

Figure 17-1 - Topography and geology at the airport site

17.3.3. Soils

17.3.3.1. Soil types

Geotechnical investigations at the airport site generally indicated surficial silt and/or clay topsoils overlying firm residual clays from the weathering of Bringelly Shale, with areas of alluvial gravels, sands, silts and clays associated with Badgerys Creek.

The soils at the airport site are categorised as the Blacktown, Luddenham and South Creek soil landscapes – based on consistent soil type, material, depth and erosion characteristics. These soil landscapes are mapped in Figure 17–2 and their characteristics are summarised in Table 17–1.

Soils at the airport site have also been mapped by their Australian Soil Classification in Figure 17–2. Mapped soils at the airport site are classified as Kurosols and Hydrosols on the Australian Soil Classification. Kurosols are soils with strong texture contrast between the A horizons (topsoils) and strongly acid B horizons (subsoils), and occur over the majority of the airport site. Hydrosols are soils that are saturated for prolonged periods, and occur in the vicinity of Badgerys Creek.

Parts of the airport site are used for agricultural activities including cattle grazing and horticulture (see Chapter 21). The site is not mapped as biophysical strategic agricultural land (high quality soil capable of sustaining high levels of productivity) in the associated mapping for the NSW *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007*.

17.3.3.2. Saline soils

Soil salinity mapping of Western Sydney (DIPNR 2002) indicates broadly moderate salinity potential with localised areas of high potential associated with Badgerys Creek and drainage lines to the south and west of the airport site.

Selected soil samples gathered during the geotechnical investigations were tested for salinity. The selected samples returned relatively low salinity levels, between 120 and 384 mg/L. Given the recognised potential for salinity to occur, further soil salinity sampling would be undertaken before construction to supplement the investigations to date.

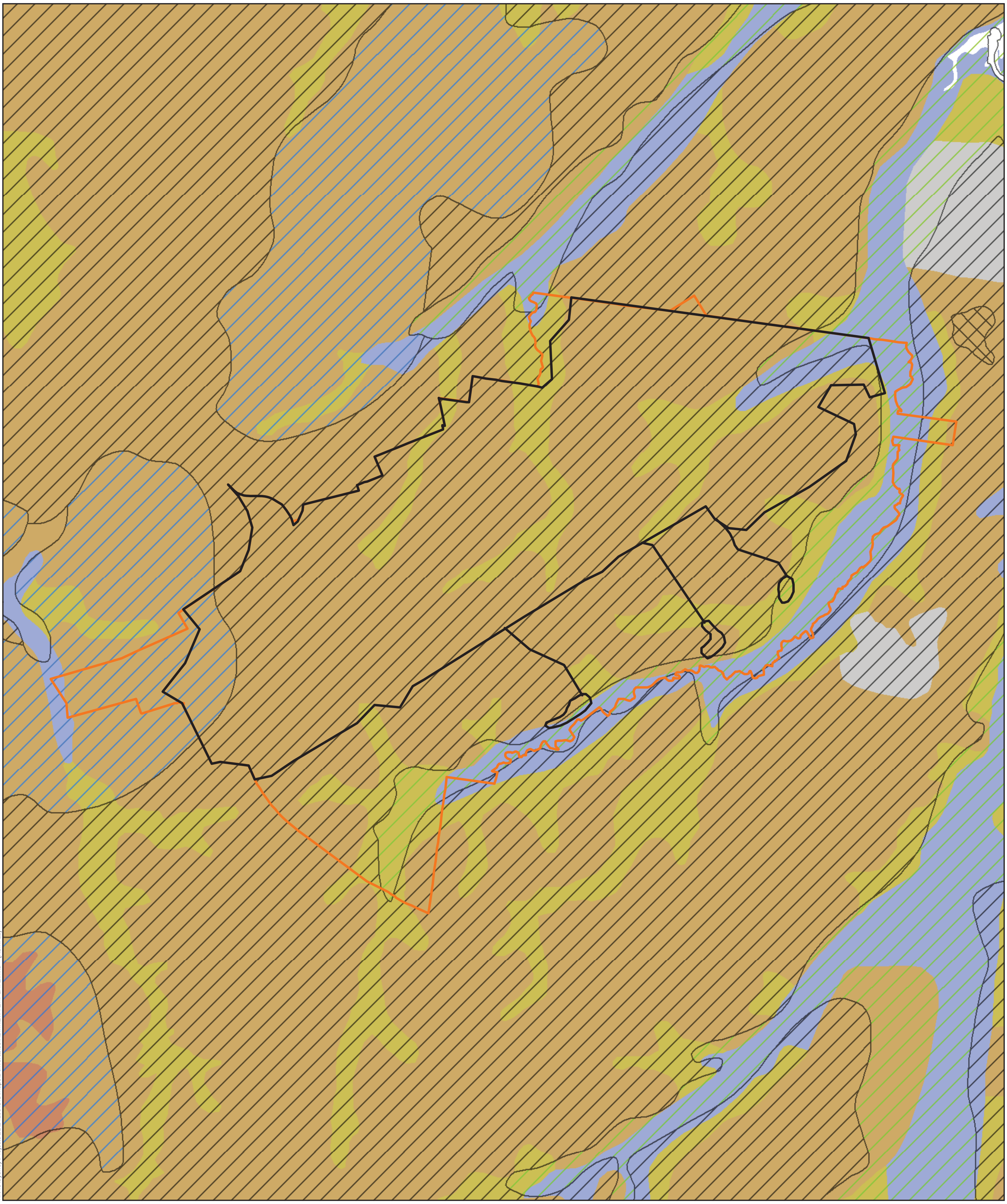
17.3.3.3. Acid sulfate soils

Acid sulfate soils are naturally occurring sediments containing iron sulfides, which produce sulfuric acid when exposed to air. These soils usually occur in coastal areas less than one metre above sea level. Acid sulfate soils are not expected at the airport site given that it is not a coastal location and has an elevation ranging between 40 and 120 metres AHD. Acid sulfate soil risk mapping indicates that there are no known occurrences at the airport site (OEH 1993).

Table 17–1 – Soil landscape characteristics

Unit	Soil matter	Soil depth	Soil fertility	Erosion potential
Luddenham	Brown loams, clay loams or clays with clay subsoils.	Shallow on crests (<100 cm) and moderately deep (≤ 150 cm) on slopes and depressions.	The soil landscape has generally low to moderate fertility. It is generally capable of being grazed and cultivated.	The potential for erosion in the soil landscape is moderate to very high with slopes of 5–20 per cent and certain clays considered highly erodible. Minor gully erosion and moderate sheet erosion are evident in disturbed areas.
Blacktown	Brownish black loams and brown clay loams with clay subsoils.	Shallow to moderately deep (>100cm).	The soil landscape has generally low to moderate fertility. It is generally capable of being grazed and cultivated.	The potential for erosion in the soil landscape is typically slight to moderate, with slopes usually greater than five per cent. Some clay subsoils are sodic and dispersive making them highly erodible. Existing minor gully erosion and sheet erosion may be found in disturbed areas.
South Creek	Brown sandy loam, sandy clay loams or clay loams with clay subsoils.	Shallow to moderately deep (>100 cm) in low terraces and channels, with deeper stratified clays (≥ 190 cm) on terraces.	The soil landscape has generally low fertility but is capable of supporting grazing and cultivation.	The potential for erosion in the soil landscape is potentially very high to extreme. The erodibility of the soil material is high. Stream bank and gully erosion are common results of concentrated water flows.

Source: (NSW Environment and Heritage 2015a; 2015b; 2015c)



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LEGEND

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

- Airport site
- Stage one construction impact zone

Soil landscape
- BERKSHIRE PARK
- BLACKTOWN
- LUDDENHAM
- SOUTH CREEK

Australian Soil Classification (Order)
- Dermosols
- Hydrosols
- Kurosols
- Kurosols (Natric)
- No data

0 0.25 0.5 1
Kilometres

N

Figure 17-2 - Soils at the airport site

17.3.4. Contaminated land

A range of contaminants associated with prior land uses may be present at the airport site. Previous and current activities at the airport site that may potentially result in contamination have included agriculture, light commercial and building demolition works. The contaminants associated with these land uses are of concern due to their potential to affect human health or the environment if not effectively managed. Potentially contaminated land is therefore identified here, while its management is discussed in Section 17.6.

The NSW Environment Protection Authority (EPA) administers a number of records relevant to contaminated land, including the record of regulatory notices issued under the NSW *Contaminated Land Management Act 1997* and the public register of environment protection licences and notices under the NSW *Protection of the Environment Operations Act 1997*.

The record of regulatory notices under the *Contaminated Land Management Act 1997* contains one record at the airport site, regarding dumping of chemical wastes. The notice was issued in 1985 and the property was subsequently remediated in 1996–97, including the removal of 1,904 tonnes of contaminated soil. Remediation and a following audit found that the property was suitable for residential use.

The public register under the *Protection of the Environment Operations Act 1997* contains one licence at the airport site for dairy animal accommodation, indicating the potential for farm chemicals or other contaminants. The licence was issued in 2002 and is held by Leppington Pastoral Company. No other environment protection licences are registered at the airport site.

A review of the airport site contamination register administered by the Department of Infrastructure and Regional Development, along with historic aerial photos (from 1947, 1965, 1975, 1986, 1991 and 2005), and subsequent inspection of the airport site identified further evidence of potential contamination. Evidence included chemical storage tanks and drums, rubbish dumping, stockpiled demolition waste, and stockpiled fill material of unknown origin. The associated contaminants include fuels, lubricants, solvents, acids, heavy metals, ash, herbicides, pesticides and pathogens. About half of the properties at the airport site were considered to have at least a moderate risk of contaminants.

Stockpiled demolition waste and fill material at multiple properties indicated potential for asbestos. Asbestos may also be present in soil beneath former demolition sites, as evidenced in historic photographs. About half of the properties at the airport site were considered to have at least a moderate risk of asbestos.

Selected soil samples gathered during the geotechnical investigations were tested for the presence of contaminants including fuels, heavy metals, herbicides and pesticides. The limited samples did not return contaminant levels presenting a significant risk to human health or the environment. Given that sample sites were selected for geotechnical purposes, further contamination investigations are expected to be undertaken before construction.

Any contamination discovered during the construction and operation of the proposed airport would be managed and mitigated to make the land suitable for its intended use and to mitigate potential impacts on human health and the environment (see Section 17.6).

17.4. Assessment of impacts during construction

17.4.1. Topography and geology

The bulk earthworks programme proposed to be carried out for construction of the Stage 1 development would change the topography of the airport site from rolling landscapes to a built environment with some landscaping. The earthworks would affect the upper geological units of the Bringelly Shale, Luddenham Dyke and alluvium down to approximately 30 metres depth. Following bulk earthworks, the elevation of the airport site within the construction impact zone would be generally level with elevations between approximately 50 and 100 metres AHD and would have no major embankments. The secondary impacts of this change would mainly relate to hydrology (see Chapter 18) and visual amenity (see Chapter 22).

17.4.2. Soil erosion and degradation

The bulk earthworks programme carried out for construction of the Stage 1 development would involve the excavation of approximately 22 million cubic metres of cut material, including about two million cubic metres of topsoil within the construction impact zone (see Figure 17–2). Topsoil would be stockpiled and the remaining cut material would be distributed within the construction impact zone. As cut and fill requirements are expected to be equal, most soil material would generally remain at the airport site and would not generally be moved further than two kilometres within the site.

Clearing and bulk earthworks would increase the surface area, and in some instances, the slope of exposed soil at the airport site. These changes to the landscape would present a risk of increasing erosion. The majority of bulk earthworks would occur in the Blacktown soil landscape which has slight to moderate erosion potential for non-concentrated flows. The Luddenham and South Creek soil landscapes, and some subsoils in the Blacktown soil landscape, have higher erosion potential and would potentially require specific mitigation and management (see Section 17.6).

Erosion may occur in the form of runoff during rainfall or windblown dust. Topsoil stockpiles would also present an erosion hazard and would be subject to potential degradation of chemical and physical fertility over time.

Potential soil erosion and degradation impacts are not expected to be significant and would be avoided, mitigated or managed by implementing standard stormwater, erosion and dust control measures. These and further measures are detailed in Section 17.6.

17.4.3. Land contamination

Construction of the Stage 1 development has the potential to interact with existing sources of potential contamination (see Section 17.3.4). Construction would also involve the controlled storage, treatment and/or handling of fuel, sewage and other chemicals with potential to contaminate land.

Any contamination discovered during construction would be managed and mitigated to make the land suitable for its intended use and to prevent impacts on human health and the environment.

Demolition works before construction would include measures to mitigate contamination risks of asbestos and lead based paints, including site clearance at the end of demolition. However, historic demolition sites and land use also present a risk of existing contamination.

Although unlikely, the accidental release or mobilisation of contaminants has the potential to affect human health and the environment through contact with pathogens (in the case of sewage), inhalation (in the case of asbestos or chemical vapours), mobilisation to surface waters or bioaccumulation. These events would be managed in the first instance through implementation of applicable Australian Standards for the storage and handling of hazardous materials. In the unlikely event of a significant leak of spill or contaminants, remediation would be implemented as soon as practicable.

Potential contamination impacts are not expected to be significant and would be avoided, mitigated and managed by implementing the measures further detailed in Section 17.6.

17.5. Assessment of impacts during operation

17.5.1. Soil erosion and degradation

Operation of the Stage 1 development would not involve any significant direct disturbance or exposure of soils. The design of the proposed airport would incorporate landscaped areas and stormwater drainage including grassed swales and detention basins to control the quantity and quality of stormwater runoff. As such, the operation of the proposed airport is not expected to have a material impact in terms of soil erosion and degradation.

If present, saline soils have the potential to damage subsurface infrastructure and disrupt revegetation. Selected soil samples gathered during the geotechnical investigations have indicated relatively low soil salinity at the airport site. Given the recognised potential for salinity to occur, further soil salinity sampling is expected to be undertaken prior to construction to supplement the investigations to date.

17.5.2. Land contamination

Operation of the Stage 1 development would involve the controlled storage, treatment and handling of fuel, sewage and other chemicals with potential to contaminate land, in relation to fuel farms, fuel reticulation and maintenance areas.

Contamination would be managed in the first instance through the implementation of applicable Australian Standards for the storage and handling of hazardous materials. In the unlikely event of a significant leak or spill of contaminants, remediation would be implemented as soon as practicable.

17.5.3. Reclaimed water irrigation

An estimated 2.5 ML of wastewater per day would be generated during operation of the Stage 1 development. Wastewater would be reticulated to a high quality treatment facility before being recycled or irrigated at the airport site. The wastewater treatment process is expected to utilise membrane biological reactor technology, which produces high quality reclaimed water suitable for a range of beneficial reuses. Recycling opportunities include the use of reclaimed water in maintenance of plant and infrastructure, industrial cooling processes or landscaping. It is expected that irrigation of excess reclaimed water would occur in areas previously disturbed by bulk earthworks, such as grassed areas between aprons and taxiways and landscape areas.

The irrigation area would be designed and operated in accordance with the relevant guidelines and management practices discussed in Section 17.6.

The key risks to soils associated with the application of reclaimed water include adverse physical or chemical changes, which may lead to an ongoing reduction in fertility and potential to grow turf or pasture. The principal risk associated with the operation of a reuse scheme is excess irrigation, leading to additional waterlogging, leaching of nutrients, a rise in water tables and increases in soil salinity or other soil properties. These risks are expected to be adequately managed through the planning, design and operation of the irrigation area (see Section 17.6).

17.6. Mitigation and management measures

Measures to manage soil erosion and degradation, land contamination and treated water irrigation during construction and operation are listed in Table 17–2.

The establishment of erosion controls in line with *Managing urban stormwater: soils and construction* (Landcom 2004) would be central to the management and mitigation of soil impacts. Erosion controls would be employed to reduce the area of exposed soil, the volume of water that reaches the exposed soil, and the quality of water that runs off. Controls would include:

- site stormwater drainage and sediment basins;
- sediment fencing around all disturbed sites;
- stabilisation (such as vegetation) on soil stockpiles; and
- progressive revegetation of landscape areas.

Any contamination discovered during construction would be managed and mitigated to make the land suitable for its intended use and to prevent impacts on human health and the environment.

Prior to site preparation for the construction of the Stage 1 development, further contamination investigations are expected to be undertaken to validate contamination risks. These investigations would be conducted with reference to the *National Environment Protection (Assessment of Site Contamination) Amendment Measure 1999* and *Guidelines for Consultants Reporting on Contaminated Sites* (OEH 2011). Any areas with significant contamination would require remediation before the start of site preparation activities.

An asbestos management plan would be prepared to mitigate risks to human health before and during construction of the Stage 1 development. The plan would identify areas of known risk and include a safety protocol, including a procedure to be followed in the event of an unexpected encounter.

The irrigation areas would be designed and operated in accordance with the risk framework and management principles contained in the *National Guidelines on Water Recycling* (EPHC 2006) and the *Environmental guidelines: Use of effluent by irrigation* (DEC 2004). It is considered that this approach would avoid environmental harm and maintain the receiving soil in a stable and productive state, given the following points.

- The irrigation area would be delineated based on the expected rate of irrigation and the drainage characteristics of the receiving soil.
- The quality of treated water would be determined to prevent accumulation of contaminants, with reference to the relevant guidelines.
- The irrigation area would be designed to include capacity to store treated water for the duration of typical wet weather events.
- The rate of irrigation would be optimised to avoid waterlogging or ponding of reclaimed water.
- Soil and groundwater conditions would be monitored to identify and correct trends in soil salinity or other potential effects of irrigation.

Table 17–2 – Mitigation and management measures

ID	Issue	Measure	Timing
17.1	Soil and water management plan	A soil and water management plan would be developed prior to construction of the proposed airport as part of the construction environmental management framework. The plan would collate measures to mitigate and manage potential impacts on soil and water.	Construction
17.2	Soil erosion and degradation	Erosion controls would be established in line with *Managing urban stormwater: soils and construction* (Landcom 2004).	Construction
17.3		Specific erosion control measures would be developed for the management of highly erodible soils such as those anticipated in the Luddenham and South Creek soil landscapes.	Construction
17.4		Cleared vegetation would be mulched and used to control erosion at construction sites.	Construction
17.5		Soil stockpiles would be covered and stabilised with vegetation or mulch.	Construction
17.6		Topsoil would be stockpiled at a maximum height of two metres.	Construction
17.7		Topsoil would be distributed and seeded over landscape areas at completion of bulk earthworks.	Construction

17.8	Land contamination	Fuel and other potential contaminants would be stored and handled in accordance with relevant Australian standards such as: • *AS 1940-2004 The storage and handling of flammable and combustible liquids* • *AS/NZS 4452:1997 The storage and handling of toxic substances* • *AS/NZS 5026:2012 The storage and handling of Class 4 dangerous goods* • *AS/NZS 1547:2012 On-site domestic wastewater management*	Construction Operation
17.9		An unexpected finds protocol and Remediation Action Plan would be established to facilitate the quarantining, isolation and remediation of contamination.	Construction
17.10		Any asbestos identified on site would be managed in accordance with applicable regulatory requirements.	Construction
17.11	Treated water irrigation	The treated water irrigation scheme would be designed and operated in accordance with the risk framework and management principles contained in the National Guidelines on Water Recycling (*Environment Protection and Heritage Council 2006*) and *Environmental guidelines: Use of effluent by irrigation* (DEC 2004).	Operation

17.7. Conclusion

The potential impacts of the construction of Stage 1 development are typical of a large scale construction project and could be managed with the implementation of standard stormwater, erosion and dust controls and adherence to industry standards for the storage and handling of chemicals. The major bulk earthworks required for site preparation would substantially alter the natural landscape of the airport site. Measures to mitigate and manage soil erosion and degradation, land contamination and treated water irrigation would be collated in environmental management plans before construction and operation.

18. Surface water and groundwater

The airport site contains about 64 kilometres of mapped watercourses and drainage lines (notably Badgerys Creek, Cosgroves Creek and Duncans Creek) and overlies the Bringelly Shale aquifer as well as unconfined areas of alluvial groundwater. Water quality sampling indicates that existing water quality is relatively degraded, with high levels of phosphorous and nitrogen in surface water attributable to land uses at the airport site and within the broader catchment.

Site preparation and construction of the Stage 1 development would transform the airport site from a rolling grassy and vegetated landscape to an essentially built environment with some landscaping. These changes would alter the catchment areas within the airport site and the permeability of the ground surface, which would in turn alter the duration, volume and velocity of surface water flow.

An estimated 1.36 ML of water would be required per day for site preparation works for the proposed airport. For the purposes of this draft EIS it has been assumed that to meet this requirement 8,600 litres (0.0086ML) of potable water would be sourced from existing assets operated by Sydney Water per day and the remaining water supplied through stormwater runoff captured in sediment dams or existing farm dams. To meet water demand during construction it may be necessary to source water from other sources such as groundwater or other sources of surface water. However, consideration of the impacts associated with using these alternative sources would be subject to a separate assessment.

Water would be utilised during construction for soil conditioning and dust suppression. Water supply options include water reticulated to the site from existing major utilities and extraction from existing surface water resources.

The design of the Stage 1 development includes a drainage system to control the flow of surface water and improve the quality of water prior to its release back into the environment. This drainage system comprises a series of channels and basins to collect and treat flows prior to release to receiving waters. The assessment indicates that this system would be generally effective at mitigating flooding and water quality impacts.

The transformation of the airport site would alter groundwater levels and recharge conditions through an increase in impervious surfaces. Bulk earthworks and excavations at the airport site would also receive some groundwater inflows, which would require management during construction and operation. Impacts on groundwater levels, including impacts on dependent vegetation or watercourses, would be unlikely to be significant given the existing low hydraulic conductivity and water quality of the Bringelly Shale aquifer. Registered bores surrounding the airport site are understood to target the Hawkesbury Sandstone aquifer, which is significantly deeper than the Bringelly Shale aquifer and not considered to be connected. As such, impacts on groundwater users are not expected.

The identified impacts would likely be further reduced during detailed design of the surface water drainage system. Baseline and ongoing monitoring of surface water and groundwater would be undertaken to characterise any residual impacts and prompt corrective action where necessary.

18.1. Introduction

This chapter provides an analysis of the surface water and groundwater systems potentially affected by the development of the proposed airport. It draws on technical assessments of hydrology and geomorphology (see Appendix K1), surface water quality (see Appendix K2) and groundwater (see Appendix K3). The assessment describes the existing surface and groundwater resources at the airport site, considers potential impacts during construction and operation of the proposed airport and proposes measures to mitigate and manage these impacts.

18.2. Methodology

A range of qualitative and quantitative assessment approaches were adopted to consider the impact of the proposed airport on surface and groundwater resources at the airport site.

Field surveys were undertaken to provide an overview of the existing surface water features at the site, determine the physical stability of watercourses, identify hydraulic structures (such as bridges and culverts) and supplement existing water quality data.

Predictive models were used to consider the impact of the change in landform characteristics at the airport site on runoff volumes and the subsequent impacts upon stream flow, flooding, groundwater recharge and water quality. Identification of the potential impacts on the environmental values and beneficial uses of surface and groundwater resources were identified, and mitigation and management measures were proposed to minimise the extent of potential impacts. The assessment included an analysis of the potential for climate change to exacerbate the environmental impacts arising from the proposed airport, including the susceptibility of the airport site to flooding.

18.2.1. Baseline data

Existing surface water and groundwater resources were described with reference to:

- aerial imagery (AusImage 2014);
- topography data (NSW LPMA 2014);
- climatology data (BoM 2015a);
- 1997-99 EIS (PPK 1997);
- geotechnical and contamination investigations (Coffey & Partners 1991; GHD 2015);
- *South Creek Flood Study* (Worley Parsons 2015); and
- surface water quality data in the *Environmental Field Survey of Commonwealth Land at Badgerys Creek* (SMEC 2014).

18.2.2. Predictive modelling and analysis

Existing hydrologic and hydraulic models were developed to simulate runoff and streamflow associated with storms of varying severity. These storms are categorised in terms of the average recurrence interval (ARI), or average length of time between successive storms, and include the one year ARI, two year ARI, five year ARI, 20 year ARI and 100 year ARI events. The largest expected flood over any duration was also modelled based on estimates of maximum rainfall. The results of the hydrologic and hydraulic models were analysed to identify changes in the volume and velocity of surface water. Water quality models were developed to assess the quality of surface water leaving the airport site. Models used as part of the assessment included:

- hydrology models (RAFTS);
- hydraulics models (MIKE 21); and
- water quality models (MUSIC).

All models included representations of the drainage system incorporated into the indicative design of the proposed airport, which includes a configuration of channels and detention basins to collect and treat flows prior to release to receiving water (see Figure 18–1).

The basins would be situated at key locations where surface water flows off the airport site and would be designed to release water at controlled flow rates. The basins would also have the effect of improving the quality of the surface water they contain prior to release.

The drainage system has been designed to contain flows up to the 100 year ARI event without uncontrolled discharges occurring. The capacities of the basins to store surface water flows are presented in Table 18–1, excluding Basin 5 which would be integrated into the drainage system for the long term development (see Chapter 36).

The results of models were analysed to identify impacts on waterways, people and property and thereby assess the effectiveness of the drainage system.

Table 18–1 – Detention basin attenuation volumes

Basin	Volume (kilolitres)	Discharge
Basin 1	64,000	Badgerys Creek
Basin 2	8,100	Badgerys Creek
Basin 3	15,900	Badgerys Creek
Basin 4	10,400	Badgerys Creek
Basin 6	75,000	Oaky Creek
Basin 7	82,000	Oaky Creek (via tributary)
Basin 8	41,000	Duncans Creek (via tributary)

Note: Basin 5 would be integrated into the drainage system for the longer term development (see Chapter 36) and so has not been included in the assessment of the Stage 1 development.

Historical water quality monitoring data available for the airport site and downstream areas, includes data from the 1997-1999 EIS and the SMEC *Environmental Field Survey of Commonwealth Land at Badgerys Creek*. A limited scope of water quality sampling was also undertaken by GHD during the aquatic ecology surveys in March 2015 at water quality sampling sites shown on Figure 18–1. The historical monitoring data and recent survey provides a snapshot of baseline water quality in the catchment at the time of each investigation.

It is recognised that water quality monitoring data is influenced by the surrounding land-use and the rainfall and run-off conditions at the time of sampling. Predictive modelling using MUSIC modelling software was therefore undertaken to estimate pollutant loads in the catchment under existing baseline conditions and calibrated with the available water quality monitoring results. The MUSIC model was chosen as it has the ability to estimate the quantity and quality of surface water generated at a site under a range of rainfall and catchment configurations and therefore a direct comparison between the baseline catchment conditions and the proposed development scenarios.

LEGEND

- Airport site
- Stage 1 development
- Hydrology assessment reporting locations
- Drainage swales
- Watercourses
- Detention ponds
- Water quality sampling sites

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

0 0.25 0.5 1 Kilometres

N

Figure 18-1 - Surface water drainage system and sample sites

The MUSIC model was initially set up to represent the existing airport catchment comprising a total of 39 individual sub catchments which were delineated using 1 m contours generated for the site. Two additional external catchments were modelled to represent the area downstream of Elizabeth Drive down to the confluence of South Creek with Blaxland Creek in order to assess the impacts on downstream water quality at a more regional scale.

Each individual sub-catchment was broken down into five land use types to represent the existing land uses at the airport site and pollution parameters assigned based upon modelling guidelines and statistical analysis from extensive research undertaken at locations throughout Australia. The existing baseline model was then stimulated for the full range of rainfall data and calibrated using the recent monitoring data using an iterative approach to achieve modelled results similar to the monitoring data. Full details of the MUSIC modelling approach is provided in Appendix L2 of Volume 4.

18.3. Regulatory and policy setting

Stage 1 would be developed in accordance with the draft Airport Plan under the provisions of the *Airports Act 1996* (Airports Act), following finalisation of the EIS.

The Commonwealth and NSW legislative and policy settings and guidelines in regards to water resources – even where not directly applicable to the proposed airport – have been considered as part of the assessment process.

18.3.1. Legislation

18.3.1.1. Airports Act 1996

Environmental management at the airport site would be undertaken in accordance with Part 6 of the Airports Act and the Airports (Environment Protection) Regulations 1997, following the grant of an airport lease to an airport-lessee company. The Airports Act specifies offences relating to environmental harm, environmental management standards, and monitoring and incident response requirements, including in relation to water pollution. Standards in relation to water pollution deal with matters such as oxygen content, pH, salinity and turbidity.

Part 4 of the Airports (Environment Protection) Regulations 1997 require an airport-lessee company to take all reasonable and practicable measures to avoid polluting water. Part 6 of the regulations requires an airport-lessee company to monitor pollution levels, including laboratory analysis accredited by the National Associated of Testing Authorities. In the period prior to granting an airport lease, any construction activities on the airport site would be conducted in accordance with the Airport Plan and have regard to the requirements of the Airports (Environment Protection) Regulations 1997.

18.3.1.2. Water Management Act 2000

The *Water Management Act 2000* (NSW) is administered by the NSW Department of Primary Industries and is intended to ensure that water resources are conserved and properly managed for sustainable use benefitting both present and future generations. The Water Management Act is also intended to provide a formal means for the protection and enhancement of the environmental qualities of waterways and their in-stream uses, and to provide for protection of catchment conditions. The intent and objectives of the Act have been considered as part of this assessment.

Water sharing plans have been developed under the Water Management Act for all water sources within NSW. The water sharing plans are developed with the aims of:

- clarifying the rights of the environment, landholders, town water suppliers and other licensed users;
- defining the long-term average annual extraction limit for water sources;
- setting rules to manage impacts of extraction; and
- facilitating the trading of water between users.

Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources

The *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources* commenced in 2011 and covers 87 management zones that are grouped into six water sources. The airport site is situated in the Hawkesbury and Lower Nepean Rivers source, or catchment.

The Hawkesbury and Lower Nepean Rivers catchment is separated into numerous management areas, which include the Upper and Lower South Creek Management Zones and the Mid Nepean River Catchment Management Zone. Badgerys, Oaky and Cosgroves Creeks are interpreted to be within the Upper South Creek Management Zone, and Duncans Creek is interpreted to be within the Wallacia Weir Management Zone (one of the Mid Nepean River Catchment Management Zones). The water sharing plan background document (NOW 2011) suggests that the South Creek region has high economic significance and depends on extraction for irrigation, town and industrial water supply.

Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources

The *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources* covers 13 groundwater sources on the east coast of NSW. The airport is located within the Sydney Basin Central Porous Rock groundwater source area. The porous rock aquifer is referenced in the plan as sedimentary sandstone and siltstone formations with intervening coal seams.

The background document for the water sharing plan (NOW 2011) lists the Sydney Basin Central porous rock aquifer as having low to moderate contact with surface water with generally long travel times (years to decades). The allocated volumes of 2,592 ML/yr versus a long-term average annual extraction limit of 45,915 ML/yr suggests that there is a significant amount of groundwater in the aquifer that has not been released for use.

18.3.1.3. Protection of the Environment Operations Act 1997

The objectives of the Protection of the *Environment and Operations Act 1997* (NSW) include the protection, restoration and enhancement of the quality of the environment, in recognition of the need to maintain ecological sustainable development including specific references the protection of water quality. This assessment has taken into account the intent and objectives of that Act.

18.3.2. Policies and guidelines

18.3.2.1. National Water Quality Management Strategy

The *National Water Quality Management Strategy* aims to protect Australian water resources, by improving water quality while supporting the businesses, industry, environment and communities that depend on water for their continued development. The strategy consists of three major elements: policy, process and guidelines.

The main policy objective of the Strategy is to achieve sustainable use of water resources, by protecting and enhancing their quality, while maintaining economic and social development. The process strives to form a nationally consistent approach to water quality management through the development of high-status national guidelines. The guidelines provide the point of reference when issues are being determined on a case-by-case basis. These include guidance on regulatory and market-based approaches to managing water quality as well as regional water quality criteria.

The policy and principles document states:

The generally accepted mechanism for establishing in-stream or aquifer water quality requirements is a two-step process which involves establishing a set of environmental values and establishing scientifically based water quality criteria corresponding to each value.

Environmental values are often interchanged with the term ‘beneficial use’ and are identified in the guidelines to include:

- ecosystem protection;
- recreation and aesthetics;
- drinking water;
- agricultural water (irrigation and stock water); and
- industrial water.

Criteria have been developed to characterise water quality relative to these environmental criteria and are outlined in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ 2000) and the *Australian Drinking Water Guidelines* (NHMRC 2011) and are discussed further below.

The criteria specified in these documents have been used as the basis for the current environmental values in this assessment for the treatment requirements for discharge to receiving water environments.

18.3.2.2. Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The national guidelines on water quality benchmarks within the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ 2000) are applicable to the Stage 1 development and provide default trigger values of various analytes for comparison with sampled values.

The core concept of the guidelines relates to managing water quality for environmental values. For each environmental value, the guidelines identify particular water quality characteristics or ‘indicators’ that are used to assess whether the condition of the water supports that value.

The environmental values, expressed as water quality objectives, provide goals to assist in the selection of the most appropriate management options within a catchment. The guiding principles include the identification and protection of the environment values of a waterway. Where targets are not achieved for environmental values, activities in the catchment should be geared toward improving these values.

The guidelines also advocate an ‘issues-based’ approach to assessing ambient water quality, rather than the application of rigid numerical criteria without an appreciation of the context. This means that the guidelines focus on:

- the environmental values we are seeking to achieve or maintain;
- the outcomes being sought; and
- the ecological and environmental processes that drive any water quality problem.

It should be also be noted that the environmental values and respective numerical indicator values apply to ambient background water quality and are not intended to be applied directly to stormwater discharges.

18.3.2.3. Australian Drinking Water Guidelines

The *Australian Drinking Water Guidelines* (NHMRC 2011) provide a framework for the management of drinking water supplies to achieve a safe and appropriate point of supply. The guidelines provide a base standard for aesthetic and health water quality levels. These values apply in this assessment to the suitability of the groundwater for potable use.

18.3.2.4. State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011

The *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011* includes provisions requiring development within Sydney drinking water catchments to demonstrate a neutral or beneficial effect on water quality. As the airport site is not within a Sydney drinking water catchment, the policy does not directly apply to the Stage 1 development. Neutral or beneficial effect has nonetheless been considered in the process of describing the potential impacts of the Stage 1 development with reference to existing water quality.

18.3.2.5. New South Wales Floodplain Development Manual

The *New South Wales Floodplain Development Manual* (Department of Infrastructure, Planning and Natural Resources 2005) concerns the management of flood-prone land within NSW. It provides guidelines in relation to flood management, including any development that has the potential to influence flooding, particularly in relation to increasing the flood risk to people and infrastructure.

Greater Sydney Local Land Service Transition Catchment Action Plan

Catchment actions plans are 10-year plans to guide the management of water, land and vegetation by state government and local communities. The main waterways at the airport site (Badgerys Creek, Oaky Creek, Cosgroves Creek and Duncans Creek) fall within the Hawkesbury-Nepean catchment, which is managed under the *Greater Sydney Local Land Service Transition Catchment Action Plan* (NSW Catchment Management Authority 2014).

The action plan is relevant to any influence the proposed airport may have on the downstream catchments in relation to surface water and aquatic ecology. Relevant strategies within the action plan include development of a more water sensitive catchment, promoting resilience through climate change adaptation and a number of strategies relating to protecting aquatic ecosystems.

18.3.2.6. Lower Hawkesbury-Nepean River Nutrient Management Strategy

The *Lower Hawkesbury-Nepean River Nutrient Management Strategy* (OEH 2010a) has been developed with the aim of reducing nutrient loads from existing sources and limiting the growth in nutrient loads from changing land uses. The strategy includes development of a catchment-wide framework to coordinate and guide action on managing nutrients in the lower Hawkesbury-Nepean. The sources of nutrients identified as a priority are: urban stormwater, agricultural practices, on-site sewage management systems, sewage treatment systems and overflows, and degraded land and riparian vegetation.

18.3.2.7. Managing Urban Stormwater: Soils and Construction

Managing Urban Stormwater: Soils and Construction (Landcom 2004), also known as ‘the Blue Book’, provides guidance on stormwater management with a focus on control of erosion and sedimentation during construction. The guidance contained in the Blue Book has been considered in the commitments to mitigation and management measures.

Water Sensitive Urban Design: Technical Guidelines for Western Sydney

Water Sensitive Urban Design: Technical Guidelines for Western Sydney (Upper Parramatta River Catchment Trust 2004) provides guidance on stormwater management with a focus on urban land uses. The technical guidelines include recommendations for on-site treatment measures to mitigate and limit the potential adverse effects on the downstream receiving waterways. The guidelines also specify percentage reduction targets for phosphorus, nitrogen and suspended solids. The technical guidelines have been considered in the assessment of potential impacts and commitment to mitigation and management measures.

18.3.2.8. Aquifer Interference Policy

The purpose of the *Aquifer Interference Policy* is to explain the role and requirements of the responsible NSW Minister in administering the water licensing and assessment processes for aquifer interference activities under the *Water Management Act 2000*. The aquifer interference assessment framework is a supporting tool to assess proposed activities against the *Aquifer Interference Policy*.

The proposed Stage 1 development includes the excavation of an underground cavity to provide for basement levels for the major terminal buildings. These works may constitute aquifer interference activities and as such the *Aquifer Interference Policy* has been considered as part of the assessment of these works.

18.3.2.9. NSW State Groundwater Policy Framework Document

The objective of the NSW *State Groundwater Policy Framework Document* (Department of Land and Water Conservation 1997) is to manage the State's groundwater resources so that they can sustain environmental, social and economic uses for the people of NSW. The NSW groundwater policy contains provisions regarding the protection of groundwater dependent ecosystems in addition to groundwater quantity and quality.

18.4. Existing environment

18.4.1. Climate and rainfall

The airport site hosts an automatic weather station operated by the Bureau of Meteorology. The weather station has recorded rainfall data at the airport site since 1998. Average annual rainfall at the airport site is 676.4 mm. Average monthly rainfall and evaporation data is shown in Table 18–2.

Table 18–2 – Average monthly rainfall at the airport site

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean monthly rainfall (mm)[a]	77.4	108.0	77.3	43.2	40.1	52.1	23.0	35.9	33.9	52.7	74.5	63.6
Highest monthly[a] rainfall (mm)	192.2	342.4	198.0	129.4	155.6	220.0	71.6	231.0	82.2	182.2	173.2	131.2
Lowest monthly rainfall (mm)[a]	13.6	13.4	21.4	1.8	1.8	2.0	2.8	1.0	6.4	0.4	8.4	14.2
Highest daily rainfall (mm)[a]	138.0	106.8	67.8	82.4	54.0	63.8	28.4	70.0	50.8	63.0	63.0	65.0
Evaporation (mm)[b]	172.7	128.4	115.9	75.6	50.2	38.4	38.4	55.5	75	120	145.5	154.1

[a] Data from the Bureau of Meteorology automatic weather station.

[b] Data from the Bureau of Meteorology Parramatta weather station, as the nearest representative location with available evaporation data.

18.4.2. Catchments

The airport site lies in the north-east of the Hawkesbury-Nepean catchment, which covers an area of 21,400 square kilometres. The Hawkesbury-Nepean catchment is characterised by meandering watercourses and is highly disturbed by clearing and urbanisation. Within the broader catchment, the airport site lies in the Badgerys Creek, Cosgroves Creek and Duncans Creek sub-catchments. Badgerys Creek and Cosgroves Creek are tributaries of South Creek which flows to the Hawkesbury River and Duncans Creek is a tributary of the Nepean River. Sub-catchments at the airport site are shown in Figure 18–2. Land uses within these sub-catchments at airport site are predominantly pastoral (85 per cent) with smaller areas of rural residential (10 per cent), forest (four per cent) and horticulture (one per cent).

Endorsed environmental values for the Hawkesbury-Nepean catchment include aquatic ecosystem protection, recreational water use, raw drinking water, irrigation and general use. Sub-catchments at the airport site are located downstream of Sydney’s drinking water catchment area and would primary used for agricultural use with recreational activities primarily undertaken considerably downstream in the Hawkesbury estuary.

The receiving waters are considered to be “slightly modified fresh water systems”. Based upon this classification a protection level of 95 per cent for freshwater ecosystems, as recommended in the ANZECC Guidelines, is considered to be suitable for toxicants. The airport site also has a ‘lowland rivers’ classification (NSW rivers, less than 150m in altitude).

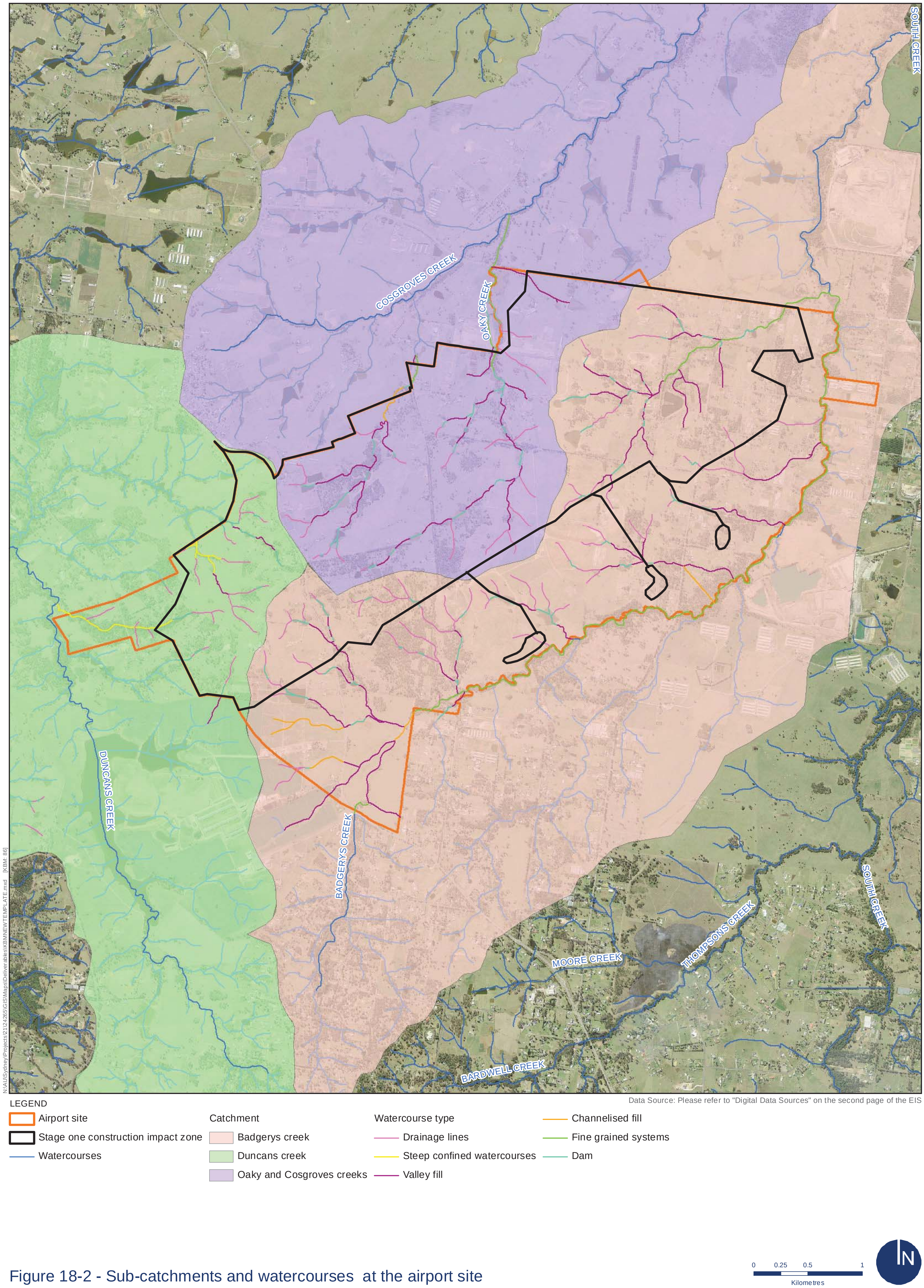

Figure 18-2 - Sub-catchments and watercourses at the airport site

Default ANZECC trigger values for physical and chemical stressors applicable to the airport site and adopted in this assessment are shown in Table 18–3. It is noted that these default trigger values are guideline values or water quality objectives only, and are not compliance standards or discharge criteria.

Table 18–3 – ANZECC Guidelines Default Trigger Values for NSW Lowland Rivers

Parameter	Default Trigger Value for Lowland Rivers
Chlorophyll a Chl a (mg/L)	0.005
Total phosphorus TP (mg/L)	0.05
Filterable reactive phosphate FRP (mg/L)	0.02
Total nitrogen TN (mg/L)	0.5
Oxides of nitrogen NOx (mg/L)	0.04
Ammonium NH4+ (mg/L)	0.02
Dissolved oxygen DO	85-110 %
pH	6.5 – 8
Salinity (µS/cm)	125-2200
Turbidity (NTU)	6 – 50

Source: ANZECC Guidelines (2000)

18.4.3. Watercourses

The airport site contains 64 kilometres of watercourses and drainage lines, including the adjacent Badgerys Creek. The watercourses at the airport site are classified in Table 18–4 and mapped in Figure 18–2. The main watercourses are Badgerys Creek, Cosgroves Creek and Duncans Creek, with the remaining watercourses being tributaries of these.

Badgerys Creek starts about two kilometres south-west of the airport site and flows north-easterly along its southern boundary before joining South Creek about four kilometres downstream. South Creek ultimately drains to the Hawkesbury River.

Cosgroves Creek starts about one kilometre north of the airport site and flows north-easterly before joining South Creek about six kilometres north-west. Oaky Creek starts at the airport site and flows north to Cosgroves Creek, before its confluence with South Creek about seven kilometres downstream.

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. Duncans Creek receives flows from a number of unnamed tributaries at the airport site.

Clearing, agriculture and the construction of in-stream dams have affected the physical stability of watercourses at the airport site. Bank erosion and head cut are evident at Badgerys Creek and Cosgroves Creek, despite these watercourses also having well vegetated riparian zones.

Table 18–4 – Watercourses at the airport site

Watercourse type	Definition
Drainage lines	Drainage lines are typically narrow flow paths set within gently concave valleys. Flows within drainage lines are sheet like due to the absence of defined channels. Typically, drainage lines are physically stable with no visible signs of erosion.
Valley fill	Valley fills are watercourses where sheet flows move along a flat valley floor, while valley slopes act as banks. The energy of flows in valley fills is dissipated across the flat valley floor, which leads to sediment deposition.
Channelized fill	Channelised fills are watercourses with defined channels that form within valley fills, with the remainder of the valley fill acting as the flood plain. Channelised fills can have moderate flow energy resulting in head cut erosion and channel erosion.
Fine grained systems	Fine grained systems are single channel set within deposited silt and sand floodplains. Channels have low gradient and capacity, meaning flows have low energy and readily spill onto the floodplain.
Steep confined watercourses	Steep confined watercourses have steep channels, which are typically stable but may slowly erode over time. Floodplains are absent and sedimentation is typically limited to bars within the channel.

18.4.4. Flooding

Existing surface water flows at the airport site during one year ARI and 100 year ARI storms were simulated in hydrologic and hydraulic models. In the one year ARI event flooding is mostly confined to main watercourse channels and dams, while considerable out-of-bank flooding is expected in a 100 year ARI event, as shown on Figure 18–3 and Figure 18–4.

The floodplain is more extensive on the airport side (western bank) of Badgerys Creek than on the eastern bank due to the wider and flatter floodplain in this location.

A number of the flood-affected rural residential lots outside the airport site are located in Bringelly in the area bounded by the airport site, The Northern Road and Badgerys Creek Road. Based on the available imagery, while a number of lots experience some inundation in a 100 year ARI event, most existing dwellings in this area remain outside the flood extent. A number of dwellings are also located within or close to the flood extent on Badgerys Creek upstream of the airport site. Two dwellings close to the flood extent were also identified downstream of the airport site on Cosgroves Creek.

LEGEND

Airport site

Flood depth (m)

	0.6 - 0.8	2 - 2.5
0.1 - 0.2	0.8 - 1	2.5 - 3
0.2 - 0.4	1 - 1.5	3 - 4
0.4 - 0.6	1.5 - 2	>4

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

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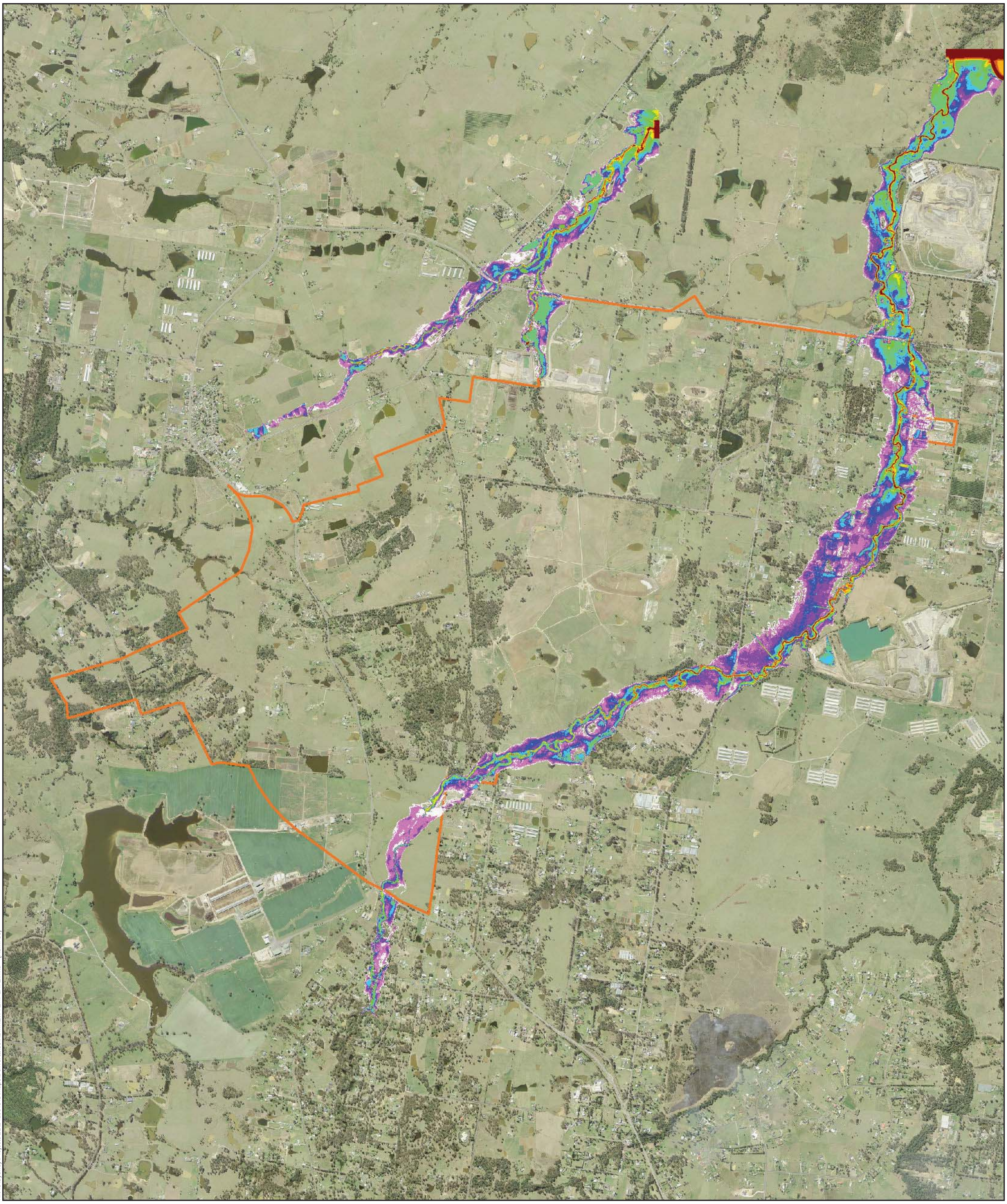
0 0.25 0.5 1
Kilometres

Figure 18-3 - Flood depth at the airport site during the 1 year ARI storm



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

LEGEND

Airport site

Flood depth (m)		
0.1 - 0.2	0.6 - 0.8	2 - 2.5
0.2 - 0.4	0.8 - 1	2.5 - 3
0.4 - 0.6	1 - 1.5	3 - 4
	1.5 - 2	>4

0 0.25 0.5 1
Kilometres

Figure 18-4 - Flood depth at the airport site during the 100 year ARI storm

18.4.5. Surface water quality

Preliminary water quality sampling was undertaken during preparation of the draft EIS and is presented in Table 18–5. The results indicate that the nutrient loads are generally well above the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ 2000). Turbidity and total suspended solids were found to be generally within acceptable levels, while dissolved oxygen levels were found to be relatively low. The data also indicate that conductivity levels were high, and above those for typical lowland rivers. These results are generally consistent with prior sampling (PPK 1997; SMEC 2014), which can be attributed to the minimal change to existing land-use between the periods of sampling.

Table 18–5 – Background surface water quality

Location	Dissolved oxygen (%)	Conductivity (µS/cm)	Turbidity (Nephelometric Turbidity Units)	Total suspended solids (mg/L)	Nitrogen (mg/L)	Phosphorous (mg/L)
Guidelines	85-100	125-2,200	6-50	<40	0.5	0.05
Badgerys Creek 2	36	3,100	7.71	5	18.5	0.31
Badgerys Creek 3	8.6	3,050	13	5	2.3	1
Badgerys Creek 4	21.3	2,710	12	23	6.2	0.42
Cosgroves Creek 1	55.4 (73.6)	4,320 (5,020)	38.1 (4.25)	19 (5)	1.2 (0.8)	0.05 (0.03)
Duncans Creek	52.5	847	89.2	14	0.9	0.06

Existing surface water quality was modelled at upstream, downstream and major outflow locations in and around the airport site and calibrated using the existing water sampling results. The surface water quality model indicated relatively high levels of nutrients (phosphorous and nitrogen), exceeding the ANZECC guidelines. Total suspended solids and dissolved oxygen were found to be at acceptable levels. The surface water quality predicts that surface water runoff from the airport site contributes 231,140 kilograms of suspended solids, 366 kilograms of phosphorous and 3,303 kilograms of nitrogen to downstream waterways on average each year. The model results are consistent with surface water quality sampling at the airport site and prior data (PPK 1997; SMEC 2014). The results of the water quality model for the existing environment and Stage 1 development are presented and discussed in Section 18.6.3.

A surface water quality monitoring program will be implemented to collect additional background data prior to the commencement of constructions. An initial monthly sampling program is commencing in October 2015 to provide additional baseline data to allow further calibration of the modelled results.

18.4.6. Groundwater

Groundwater at the airport site is generally poor quality with limited beneficial use or environmental value. The aquifers at the airport site include:

- unconfined aquifer in the shallow alluvium of the main watercourses at the airport site;
- intermittent aquifer in weathered clays overlying the Bringelly Shale;
- confined aquifer within the Bringelly Shale; and
- confined aquifer within the Hawkesbury Sandstone.

Groundwater within the alluvium has been measured at depths between 0.7 and 4.7 metres. Within the Bringelly Shale, groundwater has been measured at depths between 3.0 and 11.7 metres, and at depths between 2.4 and 4 metres in the overlying weathered material (PPK 1997; Coffey & Partners 1991). Groundwater within the Hawkesbury Sandstone is significantly deeper because the aquifer is 100 metres below ground level. The variation in depths to groundwater indicates low potential for connectivity between groundwater aquifers.

The Bringelly Shale aquifers at the airport site are considered to have limited hydraulic conductivity. Vertical hydraulic conductivities are expected to be two to three orders of magnitude lower than horizontal hydraulic conductivities, indicating a strong downward head gradient, further limiting potential for connectivity with the underlying Hawkesbury Sandstone aquifer.

The weathered soils of the Bringelly Shale that occur over most of the airport site are anticipated to result in relatively low groundwater recharge with an average of 0.5 per cent of annual rainfall entering the groundwater system. Soil infiltration testing estimates maximum recharge rates of approximately 0.012 millimetres per day for the clayey shale soils, and 0.0057 millimetres per day for the alluvium, indicating very limited groundwater recharge conditions.

An idealised hydrogeological conceptual model for the airport site is shown on Figure 18–5, highlighting the interactions between groundwater, and potential systems reliant on groundwater.

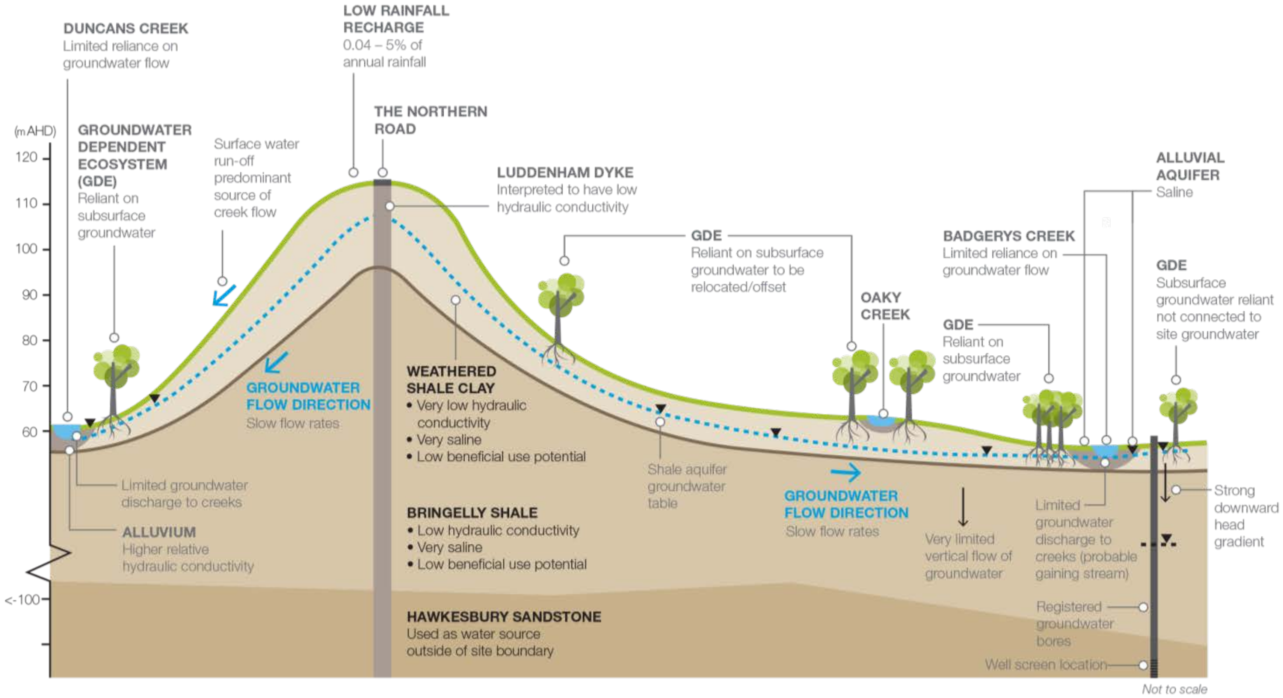


Figure 18–5 – Conceptual hydrogeological model

Groundwater quality data indicates elevated concentrations of lead, zinc, copper, nitrogen and phosphorous above ANZECC freshwater guidelines. Nitrate and sulphate exceeded guideline values at some locations. Groundwater was found to be saline with an average electrical conductivity equalling 21,474 µS/cm and exceeding the 2,200 µS/cm guideline (PPK 1997), indicating a low beneficial reuse potential.

The airport site has been cleared extensively with the exception of stands of remnant and regrowth vegetation located predominantly along Badgerys Creek and the south-western portion of the airport site. This remaining vegetation generally comprises Cumberland Plain Woodland and River-flat Forest. These stands of vegetation broadly correlate with the areas identified as potentially groundwater dependent ecosystems; however, no watercourses in or adjoining the airport site are recorded as being groundwater dependent (BoM 2015a).

The shallower alluvial aquifer at the airport site is understood to discharge at Badgerys Creek, Cosgroves Creek and Duncans Creek. However, surface discharges from the Bringelly Shale aquifer and overlying weathered material are likely to be limited by low connectivity and hydraulic conductivity. Groundwater salinity is an order of magnitude higher on average than surface water salinity at the airport site, further evidencing limited groundwater discharge to surface water.

A number of surface water dams are present across the site. These have been interpreted by site biodiversity investigations to be ‘artificial freshwater wetlands’ in good condition. These features are expected to have been developed initially to capture surface water runoff and are therefore primarily reliant on surface water inputs rather than groundwater. The low permeability clays in which these dams have been developed would limit the connection with surrounding groundwater.

A total of 42 groundwater bores are registered in the vicinity of the airport site. The groundwater bores are recorded as being constructed to significant depths and are understood to generally target the Hawkesbury Sandstone aquifer, which is known to be of higher beneficial use value. It is likely that the Hawkesbury Sandstone is preferentially targeted because of the relatively poor quality of Bringelly Shale groundwater.

18.5. Assessment of impacts during construction

Construction of Stage 1 would transform the airport site from a rolling grassy and vegetated landscape to an essentially built environment with some landscaping. These changes would alter the catchment areas within the airport site and the permeability of the ground surface, which in turn would alter the duration, volume and velocity of surface water flows.

An estimated 1.36 ML of water would be required per day for site preparation works for the proposed airport. For the purposes of this draft EIS it has been assumed that to meet this requirement 8,600 litres (0.0086ML) of potable water would be sourced from existing assets operated by Sydney Water per day and the remaining water supplied through stormwater runoff captured in sediment dams or existing farm dams. To meet water demand during construction it may be necessary to source water from other sources such as groundwater or other sources of surface water. However, consideration of the impacts associated with using these alternative sources would be subject to a separate assessment.

Stage 1 would include a drainage system to control the flow of surface water and improve the quality of water before it flows downstream (see Section 18.2.2). The assessment accounts for the effectiveness of this system in mitigating potential impacts to waterways, people and property.

18.5.1. Watercourses

The bulk earthworks program proposed to be carried out for construction of the Stage 1 development would involve the removal of minor watercourses within the construction impact zone. The total length of watercourse that would be removed is 36.5 kilometres. The majority of these watercourses are minor drainage lines and valley fills with less defined channels.

Construction would also change the topography and permeability of sub-catchment areas at the airport site. These changes would affect flows in receiving watercourses upstream and downstream of the airport site. The changes would occur progressively over construction and would be greatest at completion.

Water would be utilised during construction for soil conditioning and dust suppression. Water supply options include water reticulated to the site from existing major utilities and extraction from existing surface water resources, including capture of overland flows and water recycling.

18.5.2. Flooding

Stage 1 would include substantial and large-scale earthworks which would modify drainage direction and overland flow paths, changing the nature of flooding on the airport site. As construction progress and impervious area expands, runoff from the airport site would increase.

Without progressive introduction of formal drainage designed to cater to the new site conditions, there is potential for disruption to construction activities due to flooding and waterlogged soils, as well as the potential for downstream flooding. Detention basins have been incorporated into the indicative site design which would mitigate the increase in runoff, reducing offsite impacts of surface water flows. The detention basins would be established at the start of construction.

There is a high likelihood of large rainfall events occurring during the construction of the Stage 1 development and throughout operation of the proposed airport. The operation of the drainage system during such events is discussed in Section 18.6.2.

18.5.3. Surface water quality

Clearing and bulk earthworks would increase the surface area, and in some places the slope, of exposed soil surfaces at the airport site. These conditions would present a risk of erosion and associated surface water quality impacts. With regard to the main watercourses at the airport site bulk earthworks would not occur within 90 metres of Badgerys Creek, 300 metres of Cosgroves Creek or 880 metres of Duncans Creek.

The design capacity and placement of detention basins would ensure that all drainage water from disturbed areas would be captured prior to discharge. The drainage system would include the main detention basins (see Figure 18–1) and a series of upstream interim detention basins. The drainage system would have the effect of improving the quality of the surface water prior to release by allowing sediment to settle within the basins. The drainage system, in combination with other standard construction erosion control measures would readily mitigate the potential impacts of sedimentation. These and related measures are detailed in Section 18.7.

Construction of the proposed Stage 1 development 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. In the unlikely event of a significant leak or spill of contaminants, remediation would be implemented as soon as practicable.

Aqueous film-forming foams (AFFF) have historically been used for firefighting purposes at airports, at fuel depots, hangars and for aviation rescue and fire-fighting (for both operational and training purposes). AFFF products historically used on airport sites contain perfluorinated or polyfluorinated compounds, or fluorosurfactants (PFCs). Depending on the type of AFFF used, the principal PFC constituents could have included perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) and fluorotelomers such as 6:2 fluorotelomer sulfonate (6:2FtS) and 8:2 fluorotelomer sulfonate (8:2FtS).

AFFF has not been used for aviation rescue and fire-fighting by Airservices Australia since 2010, but continues to be used around fuel depots and hangars at many airports (GHD 2015 b).

18.5.4. Groundwater

Noting the poor quality of existing groundwater, the proposed airport has the potential to affect groundwater conditions through changes to groundwater recharge, groundwater drawdown and impacts on groundwater quality.

18.5.4.1. Groundwater recharge

Groundwater recharge, the process by which surface water infiltrates downward toward the water table would be affected by compaction and the establishment of impermeable surfaces across the airport site during construction. Re-profiling of the land surface may lead to a temporary increase in rainfall recharge during bulk earthworks, as the fill is expected to have a higher overall permeability than the existing site conditions. However, as construction progresses, the proportion of paved surfaces would increase, which would reduce recharge to below existing conditions.

Overall, minimal change to local groundwater recharge would be expected as the existing shale derived clay soils have low permeability resulting in the majority of rainfall at the site being 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.

18.5.4.2. Groundwater drawdown

Groundwater drawdown is anticipated as a result of airport site re-profiling and dewatering of excavation beneath the water table. Extensive re-profiling of the airport site would be undertaken to create a flatter surface for the development of the proposed runway and associated facilities. 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 peripheries of the re-profiled area would result in exposed cuttings that would seep and reduce groundwater elevations in the elevated areas around the cuttings. 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.

Establishment of basements in the terminal complex would likely intercept the underlying shale aquifers and require dewatering and management throughout construction. Due to low inherent hydraulic conductivities of the geology in these areas, it can be expected that seepage volumes would be relatively small.

As drawdown impacts are expected to be minor, a groundwater monitoring programme at potential sensitive receptors (riparian vegetation and creeks) is considered to be sufficient to assess the emergence of any impacts.

18.5.4.3. Groundwater quality

Potential groundwater quality risks include isolated spills and incidents occurring during construction, and diffuse impacts associated with general construction activities such as use of machinery. Contaminants of primary concern are usually hydrocarbons; however, other chemicals such as herbicides, pesticides and fertiliser may also be used during construction. Impacts would have the potential to occur through the infiltration of pollutants through the ground surface or through dirty water retention facilities (such as temporary sediment basins) to the underlying groundwater systems.

Groundwater seepage into excavations for building basements would need to be managed by pumping to stormwater management facilities or other suitable treatment systems. Chemicals of concern in groundwater seepage include total dissolved solids, metals, total nitrogen, phosphorus and sulphate. There would be small seeps from cuttings that would also require appropriate management prior to discharge offsite.

Groundwater present in the shallow geology has been identified to have high salinity values. The excavation and use of this material for infilling could permit the release of additional salts into groundwater. This would only occur where increased recharge occurs to fill areas, and where a shallow groundwater table develops in the fill material.

As the underlying aquifer system is of low beneficial use, adverse impacts may potentially emerge when affected groundwater migrates beneath areas of groundwater-reliant vegetation (located in creek riparian areas) or discharges into creeks. Groundwater flow velocities are expected to be slow, and as such the emergence of any impacts would also be slow. A groundwater monitoring approach is considered suitable to manage the identification of groundwater quality impacts.

18.6. Assessment of impacts during operation

The Stage 1 development during operation would comprise a built environment with some landscaping. The catchment areas within the airport site and the permeability of the ground surface would therefore be significantly altered, which in turn alters the duration, volume and velocity of surface water flow.

The design of the Stage 1 development includes a drainage system to control the flow of surface water (see Section 18.2.2). The assessment accounts for the effectiveness of this system in mitigating potential impacts on waterways, people and property.

18.6.1. Watercourses

The alterations to the topography and permeability of the airport site made during construction would persist through operation of the Stage 1 development. The operating Stage 1 development could therefore affect flows in receiving watercourses upstream and downstream of the airport site, relative to existing conditions. Changes to flows in receiving watercourses have the potential to affect their physical conditions.

Hydrologic and hydraulic modelling incorporated the Stage 1 development landform and drainage system indicates that duration, volume and velocity of surface water flows in watercourses are similar or reduced when compared to existing flow conditions in all but a few cases.

Increases in flood depth at Cosgroves Creek and Oaky Creek (see Section 18.6.2) have the potential to affect the physical stability of watercourses through bed or bank erosion. Localised increases are also expected to occur at basin outflows.

Changes to surface water flows elsewhere upstream and downstream of the airport site are not expected to affect the physical stability of watercourses.

Potential impacts would be mitigated through further refinement of the surface water drainage system, including the provision of erosion controls at basin outlets.

18.6.2. Flooding

The establishment of the Stage 1 development would comprise a major modification to existing on site flow paths and sub-catchment boundaries, with resultant potential impacts on surface water flows and the receiving watercourses.

Stage 1 would result in a portion of the airport site that currently drains towards the Oaky Creek and Cosgroves Creek catchments to the north being diverted south towards Badgerys Creek, while a portion of the airport site that currently drains to Badgerys Creek would be diverted to Duncans and Oaky Creeks. The proposed airport would change surface run-off conditions in the catchments it intersects, which may also create minor incidental losses associated with evaporative changes.

A summary of changes to sub-catchment areas comprising the airport site is provided in Table 18–6. A reduction in catchment area would generally result in reduced flows downstream; conversely, an increase in catchment area would increase flows downstream. An increase in impervious surfaces would also increase runoff and downstream flows.

Table 18–6 – Changes in catchment area and impervious area at the airport site

Location	Catchment area (ha)		Impervious area (%)	
	Existing	Stage 1	Existing	Stage 1
Badgerys Creek at Elizabeth Drive	2,052	↑2,362	12%	↑14%
Oaky Creek at Elizabeth Drive	361	↓292	10%	↑49%
Cosgroves Creek at Elizabeth Drive	536	↑603	14%	↑20%
Badgerys Creek at South Creek	2,799	↑2,800	12%	↑14%
Cosgroves Creek at South Creek	2,163	↓2,148	14%	↑21%
Duncans Creek at Nepean River	2,379	↑2,385	14%	↑15%

↓/↑ denotes decrease/increase

Hydrologic and hydraulic modelling indicates that duration, volume and velocity of surface water flows in watercourses would be generally similar or reduced when compared to existing flow conditions. Comparison of peak flows under existing and Stage 1 conditions for a one year ARI and 100 year ARI events are provided in Table 18–7. The reporting locations were defined in the hydrological and hydraulic models as shown in Figure 18–1.

The general reductions in peak flows demonstrate the function of the detention basins proposed at most site discharge points for the dual purpose of treating water quality and mitigating potential increases in peak flows (refer to Figure 18–1).

Despite the general reductions, increases of up to 100 mm in stream depths may occur at Cosgroves Creek and up to 250 mm in limited reaches of its tributary Oaky Creek for the smaller one year ARI and five year ARI events, plus associated increases in flow volume and velocity. Localised increases would also be expected to occur at basin outflows during discharge events. These potential impacts would need to be mitigated through further refinement of the surface water drainage system (see Section 18.7). No changes to flood levels are expected to occur at dwellings or other infrastructure surrounding the airport site.

Table 18–7 – Modelled peak flows at the airport site with Stage 1 development

Location	Basin	1 year ARI peak flows (m^3/s)			100 year ARI peak flows (m^3/s)		
		Existing	Basin inflow	Outflow	Existing	Basin inflow	Outflow
Location A	Basin 1	8.4	4.4	3.5	33.5	25.9	12.7
Location B	Basin 2	1.9	0.9	0.8	8.2	5.0	3.1
Location C	Basin 3	3.2	2.1	1.8	12.9	12.4	6.1
Location D	Basin 4	2.3	1.5	1.5	9.1	7.2	5.5
Location E/F	–	6.5[a]	–	2.9[b]	26.3[a]	–	12.6[b]
Location G/H	Basin 6	8.9[d]	8.2[c]	6.6[c] 7.9[d]	37.6[d]	54.3[c]	23.8[c] 29.3[d]
Location I	Basin 7	4.1	4.4	2.7	16.5	27.9	8.7
Location J	Basin 8	3.3	2.4	1.7	10.9	14.5	5.3
Location K	–	2.1	–	1.7	9.6	–	7.4
Location L	–	4.6	–	4.2	19.8	–	18.0

[a] Location E
[b] Location F
[c] Location G
[d] Location H

18.6.3. Surface water quality

Existing surface water quality was modelled at upstream, downstream and major outflow locations in and around the airport site. The model results are summarised in Table 18–8, and show that actual pollutant concentrations would decrease at most downstream locations. Despite the Stage 1 development leading to general improvements in pollutant concentrations locally and regionally, the improvements would not be sufficient to meet ANZECC guideline objectives, noting the catchment has not met ANZECC guidelines for several years.

Despite the general decrease in pollutant concentrations, Stage 1 would result in increased loads of phosphorous and nitrogen, largely as a function of the increase in runoff volumes associated with the modified catchment areas and changes to land-use.

Relative increases in phosphorous and nitrogen loads attributed to the proposed airport would be most pronounced at basin outlets, where surface water flows leave the airport site, but would progressively decrease downstream of the airport site as receiving waterways receive flows from the wider catchment. In any case, though loads would be volumetrically higher, actual pollutant concentrations would be generally improved in comparison to existing water quality conditions. The proposed drainage system would be generally effective at reducing loads of suspended solids in surface water, compared to existing conditions. Further resolution of mitigation measures would be provided in the final EIS having regard to identified downstream assets and potential for impacts.

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.

Table 18–8 – Surface water quality at the airport site

	Existing (mg/L)			Stage 1 development (mg/L)		
Location	Suspended solids	Phosphorous	Nitrogen	Suspended solids	Phosphorous	Nitrogen
ANZECC	40	0.05	0.5	40	0.05	0.5
Basin 1	22.1	0.14	1.54	↓12.9	↓0.11	↓0.91
Basin 2	22.1	0.09	1.25	↓16.5	↑0.11	↓0.99
Basin 3	21.9	0.09	1.26	↓12.2	↑0.12	↓0.88
Basin 4	20.7	0.38	2.91	↓15.9	↓0.11	↓1.00
Basin 6	22.5	0.15	1.60	↓6.99	↓0.12	↓0.76
Basin 7	22.3	0.14	1.46	↓10.6	↓0.12	↓0.81
Basin 8	23.2	0.13	1.51	↓11.9	↓0.11	↓0.90
Badgerys Creek 1	21.5	0.14	1.47	↑22.5	↓0.11	↓1.21
Badgerys Creek 2	21.8	0.15	1.54	↓18.1	↓0.11	↓1.10

	Existing (mg/L)			Stage 1 development (mg/L)		
Location	Suspended solids	Phosphorous	Nitrogen	Suspended solids	Phosphorous	Nitrogen
Badgerys Creek 3	21.9	0.14	1.53	↓14.8	↓0.12	↓1.00
Cosgroves Creek 1	22.7	0.14	1.54	↓10.2	↓0.12	↓0.88
Cosgroves Creek 2	22.5	0.14	1.50	↓10.9	↓0.12	↓0.88
Duncans Creek	10.3	0.06	0.70	↑13.2	↑0.11	↑0.96
Kemps Creek	20.9	0.13	1.34	↓15.4	↓0.11	↓1.03
Blaxland Creek	20.8	0.12	1.31	↓15.5	↓0.11	↓1.02

↓/↑ denotes decrease/increase

18.6.4. Reclaimed water irrigation

An estimated 2.5 ML of wastewater per day would be generated during operation of the Stage 1 development. The wastewater would be reticulated, treated and recycled (as grey water) or irrigated on site. Treatment and irrigation methods would be determined in detailed design, but it is expected that wastewater would be treated to a high quality with membrane biological reactor technology to produce high quality reclaimed water suitable for beneficial reuse or irrigation.

The key risks to surface water and groundwater associated with the irrigation of reclaimed water are runoff to surface water or infiltration to groundwater. These risks would be limited in the first instance as reclaimed water would be relatively high quality and appropriate management practices such as balancing storages and proper irrigation scheduling to avoid excessive irrigation are proposed.

18.6.5. Groundwater

Potential impacts associated with the operation of the proposed airport would continue to be associated with potential changes to groundwater recharge, groundwater drawdown and potential impacts on groundwater quality as discussed in Section 18.5.4. Impacts on groundwater recharge are not expected to be significant given the very limited groundwater recharge condition at the airport site (see Section 18.4.6). Groundwater drawdown effects due to inflows would be limited following the initial effects of bulk earthworks and excavation. Significant groundwater inflows to underground infrastructure are not expected and would be controlled, if necessary, through the use of lining or other engineering controls.

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.

18.7. Mitigation and management measures

Measures to manage potential impacts on surface water and groundwater during construction and operation are listed in Table 18–9. Some of the main proposed measures include:

- refinement of the surface water drainage system to improve flood and water quality performance as far as practicable;
- regular inspection and maintenance of the surface water drainage system to ensure all components are functioning as designed;
- implementation of standards for storage and handling of fuels or chemicals with the potential to contaminate surface water or groundwater; and
- baseline and ongoing monitoring of surface water and groundwater, fulfilling the requirements of the *Airports (Environment Protection) Regulations 1997*.

