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Department of Infrastructure, Transport, Regional Development, Communications and the Arts

Western Sydney International (Nancy-Bird Walton) Airport – Airspace and flight path design

Environmental Impact Statement

Part C: Environmental impact assessment

October 2024

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EIS guide

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Chapter 10 Approach to impact assessment

The purpose of this chapter is to describe the approach to the impact assessment for the proposed airspace and flight path design for the Western Sydney International (Nancy-Bird Walton) Airport (the project) in line with the relevant requirements of the Airports Act 1996 (including the Airport Plan) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The statutory framework applicable to the project incorporating the Environmental Impact Statement (EIS) process is provided in Chapter 5 (Statutory context). The detailed methodologies are described in individual technical papers and summarised in Chapter 11 to Chapter 23.

10.1 Introduction

Part C of this EIS presents the core of the impact assessment and covers the range of relevant effects associated with the project for single runway operations across the 3 chosen assessment years (where relevant – refer to Section 10.5).

While an approval is not required under Part 3, Division 1 of the EPBC Act, the assessment of the project still needs to consider the impacts on the 'whole of the environment', meaning the assessment is not limited to the consideration of Matters of National Environmental Significance (MNES) (refer to EIS Guidelines (EPBC 2022/9143) section 7.3.3). The EIS Guidelines for the project (refer to Appendix C (EIS Guidelines)) also require consideration of the *World Heritage Advice Note: Environmental Assessment* (IUCN, 2013) (IUCN Guidelines). As the IUCN Guidelines have been superseded, the assessment has also considered *Guidance and Toolkit for impact assessments in a World Heritage Context* (UNESCO, 2022a).

10.2 Approach

The approach to impact assessment for this EIS has been to:

- identify key potential impacts and risks to be considered in the EIS for the project with consideration to the 'whole of the environment'
- capture and address the relevant requirements of the Airports Act and the EPBC Act in the EIS, those in accordance with the EIS Guideline requirements, "…a description of all of the relevant impacts of the action (including direct, indirect, facilitated and cumulative), including the magnitude, duration and frequency of the impacts."

Through this approach, key potential impacts for each key aspect were identified for consideration as part of detailed impact assessments (technical papers), which may be in addition to those specified by the EIS Guidelines. A separate assessment of impacts on World Heritage was conducted to specifically meet the IUCN Guidelines.

The assessment has also been informed by the following guidelines:

- Matters of National Environmental Significance, Significant impact guidelines 1.1 *Environment Protection and Biodiversity Conservation Act 1999* (Significant impact guidelines 1.1) (Commonwealth of Australia, 2013a)
- Actions on, or impacting upon Commonwealth land, and actions by Commonwealth agencies, Significant impact guidelines 1.2 *Environment Protection and Biodiversity Conservation Act 1999* (Significant impact guidelines 1.2) (Commonwealth of Australia, 2013b).

10.2.1 Impacts on MNES

Significant impact guidelines 1.1 provide a definition of 'significant impact' and identify a set of criteria for each MNES to determine whether the project is likely to have such an impact. They also outline the approach to take where there is scientific uncertainty about the potential impacts. A checklist of the 9 MNES, and correlating EIS chapter/s that provide the assessment information is provided in Table 10.1.

Table 10.1 EPBC Protected Matters checklist

EPBC Act controlling provision	Relevant EIS Chapters
Matters of national environmental significance	
World Heritage properties	Chapter 16 (Biodiversity), Chapter 17 (Heritage), Chapter 23 (Matters of National Environmental Significance).
National Heritage Places	Chapter 17 (Heritage) and Chapter 23 (Matters of National Environmental Significance).
Wetlands of International importance	Chapter 16 (Biodiversity) and Chapter 23 (Matters of National Environmental Significance).
Listed threatened ecological communities	Chapter 16 (Biodiversity) and Chapter 23 (Matters of National Environmental Significance).
Listed threatened species	Chapter 16 (Biodiversity) and Chapter 23 (Matters of National Environmental Significance).
Listed migratory species*	Chapter 16 (Biodiversity) and Chapter 23 (Matters of National Environmental Significance).
Great Barrier Reef Marine Park	This aspect is not applicable as the project is located over 900 km from the Great Barrier Reef Marine Park.
Nuclear action (including uranium mining)	Not applicable as the project is located 83 km from a Commonwealth marine area and there is no impact pathway from the project to that area.
Commonwealth marine areas	Commonwealth marine areas are located within 45 nm (83 km) of the Airport Site. However, the project would not impact on a Commonwealth marine area.
A water resource, in relation to coal seam gas development and large coal mining development	This aspect is not applicable as the project does not include coal seam gas development or large coal mining development.
Other relevant protected matters	
The environment of Commonwealth land	Various Chapters in part C of the EIS, as the project provides flight paths over the WSI site and other Commonwealth Land.
Commonwealth action	This project relates to a Commonwealth action.
Commonwealth Heritage Places	Chapter 17 (Heritage).
Listed marine species; Critical habitats; Commonwealth reserves – terrestrial; and Nationally important wetlands	Chapter 16 (Biodiversity).

*listed under signed international conventions and agreements including Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), China-Australia Migratory Bird Agreement (CAMBA) and Japan-Australia Migratory Bird Agreement (JAMBA)).

Where an "action" under the EPBC Act does not trigger a need for approval under Part 3, Division 1 of the EPBC Act for impacts on listed threatened species or ecological communities (or fall within one of several other exceptions in section 197 of under the EPBC Act but may kill, injure, take, trade, keep or move a member of a listed threatened species or ecological community, a member of a listed migratory species, or a member of a listed marine species in or on a Commonwealth area, a permit may be required under Part 13 of the EPBC Act (refer to Chapter 16 (Biodiversity)).

10.2.2 Impacts on 'whole of the environment'

Significant impact guidelines 1.2 consider the whole of the environment impacts to be the "*total adverse impact of the action in the entire context of the environment which will be impacted by the project, particularly those elements of the environment which are sensitive or valuable*."

These guidelines are relevant to the project as they apply to:

- any person who proposes to take an action which is either situated on Commonwealth land or which may impact on Commonwealth land
- representatives of Commonwealth agencies who propose to take an action that may impact on the environment anywhere in the world.

An 'action' includes a project, development, undertaking, activity, or series of activities.

The guidelines identify a set of criteria against the following aspects to determine whether the project is likely to have a 'significant' impact on the environment:

- landscapes and soils
- coastal landscapes and processes
- ocean forms, ocean processes and ocean life
- water resources
- pollutants, chemicals and toxic substances
- plants
- animals
- people and communities
- heritage.

A checklist with the specific significance criteria and correlating EIS chapter/s that provide the assessment information is provided in Table 10.2. A summary assessment against each of the relevant significance criteria is provided in Chapter 25 (Conclusion).

Table 10.2 Whole of environment checklist

Environmental element	Relevant EIS chapters
Impacts on landscapes and soils	
Is there a real chance or possibility that the action will:	
• substantially alter natural landscape features	Chapter 15 (Landscape and visual amenity).
• cause subsidence, instability or substantial erosion	This aspect is not applicable as the project does not involve any ground-side works.
• involve medium or large-scale excavation of soil or minerals?	This aspect is not applicable as the project does not involve any excavation.

Environmental element	Relevant EIS chapters
Impacts on coastal landscapes and processes	
Is there a real chance or possibility that the action will: • alter coastal processes, including wave action, sediment movement or accretion, or water circulation patterns • permanently alter tidal patterns, water flows or water quality in estuaries • reduce biological diversity or change species composition in estuaries or • extract large volumes of sand or substantially destabilise sand dunes?	Not applicable as the WSI runway is located approximately 41 kilometres (km) from the coast.
Impacts on ocean forms, ocean processes and ocean life	
Is there a real chance or possibility that the action will: • reduce biological diversity or change species composition on reefs, seamounts or in other sensitive marine environments • alter water circulation patterns by modification of existing landforms or the addition of artificial reefs or other large structures • substantially damage or modify large areas of the seafloor or ocean habitat, such as sea grass • release oil, fuel or other toxic substances into the marine environment in sufficient quantity to kill larger marine animals or alter ecosystem processes • release large quantities of sewage or other waste into the marine environment?	This aspect is not applicable as the WSI runway is located approximately 41 kilometres (km) from the coast. Indirect impacts on the environment from, for example, fuel jettisoning (fuel dumping), are assessed as per the pollutants, chemicals and toxic substances criteria further below in this table.
Impacts on water resources	
Is there a real chance or possibility that the action will: • measurably reduce the quantity, quality or availability of surface or ground water • channelise, divert or impound rivers or creeks or substantially alter drainage patterns or • measurably alter water table levels?	Risks to water quality due to aircraft operations (e.g. through fuel jettisoning) has been considered in Chapter 13 (Aircraft hazard and risk).
Pollutants, chemicals, and toxic substances	
Is there a real chance or possibility that the action will:	
• generate smoke, fumes, chemicals, nutrients, or other pollutants which will substantially reduce local air quality or water quality	Chapter 12 (Air quality and greenhouse gas).
• result in the release, leakage, spillage, or explosion of flammable, explosive, toxic, radioactive, carcinogenic, or mutagenic substances, through use, storage, transport, or disposal	Chapter 13 (Aircraft hazard and risk) Chapter 16 (Biodiversity) Chapter 20 (Human health).

Environmental element	Relevant EIS chapters
• increase atmospheric concentrations of gases which will contribute to the greenhouse effect or ozone damage	Chapter 12 (Air quality and greenhouse gas).
• substantially disturb contaminated or acid-sulphate soils?	This aspect is not applicable as the project does not involve any disturbance of soils.
Impacts on plants	
Is there a real chance or possibility that the action will: • involve medium or large-scale native vegetation clearance • involve any clearance of any vegetation containing a listed threatened species which is likely to result in a long-term decline in a population or which threatens the viability of the species • introduce potentially invasive species • involve the use of chemicals which substantially stunt the growth of native vegetation • involve large-scale controlled burning or any controlled burning in sensitive areas, including areas which contain listed threatened species?	This aspect is not applicable as the project is limited to airspace and does not involve any of these activities that may impact on plants. Chemical use would be limited to that required to operate aircraft. It is not anticipated that this use would stint the growth of native vegetation.
Impacts on animals	
Is there a real chance or possibility that the action will:	
• cause a long-term decrease in, or threaten the viability of, a native animal population or populations, through death, injury or other harm to individuals	Chapter 16 (Biodiversity).
• displace or substantially limit the movement or dispersal of native animal population	
• substantially reduce or fragment available habitat for native species	
• reduce or fragment available habitat for listed threatened species which is likely to displace a population, result in a long-term decline in a population, or threaten the viability of the species	
• introduce exotic species which will substantially reduce habitat or resources for native species	This aspect is not applicable as the project does not involve any ground-side works that may introduce exotic species.
• undertake large-scale controlled burning or any controlled burning in areas containing listed threatened species	Not applicable as the project does not involve any large-scale controlled burning.

Environmental element	Relevant EIS chapters
Impact on people and communities	
Is there a real chance or possibility that the action will:	
• substantially increase demand for, or reduce the availability of, community services or infrastructure which have direct or indirect impacts on the environment, including water supply, power supply, roads, waste disposal, and housing	Chapter 13 (Aircraft hazard and risk) Chapter 18 (Social) Chapter 20 (Human health).
• affect the health, safety, welfare or quality of life of the members of a community, through factors such as noise, odours, fumes, smoke, or other pollutants	Chapter 11 (Aircraft noise) Chapter 12 (Air quality and greenhouse gas) Chapter 13 (Aircraft hazard and risk) Chapter 18 (Social) Chapter 20 (Human health).
• cause physical dislocation of individuals or communities	Chapter 14 (Land use) Chapter 18 (Social).
• substantially change or diminish cultural identity, social organisation or community resources	Chapter 17 (Heritage) Chapter 18 (Social).
Impacts on heritage	
Is there a real chance or possibility that the action will:	
• permanently destroy, remove or substantially alter the fabric (physical material including structural elements and other components, fixtures, contents, and objects) of a heritage place	Chapter 17 (Heritage) Chapter 23 (Matters of National Environmental Significance).
• involve extension, renovation, or substantial alteration of a heritage place in a manner which is inconsistent with the heritage values of the place	
• involve the erection of buildings or other structures adjacent to, or within important sight lines of, a heritage place which is inconsistent with the heritage values of the place	
• substantially diminish the heritage value of a heritage place for a community or group for which it is significant	
• substantially alter the setting of a heritage place in a manner which is inconsistent with the heritage values of the place	
• substantially restrict or inhibit the existing use of a heritage place as a cultural or ceremonial site?	

10.3 Impact scoping

The first step of the impact assessment process was to identify the key aspects of the environment that would be subject to detailed assessment as part of the EIS.

The scope of relevant aspects was informed by:

- the requirements of Condition 16 of the Airport Plan
- EIS Guidelines for the project as presented in Appendix C
- preliminary environmental assessments conducted as part of the design process to date (see Chapter 6 (Project development and alternatives))
- the 'environmental context' of the project as described in the Significant Impact Guidelines 1.2
- previous assessments for runway approvals.

The key aspects for this EIS were determined to be:

- aircraft noise
- air quality and greenhouse gas (air pollution)
- aircraft hazards and risk
- land use
- landscape and visual amenity
- biodiversity (impacts to fauna)
- heritage (Aboriginal and historic, including the GBMA)
- people and communities, covered under:
  - social
  - economic
  - human health
- cumulative impacts
- MNES (including World heritage and National heritage values).

The key aspects identified by the EIS Guidelines were informed by the referral (EPBC 2022/9143), which was submitted to support the requirements of Section 161 of the EPBC Act and Condition 16 of the Airport Plan in 2021.

10.4 Impact assessment method

10.4.1 Defining the study area

In accordance with Significant impact guidelines 1.2, the first step to setting the environmental context was to consider the components or features in the area where the action would take place. This informed the definition of the study area.

At its broadest extent, the action would take place in the WSI-specific aviation airspace contained within the north-western quadrant of the Sydney Basin. This is defined generally from Runway 05 / 23 to joining the enroute airways beyond WSI's terminal airspace control area, often referred to as the terminal manoeuvring area. The terminal manoeuvring area is a notionally circular configuration centred on the Airport Site. For the purposes of this EIS, the assessment considers the potential for effects notionally out to around 45 nautical miles (nm) (83 kilometres (km)) along each flight path from WSI.

The lateral and vertical geographical extent of the study area adopted for the EIS varied according to the matter assessed as specified in each EIS chapter and accompanying technical paper.

For certain matters the study area was divided into components to assess the components or features of the environment most likely to be impacted.

10.4.2 Defining the existing environment

Identification and assessment of baseline environmental values and conditions provides the foundation against which potential impacts are assessed. The approach to describing and defining the existing environment was specific to each impact assessment and was undertaken in accordance with relevant guidelines and best practice. Specific sources of baseline information included:

- maps and aerial photographs of both historical and contemporary features
- data collected from surveys and sampling on the Airport Site and in the defined study area, including background noise levels, historical records of fauna, landscape character; etc
- documentary information from a wide variety of sources, including historical and contemporary records
- previous studies and literature, database searches, consultation findings and modelling.

The existing environment is described in detail in the technical papers and summarised in Chapter 11 through to Chapter 23. Limitations in the available baseline data is identified in technical papers and the summary provided in the EIS.

10.4.3 Identifying potential impacts

In accordance with the Significant Impact Guidelines 1.2, the project was considered at its broadest scope to identify its potential direct and indirect impacts according to each assessment topic. Facilitated impacts, as a result of airspace changes required for other airspace users has also been assessed within this EIS (Chapter 21 (Facilitated impacts)).

In terms of on-site versus off-site impacts, in the context of WSI, the impacts from the project are all 'off-site' with on-airport impacts accounted for in the 2016 EIS. The term 'on site' is not relevant to the project.

An assessment of cumulative impacts was also required to identify whether the project, which would take place in an airspace that is already impacted, may nevertheless have a significant impact on the environment if cumulative impacts are increased to unacceptable levels, for example, through the release of pollutants or due to changes in noise levels in relation to on-ground sources such as road, rail and industry. The assessment of cumulative impacts is described in Chapter 22 (Cumulative impacts).

Consideration was given to all adverse and beneficial impacts that could reasonably be predicted to follow from the project, whether these impacts are within the control of the person proposing to take the action (the DITRDCA) or not.

10.4.4 Determining the assessment type

Potential impacts were assessed using a (predominantly) qualitative or quantitative approach, depending on the nature of the issue and the requirements of relevant guidelines and policies, including those referred to in the EIS Guidelines. These can be defined as follows:

- A **quantitative assessment** refers to a process of data analysis that can be counted or measured and allocated a numeric value. It relies on having a suitable data sample size and definitive data trend or outcome, and in the context of an airspace change proposal, a measurable output that can be clearly used to assess the level of change against standard criteria.
- A **qualitative assessment** is subjectively focused, and data is typically unstructured or semi-structured. Such data has potentially more variation or smaller data sample sizes, and in the context of facilitated change may rely on the application of precedence and generic supporting tools.

The impacts have been assessed assuming that a number of design features are incorporated into the project to minimise the potential for impacts. These features form part of the baseline project for which approval is sought.

10.4.4.1 Significance assessment

To assess significance or compliance for each assessment topic, the following steps were followed:

- define the criteria to evaluate the significance of any impact or performance against relevant guideline criteria (for example, published limits or thresholds)
- define the potential impacts of the project using the project description (see Chapter 7 (The project)), which incorporates the standard mitigation (that is, statutory compliance and measures incorporated in the design)
- assess the significance (or compliance) using a framework appropriate for each assessment topic
- where a significant impact is identified, which may be associated with a non-compliance against standard guideline values, consider additional mitigation measures to reduce the severity and/or likelihood of the impact, where feasible and safe to do so.

In the case of aircraft noise, a suite of metrics that describe aircraft noise, designed to be meaningful and understandable to both residents and decision-makers, allowing all stakeholders (airlines, airports, communities, regulators, consultants) to understand the likely resulting noise environment. As outlined in Chapter 11 (Aircraft noise), while there are no legislative criteria for the evaluation of aircraft noise in Australia, accepted industry practice is to consider changes within ANEC, N70 24-hours, N60 night and N60 24-hours.

10.4.5 Unknown and unpredictable impacts

Potential environmental impacts of the proposed action have been appropriately identified at this stage of the design development (Phase 2 – Preliminary design). Impacts relating to the majority of issues are well understood and any uncertainties are documented where relevant in individual impact assessments within Chapters 11 to Chapter 23 of the EIS. The application of comprehensive mitigation and management measures and continuous improvement through review of the performance of environmental controls would be implemented (see Chapter 24 (Mitigation and management)). Cumulative impacts associated with the project and the range of screened projects outlined in Chapter 22 (Cumulative impacts) are likely to be partially unpredictable due to the complexity and uncertainty of the exact timing associated with these developments. However, mitigation measures outlined in Chapter 24 have been developed to manage the cumulative impacts of project interfaces and mitigate uncertainty over these impacts.

10.4.6 Mitigation, management and residual impacts

Mitigation and management measures were identified to minimise or avoid those impacts identified where significant impacts were identified, where it is safe and feasible to do so. The consideration of residual impacts following implementation of available mitigation is provided in each of the subject matter chapters in the EIS and in Chapter 25 (Conclusion).

10.5 Assessment years and scenarios

The assessment of potentially significant impacts requires a comparison to be made between the likely environmental conditions that will result under the project (that is, due to the introduction of new flight paths, airspace management concepts and procedures to facilitate aircraft arriving and departing WSI's single runway system) relative to existing conditions.

10.5.1 Assessment years

For this EIS, particular years have been selected as points in time for assessing any future significant environmental impacts in the short- and long-term. These years are all tied to Stage 1, and the reasons for their selection are given below:

1. **2033** – representing the early years of airport operation, when single runway operations handle up to 10 million annual passengers and around 81,000 air traffic movements per year.
2. **2040** – representing an interim year of operation, when single runway operations handle around 15 million annual passengers and around 107,000 air traffic movements per year. This assessment year is assessed only for the assessment of aircraft noise to provide further information on the change in aircraft noise over time.
3. **2055** – representing impacts as the single runway approaches capacity, when single runway operations handle around 37 million annual passengers and around 226,000 air traffic movements per year.

Based on forecast schedules, these assessment years, and their approximate service capacity in terms of millions of annual passengers (MAPs) and air traffic movements (ATMs) per year (including freight operations) are depicted in Figure 10.1.

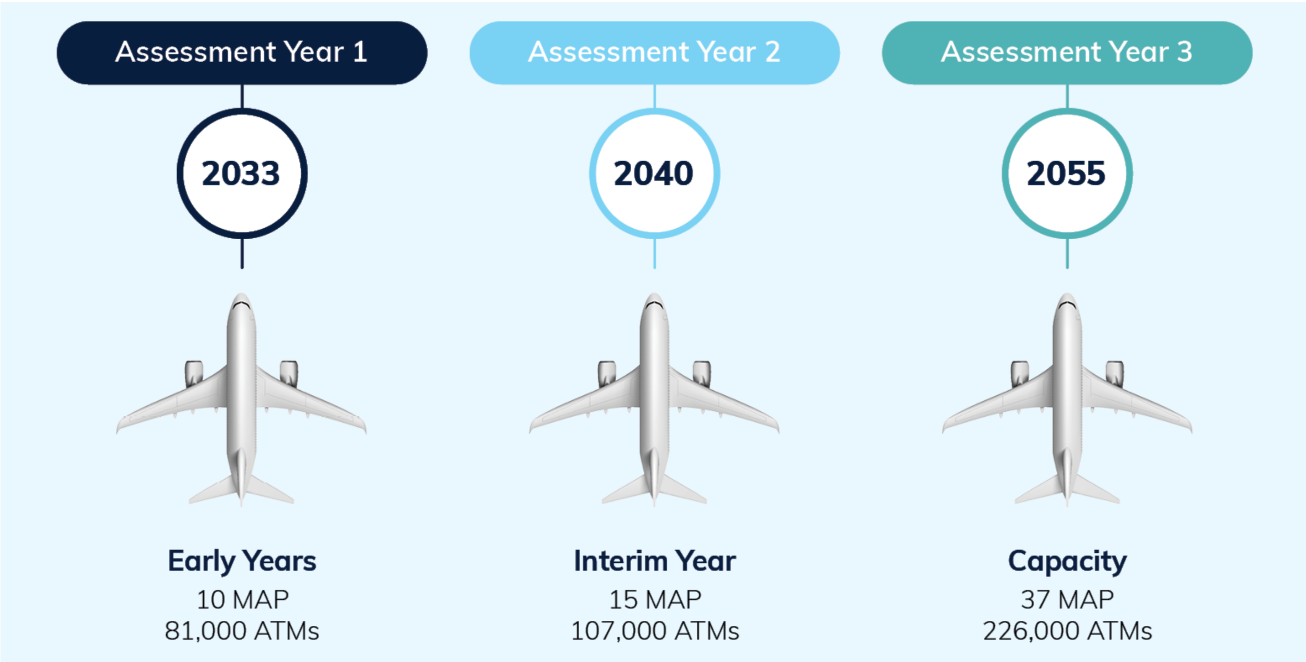


Figure 10.1 WSI assessment years

10.5.2 Assessment scenarios

The 3 runway modes of operation are presented in Chapter 7 (The project) - runway modes 05, 23 and reciprocal runway operations (RRO). Chapter 7 (The project) also includes the criteria that need to be met for the application of RRO. Runway availability and then runway usage would depend on a number of factors, including the selection criteria for each runway mode of operation, the meteorological conditions and the time of day. The selected operating scenarios used in noise modelling were:

- 'No preference', meaning that runway use was determined based on prevailing wind direction, resulting in balanced usage (approximately 50 per cent on both Runway 05 and Runway 23) in terms of runway direction and runway end exposure. This indicated that both runway ends are exposed to a similar proportion of arrivals and departures on an annualised basis
- 'Prefer Runway 05', meaning that the use of Runway 05 (day) and RRO (night) is preferred
- 'Prefer Runway 23', meaning that the use of Runway 23 (day) and RRO (night) is preferred.

For this EIS, the implications of noise exposure due to the inability to apply RRO is modelled using No preference.

The terms 'prefer' or 'preference' was given to where, if wind conditions, and traffic demand allows, a particular runway mode of operation (mode) would be used to move aircraft as efficiently as possible while reducing the noise impact over certain residential areas. Further details on operating scenarios used for modelling is provided in Chapter 11 (Aircraft noise).

For assessments that use the results of the aircraft noise assessment, the composite noise contours for 2033 and 2055 have been used (meaning the composite of the noise results from each operating scenario for each assessment year). This provides the expected 'worst case' noise exposure of communities.

10.5.3 Facilitated changes

There are required airspace changes prior to the opening of WSI as described in Chapter 8 (Facilitated changes). The assessment of these changes has applied the traffic forecast growth for Sydney (Kingsford Smith) Airport, Bankstown Airport and Camden Airports as presented in Chapter 4 (Project setting), and typically represent the year 2030.

Chapter 11 Aircraft noise

Summary of key findings

This chapter presents a summary of the nature and extent of likely short-term (year 2033), mid-term (2040) and long-term (year 2055) aircraft noise impacts associated with the preliminary airspace and flight path design (the project). It presents a comprehensive suite of noise metrics and supporting information to help all stakeholders understand the potential implications of single runway operations at Western Sydney International (Nancy-Bird) Airport (WSI).

Individuals interested in information about preliminary flight paths and aircraft noise can refer to this chapter, Chapter 7 (The project) and Technical paper 1: Aircraft noise (Technical paper 1). The online Aircraft Overflight Noise Tool is available online at https://www.wsiflightpaths.gov.au/. This tool shows preliminary flight paths and expected noise impacts on the community.

The findings of the assessment in relation to social amenity, world heritage and National heritage values and human health have been considered in Chapter 18 (Social), Chapter 23 (Matters of National Environmental Significance) and Chapter 20 (Human health) respectively.

Nature of noise

Individuals show varying sensitivity to noise. The Environmental Impact Statement (EIS) assessment of aircraft noise is based on measures outlined in *AS 2021:2015 Acoustics – Aircraft noise intrusion – building siting and construction* (AS 2021), the National Airports Safeguarding Framework (NASF) and Commonwealth Department of Transport and Regional Services (2000) '*Expanding ways to describe and assess Aircraft noise*'. These guidelines emphasise the challenge of communicating the complex nature and extent of aircraft noise and advocate using several different measures to aid interpretation of predicted noise exposure levels. While this EIS has used a range of measures for describing noise exposure, it is important to note that aircraft noise impacts could also be experienced by individuals outside the areas depicted by the various noise exposure contours. Individuals and communities newly exposed to aircraft noise are likely to show an enhanced sensitivity to changes in the noise environment.

Background and method

The aircraft noise study area (study area) was comprised of a nominal 45 nautical miles (nm) (83 kilometre (km)) radius from WSI to capture the areas most likely to be affected by noise from aircraft using the preliminary flight paths. The assessment considered the likely impacts of aircraft overflights over the 3 assessment years: 2033, 2040 and 2055 to reflect the change in noise impact as airport traffic increases.

In practice, noise impact will also depend on the WSI operating strategy adopted by air traffic control. The 5 proposed runway modes of operation as presented in Chapter 7 (The project) were the basis of runway operating scenarios which were modelled to generally cover the geographical extent of potential impacts of aircraft noise. Results were generated as a suite of information including charts, contour maps and tables and then analysed to assess and compare the significance of the projected noise exposure results.

The noise impact assessment undertaken for this EIS has adopted a conservative approach by assessing and modelling aircraft types based on those currently in service, without taking account of any future reductions in aircraft noise emissions which may occur over time due to technological advancements. The assessment excludes any considerations of overflight by existing operations at Sydney (Kingsford Smith) Airport, Bankstown and Camden Airports or RAAF Base Richmond.

Existing environment

Most parts of the Sydney Basin including Western Sydney currently experience some level of daily aircraft overflight. Aircraft noise from existing Sydney Basin operations is audible but has not been quantified as part of this assessment. The Sydney Basin is also overflown by aircraft transiting from outside the area to a mix of domestic and international destinations. These operations have not been considered in the assessment, but were perceptible based on the ambient noise monitoring presented to support this assessment.

There are a variety of acoustic environments within the WSI study area, ranging from urban areas such as Penrith's central business district (CBD), to rural areas that are largely removed from human-induced noise and the natural environments of the Greater Blue Mountains Area (GBMA).

Consideration through design

Increased levels of overflight of areas in proximity to WSI and under its preliminary flight paths is an unavoidable consequence of the introduction of new aircraft operations at WSI.

Preliminary airspace design development has been guided by Condition 16 and the 12 airspace design principles of the Airport Plan as detailed in Chapter 6 (Project development and alternatives). The impact of aircraft noise on the surrounding community has been minimised to the extent practical by directing aircraft away from overflying populated areas and visually sensitive areas where possible (whilst prioritising operational safety).

The assessment assumes the use of continuous descent approaches, which minimise the use of engine thrust by pilots. Continuous descent operations are used at a variety of other airports and are embodied in the preliminary airspace design provided by Airservices Australia.

Impact assessment

The key findings from the assessment may be summarised as follows:

- as the single runway approaches capacity in 2055, over a 24-hour period, between 7,000 to 12,200 residents may experience 5 or more aircraft noise events above 70 dB(A) which can lead to in an indoor sound level of 60 dB(A) when windows are opened (enough to disturb conversation). The number of residents affected by different levels of aircraft noise depends on the runway operating scenario adopted. Comparison of the 3 key scenarios indicates that while there is limited variability of noise exposure levels in close proximity to WSI, the choice of runway operating strategy has a more pronounced effect on communities further away
- the use of an alternative suite of proposed WSI day and night flight paths results in a level of respite and noise being shared to some areas impacted by the proposed higher traffic volumes of WSI day operations and a significant reduction in dwelling and population counts during WSI night operations, particularly when the Reciprocal Runway Operation (RRO) mode can be applied
- residential and rural-residential areas to the immediate north-east and south-west of WSI, located on extended runway alignment, and close to the preliminary arrival flight paths and initial departure turns will be subjected to a significant and unavoidable level of noise exposure.

The changes to noise impacts as a result of the refinements to the preliminary flight path design have been considered when finalising the EIS. The change in impact would be negligible to minor for some refinements. The introduction of the RRO noise abatement procedure (RRO-NAP) and the reallocation of aircraft from Runway 23 Departure Northeast Night (RRO) flight path to the Runway 23 Departure Southeast Night (RRO) flight path would result in a noticeable change to the noise contours, particularly the N60 night contours, as presented in the Draft EIS.

Options for noise mitigation

Increased exposure to aircraft noise in areas in the vicinity of WSI and under the arrival and departure flight paths will be an unavoidable consequence of aircraft operations at WSI.

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 (the focus of this EIS), and implementing land use planning or other controls to ensure that future noise-sensitive uses are not located in noise-affected areas.

External to the design, New South Wales (NSW) Government planning controls have been in place for several decades and have to the extent practical prevented incompatible noise sensitive developments around WSI. It is expected that future land use planning around the proposed airport would be influenced by final long-term Australian Noise Exposure Forecast (ANEF) contours once flight paths and operating modes are finalised and approved.

Subject to relevant considerations such as aircraft safety, all practicable opportunities for mitigating noise impacts will be considered in finalising the flight paths and aircraft operating procedures for the proposed airport.

Various operating strategies for managing aircraft noise will have differing impacts on different populations, particularly at night, when greater airspace flexibility and lower demand permits the use of different runway modes of operation and flight paths. This could be achieved by prioritising, when operationally possible, night-time flights over wedges of low-density rural land and natural areas to the south-west, west and south of WSI. However, it is noted that these areas could be more noise sensitive than urban areas experiencing similar levels of noise exposure.

11.1 Introduction

This assessment considers noise produced by aircraft during departure and arrival at WSI aircraft noise). Aircraft noise includes the noise generated.

On departure:

- from the point at which an aircraft commences its departure roll
- proceeds along the runway to the point of leaving the ground
- climbs into the air and departs the vicinity of WSI up to an altitude of around 20,000 feet (ft) (6 km).

On arrival:

- from the point at which an aircraft approaches the vicinity of WSI at an altitude of around 20,000 ft (6 km)
- descends to the runway
- touches down
- slows down along the runway to the point of exiting onto a taxiway
- uses reverse thrust if that is required to slow the aircraft down on the runway.

The separation of these noise sources from other on-ground sources such as engine ground start-ups and runs, aircraft taxiing and aircraft at the terminal is consistent with the noise classification in the *Airports (Environment Protection) Regulations 1997*. Ground-based noise from such sources was considered in the Western Sydney Airport – Environmental Impact Statement (2016 EIS) and is outside the scope of this assessment.

The full assessment is provided in Technical paper 1. The preliminary flight paths are provided in Chapter 7 (The project) and their development and finalisation is described in Chapter 6 (Project development and alternatives).

There are adjustments required to Sydney Basin operations prior to the opening of WSI in 2026 to facilitate its new flightpaths and airspace. These are described in Chapter 8 (Facilitated changes) and associated impacts (including aircraft noise) are assessed in Chapter 21 (Facilitated impacts).

Cumulative impacts, including the changes to noise levels arising from the project in relation to on-ground noises such as road, rail and industry are described in Chapter 22 (Cumulative impacts).

11.1.1 Assessment years

The assessment years for aircraft noise exposure are:

1. **2033** – representing the early years of airport operation, when single runway operations handle up to 10 million annual passengers and around 81,000 air traffic movements per year
2. **2040** – representing an interim year of operation, when single runway operations handle around 15 million annual passengers and around 107,000 air traffic movements per year
3. **2055** – representing aircraft noise impacts as the single runway approaches capacity, when single runway operations handle around 37 million annual passengers and around 226,000 air traffic movements per year.

These assessment years informed the selection of operational scenarios for consideration as discussed in Section 11.5.6.

In each year, noise exposure is predicted for the day period (5:30 am to 11 pm) and night period (11 pm to 5:30 am). The reasoning for these hours of operation is provided in Chapter 7 (The project) and explained further in the context of other noise metrics in Section 11.5.5.

11.2 Understanding aircraft noise

11.2.1 Nature of noise

Sound is a vibration that propagates as an acoustic wave through the air. It is transmitted to the human ear where such waves are received and processed by the brain as a sound or noise.

The loudness of a sound depends on its sound pressure level, which is expressed in decibels (dB). Most sounds we hear in our daily lives have sound-pressure levels in the range of 30 dB(A) and 90 dB(A), where (A) is an adjusted dB reading (A-weighted sound level) to account for the varying sensitivity of the human ear to different frequencies of sound.

The daytime background indoor sound level in a typical home is about 40 dB(A) and the average noise level of conversation is about 60 to 65 dB(A). Typical aircraft noise levels measured by Airservices Australia's Noise and Flight Path Monitoring System (NFPMS) are between 65 dB(A) and 95 dB(A), collected daily from noise monitors strategically located around communities close to Australian airports (refer to Section 11.8.2.3).

Figure 11.1 shows the A-weighted decibel (dB(A)) noise levels for a range of common situations and the comparison with spot aircraft departure noise levels for a typical aircraft (A320-200/B737-800).

Two to 3 decibels is the minimum change in sound level that most people can detect, while every 10 dB(A) increase in sound level is perceived as a doubling of loudness. Additionally, individuals may perceive the same sound differently and may be more or less affected by a particular sound.

The frequency of a sound is what gives it a distinctive pitch or tone – the rumble of distant thunder is an example of a low frequency sound and a whistle is an example of a high frequency sound. The human ear is more sensitive to high frequency sounds.

Most environmental sounds contain a broad range of frequencies. While middle to high frequency sounds tend to annoy most people, low frequency noise from aircraft-induced rattling, rumbling or vibration can also cause annoyance. Sound waves travel out equally in all directions from their source. This is like the way ripples travel when a rock is thrown into a calm pond. As soundwaves travel away from a source, they become less intense as the energy is spread out over an ever-increasing area and absorbed by the atmosphere. Higher frequencies are absorbed at shorter distances, while lower frequencies can travel further before they are absorbed. As a result, an aircraft can sound different depending on how far away it is flying. For example, a distant jet aircraft is often heard as a low frequency rumble. The amount of noise created varies according to the way in which an aircraft is flown, even for identical aircraft.

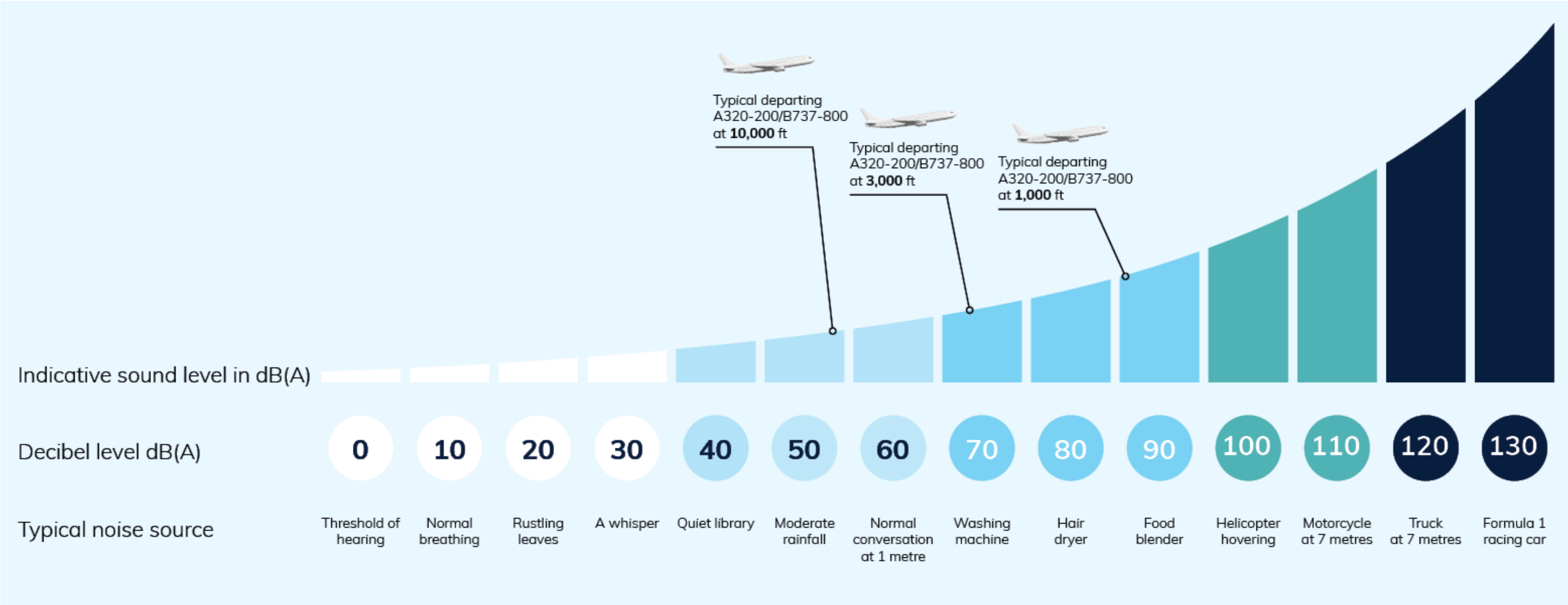


Figure 11.1 Indicative A-weighted decibel noise levels in typical situations

Experience has shown that many factors can influence an individual's response to aircraft noise, including:

- the specific characteristics of the noise (for example, the frequency, intensity and duration of noise events) and the time-of-day noise events occur
- background noise levels, and whether background noise is natural, industrial, desirable (for example, bird song) or undesirable (for example, road traffic)
- their personal circumstances and expectations about the number, frequency, loudness and timing of noise events
- their individual sensitivities and lifestyle (for example, whether they spend a lot of time outdoors, work from home or sleep with a window open)
- their reaction to a new noise source (in the case of a new airport or new runway) or to changed airport operational procedures
- their understanding of whether the noise is avoidable and their notions of fairness, and
- their attitudes towards the source of the noise (for example, general views about aviation activities and airports).

11.2.2 Sources of aircraft noise

Aircraft noise is the sound emitted through the operation of aircraft, as depicted in Figure 11.2. It is induced primarily by the engines (or propellers) and when air passes over the fuselage (the aircraft's body) and its wings. This causes friction and turbulence, which make noise. This is exacerbated when the landing gear, and control surfaces (such as ailerons and elevators) are in use.

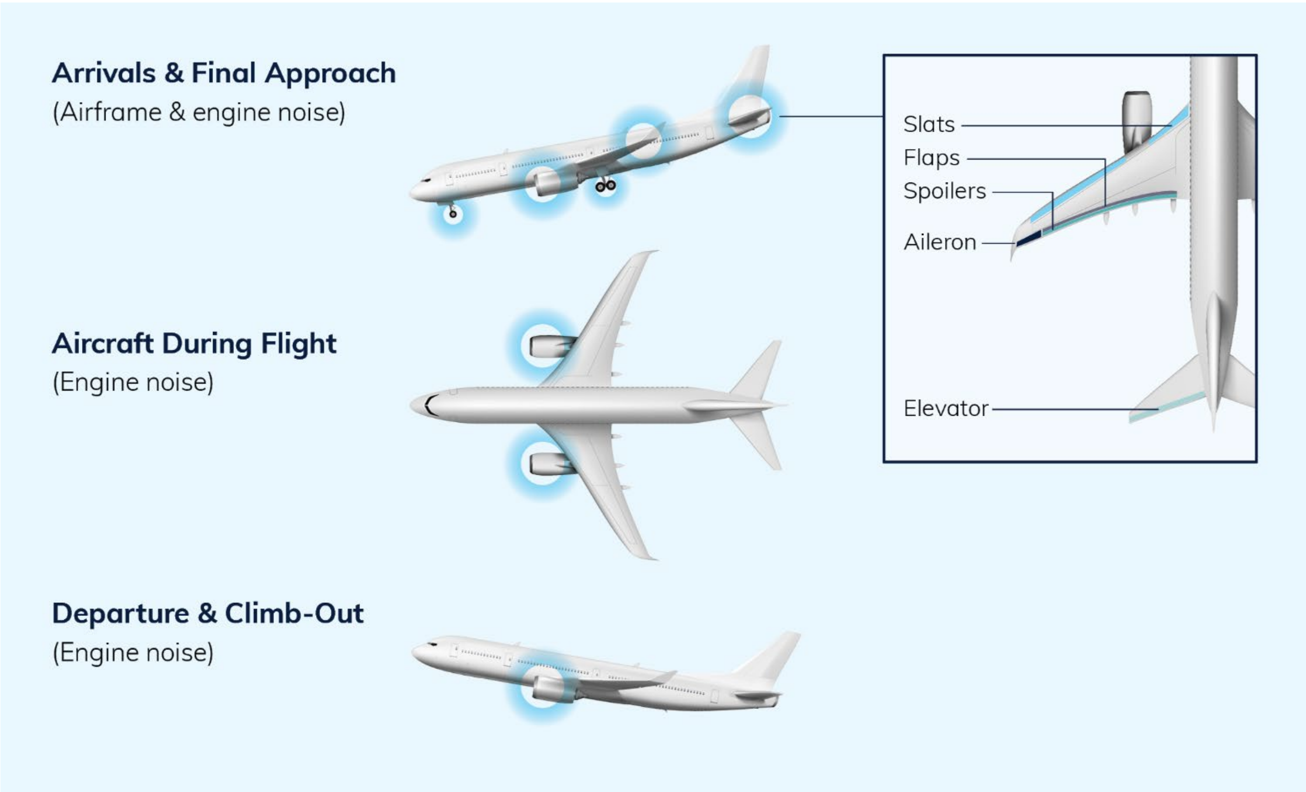


Figure 11.2 Aircraft noise sources

The level of noise heard from a plane during take-off, landing and during flight can vary. Aircraft noise is influenced by a range of factors, including:

- type and size of aircraft
- the weather, including season, wind and cloud cover
- the height of an aircraft above the terrain
- changes in engine thrust.

Generally, noise from departing aircraft is louder than from that of an arriving aircraft. Long range heavy, widebody jet aircraft such as the Boeing B747 with a full payload (including fuel) climb more slowly than smaller jet and non-jet aircraft and therefore can be heard at higher noise levels for longer. On approach, arriving aircraft are operating at a lower altitude further out from the Airport Site which may cause noise impacts at large distances from the runway. On landing, aircraft apply lower engine power (thrust) settings and are likely to be less noisy than on departing.

11.3 Legislative and policy context

There are no legislative criteria for the evaluation of aircraft noise in Australia. The relevant legislation, standards and assessment guidelines considered for the noise assessment include:

- *Airports Act 1996* (Cth) (Airports Act), specifically Condition 16 of the Airport Plan
- Air Navigation (Aircraft Noise) Regulations 2018
- Annex 16: Environmental Protection – Volume I Aircraft Noise (International Civil Aviation Organization (ICAO)) (ICAO, 2017)
- AS 2021:2015 Acoustics – Aircraft noise intrusion – building siting and construction (AS 2021:2015) (Standards Australia, 2015)
- ANEF system (endorsed by Airservices Australia)
- Balanced Approach to Aircraft Noise Management (ICAO Balanced Approach) (ICAO, 2010)
- Civil Aviation Safety Authority (CASA) regulatory standards
- Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)
- Environmental Management of Changes to Aircraft Operations standard (NOS) – AA-NOS-ENV2.100 Version 18: Effective 1 July 2022) (Airservices Australia, 2022b)
- National Airports Safeguarding Framework principles and guidelines (NASF Guidelines) (Department of Transport, Regional Development, Communications and the Arts (DITRDCA, 2012)
- NSW Noise Policy for Industry (NSW EPA, 2017)
- State Environmental Planning Policy (Precincts – Western Parkland City) 2021 (NSW) (Western Parkland City SEPP)
- Sydney (Kingsford Smith) Airport and Associated Airspace – Long Term Operating Plan (LTOP) (Airservices Australia, 1996).

The assessment was designed to address the EIS Guidelines and have due regard to the requirements of Airservices Australia's NOS. The relevance of the Airports Act and the EPBC Act to the project is described in Chapter 5 (Statutory context) and the application of international and Australian national standards and recommended practices is explained throughout the assessment. The ICAO Balanced Approach is of relevance as outlined in the following section. The responsibilities for aircraft noise as per Section 11.3.2 provides the broader context for managing airport related noise at civilian airports.

11.3.1 ICAO Balanced Approach to Aircraft Noise Management

As outlined in Table 11.1, ICAO is a specialised agency of the United Nations and is responsible for establishing the global regulatory framework for the safety of international civil aviation. This includes minimising the adverse environmental effects of civil aviation activities, including aircraft noise. The ICAO Balanced Approach was adopted in 2001 and consists of 4 principal elements as presented in Figure 11.3.