The establishment of erosion controls in line with *Managing urban stormwater: soils and construction* (Landcom 2004) would be central to the management and mitigation of erosion and associated surface water quality impacts. These measures are discussed in Chapter 17.

The reclaimed water reuse scheme would be designed and operated in accordance with the risk framework and management principles contained in the *National Guidelines on Water Recycling* (Environment Protection and Heritage Council 2006) and the *Environmental guidelines: Use of effluent by irrigation* (DEC 2004d). This approach would avoid environmental harm to surface water and groundwater. These measures are discussed in Chapter 17.

Table 18–9 – Mitigation and management measures

ID	Issue	Measure	Timing
18.1	Surface water drainage system	Preparation of a plan to refine the surface water drainage system during detailed design to address the following: • detailed design of basins and channels to capture the majority of runoff, including during construction; • refinement of drainage system design performance standards to optimise capacity and release timing, mimicking natural flows as far as practicable; • provision of intermediate sediment retention basins upstream of larger basins to provide additional treatment; • provision of separate bio-retention swales and basins to provide additional treatment and separation of these features from the drainage system to protect contained water during floods; • provision of pollutant traps to prevent debris and other coarse material entering the drainage system; • stabilisation structures at outlets to include rock check dams at regular intervals along channels and energy dissipaters at basin outlets; and • capacity for containment of accidental leaks or spills in the drainage system at maintenance areas, fuel farms or other areas where fuels or chemicals are stored or handled in accordance with Australian standards.	Pre-construction
18.2	Erosion and sedimentation	The surface area disturbed at any one time would be minimised as far as possible by construction staging and stabilised with vegetation or appropriate cover.	Construction

ID	Issue	Measure	Timing
18.3	Leaks or spills of fuel or other chemicals	Fuel and other chemicals would be stored and handled in accordance with relevant Australian standards such as: • *AS 1940-2004 The storage and handling of flammable and combustible liquids;* • *AS/NZS 4452:1997 The storage and handling of toxic substances;* • *AS/NZS 5026:2012 The storage and handling of Class 4 dangerous goods; and* • *AS/NZS 1547:2012 On-site domestic wastewater management.*	Construction
18.4	Surface water quality	Surface water quality criteria for releases from the drainage system would be developed with due consideration to the *Airports (Environment Protection) Regulations 1997* and the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ 2000) and the results of baseline water quality monitoring.	Pre-construction
18.5		Surface water quality monitoring would be conducted at basin outflows and selected upstream and downstream conditions. Once an airport lease is granted, the proposed airport would be subject to water quality monitoring requirements as set out in the *Airports (Environmental Protection) Regulations 1997* and the results of baseline water quality monitoring.	Construction Operation
18.6	Leaks or spills of fuel or other chemicals	Maintenance areas, fuel farms and other areas where fuels or chemicals are stored or handled would be bunded to contain any accidental spills or leaks.	Construction Operation
18.7	Leaks or spills of fuel or other chemicals	Develop and implement response procedures to remedy leaks or spills.	Construction Operation
18.8	Groundwater inflows	Groundwater elevation monitoring would be conducted to detect potential impacts to base flow in the vicinity of potentially sensitive creeks or groundwater dependent vegetation. Monitoring would be undertaken quarterly through construction up to a minimum period of three years after the completion of the Stage 1 development and until any identified impacts stabilise.	Construction Operation
18.9		Measures to supplement groundwater supplies would be made in the unlikely event of impacts to dependent vegetation or watercourses.	Construction Operation
18.10	Groundwater quality	Groundwater quality monitoring of alluvial and Bringelly Shale aquifers would be conducted at major infrastructure locations, down gradient from those locations and in the vicinity of groundwater dependent vegetation or watercourses. Monitoring would initially be undertaken quarterly and adjusted as appropriate. Once and airport lease is granted, the proposed airport would be subject to water quality monitoring requirements as set out in the *Airports (Environmental Protection) Regulations 1997.*	Construction Operation
18.11		Groundwater inflows would be reused or released with appropriate treatment. Where groundwater is released to surface waters, treatment would be to the appropriate level under the ANZECC guidelines.	Construction Operation

18.8. Conclusion

Construction of Stage 1 would transform the airport site from a rolling grassy and vegetated landscape to an essentially built environment with some landscaping. These changes would alter the catchment areas within the airport site and the permeability of the ground surface, which would in turn alter the duration, volume and velocity of surface water flow. The proposed bulk earthworks and excavations at the airport site are likely to receive some groundwater inflows.

Hydrologic and hydraulic modelling of the airport site during construction and operation indicates that there is a degree of variation in how the drainage system responds to different storm events. The drainage system as currently planned would be generally effective at mitigating watercourse and flooding impacts; however refinement of the drainage system would occur during detailed design of the proposed airport.

The refinement of the drainage system would address some of the more substantial increases to flows at Oaky Creek, as well as the enhanced use of bio-retention basins and swales and other intermediate structures to further improve water quality outcomes.

Overall it is considered that the residual impacts to surface water and groundwater would be reasonable considering the scale and nature of the proposed airport development. Baseline and ongoing monitoring of surface water and groundwater would be undertaken to characterise any residual impacts and prompt corrective action where necessary.

19. Aboriginal heritage

Since the early 1800s, land use at the airport site has consisted of varying phases of stock grazing, cropping, orcharding, dairying, market gardening, poultry farming and some light industrial functions. Consequently, most of the original native vegetation has been cleared and the airport site is now dominated by agricultural grasslands or cultivated fields with small pockets of open eucalypt woodland or shrubland. These activities are expected to have had a substantial impact on the Aboriginal archaeological resource, especially in the top soil and the plough zone at the airport site.

The airport site has been the subject of a number of previous archaeological assessments as part of the search for an appropriate site for a second Sydney airport. These previous assessments date back to 1978, with the most recent being undertaken in 2014. Fifty-one Aboriginal heritage sites have been recorded during these surveys, consisting of surface artefact occurrences and a modified tree. Twenty-three additional sites were recorded at the airport site during the course of the current assessment, which focused on test excavation and characterising the sub-surface archaeological resource. The new recordings comprised nine sites with surface artefacts (including a grinding groove site) and 14 sites where subsurface artefacts were confirmed through test pit excavations.

The test excavation program included a representative sample of landform types and zones within the airport site. It was determined that a relatively high average artefact incidence occurred across valley floors, basal slopes, first-order spurlines and within 100 metres of second, third and fourth order streams. These findings are generally consistent with numerous other investigations in the vicinity of the airport site that have confirmed that Aboriginal heritage sites occur widely across the landscape, but particularly on elevated level ground and slopes within relative proximity of a water source. These investigations also indicate that larger sites with higher artefact densities are more likely to be found near permanent water.

Aboriginal stakeholder consultation undertaken for the current assessment identified the airport site as a place of cultural significance and continuing cultural connection. The reasons for this include the site's material evidence of occupation, its cultural landscape values, and culturally significant plants, animals and resources. All of these contribute to a sense of place and cultural identity, and are considered to be a valuable educational resource.

In addition, the remaining Aboriginal sites across the Sydney hinterlands may be considered to have an intrinsic value because of their endurance amid concerns about disappearing heritage. The cumulative impacts on Aboriginal heritage sites caused by continuing urban and industrial development of the Cumberland Plain, of which the proposed airport would be a part, effectively impose a greater significance on those sites that remain.

All of the Aboriginal heritage sites recorded at the airport site are considered to have significance. Many sites contain archaeological material which has both cultural and scientific value, and all sites, irrespective of their scientific or other values, are considered to be culturally significant by the Aboriginal community The predicted archaeological resource of the airport site, as revealed by the test excavation program, is also assessed to be significant.

Construction of the proposed Stage 1 development would affect at least 39 sites recorded at the airport site, all of which comprise artefact occurrences. Construction activities would also impact approximately 501 hectares of archaeologically sensitive landforms. Impacts during operation of the proposed airport would be limited to indirect impacts on adjacent and nearby sites. The heritage values of these sites are unlikely to be vulnerable to indirect impacts such as loss of context. Consequently, the operational impacts of the proposed Stage 1 development would be low.

Mitigation and management measures would be implemented to minimise the impacts on Aboriginal cultural heritage. These measures would include the conservation of heritage sites, recording and salvage of heritage sites, the commemoration of cultural heritage values at the airport site, curation and repatriation of heritage items and protocols for the discovery of artefacts and human remains.

19.1. Introduction

This chapter provides a review of the Aboriginal cultural heritage values that may be potentially affected by the development of the proposed airport. In doing so, it draws on a comprehensive Aboriginal cultural heritage impact assessment, which is included as Appendix M1 in Volume 4. This chapter describes the Aboriginal cultural heritage values of the airport site and assesses the potential impacts of the proposed Stage 1 development on these cultural heritage values. Mitigation and management measures are identified to reduce potential impacts.

The assessment has been prepared in consultation with the Australian Government Department of the Environment (DoE) 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 Western Sydney Airport.

19.2. Methodology

The Aboriginal cultural heritage assessment was conducted according to the provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) and Environment Protection and Biodiversity Conservation Regulations (2000) (Cth). The assessment was also prepared in accordance with the principles of the *Australia ICOMOS Charter for Places of Cultural Significance* (the Burra Charter, as adopted in November 1999). The methodology for the Aboriginal cultural heritage impact assessment included consultation, a database and literature review, field surveys and assessments of significance.

The adopted methodology builds upon data obtained from previous site studies which focused predominantly on the investigation of surface sites. All field data generated by the archaeological survey undertaken as part of the 1997–99 *Second Sydney Airport Proposal Environmental Impact Statement* (1997–99 EIS) (PPK 1997), was reviewed, together with the results of the 2014 environmental survey, which reinspected a selection of the 1997 recordings (AMC 2014). The environmental survey revealed that only a small proportion of the 1997 recordings were still identifiable from surface artefacts, and reported low levels of ground surface visibility. This finding indicated that the current assessment should focus on the investigation of the potential subsurface archaeological resource, rather than repeat surface archaeological survey in low visibility conditions. Emphasis was also placed on recording cultural values and the views of the Aboriginal stakeholder community.

The investigation of the potential subsurface resource employed a landscape based approach and involved the development of a predictive model and a program of archaeological test excavation within a sample of locations. This complemented the site based approach of previous studies. Optimal test excavation locations were selected through a field survey program conducted with Aboriginal stakeholders.

The predictive modelling now allows the extrapolation of surface and subsurface artefact incidence data to untested landforms of the same type, and the nature of the predicted archaeological resource to be mapped in terms of broad area landforms and topographic variables. This integration of surface and subsurface information characterises current best practice, and represents a shift in paradigm – from one which is site based and focused on surface evidence, to one focused on the subsurface resource that may be revealed by both surface sites and test excavation.

19.2.1. Consultation

Consultation was undertaken with reference to *Ask First, A Guide to Respecting Indigenous Heritage Places and Values* (Australian Heritage Commission 2002) and was guided by the requirements set out in the document *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (OEH 2010b). This included:

- **Stage 1 – Notification of the project proposal and identification and registration of stakeholders**. A public notice advising of the Aboriginal cultural heritage assessment and inviting registrations from interested parties was placed in several local newspapers in February 2015. The newspapers were the *Blacktown Advocate*, *Liverpool Leader*, *Fairfield City Champion*, *Camden Advertiser*, *Penrith Press* and *Macarthur Chronicle*. Letters were also sent to organisations seeking the identification of Aboriginal stakeholders for the purpose of inviting their participation in the consultation program. There are currently 50 registered Aboriginal stakeholders for the airport proposal. A list of registered stakeholders is provided in Appendix M1 in Volume 4.
- **Stages 2 and 3 – Presentation of information about the project and proposed assessment methodology, and gathering of information about cultural significance**. A combined background paper and draft methodology for the Aboriginal cultural heritage assessment was sent to all registered Aboriginal stakeholders in March 2015 with an invitation to provide comment on both the methodology and any known cultural heritage values relevant to the airport site. Two meetings were also held with the registered stakeholders in April 2015 to discuss the airport proposal, outline previous assessment work at the airport site and explain the proposed methodology for the Aboriginal cultural heritage assessment. All Aboriginal stakeholders who were registered at the time opted to participate in the fieldwork program.
- **Stage 4 – Review of draft heritage assessment report**. All registered Aboriginal stakeholders will be provided with, or advised where to locate a copy of, the draft EIS and specialist Aboriginal cultural heritage report, and invited to provide a written response on the findings and presented mitigation and management strategies. This comment period will coincide with the statutory period for public display of the draft EIS and submission of comments. All responses will be documented, reviewed and addressed as part of the finalisation of the EIS.

Two separate meetings were held with Liverpool City Council and the NSW OEH in May 2015. A general outline of the airport proposal and the Aboriginal cultural heritage assessment approach was provided followed by a discussion of potential issues and priorities.

Further detail of the consultation undertaken is provided in Appendix M1 in Volume 4.

19.2.2. Database and literature review

A desktop assessment was undertaken to determine the nature and status of known Aboriginal heritage sites within and around the airport site, to facilitate site prediction on the basis of regional and local site patterns, and to place the area within an archaeological and heritage management context.

The desktop assessment included searches of heritage registers and schedules and a review of local histories and archaeological reports. Searches were undertaken of the following heritage registers and schedules:

- World Heritage List (United Nations Educational, Scientific and Cultural Organization (UNESCO));
- Commonwealth Heritage List (Australian Heritage Council);
- National Heritage List (Australian Heritage Council);
- Register of the National Estate (Australian Heritage Council); and
- Aboriginal Heritage Information Management System (AHIMS) (NSW OEH).

The results of previous archaeological assessments undertaken at the airport site and in the vicinity were reviewed. These included:

- Major Airport Needs of Sydney (MANS) Study (Haglund 1978);
- Second Sydney airport site Selection Programme Draft Environmental Impact Statement (Kinhill Stearns 1985);
- Draft Environmental Impact Statement Second Sydney Airport Proposal (PPK 1997);
- Draft Environmental Impact Statement Second Sydney Airport Proposal, Auditor's Report (SMEC 1998);
- Supplement to Draft Environmental Impact Statement Second Sydney Airport Proposal (PPK 1999);
- Supplement to Draft Environmental Impact Statement Second Sydney Airport Proposal, Auditor's Report (SMEC 1999);
- Proposed Second Sydney Airport at Badgerys Creek Environmental Assessment Report (Environment Australia 1999); and
- Environmental Field Survey of Commonwealth Land at Badgerys Creek (SMEC 2014).

A comprehensive list of the literature that was reviewed is provided in Appendix M1 in Volume 4.

19.2.3. Field surveys

19.2.3.1. Overview

A three week fieldwork programme was conducted from 4 to 22 May 2015. This programme reflected the objectives of the assessment, which included the identification of Aboriginal cultural values and the testing of the subsurface archaeological resource. A decision not to systematically revisit or test previously identified sites was made based on the findings of the 2014 environmental field survey conducted by Australian Museum Consulting (AMC 2014). This study encountered low ground surface visibility and found that a low proportion of previously recorded surface artefacts remained visible. The first week of fieldwork was devoted to Aboriginal consultation to provide an opportunity for stakeholders to identify and discuss cultural and intangible values associated with the airport site. This included a broad scale review of the site characteristics and diversity of landforms, and the identification and prioritisation of potential test pit locations. An archaeological test pit programme was undertaken over the subsequent two weeks of the fieldworks programme.

19.2.3.2. Test excavations

The aim of the test excavation programme was to characterise the nature and occurrence of the subsurface archaeological resource, by conducting archaeological test excavations within a representative selection of landform types present within the airport site.

Thirty-eight possible archaeological test locations were identified through a desktop assessment. Potential locations were identified based on landform representativeness, access constraints and degree of disturbance. Previously recorded sites were not prioritised in the selection process. Following on-site review and a field inspection of each location with Aboriginal stakeholders, the test locations were prioritised and a shortlist developed. Archaeological test excavations (test pits) were conducted at 13 of the 38 locations. Four of these locations were paired, resulting in a total of 11 test locations. The test locations are shown in Figure 19–1.

Ten test pits (each 1 x 0.5 square metres in area and totalling approximately five square metres) were conducted at each test location, with the exception of Test Location 26/27, where 13 pits were conducted (refer to Figure 19–1).

All test pits were excavated by hand, using spades, hand trowels and, where necessary, picks. The end depth of each pit varied depending on when stiff clay, rock or other constraints were encountered. All sieving was conducted by hand using pressurised water sourced from a water truck. All artefactual material was recovered and subject to itemised description in the laboratory. All pits were backfilled with sieved spoil and/or imported clean fill.

LEGEND

Airport site
Test pits

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

0 0.25 0.5 1
Kilometres

Figure 19-1 - Test excavation locations

19.2.4. Assessments of significance

Assessments of significance were prepared for all Aboriginal heritage sites recorded at the airport site. The assessments of significance were prepared with reference to the Burra Charter and in accordance with the provisions of the EPBC Act. The EPBC Act defines three tiers of significance through the establishment of the World Heritage List, the Commonwealth Heritage List and the National Heritage List. World heritage properties are listed on the World Heritage List administered by UNESCO. National heritage places are places of outstanding value to the nation and are listed on the National Heritage List. Commonwealth heritage values are places or items owned or controlled by Commonwealth agencies and are listed on the Commonwealth Heritage List.

The EPBC Act prescribes obligations for Commonwealth agencies that own or control properties that have, or might have, one or more Commonwealth or national heritage values. Obligations include taking all reasonable steps to assist in the identification, assessment and monitoring of values, and preparation of management plans for any identified values in line with the Commonwealth heritage management principles and National heritage management principles. Commonwealth agencies must similarly take all reasonable steps to ensure their actions are not inconsistent with the Australian World Heritage management principles or any plans in force for a World Heritage property. The EPBC Act prescribes various heritage management principles for managing heritage properties under the EPBC Act.

No heritage values consistent with World Heritage or National Heritage listing were identified within the airport site. Assessments of Commonwealth heritage values within the airport site were undertaken for this EIS, and these are described in Section 19.3.6.

19.2.4.1. The Burra Charter

The Burra Charter defines cultural significance as 'aesthetic, historical, scientific or social value for past, present and future generations' (Australia ICOMOS 1987). The Burra Charter outlines five broad categories applicable to the assessment of the significance of Aboriginal sites. These are:

- significance to contemporary aboriginal people;
- scientific or archaeological significance;
- aesthetic value;
- representativeness; and
- value as an educational and/or recreational resource.

All Aboriginal heritage sites located within the airport site have been assessed with reference to these criteria.

19.2.4.2. Commonwealth assessment criteria

Because the airport site is land owned by the Australian Government, the assessment of cultural significance must be in accordance with the EPBC Act. The EPBC Act specifies two sets of criteria for the assessment of significance: one for determining significance that would meet a standard for listing on the National Heritage List, and another for listing on the Commonwealth Heritage List.

Both the National and Commonwealth Heritage Lists employ nine similar assessment criteria but attach different thresholds. The National Heritage criteria specify a threshold of 'outstanding heritage value to the nation'. None of the cultural values identified at the airport site are considered to fulfill this threshold, and further detail regarding the National Heritage List is not presented here.

The Commonwealth Heritage List is a register of natural and cultural heritage places owned or controlled by the Australian Government. To be entered on the Commonwealth Heritage List, a place must have 'significant' heritage value (Department of the Environment, Heritage website, accessed June 2015). Nominations are assessed by the Australian Heritage Council. In accordance with the EPBC Act, a place has a significant Commonwealth heritage value if it meets one of the following criteria:

a. the place has significant heritage value because of the place's importance in the course, or pattern, of Australia's natural or cultural history;
b. the place has significant heritage value because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history;
c. the place has significant heritage value because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history;
d. the place has a significant heritage value because of the place's importance in demonstrating the principal characteristics of:
    i. a class of Australia's natural or cultural places, or
    ii. a class of Australia's natural or cultural environments;
e. the place has a significant heritage value because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group;
f. the place has significant heritage value because of the place's importance in demonstrating a high degree of creative or technical achievement at a particular period;
g. the place has significant heritage value because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons;
h. the place has significant heritage value because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history; and
i. the place has significant heritage value because of the place's importance as part of Indigenous tradition.

While a place can be assessed against the above criteria for its heritage value, this may not always be sufficient to determine whether it is worthy of inclusion on the Commonwealth Heritage List. The Australian Heritage Council may also need to apply a second test, using a 'significance threshold', to judge the level of significance of a place's heritage value by asking 'just how important are these values?' In guidelines prepared by the Australian Heritage Council it is stated that 'the threshold for inclusion on the Commonwealth Heritage List is local heritage significance'). This application of a local level threshold underlines the function of the Commonwealth Heritage List as an instrument for managing places with heritage significance. It is not intended to be a list of places with a Commonwealth or National level of significance.

19.3. Existing environment

This section describes the landscape and cultural context of the airport site. The results of previous archaeological assessments at the airport site are summarised and the results of the field surveys for the current assessment are presented. The outcomes of the stakeholder consultation are outlined and a summary of the assessments of significance is also provided.

19.3.1. Landscape context

19.3.1.1. The regional landscape

The airport site is located on the central western margin of the Cumberland Plain. This section of the Cumberland Plain is where the creek lines drain north and west to the Hawkesbury River (McDonald and Rich 1993). The Cumberland Plain is in a centrally positioned portion of the inner Sydney Basin, which consists of rolling and low gradient topographies that have developed on the shale-dominated bedrocks of the Wianamatta Group of middle Triassic age. The Wianamatta Group makes up the uppermost portion of the Triassic depositional sequence and was laid down as epimarine, intertidal, back-swamp and alluvial sediments during a period of marine regression (the exposure of former seabed), and progradation (the seaward and progressive deposition of shoreline deposits) (Smith 1979; Jones and Clarke 1991). The topography of the airport site reflects the underlying geology, which is dominated by the Bringelly Shale, the upper most unit of the Wianamatta Group.

The Cumberland Plain comprises three broad physiographic units:

- the River Plain, comprising the alluvial flats associated with the Nepean-Hawkesbury River, and the Eastern, South and Ropes Creeks (approximately 11 per cent of the plain);
- the Dissected Plateau, where stream incision into the underlying sandstone has occurred, particularly around the margins of the Plain (approximately 33 per cent of the plain); and
- the Shale Slopes, formed on the Ashfield and Bringelly Shales (approximately 56 per cent of the plain) (Department of Environment and Planning 1984).

The airport site falls within the Shale Slopes unit. The area of the airport site, approximately 1,700 hectares, comprises around 1.2 per cent of this unit. Some characteristics of the Shale Slopes unit include:

- gently undulating, rounded hills and valleys with a low degree of vertical differentiation – this has a consequence that in the more elevated country, the network of ridges and spurlines (also known as interfluves) do not pose a major obstacle to, and have less strategic value in, cross-country movement and control;
- mature landforms;
- deep texture contrast soils which are clayey and stiff;
- surface hydrology characterised by a dendritic pattern of drainage lines;
- native vegetation structures dominated by grassy woodland and open forests; and
- broad area flooding and associated aggradation of sediments across valley floor contexts.

19.3.1.2. The airport site

The landscape of the airport site is typical of the Shale Slopes component of the Cumberland Plain. It has low relief, undulating and low gradient topography, and a medium drainage line density. Ground elevation varies from 43 to 118 metres above Australian Height Datum (AHD). The Bringelly Shale outcrops throughout the area. Surface exposures of Minchinbury Sandstone also occur in isolated locations. A post-Triassic basaltic dyke outcrops along a north-west/south-east alignment in the western half of the airport site. The resistant nature of this rock has formed higher slope gradients and a small area of moderately graded undulating terrain. The steeper slopes contain screes of volcanic gravels.

Small areas of naturally occurring surface silcrete gravels occur across some portions of the airport site. These may constitute a surface lag (ancient remnant gravels from a now fully eroded deposit), or relate to as yet poorly mapped subsurface remnants of ancient weathering.

The mapped soil landscapes within the airport site are Blacktown, Luddenham and South Creek (Bannerman and Hazelton 1990).

Most of the airport site falls within the upper catchment of South Creek, a north draining tributary of the Hawkesbury River with a course length of approximately 64 kilometres and a catchment area of around 620 square kilometres (Rae 2007). The far western portion of the airport site forms part of the immediate catchment of the Nepean River, via the north and west draining minor tributary of Duncans Creek. This watershed is significant in terms of the hydrology of the Cumberland Plain but, for most of its length, provides an unimposing topographic feature as a broad and low gradient ridgeline.

The airport site is dominated by upper catchment terrain, with most of its drainage lines originating from headwaters situated within the airport site and reaching third and fourth order streams. The exceptions are Badgerys Creek along the southern and eastern boundary and Duncans Creek just outside the western site boundary. For the purposes of modelling the potential archaeological resource, these two streams have a fifth order status when they leave the site. It should be noted that stream orders identified in this heritage analysis differ marginally from those in other assessments presented in this EIS. This is a consequence of different disciplinary objectives, and do not indicate errors in fact. The headwaters of Badgerys Creek are situated about three kilometres upstream of the airport site, and its confluence with South Creek occurs approximately four kilometres downstream. The southern and eastern fall of the Badgerys Creek catchment occupies the southern margin of the airport site. Two tributaries of Cosgroves Creek, including Oaky Creek, drain to the north.

The vegetation across most of the Cumberland Plain prior to European land use comprised open eucalypt woodland in which the trees were widely spaced and the ground cover was dominated by grasses (Perry 1963). Most of the original native vegetation has been cleared and the airport site is now dominated by agricultural grasslands or cultivated fields, with scattered eucalypt and exotic trees and pockets of open eucalypt woodland or shrubland. The remaining native vegetation includes pockets of native grassland and mostly regenerating woodland or forest. Older eucalypts, dating from the early twentieth century, may remain as isolated occurrences.

Since the early 1800s, non-Aboriginal land use of the airport site has been primarily agricultural and has consisted of varied phases of stock grazing, cropping, orchards, dairying and market gardening. A pattern of increasingly smaller subdivision commenced in the mid nineteenth century and culminated in the delineation of numerous rural residential lots associated with post war immigration. A broader spectrum of activities characterised the middle and later twentieth century including market gardening, hobby farming, animal husbandry such as poultry farming, horse and dog breeding and training, and some light industrial functions.

All of these activities can be expected to have had a substantial impact on the Aboriginal archaeological resource, especially where resident in the top soil and the plough zone. Vegetation clearance and repeated ploughing and cropping will have removed nearly all trees with the potential for Aboriginal scarring. Artefact occurrences will have been affected by soil loss and lateral and vertical soil movement across the land surface, to the depth of the relevant plough zone.

19.3.1.3. Landform classification of the airport site

The following landform categories have been applied in the mapping and analysis of topographic variables across the airport site. This classification has simplified landscape variations into a concise set of types relevant to the archaeological modelling. The classification system includes large scale independent landform categories and a series of sub-categories – such as riparian corridors or ridge and spur crests – which only occur in conjunction with a large scale landform category (for example, fluvial corridor within a valley floor).

Table 19–1 summarises the proportion of various landforms within the airport site. The landform categories within the airport site are also defined in Appendix M1 in Volume 4, and shown on Figure 3.3 in that appendix.

Table 19–1 – Landform categories within the airport site

Landform category or feature	Area within airport site (hectares)	Net linear distance (kilometres)
Riparian corridor (100 metres either side of drainage line)	711	41.3
Ridge and spur crests	392.3	66.4
Broad scale landforms		
Valley floor	184.0	-
Basal slopes	214.2	-
Mid and upper slopes	1,324.4	-
Total area of 3rd, 4th and 5th order crests	122.5	18.8
Total broad scale landforms within airport site	1,845.1	-

Note: Some of these categories overlap and the area total includes Australian Government owned lands which are non-contiguous with the airport site.

19.3.2. Cultural context

19.3.2.1. Historical context

References to the Aborigines of the Sydney region are found in the journals, diaries and general writings of the early colonists, explorers and settlers.

The location and nature of boundaries between Aboriginal groups in the Sydney region that existed in 1788 are difficult to reconstruct because of the lack of reliable data from that time. A number of authors have variously interpreted the available evidence and drafted maps of the pre-contact and contact territories of Aboriginal people in the Sydney region (Mathews 1901a and 1901b, Capell 1970, Tindale 1974, Eades 1976, Kohen 1986 and 1988, Ross 1988). The identification of tribal boundaries by the early anthropologists, later ethnographers and subsequent linguists have often involved contrasting conclusions, both regarding geographic extent, and whether a distinction relates to a clan, dialect or language (Mathews 1901a and 1901b, Capell 1970, Tindale 1974, Eades 1976, Kohen 1986, Ross 1988).

Since the 1970s, archaeologists and anthropologists working in the Sydney region have adopted the nomenclature for linguistic groups compiled by Capell (1970) and amended by Eades (1976) and Attenbrow (2010). These schemes all place the airport site within the area of the Darug linguistic group. Debate continues whether the use of Darug was exclusively inland or extended in dialect form to the coast on the Sydney Peninsula (Ross 1988, Kohen 1993, Attenbrow 2010).

The Darug peoples bore the first impact of Sydney's European settlement, because their lands were situated on the Sydney peninsula and the adjoining hinterlands of the Cumberland Plain. The peninsula and its embayments became the residential and commercial focus of the settlement, while the fertile lowlands and woodland of the hinterland were developed for agricultural production and the granting of freehold lands. The Cumberland Plain was an integral component of Darug territory and cultural identity, from which they were incrementally excluded and dispossessed by European land-use and occupation.

In the five decades following the establishment of the Sydney Cove colony, the impact of European incursion saw a steep decline in the Darug population, along with loss of economic autonomy, and a break-down in traditional social organisation and practice. Despite this, the Darug and their descendants maintained their local presence and adapted as necessary to survive as a minority in a drastically changed cultural and social landscape.

Aboriginal people were granted small portions of land in some parts of the Sydney region; however, no references have been found to grants at or within the vicinity of the airport site (Kohen 1993). In fact, by 1821 all of the airport site had been the subject of European land grants, with a majority of the area falling within a 6,710-acre grant made to John Blaxland in 1813 (Robinson 1953). This pattern of land alienation was repeated across most of the Darug lands. The establishment of European ownership imposed a cumulative sequence of constraints on traditional Aboriginal land use. The effect, over the course of a relatively short period of time, was to severely limit access to traditional food and habitation sites and to disrupt the normal seasonal round of movement which formed part of social and territorial life. As a consequence, the Sydney Aborigines displaced by European settlement became increasingly dependent on European food sources, estates to live on, and employment.

Darug people are known to have lived on nearby estates, such as at 'Mamre Farm', Orchard Hills, and at Mulgoa (Martin 1988, Keating 1996). Closer to the airport site, oral history recounts how Aboriginal people were living on the Badgery Estate 'Exeter Farm' in the mid nineteenth century (AHIMS site card 45-5-215 27 Jan 1978). Darug descendants continued to have an association with Badgerys Creek into the twentieth century, with families resident in the local district (pers. comm. Ms Sharyn Halls 24 April 2015) and as part of rabbiting expeditions into the 1960s (letter from Colin Gale (DTAC) to Kerry Navin 17 Feb 1997). Further detail regarding early post-European Aboriginal history is provided in Appendix M1 in Volume 4.

19.3.2.2. Archaeological context

The Sydney region has been the subject of detailed archaeological survey and assessment since the passing of legislation protecting Aboriginal sites in 1974. The focus of this assessment has shifted in the last two decades to Western Sydney, and in particular to the new urban and industrial developments across the Cumberland Plain. This research has resulted in thousands of site recordings and a wide range of site types and features. The most prevalent recordings comprise surface occurrences of stone artefacts (ranging from single items to hundreds of artefacts), shell middens, rock shelters containing occupation evidence (including deposits and rock art), grinding groove sites, and open context engraving sites. Rare site types include culturally modified trees, quarry and procurement sites, burials, stone arrangements, and traditional story or other ceremonial places.

Hundreds of Aboriginal sites, predominantly open artefact scatters (also referred to as open camp sites), have been recorded within the Cumberland Plain. The campsites vary greatly in size from small sparse scatters to large concentrations of artefacts. Rare site types that have been recorded include scarred trees, raw material extraction/procurement sites, stratified deposits and grinding groove sites. Unlike the majority of grinding groove sites across the Sydney Basin, which occur on Hawkesbury sandstone, the few recordings on the Cumberland Plain occur on Minchinbury sandstone making them a rare site type on the Cumberland Plain.

The picture of Aboriginal utilisation and occupation of the Cumberland Plain is constantly being revised and refined as archaeological methods improve and more archaeological data become available.

Recent investigations have confirmed that sites occur widely across the landscape, particularly on hilltops and slopes and near creeks. Larger sites with higher artefact densities are more likely to be near permanent water (Haglund 1980, Kohen 1986, Smith 1989a and 1989b, Kohen 1996, McDonald and Rich 1993, Rich and McDonald 1995, Comber 2014). Recent excavations on the Cumberland Plain have also demonstrated that surface sites are generally an inaccurate representation of subsurface deposits (McDonald and Rich 1993, Rich and McDonald and Rich 1995, Comber 2014). Subsurface deposits have been found to be present even when there has been no surface indication of a site.

19.3.3. Previously recorded sites at the airport site

The airport site has been the subject of a number of previous archaeological assessments as part of investigations into the potential location for a second Sydney airport. A comprehensive review of these previous assessments is provided in Appendix M1 in Volume 4. A review of the recordings generated by these investigations revealed two sites that had been erroneously plotted within the airport site. A modified tree (site B8, AHIMS site no. 45-5-2634) was found to be situated to the south of Badgerys Creek, and a site recording situated approximately five kilometres to the east, near the Eastern Gas Pipeline, was also mis-plotted (site EG6, AHIMS site no. 45-5-2562). Fifty-one confirmed Aboriginal heritage sites have been recorded within the airport site as a result of previous heritage assessments. These consist of surface artefact occurrences and a modified tree. None of the sites are registered on Commonwealth or National Heritage Lists, but all are registered on the AHIMS. It should be noted that, at the time of the assessment, the AHIMS listed 52 Aboriginal recordings within the airport site. This total does not account for the site corrections noted above. The general location of the sites is shown in Figure 19–2.

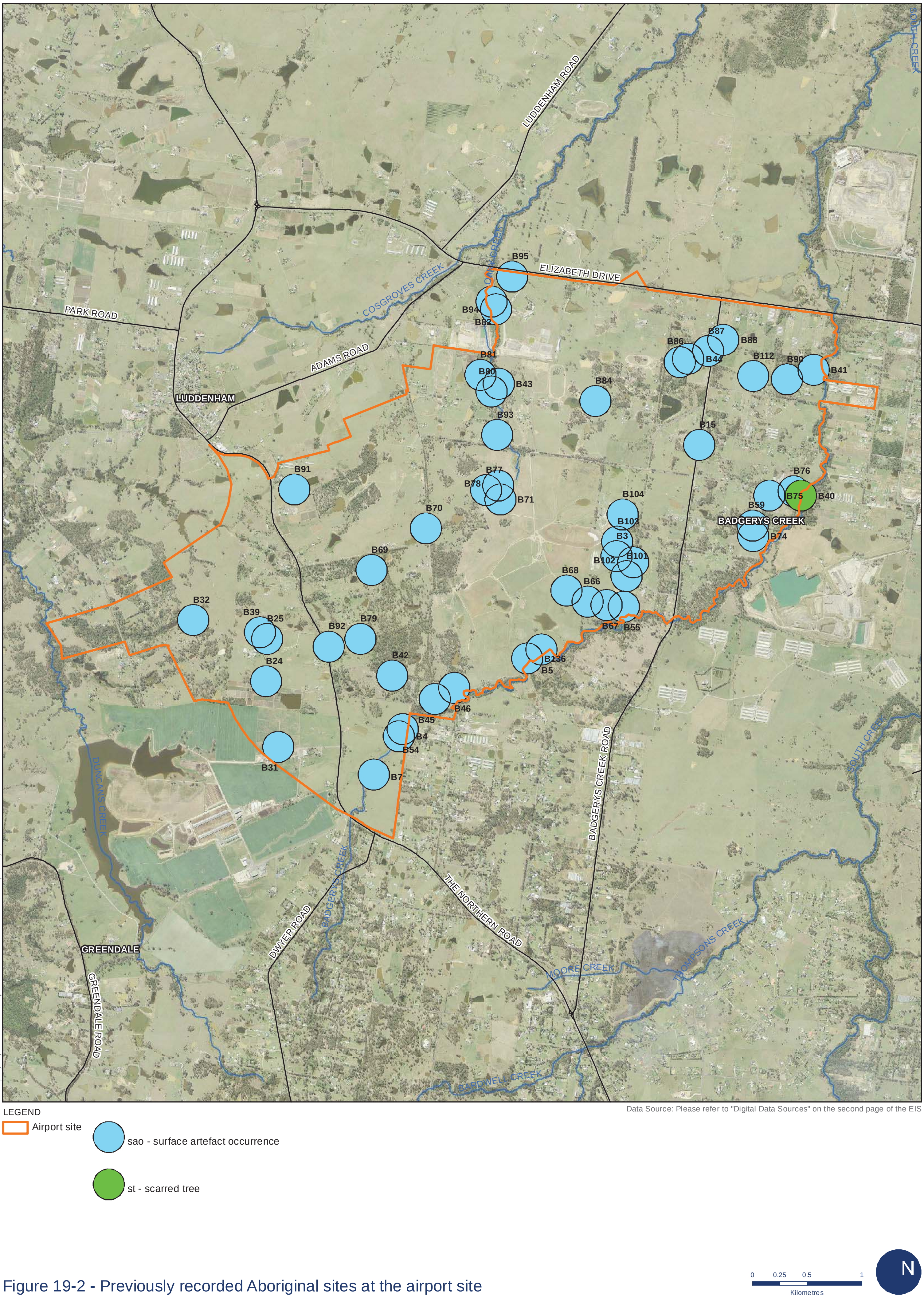


Figure 19-2 - Previously recorded Aboriginal sites at the airport site

19.3.4. Results of current field surveys

Twenty-three new recordings of Aboriginal heritage sites were recorded during the course of the field investigations for the current assessment. These comprised:

- nine recordings with surface artefacts only, including one grinding groove site (B113 to B120 and B122); and
- 14 recordings where subsurface artefacts were confirmed through test excavation (B121, B123 to B135).

Within the latter category, one site also included surface artefacts (B121 at Test Location 9).

A summary of the site recordings is provided in Table 19–2. The locations of all site recordings to date at the airport site are shown in Figure 19–3.

Table 19–2 – Summary of Aboriginal heritage sites recorded at the airport site during field investigations

Site number/type	Number of surface stone artefacts recorded	Test location and test pit numbers	Type of ground surface exposure
B113 - Surface artefact occurrence	20	-	Eroded track and dam wall
B114 – Surface artefact occurrence	10	-	Eroded track, creek edge
B115 – Surface artefact occurrence	20	-	Erosion and disturbance
B116 – Surface artefact occurrence	2	-	Track
B117 - Surface artefact occurrence	2	-	Erosion scald
B118 – Surface artefact occurrence	2	-	Edge of ploughed field
B119 - Surface artefact occurrence	2	-	Gate exposure
B120 – Grinding grooves	at least 4 grooves	-	Sandstone outcrop
B121 – Surface and subsurface artefact occurrence	3	TL9, test pits 2-10	Track/gate exposure
B122 - Surface artefact occurrence	1	-	Dam wall
B123 - Subsurface artefact occurrence	-	TL6, test pits1-4	-
B124 - Subsurface artefact occurrence	-	TL6, test pits 9, 10	-
B125 - Subsurface artefact occurrence	-	TL8/10, test pits 3, 4	-
B126 - Subsurface artefact occurrence	-	TL8/10, test pits 7, 9	-
B127 - Subsurface artefact occurrence	-	TL13, test pit 3	-
B128 - Subsurface artefact occurrence	-	TL14, test pits 1, 3	-
B129 - Subsurface artefact occurrence	-	TL14, test pit 8	-
B130 - Subsurface artefact occurrence	-	TL23, test pit 9	-
B131 - Subsurface artefact occurrence	-	TL26/27, test pit 11	-
B132 - Subsurface artefact occurrence	-	TL32, test pits 3,4	-

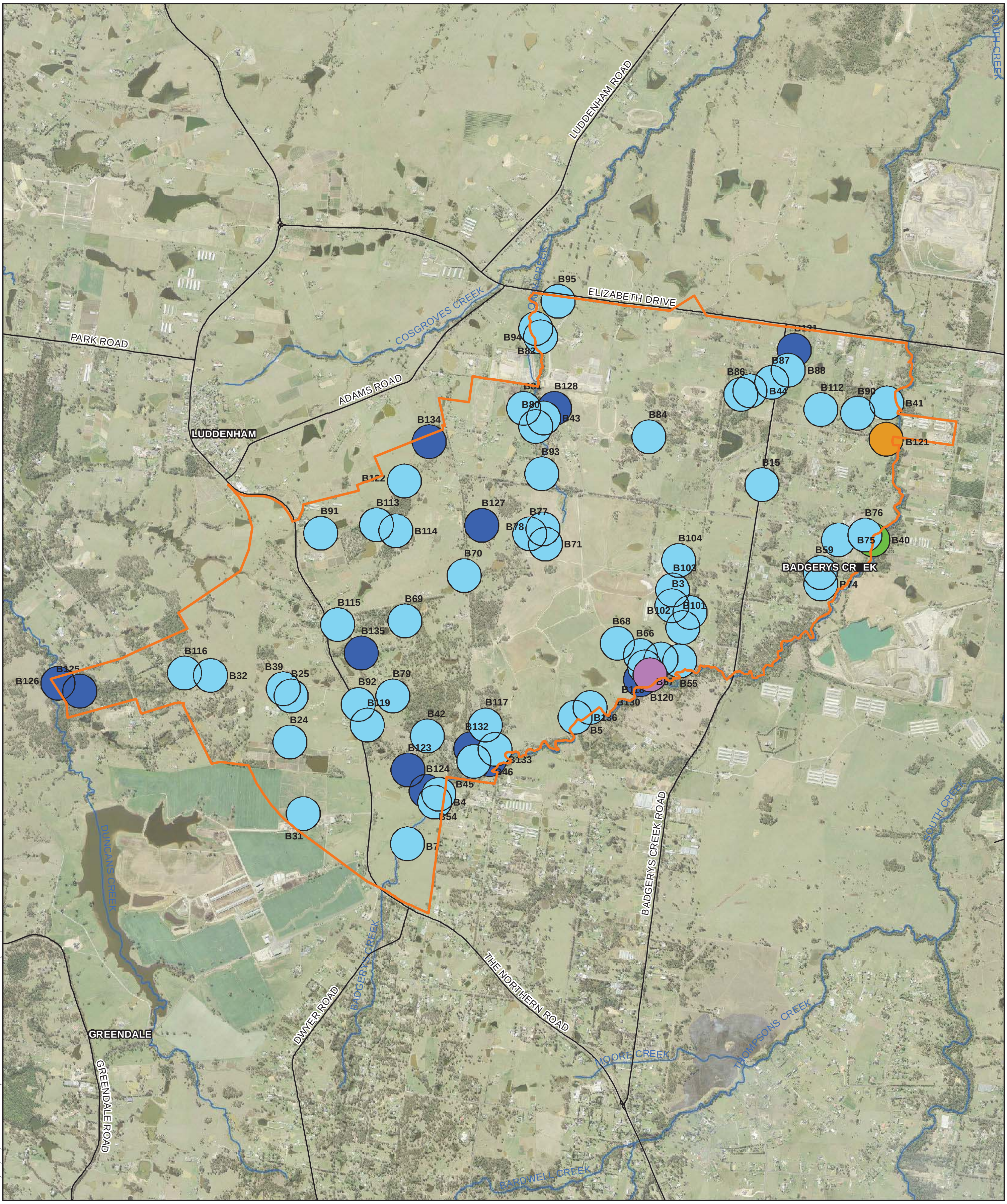
Site number/type		Number of surface stone artefacts recorded	Test location and test pit numbers	Type of ground surface exposure
B133 -	Subsurface artefact occurrence	-	TL32, test pits 9, 10	-
B134 -	Subsurface artefact occurrence	-	TL37, test pits 1,2,4, 5	-
B135 -	Subsurface artefact occurrence	-	TL4, test pit 5	-

19.3.4.1. Surface recordings

Details of the nine surface sites recorded during the field surveys are provided in Table 19–3.

Three sites previously recorded were re-inspected to confirm the findings of the previous assessments. The results of these inspections are as follows:

- **B8, Possible Aboriginal Scarred Tree, AHIMS 45-5-2634**. This site was found to be located outside of the airport site and will not be affected by the construction or operation of the proposed airport. It was, therefore, not considered further in the assessment;
- **B40, Possible Aboriginal Scarred Tree, AHIMS 45-5-2630**. This site was noted in previous assessments at the airport site to have significant damage. The site was re-inspected and it was found that the condition of the scar was poor, as was that of the tree, which had a hollow trunk and a missing crown. Despite the poor condition of the heartwood and the un-occulated scar, the regrowth around the margin of the scar appeared to be intact. This means that the tree retains a tree-ring record of regrowth following the scarring event; and
- **B136, Surface Artefact Occurrence**. This site was originally recorded as a single surface artefact by Australian Museum Consulting (AMC) in 2014 and ascribed to the previously recorded site B5 (AHIMS 45-5-2637). Following a refinement of the 1997 grid reference for B5, based on original recording data, it has been determined that the AMC find is located more than 100 metres from the original B5 recording. As a consequence, this is considered to be a new recording of a separate site and has been designated as B136.



LEGEND

Airport site

gg - grinding groove

sao + ssao - surface and subsurface artefact occurrence

st - scarred tree

sao - surface artefact occurrence

ssao - subsurface artefact occurrence

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

N:\AU\Sydney\Projects\21\24265\GIS\Maps\Deliverables\KBMNEWTEMPLATE.mxd [KBM: 83]

0 0.25 0.5 1
Kilometres

Figure 19-3 - Total Aboriginal sites recorded at the airport site, to date

Table 19–3 – Details of surface recordings

Site number/type	Description	Artefacts
B113 – Surface artefact occurrence	• Open context artefact occurrence of at least 20 surface artefacts exposed along an eroded vehicle track and dam wall. • Artefacts situated on a low gradient minor (first order) spurline, and low rise, situated between and just upstream of the confluence of two second order streamlines (tributaries of Cosgroves Creek). • Situated in a basal slope valley context. • Artefacts located over an area of approximately 150 x 30 metres. • Subsurface archaeological potential away from exposures and eroded surfaces assessed to be high.	Chert flakes, silcrete flakes, quartz flake and possible axe
B114 – Surface artefact occurrence	• Open context artefact occurrence of at least ten surface artefacts exposed along an eroded track and creek edge. Artefacts situated on low gradient slopes adjacent to, and the western banks of, a secondary order streamline (a tributary of Cosgroves Creek). • Situated in a basal slope valley context. • Artefacts located over an area of approximately 110 x 20 metres. • Subsurface archaeological potential away from exposures and eroded surfaces assessed to be high.	Chert and silcrete flakes
B115 – Surface artefact occurrence	• Open context artefact occurrence of at least 20 artefacts exposed within a disturbed area in a former church yard. • Artefacts situated on the crest of a prominent fourth order ridgeline, where it intersects with a major watershed fifth order ridgeline. • Artefacts located over an area of approximately five by five metres. • Subsurface archaeological potential away from exposures and disturbed ground is assessed to be high.	Quartz flakes
B116 – Surface artefact occurrence	• Open context artefact occurrence of at least two artefacts exposed on an eroded vehicle track which steeply traverses low to moderately graded mid slopes on the side of a spurline. • Site situated upslope of a dam which impounds a second order streamline (tributary of Duncans Creek). • Artefacts located approximately five metres apart. Subsurface archaeological potential away from exposures and eroded surfaces is assessed to be low.	Quartz flake, chert flakes
B117 – Surface artefact occurrence	• Open context artefact scatter of at least three surface artefacts exposed in erosion scalds along a low gradient crest of a first order spurline. • Exposures situated along the edge of a group of trees. • Spurline crest faces south and descends to a narrow portion of the Badgerys Creek valley floor. • Site is situated in a mid-slope valley context • Artefacts located approximately eight metres apart. Subsurface archaeological potential away from exposures and eroded surfaces is assessed to be high.	Basalt flake, basalt hammerstone, silcrete flake

Site number/type	Description	Artefacts
B118 – Surface artefact occurrence	• Open context artefact occurrence of at least two surface artefacts exposed on a recently ploughed track on the southern edge of a ploughed field. • Site is situated just above the break-of-slope of a broad crest of a third order ridgeline, approximately 150 metres north of Badgerys Creek. • Artefacts located approximately one metre apart. • Subsurface archaeological potential is assessed to be moderate, although repeated ploughing of this landform may have significantly disturbed the vertical context of subsurface artefacts.	Quartz flakes
B119 – Surface artefact occurrence	• Open context artefact occurrence of at least two artefacts exposed in a scoured area on the eastern side of a gate situated between a house paddock and the paddock behind (to the east). • Artefacts situated on a first order spurline located between, and just upstream of, the confluence of a third and a second order streamline (tributaries of Badgerys Creek). • Site situated in a basal slope valley context. • Subsurface archaeological potential away from exposures and eroded surfaces is assessed to be moderate to high.	Chert flake
B120 – Grinding grooves	• Four grinding grooves located on a series of small sandstone outcrops situated on, and just below, the break-of-slope of a mid-valley context ridge-side bench. • Bench is relatively narrow (around 40 metres wide), faces south, and extends for approximately 400 metres along the middle portion of a third order ridgeline which rises 26 metres above the creek. • Grinding grooves are located on a discontinuous and low surface outcrop of Minchinbury sandstone which is mostly exposed on the steep slope immediately downslope of the bench. • Grooves are located on three separate sandstone outcrops, two with one definite groove each and the (western most) third with two definite and two probable grooves. • Sandstone outcrops form part of an east–west aligned group of low, near ground level outcrops, and extend across a distance of 33 metres. • Located in Test Location 23. No subsurface artefacts were detected on the bench. One stone artefact was detected at this test location, and this was situated on basal slopes 4.5 metres above Badgerys Creek (site B130).	
B121 – Surface and subsurface artefact occurrence	• Open context artefact occurrence of at least two surface artefacts. • Site located on alluvial flats adjacent to Badgerys Creek, in a valley floor context. • Artefacts, approximately five metres apart, visible in erosion scalds in a road reserve at the eastern end of Pitt Street.	Silcrete flakes
B122 – Surface artefact occurrence	• Open context artefact occurrence of a single surface artefact exposed on the wall of an agricultural dam which impounds a third order streamline (tributary of Cosgroves Creek). • Site situated in a valley floor context, and in relative proximity to the natural course of the creek line. • Subsurface archaeological potential away from the disturbed ground of the dam wall and impoundment is assessed to be moderate to high.	Silcrete flake

19.3.4.2. Subsurface recordings

Aboriginal artefacts were recovered from 10 of the 11 test locations. A total of 91 artefacts were recovered from the 39 test pits. A summary of the test location artefact numbers is provided in Table 19–4.

Table 19–4 – Summary of artefact recovery data from test locations

Test location	Number of artefacts	Broad scale landform	Fine scale landform
1	0	Major watershed ridgeline	Crest/upper slope
4	1	Secondary watershed ridgeline	Crest
6	10	Mid slope, basal slope, valley floor	Minor spur crest, slope, alluvial flats
8/10	4	Mid slope, basal slope, valley floor	Minor spur crest, alluvial flats
9	36	Basal slope, valley floor	Slope, alluvial flats
13	1	Secondary spurline crest	Knoll, crest, shoulder
14	8	Mid slope, basal slope, valley floor	Minor spur crest, elevated rise
23	1	Upper slope, mid slope, basal slope	Break-of-slope, slope, minor spur crest, fan
26/27	17	Floor, valley floor, basal slope, upper slope	Alluvial flats, slope
32	7	Mid slope, basal slope, valley floor	Minor spur crest, alluvial flats, alluvial terrace
37	6	Valley floor, basal slope	Elevated rise/terrace, minor spur crest

19.3.4.3. Artefact analysis

A detailed analysis of the stone artefacts recovered during the test pit excavations is presented in Appendix M1 in Volume 4. The conclusions of the analysis are summarised below.

- Subsurface artefacts were unevenly distributed between the different excavated areas, with the majority of areas yielding relatively few artefacts, and a small number of the excavated areas being relatively rich.
- Assemblages from all excavated areas were dominated by silcrete over other raw materials and by unretouched flakes over other artefact types.
- Retouched artefacts make up 12 per cent of the combined artefact assemblage, with the majority of these being backed artefacts.
- The majority of flakes in the combined assemblage have little or no dorsal cortex. Flakes are generally small in size, with a diverse variety of platform types. It is inferred from this that the flake assemblage was produced from small parent rocks, which had been heavily reduced in size and were being exploited as a valuable resource.
- There is no evidence that the production of flakes within the study area was geared toward the preferential production of any particular flake morphology.

The analysis of landform variables relative to the tested subsurface archaeological resource provided the following findings:

- subsurface artefact density is unevenly distributed between landform categories, with valley floors and alluvial flats having significantly higher artefact densities than other landforms;
- subsurface artefact density is significantly higher in lower valley contexts than it is in middle and upper valley contexts;
- subsurface artefact density is positively correlated with the order of the closest drainage line, and with the order of the largest drainage line within 100 metres;
- subsurface artefact density is inversely correlated with elevation, with lower lying areas having higher densities of subsurface artefacts. These areas are also associated with higher order drainage lines;
- subsurface artefact density is inversely correlated with watershed spurline order, with areas associated with lower spurline orders having higher artefact densities. Low order spurlines are generally associated with higher order drainage lines; and
- as a general inference from multiple lines of data, subsurface artefacts are associated with areas likely to have had easier access to sources of water.

19.3.4.4. Archaeological sensitivity of the airport site

The average areal incidence (artefacts per square metre) of subsurface artefacts according to key landform units was found to provide an effective means of gauging archaeological sensitivity across the airport site. Landforms with a relatively high average artefact incidence (defined to be equal to or greater than one artefact per square metre) at the airport site are:

- valley floor;
- basal slopes;
- first order spurlines;
- within 100 metres of a second order streamline;
- within 100 metres of a third order streamline; and
- within 100 metres of a fourth order streamline.

Refer to Section 19.3.1 for further detail on these landform units.

19.3.5. Consultation

This section presents the results of the stakeholder consultation undertaken for the current assessment.

19.3.5.1. Aboriginal cultural values

The Aboriginal stakeholders consulted for this assessment have identified the airport site as a place of Aboriginal cultural significance and continuing cultural connection. The reasons for this include:

- **Material evidence of occupation**. The presence of archaeological sites throughout the airport site is a manifest link with their ancestors, with a past way of life and with a continuing cultural association with the land. Archaeological sites are a tangible component of cultural identity and traditional ownership. In this regard, it is also pointed out that all archaeological sites have cultural significance, regardless of their size, complexity or archaeological interpretation. The relationship between the position of an artefact and its surrounding landscape also has cultural significance. This is often expressed by stakeholders when they specify that after analysis, salvaged artefacts should be returned to 'their country'.
- **Cultural landscape values**. Although information relating to remembered traditional events in specific places has not been provided, many stakeholders state that the airport site landscape has cultural significance according to traditional lore. A number of landscape features, including prominent ridgelines, and the Badgerys Creek corridor, can be interpreted with reference to traditional knowledge held by various custodians. Many stakeholders expressed the view that there would have been areas and features that would have held special significance, including relationships to stories and law associated with gender roles.
- **Significant plants, animals and resources**. The continuing presence of native animals and plants, and the habitat they require, is considered to be an important part of the cultural significance of the airport site. These are important as traditional sources of food, medicine and raw materials, and for the specific stories and lore associated with them. Some stated examples of significant resources were yams, fresh water mussel, possums, tree timber and bark, and the water from Badgerys Creek. Areas of remnant native vegetation and the riparian corridors of the main creek lines were specifically referenced in this regard.
- **Educational value**. Many stakeholders made reference to the need to educate young people about their culture, lore and traditions. The conservation of Aboriginal sites so that they can be accessed for teaching and interpretation is considered to be an important part of maintaining cultural identify, practice and continuity. The educational values of the Badgerys Creek sites in general, and of the grinding groove site (B120) and the scarred tree (B40) in particular, were recognised by many stakeholders. Similarly, the remnant natural vegetation and riparian corridors across the study area were seen as important educational resources.

- **A disappearing heritage**. A repeated concern expressed by stakeholders was the cumulative impact on Aboriginal sites caused by the continuing urban and industrial development of Sydney across the Cumberland Plain. Given the loss of sites to date, the remaining sites, such as those at the airport site, are now recognised to have cultural value because of their increasing rarity, the need to retain artefacts and sites in their natural landscapes and original locations, and their ability to support the relationship with the land and the sense of cultural identity.

The Aboriginal stakeholders were consistent in acknowledging the importance of information gained from archaeological recording and analysis. Examples given include the evidence of radiocarbon dating, and the ability to identify past patterns of behaviour, occupation, adaptation, and technological and social change. Archaeological information is seen as complementary to remembered tradition and lore, and evidence from historical records.

While the value of the archaeological method, and the information it generates, is recognised as clearly distinct from Aboriginal cultural evaluation, it is also acknowledged by Aboriginal stakeholders that the potential of a site or an archaeological deposit to provide information about the past has high Aboriginal cultural value.

19.3.5.2. Non-Aboriginal stakeholder views

Liverpool City Council and the NSW OEH recommended the following issues be considered in the Aboriginal cultural assessment:

- cultural landscape and recording of social history;
- cumulative impacts;
- managing artefacts which would remain on-site during the proposed development of the airport site; and
- potential provision of a keeping place and alternative forms of cultural interpretation.

Further details regarding the issues raised during consultation are included in Appendix M1 in Volume 4.

19.3.6. Assessments of significance

Assessments of significance were undertaken with reference to the Burra Charter and in accordance with the Commonwealth Heritage List criteria established under the EPBC Act. The results of the assessments of significance are summarised below, with further detail provided in Appendix M1 in Volume 4.

Given the finding that Commonwealth heritage values occur within the airport site, the Commonwealth would need to consider the Commonwealth heritage provisions of the EPBC Act in developing its strategy for managing heritage as part of the development of the proposed airport.

19.3.6.1. Individual site assessments

An assessment of significance was undertaken for each site recording against the Commonwealth Heritage List criteria, as discussed in Section 19.2.4.

Artefact occurrences comprise 72 of the 74 recorded sites at the airport site. Fifteen of these include confirmed subsurface archaeological deposits and 48 have been assessed as having moderate or high subsurface archaeological potential.

Thirty-five of these recordings (49 per cent of artefact occurrences) comprise a single artefact and nine recordings include more than 10 artefacts. The highest number of artefacts recorded is 64, from the 2014 surface reinspection of site B80 by AMC (AMC 2014). The next highest is 38 from site B121, of which 36 were recovered from test pits. Based on the maximum artefact count across the various inspections and tests at each site, there are 371 stone artefacts associated with the recorded sites within the airport site.

Fifty-one of the artefact recordings are assessed as having significance because of their potential to yield information that will contribute to an understanding of Australia's cultural history (criterion c from the Commonwealth Heritage List). All are considered significant because of a strong association with cultural group for social, cultural or spiritual reasons (criterion g), and because of their importance as part of indigenous tradition (criterion i).

There is one recording of a scarred tree at the airport site (B40) which has been assessed as being of possible Aboriginal origin. Although the condition of the tree and the scar is poor, the tree retains a tree-ring record of regrowth following the scarring event, and is considered significant in accordance with a number of Commonwealth heritage list criteria. Scarred trees are relatively rare on the Cumberland Plain and represent strong cultural associations and connection with indigenous tradition. Despite the poor condition of the tree and scar, it is still considered to have potential to yield information that will contribute to the understanding of Australia's culture. The scarred tree is therefore considered to have significance according to criteria b, c, g and i.

There is one recording of a grinding groove site at the airport site (B120). This site consists of at least four grinding grooves on a series of small sandstone outcrops on the edge of a hill side bench, 14 metres above, and around 100 metres from Badgerys Creek. The site is a rare example of grinding grooves located on Minchinbury sandstone within the Cumberland Plain and has significance across five assessment criteria: b, c, d, g and i.

An assessment of each site is provided in Table 8.1 in Appendix M1 in Volume 4.

19.3.6.2. The archaeologically sensitive landscape

The results of the test excavation programme, in combination with the surface survey results, have confirmed an interrelated distribution of archaeological sensitivity which is graded and distributed according to key landform variables. Key factors in combination are proximity to water, the order (here used as an approximation of size and degree of permanence) of the water source, locally elevated ground and first order spurlines within valley floor and basal slope contexts, low gradients and aggrading depositional contexts.

Landforms and zones in which relatively higher subsurface artefact incidences have been detected (defined in this study as one or more artefacts per square metre) comprise just under half (48 per cent) of the airport site. The highest average subsurface artefact incidence was 3.1 artefacts per square metre, from select topographic contexts on the valley floor. The valley floor accounts for 10 per cent of the airport site.

Highest potential artefact occurrences on the valley floor are predicted to occur within 100 metres of third, fourth and fifth order streamlines. These fluvial corridors account for 17 per cent of the airport site (approximately 316 hectares), and occur roughly equally across the valley floor and basal slope landform categories. The latter two categories also contain the greatest potential for subsurface archaeological deposits, and for potentially rare and higher value archaeological deposits.

A total of 280 stone artefacts have been recorded from the surface of the airport site. The predicted assemblage of subsurface artefacts within the landforms with relatively high artefact incidence would far exceed this number. The predicted archaeological resource within the identified sensitive archaeological landscape must, therefore, be a foundation component of any assessment of the cultural heritage values within the airport site.

The predicted Aboriginal archaeological resource of the airport site is assessed as having significance according to criteria b, c, g and i under the Commonwealth Heritage List. These are discussed below.

Criterion b – Significance because of uncommon, rare or endangered aspects of Australia’s cultural history.

The predicted and collective subsurface archaeological resource present across the airport site is not considered to be outstanding in terms of artefact incidence or the technological diversity of the sampled assemblages. The content and variability of the analysed artefact assemblage remains consistent with the predictive model for the Cumberland Plain, and the resource can generally be regarded as characteristic of archaeological material from upper catchment and watershed regions of the Cumberland Plain.

The planned and continuing urban development of the Cumberland Plain will further affect the upper catchment landscapes that include the airport site. As the proportion of undeveloped land increases, this cumulative impact is expected to confer an increasing degree of rarity to the remaining archaeological record. Based on this outline, the predicted archaeological resource of the airport site is assessed as an endangered aspect of Aboriginal cultural history, and significant according to this criterion.

Criterion c – Significance because of potential to yield information that will contribute to an understanding of Australia's cultural history.

The predicted archaeological resource within the airport site has considerable potential to yield information that will contribute to an understanding of the Aboriginal cultural history of the Sydney Basin. Based on the evidence of the sampled archaeological deposits, the airport site provides a potential opportunity to conduct systematic archaeological research on a representative sample of sites within an upper catchment landscape. This resource, and the opportunity to investigate it as a whole, will become increasingly limited in the future. Such research would complement previously conducted large area archaeological investigations that have typically occurred in lower catchment landscapes, and in association with higher order drainage lines.

The distribution of aggrading landforms across the valley floor and basal slopes, and at a lesser and finer scale across the remainder of the airport site, provides potential for encountering rarer sites, such as cultural deposits associated with buried former land surfaces. Although this potential is considered to be highly limited and difficult to quantify using stage one test excavation methodologies, a review of geotechnical borehole data indicates scope for addressing this potential in future studies (refer to Appendix M1 for further detail).

Criterion g – Significance because of a strong or special association with a cultural group for social, cultural or spiritual reasons.

Based on statements made consistently by all stakeholders, the remaining Aboriginal archaeological record across the airport site has a strong association with persons who identify as Darug, or as Darug descendants. This association is expressed both in terms of cultural identity and a spiritual dimension. The latter may relate to the memory or 'presence' of Darug ancestors, and a belief that artefacts 'belong to', and should remain in, the 'country' where their makers and users left them. The presence of artefacts within the soil matrix, and as a part of the landscape itself, is often referenced as evidence of traditional ownership and a cultural relationship with country. Aboriginal stakeholders frequently state that all archaeological sites, ranging from single artefacts to large assemblages, are considered to have cultural significance in this way.

Criterion i – Significance because of a place's importance as part of indigenous tradition.

Based on statements by Darug stakeholders, all Aboriginal sites within the airport site, including those not yet detected (the predicted archaeological resource) are important to a wider regional tradition that remembers and celebrates the Darug relationship with their land. This relationship is described both in terms of a long history (thousands of years), and as a continuing living tradition. The Macquarie Dictionary defines 'tradition' to be 'the handing down of statements, beliefs, legends, customs, etc., from generation to generation, especially by word of mouth or by practice (Butler 1988:1798). The Aboriginal sites on the airport site are an integral part of a cultural landscape which acts as the foundation for this remembrance.

19.4. Assessment of impacts during construction

Construction of the proposed Stage 1 development would affect at least 39 Aboriginal sites, as listed in Table 19–5. All of these sites contain artefact occurrences.

Table 19–5 – Aboriginal heritage sites directly affected by construction of the Stage 1 development

Development area	Affected surface sites	Total
North and west of proposed boundary fence and earthworks boundary	B24, B25, B32, B39, B43, B44, B69, B70, B71, B77, B78, B79, B80, B81, B82, B84, B86, B87, B88, B91, B92, B94, B95, B112, B113, B114, B115, B116, B119, B122, B127, B128, B129, B131, B134	35
Detention ponds south and east of the proposed boundary fence and earthworks boundary	B5, B101, B102 and B136	4
Drainage swales between earthworks boundary and detention ponds	Subject to design	To be confirmed
Total		At least 39

With regard to the predicted subsurface archaeological resource, construction of the proposed Stage 1 development would directly affect approximately 501 hectares of archaeologically sensitive landform. This constitutes about 27 per cent of the airport site. These landform categories, and their affected proportions, are presented in Table 19–6.

The Stage 1 development would directly affect all of the archaeologically sensitive landforms associated with the airport sites three north flowing, third and fourth order tributary drainage lines. A portion of the riparian corridor within the airport site along Badgerys Creek would be protected within an environmental conservation zone. The archaeological resource within this zone would also be protected by this zoning.

All of the higher relief and prominent topography of the airport site would be transformed into a level and graded platform. This would alter and remove the natural topography that acts as a medium for Aboriginal people to ‘read’ and experience the Aboriginal cultural values of the land.

Table 19–6 – Area and proportion of archaeologically sensitive landforms directly affected by the construction of the Stage 1 development

Landform category or feature[1]	Area within Stage 1 construction impact zone (hectares)	Proportion of airport site	Total of this landform category within whole of airport site (hectares)	Proportion of total landform area within airport site (1,845 ha)[2]
Riparian corridor (100 metres either side of drainage line)	257.5	14%	369.6	20%
Ridge and spur crests	68.7	3.7%	120.3	6.5%
Broad scale landforms				
Valley floor	47.8	2.6%	184.0	10.0%
Basal slopes	127.5	6.9%	214.2	11.6%
Total	501.5	27.2%	888.1	48.1%

Note. 1. These are mutually exclusive categories. The area of fluvial corridors and crests which overlap valley floor or basal slope topography have not been separately tabulated.

2. This area total includes Australian Government owned lands which are non-contiguous with the airport site.

19.5. Assessment of impacts during operation

Impacts during operation of the proposed airport during Stage 1 would be limited to indirect impacts on adjacent and nearby sites. All known sites within approximately 500 metres of the construction impact zone of the Stage 1 development consist of artefact occurrences. The heritage values of sites of this type, unless valued for their public interpretation or visitation based on Aboriginal cultural reasons, are unlikely to be vulnerable to indirect impacts such as loss of context. Consequently, the operational impacts of the Stage 1 development would be low.

19.6. Greater Blue Mountains World Heritage Area

The Aboriginal cultural heritage values of the Greater Blue Mountains World Heritage Area are not included within the area's currently registered world heritage values. They do, however, complement the world heritage area's listed biological values. There is little potential for the proposed airport to directly affect the Aboriginal cultural heritage values of the Greater Blue Mountains Area. Indirect impacts on values potentially include those associated with the temporary loss of contextual value from the periodic intrusion of low level aircraft noise or from aircraft arriving at or departing from the proposed airport. These impacts could potentially affect the experience of those visiting sites, such as rock shelters and open sites, where there is an expectation or requirement for a quiet and natural surrounding environment. Aboriginal sites within this category could include publicly accessible sites, sites at which traditional Aboriginal activities are performed, and sites within wilderness zones. A limited number of sites have been developed or interpreted for public visitation in the Blue Mountains National Park, including Shaws Creek K1, Burralow, Red Hands Cave, Campfire Creek, Kings Tableland, Lyre Bird Dell and Asgard Swamp (DECC 2009c; Attenbrow 2010).

Wilderness zones form part of the current management zoning in the Greater Blue Mountains Area and incorporate objectives such as the conservation of 'pre-European' landscapes with minimal historical and European intrusion, including aircraft noise and vapour trails (DECC 2009c).

Based on the above discussion, any potential impacts from the proposed airport that may affect Aboriginal cultural heritage values of the Greater Blue Mountains Area would be indirect in nature and would likely relate to low levels of aircraft noise and visual intrusion from aircraft.

Impacts on the Greater Blue Mountains World Heritage Area are assessed in detail in Chapter 25 (Greater Blue Mountains World Heritage Area) in Volume 2.

19.7. Mitigation and management measures

Mitigation and management measures proposed to minimise the impacts on Aboriginal cultural heritage values are listed in Table 19–7. These measures would be incorporated into an Aboriginal heritage management plan as part of the environmental management plans for construction and operation of the proposed airport.

Table 19–7 – Mitigation and management measures

ID	Issue	Mitigation/management measure	Timing
19.1	Cultural heritage management plan	A cultural heritage management plan would be developed prior to construction of the proposed airport as part of the construction environmental management framework. The plan would collate measures to mitigate and manage potential impacts on Aboriginal cultural heritage values.	Pre-construction
19.2	Conservation of heritage sites	The scarred tree (B40) and the grinding groove site (B120) would be conserved in situ within an environmental conservation zone at the airport site, and outside any future airport site boundary fence. A low barrier fence, which does not obstruct pedestrian traffic, would be erected around specific heritage sites as is necessary to demarcate the area as a no-go zone for vehicles. The barrier would be situated so that it did not intrude upon the immediate visual and landscape quality of the heritage sites and their surrounds.	Pre-construction
19.3		The environmental conservation zone would be managed with the conservation of known and predicted Aboriginal heritage sites as one of the principal objectives.	Construction Operation
19.4		Develop a conservation management plan that defines the future care and management of Aboriginal sites situated within the environmental conservation zone(s) identified in the Airport Plan, in particular the scarred tree (B40) and the grinding groove (B120) site. The management plan would consider future public interpretation and access to sites, as appropriate.	Pre-construction
19.5	Mitigation and management of heritage sites	Develop and adopt an Aboriginal stakeholder consultation plan that specifies the nature and frequency of consultation throughout the design and construction phase of the airport. The aims of the consultation would be to: • inform on, and provide an opportunity for feedback regarding, all matters relating to the mitigation and management of Aboriginal cultural heritage values across the airport site; • provide a forum for organising future stakeholder participation in mitigation and management works; and • provide opportunities to comment on all policy and documentation drafted in regard to the mitigation and management of Aboriginal cultural values.	Pre-construction
19.6		Provide an opportunity for Aboriginal stakeholders to participate in field actions involving the mitigation and management of Aboriginal cultural values.	Pre-construction

ID	Issue	Mitigation/management measure	Timing
19.7	Recording and salvage of heritage sites	Conduct a targeted archaeological surface survey within the construction impact zone of those areas not previously subject to surface survey (and excluding highly disturbed areas) before construction of the Stage 1 development. The aim of this survey would be identify all visible surface Aboriginal sites for recording and management prior to construction.	Pre-construction Construction
19.8		A comprehensive archaeological inspection of surface sandstone outcrops across the airport site would be conducted before, and as required during, construction related activities. This action has the aim of appropriately recording and salvaging stone surfaces with evidence of Aboriginal markings.	Pre-construction
19.9		Conduct archival recording of the scarred tree (B40) and grinding groove site (B120) before the start of any ground disturbance works within the area of these Aboriginal heritage sites. This has the objective of providing a baseline record and information upon which to develop a conservation management plan.	Pre-construction Construction
19.10		Conduct a programme of oral history recording with the aim of recording memories and stories from Aboriginal people relating to the airport site and its district. It is intended that this record would serve as an archive and a resource for future interpretation of the Aboriginal heritage values of the site.	Pre-construction
19.11		Conduct a salvage programme of surface artefacts recovered across known Aboriginal artefact occurrences in the construction impact zone, with the aim of avoiding damage from construction related activities. This action would address strongly held concerns of Aboriginal stakeholders about the protection of artefacts from construction impacts. The collection programme would be conducted using an archaeological methodology and the resulting assemblage would be integrated into the archaeological analysis of salvaged material, where appropriate.	Pre-construction Construction
19.12		A selective archaeological salvage programme should be conducted prior to, and as necessary during, construction works across the initial development area subject to construction impact. The objective of the programme would be to manage impacts to archaeological or scientific values. The aim of the programme would be to recover and analyse a representative sample of surface and subsurface archaeological material from the areas subject to construction impact. The programme would aim to: • recover archaeological material from all landform types based on a systematic and representative sampling matrix; • recover additional archaeological material from areas with assessed relatively higher archaeological value, with the objective of providing a large enough artefact population for statistical analysis and from which robust results can be derived; and • apply archaeological excavation methodologies which are appropriate to the expected archaeological resource and the objectives of the salvage. As part of designing the salvage programme, consideration would be given to the feasibility of integrating relevant and existing geotechnical data into the process of determining the location and scope of the salvage programme.	Pre-construction Construction
19.13	Protocols for discovery of artefacts and human remains	Implement protocols for the unanticipated discovery of Aboriginal objects, and for the discovery of any suspected human remains for all development related works involving ground disturbance.	Construction

ID	Issue	Mitigation/management measure	Timing
19.14		Investigate the feasibility of a protocol for the management of topsoil or other soil matrix material assessed as likely to contain a relatively high density of Aboriginal stone artefacts. The aim of this protocol would be to manage excavation, storage and placement of this material in a culturally appropriate manner that minimises potential damage. If deemed feasible, the protocol should be developed in consultation with Aboriginal stakeholders and seek to address the following issues: • the appropriate identification and tracking of spoil containing artefacts; • the minimisation of physical damage to the artefacts during mechanical processing and movement; and • end use of the spoil in contexts that minimise potential future impacts on the artefacts, and where possible are culturally appropriate.	Construction
19.15	Induction training	Training in the identification of Aboriginal artefacts and management of Aboriginal heritage values would be included in compulsory induction courses for site workers. The content of this component will vary according to the stage of construction. After the completion of major cut and fill actions, training may focus on the management of spoil where there is a risk of impacting artefacts, and on no-go areas, where relevant.	Pre-construction Construction
19.16	Conservation of heritage items	Prepare a conservation management plan which defines and integrates all strategies for mitigating and managing Aboriginal heritage values across the airport site. This plan would be developed in consultation with Aboriginal stakeholders and relevant government agencies.	Pre-construction Construction Operation
19.17	Commemoration of Aboriginal heritage	Commemorate the Aboriginal cultural heritage values of the airport site. Options for consideration may include: • the use of Darug words and language in the naming of places and infrastructure; • the dedication of various spaces and places for the placement of art and interpretive elements, storage and display of cultural items, and/or the conduct of cultural activities; and • the provision of public access and interpretive facilities at Aboriginal sites conserved in situ within the airport site (such as for sites B40 and B120), subject to safety and security requirements.	Pre-construction
19.18	Curation and repatriation of heritage items	An area of open ground should be reserved within the airport site and managed for the primary purpose of repatriation of salvaged Aboriginal cultural material through reburial. The area should be selected and managed in consultation with Aboriginal stakeholders. Priority should be given to areas which retain a natural land surface and are associated with native vegetation. This provision is to accommodate the repatriation of cultural material for which it is not considered necessary by Aboriginal stakeholders to store above-ground, or to retain access for cultural purposes, interpretation, education or research.	Pre-construction
19.19		Following the completion of archaeological description and analysis, Aboriginal cultural material salvaged from the airport site should, in the first instance, be stored at an appropriate place to be determined in consultation with Aboriginal stakeholders and relevant government agencies. The longer term storage of this material, and potentially material salvaged from other developments in Western Sydney, should be managed in accordance with protocols to be developed through further consultation with Aboriginal stakeholders and relevant state, federal and local government agencies. Longer term storage options could include: • a 'keeping place', if feasible, that would provide secure, above ground storage enabling future access for cultural purposes, interpretation, education or research; and • re-positioning or reburial at an appropriate time, at one or more locations within the local landscape to be determined in consultation with Aboriginal stakeholders.	Pre-construction

ID	Issue	Mitigation/management measure	Timing
19.20	Recording and salvage of heritage sites	Conduct archival recording of the scarred tree (B40) and grinding groove site (B120) before the start of any ground disturbance works within the area of these heritage sites. This has the objective of providing a baseline record and information upon which to develop a conservation management plan.	Pre-construction

19.8. Conclusion

Construction of the proposed Stage 1 development would affect at least 39 Aboriginal heritage sites recorded at the airport site, all of which comprise artefact occurrences. Construction activities would also affect approximately 501 hectares of archaeologically sensitive landforms. Impacts during operation of the Stage 1 development would be limited to indirect impacts on adjacent and nearby sites. The heritage values of these sites are unlikely to be vulnerable to indirect impacts such as loss of context. Consequently, the operational impacts of the Stage 1 development would be low.