Noise management element	Description
Reduction of noise at source	Aircraft noise certification and international standards and recommended practices (SARPs) for aircraft noise
Land using planning and management	Compatible land use planning in the vicinity of airports
Noise abatement operational procedures	Controlling the use of runways and flight paths adjusting procedures for take-off, approach and landing
Operational restrictions	Restrictions on aircraft types and time of operation

Figure 11.3 ICAO's Balanced Approach to Aircraft Noise Management

The ICAO Balanced Approach identifies the noise occurrences at a specific airport and analyses various measures available to reduce noise which can be classified into the 4 principal elements. The goal is to address noise problems at each airport individually. This is done by using objective and measurable criteria to identify and select the most cost-effective noise-related measures that will achieve maximum environmental benefit (ICAO, n.d.).

The 4 principal elements are further explained in Section 11.8.2. Of these, the first principal element – reduction of noise at source – is relevant to the noise assessment as described in Section 11.3.1.1) and the third principal element – noise abatement procedures – is relevant to the operation of WSI as described in Section 11.8.2.2. The second and fourth principal elements are not directly relevant to this assessment.

Further information on the ICAO Balanced Approach is found in Section 7.1 of Technical paper 1.

11.3.1.1 Reduction in noise at source

The Air Navigation (Aircraft Noise) Regulations 2018 enact the ICAO noise emissions control standards for aircraft using airports in Australia.

Most operations at WSI are likely to be short haul domestic and regional routes served by narrow-body (single aisle, twin engine) jets from the Airbus 320 and Boeing 737 families. Over the past 60 years, aircraft have reduced their noise output by around 75 per cent when compared to the first-generation jet aircraft like the Boeing B707 and B727 jets. It is, however, difficult to predict future reductions in aircraft noise exposure from low noise variants because this is primarily the role of original equipment manufacturers, for example, Airbus and Boeing.

Aircraft types assessed and modelled for this EIS are based on those currently in service. This is considered a conservative approach, as even without further technological advances, it is reasonable to assume that aircraft projected noise levels around WSI would decrease over time as quieter new generation aircraft make up a greater proportion of the fleet mix.

Key future trends in aircraft type and movements at WSI are summarised in Chapter 2 (Strategic context and need) and further information on improvements in aircraft technology is provided in Section 11.4 of Technical paper 1.

11.3.2 Responsibilities for aircraft noise

Several organisations manage aircraft noise as summarised in Table 11.1. These include those who regulate and set standards for aircraft noise, manage noise through aircraft design or fleet management, or control the impact of noise through land use planning.

Table 11.1 Responsibilities for managing airport related noise at civilian airports

Organisation	Summary of responsibilities on aircraft noise
Regulators	
ICAO	• Works with member states, including Australia, to develop international standards and recommend practices for national aviation regulations. • Sets strict aircraft noise standards which aircraft built today are required to meet.
CASA	• Must maintain, enhance and promote the safety of civil aviation under the *Civil Aviation Act 1988.* • Must exercise its powers to ensure that the environment is protected from the effects of, and associated with, the operation and use of aircraft.
Airservices Australia	• Responsible for managing the aircraft movements at WSI. • 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, and the effects associated with, the operation and use of aircraft. This includes the requirement to: • prepare and publish noise abatement procedures • publish information on aircraft movements, runway and track usage and noise impacts using a range of noise descriptors • conduct noise monitoring in communities surrounding Australian airports • manage noise complaints and enquiries through the Noise Complaints and Information Service (NCIS).
Australian Government: Aircraft Noise Ombudsman (ANO)	Conducts independent reviews of Airservices Australia management of noise-related activities. Reviews include those related to: • community consultation processes for aircraft noise • the presentation and distribution of noise-related information.
Minister for Infrastructure, Transport, Regional Development and Local Government	Has specific responsibilities relating to the management of overflight noise, for example, the development of national airspace and air traffic management policies.

Organisation	Summary of responsibilities on aircraft noise
Aircraft fleet management	
Aircraft and engine manufacturers	Design and manufacture new aircraft that comply with ICAO noise standards.
Airlines and aircraft operators	Responsible for maintaining aircraft fleets and engines that meet ICAO noise standards and implementing noise abatement principles for flight operators, where applicable.
Land use control	
Airport Lessee Company (ALC) – Western Sydney Airport Company Limited (WSA Co).	• Is the airport lessee and operator. • Required to prepare the WSI masterplan, including publication of an ANEF and an environment strategy to manage noise impacts.
State government and local councils	Regulate land use planning and development in the vicinity of airports.
Community forums	
Community Aviation Consultation Group (CACG)	Supports effective engagement between Airport and Commonwealth, State and Local government agencies on strategic planning issues, including land use and aircraft noise impacts.

11.4 Avoidance and minimisation of impacts

Aircraft noise in the vicinity of flight paths is an unavoidable consequence of aircraft operations. The design process to date has focused on minimising the impact of aircraft noise on residents and sensitive areas through continuous assessment, consultation, and ongoing design development.

The 2016 EIS provided a high-level noise assessment based on indicative flight paths for WSI. Submissions raised concerns on the uncertainties of aircraft noise exposure contours and the potential for, and effectiveness of noise mitigation and management measures. The potential for aircraft arrivals to be processed in high-traffic areas by sequencing them to the runway in a structured manner over a common merge point (known as a 'point-merge' concept) was also of concern. To address this, the Airport Plan set out 12 airspace design principles that the design process is required to follow. The principles were informed by and reflect community and industry feedback on the 2016 EIS, including that aircraft arrivals will not converge through a single merge point over any single residential area.

As outlined in Chapter 6 (Project development and alternatives), flight paths have now been further developed to a preliminary design guided by Condition 16 and the 12 airspace design principles, which included noise considerations. This has included minimising the impact of aircraft noise on the surrounding community by directing aircraft away from overflying populated areas and visually sensitive areas where possible (while prioritising operational safety) and opportunities for RRO) mode of operation (refer to Chapter 7 (The project)).

Compared to the 2016 EIS, the noise assessment for this EIS presents a new suite of noise metric descriptors based on the preliminary airspace design, to be meaningful to both residents and decision-makers, and to allow stakeholders to come to an understanding of how the noise environment will change with the project. It also updates and expands on potential mitigation measures.

Management and mitigations would continue to be refined and developed as part of future phases (refer to Section 11.7.8).

11.5 Methodology

11.5.1 Overview

The methodology for the assessment of aircraft noise is detailed in Chapters 8 and 9 of Technical paper 1.

The methodology involved:

- determining an appropriate study area for the assessment of aircraft noise (Section 11.5.2)
- considering significance/compliance criteria and identifying noise sensitive areas (Section 11.5.3)
- characterising the current ambient noise environment across Western Sydney and the Blue Mountains, including background noise levels and current noise exposure from aircraft operating in the Sydney Basin (Section 11.6)
- selecting an appropriate suite of noise metrics to determine aircraft noise levels associated with the project (Section 11.5.4)
- calculating noise exposure forecasts using the chosen noise metrics for a range of scenarios (Sections 11.5.6 to 11.5.8)
- correlating the above noise exposure forecasts with the potential impact on the identified noise sensitive areas and using qualitative and quantitative descriptors of potential impact due to the implementation of the project (Section 11.7)
- consideration of reasonable and feasible management and mitigation measures (Section 11.7.8).

The aircraft noise assessment considers:

- the preliminary flight path, its lateral and vertical profile and the nature of the terrain overflown, the level of precision assumed for visual, instrument or satellite-based navigation
- the typical operating aircraft, jet or non-jet, size and weight category and whether the operation is a departure or arrival
- stage lengths (a measure of distance to destination for departing aircraft) as classified in the United States Federal Aviation Administration (US FAA)'s Aviation Environmental Design Tool (AEDT) (Version 3e) and calibrated with actual noise monitoring measurements (refer to Section 11.5.6.2), fuel loads on departure and take-off weight, engine thrust settings and vertical profiles
- the frequency of use and time of day (day or night definitions and weightings depending on the metric involved)
- the proximity of noise sensitive areas.

11.5.2 Study area

The study area is defined as an approximate 45 nm (83 km) radius from WSI to capture areas that are most likely to experience a direct impact from the noise of aircraft using WSI's preliminary flight paths at a level and frequency that could be considered disruptive.

There are existing flight paths and aircraft activity already in operation over the study area, with associated aircraft noise impacts (refer to Section 11.6).

This study area is considered appropriate for this noise assessment and EIS Guideline requirements. Not all the study area would be overflown or otherwise affected by the preliminary flight paths or changes to existing flight paths. This would be determined by factors such as elevation, flight path spread and associated single event noise levels.

11.5.3 Significance/compliance criteria

Quantitatively evaluating aircraft noise exposure is complex because its significance is influenced by many factors. Section 11.5.4 presents a suite of metrics that describe aircraft noise, designed to be meaningful and understandable to both residents and decision-makers, allowing all stakeholders (airlines, airports, communities, regulators, consultants) to understand the likely resulting noise environment. As outlined in Section 11.3, while there is no legislative criteria for the evaluation of aircraft noise in Australia, accepted industry practice is to consider changes within the defined (or selected) Australian Noise Exposure Concept (ANEC), N70 24-hours, N60 night and N60 24-hour contour levels. These metrics assist in assessing impacts, but the resulting forecasts from the application of these metrics do not, of themselves, require any responsive action to be taken.

The noise assessment considers these metrics in Section 11.5.4 in absolute terms and in terms of ‘soundscape’ (the acoustic environment as perceived by humans, in context) change. For a completely new airport like WSI, this will primarily be done in terms of comparison to ambient noise measurements.

To help evaluate the significance of aircraft noise impacts, project-specific qualitative criteria have been developed. They are described and applied in Chapter 18 (Social) and Chapter 20 (Human health), which considers the impacts of noise emissions on the community, as well as Chapter 16 (Biodiversity), Chapter 17 (Heritage) and Chapter 23 (Matters of National Environmental Significance) with respect to biodiversity and heritage impacts.

11.5.4 Noise metrics

There are a number of metrics to describe aircraft noise, each being useful for a different purpose. A few are included in national regulatory standards such as AS 2021:2015. ‘Number (N)-above’ contour levels, have developed from the NASF Guidelines and from the (then) Commonwealth Department of Transport and Regional Services (2000) ‘*Expanding ways to describe and assess Aircraft noise*’ (Department of Transport and Regional Services, 2000). This discussion paper was in response to the reliance on the ANEF system in the EIS for the proposed third runway at Sydney (Kingsford Smith) Airport (Federal Airports Corporation (Australia), 1990). The NASF Guidelines also recognise the merits of using a range of noise criteria.

The impact of aircraft noise is dependent on a number of factors, of which 3 key ones are:

- nature of noise events (intensity, tonal content, spectrum and duration)
- frequency of events
- time of events (time of day or seasonality).

The selection of metrics used to assess aircraft noise for the project are described in Table 11.2. The degree to which a noise metric considers and describes each of the above factors is classified as ‘Yes’ or ‘No’. Time periods are defined in Section 11.5.5.

Table 11.2 Family of noise metrics used in the assessment

<table>
<tr><th>Metric</th><th>Noise event</th><th>Frequency</th><th>Time</th><th>Description</th></tr>
<tr><td>N70</td><td>Yes. Trigger level based on Maximum Sound Level</td><td>Yes. Number of events over a given period (5, 10, 20, 50, 100 events)</td><td>Yes. 24-hours</td><td rowspan="2">‘Number (N)-above’ contour levels (for example N70 and N60) are used to map noise ‘zones’ around an airport. They describe aircraft-noise impacts by the number of noise events that exceed a certain noise level (threshold). For example, N70 contours represent the number of aircraft noise events with L_{Amax} that exceed 70 dB(A) (refer to Figure 11.4). N-above contours are an example of cumulative event descriptors which provide an assessment of the sustained exposure to aircraft noise.

The N70 contours are typically used to assess day-time noise impacts. An outside noise event of 70 dB(A) (such as aircraft flyover) can lead to in an indoor sound level of 60 dB(A) when windows are opened (enough to disturb conversation). Night-time sleep disturbance potential is often assessed with N60-night-time contours. These define areas where an outside noise event results in an indoor maximum sound level of 50 dB(A) with windows open, or 40 dB(A) with windows closed. A 50 dB(A) maximum noise level is considered close to the point at which someone sleeping may wake up.

N-above contours can be calculated for different periods, indicating the average number of events experienced in that time block, for example N70 (24-hours). N70 and N60 values of 5 or more events are considered appropriate for describing aircraft noise in areas currently experiencing aircraft noise, as well as areas which would be newly affected by aircraft overflights. This assessment has taken a more conservative approach and applied an N60 (night) value of 2 or more events at its lowest threshold (refer to Table 11.6).

N70 and N60 can be readily understood as they describe the number of events exceeding a certain noise level (threshold) at a given location, where the threshold represents a level above which impacts would be expected (for example, conversation interrupted). These metrics do not, however, show the intensity of noise to be experienced at that location from individual flyovers. That is, 2 different locations may have the same N70 value but be exposed to different noise exposure levels (for example, 70 dB(A) to 75 dB(A) in one location and 80 dB(A) to 85 dB(A) in another location closer to an airport). N70 and N60 metrics are therefore limited in their ability to communicate high noise levels, such as those near airports.

Metrics that more explicitly portray the number of aircraft movements (such as flight path movement charts) may also be more effective for communicating aircraft noise impact as over time individual aircraft events have become quieter but the frequency of movements has increased.

Locations beyond each noise contour boundary may still be subjected to noise exposure from aircraft overflights. Even at low exposure levels, individuals may still experience annoyance, because individual reaction to aircraft overflight noise is highly subjective (refer to Section 11.2).</td></tr>
<tr><td>N60</td><td>Yes. Trigger level based on Maximum Sound Level</td><td>Yes. Number of events over a given period (2, 5, 10, 20, 50, 100,200 events)</td><td>Yes. 24-hours and night</td></tr>
</table>

Metric	Noise event	Frequency	Time	Description
ANEF / ANEC	Yes. Cumulative exposure considers profile of aircraft noise (level, duration, tonal content)	Yes. Cumulative exposure considers number of events	Yes. Average day metric which applies a penalty to movements between 7 pm and 7 am.	Australia has adopted the ANEF / ANEC system for land use planning around airports, which describes the cumulative aircraft noise for an 'annual average day'. The system does not illustrate the day-to-day variation in noise exposure that is associated with airport operations. The ANEF was developed from social surveys of annoyance surrounding airfields. ANEF is limited in its applicability to an assessment of changing aircraft noise levels because: • previous assessments of aircraft noise in Australia have demonstrated that the ANEF system does not adequately describe people's reactions to a change in aircraft noise, such as that associated with a new runway or airspace design • it is not used outside Australia, and not generally used in describing the findings of overseas research, such as that described in the health impact assessment in Chapter 20 (Human health). The ANEF system is therefore primarily used to assess land-use planning implications of an airport operation (refer to Section 11.5.4.1). An ANEC is a noise exposure chart produced for a hypothetical future airport usage pattern. ANEC contours are calculated using the same methods as ANEF contours but have not been formally endorsed. They use indicative data on aircraft types (both jet and non-jet), aircraft operations and flight paths and are generally used in environmental assessments to depict and compare noise exposure levels for different flight path options. While this metric is not meant to capture the extent of the area that could be exposed to noise levels that could trigger a community reaction, it does identify areas where population is more likely to be impacted by aircraft noise.
L_{Amax}	Yes. Maximum sound level for various aircraft types	No	Yes. Assessed for day, and night to reflect the flight paths in use during these periods	L_{Amax} is the highest noise level from an aircraft noise event, measured in dB(A). It is an example of a single event descriptor as it denotes the maximum level of noise predicted at a location during a single overflight of a particular aircraft occurring at any time (refer to Figure 11.4). This can be depicted geographically as single event (L_{Amax}) contours. While L_{Amax} is effective in communicating the noise level of aircraft events, it fails to communicate other information about aircraft noise, such as the frequency of events, and is only useful when combined with supplementary information (for example N-above metrics).

Metric	Noise event	Frequency	Time	Description
L_{Aeq}	Yes. Average Sound Level	Yes. Cumulates all noise events to determine the average	Yes. Assessed for day, evening and night	L_{Aeq} is used for both the intrusiveness noise level and the amenity noise level. This metric represents the level of average noise energy for each assessment period (day/evening/night) and takes account of noise peaks and fluctuations (refer to Figure 11.4). This descriptor is most widely correlated with the subjective effect of noise (Miedema and Vos, 2004).
Flight path movement charts	No	Yes. Focus is on the number of overflights	Yes. Assessed for day and night	Flight path movement charts indicate the aircraft movements on each path, segment or group of paths for a nominated time (day or night). They give a general and easily understood picture of the pattern of aircraft noise exposure, but not their noise level. Combined flight path movement charts show those areas that may be impacted by a combination of arrival and departure operations. Together with single-event (L_{Amax}) noise contours, flight path movement charts are often used to describe aircraft noise in areas that are more remote from airports, for which N70 and related contours may be less meaningful.
Proportion of respite	No	Yes. Proportion of days without overflights	Yes. Respite is assessed for day, evening and night	Figures showing respite (where ‘respite’ is the proportion of days without overflight) at specific noise sensitive areas (refer to Section 11.5.8) are based on whether these areas are directly overflown or within one km of a flight path corridor. This provides greater focus for assessment of respite in specific rural, rural residential, and urban communities.
Respite charts	No	Yes. Percentage of days without movements on specific flight path	Yes. Respite is assessed for day, and night	Respite charts (where the term ‘respite’ is described as the absence of operations to or from a particular runway end) show the percentage of days and nights when little or no aircraft movements are expected on a specific arrival or departure flight path. Respite charts show those areas under flight paths combining arrival and departure operations for both runway ends. Respite charts are a useful indicator in areas where noise exposure is highly variable, generally due to meteorological variability, and airport operations can be flexibly managed. This is less relevant for the single runway development at WSI, where there is the absence of a second runway to support respite, meaning at most points around the Airport Site there will be relatively few days with no overflights.

Figure 11.4 highlights the relationship between various metrics as described in Table 11.2. Further details on the noise metrics are in Section 8.3 of Technical paper 1.

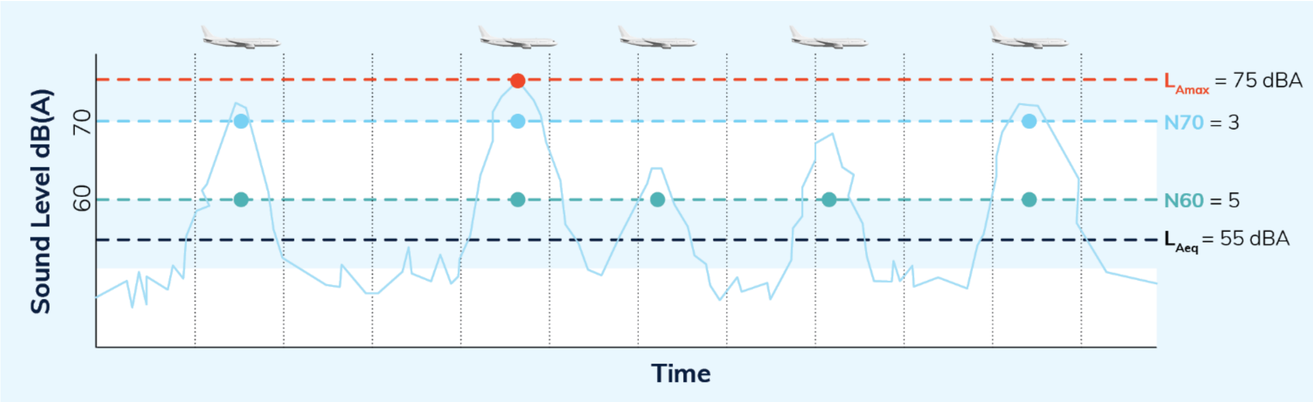


Figure 11.4 Relationship between different noise metrics

In the generic overflight sequence depicted above, the results for each metric would be as follows: L_{Amax} 75 dB(A), L_{Aeq} 55 dB(A), N70: 3 events, N60: 5 events. This shows that N60 and N70 metrics include overflights that will exceed 60 dB(A) and 70 dB(A) sound levels respectively. It also reinforces that an L_{Aeq} value as an averaging metric can be significantly exceeded in noise levels by individual overflight events across the day.

11.5.4.1 ANEF and ANEC

AS 2021:2015 provides guidance on the acceptability of certain types of development, in terms of the ANEF level in the area as shown in Table 11.3. For example, residential development is considered “acceptable” in areas with ANEF lower than 20, “conditionally acceptable” in areas with ANEF between 20 and 25, and “unacceptable” in areas with ANEF greater than 25. In “conditionally acceptable” areas the AS 2021:2015 recommends that new buildings should incorporate acoustic treatment to achieve specified internal noise levels.

Table 11.3 AS 2021:2015 – Acceptability Based on ANEF Zones (in conjunction with Table 3.3 of AS 2021:2015)

Building type	ANEF zone of site		
	Acceptable	Conditionally acceptable	Unacceptable
House, home unit, flat, caravan park	Less than 20 ANEF[1]	20–25 ANEF[2]	Greater than 25 ANEF
Hotel, motel, hostel	Less than 25 ANEF	25–30 ANEF	Greater than 30 ANEF
School, university	Less than 20 ANEF[1]	20–25 ANEF[2]	Greater than 25 ANEF
Hospital, nursing home	Less than 20 ANEF[1]	20–25 ANEF	Greater than 25 ANEF
Public building	Less than 20 ANEF[1]	20–30 ANEF	Greater than 30 ANEF
Commercial building	Less than 25 ANEF	25–35 ANEF	Greater than 35 ANEF
Light industrial	Less than 30 ANEF	30–40 ANEF	Greater than 40 ANEF
Other industrial	Acceptable in all ANEF zones		

Notes from AS 2021:2015:

1. The actual location of the 20 ANEF contour is difficult to define in aircraft flight paths.
2. Within 20 ANEF to 25 ANEF, some people may find that the land is not compatible with residential or educational uses. Land use authorities may consider that the incorporation of noise control features in the construction of residences or schools is appropriate.

The NSW planning framework takes a precautionary approach to residential land use for WSI operations, which includes requirements under the Western Parkland City SEPP on the application of the ANEF (refer to Section 11.8.1.2 and Chapter 14 (Land use)).

An indicative long-term, dual runway ANEC for WSI is provided in the Airport Plan and in Western Parkland City SEPP. An updated ANEC is presented in this chapter for single runway operations (refer to Section 11.5.6.3). The status of the ANEC/ANEF for WSI is further described in Chapter 5 (Statutory context) and Chapter 14 (Land use).

11.5.5 Time periods

The ANEF system defines 2 periods: 7 am to 7 pm and 7 pm to 7 am. Noise during the latter is weighted (by a penalty of 6 decibels) to account for the increased sensitivity during the period referred to as 'evening/night' by the ANEF definition. These standard time periods for the calculation of ANEC (an ANEF related metric) have been adopted here.

Time periods for aircraft noise using N-above and other metrics are commonly expressed differently to the ANEF system. For the purpose of this assessment these metrics are presented as day (5:30 am to 11 pm), and night (11 pm to 5:30 am) periods. Noise during the latter is not weighted by a 6 decibel penalty in terms of N-above. It is acknowledged that for other airports the hours 11 pm to 6 am have typically been selected for the N-above night metrics, as per the NASF Guidelines. The reason for the selection of these different hours of operation for WSI is related to the availability of specific night-time flight paths and runway operating modes, and is further explained in Chapter 7 (The project).

An evening period (7 pm to 11 pm) has been distinguished for the projected average sound level (L_{Aeq}) assessments at noise sensitive areas. The assessment of an evening and night-time period corresponds with periods of time that noise is generally more disturbing (as more sensitive activities typically occur, such as socialising, relaxing and sleeping). These periods also reflect when most residents are at home and noise is more intrusive due to lower background noise levels.

11.5.6 Noise modelling

The noise modelling process calculated values for the chosen noise metrics for relevant scenarios, using information and projections from a number of sources. The noise modelling process is depicted in Figure 11.5 and described in the following sections. Full details are provided in Section 8.4 of Technical paper 1.

Figure 11.5 Noise modelling process

11.5.6.1 Assumptions and operational inputs analysis

This first step of the process defined the assumptions required for the AEDT noise model. It analysed the various RMOs against the historic meteorological data set and the projected flight demand (forecast) schedules to assign each operation to a runway (05/23) and flight path (arrival and departure by day and night). This step also determined the operating scenarios for noise modelling. Detailed information on the assumptions is provided in Chapter 9 of Technical paper 1.

Runway modes of operation

The 3 runway modes of operation are presented in Chapter 7 (The project) – runway modes 05, 23 and RRO. Chapter 7 (The project) also includes the criteria that need to be met for the application of RRO.

The operating scenarios (described below) indicated the selection criteria of each runway mode of operation and consider meteorological conditions (MET) by time of day. This in turn determined runway availability and then runway usage (percentage of annual aircraft movements for Runway 05 versus Runway 23). Based on the runway allocation, the route to or from an origin or destination airport and aircraft category or type determined the flight path allocation. Figure 11.6 depicts the process of allocating a WSI operation to a runway and flight path.

Figure 11.6 Process to allocate a WSI flight operation to a runway and flight path

Operating scenarios

A preliminary macro assessment was conducted by modelling 7 runway operating scenarios to determine the scenario selection for noise modelling (refer to Figure 11.7). The selected scenarios were modelled to create a maximum outer envelope (composite of contours for selected scenarios) of potential impacts of aircraft noise for each assessment year (2033, 2040 and 2055).

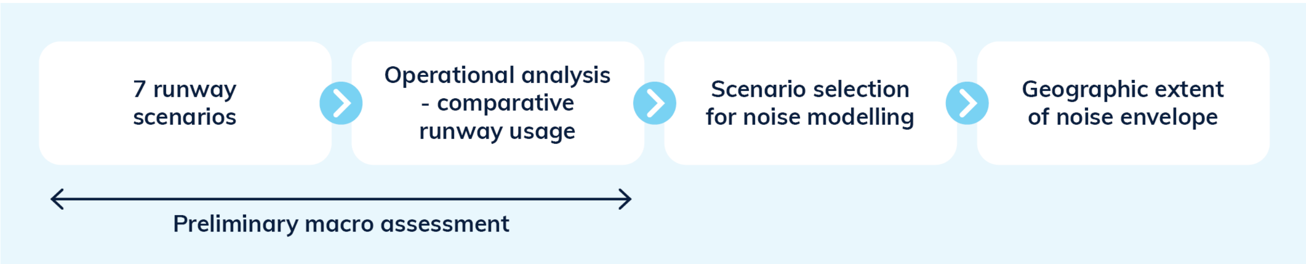


Figure 11.7 Process to create scenarios and model noise envelopes

The 7 runway operating scenarios are outlined in Table 11.4. The terms ‘preference’ or ’prefer’ was given to where, if wind conditions, and traffic demand allows, a particular runway mode of operation (mode) would be used to move aircraft as efficiently as possible while reducing the noise impact over certain residential areas (refer to Chapter 7 (The project)).

Table 11.4 Allocation of runway mode of operation by scenario

Scenario	Runway mode of operation
1	No preference (day) and no preference (night) (No preference)
2	No preference (day) and prefer RRO (night)
3	Prefer Runway 05 (day) and prefer RRO (night) (Prefer Runway 05)
4	Prefer Runway 23 (day) and prefer RRO (night) (Prefer Runway 23)
5	Prefer Runway 05 (day) and prefer RRO (night) Limited Peak-Time Change
6	Prefer Runway 23 (day) and prefer RRO (night) Limited Peak-Time Change
7	Preference Runway 23 during non-peak, no preference during peak (day) and preference RRO (night)

These scenarios were used in the preliminary macro assessment to compare runway availability, runway directional usage (the percentage of annual aircraft movements for Runway 05 versus Runway 23) and runway end noise exposure for all the operating scenarios.

Notably:

- the different scenarios varied in terms of runway direction during the day (Figure 11.8)
- during the night, the RRO mode made the assessment by runway direction less relevant and moved the focus towards a comparison of the runway end exposure to aircraft movements (Figure 11.9)
- a range of sensitivity tests were completed as discussed in Section 11.5.6.2, including a variation to Prefer Runway 05 and Prefer Runway 23.

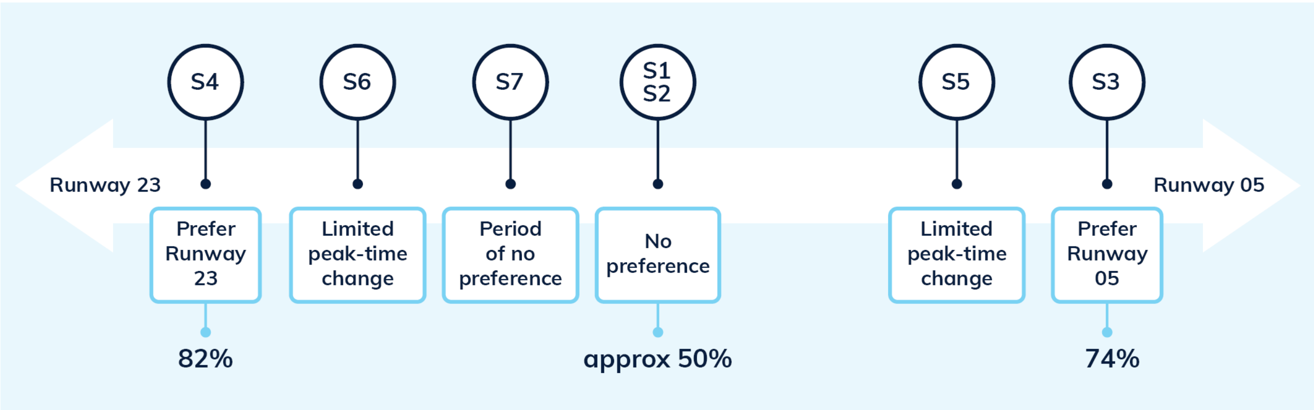


Figure 11.8 Runway direction by scenario (day)

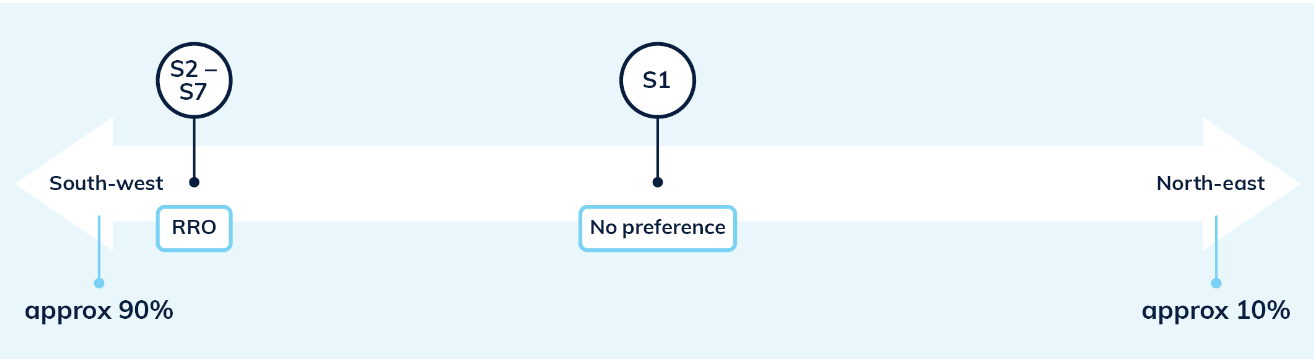


Figure 11.9 Runway end usage by scenario (night)

As shown in Figure 11.7, the results of the preliminary macro assessment determined the operating scenario selection for noise modelling.

The selected operating scenarios used in noise modelling were:

- **Scenario 1** – No preference
- **Scenario 3** – Prefer Runway 05
- **Scenario 4** – Prefer Runway 23.

The reasons for selection of these scenarios were based on the runway modal splits for the operational scenarios detailed in Section 8.4.2 of Technical Paper 1. In summary:

- where no preference was given to a runway mode (No preference), runway use was balanced (approximately 50 per cent on both Runway 05 and Runway 23) in terms of runway direction and runway end exposure. This indicated that both runway ends are exposed to a similar proportion of arrivals and departures on an annualised basis
- during the day, the outer bounds of runway usage (and by implication the extents of the noise exposure contours) was defined by Prefer Runway 23 for both arrivals and departures (82 per cent of aircraft movements in the Runway 23 direction) and Prefer Runway 05 (74 per cent of runway movements in the Runway 05 direction). However, both runway ends would experience a balanced exposure based on total movements. This indicated that Prefer Runway 05 and Prefer Runway 23 would primarily vary in terms of bias for the type of operation (arrival or departure), not in terms of total movements
- during the night:
  - prefer Runway 05 and Prefer Runway 23 introduced the RRO mode – arrivals on Runway 05 and departures on Runway 23. Hence, while runway direction was generally balanced across the night, runway-end usage indicated that almost 90 per cent of night-time movements would operate over the south-west end of the WSI, on an annualised basis
  - no preference provided a comparison case if RRO mode was not adopted or was unavailable due to weather conditions or traffic demand
- the 4 other scenarios fell somewhere between the outer bounds in terms of runway use.

This assessment assumed that for scenarios 2 to 7 the RRO mode could be sustained across the night when weather conditions (that is, wind, precipitation) are suitable. However, as demand grows over time and approaches the RRO capacity limits (represented by years 2040 and 2055), availability and usage of RRO will be more limited. This would in turn progressively increase the proportion of movements at the north-east end of the WSI.

The constraints on the use of the RRO mode and how this could be mitigated is explained in Section 7.4.1.3 of Chapter 7 (The project). For this assessment, the implications of noise exposure due to the inability to apply RRO is modelled by the No preference scenario. This is complemented by sensitivity testing (refer to Section 11.5.6.2).

The composite noise contours associated with the chosen suite of scenarios (together with the sensitivity testing) provide a level of confidence around a geographic extent of potential impacts. This shows the flexibility in the design and enables operating scenarios to be tailored as part of detailed design and finalisation of the selected airspace design.

Further explanation on this process is provided in Sections 9.2 and 9.4 of Technical paper 1.

Other operational inputs

The other key data inputs used in the noise model are outlined in Table 11.5 below. Details are provided in Chapter 9 of Technical paper 1.

Table 11.5 Key data inputs for the noise model

Input	Description
Forecast schedules for each assessment year	The average weekly schedule for both the Northern Summer (NS) and the Northern Winter (NW) schedule seasons as projected by WSC Co. These include the number of aircraft operations, the aircraft types which would operate, time of operation (both arrival and departure time) and port of origin or destination for each operation. The average weekly schedules were “annualised” by taking the relative proportions of days in the NW schedule season and the NS schedule season to create a table with 365 days’ worth of aircraft movements.

Input	Description
Meteorological data	10 years of Bureau of Meteorology data from 2012 to 2021 from the Badgerys Creek weather station. This included data on temperature, headwind, humidity and barometric pressure. The meteorological conditions are an important consideration to determine the long-term average and variation of runway usage and mode of operation, aircraft performance and noise emissions.
Aircraft types	Based on the forecast schedules. While most aircraft have a direct aircraft noise modelling profile, some aircraft have an equivalent model with adjusted noise levels. This is especially applicable to new aircraft types that have yet to be included in the AEDT database. The standard aircraft types used in the calculations are summarised in Chapter 2 (Strategic context and need). This includes a comparison of aircraft classes.
Stage lengths	Noise level on departure as calculated for various stage lengths for each aircraft type. There are 9 stage lengths from WSI as classified in the AEDT, that is, stage 1 from 0 to 500 nm (926 km) from WSI (for example, to Melbourne) to stage 9 over 6,500 nm (12,038 km) from WSI (for example, to Dallas). Longer flights generally require aircraft to carry more fuel on departure, increasing take-off weight and therefore requiring a higher thrust and more gradual ascent. This means longer flights typically produce higher noise levels than shorter flights. In contrast, noise emissions of arriving aircraft are generally independent of the distance flown. This is because minimal thrust is required with much of the noise on arrival generated by the airframe interacting with the air.
Flight profiles and procedures	Aircraft procedures and associated profiles for each aircraft in the fleet mix. The profile combines altitude, thrust and speed and results in a sound level being emitted and received on the ground. To develop customised profiles so the noise model could be calibrated based on actual recorded noise levels, aircraft profiles were modified, regardless of the destination's default AEDT stage length, so typical departures reflected the noise profile for that aircraft type recorded at selected airports from the Airservices Australia's NFPMS (refer to Section 11.7.8 for further information on Airservices Australia's NFPMS).
Flight paths	Flight paths as presented in Chapter 7 (The project). As discussed in Chapter 3 (Introduction to airspace), actual paths diverge from nominal standard arrival routes or standard instrument departure routes due to meteorological conditions, requirements for aircraft separation, and other variable factors. In modelling aircraft noise on any specified flight path, a dispersion either side of the centreline in space was specified based on data from other airports. The purpose of the flight path analysis was to identify the paths associated with specific types of aircraft operations. This allowed the noise emissions to be predicted for each of the scenarios.
Terrain data	Used to account for variations in altitude above ground level. The height of terrain relative to the aircraft altitude determines the distance between the noise source (aircraft) and the receivers on the ground. This is particularly relevant for flight paths over the Blue Mountains and the impact assessment on biodiversity and natural heritage values. The line-of-sight blockage feature (shielding of receivers from a noise source) was not considered.

11.5.6.2 Aviation Environmental Design Tool

The second step of the noise modelling process was the conduct of noise modelling using the latest Version 3e of the AEDT noise model, produced by the US FAA. The model includes aircraft overflight noise together with departure noise, landing and reverse thrust noise when the aircraft is on the runway.

A single AEDT noise model was created for each selected operating scenario chosen as part of the operational scenarios pathway (Figure 11.7).

Sensitivity analysis

An iterative process was undertaken to review sensitivity of different parameters and their significance in impacting outcomes of the modelling process. This included conducting sensitivity tests on a variation to Prefer Runway 05 and Prefer Runway 23 for periods when prevailing wind conditions would support operations using the runway in one direction across an entire day (reflecting the highest intensity of overflight). That is, when either Runway 05 or Runway 23 is used 100 per cent of the time (day and night). These tests have been termed 'unidirectional' scenarios.

While the use of RRO described above would significantly reduce the occurrence of unidirectionality (for Prefer Runway 05 and Prefer Runway 23), review of historical wind data shows that under a No Preference scenario, unidirectionality could occur approximately 34 per cent of the time (refer to Section 8.1.2 of Technical paper 1).

These tests were incorporated into the generation of noise metrics (Section 11.5.6.3) and the impact assessment (Section 11.7).

Other sensitivities tested included seasonality (temperature and weather), fleet mix (Airbus A320neo versus Airbus A320ceo), aircraft calibration (Standard AEDT profiles versus calibrated profiles), day of the week (weekday versus weekend splits), and the use of hold down procedures (level hold downs at specific altitudes (ranging between 4,000 ft (1.2 km), and 15,000 ft (4.5 km) to keep aircraft below both Sydney (Kingsford Smith) Airport and other WSI aircraft).

The single most important variable in the sensitivity analysis was the flight schedule which includes the number of movements. There was a material impact identified from the sensitivity analysis with aircraft calibration, which supported the calibration of modelled aircraft noise levels using actual noise monitoring measurements at Brisbane, Perth and Melbourne airports. The impact from the use of operational procedures such as hold downs could be perceptible for specific aircraft types (single events) but the communities impacted by hold downs would be the same communities that are already impacted by continuous climb operations. Further information on the sensitivity analysis is available in Section 9.8 of Technical paper 1.

11.5.6.3 Generation of noise metrics and charts

The final step in the noise modelling process generated the suite of noise metrics and charts described in Section 11.5.4 to assess the aircraft noise from the project. These are as described in Table 11.6.

In relation to this step:

- the L_{Aeq} metric was used to generate a location based metric at each noise sensitive area, to compare with noise monitoring sites (refer to Section 11.6.2). No contours were generated using this metric
- unidirectional scenarios (all movements on Runway 05 or all movements on Runway 23) were included for N70 (24-hour) metric only.

Table 11.6 Generation of noise metrics

Noise metric	Input	Output
N-above contours	Assessment years 2033, 2040 and 2055 for the 3 scenarios (No Preference, Prefer Runway 05 and Prefer Runway 23). Unidirectional scenarios for N70 (24-hour). Based on a typical average day for aircraft movement numbers but considered seasonal variations associated with different wind patterns.	Standard contours for each scenario: • N60 (24-hour) for 10 and over events • N70 (24-hour) for 5 and over events • N70 (unidirectional) for 5 and over events (dashed blue lines) • N60 (night) for 2 and over events • composite contours.
ANEC contours	Assessment years 2033, 2040 and 2055 the 3 scenarios (No Preference, Prefer Runway 05 and Prefer Runway 23). Average annual day movements.	ANEC 20, 25, 30, 35 and 40 contours for each scenario Composite contours.

Noise metric	Input	Output
L_{Amax}	11 typical aircraft types (across large wide-body jets, narrow-body jets and non-jets). Based on destination and different flight paths used for arrivals and departures at each runway end for day, night and RRO.	L_{Amax} contours (60, 65, 70, 75, 80, 85 and 90 dB(A)) for each aircraft.
Flight path movement charts	Assessment years 2033, 2040 and 2055 for the 3 scenarios (No Preference, Prefer Runway 05 and Prefer Runway 23). 10 years of meteorological data (2012–2021).	Flight movement charts showing the number of movements on each flight path, segment or group of flight paths for day and night. Shows average, maximum and minimum daily (or nightly) movements on each combination of flight paths.
Proportion of respite	Assessment years 2033, 2040 and 2055 for the 3 scenarios (No Preference, Prefer Runway 05 and Prefer Runway 23).	Figures and tables showing the projected portion of respite (days without overflights) at noise sensitive areas for day, evening and night.
Respite charts	Assessment years 2033, 2040 and 2055 for the 3 scenarios (No Preference, Prefer Runway 05 and Prefer Runway 23).	Respite charts showing the percentage of days and nights when no aircraft movements are expected on a specific arrival or departure flight path. Shows average daily (or nightly) movements, daily range of movements and percentage of days without movements.

11.5.6.4 Modelling limitations

Noise modelling inherently relies on assumptions, which are either averaged or simplified for modelled purposes. This assessment has involved the careful selection of key assumptions including supporting analytics of forecast schedules, use of long-term meteorological data, use of a range of noise metrics to reflect a range of perception factors, undertaking of sensitivity variations, and clear description of anticipated air traffic levels and variations from future aircraft operations at WSI. These aspects combine to provide information that best reflects what the community may experience in the vicinity of WSI, when operations commence and progressively increase over the coming decades.

While aircraft have their noise levels on take-off and landing certified by an internationally sanctioned process, the actual operating conditions and human factors means that no 2 aircraft on any day will follow the exact flight path (in both vertical and lateral extents). The amount of aircraft noise created is also influenced by ground or surface reflections and localised weather conditions. Other than lateral extents (dispersion) none of these factors are accounted for in the modelling at that level of detail.

The noise contours and metrics predict noise exposure, not annoyance level. Community or individuals' reactions to noise exposure will vary and cannot be represented by the metrics. Some generalisations can be made about how exposure to a particular level of noise might affect populations (for example 20 ANEF, N70 for indoor conversation disturbance, N60 for night-time awakenings) but it is only the ANEF that has any link to annoyance (refer to Table 11.2). The metrics are meant to inform community stakeholders about the likely exposure and possible variations. It is now well accepted that a range of non-acoustic factors (for example, the number of arrivals or departures on a specific or the period of respite) also play a role in how individuals will respond to different noise events.

Further detail on modelling limitations is provided in Section 8.14 of Technical paper 1.

11.5.7 Population and dwellings

An estimate of the number of people and dwellings potentially impacted by aircraft noise was assessed based on N-above contours, L_{Amax} and ANEC contours criteria as described in Section 11.5.4.

As outlined in Section 11.6, the surrounding areas of WSI are already subject to aircraft noise from existing operations associated with other Sydney Basin airports, which has not been quantified in this assessment. The population and dwellings potentially exposed to aircraft noise are therefore assessed solely on new traffic introduced by operations at WSI and do not consider current broader Sydney Basin airspace uses. Chapter 21 (Facilitated impacts) specifically addresses the nature of impacts associated with the change from the current airspace operations to future airspace operations ahead of WSI's planned opening in 2026.

Population and dwelling counts were sourced from Australian Bureau of Statistics (ABS) 2021 census data (ABS, 2022). The assessment was undertaken by overlaying the different contours over census data using GIS software.

The assessment provides a population and dwelling count for assessment years 2033, 2040 and 2055 for 3 scenarios, as well as a cumulative count based on a worst-case composite contour of the 3 operating scenarios.

11.5.8 Noise sensitive areas

Noise sensitive areas are defined as specific sensitive receivers or geographic points that were selected to report on the maximum sound level and are representative of either a residential area, or a non-residential land use that is sensitive to noise – for example, a recreational area, hospital, school, library, church etc. Recreational areas 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 noise sensitive areas specified for the project across the Western Sydney region are depicted in Figure 11.10. These are comprised of:

- recreational areas and noise-sensitive receivers defined in the 2016 EIS
- additional sensitive areas within a 15 km radius from WSI (residential and public buildings)
- additional sites up to 50 km in rural areas and Blue Mountains urban areas where aircraft noise is more likely to be noticeable due to the lower ambient soundscape
- ambient noise monitoring sites (29 in total) (refer to Section 11.6.2).

Projected changes in the ambient noise environment surrounding WSI that would be subjected to overflight by WSI operations were calculated using a series of assessments for all noise sensitive areas – projected average sound level (L_{Aeq}), projected maximum sound level (L_{Amax}); and average sound level variation for each noise monitoring site (defined in Section 11.6.2). These involved the expected change in noise exposure being calculated by comparing the ambient/background noise data collected at the 29 noise sensitive areas (refer to Section 11.6.2) with the projected noise from WSI aircraft operations.

Each assessment was undertaken for the 2033, 2040 and 2055 assessment years, across day (5:30 pm to 7 pm), evening (7 pm to 11 pm) and night (11 pm to 5:30 am) for 3 operating scenarios and a series of maps generated.

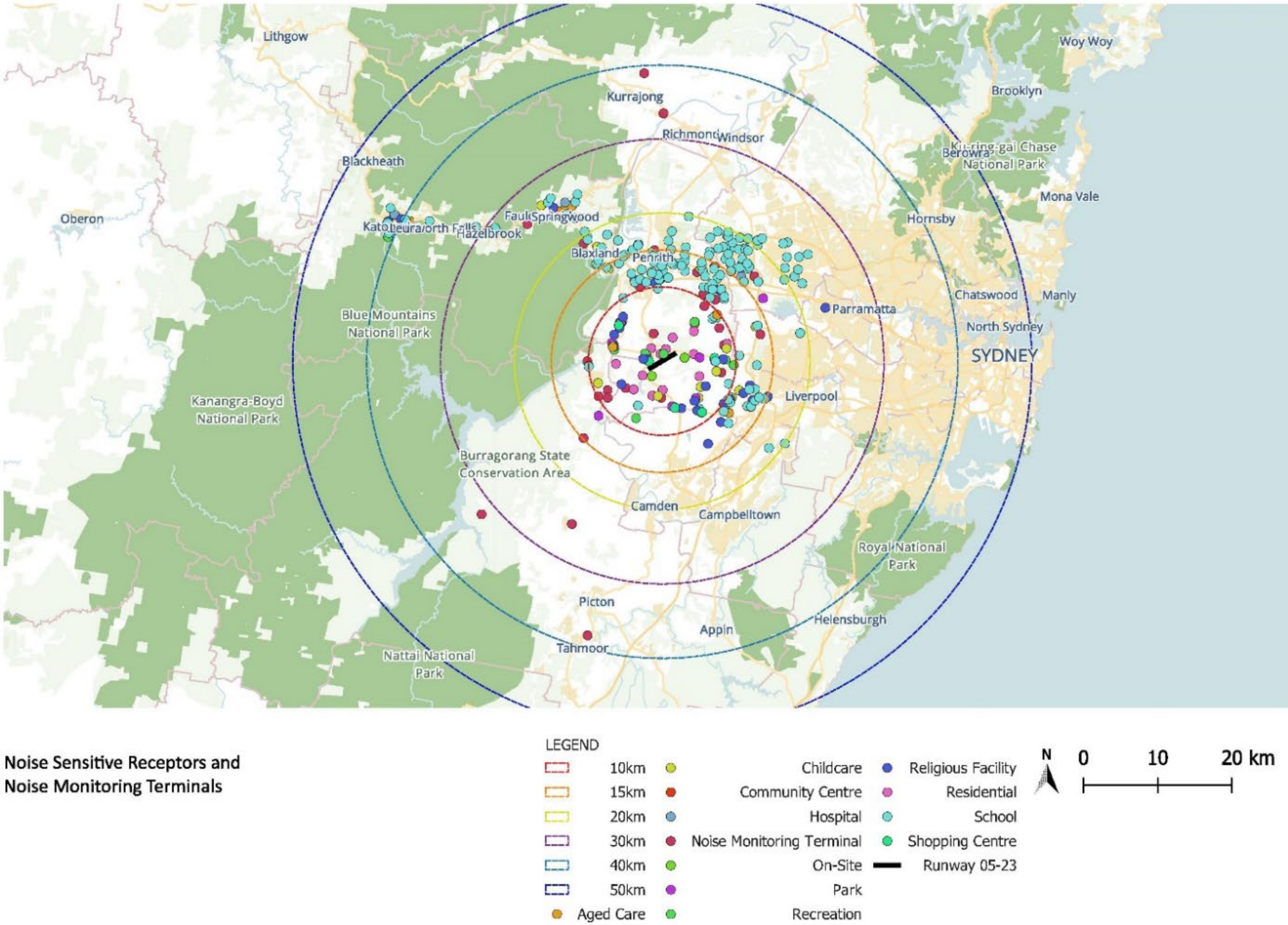


Figure 11.10 Noise sensitive areas including noise monitoring sites

A series of graphs (examples provided in Section 11.7.3.1) were produced by correlating projected average sound level (L_{Aeq}) with projected maximum sound level (L_{Amax}) to identify noise sensitive areas likely to be more impacted by aircraft noise, by assessment year, by time of day and by operating scenario. Individual graphs were produced for suburbs, schools, hospital, aged care and childcare facilities; religious and community centre facilities and shopping malls, parks and recreation. Absolute sound levels are based on the preliminary airspace design as well as projections of the fleet mix across the various flight paths. Changes to the maximum sound level over time would be driven by the actual fleet mix using each track.

An assessment of the proportion of respite was also undertaken at each noise sensitive area (refer to Table 11.2 and Section 11.7.3.2). This was based on direct overflights, or flights within a one km width from a flight path corridor, regardless of sound level.

11.6 Existing environment

There are a variety of noise environments within the study area. This section describes the existing noise environment based on current land uses and presents the results of the project noise monitoring.

11.6.1 General existing noise levels

Background (low level constant noise) and ambient (noticeable) noise environments range from urban environments such as the centres of Campbelltown, Fairfield, Liverpool and Penrith (located within 15 to 20 km of the site of the Airport Site) to rural environments and the natural environment of the GBMA that are largely removed from human-induced noise.

Although WSI is a completely new airport, the surrounding areas are already subject to aircraft noise. This is from the existing operations of Sydney (Kingsford Smith) Airport, Bankstown and Camden Airports, and RAAF Base Richmond. According to Airservices Australia reporting for movements at Australian airports, in calendar year 2019, more than 700,000 aircraft movements were recorded at Sydney (Kingsford Smith) Airport, Bankstown and Camden Airports in the Sydney Basin airspace (Airservices Australia, 2019) (refer to Chapter 4 (Project setting)).

Most of the land within and immediately surrounding the Airport Site comprises low density rural residential and agricultural land uses. To the north-east and east of the Airport Site are the localities of Badgerys Creek, Kemps Creek and Mount Vernon. The villages of Luddenham and Wallacia lie immediately west of the Airport Site and the villages of Silverdale and Warragamba are located south-west in the vicinity of Greendale. The development of the Aerotropolis associated with WSI will bring significant change in the nature of the surroundings.

In terms of natural values, the Badgerys Creek riparian corridor defines the eastern boundary of the Airport Site and the GBMA is located 8 km to the west. Lake Burragorang, a man-made lake created by Warragamba Dam, and major water supply for Sydney is located to the south-west.

The existing network of roads serving WSI includes Elizabeth Drive, The Northern Road and Badgerys Creek Road. Additional road infrastructure is to include the M12 Motorway and associated connections.

It is useful to understand the various receiving environments to consider the emergence (or otherwise) of aircraft noise events above the ambient noise environment. Representative average background and ambient noise levels for various areas are shown in Table 11.7. The perceived prominence of aircraft noise events is partly dependent on those events becoming distinct from the ambient noise environment.

Table 11.7 Ambient and background recommended amenity noise levels (based on NSW EPA, 2017[1])

Receiver category	Description	Recommended amenity noise level (L_{Aeq}) dB(A)			Typical existing background noise levels (RBL) dB(A)		
Residential		**Day**	**Evening**	**Night**	**Day**	**Evening**	**Night**
Rural residential	An area with an acoustical environment that is dominated by natural sounds, having little or no road traffic noise and generally characterised by low background noise levels. Settlement patterns would be typically sparse.	50	45	40	<40	<35	<30
Suburban residential	An area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry. This area often has evening ambient noise levels defined by natural environment and human activity.	55	45	40	<45	<40	<35
Urban residential	An area with an acoustical environment that is dominated by 'urban hum' or industrial source noise, where urban hum means the aggregate sound of many unidentifiable, mostly traffic and/or industrial related sound sources; has through-traffic with characteristically heavy and continuous traffic flows during peak periods; is near commercial districts or industrial districts, or any combination of the above.	60	50	45	<45	<40	<35
Other	**Description**	**Recommended amenity noise level (L_{Aeq}) dB(A)**			**Typical existing background noise levels (RBL) dB(A)**		
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks		5 dB(A) above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day			N/A		
School – internal	Noisiest 1-hour when in use	35[2]			N/A		
School – external	Noisiest 1-hour when in use	45			N/A		
Hospital – internal	Noisiest 1-hour when in use	35			N/A		
Hospital – external	Noisiest 1-hour when in use	50			N/A		

Other	Description	Recommended amenity noise level (L_{Aeq}) dB(A)	Typical existing background noise levels (RBL) dB(A)
Place of Worship – internal	When in use	40	N/A
Passive Recreation	Area reserved specifically for passive recreation (e.g., national park)	50	N/A
Active Recreation	Area reserved specifically for active recreation (e.g. golf course)	55	N/A
Commercial Premises	Commercial activities being undertaken in a planning zone that allows commercial land uses	65	N/A

1. While the amenity noise levels were extracted from NSW EPA (2017), it broadly reflects the levels of AS1055:1997, which has since been superseded by AS1055:2018.
2. In the case where existing schools are affected by noise from existing industrial noise sources, the acceptable L_{Aeq} noise level may be increased to 40 dB $L_{Aeq(1hr)}$

11.6.2 Project existing noise levels

Noise monitoring using noise loggers was conducted from August to October 2022 to establish background and ambient noise levels in areas surrounding WSI. There were 29 noise loggers installed to continually measure ambient sound levels for a 2 to 4-week period. Unattended and attended measurements were taken at the same locations; attended measurements were taken for 1-hour periods to qualify the noise environment at each unattended location.

Figure 11.11 shows the location of the ambient noise monitoring sites. These sites were chosen to characterise background noise levels, including from aircraft operating inbound to and outbound from Sydney Basin airports and the current ambient noise environment across Western Sydney and the Blue Mountains.

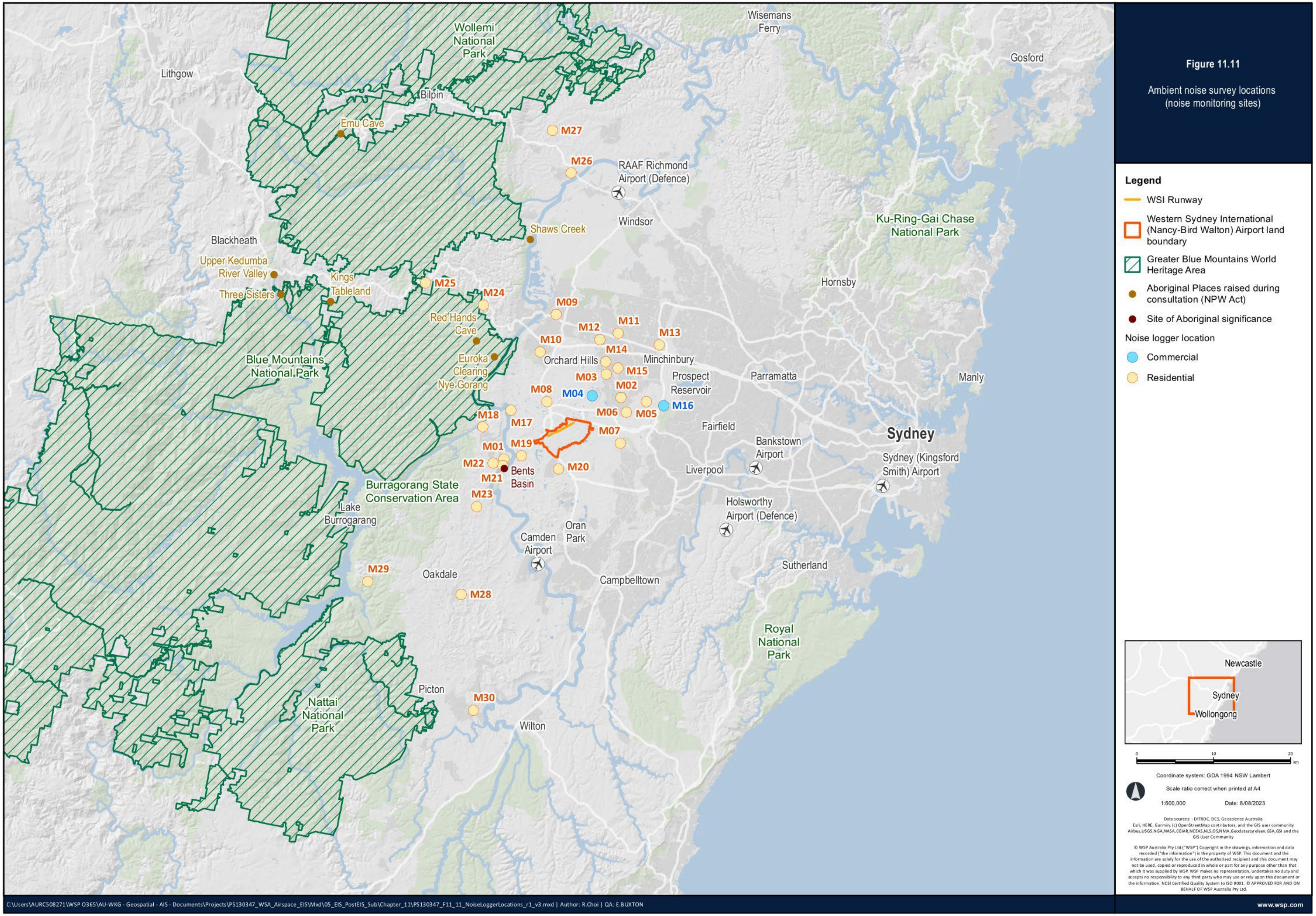


Figure 11.11

Ambient noise survey locations (noise monitoring sites)

Table 11.8 presents the average and background noise levels for the various environments. The noise metrics used are:

- L_{Aeq} – as defined in Table 11.2
- RBL – the overall background noise level for each assessment period (day/evening/night) measured over the entire monitoring period (as outlined by the NSW Noise Policy for Industry (NSW EPA, 2017)).

The levels shown in Table 11.8 are considered typical for the relevant areas.

Table 11.8 Average and background noise monitoring locations and levels

ID	Area	Average noise level L_{Aeq} (dB(A))			Background noise level RBL (dB(A))		
		Day[1]	Evening	Night	Day	Evening	Night
M01	South-West Departure (Wallacia)	58	49	43	33	32	27
M02	North-East Departure	63	47	44	36	37	36
M03	North-East Runway	67	53	53	47	45	39
M04	Twin Creeks	49	47	45	34	35	33
M06	Mount Vernon	51	53	50	37	49	42
M07	Kemps Creek Nature Reserve	58	45	45	36	37	32
M08	Luddenham	62	59	58	47	45	39
M09	Penrith	52	46	42	36	36	33
M10	Glenmore Park	57	51	46	39	39	30
M11	Oxley Park	72	47	44	36	38	32
M12	St Marys	57	50	44	37	37	31
M13	Rooty Hill	54	47	46	38	40	36
M14	St Clair	57	45	49	37	36	29
M15	Erskine Park	59	51	43	39	36	33
M16	Sydney Int. Equestrian Centre	55	51	50	45	45	40
M17	Wallacia	53	49	45	40	34	26
M18	Warragamba	51	46	46	36	41	41
M19	Greendale	49	50	45	31	38	33
M20	Bringelly	52	48	44	34	39	34
M21	Bents Basin	63	51	47	36	44	38
M22	Silverdale	51	48	44	34	36	32
M23	Werombi	58	47	45	30	36	30
M24	Blaxland	50	42	42	33	32	26
M25	Linden	51	45	43	35	36	28

ID	Area	Average noise level L_{Aeq} (dB(A))			Background noise level RBL (dB(A))		
		Day[1]	Evening	Night	Day	Evening	Night
M26	North Richmond	53	47	41	40	35	26
M27	Kurrajong	51	44	44	36	37	34
M28	The Oaks	56	48	44	29	36	32
M29	Lake Burragorang	46	42	44	25	27	24
M30	Tahmoor	56	46	48	40	39	38

1. Day, evening and night-time periods relate to those of the NSW Noise Policy for Industry (NSW EPA, 2017), defined as day – the period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays; evening – the period from 6 pm to 10 pm; night – the remaining periods.

The results found the existing ambient noise environment is mostly dominated by road traffic noise which is audible at nearly all locations emanating from a combination of relatively busy roads including the Northern Road, Elizabeth Drive and Badgerys Creek Road, up to the Western Motorway (M4), Westlink (M7 Motorway). There is also a hierarchy of other connector and local roads which carry varying levels of traffic.

Aircraft noise from existing Sydney Basin operations is audible (refer to Section 11.6.1) but has not been quantified. Furthermore, the Sydney Basin is also overflown by aircraft transiting from outside the area to a mix of domestic and international destinations. These operations have not been considered in the assessment, but were perceptible based on the ambient noise monitoring presented in Table 11.8.

The data sheets from each noise monitoring location including the characteristics of the noise environment are included in Appendix E of Technical paper 1. The key characteristics of the noise environment at select noise monitoring sites (including from any observed aircraft flyovers) have been summarised in the following paragraphs to represent the different receiving environments. Note that the levels in Table 11.8 refer to average noise levels over the assessment period (per table note 1). The observed aircraft flyovers noted below are short-term observations between 30 seconds and one minute, which do not contribute in a meaningful way to the levels in Table 11.8.

Location M01 is situated in a rural residential area of Wallacia, as typified by low background noise levels with occasional traffic passbys on local roads. The local noise environment was dominated by natural sounds, with cicadas audible during evening periods, and birds audible during the night periods. Several aircraft passbys were observed overhead at this location with maximum noise levels observed to be in the order of 35 to 58 dB(A) for durations of 30 seconds and one minute during the day, evening and night-time periods.

Measurements conducted at Sydney International Equestrian Centre (M16) indicated a background acoustic environment typical of a suburban area, due to constant traffic on the nearby M7 Westlink Motorway. Ambient noise sources also included various animal and insect sounds. Aircraft were observed at a distance with a maximum sound level in the range of 47 dB(A) to 54 dB(A) for up to one minute passbys during the day, and aircraft overhead observed during evening and night periods for between 30 seconds to a minute in the range of 50 to 61 dB(A).

Observations at the Bents Basin Road Picnic Area (M21) identified aircraft noise levels in the range of 36 to 60 dB(A) for passbys between 30 seconds to one minute during the day, and between 43 dB(A) and 57 dB(A) during the evening period. The background noise environment was typified by distant traffic during the day, cicadas during the evening and night-time periods, typical of a suburban residential environment.

Measurements taken in suburban areas such as Penrith (M09) suburban areas were found to be affected by suburban traffic noises, with several aircraft flyovers observed between 30 seconds to one minute up to with maximum levels of 38 dB to 59 dB(A) during the day period. Evening and night time ambient levels were influenced by local traffic and suburban hum, with no flyovers observed.

Measurements at Erskine Park were made at location M15, located in the vicinity of some industrial land uses. Noise levels at this location were found to be dominated by local industrial noise activities, local traffic and occasional mechanical plant noise from adjacent residences. Aircraft were observed during the day period at this location however levels were not sufficient over ambient noise to quantify over other sources. During the eventing period one passby of up to 49 dB(A) was observed for approximately one minute. Noise levels are dominated by other noise sources at this location.

Background noise levels were measured at Twin Creeks (M04) active recreation area. The noise environment was found to be dominated by natural sounds, with occasional vehicle passbys audible on local roads. Several flight passbys were noted, with maximum levels between 43 and 54 dB(A) for durations up to 30 seconds during day time periods. During evening periods, several aircraft flybys were observed but not quantifiable over background noise levels associated with wind, natural noise and insect noise.

The ambient noise levels are used when considering the impact of WSI aircraft-noise levels on populations and dwellings.

The degree of likely change in noise at each location/sensitive area is presented by the series of projected average sound level variation figures in Appendix D of Technical paper 1.

Changes to social amenity due to noise is represented by charts in Appendix D of Technical paper 1 and summarised in Section 11.7.3.1. These charts reflect those suburbs and schools most likely to be affected by higher average sound levels and higher noise levels from an aircraft noise event. This is done by correlating projected average sound level (L_{Aeq}) with projected maximum sound level (L_{Amax}).

How aircraft noise is experienced is provided in Section 11.2.

11.7 Assessment of impacts

This section presents the key results of noise predictions based on WSI aircraft operations for each assessment year (refer to Section 11.1.1). It also presents the key results of metrics that are not informed by assessment years.

The full set of charts and noise contours are found in Appendix B and C respectively of Technical paper 1.

11.7.1 Noise levels over 24-hours

Aircraft noise exposure over a full day can be described by the number of aircraft noise events with L_{Amax} that exceed 60 or 70 dB(A), or N60 or N70 (refer to Table 11.2).

Individual figures for N60 and N70 (24-hour) contours for 2055 operating scenarios represent the differences in aircraft noise impacts between these scenarios at these thresholds as the single runway approaches capacity.

The composite scenarios (made up of the different scenarios) provides a worst-case scenario based on noise being shared (using full suite of possible runway modes of operation (which RRO is part)) rather than the consistent use of a single operating strategy or runway allocation scenario.

N60 and N70 (24-hour) contours are supported by population and dwelling counts of each operating scenario as well as a cumulative count based on a worst-case composite scenario.

Dwelling counts are not presented here because the number of affected dwellings were found to follow a similar trend to population counts. Full details of the population and dwelling counts assessment are found in Section 9.6 of Technical paper 1.

11.7.1.1 N70

The key findings are depicted by:

- for 2055 – calculated N70 (24-hour) noise contours for each of the 3 operating and unidirectional scenarios – shown on Figure 11.12 to Figure 11.15
- for 2055, 2040 and 2033 – composite scenario N70 (24-hour) noise contours comprised of the 3 operating scenarios plus unidirectional scenarios for each assessment year – shown on Figure 11.16, Figure 11.17 and Figure 11.18 respectively.

The hard shaded blue line depicting 5–9 movements is the limit of exposure to at least 5 movements per day under one of the 3 operating scenarios. Once the hard dark unshaded blue line is reached, this becomes the 10 movements per day threshold.

Unidirectional scenarios (where all movements are either all Runway 05 or all Runway 23) are described in Section 11.5.6.2. The dashed blue line is the only line assessing solely the unidirectional scenarios. This shows the additional area that could be exposed to at least 5 movements above 70 dB(A) if all movements were in one direction only on a given day.

Geographical extent

As the single runway approaches capacity at around 37 million annual passengers (2055), the extent of predicted noise impact is at its greatest (refer to Figure 11.12 to Figure 11.14.

The key findings for 2055 are:

- the No Preference and Prefer Runway 05 scenarios results in greater impact on residents in densely populated areas to the north-east of the Airport Site, with a predicted 5 to 9 events per day above 70 dB(A) over more densely-populated areas around St Clair and reaching north to Claremont Meadows
- in comparison, the Prefer Runway 23 scenario is predicted to result in an impact of less than 5 events per day in these areas and the predicted impact would be greater in less densely populated areas to the north of Horsley Park
- to the south-east of the runway, additional N70 = 5–9 contours for the Prefer Runway 05 and Prefer Runway 23 scenarios 'lobe' toward the rural residential areas around Wallacia and south toward Greendale compared to the No Preference scenario. This is due to the use of RRO. The Prefer Runway 05 scenario also results in slightly higher predicted impacts (N70 = 5-9) in the Burragorang State Conservation Area to the south-west of the Airport Site compared to the other scenarios.

For the early years of operation at around 10 million annual passengers (2033), N70 contours extend well beyond the runway ends (Figure 11.18). The N70 = 5 contours extends approximately 6 km to the north, 11.5 km to the north-east and 13.5 km to the south-west of the runway. With the application of Prefer Runway 05 or Prefer Runway 23 scenarios (which use RRO), the contours also form 'lobes' toward Wallacia and south toward Greendale compared to No preference scenario. These lobes do not extend into major population centres.

The unidirectional scenarios (all movements on Runway 05 or all movements on Runway 23) show the typical worst-case day, when either mode is required to be used 100 per cent of the time (day and night). The most noticeable aspect of the inclusion of these scenarios (depicted separately for 2055 in Figure 11.15 and in the composite scenario for 2040 and 2033 (Figure 11.17 and Figure 11.18 respectively) is that generally the difference between the noise impact on average versus worst-case day is limited. This is due to the single runway system which reduces the potential runway modes of operation compared to a multi-runway system airport.

2055 scenarios (other than composite)

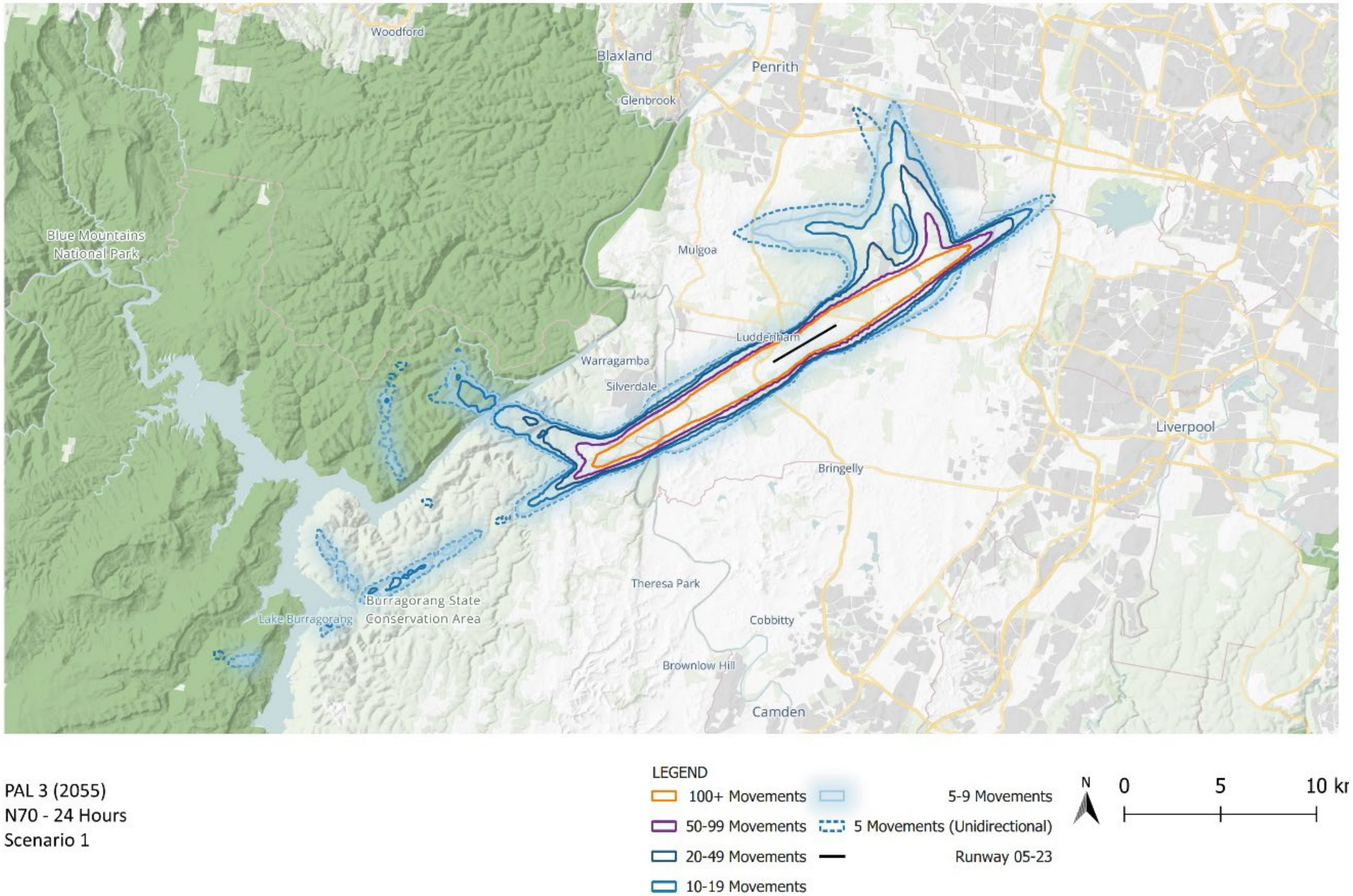


Figure 11.12 N70 noise contours – 24-hours – No preference – 2055

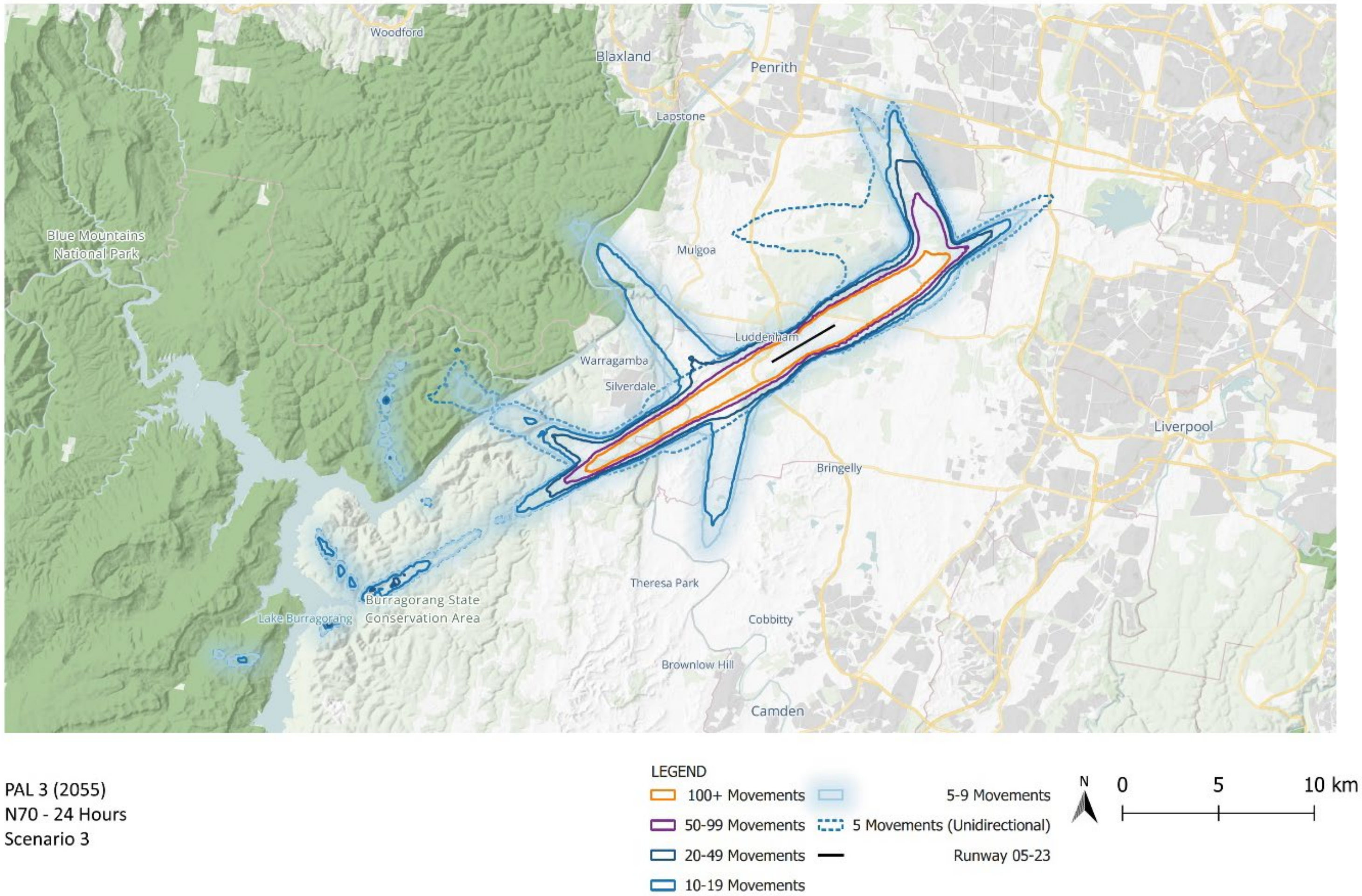


Figure 11.13 N70 noise contours – 24-hours – Prefer Runway 05– 2055

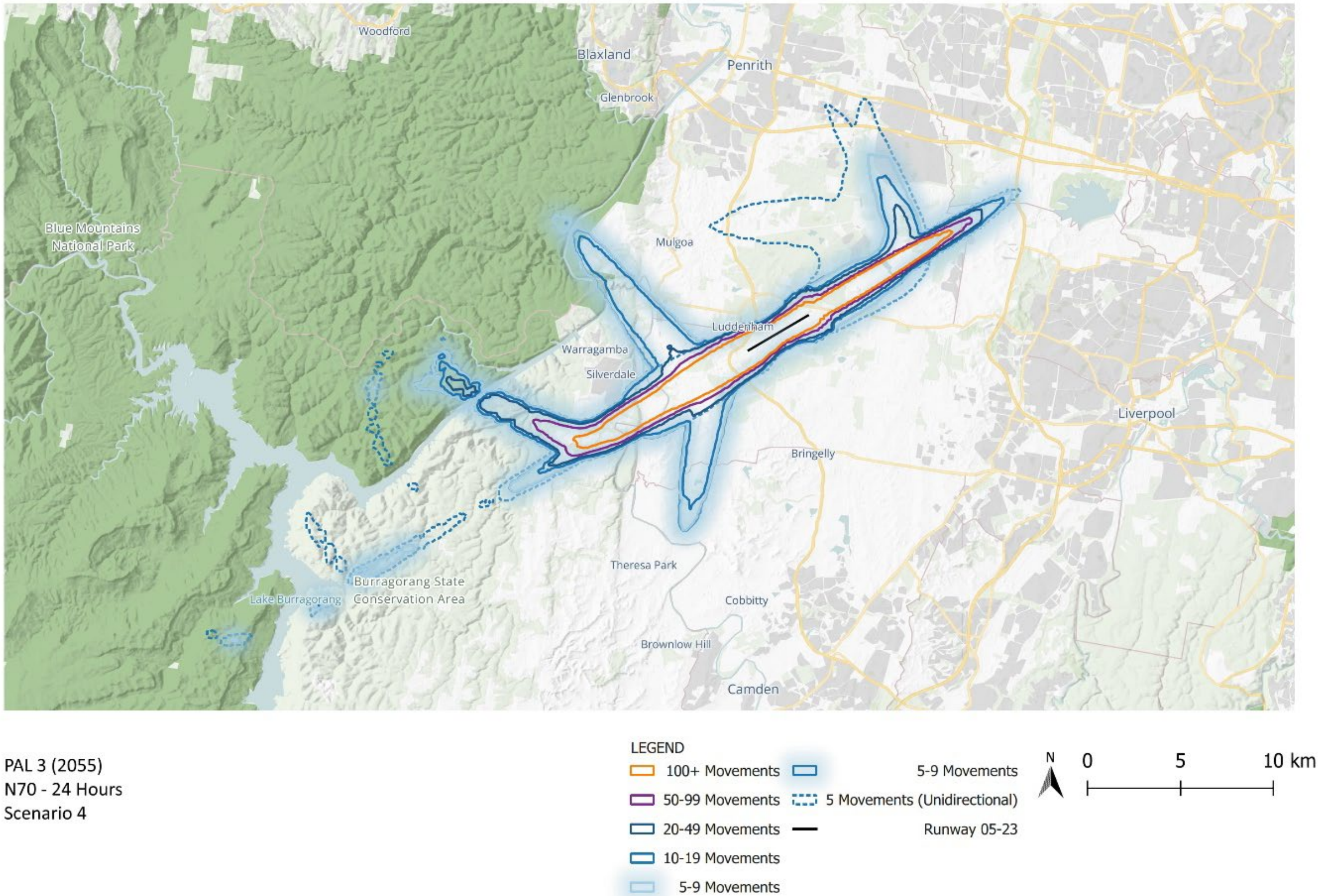


Figure 11.14 N70 noise contours – 24-hours – Prefer Runway 23 – 2055

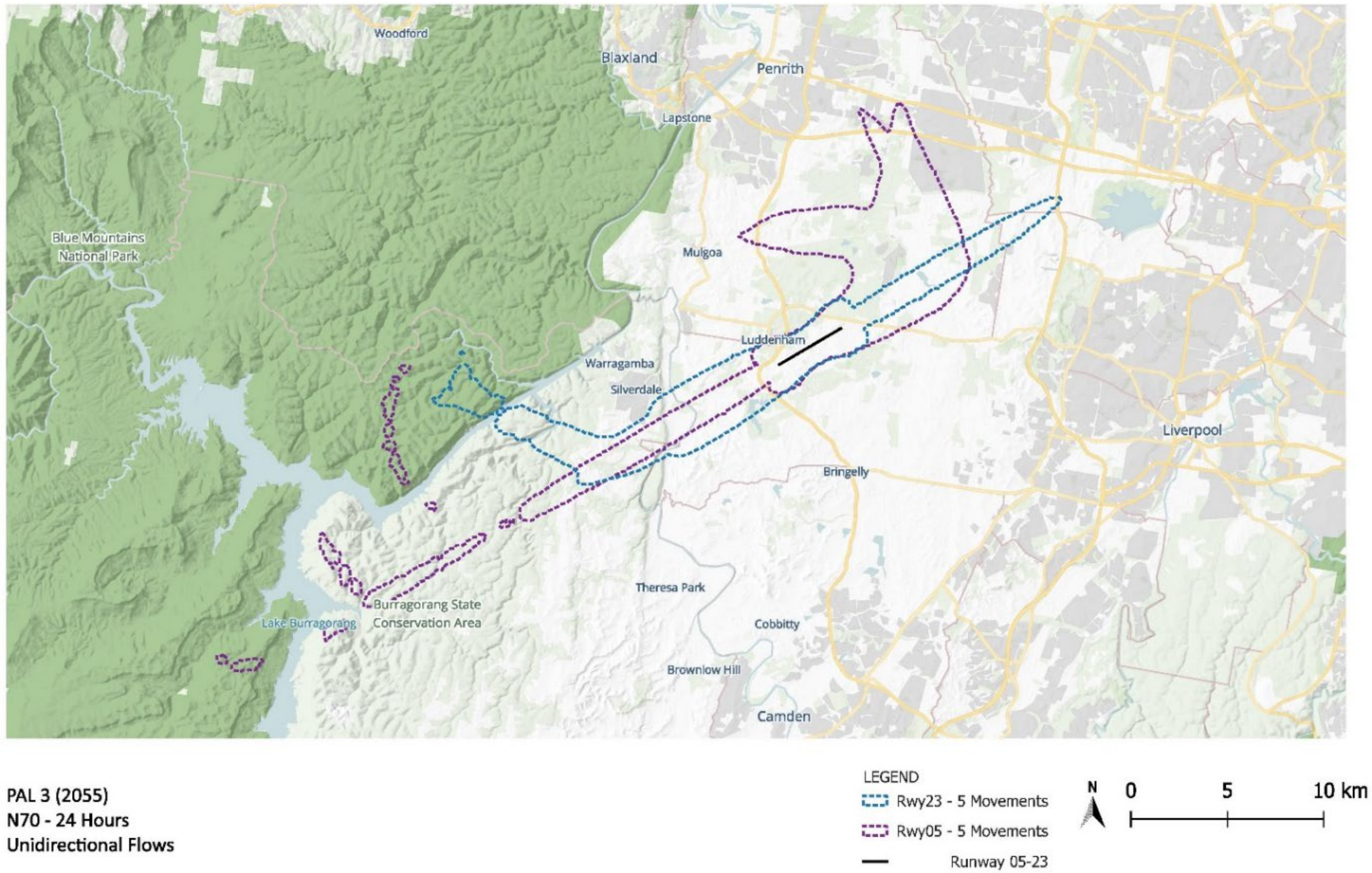


Figure 11.15 N70 noise contours – 24-hours – Unidirectional scenarios – 2055

Composite scenarios

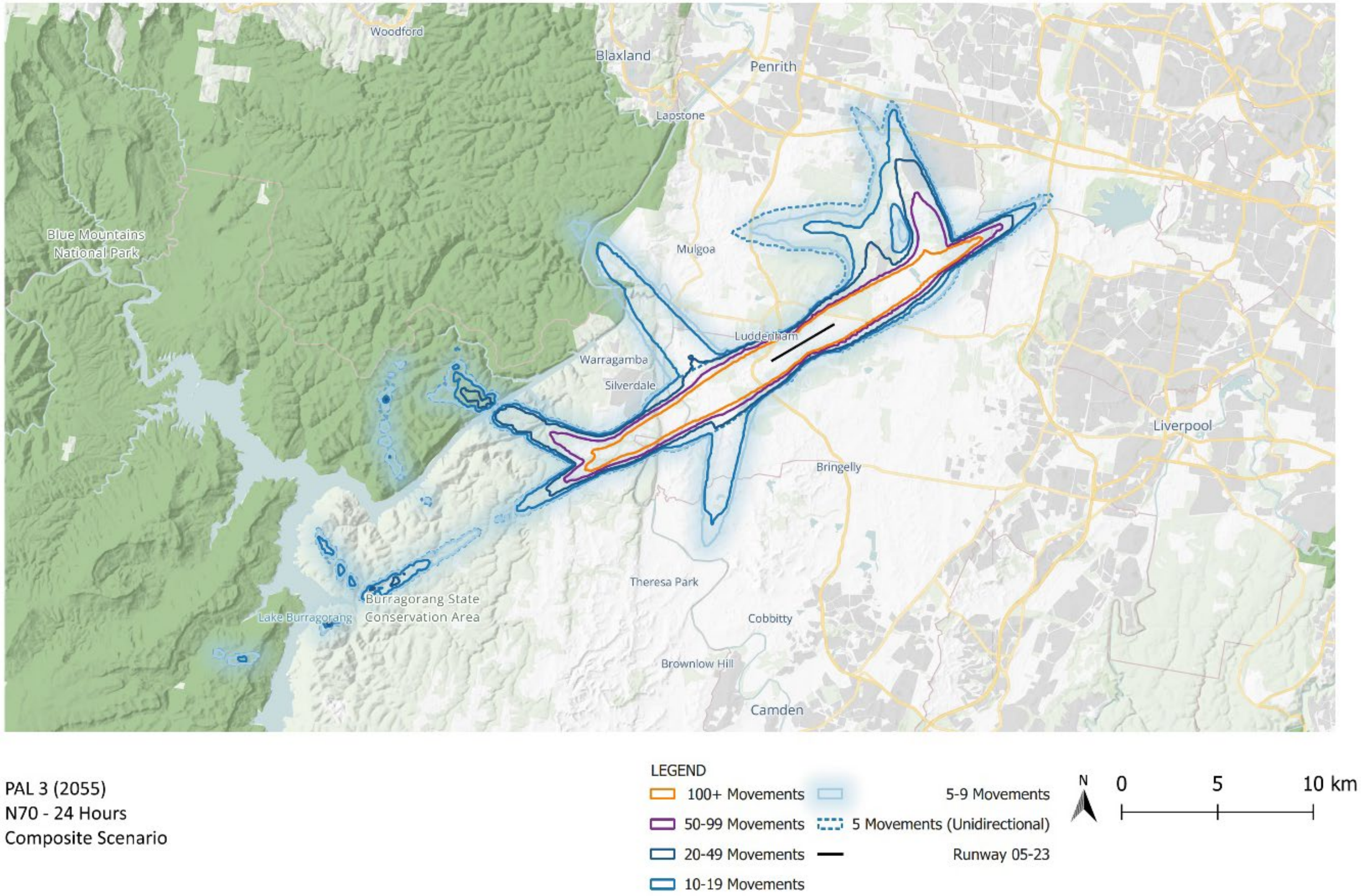


Figure 11.16 N70 noise contours – 24-hours – composite scenario – 2055

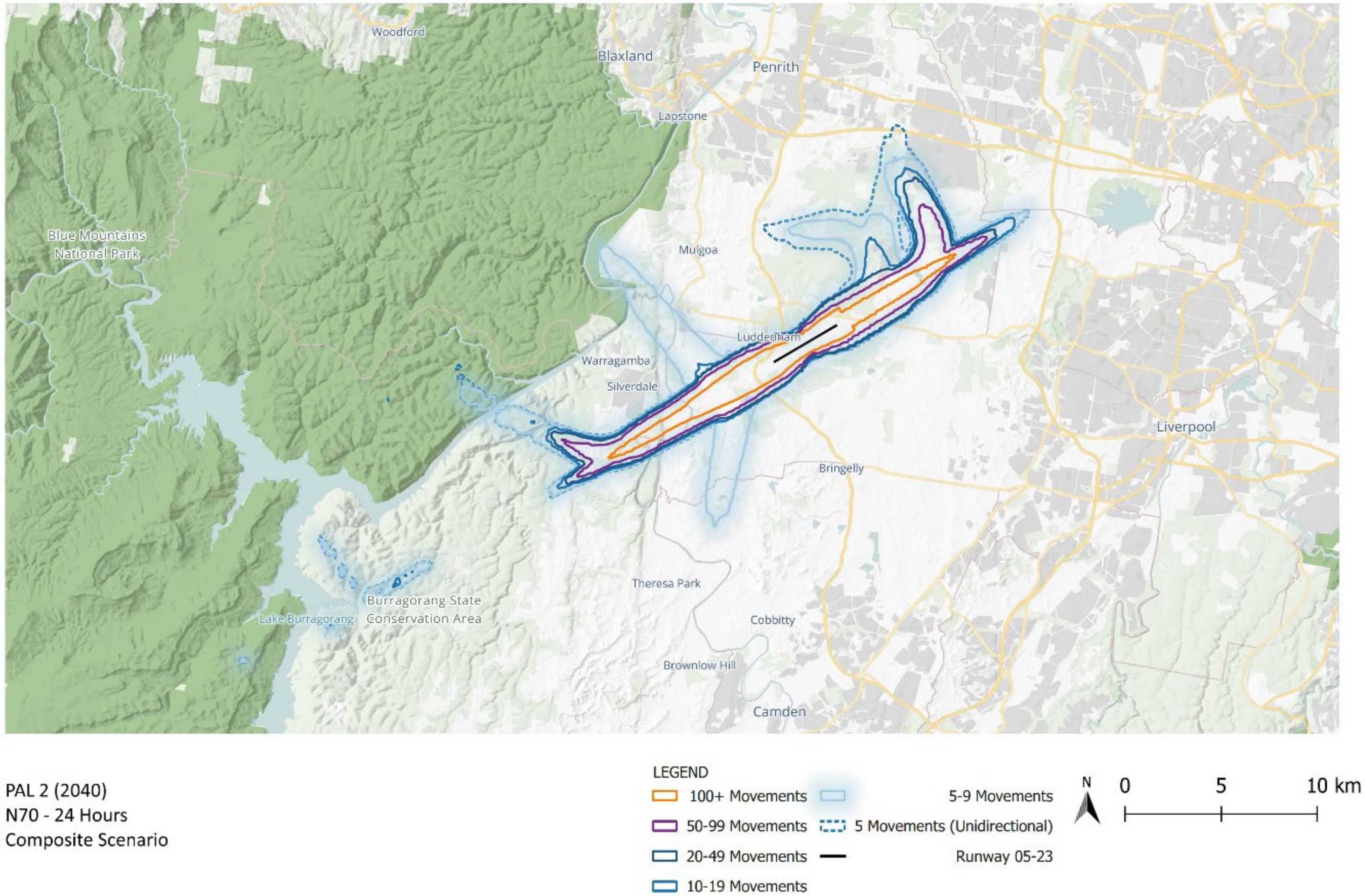


Figure 11.17 N70 noise contours – 24-hours – composite scenario – 2040

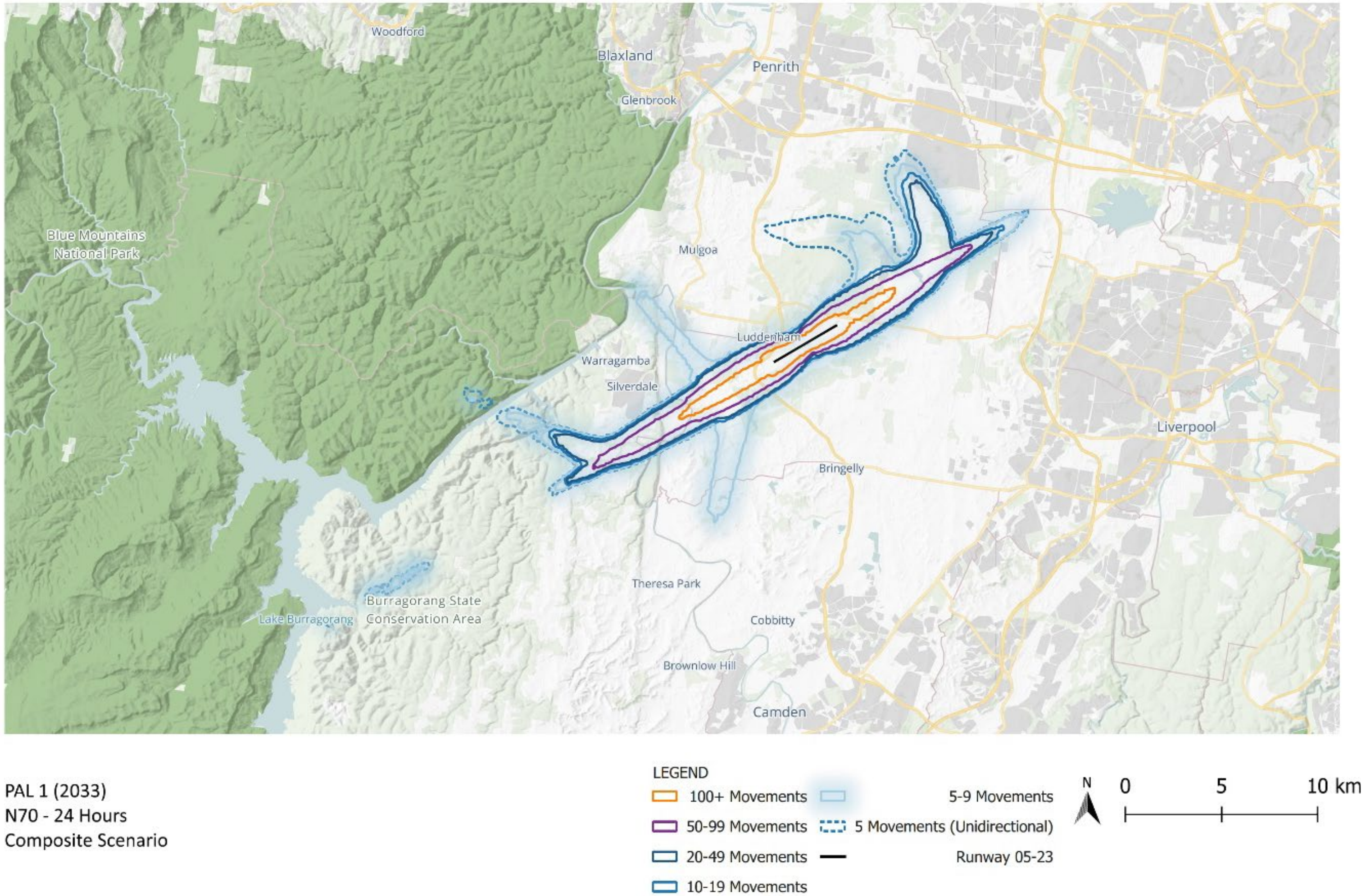


Figure 11.18 N70 noise contours – 24-hours – composite scenario – 2033

Population and dwelling counts

The assessment of population and dwellings exposed to an average of more than 5 daily movements above 70 dB(A) reflects disturbance associated with noisier events that can impact a normal conversation, even in urban areas. Figure 11.19 highlights the growth in population likely to be exposed to different thresholds of aircraft noise events exceeding 70 dB(A) over a 24-hour period as WSI operational demand increases from 2033 to 2055.