Mitigation and management measures would be implemented to minimise the impacts on cultural heritage. These measures would include the conservation of heritage sites, recording and salvage of heritage sites, the commemoration of cultural heritage values at the airport site, curation and repatriation of heritage items, and protocols for the discovery of artefacts and human remains.

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20. European heritage

The assessment of European heritage identified 19 European heritage items at the airport site and an additional 22 heritage items in the surrounding area. The identified European heritage items were largely locally significant but would also trigger potential inclusion on the Commonwealth Heritage List given their presence on Commonwealth land.

The identified items reflect the historical context of the airport site and European settlement more generally, including early attempts to develop local agricultural and pastoral economies and the emergence of settled village communities.

Construction of the proposed Stage 1 development would involve large-scale clearing and earthworks, which would preclude the preservation of European heritage items in situ. The identified European heritage items at the airport site are all within the area of the Stage 1 development and would therefore be documented and salvaged, where feasible and prudent, before construction. Other measures to preserve the European heritage of the airport site would include the preparation of an oral history of the site. Measures to mitigate and manage impacts on European heritage would be collated in environmental management plans before construction and operation.

20.1. Introduction

This chapter provides a review of the European heritage values in localities potentially affected by the development of the proposed Western Sydney Airport. The chapter draws on a comprehensive assessment of European heritage (see Appendix M2).

European heritage investigations were undertaken at the airport site as part of preparation of two previous environmental impact statements for the development of a second Sydney airport at Badgerys Creek. These investigations identified a number of items of local significance within or in the vicinity of the airport site. The identified European heritage items at the airport site would also trigger potential inclusion on the Commonwealth Heritage List.

This assessment of European heritage draws upon the results of all previous assessments and documentation for the airport site and augments this information with further research, site investigations, test excavation and analysis.

The assessment addresses the Australian Government's environmental assessment requirements in relation to the project for European and other heritage. Comments and recommendations on the scope of the environmental assessment from the Heritage Division of the NSW Office of Environment and Heritage are also addressed in this assessment.

The assessment considers the significance of all heritage items located within and around the airport site and recommends mitigation and management measures for all items potentially affected by the proposal.

20.2. Methodology

20.2.1. Historical sites

The overall approach to the assessment involved the identification of heritage items within and around the airport site through a review of previous heritage studies, searches of relevant heritage registers and schedules, and a field survey informed by a predictive landscape model.

The significance of each heritage item was assessed in accordance with Commonwealth Heritage criteria and the potential for direct and indirect impacts associated with the proposed airport were considered for each item.

The following tasks were undertaken to describe the existing environment at the airport site and to assess the impact of the proposed airport with regard to European heritage:

- review of relevant heritage legislation;
- review of background information including previous thematic studies, field surveys and assessments undertaken during previous assessments of the airport site;
- searches of all available historic heritage registers, including the World Heritage List, National Heritage List, Commonwealth Heritage List, State Heritage Register, Heritage and Conservation registers for State government agencies (known as Section 170 registers), local environmental plans, National Trust of Australia List, Register of the National Estate, Historic Heritage Information Management System and the Australian Institute of Architects Register of Significant Architecture in NSW;
- collation of known heritage curtilage;
- e (boundary) information as part of the heritage searches;
- literature review including previous archaeological reports, heritage studies, conservation management plans and regional and local history documents and maps;
- preparation of a thematic history for the site and surrounds;
- field survey of the airport site to identify known historic heritage items, unrecorded historic heritage items and to assess the potential for any unrecorded historic heritage items, as informed by a predictive landscape model;
- consultation with relevant local councils and the NSW Office of Environment and Heritage;
- further targeted surveys and test excavation of selected areas to record identified historic heritage items and determine heritage curtilage of the items;
- assessment of the significance of identified European heritage items including cumulative impacts on historic heritage and cultural landscapes; and
- development of mitigation and management measures for affected items.

20.2.2. Archaeological assessment

Evaluation of the historical archaeological potential of the airport site was based on a consideration of historical information about the development and occupation of the airport site, physical evidence observed during field surveys and identified areas of previous disturbance. A broad approach to the identification of potential archaeological evidence was adopted based on a predictive model, which assumes that historical archaeological remains are generally located close to occupation and activity areas.

The assessment of archaeological impacts was prepared based on historical research, a field survey and the results of test excavation. Background information and the assessed significance of identified sites were primarily based on historical research. Field survey results were used to assess the condition of the historical archaeological sites.

20.2.3. Assessment of significance

Statements of significance for the assessed heritage items were drawn from Commonwealth and State statutory and non-statutory heritage registers and supplemented with additional historical research.

European heritage items identified at the airport site were assessed against Commonwealth Heritage criteria (Department of the Environment and Water Resources 2007), which align closely with State heritage criteria (NSW Heritage Office 2001). The criteria are shown in Table 20–1.

The criteria were considered with regard to the history and physical evidence of each identified heritage item. The criteria detailed in the International Council on Monuments and Sites *Burra Charter* (2013) are very similar to the Commonwealth Heritage criteria and, as such, they are not considered separately. Each identified heritage item within the airport site was also considered with regard to the *Australian Historic Themes Framework* (Australian Heritage Commission 2000).

Table 20–1 – Commonwealth and State heritage criteria

Category	Commonwealth criteria	State criteria
Events and processes	Criterion (a) the place has significant heritage value because of the place's importance in the course, or pattern, of Australia's natural or cultural history.	Criterion (a) an item is important in the course, or pattern, of NSW's cultural or natural history (or the cultural or natural history of the local area).
Rarity	Criterion (b) the place has significant heritage value because of the place's possession of uncommon, rare or endangered aspects of Australia's cultural or natural history.	Criterion (f) an item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area).
Research	Criterion (c) the place has significant heritage value because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history.	Criterion (e) an item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area).
Principal characteristics of a class	Criterion (d) the place has significant heritage value because of the place's importance in demonstrating the principal characteristics of: i. a class of Australia's natural or cultural places, or ii. a class of Australia's natural or cultural environments.	Criterion (g) an item is important in demonstrating the principal characteristics of a class of NSW's: iii. Cultural or natural places; or iv. Cultural or natural environments.

Category	Commonwealth criteria	State criteria
Aesthetic	Criterion (e) the place has significant heritage value because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group.	Criterion (c) an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area).
Creative or technical achievement	Criterion (f) the place has significant heritage value because of the place's importance in demonstrating a high degree of creative or technical achievement at a particular period.	Criterion (c) an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area).
Social	Criterion (g) the place has significant heritage value because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons.	Criterion (d) An item has strong or special associations with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons.
Associative	Criterion (h) the place has significant heritage value because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history.	Criterion (b) an item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history (or the cultural or natural history of the local area).
Indigenous tradition	Criterion (i) the place has significant heritage value because of the place's importance as part of indigenous tradition.	NSW law provides separately for indigenous heritage (see *National Parks and Wildlife Act 1974).*

20.2.4. Legislative and policy framework

The assessment has been completed in the context of the Commonwealth legislative framework with reference to the principles and objectives of NSW policy, where appropriate.

20.2.4.1. Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides a legal framework for the protection of matters of national environmental significance. These matters include World Heritage properties, National Heritage places and Commonwealth Heritage places. The EPBC Act also provides for the protection of the environment generally, where actions are undertaken by the Commonwealth or on Commonwealth land.

World Heritage properties are listed on the World Heritage List administered by the UNESCO. National Heritage places are places of outstanding value to the nation and are listed on the National Heritage List. Commonwealth Heritage places are places owned or controlled by Commonwealth entities that have Commonwealth Heritage values and are listed on the Commonwealth Heritage List.

A heritage value of a place is defined under the EPBC Act as including the place's natural and cultural environment having aesthetic, historic, scientific or social significance, or other significance, for current and future generations of Australians.

Approval form the Minister for the Environment is required for controlled actions which will, or are likely to, have a significant impact on items and places included on the World Heritage List, National Heritage List or Commonwealth Heritage List. Approval is also required for an action undertaken by the Commonwealth or on Commonwealth land which is likely to have a significant impact on heritage values, even if those values are not included in one of these lists.

The EPBC Act also prescribes obligations for Commonwealth agencies that own or control properties that have, or might have, one or more Commonwealth or National Heritage values. Obligations include taking all reasonable steps to assist in the identification, assessment and monitoring of values and preparation of management plans for any identified values in line with the Commonwealth Heritage management principles and National Heritage management principles. Commonwealth agencies must similarly take all reasonable steps to ensure their actions are not inconsistent with the *Australian World Heritage management principles* or any plans in force for a World Heritage property. The EPBC Act prescribes various heritage management principles and guidelines for managing heritage properties protected under the EPBC Act.

20.2.4.2. Environmental Planning and Assessment Act 1979

The NSW *Environmental Planning and Assessment Act 1979* is the main law regulating land use, planning and development in NSW. The Act enables the making of local environmental plans, which commonly provide for the protection of locally significant heritage items and heritage conservation areas. The local environmental plans that apply to the airport site or surrounds are the *Liverpool Local Environmental Plan 2008* and the *Penrith Local Environmental Plan 2010*. Both plans contain lists of items of European heritage significance.

20.2.4.3. Heritage Act 1977

The NSW *Heritage Act 1977* (Heritage Act) provides protection for heritage places, buildings, works, relics, moveable objects, precincts and archaeological sites that are important to the people of NSW. These include items of Aboriginal and non-Aboriginal heritage significance. Where these items have particular importance to the people of NSW, they are listed on the State Heritage Register.

Section 170 of the Heritage Act requires NSW Government departments and agencies to maintain a Heritage and Conservation Register, commonly known as a Section 170 Register. These registers include items of Aboriginal and non-Aboriginal heritage significance.

20.3. Existing environment

20.3.1. Historical context

European settlement around Badgerys Creek, including Luddenham and Bringelly, began with land grants to settlers for the purpose of establishing large rural estates in 1809. It was intended that these rural estates would contribute crops and livestock to feed the colony's growing population. Grantees included James Badgery (804 acres in 1809 at South Creek), Robert Lowe (1,000 acres in 1812 at Bringelly) and John Blaxland (6,710 acres of land in 1813 which he named 'Luddenham Estate'). Smaller grants were made to Sarah Howe, Edward Powell, Ellis Bent, D'Arcy Wentworth and Thomas Laycock (Keating 1996). These rural estates were highly successful, producing wheat and breeding cattle, sheep and horses.

The end of transportation and the consequent withdrawal of convict labour signaled the start of a decline in the fortune for the area. A severe drought from 1838 to 1840 resulted in wheat crop failure for two consecutive years. This was followed in 1841 by an economic depression due in part to a crash in wool prices and a reduction in British investment capital (Keating 1996). The increasing demand for land close to the growing population centres, the collapse of viable wheat farms after an outbreak of rust, and the de-population of the area as small tenant farmers moved in search of better land, culminated in the subdivision of many large estates into smaller allotments.

The most obvious effect of the downturn in the area was the sale and subsequent subdivision of Luddenham Estate. The breakup and sale of Luddenham Estate between 1859 and 1864 has been identified as the beginning of the next phase in the area, which saw the subdivision of the original grants.

Subdivisions of the mid-nineteenth century changed the pattern of land settlement in the region by breaking up the larger estates into much smaller farming lots and laying out uniform streets and allotments in a regular grid. In many instances, this supplanted an existing irregular alignment of informal roads and paddock fence lines. The subdivisions were set out by private surveyors often working on different estates.

As a result of subdivision, small farmers were attracted to the area. Improvements were made, orchards and vineyards planted, and cottages built (Paul Davies Pty Ltd 2007). For instance, Franz Anschau and his family established a 200 acre vineyard south of Luddenham village in the late 1850s, complete with wine cellars, a substantial home and a working farm with sheep (*Camden News* 1954).

Land advertised as ‘Luddenham Village’ was offered for sale in 1859. Luddenham Village was located along the eastern boundary of The Northern Road and featured one acre and half acre blocks. In 1859, the central and western portions of Luddenham Estate had been surveyed (3,515 acres) and the survey of the eastern district (within the airport site), which represented the balance of the estate at 4,158 acres, followed in 1862. At the time of the 1859 survey, 2000 acres of the Estate were under cultivation, which over the following decades appears to have been managed by tenant farmers (*Sydney Morning Herald* 25 May 1859; Paul Davies Pty Ltd 2007).

Population figures at Luddenham are difficult to determine but by 1860, the local community warranted the establishment of a local school (*Sydney Morning Herald* 2 October 1860), and a post office followed in 1872. The village was close to Lawson’s Thistle Inn and provisions were made for a church and a public reserve (Neustein and Associates 1992). Immediately surrounding the village, allotments of no more than 75 acres were offered, while lots of 100 – 300 acres were offered further east to the boundary of Badgerys Creek (AMC 2014). In 1862, the remainder of the western and central divisions around Lawson’s Thistle Inn was also auctioned (Kinhill Stearns 1985, Keating 1996).

By 1872 there were 29 residents, and the village offered a range of services including two blacksmiths, a bootmaker, a butcher and an inn (Lawson’s Thistle Inn). Rural life revolved around farming, but Anschau had established his winery at his property ‘Steinberg’ and five local people were employed in the timber trade as sawyers and wood splitters (Paul Davies Pty Ltd 2007).

In 1885, Luddenham Estate was purchased by a syndicate of Sydney land developers and re-subdivided to form a patchwork of semi-rural allotments in freehold title. From this time, the village of Luddenham developed as a centre for civic services.

The small rural Luddenham Village provided the surrounding estates with a focal point and Luddenham soon established itself as a viable settlement. A small weatherboard Methodist school was established in 1857 and was replaced with a more substantial brick school in 1862 (Keating 1996, Godden Mackay 1997). Luddenham Post Office was opened on 1 March 1872 and played an important role in the village, serving as a money order office from January 1885, acquiring a telephone and telegraph service from August 1905, and creating a Commonwealth Savings Bank Office in April 1914 (Hopson and Tobin 1995). Both the Luddenham Uniting Church and Progress Hall were established in the 1880s (AMC 2014).

In comparison to Luddenham, neither Bringelly nor Badgerys Creek developed well defined village centres, despite being offered for sale on similar terms.

Around the turn of the century, the main alternative land use to grazing and cropping in the area was orchards. City families, displaced by the depression of the 1890s, were attracted by the subdivision of the large estates into smaller manageable land parcels. The subdivisions, many between three and 10 acres, were designed to encourage settlement in the area. Reasonable deposits and easy repayments belied the trouble that many of these new farmers were to face. Inexperience, seasonal changes and small lots combined to make life difficult on the land.

Roads to Sydney such as Mulgoa Road (now Elizabeth Drive) and Bringelly Road were in poor condition, while the closest railway station was located 12 miles away at St Marys (Donald and Gulson 1996:9, Godden Mackay 1997). There was no easy access to waterways for taking perishable goods to market, so the area tended to be used for fruit growing, grazing, and for the production of milk for the local Liverpool area. Small orchards dominated land use on the smaller properties, while dairy farms and some vine growing occupied other farms (Godden Mackay 1997, Neustein and Associates 1992, Kinhill Stearns 1985).

William Longley was one such farmer in the Badgerys Creek district who established an extensive and well-known fruit orchard after purchasing land during the first Luddenham subdivision of 1859. The Longley family grew fruit in the district for over 50 years before their estate was sold, together with their home and household furniture, in 1912 (*Camden News* 1912). Other orchards of the period include those belonging to the Anschaus, Booths, Outridges, Leggos and Smiths.

Often, farmers in the area supplemented their farm income with a trade such as carting, shoemaking, coach building or stints at the local brick pits (Keating 1996). To service the small Badgerys Creek community, a butcher's shop operated from 1886, a public school was opened on Badgerys Creek Road in 1895, and a post office was established in 1896 (Paul Davies Pty Ltd 2007; Liverpool City Council 2012). St John's Anglican Church and Badgerys Creek Uniting (Methodist) Church serviced local residents and were constructed in the early 1900s (AMC 2014). Despite the modest development in the area, Badgerys Creek remained essentially rural and sparsely populated throughout the nineteenth century.

By 1904, the areas of Badgerys Creek, Luddenham and Bringelly were moderately settled and a Parliamentary Standing Committee was established for the purpose of determining the viability of a railway between Mulgoa and Liverpool (AMC 2014). The proposed railway never eventuated and the districts of Badgerys Creek and Bringelly remained sparsely populated, retaining their rural character. It was noted that in the 1900s, there were still large areas available for purchase around Badgerys Creek and Nicholson Park Estate in Luddenham (Donald and Gulson 1996).

Local government representation was forced on Badgerys Creek by the NSW Government in 1906 through the establishment of Nepean Shire.

In 1916, Cecil Vicary purchased a portion of D'Arcy Wentworth's Greendale estate for the purpose of establishing a dairy, grazing land and a vineyard (AS11). The property on the south-western side of The Northern Road, opposite Anschau's vineyard, had served as a working farm from the 1880s and featured a slab homestead, a woolshed and shearers' quarters. Originally a sideline to running the sheep and dairy farm, the first grapes were planted in 1917 and commercial production began in 1923, though dairy cows were reared until the early 1940s (AMC 2014). In the 1930s at the height of production, 65 hectares of land were cultivated, though production began declining from the late 1930s (AMC 2014).

From the 1920s, further settlement occurred in Badgerys Creek when portions of James Badgery's early grant were subdivided under the provisions of the *Soldier Settlement Act 1919*. Exeter House was at that time in the ownership of the Stivens family, who later sold a portion of the Exeter estate to Ern Kent (AMC 2014). In the 1930s, Kent sold his property to Peter Nobbs, who moved into the homestead with his family to pursue dairying (Donald and Gulson 1996). In 1936, a large area with frontage to South Creek was acquired by the Commonwealth of Australia for a CSIRO animal health research station, known as McMaster's Field Station, which was also used for a short time as a field station for research into radio astronomy. The site was sold by the CSIRO in 1996 (Paul Davies Pty Ltd 2007). Also in 1936, the Veterinary Department of the University of Sydney (in association with the McGarvie Smith Institute) purchased and developed a 160 hectare property at Badgerys Creek for the training of veterinary students in animal husbandry (Paul Davies Pty Ltd 2007).

A number of research facilities were established at Badgerys Creek and its surrounds in the 1950s, including the Overseas Telecommunication Commissions's Bringelly Radio Receiving Station Complex and the Australian Air Force Radio Receiving Station in 1952–55. Rural land use intensified in the 1960s with the establishment of dairy and poultry farming, beekeeping, timber and market gardening operations, and horse and dog training, but the district saw little development thereafter.

The districts of Badgerys Creek, Luddenham and Bringelly retain a great deal of their former rural character. Though subdivision and development of large estates has occurred, early slab cottages, substantial homesteads, cisterns, sheds, vineyards and small rural allotments remain. Market gardens, working farms, vineyards and close knit village communities reflect the district's rural development.

20.3.2. European heritage items

A review of prior assessments, heritage listings and a field survey identified 19 European heritage items at the airport site and an additional 22 heritage items in the surrounding area. The identified European heritage items within the airport site are listed in Table 20–2 while the identified European heritage items in the vicinity of the airport site are listed in Table 20–3. All of the identified items are mapped in Figure 20–1.

20.3.2.1. Prior assessments

The airport site has been subject to a number of past European heritage assessments including the *Second Sydney Airport Site Selection Programme: Draft Environmental Impact Statement* (Kinhill Stearns 1985) and subsequently *Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) for inclusion in the *Draft Environmental Impact Statement: Second Sydney Airport Proposal* (PPK, 1997). Twenty-one of the identified European heritage items within and around the airport site were considered in these prior assessments. These European heritage items are listed and described in Table 20–2 and Table 20–3 and are mapped in Figure 20–1.

Preliminary field investigations undertaken to inform the referral of the proposed airport under the EPBC Act (AMC 2014) reflected these earlier findings and identified an additional eight European heritage items within and around the airport site. These European heritage items are listed and described in Table 20–2 and Table 20–3 and are mapped in Figure 20–1.

20.3.2.2. Commonwealth listings

None of the European heritage items identified within and around the airport site are inscribed on the World Heritage List, National Heritage List or Commonwealth Heritage List.

The Greater Blue Mountains Area is about seven kilometres north-west of the airport site at its closest point. The area is inscribed on the World Heritage List and on National Heritage List (for its World Heritage values) and is therefore a matter of national environmental significance under the EPBC Act. The one million hectare area was inscribed on the World Heritage List for its outstanding universal value, which is characterised by examples of the evolution of Australia's diverse ecosystem and the in situ conservation of biological diversity. Potential impacts on the Greater Blue Mountains World Heritage Area are assessed in Chapter 26.

The Greater Blue Mountains Area also contains various European heritage items including evidence of rural settlement, mining and transportation. The proposed airport is not expected to impact on these European heritage items, directly or indirectly.

20.3.2.3. NSW listings

No European heritage items of State significance were identified within the airport site; however, a State significant farmhouse complex is situated near the airport site. The site is described in Table 20–3 and mapped in Figure 20–1.

20.3.2.4. Local listings

A total of 14 European heritage items identified within and around the airport site are listed on the *Liverpool Local Environmental Plan 2008*. The following three items are within the airport site:

- St John's Anglican Church group;
- Badgerys Creek Public School; and
- Vicary's Winery group.

Another eight European heritage items listed on the *Penrith Local Environmental Plan 2010* are situated in the vicinity of the airport site. These and the other sites in the vicinity of the airport site are listed and described in Table 20–3 and are mapped on Figure 20–1.

A brick cottage at 406 Park Road, Luddenham listed on the *Penrith Local Environmental Plan 2010* is not included in Table 20–3 as it is demolished and is not of archaeological significance. There is therefore negligible potential for impacts and this European heritage item is not assessed further.

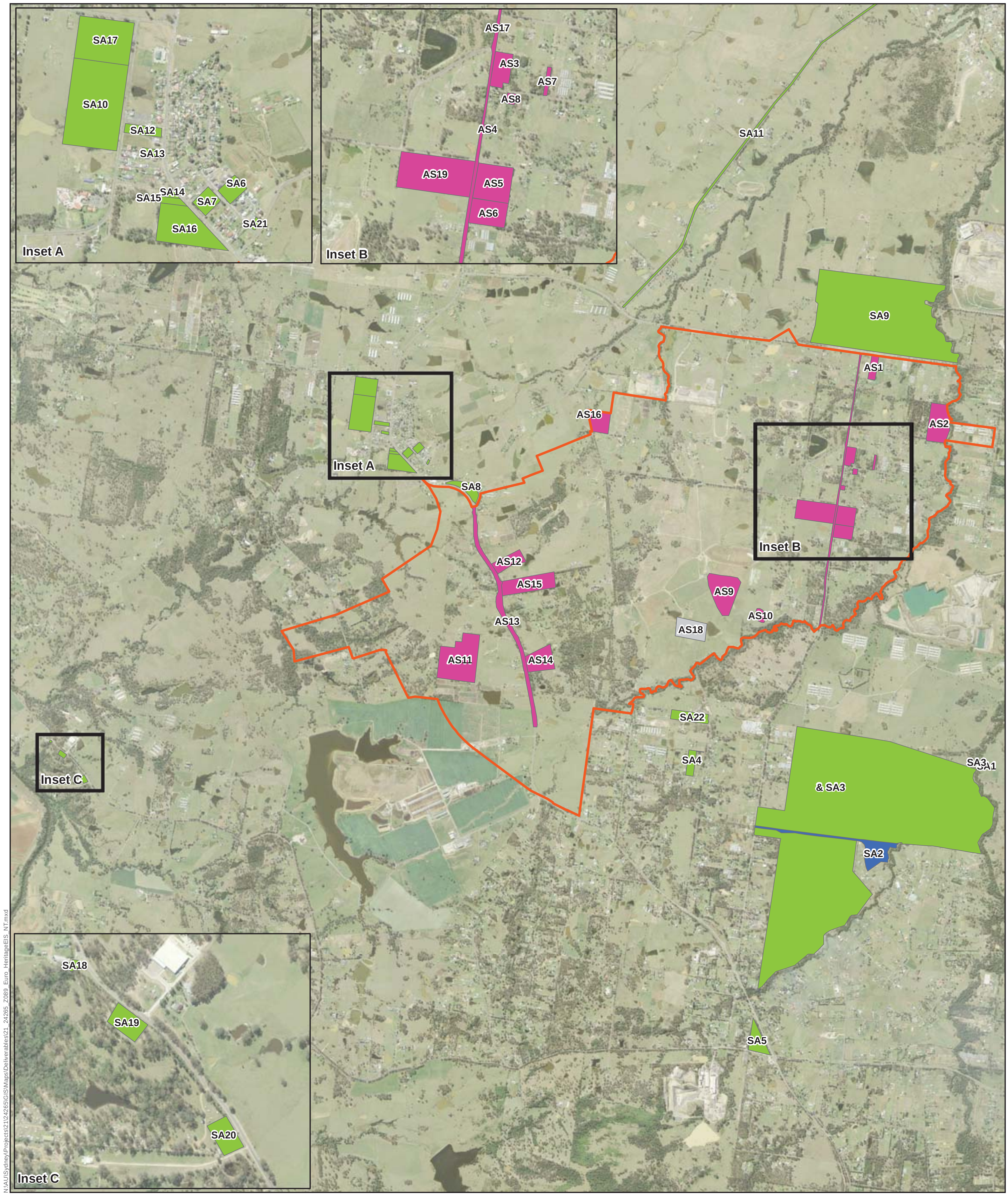
20.3.2.5. Field survey

A field survey of the airport site was undertaken to validate and build on the information from prior assessments and in various European heritage registers. The survey approach was informed by a predictive landscape model that considered the types of sites identified in prior research as well as the historic context of the area (see Section 20.3.1).

Evidence of early land grants and associated development were predicted, in line with the researched historical context of Badgerys Creek and Luddenham (see Section 20.3.1). This included evidence of the development of farms, orchards, vineyards, cottages, roads, schools and churches. These predictions were consistent with prior assessments and were validated through the field survey. The potential for evidence of convict settlement and Aboriginal–European contact at the airport site was recognised, however, no such evidence was observed.

The previously identified European heritage items within the airport site were included in the survey. Archaeological excavation was necessary at Orange Hill to characterise subsurface structural features and other remains. The excavation initially revealed a scattering of bricks; some whole, mostly broken. Following the removal of the bricks, an arranged course of sandstone blocks was uncovered, thought to be flagging or foundations of a building. Other evidence of occupation, including ceramics, glass, metal, a bead and a brass button with a military-style insignia was also recovered during the test excavation at Orange Hill.

The results of the field survey and archaeological excavation, in conjunction with the review of prior research and listings, informed the assessment of heritage significance included in Table 20–2.



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

LEGEND

Airport site

European heritage items

- Commonwealth significance
- Local significance
- State significance
- Undetermined significance

0 125 250 500
Metres

N

Figure 20-1 - European heritage items within and surrounding the airport site

Table 20–2 – European heritage items within the airport site

Item	Map ID	Location	Description	Significance	Listing	Reference
Pennell's property	AS1	2170 Elizabeth Drive, Badgerys Creek	Pennell's property is likely to contain subsurface remains of an early farm homestead.	Local (Commonwealth)	–	*1859 Map of the Eastern Division of Luddenham Estate* Field survey
Gardiner Road farm complex	AS2	5 Gardiner Road, Badgerys Creek	Gardiner Road farm complex comprises an early twentieth century farm cottage and outbuildings.	Local (Commonwealth)	–	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014), Field survey
Badgerys Creek Public School	AS3	Corner of Pitt Street and Badgerys Creek Road, Badgerys Creek	Badgerys Creek Public School is a small rural school containing elements from the early twentieth century. The school has been damaged by vandalism following its closure in 2014.	Local (Commonwealth)	*Liverpool Local Environmental Plan 2008*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014) Field survey
Badgerys Creek butchery	AS4	Lot 51A Badgerys Creek Road, Badgerys Creek	Badgerys Creek butchery was one of two retail outlets in Badgerys Creek and had been operating for over a hundred years prior to its demolition in the 1990s.	Local (Commonwealth)	–	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014) Field survey
Badgerys Creek post office	AS5	Lot 52 Badgerys Creek Road, Badgerys Creek	Badgerys Creek post office operated between 1894 and 1989. No surface elements of the post office remain however subsurface remains are likely.	Local (Commonwealth)	–	Historic research Field survey
Saw pit	AS6	61 Badgerys Creek Road, Badgerys Creek	Although marked on the 1859 map of Luddenham, there is very little observable evidence of the saw pit due to overgrowth and use of the site as a dam.	Local (Commonwealth)	–	*1859 Map of the Eastern Division of Luddenham Estate* Field survey

Item	Map ID	Location	Description	Significance	Listing	Reference
Badgerys Creek Uniting Church and cemetery	AS7	15 Pitt Street, Badgerys Creek	Badgerys Creek Uniting Church was the first formal place of worship at Badgerys Creek, opening in 1898 followed by the cemetery in 1927. The church was removed from the site in the early 1990s. The cemetery has two marked graves and could contain further unmarked graves.	Local (Commonwealth)	–	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014) Field survey
St John's Anglican Church and cemetery	AS8	30 Pitt Street, Badgerys Creek	St John's Anglican Church was built in the early 1900s. The church was removed or demolished after 1992. The cemetery contains at least 27 graves, while the church yard retains a small monument comprising a plaque, small brick base and corrugated iron roof.	Local (Commonwealth)	*Liverpool Local Environmental Plan 2008*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014) Field survey
Braeburn homestead	AS9	55 Longleys Road, Badgerys Creek	Braeburn was a farm homestead circa 1910. The homestead and associated shed were demolished in the late 1990s.	Local (Commonwealth)	–	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014) Field survey
Orange Hill homestead	AS10	5 Jagelman Street, Badgerys Creek	Orange Hill was a farm homestead thought to be a predecessor to Braeburn. Two wells and a number of subsurface sandstone bricks were identified by text excavation at the site.	Local (Commonwealth)	–	*Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014) Field survey
Vicary's Winery	AS11	1935 The Northern Road, Luddenham	Vicary's Winery was a farm property in the late 19th century. The site features a slab homestead circa 1860s and woolshed circa 1880s. The site was converted to a dairy and vineyard in the early 20th century and at the time of writing remains in operation as a winery.	Local (Commonwealth)	*Liverpool Local Environmental Plan 2008*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014) Field survey

Item	Map ID	Location	Description	Significance	Listing	Reference
Well	AS12	1972 The Northern Road, Luddenham	The undated sandstone well sits within a more recently constructed homestead. The presence of such a well is rare in the local area.	Local (Commonwealth)	–	Field survey (personal communication)
The Northern Road alignment within the airport site	AS13	The Northern Road, Luddenham	The Northern Road is a very early road alignment. The route is recorded in an edition of the *Sydney Gazette* dated 1821 and a map of Bringelly dated 1834. The alignment of The Northern Road has deviated in some areas of the airport site since that time.	Local (Commonwealth)	–	Historic research *Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014), Field survey
Anschau Vineyard, Steinberg and grave(s)	AS14	1845–1875 The Northern Road, Luddenham	Anschau Vineyard operated from the late 1800s. No evidence of the vineyard remains; however, blacksmith tools and remains of a homestead have been identified. A grave suspected to belong to a member of the Anschau family is also present at the site.	Local (Commonwealth)	–	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014), Field survey
St Francis Xavier Church and cemetery	AS15	1966 The Northern Road, Luddenham	St Francis Xavier Church was built in 1912 while it is probable that the associated cemetery was established earlier. The contents of the church and a number of graves were relocated to a new site at Greendale in the 1990s. Unmarked graves may exist at the site.	Local (Commonwealth)	–	Historic research Field survey
Jackson Road cottage	AS16	Lot 2 Jackson Road, Luddenham	Jackson Road hosted a farm cottage and several ancillary structures circa 1890. The cottage and structures remain at the site.	Local (Commonwealth)	–	Field survey
Badgerys Creek Road alignment within the airport site	AS17	Badgerys Creek Road, Badgerys Creek	Badgerys Creek road alignment has been noted on maps since the 1850s and has not changed substantially since that time.	Local (Commonwealth)	–	Field survey Historic research

Item	Map ID	Location	Description	Significance	Listing	Reference
Spredenberg	AS18	55 Longleys Road, Badgerys Creek	Spredenberg features in a map of Luddenham Estate dated 1859 with a house visible in an aerial photograph dated 1947. The site is overgrown, confounding validation of its heritage.	Unknown	–	*1859 Map of the Eastern Division of Luddenham Estate* Field survey
Howe residence	AS19	Corner Badgerys Creek Road and Longleys Road, Badgerys Creek	The Howe residence is thought to have been occupied from the early 19th century. Potential homestead remains were identified at the site including wooden posts, bricks, corrugated iron and a potential well site.	Local (Commonwealth)	–	Field survey Personal communication

Table 20–3 – European heritage items in the vicinity of the airport site

Item	Map ID	Location	Significance	Listing	Reference
Former Overseas Telecommunications Commission site group	SA1	Badgerys Creek Road, Bringelly	Local	*Liverpool Local Environmental Plan 2008*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Kelvin Park complex	SA2	30 The Retreat, Bringelly	State	State heritage register *Liverpool Local Environmental Plan 2008*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Two RAAF water tanks	SA3	Badgerys Creek Road, Bringelly	Local	*Liverpool Local Environmental Plan 2008*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Mount Pleasant homestead	SA4	3 Shannon Road, Bringelly	Local	*Liverpool Local Environmental Plan 2008*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Bringelly Public School group	SA5	1205 The Northern Road, Bringelly	Local	*Liverpool Local Environmental Plan 2008*	*Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Willmington Reserve	SA6	17 Jamison Street, Luddenham	Local	*Liverpool Local Environmental Plan 2008*	*Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Luddenham Public School	SA7	The Northern Road, Luddenham	Local	*Liverpool Local Environmental Plan 2008*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)

Item	Map ID	Location	Significance	Listing	Reference
Lawson's Inn[a]	SA8	Lot 2 DP 623457	Local	*Liverpool Local Environmental Plan 2008*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
McGarvie Smith University Farm	SA9	124 Elizabeth Drive, Badgerys Creek	Local	–	National Heritage List[b]
Brick cottage	SA10	21–55 Campbell Street, Luddenham	Local	*Penrith Local Environmental Plan 2010*	*Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Luddenham Road alignment	SA11	Luddenham Road, Luddenham	Local	*Penrith Local Environmental Plan 2010*	–
Weatherboard cottage	SA12	3065–3067 The Northern Road, Luddenham	Local	*Penrith Local Environmental Plan 2010*	*Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Weatherboard cottage	SA13	3075 The Northern Road, Luddenham	Local	*Penrith Local Environmental Plan 2010*	*Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Luddenham Progress Hall	SA14	3091–3095 The Northern Road, Luddenham	Local	*Penrith Local Environmental Plan 2010*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997), *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Luddenham Uniting Church and cemetery	SA15	3097–3099 The Northern Road, Luddenham	Local	*Penrith Local Environmental Plan 2010*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997), *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
St James Anglican Church and cemetery	SA16	3101–3125 The Northern Road, Luddenham	Local	*Penrith Local Environmental Plan 2010*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997), *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)

Item	Map ID	Location	Significance	Listing	Reference
Showground	SA17	428–452 Park Road, Luddenham	Local	*Penrith Local Environmental Plan 2010*	*Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Shadforth Monument	SA18	Greendale Road, Greendale	Local	*Liverpool Local Environmental Plan 2008*	–
Private dwelling (former St Mark's Anglican Church Group, including church cemetery)	SA19	Greendale Road, Greendale	Local	*Liverpool Local Environmental Plan 2008*	–
Greendale Roman Catholic Cemetery	SA20	Greendale Road, Greendale	Local	*Liverpool Local Environmental Plan 2008*	–
Vertical slab dairy	SA21	Lot 10, Adams Road, Badgerys Creek	Local	–	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Evergreen homestead	SA22	Off Derwent Road, Bringelly	Local	–	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)

[a] Lawson's Inn is incorrectly recorded in the *Liverpool Local Environmental Plan 2010* as occurring within the airport site.

[b] McGarvie Smith University Farm was nominated for the National Heritage List, however the nomination is now ineligible. This European heritage item is nonetheless considered to have local significance.

20.3.3. Summary

The review of prior reports, historical studies, databases and the surveys undertaken as part of the assessment identified 19 European heritage items within the airport site and an additional 22 European heritage items around the site.

The identified European heritage items reflect the historical context of the airport site and European settlement more generally, including early attempts to develop local agricultural and pastoral economies and the emergence of settled village communities. The identified items are considered to be of Commonwealth Heritage significance, excluding Spredenberg which was not classifiable. The location of all identified items is shown in Figure 20–1.

The cultural significance of the airport site as a whole is characterised by the following.

- The region developed as a centre of agricultural production in the nineteenth century. The site was associated with cropping and later vineyards and orchards.
- The site includes Blaxland's early land grant, Luddenham Estate. This land grant and subsequent subdivision represent some of the early attempts to develop an agricultural and pastoral economy in Australia. These farmlands have continued in rural use and, due to the integrity of subdivision patterns, provide insight into early agricultural production.
- The site is crossed by The Northern Road and Badgerys Creek Road, which have historic associations with development in Badgerys Creek and the region.
- The site retains longstanding historic associations with nineteenth and early twentieth century markets for the supply of meat and livestock for metropolitan Sydney. Remnant tracts of cleared grazing land at Badgerys Creek continue to provide insight into this economic activity.
- The site includes a public school which demonstrates the development of public education from the late 1800s. The scale, material and design of the school buildings reflect the evolving fortunes of Badgerys Creek, education reform, the local community and architectural styles.
- The emergence of a settled village and farm community at Badgerys Creek in the last half of the nineteenth century is historically associated with the breakup of the large estates for closer settlement. This is demonstrated in street alignments, subdivision patterns, dwellings, churches and cemeteries, community gathering places, recreation grounds, park reserves, and places for education.

20.4. Assessment of impacts during construction

Site preparation activities would take place prior to construction of the proposed Stage 1 development. Site preparation activities would require the removal of structures from the airport site, thereby precluding the in situ preservation of European heritage items.

A range of measures is proposed to mitigate and manage potential impacts to particular European heritage items at the airport site (see Section 20.6).

Indirect impacts of construction on European heritage items surrounding the airport site would be limited to altered landscapes, views and ambience. These impacts are not expected to be significant and would not require implementation of management and mitigation measures.

20.5. Assessment of impacts during operation

European heritage items at the airport site would be removed before the start of operation. As such, operation of the proposed Stage 1 development would not directly impact European heritage items. Indirect impacts to European heritage items surrounding the airport site would be limited to altered landscapes, views and ambience. These impacts are not expected to be significant and would not require implementation of management and mitigation measures.

20.6. Mitigation and management measures

A European heritage management plan would be developed prior to construction of the proposed airport as part of the construction environmental management framework. The plan would collate measures to mitigate and manage potential impacts on European cultural heritage values. Measures proposed to be considered in the plan are included in Table 20–4.

Table 20–4 – Mitigation and management measures

ID	Issue	Measure	Timing
20.1	European heritage management plan	A European and other heritage management plan would be developed prior to construction of the proposed airport as part of the construction environmental management framework. The plan would collate measures to mitigate and manage potential impacts on European cultural heritage values. Measures proposed to be considered in the plan include: • further targeted archaeological investigation – to record subsurface remains and infer the layout, occupants and activities of certain European heritage places; • archival recording – including photographic records and measured drawings in their local context for future reference, having regard to the guidelines How to Prepare Archival Records of Heritage Items (NSW Heritage Office 1998) and Guidelines for Photographic Recording of Heritage Items Using Film or Digital Capture (NSW Heritage Office 2006); • inventory of moveable items – to record information such as location, designer, creator, use and owner of items such as tools of trade or machinery; • cultural planting investigation – to identify and collect samples of local or historic plant varieties that are characteristic of the area or not otherwise broadly planted; • exploration of options for potential relocation of identified European heritage structures – to preserve intact surface structures; • relocation of cemeteries in accordance with the Cemeteries Relocation Management Plan; and • staged demolition – to deconstruct identified European heritage structures in a careful manner that reveals information about their construction, renovation, finishes and so on, which would be recorded.	Pre-construction Construction
20.2	Heritage awareness	Heritage awareness training would be provided to all workers involved in site preparation and construction of the proposed airport.	Pre-construction
20.3	Unexpected finds	A procedure would be developed to be followed in the event that European heritage items are discovered during site preparation or construction.	Pre-construction

ID	Issue	Measure	Timing
20.4	Cultural significance of the airport site	The preparation of an oral history would be considered as a measure to preserve the heritage value of the airport site. This could include descriptions and reminiscences by people closely associated with the site.	Pre-construction
20.5	Cultural significance of the airport site	The European heritage value of the airport site would also be considered through detailed design.	Pre-construction
20.6	Management of European and other heritage items	A procedure would be developed to be followed in the event that European heritage items are discovered during site preparation or construction.	Pre-construction
20.7		A procedure would be developed to be followed in the event that human remains are discovered, given the potential presence of unmarked graves at the airport site.	Pre-construction

20.7. Conclusion

The assessment of European heritage identified 19 European heritage items at the airport site and an additional 22 heritage items in the surrounding area. All of the identified European heritage items at the airport site would be directly affected by site preparation for the construction of the proposed Stage 1 development. The mitigation and management of European heritage would ensure, as far as practicable, that the heritage values of the airport site would be preserved.

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21. Planning and land use

The site for the proposed Western Sydney Airport is located within Badgerys Creek and Luddenham, in the Liverpool local government area. The Australian Government acquired approximately 1,700 hectares of land for the proposed airport over the period 1986-1991. Planning for the airport development and surrounding land uses has been ongoing for a number of decades, across all levels of government.

Following the development of the proposed Western Sydney Airport, existing rural residential, agricultural, recreational, community and extractive industry land uses on the airport site would be removed (where required to support the development of the airport). Surrounding land uses could be expected to transition from rural to urban both as a result of airport operations, and as strategic land use planning under the Western Sydney Employment Area and the South West Priority Growth Area takes effect. Infrastructure improvements to main roads and railways would also facilitate land use change in the region.

Measures to manage land use and planning impacts are proposed, including mitigation measures for employment land use conflict, zoning rationalisation, operational airspace controls, aircraft noise and infrastructure corridor protection. Through successful implementation of these measures, the airport and its surrounds would become a focus for employment generating land uses in Western Sydney, creating jobs for the new residents of the South West Priority Area and Greater Western Sydney.

21.1. Introduction

This chapter assesses the planning and land use impacts of Stage 1 of the Western Sydney Airport proposal.

The construction and operation of the proposed Western Sydney Airport (the airport) would affect the existing land uses and potential future uses of surrounding lands for the purposes for which they are zoned.

Consideration of the need and potential location for a second Sydney airport has been ongoing for a number of decades. Planning for land use change by the Australian and NSW governments, and surrounding local councils, has therefore considered the potential impacts of an airport at Badgerys Creek.

The proposed Western Sydney Airport raises the prospect of rezoning some surrounding land, or making additional land use controls, to deal with potential land use conflicts between Western Sydney Airport and surrounding land.

This assessment builds upon previous studies and considers how the proposed airport would affect rural, agricultural, employment and recreational lands. Development controls are considered for the management of aircraft safety, noise, lighting and air quality impacts anticipated to occur from operations at the proposed airport. The need for local traffic and transport improvements is identified.

21.2. Methodology

A specialist report on planning and land use impacts of the Western Sydney Airport proposal was prepared for this EIS (refer to Appendix N). The broad methodology adopted for the preparation of the planning and land use assessment included:

- inspection and analysis of the key characteristics of the airport site and surrounding land;
- review of existing Commonwealth and NSW legislation applying to the airport site and surrounding land;
- review of strategic land use plans relevant to the airport site and surrounding land to identify NSW Government objectives for development of the area;
- consultation with planning staff in local councils within the vicinity of the airport site to confirm applicable land use plans, policies and assessment considerations;
- review of relevant sections of other technical reports prepared for the EIS;
- assessment of the likely impacts of the airport proposal on surrounding land uses; and
- recommendations for mitigation measures to minimise the impacts of the proposal.

The planning and land use assessment has been prepared in accordance with the Australian Government Department of the Environment assessment guidelines for the airport proposal issued in January 2015.

21.3. Existing environment

The airport site is located within the localities of Badgerys Creek and Luddenham, within the Liverpool local government area (LGA). The northern boundary of the airport site adjoins the Penrith LGA boundary. The study area is situated about 50 kilometres west of the Sydney central business district and Sydney (Kingsford-Smith) Airport.

Commencing in the mid-1980s the Australian Government acquired approximately 1,700 hectares of land for the airport site. The current Australian Government land holding comprises over 20 lots, with the majority of the land located on a consolidated title (1,667 hectares).

21.4. Existing land uses

21.4.1. Airport site

The majority of the airport site comprises low density rural residential and agricultural land uses. Rural residential tenancies range from approximately 1 to 40 hectares in area. Agricultural land uses include cattle grazing and horticulture.

In addition to rural residential and agricultural land uses, the following built features are also found on the airport site:

- the former Badgerys Creek Primary School (closed in December 2014);
- Badgerys Creek Park;

- four gravesites (St Johns Anglican Church, Badgerys Creek Uniting Church, Anschau family grave (Luddenham), and St Francis Xavier Church);
- a quarry (Blue Sky Mining); and
- scout hall.

Badgerys Creek flows along the southern and eastern boundary of the airport site, and Oaky Creek originates in the centre of the site and flows northwards. Both creeks drain to South Creek and the Hawkesbury River.

The airport site is contained within the 'Cumberland Plain' Mitchell Landscape. This landscape 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 forest dominated by Grey Box (*Eucalyptus moluccana*) and Forest Red Gum (*Eucalyptus tereticornis*) and poorly drained valley floors with forests of Cabbage Gum (*Eucalyptus amplifolia*) and Swamp Oak (*Casuarina glauca*).

The airport site contains a number of internal roads, all of which (except for The Northern Road) were compulsorily acquired by the Australian Government in July 1991. The following roads within the site are currently maintained by Liverpool Council under an agreement with the Australian Government:

- Anton Road
- Badgerys Creek Road
- Ferndale Road
- Fuller Street
- Gardiner Road
- Jackson Road
- Jagelman Road
- Leggo Street
- Longleys Road
- Pitt Street
- Taylors Road
- Vicar Park Lane
- Winston Close

It is noted that Willowdene Avenue also crosses the site in part. This road is not owned by the Commonwealth or proposed to be acquired.

The arterial roads that currently service the site are:

- Elizabeth Drive – a classified road which forms the northern border of the airport site;
- The Northern Road – a classified road which intersects the western part of the airport site on a north-west to south-east alignment; and
- Badgerys Creek Road – a local road which intersects the eastern part of the airport site on a north to south alignment, connecting Elizabeth Drive to The Northern Road.

21.4.2. Surrounding land

The airport site is located within Liverpool LGA, with the northern airport site boundary coinciding with the Penrith LGA southern boundary at Elizabeth Drive. Beyond the immediate LGAs, Blue Mountains LGA lies to the west; Wollondilly, Camden and Campbelltown LGAs lie generally to the south; and Bankstown, Fairfield and Blacktown LGAs lie generally to the east of the airport site.

21.4.3. Liverpool local government area

The village of Luddenham is located immediately west of the airport site, generally straddling The Northern Road between Park Road and Adams Road. As of 2012, Luddenham village contained 224 properties with a population of 819 (Liverpool Council). Luddenham village comprises neighbourhood retail shops and low density residential housing with average lot sizes of around 500 square metres.

Luddenham also has two large recreation reserves (Luddenham Showground and Sales Park) and two primary schools (Holy Family Primary School and Luddenham Public School). The Hubertus Country Club directly adjoins the north-western boundary of the airport site. Rural residential properties of up to 10 hectares surround the village.

To the northeast/east of the airport site are the localities of Badgerys Creek and Kemps Creek. The Badgerys Creek riparian corridor defines the eastern boundary of the site. The land to the east of Badgerys Creek is largely used for agriculture, including the Ingham's Multiplication Farm (poultry farm). The recreational areas of Kemps Creek Nature Reserve and the Western Sydney Parklands are also located to the east of the airport site.

Southwest of the airport site in the locality of Greendale, land use is predominantly large lot rural-residential. Some agricultural activities are present, including the Leppington Pastoral Company and the University of Sydney Research Farms. The area contains the largest landholdings within Liverpool LGA with many properties exceeding 40 hectares in area (Liverpool Council 2012).

Bringelly is located 3.5 kilometres south of the airport site and is characterised by large lot residential properties. The 2012 Liverpool Rural Lands Study recommended 775 hectares of land be converted from RU1 to RU4 in order to further limit fragmentation of the land in Bringelly, with a minimum lot size of 10 hectares. A decommissioned Royal Australian Air Force Telecommunications facility and the Boral Bringelly Brickworks are also located in Bringelly.

21.4.4. Penrith local government area

Land uses are predominantly rural residential in the vicinity of Badgerys Creek to the north of the site. Adjoining the northern boundary of the airport site, north of Elizabeth Drive, is a cattle grazing farm adjacent to a landfill facility. The area north of the airport is drained by two creeks, Cosgroves Creek and Badgerys Creek, which are identified as 'Environmental Conservation' areas in the *Penrith Local Environmental Plan 2010* (Penrith LEP).

About three kilometres north of the airport site is the proposed Sydney Science Park. The area was rezoned in July 2015 from RU2 Rural Landscape to B7 Business Park, B4 Mixed Use and RE1 Public Recreation. The objectives of the rezoning are to accommodate research and development employment, education and supporting retail, and residential uses. The Sydney Science Park would form part of the Broader Western Sydney Employment Areas (refer to Section 21.5.4) for further details.

About five kilometres north of the airport site is the Twin Creeks estate. The 340 hectare estate comprises an 18-hole golf course, function centre, restaurant and more than 200 dwellings.

The localities of Kemps Creek and Mount Vernon are located to the northeast of the airport site. These localities largely comprise rural residential dwellings with average lot sizes of 10 hectares. Lot sizes decrease in the eastern part of Mount Vernon, east of Mamre Road. These localities are drained by two creeks, South Creek and Kemps Creek, which are identified as an ‘Environmental Conservation’ area in the Penrith LEP.

The Defence Establishment Orchard Hills is located approximately nine kilometres north of the airport site and is utilised for storage, distribution and Defence explosive ordnance training.

21.5. Planning for Western Sydney Airport and surrounds

21.5.1. Australian Government legislation and regulation

21.5.1.1. Environment Protection and Biodiversity Conservation Act 1999

The Department of Infrastructure and Regional Development submitted a referral under the EPBC Act for the development of the proposed airport on 4 December 2014. The Department of the Environment invited public comment on the referral for 12 business days.

On 23 December 2014, a delegate of the Minister for the Environment determined the proposed Western Sydney Airport to be a controlled action. The referral decision instrument identifies the following controlling provisions under the EPBC Act as being relevant for this proposal:

- world heritage properties (sections 12 and 15A);
- national heritage places (sections 15B and 15C);
- listed threatened species and communities (sections 18 & 18A); and
- Commonwealth actions (section 28).

The delegate also determined that the proposed airport development would be assessed by the preparation of an EIS. As a result of recent amendments to the *Airports Act 1996* (Airports Act), approval decision under Part 9 of the EPBC Act is not required, but the EIS for the proposed airport must be prepared and an Airport Plan for the proposed Airport must be determined before the proposed airport can proceed.

21.5.1.2. Airports Act 1996

The proposed Western Sydney Airport would be developed and operated under the Airports Act. The Airports Act has been amended to provide for an Airport Plan which is a transitional planning instrument for the initial development of Western Sydney Airport as a greenfield airport site. This amendment provides a single and transparent environment and development approval for the Western Sydney Airport proposal. The Airports Act amendment provides for the preparation of an Airport Plan which is determined by the Minister for Infrastructure and Regional Development.

In determining the Airport Plan the Minister for Infrastructure and Regional Development must accept any environmental conditions proposed by the Minister for the Environment, taking into account the EIS.

An airport lease would in due course be granted by the Commonwealth to an airport lessee company which would then become responsible for the airport site. Leased federal airports are subject to a planning framework set out in the Airports Act. As part of the planning framework, airports are required to prepare a Master Plan that incorporates an Environment Strategy.

A Master Plan is a 20-year strategic vision for the airport site which is renewed every five years. It addresses future land uses, types of permitted development, and noise and includes an environment strategy. A Master Plan must also address the likely effect of the proposed development on the local and regional economy and community. This includes an analysis of how the proposed development fits within the planning schemes for commercial and retail development in the area that is adjacent to the airport.

The Environment Strategy sets out the airport's strategy to manage environmental issues within a five-year period and beyond. It is the basis on which the Commonwealth measures the environmental performance of airports and the document by which airport tenants would determine their environmental responsibilities. Leased federal airports are subject to a planning framework set out in the Airports Act. As part of the planning framework, airports are required to prepare a Master Plan that incorporates an Environment Strategy.

21.5.1.3. Australian Standard 2021

The Australian Standard 2021:2015 – Acoustics – Aircraft noise intrusion – Building siting and construction (Australian Standard 2015) provides guidance on the siting and construction of buildings in the vicinity of airports to minimise aircraft noise intrusion. The guidance provided by AS2021 is based on the level of potential aircraft noise exposure at a given site using the Australian Noise Exposure Forecast (ANEF) system.

The NSW Government and local councils give effect to AS 2021 in land use planning for new development in environmental planning instruments, and as a necessary consideration in building siting and design as part of the assessment of new development applications within the noise impact zone of airports.

Airservices Australia provides air traffic control, aviation rescue and firefighting as well as other related services to the aviation industry. This includes maintaining technology used by the industry for navigation and surveillance and aircraft noise monitoring.

Actions and processes under Airservices Australia’s policy on aircraft noise management are aligned to the International Civil Aviation Organization’s Balanced Approach to Noise Management. Four key elements of this approach are:

- reduction of noise at source – e.g. quieter planes, noise standards;
- land use planning and management – e.g. zoning, easements and building standards;
- noise abatement operational procedures – e.g. noise-preferred flight routes and runways; and
- operating restrictions on aircraft – e.g. flight curfews and quotas.

21.5.2. National Airport Safeguarding Framework

The National Airports Safeguarding Framework (NASF) is a national land use planning framework, agreed to by Commonwealth, State and Territory Ministers in 2012. The NASF recognises that responsibility for land use planning rests with State and local governments, but that a national approach can assist in improving planning outcomes on and near airports and flight paths. The framework aims to:

- Improve community amenity by minimising aircraft noise-sensitive developments near airports including through the use of additional noise metrics and improved noise-disclosure mechanisms; and
- Improve safety outcomes by ensuring aviation safety requirements are recognised in land use planning decisions through guidelines being adopted by jurisdictions on various safety-related issues.

The NASF comprises seven key planning principles:

- Principle 1: The safety, efficiency and operational integrity of airports should be protected by all governments, recognising their economic, defence and social significance;
- Principle 2: Airports, governments and local communities should share responsibility to ensure that airport planning is integrated with local and regional planning;
- Principle 3: Governments at all levels should align land use planning and building requirements in the vicinity of airports;
- Principle 4: Land use planning processes should balance and protect both airport and aviation operations as well as community safety and amenity expectations;
- Principle 5: Governments will protect operational airspace around airports in the interests of both aviation and community safety;
- Principle 6: Strategic and statutory planning frameworks should address aircraft noise by applying a comprehensive suite of noise measures; and
- Principle 7: Airports should work with governments to provide comprehensive and understandable information to local communities on their operations concerning noise impacts and airspace requirements.

The NASF guidelines provide comprehensive information and recommendations relating to six airport safeguarding matters. The NASF guidelines are:

- Guideline A: Measures for Managing Impacts of Aircraft Noise;
- Guideline B: Managing the Risk of Building Generated Windshear and Turbulence at Airports;
- Guideline C: Managing the Risk of Wildlife Strikes in the Vicinity of Airports;
- Guideline D: Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation;
- Guideline E: Managing the Risk of Distractions to Pilots from Lighting in the Vicinity of Airports; and
- Guideline F: Managing the Risk of Intrusions into the Protected Airspace of Airports.

Additional guidelines for the protection of Public Safety Zones and Communication, Navigation and Surveillance infrastructure are proposed to be developed by National Airports Safeguarding Advisory Group in the near future.

21.5.3. Protection of Operational Airspace Surfaces

Protecting immediate airspace around airports is essential to ensuring and maintaining a safe operating environment and to provide for future growth.

Obstacle Limitation Surfaces (OLS) are a series of surfaces that define the airspace to be protected for aircraft operations during the initial and final stages of flight. The OLS are generally the lowest surfaces and are designed to provide protection for aircraft flying into or out of an airport when the pilot is flying by sight.

The Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS) provide for the establishment of surfaces to protect aircraft during take-off, landing or manoeuvring and when aircraft are operating in non-visual conditions. The PANS-OPS surfaces are generally above the OLS and are designed to safeguard an aircraft from collision with obstacles when an aircraft's flight may be guided solely by instruments, in conditions of poor visibility.

Structures, trees or other activities that intrude into these surfaces are potential obstacles to aircraft, and therefore a potential safety hazard, and must be controlled.

Both OLS and PANS-OPS would be prepared for the proposed airport.

21.5.4. NSW Government Legislation

The NSW planning legislative framework consists primarily of the *Environmental Planning and Assessment Act1979* (the EP&A Act) and the *Environmental Planning and Assessment Regulation 2000* and the following three key instruments which are made under the EP&A Act:

- State environmental planning policies (SEPPs) – these policies outline the NSW Government's approach to dealing with particular planning issues. They can be either site or subject specific. Often SEPPs would provide land zoning and development controls, designate particular types of development for State or regional planning governance, or add specific requirements for existing development processes.
- local environmental plans (LEPs) – each local government area has a LEP to guide development and protect natural resources within local government areas. LEPs are prepared by local councils and made by the NSW Minister for Planning. Most follow a standard form and include mainly standard provisions, which are applied to the particular circumstances of the relevant LGA.
- local planning directions, issued by the Minister for Planning under section 117 of the EP&A Act, provide direction on matters which planning proposals need to address.

21.5.5. State Environmental Planning Policies

A summary of SEPPs that are relevant to planning and land use around the proposed airport is presented in Table 21–1.

Table 21–1 – Applicable State environmental planning policies

State environmental planning policy	Provision
State Environmental Planning Policy (Sydney Region Growth Centres) 2006 (Growth Centres SEPP)	This policy aims to coordinate the release of land for residential, employment and other urban development in the North West and South West Growth Centres of Sydney. The proposed airport site is located adjacent to the South West Growth Centre. The Growth Centres SEPP provides development controls for the land in the vicinity of the airport site.
State Environmental Planning Policy (Infrastructure) 2007 (Infrastructure SEPP)	This policy aims to facilitate the effective delivery of infrastructure across the State.
State Environmental Planning Policy (Western Sydney Employment Area) 2009 (WSEA SEPP)	This policy establishes the Western Sydney Employment Area (WSEA) to provide businesses in Western Sydney with land for industry and employment generating uses, including transport and logistics, warehousing and commercial office space. The WSEA lies to the north of the airport site.

21.5.6. Local planning directions

Under section 117(2) of the EP&A Act the NSW Government issues directions which the relevant consent authority should consider when preparing a planning proposal for a new (or amending) LEP. Relevant section 117 Directions are listed in Table 21–2.

Table 21–2 – Applicable section 117 directions

Direction	Objective	Requirement
3.5 Development near licensed aerodromes (issued July 2009)	The objective of this Direction is to ensure the effective and safe operation of aerodromes, uncompromised by development. It is also to ensure development for residential purposes incorporates appropriate mitigation measures so that the development is not adversely affected by aircraft noise.	A planning proposal that rezones land in the vicinity of an airport must include a provision to ensure that development meets AS 2021 regarding interior noise levels. The planning authority must also consult with the Commonwealth and take into account relevant development standards such as height limitations. Development which is compatible with the operation of an aerodrome must be permissible with consent.
5.8 Second Sydney Airport: Badgerys Creek (Issued in 2005. Re-issued July 2009)	The objective of this direction is to avoid incompatible development in the vicinity of any future second Sydney Airport at Badgerys Creek.	Planning proposals must not contain provisions that enable the carrying out of development, either with or without development consent, which could hinder the potential for development of a Second Sydney Airport. It should be noted that this direction was made by the minister in 2005, prior to the consolidation of section 117 directions in July 2009. This direction applies to land within the boundaries of the proposed airport site and the 20 ANEF contour of the 1985 Second Sydney Airport Draft EIS within Fairfield, Liverpool, Penrith and Wollondilly local government areas.

21.5.7. Strategic documents

21.5.7.1. A Plan for Growing Sydney

A Plan for Growing Sydney (the Metropolitan Plan) (DP&E 2014) is the NSW Government's 20-year strategic development plan for the Sydney Metropolitan Area. It provides direction for Sydney's productivity, environmental management, and liveability. To deliver upon these directions, the Metropolitan Plan identifies the location of future housing, employment, infrastructure and open space areas. An element of the Metropolitan Plan outlines how the proposed airport would transform Western Sydney.

Action 1.4.1 of the Metropolitan Plan aims to improve transport links and create a new services centre and industrial precinct to support the growth of the proposed Western Sydney Airport. The proposed airport would transform and drive future investment and jobs growth in Western Sydney. In order to protect and promote the proposed airport, the NSW Government plans to:

- ensure adequate development controls are provided for areas affected by aircraft noise and airspace to provide for future aviation needs;
- preserve land for complementary airport-related activity including a jet fuel pipeline to service the proposed airport and freight-related uses; and
- identify and preserve future transport and infrastructure corridors and related sites in the Western Sydney Airport precinct.

Accordingly, the proposed Western Sydney Airport is appropriately identified in and compatible with the broader strategic planning for Sydney.

The NSW Government seeks to develop strategic employment corridors to service the proposed airport to capitalise on the airport development. In order to promote employment growth, under Action 1.4.2 of the Metropolitan Plan the NSW Government will:

- facilitate an enterprise corridor from Leppington to the proposed Western Sydney Airport along Bringelly Road, potentially linked to a future extension of the South West Rail Link. A flexible and innovative regulatory environment will be developed to enable a wide range of commercial activities to take advantage of transport access to this precinct and its proximity to the airport, Leppington and the future population of the South West Growth Centre;
- facilitate development opportunities that can leverage off improved transport connections, including improvements to Elizabeth Drive, The Northern Road and Bringelly Road;
- investigate how improved transport connections, associated with the proposed South West Rail Link extension between the proposed Western Sydney Airport to the western line will influence land use planning; and
- preserve the land needed for a major intermodal terminal and for a related Western Sydney Freight Line between Port Botany and the Western Sydney Employment Area.

21.5.7.2. South West Priority Growth Area

The NSW Government established the South West Growth Centre (refer to Figure 21–1) in 2005 to encourage a sustainable plan for Sydney's greenfield land development on its urban edge. Planning for the South West Growth Centre is delivered primarily through *State Environmental Planning Policy (Sydney Region Growth Centres) 2006* (Growth Centres SEPP). It is now referred to as the South West Priority Growth Area.

The South West Priority Growth Area is located directly to the southeast and east of the airport site, with Badgerys Creek as the border. The area is about 17,000 hectares in size and incorporates land in Liverpool, Camden and Campbelltown LGAs. The South West Priority Growth Area comprises 18 precincts that are being progressively released for urban development. Seven of these precincts have already been rezoned since 2005 (Figure 21–1). The South West Priority Growth Area will ultimately provide 110,000 new dwellings and capacity for at least 22,000 jobs. The proposed extension of the South West Rail Link from Leppington to the airport and further north to the Western Line would also pass through the South West Priority Growth Area.

The area directly south and southeast of the airport site is identified in the South West Priority Growth Area Structure Plan as future industrial/employment lands. Further detailed planning for this area is being undertaken by the Department of Planning and Environment (DP&E). Detailed precinct plans are yet to be publicly released.

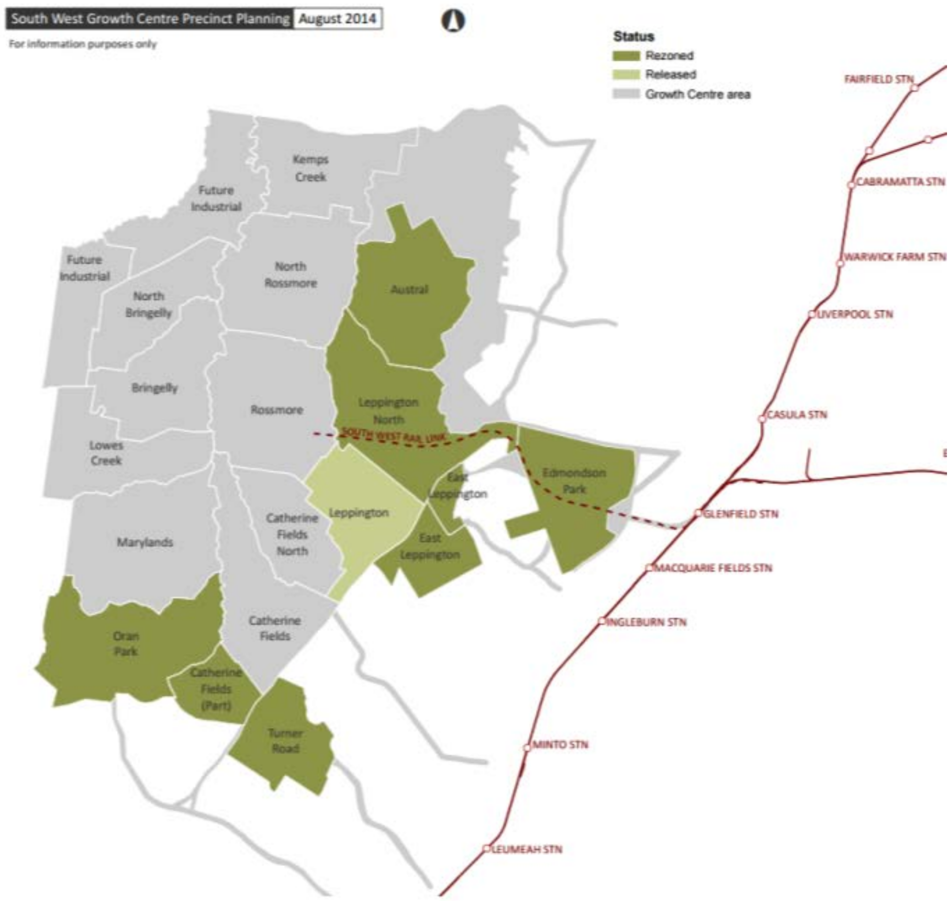

Figure 21–1 – South West Priority Growth Area (DP&E)

21.5.7.3. Western Sydney Employment Area

The NSW Government established the Western Sydney Employment Area (WSEA) to provide businesses in Western Sydney with land for industry and employment generating uses, including transport and logistics, warehousing and commercial office space (refer to Figure 21–2). The NSW Government forecasts the population of Western Sydney to rise from 2.1 million in 2011 to 2.9 million in 2031. The Western Sydney Employment Area has been developed to help provide employment opportunities to support this growth.

State Environmental Planning Policy (Western Sydney Employment Area) 2009 is the environmental planning instrument which outlines development controls for the Western Sydney Employment Area. In January 2015, the WSEA SEPP was amended to extend the boundaries to include land adjacent to the airport site (known as the Broader Western Sydney Employment Area). The Broader Western Sydney Employment Area amendment allows for even closer linkages between employment generating land uses and the proposed airport. The amendment identifies a further 4,573 hectares of land for future employment uses. The Broader Western Sydney Employment Area is expected to accommodate more than 36,000 industrial jobs and 21,000 office jobs over the next thirty years.

The Broader WSEA now comprises over 10,690 hectares of land, spanning four LGAs: Penrith, Blacktown, Liverpool and Fairfield. Most of the land in the newly identified employment area is zoned rural, allowing rural residential and/or agricultural uses. Other zoning in the area includes special uses for the Australian Department of Defence and environmental conservation areas.

Land within the more established northern portion of Western Sydney Employment Area has already been rezoned to industrial. The Broader Western Sydney Employment Area confirms the NSW Government's intention for additional future employment land uses and provides certainty for infrastructure agencies, landowners and businesses of intended future development objectives.

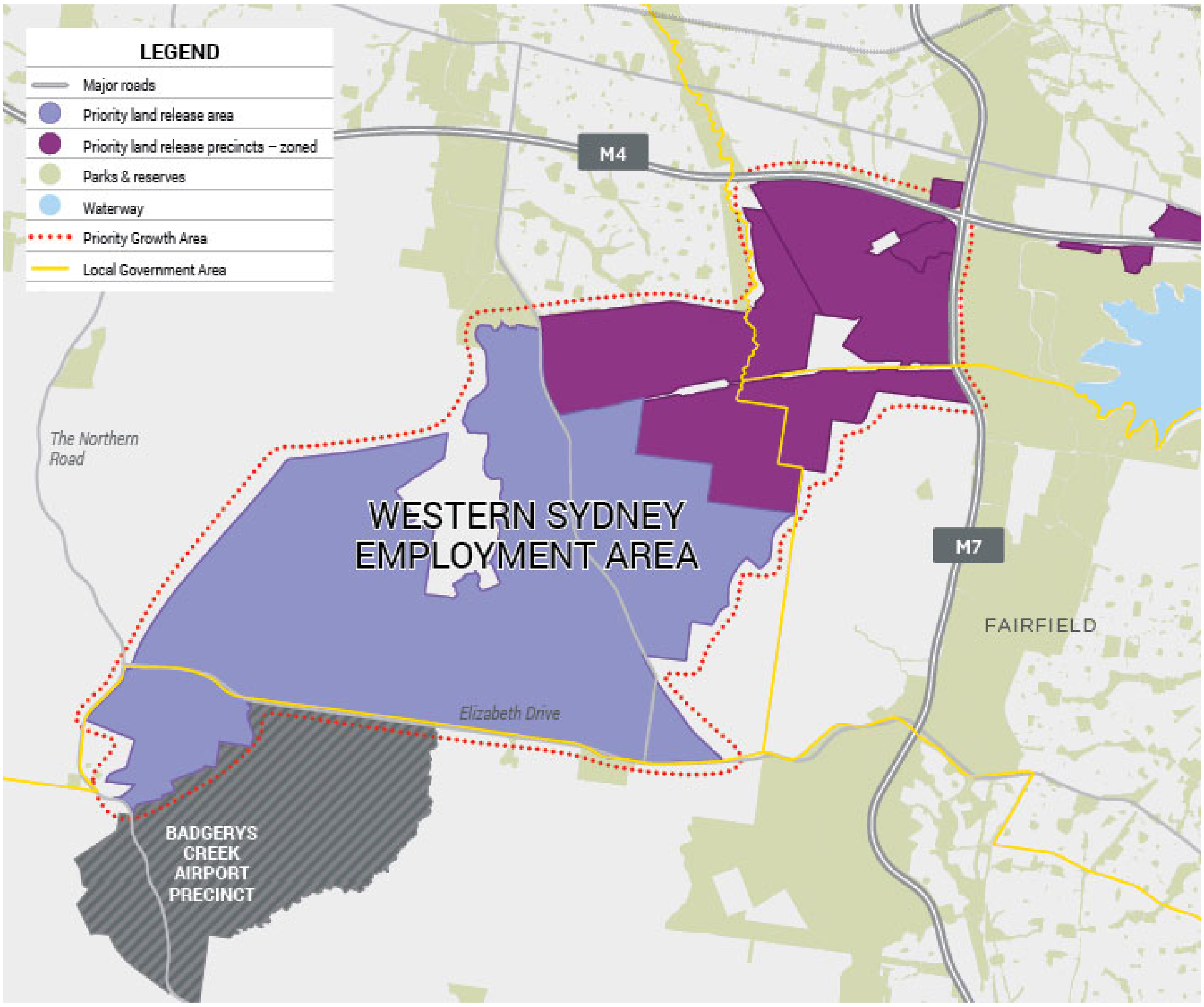

Figure 21–2 – Western Sydney Employment Area (DP&E)

21.5.8. Infrastructure projects

21.5.8.1. Western Sydney Infrastructure Plan

The Australian and NSW Governments are currently delivering a plan to improve transport infrastructure in Western Sydney. The Western Sydney Infrastructure Plan seeks to ensure that the proposed Western Sydney Airport would be supported by high quality transport infrastructure for the efficient movement of passengers, employees and freight. The Australian Government's contribution of $2.9 billion to the Western Sydney Infrastructure Plan includes funding for the following works:

- upgrade of The Northern Road to a minimum of four lanes from Narellan to Jamison Road, including realignment of the road around the western boundary of the airport site;
- construction of a new four-lane motorway between the M7 Motorway and The Northern Road;
- upgrade of Bringelly Road to a minimum of four lanes from Camden Valley Way to The Northern Road;

- improvement of interchanges connecting The Northern Road and a new motorway at Elizabeth Drive and Bringelly Road;
- building the Werrington Arterial Road between the M4 Motorway and the Great Western Highway;
- upgrade of Ross Street and Great Western Highway intersection at Glenbrook; and
- a $200 million local roads package.

21.5.9. Infrastructure projects

21.5.9.1. South West Rail Link Extension

The NSW Government is in the process of protecting a future public transport corridor that would extend the South West Rail Link which was opened for operation in February 2015. The proposed corridor extends from Leppington to Bringelly and then heads in two directions: south to Narellan and north to the Western Line near St Marys.

In the context of the South West Rail Link Extension, rail services would be required at the proposed airport initially through a connection to the Sydney metropolitan network and in the longer term, a dedicated airport express rail service from a key transport node. The rail line would be predominantly underground through the airport site to avoid critical infrastructure, and also preserves flexibility for a station(s) in the terminal precinct.

The Stage 1 development does not currently include a rail service as the forecast demand would not require rail access. However, planning for the airport preserves flexibility for two types of possible rail alignment options. These alignments would follow either a corridor under the terminal at 90 degrees to the runways, or along the airport site ground transport access corridor parallel to the runways, or a combination of both.

A final rail alignment would be determined in consultation with the NSW Government. Depending on the final alignment and preferred timing to develop rail services, some enabling work may be required during the Stage 1 airport development to future-proof the corridor. Any such work is expected to be subject to a separate approval process.

21.5.9.2. Outer Sydney Orbital

Transport for NSW is investigating suitable corridors for the Outer Sydney Orbital. The Outer Sydney Orbital would provide a north-south connection for a future motorway, freight rail, and where practical, may be co-located with the South West Rail Link Extension.

The proposed alignment would be located to the west of the airport site, possibly connecting the M5 South West Motorway to the M4 Western Motorway.

The proposed airport development is to the immediate east of the corridor investigation area. Transport for NSW has committed to take into consideration the development of the future airport by coordinating and working closely with relevant government agencies in assessing corridor options for the Outer Sydney Orbital. The corridor provides the opportunity for multimodal linkages for employment, freight and passenger movements directly related to the proposed airport.

21.5.10. Local government

21.5.10.1. Liverpool

Land use zones

The airport site is located within the Liverpool LGA. The *Liverpool Local Environmental Plan 2008* (Liverpool LEP) sets out the land use controls and matters for consideration for development within the Liverpool LGA, and follows the Standard Instrument format.

The majority of the airport site is zoned SP1 – Special Activities (Commonwealth) under the Liverpool LEP.

Surrounding land zones are RU1 – Primary Production (east and west), RU4 Primary Production Small Lots (south east) and R5 – Large Lot Residential (south). These lots allow for rural and residential land uses.

Noise management

Liverpool LEP, it included a provision (clause 7.18) for development in areas subject to potential aircraft noise from the proposed airport. This clause responds to the Minister's section 117 direction for noise management. Under clause 7.18:

- development consent is required for the erection of a building on land where the ANEF shown on the Liverpool LEP Airport Noise Map exceeds 20 if it is erected for residential purposes or for any other purpose involving regular human occupation;
- the following development is prohibited unless it meets the requirements of AS 2021 with respect to interior noise levels:
  - residential accommodation on land where forecast noise exposure levels exceed 20 ANEF; and
  - business premises, entertainment facilities, office premises, public administration buildings, retail premises and tourist and visitor accommodation on land where forecast noise exposure levels exceed 25 ANEF.
- the following development is prohibited:
  - educational establishments, hospitals and places of public worship on land where forecast noise exposure levels exceed 20 ANEF;
  - dwellings on land where forecast noise exposure levels exceed 25 ANEF (other than development consisting of the alteration, extension or replacement of an existing dwelling house where the development is consistent with the objectives of this clause); and
  - business premises, entertainment facilities, office premises, public administration buildings, retail premises and tourist and visitor accommodation on land where forecast noise exposure levels exceed 30 ANEF.

21.5.10.2. Penrith

Land use zoning

Penrith Local Environmental Plan 2010 (Penrith LEP) sets out the land use controls and matters for consideration for development within the Penrith LGA, and follows the Standard Instrument format. Surrounding land to the north of the airport site is zoned RU2 Rural landscape under the Penrith LEP.

There are three urban settlements in close proximity to the project area within the Penrith LGA. These are at Luddenham, Twin Creeks and Kemps Creek. Development under the Broader Western Sydney Employment Area would likely lead to land use transition in the Luddenham village (refer to Section 21.5.4).