The results show Prefer Runway 23 scenario (with RRO operations at night) has the lowest number of people impacted by various noise event thresholds. While other scenarios initially expose up to 5,000 people to at least 5 noise events above 70 dB(A) per day, growing to over 12,000 people by 2055, Prefer Runway 23 scenario minimises the number of people exposed to 5 N70 or above noise events to approximately 7,000 people by 2055, approximately the same level that can be expected to the composite scenario at the earlier year of 2040.

Prefer Runway 05 scenario shows increased population exposure to an average of 5 daily movements above 70 dB(A) in the communities of St Clair and Kingswood. Those same communities would see a decrease under Prefer Runway 23 scenario, as well as in St Marys.

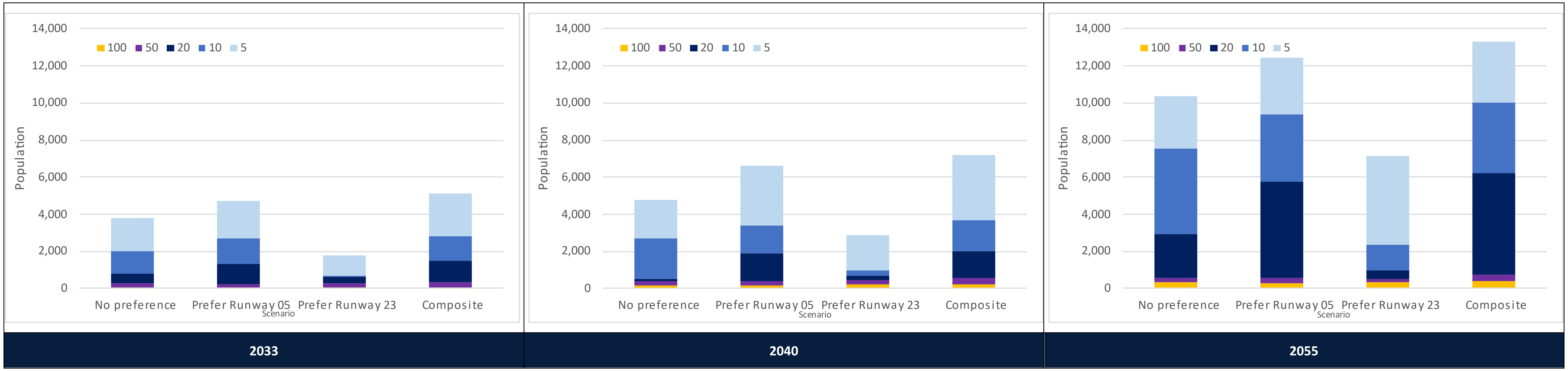


Figure 11.19 Population counts – N70 24-hour contours for all scenarios

11.7.1.2 N60

The key findings are depicted by:

- for 2055 – calculated N60 (24-hour) noise contours for each of the 3 operating scenarios – shown on Figure 11.20 to Figure 11.22
- for 2055, 2040 and 2033 – composite scenario N60 (24-hour) noise contours comprised of the 3 operating scenarios for each assessment year – shown on Figure 11.23, Figure 11.24 and Figure 11.25 respectively.

Geographical extent

As the single runway approaches capacity at around 37 million annual passengers (2055) (refer to Figure 11.20 to Figure 11.22), the extent of predicted noise impact based on N60 (24-hour) contours is at its greatest. N60 contours extend well beyond the runway ends, north towards Penrith, north-east towards St Marys and north, west and south-west into the Blue Mountains National Park. The N60 = 10–19 contours extend approximately 46 km to the north-west of the runway centre, 27 km to the north-east and 46 km to the south-west of the runway ends. With the application of Prefer Runway 05 scenario the N60 = 10-19 contours extend over Blaxland and Penrith whereas with Prefer Runway 23 or No preference scenarios these contours do not affect these areas to the same extent.

2055 scenarios (other than composite)

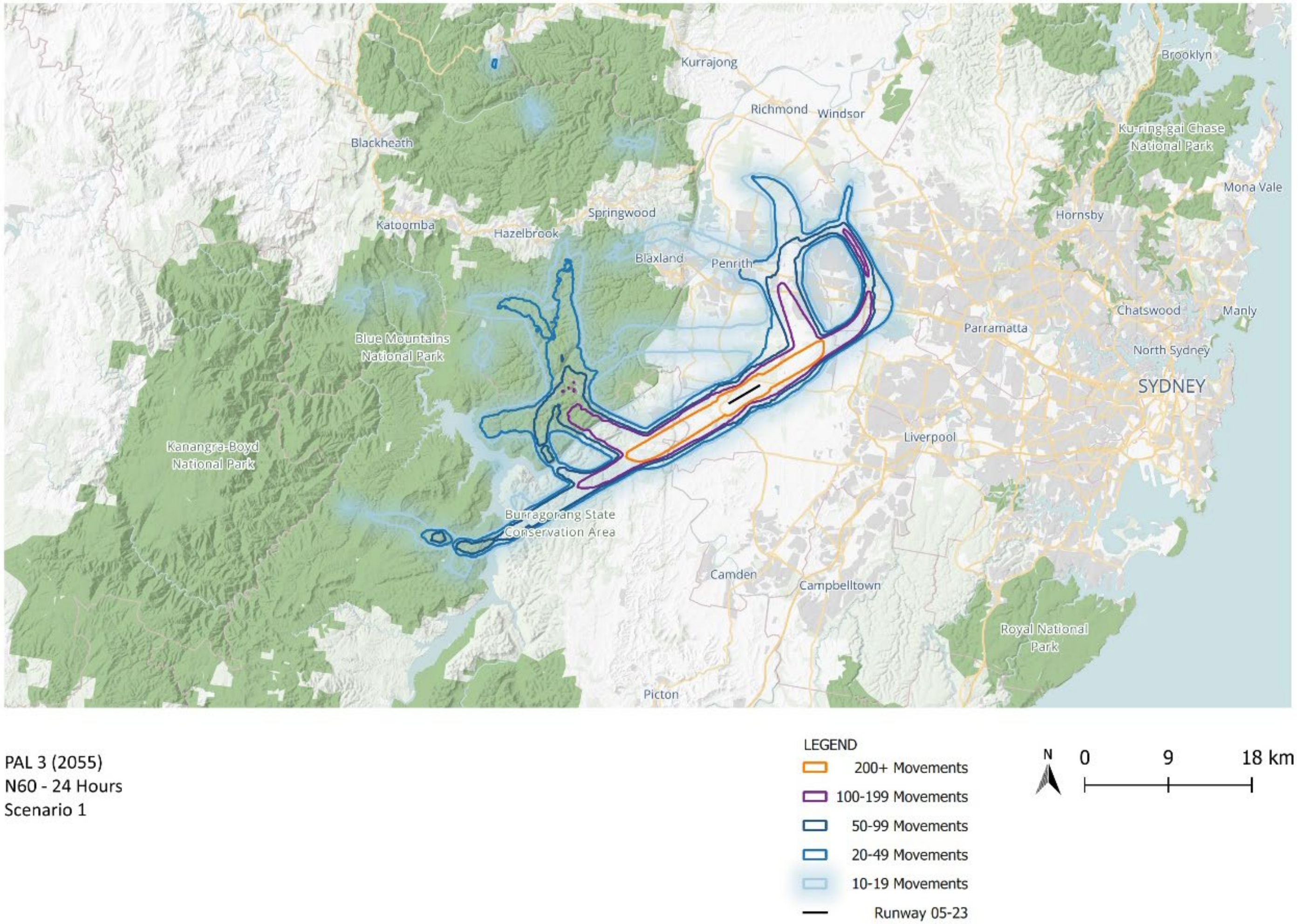


Figure 11.20 N60 noise contours – 24-hours – No preference – 2055

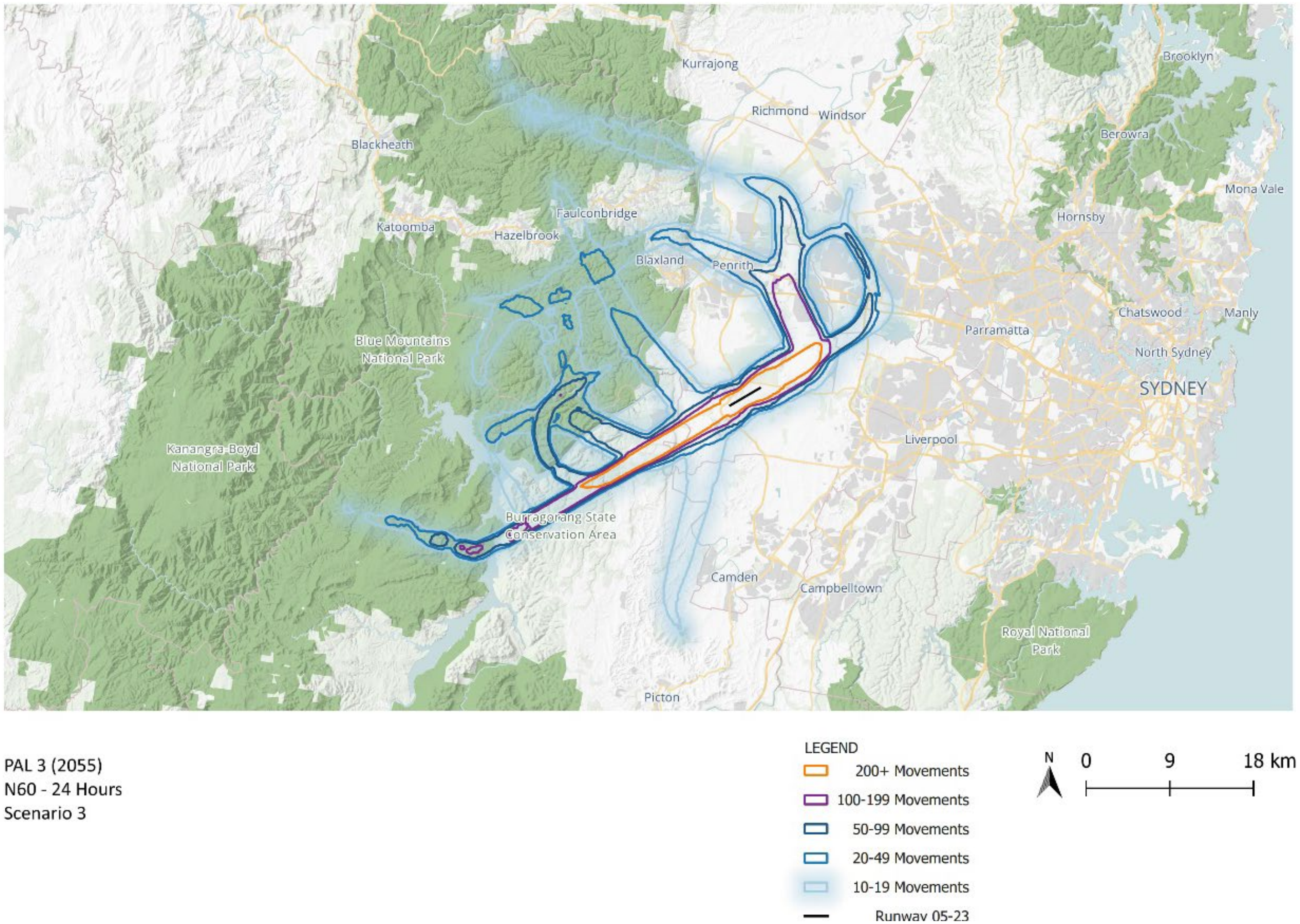


Figure 11.21 N60 noise contours – 24-hours – Prefer Runway 05 – 2055

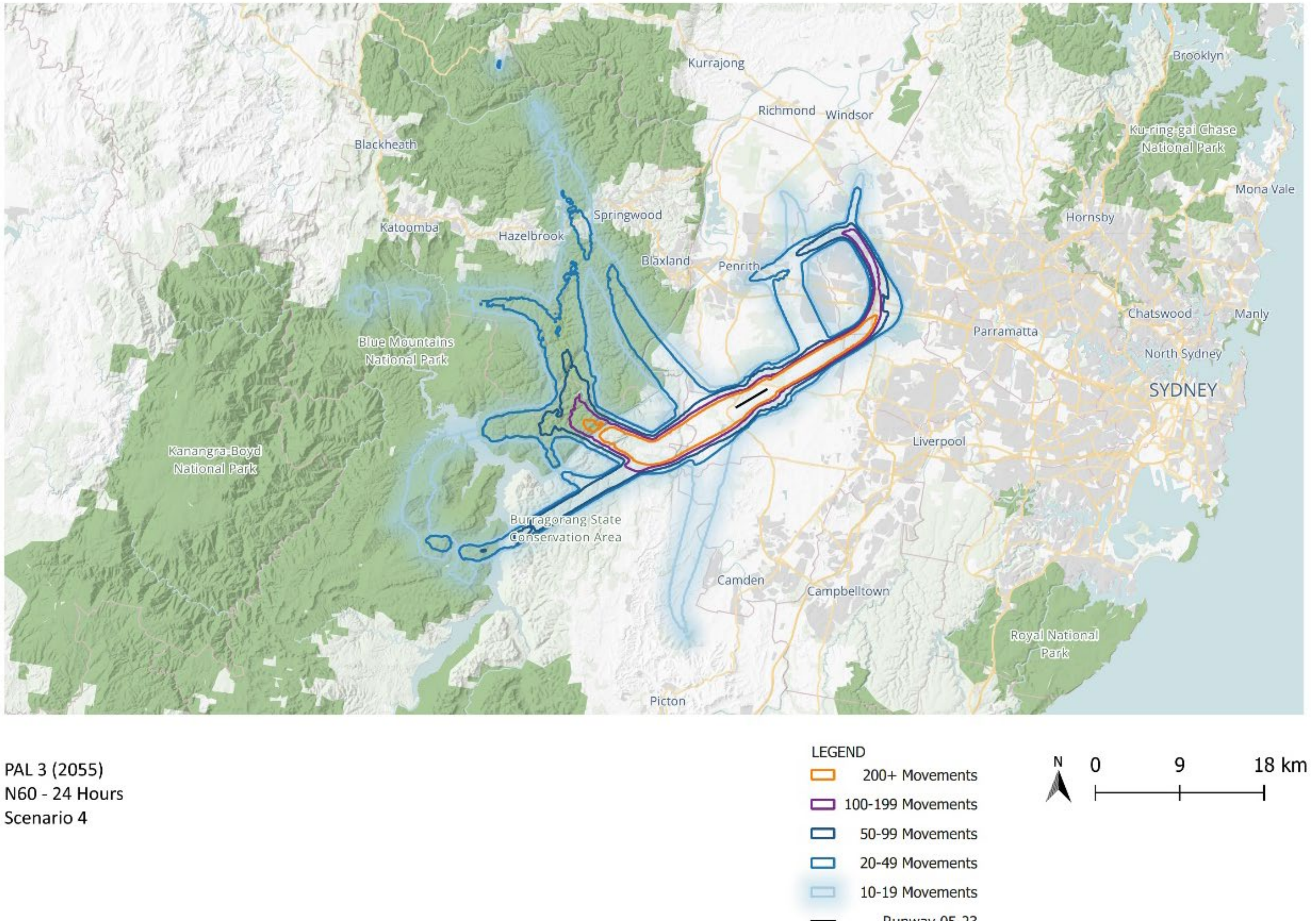


Figure 11.22 N60 noise contours – 24-hours – Prefer Runway 23 – 2055

Composite scenarios

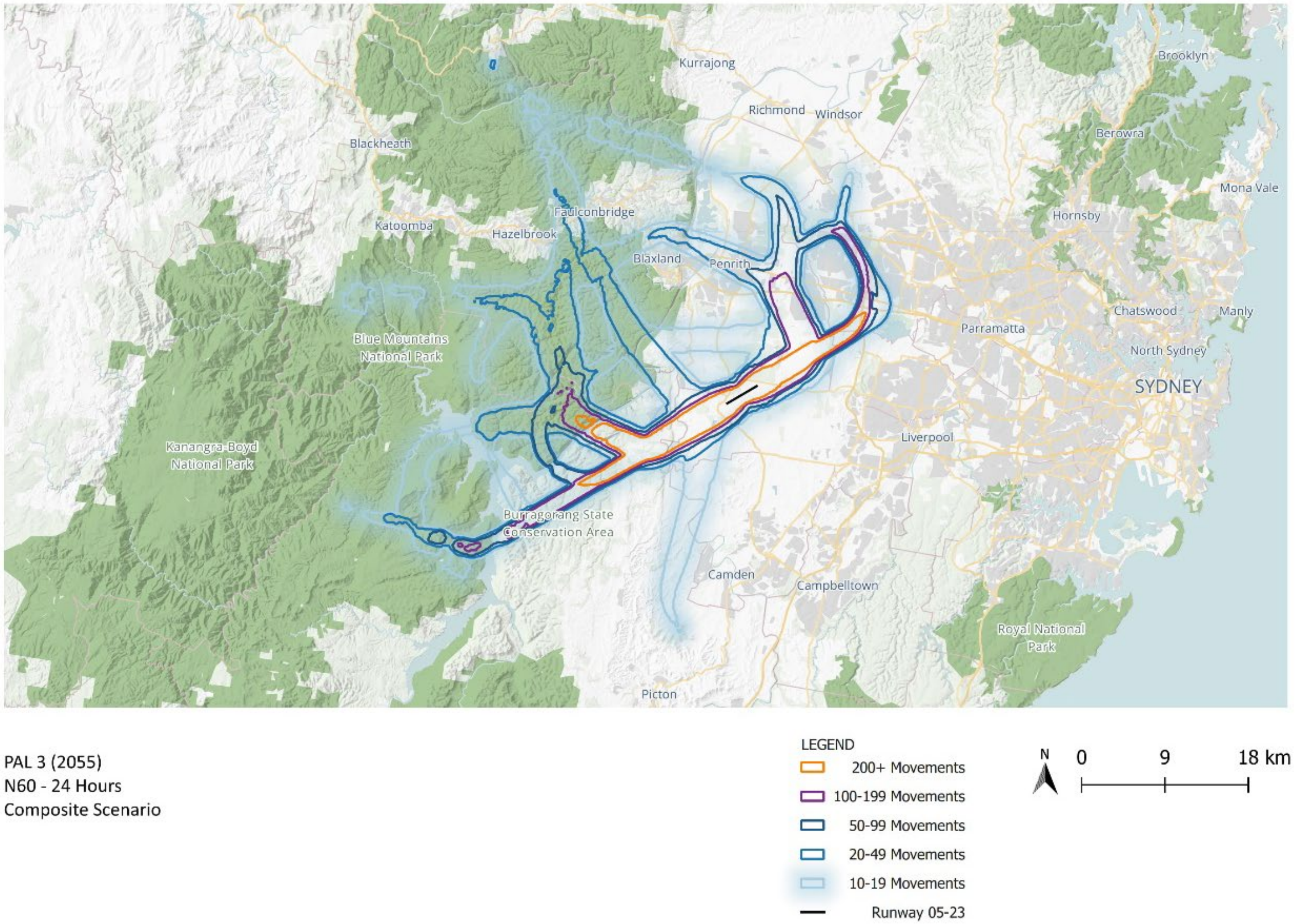


Figure 11.23 N60 noise contours – 24-hours – composite scenario– 2055

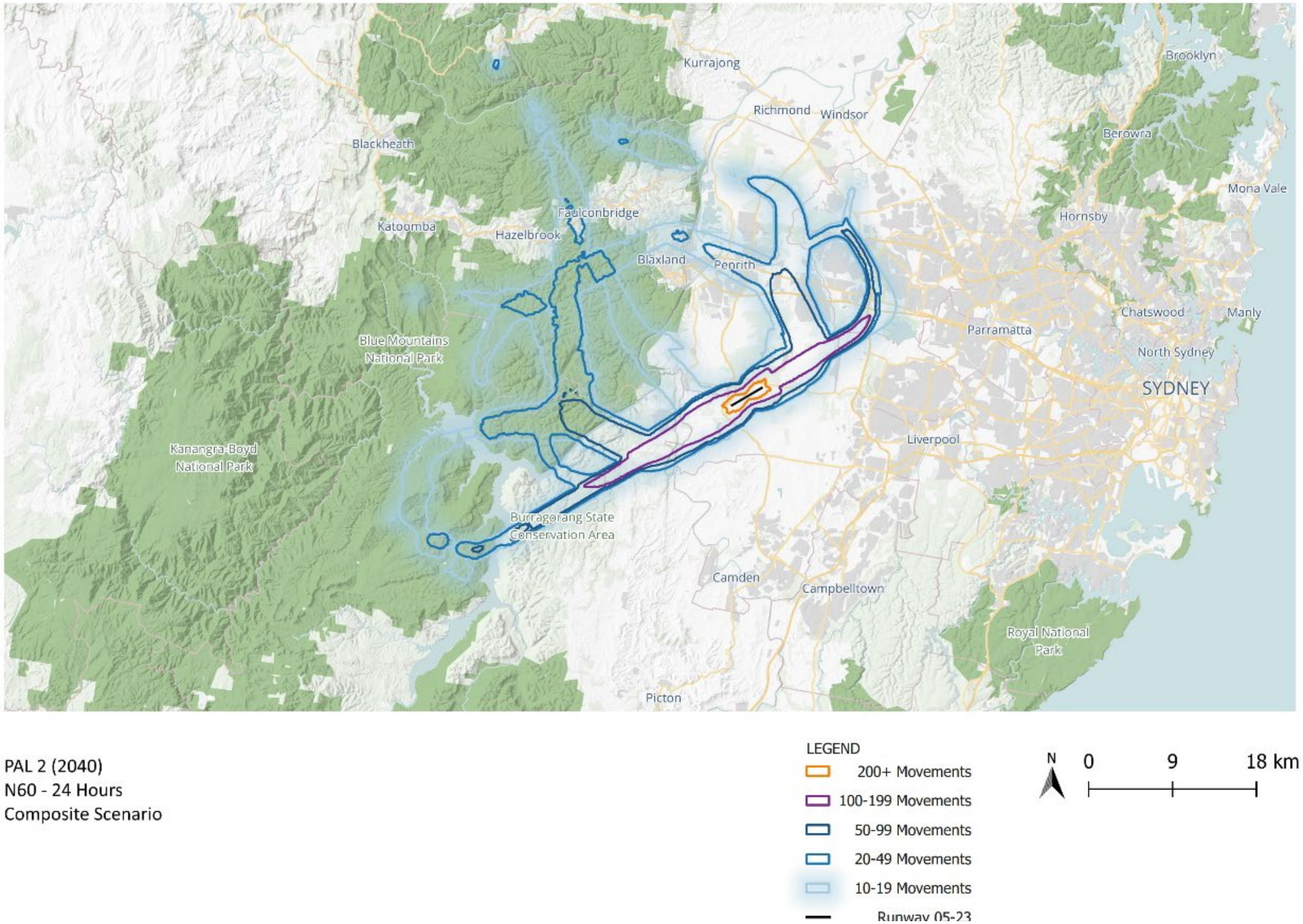


Figure 11.24 N60 noise contours – 24-hours – composite scenario – 2040

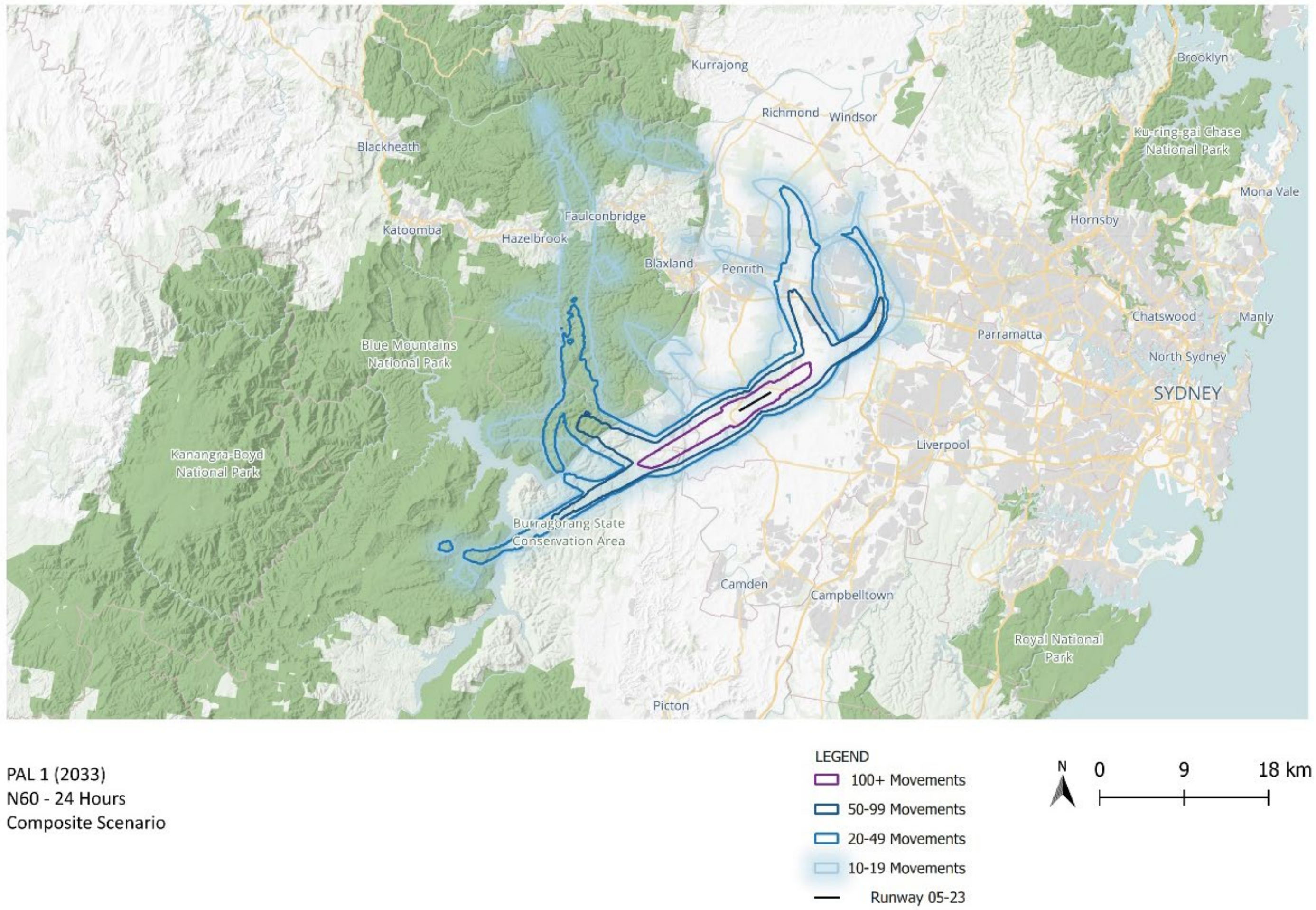


Figure 11.25 N60 noise contours – 24-hours – composite scenario – 2033

Population and dwelling counts

The assessment of population and dwellings exposed to an average of more than 10 daily events above 60 dB(A) reflects disturbance associated with the frequency of events, especially in rural areas where movements will be more noticeable at a lower noise threshold. Figure 11.26 highlights the growth in population likely to be exposed to different thresholds of aircraft noise events exceeding 60 dB(A) over a 24-hour period as WSI operational demand increases from 2033 to 2055.

Similar to the N70 24-hour contours, Figure 11.26 shows that for N60 24-hour contours, Prefer Runway 23 scenario (with RRO operations at night) has the lowest number of people impacted by various noise event thresholds.

While other scenarios expose over 150,000 people to at least 10 noise events above 60 dB(A) per day in 2055, Prefer Runway 23 scenario decreases the number of people exposed to approximately 114,000 by 2055, lower than the numbers that can be expected under other scenarios at the early year of 2040.

While Prefer Runway 05 scenario (with RRO operations at night) would an increased noise exposure compared to No preference scenario in 2033 and 2055, Prefer Runway 23 scenario would reduce exposure to at least 10 daily movements above 60 dB(A) for the communities of Penrith, Emu Plains, Colyton, Erskine Park, Jordan Springs, Cambridge Park and Blaxland.

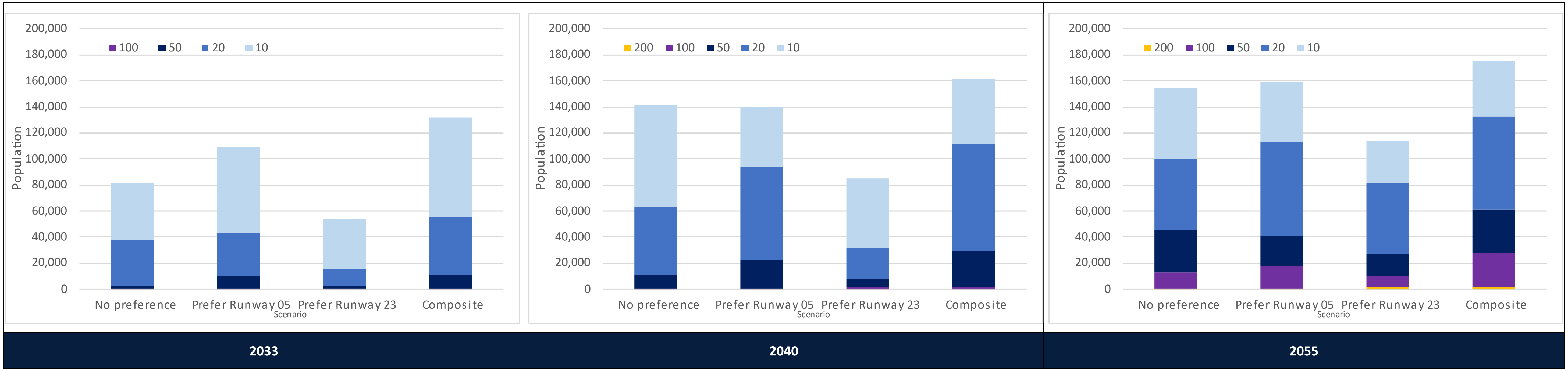


Figure 11.26 Population counts – N60 24-hour contours for all scenarios

11.7.2 Night-time noise levels

The number of noise events exceeding 60 dB(A) (N60) has been used to describe the impact of noise at night. N60 values have been predicted for the night-time period 11 pm to 5:30 am.

The key findings are depicted by:

- for 2055 – calculated N60 (night) noise contours for each of the 3 scenarios – shown on Figure 11.27 to Figure 11.29
- for 2055, 2040 and 2033 – composite scenario N60 (night) noise contours comprised of the 3 operating scenarios for each assessment year – shown on Figure 11.30, Figure 11.31 and Figure 11.32 respectively.

Geographical extent

At night, the No preference scenario is predicted to have a greater impact on built-up areas around St Marys (up to Hassal Grove). The Prefer Runway 05 and Prefer Runway 23 scenarios (both with RRO) are operationally identical but could behave differently during the transition between day and night and would have less impact on these built-up areas and a greater impact on rural residential areas around Greendale and Silverdale. The Prefer Runway 05 and Prefer Runway 23 scenarios extend south of the runway to east of Picton. By 2055, all scenarios would impact areas of Luddenham to the north of the runway (up to 49 noise events per night).

The number of night-time noise events in densely populated areas could be reduced by use of RRO where available. As demonstrated in Figure 11.28 and Figure 11.29, this would result in no built-up residential areas being exposed on average to more than 9 events per night above 60 dB(A).

2055 scenarios (other than composite)

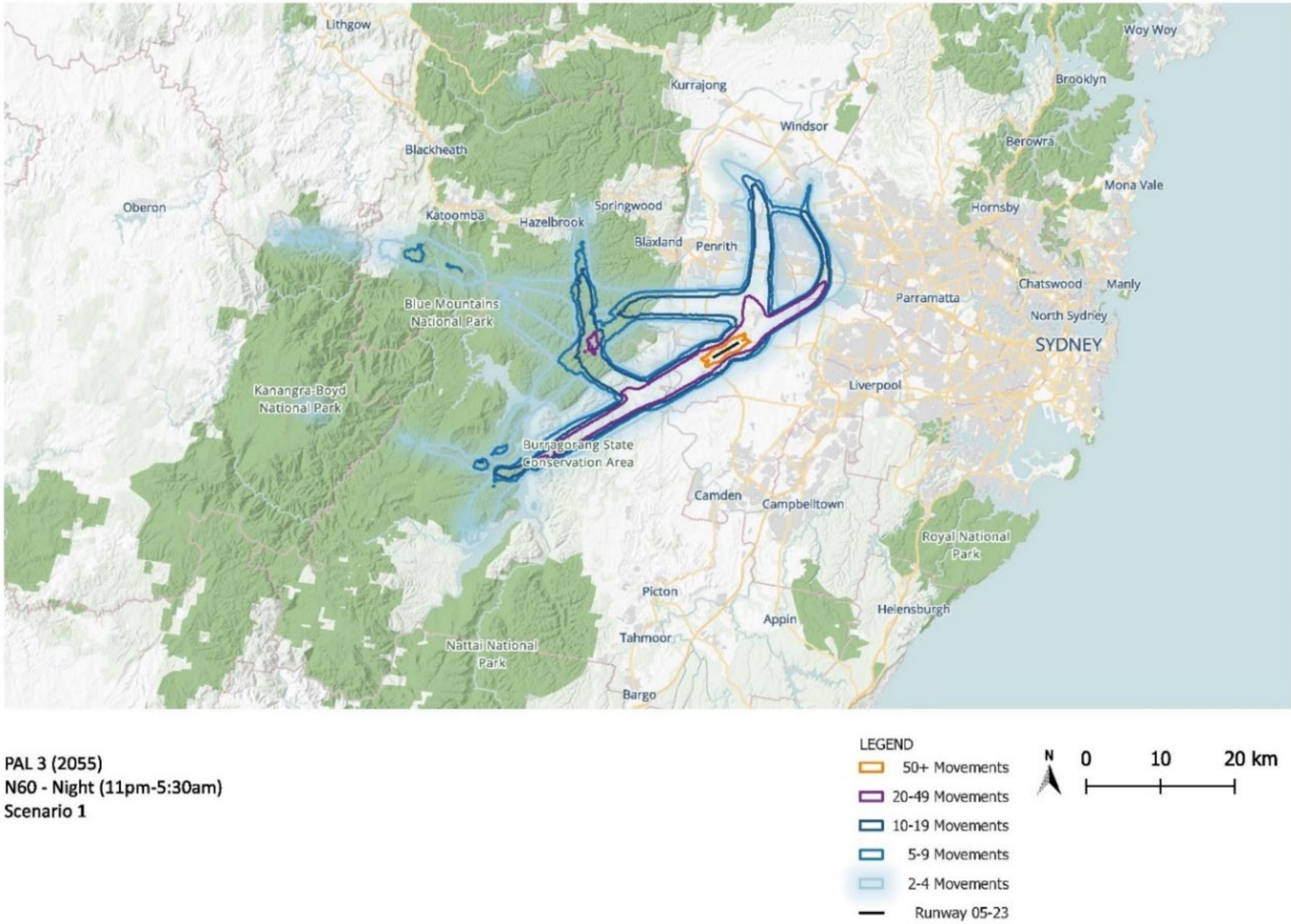


Figure 11.27 N60 noise contours – night – No preference– 2055

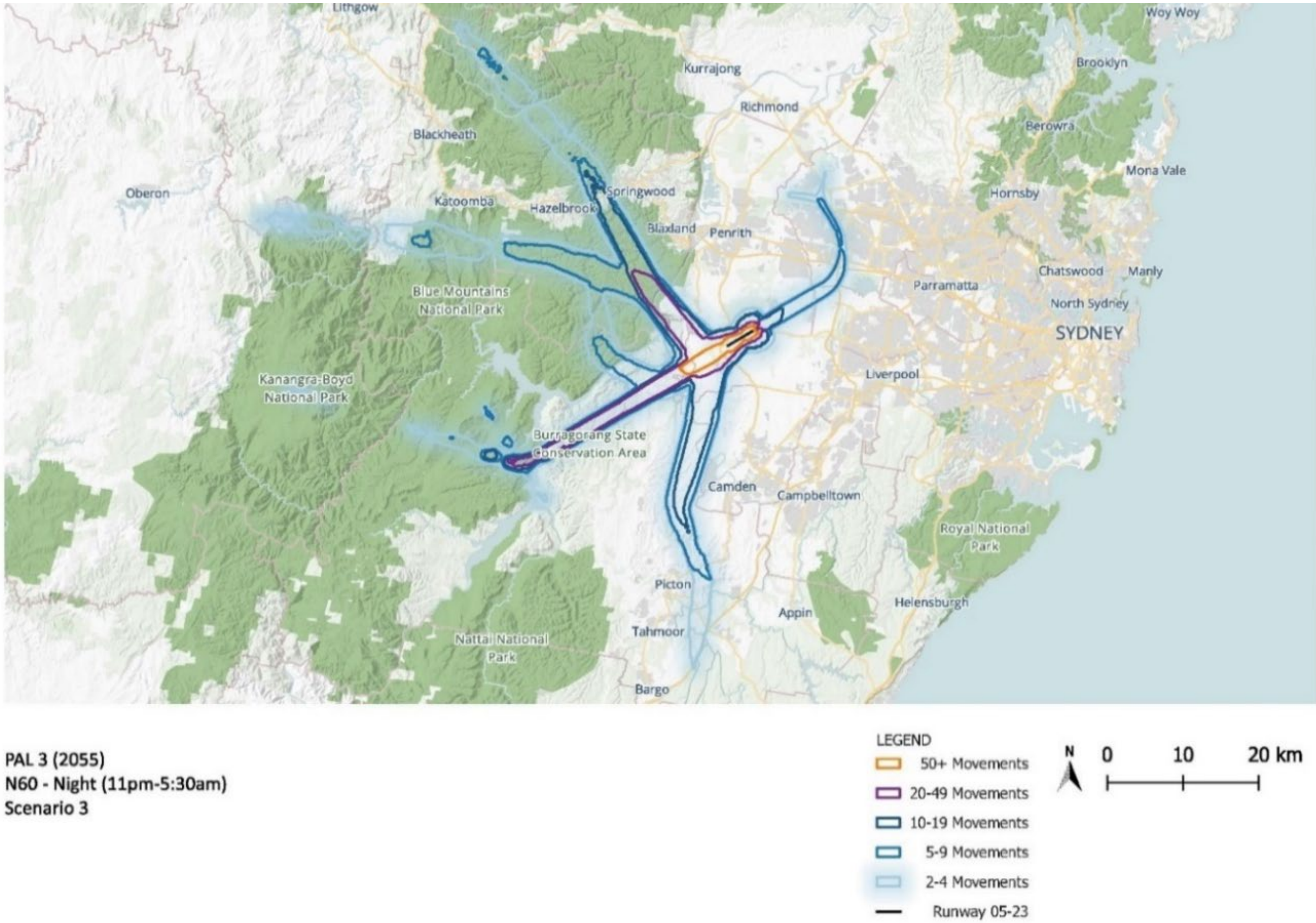


Figure 11.28 N60 noise contours – night – Prefer Runway 05 – 2055

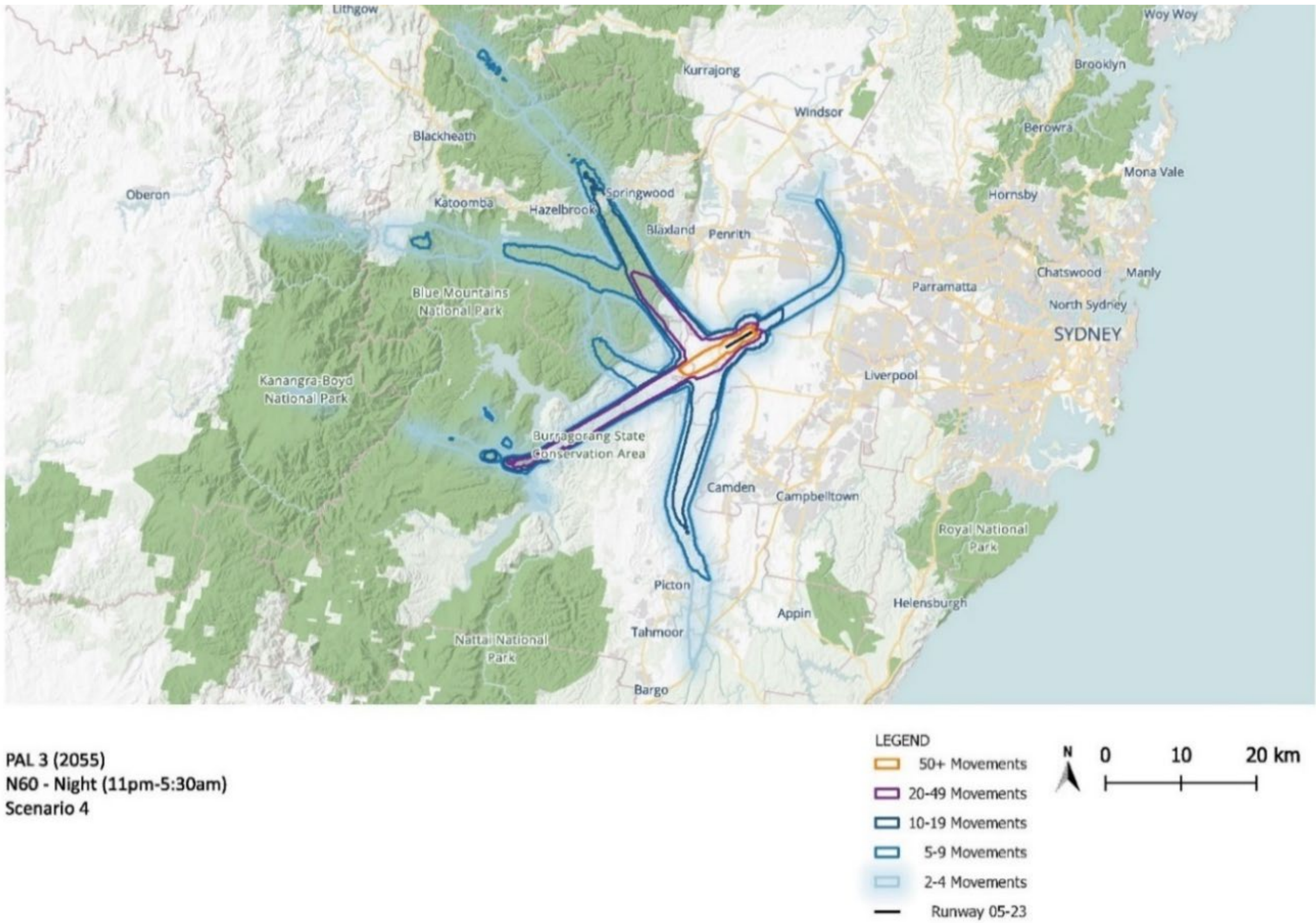


Figure 11.29 N60 noise contours – night – Prefer Runway 23 – 2055

Composite scenarios

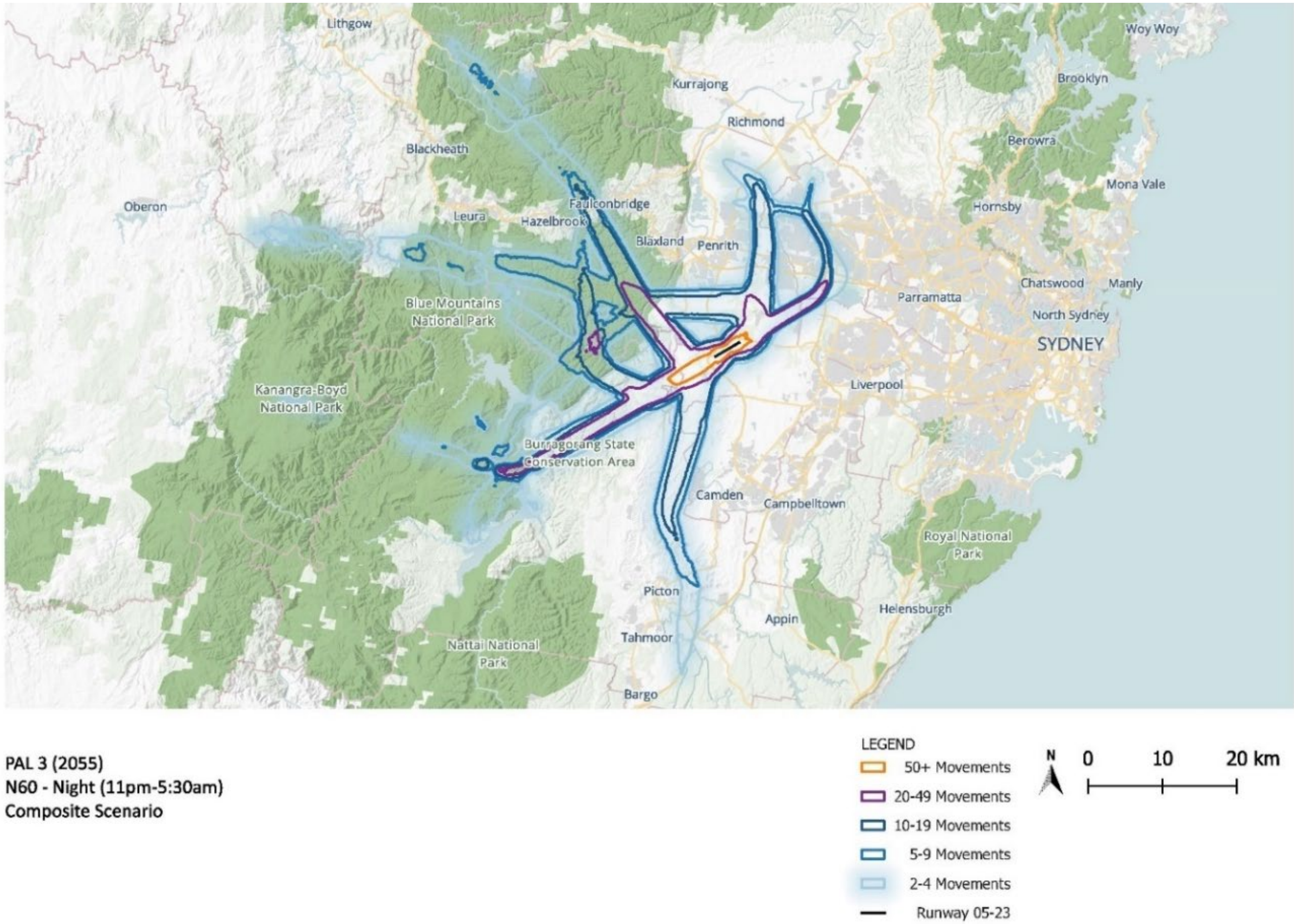


Figure 11.30 N60 noise contours – night – composite scenario – 2055

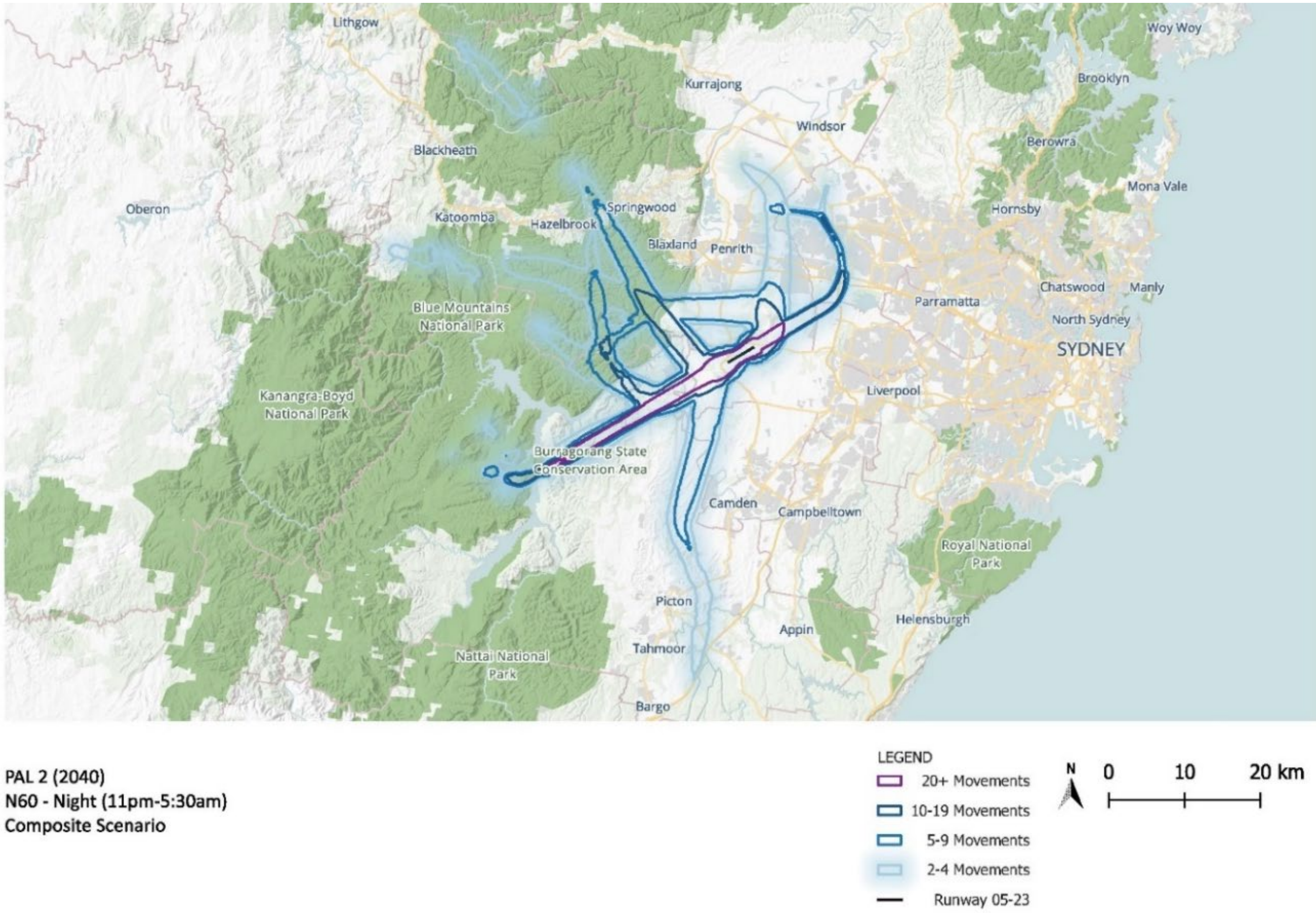


Figure 11.31 N60 noise contours – night – composite scenario– 2040

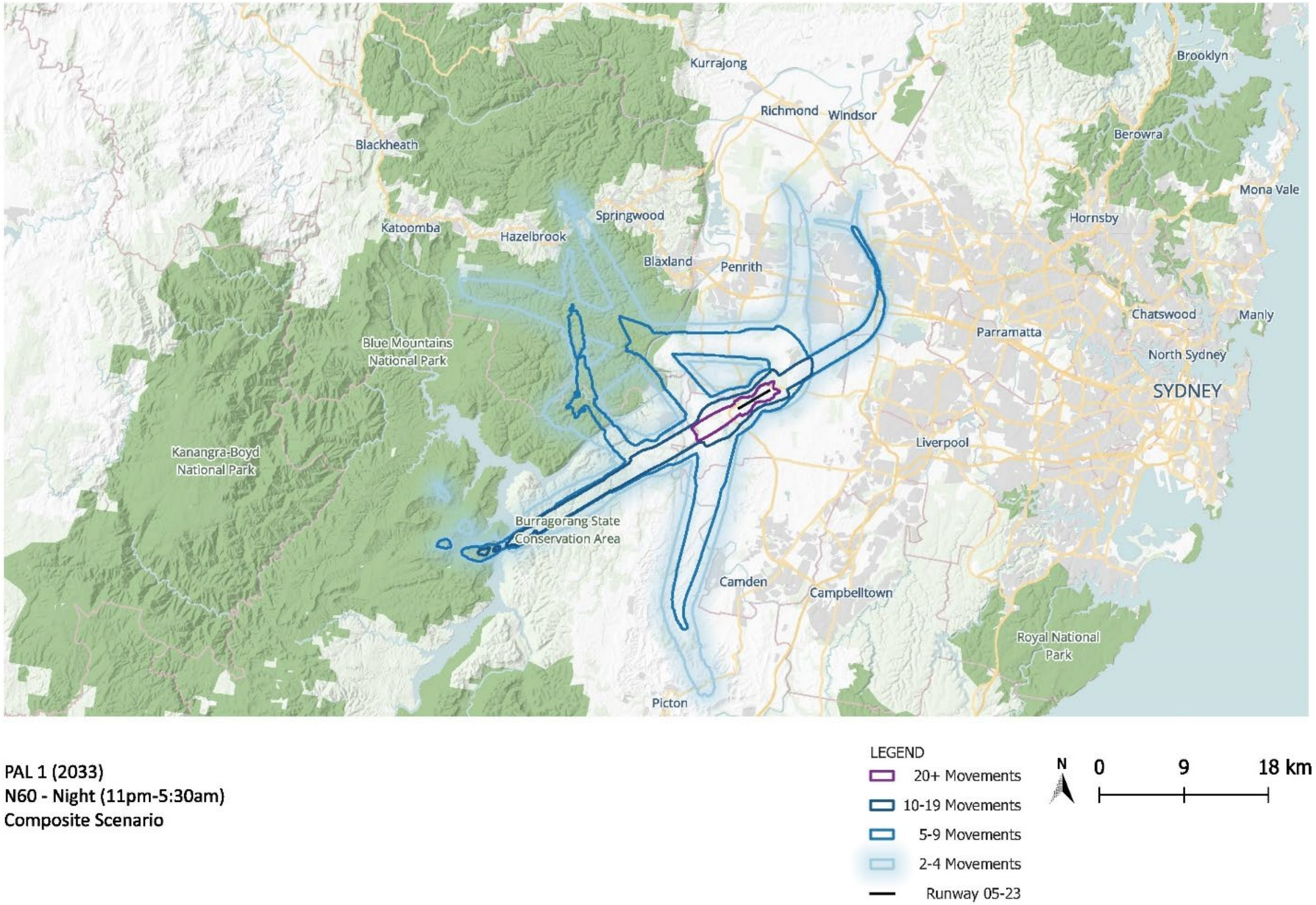


Figure 11.32 N60 noise contours – night – composite scenario– 2033

Population and dwelling counts

The assessment of population and dwellings exposed to an average of more than 2 movements above 60 dB(A) between 11 pm and 5:30 am daily – (Night), indicates the potential for disturbances during sleep hours. Figure 11.33 highlights the growth in population numbers, likely to be exposed to different thresholds of aircraft noise events exceeding 60 dB(A) during night-time (11 pm to 5:30 am) as WSI operational demand increases from 2033 to 2055.

The results show that Prefer Runway 05 and Prefer Runway 23 scenarios (which both incorporate RRO operations) decrease the number of people impacted by various night-time noise event thresholds when compared to a baseline or No Preference (scenario 1) without RRO. While the No preference scenario initially exposes up to 27,500 people to at least 2 noise events above 60 dB(A) per night in year 2033, this grows to over 84,500 people in 2055. The Prefer Runway 05 scenarios and Prefer Runway 23 scenarios minimise numbers of people exposed to approximately 23,000 people in 2055. This number is less than the number that can be expected to be exposed to 2 noise events above 60 dB(A) per night under the No preference scenario in 2033.

Communities such as St Marys, St Clair, Kingswood, Jordan Springs, Werrington and Orchard Hills will benefit from the use of the RRO mode of operation as used in Prefer Runway 05 and Prefer Runway 23. Communities such as the Oaks, Warragamba, Silverdale, Cobbitty, Greendale, Hazelbrook and Linden will see a likely increase in noise exposure when the RRO mode of operation is in use (noting the criteria required to be met for its application).

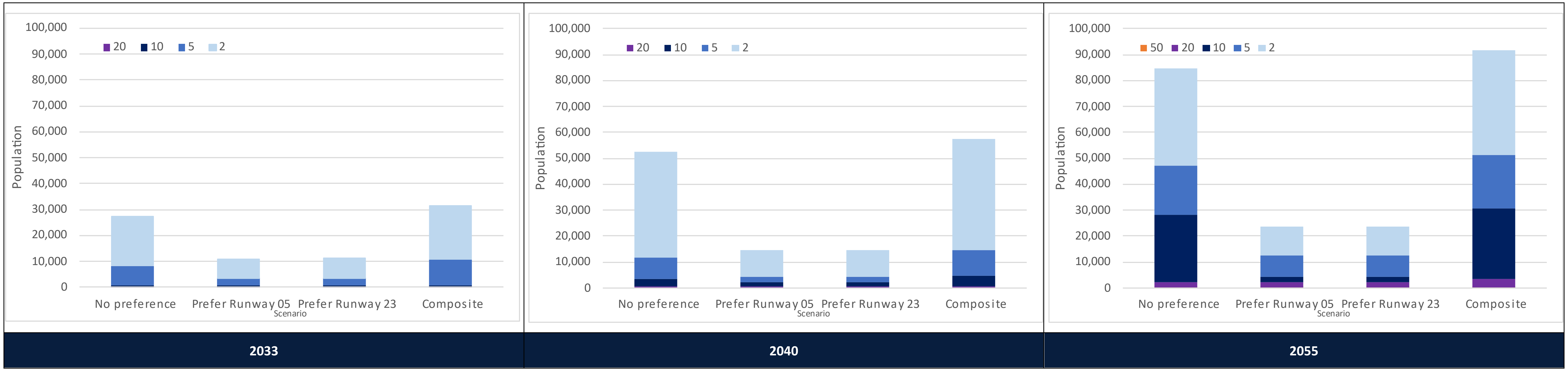


Figure 11.33 Population counts – Night N60 contours for all scenarios

11.7.3 Noise sensitive areas

Appendix D in Technical paper 1 presents the full results for the assessments on noise sensitive areas as described in Section 11.5.8. These assessments were used to inform the determination of noise impact on social amenity in Chapter 18 (Social).

11.7.3.1 Projected average and maximum sound level

The key findings can be depicted by the assessment of the project's impact on residences (by suburb) (refer to Figure 11.34 and Figure 11.35) and schools (refer to Figure 11.36 and Figure 11.37) using projected average sound level (L_{Aeq}) correlated with projected maximum sound level (L_{Amax}) (defined in Section 11.6.2).

The suburbs and schools depicted as outliers from the general grouping on these figures are likely to be more impacted by aircraft noise – that is, by higher average sound levels and higher noise levels from an aircraft noise event.

In terms of suburbs, during the night in 2055 under the Prefer Runway 23 scenario (Figure 11.35), the suburbs of Greendale, Luddenham, Silverdale and Wallacia could be exposed to single events exceeding 70 dB(A) and an average sound level of 50 dB(A) between 11 pm and 5:30 am.

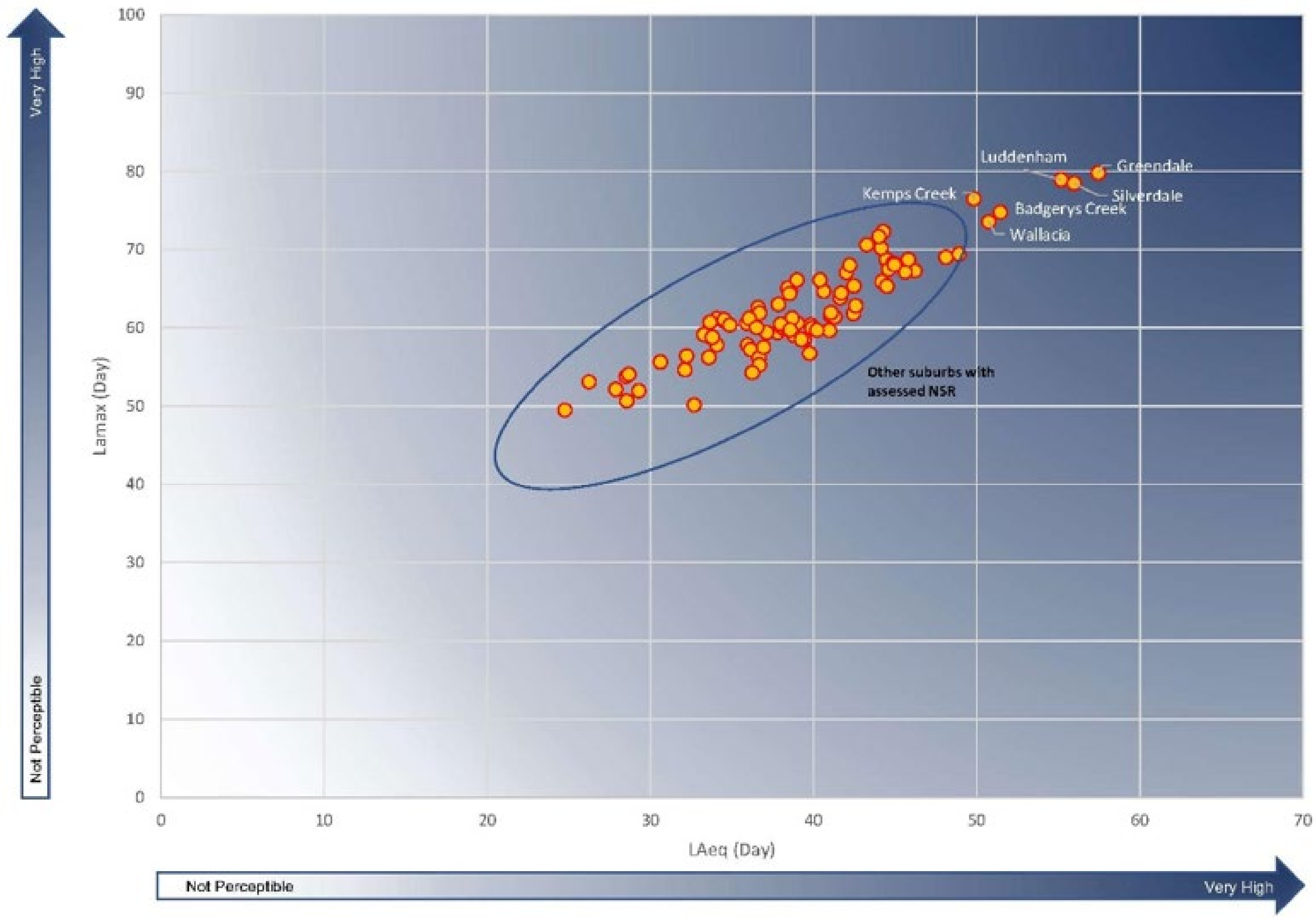


Figure 11.34 Suburbs – maximum sound level vs average sound level – day (5:30 am – 7 pm) – Prefer Runway 23 – 2055

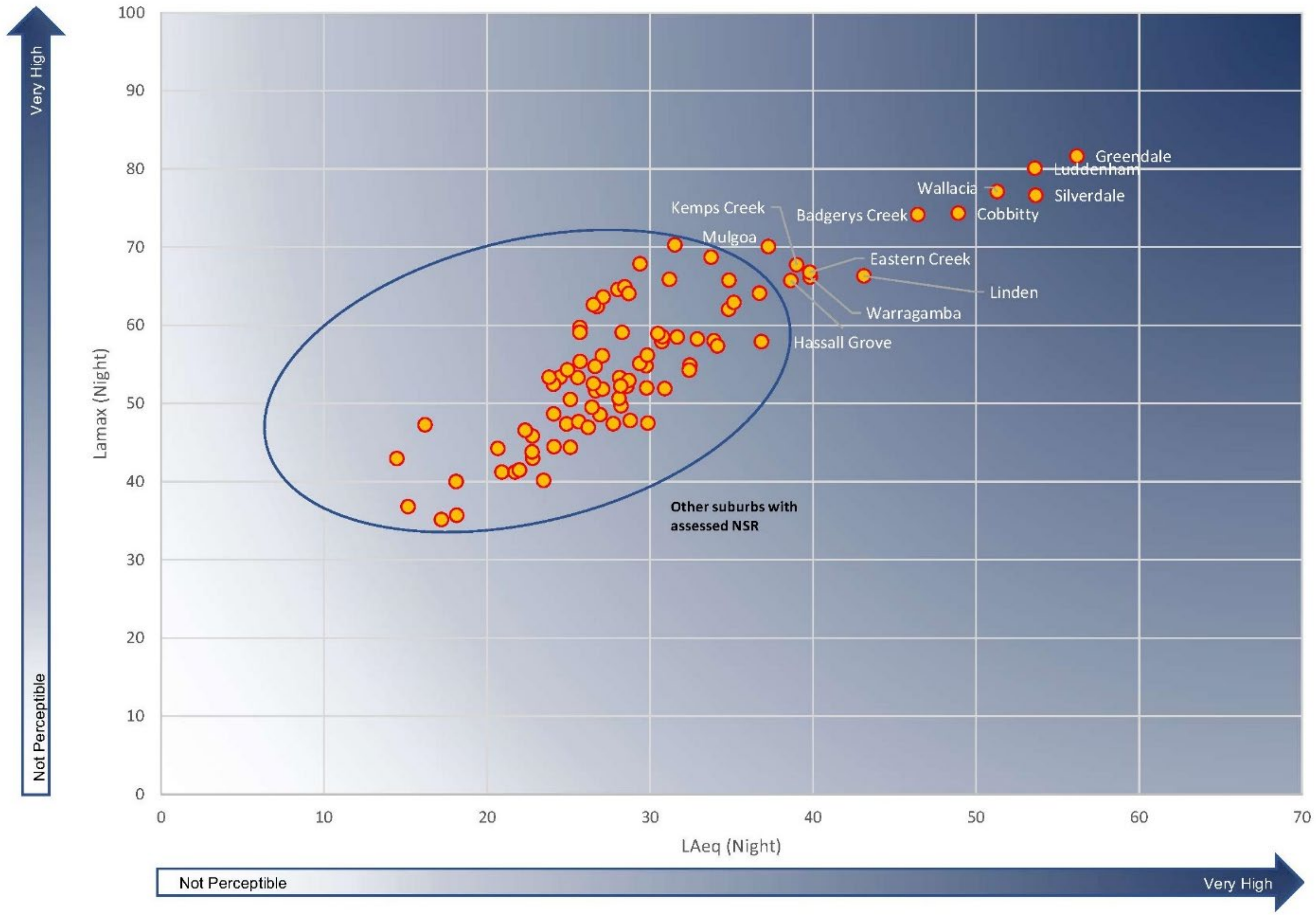


Figure 11.35 Suburbs – maximum sound level vs average sound level – night (11 pm – 5:30 am) – Prefer Runway 23 – 2055

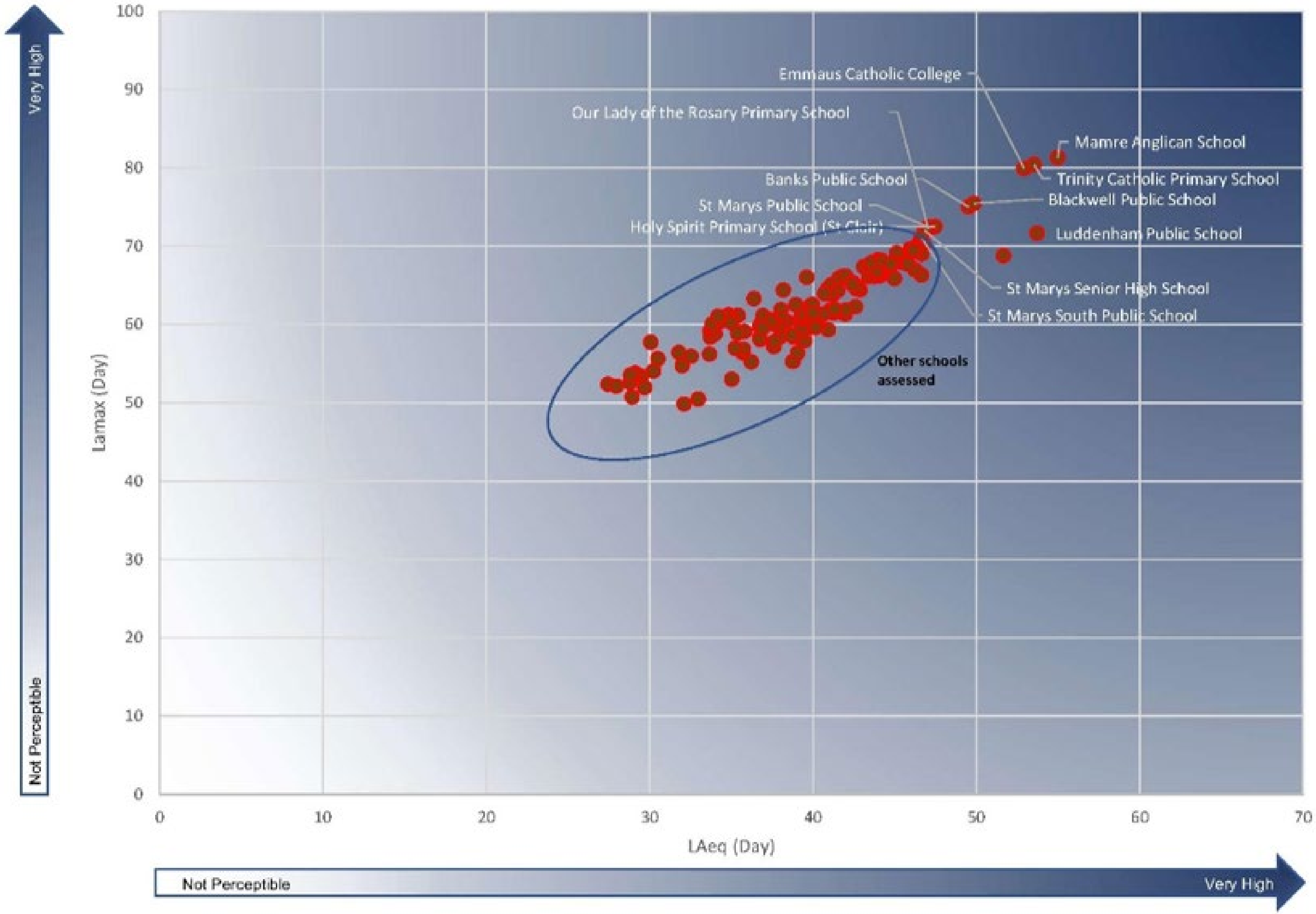


Figure 11.36 Schools – maximum sound level vs average sound level –day (5:30 am – 7 pm) – No preference – 2055

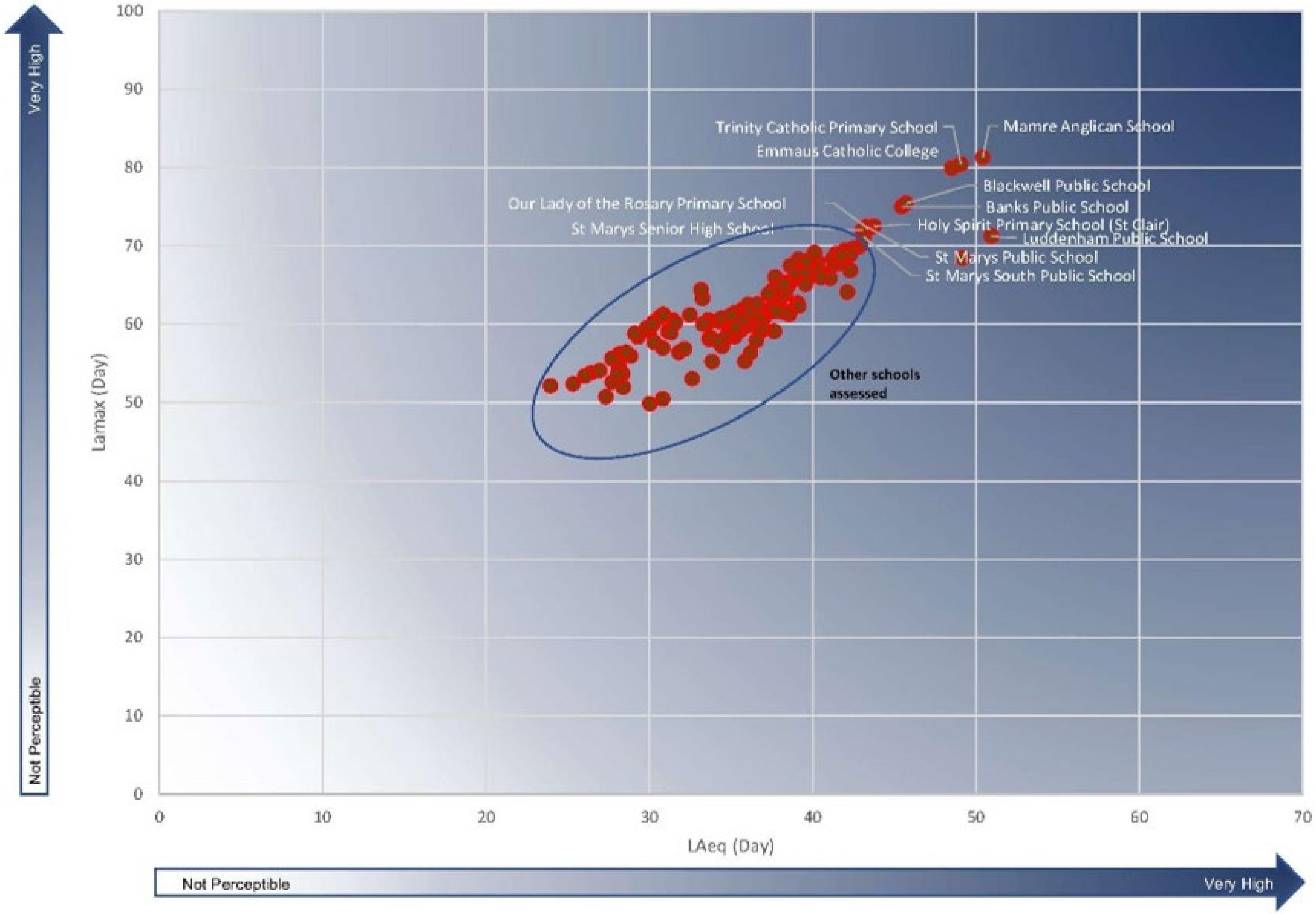


Figure 11.37 Schools – maximum sound level vs average sound level – day –Prefer Runway 23 – 2055

11.7.3.2 Proportion of respite

Figure 11.38 presents an example of a map highlighting the projected proportion of respite at various noise sensitive areas across the Sydney Basin. As supported by Table 11.2 in this context respite is the proportion of days without direct overflights, or flights within a one km width from a flight path corridor, regardless of sound level. This means that some noise sensitive areas may be exposed to a high volume of overflights at low sound levels while others may see no direct overflights but may still be exposed to noticeable sound levels.

Appendix A of Technical paper 1 contains a series of tables presenting the proportion of respite for each noise sensitive area for day, evening and night and the 3 assessment years.

By correlating the proportion of respite with the average daily frequency of aircraft movements, it is possible to identify noise sensitive areas based on the extent of respite that they are likely to experience, by representative year, by time of day and by operating scenario. Figure 11.39 presents a typical scenario, highlighting the noise sensitive areas without respite, and with a high average frequency of movements.

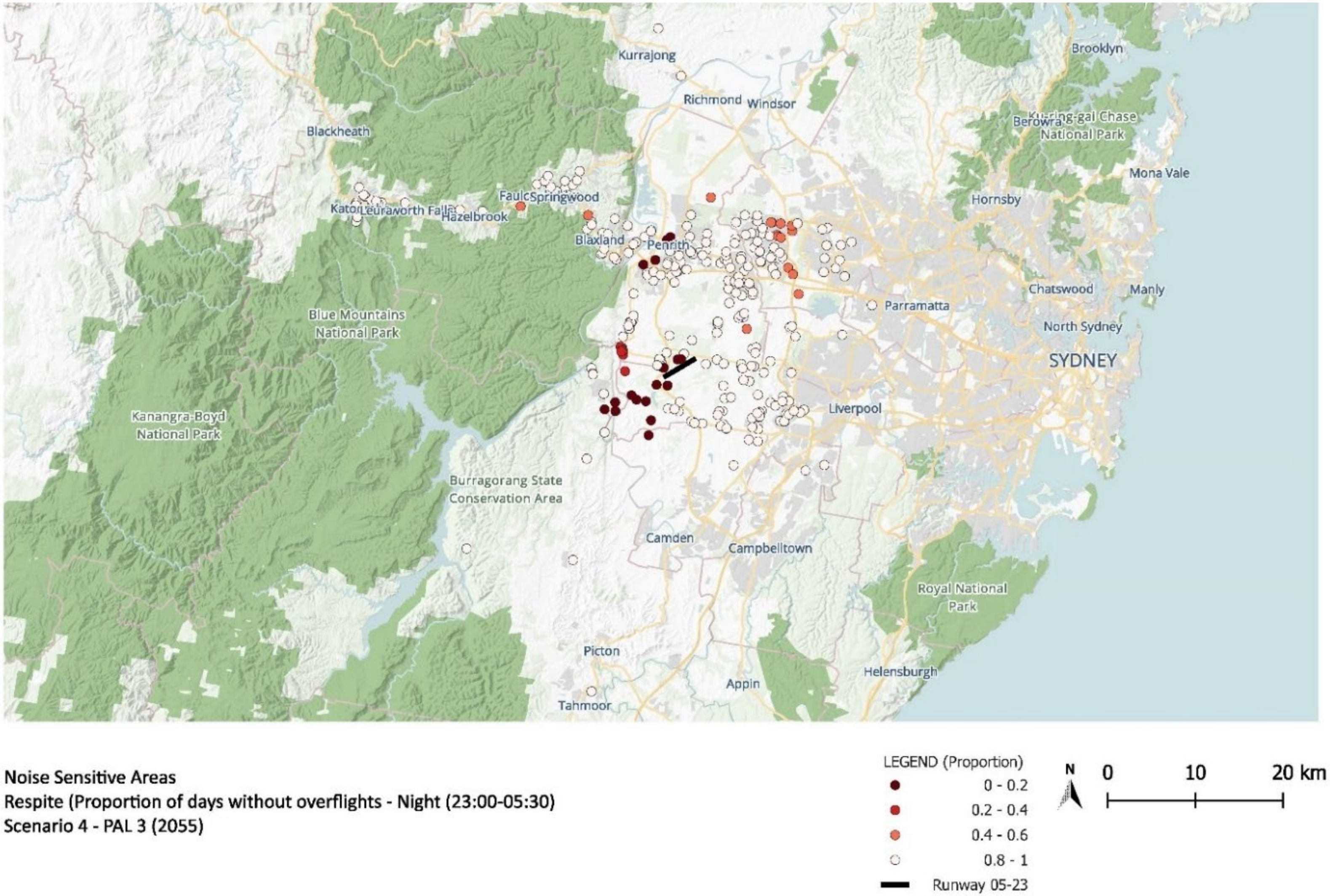


Figure 11.38 Noise sensitive areas – proportion of respite – Night – Prefer Runway 23 (scenario 4) – 2055

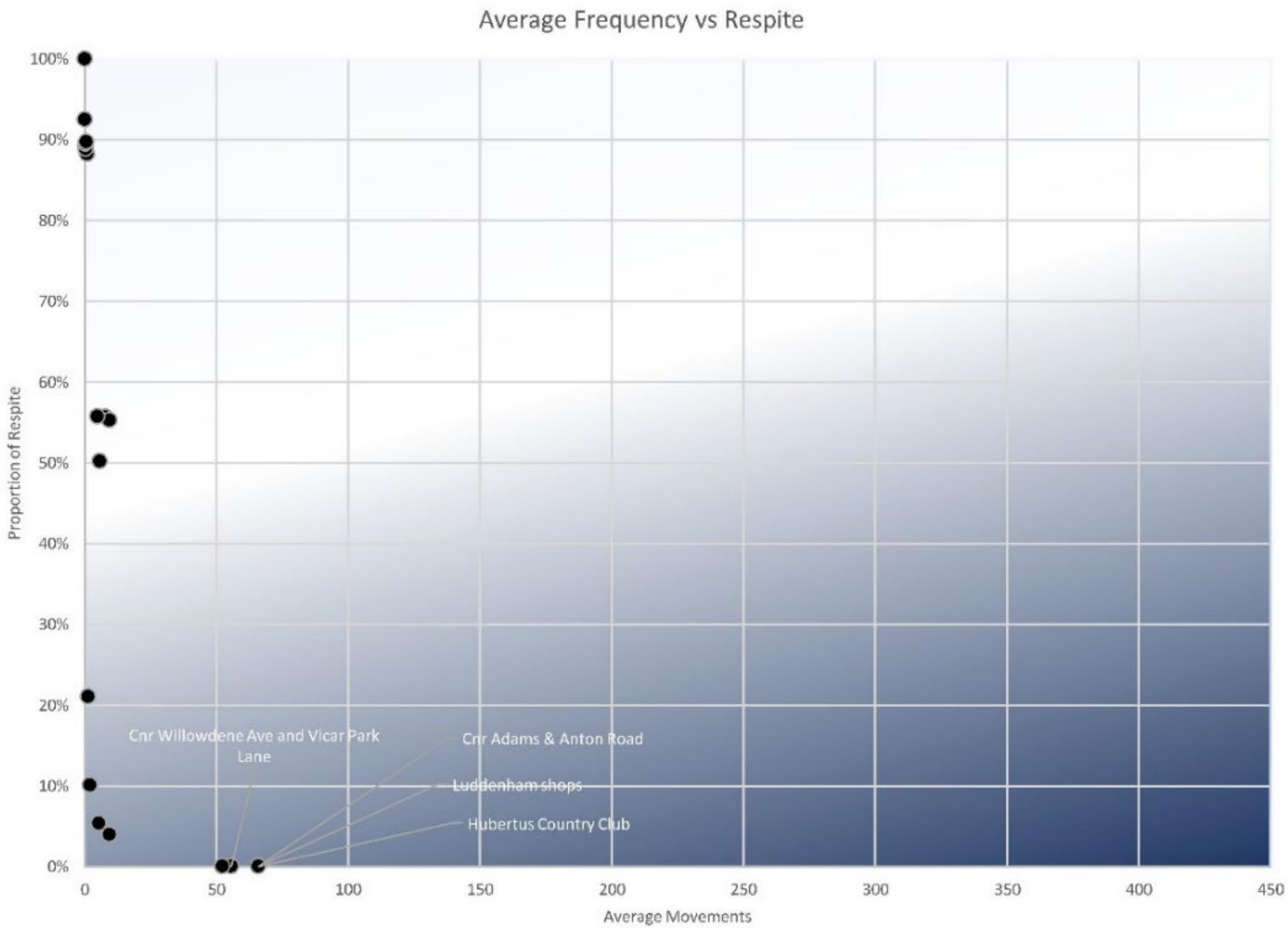


Figure 11.39 Noise sensitive areas – proportion of respite – Night – Prefer Runway 23 – 2055

11.7.3.3 Detailed respite charts

Figure 11.40 and Figure 11.41 present examples of respite charts generated for 15 specific noise sensitive areas, including minimum, average, 90th percentile and maximum movements for day, evening and night, as well as the proportion of days with respite. The sites were selected because they were representative of those most affected under one or more scenarios.

In this example, the percentage of days with respite is shown for locations under the Prefer Runway 23 scenario in 2055 for day, evening and night. Figure 11.40 shows that Blaxland is likely to experience 34 per cent of days with respite during the day, increasing to 100 per cent of days (full respite) during the night (which includes use of RRO in this case) (Figure 11.41).

Scenario 4 - Daytime (5:30 to 18:59)

Location	Minimum Movements	Average Movements	90th Percentile Movements	Maximum Movements	% of Days with Respite
Bents Basin	116	219.8	230.7	244	0%
Kemps Creek (College)	0	45.1	120.6	225	34%
Hassall Grove (School)	1	163.1	206.6	210	0%
Kingswood (School)	46	125.3	136.0	140	0%
St. Marys	0	27.6	73.5	137	34%
Mulgoa Park	0	21.3	56.0	110	34%
Linden	0	73.6	94.0	94	0%
Blaxland	0	17.6	47.4	88	34%
Kemps Creek (School)	0	31.7	41.0	41	0%
Twin Creeks	0	0.0	0.0	0	100%
Luddenham (Shops)	193	418.8	443.1	450	0%
Penrith (High School)	0	17.6	47.4	88	34%
Wallacia (School)	0	6.2	9.0	9	1%
Natai, Brownlow Hill	0	2.6	4.0	4	9%
Bringelly	0	1.2	2.0	2	29%

Scenario 4 - Evening (19:00 to 22:59)

Location	Minimum Movements	Average Movements	90th Percentile Movements	Maximum Movements	% of Days with Respite
Bents Basin	0	34.2	38.7	63	0%
Kemps Creek (College)	0	2.4	9.0	37	75%
Hassall Grove (School)	0	53.7	61.0	62	1%
Kingswood (School)	0	34.5	43.2	46	12%
St. Marys	0	1.5	5.8	21	75%
Mulgoa Park	0	1.8	7.0	29	78%
Linden	0	12.4	15.0	18	1%
Blaxland	0	0.8	2.4	16	76%
Kemps Creek (School)	0	7.5	11.0	12	13%
Twin Creeks	0	0.1	0.0	13	99%
Luddenham (Shops)	0	89.5	98.0	98	0%
Penrith (High School)	0	0.8	2.4	16	76%
Wallacia (School)	0	0.0	0.0	0	100%
Natai, Brownlow Hill	0	0.0	0.0	10	99%
Bringelly	0	0.0	0.0	0	100%

Figure 11.40 Noise sensitive areas – respite charts – Day and Evening – Prefer Runway 23 – 2055

Scenario 4 - Night (23:00 to 5:29)

Location	Minimum Movements	Average Movements	90th Percentile Movements	Maximum Movements	% of Days with Respite
Bents Basin	22	49.0	54.6	68	0%
Kemps Creek (College)	0	0.0	0.0	0	100%
Hassall Grove (School)	0	9.4	28.5	56	55%
Kingswood (School)	0	0.0	0.0	0	100%
St. Marys	0	0.5	0.8	20	90%
Mulgoa Park	0	0.4	1.0	13	89%
Linden	0	3.5	11.4	20	53%
Blaxland	0	0.0	0.0	0	100%
Kemps Creek (School)	0	0.0	0.0	0	100%
Twin Creeks	0	0.9	1.9	31	88%
Luddenham (Shops)	24	65.9	81.6	105	0%
Penrith (High School)	0	0.0	0.0	0	100%
Wallacia (School)	0	1.4	2.0	2	21%
Natai, Brownlow Hill	0	0.3	0.6	9	90%
Bringelly	0	0.0	0.0	0	100%

Figure 11.41 Noise sensitive areas – respite charts – Night – Prefer Runway 23 – 2055

11.7.4 Land use planning impacts

As outlined in Table 11.2 the most important use of ANEC contours is in land use planning around airports, using the principles set out in the AS 2021:2015 (refer to Section 11.5.4.1).

The key findings are depicted by:

- for 2055 – calculated ANEC contours for each of the 3 operating scenarios – shown on Figure 11.42 to Figure 11.44
- for 2055, 2040 and 2033 – combined ANEC contours for the 3 operating scenarios – shown on Figure 11.45, Figure 11.46 and Figure 11.47 respectively.

Individual figures for ANEC contours for 2055 operating scenarios represent the differences in aircraft noise impacts between these scenarios at these thresholds as the single runway approaches capacity.

As the combined ANEC contours compile noise exposure levels for the 3 operating scenarios, they are a conservative or ‘worst-case’ representation of noise exposure levels.

Geographical extent

While the No preference (scenario one) contours are balanced at both ends of the runway, the shape of Prefer Runway 05 (scenario 3) and Prefer Runway 23 (scenario 4) contours reflect operations to be more biased either in the Runway 05 direction or in the Runway 23 direction respectively.

In the early years of operation (2033) (refer to Figure 11.47), the ANEC extends along the standard instrument arrival and departure routes, up to approximately 7 km north-east towards Eastern Creek and 9 km south-west towards Lake Burragorang from the runway ends and a maximum of approximately 2 km wide. In the interim year of operation (2040) (refer to Figure 11.46), the ANEC extends in a similar pattern, but the contours cover a larger area. By the time single runway operations approach capacity (2055) (refer to Figure 11.45), the ANEC covers the largest area of the 3 assessment years, up to approximately 10 km north-east and around 15 km south-west from the runway ends and a maximum of approximately 5 km wide.