- To the west of the site is Luddenham village, which spans Penrith and Liverpool LGAs. The applicable land use zones for the Luddenham village under the Penrith LEP are:R5 Large Lot Residential;
- R2 Low Density Residential;
- RU5 Village;
- B1 Neighbourhood Centre; and
- RE1 Public Recreation.

Twin Creeks Golf and Country Club is located about five kilometres north of the airport site. This locality comprises 200 large-lot residential dwellings and a golf course, and is zoned E4 Environmental Living.

Kemps Creek is to the north/northeast of the site, with a small village cluster within the RU4 Rural Small Holdings zoned land and a cluster of smaller lot rural residential properties in the E4 Environmental Living zone at Mount Vernon.

Oaky Creek and Badgerys Creek to the north of the site are zoned E2 Environmental Conservation.

Noise management

Clause 7.9 of Penrith LEP adopts provisions for noise management (similar to the Liverpool LEP). Under this clause development in the vicinity of the airport site must have regard to the use or potential future use of the site as an airport, and must not have an adverse impact on the development or operation of an airport.

Clause 7.9 applies to development that is on land near the airport site and is in an ANEF contour of 20 or greater. Prior to determining a development application to which this clause applies, Penrith Council must:

- consider whether the development would result in an increase in the number of dwellings or people affected by aircraft noise;
- consider the location of the development in relation to recommended development types within ANEF zones, as outlined in the AS 2021; and

- be satisfied that the development would meet AS 2021 with respect to interior noise levels for the purposes of:
  - if the development will be in an ANEF contour of 20 or greater—child care centres, educational establishments, entertainment facilities, hospitals, places of public worship, public administration buildings or residential accommodation; and
  - if the development will be in an ANEF contour of 25 or greater—commercial premises, hostels or hotel or motel accommodation.

21.5.10.3. Fairfield

Noise management

Whilst Fairfield City Council is yet to adopt any LEP controls for the management of aviation noise, Council adopted an interim policy in May 2014. The interim policy sets out 'deemed to comply' requirements for acoustic proofing measures for residential development in Horsley Park and Cecil Park.

These requirements apply to all forms of new residential accommodation (as defined under the Fairfield LEP 2013) permitted in zones RU1 – Primary Production, RU2 – Rural Landscape, RU4 – Primary Production Small Lots, RU5 – Village. The requirements also apply to alterations and additions to existing residential accommodation.

21.6. Assessment of impacts during construction

The incidental land use and planning impacts which may occur during the construction phase of the proposal are assessed in the relevant (noise, air quality and traffic) impact assessment chapters of this draft EIS (chapters 10, 11, 12 and 15).

Changes to land uses within the footprint of the airport site would occur with the commencement of construction of the proposed airport and continue throughout the operation of the airport. Potential impacts associated with land use changes at the airport site are discussed in the following section on operational impacts.

21.7. Assessment of impacts during operation

Having regard to the existing environment, strategic planning at the local and regional scale, and the scope of the proposal, the following likely impacts on land use and planning from the proposed airport have been assessed.

21.7.1. Land use impacts

21.7.1.1. Rural residential lands

Since the mid-1990s, land use planning controls have been in place to protect against the likely impacts of a potential airport at Badgerys Creek. The impacts of the proposed airport on sensitive surrounding land uses would likely be reduced by the considered application of land use zones and development controls that are largely already in place through planning instruments for the South West Priority Growth Area, Western Sydney Employment Area and local council planning controls.

With the development of the airport site, a change in character of the surrounding area is inevitable. The proposed airport is expected to accelerate the transition from rural-residential to urban land uses. This is already underway due to the planning intentions of the NSW Government in the expansion of the Western Sydney Employment Area and the South West Priority Growth Area. The proposed airport would increase passenger and freight road traffic, and result in increased aircraft noise and air quality impacts. The social impact assessment provides further details on these impacts and the socio-economic benefits expected from the proposed development (refer to Chapter 23).

21.7.1.2. Agricultural lands

Construction and operation of the proposed airport and associated urban expansion in Western Sydney over the next few decades would necessitate the loss of productive agricultural land that is close to the Sydney market. This loss of agricultural activity would occur both within the direct footprint of the proposed airport itself and within surrounding lands as land uses transition from rural to urban. Ongoing regional urbanisation is facilitated by the NSW Government's Metropolitan Plan which recognises the role of the proposed airport in transforming and driving future investment and jobs in Western Sydney.

Existing agricultural activities located in the Cumberland Basin are provided a competitive advantage of proximity to the Sydney market. Locational factors of agricultural activities in Western Sydney are seldom related to environmental or other factors of production. Agricultural activities which are currently located in areas affected by urban transition in Western Sydney would be displaced to alternate urban fringe locations. The Metropolitan Plan identifies other rural lands within or close to the Sydney metropolitan area which may be used as alternate agricultural sites. The Department of Primary Industries is also managing this transition, and released an Industry Action Plan for Agriculture in November 2014 which includes considerations in this regard.

21.7.1.3. Employment lands

The Broader WSEA was established directly in response to the announcement by the Australian Government in 2014 that the site for the proposed Western Sydney Airport would be the Commonwealth-owned land at Badgerys Creek. The extension of the boundary south to Elizabeth Drive and to include land west of the airport site resulted in over 4,500 more hectares being dedicated to employment growth in the area.

The proposed airport development supports the future development of the adjacent South West Priority Growth Area employment lands. The proposed airport would be a mutually beneficial land use creating demand for employment generating activities and transport infrastructure required for freight and logistics.

The Land Use Plan in the draft Airport Plan identifies land use zones for retail and commercial development within the airport site. Though specific businesses/activities are yet to be confirmed, the impacts of these proposals on the proposed airport and surrounding lands would be subject to a separate approval process under the *Airports Act 1996.* This may include a requirement for a Major Development Plan to be prepared, depending on the nature of proposed development.

21.7.1.4. Recreational lands

Badgerys Creek Park would be removed as part of the development of the airport.

Aircraft overflights may result in visual and noise impacts on the following recreational reserves:

- North – Twin Creeks Country Club, Ropes Creek Reserve (Erskine Park), Eastern Creek Raceway, Sydney International Equestrian Centre (Horsley Park), Western Sydney Parklands (Horsley Park), and Calmsley Hill City Farm (Abbotsbury); and
- South – Sales Park (Luddenham), Bents Basin State Conservation Area (Greendale), and Burragorang Recreation Area (Silverdale).

The Twin Creeks Golf Course could be exposed to more than 10 noise events above 70 dBA on average each day and Bents Basin Conservation Area could experience night time noise levels above 60 dBA, which could affect camping amenity, based on Stage 1 noise modelling (refer to Chapter 10). However, analysis has shown that noise exposure levels from aircraft overflights in these locations would generally not be significant for Stage 1 operations. Impacts on recreational lands are not currently addressed under AS2021.

Impacts on the Greater Blue Mountains World Heritage Area are assessed in Chapter 26.

21.7.1.5. Airport site land use zone

Most of the airport site is currently zoned SP1 – Commonwealth Activities under state planning instruments.

The Department of Infrastructure and Regional Development would liaise with the Department of Planning and Environment to ensure that all land which is to be incorporated into the airport site be rezoned to SP1 – Commonwealth Activities to provide clarity and certainty for the future use of the land and a consistency of zoning approach.

21.7.2. Airport operations

21.7.2.1. Airspace development controls

Protecting airspace on and around airports is essential to maintaining a safe operating environment. Obstacle Limitation Surfaces (OLS) and the Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS) surfaces would be identified for the proposed airport as part of ongoing operations planning.

OLS are a series of theoretical surfaces in the airspaces established under International Civil Aviation Organization guidelines. The OLS defines the airspace to be protected from protrusion by natural or man-made structures which might cause a safety hazard for aircraft during the initial and final stages of flight. The OLS serves as a first filter for assessing the operational impact of an obstacle. Subject to an assessment, obstacles may need to be lowered, removed or marked and/or lit and noted in aeronautical publications.

PANS-OPS are established to protect stages of flight during take-off, landing or manoeuvring and when aircraft are operating in non-visual conditions. Obstacles cannot be permitted into the PANS-OPS. If an obstacle were within the PANS-OPS, the published approach or departure procedure would need to be withdrawn and redesigned to ensure safe operation of aircraft.

The OLS and PANS-OPS for the proposed airport would be prescribed airspace under the *Airports (Protection of Airspace) Regulations 1996*. Part 12 of the *Airports Act 1996* regulates building and other activities within prescribed air space. The Department of Infrastructure and Regional Development would liaise with the NSW Department of Planning and Environment and relevant local councils to seek the adoption of the necessary OLS and PANS-OPS designs in applicable State environmental planning instruments to ensure future development does not impede safe aircraft operations in accordance with the National Airport Safeguarding Framework.

21.7.2.2. Aircraft noise

Land use planning by the NSW Government and local councils over the last two decades has had a high regard to the potential for aircraft noise from a proposed airport at Badgerys Creek. Planning for the South West Priority Growth Area anticipated the potential impacts of aircraft noise by locating a substantial buffer of employment-generating development areas against the airport site's south-eastern boundary.

As discussed previously, the NSW Minister for Planning's section 117 directions have required the adoption of planning controls in local environmental plans based on the 1985 EIS noise forecast. Following this approach, Liverpool Council prepared a Rural Lands Strategy in 2012 that recommended not expanding Luddenham village beyond its current extent as it may be impacted by aircraft noise from the proposed Western Sydney Airport.

For land use planning purposes, aircraft noise impacts are measured using the Australian Noise Exposure Forecast (ANEF) measure (refer to Chapters 10 and 11). The noise technical report prepared for the EIS provides Australian Noise Exposure Concept (ANEC) noise contour maps, which show forecast aircraft noise exposure levels for hypothetical future scenarios, based on indicative flight tracks and airport operating modes. It is expected that an endorsed ANEF noise exposure chart would be produced prior to the commencement of operations at the proposed airport. This would provide an updated noise exposure map to guide future land use planning. Table 21–3 identifies the recommended development types within ANEF zones, as outlined in AS2021.

Table 21–3 – Building Site Acceptability Based on ANEF zone (AS 2021)

Building Type	ANEF zone of site		
	Acceptable	Conditionally acceptable	Unacceptable
House, home unit, flat, caravan park	Less than 20 ANEF	20 to 25 ANEF	Greater than 25 ANEF
Hotel, motel, hostel	Less than 25 ANEF	25 to 35 ANEF	Greater than 30 ANEF
School, university	Less than 20 ANEF	20 to 25 ANEF	Greater than 25 ANEF
Hospital, nursing home	Less than 20 ANEF	20 to 25 ANEF	Greater than 25 ANEF
Public building	Less than 20 ANEF	20 to 30 ANEF	Greater than 30 ANEF
Commercial building	Less than 25 ANEF	25 to 35 ANEF	Greater than 35 ANEF
Light industrial	Less than 30 ANEF	30 to 40 ANEF	Greater than 40 ANEF
Other industrial	Acceptable in all ANEF		

A number of areas surrounding the airport site are identified as affected by noise generated by aircraft overflights and airport operations and are within ANEC contours. The NSW Department of Planning and Environment and relevant local councils would be consulted to ensure applicable environmental planning instruments are amended to include the revised ANEF forecast and supporting AS2021 building siting and development controls.

The implementation of *Guideline A: Measures for Managing Impacts of Aircraft Noise* under the NASF would be instrumental in managing potential future operational noise impacts for future land use planning and development around the airport.

21.7.2.3. Lighting

The proposed runway orientation limits the possible areas that could be affected by airport approach lighting and runway lighting. The location of the infrastructure buildings between the two runways also provides a buffer for the potential impact of the airport buildings' lighting on surrounding sensitive land uses. LED apron lighting and directional external lighting would minimise potential impacts to surrounding land. The proposed airport lighting would likely have minimal impact to the surrounding land uses.

Refer to Chapter 22 for further details relating to the assessment of light spill and sky glow.

21.7.2.4. Air quality

An air quality assessment prepared for the EIS provides a forecast of the air quality impacts to the surrounding areas. Potential impacts from the proposed airport include those on local and regional air quality, and human health (refer to Chapters 12 and 13 for further details).

Land use zoning under local environmental planning instruments, South West Sydney Priority Growth Area, and the Western Sydney Employment Area for employment generation and other less sensitive land uses are likely to avoid long term local air quality impacts on future sensitive receivers in the vicinity of the airport site.

The regional impact on air quality from operations at the proposed airport would be a cumulative effect of aircraft operations, road traffic, industrial emissions and other regional sources. The discrete direct impact of airport operations is not likely to be significant.

21.7.2.5. Traffic and transport

As outlined in the traffic and transport assessment (refer to Chapter 15), several local road improvements are planned for or underway in the vicinity of the airport site. Badgerys Creek Road would be partially closed as part of the development of the airport site.

The current alignment of The Northern Road would be partially acquired for the construction of the proposed airport. Investigations are proposed under the Western Sydney Infrastructure Plan to upgrade and realign The Northern Road to outside the western boundary of the airport site. In addition, Roads and Maritime Services and Transport for NSW are undertaking corridor studies for a new M12 motorway between The Northern Road and the M7 Westlink Motorway.

Planning for the proposed South West Rail Link Extension is expected to include a possible railway station to service the airport site. Opportunities for corridor protection are being considered in planning for the proposed airport and ongoing consultations with Transport for NSW, the Department of Planning and Environment and local councils are proposed.

21.7.3. Additional land acquisition

Although much of the land required for the construction of the airport has been acquired by the Australian Government, a small amount of additional land may be needed to meet operational safety and construction requirements.

The draft Land Use Plan for the proposed airport identifies parcels of land that may be acquired prior to the commencement of substantial works on the airport site.

A jet fuel pipeline may service the proposed airport in the future. It is important to note that a fuel pipeline corridor has not yet been identified. Consultation is underway between the Department of Infrastructure and Regional Development and the NSW Department of Planning and Environment to identify a potential future corridor and seek to preserve the corridor through relevant planning controls. Arrangements for access to the fuel pipeline, which may involve an easement, are required along the pipeline corridor alignment to ensure maintenance access and as a public safety measure. This may include planning controls restricting development on and adjacent to the pipeline.

21.8. Mitigation and management measures

Having regard to the planning and land use impact assessment, Table 21–4 summarises the mitigation measures identified in this report for the construction and operation of the airport site.

Table 21–4 – Mitigation measures

ID	Issue	Mitigation measure	Timing
21.1	Corridor protection – road	Liaise with relevant State and local government agencies regarding future access arrangements from The Northern Road and Elizabeth Drive.	Pre-construction
21.2	Land use zoning	Liaise with the relevant State and local government agencies to seek the appropriate adjustment to zoning of the airport site under applicable environmental planning instruments.	Construction
21.3	Operational airspace	Liaise with relevant State and local government agencies to identify appropriate environmental planning instruments to reflect protected airspace under the Airports (Protection of Airspace) Regulations 1997.	Pre-operation
21.4	Noise	Liaise with the relevant State and local government agencies to identify appropriate noise management controls in applicable environmental planning instruments with reference to *AS2021-2000 Acoustics Aircraft noise intrusion – Building siting and construction* and noise guidelines under the National Airports Safeguarding Framework.	Pre-operation
21.5	Corridor protection – rail	Liaise with the relevant State government agencies to identify opportunities for corridor protection for the provision of future rail connection to the airport site.	Pre-operation
21.6	Corridor protection – fuel pipeline	Liaise with the relevant State and local government agencies to identify opportunities for protection of a corridor for a future fuel pipeline.	Pre-operation

21.9. Conclusion

The development of the proposed airport would change the rural character of Badgerys Creek and surrounding lands. This land use outcome has been anticipated in Commonwealth, NSW and local government strategic planning for the area over several decades. The Australian Government will continue to work closely with State government agencies and local councils to ensure regional and local land use planning complements the future operation of the proposed airport and limits incompatible land uses in the vicinity of the airport site.

The proposed airport development would be a catalyst for a range of infrastructure projects flagged by government to support Western Sydney's growth into the future. The proposed airport development would also be a focus for employment generating development in Western Sydney, creating jobs for the new residents of the South West Priority Growth Area.

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22. Landscape and visual amenity

The airport site and surrounds is typified by gently undulating landform within a highly modified landscape. The overall landscape character is open and rural with expansive views possible from surrounding hill tops and higher elevations to the west. The area's character is also defined by cleared pastureland, and large lot residences (both single and double storey) set back from the road network and punctuated with exotic planting. Patches of remnant vegetation exist within the airport site, particularly along creek lines, road edges and near farm dams.

The construction of the proposed airport is likely to have temporary visual impacts for the nearest sensitive receivers in Luddenham and Bringelly. This would be largely due to the visual effect of earthworks and the presence of construction plant, equipment, stockpiling areas and storage areas. Viewpoints that are further away would have more restricted views of the site and would therefore be less affected.

During operation, the potential for moderate to high visual impacts as a result of overflights have been identified for Luddenham, Elizabeth Drive, Lawson Road and Mount Vernon. Lower level impacts as a result of overflights were identified for areas to the south of the airport site including Silverdale Road, Bents Basin State Conservation Area and Dwyer Road. Operational lighting is likely to have low impacts on sensitive receivers due to topography, existing vegetation, building design, lighting design and runway configuration.

Mitigation measures have been proposed to minimise visual impacts during construction and operation. These include design measures as well as investigating opportunities for retention of existing vegetation and revegetation in suitable areas.

22.1. Introduction

This chapter provides a review of the visual and landscape values for the airport site and surrounding locality. The chapter draws upon a comprehensive visual assessment undertaken for the proposed airport which is included as Appendix N in Volume 4. The assessment considers the visibility of the proposed airport from key vantage points in the surrounding locality and the potential impacts on the visual and landscape character of the area.

The assessment addresses the requirements of the *Guidelines for the Content of a Draft Environmental Impact Statement – Western Sydney Airport* (EIS guidelines) issued by the Commonwealth Department of the Environment for consideration of landscape and visual impacts associated with the proposal. The visual impact of aircraft overflights on the Blue Mountains World Heritage area is assessed in Chapter 26.

22.2. Methodology

The methodology for the visual impact assessment has been adapted from the approach developed by NSW Roads and Maritime Services as set out in the *Environmental Impact Assessment Practice Note – Guideline for Landscape Character and the Visual Impact Assessment and Guidelines for Landscape Visual Impact Assessment* (RMS 2013). The assessment focuses on the effect on visual amenity including specific viewpoints in the surrounding area.

The guidelines establish an assessment process for visual impact by reference to the sensitivity of the area and the magnitude (or visual effect) of the proposal in that area.

Visual sensitivity refers to the character of a setting, the quality of a view and how critically a change to the existing landscape would be viewed from various viewpoints. For example, using recreation areas view the surrounding landscape as part of their leisure experience and would consider view changes to the landscape more critically than others.

The visual magnitude (or visual effect) of a development is the degree of contrast between the development and the pre-existing landscape.

The visual impact of a proposal is determined by considering both the sensitivity of the receivers and the magnitude of impact as indicated in Figure 22–1. The combination of visual sensitivity and visual magnitude results in specific levels of impacts for each receiver.

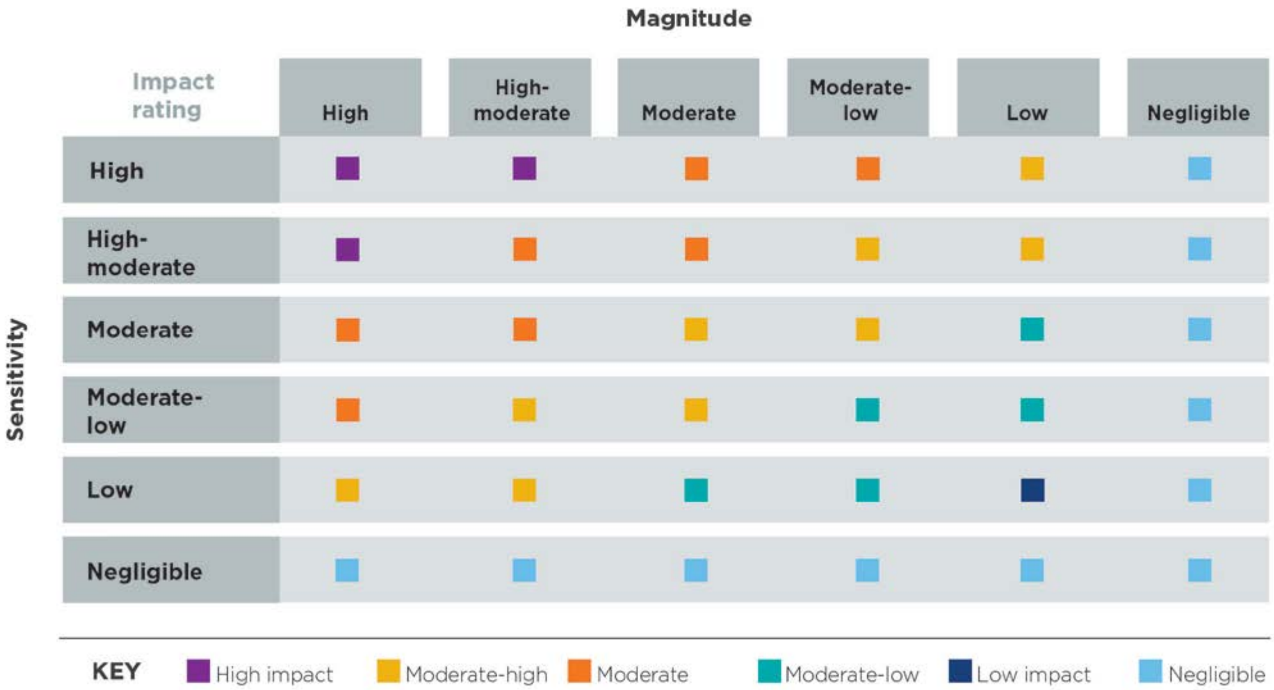


Figure 22–1 – Landscape character and visual impact grading matrix

The assessment considers the visibility of the proposed airport from representative viewpoints, identifies visual sensitivity and then assesses visual impact. The viewpoints selected for assessment are intended to represent a range of typical views found within the area, including those viewpoints where a reduction in visual amenity would have some visual impact due to:

- the duration of the view (such as views from residential areas);
- the importance of visual amenity to the experience of the location (such as recreational areas); or
- where there are large numbers of potential viewers (such as busy roads).

The visual impacts of the construction and operation of the Stage 1 development are considered in this chapter. Potential visual impacts associated with the long term development are considered in Chapter 38.

22.3. Existing environment

22.3.1. Site context

The airport site and surrounding areas include ridgelines and rolling hills within the visual context of the Greater Blue Mountains World Heritage Area to the west, which provides the backdrop for many views from the east.

The site landscape is typically gentle and undulating within a highly modified landscape. The overall landscape character is open and rural with views determined by both landform and trees with expansive views possible from surrounding hilltops and higher elevations to the west. The area’s character is also defined by cleared pastureland and large lot residences (both single and double storey) set back from the road network and punctuated with exotic planting. Patches of remnant vegetation exists within the airport site, particularly along creek lines, road edges and near farm dams.

Immediately north of the site are farm buildings generally set well back from Elizabeth Drive. The area north of Elizabeth Drive is rural pasture land with scattered remnant vegetation, farm dams and open views of the landscape. North-east of the airport site is a landfill, which is set back and screened from Elizabeth Drive and therefore has only a minor visual presence. Badgerys Creek runs north–south forming the eastern, and part of the southern, site boundary. The remnant vegetation along its edges establishes a natural character which contrasts with the open rural character of the rest of the site. It also screens views to the eastern areas of the airport site from viewpoints further east.

East of the airport site there is a more regular patterning of lots, residences and farm buildings, with smaller lot sizes aligned perpendicular to the streets. Roads in the area have undefined edges and contribute to the overall rural character. A good example can be seen in Photograph 22–1.

Photograph 22–1 – View south from Lawson Road

The area south of the airport site near Badgerys Creek Road is characterised by large, rural residential lots and farms on undulating topography. Homes are generally set back from the road and characterised by a mix of remnant vegetation, exotic planting, farm dams and open lawn. An example can be seen in Photograph 22–2.

Photograph 22–2 – View west from Badgerys Creek Road

The Bringelly and Greendale areas south and south-west of the airport site are characterised by large lot rural houses, within a mix of remnant native vegetation, exotic tree plantings and mown grass areas. The landscape opens up in areas with views west to the Greater Blue Mountains World Heritage Area as shown in Photograph 22–3.

Photograph 22–3 – View west from Dwyer Road, Bringelly

Luddenham is the most urbanised of the areas near the airport site. It consists of a retail area accessed from The Northern Road and a residential area to its east. The character of the residential area is shown in Photograph 22–4.

Photograph 22–4 – View north-west along Jamison Road, Luddenham

Mount Vernon is a sparsely populated rural suburb approximately five kilometres north-east of the airport site. Much of the suburb consists of an undulating landscape and some rural-residential properties have views over the wider area including to the west toward the airport site and the Greater Blue Mountains World Heritage Area. This is shown in Photograph 22–5.

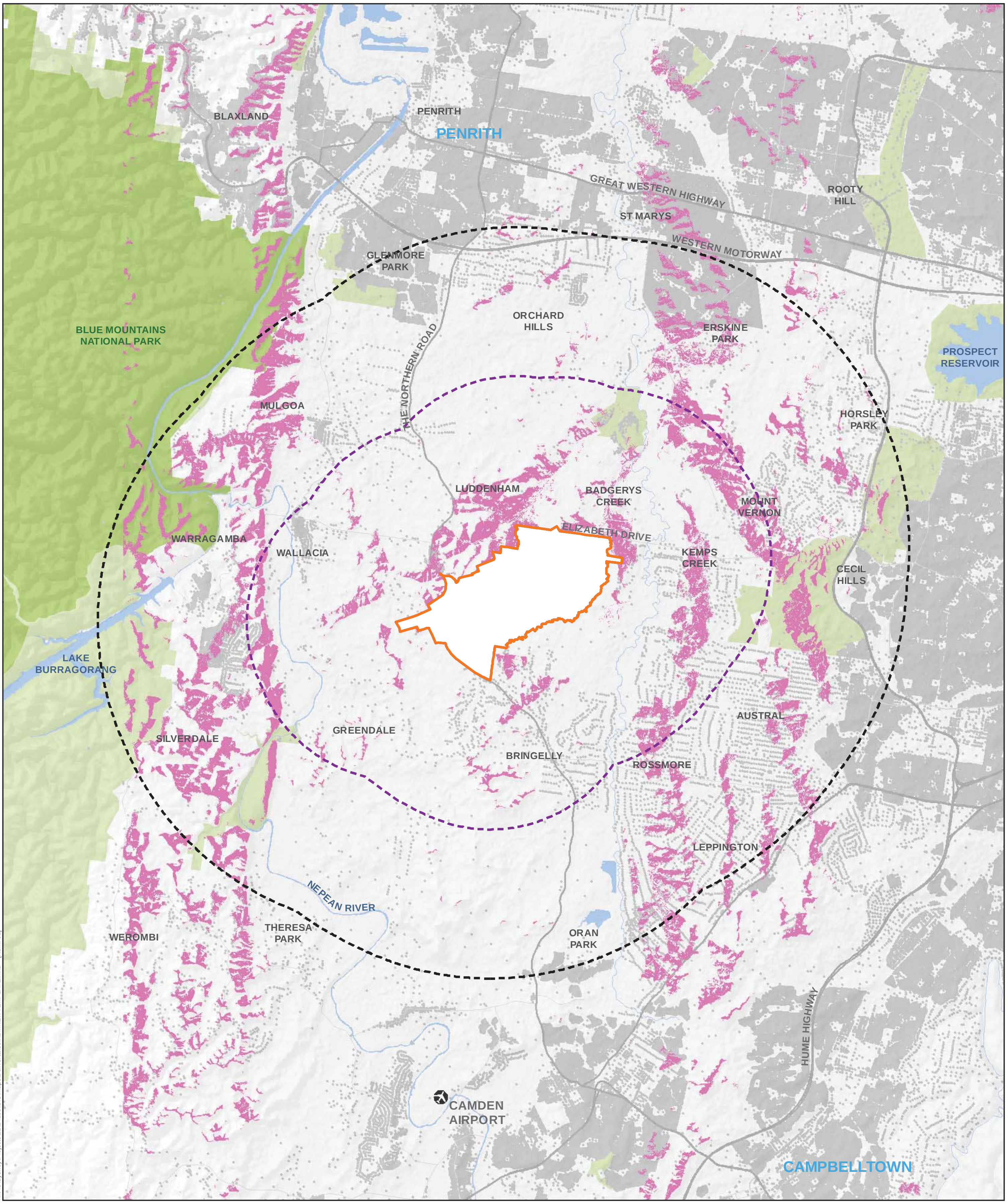
Photograph 22–5 – View south from Mount Vernon Road, Mount Vernon

22.3.2. Visual catchment and viewpoints

The visual catchment of a site is the extent of the landscape that can be viewed from the site and the extent of locations from which the site can be seen. Landscape vegetation, land use and landform all play a large role in determining the visual catchment.

The visibility of the airport site was determined for areas within a 10 kilometre radius, based on the maximum allowable structure heights within the obstacle limitation surface established for the purpose of flight safety. This gave a better understanding of the potential visibility of the proposed airport development and informed the selection of representative viewpoints for analysis. The assessment of visibility was inherently conservative, as the majority of the buildings expected to be developed as part of the Stage 1 development would be two to three storeys high, falling well below the maximum elevation permitted by the obstacle limitation surface. Figure 22–2 illustrates the visibility of the Stage 1 development.

The airport site would be theoretically visible from the pink shaded areas based on existing topography and the maximum allowed building heights of key buildings and structures that would be constructed, such as the airport control tower, terminal buildings and other major structures. Existing structures or vegetation in the surrounding areas were not taken into account, but their presence would further limit visibility from surrounding sensitive viewpoints.



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

LEGEND
- Airport site
- 5km Site Buffer
- 10km Site Buffer
- Areas of no theoretical visibility
- Areas of theoretical visibility

0 1 2 4
Kilometres

N

Figure 22-2 - Visibility of the Stage 1 Airport Development

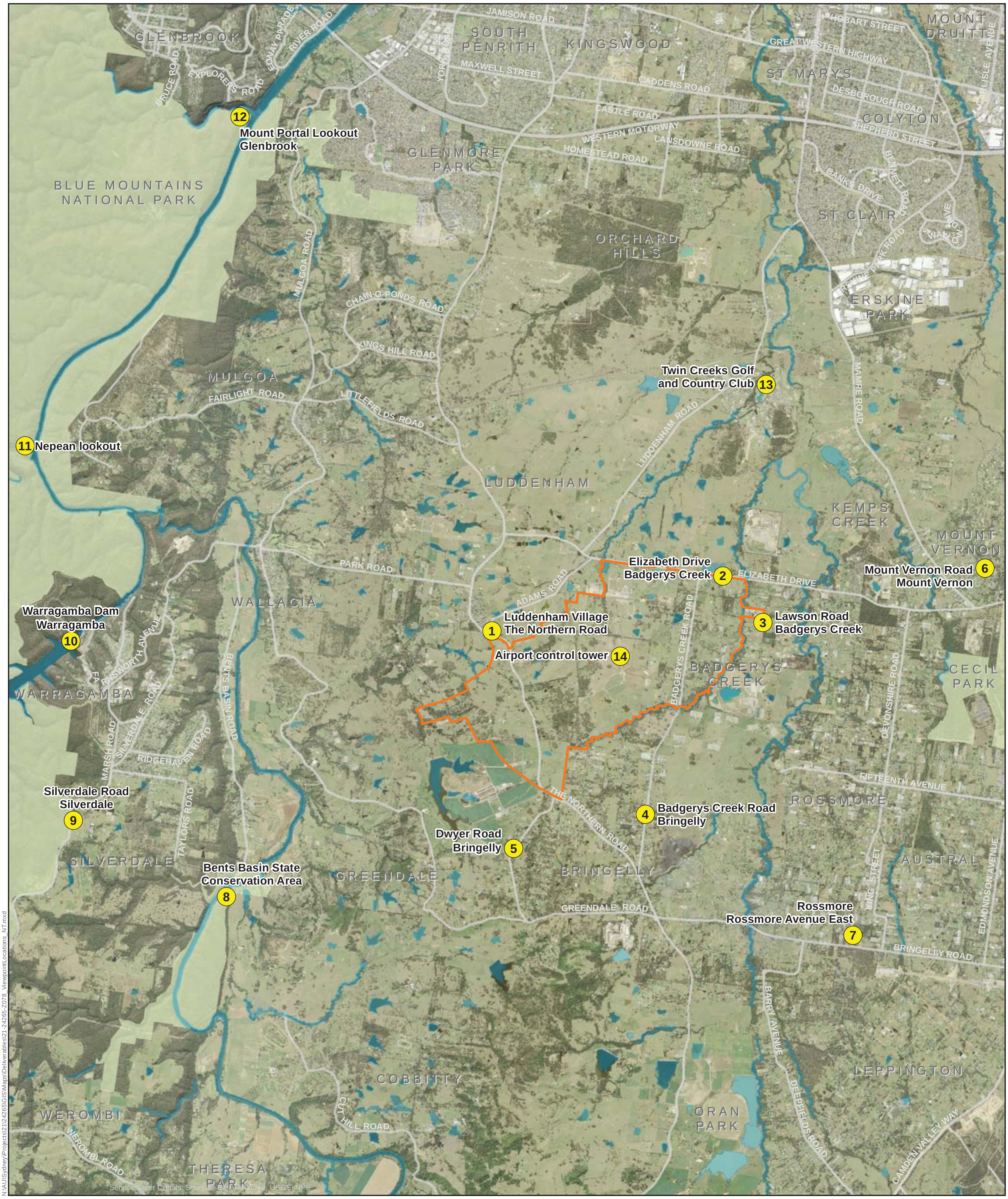
Viewpoints were selected for the assessment to represent a range of typical views found within the area. The details of each viewpoint are provided in Table 22–1, while the location and direction of each viewpoint from the air traffic control tower is shown in Figure 22–3.

The selected viewpoints are considered to represent locations where a reduction in visual amenity would have some visual impact either because of:

- the duration of the view (such as views from residential areas);
- the importance of visual amenity to the land use (such as recreational areas); or
- expected large numbers of potential viewers (such as busy roads).

Table 22–1 – Relative heights and distances to representative viewpoints

Viewpoint No.	Location	Approximate height (metres above sea level)	Approximate distance to the air traffic control tower
1	Luddenham Village, east of The Northern Road, Luddenham	100–105	3 kilometres
2	Elizabeth Drive, Badgerys Creek	65–90	2 kilometres
3	Lawson Road, Badgerys Creek	60–65	3 kilometres
4	Badgerys Creek Road, Bringelly	60–75	2 kilometres
5	Dwyer Road, Bringelly	105	5 kilometres
6	Mount Vernon Road, Mount Vernon	80	7 kilometres
7	Rossmore Avenue East, Rossmore	90	7 kilometres
8	Bents Basin State Conservation Area	45	10 kilometres
9	Silverdale Road, Silverdale	210	13 kilometres
10	Warragamba Dam, Warragamba	155	12 kilometres
11	Nepean Lookout, Glenbrook, Greater Blue Mountains World Heritage Area	115	13 kilometres
12	Mount Portal Lookout, Glenbrook, Greater Blue Mountains World Heritage Area	150	14 kilometres
13	Twin Creeks Golf and Country Club, Luddenham	45–50	6 kilometres



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

LEGEND

- Badgerys Creek site boundary
- Waterways
- Parks and reserves
- Roads
- Viewpoints

0 1 2 4
Kilometres

Figure 22-3 - Location of viewpoints used for assessment

22.3.3. Assessment of impacts

The assessment of visual impacts for the proposed airport has been completed based upon the methodology for assessing visual sensitivity and visual magnitude as discussed in section 22.2. Visual sensitivity is based primarily upon the character, land use and quality of views from surrounding viewpoints, and would be relatively consistent throughout each phase of the proposed development. The visual magnitude or effect of the proposed airport would change based on the scale and visibility of activities undertaken during the construction and operation of the Stage 1 development.

This section provides an analysis of the potential activities during construction and operation of the Stage 1 development, which would influence the visibility and magnitude of the visual impact of the proposed airport. The visual impact of the proposed airport from these representative viewpoints is then assessed.

22.3.4. Construction

Construction of the proposed airport would result in substantial changes to the landscape, primarily through major earthworks and the removal of existing vegetation. The area would change from an undulating, rural landscape to an essentially flat, constructed landscape. This would occur in the context of an area that has limited capacity to absorb the change due to limited vegetation cover, the form of the land, the frequency of views, and the distance between viewers and the Stage 1 development. While the changes to the landform would become a permanent feature, the visual effect of earthworks, construction plant, equipment, stockpiling areas and storage areas would be temporary and confined to the construction period.

Construction activities include the works necessary for site preparation and the works involved in the establishment of aviation infrastructure. Major construction activities would consist of erecting security fencing, establishing temporary site facilities, bulk earthworks, topsoil stripping and stockpiling, construction of access roads and services, and the construction of aviation infrastructure.

22.3.5. Operations

22.3.5.1. Airport infrastructure

There would be two general types of visual impacts created by the operation of the Stage 1 development. The visual impact for the airport site from representative viewpoints is discussed in Section 22.3.6:

- permanent views of the airport site with associated infrastructure including:
  - a 35 metre high air traffic control tower;
  - a 3,700 metre long runway and associated taxiway system;
  - passenger terminal and freight buildings;
  - other facilities including aircraft stands, emergency services, aircraft maintenance facilities, navigational aids and lighting; and
- ongoing views of aircraft taking off and landing.

22.3.5.2. Airport lighting

Potential lighting impacts associated with the operation of the proposed airport were considered in a specialised assessment (refer to Appendix N in Volume 4).

The draft Airport Plan provides an indicative concept design of how an airport may be developed at the airport site. A detailed approach to airport lighting would be developed as part of the detailed design of the proposed airport to comply with civil aviation regulatory requirements. In this context, this draft EIS has provided a preliminary assessment of lighting impacts has been based on information from the Civil Aviation and Safety Authority *Manual of Standards* and *Australian Standard AS 4280: Control of the obtrusive effects from outdoor lighting*. Consideration has also been given to the previous operational lighting impact assessment, performed as part of the *Supplement to Draft Environmental Impact Statement: Second Sydney Airport Proposal* (PPK 1999).

The *Manual of Standards* provides guidance on the design of airport lighting, including cyclic/flashing lighting and approach/runway lighting. The Manual regulates the light above the horizontal plane for lighting near runways to limit pilot confusion and glare. While this does not directly address the obtrusive effects of lighting (because the majority of lighting is directed skyward) visual impacts are anticipated to be minimal.

Taxiway lighting would likely be low intensity and would have a negligible effect beyond the airport boundary. Similarly, runway light fittings would be ground mounted and would likely have low visibility impacts.

The airport beacon light is designed to be at peak intensity between two and eight degrees above the horizontal plane. As the position of the beacon is elevated and the surrounding terrain is relatively flat, it is expected that visual impacts from the beacon light at ground level would be low.

Having regard to the provisions of Australian Standard *AS 4280: Control of the obtrusive effects from outdoor lighting*, the lighting for the proposed roads, car parks, apron lighting and other ancillary infrastructure is likely to be low impact, due to the large separation distances to sensitive receivers.

22.3.5.3. Sky glow

Sky glow (brightening of the night sky due to artificial lighting) can affect the work of professional and amateur astronomers and generally limit the community's ability to observe and appreciate the night sky. Animal populations can also be affected (refer to Chapter 16). The visual impact assessment identified three ways that sky glow may be generated by the proposed airport:

- Airfield direct light – the main source of sky glow would be from approach and runway lighting, which is designed to be visible from the sky. Ancillary infrastructure would be shielded from above to reduce sky glow;
- Reflected light – sky glow from reflection would be dependent on the lighting illumination level and how reflective nearby surfaces and structures are; and
- Building internal light – sky glow may also occur due to the internal illumination of buildings, which may be visible externally through windows on those buildings.

Sky glow is expected to be minimal from these sources, particularly if appropriate lighting fixtures are selected and oriented.

22.3.5.4. Aircraft and flight paths

As outlined in Chapter 7, the proposed airport would operate on a 24 hour basis with flights expected to occur during the day and night. Indicative flight paths for the Stage 1 operation of a single runway (in the preferred 05/23 orientation) show that aircraft would land from the south-west and take off to the north-east, or vice-versa.

An assessment of the indicative flight paths shows that aircraft may be directed over a range of visually sensitive areas, including residential areas, recreational areas and national parks, which may result in visual impacts beyond the airport site. Aircraft would be visible flying overhead as well as when they pass through views near the airport site. Both of these types of views are temporary and at varying distances/heights. Accordingly they would have a range of different impacts on visual receivers.

Arriving and departing aircraft would generally be less prominent the further they are away from the proposed airport. Views of aircraft would also be affected by airport operational patterns which, although generally consistent, could vary depending on wind conditions and other operational factors.

Generally aircraft at 3,000 feet are not prominent visual features although they are visible from the ground. Between 5 and 10 kilometres from the airport site, aircraft would have an altitude above 5,000 feet and increasing to above 10,000 feet above sea level. At 7,000 feet, aircraft are likely to be difficult to discern from ground level and are not considered to be visually obtrusive. For context, an aircraft at 3,000 feet is presented in Photograph 22–6. The expected altitudes of aircraft at various points along their flight paths are presented in Chapter 7. Built up areas are mostly at a distance of greater than six kilometres from the airport site and are unlikely to experience significant visual impacts.

Photograph 22–6 – Aircraft at approximately 3,000 ft at a ground distance of 2.75 kilometres

Many aircraft currently approaching and departing Sydney Airport fly over the Blue Mountains. Aircraft arriving and departing from the proposed airport would further contribute to the existing density of flights over the Blue Mountains, and would likely be at lower altitudes compared to aircraft using Sydney Airport. Consequently, aircraft approaching and departing the proposed airport would likely be more visible to residents and visitors in the Blue Mountains area.

The impact of aircraft overflights on the Greater Blue Mountains World Heritage values and other values are considered separately in Chapter 26 for the Stage 1 development and Chapter 41 for the long term development.

22.3.6. Representative viewpoints

An assessment of likely visual impacts at representative viewpoints during construction and operation of the Stage 1 development is provided in Table 22–2.

Table 22–2 – Impact assessment for representative viewpoints

Viewpoint		Assessment	Impact Level
1.	Luddenham Village east of The Northern Road, Luddenham	Sensitivity = Moderate–high This viewpoint is representative of views from the Luddenham commercial and residential area. Views to the south and west would be dominated by the proposed airport development and boundary fence in the foreground. There is assumed cultural value placed on the existing rural landscape by local residents where visual amenity is important and where residents and workers would be subject to long duration views. MAGNITUDE = Moderate–high The existing ridge line south of the Luddenham residential area would assist in restricting views directly south from residents, however airport development along the western boundary would likely be partially or directly visible by residents and workers. Viewing distance is approximately one kilometre from the western end of the runway and there would be views of aircraft taking off or landing. The surrounding rural landscape has limited capacity to absorb the visual effect of the proposed airport due to limited vegetation cover, landform, frequency of views and the distance between viewers and the proposed airport site.	Moderate-high
2.	Elizabeth Drive, Badgerys Creek	Sensitivity = Moderate This viewpoint is representative of views from drivers and passengers of vehicles using Elizabeth Drive. Views are brief but are relatively close to the northern areas of the proposed airport and runway. MAGNITUDE = High The existing landscape character within the airport site would be highly modified with landform changes and removal of the existing vegetation. The scale and nature of the airport site development would be noticeable with views of the Stage 1 development and boundary fence in the foreground. Aircraft would be similarly prominent as flights are expected to be directed over Elizabeth Drive (and the proposed M12 Motorway) from the eastern end of the runway.	Moderate-high
3.	Lawson Road, Badgerys Creek	Sensitivity = High This viewpoint is representative of views from rural residences and farms approximately five hundred meters east of the airport site boundary. Views toward the western part of the Stage 1 development may be possible from some properties with the boundary fence in the foreground. There is assumed cultural value placed on the existing rural landscape and the landscape along Badgerys Creek by local residents where visual amenity is important and where residents and workers would be subject to long duration views. MAGNITUDE = Moderate The clearance of vegetation and overall extent of change in topography is likely to be visible from some properties in this area. Nevertheless, it would not be prominent as the vegetation along Badgerys Creek would be retained as an environmental conservation zone that would obscure much of the airport site. Aircraft movements are expected to be directed to the north and the south, resulting in a lower level of impact than for viewpoints with direct overflights.	Moderate-high

Viewpoint	Assessment	Impact Level
4. Badgerys Creek Road, Bringelly	Sensitivity = Moderate–high This viewpoint is representative of views from rural residences and farms one to two kilometres south of the airport site boundary. Views to the north of the proposed airport and its features may be possible from some properties. There is assumed cultural value placed on the existing rural landscape by local residents where visual amenity is important and where residents and workers would be subject to long duration views. Magnitude = Low–moderate The clearance of vegetation and overall extent of change in topography is likely to be visible from some properties in this area, however it would not be prominent due to vegetation obscuring much of the airport site. Aircraft are expected to be visible as flights are directed in a north-south direction approximately one kilometre to the east of Badgerys Creek Road.	Moderate
5. Dwyer Road, Bringelly	Sensitivity = Moderate–high This viewpoint is representative of views from rural residences approximately two kilometres south of the airport site boundary. There is assumed cultural value placed on the existing rural landscape by local residents where visual amenity is important and where residents would be subject to long duration views. Magnitude = Low–moderate During construction and operation, views to the north of the proposed airport are unlikely due to existing obscuring vegetation and topography. Aircraft would be visible as movements are expected to be directed in a north-south direction approximately two kilometres to the east of Dwyer Road.	Moderate
6. Mount Vernon Road, Mount Vernon	Sensitivity = Moderate–high This viewpoint is representative of views from rural properties at elevations higher than Badgerys Creek approximately five kilometres from the airport boundary. Some properties have broad views of areas to the west and possibly of the Blue Mountains beyond. Sensitivity is derived from the assumed cultural value placed on the existing rural landscape by local residents where visual amenity is important and where residents would be subject to long duration views. Magnitude = Moderate Airport features such as the air traffic control tower as well as aircraft taking off and landing would be visible. Views of some areas within the airport site may be partially screened by vegetation and topography, depending on the elevation and aspect of individual residences. The overall landscape has some capacity to absorb views of the development given the views consist of an existing modified landscape character. Aircraft may be seen but at a distance of over four kilometres away.	Moderate-high
7. Rossmore Avenue East, Rossmore	Sensitivity = Moderate This viewpoint is representative of views from rural residential and agricultural properties approximately seven kilometres from the airport boundary. Properties in this area are at elevations higher than the airport site, some having broad views toward the west and north-west. The visual sensitivity of this location is derived from it being a residential and agricultural area, where visual amenity is important and where residents and workers would be subject to long duration views. Magnitude = Low Changes to the landscape including vegetation clearance, earthworks and new structures, such as the air traffic control tower and terminal, would result in a noticeable change in the view and a reduction in visual amenity although it would be filtered by local vegetation. Aircraft movements are expected to be visible in the sky at a distance of over five kilometres.	Moderate-low

Viewpoint	Assessment	Impact Level
8. Bents Basin State Conservation Area	Sensitivity = Moderate Some visual sensitivity at this location is derived from the importance of visual amenity due to its use as a state recreation area by visitors and staff. Visitor numbers fluctuate seasonally and are only temporary. At night the location would have a higher degree of sensitivity due to its use for overnight recreation. Magnitude = Low There are no direct views of the proposed airport, however visual receivers are expected to be able to see aircraft in the sky from a distance of approximately two kilometres.	Moderate-low
9. Silverdale Road, Silverdale	Sensitivity = Moderate This visual sensitivity of this location is derived from it being an elevated, rural residential area with broad expansive views over surrounding areas, where visual amenity is important and where residents are subject to long duration views. Residences are located approximately 10 kilometres from the airport site. Magnitude = Low Vegetation clearance for the airport would result in a change in the view and a reduction in visual amenity in the vicinity of this view, particularly from houses that may have an unobstructed view of the Badgerys Creek landscape. The new runway and airport structures would be visible from some residences and limited in others, depending on aspect, topography and vegetation. Visual impacts from aircraft are possible due to the south-west to north-east alignment of the flight path two to three kilometres to the south.	Moderate-low
10. Warragamba Dam Recreation Area	Sensitivity = High Visual sensitivity is derived at this location from the importance of visual amenity due to its use as a recreation, educational and historic area. It is assumed that there is significant value placed on both the natural and cultural landscape by visitors and staff. As an operational facility, workers would be subject to long duration views, however views for visitors would only be temporary. Magnitude = Negligible There are no direct views of the airport site and aircraft would not be prominent as they are expected to be at a distance of approximately five kilometres from the recreation areas and visitor centre.	Negligible
11. Glenbrook Nepean Lookout	Sensitivity = Moderate–high Visual sensitivity is derived from this location being one of the closest elevated positions to the west of the airport site at approximately 11 kilometres and within the Blue Mountains area. It is assumed that there is significant recreational and cultural value placed on the natural landscape and bush setting by park users. Viewer times may be of a long or short duration and the number of viewers fluctuates seasonally. Magnitude = Low Direct views of the airport construction and operation are prevented by topography and vegetation. Views of aircraft may be possible at a distance of over three kilometres.	Moderate

Viewpoint	Assessment	Impact Level
12. Mount Portal Lookout	Sensitivity – Moderate–high This location is an elevated lookout 12 kilometres northwest of the airport site within the Blue Mountains, and offers broad views over western Sydney on a clear day to the south and west. Visitors may stay for short or long durations and fluctuate seasonally. It is assumed that there is significant recreational and cultural value placed on the landscape by visual receivers. Magnitude = Negligible Landform and vegetation in the foreground would largely prevent views of the airport site to the south. There is capacity of the landscape to absorb views of the airport development due to broad landscape views of the existing developed areas to the south and east. Views of aircraft are possible at a distance of more than ten kilometres.	Negligible
13. Twin Creeks Golf and Country Club	Sensitivity = Moderate–high Twin Creeks Golf and Country Club is located approximately six kilometres to the northeast of the airport boundary. The sensitivity of this view relates to its use as a country club and recreational and social hub with a presumed high level of use as well as a residential estate. Many views therefore would be of a long duration. Magnitude = Low–moderate The existing vegetation and landform prevent direct views of the proposed airport site. Aircraft movements are expected to be prominent with the indicative flight path positioned over the golf club and oriented on a north-south alignment.	Moderate

22.4. Mitigation and management measures

Table 22–3 outlines the broad mitigation and management measures that are proposed to address the visual effects of the Stage 1 development. All mitigation and management measures would be collated in management plans prepared for construction and operation of the proposed airport.

Table 22–3 – Mitigation and management measures – landscape and visual amenity

ID	Issue	Mitigation/management measure	Timing
22.1	Visual and landscape management plan	A visual and landscape management plan would be developed prior to construction of the proposed airport as part of the construction environmental management framework. The plan would establish urban design principles and identify appropriate landscape treatments for the site, as well as collate further measures to mitigate and manage potential impacts on visual amenity and the landscape.	Pre-construction
22.2	Visual disturbance and clutter	Stockpiles, bunds and surcharge areas would be covered, where practicable.	Construction
22.3		Impacts on the visual character of the landscape would be minimised by avoiding large grade cut and fill transitions where practical, particularly near the airport site boundary.	Pre-construction
22.4		Existing vegetation would be retained, where practicable, particularly along the airport site boundary, to provide visual screening.	Construction Operation
22.5		Construction plant, machinery and vehicle parking areas would be located as far as practicable from sensitive receivers.	Construction

ID	Issue	Mitigation/management measure	Timing
22.6		Any night lighting required for construction works would be located as far as practicable from sensitive receivers with appropriate screening as required.	Construction
22.7		Construction site areas would be progressively rehabilitated. Consideration would be given to the rehabilitation of earthworks areas if there is a considerable period of time between the completion of earthworks and construction of aviation infrastructure.	Construction
22.8		Opportunities for vegetation screening would be investigated, particularly in relation to the identified moderate-high impact viewpoints. The revegetation strategy would take into consideration bushfire risks and potential impacts on aviation operations, and opportunities for the reestablishment of endemic native species and ecological communities.	Construction
22.9		Subject to safety and security requirements, perimeter fencing design would have regard to the following considerations: • avoiding long, straight continuous runs; • avoiding finish and colour that is reflective or brightly coloured; • providing a two metre (minimum) setback from the property boundary to allow for perimeter plantings, where possible; and • providing a buffer from riparian corridors along the boundary of the airport site.	Pre-construction
22.10	Airport lighting impacts	Low angle, cut off LED fixtures would be considered wherever practicable in the design of airport infrastructure.	Pre-construction

22.5. Conclusion

The visual impact of Stage 1 of the proposed airport has been assessed by applying an accepted visual impact assessment methodology. This has involved consideration of the existing landscape character and views and the effects of construction and operation of the proposed airport.

During construction, the proposed airport would be likely to have temporary visual impacts for the nearest sensitive receivers in Luddenham and Bringelly. Viewpoints further away would have restricted views of the airport site and the visual impact would likely below to negligible.

During operation, the potential for moderate to high visual impacts as a result of overflights have been identified for Luddenham, Elizabeth Drive, Lawson Road and Mount Vernon. Operational lighting is likely to have low impacts on sensitive receivers due to topography, existing vegetation, building design, lighting design and runway configuration.

Mitigation measures have been proposed where appropriate to minimise visual impacts during construction and operation of the Stage 1 development.

23. Social

The Western Sydney region is diverse, with densely populated and highly urbanised areas, as well as semi-rural, recreational and natural areas. The region is culturally diverse, with strong heritage values (both Indigenous and non-Indigenous), cohesive communities, natural and recreational values, and connections to the employment hubs of the Parramatta and Sydney CBDs.

The major employment, residential and transport infrastructure projects proposed for Western Sydney demonstrate the critical role the Western Sydney region plays in Sydney's future. The proposed Western Sydney Airport will be a significant catalyst for increased and faster growth for both Western Sydney, and Greater Sydney more broadly.

The proposed airport has the potential to bring significant benefits to the people and economy of Western Sydney. The majority of benefits for Western Sydney and Greater Sydney communities are expected to relate to economic development and employment opportunities. The project would create jobs for many types of workers of various skills and qualifications, contributing to increased incomes across the Western Sydney region. This report's recommendation to develop a Local Participation Plan as part of an Australian Industry Participation Plan would aim to ensure a high level of local and regional community involvement in the development of the proposed airport. As a facilitator of growth and change in Western Sydney, the proposed Western Sydney Airport would stimulate further development in regional and local centres, providing better quality social infrastructure, such as shops, health services, recreation and leisure services. Additionally, the development of training opportunities in the region undertaken by the state government and local governments would encourage innovation and the creation of new small and large businesses supporting the proposed airport development.

The construction and operation activities of the proposed Western Sydney Airport would be likely to result in changes to the social amenity and lifestyle of communities both in the vicinity of the airport site, and in Western Sydney more broadly. The rural character of the area would change with the development of the airport, and nearby properties would be impacted by noise. When considered with other employment initiatives taking place in the region, the opportunities for positive change and improved socio-economic outcomes for Western Sydney are significant.

23.1. Introduction

This chapter assesses the likely social impacts of the construction and operation of the Stage 1 development of the proposed Western Sydney Airport (the proposed airport). This chapter draws on a comprehensive social impact assessment, as well as relevant sections of the economic impact assessment, both of which are included as Appendix P1 in Volume 4. The potential social impacts of the Stage 1 development on the communities of Western Sydney are assessed and mitigation and management measures are identified to reduce potential impacts.

The assessment has been carried out in accordance with the *Guidelines for the Content of a Draft Environmental Impact Statement – Western Sydney Airport* (EIS guidelines) for Western Sydney Airport.

23.2. Methodology

The following tasks were undertaken in the preparation of the social impact assessment:

- identification and definition of the social area of influence (the study area) including communities and regions likely to be affected by the proposed airport;
- development of an appreciation of the existing social, economic and cultural characteristics and dynamics of the communities within the study area to establish a social baseline on which potential social impacts could be predicted;
- identification of potential benefits and impacts of the proposed airport on the study area communities and an assessment of these impacts in terms of the likelihood and consequence of their occurrence; and
- development of mitigation and management strategies to avoid or minimise potential adverse impacts and maximise benefits to communities.

23.3. Existing environment

The study area has been considered at the following scales:

- **Airport site**: this is defined as the area within the project site boundary.
- **Local study area**: this is defined as the communities surrounding the airport site and those that may experience more impacts from the proposed airport. The local study area includes Arndell Park, Austral, Badgerys Creek, Bringelly, Chatsworth, Cobbitty, Eastern Creek, Erskine Park, Glenfield, Greendale, Horsley Park, Kemps Creek, Leppington, Luddenham, Mount Vernon, Mulgoa, North St Marys, Orchard Hills, Penrith, Prospect, Rossmore, Silverdale, South Penrith, St Clair, St Marys, Theresa Park, Wallacia, Werombi and Werrington.
- **Western Sydney region**: the regional study area is defined as the area and communities which may potentially experience a high level of social interaction with the proposed airport. The regional study area was identified in line with the planning regions surrounding the proposed airport as determined by NSW Government in *A Plan for Growing Sydney 2014* (NSW Department of Planning and Environment, 2014). For the purpose of this assessment, the regional study area includes the local government areas (LGAs) within the following three subregions of Sydney:
  - **South West subregion:** – includes Camden, Campbelltown, Fairfield, Liverpool and Wollondilly LGAs;
  - **West subregion:** includes Blue Mountains, Hawkesbury and Penrith LGAs; and
  - **West Central subregion:** includes Auburn, Bankstown, Blacktown, Holroyd, Parramatta and The Hills LGAs.

  Greater Sydney metropolitan area: this wider area of influence is the area from which some goods, services and workforce are anticipated be sourced for the Stage 1 development.

23.3.1. Airport site

The airport site is located at Badgerys Creek in the Liverpool LGA. The northern boundary of the airport site adjoins the Penrith LGA boundary. The study area is situated about 50 kilometres west-southwest of the Sydney CBD. The suburb of Badgerys Creek can be accessed from the north via Elizabeth Drive or The Northern Road, both of which are main roads in this area. Kemps Creek and Luddenham are the closest retail centres. Some minor additional land acquisitions may be required to support the development and operation of the proposed airport.

23.3.2. Land ownership

The airport site is around 1,700 hectares in size and located on land acquired by the Australian Government in the 1980s and 1990s. Since the land was acquired, the Australian Government has been leasing properties to private tenants, and a property management agency has been contracted to manage the properties.

23.3.3. Existing land uses

The key existing land uses on the airport site, prior to the tenant relocation process, are outlined below:

- 139 residential tenancies ranging in area from approximately one to 40 hectares each;
- 16 agricultural tenancies including market gardens growing cucumber, strawberry, Asian herbs and tomatoes, and livestock farming including poultry and cattle grazing;
- eight commercial tenancies including the operator of a shale quarry, vineyard and a Christmas tree farm;
- The former Badgerys Creek Primary School, which was closed by the NSW Department of Education and Communities in December 2014;
- Badgerys Creek Park;
- Two cemeteries (St Johns Anglican Church and Badgerys Creek Uniting Church); and
- A Scout hall located on Elizabeth Drive.

23.3.4. Social characteristics

Consistent with the semi-rural location of the site and the Australian Bureau of Statistics (ABS) data for Badgerys Creek, dwellings on the residential tenancies were generally separate houses. The tenancies included a range of household types, including families with children, couples without children, and single households. Tenants were primarily from English speaking backgrounds, with some people from Italian and Maltese backgrounds.

Some tenants were over 65 years of age, a proportion of which were on aged pensions or disability pensions. This is supported by the lower rate of labour force participation for Badgerys Creek (49 per cent) compared to the wider Liverpool local government area (58 per cent).

Of the 139 residential tenancies, 38 were long term tenants who had been living in the same property for 20 years or more and six tenancies were original land owners who had been leasing properties on the site since they sold to the Australian Government.

The occupations of tenants varied, from those who were self-employed and worked from home, or worked on the land (i.e. agriculture), to professionals, contractors and truck drivers. This is reflected by the employment profile for Badgerys Creek, with the top industries of employment being construction (13.3 per cent), agriculture (9.8 per cent) and transport and warehousing (9.2 per cent). The top occupations were managers (18.5 per cent), labourers (16.8 per cent) and technicians and trades (16.8 per cent).

23.3.5. Western Sydney region

The existing communities of the Western Sydney region are diverse; from densely populated and highly urbanised areas, to semi-rural, recreational and natural areas. Many communities are known for their cultural diversity, heritage (both Aboriginal and European), strong and cohesive communities, and recreational values. The Western Sydney region has a number of employment hubs such as Parramatta and Liverpool CBDs and has major transport connection within the region and to other parts of Greater Sydney.

The major employment, residential and transport infrastructure projects proposed for Western Sydney, such as the Western Sydney Infrastructure Plan, the South West Priority Growth Area, the Western Sydney Employment Area and the proposed airport, demonstrate the critical role the Western Sydney region will play in Sydney's future. As outlined in Chapter 2, these projects will support each other. The proposed airport will accelerate investment in employment, transport, housing infrastructure, while the Western Sydney Infrastructure Plan and other projects will provide the necessary infrastructure to support the development of the proposed airport. The proposed airport, along with the other projects in the Western Sydney region, has the potential to bring significant change to Western Sydney communities.

23.3.6. Employment growth

A Plan for Growing Sydney (DP&E 2014) focuses heavily on the role of Western Sydney in driving the growth of Sydney and NSW over the coming decades. Along with the development of the region more broadly, the emergence of Parramatta as Sydney's second CBD will further increase Western Sydney's national and metropolitan influence. The NSW Government proposes that, as well as an employment hub, Parramatta will become an education hub, with the Western Sydney University currently developing a new campus in the CBD, and plans to increase the capacity of the campus at Rydalmere. Adjacent to Parramatta, the Westmead Health precinct is one of the largest integrated health, research, education and training precincts in the world. Parramatta CBD will link with the Global Economic Corridor which will link Port Botany and Sydney (Kingsford Smith) Airport to the future employment hubs at Norwest and Sydney Olympic Park.

Providing more jobs in Western Sydney is a key requirement to providing liveable and healthy communities. Although half of Sydney's population lives in Western Sydney, only a third of Sydney's jobs are located in the region, leading to long commutes for many workers. This will be particularly important given the demand for employment in Western Sydney is expected to increase faster than overall demand for employment in Greater Sydney. By 2025, the total labour force (persons aged 15 to 64 years) of Western Sydney is expected to be 1,609,401 persons, increasing to 1,744,955 persons by 2030 and 2,664,991 persons by 2065. This is equivalent to an increase of approximately 66 per cent between 2025 and 2065. The total labour force for Greater Sydney is expected to be 3,297,664 by 2025, 3,522,912 persons by 2030 and 5,016,069 by 2065, which is equivalent to an increase of approximately 52 per cent over the same period (SGS Economics and Planning 2015).

Employment areas will be key contributors to providing new jobs to meet this projected demand. The Western Sydney Employment Area is planned to be a major contributor to the economic development of Western Sydney. Western Sydney Employment Area has been established to provide businesses with land for industry and employment, particularly transport and logistics, warehousing and office space. It is located close to major roads and utility services, and is near the airport.

The Western Sydney Employment Area is expected to have capacity for more than 57,000 jobs over the next 30 years, and 212,000 jobs in the long term. The Western Sydney Employment Area has also been extended to the south to Elizabeth Drive, and to include land to the west of the proposed airport site.

23.3.7. Population growth

23.3.7.1. New release areas

Many areas in Western Sydney have experienced a significant amount of development and growth over recent years. This is expected to continue, as new areas in Western Sydney are developed, and population density intensifies around regional and town centres.

The population of Western Sydney is expected to grow significantly. By 2030, the population is expected to increase by 29 per cent to 2,734,565 persons (SGS Economics and Planning 2015). Significant new development is required to support this expected population growth. Housing affordability was noted by most stakeholders during consultation for the social impact assessment as a key growing issue for communities in the regional study area.

Two key growth areas in Western Sydney are the North West and South West Priority Growth Areas, which were established by the NSW Government in 2005 to sustainably plan Sydney's growth on its urban edge. It is anticipated that the growth areas, when considered together, will become home to half a million people over the next 25 to 30 years.

The North West Priority Growth Area covers around 10,000 hectares across The Hills, Blacktown and Hawkesbury local government areas with capacity for 70,000 new dwellings and up to 200,000 people (NSW Department of Planning and Environment 2011). The North West Priority Growth Centre will support the Rouse Hill Town Centre which has been identified in *A Plan for Growing Sydney* as a strategic centre, and has been developed in recent years with a large shopping centre and key services (e.g. public library and community centre). In the future, Marsden Park will be developed as a new strategic centre within the North West Growth Centre.

The South West Priority Growth Area is located across the Liverpool, Camden and Campbelltown local government areas. Covering approximately 17,000 hectares, the South West Growth Centre has capacity for up to 110,000 new dwellings and 300,000 people (NSW Department of Planning and Environment 2011). The South West Priority Growth Area will support a new strategic centre at Leppington. Recent developments within the South West Priority Growth Area include Oran Park, which supports a town centre including shopping centre, and will soon include a new library, community centre, and administration building for Camden Council. Edmondson Park is another recent area which will provide a new town centre around a bus and rail interchange.

The NSW Government is also investigating releasing land for new residential development in the Greater Macarthur region, which is located in the Campbelltown and Wollondilly local government areas. The investigation will consider the impacts of new urban areas on the environment, agricultural and mining activities, as well as how new communities would access jobs, services and amenities. The investigation will also consider existing planning proposals for land release in areas within the Greater Macarthur region (NSW Department of Planning and Environment 2011). This includes Wilton Junction, which is proposed to include a new town centre, with a population of over 30,000 people (Wilton Junction Consortium 2015).

23.3.7.2. Urban renewal

The renewal of established areas is also a key strategy for the NSW Government to provide increased housing and jobs in Sydney, with the focus on transport corridors and around strategic centres. A number of areas in Western Sydney have been identified as priority urban renewal areas including:

- **Glenfield to Macarthur priority urban renewal corridor** – located in Campbelltown local government area, with the area around seven train stations being investigated for redevelopment and provision of new homes.
- **Greater Parramatta to Olympic Peninsula priority urban renewal area** – located across the Parramatta and Auburn local government areas, work has already begun on revitalising Wentworth Point and Carter Street, and plans are being developed for Camellia.

23.3.8. Major transport infrastructure projects

A number of major transport projects are in various stages of planning and construction throughout Greater Sydney, which will connect Western Sydney to various centres and the central business districts of Parramatta and Sydney City.

23.3.8.1. South West Rail Link

The South West Rail Link was delivered in response to population growth and reliability issues on the metropolitan rail network in south-west Sydney. The South West Rail Link opened to the public in early 2015 and included a major upgrade of the existing station at Glenfield, and a new twin track passenger rail line between Glenfield and Leppington.

The NSW Government is also currently preserving additional public transport corridors for future extensions of the South West Rail Link. The extension corridor is proposed to connect Leppington Station to Bringelly, and then head into two different directions: north via the airport site to the T1 Western Line near St Marys; and south to Narellan in the Camden local government area. The NSW Government is also considering extending the corridor further south to the T2 South Line near Campbelltown.

The extension will provide a north-south connection through the South West Priority Growth Area and Western Sydney Employment Area including the proposed Western Sydney Airport. New stations are proposed for Rossmore, Bringelly, North Bringelly, Oran Park, Narellan and at the proposed Western Sydney Airport (Transport for NSW 2015).

23.3.8.2. Western Sydney Infrastructure Plan

Under the Western Sydney Infrastructure Plan, the Australian and NSW governments are investing $3.6 billion in a number of road upgrades and new roads in Western Sydney to support the proposed airport and improve road connections in Western Sydney. The package includes:

- upgrade of The Northern Road to a minimum of four lanes from Narellan to Jamison Road;
- construction of a new east-west motorway to the airport between the M7 Motorway and The Northern Road;
- upgrade of Bringelly Road to a minimum of four lanes between The Northern Road and Camden Valley Way;
- construction of the Werrington Arterial Road between the M4 Motorway and the Great Western Highway;
- upgrade of Ross Street and the Great Western Highway intersection at Glenbrook; and
- a $200 million package for local roads upgrades.

Together, the package of new roads and upgrades aims to ease congestion and relieve pressure on existing roads while improving connections between major hubs (DIRD 2015).

23.3.8.3. Outer Sydney Orbital

The Outer Sydney Orbital is a corridor being investigated by the NSW Government to provide a north-south connection for a future motorway, freight rail, and where practical a passenger rail line. The corridor would provide increased capacity for the road network to improve accessibility to housing and employment, and the freight rail would connect from Port Kembla to the South Line, Western Line and Northern Line. The area under investigation starts at the North West Priority Growth Area in the north, finishes in the south near Picton in Wollondilly LGA, and travels to the west of the proposed airport site.

23.4. Assessment of impacts during construction

The direct and indirect impacts associated with the construction of the Stage 1 development on people's lifestyle and social amenity are outlined in this Section. These issues are outlined below and include a reference to the relevant EIS chapters where the associated direct impacts are addressed:

- Economic and employment (see Chapter 24);
- Transport and access (see Chapter 15);
- Landscape and visual character (see Chapter 22);
- Air quality (see Chapter 12);
- Health (see Chapter 13); and
- Hazards and risk (see Chapter 14).

23.4.1. Economic and employment benefits

Economic benefits from the Stage 1 construction activities would be substantial, through the demand for goods and services. Over the construction period (2016-2024) the cumulative value-add from the construction of the Stage 1 development is expected to be $1.9 billion for Western Sydney and an additional $400 million for the rest of the Greater Sydney region. This includes direct spending from the development of the proposed airport, spending from industries supplying the proposed airport, and flow-on benefits.

The Stage 1 construction would generate a large number of direct, indirect and induced jobs. Direct jobs are those that are entirely related to, and dependent on, the construction of the proposed airport. Indirect jobs are those businesses which supply goods and services to the proposed airport. Examples might include suppliers of material, engineering services, heavy vehicle drivers, waste management services and others. Further to this are the induced jobs that would be created by the expenditure from construction employees. This could be through expenditure at retail stores, restaurants and professional services which would result in the creation of new job opportunities.

During construction, the direct jobs would be anticipated to require skills in:

- Non-Residential Building Construction – construction of non-residential buildings such as hotels, motels, or other buildings;
- Heavy and Civil Engineering Construction – construction or general repair of roads, bridges, aerodrome runways or parking lots; and
- Construction Services – a range of services provided as part of construction activities, including installation, finishing, management and others.

In presenting construction employment figures, this draft EIS uses two measures: peak workforce and person-years:

- Peak workforce is based on the actual workforce required to implement the indicative construction schedule discussed in Chapter 6. The peak workforce represents the highest number of jobs that will be in existence in a single year.
- Person-years provides a measure of the workforce effort required and is a measure which takes into account the number of people employed full-time and the length of the employment period. For example, five person-years of employment could be one person employed full time for five years or five different people working full-time in different roles of one year each. Person-years provides a basis for understanding the cumulative employment impact over the construction period (notionally from 2016-2024).

The estimated peak workforce required during Stage 1 construction would be 758 full-time equivalent (FTE) jobs in 2022. Cumulatively, the proposed airport would generate direct employment for approximately 3,200 person-years, as well as indirect and induced employment for 8,000 person-years over the construction period between 2016 and 2024 in Western Sydney. During the construction period, the proposed airport would generate an additional 2,200 person-years in the rest of Sydney.

23.4.2. Transport and access

The transport and access assessment (refer to Chapter 15) found that the proposed airport would lead to an increase of traffic on the local road network during construction. The major roads surrounding and connecting to the site include the M7 Motorway, The Northern Road, Elizabeth Drive, Bringelly Road, Badgerys Creek Road, Adams Road and Mamre Road. The assessment found that the existing road network currently experiences capacity constraints during peak periods, however the immediate area surrounding the site does not currently have significant traffic congestion.

The construction phase would lead to an increase of construction traffic on the road network surrounding the site compared to the existing situation with up to an additional 1,254 vehicle movements per day. The expected distribution and volume of construction traffic suggests that there would be approximately 160 additional vehicle movements (to and from the airport site) on Elizabeth Drive during the AM peak and 150 additional vehicle movements (to and from the airport site) on Elizabeth Drive during the PM peak.

Modelling indicates that this level of additional traffic volume would not result in operating conditions worse than Level of Service C on Elizabeth Drive in the vicinity of the airport site. There would be capacity constraints on the wider network, principally on the M4, M5 and M7 motorways, however:

- these constraints currently exist;
- the Level of Service does not deteriorate when construction traffic is included; and
- the proportion of construction traffic compared to overall traffic reduces with distance from the airport site and therefore the impact of construction is reduced with distance from the site.

It is expected that there would be a minor impact on the semi-rural lifestyles of residents in properties surrounding the site due to increased vehicles on the road. This may be associated with a decrease in air quality. There is not expected to be a perceptible noise impact (refer Chapter 11).

23.4.3. Landscape character and visual

The landscape and visual assessment (see Chapter 22) identifies that the construction of the Western Sydney Airport would result in landscape changes at the site. The assessment indicates that there would be varying levels of impact on different communities depending on their distance and elevation from the airport site, and their cultural and recreational values.

The proposed airport development would involve substantial modification of the landscape and the existing rural visual quality in the area to a more urbanised and commercial character. Construction would likely have the most visual impacts on areas to the north such as Luddenham and Elizabeth Drive due to their relatively close proximity to the airport. Surrounding rural residential areas at higher elevations such as Mount Vernon, Silverdale and Rossmore would experience moderate to low visual impact due to their views of the airport site.

23.4.4. Air quality

The air quality impacts assessment (see Chapter 13) identifies that construction air quality impacts are expected to be temporary and isolated in nature. Standard mitigation measures are proposed to reduce potential impacts.

23.4.5. Health

A human health impact assessment (see Chapter 13) identifies the likely impacts of the construction of the Western Sydney Airport on human health. There are a number of potential pathways by which the airport development may influence human health, and the assessment focussed on the key issues of air quality, noise and surface water and groundwater.

The assessment concluded that there would be minimal impacts on human health during construction. Mitigation measures proposed in the EIS would minimise health impacts on people surrounding the airport.

23.4.6. Social infrastructure

It is anticipated that construction of the proposed Western Sydney Airport would not generate demand for social infrastructure in the areas near the airport site. Because of the local and temporary nature of construction work, it is anticipated that the workers will be residents of the Western Sydney or the Greater Sydney Metropolitan region and will access social infrastructure facilities and services at their area of residence. The development of the proposed airport would also result in the removal of Badgerys Creek Park during construction.

23.4.7. Emergency services

The lead construction contractor of the airport would be expected to develop and implement safety protocols including an Emergency Response Plan in collaboration with all NSW emergency services. The Department of Infrastructure and Regional Development is also currently preparing a Bushfire Management Plan for the site. It is anticipated that these plans would cover emergency response, first aid and basic medical services, fire prevention, firefighting equipment, and security.

23.5. Assessment of impacts during operation

The indirect impacts associated with the operation of the Stage 1 development on people's lifestyle and social amenity are outlined in this Section. These issues are outlined below and include a reference to the relevant EIS chapters where the associated direct impacts are addressed:

- Economic and employment (see Chapter 24);
- Noise (see Chapters 10 and 11);
- Air quality (see Chapter 12);
- Health (see Chapter 13);
- Transport and access (see Chapter 15); and
- Hazards and risk (see Chapter 14).

23.5.1. Economic and employment benefits

During Stage 1 operations, economic and employment benefits are expected to increase commensurate to passenger movements at the proposed airport. In 2031 (roughly aligning with the end of Stage 1), the proposed airport is forecast to generate demand for 8,730 FTE jobs in airport operations and a further 4,440 FTE jobs in the expected commercial development in business parks on the airport site in 2031. The operation of the proposed airport is also forecast to generate approximately $77 million in value-add for Western Sydney and a further $145 million in value-add for the rest of Sydney in 2031.

In addition, the operation of the proposed airport would drive growth in business profits, productivity and household income in the region and is expected to drive the redistribution of population and employment growth towards Western Sydney. In this way, the proposed airport would shape investment in the region and contribute to a more balanced and sustainable growth for Sydney as a whole.

23.5.2. Noise

The proposed airport would result in an increase in exposure to aircraft noise in Western Sydney due to additional aircraft flight paths and airport operating modes. The Stage 1 noise impact assessment is presented in Chapters 10 and 11 of the EIS.

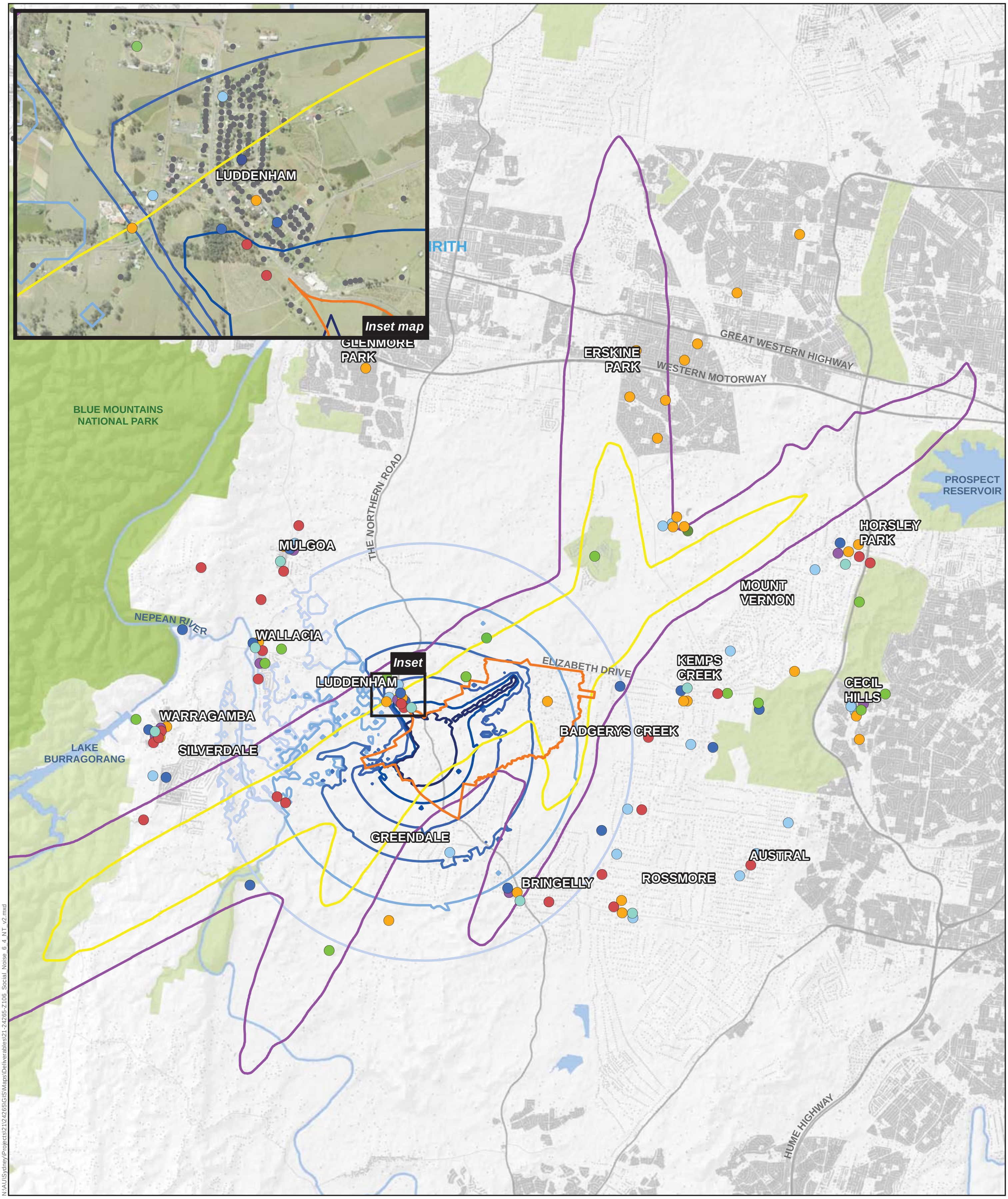
Based on the findings of the overflight noise assessment, the proposed airport could lead to a reduction in social amenity and impact on existing lifestyle for some communities across Western Sydney depending on the design, availability and usage of airport operating modes. The communities that could be most impacted by overflights would include areas of Luddenham, St Marys, Erskine Park, Greendale, Silverdale, Horsley Park, and parts of Blacktown. Many of these areas (particularly Luddenham, Greendale, Silverdale and Horsley Park) are semi-rural and large lot suburban areas with lower population density. It is likely that some sensitive social infrastructure in affected areas could also be subject to noise (including childcare centres, schools, churches, parks and recreation facilities, hospitals and other health care facilities) which may impact on their users.

An indicative 'worst case' representation of the operational noise envelope is shown on Figure 23–1. The analysis includes the N70 and N60 noise contours (number of overflights per day above 70dBA and number of overflights above 60dBA over the night time period (10pm to 6am)) and engine ground running contours in 2030. These N70 and N60 contours include calculation of composite Prefer 05 and Prefer 23 operating strategies and therefore show a larger combined area of noise impact than would be experienced under typical operations. Social infrastructure that would be affected by one or more types of operational noise are primarily located in Luddenham and Mulgoa including five schools and child care centre, three places of worship, three parks and three recreation facilities in Luddenham and Mulgoa.

It is important to note that the formal flight path design for the proposed airport would be undertaken much closer to the commencement of operations. The formal design process would provide an opportunity to optimise flight paths on the basis of safety, efficiency, noise and environmental considerations, as well as minimising changes to existing regional airspace arrangements.

Decisions about airspace management arrangements including the determination of flight paths would be made by Airservices Australia and the Civil Aviation Safety Authority (CASA). These decisions may engage further environmental assessment processes, community and stakeholder engagement, and may be the subject of a future referral under the EPBC Act following detailed design.

Based on the outcomes of the ground-based noise study, the proposed airport may lead to a reduction in social amenity and impacts on the existing lifestyle of people living and working in communities close to the airport site, particularly Luddenham, Badgerys Creek, Bringelly, Greendale, and Wallacia. These localities are all semi-rural or small townships with lower population densities compared to other parts of Liverpool and Penrith LGA. Noise impacts would be expected for a number of social infrastructure in Luddenham and two childcare centres in Mulgoa, which may result in a negative social impact for users of these facilities.



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LEGEND

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

Airport site

Sensitive receivers

- Residential
- Aged Care
- Childcare
- Community Centre
- Education
- Park
- Recreation
- Religious Facility
- Shopping Centre

Ground Engine Run-Up Single Runway 2030

- 45dBA
- 50dBA
- 55dBA
- 60dBA
- 65dBA
- 70dBA

24 hours overflight noise impacts, N70 (n = 5-10) 2030

Night time overflight noise impacts, N60 (n = 5-10) 2030

Figure 23-1 - Social infrastructure and residences potentially affected by worst case operational noise envelope in 2030

0 1 2 4
Kilometres

N

23.5.3. Air quality

The air quality impacts of Stage 1 operations of the proposed airport are identified in Chapter 12 of the EIS.

The operation of the proposed airport may lead to a minor reduction in air quality for communities close to the airport site, including the townships and surrounding areas of Luddenham, Wallacia, Mulgoa, Greendale, Badgerys Creek, Rossmore, Mt Vernon, Kemps Creek and Badgerys Creek.

However, it is noted that the proposed airport would generally meet air quality criteria for operation of the Stage 1 development.

23.5.4. Health

A human health impact assessment (see Chapter 13) identifies the likely impacts of the Stage 1 operation of the Western Sydney Airport on human health. The assessment concluded that there would be minimal impacts on human health during Stage 1 operations.

The consideration of the potential for noise and air emission impacts from operations identified minor increases in attributable health risks as a result of the airport development. These risk level increases are generally within the range of acceptability identified by Australian and international public health agencies. Whilst there is the potential for overflights to impact on Sydney's drinking water supply, the likelihood of emissions or fuel jettison to impact on Warragamba Dam or Prospect Reservoir is remote.

23.5.5. Traffic and access

The traffic, transport and access impacts of Stage 1 operations of the proposed airport are identified in Chapter 15 of the EIS.

Stage 1 operations of the proposed airport would lead to an increase in traffic on roads surrounding the site. This would be expected to impact the social amenity and lifestyle of these semi-rural areas. However with the planned upgrades of surrounding roads and introduction of new roads in areas surrounding the site through the Western Sydney Infrastructure Plan, the increase in traffic would not be expected to result in major capacity issues.

23.5.6. Landscape and visual

The assessment indicates varying levels of impact on different communities depending on their distance and elevation from the proposed airport site, the presence of visual obstructions such as vegetation or terrain, their cultural and recreational values, and their location with respect to the orientation of the runways and flight paths.

Key findings from the visual assessment include:

- The proposed airport development would involve substantial modification of the landscape and the existing rural visual quality in the area to a more urbanised character;
- The most visual impacts would be on areas to the immediate north such as Luddenham and Badgerys Creek due to their relative proximity to the airport as well as areas to the south of the airport such as Bringelly, Greendale and Bents Basin due to aircraft overflights;

- Surrounding rural residential areas at higher elevations such as Mount Vernon, Silverdale and Rossmore would experience moderate to low visual impact due to views of the airport site. The impact would, however, be increased by aircraft overflights; and
- Visual impacts at selected important cultural and recreational areas, including the Bents Basin State Recreation Area and Blue Mountains would range from moderate to high due to the high sensitivity ratings of the viewpoints and the effect of aircraft overflights.

23.5.7. Lifestyle impacts

The proposed size, scale and nature of the Stage 1 development, combined with planned infrastructure, residential, business and commercial developments in the Western Sydney region are likely to modify the existing rural character of the area and increase the population.

The proposed airport would bring improved lifestyles for some residents in the region, through increased local employment and income generation opportunities. A large proportion of the population from the Western Sydney region currently undertake long commutes on a daily basis to access work opportunities. During Stage 1, the proposed airport would provide employment opportunities closer to home, reducing travel time and offering the prospects for improved lifestyle.

23.5.8. Impacts on recreational assets

Flight paths may result in visual and noise impacts on some recreational reserves in the Western Sydney region. Stakeholder consultation during the preparation of the draft EIS identified that some recreational areas may be more sensitive to aircraft noise and visual impacts.

The following recreational spaces are identified to be within the Western Sydney region:

- Twin Creeks Country Club;
- Ropes Creek Reserve (Erskine Park);
- Eastern Creek Raceway;
- Sydney International Equestrian Centre (Horsley Park);
- Western Sydney Parklands (Horsley Park);
- Calmsley Hill City Farm (Abbotsbury);
- Sales Park (Luddenham);
- Bent Basin State Conservation Area (Greendale);
- Burragorang Recreation Area (Silverdale);
- Gulguer Nature Reserve;
- Mulgoa Nature Reserve;
- Warragamba Dam; and
- Greater Blue Mountains Area.

These recreational areas are valued for their environmental and amenity values, and these values may be impacted by overflight noise. The amenity of areas located in rural or more isolated locations (such as the Bents Basin Recreational Area in Greendale, Burragorang State Conservation Area and a small part of the Western Sydney Parklands and Prospect Nature Reserve) is likely to be reduced for users.

The wilderness amenity of the Greater Blue Mountains Area has the potential to be impacted by an increase in aircraft overflight noise. However, aircraft noise would generally be limited as the height of the aircraft is expected to be in excess of 5000 feet above ground level, limiting noise impacts at sensitive locations to below 55dBA. Marginal impacts are anticipated from the infrequent operation of a Boeing 747 which is the noisiest aircraft expected to operate at the proposed airport. As outlined in Chapter 7, there is a general decline in the use of Boeing 747s as airlines replace these aircraft with newer and quieter aircraft. This would further reduce the noise impacts associated with airport operations.

23.5.9. Impacts on social infrastructure and housing

The increase in population due to the development of Stage 1 of the proposed airport would result in additional demand on social infrastructure in the region.

The Stage 1 operational workforce at the proposed airport may impose additional demand on social infrastructure in areas near the airport site (e.g. medical centres, dentists, pharmacies) and recreational facilities (e.g. swimming pools, gymnasiums, public parks). This may affect access to these services and facilities by existing residents.

Consultation with the NSW Department of Education and Communities indicated there may be some impact on demand for schools as a result of the operational workforce. Some workers may prefer for their children to attend a school near their workplace.

Some workers at the airport site may choose to move from other parts of Sydney or outside of Sydney to areas in Western Sydney, resulting in a small increase in demand for housing. It is expected that the proposed airport may contribute to population growth in Western Sydney of 17,800 persons by 2031. Such increase in demand for housing, coupled with the overall growth in Western Sydney, may exacerbate housing availability and affordability issues for socio-economically disadvantaged groups.

Stage 1 airport aeronautical operations and increased road vehicle traffic are likely to generate noise, visual and air quality impacts on social infrastructure facilities such as schools, educational institutions, hospitals, recreational spaces and places of worship.

23.5.10. Emergency services

Operational safety protocols including an Emergency Response Plan would be developed and implemented for the proposed airport. It is anticipated this would occur in collaboration with relevant Australian and NSW emergency services to cover emergency response, first aid and basic medical services, fire prevention, firefighting equipment, and security.

An Airservices Australia Aviation Rescue Fire Fighting Service station is proposed for Stage 1, with a mutual aid agreement with the Rural Fire Service expected to be in place before airport operations commence. Should local resources be required to assist with an emergency situation at proposed airport, it is likely NSW Fire and Rescue would manage and re-distribute its resources as appropriate.

NSW Ambulance does not expect an on-site station to be provided at the airport site and does not expect airport operations to directly impact its ability to service the local community.

23.5.11. Property values

The potential adverse effect on property prices associated with aircraft noise (among other factors) is documented in a number of Australian and international studies. A review of recent literature and was undertaken in the preparation of the EIS to explore the potential price devaluation effects on lower density, large lot land holdings similar to those found at Badgerys Creek. Comparable examples including Melbourne (Tullamarine and Avalon) and Perth airports were analysed for a potential relationship between price and noise effects. However the analysis failed to establish a statistically significant relationship between noise exposure and property prices. Possible reasons for this might include the lesser significance of the dwelling in the context of large land areas, land used for primary production may be less affected by noise and/or the wider range of factors influencing price that cannot be analysed.

The potential for reduction in property values could affect a range of properties given the nature of the development and the scale of the noise envelope. The effect would differ depending on location and individual circumstances. Analysis of long run house prices in Sydney since 1991 however found no appreciable difference in growth rate between median prices in suburbs subject to noise in excess of 20 ANEF and those in similar areas not exposed to aircraft noise.

Over the past 12 months since the Australian Government announcement that Badgerys Creek is the preferred site for a new airport for Western Sydney, there has been a spike in house prices in areas closer to the airport site. Analysis of longer term growth rates of residential sales in the suburbs around Badgerys Creek between 1991 and 2015 indicates that despite short term fluctuations, property prices have increased at a similar rate to dwelling across Sydney. Rather than suffering a slowing of growth as a result of concerns relating to environmental impacts, residential prices in the suburbs around Badgerys Creek grew strongly in the period following the Australian Government announcement, increasing by almost 24 per cent, which was substantially greater than the average increase in both Western Sydney and the Sydney metropolitan regions.

23.6. Summary of key social benefits and impacts

The key social and economic benefits and impacts arising from the construction and operation of the Stage 1 development are summarised in Table 23–1 and Table 23–2.

Table 23–1 – Summary of social and economic benefits

Social and economic benefits	Construction	Operation
Increased opportunities for local, regional and Greater Sydney businesses through direct, indirect and induced spending from the airport development.	✓	✓
Increased benefits for other industry sectors such as construction, utilities, trade, transport and services, accommodation, retail, professional services, public administration and tourism.	✓	✓
The value-add from construction of the proposed airport would peak in 2022 with benefits to Western Sydney reaching $450 million, and a further $90 million to Greater Sydney in that year. The cumulative value-add for Western Sydney from Stage 1 construction is estimated to be $1.9 billion with an additional $400m to the rest of Greater Sydney over the construction period.	✓	-
During operations, the economic benefits are expected to increase commensurate with passenger movements. In 2031 (roughly aligning with the end of Stage 1), the proposed airport is estimated to generate an additional $205 million in value-add in the Australian economy, with $77 million in value-add being in Western Sydney.	-	✓
An increase in average incomes in Western Sydney. By the time the airport is fully operational, average incomes in Western Sydney are expected to increase to just over 95 per cent of the average for Greater Sydney, compared to 90 per cent in 2014.	-	✓
The proposed airport development would generate a number of direct, indirect and induced jobs in Western Sydney and Greater Sydney during both construction and operations: ▪ Construction employment would peak at 758 direct FTE jobs in 2022 in Western Sydney, with 3,200 cumulative person-years in Western Sydney over the construction period for Stage 1 (between 2016-2024) ▪ There would be indirect and induced employment generated for 8,000 person years in Western Sydney over the construction period between 2016-2024 ▪ An additional 2,200 person years in the rest of Greater Sydney over the construction period between 2016-2024 ▪ An estimated 8,730 FTE jobs would be required for airport operations by the end of Stage 1 in 2031 and a further 4,440 FTE jobs are expected to be generated by commercial developments in business parks on the airport site.	✓	✓
Employment opportunities from the proposed Western Sydney Airport would provide work prospects closer to home for the residents of Western Sydney, who otherwise often have long commutes. This will reduce travel times and improve quality of life (e.g. increased time spent with families, recreation and leisure as well as increases in household incomes) for people from Western Sydney engaged in employment at the airport site.	✓	✓
Employment opportunities due to the airport development would contribute to strong population growth of approximately 17,800 additional persons in Western Sydney by 2031. The new residents are likely to be younger people attracted to employment opportunities and housing that is affordable compared to other parts of Sydney.	-	✓
Potential increase in tourism to the Blue Mountains recreation areas and related attractions and services due to the close proximity of the new airport.	-	✓

Table 23–2 – Summary of social impacts

Social impacts	Construction	Operation
Amenity and lifestyle impacts resulting from construction dust, noise, changes to visual amenity, traffic and related health impacts, particularly on communities surrounding the site.	✓	-
Noise impacts due to airport ground-based operational noise. These impacts would occur during the daytime and night time and affect dwellings and community infrastructure, particularly in Luddenham, Badgerys Creek, Bringelly, Greendale and Wallacia.	-	✓
Depending on the operating strategy adopted for the proposed Western Sydney Airport, communities that may experience overflight noise at varying levels during the daytime and night time include areas of St Marys and Erskine Park, Greendale, Silverdale, Horsley Park and parts of Blacktown. Many of these areas (particularly Greendale, Silverdale and Horsley Park) are semi-rural areas where a high value is placed on the amenity provided by a semi-rural lifestyle.	-	✓
Overflight noise and visual impacts may lead to a minor reduction in amenity and enjoyment of recreational areas located in Western Sydney e.g. Bents Basin Conservation Area, Burragorang State Conservation Area as well as the Greater Blue Mountains Area.	-	✓
Visual amenity impacts for communities close to the site, including Luddenham, Badgerys Creek, Mount Vernon, Silverdale and Rossmore. Views would be permanently changed due to the proposed change in use of the site.	-	✓
Increased emissions of ozone and particles but below guideline criteria levels during airport operation for communities close to the airport site including in Luddenham, Wallacia, Mulgoa, Greendale, Badgerys Creek, Rossmore, Mount Vernon, Kemps Creek and Badgerys Creek.	-	✓
Increased traffic on local and regional roads as a result of the airport operations.	-	✓
Changes to air quality due to aircraft emissions could increase the risk of health impacts on communities near the site, particularly in Bringelly, Luddenham, Rossmore and Kemps Creek.	-	✓
The risk of health effects resulting from daytime and night time (sleep disturbance) noise would increase, particularly in areas surrounding the site and particularly as a result of ground based airport activities. The risks are highest in Luddenham, Greendale, Bringelly, Rossmore, Badgerys Creek and Horsley Park. The specific impacts from aircraft overflights will be determined by the preferred airport operating strategy following the finalised EIS.	-	✓
Overall there is no discernible negative impact expected on property values, as the anticipated value uplift from land use changes will outweigh any consequence or concern about noise impacts.	-	✓
Changes to land use in Western Sydney due to the proposed Western Sydney Airport development and other planned development may result in competition for land and labour and a consequential decline in industry sectors such as agriculture and manufacturing. Stakeholder consultations conducted for the social impact assessment and ABS data show these industries are already in decline in Western Sydney.	✓	✓
There may be a minor impact on some businesses that would need to hire new staff to replace workers taking up employment at the Western Sydney airport.	✓	✓
Proposed airport employees may choose to relocate to live closer to the future airport, which may increase demand for housing locally in Western Sydney. This may particularly affect socio-economically disadvantaged groups due to issues of housing availability and affordability.	-	✓

23.7. Mitigation and management measures

This section identifies proposed measures to reduce the social impacts of the proposed airport. In addition to the mitigation measure identified below, additional mitigation measures for social impacts have been identified in the traffic, noise, air quality, planning and land use chapters and the Community and Stakeholder Engagement Plan of the draft EIS.

Table 23–3 – Mitigation measure

ID	Issue	Recommended mitigation measure	Timing
23.1	Local employment generation	Develop an Australian Industry Participation Plan, including consideration of local industry participation.	Construction
23.2	Stakeholder engagement	Liaise with relevant agencies to inform their planning allocation of funding to programs that may benefit from the proposed airport. Relevant agencies may include local and State government agencies, tourism agencies, agencies responsible for affordable housing and other organisations (e.g. Western Sydney Business Chamber, educational facilities including universities and TAFE).	Operation

23.8. Conclusion

The construction and operation of the proposed airport would result in significant economic and employment opportunities for the Western Sydney region, as well as wider economic benefits throughout the Greater Sydney area. Benefits would be accrued beyond the aviation industry, and extend to businesses and employees in industries such as construction, utilities, trade, transport, accommodation, retail professional services and administration.

Impacts on the amenity of the people Western Sydney would vary between communities, depending on proximity to the airport site, and their location with respect to flight paths. The rural character of the local area would transition to urban with the development of the airport and the implementation of the Western Sydney Employment Area and the South West Priority Growth Area. Noise impacts would affect amenity on local communities, particularly Luddenham and Greendale. Social infrastructure may also be put under stress during the construction of the airport and early stages of operation, but as urbanisation advances in the region, additional services would be expected to come online to meet demand.

Mitigation measures are proposed to manage the social impacts and to maximise the expected economic and employment benefits associated with the proposed airport.

24. Economic

The construction and operation of the proposed airport is expected to have significant benefits on the local and regional economy. These benefits will grow commensurate with the forecast increase passenger demand over time. Overall, the Western Sydney region is expected to experience a significant share of the economic and employment benefits generated by the proposed airport.

Over the construction period (notionally scheduled to occur from 2016 to 2024), the Stage 1 development is forecast to generate a number of economic and employment benefits, including:

- direct construction employment would peak at 758 full-time equivalent (FTE) jobs in 2022 in Western Sydney, with approximately 3,200 cumulative person-years over the construction period. In addition, there would be indirect jobs for Western Sydney and the broader region; and
- the generation of $1.9 billion in value-add across Western Sydney and a further $400 million in the rest of Sydney.

During operation of the Stage 1 development, the proposed airport is expected to continue its role as a substantial source of economic and employment opportunities in the region. In particular, the proposed airport would:

- generate 8,730 FTE jobs in airport operations and a further 4,440 FTE jobs in the expected commercial development in business parks on the airport site in 2031;
- generate approximately $77 million in value-add for Western Sydney and a further $145 million in value-add for the rest of Sydney in 2031; and
- drive growth in business profits, productivity and household income.

24.1. Introduction

This chapter provides a review of the potential economic effects that could be expected as a result of the construction and operation of the Stage 1 development. The chapter draws on the findings of an analysis of economic impacts undertaken to inform this EIS and addresses the requirements of the EIS Guidelines. The economic analysis is included in Appendix P1.

The EIS Guidelines include a requirement to assess both the positive and negative economic impacts associated with the proposed airport. This includes consideration at the local, regional and national level of the expected economic costs and benefits and employment opportunities likely to be generated during construction and operation.

The following analyses were undertaken for the construction and operational phases:

- construction – An economic contribution analysis of the construction of the Stage 1 development; and
- operations – Land use modelling of the operation of the Stage 1 development.

24.2. Methodology

24.2.1. Construction

The economic impact assessment adopted the following employment sector general descriptions of construction activities to analyse the potential direct and flow-on economic contributions:

- non-residential building construction – construction of non-residential buildings, which in this case includes the terminal and other aviation and service buildings;
- heavy and civil engineering construction – construction of infrastructure, which in this case includes construction of roads on the site, the northern runway and parking lots; and
- construction services – a range of services provided as part of construction activities, including installation, finishing, management, etc.

The analysis identifies the 'direct jobs' and the 'value-add' associated with the proposed airport within these employment sectors. The analysis also measures the flow-on impacts upon jobs and value-add in other sectors along the supply chain, as well as consumption impacts through additional household expenditure.

The following definitions apply to the economic contributions analysis:

- value-add: this is the value of production outputs for each industry (both direct and flow-on) minus the value of inputs sourced from other sectors. The sum of value-add across all industry sectors in a specific region is known as the Gross Regional Product (GRP);
- direct jobs and direct value-add: this is the number of jobs and amount of value-add directly related to the construction activities on-site. It includes the construction and fitting out of the airport, terminal buildings, the business park and associated infrastructure; and
- indirect jobs and indirect value-add: this is the change in economic activity (i.e. jobs and value-add) across other industry sectors as a result of the activity (the proposed airport) and is often called the 'multiplier effect' or 'indirect economic contribution'. It has two components; the 'industrial' effect (demand for goods and services by businesses providing inputs to the activity) and the 'consumption' effect (demand for goods and services by people employed within the activity).

The combined direct and indirect effect changes are the 'economic footprint' of the proposal.

24.2.2. Operation

The SCGE model was used to identify the potential economic impacts of the proposed airport on the wider economy. The SCGE model assists in the translation of benefits and costs into real economic impacts accrued through time, cost savings to individuals and businesses, and accessibility gains into area-specific changes in wages, productivity, incomes, value add, and prices. Metrics to describe the economic impact of the proposed airport through the SCGE model include:

- Increased value add – value add is the value of output produced less the cost of intermediate inputs used in the production of that output and expresses the net wealth generated by the activity. The proposed airport will result in higher value-add per year by supporting productivity and growth, delivering benefits to businesses and workers alike;
- Gross business profits – the share of an increase in value-add that is retained as real returns to owners, investors and other who finance businesses;
- Gross household labour incomes – the share of an increase in value-add that is enjoyed by households through an increase real wages;
- Enhanced productivity per worker – this is change in real value-add per worker per year. The proposed airport enables workers in Sydney to be more productive due to a reduction in the cost of aviation services; and
- Net imports – the balance of the real value of exports and imports in a region, representing both domestic, inter-regional trade and international trade.

The SCGE model is intended to represent transactions taking place between individuals, businesses and government agencies in terms of consumption, labour, capital, real estate and trade. Households provide labour and capital to firms and use the income to purchase goods and services. Firms use inputs sourced from other firms, as well as labour and capital, to produce goods and services, which are in turn sold to households and to other firms. These transactions are represented across four spatial areas: Western Sydney, Rest of Sydney, the Rest of NSW, and the Rest of Australia.

24.3. Existing environment

The airport site is located in the localities of Badgerys Creek and Luddenham in the Liverpool local government areas (LGA). The northern boundary of the airport site adjoins the Penrith LGA boundary at Elizabeth Drive. The study area is situated about 50 kilometres west-southwest of the Sydney CBD. The locality of Badgerys Creek can be accessed from the north via Elizabeth Drive or from the south via The Northern Road, both of which are main roads in this area. Kemps Creek and Luddenham are the closest retail centres.

At present, Western Sydney has relatively low incomes, with average household income only around 90 per cent of the Greater Sydney Metropolitan area average.

Strategic planning documents for Western Sydney, including the South West Priority Growth Area and the Western Sydney Employment Area, identify the significant population growth and change over recent decades, and propose measures to adapt to continued growth over the next several decades.

As outlined in the NSW Government *A Plan for Growing Sydney* (Department of Planning 2014) Parramatta is recognised as Sydney's second CBD and will be supported by regional cities at Liverpool, Campbelltown-Macarthur and Penrith. These centres will provide a major focus for jobs, transport and services in Western Sydney communities.

For the purposes of this assessment, Western Sydney is defined as the combination of the following subregions:

- Sydney South West – Liverpool, Fairfield, Camden, Campbelltown and Wollondilly;
- Sydney West – Penrith, Hawkesbury and Blue Mountains; and
- Sydney West Central – Auburn, Bankstown, Blacktown, Holroyd, Parramatta and the Hills Shire.

24.4. Assessment of impacts during construction

24.4.1. Economic contribution – employment

Western Sydney

The number of full time equivalent (FTE) jobs expected to be generated within each construction sector, by type of activity and for each financial year during the construction of Stage 1, is presented in Table 24–1. These employment figures are based on the level of work required to construct the Stage 1 development over the indicative construction schedule as outlined in Chapter 6.

Based on the estimated direct FTE jobs required for construction, Table 24–2 presents the number of indirect-on jobs expected to be generated in the Western Sydney region in each year during construction.

The construction of the Stage 1 development would be expected to generate up to 758 direct FTE jobs on site at its peak in 2022. A further 1,902 FTE indirect jobs are also expected to be generated in 2022, with up to 1,238 FTE jobs created in the supply chain through the industrial effect, and up to 664 jobs created through consumption effects. Over the construction period, the Stage 1 development is forecast to generate up to 3,231 FTE person years of employment in Western Sydney.

Table 24–1 – Stage 1 construction employment estimates

Employment type	2017	2018	2019	2020	2021	2022	2023	2024	Total
Site preparation (Civil)	52	141	103	15	26	61	28	-	427
Aviation (Civil)	-	-	27	159	128	114	74	104	605
Site preparation (Contract administration)	4	14	22	23	21	12	2	-	97
Site preparation (Supervisory and management)	16	48	78	80	73	44	7	-	346
Aviation (Contract administration)	-	-	3	40	97	113	107	60	419
Aviation (Supervisory and management)	-	-	4	55	135	157	148	84	583
Aviation (Building)	-	-	-	74	124	256	217	82	754
TOTAL	72	203	236	446	605	758	583	330	3,231

Table 24–2 – Potential jobs generated in the Western Sydney region during construction

Effects (FTE jobs per year)	2017	2018	2019	2020	2021	2022	2023	2024	Total
Direct jobs	72	203	236	446	605	758	583	330	3,231
Indirect jobs									
Industrial effect	117	331	386	729	988	1,238	953	540	5,281
Consumption effect	63	178	207	391	530	664	511	290	2,834
TOTAL	251	712	828	1,565	2,123	2,660	2,047	1,160	11,346

The expected annual contribution to employment in Western Sydney over the construction period is shown Figure 24–1.

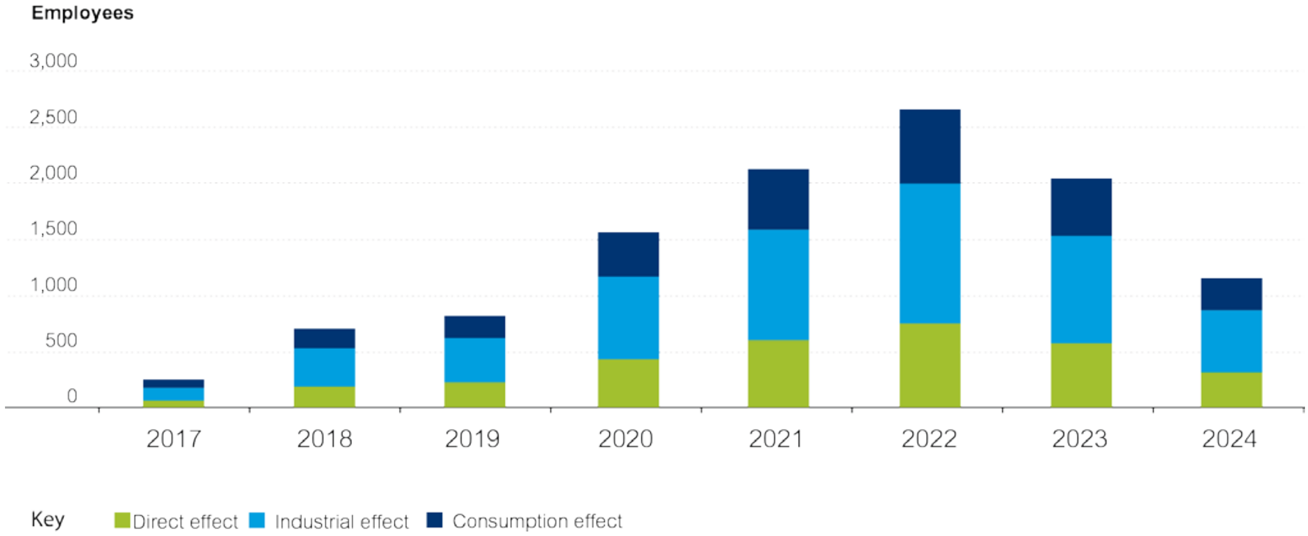

Figure 24–1 – Expected annual contribution to employment in Western Sydney (FTE jobs per year)

Greater Sydney

The potential economic footprint across the greater Sydney region, which includes Western Sydney, associated with the construction of the Stage 1 development is summarised in Table 24–3. The table presents the number of FTE jobs expected to be generated in the greater Sydney region in each financial year during the construction period.

Table 24–3 – Potential jobs generated across the Greater Sydney Region (including Western Sydney) during construction

Effects (FTE jobs per year)	2017	2018	2019	2020	2021	2022	2023	2024	Total
Direct jobs	72	203	236	446	605	758	583	330	3,231
Indirect jobs									
Industrial effect	130	369	429	810	1,099	1,377	1,060	600	5,874
Consumption effect	99	179	325	614	833	1,043	803	455	4,451
TOTAL	300	850	990	1,870	2,537	3,178	2,446	1,386	13,556

Across the greater Sydney region, the expected employment footprint associated with the construction of the Stage 1 Development would be greater because larger shares of potential indirect jobs are captured within this larger geographical area. The greater Sydney employment footprint could be expected to reach up to 3,178 jobs during the construction peak in 2022, and up to13,556 FTE job-years generated in total during construction.

Over the construction period, the Stage 1 development is forecast to generate up to 2,210 FTE indirect jobs outside of Western Sydney. This means that approximately 84 per cent of all direct and indirect jobs generated by the proposed airport during construction are forecast to be located in Western Sydney.

The expected annual contribution to employment in the greater Sydney region over the construction period is shown in Figure 24–2.

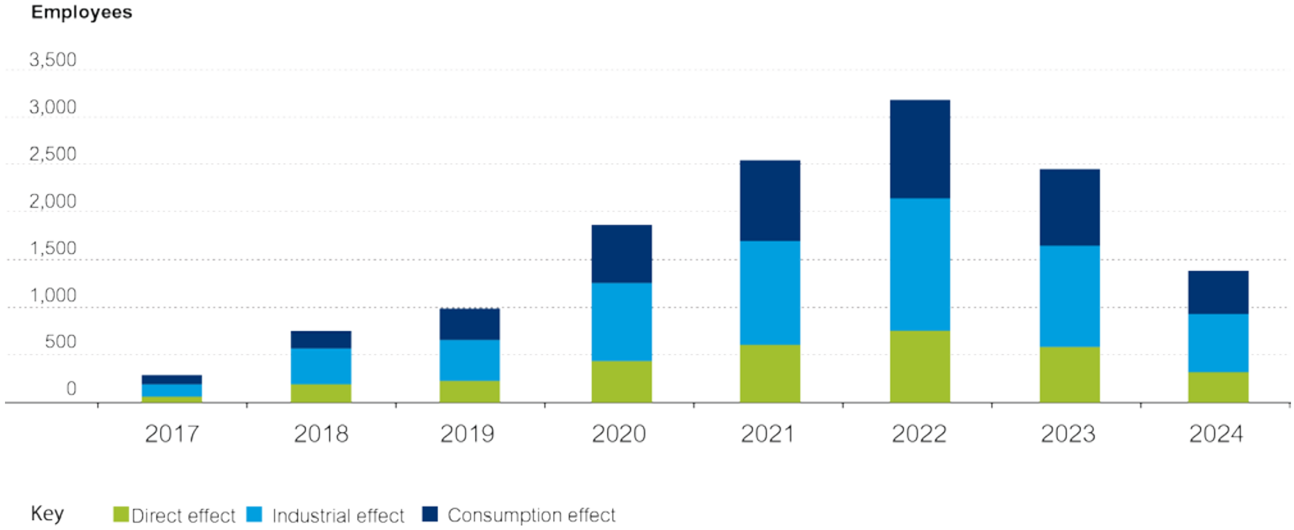

Figure 24–2 – Expected annual contribution to employment – greater Sydney, including Western Sydney (FTE jobs per year)

24.4.2. Economic contribution – value add

Western Sydney

The potential economic footprint related to the construction of the Stage 1 development in terms of value-add is summarised in Table 24–4. The table presents the forecast economic contribution expected for the Western Sydney region in each year in terms of millions of dollars of value-add.

Table 24–4 – Potential economic contribution to the Western Sydney region

Effects (millions of dollars per year)	2017	2018	2019	2020	2021	2022	2023	2024	Total
Direct contribution	16	44	52	98	132	166	128	72	707
Indirect contribution									
Industrial effect	17	47	55	104	141	176	136	77	751
Consumption effect	10	28	33	62	84	105	81	46	446
TOTAL	42	119	139	263	356	446	344	195	1,904

Direct on-site value-add during construction of Stage 1 could be expected to reach up to $166 million during the busiest construction period in 2022, generating another $176 million and $105 million indirectly (through industrial and consumption effects). The total Western Sydney value-add footprint could be expected to reach up to $446 million in 2022 with a total value-add over the construction period of up to $1.9 billion (undiscounted).

The expected annual contribution to value-add over time for the Western Sydney region is shown in Figure 24–3.

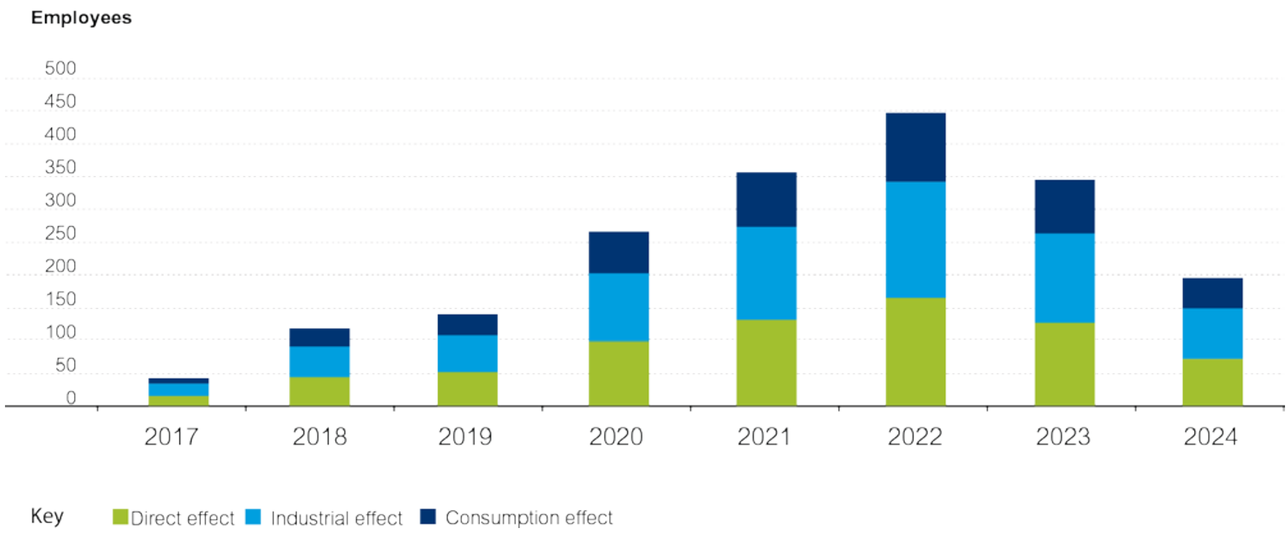

Figure 24–3 – Value-add annual contribution – Western Sydney (millions of dollars per year)

Greater Sydney

The potential economic footprint across the greater Sydney region associated with the construction of the Stage 1 development is summarised in Table 24–5. The table presents the economic contribution expected for the greater Sydney region in each year in terms of millions of dollars.

Table 24–5 – Potential economic contribution to the Greater Sydney region (millions of dollars per year)

Effects (millions of dollars per year)	2017	2018	2019	2020	2021	2022	2023	2024	Total
Direct contribution	16	44	52	98	132	166	128	72	707
Indirect contribution									
Industrial effect	19	55	64	121	165	206	159	90	880
Consumption effect	16	45	52	99	134	168	129	73	716
TOTAL	51	145	168	318	431	540	416	235	2,304

Similar to employment impacts, the greater Sydney value-add footprint would be of a greater magnitude than for Western Sydney, reaching up to $540 million in 2022 and up to $2.3 billion (undiscounted) over the construction period. The Stage 1 development is forecast to generate $400 million in value-add outside of Western Sydney over the construction period. This means that approximately 83 per cent of all value-add generated by the proposed airport during construction is forecast to be in Western Sydney.

The expected annual contribution to value-add over time for the Greater Sydney region is shown in Figure 24–4.

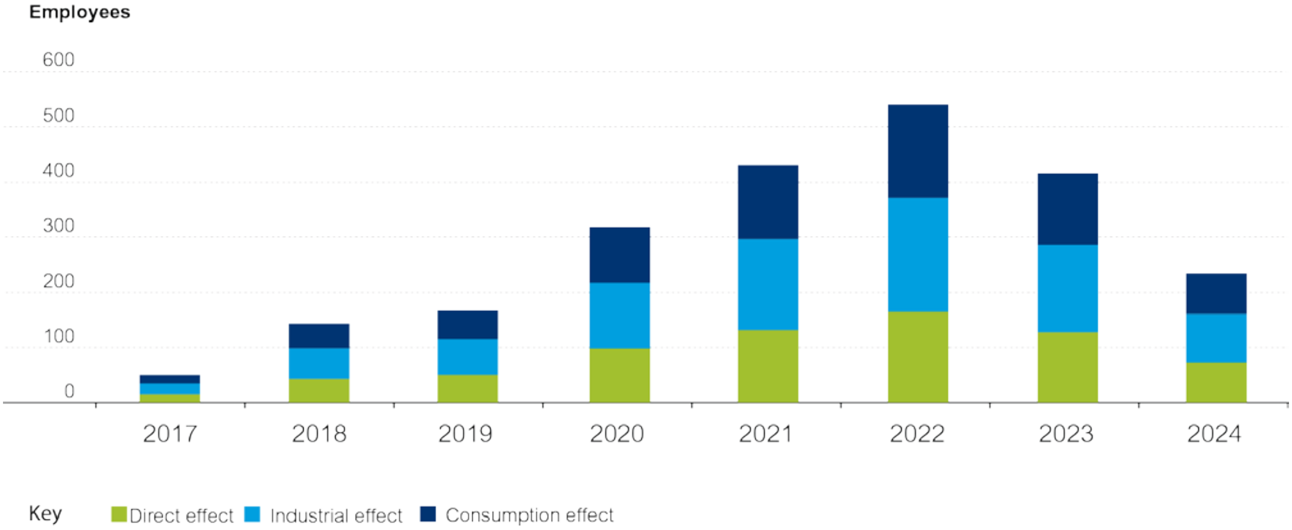

Figure 24–4 – Value-add annual contribution – greater Sydney, including Western Sydney (millions of dollars per year)

24.5. Assessment of impacts during operation

24.5.1. Economic impacts of Stage 1

The Stage 1 development of the proposed airport would result in economic benefits for Western Sydney and the wider region. Benefits would be accrued beyond the aviation industry, and extend to businesses and employees in industries such as construction, utilities, trade, transport, accommodation, retail professional services, tourism and hospitality, and administration. These benefits would have flow-on effects to individuals through increased household income and greater access to employment opportunities.

The economic benefits associated with the Stage 1 development are commensurate with the 10 million annual passengers expected to be accommodated by 2030. As the proposed airport grows beyond 10 million annual passengers it is expected that the economic benefits would also increase. An overview of the potential economic benefits associated with the long term development is presented in Chapter 39.

Table 24–6 provides an overview of the economic impacts associated with the Stage 1 development. The figures presented are for the year 2031, the year after Stage 1 development. The use of 2031 was necessary to ensure consistency with data provided by external sources.

Table 24–6 – Stage 1 economic impacts, in 2031 (undiscounted 2015 real values)

Metric (per year)	Western Sydney	Rest of Sydney	Rest of NSW	Rest of Australia	Total
Value add ($ millions)	$77	$145	$23	-$39	$205
Business profits ($ millions)	$27	$42	$11	-$8	$73
Productivity per worker ($/worker)	$90	$95	$20	-$4	$17
Household income ($ millions)	$44	$50	$15	$32	$140

In 2031 the operation of the proposed airport could generate an additional $205 million in value-add per year across Australia. Of this, approximately $77 million would be generated in Western Sydney alone. There is a reduction in value-add in the Rest of Australia (outside NSW), reflecting the proposed airport's role in attracting economic activity to the region. The increase in value-add is supported by increases in productivity per worker, averaging $90 in Western Sydney and $95 per worker in Rest of Sydney.

The operation of the Stage 1 development would also result in economic benefits for business in the regions surrounding the airport site. In 2031 the proposed airport would generate an additional $27 million in profits for businesses in Western Sydney and $42 million in increased profits for businesses in the rest of Sydney. There are smaller positive benefits to the rest of NSW and a negative impact on the Rest of Australia, again reflecting the proposed airport's role in redistributing economic activity to Western Sydney and the broader metropolitan area.

In relation to household income, the proposed airport would generate $44 million and $50 million in additional household income for Western Sydney and the Rest of Sydney. It is expected there would be significant regional spill-overs, with a substantial share of the total gains falling to rest of Australia.

24.5.2. Employment growth at the airport

The proposed airport is expected to support a number of jobs on the airport site. Specifically, these jobs can be divided into direct airport jobs and non-aeronautical jobs at the proposed on-site business park.

In 2031 the operation of the Stage 1 development is expected to generate a total of 11,940 jobs on the airport site. This would include approximately 8,730 jobs directly associated with the operation of the proposed airport, and 4,440 jobs in the manufacturing, business services and consumer services sectors as part of the non-aeronautical developments on the airport site. There is also expected to be an associated reduction in employment growth at Sydney Airport as demand for aviation services shifts to Western Sydney.

A breakdown of the expected employment can be seen in Table 24–7.

Table 24–7 – Stage 1 onsite employment impacts in 2031

Category	Employment impact in 2031
Direct airport jobs	8,730
On-site business park	4,440
Total	13,170

24.5.3. Employment impacts of Stage 1

Potential changes in employment growth in the region associated with the development of the proposed airport are expected to be driven by:

- changes in access to new or relocated firms (measured by the number of jobs) resulting from the redistribution of employment to areas around the airport site;
- changes in access to workers and customers resulting from the change in population associated with the development of the proposed airport; and
- increases in employment zones in the area surrounding the proposed airport due to changes in land use and increased commercial and business development areas.

The results below only consider and incorporate changes to employment opportunities outside the airport site, and do not incorporate the number of employees that are expected to be employed at the proposed airport during the Stage 1 development. This is similar to the population model, because the proposed airport would only be operating for about 5 years up until 2030, it is assumed that there would be no net new employment in Sydney as a result of the Stage 1 development. Instead, employment is presumed to be redistributed across Sydney after following development of the proposed airport and the associated changes in liveability and accessibility around the airport site.

The estimated change in employment is formulated on the base case of no airport. Therefore, areas that see a reduction in employment in the analysis do not necessarily decline in absolute terms, rather they do not grow by as much as they otherwise would have without the proposed airport.

The analysis found that in 2031, the Stage 1 development would facilitate an additional increase of 6,930 FTE jobs in Western Sydney (above the natural growth that would be expected without the development of the proposed airport). These jobs would be redistributed to Western Sydney from other areas of Sydney.

A summary of the expected effects of the proposed airport on employment in the Western Sydney region is presented in Table 24–8. Cumulative employment growth between 2016 and 2031 for each Western Sydney subregion is presented for the base case with no airport development. In addition the table shows the employment impact for each of the Western Sydney subregions due to the proposed airport for the year 2031. This only shows the results for a particular year and does not show the cumulative employment impact over an extended period of time. However, as the proposed airport is anticipated to commence operations in the mid-2020s, by 2031 it is expected that the airport would have only been operational for around five years.

With the operation of the Stage 1 development, the Sydney West subregion is anticipated to see the largest increase in employment across the broader Western Sydney region in 2031. The Sydney South West and Sydney West Central subregions are also likely to experience employment increases over and above that which would be expected without the development of the proposed airport.

Table 24–8 – Western Sydney employment growth (FTE jobs)

Area	Additional employment in 2031 associated with the proposed airport
Sydney South West	2,042
Sydney West	3,020
Sydney West Central	1,869
Total Western Sydney	6,930

Western Sydney would be expected to see increases in employment in areas surrounding the airport driven by increased access to workers and business opportunities. Areas around the airport site that currently have very little employment would see large proportional increases.

Outside of Western Sydney, there is expected to be a slowing or small reduction in employment growth in other areas Sydney. The LGAs closest to Sydney Airport are likely to have the greatest proportional slowing in employment growth, as transport and logistics jobs are redistributed towards Western Sydney. Similar to the previous table, Table 24–9 presents the employment impact for the year 2031 due to the Stage 1 development. This time, the results are for the LGAs in Sydney that are expected to see the largest slowing down in job growth in the year 2031 due to the proposed airport.

Table 24–9 – Selected LGAs in rest of Sydney – employment effects

Selected LGA	Employment change in 2031 associated with the proposed airport
City of Sydney	-3,832
Botany Bay	-1,333
Rockdale	-231
North Sydney	-335
Randwick	-259

24.5.4. Population impacts of Stage 1

As the proposed airport is scheduled to commence operation in the mid-2020s, it is expected that the proposed airport would have only been operating for around 5 years up until 2030. Therefore, the majority of economic and employment impacts associated with the operation of the proposed airport will occur beyond 2030 and so are considered outside the scope of the Stage 1 assessment. However, a preliminary analysis of land use changes associated with the proposed airport have been included in the draft EIS to provide an indication of the impacts likely to result from the operation of the Stage 1 development.

Potential changes in population distribution in the region associated with the introduction of the proposed airport could broadly be driven by:

- changes in access to jobs as a result of increased employment opportunities in the region;
- increased attractiveness of travel zones that would be closer to a major airport (with the introduction of the proposed airport), and
- the amenity impacts of introducing an airport to the immediate surrounding area (noise, visual, and other amenity issues) and the likely change in surrounding land use may result in a reduction in population densities in areas within five kilometres of the proposed airport.

For the purposes of this assessment, it was assumed that there would be no net additional population in Sydney as a result of the Stage 1 development. However, there is expected to be some redistribution of population across the Sydney region associated towards Western Sydney with increased employment opportunities and changes in accessibility to a major airport.

The estimated change in population is expected to be incremental compared to a base case of not developing the proposed airport. Areas that see a reduction in population in the analysis would not necessarily decline in absolute terms. Rather they would not grow as much as they otherwise would have without the development of the proposed airport.

The analysis indicated that by 2031, the Stage 1 development would result in an additional population of 17,823 residents in Western Sydney. The strongest population growth is estimated to occur in the following LGAs:

- Penrith;
- Blue Mountains;
- Blacktown;
- Wollondilly
- Camden; and
- Liverpool.

A summary of the potential effects of the proposed airport on population in the Western Sydney region in 2031 is provided in Table 24–10. The potential effects on population across the rest of the Sydney region are presented in Table 24–11. These tables only show the results for a particular year and do not show the cumulative additional population impact over an extended period of time. However, as the proposed airport is anticipated to commence operations in the mid-2020s, by 2031 it is expected that the airport would have only been operational for around five years.

The subregion of Sydney West is anticipated to see the largest increase in population across the broader Western Sydney region in 2031 as a result of the Stage 1 development. This strong growth would be expected as a result of some redistribution of population from the rest of Sydney, the rest of NSW, and the Sydney West Central subregion. This redistribution would be linked to the increased attractiveness of the area around the airport site in terms of employment opportunities and accessibility to aviation services following the development of the proposed airport. As a result of the redistribution of population, the City of Sydney, Parramatta, Bankstown and Hornsby are forecast to experience a slower population growth.

Table 24–10 – Western Sydney population changes in 2031 (people)

Subregion	Population change in 2031 associated with the proposed airport
Sydney South West	4,856
Sydney West	16,184
Sydney West Central	-3,217
Total Western Sydney	17,823

Table 24–11 – Selected LGAs in rest of Sydney – population changes in 2031 (people)

Selected LGA	Population change in 2031 associated with the proposed airport
City of Sydney	-821
Canterbury	-1,017
Parramatta	-1,234
Randwick	-1,166
Bankstown	-1,220
The Hills	-1,234
Hornsby	-1,009

A significant increase in population would be expected near the airport site of up to nine per cent. However there would also be negative impacts in the immediate vicinity of the proposed airport, due to a combination of the airport development and the changing land uses. The relative population increases would be less pronounced with further distance to the proposed airport.

There is predicted to be slower population growth around Sydney (Kingsford Smith) (Sydney Airport) relative to the base case of not developing Western Sydney Airport. This is likely because there may be slower job growth at Sydney Airport compared to the increased opportunities in the Western Sydney region associated with the Stage 1 development. There may also be small population growth reductions elsewhere (less than one per cent) as population is redistributed towards Western Sydney.

24.6. Conclusion

The construction and operation of the Stage 1 development would have significant positive impacts on the Western Sydney and the greater Sydney regional economies.

The assessment of the economic contribution of the construction of Stage 1 finds that, at the peak of construction activity, there would be an additional 758 jobs generated on site, with an associated employment footprint of up to 2,660 full time equivalent jobs in Western Sydney and an additional 520 jobs across the rest of Sydney. Over the construction period, the total employment footprint would be up to 13,556 FTE jobs for the greater Sydney region with approximately 84 per cent of those jobs being based in Western Sydney. In terms of value-add, the construction period would generate a total economic footprint of approximately $2.3 billion in the greater Sydney region, with Western Sydney expected to benefit from $1.9 billion or approximately 83 per cent of all value-add generated by the proposed airport.

During the operation of the proposed airport, Western Sydney is expected to see increases in population and employment driven by increased access to aviation services, economic and employment opportunities. Manufacturing and consumer service sectors are likely to see the largest changes in response to improved accessibility. This is expected to result in a redistribution of population and employment to Western Sydney from other parts of Sydney.

Due to employment opportunities, there is expected to be a significant increase in population near the airport site of up to nine per cent. However there would be some negative impacts in the immediate vicinity of the airport site due to a combination of the airport development and the changing land uses. The expected population increases would be likely to reduce with as distance from the airport site increases.

25. Resources and waste

Construction of the proposed airport would involve clearing and a major bulk earthworks program to achieve a level surface suitable for the construction of airport facilities, along with the use of a range of construction materials. The operational airport would employ a large workforce and service some 10 million passengers each year. As with any large infrastructure project, the construction and operation of the proposed airport would involve the consumption of natural resources and has the potential to generate substantial quantities of waste.

The peak for waste generation would be during construction, when an estimated 202,500 tonnes of waste vegetation and construction materials such as concrete and timber would be generated. During the initial airport operations, an estimated 5,251 tonnes of waste would be generated each year, and would include general waste, food, packaging waste from terminals and waste oils, paints and cleaners from maintenance activities.

Resources and waste from the airport would be sustainably managed by maximising waste avoidance, reduction, reuse and recycling (in accordance with a waste management hierarchy), while mitigating and managing impacts on human health and the environment. A waste management plan would be prepared prior to construction and operation of the airport, which would guide the management of waste during construction and operation.

Consideration would also be given to the achievement of an Infrastructure Sustainability Council of Australia 'As Built Rating' and 'Operations Rating' to promote sustainability – covering the design, construction and operation of the Stage 1 development.

The waste management market in Western Sydney is mature and handles significant volumes of waste from various domestic, commercial and industrial sources across all of Sydney. Waste facilities in Western Sydney have sufficient capacity to handle wastes of the type and volume expected to be generated at the airport site.

25.1. Introduction

This chapter provides an analysis of the resources that would be consumed and waste generated by the construction and operation of the proposed Western Sydney Airport. Potential impacts arising from the construction and operation of the proposed airport are characterised and measures to mitigate and manage these impacts are identified.

25.2. Methodology

The following tasks were undertaken to assess resource consumption and waste generation associated with the development of the proposed airport:

- review of waste legislation and policy in order to consider which matters must be complied with and which matters may provide guidance in developing waste management strategies;
- estimation of waste generated by construction and operation of the airport; and
- determination of waste management options.

Resources consumed and waste generated during construction were estimated with reference to data on construction planning and logistics data (see Chapter 6) applied to typical waste generation rates for construction of certain types of infrastructure (e.g. roads, runways, hardstands and commercial buildings) based on area and taking into account certain assumptions such as concrete density and thickness.

Waste that would be generated during operation was estimated by referring to data from a number of existing airports. The airports were selected based on the availability and applicability of waste data. This was used to estimate the types and quantities of waste that may be generated from particular airport facilities at the proposed airport. The researched airport data are summarised in Table 25–1. The types of data typically reported were either:

- amounts for components of waste streams, such as food and cardboard;
- whole amounts for parts of airports, such as terminals and maintenance; or
- amounts of waste for the whole airport.

Outlying values were removed from the collected data, then converted to kilograms per 1,000 passengers and averaged out. The averages were then multiplied by the number of passengers to account for the 10 million annual passengers forecast each year during the Stage 1 development.

Table 25–1 – Summary of waste data from researched airports

Airport	Passengers per year (million)	Waste type	Annual volume per 1,000 passengers (kg)
Aberdeen (ABZ), UK (2007)	2.7	General waste	187.0
Adelaide (ADL), Australia (2013)	7.5	General waste	95.7
Athens (ATH), Greece (2005)	14.3	General waste	819.1
		Recyclables	120.0
		Hazardous	24.9
Copenhagen (CPH), Denmark (2005)	24	General waste	144.0
Dubai (DXB), UAE (2004)	21.7	General waste	944.8
Edinburgh (EDI), UK (2007)	8.7	General waste	219.9
Fort Lauderdale (FLL), USA (2004)	10	General waste	477.4 (average)
Los Angeles (LAX), USA (2004)	29		
Portland (PDX), USA (2004)	6.5		
San Francisco (SFO), USA (2004)	36		
Baltimore-Washington (BWI), USA (2004)	21		
Glasgow (GLA), UK (2007)	8.9	General waste	305.1
Heathrow (LHR), UK (2005)	36.1	Non-hazardous	205.4
		Recyclables	24.8
		Hazardous	115.6
		Hazardous liquids	8.6

Airport	Passengers per year (million)	Waste type	Annual volume per 1,000 passengers (kg)
Melbourne (MEL), Australia (2004)	19	General waste	124.2
Munich (MUC), Germany (2013)	38.7	General waste	231.2
Oakland (OAK), USA (2007)	13.6	General waste	31.5
Southampton (SOU), UK (2007)	1.9	General waste	226.8
Stanstead (STN), UK (2007)	23.8	General waste	263.1
Toronto (YYZ), Canada (2005)	28.6	Non-hazardous	151.0
		Hazardous	1.4

25.3. Legislation and policy

25.3.1. Legislative framework

As a Commonwealth facility, the airport site would principally be governed by Commonwealth legislation. Although this legislation does not explicitly regulate waste, it prescribes duties for airport operators to take all reasonable and practicable measures to avoid polluting as described in Chapter 3 of this draft EIS and Part 4 of the *Airports (Environment Protection) Regulations 1997* (Cth). Other relevant laws and regulations administered by the Commonwealth generally relate to national matters such as import, export and quarantine. These laws apply to particular wastes at the airport site and include the:

- *Quarantine Act 1908* (to be replaced by the *Biosecurity Act 2015*); and
- *Hazardous Waste Act 1989*.

As most waste generated at the airport site would be transported off-site, a range of State laws are also applicable. The principal NSW laws concerning waste are the:

- *Waste Avoidance and Resource Recovery Act 2001*;
- *Protection of the Environment Operations Act 1997*; and
- *Protection of the Environment (Waste) Regulation 2014*.

Definitions and a summary of key provisions are outlined below.

25.3.2. Quarantine Act 1908

The *Quarantine Act 1908* (Cth) allows the Australian Government to quarantine vessels, persons or goods to protect human health and the environment from pests and disease. Quarantine activities are controlled by the Australian Government Department of Agriculture. The service is responsible for the clearance of all incoming international aircraft, aircraft waste, passengers and baggage. Quarantine activities at airports typically involve screening of passengers and their baggage using a range of techniques such as x-ray, detector dogs and physical inspection as well as specific waste management requirements. Screening is usually undertaken in designated examination areas after baggage reclaim but can also involve access to airside and apron areas.

The Act is supported by the Quarantine Regulations 2000 which detail provisions regarding offences under the Act and procedural matters on when and how quarantine activities are undertaken. The Act will be repealed and replaced by the *Biosecurity Act 2015*, which will commence on 16 June 2016.

25.3.3. Hazardous Waste (Regulation of Imports and Exports) Act 1989

The *Hazardous Waste (Regulation of Imports and Exports) Act 1989* (Cth) implements Australian Government obligations under the Basel Convention and prohibits the export and import of hazardous waste without a permit. A permit may be obtained to export hazardous waste where it can be shown that the waste would be managed in an environmentally sound manner in the country of import.

The Australian Government has banned the export of hazardous waste for disposal in all but exceptional circumstances. Export of hazardous waste for reuse, recycling or recovery is permitted providing certain conditions are met. Consideration may need to be given to the Act if waste materials originating from the airport, such as electronic waste, are exported overseas.

25.3.4. Waste Avoidance and Resource Recovery Act 2001

The *Waste Avoidance and Resource Recovery Act 2001* (NSW) is the overarching waste management legislation in NSW. The objectives of the Act include encouraging the most efficient use of resources, reducing environmental harm and ensuring resource management decisions are made against a hierarchy that gives preference to waste avoidance and resource recovery. The main provisions of the Act relate to the preparation of waste strategies and extended producer responsibility schemes. The current statutory waste strategy is the NSW Waste Avoidance and Resource Recovery Strategy 2014–21 (EPA 2014a). The waste strategy is explained in Section 25.3.2.

Extended producer responsibility schemes may be made under the Act. The schemes relate to the lifecycle of a product and therefore may apply to the extraction of raw materials for a product, the manufacturing of a product and the consumption of a product, through to disposal and ongoing management requirements. The schemes may apply to producers or consumers of particular products.

Extended producer responsibility schemes in place in NSW are identified in the NSW Extended Producer Responsibility Priority Statement 2010 (DECCW 2010b) and include schemes for waste packaging, mobile phones, agricultural chemicals and containers, polyvinyl chloride, oils and lubricants, and tyres. Consumers such as an airport lessee company would be expected to cooperate in producer responsibility schemes by isolating relevant waste streams for collection.

25.3.5. Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (NSW) is the principal environmental protection legislation administered by the NSW Environment Protection Authority The Act sets out the waste classifications, licensing requirements and other regulatory controls that would be applicable to waste transported from the airport site.

The objectives of the Act include the protection, restoration and enhancement of the quality of the environment and reduction of risks to human health. The main provisions of the Act relate to the grant and oversight of environment protection licences, the control of certain actions which may give rise to pollution and the control of waste management activities. The Act broadly defines 'waste' for the purpose of regulation as:

a. *any substance (whether solid, liquid or gaseous) that is discharged, emitted or deposited in the environment in such volume, constituency or manner as to cause an alteration in the environment; or*

b. *any discarded, rejected, unwanted, surplus or abandoned substance; or*

c. *any otherwise discarded, rejected, unwanted, surplus or abandoned substance intended for sale or for recycling, processing, recovery or purification by a separate operation from that which produced the substance; or*

d. *any processed, recycled, re-used or recovered substance produced wholly or partly from waste that is applied to land, or used as fuel … in the circumstances prescribed by the regulations; or*

e. *any substance prescribed by the regulations to be waste.*

Schedule 1 of the Act also sets out the waste classification which provides the basis for the NSW *Waste Classification Guidelines* (see Section 25.3.2). The classification of waste under the Act and supporting guidelines is summarised in Table 25–2. Full definitions can be found within the Act, associated Regulations and the *Waste Classification Guidelines*.

Part 5 of the Act prescribes a range of offences for polluting water, air, noise and land. Part 5.6 of the Act specifically deals with offences relating to land pollution and waste. Relevant offences include the unlawful transporting or depositing of waste, providing false or misleading information about waste, or operating a waste facility without lawful authority.

Table 25–2 – Summary of waste classifications in NSW

Waste type	Definition
Restricted solid waste	A substance meeting the specific contaminant concentrations and/or toxicity characteristics defined in the NSW *Waste Classification Guidelines*.
Liquid waste	Under the NSW *Waste Classification Guidelines*, a substance that shows flowing characteristics at an angle of less than 5 degrees above horizontal, and becomes free flowing at or below 60 degrees Celsius or when it is transported.
Special waste	Clinical and related waste, asbestos waste and waste tyres as per the NSW *Waste Classification Guidelines*.
Hazardous waste	Substances that are Class 1 (explosives), Class 2 (gases), Class 5 (oxidising substances and organic peroxides) or Class 8 (corrosives) under the *Transport of Dangerous Goods Code*. Substances under Division 4.1 (flammable solids), Division 4.2 (substances liable to spontaneous combustion), Division 4.3 (substances which emit flammable gas on contact with water) or Division 6.1 (toxic substances) of the *Transport of Dangerous Goods Code*. Containers having previously contained Class 1, 3, 4, 5, 6.1 or 8 dangerous goods under the *Transport of Dangerous Goods Code*. Other materials generated or collected under certain circumstances including coal tar or coal tar pitch waste, lead-acid or nickel-cadmium batteries, lead paint, or otherwise classified as hazardous waste by the NSW Environment Protection Authority and a mixture of any of the above.

Waste type	Definition
General solid waste (non-putrescible)	Numerous wastes other than those listed above. Examples include glass, plastic, concrete, metal, wood, asphalt and non-contaminated excavated material such as soil or gravel.
General solid waste (putrescible)	Numerous wastes other than those listed above. Examples include manure and nightsoil, food waste and domestic waste with putrescible organics.
Trackable waste	Substances listed in Schedule 1 of the Protection of the Environment Operations (Waste) Regulation 2014 (NSW). Asbestos has separate tracking requirements under Part 7 of the Regulation.

25.3.6. Protection of the Environment Operations (Waste) Regulation 2014

The Protection of the Environment Operations (Waste) Regulation 2014 (NSW) sets out obligations that would apply to waste managers, consigners, transporters and receivers dealing with waste coming from the airport site.

The main provisions of the Regulation relate to the payment of a waste levy by licensed waste receivers, the requirements to track the transportation and disposal of certain types of waste, and specific requirements regarding the transportation and management of asbestos waste.

Schedule 1 of the Regulation lists types of waste that must be tracked during transport and disposal. Obligations to track these wastes apply to consigners, transporters and receivers. The responsibilities of consigners generally relate to ensuring that transporters and receivers of their waste hold the relevant licences to deal with the waste. Part 7 of the Regulation contains provisions for the transportation and management of asbestos waste, including requirements for its containment during transport, reporting requirements for transporters and receivers of asbestos waste, the manner in which asbestos is disposed, and a prohibition on the reuse or recycling of asbestos waste.

25.3.7. Other laws and regulations

Other laws and regulations concerning waste include the following:

- State laws and regulations controlling hazardous substances:
  - *Explosives Act 2003* (NSW);
  - *Radiation Control Act 1990* (NSW);
  - *Environmentally Hazardous Chemicals Act 1985* (NSW); and
  - *Dangerous Goods (Road and Rail Transport) Act 2008* (NSW), which gives effect to the Australian Code for the Transport of Dangerous Goods by Road and Rail; and
- *Product Stewardship Act 2011* (Cth), which sets the framework for product stewardship in line with the National Waste Policy (see Section 25.3.2).

25.3.8. Policies, plans and guidelines

A range of policies, plans and guidelines would also apply to waste generated at or transported from the airport site. The main documents are:

- *National Waste Policy*;
- NSW *Waste Avoidance and Resource Recovery Strategy 2014–21*; and
- NSW *Waste Classification Guidelines*.

Definitions and a summary of key provisions are outlined below.

25.3.9. National Waste Policy

The *National Waste Policy* is an overarching policy that guides the development of legislation and policy within States and Territories. The objectives of the National Waste Policy include the avoidance and reduction of waste for disposal, management of waste as a resource, and management of waste in a safe, scientific and environmentally sound manner.

The Policy identifies a range of strategies to be implemented by the Australian Government in collaboration with the States and Territories. The strategies include:

- establishment of Commonwealth product stewardship framework legislation;
- sustainable procurement principles and practices across government operations;
- improvements in waste avoidance and re-use in commercial waste streams; and
- best practice waste management and resource recovery for construction and demolition.

25.3.10. Waste Avoidance and Resource Recovery Strategy 2014–21

The current waste strategy under the *Waste Avoidance and Resource Recovery Act 2001* (NSW) is the *NSW Waste Avoidance and Resource Recovery Strategy 2014–21* (EPA 2014a). The Strategy sets objectives to avoid waste generation, increase recycling, divert waste from landfill, manage problem wastes, reduce litter and reduce illegal dumping. To achieve these objectives, the Strategy assigns the following responsibilities to industry and business:

- avoid and reduce waste through efficiency measures and industrial ecology partnerships;
- separate recycling streams at source to enable collection separate from residual waste;
- work with suppliers to reduce packaging and waste in supply chains;
- implement and maintain best practice resource recovery systems;
- actively seek other businesses that may use waste as a resource;
- ensure waste and recycling streams are taken to appropriate facilities by legitimate operators;
- specify and purchase recycled materials;
- work with other producers to take responsibility for management of problem wastes; and
- comply with regulations.

The Strategy also elaborates on a waste management hierarchy (see Figure 25–1) which supports the objectives of the *Waste Avoidance and Resource Recovery Act 2001*.

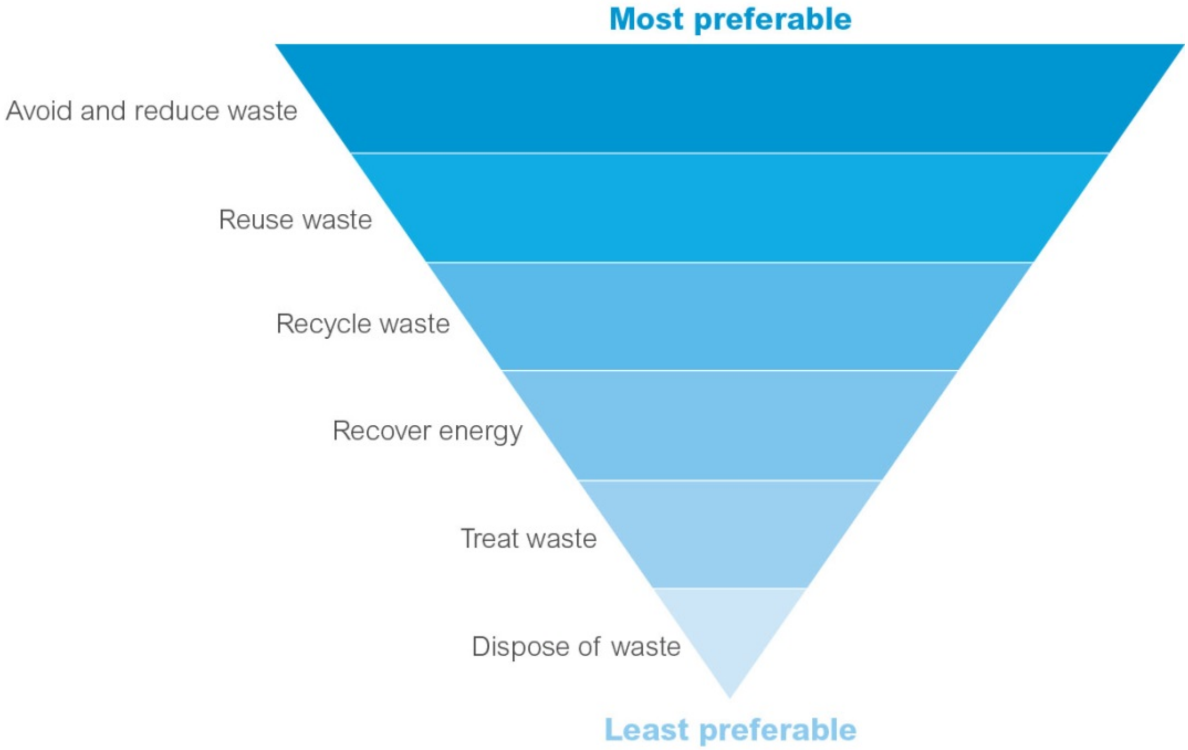

Figure 25–1 – Waste management hierarchy

Source: NSW Waste Avoidance and Resource Recovery Strategy 2014–21 (NSW EPA 2014a)

Under the waste management hierarchy, it is preferable to avoid or reduce waste by procuring only necessary materials, and consuming materials with limited production or packaging requirements. Reusable or recyclable materials should be considered where waste cannot be avoided. If waste cannot be reused or recycled, efforts should be made to recover energy to maximise its beneficial use prior to its eventual disposal. Waste with harmful characteristics should be treated prior to disposal to minimise their potential to affect human health and the environment.

25.3.11. Waste Classification Guidelines

The NSW *Waste Classification Guidelines* (EPA 2014b) expand on the classifications of waste in Schedule 1 of the *Protection of the Environment Operations Act 1997* (NSW) and Schedule 1 of the NSW Protection of the Environment Operations (Waste) Regulation 2014 (NSW). The classification of waste is summarised in Table 25–2.

25.3.12. Other policies, standards and codes

Other policies, standards and codes include the following:

- *Australian Code for the Transport of Dangerous Goods by Road and Rail*;
- Australian standards relating to the storage and handling of hazardous substances:
  - *AS 1940-2004 The storage and handling of flammable and combustible liquids*;
  - *AS/NZS 3816:1998 Management of clinical and related wastes*;
  - *AS 2714-1993 The storage and handling of hazardous chemical materials – Class 5.2 substances (organic peroxides)*;
  - *AS/NZS 3833:2007 The storage and handling of mixed classes of dangerous goods, in packages and intermediate bulk containers*;
  - *AS/NZS 4452:1997 The storage and handling of toxic substances*;
  - *AS/NZS 4681:2000 The storage and handling of Class 9 (miscellaneous) dangerous goods and articles*; and
  - *AS/NZS 5026:2012 The storage and handling of Class 4 dangerous goods*.
- Australian standards and guidelines relating to the labelling and signage of waste:
  - *AS 1216-1995 Class labels for dangerous goods*;
  - *AS 1319-1994 Safety signs for the occupational environment*; and
  - *AS 4123.7-2006 Mobile waste containers – Colours, markings, and designation requirements.*

25.4. Resource consumption

Natural resources and construction materials would be used during construction and operation of the Stage 1 development.

25.4.1. Construction

Table 25–3 provides an overview of the types and estimated quantities of resources required during construction. All quantities and sources would be confirmed during detailed design and construction planning.

Construction and operation of the Stage 1 development would also consume resources through utilities such as potable water, electricity, gas and fuel. Daily requirements for construction would include up to 1.36 megalitres of water (including approximately 8,600 litres of potable water), 300 kilovolt amperes of electricity and 55 kilolitres of fuel (see Chapter 6).

Table 25–3 – Natural resources consumed during construction

Activity	Material	Quantity (daily)	Quantity (total)	Potential sources
Earthworks[a]	Water	1.36 ML	650 ML	Existing surface water, farm dams and sediment basins Potable water supply pipes and temporary storage dams
Asphalt	Aggregate (63%)	822 tonnes	450,000 tonnes	Gunlake Marulan Quarry Holcim Lynwood Quarry Boral Peppertree Quarry
	Sand (8%)	380 tonnes	57,000 tonnes	Calga Quarry Kurnell Quarry
	Lime filler (2%)	27 tonnes	14,000 tonnes	Various
	Crusher dust (22%)	279 tonnes	157,000 tonnes	Various
	Bitumen (5%)	70 tonnes	36,000 tonnes	Camellia
Concrete	Cement (13%)	128 tonnes	60,000 tonnes	Boral Cement Australia
	Sand (38%)	373 tonnes	174,000 tonnes	Calga Quarry Kurnell Quarry
	Aggregate (44%)	434 tonnes	200,000 tonnes	Gunlake Marulan Quarry Holcim Lynwood Quarry Boral Peppertree Quarry
	Fly ash (1%)	42 tonnes	19,300 tonnes	Various
	Admixture (0.1%)	1 tonne	460 tonnes	Various
Machinery operation	Fuel/diesel	55,000 litres	–	Banksmeadow Silverwater

[a] Earthworks would involve the redistribution of approximately 22 million m^3 of fill material, including approximately 2 million m^3 of topsoil, around the airport site

25.4.2. Operation

Operation of the proposed airport would demand significantly lower quantities of resources than construction. The anticipated daily requirements of the proposed airport operating at 10 million annual passenger movements during operation of the Stage 1 development would include an estimated 1.6 megalitres of potable water, 16 megavolt amperes of electricity, 156 gigajoules of gas and 2.7 megalitres of aviation fuel.

Use of resources would be minimised through the implementation of sustainable design principles in the design of the proposed airport, careful procurement planning to avoid unnecessary consumption and the efficient operation of plant and equipment to avoid excess usage of fuel and other utilities.

25.5. Waste generation

Construction of Stage 1 of the airport would generate approximately 202,500 tonnes of waste in total. About 5,251 tonnes of waste would be generated each year during Stage 1 operation. Waste during construction is estimated in Section 25.5.1 while waste during operation is estimated in Section 25.5.2.

A contamination assessment of the airport site has identified the potential for hazardous materials, including asbestos to be present. The removal of existing structure, and any associated management of asbestos or contamination, would be carried out on behalf of the Department of Infrastructure and Regional Development in accordance with relevant legislation and regulations (see Section 25.6). Further information on land contamination can be found Chapter 17.

25.5.1. Construction

Construction at the airport site would generate a range of wastes from surplus or offcut construction materials, clearing and the demolition of existing infrastructure.