2055 scenarios (other than composite)

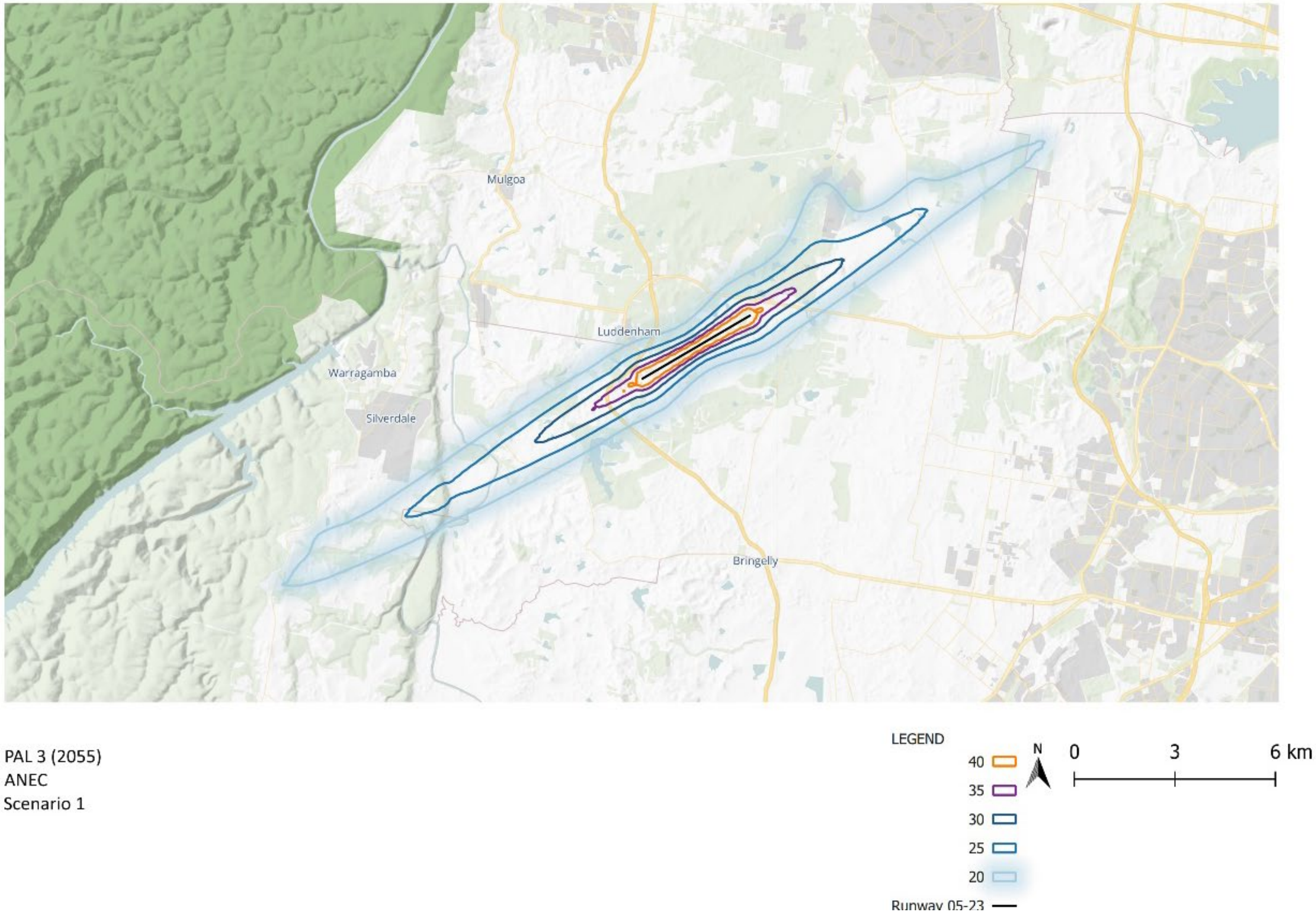


Figure 11.42 ANEC Contours – 2055 – No preference

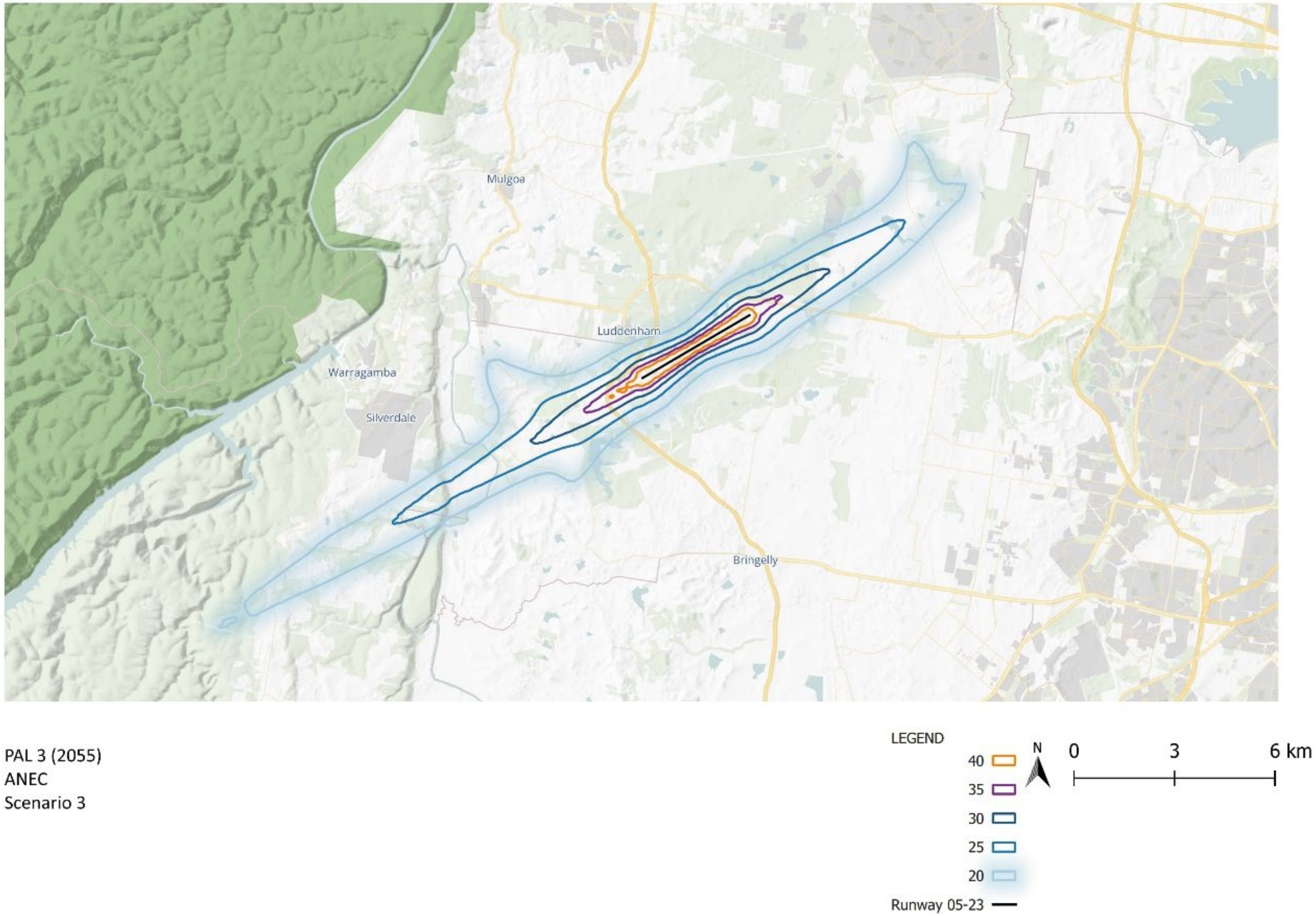


Figure 11.43 ANEC Contours – 2055 – Prefer Runway 05

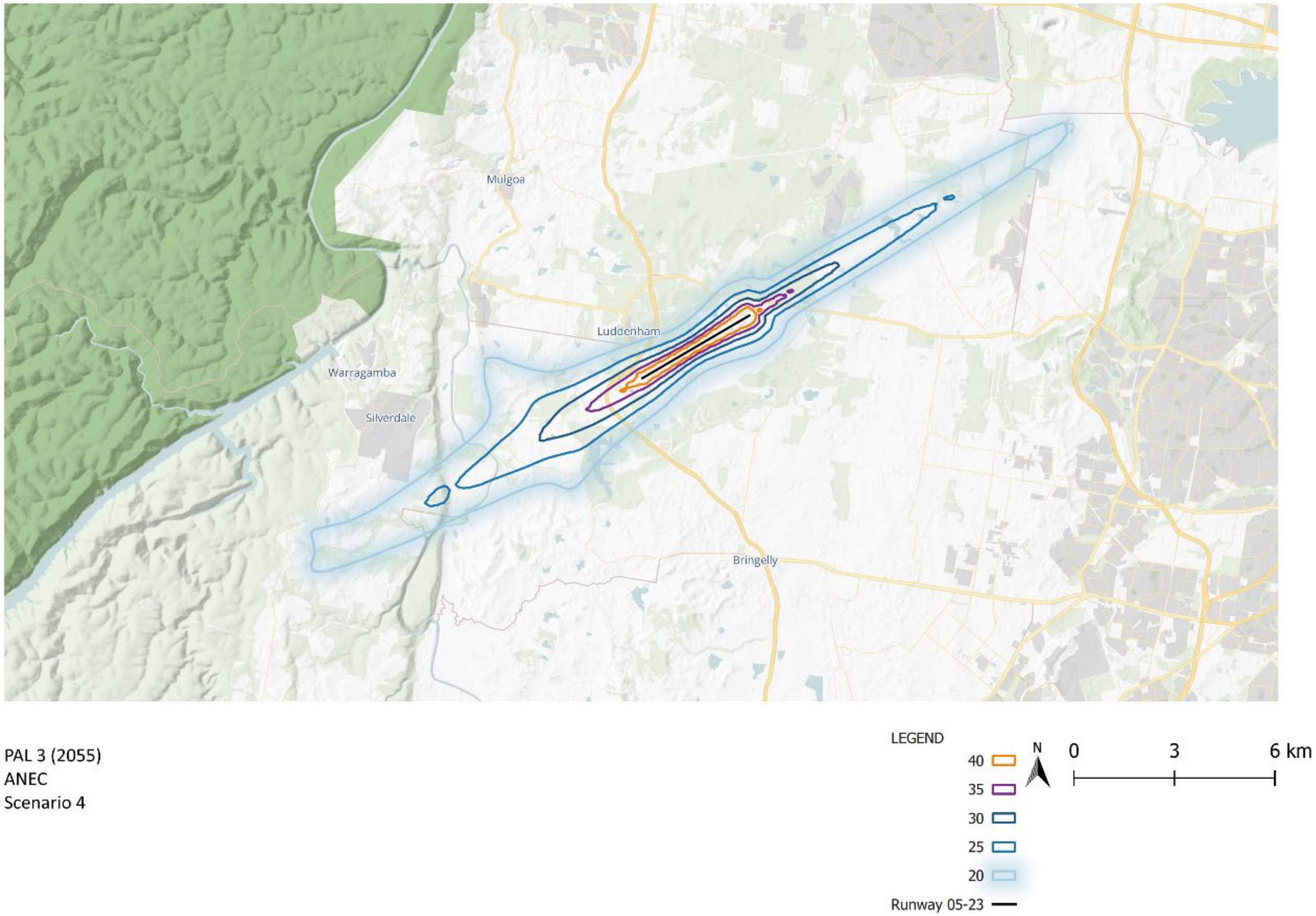


Figure 11.44 ANEC Contours – 2055 – Prefer Runway 23

Composite scenarios

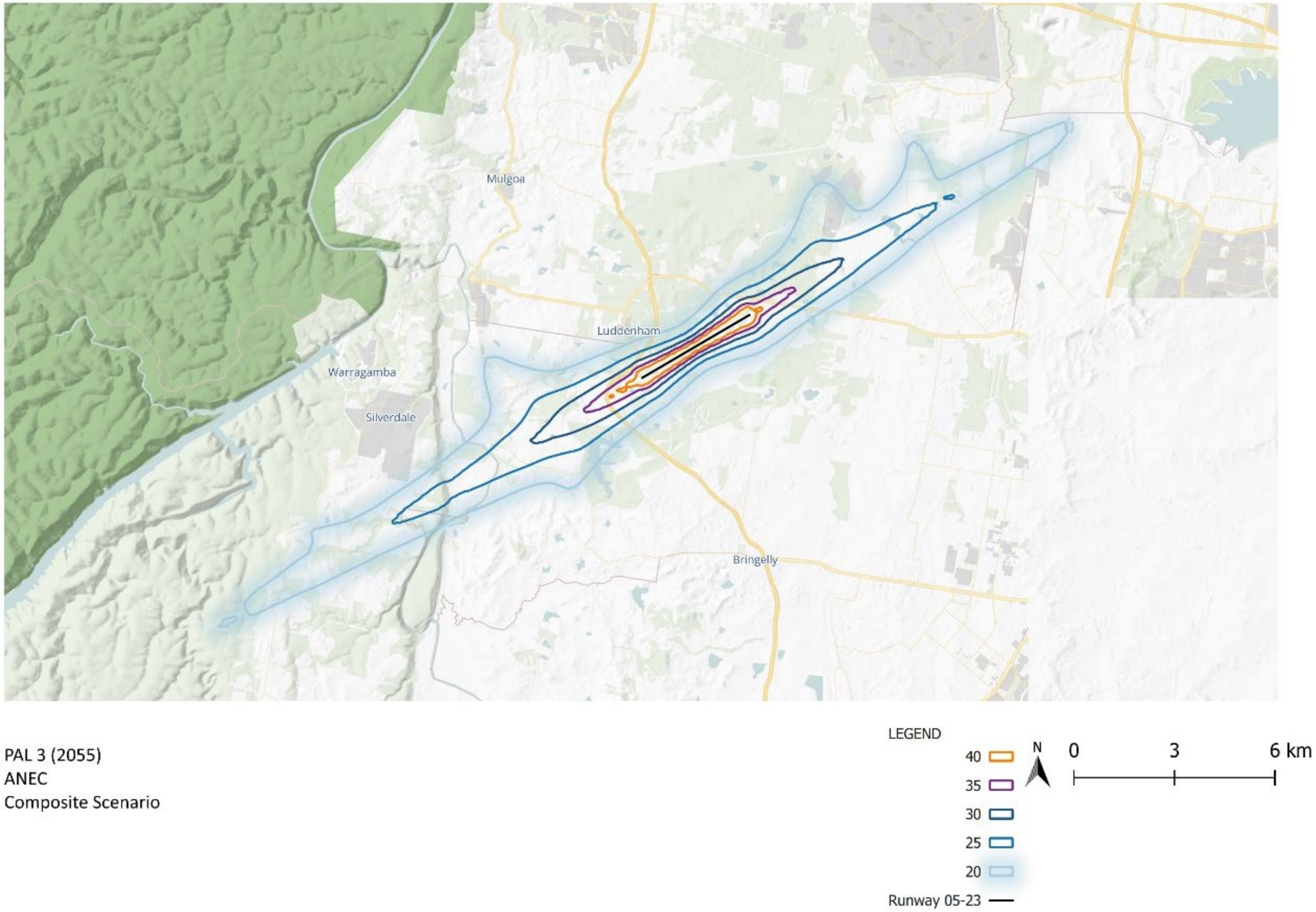


Figure 11.45 ANEC Contours – 2055 – Composite scenario

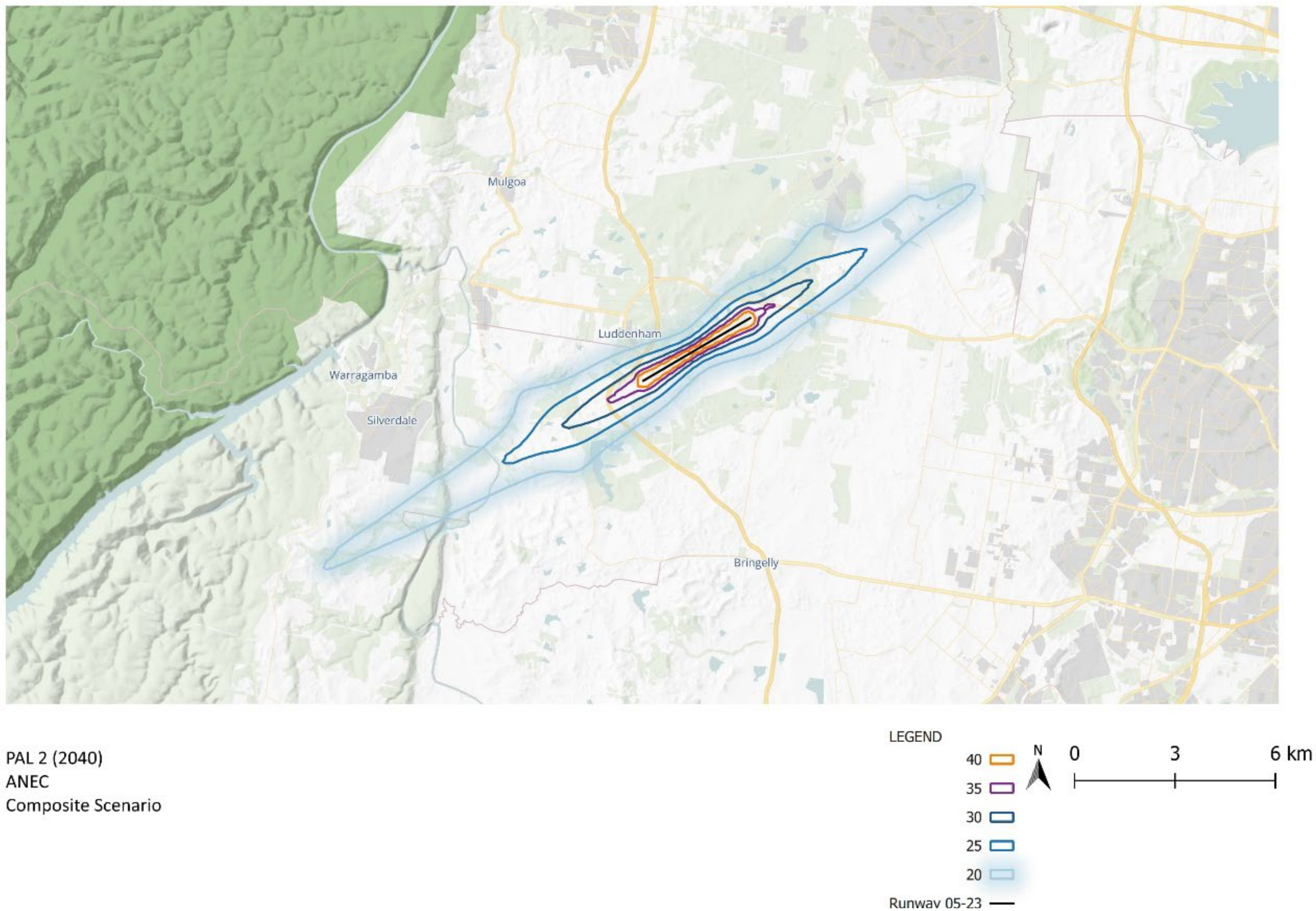


Figure 11.46 ANEC Contours – 2040 – composite scenario

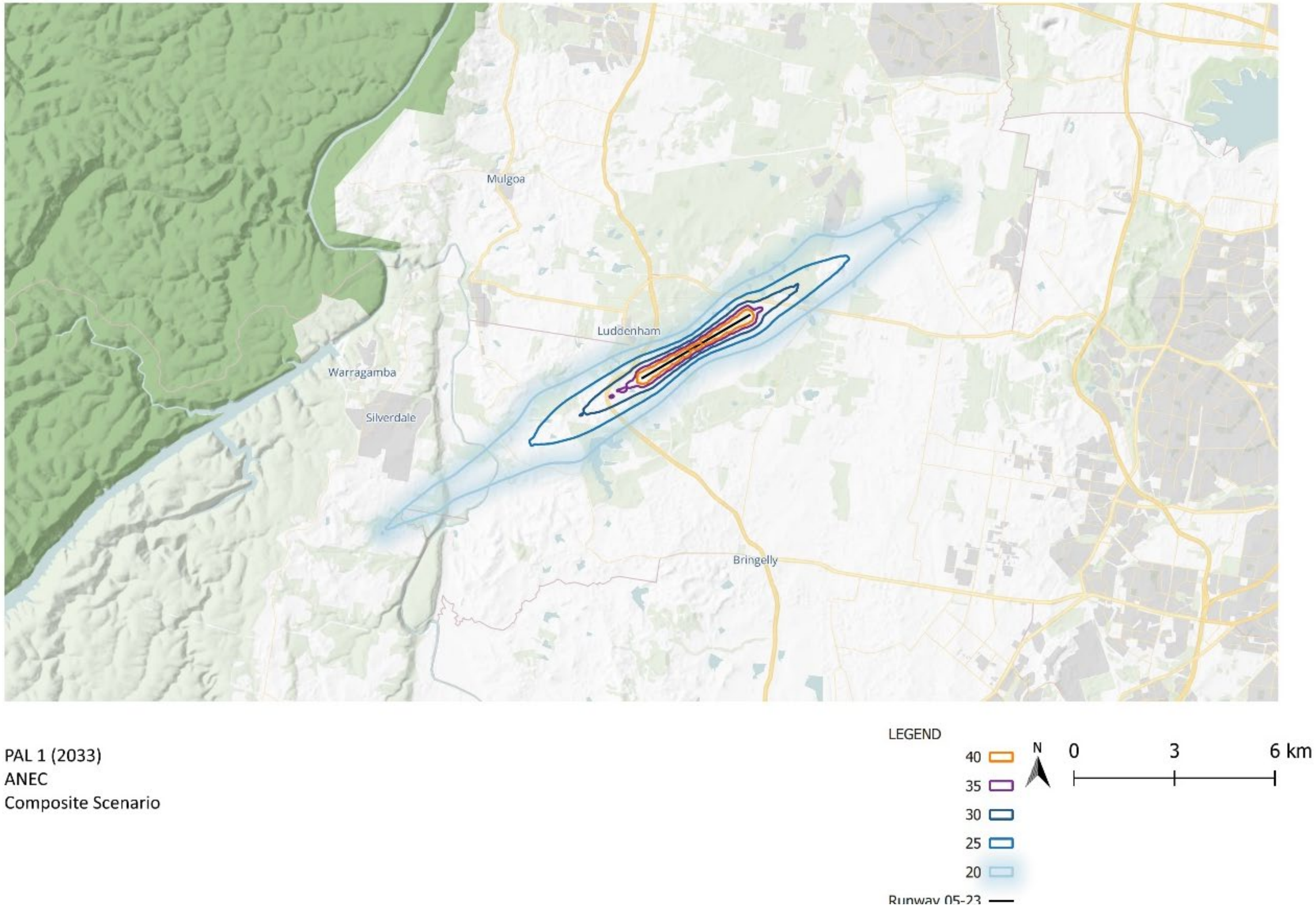


Figure 11.47 ANEC Contours – 2033 – composite scenario

Population and dwelling counts

The estimated population and dwellings count within these contours across the 3 assessment years is shown in Table 11.9.

Table 11.9 Estimated population and dwellings count within ANEC contours

Year	ANEC contours	No Preference		Prefer Runway 05 (with RRO)		Prefer Runway 23 (with RRO)	
		Population	Dwellings	Population	Dwellings	Population	Dwellings
2033	20	270	79	210	65	240	74
	25	57	17	55	16	72	22
	30	13	3	16	4	19	5
	35	4	1	4	1	4	1
	40	2	0	2	0	2	0
2040	20	440	130	330	100	350	110
	25	80	20	80	20	90	30
	30	23	6	23	7	31	9
	35*	4	1	5	1	5	1
	40*	2	0	2	1	2	0
2055	20	990	285	660	205	600	188
	25	170	50	170	50	170	50
	30	42	12	45	13	52	15
	35	9	3	12	4	13	4
	40*	3	1	3	1	2	1

* Estimate based on interpolation of census data. More granular review of specific properties required to identify specific dwellings impacted.

The results show that less than 1,000 people may be living within the 20 ANEC contours by 2055, up from approximately 250 people in 2033, regardless of the operational scenario.

While there are very few residents within the 25 ANEC contours, mostly in Greendale, the 20 ANEC contours could progressively over time include the community of Twin Creeks and rural portions of the suburb of Kemps Creek.

11.7.5 Flight path movement and respite charts

The full set of flight path movement charts and respite charts generated by the assessment is found in Appendix B of Technical paper 1. An example of a flight path movement chart is provided in Figure 11.48, showing the number of aircraft movements on each Runway 05 Day departure flight path.

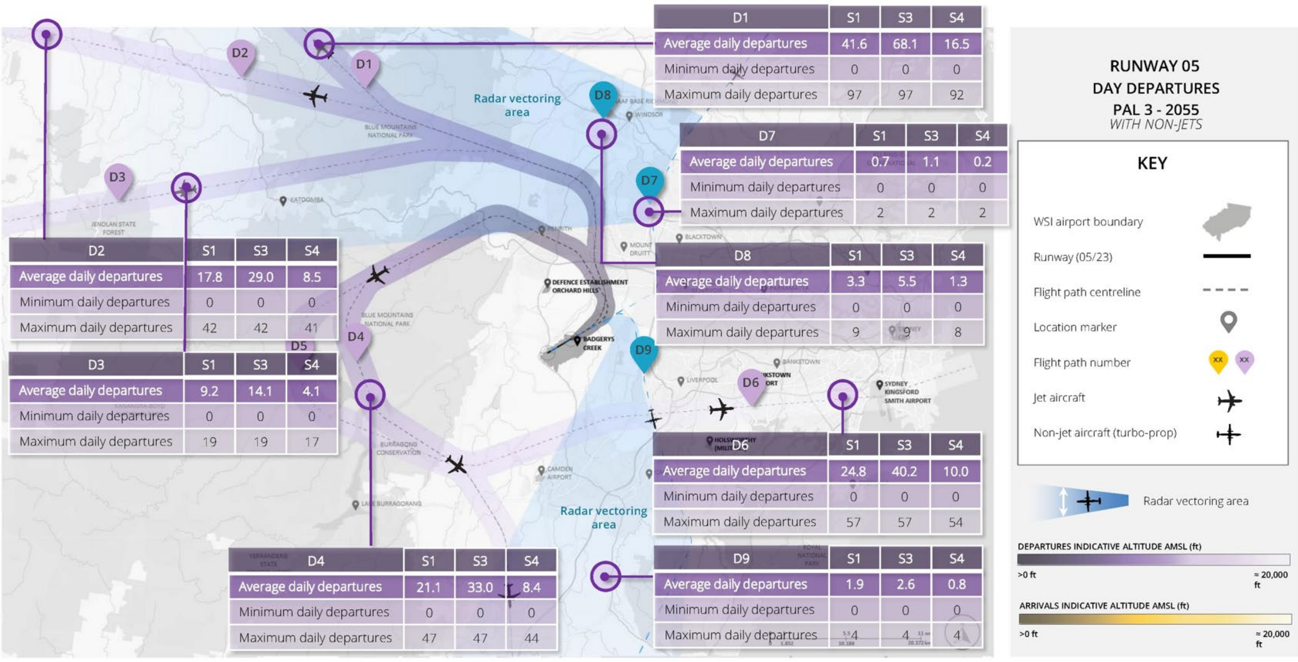


Figure 11.48 Example flight path movement chart for Runway 05 Day departures

Separate respite charts were generated for day, night and RRO flight paths. Respite ranges from 0 per cent (no respite – at least one daily movement every day of the year) to 100 per cent (full respite – no projected movements on all days of the year). An example respite chart is provided as Figure 11.49.

The respite charts focus on the individual flight paths (where the term 'respite' is described as the absence of operations to or from a particular runway end). Section 11.7.3.2 presents an example of the assessment of respite at a range of noise sensitive areas based on whether these areas are directly overflow or within one km of a flight path corridor and Section 11.7.3.3 presents an example of detailed respite charts for specific noise sensitive areas. This provides greater focus for assessment of respite in specific rural, rural residential, and urban communities.

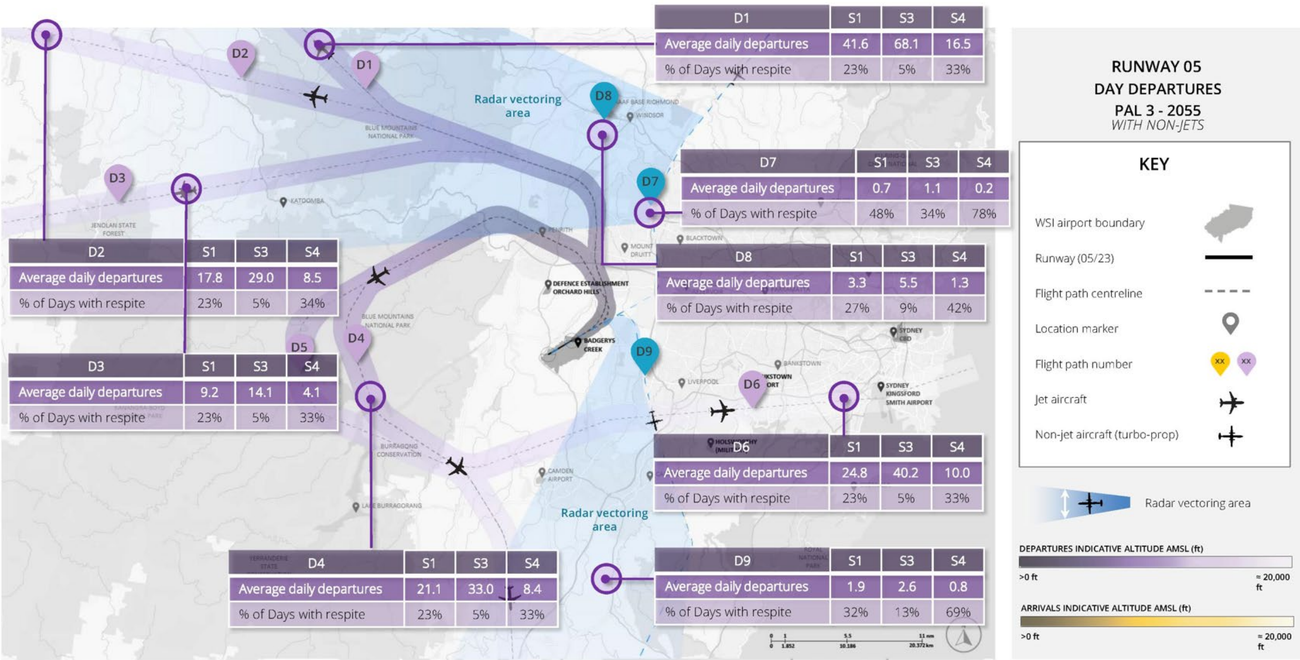


Figure 11.49 Example respite chart for Runway 05 Day departures

11.7.6 Single event or maximum noise levels

Assessment years are not relevant to single event noise contours, as they indicate the maximum (L_{Amax}) noise levels resulting from a single operation of a specific aircraft type on all applicable arrival or departure flight paths. As the aircraft types used in the modelling for the assessment years are generally the same, the single event contours would typically remain unchanged. The full set of figures for single event contours by representative aircraft type (as defined by Table 11.6) are found in Appendix C of Technical paper 1.

11.7.6.1 Loudest and most common aircraft existing

Examples of single event noise contours (L_{Amax} contours) are shown in Figure 11.50 to Figure 11.55. The highest predicted noise levels are typically associated with widebody aircraft such as the Boeing 777-300ER, Boeing 747-8 and Airbus A330 aircraft. However, the more common and likely noise levels are represented by Airbus A320neo and Boeing 737max aircraft.

11.7.6.2 Cumulative maximum noise level – all aircraft types

Figure 11.56 shows the cumulative maximum sound levels for all modelled aircraft types, over 24-hours for 2055, noting there is little difference in single event noise contours for assessment years (refer front of this section).

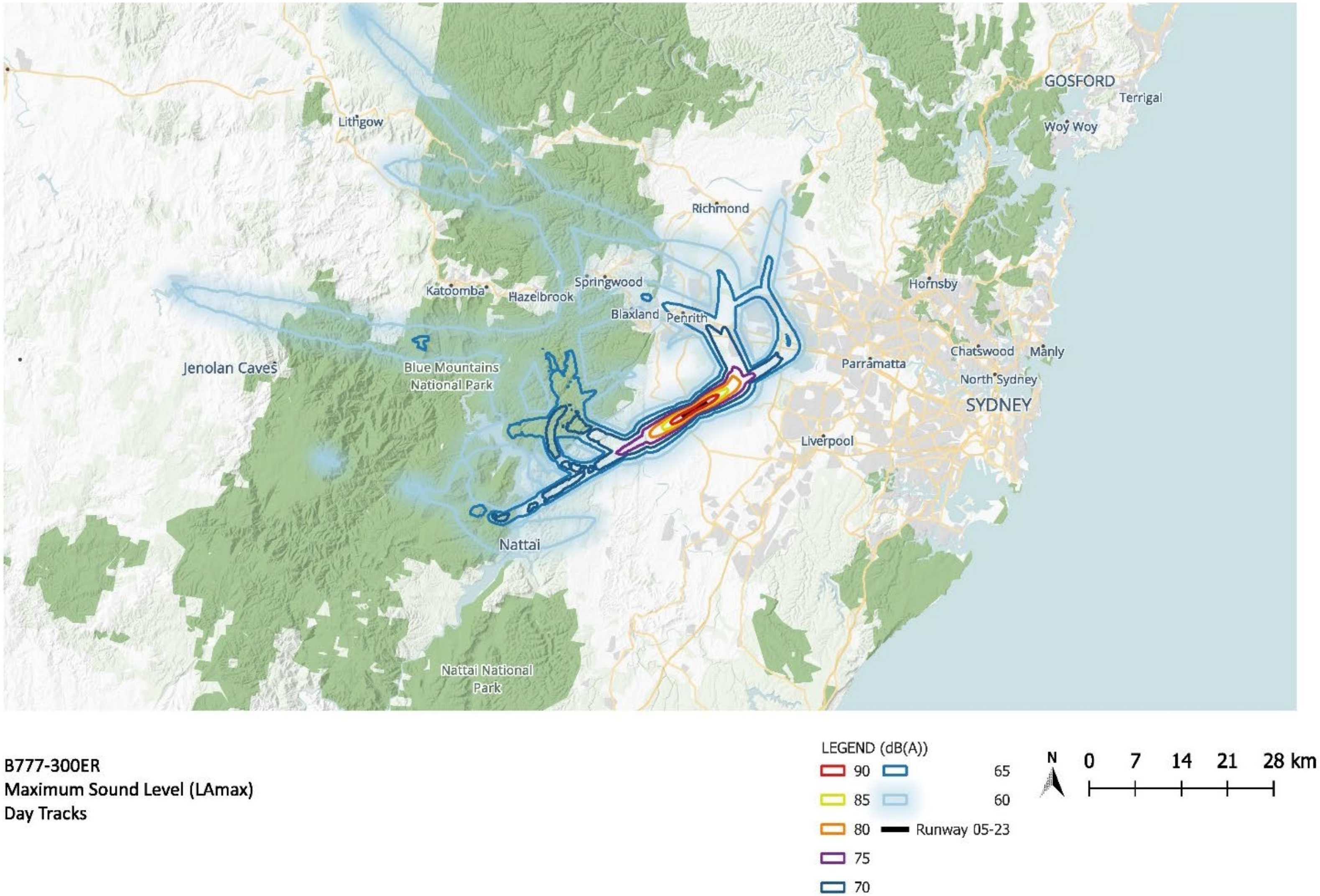


Figure 11.50 L_{Amax} (maximum noise level) – B777-300ER – day

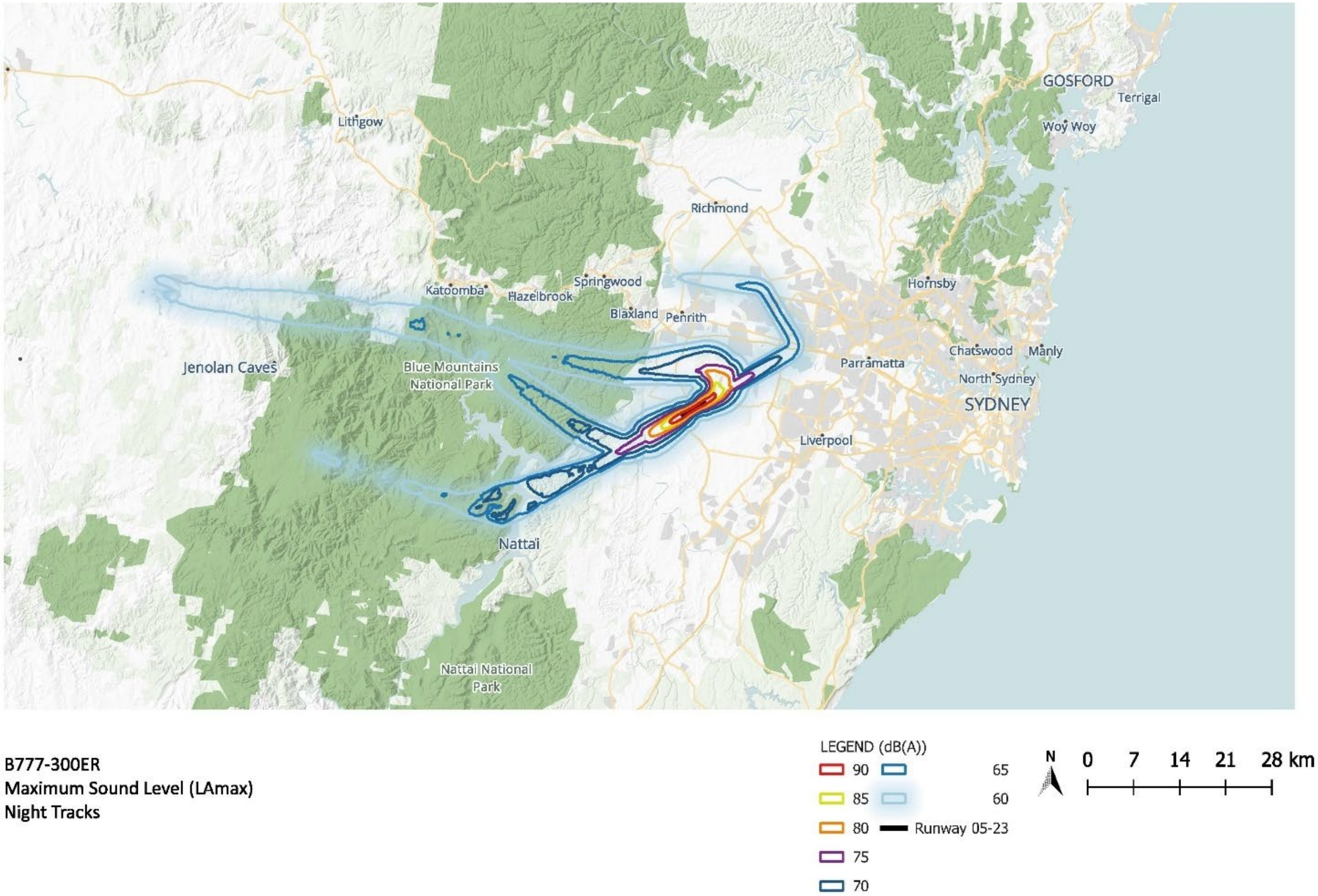


Figure 11.51 L_{Amax} (maximum noise level) – B777-300ER – night

Figure 11.52 L_{Amax} (maximum noise level) – B777-300ER – night (RRO)

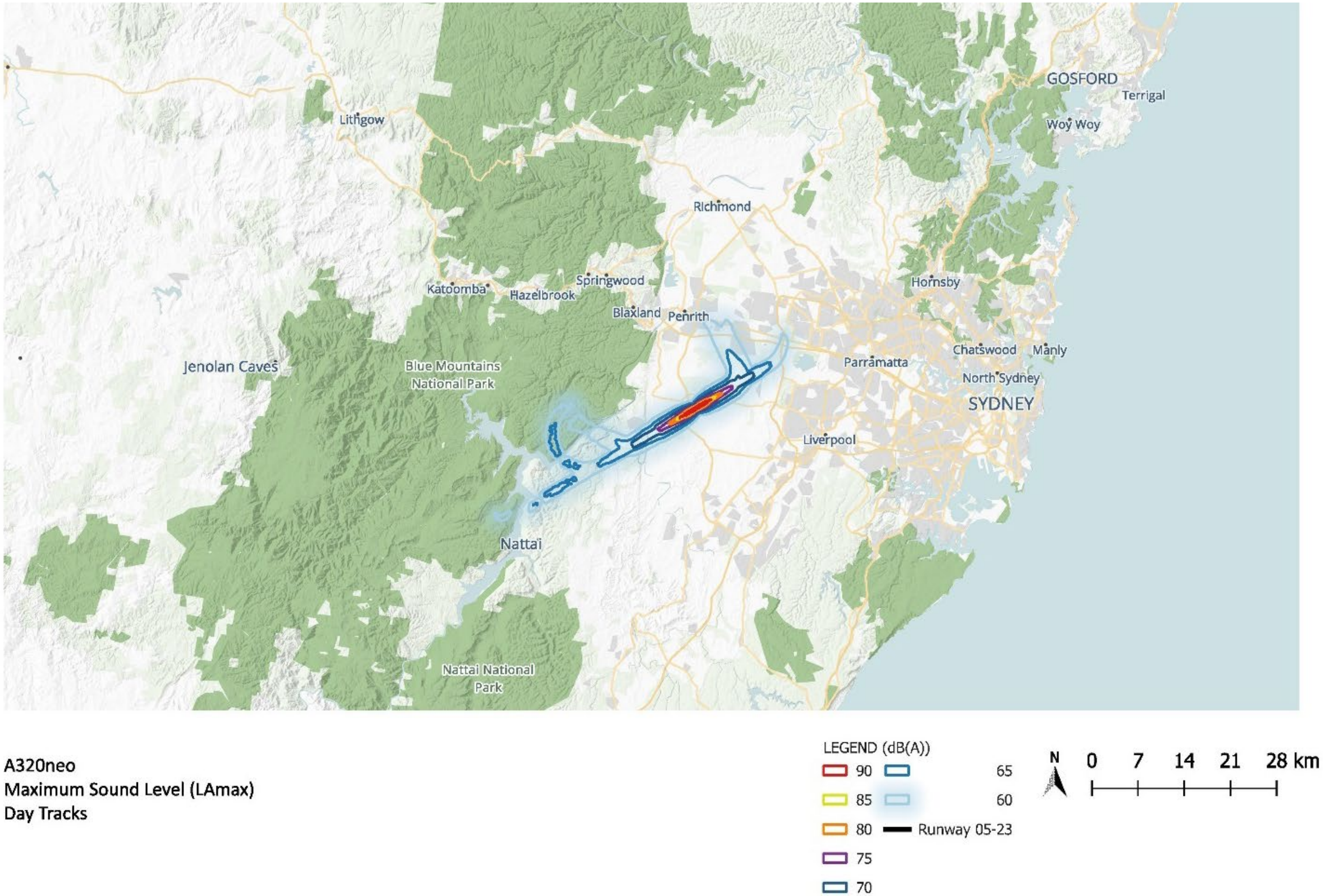


Figure 11.53 L_{Amax} (maximum noise level) – A320neo – day

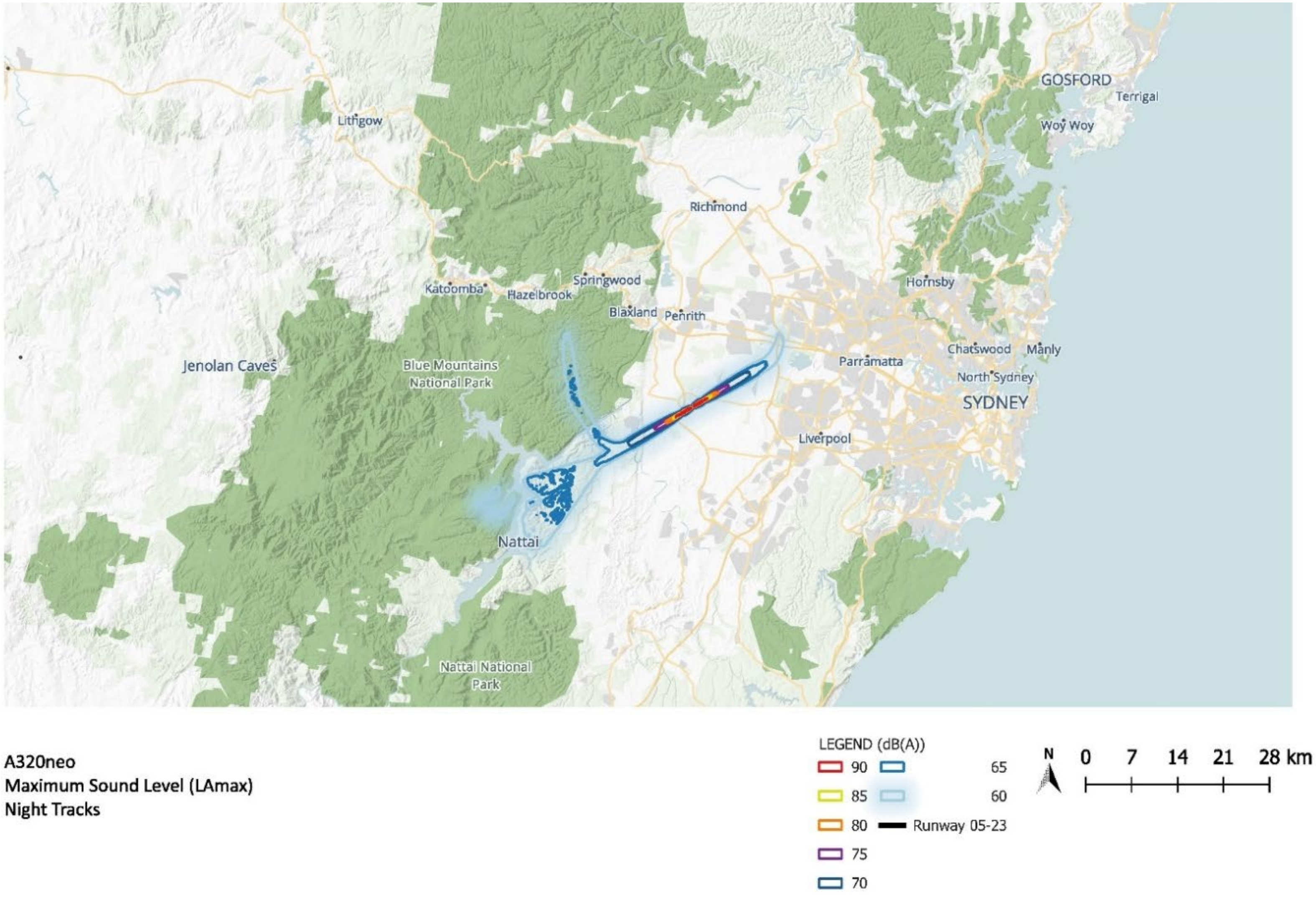


Figure 11.54 L_{Amax} (maximum noise level) – A320neo – night

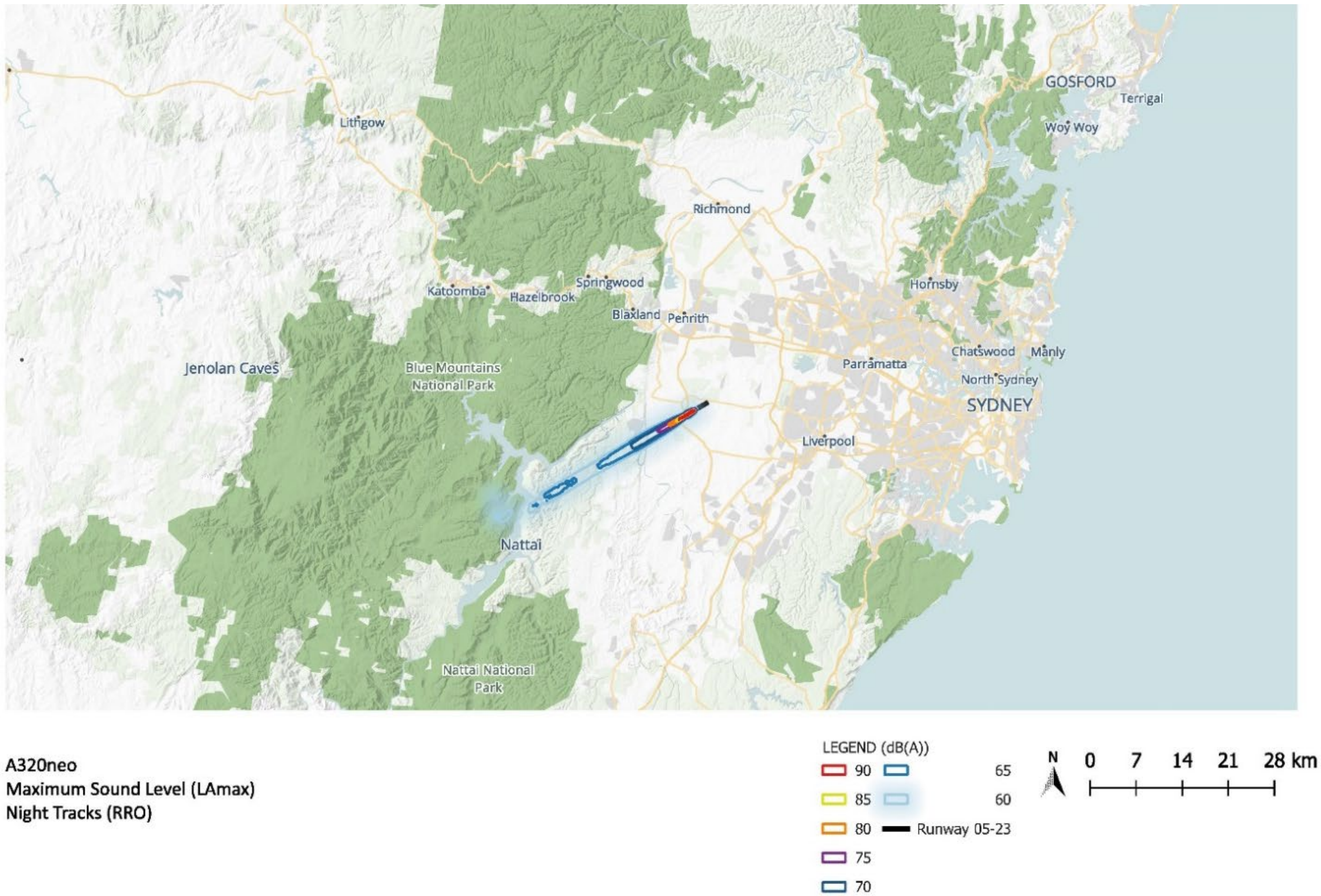


Figure 11.55 L_{Amax} (maximum noise level) – A320neo – night (RRO)

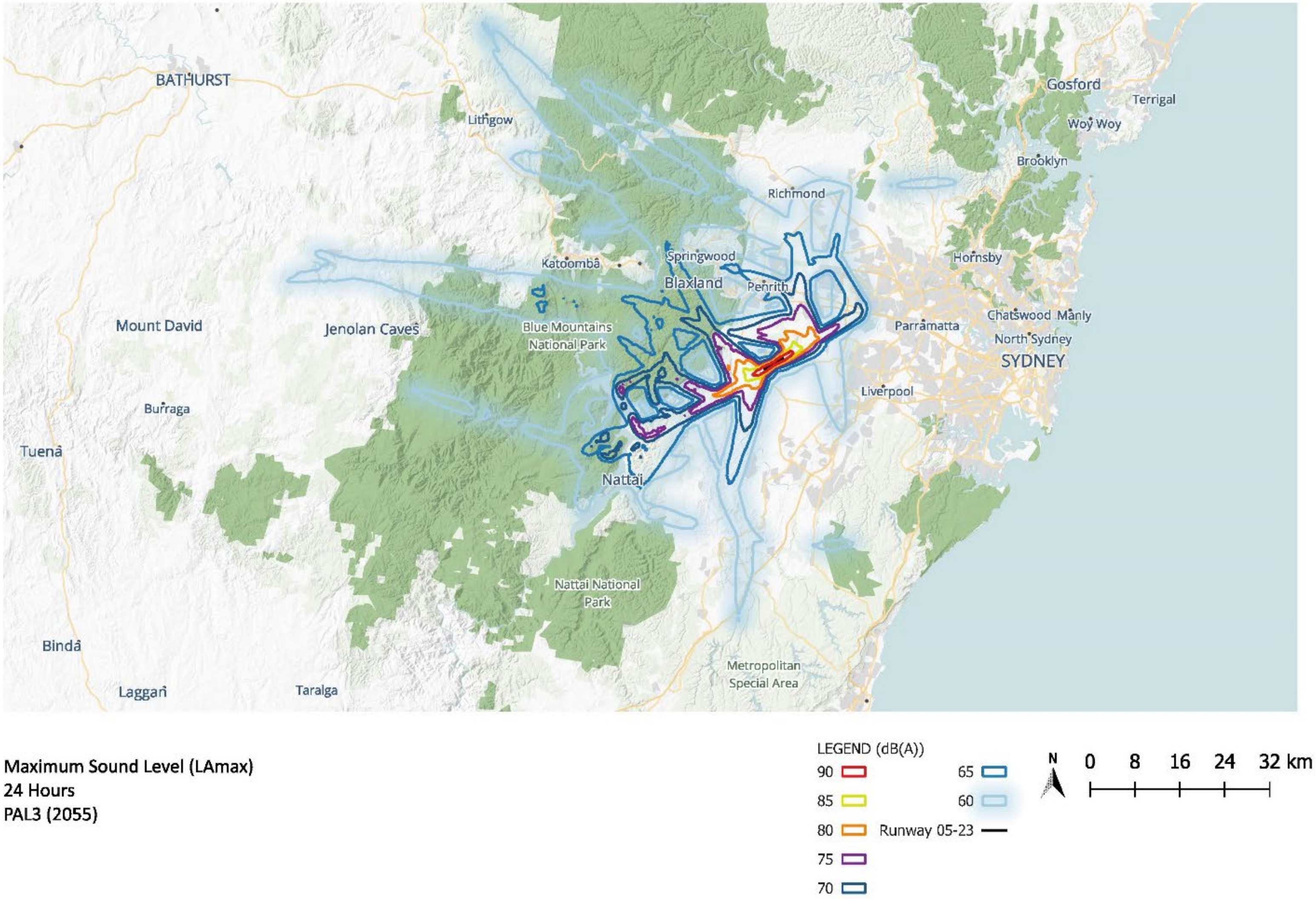


Figure 11.56 L_{Amax} (maximum noise level) – 24-hours – all aircraft types– 2055

11.7.6.3 Single event noise contours population and dwelling counts

This assessment provides an order of magnitude of the population likely to be exposed to at least one event above a 60 dB(A) noise threshold in 5 dB(A) increments. This assessment highlights that the number of people exposed to at least one noise event above 60 dB(A) will remain steady across the scenarios, based on the existing census data (for example, around 360,000 people within 60 dB(A) L_{Amax} contour in 2033 and around 375,000 people within 60 dB(A) L_{Amax} contour in 2055. In practice, the outcome will depend on the evolution of the aircraft fleet and on their operation on all flight paths to and from WSI.

Table 11.10 Population and dwellings counts – projected maximum sound level

Specifications		Population			Dwellings		
Metric	**Contour**	**2033**	**2040**	**2055**	**2033**	**2040**	**2055**
L_{Amax}	60	360,000	355,000	375,000	126,000	125,000	132,000
	65	152,000	150,000	164,000	56,500	55,900	61,300
	70	32,300	32,300	33,300	11,700	11,700	12,000
	75	9,700	9,500	9,900	3,200	3,100	3,300
	80	1,500	1,200	1,500	400	320	420
	85	180	100	220	50	30	58
	90	34	35	36	10	10	11

11.7.7 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 dB(A). The effect is more common on take-offs than for landings because the noise spectrum for a take-off close to WSI has stronger low frequency components. Figure 11.57 below depicts the 90 dB(A) L_{Amax} footprint for WSI confirming that it is largely contained within the Airport Site.

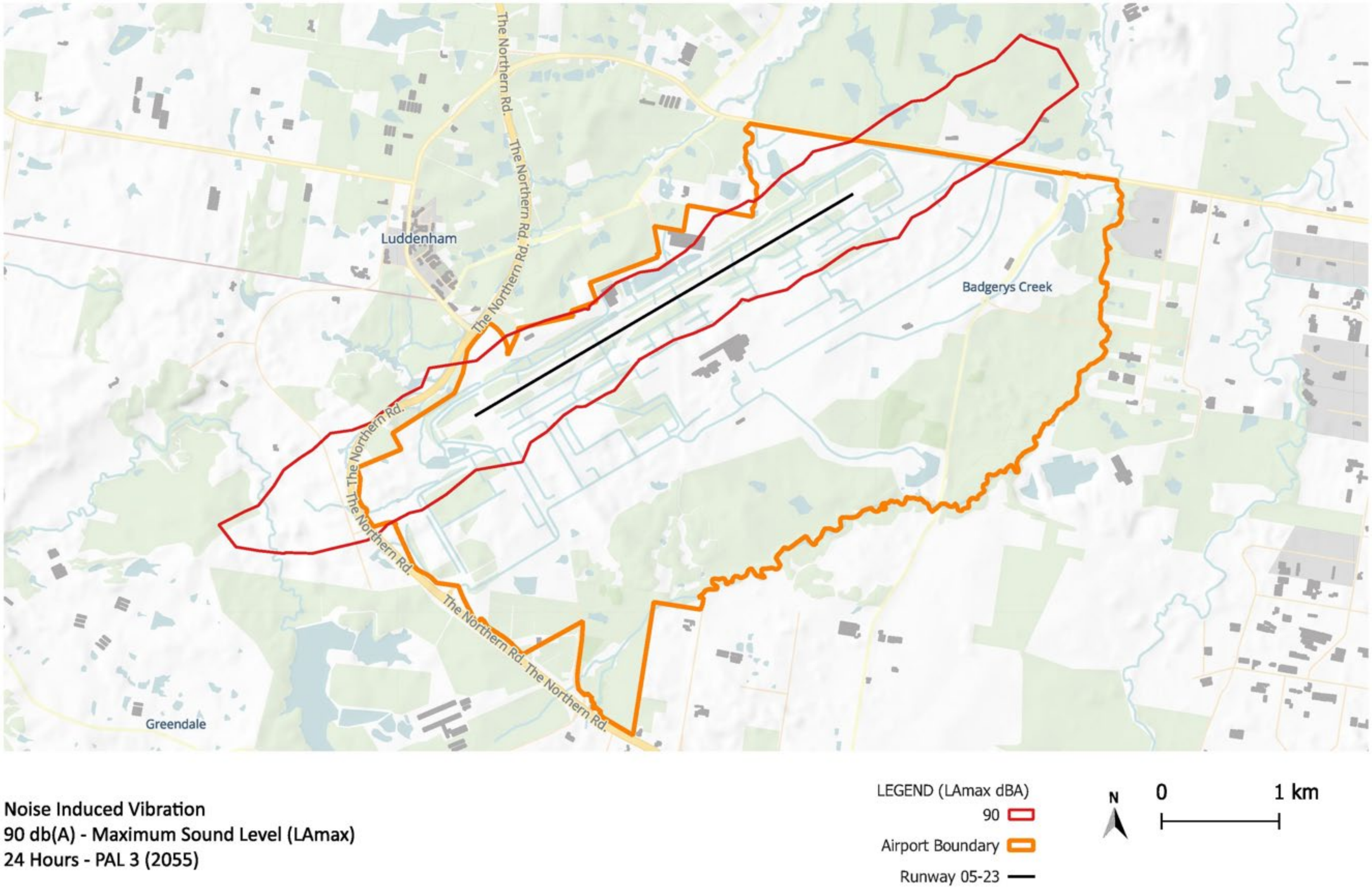


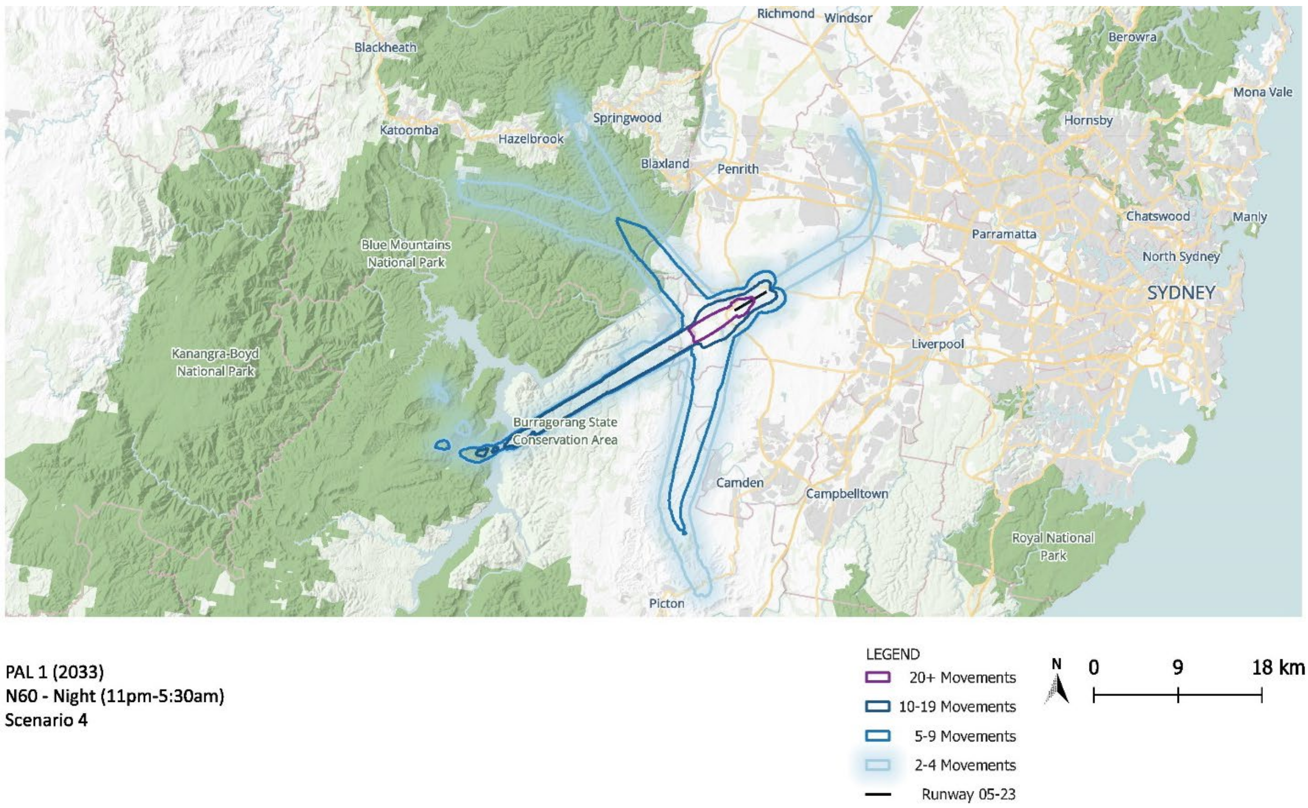
Figure 11.57 Noise induced vibration

11.7.8 Assessment of the refinements

The redistribution of jet aircraft traffic to Runway 23 Departure Southeast Night (RRO) (preliminary flight path D32) from Runway 23 Departure Northeast Night (RRO) flight path (preliminary flight path D28), and the introduction of a new night-time RRO noise abatement procedure (RRO-NAP) has been assessed using the same methodology described in Technical paper 1. As these changes only apply to RRO mode of operation, the assessment focused on night time operations (11 pm to 5.30 am). Impacts and benefits were identified based on absolute noise level or number of events, and are presented in the Addendum Technical paper 1: Aircraft noise as a comparison against those presented in the baseline assessment presented in Technical paper 1.

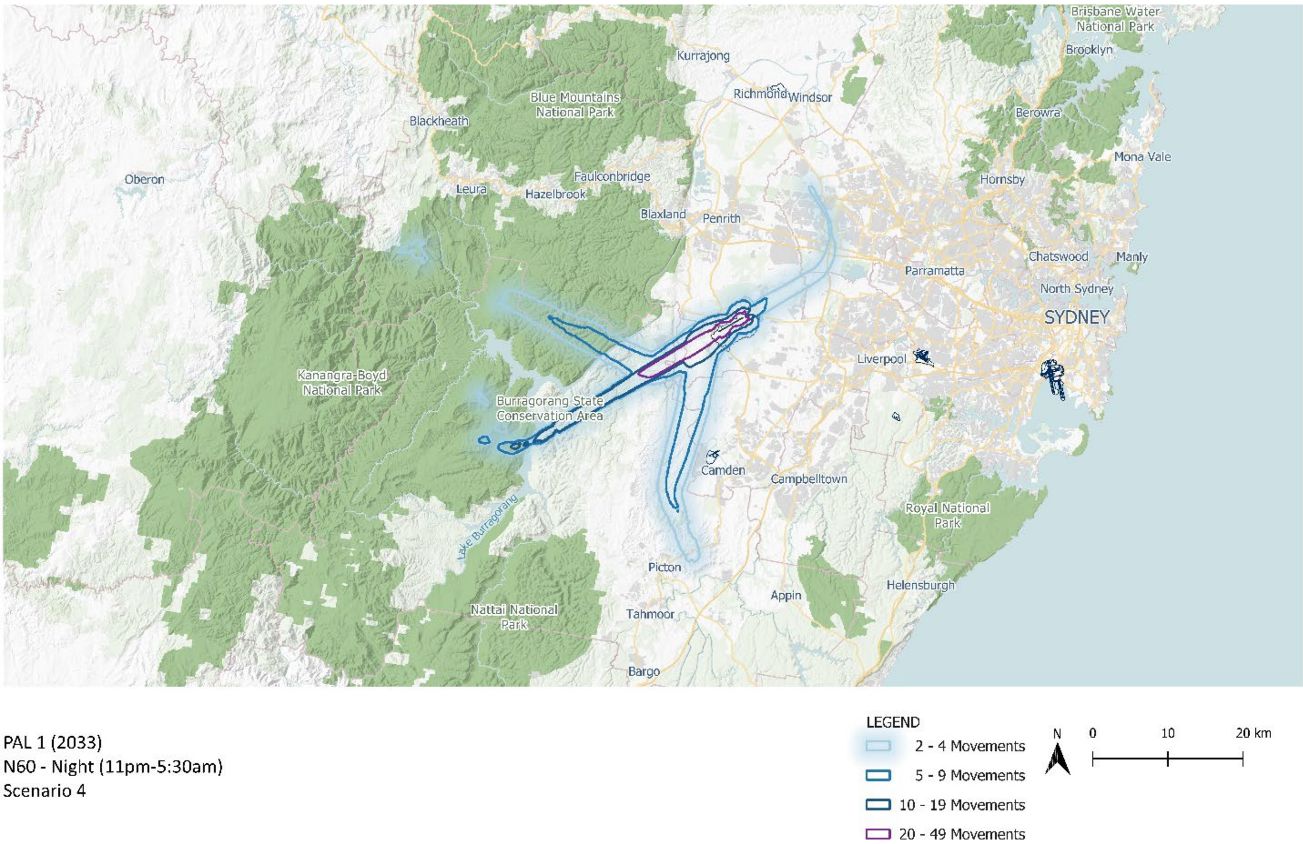
The proposed refinements would result in a noticeable change to the noise contours, particularly for the N60 night contours for scenarios where RRO mode of operation is preferred. Figure 11.58 reproduces Scenario 4 with the assessment year 2033 as presented in Technical paper 1. Figure 11.59 displays the revised assessment for Scenario 4 in the assessment year 2033 with both proposed changes to RRO (reallocation of D28 departures and RRO-NAP) included.

Additional detail on these changes to noise impacts is provided in the Addendum Technical paper 1: Aircraft noise.



Source: Technical paper 1 (Appendix C)

Figure 11.58 N60 contour Night (11 pm to 5:30 am) –2033 (Scenario 4) – Draft EIS preliminary flight path



Source: Addendum Technical paper 1: Aircraft noise (Appendix C)

Figure 11.59 N60 contour Night (11 pm to 5:30 am) –2033 (Scenario 4) – RRO-NAP preliminary flight path

A qualitative assessment has been completed for the other refinements to the preliminary flight paths, given the nature of these changes. This assessment is summarised in Table 18.21 and is further discussed in Appendix G (Assessment of the refinements to the project) of the EIS.

Table 11.11 Assessment of other refinements

Refinement	Assessment
Mt Tomah, Mt Wilson and Mt Irvine	The N60 contours as depicted in the assessment do not typically extend along this preliminary flight path, with the exception of N60 (24 hour) in 2055 with minor impacts (10–19 movements over 24 hours). These impacts however would occur over unpopulated areas. Therefore, any minor shift of the N60 (24 hour) to align with the refined preliminary flight path is unlikely to change the assessment that was presented in the Draft EIS. The other assessed scenarios do not generally have N60 noise contours that extend as far as the location of the proposed change.
Required Navigation Performance – Approval Required (RNP – AR) approach	Overall there would not be an increase in the number of flights using the section of arrival path from where the path turns toward the RNP-AR approach to where it meets the longer approach to Runway 05. However, with the removal of the A13 flight path, the spread of aircraft arriving across the two flight paths would be changed, with all aircraft now proposed to arrive along the A10 flight path. This aircraft approach however is generally over unpopulated areas and is therefore not expected to result in any change in noise impacts compared to those already discussed in the Draft EIS (as exhibited).

Refinement	Assessment
RRO night approach to Runway 05 (Arrival East)	The refined preliminary flight path would be slightly closer to the suburb of Waterfall (up to around 900 m closer in comparison to the preliminary flight path identified in the Draft EIS), but at altitudes of around 12,000 ft (3.7 km), the changes in impacts to those described in the Draft EIS are expected to be negligible. The change would result in reduced direct overflight of some areas at around 12,000 ft (3.7 km), and increased distance to other areas.

11.8 Mitigation and management

Aircraft noise is an inevitable and unavoidable consequence of an operating airport. The collective responsibilities for the management of aircraft noise are described in Section 11.3.2.

As described in Section 11.3.1 there are 4 fundamental options for mitigation of aircraft noise, noting the safe and efficient operation of WSI may limit their availability:

- reduce noise emissions from the aircraft at source
- develop land-use planning or other controls to ensure future noise-sensitive uses are not located in noise affected areas
- plan flight paths, air traffic control and noise abatement procedures and airport operating strategies to achieve lower impacts over noise sensitive areas
- place operational restrictions on aircraft types and time of operation.

As discussed in Section 11.3.1.1, the magnitude of future reductions in aircraft noise emission levels is primarily determined by aircraft designers and manufacturers and future international regulatory initiatives. It is very likely that noise emission from future aircraft will be lower than from current aircraft but due to the absence of specific information this report has adopted a conservative approach by modelling future aircraft types based on existing noise emission levels.

On the second point, the NSW Government and local governments have been actively planning for an airport at Badgerys Creek since the 1980’s and have undertaken steps aimed at limiting future noise exposure of the residential population. These have included:

- zoning land near WSI as appropriate for less sensitive uses
- ensuring that local government has planning procedures in place to limit sensitive uses in areas potentially affected by aircraft overflight noise.

This has limited the potential noise impact from an urban greenfield airport to a level that is lower than would otherwise be expected for a development of this type and scale. Planning protections would continue to be part of the operational framework as discussed in Section 11.8.1.1.

The third point is the focus of this EIS, and the basis of mitigation measures recommended in Section 11.8.2.

On the fourth point, WSI will operate over 24-hours, 7 days a week. Restrictions on its operation may affect the efficiency and economic viability of WSI. Restrictions on aircraft types may also be impractical given the proposed level of freight activity.

11.8.1 Operational framework

The WSI operational framework would consist of a range of mechanisms to manage aircraft noise, including planning, policy and consultative measures.

11.8.1.1 Planning protections

A number of planning protections are already in place around the Airport Site following the previous EISs (one in 1985, the next between 1997 and 1999 and most recently in 2016). The indicative ANEC for WSI provided in the Airport Plan and Western Parkland City SEPP was generated based on the runway direction, dual runway operations and indicative flight paths as presented in the 2016 EIS. An updated ANEC is presented in this chapter for single runway operations. Until the ANEF contour is approved for WSI, the ANEC contour presented as the Noise Exposure Contour Map in the Western Parkland City SEPP, representing the long-term, dual-runway for WSI will continue to inform land use planning.

The Australian Government would continue to work closely with the NSW Government and local governments to implement any long-term planning protections that have been put in place around the proposed airport to minimise incompatible development.

As described in Chapter 5 (Statutory context), the Airport Plan will eventually be replaced by a Master Plan. The Master Plan is required to include a number of measures relevant to noise including an endorsed ANEF chart, flight paths and plans for managing aircraft noise intrusion in areas forecast to be subject to exposure above the significant ANEF level.

11.8.1.2 Noise insulation and property acquisition policy

Under Condition 16(7) of the Airport Plan, DITRDCA has developed a Noise Insulation and Property Acquisition (NIPA) policy in relation to aircraft overflight noise for buildings outside the Airport Site and having regard to the 24-hour, 7 days a week operation. This condition was included as part of the Australian Government's approval for Stage 1 of WSI for single runway operations and 10 million annual passengers.

The draft NIPA policy was released for public consultation alongside the Draft EIS. Details of the final NIPA policy, based on the aircraft noise results from this assessment and feedback from the local community and other stakeholders, is included in this EIS.

Further detailed information on the NIPA program, including program guidelines and application processes, will be released prior to the program's implementation in mid-2025.

Background information on the development of the NIPA policy is available at Appendix F.

The development of a new, greenfield, 24-hour domestic and international airport will result in significant additional aircraft overflight noise exposure to surrounding communities than is currently experienced. The NIPA policy is intended to provide assistance to these communities, through noise insulation and amelioration works, to preserve existing building uses and living amenity for landowners and residents.

The NIPA policy is informed by:

- land use planning and noise exposure documentation including AS 2021:2015, the National Airports Safeguarding Framework, and the Western Parkland City SEPP
- the noise exposure forecasts presented in this EIS
- existing building typologies within the Western Sydney area, and associated noise treatments
- previous domestic insulation programs undertaken for Sydney (Kingsford Smith) Airport and Adelaide Airport
- feedback received during the public exhibition of the Draft EIS and draft NIPA policy, including at community information and feedback sessions and one-on-one meetings between DITRDCA and landowners and residents in the draft NIPA eligibility and surrounding area.

This policy is not intended to compensate for economic impacts, for example to building values or other broader impacts resulting from the operations at WSI. These impacts, and any potential mitigations are discussed in the relevant chapters of this EIS.

Overview of NIPA policy eligibility criteria

Based on these factors, the NIPA policy would offer noise treatment assistance to pre-existing properties that meet the criteria in Table 11.12 and Figure 11.60.

Table 11.12 Eligibility criteria for noise insulation and property acquisition policy

Eligibility criteria		Inclusions	Exclusions
Acquisition	**Noise treatment**		
ANEC 40 (automatic eligibility) ANEC 20 (case by case where noise reduction target cannot be efficiently met)	ANEC 20	Noise sensitive areas within residential buildings, including bedrooms, living areas and workspaces Noise sensitive areas within public buildings (educational facilities, child care facilities, health care and clinical facilities, places of worship)	Unapproved buildings and structures Buildings with pre-existing obligations to undertake noise treatment works to achieve building compliance Commercial and industrial buildings
Noise reduction target			
Reduce the level of aircraft noise experienced inside an eligible building (in noise-sensitive spaces), during the forecast worst-case aircraft noise events, to 50 dB(A). The 50 dB(A) noise reduction target is non-binding and treatment plans to achieve the target will be based on desktop analysis of forecast noise. In some cases, the 50 dB(A) may not be able to be cost effectively achieved, however best endeavours will be taken in aiming to achieve this outcome, in which instance, noise treatment works will aim to provide a noticeable aircraft noise reduction, specific to building type, use and location.			
Note: The ANEC 20 and 40 contours used to determine NIPA policy eligibility are the composite contours, reflecting all runway modes, for the 2040 forecast year. The ANEC 20 and 40 contours are illustrated in Figure 11.60.			

Land use planning framework

The Western Parkland City SEPP provides airport safeguards that prevent development approval being granted for most noise sensitive developments, including residential buildings, near WSI that are within the long term ANEC 20 or ANEF 20 contour. Where development approval is able to be granted, for example for vacant land where residential development had been approved prior to the commencement of provisions, these buildings must meet the indoor design sound levels in AS 2021:2015. This standard provides guidance on the siting and construction of buildings in the vicinity of airports to minimise aircraft noise intrusion. The standard also informs land use planning to prevent non-complementary development in areas that either currently, or under future planned runways, will be severely impacted by aircraft noise. The standard provides that buildings within the ANEC 20 contour should be constructed to achieve an indoor design sound level of 50 dB(A) for sleeping areas and dedicated lounges, with 55 dB(A) for other habitable spaces, requiring significant additional noise insulation treatment than standard residential construction. Noise sensitive receivers should not be constructed in ANEC 25 and above contours.

Guideline A of the NASF Guidelines also indicates that land use planning should not include new designations or zoning changes that would provide for noise sensitive developments within ANEF 20 contours where that land was previously rural or for non-urban purposes (in keeping with AS 2021:2015).

All 3 documents rely on the ANEC 20 or ANEF 20 contour as the threshold whereby noise sensitive receivers, such as residential buildings, should either not be constructed, or should only be constructed with additional noise insulation treatment. The NIPA policy for WSI therefore adopts ANEC 20 contour as the principal eligibility criterion for noise insulation treatment.

Use of ANEC composite contours and natural boundaries

ANEC contours have been adopted for the NIPA policy to consider noise impacts and potential eligibility for treatment or property acquisition. The ANEC, which is utilised in this policy, as well as ANEF, is explained further in Technical paper 1 and Technical paper 6: Land use and planning (Technical paper 6).

The NIPA policy has adopted the 'ANEC composite' contour which reflects all 5 runway modes of operation, including night modes, and represents the largest ANEC footprint. This is a conservative approach to capture the highest number of properties that may be eligible for amelioration treatment or acquisition.

It is important to note that an ANEC contour is a computer-generated contour based on a finite number of inputs and assumptions. ANEC contours do not recognise geographical 'natural boundaries' and can, for example, pass through streets even though buildings on either side of the contour may have the same or similar noise experience.

A lesson learned from the implementation of the noise insulation programs at Sydney (Kingsford Smith) and Adelaide airports was the need to consider natural boundaries, such as the inclusion of properties on either side of the street and the use of waterways, terrain (for example, hills or crests), and green spaces to determine the boundary. Feedback received during the public exhibition of the Draft EIS and draft NIPA policy and discussions with landowners also identified support for the consideration of natural boundaries when determining eligibility guidelines for the NIPA program.

Given the different characteristics of the area surrounding WSI (with large irregular lot sizes, lower density rural-residential land uses) compared to the areas surrounding Sydney (Kingsford Smith) and Adelaide airports, the natural boundary considerations used to determine the WSI NIPA eligibility area will be modified to provide more equitable outcomes across the eligibility area. This includes:

- recognising differences in property lot sizes and shapes – buildings on the whole of a property lot that is touched by the ANEC 20 contour will be eligible. To avoid inequitable or arbitrary outcomes, however, individual buildings on lots that are located over one km outside the ANEC contour will be excluded from program eligibility
- recognising differences between the predominantly rural areas and the smaller pockets of suburban development (in Luddenham Village and the Twin Creeks estate) – extending the natural boundary to include both sides of a street will be limited to those suburban areas only. This is consistent with the way this natural boundary consideration was applied in streets surrounding Sydney (Kingsford Smith) and Adelaide airports.

Based on these factors, the program eligibility area, based on the ANEC 20 composite contour, will be extended in some locations to include natural boundaries, using the following guidelines:

1. The whole of a property lot, where the ANEC 20 contour passes through, or touches, part of the property – however, a distance rule will be applied on large property lots to exclude buildings located more than one km from the ANEC 20 contour.
2. Some additional properties, in close proximity to the ANEC 20 contour where a localised geographic feature creates a natural boundary, such as a road, waterway, terrain or green space.
3. Within the suburban area of Luddenham Village and Twin Creeks estate, where the ANEC 20 contour runs broadly parallel along a street, or immediately adjacent to a street, additional properties that are immediately opposite (i.e. across the street to) eligible properties.
4. Within the suburban area of Luddenham Village and Twin Creeks estate, where the ANEC 20 contour runs broadly perpendicular across a street, additional properties that are on the same street frontage and immediately adjacent to (i.e. next door to) eligible properties.

Further detailed information on where natural boundaries will be considered, including details of the final NIPA eligibility area, will be included in the program guidelines, which will be released prior to the program's expected implementation in mid-2025.

Figure 11.60

ANEC contours for NIPA eligibility

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:100,000 Date: 6/08/2024

Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

C:\Users\AURC508271\WSP O365\AU-WKG - Geospatial - AIS - Documents\Projects\PS130347_WSA_Airspace_EIS\Mxd\08_EIS_PostEIS_Rev202407\Chapter_11\PS130347_F11_60_ANEC_2040_Composite_r1_v1.mxd | Author: R.Choi | QA: E.BUXTON

Forecast operation year is based on 2040

With WSI opening in 2026 and the anticipated gradual increase in utilisation, and therefore gradual increase in noise overtime, the NIPA policy has used the 2040 forecast operation year instead of 2033 or 2055 (refer to Appendix F). In developing this policy, 2033 was considered too soon after establishment of WSI to reflect the time frame of the program, and 2055 did not take into account the potential second runway that is anticipated to be required around that time, nor any technological advances in aircraft. With these considerations, the NIPA policy is taking into consideration a higher operational noise impact than what is expected to be experienced when WSI initially opens, or even in 2033. This also reflects moderate airport maturity, when it is forecast to be operating at 15 million annual passengers.

Estimate of number of properties eligible

For the draft NIPA policy, a desktop approach was used to identify sensitive receptors within the noise contours. Following release of the draft policy, DITRDCA undertook further work to better understand the number, type and nature of properties and buildings in the NIPA eligibility area.

The ANEC 20 contour directly impacts (i.e. touches) approximately 171 property lots surrounding the Airport Site. This does not include any additional properties that may be subject to the natural boundary considerations.

The actual number of properties that will be eligible to apply to the program is expected to be lower than the total number of impacted properties, for the following reasons:

- some rural properties are vacant, or have derelict or abandoned buildings
- some areas are also currently undergoing rezoning from rural-residential to commercial-industrial, with this trend continuing given increasing developments within the surrounding Western Sydney Aerotropolis area
- some properties are currently, or likely to be, subject to other acquisition processes related to NSW Government Aerotropolis and transport planning
- program eligibility guidelines will exclude works on buildings with pre-existing obligations to undertake noise treatment works to achieve building compliance due to existing state and local planning laws
- program eligibility guidelines will exclude works on unapproved or non-compliant buildings and structures
- program eligibility guidelines for non-residential properties are limited to noise sensitive public buildings (educational facilities, health care and clinical facilities and places of worship).

The NIPA program will be voluntary and the final number of landowners that will participate is not known at this stage. DITRDCA will undertake further on-ground investigation of properties within the eligibility area during detailed NIPA program design and delivery.

The eligibility criteria for WSI NIPA policy is broader than both previous domestic programs at Sydney (Kingsford Smith) and Adelaide airports – the lower number of properties potentially eligible for treatment (compared to Sydney (Kingsford Smith) and Adelaide) reflects lower residential density in the areas surrounding the Airport Site, combined with careful land use planning over many years. For example, had the same eligibility criteria for Sydney (Kingsford Smith) Airport been applied to WSI, as few as 5 properties would be eligible for noise treatment assistance. In addition to consistency with the land use planning framework, the broader eligibility for WSI reflects the lower existing ambient noise levels around the Airport Site and its character as a new, greenfield, development that will operate on a 24-hour basis.

Treatments for residential and non-residential buildings

Noise amelioration treatments provided by the NIPA program are to be based on the application of AS 2021:2015*,* as well as research undertaken by DITRDCA with experts in this field.

Based on research, the ANEC noise contours will be used to identify properties considered eligible for insulation treatments if located within the NIPA eligibility area. Under the standard, potential treatments, depending on technical assessment, include double glazed windows, wall and ceiling insulation, external door seals and cooling. For more information on aircraft noise treatment refer to Appendix F.

While further detailed information on the NIPA program, including program guidelines and application processes, will be released prior to the program's implementation in mid-2025, the program is expected to follow the delivery process outlined below.

1. *Application process* – following a public awareness campaign, landowners within the NIPA eligibility area will be invited to apply to the NIPA program. Building eligibility will be assessed against the program eligibility criteria.
2. *Building acoustic assessment* – eligible buildings will be assessed by specialist acoustic engineers and a Noise Treatment Plan developed to identify the insulation works required. Related building works to support any treatment works will also be included in the Plan.
3. *Noise Treatment Plan approval* – Noise Treatment Plans would be assessed by DITRDCA for their effectiveness in reaching the noise reduction target in a cost-effective manner. Landowners would also need to agree to Noise Treatment Plans before any work is carried out.
4. *Delivery of works* – Works would be delivered using qualified builders and following all work health and safety laws.
5. *Quality assurance and acceptance of works* – Works would be assessed for compliance with relevant building codes and the level of noise reduction achieved.

Internal noise target

The NIPA policy sets an internal noise target of 50 dB(A) within noise sensitive areas, including bedrooms, living areas and workspaces. This aligns with recommended indoor noise level under AS 2021:2025 for new properties constructed adjacent to an airport. The composite L_{Amax} contour including all modelled aircraft types will be used to determine the maximum noise level each dwelling is predicted to experience based on the projected flight schedules. The L_{Amax} represents the absolute maximum sound level modelled on any flight path by any scheduled aircraft movement. It is the highest aircraft single noise event in a 24-hour period. This will determine the level of noise reduction required to achieve the desired internal noise target.

Where the 50 dB(A) target cannot be effectively or efficiently achieved, noise treatment works will aim to provide a noticeable aircraft noise reduction, at a level to be determined during detailed program design, specific to the individual building type, use and location.

Program participation

Participation in the NIPA program by landowners will be voluntary. Further detailed information on the NIPA program, including program guidelines and eligibility, and application processes, will be released prior to the program's implementation in mid-2025. At this time DITRDCA will contact all landowners within the NIPA eligibility area to advise of the details of the program and the application process.

Acquisition of a property

There are no properties identified as located within the ANEC 40 contour. ANEC 40 is the metric used in this policy to determine automatic consideration for property acquisition and aligns with the approach taken for the Sydney Airport noise insulation program. No eligible building is currently within the ANEC 40 composite for 2040, however consideration may be made on a case by case basis for requests for the acquisition of a property outside the ANEC 40, yet still located within the ANEC 20.

DITRDCA will take the following additional criteria into account in making a recommendation on whether a property should be acquired:

1. The proposed acquisition is voluntary and at the request of the owner.
2. The property is very significantly impacted by aircraft overflight noise.
3. Effective noise amelioration treatments are not possible.
4. Agreement on fair value with the landowner can be reached.

All final decisions on whether a property should be acquired are a matter for the Australian Government.

11.8.1.3 Other mechanisms

WSA Co will establish a WSI CACG to ensure appropriate community engagement on airport planning and operations.

Other mechanisms supporting the WSI operational framework would include:

- the Airservices Australia's NCIS – to handle complaints and enquiries about aircraft noise and operations associated with WSI to help identify issues of community concern and provide opportunities for improvement
- the ANO (an independent administrative office) – to conduct reviews of Airservices Australia's and Defence's management of aircraft noise-related activities. The ANO would also monitor and report on the effectiveness of the community consultation processes related to aircraft noise for WSI and the presentation and distribution of aircraft noise-related information.

The operational framework would support the implementation of the mitigation measures proposed in Section 11.8.2.

11.8.2 Mitigation measures

Effective noise mitigation often requires several small, incremental improvements that, when combined, could result in a substantial and noticeable reduction in aircraft noise impacts. This must be balanced against a safe and efficient airport operation. The proposed mitigation measures outlined in this section for WSI would be given further consideration at the appropriate stages indicated. Further explanation is provided in Section 11.1 of Technical paper 1.

11.8.2.1 Future phases

As outlined by Chapter 6 (Project development and alternatives), there are 3 remaining phases of the airspace and flight path design process. During the detailed design phase more detailed planning of the airspace design and operating procedures, including the evaluation of the viability and finalisation of noise mitigation measures presented in this chapter, would be undertaken in consultation with industry and stakeholders.

All design decisions made during detailed design for improved noise impact mitigation would be made by Airservices Australia in discussion with DITRDCA and assessed as appropriate prior to being considered by CASA.

During the implementation phase, the final noise abatement procedures and noise management measures would be recorded as part of the overarching noise management plan for WSI. The refinement of noise abatement procedures would then require the actual commencement of operations and measurement and monitoring of the benefits or disbenefits individual initiatives deliver as part of the post-implementation phase.

11.8.2.2 Noise abatement procedures

The concept and different types of noise abatement procedures are introduced in Chapter 3 (Introduction to airspace), along with limitations to their use.

The proposed noise abatement procedures for WSI (see Chapter 7 (The project)) were developed to minimise noise impacts as much as practical without unduly compromising the safe operation of WSI. Advanced mitigations such as Noise Abatement Departure Procedure climb profiles would be considered in the detailed design phase. These are explained in detail in Section 11.2 of Technical paper 1.

11.8.2.3 Monitoring of aircraft noise and flight paths

As a major new international airport, it is expected that a system of permanent noise monitoring terminals (loggers) would be installed at suitable locations around WSI and incorporated into Airservices Australia's NFPMS network and reporting systems. This system operates 24-hours-a-day, 7 days a week, collecting data from every aircraft operating to and from each of these airports. Further information is available in Section 10.1.1 of Technical paper 1 and the Airservices Australia website https://www.airservicesaustralia.com/community/environment/aircraft-noise/monitoring-aircraft-noise/noise-monitor-reporting/.

The WebTrak interface allows community and other stakeholders to see where aircraft fly and explore historical trends and patterns.

11.8.2.4 Communication and coordination

It is recommended that information is provided to existing and potential new residents in areas likely to be affected by noise. For existing residents, this information will allow them to understand the anticipated aircraft noise (including the number, frequency, loudness, and timing of events and periods of respite). For potential new residents, comprehensive and accurate information enables their informed consideration of a move into the area. The results of the noise assessment will seek to support this process.

Ongoing consultation with the local community and other important stakeholders would continue in parallel with the future phases of the airspace and flight design process to provide the chance to be consulted and fully informed of the final expected impacts before WSI commences operations (refer to Chapter 9 (Community and stakeholder engagement)).

11.8.2.5 Project specific mitigation measures

Table 11.13 provides a summary of aircraft noise mitigation measures identified for the project. These are supported by the proposed monitoring program in Table 11.14.

Table 11.13 Proposed mitigation measures – aircraft noise

ID No.	Issue	Mitigation measure	Owner	Timing
N1	Noise insulation and property acquisition	DITRDCA will deliver the NIPA policy which will apply to eligible properties that are significantly impacted by aircraft overflight noise from WSI.	DITRDCA	**Pre-operation** (Detailed design, 2024–2026) and **Operation** (Implementation, 2026 – conclusion of program)
N2	Noise abatement	Airservices Australia will develop and review noise abatement procedures in consultation with stakeholders, including aircraft operators, airlines, WSA and Forum on Western Sydney Airport (FoWSA)/WSI CACG following a draft proposal developed by the Expert Steering Group in response to feedback on the draft EIS.	Airservices Australia/ DITRDCA	**Pre-operation** (Initial proposal as part of the EIS, with any further refinements in detailed design, 2024–2026) and **Operation** (Implementation, 2026–ongoing)

ID No.	Issue	Mitigation measure	Owner	Timing
N3	Communication	WSA Co will establish a CACG to ensure appropriate community engagement on airport planning and operations. This will ensure community and industry have a forum for the groups best positioned to identify, share and test solutions or measures including relevant national or international best practice initiatives.	WSA Co	**Pre-operation** (At the conclusion of detailed design, 2024–2026)
N4	Noise complaints	The Airservices Australia NCIS will handle complaints and enquiries about aircraft noise and operations associated with the project to help identify issues of community concern and provide opportunities for improvement.	Airservices Australia	**Operation** (Implementation, 2026–ongoing)
N5	Aircraft noise	The ANO provides independent reviews of aircraft noise-related activities to ensure appropriate governance and oversight of operations. The ANO is also available to make targeted reviews on specific issues as they are identified or arise.	Airservices Australia	**Operation** (Implementation, 2026–ongoing)
N6	Flight path design	Airservices Australia will undertake a post-implementation review (PIR) of the flight path design and implementation.	Airservices Australia	**Operation** (2026 – within 2 years of implementation)

Table 11.14 Proposed monitoring program – aircraft noise

ID No.	Issue	Monitoring measure	Owner	Timing
M1	Aircraft noise	Airservices Australia will install a system of permanent and temporary noise monitoring terminals at suitable locations and incorporated into the Airservices Australia NFPMS network and reporting systems. The interface will allow community and other stakeholders to see where aircraft fly and explore historical trends and patterns. The system will provide accurate noise monitoring data for reporting, validation and noise model calibration. With an established baseline it could give an evidence base for any future flight path modification or noise abatement initiatives. This system will operate 24-hours-a-day, 7 days week, collecting data from every aircraft operating to and from WSI. Noise monitoring will consider the requirements of the WSI Stage 1 Development Noise Operational Environment Management Plan (OEMP).	Airservices Australia	**Operation** (Implementation, 2026–ongoing)

11.8.2.6 Dependencies and interactions with other mitigation measures

Mitigation measures in other chapters that are relevant to the minimisation and management of aircraft noise impacts include:

- Chapter 14 (Land use), specifically the requirement for continued liaison between DITRDCA and WSA Co with State and local government agencies to ensure applicable environmental planning instruments have regard ANEC forecasts produced for the project
- Chapter 18 (Social), specifically the requirement for WSI CACG to undertake consultation with stakeholders and community, including social organisations, to seek feedback on social issues and to promote social and economic welfare of the community.

Chapter 12 Air quality and greenhouse gas

This chapter provides an overview of the existing environmental conditions and the potential local and regional air quality and greenhouse gas (GHG) emissions impacts associated with the project.

The refinements to the preliminary flight path design since the exhibition of the Draft EIS would not change the conclusions of the overall air quality assessment or greenhouse gas assessment as presented in this chapter and supporting technical papers. Any change to air quality or greenhouse gas emissions would be minimal. Further detail is provided in Appendix G (Assessment of the refinements to the project) of the EIS.

Air quality

The local air quality assessment has focused on direct emissions near to the source, whereas the regional air quality assessment has also considered secondary pollutants (such as ozone (O_3)), which may form in the atmosphere sometime after the emission of any precursor pollutants such as oxides of nitrogen (NO_X) and Volatile Organic Compounds (VOC).

The assessment has used well established, commonly used modelling methods and has been completed in accordance with NSW Environment Protection Authority guidelines including the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA, 2022) (the Approved Methods) and the *Tiered Procedure for Estimating Ground Level Ozone impacts from Stationary Sources* (NSW EPA 2011). The assessment has also considered recognised Australian air quality impact assessment criteria, guidelines and recommended practices.

The prevailing wind flows in the area surrounding the WSI are influenced by the topography of the Sydney Basin. The ambient air quality levels that are monitored at various locations surrounding WSI indicate that air quality in the area is generally good and is typically below the relevant NSW Environment Protection Authority (EPA) goals except for annual average particulate matter (PM) less than 2.5 micrometres in diameter ($PM_{2.5}$) levels and O_3. Historically, adverse air quality conditions arise from time to time due to extraordinary events such as dust storms and bushfires.