The airport site would largely be cleared of existing structures prior to construction. As such, demolition waste is expected to be limited. The main activity generating demolition waste during construction would be clearing vegetation. Removal of The Northern Road and other roads at the airport site would generate waste asphalt. Fill material from demolition would be used in bulk earthworks.

Any residual hazardous waste, including asbestos, identified at the site would be managed in accordance with the relevant legislation.

The 300 kilovolt TransGrid transmission line at the airport site would be relocated in accordance with TransGrid's options for relocation. Options being considered by TransGrid include a buried transmission line or an alternative overhead route. The relocation of existing infrastructure would be subject to separate approvals, but may occur concurrently with other site preparation works.

Following these site preparation activities, construction waste would be generated by the construction of roads, runways, taxiways, aprons and buildings. The main waste streams generated by these activities would be general solid wastes including:

- excess and broken bricks;
- leftover concrete;
- plasterboard and fibre cement offcuts;
- carpet, tiling and insulation leftovers and offcuts;
- leftover metal from concrete reinforcements;
- metal sheet offcuts;
- plastic (pipework offcuts and packaging);
- soil (leftover bedding material); and
- timber (formwork and offcuts).

Table 25–4 quantifies the estimated volumes of waste that would be generated by demolition and construction activities for Stage 1. As shown, the total volume of waste generated during construction would be of the order of 202,500 tonnes. In addition to the identified construction waste, about 24,000 litres of domestic waste water and sewage would be generated each day. This would be stored at the airport site for collection by disposal trucks.

Table 25–4 – Waste generated during construction of Stage 1 development

Activity	Waste classification	Tonnes (total)
Clearing	Green waste	65,000[a]
Removal of roads	General solid waste	3,000[b]
Removal of transmission line	General solid waste	90
Road construction	General solid waste	78,000[c]
Runway construction	General solid waste	6,100[d]
Taxiway and apron construction	General solid waste	18,400[e]
Building construction	General solid waste	32,000[f]
Total	–	202,500

[a] Assumed biomass for woodland (Ximenes et al. 2012) and grassland (Yunusa et al. 2012); 1 tonne per m^3
[b] Approximately 3 km of road with a width of 10 m to a depth of 0.1 m
[c] Approximately 31 km of roads with a width of 10.5 m
[d] Approximately 341,000 m^2 of runways, taxiways and aprons and associated paved areas to a depth of approximately 0.43 m, an assumed wastage rate of 5 per cent; 0.83 tonnes per m^3
[e] Approximately 1 million m^2 of runways, taxiways and aprons and associated paved areas to a depth of approximately 0.43 m, an assumed wastage rate of 5 per cent; 0.83 tonnes per m^3
[f] Approximately 250,000 m^2 of buildings

25.5.2. Operation

The majority of waste generated during operation would be from staff, retailers and passengers in the terminal complex. An estimated two-thirds of waste could be generated in these areas, while up to a third could be generated from satellite buildings and aircraft stands along with engineering and maintenance.

The main waste streams generated during operation of the airport include the following:

- general solid waste (non-putrescible) – including waste cardboard, glass, green waste, metals, paper, plastics, wood and electronic waste (including toner and printer cartridges);
- general solid waste (putrescible) – including food waste and animal waste; and
- hazardous wastes – including waste batteries, fertilisers, fuels, herbicides, oils pesticides, paints, solvents, cleaners, clinical and pharmaceutical waste, and waste tyres.

The anticipated quantities of waste generated by the proposed airport operating at 10 million annual passenger movements during operation of the Stage 1 development are outlined in Table 25–5. An estimated 101 tonnes of waste would be generated on average each week or 5,251 tonnes each year.

In addition, approximately 2.5 megalitres of domestic waste water would be generated each day and treated at an onsite facility. Treated water in excess of recycled water demand would be irrigated to land, while an estimated 0.1 megalitres of sludge generated each day would be stored for collection by disposal trucks. Irrigation of treated water is discussed in Section 25.6.4.

Table 25–5 – Waste generated during operation of Stage 1 development

Waste classification	Tonnes each week	Tonnes each year
General solid waste	79.0	4,108
General solid waste (recyclable)	13.7	710
Hazardous waste	6.7	348
Hazardous waste (liquid waste)[a]	1.6	85
Total	101	5,251

[a] Excludes treated water and waste water sludge

25.6. Waste management

Waste must be managed appropriately to mitigate and manage potential impacts on human health and the environment. If not managed appropriately, waste has the potential to create a range of impacts. The potential impacts of inappropriately managed waste are listed in Table 25–6.

A waste management plan would be developed prior to construction of the proposed airport as part of the construction environmental management framework. The plan would collate measures to manage resource consumption and waste generation and would be developed in consultation with the relevant State authorities including the NSW Environment Protection Authority. The waste management plan is explained further in Section 25.6.1.

Consideration would also be given to the achievement of an Infrastructure Sustainability Council of Australia 'As Built Rating' and 'Operations Rating' to promote sustainability – covering the design, construction and operation of the Stage 1 development.

Table 25–6 – Potential impacts of improperly managed waste

Waste type	Potential impacts
Green waste	Fire hazard, spread of weeds, visual impact, harbouring of pest species
General solid waste	Visual impact, localised increases in pH (concrete sediment), leachate (waste metal), attraction of pest species (food waste), odour (food waste)
Hazardous wastes	Land contamination, toxicity to plants and animals, degradation of water resources

25.6.1. Waste management plan

A waste management plan would be prepared prior to construction and operation of the airport, which would collate measures to manage waste and thus avoid, mitigate and manage impacts to human health and the environment. The plan would define processes to track waste quantities, roles and procedures for the handling of waste at the airport site, and processes for the continual improvement of airport waste management.

The plan would collate measures to manage resource consumption and waste generation and would be developed in consultation with the relevant State authorities including the NSW Environment Protection Authority. The measures contained in the waste management plan would reflect the waste management hierarchy as per the *Waste Avoidance and Resource Recovery Act 2001* (NSW) (see Section 25.3.1) as well as relevant standards such as those for hazardous substances (see Section 25.3.2).

The plan would align with standard sustainable procurement policies with consideration of product lifecycles, recyclable content, minimal/returnable packaging and on site recyclability. Agreements with tenants, contractors and suppliers would require compliance with the plan.

Measures to avoid and reduce waste in the waste management plan would include:

- efficient utilisation of resources to reduce consumption;
- optimisation of detailed designs to avoid unnecessary resource consumption;
- implementation of high efficiency water systems to reduce water consumption;
- procurement policies that preference recyclable, minimal and/or returnable packaging; and
- procurement of necessary materials in bulk to minimise packaging waste.

Measures to reuse and recycle waste in the waste management plan would include:

- reuse of green waste and topsoil during site rehabilitation;
- reuse of waste streams including metals, oils and solvents;
- recycling of waste streams including brickwork, metals, plasterboard, plastics and timber;
- contract terms with suppliers that specify recyclable content and returnable packaging; and
- cooperation in stewardship programs for compatible waste streams including pallets.

Measures to recover and treat waste would include recovery (prior to reuse) of compatible waste streams including metals, oils, solvents, brickwork, metals, plasterboard, plastics and timber. Hazardous wastes or asbestos identified during construction and operation would be managed consistently with the Protection of the Environment Operations (Waste) Regulation 2014 (NSW).

Residual waste that cannot be avoided, reduced, reused, recycle, recovered or treated would be collected by a licensed contractor for disposal at a licensed facility (refer to Section 25.6.5).

25.6.2. Waste storage area

A central waste area (or areas) would be established during construction, at which waste (including recyclables) would be stored. Some materials would be stored in stockpiles while others would be stored in bins. Stockpiles and bins would be appropriately labelled, managed and monitored.

During operation, waste generated at the airport site would be collected in bins located throughout the terminal complex and elsewhere. Purpose-designed containment equipment for sharps and other special or hazardous wastes would be situated at relevant facilities. Waste would then be collected and stored at the waste storage area.

The waste storage area would allow for the separation of waste streams based on their management requirements, and would therefore include:

- wheeled bins;
- front lift bins;
- bulk bins and skips;
- bulk material storage bays;
- hazardous waste storage areas;
- bunded bulk storage for fuels and oils;
- balers for cardboard or plastic; and
- battery storage containers.

The waste storage area may also include facilities to recycle, recover or treat waste such as:

- anaerobic digestion for recovery of energy from organic waste;
- a waste to energy facility for recovery of energy from quarantined waste; and
- a composting facility for processing of garden and food waste.

Waste would be routinely collected from the waste storage area and transferred to appropriately licensed waste management facilities described in 25.6.5.

25.6.3. Quarantine areas

The proposed airport would meet the definition of a landing place under the *Biosecurity Act 2015* (Cth) and would therefore be subject to quarantine regulations. Waste to be quarantined would include food waste and other organic material, or non-washable material such as packaging that comes into contact with quarantine material. Waste generated by the proposed airport operating at 10 million annual passenger movements during Stage 1 includes an estimated 30 tonnes of quarantine material per year.

Quarantine waste would be managed in accordance with the requirements of the relevant quarantine authority, presently the Australian Government Department of Agriculture.

For example, under current biosecurity requirements, quarantine waste is stored in a secure quarantine area, within purpose built biosecurity bins. Consistent with quarantine operations at other airports, waste would be placed in cold storage if kept for more than 48 hours. Once cleared by the quarantine authority, quarantine waste would be sterilised on-site by autoclave prior to disposal at an appropriately licensed facility.

25.6.4. Effluent disposal by subsurface irrigation

An estimated 2.5 ML of wastewater per day would be generated during operation of the Stage 1 development. Wastewater would be reticulated to a treatment facility before being recycled or irrigated at the airport site. The wastewater treatment process is expected to utilise membrane biological reactor technology, which produces high quality reclaimed water suitable for a range of beneficial reuses. Recycling opportunities include the use of reclaimed water in maintenance of plant and infrastructure, industrial cooling processes or landscaping. It is expected that irrigation of excess reclaimed water would occur on land previously disturbed by the construction of the Stage 1 development, such as grassed areas between aprons and taxiways and landscaped areas. Irrigation areas would be designed and operated in accordance with the relevant guidelines and management practices discussed in Section 25.6. Further information is provided in Chapter 17.

25.6.5. Waste management facilities

The waste management market in Western Sydney has matured to manage a large volume of waste from various domestic, commercial and industrial sources. About 12 million tonnes of waste is generated in Sydney each year. Major solid waste streams in the region include:

- industrial waste from light industry such as manufacturing, warehousing and transport;
- agricultural waste including pesticides and herbicides;
- commercial waste from businesses, shopping centres and retailers;
- special waste including from hospitals; and
- general domestic waste from residential households.

There are many waste management facilities situated in the Western Sydney region. These facilities would provide a range of options for reuse, recycling, recovery and treatment of waste generated at the airport. Table 25–7 lists the identified waste management facilities.

The quantities and types of waste generated by the proposed airport are expected to be within the capacity of the various waste management facilities in the Western and Greater Sydney regions. Recyclable materials that have been separated at source (cardboard, glass and other containers, food organics) could be collected by contractors and taken to facilities specifically designed to either consolidate them for transportation to reprocessing facilities, or to sort them for transportation to such facilities. Non-recyclable wastes could be taken to transfer stations, or direct to landfills or to alternative waste processing facilities for disposal or treatment respectively.

Table 25–7 – Waste management facilities

Facility	Type of waste	Operator	Address	Council
Brandown landfill	Landfill disposal of non-putrescible wastes. Hazardous, putrescible and other waste not accepted.	Brandown Pty Ltd	Lot 9 Elizabeth Dr, Kemps Creek	Liverpool
Elizabeth Drive Landfill Facility	Landfill disposal of non-putrescible wastes. Some hazardous waste but no putrescible waste accepted.	Suez Environnement	1725 Elizabeth Dr, Kemps Creek	Penrith
Erskine Park Landfill	Landfill disposal of non-putrescible wastes. Does not accept asbestos, putrescible waste, contaminated soils or hazardous waste.	Transpacific Cleanaway	Quarry Rd, Erskine Park	Penrith
Lucas Heights Resource Recovery Park	Landfill disposal of putrescible wastes including some hazardous waste	Suez Environnement	New Illawarra Road, Lucas Heights	Sutherland
Eastern Creek Resource Recovery Park	Landfill disposal of putrescible wastes including some hazardous waste	Suez Environnement	Wallgrove Road, Eastern Creek	Blacktown
Clyde Transfer Terminal	Transfer station for disposal of putrescible wastes. No other waste accepted.	Veolia Environmental Services (Australia) Pty Ltd	322 Parramatta Road, Clyde	Auburn
Wetherill Park Resource Recovery Facility	Transfer station for disposal of putrescible wastes including some hazardous waste	Suez Environnement	20 Davis Rd, Wetherill Park	Fairfield
Seven Hills Waste & Recycling Centre	Transfer station for disposal of putrescible wastes including some hazardous waste	Suez Environnement	29 Powers Road, Seven Hills	Blacktown
Visy Blacktown MRF	Materials recovery facility for recyclables. No other waste accepted.	Visy Recycling	9 Bessemer St, Blacktown	Blacktown
Visy Smithfield MRF	Materials recovery facility for recyclables. No other waste accepted.	Visy Recycling	158-160 McCredie St, Smithfield	Holroyd
Camellia Resource Recovery and Treatment Facility	Food organics processing facility. No other waste accepted.	Suez Environnement	Grand Ave, Camellia	Parramatta
ANL Badgerys Creek	Garden organics processing facility. No other waste accepted.	Australian Native Landscapes	210 Martin Rd, Badgerys Creek	Penrith
Genesis Recycling Facility	Non putrescible waste processing facility. Does not accept food waste, liquid, medical and chemical wastes	Dial-A-Dump (Ec) Pty Ltd	Honeycomb Drive, Eastern Creek	Blacktown

Facility	Type of waste	Operator	Address	Council
Suez Advanced Waste Treatment Facility	Mixed waste processing facility. Accepts mixed waste containing organics and separated food and organic waste.	Suez Environment	1725 Elizabeth Drive, Kemps Creek	Penrith
UR-3R	Mixed waste processing facility. Accepts mixed waste containing organics and separated food and organic waste.	Global Renewables Limited	Wallgrove Rd, Eastern Creek	Blacktown

25.7. Conclusion

The total volume of waste generated during construction of the Stage 1 development would be in the order of 202,500 tonnes, while an estimated 5,251 tonnes of waste would be generated each year during operation.

A combination of on-site and off-site management measures would provide a range of options to reuse, recycle, recover and treat waste generated at the proposed airport. A waste management plan would be prepared prior to construction and operation of the proposed airport, which would collate measures to manage waste and thus avoid and mitigate impacts to human health and the environment.

The quantities and types of waste generated by the airport would be readily manageable through the implementation of the waste management plan, and within the capacity of the various waste management facilities in the Western and Greater Sydney regions.

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26. Greater Blue Mountains

The Greater Blue Mountains World Heritage Area (GBMWHA) and National Heritage Area covers 1.03 million hectares of sandstone plateaus, escarpments and gorges dominated by temperate eucalypt forest. The site constitutes one of the largest and most intact tracts of protected bushland in Australia and is noted for its representation of the evolutionary adaption and diversification of the eucalypts in post-Gondwana isolation on the Australian continent. The Greater Blue Mountains Area is a declared property, listed on the United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage List for its outstanding universal value, including representative examples of the evolution of Eucalyptus species (Criterion ix) and diversity of habitats and plant communities (Criterion x). In addition to the features recognised by the World Heritage Committee as having World Heritage value, the GBMWHA has a number of other important values which complement and interact with the World Heritage values of the area including recreation, tourism, wilderness, scenic and aesthetic values.

Potential impacts arising from the proposed airport to the World Heritage and National Heritage values and other values of the Greater Blue Mountains Area were assessed against the Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (DoE 2013). The GBMWHA is approximately eight kilometres from the proposed airport at its closest point. Site specific direct impacts associated with the construction of the airport are not expected to influence the values of the GBMWHA. A number of indirect operational impacts on the GBMWHA are expected in relation to noise, air emissions and visual impact from the overflight of aircraft.

Based on preliminary airspace design by Airservices Australia, almost all flights are expected to be at an altitude greater than 5,000 feet and most would be more than 10,000 feet above sea level when passing over the GBMWHA. No flights are expected to occur below 6,000 feet above ground level in the vicinity of identified sensitive areas. At these altitudes, aircraft are likely to be difficult to discern from ground level and are not considered to be visually obtrusive. Indicative flight tracks at altitudes of less than 5000 feet are limited to Warragamba and the eastern boundary of the Blue Mountains National Park, which would experience 50 to 100 flights per day.

Generally across the GBMWHA, minimal incursion of noise levels in excess of 55 dBA would occur. Echo Point at Katoomba would not experience impacts from increased noise levels, and the majority of other sensitive areas are predicted to only be impacted during the infrequent operation of the Boeing 747.

Emergency fuel dumping is very unlikely to have any impact on the GBMWHA due to the rarity of these events, the inability of many aircraft to perform fuel dumps, the rapid vaporisation and wide dispersion of jettisoned fuel and the strict guidelines on fuel dumping altitudes and locations.

Mitigation and management of potential noise impacts would be achieved through the implementation of flight planning and airspace design. The measures would include requirements regarding flight paths, altitude and operational parameters for different aircraft. The potential noise and amenity impacts from aircraft flying over wilderness areas of the GBMWHA, and Aboriginal sites promoted for public visitation, would be considered in the future development of formal flight paths for the proposed airport by Airservices Australia, subject to requirements for safe and efficient aircraft operations. Having regard to the indirect impacts of aircraft operations it is concluded that the proposed airport would not have a significant impact upon the GBMWHA and its recognised World Heritage values. The proposed action would not result in attributes of the World Heritage Area being lost, degraded or damaged, or notably altered, modified, obscured or diminished.

26.1. Introduction

This chapter considers the potential impacts of development of the proposed airport on the World Heritage and National Heritage values and other values of the Greater Blue Mountains Area. The chapter draws upon detailed environmental and social assessments undertaken for the proposed airport which are included in Volume 4 as well as the relevant assessment chapters in Volume 2.

The assessment is in accordance with the requirements of the *Guidelines for the Content of a Draft Environmental Impact Statement – Western Sydney Airport* (EIS guidelines) issued by the Commonwealth Department of the Environment for consideration of world heritage impacts associated with the proposal.

26.2. Methodology

The assessment of impacts on the Greater Blue Mountains Area (GBMA) involved:

- identification of the property's World Heritage and National Heritage values, including attributes recognised in the Statement of Outstanding Universal Value;
- identification of key examples or attributes of other values that complement the property's World Heritage and National Heritage values;
- collation of relevant baseline information on environmental factors and existing impacts including baseline noise levels and flight paths associated with Sydney Airport;
- assessment of significance of impacts on World Heritage values and the integrity of the world heritage property and the National Heritage values based on the Significant Impact Guidelines 1.1 (DoE 2013a) and the property's Statement of Outstanding Universal Value; and
- assessment of the National Heritage area having regard to all environmental matters.

26.3. Existing environment

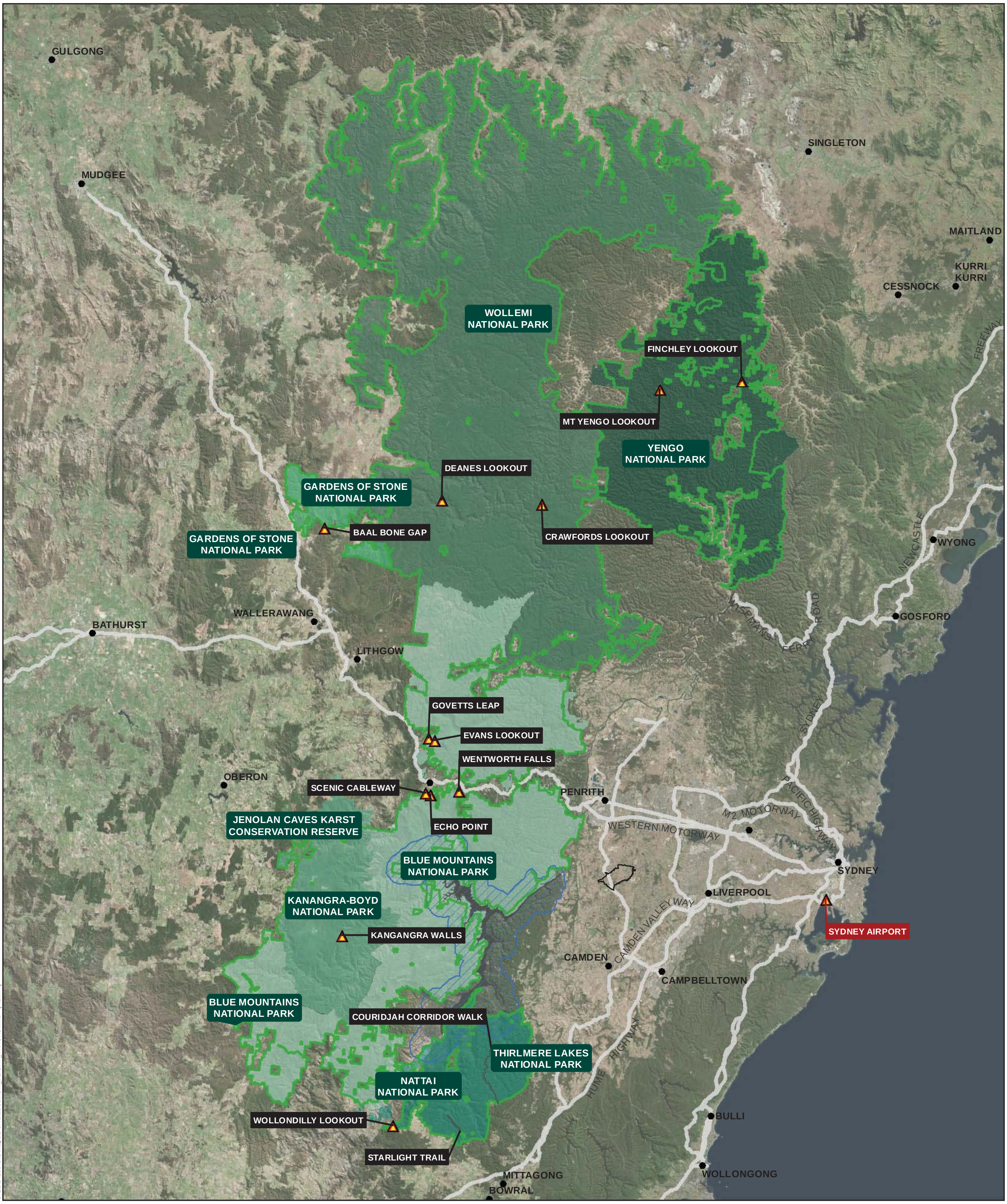
26.3.1. Overview

At its closest point, the GBMA is approximately eight kilometres from the proposed airport. The GBMA covers 1.03 million hectares of sandstone plateaus, escarpments and gorges dominated by temperate eucalypt forest (UNESCO 2015). The site constitutes one of the largest and most intact tracts of protected bushland in Australia and is noted for its representation of the evolutionary adaption and diversification of the eucalypts in post-Gondwana isolation on the Australian continent (UNESCO 2015). The Greater Blue Mountains Area was inscribed on the World Heritage list in 2000. This listing formally recognises that the area has outstanding universal value under the World Heritage Convention. The GBMA comprises eight protected areas (see Figure 26–1)

- Blue Mountains National Park
- Wollemi National Park;
- Yengo National Park;
- Nattai National Park;

- Kanangra-Boyd National Park;
- Gardens of Stone National Park;
- Thirlmere Lakes National Park; and
- Jenolan Caves Karst Conservation Reserve.

The GBMA provides significant representation of Australia's biodiversity with 10 per cent of the country's vascular flora as well as significant numbers of rare or threatened species (UNESCO 2015). In addition to its outstanding eucalypts, the area also contains ancient, relict species of global significance including the Wollemi pine (*Wollemia nobilis*), one of the world's rarest species that was thought to have been extinct for millions of years (DoE 2015d). The few surviving trees are known only from three small populations located in remote, inaccessible gorges within the Greater Blue Mountains (DoE 2015d).



LEGEND

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

- Airport site
- Greater Blue Mountains World Heritage Area
- Drinking Water Catchment – No Entry Area

0 5 10 20
Kilometres

Figure 26-1 - Greater Blue Mountains World Heritage Area

26.3.2. Outstanding universal value

26.3.2.1. World Heritage values of the Greater Blue Mountains Area

The Greater Blue Mountains Area was inscribed on the World Heritage List because it satisfies two of the criteria for natural values of outstanding universal value. While the criteria for outstanding universal value have changed over time, the underlying concepts have remained constant (UNESCO 2015). The two criteria for which the property is listed are criterion ix and criterion x.

Criterion ix

Criterion ix is defined in the *Operational Guidelines for the Implementation of the World Heritage Convention* (UNESCO 2015) as follows:

> *to be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals.*

The GBMWHA includes outstanding and representative examples of the evolution and adaptation of the genus *Eucalyptus* and eucalypt-dominated vegetation in a relatively small area of the Australian continent (UNESCO 2015). It is a centre of diversification for Australian scleromorphic flora, including significant aspects of eucalypt evolution and radiation (UNESCO 2015). Primitive species of outstanding significance to the evolution of the planet's plant life such as the Wollemi pine and the Blue Mountains pine (*Pherosphaera fitzgeraldii*). These are examples of ancient, relict species with Gondwanan affinities that have survived past climatic changes and demonstrate the highly unusual juxtaposition of Gondwanan taxa with the diverse scleromorphic flora (UNESCO 2015).

Criterion x

Criterion x is defined in the *Operational Guidelines for the Implementation of the World Heritage Convention* (UNESCO 2015) as follows:

> *to contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.*

The GBMWHA includes an outstanding diversity of habitats and plant communities and a significant proportion of the Australian continent's biodiversity, especially its scleromorphic flora, (UNESCO 2015). As described above, the GBMWHA includes primitive and relict species with Gondwanan affinities and supports many plants of conservation significance including 114 endemic species and 177 threatened species (UNESCO 2015). Habitat diversity has also resulted in an outstanding representation of Australian fauna with more than 400 vertebrate taxa recorded (of which 40 are threatened) including 52 native mammals, 265 bird species (one third of the Australian total), 63 reptile species and more than 30 frog species (UNESCO 2015).

26.3.2.2. Integrity

In addition to meeting at least one of the criteria for outstanding universal value, a world heritage property listed for natural values also needs to meet conditions of integrity. Integrity is a measure of the 'wholeness and intactness' of the natural heritage and its attributes (UNESCO 2015). Examining the condition of integrity requires assessing the extent to which the property:

- includes all elements necessary to express its outstanding universal value;
- is of adequate size to ensure the complete representation of the features and processes that convey the property's significance; and
- suffers from adverse effects of development and/or neglect (UNESCO 2015).

The Statement of Outstanding Universal Value for the GBMWHA states that the eight protected areas that comprise the listed property are of sufficient size to protect the biota and ecosystem processes, although the boundary has several anomalies that reduce the effectiveness of its one million hectare size. These anomalies are explained by historical patterns of clearing, private land ownership and topography such as escarpments that act as barriers to potential adverse impacts from adjoining land (UNESCO 2015).

A number of historical land uses have affected the past integrity of the area including Warragamba Dam, cattle grazing, logging, land clearing, coal mining, oil shale mining, military activities and fire regimes (IUCN 1999). However, active management has reduced these impacts and the landscape is in recovery (IUCN 1999).

Much of the property is largely protected by adjoining public lands of State forests and State conservation areas. Additional regulatory mechanisms, such as the statutory wilderness designation over 65 per cent of the property, the closed and protected catchment for the Warragamba Dam and additions to the conservation reserves that comprise the area all serve to further protect the integrity of the GBMWHA (UNESCO 2015).

The plant communities and habitats within the GBMWHA occur almost entirely as an extensive, mostly undisturbed matrix almost entirely free of structures, earthworks and other human intervention (UNESCO 2015). Because of its size and connectivity, the area will continue to provide opportunities for adaptation and shifts in range for flora and fauna species within it. The area's integrity depends upon the complexity of its geological structure, geomorphology and water systems, which have created the conditions for the evolution of its outstanding biodiversity (UNESCO 2015).

Aboriginal people from six language groups continue to have a custodial relationship with the area through ongoing practices that reflect both traditional and contemporary presence (UNESCO 2015). Aboriginal sites including important rock art sites provide physical evidence of the longevity of the strong Aboriginal cultural connections with the land. The conservation of these associations contributes to integrity of the GBMWHA (UNESCO 2015).

26.3.2.3. Protection and management

All properties inscribed on the World Heritage List must have adequate protection and management mechanisms in place, the nature of which can vary so long as they are effective. In most cases, both the Australian and state or territory governments are responsible for the management and protection of Australia's World Heritage properties, with state and territory agencies taking responsibility for on-ground management where relevant.

The GBMWHA is protected and managed primarily under the following Commonwealth and New South Wales legislation:

- *Environment Protection and Biodiversity Conservation Act 1999 (Cth);*
- *National Parks and Wildlife Act 1974 (NSW); and*
- *Wilderness Act 1987 (NSW).*

Other relevant legislation includes the New South Wales *Threatened Species Conservation Act 1995*, the *Environmental Planning and Assessment Act 1979,* the *Sydney Water Catchment Management Act 1998* and the *Heritage Act 1977*.

The New South Wales Office of Environment and Heritage manages the GBMWHA. The Greater Blue Mountains World Heritage Area Strategic Plan (DECC 2009c) provides a framework for the property's integrated management, protection, interpretation and monitoring.

The key management objectives set out in the Strategic Plan provide the philosophical basis for the management of the area and guidance for operational strategies, in accordance with requirements of the World Heritage Convention and its Operational Guidelines (UNESCO 2015). These objectives are also consistent with the Australian World Heritage management principles, contained in regulations under the *EPBC Act* (UNESCO 2015).

The Strategic Plan (DECC 2009c) identifies the following threats to the integrity of the area:

- uncontrolled and inappropriate use of fire;
- inappropriate recreation and tourism activities, including development of tourism infrastructure;
- invasion by pest species including weeds and feral animals;
- loss of biodiversity and geodiversity;
- impacts of human enhanced climate change; and
- lack of understanding of heritage values.

26.3.3. National Heritage Area

The Greater Blue Mountains National Heritage Area was included on the National Heritage Register in 2007. The National Heritage Area is the same as that listed for the World Heritage Area and the values identified for the listing are the same as those for the World Heritage Area. As such the following assessment against the heritage values is taken to address both the National and World Heritage values of the GBMA.

26.3.4. Other values of the Greater Blue Mountains Area

In addition to the features recognised by the World Heritage Committee as having World Heritage value, the Greater Blue Mountains Area has a number of other important values which complement and interact with the World Heritage values of the area (DECC 2009c). Protection of these values is considered to be integral in managing individual protected areas and the GBMA as a whole (DECC 2009c). Table 26–1 provides a summary of the values identified by the NPWS in the GBHA Strategic Plan which contribute to the overall values of the area.

Table 26–1 – Other important values of the GBMA

Value	Description
Geodiversity and biodiversity	In addition to the outstanding biodiversity of the GBMA, the area also has a diversity of landscapes and geological features including the most extensive sandstone canyon system in eastern Australia. The site also contains karst landscapes with several cave systems including Jenolan Caves, the world's oldest open cave system. Other features include prominent basalt-capped peaks, quaternary alluvial deposits and perched perennial freshwater lakes.
Water catchment	The GBMA 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.
Indigenous heritage values	Although no comprehensive surveys have been taken, known Aboriginal sites within the area are widespread and diverse including landscape features of spiritual significance and rock art sites. Given the wilderness nature of the area and the limited survey to date, there is high potential for the discovery of further significant Aboriginal sites.
Historic heritage values	The GBMA includes numerous places of historic significance some of which date back to the early years of European settlement and exploration in Australia. Recorded sites demonstrating post-1788 human use are associated with rural settlement, pastoral use, timber getting, mining, transport routes, tourism and recreation. The sites include small graziers' huts, logging roads, stock routes and the ruins of mines.
Recreation and tourism	The GBMA has high recreational values due to the area's intrinsic beauty, natural features and accessibility from major population centres. Recreational opportunities are wide ranging and include canyoning, bushwalking, rock climbing, nature observation, caving, picnicking, camping and photography. The regional economy surrounding the GBMWHA is increasingly supported by tourism with the area contributing directly and indirectly to the employment, income and output of the region.
Wilderness	The high wilderness quality of much of the GBMA constitutes a vital and highly significant contribution to its World Heritage value and has ensured the integrity of its ecosystems and the retention and protection of its heritage value. The wild and rugged landscapes, diverse flora and fauna, and opportunities for solitude, self-reliant recreation and reflection are attributes that promote inspiration, serenity and rejuvenation of the human mind and spirit. Such experiences are valued by individuals and society.
Research and education	The GBMA is ideal for research and educational visits due to the variety of ecological communities, landscape and associated cultural sites. The high scientific value reflects what has been discovered and what remains to be discovered as large gaps in knowledge remain in regard to Aboriginal use and occupation of the area and the ecological needs of threatened species and communities.
Scenic and aesthetic	Dramatic scenery within the GBMA includes striking vertical cliffs, waterfalls, ridges, escarpments, uninterrupted views of forested wilderness, extensive caves, narrow sandstone canyons and pagoda rock formations.

Source: NSW NPWS 2009

26.3.5. Wilderness areas

One of the key features of the GBMA are the wilderness areas located primarily in the northern section of the World Heritage and National Heritage area. The National Wilderness Inventory (AHC 2003) identifies 83.5 per cent of the GBMA as wilderness area.

The identified wilderness areas cover a significant proportion of the GBMA, with the specific exclusion of the area northern portions of both the Blue Mountains National Park and Kanangra-Boyd National Park associated with the Katoomba region.

26.3.6. Sensitive tourism and recreation areas

Sensitive tourism and recreation areas were determined for this assessment based on the identification of key attractions and associated viewing locations within the GBMA (Table 26–2). The assessment considered the remoteness, accessibility and accommodation options as an indication of the type of tourism and recreational experiences available at each location.

Table 26–2 – Key tourist and recreational attractions, viewing locations and accessibility

National park	Key attractions	Key viewing locations	Location	Accessibility	Accommodation
Blue Mountains National Park	Jamison Valley including the Thee Sisters	Echo Point Lookout, Sublime Point Lookout, Perrys Lookdown, Evans Lookout, Mt Hay, Lockleys Pylon, Pulpit Rock Lookout, Gladstone Lookout, Moya Point Lookout, Sunset Rock Lookout, Cleary Memorial Lookout, Honeymoon Lookout, Queen Elizabeth and Drum Lookouts, Scenic Cableway and Scenic Railway, Narrowneck Lookout, Castle Head Lookout, Cahills Lookout, Peckmans Plateau Lookout, Eaglehawk Lookout, Hildas Lookout, Norths Lookout, McMahons Lookout,Peckmans Plateau Lookout, Norths Lookout, Nepean Narrows Lookout, Nepean Gorge Lookout, Nepean Lookout, Freds Lookout, Erskine Lookout, Mt Portal Lookout, Rileys Lookout, The Rock Lookout Greenfields Lookout, Melville Lookout, Wynnes Rocks Lookout, Point Pilcher Lookout, Du Faurs Lookout, Mt Banks Lookout, and Walls Lookout.	Katoomba	Sealed road	Hotels, motels, guesthouses, bed and breakfasts, cabins, cottages, caravan parks.
	Wentworth Falls waterfall	Wentworth Falls lookout	Wentworth Falls	Sealed road	Retreat, guesthouses, bed and breakfasts, cabins, cottages.
	Grose Valley	Evans lookout Govetts Leap lookout	Blackheath	Sealed road	Hotel, motel, bed and breakfasts, cabins, cottages, caravan park
	Wilderness, bushwalking, rock-climbing, trail bike riding, picnicking and remote camping	Views from walking tracks such as National Pass, Federal Pass, Mt Solitary, and Narrowneck Firetrail	Southern sections of the park	Sealed roads and Unsealed roads, vehicular tracks, walking tracks	Campgrounds within park
Wollemi National Park	Wilderness Bushwalking, rock climbing, canoeing, picnicking	Deanes lookout Crawfords lookout	Non-specific	Unsealed roads, vehicular tracks, walking tracks	Campgrounds within park

National park	Key attractions	Key viewing locations	Location	Accessibility	Accommodation
Yengo National Park	Wilderness Bushwalking, horse riding, trail bike riding, picnicking	Finchley lookout Mt Yengo lookout	50 km south-west of Cessnock	Unsealed roads, walking tracks	Campgrounds within park – tent, camper trailer, vehicle
Nattai National Park	Wilderness Bushwalking, remote camping	Wollondilly lookout Starlights trail Couridjah Corridor walk	30 km north of Mittagong	Vehicular tracks, walking tracks	No facilities within park. Remote backpack camping only at Emitts Flat.
Kanangra-Boyd National Park	Kanangra Walls Mount Cloudmaker	Kanangra-Boyd lookout, Kowmung Lookout, Rigby Rock Lookout, Moorilla Lookout, Mt Dingo Lookout, and Kanangra Walls Lookouts	50 km south-east of Oberon	Unsealed road from park entrance	Boyd River Campground – tent, camper trailer, caravan, vehicle
	Wilderness, bushwalking, rock-climbing, trail bike riding, picnicking and remote camping	Non-specific	Southern sections of the park	Sealed roads and Unsealed roads, vehicular tracks, walking tracks	Campgrounds within park
Gardens of Stone National Park	Baal Bone Gap, four-wheel driving	Baal Bone Gap picnic area	35 km north of Lithgow	Unsealed road requiring 4WD vehicle	No facilities within park. Remote backpack camping only.
Thirlmere Lakes National Park	Birdwatching, picnicking, walking and swimming	Werri Berri picnic area	Couridjah	Sealed road	No facilities within park.
Jenolan Caves Karst Conservation Reserve	Jenolan Caves	Not applicable	Jenolan	Sealed road	Cabins, cottages and hostels

The upper Blue Mountains, with its extensive system of scenic lookouts and walking tracks, is one of the major nature-based tourism destinations in Australia (NPWS 2001). Echo Point at Katoomba is the main lookout over Jamison Valley, including the Three Sisters rock formation, and attracts around two million visitors each year (NPWS 2001; NSW Government 2015). Other key attractions include Wentworth Falls and Grose Valley viewed from Govetts Leap lookout and Evans lookout at Blackheath.

The Wollemi wilderness area is primarily accessed at Newnes Plateau Cliffs on the western boundary and via Putty Road on the eastern side of the park. Most campgrounds and park facilities are located within proximity to the park boundaries. While only Dunns Swamp-Ganguddy and Wheeny campgrounds are accessible to caravans, Coorongooba and Newnes campgrounds are open to tent, camper trailer and vehicle camping. Colo Meroo campground is only accessible by foot and is suitable for tent and remote/backpack camping. Deanes lookout (west) and Crawfords lookout (east), which are accessible by foot and provide views of the Wollemi wilderness area.

Yengo National Park and wilderness area is accessed via unsealed roads, vehicle tracks and walking tracks. Campgrounds are accessible to tent, camper trailer and vehicle camping. Bushwalking is popular in the park and other popular forms of recreation include horse riding, trail bike riding, mountain bike riding and bird watching. Mt Yengo lookout (west) and Finchley lookout (east) provide views over the Yengo wilderness area.

Nattai National Park offers opportunities for bushwalking and backpack camping in a relatively untouched wilderness environment. Wollondilly lookout near the south-east boundary provides views of eucalypt forests, sandstone cliffs and mountain ranges. Other areas of the park and wilderness areas are accessible via walking tracks.

The Kanangra Walls and wilderness area is the main focus of activity in Kanangra-Boyd National Park. Baal Bone Gap picnic area within the Gardens of Stone National Park is accessible to four wheel drive vehicles. The site includes examples of rock pagoda formations, sheer cliffs and scenic views over Baal Bone Gap. No significant viewpoints were identified within the Thirlmere Lakes National Park or Jenolan Caves Karst Conservation Reserve.

The following areas within the GBMA were identified as sensitive tourism and recreation areas in relation to potential impacts of the proposed airport development on noise, air quality and amenity (see Figure 26–1):

- Jamison Valley south of Echo Point lookout and the Scenic Cableway at Katoomba and Wentworth Falls lookout;
- Grose Valley east of Evans lookout and Govetts Leap lookout;
- the wilderness area between Deanes lookout and Crawfords lookout within Wollemi National Park;
- the wilderness area between Mt Yengo lookout and Finchley lookout within Yengo National Park;
- Nattai wilderness area;
- Kanangra Walls and wilderness area east of Kanangra-Boyd lookout; and
- Baal Bone Gap within Gardens of Stone National Park.

26.4. Assessment of impacts during construction

Construction of the proposed airport would involve a number of specific direct impacts to the airport site. Having regard to the distance and lack of direct connectivity between the site and the GBMWHA, none of these impacts are expected to influence the values of the GBMWHA.

26.5. Assessment of impacts during operations

26.5.1. Direct operational impacts

There would be no direct impacts on the GBMA and its associated World Heritage values from the operation of the proposed airport.

26.5.2. Indirect operational impacts

Operation of the proposed airport may have several potential indirect impacts on the GBMA, primarily from the overflight of aircraft. These potential impacts include:

- noise;
- air quality impacts from aircraft emissions; and
- amenity impacts.

26.5.2.1. Noise

Noise impacts from aircraft overflying the GBMA have been assessed having regard to the maximum noise levels generated. Specific noise criterion for wilderness areas are not available relevant to aircraft noise, consequently alternate values have been adopted. Whilst the NSW Industrial Noise Policy is not a regulatory provision for the project it does provide guidance in regard to noise values for wilderness areas. The policy identifies values of 50 dBA L_{Aeq} and 55 dBA L_{Aeq} as being acceptable and recommended maximum values respectively for rural areas incorporating wilderness areas (EPA 2000). Between 50 and 60 dBA is equivalent to normal conversational noise or background music/radio (Sydney Metro Airport 2010) or a bird call within a wilderness setting.

The assessment of noise impacts from the proposed airport over the GBMA has modelled L_{Amax} levels for single event flights. These are considered to represent a conservative worst case basis for assessment. Noise modelling methodology is described in detail in Appendix E, in regard to the GBMA the model incorporates the topography of the areas and as such the height of aircraft as they overpass the GBMA. This captures the variance in noise across peaks and valleys within the GBMA. Noise levels from specific aircraft have been modelled as detailed in Appendix E. The highest predicted noise levels are associated with a departing Boeing 747 aircraft, while the more common noise levels are represented by a departing Airbus 320.

Figure 26–2 and Figure 26–3 show the indicative noise contours for a single event departure and arrival (for both 05 and 23 directions) for the Boeing 747 and Airbus 320 respectively on all indicative arrival and departure flight tracks. The Boeing 747 is the maximum noise event for all aircraft arriving and departing the proposed airport. However, it is important to note that a Boeing 747 flying to the south would only be expected to depart once every two days on average during Stage 1 operations. As shown in Figure 26–2, noise levels above 50 dBA L_{Amax} and 55 dBA L_{Amax} are experienced in some areas of the GBMA for the maximum noise level in a single event.

Figure 26–3 indicates that a noise exposure contour of 50 dBA L_{Amax} associated with the Airbus 320 extends into the GBMA on the north-eastern fringes during arrivals and the southern area only during departures. Generally across the GBMWHA, minimal incursion of noise levels in excess of 55 dBA occurs. As shown in Table 26–3, two of the key areas identified for this assessment do not experience noise levels at or above 50 dBA L_{Amax}, and the majority of areas would only be affected by noise above this level during the infrequent operation of the Boeing 747 (an aircraft type that is generally being phased out by airlines).

In addition to the assessment of noise impacts at levels below 55 dBA as described above, it is important to note that it is unlikely that any areas of the GBMA would experience noise levels above the general assessment level of 70 dBA L_{Amax} on a regular basis during Stage 1 operations (refer to Chapter 10).

Increased noise levels are shown for the walking trails within the Nattai wilderness area. However, impacts along walking trails would be minimised by vegetation cover and lower elevations within valley areas and along creeks. Similarly, areas affected by increased noise levels within the Wollemi wilderness area are accessible only on foot and impacts would be reduced by the nature of the steep terrain and vegetation cover.

Table 26–3 – Predicted peak noise levels affecting sensitive areas (L_{Amax})

Area	Single event B747		Single event A320	
	50 dBA	55 dBA	50 dBA	55 dBA
Jamison Valley south of Echo Point lookout and the Scenic Cableway at Katoomba and Wentworth Falls lookout	No impact	No impact	No impact	No impact
Grose Valley east of Evans lookout and Govetts Leap lookout	Marginal impact at lookouts	No impact	No impact	No impact
Wilderness area between Deanes lookout and Crawfords lookout within Wollemi National Park	Impact along north eastern alignment	No impact	No impact	No impact
Nattai wilderness area	Impact on eastern wilderness area	Impact on eastern wilderness area	No impact	Impact on eastern wilderness area
Kanangra Walls and wilderness area east of Kanangra-Boyd lookout	No impact on eastern wilderness area	Marginal impact at lookout	No impact	No impact
Baal Bone Gap within Gardens of Stone National Park	No impact	No impact	No impact	No impact

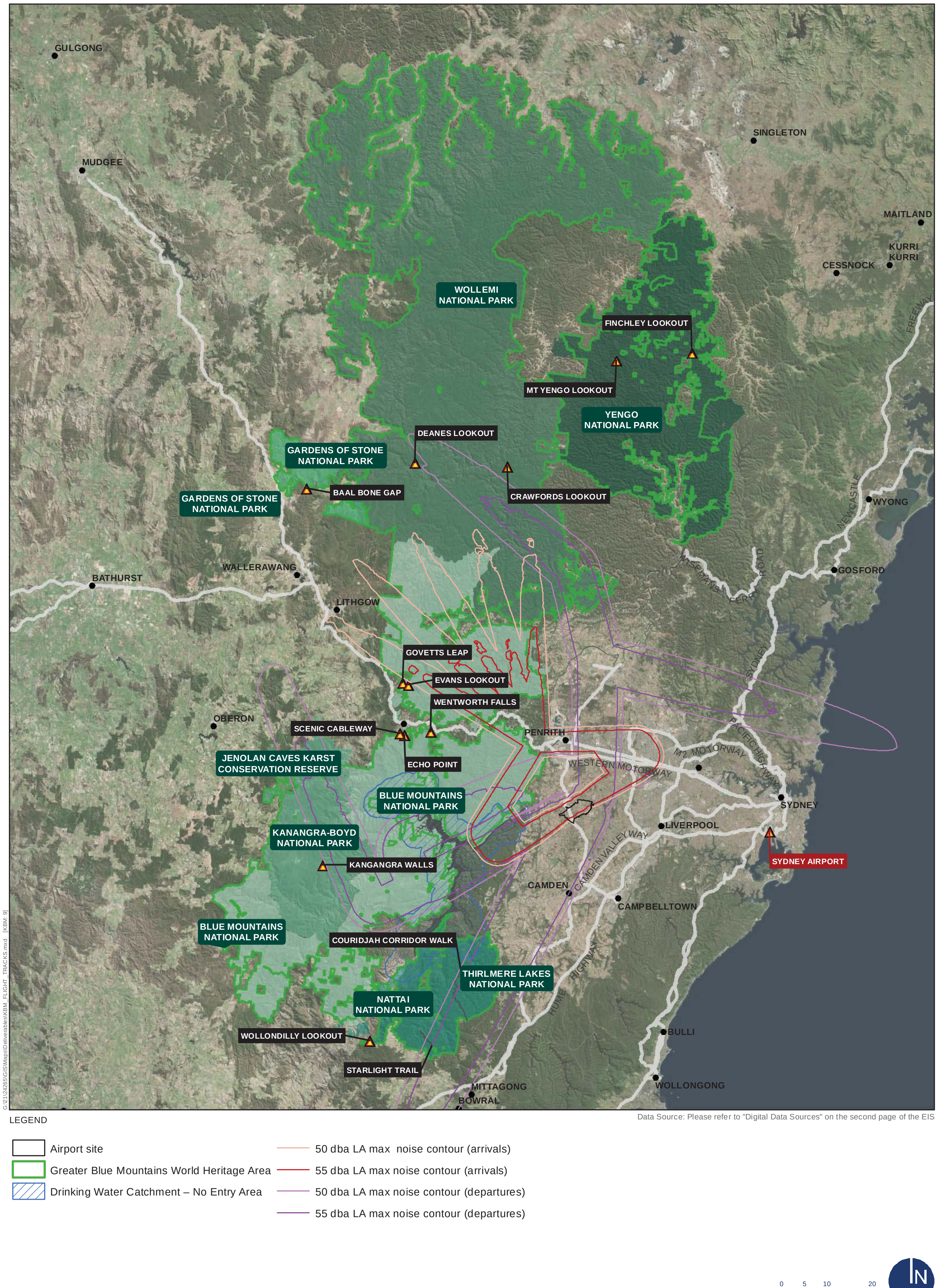
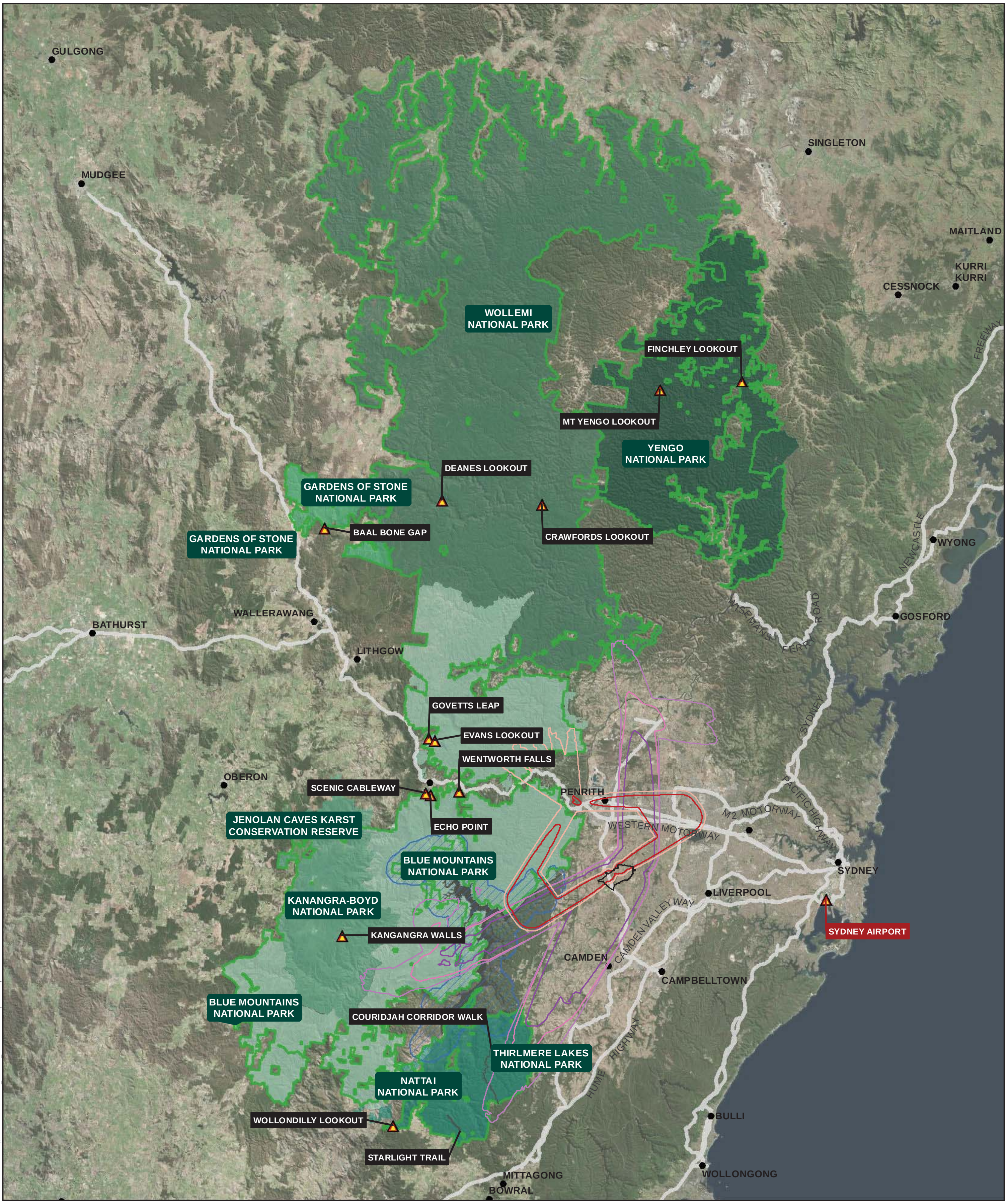


Figure 26-2 - Combined single event noise level for a B747



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LEGEND

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

- Airport site
- Greater Blue Mountains World Heritage Area
- Drinking Water Catchment – No Entry Area
- 50 dba LA max noise contour (arrivals)
- 55 dba LA max noise contour (arrivals)
- 50 dba LA max noise contour (departures)
- 55 dba LA max noise contour (departures)

0 5 10 20
Kilometres

N

Figure 26-3 - Combined single event noise level an A320

Noise has been shown to have a variety of impacts on fauna, including changing foraging behaviour, impacting breeding success and changing species occurrences. Low-flying aircraft can cause flight response in some species, causing them to abandon nests, and other species are known to avoid higher elevation areas where noise levels are higher, potentially resulting in fragmentation of habitat (Ellis, Ellis, & Mindell, 1991). Most of these impacts occur when noise levels are high (greater than 65 dB). Given the height at which flights to and from the proposed airport are likely to occur over the GBMA, these impacts are unlikely. While noise would increase marginally above background levels on an intermittent basis directly under the flight paths, fauna are likely to become habituated to any elevation in noise levels in the long term (Conomy et al 1998), particularly as aircraft would not be flying at low altitudes over the GBMA. Operation of aircraft at the proposed airport is highly unlikely to permanently alter foraging or breeding behaviour of any fauna species. Any impacts would be localised, with impacts occurring under the main flight paths. The majority of fauna within the vast GBMA would not be impacted by aircraft noise. As such, noise would not result in a loss of biodiversity and would not interfere with the ecological viability and capacity for ongoing evolution of species within the GBMA.

26.5.2.2. Air quality

Regional air quality impacts relevant to the GBMA have been assessed in regard to three principal elements:

- regional air quality (ozone);
- contribution to climate change; and
- emissions from fuel dumping.

Regional air pollutants (Ozone)

Regional air pollutants including ozone formed by the photochemical reaction of precursor emissions from the proposed airport can contribute to regional photochemical smog which may have an impact on the amenity of the GBMA. The National Environment Protection Measures (NEPM) ambient air quality standard for ozone is 0.10 parts per million for a one hour period (equivalent to 100 parts per billion) and 0.08 parts per million for a four hour period (equivalent to 80 parts per billion).

To assess the impact from the addition of airport emissions, 12 days were selected for detailed analysis to represent the meteorological conditions that have historically led to peak ozone formation with strong model calibration with existing monitoring data.

The assessment of air quality impacts associated with the proposed airport identified that the peak predicted one hour ozone concentrations were unchanged between the 2030 base case and the 2030 ‘with airport’ case. This is because the predicted ozone concentrations from the proposed airport occur in different locations to where ozone peaks occur. The predicted average of the 2nd to 4th highest increase in daily maximum one-hour ozone concentration was 1.1 parts per billion.

The peak predicted four-hour ozone concentration was unchanged on ten days, increased on four days and decreased on two days due to 2030 airport emissions. The peak predicted four-hour ozone concentration increased by 0.1 parts per billion due to the proposed airport. The highest predicted change in daily maximum four-hour ozone concentration from the addition of airport emissions was 2.4 parts per billion, while the average of the 2nd to 4th highest modelled increase in daily maximum four-hour ozone was 0.9 parts per billion. The background levels for ozone in Western Sydney regularly exceed NEPM guidelines in the summer months. For example, ozone concentrations of 124 parts per billion were monitored at in November 2014 and 108 parts per billion in October 2013. The modelled contribution of emissions from the proposed airport would represent an increase of less than one per cent on these measured values which are not considered significant in the context of regional emission sources.

Contribution to climate change

Climate change is identified as a threat to the GBMA due to its potential to alter the frequency and intensity of fires and for increased temperatures to impact upon biodiversity and ecosystem function (UNESCO 2015). Greenhouse gas emissions (GHG) are identified as a contributing factor to climate change. The proposed airport is expected to contribute approximately 0.10 per cent of Australia's projected 2030 transport-related GHG emission inventory. Given the small percentage of contribution, it is concluded the GHG emissions from the proposed airport would not be material in terms of the national inventory, or represent a significant contribution to climate change.

Emissions from fuel jettison

Emergency fuel jettison (commonly referred to as fuel dumping) is a procedure used by an aircraft in certain emergency situations. The objective of fuel dumping is to reduce an aircraft's weight to allow it to land safely. Instances of fuel dumping are extremely rare worldwide. In Australian airspace, there were 10 reported instances of civilian aircraft dumping fuel in 2014 from 698,856 domestic air traffic movements and 31,345 international movements (approximately 0.001 per cent of all movements).

The procedure for jettisoning fuel is specified in the En Route supplement of the Aeronautical Information Package published by Airservices Australia as outlined in Chapter 7 of Volume 2. When fuel jettisoning is required, the pilot in command requests authority from air traffic control before commencing a fuel jettison and must:

- take reasonable precautions to ensure the safety of persons or property in the air and on the ground;
- where possible, conduct a controlled jettison in clear air at an altitude of above 6,000 feet (approximately 1.8 kilometres) and in an area nominated by air traffic control; and
- notify air traffic control immediately after an emergency jettison.

The authority for fuel jettisoning is the Air Navigation (Fuel Spillage) Regulations 1999, which prescribe penalties for the unauthorised release of fuel from an aircraft other than in an emergency.

The results of a previous study on fuel dumping indicate that when fuel is jettisoned above 1,500 metres in above freezing temperatures, 98 per cent will evaporate before reaching ground level (Clewell 1983). Due to the dispersion of fuel after release, the highest concentrations of fuel at ground level during calm, sunny and cool weather conditions (with wind speeds of three metres per second), were determined to occur seven kilometres downwind away from the location of the aerial dumping. The maximum concentrations were determined to be 0.021 parts per million with a maximum duration of airborne jet fuel at any site being 17 minutes. These results indicate that vaporisation and dispersion of fuel occurs very quickly when jettisoned and is unlikely to have a significant local impact on air quality.

These results indicate that fuel dumping is very unlikely to have a significant impact on the GBMWHA due to the rarity of such events, the inability of many aircraft to perform fuel dumps, the rapid vaporisation and wide dispersion of jettisoned fuel and the strict guidelines on fuel dumping altitudes and locations.

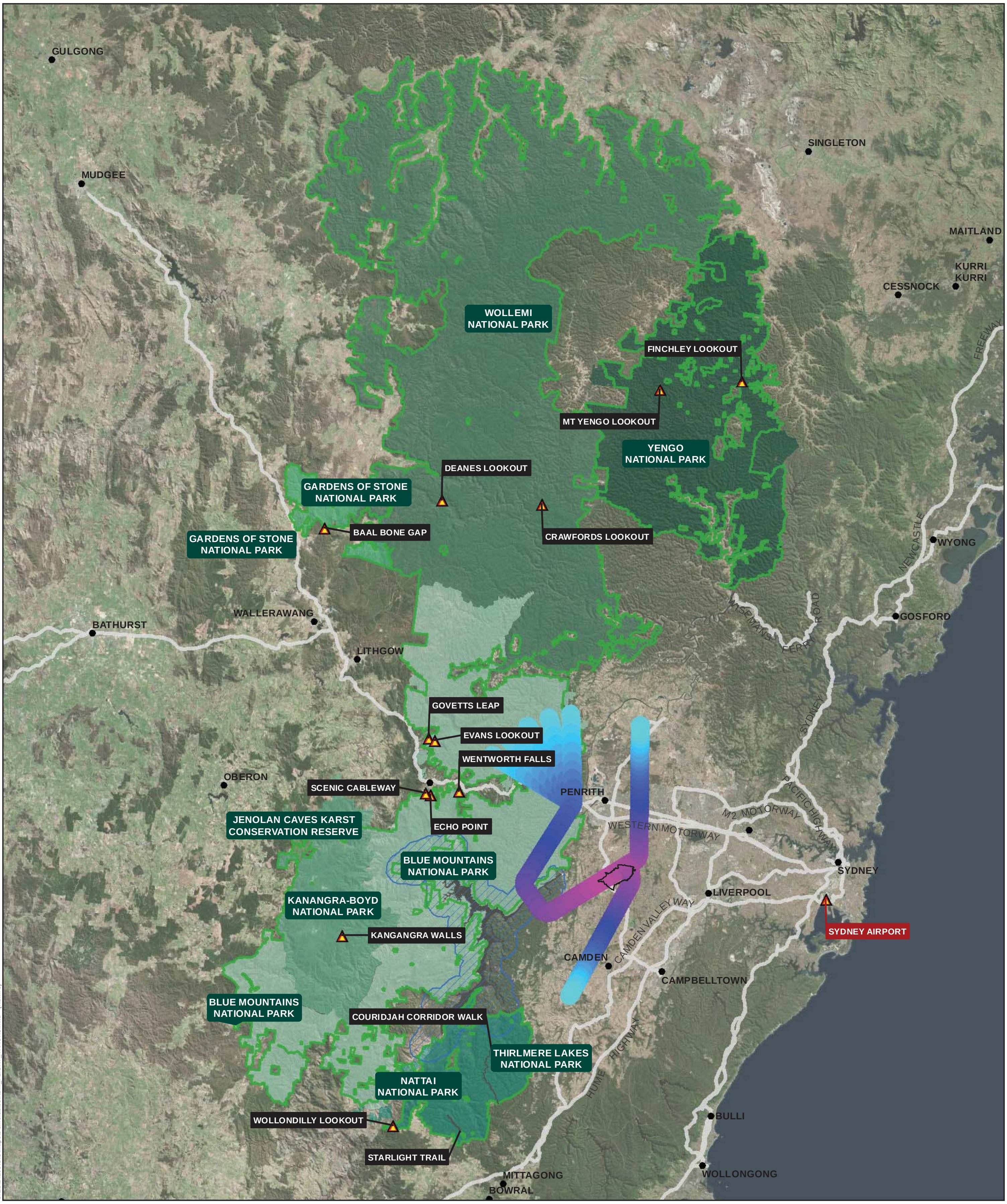
26.5.2.3. Amenity

Amenity impacts have been assessed by reviewing the density of flights and altitude of flights to provide a cumulative measure of the visibility of overflights.

Almost all aircraft approaching or departing the proposed airport over the GBMA would be at an altitude in excess of 5,000 feet and most would be in excess of 10,000 feet above sea level. The anticipated altitude of arriving and departing flights is shown in Figure 26–4 and Figure 26–5.

The altitude of key sensitive areas and the average altitude of aircraft above ground level relevant to these sensitive areas are shown in Table 26–4. No flights would be expected to occur below 6,000 feet above ground level in the vicinity of sensitive areas.

The levels for each sensitive area relate to lookout locations at high elevations within the GBMA. Some areas frequented by tourists and recreational users are at significantly lower altitudes such as the Jamison Valley walking tracks (1570 feet), the Starlights trail within the Nattai wilderness area (305 feet at Nattai River) and Wollemi Creek within the Wolllemi wilderness area (450 feet).



LEGEND

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

- Airport site
- Greater Blue Mountains World Heritage Area
- Drinking Water Catchment – No Entry Area

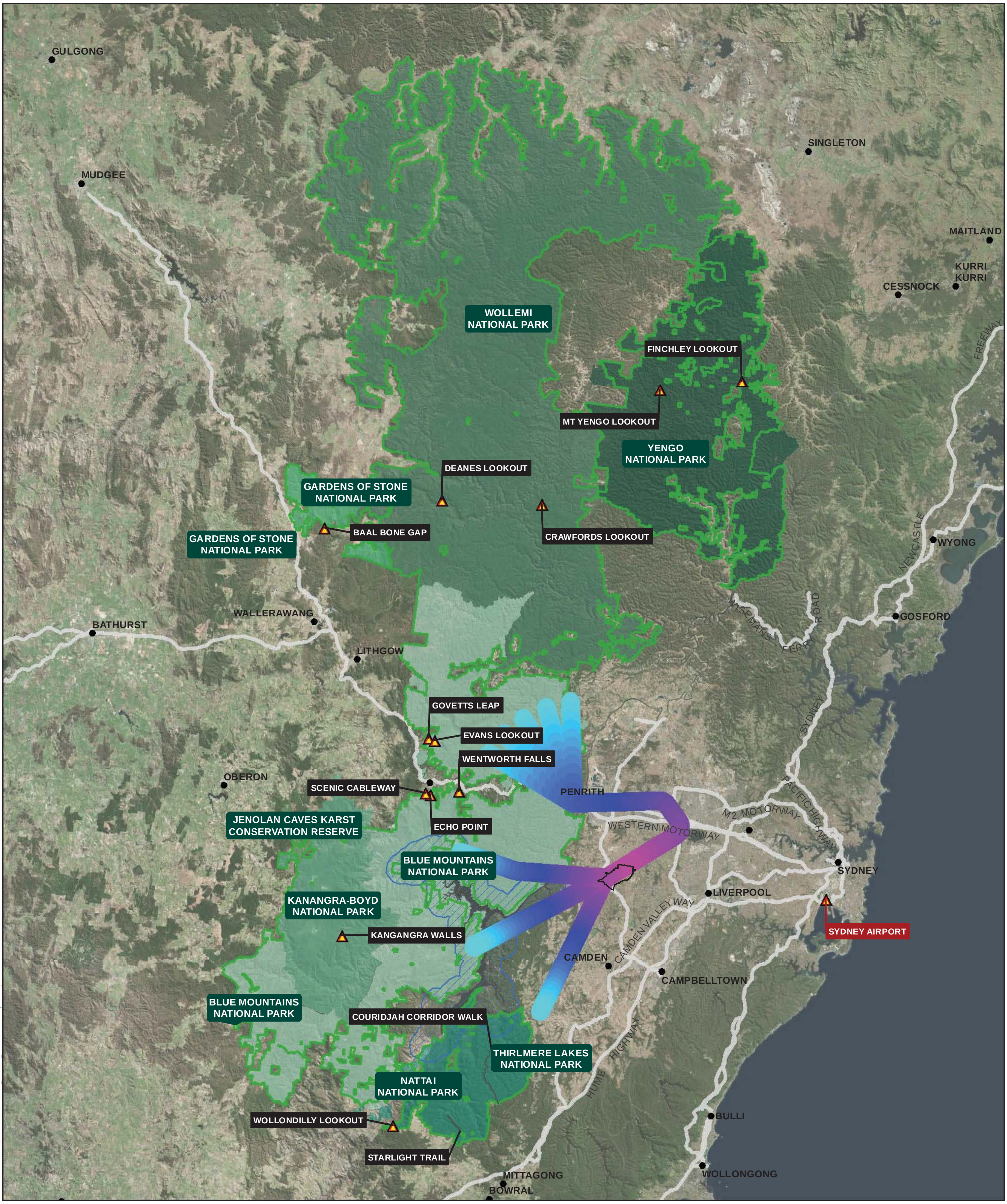
Flight track altitude below 10,000 feet

- 10,000 ft
- 5,000 ft
- 0 ft

0 5 10 20
Kilometres

N

Figure 26-4 - Flight track altitude below 10,000 feet above sea level, prefer 05 single runway



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

LEGEND

- Airport site
- Greater Blue Mountains World Heritage Area
- Drinking Water Catchment – No Entry Area

Flight track altitude below 10,000 feet

- 10,000 ft
- 5,000 ft
- 0 ft

0 5 10 20
Kilometres

Figure 26-5 - Flight track altitude below 10,000 feet above sea level, prefer 23 single runway

Table 26–4 – Flight levels above sensitive areas

Area	Site altitude (~ above sea level)	Flight altitude	Flight above ground level
Jamison Valley south of Echo Point lookout and the Scenic Cableway at Katoomba and Wentworth Falls lookout	3,350 feet	> 10,000 feet	> 6,650 feet
Grose Valley east of Evans lookout and Govetts Leap lookout	3,350 feet	> 10,000 feet	> 6,650 feet
Wilderness area between Deanes lookout and Crawfords lookout within Wollemi National Park	3,000 feet	> 10,000 feet	> 7,000 feet
Nattai wilderness area	2,150 feet	> 10,000 feet	> 7,850 feet
Kanangra Walls and wilderness area east of Kanangra-Boyd lookout	3,550 feet	> 10,000 feet	> 6,450 feet
Baal Bone Gap within Gardens of Stone National Park	3,050 feet	> 10,000 feet	> 6,950 feet

The density of flights equates to the total number of overflights at all altitudes from existing operations and also from operation of the proposed Western Sydney Airport. Flight densities are shown in Figure 26–6 for the 2015 base case (existing operations) and in Figure 26–7 reflecting full operations for Stage 1 of the proposed airport. Much of the GBMWHA is currently impacted by between one and 10 flights per day with specific areas under flight paths experiencing an average of 50 flights. The broad area of impact associated with one to 10 flights per day is generally related to high altitude commercial flights over the area and low altitude small aircraft. The areas of greater density are flight tracks to Sydney Airport.

Total flight numbers at the proposed airport in 2030 are expected to be approximately 200 movements per day. As shown in Figure 26–7, the area currently impacted by one to 10 flights per day remains unchanged with the increase in density being associated with the indicative flight tracks of the proposed airport. When reviewed in the context of the flight altitudes shown in Figure 26–4 and Figure 26–5, the majority of the dense flight tracks are at altitudes exceeding 10,000 feet.

As shown in Photograph 26–1, aircraft at 3,000 feet are not prominent visual features although they are visible from the ground. Aircraft viewed from a distance of between five and 10 kilometres from the airport would have an altitude above 5,000 feet and increasing to above 10,000 feet above sea level. When viewed from the key sensitive areas this equates to at least 6,000 feet above ground level. At 6,000 feet, aircraft are likely to be difficult to discern from ground level and are not considered to be visually obtrusive.

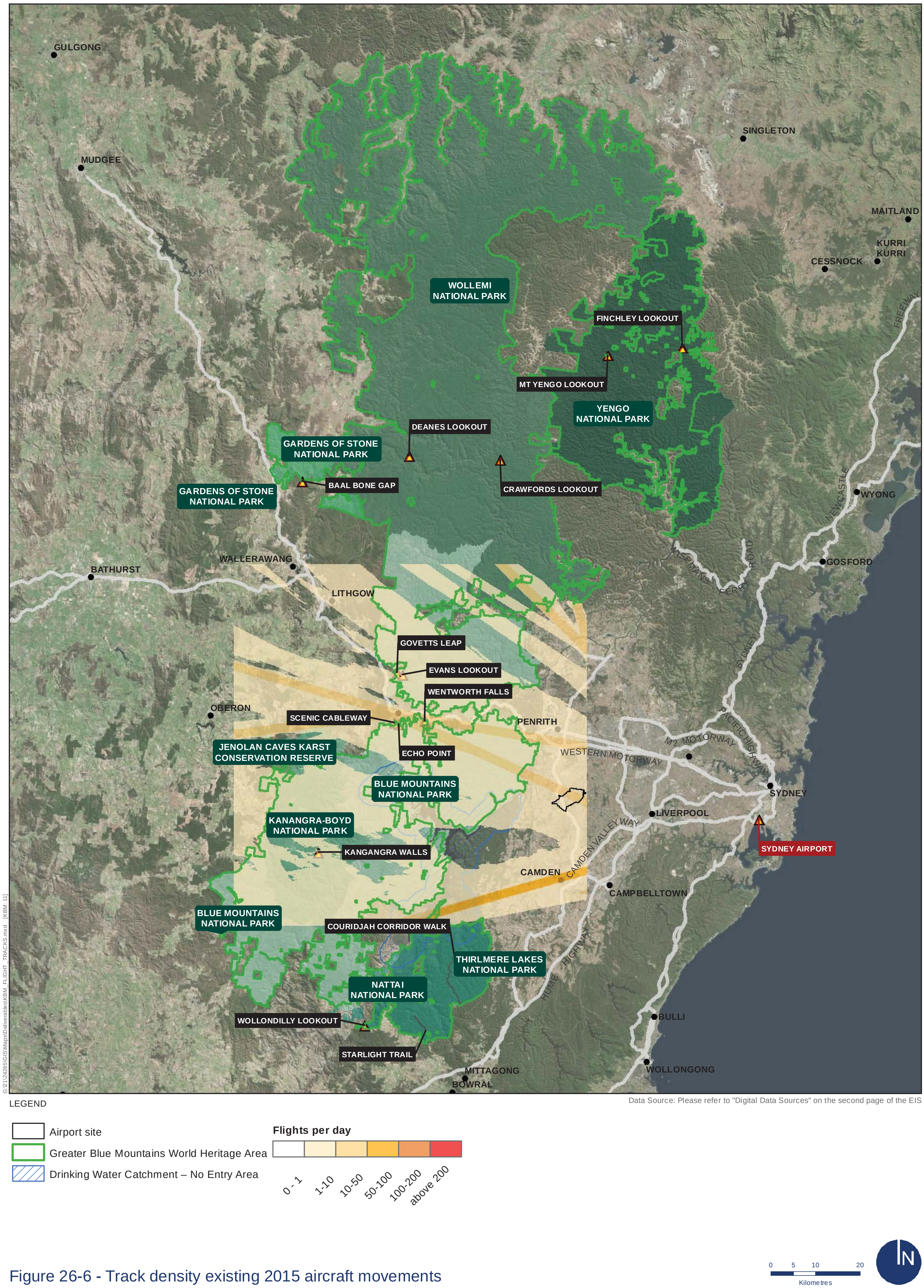
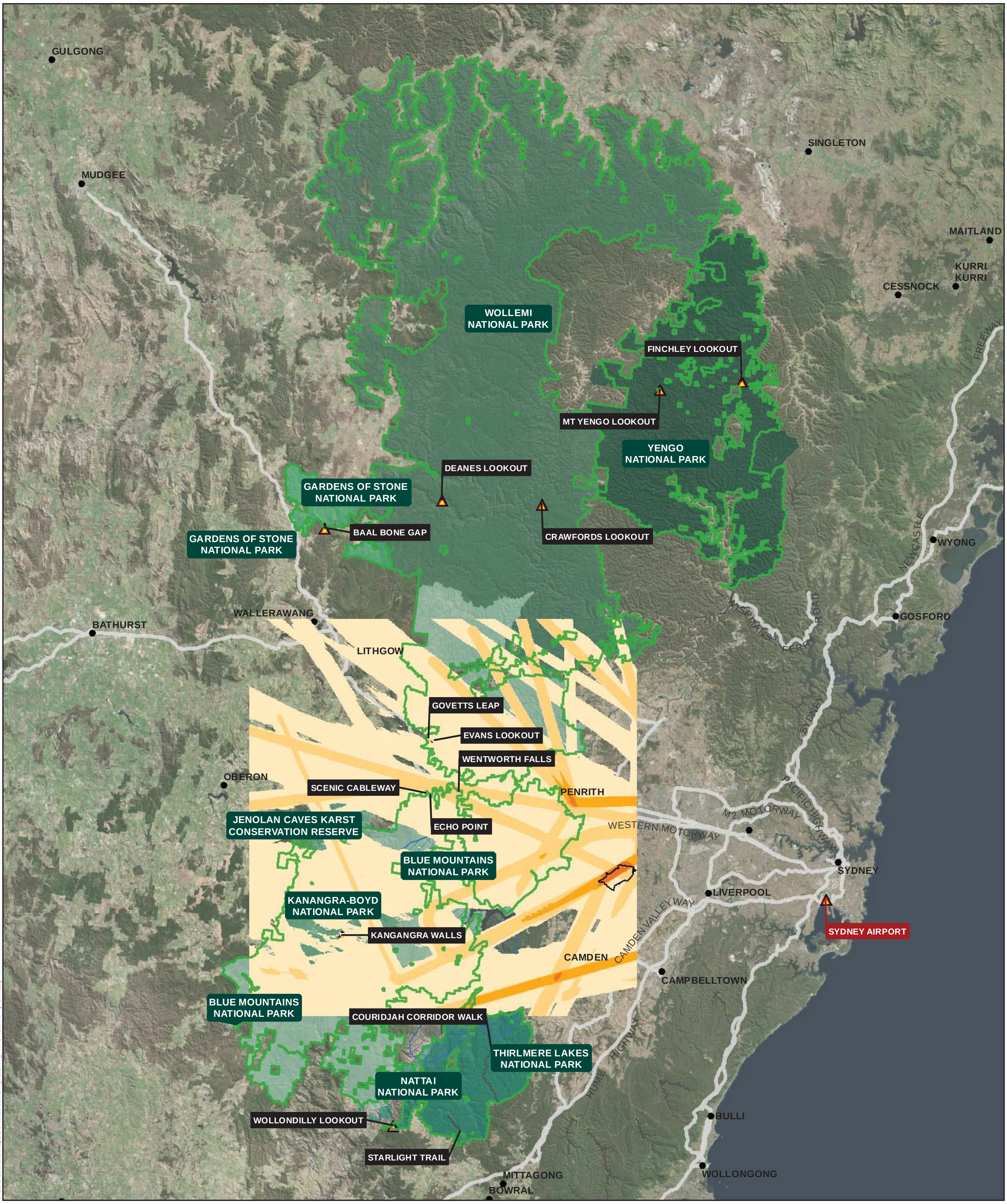


Figure 26-6 - Track density existing 2015 aircraft movements



LEGEND

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

- Airport site
- Greater Blue Mountains World Heritage Area
- Drinking Water Catchment – No Entry Area

Flights per day

0 - 1 | 1-10 | 10-50 | 50-100 | 100-200 | above 200

0 5 10 20
Kilometres

N

Figure 26-7 - Track density, exisitng and WSA 2030 aircraft movements

Photograph 26–1 – Aircraft at approximately 3,000 feet at a ground distance of 2.75 kilometres

The proposed airport site may potentially be visible from Nepean lookout and Mount Portal Lookout both located at Glenbrook and between 13 and 14 kilometres from the airport site. A detailed assessment of visual impact of the airport site is included in Chapter 22. This assessment concluded that a moderate impact to visual amenity was likely at Nepean Lookout and a negligible impact at Mount Portal.

Amenity can also be influenced by light spill from the proposed development. Having regard to the provisions of Australian Standard AS 4280: Control of the obtrusive effects from outdoor lighting, the lighting for the proposed roads, car parks, apron lighting and other ancillary infrastructure is likely to be low impact, due to the large separation distances to sensitive receivers. Sky glow can occur from airfield lighting; reflective lighting and building lighting; within the context of the site within an existing major urban environment and the distance to sensitive receptors it is considered unlikely that sky glow would represent a significant impact.

26.5.3. Outstanding universal value

Operation of the proposed airport would have no direct impact on the outstanding universal value of the GBMA. Indirect impacts on the property's outstanding universal value are expected to be limited to potential noise and air quality. These potential impacts are described and their significance assessed in Table 26–5.

The assessment of significance is based on the requirements of the EPBC Act Significant Impact Guidelines 1.1, which state that an action is likely to have a significant impact on the World Heritage values of a declared World Heritage property if there is a real chance or possibility that it will cause:

- one or more of the World Heritage values to be lost,
- one or more of the World Heritage values to be degraded or damaged, or
- one or more of the World Heritage values to be notably altered, modified, obscured or diminished.

Table 26–5 – Operational impacts on the outstanding universal value of the GBMWHA

Criterion/ element	Attributes	Operational impacts	Assessment of significance
Criterion (ix) ongoing evolutionary processes	• Outstanding and representative examples of: ▪ evolution and adaptation of the genus *Eucalyptus* and eucalypt-dominated vegetation on the Australian continent; and ▪ products of evolutionary processes associated with the global climatic changes of the late Tertiary and the Quaternary; • Centre of diversification for the Australian scleromorphic flora, including significant aspects of eucalypt evolution and radiation; • Primitive species of outstanding significance to the evolution of the earth's plant life: ▪ Wollemi pine (*Wollemia nobilis*); and ▪ Blue Mountains pine (*Pherosphaera fitzgeralii*).	Impacts on these attributes would only occur if there were direct loss through ground disturbance or significant pollution resulting in loss of habitat or alteration to evolutionary processes. Noise and air emissions represent indirect impacts and given the distance from the airport site and the predicted emission levels are not considered to pose a threat to these listed values. The assessment of these impacts indicates that noise from overflights would not impact evolutionary processes. Air emissions from airport operations are not considered to represent a material contribution to global climate change which may impact these processes. Direct emissions from fuel jettisoning are rare and fuel evaporates before reaching the ground. As such, air emissions would not have an impact on evolutionary processes. Outstanding and representative examples of evolutionary processes relate to pre-historical processes associated with climatic, geological, biological and ecological factors which have shaped the development of the GBMA. Similarly the significant aspects of scleromorphic flora and the existence of primitive species present in the GBMA are representative of evolutionary processes. No direct or indirect operational activities would have an impact on these processes in the GBMA and, as such, no discernible impact on the attributes under this criterion would likely occur as a result of operation of the proposed airport.	The operation of the proposed airport would not result in direct impacts on the attributes demonstrated within the GBMA relevant to evolutionary processes. The indirect impacts of the proposed airport would not result in a World Heritage value being lost, degraded or damaged, or notably altered, modified, obscured or diminished. Accordingly, the proposed action would not have a significant impact on the attributes of this World Heritage criterion.

Criterion/ element	Attributes	Operational impacts	Assessment of significance
Criterion (x) biological diversity	• Outstanding diversity of habitats and plant communities; • Significant proportion of the Australian continent's biodiversity (scleromorphic flora); • Primitive and relictual species with Gondwanan affinities; • Plants of conservation significance including 114 endemic species and 177 threatened species; and • Habitat that supports 52 mammal species, 63 reptile species, over 30 frog species and about one third of Australia's bird species.	Impacts on these attributes would only occur if there were direct loss through on- ground impacts or significant pollution resulting in loss of habitat or alteration to biological diversity. Noise and air emissions represent indirect impacts and given the distance from the airport and predicted emission levels are not considered to pose a threat to these listed values. The assessment of these impacts indicates that noise from overflights would not impact biological diversity values. While peak noise levels associated with overflights may disturb species close to operations, flights to and from the proposed airport over the GBMA would generally be more than 5,000 feet above ground level, and would not exceed 55 dBA. These intermittent noise levels are unlikely to disturb fauna within the GBMA. Air emissions from the operation of the proposed airport are not considered to represent a material contribution to climate change which may impact biodiversity. Direct emissions from fuel dumping would not impact biological diversity values. An assessment of the potential for the proposed development to impact upon biodiversity is provided in Chapter 15. Based on that assessment, no direct or indirect operational activities would impact upon biological diversity of the GBMA and as such no discernible impact on the attributes under this criterion would likely occur as a result of operation of the proposed airport.	The operation of the proposed airport would not result in direct impacts on the examples of biological diversity present within the GBMA. The indirect impacts of the proposed airport would not result in a World Heritage value being lost, degraded or damaged, or notably altered, modified, obscured or diminished. Accordingly the proposed action would not have a significant impact on the attributes of this World Heritage criterion.

Criterion/ element	Attributes	Operational impacts	Assessment of significance
Integrity	• Sufficient size to protect the biota and ecosystem processes; • Largely protected by adjoining public lands of state forests and state conservation areas; • Statutory wilderness designation over 83.5% of the property; • Closed and protected catchment for the Warragamba Dam; • Plant communities and habitats occur almost entirely as an extensive, largely undisturbed matrix almost entirely free of structures, earthworks and other human intervention; and • Custodial relationship of Aboriginal people from six language groups through ongoing practices that reflect both traditional and contemporary presence.	The operation of the proposed airport would not directly affect the physical size of the GBMA or the adjoining lands. Statutory provisions which provide protection to wilderness areas and the Warragamba Dam would not be impacted as the project will not directly encroach upon wilderness areas and indirect impacts are not expected to alter the wilderness values for which these areas have been designated under the National Wilderness Inventory. The operation of the proposed airport would have no direct or indirect impact on the plant communities and habitats within the property. The operation of the airport would not directly or indirectly impact upon the maintenance of Aboriginal cultural practices within the GBMA.	The proposed airport would not result in the loss of any elements necessary for the property to express its outstanding universal value. The proposed airport would not reduce the size or change the boundary of the GBMA and would not impact on any features and processes that convey the property's outstanding universal value. As described in Section 26.5.5, the proposed airport would not exacerbate existing threats to the integrity of the GBMA.

26.5.4. Other values

Table 26–6 provides an assessment of the potential operational impacts of the proposed airport on the additional values of the Greater Blue Mountains Area identified in the Strategic Plan (DECC 2009c). These values complement and interact with the property's World Heritage values but are not part of the defined natural values for which the property is listed. The assessment of these values is relevant to the National Heritage listing of the GBMA.

Table 26–6 – Operational impacts on other important values of the GBMA

Value	Attributes	Operational impacts	Assessment of significance
Geodiversity and biodiversity	• Extensive dissected sandstone plateaus; • Karst landscapes with several cave systems; • Prominent basalt-capped peaks; and • Quaternary alluvial deposits.	Potential impacts on this value would only occur if there were direct loss through ground impacts or pollution resulting in loss of geodiversity and biodiversity. No direct or indirect operational activities would have an impact on these processes and as such no impact on this value would occur as a result of operation of the proposed airport.	The proposed airport would not have a significant impact on the geodiversity and biodiversity of values associated with the GBMA.
Water catchment	• Wild rivers; • Pristine and relatively undisturbed catchment areas; and • Substantial contribution to maintaining high water quality.	Potential impacts on this value would only occur if there were direct loss through ground impacts or pollution resulting in harm to a water catchment. A portion of the GBMWHA fronts the Nepean River downstream of its confluence with Duncans Creek. The Duncans Creek catchment only covers approximately 11 percent of the airport site, the majority of which is outside of the footprint of the proposed works. In addition with the implementation of the proposed water quality control measures the impact to this creek and therefore changes to water quality and hydrology have very low potential to impact water quality in the Creek and the Nepean River. The remainder of the site discharges to the South Creek catchment with discharges to the Nepean River downstream of the GBMA No direct or indirect operational activities would have an impact on these catchments and waterways, and as such no impact on these values would occur as a result of operation of the airport.	The proposed airport would not have a significant impact on the water catchment values associated with the GBMA.
Indigenous heritage values	• Prominent landscape features with spiritual significance: ▪ Mt Yengo; and ▪ Coxs River and Wollondilly River valleys • Aboriginal rock art; and • Potential for uncovering further significant sites.	Operation of the proposed airport would not directly impact sites within the GBMA that have Indigenous heritage values. The only form of indirect impact on cultural heritage values that can be reliably anticipated by this assessment is the temporary loss of contextual value from the periodic intrusion of low levels of aircraft noise. Mt Yengo is located in the north eastern extent of the GBMA and is not expected to be impacted by overflights or noise from aircraft having regard to the noise assessment criteria. Similarly the Coxs River and Wollondilly River valley are located in areas of little to no noise impact.	The proposed airport would not have a significant impact on the Indigenous heritage values associated with the GBMA.

Value	Attributes	Operational impacts	Assessment of significance
Historic heritage values	• Small graziers' huts; • Cedar logging roads and stock routes; • Ruins of oil shale mines and coal/shale mines; • Road and transport routes; and • Recreation and tourism.	Operation of the proposed airport would not directly or indirectly impact on sites of historic cultural heritage within the GBMA. Indirect impacts on recreation and tourism are considered below.	The proposed airport would not have a significant impact on the historic heritage values associated with the GBMA.
Recreation and tourism	• Canyoning, bushwalking, rock climbing, nature observation, scenic driving, photography; • Picnic sites and basic camping facilities; • Catering, tours, accommodation; and • Direct and indirect contribution to the employment, income and output of the regional economy.	Key areas of recreation and tourism have been identified and assessed in regard to potential impacts from operation of the proposed airport. Whilst some areas are expected to experience intermittent noise levels above 50 dBA, such areas are limited in the context of the entire property. Similarly visual and lighting impacts are not considered to represent a significant change to existing conditions for recreation and tourism. The major tourism areas around Katoomba and Wentworth Falls would not be impacted by aircraft noise. Potential impacts may occur associated with increased traffic due to increased tourism in the region. However, these are expected to be limited to existing traffic routes and be limited to minor increases. Some increases in tourism development and infrastructure may occur, as a result of the increased tourism numbers, in the longer term result in an increase in regional traffic and economic development associated with tourism in the region. However, potential impacts from these facilitated developments can be effectively managed through the implementation of existing management plans for the region.	The proposed airport would not have a significant impact on the recreation and tourism values associated with the GBMA.

Value	Attributes	Operational impacts	Assessment of significance
Wilderness	• Extensive natural areas; • Absence of significant human interference; • Opportunity to maintain integrity, gradients and mosaics of ecological processes; • Opportunities for solitude and self-reliant recreation; and • Aesthetic, spiritual and intrinsic value.	The wilderness areas of the GBMA are generally associated with the Nattai National Park and the Wollemi National Park. With lower noise levels potentially also affecting Blue Mountains and Kanangra Boyd National Parks (e.g. effects on Grose and Kanangra Boyd Wilderness Areas). Access to these areas is generally limited to hikers and low impact tourism. These limitations restrict the number of people within the area and as such limits the number of people potentially affected. Some areas of Nattai National Park and Wollemi National Park would be affected by maximum noise levels associated with infrequent overflights of Boeing 747 aircraft, an aircraft type gradually being phased out by airlines. A small proportion of the wilderness areas may be impacted by visual and lighting changes; however these are considered to be insignificant for the vast majority of wilderness areas. A potential increase in tourism numbers in the longer term may impact the wilderness experience of some areas.	The majority of aircraft using the proposed airport such as the Airbus 320 (refer Figure 25-5) would have minimal noise impacts on the GBMA. Some new generation aircraft such as the Boeing 787 which are already in use in Australia have less noise impact than the A320. It is expected that future generations of aircraft would utilise quieter engine technologies which would reduce noise impact further. In addition, the current generation of larger aircraft (i.e. Boeing 747) are predicted to use the proposed airport infrequently (once every two days on average). Aircraft passing over the GBMA on approach to or departure from the proposed airport would generally be at least 5,000 feet to 10,000 feet above ground level and are unlikely to be visually intrusive. Based on these factors it is not expected that a significant impact on wilderness values would occur as a result of the operation of the airport.
Research and education	• High scientific value discovered and undiscovered; • Scientific research into the identification, conservation and rehabilitation of World Heritage values, best management practice and threat abatement; and • Education value for schools and universities.	Operation of the proposed airport is not expected to have an impact on the biological diversity of the GBMA and, as such, the availability of the area for scientific investigation and research would not be limited.	The proposed airport would not have a significant impact on the research and education values associated with the GBMA.

Value	Attributes	Operational impacts	Assessment of significance
Scenic and aesthetic	• Vertical cliffs, waterfalls, ridges, escarpments; • Outstanding vistas, uninterrupted views of forested wilderness; • Extensive caves; and • Sandstone canyons and pagoda rock formations.	Aircraft overflying the key lookouts that take advantage of the unique scenic qualities of the GBMA would be more than 6,000 feet above the relevant ground level and at this altitude would have limited visual intrusion. Similarly visual and lighting impacts are not considered to represent a significant change to existing conditions for scenic and aesthetic amenity.	Based on the altitude of aircraft overflying scenic areas it is not expected that a significant impact would occur as a result of the operation of the proposed airport.

26.5.5. Influence on existing threats

Table 26–7 provides a description of the proposed airport's influence on existing threats identified in the Strategic Plan for the GBMA (DECC 2009c).

Table 26–7 – Operational impacts contribution to existing threats within the GBMWHA

Threat	Project influence
Uncontrolled and inappropriate use of fire	The only risk of fire associated with the operation of the proposed airport would be as a result of an aircraft crash. This would be a very rare and unlikely event and is not considered to be a contributory factor in the overall threat of uncontrolled and inappropriate use of fire.
Inappropriate recreation and tourism activities, including development of tourism infrastructure	The proposed airport would provide progressively increasing aviation capacity in the Sydney region, which could also parallel a growth in tourism and visitation for the GBMA. Such an increase in tourism may influence potential for inappropriate tourism development. However it is very unlikely that the proposed airport would directly contribute to inappropriate development or uncontrolled visitor access particularly within the context of strong management plans which are in place for the GBMA. Other factors such as Sydney's expanding population are likely to drive the need for any new management responses to threats posed by increased visitations.
Invasion by pest species including weeds and feral animals	No direct impacts on biodiversity are expected as a result of the proposed airport. It is very unlikely that the proposal would contribute to threats associated with weed and pest species.
Loss of biodiversity and geodiversity	Loss of biodiversity and geodiversity would only occur as a direct loss through ground impacts, such as an aircraft crash, or significant pollution resulting in loss of habitat or alteration to evolutionary processes. Noise and air emissions from overflying planes are not expected to negatively impact biodiversity or geodiversity. As such the indirect impacts associated with the proposed airport are not considered to be a contributing factor to this threat.
Impacts of human enhanced climate change	The proposed airport is expected to have a marginal contribution to overall transport related GHG emissions. A predicted overall contribution of 0.10 per cent of GHG emissions is considered to be negligible. As such the proposed airport is not considered to be a contributing factor to this threat.
Lack of understanding of heritage values	This threat would be relevant if no assessment of potential impacts was undertaken. An assessment of heritage values has been undertaken and as such the proposed airport is not considered to be a contributing factor to this threat.

26.6. Mitigation and management measures

Noise modelling and impact assessment for this EIS have been based on indicative flight paths and a preliminary analysis of airspace arrangements undertaken by Airservices Australia. The principal objective of the preliminary assessment was to establish whether safe and efficient operations could be introduced at the proposed airport through the development of indicative proof-of-concept design does not take into account other influences on air traffic movement such as consideration of potential noise or other environmental impacts. This work does not present a comprehensive airspace and air route redesign, nor does it consider all essential components of any such design process.

Formal design of airspace arrangements and flight paths for the proposed airport would be undertaken closer to the commencement of operations. That design process would take account of all relevant factors, including potential environmental impacts on sensitive areas such as the GBMA, in determining operating procedures for the proposed airport.

The current assessment based on the above indicative arrangements shows that level of impacts on the Greater Blue Mountains, including the World Heritage and National Heritage values of the GBMA, from operation of the proposed Western Sydney Airport is likely to be low. The potential to further reduce the noise and visual impact from aircraft flying over wilderness and other areas of the GBMA would be key considerations in determining the final and formal airspace and operational arrangements prior to the commencement of operations at the proposed airport.

Detailed management plans are in place for the GBMA; including the Strategic Plan. This plan would be considered in the development of the detailed environmental; management plan for the project.

26.7. Conclusion

At its closest point, the GBMA is approximately eight kilometres from the proposed airport. As such, no direct impacts are expected on World Heritage or National Heritage values from the construction or operation of the proposed Western Sydney Airport. Potential indirect impacts on World Heritage and National Heritage values from the operation of the airport were assessed having regard to the attributes identified in the Statement of Outstanding Universal Value for the GBMA and the complementary values of the area as defined in the GBMA Strategic Plan. The assessment considered noise, air emissions and amenity impacts from overflight of aircraft; lighting and traffic.

The assessment's findings are that the proposed airport would not have a significant impact on the GBMA. In particular, the indirect impacts of airport operation would not result in an attribute of the property being lost, degraded or damaged, or notably altered, modified, obscured or diminished.

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27. Cumulative impact assessment

Cumulative impacts may arise as a result of the development of the proposed airport concurrently or sequentially with other major projects in the region. To identify the likelihood of airport related cumulative impacts, other significant projects and/or initiatives were reviewed including:

- Western Sydney Infrastructure Plan
- Broader Western Sydney Employment Area
- South West Priority Growth Area
- other major projects identified in the region

Cumulative impacts associated with the long term development of the proposed airport are considered separately as part of the strategic environmental assessment presented in Volume 3.

There is considered to be minimal potential for cumulative noise impacts upon sensitive receivers as a result of the distance from other major projects. The relocation and upgrade of The Northern Road, construction of the M12 motorway and potential realignment works on Elizabeth Drive in the vicinity of the airport site have the highest potential for cumulative noise impacts. The majority of the roads on the anticipated construction haulage routes carry relatively high volumes of existing traffic and the increase in noise from construction traffic is unlikely to be perceptible. Further, aspects of likely noise impacts from additional road projects, such as the M12, have been considered on a preliminary basis in the noise assessment as part of this draft EIS.

Existing background air quality monitoring data in conjunction with the modelled emissions from the surrounding road network were used in the local air quality assessment. Consideration of the potential for increases in ozone in Sydney's regional airshed was also undertaken as part of the assessment. Predicted emissions would typically be below the respective air quality assessment criteria during construction and operation for both incremental impacts of the airport alone and when considered cumulatively with other surrounding land use and development.

The traffic assessment utilised land use forecasts to model anticipated future traffic generation in the region together with expected traffic from the proposed airport. Additional vehicle movements associated with the construction and operation of the proposed airport are not likely to significantly affect the operation of the surrounding road network. Substantial road improvement works are proposed as part of the Western Sydney Infrastructure Plan and other planned developments in Western Sydney. These are expected to provide sufficient capacity to cater for the expected passenger and employee traffic demand associated with the operation of the proposed airport in 2030.

The progressive development and urbanisation of Western Sydney has placed increased pressure on biodiversity, Aboriginal and European heritage values of the region. Development of a biodiversity offsets strategy, consideration of a Keeping Place and additional archaeological and archival recording would assist in mitigating cumulative impacts.

27.1. Introduction

This chapter provides an assessment of the potential cumulative impacts that may arise as a result of the construction and operation of the proposed airport concurrently or sequentially with other projects in the region.

Cumulative impacts are incremental environmental impacts that are caused by past, present or reasonably foreseeable future activities that, when combined, may have a cumulative effect. When considered in isolation, the environmental impacts of any single project upon a receiver or resource may not be significant. However, the potential impacts may increase when individual effects are considered in combination, either within the same project or together with other projects.

The proposed airport may result in both adverse and beneficial cumulative effects as a result of:

- concurrent or co-located projects under construction;
- regional land use changes;
- off-site infrastructure needed to support the operation of the airport;
- landside transport access to the airport; and
- incremental increases in the capacity of the airport including both the Stage 1 and long term development.

Another type of cumulative impact is known as construction fatigue. This concept relates to sensitive receivers that experience construction impacts from a variety of projects over a long period of time with few or no breaks between construction periods. Construction fatigue typically relates to amenity impacts from projects that are constructed consecutively or 'back to back'.

27.1.1. Assessment approach

The assessment of cumulative impacts builds upon the detailed assessment of environmental aspects presented in Chapters 10 through to 26 in this volume.

To identify the likelihood of airport related cumulative impacts, potential construction and operational phase interfaces with other significant projects and/or initiatives were reviewed, specifically:

- relevant projects under construction;
- projects and/or initiatives that have publicly declared financial commitments;
- projects for which approval has been sought or that have been approved under relevant NSW legislation; and
- projects that are committed to in planning strategies for the region.

In determining which other projects/initiatives are relevant to the cumulative impacts assessment, the following criteria were taken in account:

- **location**: the projects are located in proximity to the airport;
- **project timeframe**: projects likely to be under construction concurrent with the airport (or which would otherwise have a noteworthy operational interaction) were considered; and
- **project size**: projects were listed on either the NSW Department of Planning and Environment Major Projects Register or local government websites.

Consideration of cumulative impacts was inherently addressed as part of the detailed modelling approach for a number of environmental aspects assessed as part of specialist investigations presented in Volume 4 of this draft EIS. For example the traffic assessment considered the impacts of the proposed airport within the context of the modelled urban growth predictions for Western Sydney. The air quality assessment included modelling of the incremental impacts of the proposed airport together with background monitoring data and the modelled pollutant sources from surrounding projects.

The long term impact assessment presented in Volume 3 of this draft EIS considers the cumulative impacts associated with the possible progressive expansion of the proposed airport beyond the scope of the proposed Stage 1 development.

27.2. Relevant plans and projects

There are a number of initiatives and projects in progress or proposed for Western Sydney, which have the potential to generate cumulative impacts/interactions with the proposed Stage 1 development. These initiatives and projects are summarised below.

27.2.1. Western Sydney Infrastructure Plan

The Western Sydney Infrastructure Plan involves the Australian and New South Wales Governments investing $3.6 billion over 10 years in major Western Sydney road infrastructure upgrades. The plan aims to relieve pressure on existing infrastructure and unlock the economic capacity of the region by easing congestion, reducing travel times and creating local jobs. The plan includes:

- upgrade of The Northern Road to a minimum of four lanes from Narellan to Jamison Road;
- construction of a new east-west four-lane M12 Motorway to provide access and traffic capacity for the proposed airport between the M7 Motorway and The Northern Road, with the retention of Elizabeth Drive for local traffic;
- upgrade of Bringelly Road to a minimum of four lanes between The Northern Road and Camden Valley Way;
- upgrade of the intersection of Ross Street and the Great Western Highway;
- construction of the Werrington Arterial road; and
- a $200 million package for local roads upgrades.

27.2.2. Broader Western Sydney Employment Area

The Broader Western Sydney Employment Area comprises a land area of approximately 10,690 hectares and encompasses portions of the local government areas of Blacktown, Fairfield, Liverpool and Penrith.

The *Broader Western Sydney Employment Area Draft Structure Plan* was released in June 2013 by the NSW Government (now referred to as the Western Sydney Employment Area Extension). It outlines a broad framework for the area including the location of future employment land and centres, a road network, potential freight and transport corridors and staging scenarios. The Draft Structure Plan is currently being revised to recognise the Western Sydney Airport and a revised structure plan is expected by the end of 2015.

The Draft Structure Plan shows approximately 8,100 hectares of employment land, comprising 1,750 hectares of currently zoned employment land and 6,350 hectares of future employment land. The Western Sydney Employment Area Extension has the potential to generate 57,000 jobs to 2046, of which 36,000 would be industrial jobs and 21,000 office based jobs.

The Draft Structure Plan also identifies opportunities for two specialised centres and one local centre as follows:

- one specialised centre proposed to be located on the airport site south of Elizabeth Drive;
- a second specialised centre proposed to be located at the proposed intersection of Aldington Road and the Erskine Park Southern Link Road; and
- a local centre planned along the potential passenger rail corridor close to the intersection of the potential Outer Sydney Orbital corridor and Luddenham Road.

27.2.3. South West Priority Growth Area

The South West Priority Growth Area is approximately 17,000 hectares in size and includes parts of the Liverpool, Camden and Campbelltown LGAs. It is divided into 18 Precincts that are being progressively released for planning and rezoned for sustainable urban development.

The South West Priority Growth Area will be supported by a Major Centre at Leppington and serviced by the new South West Rail Link. It is presently estimated that this Area will contain about 110,000 new dwellings for some 300,000 residents.

To date, seven South West Growth Centre precincts including Oran Park, Turner Road, Edmondson Park, Austral, Leppington North, Catherine Field (part) and East Leppington have been rezoned to allow urban development. Collectively, these precincts have potential for 42,560 homes to accommodate approximately 130,200 residents and capacity for 22,120 jobs.

The Leppington Precinct is currently undergoing precinct planning and upon rezoning is expected to provide land for approximately 9,000 additional homes.

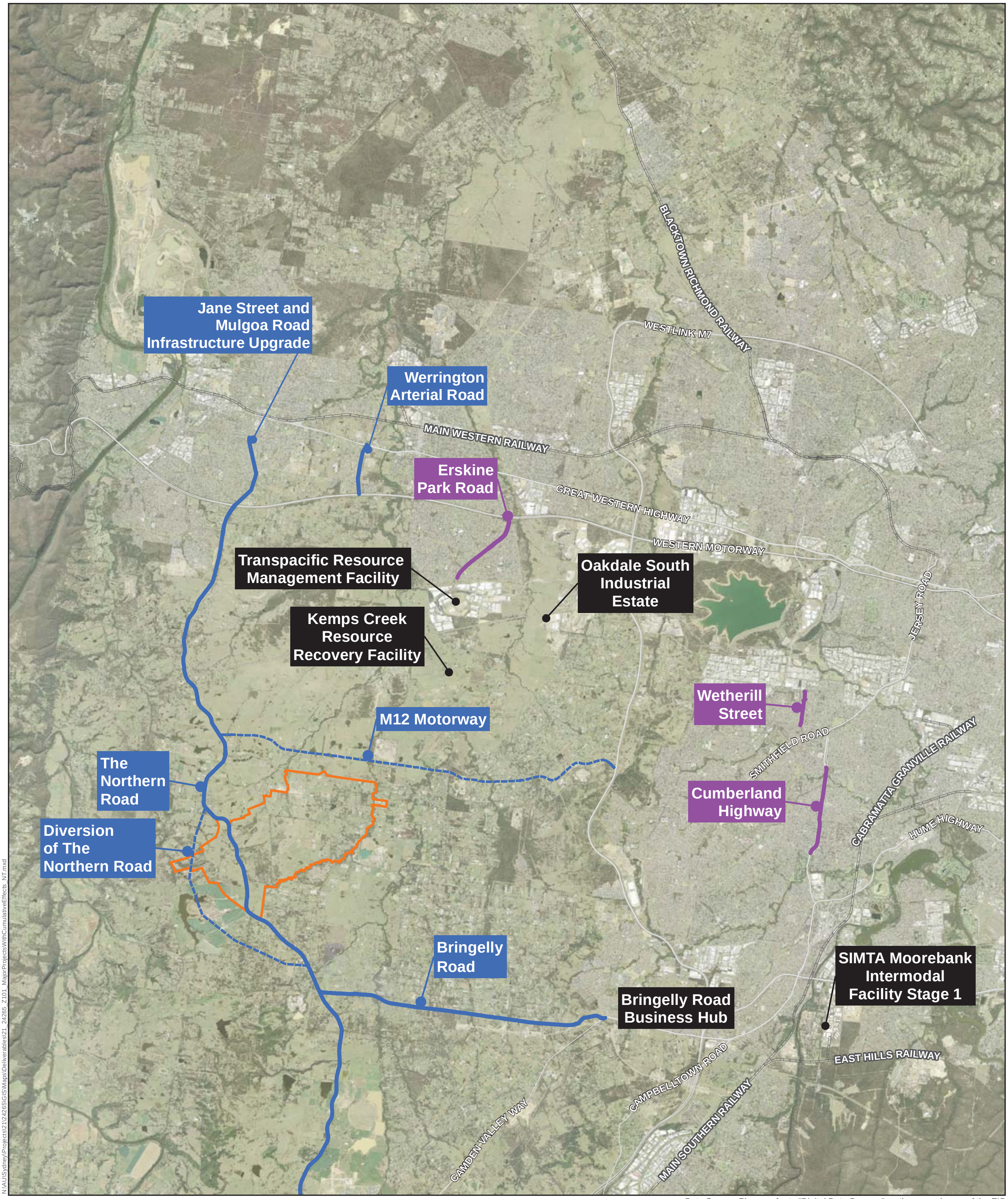
27.2.4. Major projects

In addition to the broad transformational plans identified above, five major projects which are currently undergoing project assessment or have been approved recently were identified as relevant for the assessment of construction and operational phase cumulative effects based on the criteria explained in Section 27.1. The projects are described in Table 27–1 and their locations are shown in Figure 27–1.

Table 27–1 – Major projects with potential cumulative effects

Project and location	Description	Status
SIMTA Moorebank Intermodal Facility Stage 1, Moorebank Avenue, Moorebank	Construction and operation of Stage 1 of the facility comprises the following components: • intermodal terminal facility operating 24 hours per day, seven days per week with a capacity to handle up to 250,000 twenty foot equivalent units including: truck processing and loading areas; rail loading and container storage areas; and an administration facility and associated car parking; • a rail link connecting the southern end of the site to the Southern Sydney Freight Line; and • associated works including: rail sidings; vegetation clearing, remediation and levelling works; and drainage and utilities installation.	State Significant Development Concept Plan Approved Stage 1 EIS exhibition
Bringelly Road Business Hub, Bringelly Road, Leppington	The proposed Bringelly Road Business Hub would accommodate large format retail, bulky goods and light industrial premises and may include the sale of home wares, electrical appliances, home building materials and/or office supplies. The proposal involves: • demolition of existing structures; • subdivision of the site into eight developable lots; • bulk earthworks to regrade the land and provide generally level developable lots; • construction of new internal roads accessed from the realigned Bringelly Road; • construction and delivery of utilities, services and stormwater management infrastructure; and • public domain and landscaping works.	State Significant Development Proponent reviewing submissions on EIS
Kemps Creek Resource Recovery Facility, 788 – 804 Mamre Road, Kemps Creek	The facility is intended to process general solid waste associated with the construction and property development industries. In particular, it seeks to screen, crush and sort building and demolition materials, excavated natural materials, and the like. It is expected that the site would process between 200,000 to 250,000 tonnes of such material annually. Recovered materials would be distributed throughout the Sydney metropolitan area, as required.	EIS requirements issued
Transpacific Resource Management Facility, 50 Quarry Road, Erskine Park	Erskine Park Resource Management Facility would include: • Stage 1: Erskine Park Waste Transfer Station with a design capacity of 300,000 tonnes per year of waste (putrescible and non-putrescible) for sorting and transfer; and • Stage 2: Erskine Park Resource Recovery Facility designed to receive up to 150,000 tonnes per annum of selected recyclable material from the transfer station for processing into a number of saleable commodities.	EIS requirements issued

Project and location	Description	Status
Oakdale South Industrial Estate, Erskine Park	Oakdale South Industrial Estate is a 117 ha site located within the Western Sydney Employment Area and is the second of four stages of the broader Oakdale Industrial Estate (421 hectares). Land uses permitted at Oakdale South Industrial Estate include those associated with warehouse, distribution and manufacturing. Staged development of the Oakdale South Industrial Estate would comprise: • a Master Plan for the entire site establishing key development parameters; • subdivision of the entire Oakdale South site into six sub-precincts to allow for the staged development of the site.; • bulk earthworks across the entire Oakdale South site, staged to align with infrastructure delivery and market demand; • staged infrastructure/civil works; and • development of selected precincts for warehousing and distribution.	EIS requirements issued



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

LEGEND

- Airport site
- Rail
- Roads

Western Sydney Infrastructure Plan

- Local roads package
- Major road projects
- Route to be decided

0 1 2 4
Kilometres

N

Figure 27-1 - Location of major projects with potential cumulative effects

27.2.5. Long term development of the proposed airport

It is expected that the proposed airport would be progressively developed as demand increases beyond 10 million annual passengers. Additional aviation infrastructure and support services such as taxiways, aprons, terminals and support facilities would be required to service the growing demand.

The need for a second runway would be triggered when operational demand approaches 37 million annual passengers, which is forecast to occur around 2050. Conceptual layouts have been developed for an airport with the capacity to service approximately 82 million annual passengers. This level of patronage is forecast to occur by around 2063.

A strategic level environmental assessment of this possible long term development is provided in Volume 3 to provide an indication of the impacts associated with the progressive expansion of operations beyond the scope of the proposed Stage 1 development. The strategic level assessment therefore provides consideration of the cumulative impacts arising from long term development stages of the proposed airport.

27.2.6. Airspace operations

The operation of the proposed airport would interact with the operations of Sydney Airport, Camden Airport, Bankstown Airport, RAAF Base Richmond and several other minor aviation facilities in the region. A preliminary assessment of airspace implications for the Sydney region associated with an introduction of flights at the proposed airport was undertaken by Airservices Australia to develop indicative air traffic management designs. The indicative designs demonstrate that Stage 1 of the proposed airport and Sydney Airport could safely operate independently as high capacity airports. Further detail is available in Chapter 7.

The cumulative environmental impacts (noise, air quality and public safety) of additional aircraft movements over the Sydney metropolitan area would be considered as part of future airspace planning. A separate regulated airspace design process to develop operational flight paths would be required closer to the commencement of operations at the proposed airport. The design process would require extensive consultation with airlines, the community, Sydney Basin airspace users and other stakeholders as part of a separate regulatory approvals process.

27.3. Cumulative impacts

The cumulative impacts that may arise during construction and operation of Stage 1 of the proposed airport development are outlined below.

27.3.1. Noise

There is considered to be limited potential for cumulative noise impacts as a result of construction activities at the airport site. Noise emissions arising from construction activities would be predominantly limited to the airport site and immediate surrounds. The geographic separation from other major developments in Western Sydney would limit the potential for cumulative effect of noise upon any individual sensitive receivers.

The relocation of The Northern Road and other site infrastructure is proposed to be undertaken concurrently with site preparation activities at the airport site. Site preparation activities would generally proceed from east to west within the airport site to facilitate relocation of the existing infrastructure. The distance between concurrent construction activities would limit the potential for cumulative impacts to receivers in close proximity to the airport site

Cumulative noise impacts may be experienced along haulage routes associated with construction vehicles accessing the airport site and surrounding developments. The majority of the roads on the anticipated haulage routes carry relatively high volumes of existing traffic and the increase in noise from construction traffic is predicted to be less than two dBA, which is unlikely to be perceptible.

During operation, aircraft operating concurrently with those from other Sydney region airports have the potential to increase noise exposure to the surrounding community. While the proposed airport would result in additional aircraft movements, the indicative flight paths are designed to facilitate safe, efficient and independent airspace operations for each airport. As a result, there are not expected to be any significant cumulative noise impacts upon any individual receivers. Noise abatement opportunities are expected to be considered in conjunction with future airspace design processes.

There is also anticipated to be a general increase in background noise levels associated with the ongoing urbanisation and development of Western Sydney. For example, certain proposed road projects, such as the proposed relocation and upgrade of The Northern Road, would contribute to changed background noise levels in the vicinity of the airport site. An increase in background noise would effectively limit the incremental increase associated with noise generated by the airport operations.

27.3.2. Air quality

Emissions from existing local sources were reflected in the ambient air quality data obtained from monitoring stations in the vicinity of the airport site. The inclusion of this background data in the impact assessment of the proposed airport, coupled with a generally conservative approach to impact assessment, means that the potential impacts identified would account for any potential cumulative air quality impacts associated with existing sources. To address the potential cumulative impacts of the airport in combination with the major roadways, emissions from both sources have been characterised within the modelling. The potential for increases in ozone in Sydney’s regional airshed was also considered as part of the assessment process.

Consideration of cumulative impacts is therefore inherently captured in the overall modelling approach for the assessment of air quality impacts associated with the proposed airport.

The results of the air dispersion modelling indicate that predicted emissions would typically be below the respective air quality assessment criteria during construction and operation for both incremental impacts of the airport alone and when considered cumulatively with other surrounding land use and development. Predicted exceedances were generally associated with external sources such as regional dust storms and emissions generated by traffic on the surrounding road network. The assessment of regional air quality impacts has found that operation of the proposed airport would have only a marginal impact on regional ozone levels.

27.3.3. Traffic and transport

The traffic impact assessment was undertaken using the Sydney Strategic Travel Model which is a tool developed by the Transport for NSW Bureau of Transport Statistics to project travel patterns in the Sydney Greater Metropolitan Area. The model uses land use forecasts in the form of population and employment projections by travel zone combined with a detailed representation of the road and public transport networks to assess the impact of growth and trip making behaviour on transport infrastructure. Cumulative impacts associated with the proposed airport in conjunction with other major developments in Western Sydney are therefore inherently captured in the modelling approach.

Additional vehicle movements associated with the construction and operation of the proposed airport are not likely to significantly affect the operation of the surrounding road network. A plan would be developed in consultation with relevant stakeholders to control and manage traffic during the construction phase of the proposed airport development. Development of the plan would seek to ensure coordination of measures with any concurrent road works projects.

A large amount of road improvement works is proposed as part of the Western Sydney Infrastructure Plan and other planned developments in Western Sydney. These works are expected to provide sufficient capacity to cater for the expected passenger and employee traffic demand associated with the operation of the proposed airport in 2030 and beyond.

The NSW Government has also started planning to extend the South West Rail Link. The rail link will be considered as part of the planning for the wider transport network for Western Sydney.

27.3.4. Biodiversity

The progressive development and urbanisation of Western Sydney has placed increased pressure on the biodiversity values of the region including the endangered Cumberland Plain Woodland and a range of threatened flora and fauna. The cumulative impacts of the proposed airport development combined with surrounding major projects and other development would include further loss and fragmentation of habitat, and creation of edge effects in retained remnant native vegetation.

The biodiversity offset package detailed in Chapter 16 and Appendix K in Volume 4 would help address unavoidable impacts of the proposed airport on Cumberland Plain Woodland and other threatened species, including the likely cumulative impacts outlined above. The biodiversity offset package would include the conservation and management of offset sites that support the biodiversity values affected by development of the proposed airport. The quantum of biodiversity offsets required has been calculated in accordance with the EPBC Act Offset Policy (DSEWPaC 2012).

Offset sites would be conserved in the locality and surrounding region and would be managed by relevant land owners within the NSW Biobanking framework. Much of the offset package may be delivered, and biodiversity gains achieved, prior to many of the impacts of Stage 1 of the airport and the majority of the potential cumulative impacts occurring. Offsets with equivalent ecological communities and species would be acquired in the local bioregion.

Long term development at the airport site would require separate calculation of any additional biodiversity offsets with reference to the prevailing airport master plan(s) and the EPBC Act Offsets Policy. Other major projects and the development of the Western Sydney Infrastructure Plan, Western Sydney Employment Area and the South West Priority Growth Area would need to deliver biodiversity offsets (as required) in accordance with the Framework for Biodiversity Assessment (OEH 2014b), the EPBC Act Offset Policy (DSEWPaC 2012) and/or the outcomes of the strategic assessment of the Western Sydney growth centres conducted under the EPBC Act.

27.3.5. Water Resources

Existing water quality in waterways in the vicinity of proposed airport site are generally poor. Hydrologic and hydraulic modelling of the airport site for construction and operation indicates that the proposed drainage system would be generally effective at mitigating watercourse and flooding impacts. It is also anticipated that the quality of water discharged from the site would be improved compared to existing conditions. Accordingly, whilst the extent of future development surrounding the airport may increase the cumulative surface water quality impacts, it is not expected that the proposed airport would significantly contribute to this risk.

27.3.6. Aboriginal and European heritage

The progressive development and urbanisation of Western Sydney has placed pressure on the Aboriginal and European heritage values of the locality. Further development such as the proposed airport and other major projects and growth initiatives would result in an increasing rarity for Aboriginal sites and historic structures to be retained in their original location and landscape setting.

To facilitate preservation of artefacts and cultural values consideration could be given to the establishment of an Aboriginal ‘Keeping Place’ for the archival storage, conservation management and interpretation of salvaged Aboriginal cultural material.

27.3.7. Planning and land use

The cumulative effects of the development of the Western Sydney Employment Area and the South West Priority Growth Area would transform existing rural land uses to urban land uses, particularly over the long term. Land use planning across all levels of government has been designed to reduce land use conflict between the airport and surrounding land uses. For example, lands adjoining the north-west and south-east sides of the airport site have been earmarked for commercial and industrial purposes.

The draft EIS provides ANEC contours and identified other potential noise impact areas which can be used to guide appropriate future land use planning and compatible development.

27.3.8. Landscape and visual amenity

The rural character that has existed for many decades in Western Sydney is changing due to the development of the South West Priority Growth Area, the commitment by the Australian Government to the Western Sydney Infrastructure Plan and the establishment of the Broader Western Sydney Employment Area. These projects will lead to increased urbanisation of the area over time and corresponding visual effects. The increased urbanisation of the area will generally reduce the impact of the airport development, including night sky glow, as it becomes a part of the developing urban visual character of the area.

27.3.9. Social

The cumulative effect of developing the proposed airport and surrounding lands would increase the demand on existing social infrastructure and recreational assets. The development of surrounding land uses and major projects may also increase the availability of social infrastructure as the region transitions from rural to residential and industrial lands which would likely offset a cumulative increase in social infrastructure demand.

27.3.10. Economic

The proposed airport and surrounding land use changes associated with the development of the Western Sydney Employment Area and the South West Priority Growth Area would further increase population and employment growth in Western Sydney. These projects are likely to result in a cumulative economic benefit in terms of economic activity, employment and population growth.

27.3.11. Resources and waste

The generation of waste during construction and operation of the proposed airport would be reduced through the implementation of a waste management plan. Waste requiring disposal would be sent to an appropriately licensed facility. The waste management market in Western Sydney is mature and handles significant volumes of waste from various domestic, commercial and industrial sources across Sydney.

Waste facilities in Western Sydney have sufficient capacity to handle wastes of the type and volume expected to be generated at the airport site in conjunction with the broader development of Western Sydney.

27.3.12. Greater Blue Mountains World Heritage Area

The proposed airport would have no direct impact on the Greater Blue Mountains Area. The contributory factors influencing potential cumulative impacts on the Greater Blue Mountains World Heritage Area (GBMWHA) are potential direct impacts from other projects and indirect impacts of the proposed airport on noise, air quality and amenity. Indirect impacts associated with operation of the airport are unlikely to have a significant impact on World Heritage values or the integrity of the listed property.

While the proposed airport would provide progressively increasing aviation capacity in the Sydney region, which could also parallel a growth in tourism and visitation for the GBMWHA, it is very unlikely that an airport would directly contribute to inappropriate development or uncontrolled visitor access, particularly within the context of strong management plans which are in place for the GBMWHA. Other factors such as Sydney's expanding population are considered more likely to influence the need for any new management responses to threats posed by increased visitations.

The predicted increase in aircraft overflights over the GBMWHA is considered in Chapter 26. Large areas of the World Heritage area would not experience aircraft overflights, or would do so infrequently. In those areas directly under flight paths, potential indirect impacts on noise and visual amenity are not considered to be significant due to the high altitude of operating aircraft.

27.4. Conclusion

This assessment considers the potential cumulative impacts that may arise as a result of the construction and operation of the proposed airport and other major projects that are planned to occur in the vicinity of the airport site. The chapter identifies key major projects to consider in project planning and key cumulative risks.

As part of its Stakeholder and Community Engagement Plan, the Department of Infrastructure and Regional Development would liaise with the proponents for the major projects identified and key stakeholders (such as Roads and Maritime Services, Transport for NSW, and the Department of Planning and Environment) to reduce the potential for cumulative impact to arise during construction.

The highest risk for cumulative impact is the concurrent upgrade and relocation of The Northern Road and the construction of the M12 motorway between the M7 and The Northern Road which could contribute to construction fatigue for surrounding communities. To manage this risk a high level of coordination would be required between the Department of Infrastructure and Regional Development, Roads and Maritime and relevant construction contractors.

Prior to and during operations, the ALC and the Department of Infrastructure and Regional Development would liaise with Airservices Australia, the Civil Aviation Safety Authority, other Sydney basin airport operators, NSW Government agencies and other key stakeholders to identify measures to reduce operational cumulative impacts.

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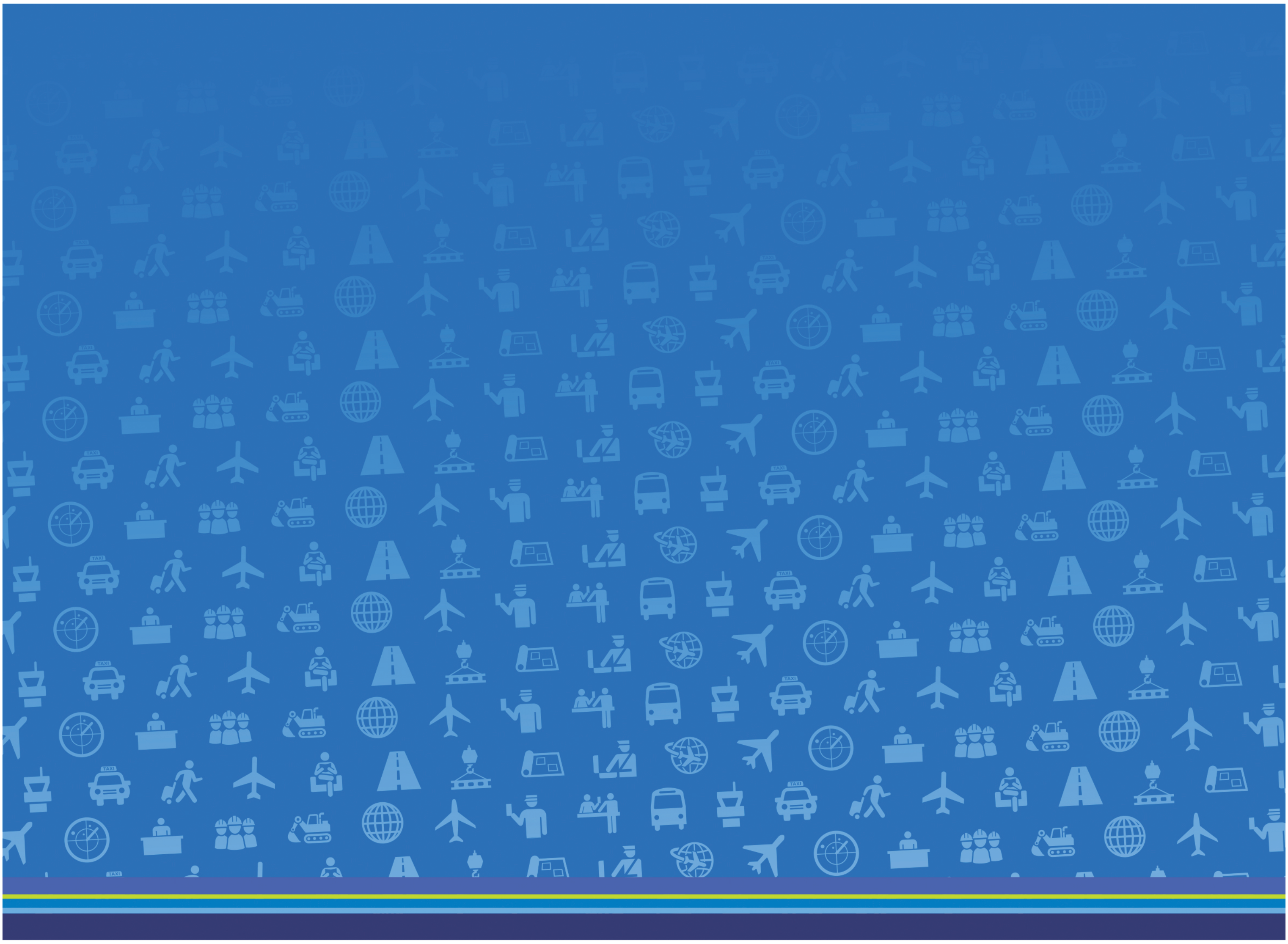
PART E:

Environmental management



28. Environmental management framework

28.1. Introduction

The purpose of this environmental management framework (EMF) is to identify the preferred means of addressing environmental impacts and issues associated with construction and operation of Stage 1 of the proposed airport.

The development of this environmental management framework is tailored to reflect current considerations including site conditions, airport planning and design, governance and project delivery. In this respect it is recognised that:

- the initial development of the proposed airport would occur in accordance with the Airport Plan which is a transitional planning instrument for a greenfield airport development. The proposed airport would transition into the generally applicable planning and environmental management framework for airports set out in the Airports Act 1996 (Airports Act) including development of a master plan which includes an environment strategy and the airport lessee company's (ALC's) plans for managing aircraft noise;
- some site preparations work may be undertaken by the Commonwealth with the balance of Stage 1 construction and subsequent operation of the proposed airport expected to be undertaken by an ALC following grant of an airport lease;
- finalisation of flight paths after the Airport Plan has been determined would establish more definitively which areas would be exposed to various levels of noise. A noise management plan would be developed having regard to forecast noise exposure levels which may include both on and off site management measures; and
- the Commonwealth would be responsible for the environment management framework until an airport lease is granted. Once an airport lease is granted, the ALC would take over responsibility for implementation of the environment management framework.

Environmental management plans would be progressively developed for specific issues in accordance with the applicable governance framework for both construction and operational periods of the Stage 1 development.

This chapter sets out:

- objectives for the EMF (Section 28.2);
- a high level overview of statutory requirement and governance, including roles and responsibilities (Section 28.3);
- a consolidated list of identified environmental impacts and mitigation measures (Section 28.4); and
- an outline of proposed environmental management plans (Sections 28.5 and 28.6).

This chapter draws on the assessments presented in Volume 2 of this draft EIS and includes measures that have been proposed to avoid, reduce or otherwise mitigate identified impacts related to the construction and operation of the Stage 1 development.

28.2. Objectives for environmental management

The following objectives have been developed to guide environmental management of the Stage 1 development:

- to ensure that all construction and operational activities are consistent with sustainability and environmental management principles;
- to ensure that all identified environmental impacts and issues are appropriately managed and mitigated during construction and operation of the proposed airport;
- to provide a comprehensive framework for the development and implementation of detailed environmental management measures and environmental management plans; and
- to identify the regulatory and governance framework for environmental management of the construction and operation of the proposed airport.

It is anticipated these objectives may be modified in subsequent stages of project implementation in response to applicable government or corporate polices on issues such as sustainability and environmental management.

28.3. Statutory requirements and governance

The Stage 1 development would be constructed and operated in accordance with the Airport Plan, which forms a transitional planning instrument under the *Airports Act 1996*. While the Airport Plan defines the parameters for the proposed Stage 1 airport, future work beyond this initial development would be undertaken under the planning framework in Part 5 of the *Airports Act 1996* as applies to existing major airports. Further detail on the overall approvals framework for the proposed airport is described in Chapter 3 in Volume 1 of this draft EIS.

The specific statutory and governance requirements for environmental management are set out below. These requirements in relation to environmental management reflect the transition of the project from environmental assessment under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) to a fully operational Stage 1 development under the provisions of the Airports Act.

28.3.1. Environmental Protection and Biodiversity Conservation Act

The draft EIS has been prepared to address the requirements of the EPBC Act and the EIS guidelines issued by the Department of the Environment (refer Volume 4, Appendix C). The specific requirements in the guidelines which informed the development of this environmental management framework are outlined in Section 6(c):

The EIS must include specific and detailed descriptions of the proposed avoidance and mitigation measures based on best available practices. This must include the following elements:

i. A consolidated list of mitigation measures proposed to be undertaken to prevent, minimise or compensate for the relevant impacts of the action, including:
   - a detailed description of proposed measures;
   - assessment of the expected or predicted effectiveness of the mitigation measures;
   - any statutory or policy basis for the mitigation measures; and
   - the likely cost of the mitigation measures.

ii. A detailed outline of a plan for the continuing management, mitigation and monitoring of relevant matters protected by a controlling provision, including a description of the outcomes that will be achieved and any provisions for independent environmental auditing.

iii. Where appropriate, each project phase (construction and operation) must be addressed separately. It must state the environmental outcomes, performance criteria, monitoring, reporting, corrective action, contingencies, responsibility and timing for each environmental issue.

iv. The name of the agency responsible for endorsing or approving each mitigation measure or monitoring program.

28.3.2. Construction

The Airports Act has recently been amended to provide for preparation of an Airport Plan which is both a transitional planning instrument for the proposed airport and a description of the Stage 1 development. The Airport Plan would be the primary instrument governing development of the proposed airport during the construction period.

In determining the Airport Plan the Minister for Infrastructure and Regional Development must include any conditions or provisions that the Minister for the Environment considers should be included for the purpose of protecting the environment. It is expected that conditions contained in the Airport Plan would require implementation of the EMF including the relevant plans and mitigation measures applicable to the construction period.

In addition to the Airport Plan, the Airports Act contains provisions for building controls and environmental management which would apply to all development activities on the proposed airport once an airport lease is granted. Prior to the granting of an airport lease, development activities would be undertaken so as to comply with the standards and objectives of those provisions.

28.3.3. Operations

The statutory framework for on-going environmental management at the airport site will be provided by:

- Airports Act Part 5 and Part 6 and associated parts of the *Airports Regulations 1997* which relate to land use, planning, building controls and environmental management;
- *Airports (Environment Protection) Regulations 1997* which establishes a system of regulation of, and accountability for, activities at airports that generate or have the potential to generate pollution or excessive ground based noise. These regulations also promote improving environmental practices for activities carried out at airports;
- *Airports (Building Control) Regulations 1996* which require approval from an airport building controller of building activities on airport sites for which there is an airport lease, and require that those activities to be consistent with applicable planning instruments such as the Airport Plan; and
- other applicable laws such as the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

28.3.3.1. Airports Act – master plan

The environmental management framework for existing airports is established in an airport's master plan. The ALC of the proposed airport would be required to submit for approval its first master plan within five years of an airport lease being granted, or in such a longer period as approved by the Minister for Infrastructure and Regional Development. Airport master plans are subject to public consultation prior to approval and are updated every five years.

Table 28–1 describes the purpose of a master plan as outlined in the Airports Act. Table 28–2 outlines the required content of a master plan and Table 28–3 outlines the required content of an environment strategy which is part of a master plan.

Table 28–1 – Purpose of a master plan

Purpose of a master plan
As outlined in section 70 of the Airports Act, the purpose of a master plan is to: • establish the strategic direction for efficient and economic development at the airport over the planning period of the plan; • provide for the development of additional uses of the airport site; • indicate to the public the intended uses of the airport site; • reduce potential conflicts between uses of the airport site, and to ensure that uses of the airport site are compatible with the areas surrounding the airport; • ensure that all operations at the airport are undertaken in accordance with relevant environmental legislation and standards; • establish a framework for assessing compliance at the airport with relevant environmental legislation and standards; and • promote the continual improvement of environmental management at the airport.

Table 28–2 – Content of a master plan

Content of a master plan
Section 71 of the Airports Act states that a master plan is required to include: • the ALC's development objectives for the airport; • the ALC's assessment of the future needs of civil aviation users of the airport, and other users of the airport, for services and facilities relating to the airport; • the ALC's intentions for land use and related development of the airport site, where the uses and developments embrace airside, landside, surface access and land planning/zoning aspects; • an Australian Noise Exposure Forecast for the areas surrounding the airport; • flight paths at the airport; • the ALC's plan for managing excessive noise , developed following consultations with the airlines that use the airport and local government bodies in the vicinity of the airport, for managing aircraft noise intrusion in areas forecast to be subject to exposure above the significant ANEF levels; • the ALC's assessment of environmental issues that might reasonably be expected to be associated with the implementation of the master plan; • the ALC's plans for dealing with the environmental issues (including plans for ameliorating or preventing environmental impacts); • a plan for a ground transport system on the landside of the airport; • detailed information on the proposed developments in the master plan that are to be used for commercial, community, office or retail purposes or for any other purpose that is not related to airport services; and • the likely effect of the proposed developments in the master plan on employment levels at the airport; and the local and regional economy and community, including an analysis of how the proposed developments fit within the planning schemes for commercial and retail development in the area that is adjacent to the airport.

Table 28–3 – Content of an environment strategy

Content of an environment strategy

In addition to the contents of a master plan outlined in Table 28–2, section 71 of the Airports Act and the Airports Regulations states the master plan must contain an environment strategy that details:
• the ALC's objectives for the environmental management of the airport;
• the areas (if any) within the airport site which the ALC, in consultation with State and Federal conservation bodies, identifies as environmentally significant including;
• the sources of environmental impact associated with airport operations including;
• the studies, reviews and monitoring to be carried out by the ALC in connection with the environmental impact associated with airport operations (including matters such as proposed systems of testing and qualifications of experts);
• the time frames for completion of those studies and reviews and for reporting on that monitoring;
• the specific measures to be carried out by the ALC for the purposes of preventing, controlling or reducing the environmental impact associated with airport operations;
• the time frames for completion of those specific measures;
• details of the consultations undertaken in preparing the strategy (including the outcome of the consultations);
• specify any areas within the airport site to which the strategy applies that the ALC for the airport has identified as being a site of indigenous significance, following consultation with any relevant indigenous communities and organisations; and any relevant Commonwealth or State body;
• specify the ALC's strategy for environmental management of areas of the airport site that are, or could be, used for a purpose that is not connected with airport operations;
• specify the training necessary for appropriate environment management by persons, or classes of persons, employed on the airport site by the ALC or by other major employers (and relevant training programs);
• the environment strategy must address the ALC's policies and targets for:
  ▪ continuous improvement in the environmental consequences of activities at the airport;
  ▪ progressive reduction in extant pollution at the airport;
  ▪ development and adoption of a comprehensive environmental management system for the airport that maintains consistency with relevant Australian and international standards;
  ▪ identification, and conservation, by the airport lessee company and other operators of undertakings at the airport, of objects and matters at the airport that have natural, indigenous or heritage value;
  ▪ involvement of the local community and airport users in development of any future strategy; and
  ▪ dissemination of the strategy to sub lessees, licensees, other airport users and the local community.

28.3.4. Transition to operations

Operations at the proposed airport would take place in accordance with the environmental management framework described below. In the period leading up to operations commencing, the plans and measures identified in the EIS would be prepared and implemented, and in due course addressed in the process of preparing the master plan framework outlined in section 28.3.3. Once a master plan is in place (which may be before or after operations commence), it would replace the EMF described in this chapter. Future variations and updates would occur in accordance with the master plan framework. The approach to flight paths and noise in the transition to operations is discussed in Section 28.6.3.

28.3.5. Contractual arrangements

Construction activities at the airport site are expected to be undertaken under contracts with suitably qualified construction companies. Tender processes for the selection of contractors will assess their ability to implement strong environmental management practices on the airport site including compliance with the mitigation and other measures identified in the EIS.

The contract documentation will require compliance with all regulatory requirements including the Airport Plan and its conditions. As noted above, it is expected that the Airport Plan will require compliance with the mitigation measures identified in this EIS.

28.4. Identified environmental impacts and mitigation measures

This section of the environmental management framework presents a consolidated list of the environmental impacts or issues and mitigation measures identified in Volume 2 of the draft EIS for both the construction and operation of the proposed Stage 1 development.

The listed measures incorporate standard construction industry practice that have been proven effective in the reduction of environmental and community impacts as part of other major infrastructure projects. Additionally, the resourcing and cost implications are well known to the parties who may be engaged to develop the site. A number of the measures, particularly in relation to mitigation of operation issues, depend upon the completion of other processes or activities by third parties and are therefore strategic by nature and require further development.

Effectiveness of the mitigation and management measures proposed will be ensured through:

- inclusion of any additional best-practice and widely accepted measures throughout the detailed design, construction and operation of the proposed airport, where appropriate;
- requirement of approval of environmental management plans by the Minister for Infrastructure and Regional Development including clear statements of the intended outcomes and performance criteria of those plans;
- Ongoing monitoring and compliance of environmental management plans through a review, reporting and auditing framework approved by the Minister for Infrastructure and Regional Development;
- ongoing environmental management requirements which currently exist under the Airports Act, including the regulation of land use through ongoing master planning and environmental strategy requirements, as well as a system of regulation of, and accountability for, activities at the airport site that generate or have the potential to generate pollution; and
- ongoing stakeholder consultation and oversight through relevant community forums as required by the Australian Government at major airports in Australia.

Taken together, these mechanisms will ensure that mitigation measures proposed in the EIS are effective and achieve the intended outcomes.

28.4.1. Impacts of construction

Construction of the Stage 1 development would involve land clearing and bulk earthworks within the construction impact zone in the northern part of the airport site. This would result in major changes to the landform in order to develop the necessary airport infrastructure for Stage 1, including airfield facilities (runway, taxiways and aprons), terminals and other facilities such as roads and car parks.

Construction would result in a range of environmental impacts associated with removal and relocation of existing utilities, vegetation clearing, large scale earthworks movement and reshaping and installation of drainage, and ultimately construction of significant infrastructure on the site. The impacts resulting from these activities would be managed to mitigate residual impacts within the site as well as avoiding, reducing or otherwise mitigating impacts beyond the site boundary. Table 28–4 lists the mitigation and management measures applicable to Stage 1 construction. The listed measures incorporate standard industry practice and have proven effective in the reduction of environmental and community impacts as part of other major NSW Government infrastructure projects. Additionally, the resourcing and cost implications are well known to the parties who may be engaged to develop the site.

For each measure, the timing is identified as pre-construction or construction. Unless otherwise stated, pre-construction timing refers to a measure being undertaken before the relevant impact occurs. Because of the size of the airport site and the progressive nature of planning, design and construction activities across the airport site, it may not always be feasible to implement pre-construction plans, surveys or other activities across the whole airport site at once.

As such, pre-construction mitigation measures may be broken down into location-specific parts and may be phased across the airport site consistent with the progression of construction activity. This generally means that:

- a pre-construction activity such as a plan, design or survey for a particular area of the airport site must occur before the relevant construction impact occurs in that particular area;
- a plan or strategy may be prepared and implemented in two or more sections at different times as construction activity moves from one area of the airport site to another; and
- some parts of a pre-construction plan or strategy may be prepared for parts of the airport site after construction has commenced in other parts of the airport site.

Where a plan is proposed to mitigate impacts during construction, the development and approval of the plan is identified as a pre-construction requirement which would be completed before the relevant activities and impacts occur. The plan would be implemented during relevant construction activities. Given the scope and duration of the construction work, it is expected that plans would need to be updated from time to time, for example to reflect the detailed requirements of a new stage of works, a change in circumstances or a change in responsible contractors.

A number of measures associated with preparing for operations would occur during the construction phase. These are classified as 'pre-operation' mitigation measures and are set out in Section 28.4.2.

Opportunities have been identified to undertake early mitigation measures such as surveys, monitoring, preparation of plans and consultation. Some of these could commence prior to an Airport Plan being determined.

Table 28–4 – Mitigation measures applying to Stage 1 design and construction

Issue	Mitigation	Timing
Noise (ground operations, construction, road)		
Construction noise and vibration	A noise and vibration management plan would be developed prior to construction of the proposed airport as part of the construction environmental management framework. The plan would: • assist in ensuring that the noise during construction complies where feasible with the construction noise management levels set for the project including Schedule 4 of the Airports (Environment Protection) Regulations where relevant; • determine noise and vibration monitoring, reporting and response procedures. • describe specific mitigation treatments, management methods and procedures to be implemented to control noise and vibration during construction; • describe construction timetabling to minimise noise impacts including time and duration restrictions, respite periods and frequency; • describe procedures for notifying residents of construction activities likely to affect their amenity through noise and vibration; and • define contingency procedure to be implemented in the event of noncompliance and/or noise complaints.	Pre-construction
Operational ground-based noise	The airport-lessee company would establish and operate a community aviation consultation forum and a planning coordination forum consistent with practice at other airports.	Pre-construction Construction
Air quality and greenhouse gases		
Dust management Plan	A dust management plan would be developed prior to construction of the proposed airport as part of the construction environmental management framework. The plan would collate measures to mitigate and manage potential impacts on air quality. The plan should include standard measures such as watering of exposed surfaces and covering of stockpiled material. The plan may also include monitoring of dust deposition, dust flux, real time PM_{10} continuous monitoring and/or visual inspections.	Pre-Construction
Community engagement	Develop and implement a stakeholder communications plan that specifically addresses construction and includes community engagement before work commences on-site.	Pre-Construction
	Display the name and contact details of person(s) accountable for environmental management at the airport site boundary.	Construction
Dust management	Record all dust and air quality complaints, identify cause(s), and record the response to the complaint, including any further mitigation measures taken.	Construction
	Make the complaints log available to the relevant authority when asked.	Construction
	Record in a log book any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation.	Construction
	Carry out regular site inspections to monitor compliance with the dust management plan, record inspection results, and make an inspection log available to the relevant authority when asked.	Construction
	Increase the frequency of site inspections by the person accountable for air quality and dust issues on-site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.	Construction

Issue	Mitigation	Timing
	Determine dust deposition, dust flux, or real-time PM_{10} continuous monitoring locations in consultation with the relevant authorities. Where possible commence baseline monitoring at least three months before work commences on site or before work on a construction phase commences.	Pre-Construction
	Avoid site runoff of water or mud. This will reduce the potential for track-out dust emissions.	Construction
Vehicle and equipment emissions	Vehicle operators would be required to switch off engines when not in use.	Construction
	Avoid the use of diesel or petrol powered generators and use mains electricity or battery powered equipment where practicable.	Construction
	Appropriate vehicle speeds on sealed and unsealed roads would be considered as part of the dust management plan.	Construction
	Produce a construction logistics plan to manage the sustainable delivery of goods and materials.	Pre-Construction
	Prepare a travel plan that supports and encourages sustainable travel for construction workers (public transport, cycling, walking, and car-sharing).	Construction
	Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays.	Construction
	Adequate water would be made available on the site for effective dust and particulate matter suppression and mitigation, using non-potable water where possible and appropriate.	Construction
	Use enclosed chutes and conveyors and covered skips.	Construction
	Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment. Use fine water sprays on such equipment wherever appropriate.	Construction
	Equipment would be readily available on-site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.	Construction
Demolition	Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible), to provide a screen against dust.	Construction
	Effective water suppression methods are to be used during demolition operations. Hand held sprays are more effective than hoses attached to equipment as the water can be directed to where it is needed. In addition high volume water suppression systems, manually controlled, can produce fine water droplets that effectively bring the dust particles to the ground.	Construction
	Avoid use of explosive blasting in demolition building works, using appropriate manual or mechanical alternatives.	Construction
	Bag and remove any biological debris or damp down such material before demolition.	Construction
Earthworks	Re-vegetate earthworks and exposed areas or soil stockpiles to stabilise surfaces as soon as practicable.	Construction
	Use hessian, mulches or tackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.	Construction
	Minimise exposed areas as far as is practical.	Construction
Aviation Infrastructure	Avoid scrabbling (roughening of concrete surfaces) if possible.	Construction

Issue	Mitigation	Timing
	Sand and other aggregates would be stored in bunded areas and not allowed to dry out, unless required for particular processes. If so, appropriate additional control measures would be in place.	Construction
	Bulk cement and other fine powder materials would be delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	Construction
	Seal and appropriately store bags of any fine powder materials to prevent dust generation.	Construction
Track out dust	Use water-assisted dust sweeper(s) on the access and local roads to remove, as necessary, any material tracked out of the site. This may require the sweeper to be continuously in use.	Construction
	Avoid dry sweeping of large areas.	Construction
	Vehicles entering and leaving sites should be covered to prevent escape of material during transport.	Construction
	Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	Construction
	Record all inspections of haul routes and any subsequent action in a site log book.	Construction
	Hard surfaced haul routes would be regularly cleaned and damped down with fixed or mobile sprinkler systems or mobile water bowsers.	Construction
	Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud) prior to leaving the site where reasonably practicable.	Construction
	An adequate area of hard surfaced road between the wheel wash facility and the site exit would be provided, wherever site size and layout permits.	Construction
	Site access points would be located as far as practicable from sensitive receptors.	Construction
Greenhouse gases – Scope 2 emissions	Consideration will be given to designing, constructing and operating the Stage 1 development to achieve the following where appropriate: • 5 Star Green Star – Design & As Built; • 5 Star NABERS Office Energy Rating; and • 4 Star Green Star – Performance	Pre-Construction Construction
Demolition	Avoid use of explosive blasting in demolition works, using appropriate manual or mechanical alternatives.	Construction
Earthworks	Minimise exposed areas as far as practical.	Construction
Traffic, transport and access		
Construction related traffic and transport impacts	A community awareness programme would be implemented prior to construction commencing and would continue throughout the entire construction period. The programme would aim to make road users (including local residents) aware of construction traffic and safety issues, such as diversions, temporary road closures, traffic signalling and speed limits.	Pre-Construction

Issue	Mitigation	Timing
Construction related traffic and transport impacts	A traffic and access management plan would be developed prior to construction of the proposed airport as part of the construction environmental management framework. The plan would collate measures to mitigate and manage potential traffic impacts. The plan would consider the following elements: • management for the temporary and permanent closures of roads within the airport site; • a community engagement strategy; • ongoing consultation with Roads and Maritime, local councils as appropriate and emergency services; • induction for drivers working on the project to cover safety measures particularly for night works; • review of speed environments along transport corridors; • restriction of construction related traffic within the AM and PM peak periods where required; • management of the transportation of construction materials to optimise vehicle loads in order to minimise vehicle movements; • traffic control measures to manage and regulate traffic movements during construction; • identification of potential disruption to road users; • identification of any road closures and/or road upgrades that may be required; • construction vehicle routes, including the use of arterial roads, haulage routes, access to the airport site and procedures for oversize and heavy vehicles; and • parking facilities for construction workers. The plan would be developed in consultation with relevant stakeholders prior to the commencement of construction. The plan would provide the overall plan and staging for managing traffic through and around each work site. This would be in accordance with the Roads and Maritime's *Road Design Guide*, the Roads and Maritime Services *Traffic Control at Work Sites* manual and AS1742.3 *Manual of Uniform Traffic Control Devices – Traffic control for works on roads*, and any other relevant standard, guide or manual. The draft plan would be reviewed by relevant stakeholders including NSW Police, Transport for NSW, Road and Maritime Services and affected local councils.	Pre-Construction
Biodiversity		
Biodiversity management plan	A biodiversity management plan would be developed prior to construction of the proposed airport as part of the construction environmental management framework. The plan would collate measures to mitigate and manage potential impacts on biodiversity.	Pre-construction
Worker inductions	All workers are to be provided with an environmental induction prior to starting construction activities on site. This would include information on the ecological values of the airport site and protection measures to be implemented to protect biodiversity during construction.	Pre-construction Construction

Issue	Mitigation	Timing
Vegetation clearance and habitat loss	Reduce the potential for adverse impacts on ecologically sensitive areas by: • deferring vegetation removal until necessary; • locating site offices and stockpiles in already cleared and disturbed areas, to avoid further unnecessary removal or disturbance of native vegetation and hollow-bearing trees, where possible; • providing maps to construction staff clearly showing vegetation clearing boundaries and exclusion/no-go zones; and • engaging a suitably qualified ecologist or environmental officer prior to any clearing works to clearly demarcate vegetation protection areas.	Pre-construction Construction
Disease management	Management of plant disease (such as Phytophthora, Myrtle Rust and Chytrid fungus) would be a principal consideration in the development of the construction environmental management plans, with particular regard to protection of environmental conservation zones.	Pre-construction Construction
Threatened fauna management plans	Prepare and implement athreatened fauna species management plans to reduce the potential for impacts on relevant species. These would include maps identifying locations of threatened species, scope and requirements for targeted surveys and pre-clearing surveys, unexpected finds protocol, salvage and translocation of threatened species as per the measures recommended below, clearing protocols, and reporting and adaptive management measures.	Pre-construction Construction
Threatened flora translocation plan	Prepare and implement a threatened flora salvage and/or translocation plan in consultation with the Australian Botanic Garden Mount Annan. This would include the salvage and propagation or transplanting of the known local populations of *Pultenaea parviflora* and *Marsdenia viridiflora* subsp. *viridiflora* and any other threatened plants detected at the airport site. The translocation plan will build upon conservation activities previously undertaken for *Pultenaea parviflora* following the 1997-99 EIS. The plan would consider the suitability of sites within the environmental conservation zone and any biodiversity offset sites that are within the vicinity of the airport site in order to maintain populations of these species as close to their original location as is possible.	Pre-construction Construction
Pre-clearance surveys for threatened species	Undertake pre-clearance surveys for threatened species by a qualified ecologist. Specific management plans would be prepared to manage impacts on threatened flora and fauna species. Surveys 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; • surveying any bridges or culverts that need removal to search for roosting bats; • 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.	Pre-construction

Issue	Mitigation	Timing
Habitat clearing and fauna management protocol	Develop measures for the management of impacts on fauna species during clearing activities. Measures would include: • preparing a nest box strategy, including provisions for the: ▪ installation of nest-boxes within conservation areas prior to clearing areas of native vegetation on the airport site to provide a safe location for hollow-dwelling fauna to be transferred to during clearing operations; and ▪ salvage of native fauna from existing nest boxes on the airport site prior to their removal and translocation of fauna to newly established nest box sites; • pre-clearing surveys 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 vegetation and safe tree felling and log remove to reduce the risk of fauna mortality; • 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
Weeds	Prepare and implement a weed management plan that would include: • 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 Construction
Unexpected finds	Establish 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 clearing or construction activities.	Pre-construction

Issue	Mitigation	Timing
Dam decommissioning	Establish a protocol for the decommissioning of dams in consultation with relevant agencies, to include: • dam removal following any requirements of a Green and Golden Bell Frog management plan; • eradication of 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 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 where practicable, 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 draining of farm dams. Eastern Gambusia would be eradicated from dams using humane methods; and • establishing protocols for the humane euthanasia of aquatic fauna, including fish.	Pre-construction
Fire	Prepare a bushfire management plan in consultation with NSW Rural Fire Service to minimise the risk of bushfire and associated impacts on adjoining areas of native vegetation, including the proposed environmental conservation area. This would include: • identifying activities likely to generate sparks and putting in place appropriate restrictions based on the forecasted 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; and • 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 prescribed burning and hand removal; and • ensuring that fuel-reduction measures are appropriate to biodiversity values in each area e.g. low intensity prescribed burns rather than slashing would be used in native woodland and forest.	Pre-construction
Lighting	Avoid unnecessary light spill into nearby areas of retained vegetation (such as in the environmental conservation areas) as much as possible.	Construction

Issue	Mitigation	Timing
Fauna management	Subject to safety and security, implement measures for the management of impacts on fauna species during clearing activities, including: • implementing a staged vegetation clearing process. This would provide opportunity for fauna that are resident in the Stage 1 development construction impact zone to seek refuge in alternative habitat in the environmental conservation zone, long term development impact zone or outside the airport site. Clearing would commence in the north-east of the site and proceed south and west. Subject to safety and security requirements, the clearing would be undertaken before the construction of the southern perimeter fence to allow fauna to relocate offsite and towards the environmental conservation zones. This approach has been identified to maximise the opportunity for resident fauna to vacate the clearing footprint via vegetated remnants and move toward alternative habitat; • identifying and assessing potential habitat trees and logs through a fauna spotter, prior to the commencement of clearing. These would be clearly identified with spray paint. A dozer would then clear the undergrowth and trees not identified as potential habitat trees. An excavator would follow several days behind the dozer to give resident fauna the opportunity to vacate habitat trees. The excavator would drop trees in a manner to increase the likelihood of survival of any fauna present; and • engaging an experienced fauna spotter-catcher, licenced wildlife carer or ecologist to supervise native vegetation clearing or removal/disturbance of other habitat features (e.g. culverts), and to capture and relocate fauna, if required. Any injured native fauna would be transferred to the care of a licenced wildlife carer.	Construction
Vegetation	Prepare and implement a vegetation management plan. The vegetation management plan would apply to open space within the airport site and the environmental conservation zone and would include: • retaining native 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; • monitoring of the success of revegetation, weed control and adaptive management; and • reporting.	Construction
Topography, geology and soils		
Soil and water management plan	A soil and water management plan would be developed prior to construction of the proposed airport as part of the construction environmental management framework. The plan would collate measures to mitigate and manage potential impacts on soil and water.	Construction
Soil erosion and degradation	Erosion controls would be established in line with *Managing urban stormwater: soils and construction* (Landcom 2004).	Construction
	Specific erosion control measures would be developed for the management of highly erodible soils such as those anticipated in the Luddenham and South Creek soil landscapes.	Construction
	Cleared vegetation would be mulched and used to control erosion at construction sites.	Construction
	Soil stockpiles would be covered and stabilised with vegetation or mulch.	Construction

Issue	Mitigation	Timing
	Topsoil would be stockpiled at a maximum height of two metres.	Construction
	Topsoil would be distributed and seeded over landscape areas at completion of bulk earthworks.	Construction
Land contamination	Fuel and other potential contaminants would be stored and handled in accordance with relevant Australian standards such as: • *AS 1940-2004 The storage and handling of flammable and combustible liquids* • *AS/NZS 4452:1997 The storage and handling of toxic substances* • *AS/NZS 5026:2012 The storage and handling of Class 4 dangerous goods* • *AS/NZS 1547:2012 On-site domestic wastewater management*	Construction
	An unexpected finds protocol and Remediation Action Plan would be established to facilitate the quarantining, isolation and remediation of contamination.	Construction
	Any asbestos identified on site would be managed in accordance with applicable regulatory requirements.	Construction
Surface water, groundwater and water quality		
Surface water drainage system	Preparation of a plan to refine the surface water drainage system during detailed design to address the following: • detailed design of basins and channels to capture the majority of runoff, including during construction; • refinement of drainage system design performance standards to optimise capacity and release timing, mimicking natural flows as far as practicable; • provision of intermediate sediment retention basins upstream of larger basins to provide additional treatment; • provision of separate bio-retention swales and basins to provide additional treatment and separation of these features from the drainage system to protect contained water during floods; • provision of pollutant traps to prevent debris and other coarse material entering the drainage system; • stabilisation structures at outlets to include rock check dams at regular intervals along channels and energy dissipaters at basin outlets; and • capacity for containment of accidental leaks or spills in the drainage system at maintenance areas, fuel farms or other areas where fuels or chemicals are stored or handled in accordance with Australian standards.	Pre-construction
Erosion and sedimentation	The surface area disturbed at any one time would be minimised as far as possible by construction staging and stabilised with vegetation or appropriate cover.	Construction
Leaks or spills of fuel or other chemicals	Fuel and other chemicals would be stored and handled in accordance with relevant Australian standards such as: • *AS 1940-2004 The storage and handling of flammable and combustible liquids;* • *AS/NZS 4452:1997 The storage and handling of toxic substances;* • *AS/NZS 5026:2012 The storage and handling of Class 4 dangerous goods; and* • *AS/NZS 1547:2012 On-site domestic wastewater management.*	Construction

Issue	Mitigation	Timing
Surface water quality	Surface water quality criteria for releases from the drainage system would be developed with due consideration to the *Airports (Environment Protection) Regulations 1997* and the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ 2000) and the results of baseline water quality monitoring.	Pre-construction
	Surface water quality monitoring would be conducted at basin outflows and selected upstream and downstream conditions. Once an airport lease is granted, the proposed airport would be subject to water quality monitoring requirements as set out in the *Airports (Environmental Protection) Regulations 1997* and the results of baseline water quality monitoring.	Construction
Leaks or spills of fuel or other chemicals	Maintenance areas, fuel farms and other areas where fuels or chemicals are stored or handled would be bunded to contain any accidental spills or leaks.	Construction
Leaks or spills of fuel or other chemicals	Develop and implement response procedures to remedy leaks or spills.	Construction
Groundwater inflows	Groundwater elevation monitoring would be conducted to detect potential impacts to base flow in the vicinity of potentially sensitive creeks or groundwater dependent vegetation. Monitoring would be undertaken quarterly through construction up to a minimum period of three years after the completion of the Stage 1 development and until any identified impacts stabilise.	Construction
Groundwater inflows	Measures to supplement groundwater supplies would be made in the unlikely event of impacts to dependent vegetation or watercourses.	Construction
Groundwater quality	Groundwater quality monitoring of alluvial and Bringelly Shale aquifers would be conducted at major infrastructure locations, down gradient from those locations and in the vicinity of groundwater dependent vegetation or watercourses. Monitoring would initially be undertaken quarterly and adjusted as appropriate. Once an airport lease is granted the proposed airport would be subject to water quality monitoring requirements as set out in the Airports (Environmental Protection) Regulations 1997.	Construction
	Groundwater inflows would be reused or released with appropriate treatment. Where groundwater is released to surface waters, treatment would be to the appropriate level under the ANZECC guidelines.	Construction
Aboriginal heritage		
Cultural heritage management plan	A cultural heritage management plan would be developed prior to construction of the proposed airport as part of the construction environmental management framework. The plan would collate measures to mitigate and manage potential impacts on Aboriginal cultural heritage values.	Pre-construction
Conservation of heritage sites	The scarred tree (B40) and the grinding groove site (B120) would be conserved in situ within an environmental conservation zone at the airport site, and outside any future airport site boundary fence. A low barrier fence, which does not obstruct pedestrian traffic, would be erected around specific heritage sites as is necessary to demarcate the area as a no-go zone for vehicles. The barrier would be situated so that it did not intrude upon the immediate visual and landscape quality of the heritage sites and their surrounds.	Pre-construction
	The environmental conservation zone would be managed with the reservation of of known and predicted Aboriginal heritage sites as one of the principal objectives of the management of environmental conservation zones.	Construction

Issue	Mitigation	Timing
	Develop a conservation management plan that defines the future care and management of Aboriginal sites situated within the environmental conservation zone(s) identified in the Airport Plan, in particular the scarred tree (B40) and the grinding groove (B120) site. The management plan would consider future public interpretation and access to sites, as appropriate.	Pre-construction
Mitigation and management of heritage sites	Develop and adopt an Aboriginal stakeholder consultation plan that specifies the nature and frequency of consultation throughout the design and construction phase of the airport. The aims of the consultation would be to: • inform on, and provide an opportunity for feedback regarding, all matters relating to the mitigation and management of Aboriginal cultural heritage values across the airport site; • provide a forum for organising future stakeholder participation in mitigation and management works; and • provide opportunities to comment on all policy and documentation drafted in regard to the mitigation and management of Aboriginal cultural values.	Pre-construction
	Provide an opportunity for Aboriginal stakeholders to participate in field actions involving the mitigation and management of Aboriginal cultural values.	Pre-construction
Recording and salvage of heritage sites	Conduct a targeted archaeological surface survey within the construction impact zone of those areas not previously subject to surface survey (and excluding highly disturbed areas) before construction of the Stage 1 development. The aim of this survey would be identify all visible surface Aboriginal sites for recording and management prior to construction.	Pre-construction Construction
	A comprehensive archaeological inspection of surface sandstone outcrops across the airport site would be conducted before, and as required during, construction related activities. This action has the aim of appropriately recording and salvaging stone surfaces with evidence of Aboriginal markings.	Pre-construction
	Conduct archival recording of the scarred tree (B40) and grinding groove site (B120) before the start of any ground disturbance works within the area of these Aboriginal heritage sites. This has the objective of providing a baseline record and information upon which to develop a conservation management plan.	Pre-construction
	Conduct a programme of oral history recording with the aim of recording memories and stories from Aboriginal people relating to the airport site and its district. It is intended that this record would serve as an archive and a resource for future interpretation of the Aboriginal heritage values of the site.	Pre-construction
	Conduct a salvage programme of surface artefacts recovered across known Aboriginal artefact occurrences in the construction impact zone, with the aim of avoiding damage from construction related activities. This action would address strongly held concerns of Aboriginal stakeholders about the protection of artefacts from construction impacts. The collection programme would be conducted using an archaeological methodology and the resulting assemblage would be integrated into the archaeological analysis of salvaged material, where appropriate.	Pre-construction Construction

Issue	Mitigation	Timing
	A selective archaeological salvage programme should be conducted prior to, and as necessary during, construction works across the initial development area subject to construction impact. The objective of the programme would be to manage impacts to archaeological or scientific values. The aim of the programme would be to recover and analyse a representative sample of surface and subsurface archaeological material from the areas subject to construction impact. The programme would aim to: • recover archaeological material from all landform types based on a systematic and representative sampling matrix; • recover additional archaeological material from areas with assessed relatively higher archaeological value, with the objective of providing a large enough artefact population for statistical analysis and from which robust results can be derived; and • apply archaeological excavation methodologies which are appropriate to the expected archaeological resource and the objectives of the salvage. As part of designing the salvage programme, consideration would be given to the feasibility of integrating relevant and existing geotechnical data into the process of determining the location and scope of the salvage programme.	Pre-construction Construction
Protocols for discovery of artefacts and human remains	Implement protocols for the unanticipated discovery of Aboriginal objects, and for the discovery of any suspected human remains for all development related works involving ground disturbance.	Construction
	Investigate the feasibility of a protocol for the management of topsoil or other soil matrix material assessed as likely to contain a relatively high density of Aboriginal stone artefacts. The aim of this protocol would be to manage excavation, storage and placement of this material in a culturally appropriate manner that minimises potential damage. If deemed feasible, the protocol should be developed in consultation with Aboriginal stakeholders and seek to address the following issues: • the appropriate identification and tracking of spoil containing artefacts; • the minimisation of physical damage to the artefacts during mechanical processing and movement; and • end use of the spoil in contexts that minimise potential future impacts on the artefacts, and where possible are culturally appropriate.	Construction
Induction training	Training in the identification of Aboriginal artefacts and management of Aboriginal heritage values would be included in compulsory induction courses for site workers. The content of this component will vary according to the stage of construction. After the completion of major cut and fill actions, training may focus on the management of spoil where there is a risk of impacting artefacts, and on no-go areas, where relevant.	Pre-construction Construction
Conservation of heritage items	Prepare a conservation management plan which defines and integrates all strategies for mitigating and managing Aboriginal heritage values across the airport site. This plan would be developed in consultation with Aboriginal stakeholders and relevant government agencies.	Pre-construction Construction

Issue	Mitigation	Timing
Commemoration of Aboriginal heritage	Commemorate the Aboriginal cultural heritage values of the airport site. Options for consideration may include: • the use of Darug words and language in the naming of places and infrastructure; • the dedication of various spaces and places for the placement of art and interpretive elements, storage and display of cultural items, and/or the conduct of cultural activities; and • the provision of public access and interpretive facilities at Aboriginal sites conserved in situ within the airport site (such as for sites B40 and B120), subject to safety and security requirements.	Pre-construction
Curation and repatriation of heritage items	An area of open ground should be reserved within the airport site and managed for the primary purpose of repatriation of salvaged Aboriginal cultural material through reburial. The area should be selected and managed in consultation with Aboriginal stakeholders. Priority should be given to areas which retain a natural land surface and are associated with native vegetation. This provision is to accommodate the repatriation of cultural material for which it is not considered necessary by Aboriginal stakeholders to store above-ground, or to retain access for cultural purposes, interpretation, education or research.	Pre-construction
	Following the completion of archaeological description and analysis, Aboriginal cultural material salvaged from the airport site should, in the first instance, be stored at an appropriate place to be determined in consultation with Aboriginal stakeholders and relevant government agencies. The longer term storage of this material, and potentially material salvaged from other developments in Western Sydney, should be managed in accordance with protocols to be developed through further consultation with Aboriginal stakeholders and relevant state, federal and local government agencies. Longer term storage options could include: a. a 'keeping place', if feasible, that would provide secure, above ground storage enabling future access for cultural purposes, interpretation, education or research; and b. re-positioning or reburial at an appropriate time, at one or more locations within the local landscape to be determined in consultation with Aboriginal stakeholders.	Pre-construction

Issue	Mitigation	Timing
European heritage		
European heritage management plan	A European and other heritage management plan would be developed prior to construction of the proposed airport as part of the construction environmental management framework. The plan would collate measures to mitigate and manage potential impacts on European cultural heritage values. Measures proposed to be considered in the plan include: • further targeted archaeological investigation – to record subsurface remains and infer the layout, occupants and activities of certain European heritage places; • archival recording – including photographic records and measured drawings in their local context for future reference, having regard to the guidelines How to Prepare Archival Records of Heritage Items (NSW Heritage Office 1998) and Guidelines for Photographic Recording of Heritage Items Using Film or Digital Capture (NSW Heritage Office 2006); • inventory of moveable items – to record information such as location, designer, creator, use and owner of items such as tools of trade or machinery; • cultural planting investigation – to identify and collect samples of local or historic plant varieties that are characteristic of the area or not otherwise broadly planted; • exploration of options for potential relocation of identified European heritage structures – to preserve intact surface structures; • relocation of cemeteries in accordance with the Cemeteries Relocation Management Plan; and • staged demolition – to deconstruct identified European heritage structures in a careful manner that reveals information about their construction, renovation, finishes and so on, which would be recorded.	Pre-construction Construction
Heritage awareness	Heritage awareness training would be provided to all workers involved in site preparation and construction of the proposed airport.	Pre-construction
Unexpected finds	A procedure would be developed to be followed in the event that European heritage items are discovered during site preparation or construction.	Pre-construction
Cultural significance of the airport site	The preparation of an oral history would be considered as a measure to preserve the heritage value of the airport site. This could include descriptions and reminiscences by people closely associated with the site.	Pre-construction
Cultural significance of the airport site	The European heritage value of the airport site would also be considered through detailed design.	Pre-construction
Management of European and other heritage items	A procedure would be developed to be followed in the event that European heritage items are discovered during site preparation or construction.	Pre-construction
	A procedure would be developed to be followed in the event that human remains are discovered, given the potential presence of unmarked graves at the airport site.	Pre-construction
Planning and land use		
Corridor protection – road	Liaise with relevant State and local government agencies regarding future access arrangements from The Northern Road and Elizabeth Drive.	Pre-construction
Land use zoning	Liaise with the relevant State and local government agencies to seek the appropriate adjustment to zoning of the airport site under applicable environmental planning instruments.	Construction

Issue	Mitigation	Timing
Landscape and visual amenity		
Visual and landscape management plan	A visual and landscape management plan would be developed prior to construction of the proposed airport as part of the construction environmental management framework. The plan would establish urban design principles and identify appropriate landscape treatments for the site, as well as collate further measures to mitigate and manage potential impacts on visual amenity and the landscape.	Pre-construction
Visual disturbance and clutter	Stockpiles, bunds and surcharge areas would be covered, where practicable.	Construction
	Impacts on the visual character of the landscape would be minimised by avoiding large grade cut and fill transitions where practical, particularly near the airport site boundary.	Pre-construction
	Existing vegetation would be retained, where practicable, particularly along the airport site boundary, to provide visual screening.	Construction
	Construction plant, machinery and vehicle parking areas would be located as far as practicable from sensitive receivers.	Construction
	Any night lighting required for construction works would be located as far as practicable from sensitive receivers with appropriate screening as required.	Construction
	Construction site areas would be progressively rehabilitated. Consideration would be given to the rehabilitation of earthworks areas if there is a considerable period of time between the completion of earthworks and construction of aviation infrastructure.	Construction
	Opportunities for vegetation screening would be investigated, particularly in relation to the identified moderate-high impact viewpoints. The revegetation strategy would take into consideration bushfire risks and potential impacts on aviation operations, and opportunities for the reestablishment of endemic native species and ecological communities.	Construction
	Subject to safety and security requirements, perimeter fencing design would have regard to the following considerations: • avoiding long, straight continuous runs; • avoiding finish and colour that is reflective or brightly coloured; • providing a two metre (minimum) setback from the property boundary to allow for perimeter plantings, where possible; and • providing a buffer from riparian corridors along the boundary of the airport site.	Pre-construction
Airport lighting impacts	Low angle, cut off LED fixtures would be considered wherever practicable in the design of airport infrastructure.	Pre-construction
Social		
Local employment generation	Develop an Australian Industry Participation Plan, including consideration of local industry participation.	Construction

Issue	Mitigation	Timing
Resources and waste		
Resources and Waste	A waste management plan would be prepared prior to construction of the airport, which would collate measures to manage waste and thus avoid, mitigate and manage impacts to human health and the environment. The plan would define processes to track waste quantities, roles and procedures for the handling of waste at the airport site, and processes for the continual improvement of airport waste management. The measures would reflect the waste management hierarchy as per the Waste Avoidance and Resource Recovery Act 2001 (NSW) as well as relevant standards such as those for hazardous substances.	Construction
Cumulative impacts		
Sustainability	Consideration will be given to designing, constructing and operating the Stage 1 development to achieve the following where appropriate: • 5 Star Green Star – Design & As Built; • 5 Star NABERS Office Energy Rating: and • 4 Star Green Star – Performance	Pre-construction
	Consideration will be given to the achievement of an ISCA 'As Built Rating', covering the design and construction of the proposed Stage 1 development.	Pre-construction

28.4.2. Impacts of Stage 1 operations

The draft EIS has considered impacts of the proposed airport accommodating approximately 10 million annual passengers and 63,000 air traffic movements per year during the operation of the Stage 1 development. The proposed airport is expected to commence operations in around 2025 and would operate on a 24 hour basis.

Table 28–5 sets out a list of general mitigation and management measures applicable to operation of the Stage 1 development. These measures are identified as pre-operation or operation. Pre-operation measures would be taken prior to commencement of operations of the Stage 1 development and in some cases would require consideration as part of the design of airport infrastructure.

The measures outlined in Table 28–5 would apply until a master plan is in place. Once in place, the master plan would provide the overarching framework for environmental management during operation of the Stage 1 development, consistent with other airports in Australia. Relevant measures that have ongoing application would be incorporated into the framework established by the master plan and environment strategy (see Section 28.3).

Operation of the Stage 1 development is expected to commence in around 2025, approximately 10 years after this draft EIS. As a result, the preliminary airspace assessment undertaken by Airservices Australia to inform preparation of the draft EIS and draft Airport Plan was limited to a conceptual level airspace management design. The principal objective of that assessment was to establish whether safe and efficient operations could be introduced at the airport site through the development of proof-of-concept air traffic management designs. A key mitigation measure would be development of a noise management plan in parallel with refinement of flight paths and procedures for the proposed airport. This is discussed in section 28.6.3.

Table 28–5 – List of mitigation and management measures applicable to Stage 1 operation

Issue	Mitigation	Timing
Aircraft noise		
Noise management plan	A noise management plan would be prepared for aircraft operations prior to the commencement of airport operations. To the extent practicable, development and implementation of the noise management plan would be integrated with and draw on the outcomes of future detailed airspace and airport operations design undertaken by Airservices Australia and the Civil Aviation Safety Authority (CASA). This formal design process would provide an opportunity to optimise flight paths on the basis of safety, efficiency, noise and environmental considerations, as well as minimising changes to existing regional airspace arrangements. Establishing airspace management arrangements for the proposed airport, including the determination of flight paths, is expected to involve additional formal environmental assessment and community and stakeholder engagement. Development and implementation of the noise management plan would involve the airport lessee company, Airservices Australia, CASA, the Department of Infrastructure and Regional Development, other Australian Government agencies, State and local government, the airline industry, and community representatives. Terms of reference would be prepared for the plan. These would specify the objectives of the plan, identify the matters and actions to be considered, establish planning horizons, guide the participation of stakeholders and outline decision-making processes for determining preferred actions. Issues to be addressed in the plan would include but not be limited to: • options for flight paths and airport operating modes for day and night operations, having regard to environmental impacts, operation efficacy and safety considerations; • the number of aircraft overflights, levels of noise exposure predicted to be experienced by communities, and the impacts on amenity in conservation and recreation areas, and at other noise sensitive locations; • opportunities for the provision of periods of respite from aircraft noise; • the control of the loudness of noise events, including noise abatement departure and arrival procedures (e.g. the use of reverse thrust); • the management of noise at night; • the possible insulation or acquisition of buildings exposed to the highest noise levels having regard to Australian Standard 2021, including mechanisms for funding potential noise amelioration works and property acquisitions; • the design and installation of a noise and flight path monitoring system; • arrangements for noise enquiries and complaints; • identification of responsibilities for implementing individual actions; and • land use planning policies and instruments for areas surrounding the airport taking account of predicted noise exposure levels.	Pre-operation

Issue	Mitigation	Timing
Noise (ground operations, construction, road)		
Operational ground-based noise	A ground-based noise amelioration management strategy would be developed that identifies reasonable and feasible noise mitigation measures. The Issues to be addressed in the strategy would include but not be limited to: • the identification of reasonable and feasible noise mitigation measures for on-ground noise generating activities, including: ▪ aircraft ground running operating procedures; ▪ opportunities to refine the location and design of airport features to reduce noise impact; ▪ aircraft taxiing operating procedures; and ▪ other measures to address excessive noise where noise mitigation by physical features (e.g. noise barriers) is deemed ineffective. • additional noise modelling and assessment conducted during the detailed airport design phase to examine with the objective of examining the effectiveness of any proposed noise amelioration mitigation measures and identifying any residual excessive noise levels in areas surrounding the airport site; • if off-site noise exposure cannot be managed appropriately by operational and other on-site mitigation measures, a detailed noise amelioration plan for affected residences and other sensitive receivers surrounding the airport site should be developed for consideration by the Australian Government and any reasonable and feasible noise mitigation measures; • stakeholder engagement with affected residences and other stakeholders regarding potential noise impacts, and potential mitigation and amelioration measures; • similar to other airports, implementation of aircraft ground running operating procedures including investigations of feasible measures to reduce the impact of noise; • other specific measures to address noise exceedances where physical noise mitigation is ineffective; and • noise monitoring and reporting arrangements.	Pre-operation Operation
	The airport-lessee company would incorporate noise monitoring and reporting into any future master plan in accordance with the *Airports Act 1996*.	Operation
Air quality and greenhouse gases		
Management of air quality and odour	Develop and implement an operational air quality and odour management plan for the proposed airport.	Operation
Air quality monitoring	Install an air quality monitoring station at the airport site to monitor NO_x, NO, NO_2, CO, O_3, PM_{10}, $PM_{2.5}$ and VOCs.	Pre-operation Operation
	Conduct ambient air quality monitoring prior to operation to record baseline air quality conditions prior to operation activities.	Pre-operation

Issue	Mitigation	Timing
Emissions	Consider best available techniques to reduce the potential for ground level ozone formation, which may include: • replacing conventionally fuelled ground support equipment with electric or hydrogen powered belt loaders, pushback tractors, bag tugs, and cargo loaders; • using remote ground power for remote aircraft parking positions; • installing co-generation or tri-generation in-lieu of traditional gas fired boilers or solar hot water systems to replace gas fired boilers; • avoiding certain activities, such as training fires, maintenance (spray painting) during the ozone seasons; • using underground fuel hydrant systems and/or vapour recovery systems for refuelling and fuel storage; and • promoting the use of public transport to the airport.	Operation
Greenhouse gases – Scope 1 emissions	Support alternatively fuelled and 'modernised' ground support equipment – including compressed natural gas, hydrogen, electric, compressed air and hybrid vehicles.	Operation
	Educate ground support equipment drivers in techniques to conserve fuel and implement a no-idling policy.	Operation
	Design runways, taxiways, gates and terminals to minimise aircraft and ground support equipment travel distances where practical.	Operation
	Aircraft management procedures would consider the reduction of fuel use as far as practical.	Operation
	Reduce the use of auxiliary power units by using fixed electrical ground power and preconditioned air supply to aircraft where possible.	Operation
	Specify high efficiency power, heating and cooling plants.	Operation
	Make use of renewable energy sources where practical for the generation, use or purchase of electricity, heating and cooling.	Operation
Greenhouse gases – Scope 3 emissions	Consider the use of high capacity public transport to and from the proposed airport as part of the ground transport plan. Support the use of the low emission vehicles to and from the proposed airport, including the provision of recharging stations.	Operation
	Develop an integrated solid waste management plan to implement waste saving initiatives such as composting and recycling.	Operation
	Install tenant energy sub-metering systems.	Operation
Hazard and risks		
Bird and bat strike	Develop a Wildlife Hazard Management Plan to include: • conduct of additional surveys to study and monitor for changes in species and movement patterns. The surveys would be conducted in accordance with relevant Commonwealth and State guidelines and standards including any recovery plans for threatened species; • review of detailed design documentation to identify potential bird and bat attractants; and • liaise 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.	Pre-operation
	Actively manage bird and bat presence at the airport site six months prior to the commencement of runway operations.	Pre-operation

Issue	Mitigation	Timing
	The outcomes of bird and bat strike monitoring would 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.	Operation
Public safety zones	Consider whether any planning measures are required for areas not currently Commonwealth-owned.	Pre-operation
Traffic, transport and access		
Operational traffic and transport impacts	A ground transport plan would be prepared as part of the detailed design of Stage 1 and before the proposed airport begins operating. The plan would address: • road design speeds; • security issues; • traffic loads from airport and other developments on site; • connections with off-site/external roads, including matching capacity, speeds and road geometry; • forecast traffic flows, including public transport requirements; • car parking; • commercial and operational vehicles and storage; • terminal interface; • passenger pick-up and drop-off by private and commercial vehicles; • pedestrian linkages between terminals and all transport drop-off/pick-up areas; • pedestrian, cycle or road networks for movement around the Airport Site; • use of dedicated busways; • ability to continue to provide access to and from the Airport when key intersections are unavailable; and • the ability to expand, with minimal disruption, to meet future airport and business development requirements.	Pre-operation
Biodiversity		
Vegetation	Prepare and implement a vegetation management plan. The vegetation management plan would apply to open space within the airport site and the environmental conservation zone and would include: • retaining native 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; • monitoring of the success of revegetation, weed control and adaptive management; and • reporting.	Operation
Fire	Review, update and implement the bushfire management plan in response to the transition to the airport operation phase, including in response to changes to changes to locations of building envelopes, fuel loads, ignition sources etc.	Operation

Issue	Mitigation	Timing
Topography, geology and soils		
Land contamination	Fuel and other potential contaminants would be stored and handled in accordance with relevant Australian standards such as: • *AS 1940-2004 The storage and handling of flammable and combustible liquids* • *AS/NZS 4452:1997 The storage and handling of toxic substances* • *AS/NZS 5026:2012 The storage and handling of Class 4 dangerous goods* • *AS/NZS 1547:2012 On-site domestic wastewater management*	Operation
Treated water irrigation	The treated water irrigation scheme would be designed and operated in accordance with the risk framework and management principles contained in the *National Guidelines on Water Recycling* (EPHC 2006) and *Environmental guidelines: Use of effluent by irrigation* (DEC 2004).	Operation
Surface water, groundwater and water quality		
Surface water quality	Surface water quality monitoring would be conducted at basin outflows and selected upstream and downstream conditions. Once an airport lease is granted, the proposed airport would be subject to water quality monitoring requirements as set out in the *Airports (Environmental Protection) Regulations 1997* and the results of baseline water quality monitoring.	Operation
Leaks or spills of fuel or other chemicals	Maintenance areas, fuel farms and other areas where fuels or chemicals are stored or handled would be bunded to contain any accidental spills or leaks.	Operation
	Develop and implement response procedures to remedy leaks or spills.	Operation
Groundwater inflows	Groundwater elevation monitoring would be conducted to detect potential impacts to base flow in the vicinity of potentially sensitive creeks or groundwater dependent vegetation. Monitoring would be undertaken quarterly through construction up to a minimum period of three years after the completion of the Stage 1 development and until any identified impacts stabilise.	Operation
	Measures to supplement groundwater supplies would be made in the unlikely event of impacts to dependent vegetation or watercourses.	Operation
Groundwater quality	Groundwater quality monitoring of alluvial and Bringelly Shale aquifers would be conducted at major infrastructure locations, down gradient from those locations and in the vicinity of groundwater dependent vegetation or watercourses. Monitoring would initially be undertaken quarterly and adjusted as appropriate. Once and airport lease is granted, the proposed airport would be subject to water quality monitoring requirements as set out in the *Airports (Environmental Protection) Regulations 1997*.	Operation
	Groundwater inflows would be reused or released with appropriate treatment. Where groundwater is released to surface waters, treatment would be to the appropriate level under the ANZECC guidelines.	Operation
Aboriginal heritage		
Conservation of heritage sites	The environmental conservation zone would be managed with the conservation of known and predicted Aboriginal heritage sites as one of the principal objectives.	Operation
Planning and land use		
Operational airspace	Liaise with relevant State and local government agencies to identify appropriate environmental planning instruments to reflect protected airspace under the Airports (Protection of Airspace) Regulations 1997.	Pre-operation

Issue	Mitigation	Timing
Noise	Liaise with the relevant State and local government agencies to identify appropriate noise management controls in applicable environmental planning instruments with reference to *AS2021-2000 Acoustics Aircraft noise intrusion – Building siting and construction* and noise guidelines under the National Airports Safeguarding Framework.	Pre-operation
Corridor protection – rail	Liaise with the relevant State government agencies to identify opportunities for corridor protection for the provision of future rail connection to the airport site.	Pre-operation
Corridor protection – fuel pipeline	Liaise with the relevant State and local government agencies to identify opportunities for protection of a corridor for a future fuel pipeline.	Pre-operation
Landscape and visual amenity		
Visual disturbance and clutter	Existing vegetation would be retained, where practicable, particularly along the airport site boundary, to provide visual screening.	Operation
Social		
Stakeholder engagement	Liaise with relevant agencies to inform their planning allocation of funding to programs that may benefit from the proposed airport. Relevant agencies may include local and State government agencies, tourism agencies, agencies responsible for affordable housing and other organisations (e.g. Western Sydney Business Chamber, educational facilities including universities and TAFE).	Operation
Cumulative impacts		
Sustainability	Consideration will be given to the achievement of an ISCA 'Operations Rating', covering overall operations of the proposed Stage 1 development.	Operation

28.5. Construction environmental management framework

The overarching approach to environmental management for construction of the Stage 1 development is illustrated in Figure 28–1. The construction environmental management framework (CEMF) shows the relationship between relevant statutory requirements and approval documentation and plans.

As noted earlier, until an airport lease is granted, the Commonwealth would be responsible for the CEMF. It is expected that this would largely be implemented through construction contractors.

Once an airport lease is granted, the ALC would take statutory responsibility for all relevant aspects of the CEMF. Again it is expected that construction contractors would have a key role in complying with the requirements of the obligations within the CEMF. An airport environmental officer, appointed by the Commonwealth Government, would have a regulatory role on the airport site for environmental matters under Part 6 of the Airports Act and the Airports (Environment Protection) Regulations, and an airport building controller, also appointed by the Commonwealth Government, would have a regulatory role on the airport site for building control matters under Part 5 of the Airports Act and the Airports (Building Control) Regulations.

It is recognised that compliance with the requirements of relevant plans does not remove general obligations and responsibilities under relevant legislation or approvals obtained for the proposed airport including any relevant conditions.

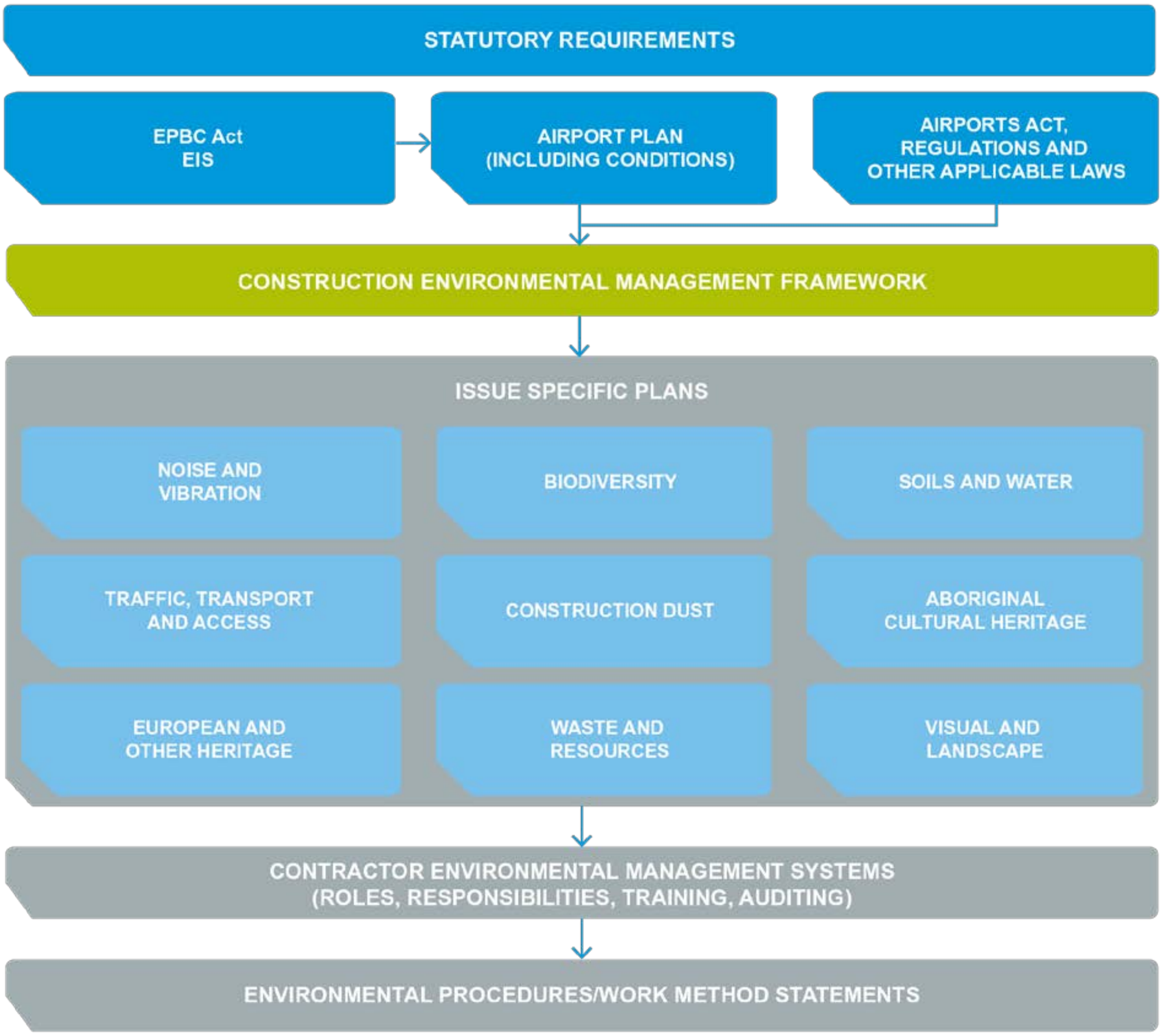


Figure 28–1 – Construction environmental management framework

28.5.1. Construction environmental management plans

The CEMF would draw together all of the relevant plans associated with the construction of the Stage 1 development. As outlined earlier, the Commonwealth would have overarching responsibility for the CEMF until an airport lease is granted.

The CEMF would reference the environmental management plans outlined below. These plans would specify objectives, procedures, performance standards and criteria, monitoring and reporting requirements, roles and responsibilities and other environmental management measures. Unless otherwise stated, it is intended that plans would be approved by the Minister for Infrastructure and Regional Development (or a person nominated by the Minister).

Environmental management plans would be prepared to guide management of the following matters during the construction phase:

- construction noise and vibration;
- biodiversity;
- soil and water;
- construction traffic and access;
- dust and odour;
- Aboriginal cultural heritage;
- European and other heritage;
- waste and resources; and
- visual and landscape.

Each plan could be structured as follows:

- key objectives;
- background – relevant legislation and standards and links to other plans;
- all required statutory and other obligations, including consents, licences, approvals and voluntary agreements;
- key management measures;
- key performance indicators;
- any specific protocols or procedures including requirements and guidelines for management in accordance with mitigation measures specified by this EIS, and related conditions in the Airport Plan;
- requirements in relation to incorporating environmental protection measures and instructions in all relevant standard operating procedures and emergency response procedures;
- roles and responsibilities of all personnel and contractors to be employed on site;
- procedures for complaints handling and ongoing communication with the community where applicable;
- a monitoring, reporting and auditing programme where applicable; and
- contingency management and incident response procedures where applicable.

An overarching plan may be prepared to deal with common elements that are applicable to more than one of the subject matter plans.

28.5.2. Stakeholder and community engagement

A Community and Stakeholder Engagement Plan would be prepared to guide activities, keep the community informed, address enquiries and complaints, and help manage potential impacts during construction of the proposed airport.

Table 28–6 outlines the range of communication tools and initiatives that may be used during the construction programme.

Table 28–6 – Potential community and stakeholder engagement during construction

Potential stakeholder category	Potential impact or area of interest	Potential communication tools and initiatives
Community		
Communities in the direct environs of the construction site (eg Luddenham, Kemps Creek, Bringelly, Rossmore, Mount Vernon, Silverdale)	• Construction traffic and condition of local roads • Local amenity and history • Noise, dust, vibration, and lighting • Employment and business opportunities • Impact on local developments • Project timing and general interest • Integration with other major infrastructure projects	• Coordination with relevant government agencies • 1800 Freecall information line and project email address • Media releases and information provided to stakeholders to distribute • Project website with links to further information • Regular written communication and at completion of project milestones • Written communication, local paper advertisements, project website updates and revised signage before new major phases of construction begin • Focused letterbox drops where an activity is likely to affect a specific group or location • Community events
Communities along key transport routes for construction	• Construction traffic and condition of local roads • Local amenity • Employment and business opportunities • Impact on local developments • Project timing and general interest • Integration with other major infrastructure projects	• Coordination with relevant government agencies • Liaison with community relations team • 1800 Freecall information line and project email address • Media releases and information provided to stakeholders to distribute • Project website with links to further information • Regular written communication and at completion of project milestones • Focused letterbox drops where an activity is likely to affect a specific group or location

Potential stakeholder category	Potential impact or area of interest	Potential communication tools and initiatives
Broader Western Sydney community	• Construction traffic • Employment and business opportunities • Impact on local developments • Project timing and general interest • Integration with other major infrastructure projects • Impacts on Greater Blue Mountains World Heritage Area	• Coordination with relevant government agencies • 1800 Freecall information line and project email address • Media releases and information provided for stakeholders to distribute • Project website with links to further information
Broader Sydney community	• Project timing and general interest • Integration with other major infrastructure projects	• 1800 Freecall information line and project email address • Media releases • Email alerts to stakeholder lists (around major milestones) • Project website with links further information
Indigenous communities	• Environment protection • Cultural heritage • Employment and business opportunities	• Refer Aboriginal Heritage Management Plan • Liaison with community relations team • 1800 Freecall information line and project email address • Project website with links to further information
Special interest community and environment groups	• Construction traffic • Environment protection • Local amenity • Employment and business opportunities • Impact on local developments • Project timing and general interest • Integration with other major infrastructure projects	• Liaison with community relations team • 1800 Freecall information line and project email address • Project website with links to further information • Regular written communication and at completion of project milestones
Government		
Federal, state and local government elected representatives	• Construction progress • Impacts to local constituents • Integration with other major infrastructure projects	• Briefings and regular newsletters • Liaison with community relations team • Project website with links to further information

Potential stakeholder category	Potential impact or area of interest	Potential communication tools and initiatives
Local government in Western Sydney	• Construction traffic • Project timing and general interest • Impacts to residents • Employment and business opportunities • Impact on local developments • Integration with other major infrastructure projects	• Liaison with community relations team • 1800 Freecall information line and project email address • Project website with links to further information • Briefings and regular newsletters
State government agencies, federal government agencies and local government in broader Sydney	• Project timing and general interest • Environment protection • Employment and business opportunities • Impact on local developments • Integration with other major infrastructure projects	• Liaison with community relations team • 1800 Freecall information line and project email address • Project website with links to further information • Briefings and regular newsletters
Aviation		
Airlines and aviation operators that may use Western Sydney Airport	• Construction progress	• Briefings and regular newsletters • Project website with links to further information
Other airports in Australia and internationally	• Construction progress • Integration with other related projects	• Briefings and regular newsletters • Liaison with community relations team • Project website with links to further information
Businesses / Industry / Education		
Construction and related businesses	• Construction progress • Employment and business opportunities • Integration with other related projects	• 1800 Freecall information line and project email address • Project website with links to further information
Trade unions and employment organisations	• Construction progress • Employment and business opportunities • Integration with other related projects	• 1800 Freecall information line and project email address • Project website with links to further information
Tourism, education and economic development groups	• Construction progress • Employment and business opportunities • Impact on local developments • Integration with other related projects	• 1800 Freecall information line and project email address • Project website with links to further information

28.5.3. Training, awareness and competence

Environmental training for relevant personnel would be carried out prior to commencement of construction works. The training would address the following issues:

- the importance of conformance with procedures outlined in the various plans;
- the environmental impacts (actual and potential) of their work activities;
- the environmental benefits of improved performance;
- their role and responsibility in environmental management; and
- the potential consequences of departure from specified procedures.

All entities directly involved in environmental management must be appropriately experienced to undertake their relevant tasks. Appropriate documentation including the following would be required:

- copies of any applications for consents, licences and approvals and the responses from authorities;
- details of complaints or incidents and corrective and preventative actions taken;
- summary of any correspondence or consultation with regulatory authorities or other stakeholders;
- a copy of any environmental studies, monitoring results and analysis; and
- a copy of the external audit reports, any environmental internal audit reports or reviews conducted of environmental management systems (EMS).

28.5.4. Performance review

Compliance with the required plans (as updated following determination of the Airport Plan) and the performance requirements for construction works would be monitored through a review, reporting and auditing framework which would be approved by the Minister for Infrastructure and Regional Development (or a person nominated by the Minister).

28.6. Operational environment management

28.6.1. Overview of operational environmental management

To address the potential environmental issues associated with the operation of Stage 1 development a number of operational environmental plans would be developed. These plans are outlined in Section 28.6.2.

As noted in Section 28.3.3, a comprehensive environmental strategy that addresses the detailed requirements of the Airports Act would be developed and approved as part of the proposed airport's first master plan. If the first master plan is in place before operations commence, the operational environmental management plans (or proposed plans, if they have not been prepared by then) identified below would be developed and approved under the framework of the airport environment strategy, which is a component of the master plan.

If airport operations commence before the first master plan is in place, the plans identified below would be developed and approved as standalone operational environmental management plans. In this case, they would be considered in the process of preparing the master plan and overarching environment strategy which forms part of the master plan.

Once a master plan is in place, future environmental management would be addressed under the master plan framework.

28.6.2. Operational environmental management plans

Environmental management plans addressing the following matters would be prepared and approved prior to the commencement of operations of the proposed airport:

- air quality;
- water quality;
- soil and land management;
- spills response and hazardous materials;
- ground transport;
- aircraft operational noise (discussed further in Section 28.6.3);
- ground-based noise;
- biodiversity and conservation;
- heritage;
- wastes and resource use;
- climate change and energy; and
- social and community issues.

Each management plan could be structured as follows:

- key objectives;
- background – relevant legislation and standards and links to other management plans;
- current environmental management practices (following on, as appropriate, from issues addressed during construction);
- key performance indicators;
- key management measures;
- any specific protocols or procedures including requirements and guidelines for management in accordance with mitigation measures specified by this EIS, and related conditions in the Airport Plan;
- requirements in relation to incorporating environmental protection measures and instructions in all relevant standard operating procedures and emergency response procedures;
- roles and responsibilities of all personnel and contractors to be employed on site;

- procedures for complaints handling and ongoing communication with the community where applicable;
- a monitoring, reporting and auditing programme where applicable; and
- contingency management and incident response procedures where applicable.

Each plan would be approved by the Minister for Infrastructure and Regional Development (or an authorised officer in the Department).

28.6.3. Aircraft operation noise management plan

28.6.3.1. Existing operational framework for noise management

A number of land use planning protections are already in place around the Western Sydney Airport site following the outcomes of previous EISs. In the lead up to the airport becoming operational, the Department would work closely with the NSW Government and local governments to identify additional long term planning protections required to be put in place around the airport to prevent incompatible development in areas predicted to experience more than 20 Australian Noise Exposure Forecast (ANEF) levels. An ANEF endorsed by Airservices Australia would be included in the first master plan for the airport.

Major developments that would significantly increase the capacity of the airport to handle additional aircraft movements beyond those accommodated by the Stage 1 development would require a major development plan to be developed by the ALC. Changes to the extent and intensity of aircraft noise exposure levels arising from such developments would be a key consideration for the major development plan. A major development plan would be released for public consultation and approved by the Infrastructure Minister based on advice from the Environment Minister following a referral and any necessary assessment under the EPBC Act.

In addition to the initial design of flight paths and procedures for the airport, Airservices Australia would also have an ongoing role in:

- ensuring that flight departures and arrivals are designed to minimise noise impacts;
- providing information about aircraft noise;
- monitoring aircraft noise around major airports; and
- providing a national Noise Complaints and Information Service.

28.6.3.2. Assessment of Stage 1 aircraft noise impacts and future airspace design

As noted in Chapter 10, the assessment of aircraft noise has been based on Airservices Australia's preliminary assessment of airspace implications and air traffic management arrangements for the Sydney region associated with the potential commencement of operations at the proposed airport. The assessment of potential impacts of aircraft overflight noise is based on indicative flight paths. A future airspace design process, including the preparation of final flight paths, is expected to be undertaken closer to the commencement of operations at the proposed airport.

The formal design process would provide an opportunity to optimise flight paths on the basis of safety, efficiency, noise and environmental considerations, as well as minimising changes to existing regional airspace arrangements. Decisions about airspace management arrangements including the determination of flight paths would be made by Airservices Australia and the Civil Aviation Safety Authority (CASA).

In accordance with the *Air Services Act 1995*, Airservices Australia is required to exercise its functions, as far as practicable so as to protect the environment. It has published a document called *Airservices commitment to noise management* which outlines the considerations which are taken into account in designing flight paths and procedures[3]. As outlined in the EIS, one of the primary environmental considerations would be noise impacts on populations and upon other places of special sensitivity. In relation to the GBMWHA, Airservices would give consideration to the requirements of the GBMWHA Strategic Plan (NPWS 2009).

CASA would also need to validate proposed flight paths and procedures. Under the *Civil Aviation Safety Act 1988*, CASA is also required to exercise its functions so as to, as far as practicable, protect the environment.

The airspace management arrangements for commencement of operations at the proposed airport are expected to be subject to a referral under section 160 of the EPBC Act and, if required by the Minister for the Environment, would be subject to further environmental assessment.

28.6.3.3. Preparation of a Stage 1 noise management plan

A noise management plan would be prepared for aircraft operations prior to the commencement of Stage 1 operations. To the extent practicable, development and implementation of the noise management plan would be integrated with and draw on the outcomes of future detailed airspace and airport operations design undertaken by Airservices Australia and CASA. As noted above, this design process is expected to involve additional formal environmental assessment and community and stakeholder engagement.

Development and implementation of the noise management plan would involve the airport lessee company, Airservices Australia, CASA, the Department of Infrastructure and Regional Development, other Australian Government agencies, State and local government, the airline industry, and community representatives. Terms of reference would be prepared for the plan. These would specify the objectives of the plan, identify the matters and actions to be considered, establish planning horizons, guide the participation of stakeholders and outline decision-making processes for determining preferred actions.

Issues to be addressed in the plan would include but not be limited to:

- options for flight paths and airport operating modes for day and night operations, having regard to environmental impacts, operation efficacy and safety considerations;
- the number of aircraft overflights, levels of noise exposure predicted to be experienced by communities, and the impacts on amenity in conservation and recreation areas, and at other noise sensitive locations;

[3] See Air Services Australia Aircraft Noise Management

- the provision of periods of respite from aircraft noise;
- the control of the loudness of noise events, including noise abatement departure and arrival procedures (e.g. the use of reverse thrust);
- the management of noise at night;
- the possible insulation or acquisition of buildings exposed to the highest noise levels having regard to Australian Standard 2021, including mechanisms for funding potential noise amelioration works and property acquisitions;
- the design and installation of a noise and flight path monitoring system;
- arrangements for noise enquiries and complaints;
- identification of responsibilities for implementing individual actions; and
- land use planning policies and instruments for areas surrounding the airport taking account of predicted noise exposure levels.

Having regard to different regulatory arrangements and responsibilities, it is currently proposed that management of ground-based noise would be addressed through a separate management plan.

28.6.4. Environmental management system procedures

The environmental management system (EMS) to be implemented before and during the Stage 1 operational period of the proposed airport would be consistent with applicable best available practice at the time.

28.6.5. Environmental studies, monitoring, performance and reporting

As required to assist the environmental management of airport operations, more detailed environmental studies would be undertaken where identified in this draft EIS or in subsequent assessments, plans and strategies. In addition, monitoring and reporting on environmental management issues would be undertaken in accordance with commitments in the action plans and the requirements of the *Airports (Environmental Protection) Regulations*.

28.6.6. Stakeholder and community engagement

Once operational, the proposed airport would operate under the compliance monitoring and reporting requirements that are applicable to other airports. The proposed airport would be expected to adopt similar community and stakeholder engagement during operations to other airports. These measures typically include the types of measures set out in Table 28–7.
The Government expects airports such as the proposed Western Sydney Airport to operate Community Aviation Consultation Groups (CACGs). There are guidelines for CACGs which require that they be independently chaired and should engage broad community representation. While they are not decision-making bodies, CACGs provide for effective and open discussion of airport operations and their impacts on nearby communities.

Major capital city airports are also required to establish Planning Coordination Forums (PCFs). The purpose of PCFs is to support a strategic dialogue between the airport operator and local, state and federal government agencies responsible for town planning and infrastructure investment.

Effective discussions in PCFs support better integration of planning for the airport and for the surrounding urban and regional community.

Table 28–7 – Potential community and stakeholder engagement during operation

Potential stakeholder category	Potential impact or area of interest	Potential communication tools and initiatives
Community		
Communities in the direct environs of the airport (eg Luddenham, Kemps Creek, Bringelly, Rossmore, Mount Vernon, Silverdale)	• Traffic from operations and condition of local roads • Impacts from ground operations including noise, lighting and air quality • Visual amenity and lighting • Aircraft noise exposure – levels and patterns • Employment and business opportunities • Changes in Property values and changes in nearby land use over time • Public safety	• Coordination with relevant government agencies • 1800 Freecall information line and complaints management process • Website • Representation on Community Aviation Consultation Group
Communities under flight paths	• Aircraft noise exposure – levels and patterns • Changes in Property values over time • Public safety	• 1800 Freecall information line and complaints management process • Website
Airport users	• Access, public transport, parking • Customer service, retail outlets, amenity, costs • Public safety	• 1800 Freecall information line and complaints management process • Website • Fact sheets • Airport display • Local signage • In-airport signage
Broader Western Sydney community	• Noise from overhead flights • Visual amenity • Employment and business opportunities • Property values and changes in nearby land use over time	• 1800 Freecall information line and complaints management process • Website
Broader Sydney community	• General interest • Access to and air services to and from Airport	• 1800 Freecall information line • Website • Media releases • Fact sheets

Potential stakeholder category	Potential impact or area of interest	Potential communication tools and initiatives
Indigenous communities	• Cultural heritage • Employment and business opportunities	• 1800 Freecall information line • Website • Interpretive signage and design of some elements consistent with Indigenous culture and local histories
Special interest community and environment groups	• Local amenity • Environment protection • Employment and business opportunities • Changes in property values and changes in nearby land use over time	• 1800 Freecall information line and project email address • Website • Representation on Community Reference Group
Government		
Federal, state and local government elected representatives	• Impacts to local constituents • Benefits of airport operation for constituents	• Briefings on request
State government agencies, federal government agencies and local government	• Regulations • Public safety • Environment protection • Employment and business opportunities • Impact on local developments • Integration with other major infrastructure projects	• Briefings on request • Website • Fact sheets
Aviation		
Airlines and aviation operators that may use Western Sydney Airport	• Flight and airport operations	• Briefings on request • Website • Fact sheets
Other airports in Australia and internationally	• Integration with other related projects • Integration with air services networks	• Briefings • Website
Ground transport operators	• Integration with other related projects	• Briefings • Website • Fact sheets

Potential stakeholder category	Potential impact or area of interest	Potential communication tools and initiatives
Businesses / Industry / Education		
Businesses which operate on the airport site	• Traffic from operations and condition of local roads • Impacts from ground operations including noise, lighting and air quality • Employment and business opportunities • Integration with other related projects • Environment protection • Access, public transport, parking • Access to infrastructure and services, amenity • Public safety	• Briefings on request • Website • Fact sheets
Construction and related businesses	• Employment and business opportunities • Integration with other related projects	• Local paper and trade magazine advertising • Industry briefings
Trade unions and employment organisations	• Employment and business opportunities • Integration with other related projects	• Industry briefings
Tourism, education and economic development groups	• Employment and business opportunities • Impact on local developments • Integration with other related projects	• Industry briefings

28.7. Sustainability strategy

Early integration of appropriate sustainability and environmental management considerations into the progressive design phases for the construction of the Stage 1 development will assist in avoiding, reducing or otherwise mitigating adverse environmental impacts.

A sustainability plan would be prepared by the ALC and relevant elements of the plan would be taken into account in the design and construction of airport infrastructure and its subsequent operation. The plan would include:

- incorporation of Airport Plan and EIS requirements and other relevant approvals into detailed design;
- key design features, such as:
  - high efficiency central plant;
  - passive design features;
  - fresh air pre-conditioning; and
  - intelligent controls.

- consideration of designing, constructing and operating buildings on the airport site to achieve the following where appropriate:
  - 5 Star Green Star – Design & As Built;
  - 5 Star NABERS Office Energy Rating;
  - 4 Star Green Star – Performance; and
  - consideration of a comprehensive sustainability rating for design, construction and operation of the proposed airport such as the Infrastructure Sustainability Council of Australia (ISCA) 'As Built Rating' and 'Operations Rating.
- goals and indicators for:
  - water catchment protection, water use and efficiency;
  - air quality and greenhouse gas emissions for site activities;
  - energy use and efficiency;
  - waste and recycling;
  - encourage the use of public transport;
  - community and stakeholder impacts; and
  - environmental conservation.

28.8. Cost of environmental management measures

In parallel with the preparation of this draft EIS, the Department is undertaking planning for the proposed airport. One of the outputs of this process is the draft Airport Plan which provides a detailed outline of the specifications and future performance requirements for the Stage 1 development.

Costings for both the proposed development and all proposed environmental management measures will be considered by Government as part of its overall consideration of the project. This will have particular regard to significant cost items including environmental management measures outlined in the draft EIS. Appropriate allowances will be made for contingency events, should they occur.

PART E:

Conclusion

29. Conclusion

29.1. Introduction

This chapter summarises the justification for the proposed airport and potential environmental impacts, including anticipated benefits and the consequences of not proceeding.

29.2. Justification of the proposal

Airports are key international gateways for passenger and freight transport, taking on an increasingly important economic role in a globalised economy. Sydney in particular is reliant on the aviation system to maintain its status as a global city, tourist destination and major financial and services centre in the Asia Pacific region.

The need for a second airport in Sydney is driven principally by the increasing demand for aviation services in both Western Sydney and the Sydney region in general, and the limited capacity of existing airports to accommodate the predicted growth.

Strategic alternatives to the development of a new airport in Western Sydney have been considered over a number of decades. Commonly referenced alternatives include increasing the capacity of Sydney (Kingsford Smith) Airport or other existing airport facilities, establishing a new airport outside the Sydney basin, or developing a regional high speed rail network. While these alternatives have demonstrated potential to provide marginal capacity benefits, they would not replace the need for the proposed airport. Detailed studies have been undertaken over a number of decades to assess these options and have consistently found that the most effective way to address increased aviation demand, while mitigating environmental and social impacts, is to develop a new airport at Badgerys Creek.

Western Sydney is identified as the source of many of Sydney's greatest opportunities for economic and employment growth in the NSW Government's *A Plan for Growing Sydney* (DP&E 2014). It is also a region in which several of Sydney's challenges are most pressing, such as ageing infrastructure, housing demand, growth and access to employment.

Development of the proposed Western Sydney Airport would be a catalyst for investment and job creation in the region by accelerating the delivery of vitally important infrastructure and the release of employment and housing land, and providing a long term and diverse source of local jobs and economic activity. Additionally, the proposed airport would improve access to aviation services for the growing population of Western Sydney.

29.2.1. Summary of benefits of the proposal

Proceeding with the proposal would provide the following key benefits:

- Additional aviation capacity for Sydney – existing airports in the Sydney basin do not have the capacity to absorb future aviation demand. The proposed airport would provide the additional capacity to meet increases in demand over the long term.
- Access to aviation for Western Sydney – providing Western Sydney with better access to aviation services and accelerating critical infrastructure and urban development in the region.
- Economic benefits – Generating opportunities for employment growth and increased economic development in the Western Sydney Region.

29.2.2. Alternatives considered

The development of a new airport at Badgerys Creek has consistently been found to be the most effective solution to address long term aviation demand in the Sydney region, a position confirmed by the Joint Study on aviation capacity in the Sydney region (Department of Infrastructure and Transport 2012). In coming to this conclusion, the Joint Study provided a re-evaluation and broad consideration of a number of strategic alternatives to the development of a new airport, including:

- expanding Sydney Airport to meet increased demand;
- reviewing the policy settings and operational restrictions to optimise the use of Sydney Airport;
- optimising the use of other existing airports in the Sydney region;
- using high speed rail to reduce demand for aviation services; and
- developing other new airports.

While the Joint Study acknowledged that some of the options had potential to provide marginal capacity benefits, such as amending cap and curfew arrangements at Sydney Airport, they were considered short term solutions that would not address Sydney's long term aviation capacity requirements. Other proposals, such as expanding Sydney Airport or developing a high speed rail link to Canberra or Newcastle airports, were found to require significant capital investment and would not necessarily address the underlying key drivers of aviation demand growth such as demand for international services.

The Joint Study identified that a major new airport in the Sydney basin would be required before the end of 2030 and that development of the airport site at Badgerys Creek would be best placed to meet this growing demand.

29.2.3. Consequences of not proceeding

The consequences of not proceeding with the proposed airport would include:

- long term operational constraints at Sydney Airport would not be resolved and there would be increased congestion of existing facilities and reduced efficiency of aviation services in the Sydney region; and
- the regional economic benefits expected to be generated by the proposed airport, such as new employment, industry expansion and training opportunities would not be realised.

29.3. Environmental impacts

Potential environmental impacts associated with construction and operation of Stage 1 of the proposed airport, as well as mitigation measures identified to reduce and manage these potential impacts, are documented in this volume of the draft EIS. Consideration of the long term operation of the proposed airport is provided in Volume 3. A summary of the potential key environmental impacts associated with Stage 1 is provided in Table 29–1.

Table 29–1 – Summary of key environmental impacts

Issue	Key environmental issues
Noise – aircraft	• Maximum noise levels of over 85 dBA would be experienced at a small number of residential locations close to the airport site in the area of Badgerys Creek; and levels of 70 to 75 dBA within built-up areas in St Marys and Erskine Park due to worst case loudest aircraft operations (such as Boeing 747). • Maximum noise levels of over 70 dBA would be experienced in some areas adjacent to the south west of the airport, notably the area of Luddenham and Greendale; and levels of 60 to 70 dBA in built-up areas around St Marys and Erskine Park due to more common aircraft types (such as Airbus A320 or equivalent). • About 1,500 people would experience five or more aircraft noise events per day above 70 dBA during the day. None of these are in built-up residential areas. • An estimated 48,000 people would experience more than five events above 60 dBA at night under the 'Prefer 05' operating strategy (approach and depart the airport in a south west to north east direction). • Approximately 6,000 people would experience more than five events above 60 dBA at night under the 'Prefer 23' operating strategy (opposite direction to 'Prefer 05'). • Approximately 4,000 people would experience more than five events above 60 dBA at night under the 'Head to Head' operations (both approach from and depart to the south west). • Most recreational areas would not be subject to aircraft overflight noise events with maximum levels exceeding 70 dBA – or their exposure will be less than one event per day. • The predicted Australian Noise Exposure Concept (ANEC) 20 contour presented in this draft EIS is largely contained within the 1985 EIS ANEC 20 contour used since this time by surrounding councils for land use planning. • The ANEC contours presented in this draft EIS would lead to the final Australian Noise Exposure Forecast (ANEF) contours once flight paths and operating modes are finalised and approved.
Noise – ground operations, construction and road traffic	• Construction noise would be largely confined to within the airport boundary, although there would also be impacts on parts of Luddenham and Badgerys Creek outside of the airport site. • Ground-based operational noise would be generated by aircraft engine run-up and taxiing. • Noise above the adopted criteria associated with aircraft engine run-up under worst case meteorological conditions would potentially affect Luddenham, Badgerys Creek, Bringelly, Wallacia and Greendale. • Noise impacts from taxiing would primarily affect Luddenham.

Issue	Key environmental issues
Air quality and greenhouse gasses	• Dust emissions would be generated during construction by both the bulk earthworks and the aviation infrastructure works. • Operation of an asphalt batching plant is required to facilitate construction of the aviation infrastructure would potentially result in minor odour emissions. • Operation of Stage 1 would result in an increase in emissions of nitrogen dioxide (NO2), particulate matter (as PM10 and PM2.5), carbon monoxide (CO), sulphur dioxide (SO2) and air toxics. • There would be odour emissions from exhaust and from the on-site wastewater treatment plant. • Marginal ozone impacts would result from the operation of Stage 1 and greenhouse gas emissions are not expected to be material in terms of the regional air-shed.
Human health	Air Quality • Levels of airborne particulates generated by construction would be low overall and within the NEPM Advisory Reporting Standards. The highest concentrations are predicted at Badgerys Creek, Greendale and Rossmore. • Levels of health risk as a result of exposure to diesel during construction would be within levels considered acceptable by regulatory agencies. • Risks from particulate exposure during airport operation would be very low with the highest risk for all-cause mortality and cardiopulmonary mortality between one additional death every 1,000 years and six additional deaths every 100 years. • Exposure to nitrogen dioxide would be the highest risk category resulting from airport operation, with between six additional deaths every 100 years and six additional deaths every 10 years in people over 30 years of age. If traffic on roads external to the airport is excluded, this risk would reduce to four additional deaths every 10 years. • Exposure to sulphur dioxide from the airport operations would be very low. The highest risk is for hospital admissions from respiratory causes with approximately three additional admissions per 1,000 years. • The health risk arising from exposure to carbon monoxide would be negligible. The highest risk is for hospital admissions for cardiovascular disease in people 65 years of age and older with a maximum of five additional hospital admissions in 1,000 years. • The risk from exposure to benzene during airport operations would result in a very small increase in health risk which is within levels considered acceptable by regulatory agencies. Noise • The results for the health risk assessment for noise shows that airport operations would lead to an increase in sleep disturbance (assessed as awakenings), increases in risk of cardiovascular disease and delays in childhood learning and cognitive development. These effects are predicted for suburbs close to the airport site. • Further work would be undertaken by the Department of Infrastructure and Regional Development, Airservices Australia and the airport lessee company to identify feasible noise amelioration measures that would reduce these impacts. Water • While there are potential risks to surface and groundwater resources from construction and operation of the airport site, most of these are not specific to airport developments and a range of standard industry design and precautionary measures would be implemented to reduce these risks. • It is considered unlikely that emergency fuel jettisoning would result in impacts to surface water bodies including potable water storages given the rarity of its occurrence and restrictions on where it can be undertaken.

Issue	Key environmental issues
Hazard and risk	• With the completion of the necessary design studies for Civil Aviation Safety Authority aerodrome certification, as well as implementation of the requirements of the existing regulatory framework, no insurmountable risks associated with Stage 1 would be likely. • Key issues that would be finalised prior to the operation of the airport include: ▪ resolution of off-site risks associated with jet fuel storage; ▪ reservation of a pipeline corridor to secure future fuel supply by means other than road transport in conjunction with NSW Department of Planning and Environment; ▪ additional bird and bat surveys to confirm the preliminary risk identified; ▪ completion of a study to identify stack emissions in the proposed airspace; and ▪ implementation of development controls on public safety zones outside Commonwealth land. • Prior to operations commencing at the airport, a safety review would need to be undertaken in accordance with the requirements of the applicable work, health and safety legislation.
Traffic, transport and access	• There would be an estimated 1,254 additional vehicle movements per day on the surrounding road network during construction. This includes 314 peak vehicle movements per hour during the AM peak period. • During operation there would be approximately 41,858 vehicles entering and leaving the airport site each day by 2030. • With the introduction of the M12 Motorway, this additional traffic would not likely significantly affect the operation of the surrounding road network but is expected to result in a small increase in congestion at The Northern Road/M4 intersection and a small increase in congestion on Mamre Road.
Biodiversity	• The proposed airport would result in the removal of approximately 1,065 hectares of vegetation during construction, including about 280.8 hectares of native vegetation. • Removal of vegetation would result in the loss of fauna foraging, breeding, roosting, sheltering and/or dispersal habitat. • Threatened species, populations and ecological communities listed under both the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) and the *Threatened Species Conservation Act 1995* (NSW) (TSC Act) would be affected by Stage 1. • There is an associated risk of fauna strike from contact with aircraft and ground transportation vehicles both on and surrounding the airport site. • Indirect impacts would be associated with light, noise and vibration and the introduction of exotic species. • Offset package prepared to compensate for the removal of approximately 90.8 hectares of Cumberland Plain Woodland, the removal of about 120.6 hectares of foraging habitat for the Grey-headed Flying-fox, and impacts on other features of the natural environment including plant populations, fauna populations and several species and communities listed under NSW legislation.

Issue	Key environmental issues
Topography, geology and soils	• The topography of the site would change as a result of a major bulk earthworks programme involving the redistribution of about 22 million cubic metres of soil and rock across a construction impact zone covering about 60 per cent of the airport site. • Storage, treatment and handling of fuel, sewage and other chemicals with potential to contaminate land required for construction and operation. • Potential contaminated land associated with prior activities at the airport site including agriculture, light commercial and building demolition. • Potential impacts during operation are typical of a large scale infrastructure project and would be managed with the implementation of stormwater, erosion and dust controls and adherence to industry standards for the storage and handling of chemicals.
Surface water and groundwater	• Changes to catchment areas within the airport site and the permeability of the ground surface, would alter the duration, volume and velocity of surface water flow. • Bulk earthworks and excavations at the airport site would likely to receive some groundwater inflows. • An estimated 1.36 ML of water would be required per day for site preparation works. For the purposes of this draft EIS it has been assumed that to meet this requirement 8,600 litres (0.0086ML) of potable water would be sourced from existing assets operated by Sydney Water per day and the remaining water supplied through stormwater runoff captured in sediment dams or existing farm dams. • An estimated 2.5 ML wastewater generated during operation would be treated and recycled (as grey water) or irrigated on site.
Aboriginal heritage	• Construction would affect around 39 sites recorded at the airport site, all of which comprise artefact occurrences. • Construction activities would also impact approximately 501 hectares of archaeologically sensitive landforms. • Impacts during operation would be limited to indirect impacts on adjacent and nearby sites. The heritage values of these sites are unlikely to be vulnerable to indirect impacts such as loss of context.
European heritage	• Removal of up to 19 European heritage items from the airport site would not be able to be preserved in situ due to the large-scale clearing and earthworks required.
Planning and land use	• The proposed airport would result in the removal of existing rural residential, agricultural, recreational, community and extractive industry land uses on the airport site. • Surrounding land uses would be expected to transition from rural to urban land uses both as a result of airport operations, and as strategic land use planning under the Western Sydney Employment Area and the South West Priority Growth Area take effect. Infrastructure improvements to main roads and railways would also facilitate land use change in the region. • The successful implementation of measures to manage land use and planning impacts, including mitigation measures for employment land use conflict, zoning rationalisation, operational airspace controls, aircraft noise and infrastructure corridor protection, the proposed airport and its surrounds would become a focus for employment generating land uses in Western Sydney, creating jobs for the new residents of the South West Priority Area and Greater Western Sydney.

Issue	Key environmental issues
Landscape and visual amenity	• The proposed airport would result in temporary visual impacts during construction for the nearest sensitive receivers in Luddenham and Bringelly due to earthworks and the presence of construction plant, equipment, stockpiling areas and storage areas. • Potential moderate to high visual impacts during operation would result from overflights in Luddenham, Elizabeth Drive, Lawson Road and Mount Vernon. • Lower level impacts as a result of overflights would be likely for areas to the south of the airport site including Silverdale Road, Bents Basin State Conservation Area and Dwyer Road. • Operational lighting would likely have low impacts on sensitive receivers due to topography, existing vegetation, building design, lighting design and runway configuration.
Social	• The proposed airport would increase employment and population growth for Western Sydney, and Greater Sydney more broadly. • Significant benefits to the people and economy of Western Sydney would be related to economic development and employment opportunities. • Creation of jobs for many types of workers of various skills and qualifications, which would contribute to increased incomes across the Western Sydney region. • Stimulation of further development in regional and local centres, providing better quality social infrastructure, such as shops, health services, recreation and leisure services. • Development of training opportunities in the region undertaken by the state government and local governments will encourage innovation to create new small and large businesses supporting the proposed Western Sydney Airport development. • Varying amenity and lifestyle impacts in the Western Sydney region depending on proximity to the airport, and location with respect to flight paths.
Economic	• Up to 758 new full-time equivalent jobs are expected on the airport site, which would employ up to a further 2,660 people in Western Sydney during the busiest periods of construction. • In addition, up to 520 jobs would be created across the rest of the Sydney region in 2022 due to the multiplier effect. • Estimated economic footprint of $1.9 billion (in terms of value add) is expected to be generated during the construction period, with a further $400 million generated across the rest of Sydney. • In 2031 the Stage 1 development would facilitate an increase of 6,930 FTE jobs in Western Sydney (above natural growth expected without the development of the proposed airport). • Increases in employment in Western Sydney would be driven by increased access to workers and other businesses.
Resources and waste	• Estimated 202,500 tonnes of waste vegetation and construction materials such as concrete and timber would be generated during construction. • Estimated 5,251 tonnes of waste would be generated each year during initial operations, including general waste, food, packaging waste from terminals and waste oils, paints and cleaners from maintenance activities.

Issue	Key environmental issues
Greater Blue Mountains World Heritage Area	• Indirect operational impacts would be expected in relation to noise, air emissions and visual impact from the overflight of aircraft. • Almost all flights would be at an altitude greater than 5,000 feet and most would be more than 10,000 feet above sea level when passing over the area. At these altitudes, aircraft are likely to be difficult to discern from ground level and are not considered to be visually intrusive. • Indicative flight tracks at altitudes of less than 5,000 feet are limited to Warragamba and the eastern boundary of the Blue Mountains National Park, which would experience 50 to 100 flights per day. • Generally minimal incursion of noise levels in excess of 55 dBA would occur. Echo Point at Katoomba would not experience impacts from increased noise levels, and the majority of other sensitive areas are predicted be impacted only infrequently.
Cumulative impacts	• Potential cumulative impacts with other major projects in the region requiring coordination with NSW Government agencies include: ▪ Western Sydney Infrastructure Plan; ▪ Western Sydney Employment Area; ▪ South West Priority Growth Area; and ▪ other major projects identified in the region. • Minimal potential for cumulative noise impacts upon sensitive receivers as a result of the distance from other major projects, with the relocation of The Northern Road and construction of the M12 motorway having highest potential for cumulative noise impacts. • Predicted air quality impacts (emissions) would typically be below the respective air quality assessment criteria during construction and operation for both incremental impacts of the airport alone and when considered cumulatively with other surrounding land use and development. • Additional vehicle movements associated with construction and operation are not likely to significantly affect the operation of the surrounding road network.

29.3.1. Mitigation measures

Mitigation measures would be implemented during both construction and operation to reduce potential environmental impacts. Where developments or designs, such as the development of flight paths, are subject to subsequent approval processes, further environmental assessment and consultation would be undertaken as required.

The environmental performance of the proposal would be managed through the implementation of the construction and operational environmental management plans and monitoring programs. This would also aide in compliance with relevant legislation and conditions of approval.

29.4. Consideration of the objects of the EPBC Act

Section 3 of the EPBC Act identifies the following objects:

a. *to provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance;*

b. *to promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources;*

c. to promote the conservation of biodiversity;

d. to promote a cooperative approach to the protection and management of the environment involving governments, the community, landholders and indigenous peoples; and

e. to promote the use of indigenous peoples' knowledge of biodiversity with the involvement of, and in cooperation with, the owners of the knowledge.

The proposed airport is consistent with the objectives of the EPBC Act.

This draft EIS assesses the likely impacts of the proposal and provides mitigation measures for protection of the environment. The draft EIS specifically assesses potential impacts on, and triggers to, matters of national environmental significance, including listed species and ecological communities, the Greater Blue Mountains World Heritage Area, Commonwealth land, and Commonwealth actions.

A biodiversity offset is proposed to allow for the conservation of regional biodiversity values in perpetuity.

The environmental impact assessment of the proposed airport has involved extensive consultation with key stakeholders in a cooperative approach to project development. Consultation with key stakeholders and the community would continue through the public exhibition of this draft EIS, post-determination, during construction and following commencement of operations.

The principles of ecologically sustainable development were adopted during the preparation of this draft EIS. An assessment of the proposal against these principles follows below.

29.5. Consideration of the principles of ecologically sustainable development

Section 3A of the EPBC Act adopts the following principles of ecologically sustainable development:

a. Decision making processes should effectively integrate both long term and short term economic, environmental, social and equitable considerations.

b. If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

c. The principle of inter-generational equity – that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

d. The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision making.

e. Improved valuation, pricing and incentive mechanisms should be promoted.

An assessment of the proposal against these principles is provided below

29.5.1. Consideration of long term and short term

The proposed airport would be consistent with the objective of effectively integrating both long term and short term economic, environmental, social and equitable considerations in decision making.

This draft EIS has considered the environmental impacts of the construction phase, and both the short term (Stage 1) and long term operation phases of the proposed airport. The proposed airport would provide both short and long term benefits in terms of job creation and provision of accessibility to aviation services. The airport would also address the long term aviation capacity requirements of the Sydney region.

29.5.2. Precautionary principle

The precautionary principle states that if there are threats of serious environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In applying the principle, decisions should be guided by careful evaluation to avoid, wherever practicable, serious damage to the environment, including an assessment of the risks associated with various options. The proposed airport would be consistent with the precautionary principle.

Potential environmental impacts associated with the proposed airport have been assessed and documented in this draft EIS to minimise the likelihood of serious damage to the environment, with necessary mitigation measures proposed as required. Conservative approaches in line with the precautionary principle, including contingencies in assumptions such that assessed impacts were likely to be worse than would actually occur, were applied in a number of environmental assessments.

This draft EIS implemented a compliance, risk, and/or significance-based approach to impact assessment (refer to Chapter 9). Higher risk aspects were managed through avoidance or suitable mitigation strategies to an acceptable level of residual risk.

The project would adopt 'leading practice' environmental and community management and monitoring plans to manage, mitigate and monitor impacts identified in this draft EIS. These plans aim to ensure that impacts are within the range predicted in this draft EIS, and to ensure corrective action is taken if unpredicted impacts are identified.

29.5.3. Intergenerational equity

The principle of intergenerational equity states that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations. The proposed airport would be consistent with the principle of intergenerational equity.

Given the alternatives considered (refer to Chapter 2) and the proposed environmental management framework (refer to Chapter 28), the proposed airport would operate to ensure there would be no significant impact that would diminish the health, diversity or productivity of the environment for future generations.

The incremental nature of the long term development of the airport would provide opportunities for intergenerational equity and decision making that takes full advantage of changing conditions and technologies. The proposed airport would also provide a broad range of economic benefits which would continue to increase with time.

29.5.4. Conservation of biodiversity and ecological integrity

The conservation of biological diversity and ecological integrity should be a fundamental consideration of any development proposal. The proposed airport would be consistent with this principle.

Where feasible, the project would minimise impacts on sensitive ecological areas and minimise clearing of native vegetation more generally. An offset package has been prepared to compensate for the removal of approximately 90.8 hectares of Cumberland Plain Woodland, the removal of about 120.6 hectares of foraging habitat for the Grey-headed Flying-fox, and impacts on other features of the natural environment.

29.5.5. Valuation, pricing and incentives

The principle of improved valuation states that environmental factors should be considered in the valuation of assets and services. The principle is implicit in such concepts as ‘polluter pays’, lifecycle costing, and triple bottom line accounting.

The proposed airport would be consistent with this principle as environmental factors were integrated into the environmental impact assessment and cost benefit analysis, including environmental externalities such as traffic congestion and air quality impacts; and the opportunity costs of other uses of the airport site.

29.6. Summary

The proposed airport would be developed on the Commonwealth-owned land at Badgerys Creek in Western Sydney and would cater for ongoing growth in demand for air travel, servicing both domestic and international markets.

A draft Airport Plan has been developed to set out the Australian Government’s requirements for development of the proposed airport, forming the basis of the authorisation for the project under the Airports Act. The draft Airport Plan includes details of the Stage 1 development with a single 3,700 metre runway on a north-east/south-west orientation and aviation support facilities to provide an operational capacity of 10 million annual passengers as well as freight traffic. Stage 1 is designed to cater for the predicted demand for five years following opening around 2025 until around 2030 and forms the basis for the consideration of potential impacts.

This draft EIS has been prepared in accordance with Part 3 of the EPBC Act and the Department of the Environment guidelines for the assessment of the airport proposal (EPBC 2014/7391).

Based on the findings of the environmental investigations undertaken to inform this draft EIS, the proposed airport would result in some adverse impacts on the environment and the community. Mitigation measures have been proposed to reduce these potential impacts during construction and operation.

The environmental performance of the proposal would be managed through the implementation of the construction and operational environmental management plans and monitoring programs. This would aide in ensuring compliance with relevant legislation and conditions of approval.

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