The local air quality assessment indicated the predicted levels associated with the project would be below criteria for all the assessed air pollutants, except for $PM_{2.5}$ and NO_2 in 2055 at a series of receivers located to the immediate north-west of the runway. However, the elevated $PM_{2.5}$ levels are predicted to arise due to existing elevated background levels and the effect of the project is expected to be insignificant. Whilst the project would contribute significantly to 1-hour average NO_2 levels at the nearest receivers to the north-west of the runway, the predicted levels of NO_2 are slightly above the more stringent, recently updated NSW EPA criteria for only a portion of the hours throughout the year that were assessed. The elevated NO_2 levels would only occur at a few locations immediately adjacent to WSI. As the predicted results are likely to be conservative (overestimating of impacts) and as it is likely there will be improvements in fuel efficiency (for aircraft and motor vehicles) and decreases in aircraft emissions in the future, it is reasonable to conclude that no significant impacts would arise.

The regional assessment identified a similar small scale of NO_2 impacts consistent with the local assessment, with predicted levels above the new NSW EPA criteria in close vicinity to WSI in 2055, representing a small localised potential impact. Importantly however, the regional modelling results indicated that the project would not increase maximum O_3 concentrations and would generally result in a net reduction in O_3 concentrations (particularly at night) during periods of high O_3 levels in densely populated areas. This arises as the additional NO_x emitted by the project would react with and thus and diminish existing elevated O_3 concentrations. The results also indicated some increases in maximum O_3, which would occur predominantly over uninhabited forest land and sparsely populated areas. Overall, it can be concluded that the predicted impacts for NO_2 are small, infrequent and highly localised, $PM_{2.5}$ impacts arise due to elevated background pollutant levels, and that the results show an improvement in the predicted maximum O_3 impacts relative to the 2016 EIS.

The project's impact on the concentrations of all other assessed pollutants would be negligible and unlikely to be discernible or measurable within the existing background concentrations.

Monitoring of air quality in the vicinity of WSI commenced as part of the Airport Plan approval, and requires the ongoing monitoring of local air quality once WSI is operational. No further mitigation has been proposed.

Greenhouse gas emissions

With respect to potential GHG emissions, the most carbon-intensive flights are those operating regular public transport (RPT) services to medium and long haul destinations. In 2033 and 2055, these RPT services accounted for only 27 and 23 per cent of projected total air traffic movements but were responsible for more than half of all flight emissions of carbon dioxide equivalents (CO_2e) from WSI to destinations across its anticipated route networks. Emissions of CO_2e from domestic aviation are projected to grow steadily between 2033 and 2055, as activity continues to grow generally in line with population.

Overall, the emissions of CO_2e in the engine exhaust behind aircraft using WSI's flight paths and route network in 2033 and in 2055 are not considered to result in significant impacts or inhibit the achievement of net zero economy targets set by the Australian or NSW Government for 2050.

The total aircraft engine emissions of CO_2e from WSI are expected to be lower than the projections for 2033 and 2055 due to next generation aircraft and propulsion technologies, air navigation and air traffic management infrastructure and operational improvements, and the uptake and use of sustainable aviation fuels (SAF).

Wide-ranging measures will be required to manage and reduce emissions of CO_2e produced in the engine exhaust behind the aircraft operating along WSI's flight paths and route network, many of which are dependent on other aviation stakeholders – such as WSA Co, Airservices Australia, airlines, aerospace manufactures and fuel companies. Future controls to manage and adapt to a changing climate may also be required.

An Operational Sustainability Strategy and Operational Sustainability Plan for WSI is also currently under development by WSA Co and will be released prior to the opening of WSI in 2026. A core component of this strategy and plan will be a roadmap to guide WSI along a 'Carbon Neutral Pathway' that will be supported by participation in Airport Council International's (ACI) *Airport Carbon Accreditation* programme, and a strategy to support aviation partners to reduce scope 3 emissions, including those produced by aircraft engine use in the landing take-off (LTO) cycle below 3,000 feet (ft) or 914 metres (m).

WSA Co is also planning to join the ACI's *Airport Carbon Accreditation* programme at one of the 2 highest available levels (being Transformation level (4) or Transition level (4+)). This means that WSA Co will be required to set a policy commitment that will achieve absolute emissions reductions of CO_2e and implement a Carbon Management Plan. This plan will define the emissions reduction trajectory, interim milestones and the measures required to achieve a future science-based target in line with the Intergovernmental Panel on Climate Change's (IPCC) 1.5 degrees Celsius pathway. It will also help WSI operate with the lowest carbon footprint possible as it closely works with all its stakeholders to address third party emissions of CO_2e, particularly for sources that are outside its direct control and ownership (i.e., aircraft engine emissions).

12.1 Introduction and previous assessment

This chapter provides a summary of the potential air quality and GHG emissions impacts associated with the preliminary airspace design. The full assessment of air quality impacts is provided in Technical paper 2: Air quality (Technical paper 2) and a full assessment of the potential GHG emissions impacts and climate change risk is provided in Technical paper 3: Greenhouse gas emissions (Technical paper 3).

The local air quality assessment focussed on direct emissions near WSI, whereas the regional assessment considered a much larger area and also considered potential secondary pollutants, such as ozone, which may form in the atmosphere sometime after the emission of any precursor pollutants such as nitrogen oxides (NO_X) and Volatile Organic Compounds (VOC). The assessment of the potential GHG focuses on the contribution of carbon dioxide (CO_2) emissions from aircraft operating to and from WSI. Appropriate mitigation and management measures have been identified to reduce potential impacts. The impact assessment on air quality and aircraft engine GHG have been prepared in consultation with the Australian Government Department of Climate Change, Energy, the Environment and Water and have been carried out in accordance with the EIS guidelines.

12.1.1 The 2016 EIS

It is important to note that both local and regional air quality assessments were prepared as part of the 2016 *Western Sydney Airport Environmental Impact Statement* (Department of Infrastructure and Regional Development, 2016) (2016 EIS) that quantified the potential local air quality impacts due to the operation of Stage 1 Development and long-term airport development. The Stage 1 Development considered a single runway with associated landside and airside facilities (2030). The long-term development (2063) included parallel runways and additional facilities to cater for the additional passenger movements.

The local air quality assessment identified aircraft movements to be the largest source of emissions (consisting of particulate matter (PM) (PM_{10} and $PM_{2.5}$), NO_X and sulphur dioxide (SO_2)) followed by the operation of onboard aircraft auxiliary power units and ground support equipment. The biggest contributor of VOC emissions was determined to be from aircraft and fuel storage tanks.

The local assessment concluded that the Stage 1 Development would not result in any exceedances of the applicable air quality criteria at the nearest residential receivers, and that the highest predicted off-site concentrations were found to generally occur to the north and north-east of the Airport Site. This was associated with the location of the runway and the prevalence of south-westerly winds. The long-term operational impacts were only evaluated for key air quality metrics, i.e., NO_2, PM_{10} and $PM_{2.5}$. The results indicated some exceedances of the predicted 1-hour average NO_2 concentrations at 6 residential receivers, intermittently over the modelling period. Two off-site receivers were also predicted to experience an annual average $PM_{2.5}$ level above the relevant criterion.

For the regional assessment, the modelling results were compared against the air quality objectives for maximum 1-hour and 4-hour ozone (O_3) concentrations. For the Stage 1 Development (as described for the 2030 reference year in the 2016 EIS) the peak predicted 1-hour and 4-hour O_3 concentrations were relatively unchanged compared to the base case. For the longer-term development (as described for the 2063 reference year in the 2016 EIS) the maximum predicted 1-hour ozone concentrations remain unchanged, however the maximum 4-hour O_3 concentrations increased on some days.

It is important to note that the assessment presented for this EIS relates only to the flight paths, and no changes to the construction phase of WSI or ground-based operations are proposed. The numbers and types of aircraft have been updated (from those presented in the 2016 EIS) to reflect a more modern aircraft fleet. The relevant air quality criteria have also become more stringent for some key air pollutants. To account for the cumulative impact of the project with operational ground level activities, the predicted impacts from the 2016 EIS air quality assessment have been directly applied.

12.2 Legislative and policy context

This section identifies the applicable air quality and GHG emissions legislation relevant to the project. While the NSW legislative requirements outlined below are not specific to Australian Government airport activities or aircraft operations, the general provisions of both the NSW and Commonwealth legislation has been included for completeness of consideration.

12.2.1 Gaseous pollutants and particulate matter performance criteria

Legislation, guidelines and standards governing ambient air quality and emissions from air pollutants have been established by both the Australian and NSW governments.

Regulated air pollutants are divided into 'criteria' pollutants and 'air toxics'. Criteria pollutants are those emissions that are generally emitted in relatively large quantities and abundant in the atmosphere. Air toxics, such as VOCs, are gaseous or particulate pollutants that are typically present in lower concentrations and can be hazardous to humans, plants or animal life.

Legislation, guidelines, and other standards which have been considered for this assessment are summarised in Table 12.1.

Table 12.1 Emissions and air quality legislation

Regulator	Legislation/policy	Summary of legislation requirement(s)
Ambient air quality and odour		
Australian Government	*Airports Act 1996* (Airports Act)	The Airports Act contains an obligation on airport lessee companies to develop a master plan every 5 years including a detailed environmental strategy for WSI. The Airports Act also contains a number of offences that are related to pollution.
	Air Navigation (Aircraft Engine Emissions) Regulations 1995 (Annex 16)	The *Air Navigation (Aircraft Engine Emissions) Regulation 1995* was created under the *Air Navigation Act 1920* and provides the regulatory framework for air pollution generated by aircraft.
	National Environment Protection (Ambient Air Quality) Measure (Ambient Air Quality NEPM) (NEPC, 2021)	The Ambient Air Quality NEPM specifies national ambient air quality standards for air pollutants. It sets the air quality standards for 6 air pollutants (carbon monoxide, nitrogen dioxide, sulphur dioxide, lead, ozone and PM_{10}) and includes advisory reporting standards for $PM_{2.5}$. It is important to note that NEPM air quality standards are not designed to be applied to the impact assessment of a specific project. The NEPM standards apply to the average exposure to air pollutants of the general population, in each state.
	National Environment Protection (Air Toxics) Measure (Air Toxics NEPM) (NEPC, 2004)	The Air Toxics NEPM specifies investigation levels for ambient air toxics concentrations. Similar to the Ambient Air Quality NEPM, the Air Toxics NEPM aims to facilitate the development of standards that will allow for the equivalent protection of human health and well-being. It sets a nationally consistent approach to monitoring for 5 air toxics: benzene, formaldehyde, toluene, xylenes and benzo(a)pyrene (as a marker for polycyclic aromatic hydrocarbons). The Air Toxics NEPM does not provide 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.

Regulator	Legislation/policy	Summary of legislation requirement(s)
NSW Government	*Protection of the Environment Operations Act 1997* (POEO Act) *Protection of the Environment Operations (General) Regulation 2009*	The POEO Act (and the relevant Regulations made under the Act (i.e., the NSW *Protection of the Environment Operations (Clean Air) Regulation, 2021*) includes a range of controls with regard to air quality. NSW legislation (POEO Act) prohibits emissions that cause offensive odour to occur at any off-site receiver. The NSW legislative requirements are not specific to Commonwealth airport activities or aircraft operations, but the general provisions in this legislation are relevant for consideration. These aspects include appropriately managing and mitigating potential emissions to reduce overall environmental harm or impact in the environment due to operations from the project.
	NSW Odour Policy (NSW DEC, 2006)	The range of a person's ability to detect odour varies greatly in the population, as does their sensitivity to the type of odour. The wide-ranging response in how any particular odour is perceived by any individual poses specific challenges in the assessment of odour impacts and the application of specific air quality goals related to odour. The *NSW Odour Policy* sets out a framework specifically to deal with such issues. The NSW criteria for acceptable levels of odour range from 2 to 7 odour units (OUs), with the more stringent 2 OU criteria applicable to densely populated urban areas and the 7 OU criteria applicable to sparsely populated rural areas, as outlined below (refer to Section 12.3.2).
Emissions of air quality criteria pollutants		
Australian Government	*Environmental Management of Changes to Aircraft Operations Standard* (NOS) (Airservices Australia, 2022b)	The purpose of the NOS is to prescribe the requirements for environmental impact assessment, social impact analysis and community engagement that must be met, prior to implementing changes to aircraft operations. NOS criteria have been developed by Airservices Australia to provide a quantitative mechanism for determining proposed changes to aircraft operations with the potential to result in 'significant impact' to the environment (as defined under the *Environment Protection and Biodiversity Conservation* Act 1999 (EPBC Act)). Section 2 of Appendix B of the NOS provides criteria to determine whether to seek advice under the EPBC Act regarding potentially significant environmental impacts associated with increases in aircraft fuel burn and emissions (including NO_X, SO_x and PM). It also provides steps in applying fuel burn and emissions criteria: if specific criteria are met, advice must be sought from the Australian Minister for the Environment and Water regarding the potential for the change to cause 'significant impact'. The NOS seeks to endure that that flightpaths be designed to avoid environmental (and social) impacts to the greatest extent practicable, whilst prioritising operational safety. Details of the specific NOS criteria are detailed in Section 2.1.8 of Technical paper 2 and Section 4.3.7 of Technical paper 3.

Regulator	Legislation/policy	Summary of legislation requirement(s)
NSW Government	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 is the key regulatory mechanism in NSW for reducing emissions of harmful pollutants in the air. The regulation prescribes 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 (NSW EPA Approved Methods) (NSW EPA, 2022)	The NSW Environment Protection Authority (EPA) document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* lists the statutory methods that are to be used to model and assess emissions of air pollutants from stationary sources in NSW. This policy document includes criteria for a range of pollutants that may be emitted from a development or facility. It is referred to in Part 5: Air impurities from emitted activities and plant of the Clean Air Regulation.
Emissions of greenhouse gases		
Australian Government	*National Greenhouse and Energy Reporting Act (2007)* (NGER Act) and *National Greenhouse and Energy Reporting (Measurement) Determination 2008*	The NGER Act provides for the reporting and dissemination of information related to GHG emissions, GHG projects, energy production and energy consumption. Under the NGER Act, corporations in Australia which exceed thresholds for GHG emissions or energy production, or consumption are required to measure and report data to the Clean Energy Regulator on an annual basis (the NGER Scheme). The *National Greenhouse and Energy Reporting (Measurement) Determination 2008* identifies several methodologies to account for GHGs from specific sources which are relevant to WSI. This includes emissions of GHGs from direct fuel combustion (e.g., fuel for transport energy purposes). Aircraft GHG emissions associated with single runway operations at WSI from its planned opening in 2026 would be included in this ongoing reporting under the NGER Scheme.
	Climate Change Act 2022 and Climate Change (Consequential Amendments) Act 2022	These Acts legislate Australia's emissions reduction targets, including a 43 per cent emissions reduction by 2030 and transition to a net zero economy by 2050.
NSW Government	*Net Zero Plan Stage 1: 2020-2030* (NSW Government, 2020)	The NSW Government has committed to action on climate change and a goal for a net zero carbon economy by 2050. This is set out under the *Net Zero Plan Stage 1: 2020-2030.* The Plan aims to help achieve the State's objective to deliver a 50 per cent cut in emissions by 2030 compared to 2005 levels. It also supports a range of initiatives targeting energy, electric vehicles, hydrogen, primary industries, technology, built environment, carbon financing and organic waste.

Regulator	Legislation/policy	Summary of legislation requirement(s)
Ozone-depleting substances		
Australian Government	*Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* (Ozone Act) and Regulations 1995	This Act and these Regulations impose controls to protect the environment by reducing emissions of ozone depleting substances and synthetic greenhouse gases that deplete ozone in the atmosphere including various Chlorofluorocarbons.
NSW Government	*Ozone Protection Act 1989* (Ozone Protection Act)	The Ozone Protection Act regulates or prohibits the manufacture, sale, distribution, conveyance, storage, possession and use of ozone-depleting substances in NSW.

Further details regarding the legislative and policy context with are provided in Chapter 2 of Technical paper 2 and in Chapter 4 of Technical paper 3.

12.3 Methodology

A summary of the approach to the assessment is provided in this section, including the methodology used to undertake the assessment and the relevant criteria which was applied to the assessment of potential impacts. The air quality and GHG emissions adopted the following 2 assessment years for the project:

- 2033 – selected to represent the early years of operations after the planned 2026 opening of WSI
- 2055 – selected to represent a year when WSI's single runway is expected to operate at near capacity.

For each reference year 7 different flight scenarios were considered to, of which 3 scenarios (No preference, Prefer Runway 05 and Prefer Runway 23) were identified to represent the worst case for potential air quality impacts. These 3 scenarios were selected for detailed assessment to examine the potential maximum air quality impacts associated with the project (refer to Section 12.3.4). A summary of the impact assessment approaches for both the air quality and GHG emissions assessments is outlined in the following sections.

12.3.1 Study area

12.3.1.1 Local air quality study area

The study area for the local air quality assessment generally considered an area within an approximate 10 km radius around the boundary of WSI. The topography of WSI and immediate surroundings are generally gently undulating with decreasing elevation to the east and south-east towards Thompsons Creek. Outside of WSI there are elevated ridges to the south-west and north-west. To the east of the site the terrain remains relatively flatter with some slight undulations. The Blue Mountains are located to the west with the terrain becoming elevated and complex to the west of the north flowing riverine channel. These terrain features influence the local wind distribution patterns and flows which are important for the dispersion and propagation of air emissions.

Figure 12.1 presents a 3-dimensional visualisation of the terrain features surrounding WSI. In terms of air quality, the emissions from aircraft that occur near to WSI and close to the ground are considered to be of primary relevance to the air quality assessment.

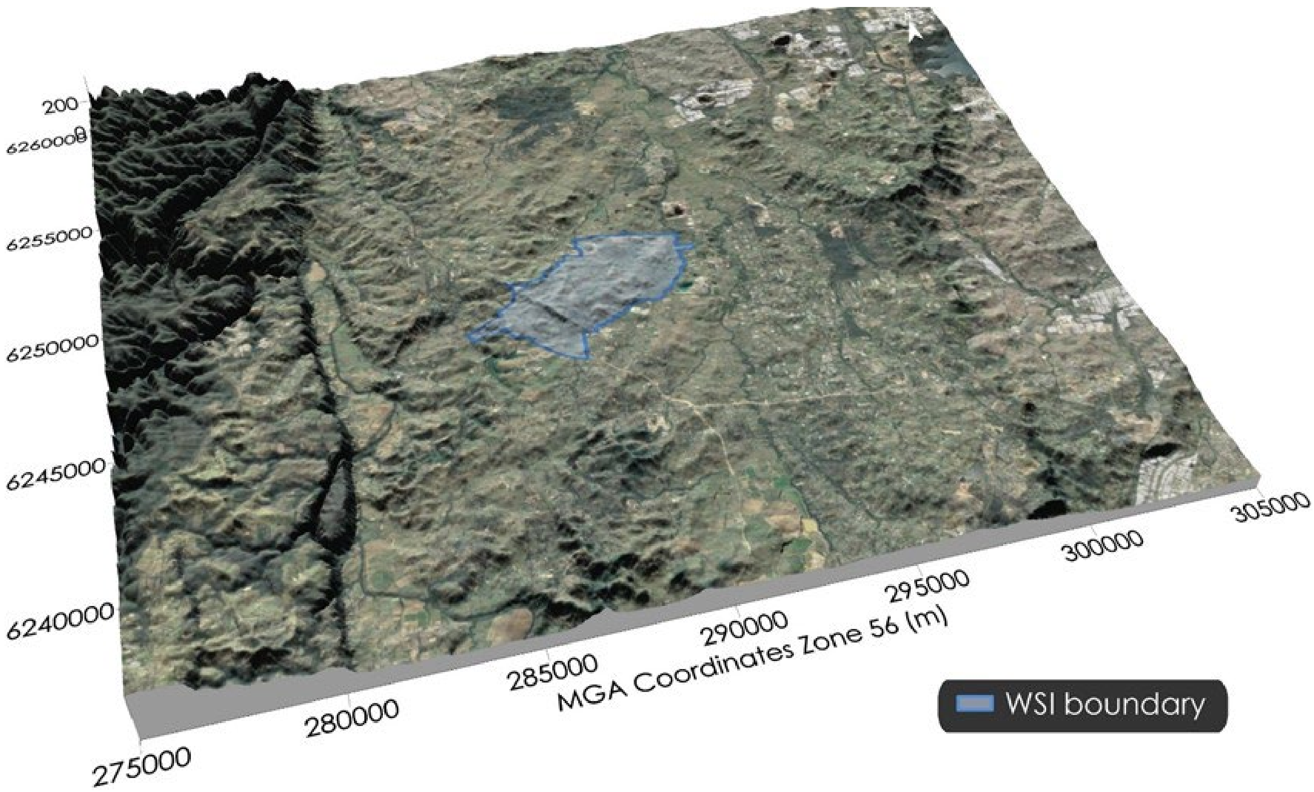


Figure 12.1 Representative visualisation of the local air quality study area topography

Sensitive receivers

Figure 12.2 presents the location of the project and key residential and community receivers considered in this assessment. For the assessment, community receivers included consideration of schools/child care centres, shopping locations, places of worship, parks, nature reserves and recreational/sporting club facilities. According to the Australian Bureau of Statistics 2021 census, there are more than 5.2 million residents in the Sydney Basin however, the selected receivers that were assessed were considered to represent the potentially most affected locations. The sensitive receivers are consistent with the locations assessed in the 2016 EIS. Receivers that represent the key potentially affected community and residential locations are summarised in Table 4.1 of Technical paper 2.

Table 4.1 of Technical paper 2 provides a comprehensive list of the key residential and community receivers considered as part of the assessment.

12.3.1.2 Regional air quality study area

The regional air quality modelling was undertaken at a larger scale than the local air quality assessment. The regional air quality assessment is focused on the effects of the project on ground level air quality spanning over the Sydney Basin. This area generally extends from Newcastle in the north to Shellharbour in the south, and as far west as Medlow Flat (east of Bathurst). An overview of the modelling area for the regional air quality assessment is shown in Figure 12.3.

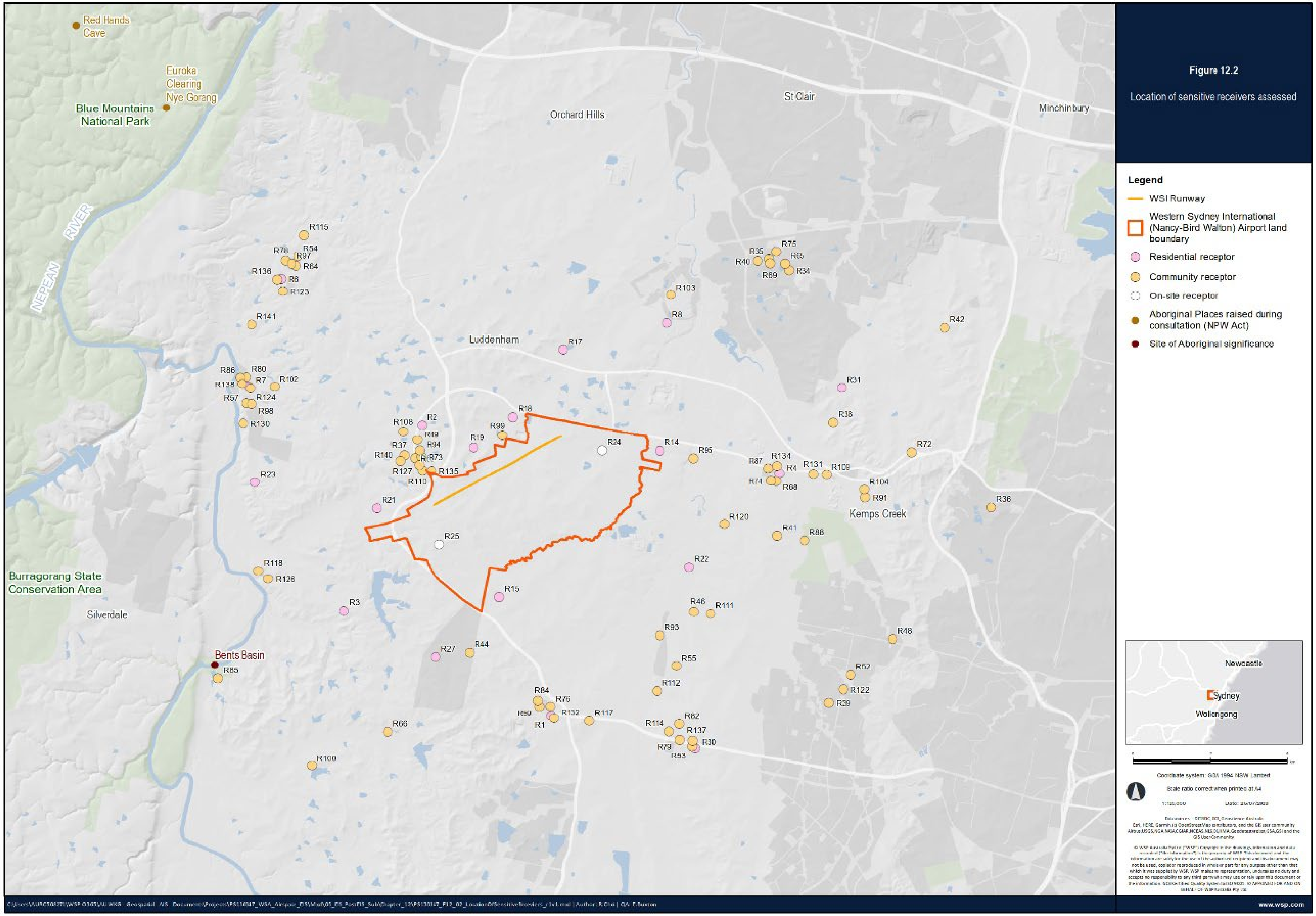
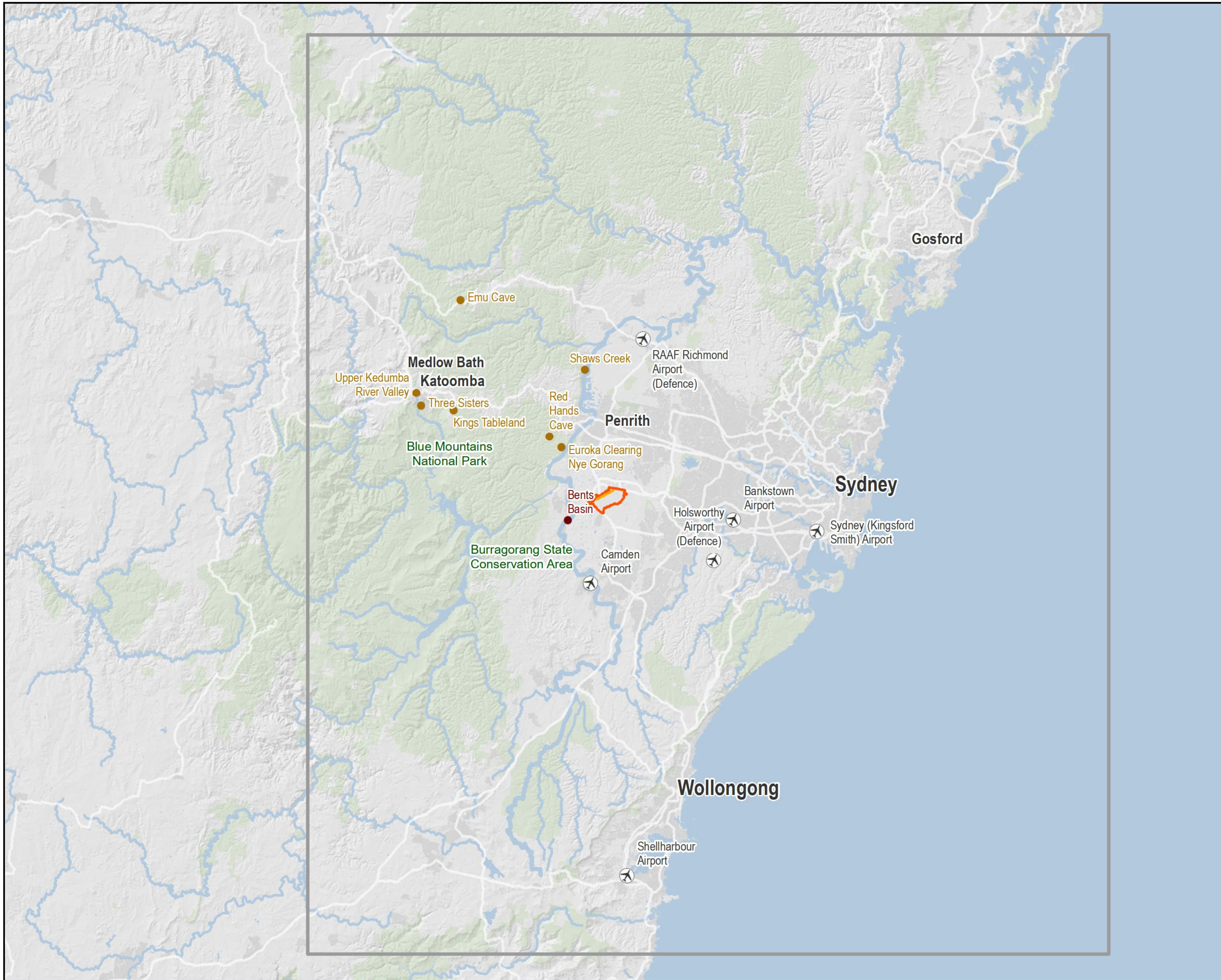


Figure 12.2

Location of sensitive receivers assessed

Figure 12.3

Overview of the regional study area



Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- Regional study area
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

0 10 20 km

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:1,000,000 Date: 26/07/2023

Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

12.3.1.3 GHG emissions

For the assessment, the GHG emissions boundary was defined with reference to the methodology described in ISO 14064-1:2018 and the GHG Protocol (a partnership between the World Resources Institute and the World Business Council for Sustainable Development which provides standards, guidance, tools, and training for business and government to measure and manage climate-warming emissions). The calculation methodology adopted for LTO cycle emissions below 3,000 ft (914 m) was based on the International Civil Aviation Organization (ICAO) Document 9889, Air Quality Guidance Manual (latest edition) with the United States Federal Aviation Administration's (US FAA) Aviation Environmental Design Tool (AEDT) (Version 3e) used to model emissions in an extended cruise and descent cycle below 10,000 ft (3,048 m).

The use of engines to propel the aircraft forward during the take-off roll, in the airspace below 10,000 ft (3,048 m), and to guide an aircraft into land at WSI are the sources of GHG emissions that have been assessed for the project. Aircraft engines are classified as either gas turbine turbofans or turbo-prop engines fuelled with aviation kerosene (commonly referred to as Jet A-1 fuel).

The methodology from ACI's *Airport Carbon Accreditation* Application Manual (Issue 13, March 2023) and the ICAO Carbon Emissions Calculator (Version 11.1, June 2018) were also used to calculate full flight emissions from WSI to all destinations across its anticipated route network. Each departing flight in the projected demand schedules provided by WSA Co, including the individual aircraft types and flight distances to each destination across WSI's anticipated 2033 and 2055 route networks were modelled. Calculations were made of individual aircraft fuel consumption according to the destination airport they were flying to using the adjusted Greater Circle Distance[1] with emission factors from ICAO and the National Greenhouse Gas Accounts 2022 applied to calculate emissions of CO_2e in tonnes (tCO_2e).

The results of the aircraft engine GHG emissions modelling have been presented as total aggregated emissions in both assessment years (2033 and 2055), representing the anticipated tailpipe CO_2e emissions produced in the engine exhaust behind the aircraft using WSI's flight paths to destination airports across its anticipated route networks.

12.3.2 Assessment criteria

This section identifies the applicable national air quality standards and state impact assessment criteria in order to assess acceptable impacts or compliance by the project. It should be noted that for some air pollutants, the standard or criteria may already be exceeded in the existing environment, and this does not indicate that the project would have an unacceptable effect. The sections below also identify both Australian Government and NSW air quality criteria, noting that the NSW criteria do not formally apply to the project.

12.3.2.1 Gaseous pollutants and particulate matter performance criteria

The air quality criteria adopted for use in the air quality assessment are principally those defined in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* EPA Approved Methods (NSW EPA, 2022). The NSW EPA Approved Methods account for various pollutant criteria and averaging periods from multiple sources, including the Ambient Air Quality NEPM.

A summary of the adopted air quality goals/criteria and their source is provided in Table 12.2 (including individual odorous air pollutants – toluene and xylene). In each case, where several performance criteria are available, the more stringent criterion has been identified.

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1 Greater Circle Distance is the distance between origin and destination airports is derived from latitude and longitude coordinates originally obtained from the ICAO Location Indicators database.

Table 12.2 NSW EPA air quality impact assessment criteria

Pollutant	Averaging period	Percentile	Criterion	Criterion	Location
Total suspended particulates (TSP)	Annual	100	90 µg/m^3	–	Receiver
Particulate matter ≤10µm (PM_{10})	Annual	100	25 µg/m^3	–	Receiver
	24-hours	100	50 µg/m^3	–	Receiver
$PM_{2.5}$	Annual	100	8 µg/m^3	–	Receiver
	24-hours	100	25 µg/m^3	–	Receiver
Deposited dust	Annual	100	2 g/m^2/month [a]	–	Receiver
	Annual	100	4 g/m^2/month [b]	–	Receiver
CO	15-minutes	100	100 mg/m^3	87 ppm	Receiver
	1-hour	100	30 mg/m^3	25 ppm	Receiver
	8-hours	100	10 mg/m^3	9 ppm	Receiver
SO_2	1-hour	100	286 µg/m^3	0.1 ppm	Receiver
	24-hours	100	57 µg/m^3	0.02 ppm	Receiver
NO_2	1-hour	100	164 µg/m^3	0.08 ppm	Receiver
	Annual	100	31 µg/m^3	0.015 ppm	Receiver
O_3	8-hours	100	139 µg/m^3	0.065 ppm	Receiver
Benzene	1-hour	99.9	0.029 mg/m^3	0.009 ppm	Boundary
Benzo[a]pyrene	1-hour	99.9	0.0004 mg/m^3	–	Boundary
Formaldehyde	1-hour	99.9	0.02 mg/m^3	0.018ppm	Boundary
Toluene	1-hour	99.9	0.36 mg/m^3	0.09ppm	Receiver
Xylene	1-hour	99.9	0.19 mg/m^3	0.19ppm	Receiver

Notes: µm = micrometre, g/m^2/month = grams per square metre per month, µg/m^3 = micrograms per cubic metre, mg/m^3 = milligrams per cubic metre, ppm = parts per million

Deposited dust pollutant:
[a] maximum increase in deposited dust level.
[b] maximum total deposited dust level.

The Ambient Air Quality NEPM also includes standards appliable from 2025 onwards for SO_2 of 0.075 ppm (current standard as shown in Table 12.2 is 0.1 ppm) and also 2025 goals for $PM_{2.5}$ of 20 µg/m^3 for a one day averaging period and 7 µg/m^3 for one year averaging period (currently 25 µg/m^3 and 8 µg/m^3 respectively). It is important to note that NEPM air quality standards are not designed to be applied to specific projects. The NEPM standards apply to the average exposure to air pollutants of the general population, in each state.

Additionally, in order to include consideration of the potential health issues that may arise from exposure to air toxics, 'investigation levels' have been identified for 5 pollutants in ambient air under the Air Toxics NEPM. These investigation levels are listed in Table 12.3.

Table 12.3 Advisory standard air toxic investigation levels applicable to the project

Pollutant	Averaging period	Investigation level
Benzene	1 year	0.003 ppm
Benzo[a]pyrene	1 year	0.3 ng/m³
Formaldehyde	24-hours	0.04 ppm
Toluene	24-hours	1 ppm
	1 year	0.1 ppm
Xylene	24-hours	0.25 ppm
	1 year	0.2 ppm

Source: Schedule 3 (Table 2), NEPC, 2004

12.3.2.2 Odour performance criteria

For activities with potential to release significant odour it may be necessary to predict the likely odour impact that may arise. This is done by using air dispersion modelling which can calculate the level of dilution of odours emitted from the source at the point to where odour reaches surrounding receivers. This approach allows the air dispersion model to produce results in terms of odour units (OUs). The number of odour units represents the number of times that the odour would need to be diluted to reach a level that is just detectable to the human nose.

The NSW EPA Approved Methods (NSW EPA, 2022) provides ground-level concentration criteria for complex mixtures of odorous air pollutants, taking account of population density in a given area. Table 12.4 lists the odour assessment criteria across different population densities. This criterion has been refined to consider population densities of specific areas and is based on a 99th percentile of dispersion model predictions calculated as 1-second averages (nose-response time).

Table 12.4 Impact assessment criteria for complex mixtures of odorous air pollutants (nose-response-time average, 99th percentile)

Population of affected community	Impact assessment criteria for complex mixtures of odorous air pollutants (OU)
Urban (≥~2000) and/or schools and hospitals	2.0
~500	3.0
~125	4.0
~30	5.0
~10	6.0
Single rural residence (≤~2)	7.0

Source: NSW EPA, 2022

12.3.2.3 GHG emissions – scopes and sources

In the GHG Protocol (WRI, 2004), emissions are categorised into 3 scopes, and each are reported on separately. These scopes are defined in Table 12.5 and provide a means for identifying the ownership and control of emissions sources and thus responsibility for managing the emissions.

Table 12.5 GHG emission scope and sources

Scope	Description
1	Direct GHG emissions that occur from sources owned and/or controlled by the reporting company (i.e., airline or airport operator), including emissions such as from the combustion of fuels in owned/controlled generators including back-up (emergency) systems, fire extinguishers and fleet vehicles and for airlines and freight companies, the aircraft they operate both in the air and on the ground (in the case of an airline company or air freight operator).
2	Indirect emissions from the offsite generation of purchased electricity consumed by the reporting company (i.e., airline or airport operator).
3	All other indirect emissions, which are the consequence of the reporting company's (i.e., airline or airport operator) activities, but occur from sources not owned and/or controlled by the reporting company, including ground transport, third party energy use, third party fleet vehicles, staff commute and business travel, offsite waste/water treatment, and aircraft engine use on the ground (onboard aircraft auxiliary power unit, ground running, taxiing) and in the air (take-off roll, initial climb, final approach and landing roll) within the ICAO defined LTO cycle below 3,000 ft (915 m), etc.

To ensure a consistent approach across each impact assessment presented in this EIS, project-specific criteria have been developed for the assessment of GHG emissions produced in the engine exhaust behind aircraft using WSI’s flight paths and route network as described in Table 12.6.

Table 12.6 Aircraft GHG emissions significance criteria

Impact severity	Description	Other comments
Major	A significant increase in annual GHG emissions representing >1% of Australia’s total annual GHG emissions, or >1% of NSW’s total annual GHG emissions, excluding the Land Use, Land-Use Change and Forestry (LULUCF) sector[1].	Comparison with latest publicly available GHG emissions inventories. Exceedance of these levels assumes negative reputation and media attention globally, affecting the Australian Government’s ability to comply with the Paris Agreement.
High	An increase in annual GHG emissions representing >0.5% but <1% of Australia’s total annual GHG emissions, or >0.5% but <1% of NSW’s total annual GHG emissions, excluding LULUCF.	Comparison with latest publicly available GHG emissions inventories. Exceedance of these levels assumes negative reputation and media attention nationally, affecting the Australian Government’s ability to comply with the Paris Agreement.
Moderate	An increase in annual GHG emissions representing >0.1% but <0.5% of Australia’s total annual GHG emissions, or >0.1% but <0.5% of NSW’s total annual GHG emissions, excluding LULUCF.	Comparison with latest publicly available GHG emissions inventories. Exceedance of these levels assumes negative reputation and media attention state-wide, affecting the NSW Government’s delivery of a net zero economy by 2050.

Impact severity	Description	Other comments
Minor	An increase in annual GHG emissions representing <0.1% of Australia's total annual GHG emissions, or <0.1% of NSW's total annual GHG emissions, excluding LULUCF.	Comparison with latest publicly available GHG emissions inventories. Exceedance of these levels assumes negative reputation and media attention state-wide and locally, affecting local efforts to delivery of a net zero economy by 2050 for Western Sydney.
Negligible	No net annual increase in Australian aviation's share of total annual GHG emissions, or NSW's aviation share of total GHG emissions when measured against 2019 levels (carbon neutral growth).	

1. Accounts for emissions from and removals by human-induced activities in forest lands, croplands, grasslands, wetlands and settlements, including land clearing, timber harvesting, wildfires and prescribed fires (NSW Department of Planning and Environment).

12.3.3 Impact assessment approach

12.3.3.1 Air quality

Separate technical air modelling assessment approaches were undertaken for the local and regional air quality impact assessments. The local air quality impact assessment focused on the potential for air quality impacts to arise in the immediate vicinity of WSI and assess a range of potential air pollutants that would be directly emitted into the air and primarily affect ground-based sensitive receivers. The regional air quality impact assessment focuses on the potential for air pollutants to affect the regional air quality environment in the Sydney Basin, and specifically considers the potential formation of secondary pollutants, in particular ground level O_3. The regional assessment has focussed on any additional formation of O_3 that may arise from the direct emissions of aircraft take-offs and landings.

Local air quality

The local air assessment utilised well established, commonly used modelling methods to calculate the dispersal of air pollutants associated with the project. The assessment followed the NSW EPA guidelines set out in *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA, 2022), and the NSW EPA document *Generic Guidance and Optimum Model Setting for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia'* (TRC Environmental Corporation, 2011).

In summary, the local air quality assessment adopted the following approach:

- generation of meteorological files
- identification and collection of modelling inputs including:
  - aircraft emissions data from the US FAA's AEDT (Version 3e) software to develop emissions profiles of the proposed aircraft operations. AEDT is a software system that models aircraft performance in space and time to estimate fuel consumption, emissions, noise, and air quality effects
  - background ambient air monitoring data and weather conditions
  - nearest sensitive receivers

- a quantitative assessment of the potential impacts associated with the project using CALPUFF air dispersion modelling in accordance with the NSW EPA Approved Methods with estimated emission rates for aircraft including:
  - carbon monoxide (CO)
  - VOCs
  - Total Organic Gases
  - NO_x
  - sulfur oxides
  - PM_{10} and $PM_{2.5}$
- a quantitative assessment of emission estimates generated by the project that arise below 1,000 ft (305 m)
- identifying mitigation measures.

Further details regarding the local air quality modelling methodology is provided in Section 3.1, Chapter 5 and Appendix A of Technical paper 2.

Regional air quality

This assessment has considered NO_2, SO_2, CO, $PM_{2.5}$, PM_{10} and O_3 at ground level within the regional study area.

For the assessment of ozone, the modelling for the regional assessment followed the current NSW EPA guidelines, specifically the *Tiered Procedure for Estimating Ground-Level Ozone Impacts from Stationary Sources* (NSW EPA, 2011). It is noted that this guideline is not strictly applicable to the project as it applies to stationary sources, however it is the only generally suitable O_3 guideline available that is specifically designed for use in NSW.

As noted in Table 12.2, the current impact assessment criteria for O_3 is based on an 8-hour average (which was adopted by the NSW EPA in late 2022 and is based on the NEPM reporting standard that came into force in May 2021) which is considered to be more stringent than the previous one hour and 4-hour average criteria. For completeness, all 3 averaging periods were considered as part of the regional air quality methodology.

Unlike the local air quality assessment, only selected periods of high O_3 impact potential were analysed. This is in accordance with the NSW EPA guidelines. The periods of high O_3 impact potential arise in the warmer seasons, when the conditions are most conducive to the chemical reactions in the atmosphere that form O_3.

The *NSW EPA Air Emissions Inventory* (NSW EPA, 2019) was used to characterise existing sources of air emissions in the Sydney Basin air shed, including biogenic emissions (from plants). The model was run without including the potential new emissions from WSI and compared with the measured data as part of the due diligence or verification of model performance. The verified regional model was then re-run with the WSI emissions included, and the results compared with the base case to determine the effects on air quality that may arise due to the project.

Further details regarding the local air quality modelling methodology is provided in Section 6.1.2 and Appendix B of Technical paper 2.

Modelling limitations

The AEDT model only utilises verified emission performance for existing aircraft. It is likely that more efficient and less polluting aircraft will be developed and become operational in the timeframes considered in this assessment. The model as a result may overestimate likely emissions from aircraft in the future scenarios.

The projections in the *NSW EPA Air Emissions Inventory* do not extend to 2055, and there is a high degree of uncertainty regarding emissions from transport and other sources at that time. For example, it is reasonable to assume a larger proportion of electric vehicles in the NSW fleet by 2055 and that NO_2 contributions from vehicle emissions would reduce. These changes have not been accounted for in this assessment.

Increases in global temperatures may increase ozone reactions in the future, provided there is sufficient NO_x present to sustain these reactions noting that the de-carbonisation of energy and transport sectors will likely limit future fuel combustion. The CSIRO projections (Cope et al., 2008) for 2020–30 do indicate more widespread but not more frequent O_3 impacts, which aligns with O_3 levels measured in 2021. While it is likely that more widespread O_3 impacts may arise in the future, this cannot be known with a high degree of certainty.

12.3.3.2 GHG emissions

Sources of GHG emissions from aircraft occur during all phases of flight. The assessment projected the aircraft engine GHG emissions for:

- the LTO cycle below 3,000 ft (914 m) above ground level (in accordance with the definition in Document 9889, Air Quality Guidance Manual (2020 edition))
- an extended climb and descent cycle below 10,000 ft (3,048 m) above ground level to capture GHG emissions from additional phases of flight as aircraft climb to 10,000 ft or descend from this altitude to their landing threshold
- all one-way flights (departures only) to each destination across WSI's anticipated route network in 2033 and 2055.

Absolute and intensity based GHG emissions from aircraft engine operations for regional, domestic and international RPT and freight services were estimated in each assessment year (2033 and 2055).

The purpose of the assessment was to calculate GHG emissions produced in the engine exhausts behind the aircraft using WSI's flight paths and route network in the early years of operation after opening (in 2033) and when single runway operations approach capacity (in 2055). This assessment focused on the potential impacts of the project itself (flight path impacts from take-off to landing below 10,000 ft (3,048 m) and all flights departing from WSI to each destination airport across its anticipated route network), excluding GHG emissions associated with one-way flights from each origin airport to WSI, aircraft engine use on the ground (taxiing operations or use of the onboard aircraft auxiliary power unit), other airfield operations (engine ground running), and airside ground support equipment and other vehicles required to handle/service an aircraft turnaround. The assessment also excluded the GHG emissions associated with all other landside or terminal activities.

The calculation of aircraft engine GHG emissions primarily comprised 3 main parameters:

1. **Time in mode.** Being the time, usually measured in seconds, that the aircraft engines operate at an identified engine power (thrust) setting in one of flight phases identified in the assessment
2. **Main engine fuel flow.** The unit mass of fuel burned, kilograms of fuel, for a specific engine in each phase of flight identified in the assessment
3. **Main engine emission index.** Represents the units of CO_2-equivalent (CO_2e) emitted per kilogram of fuel burned. Multiplying the mode-specific emission index by the time in mode-specific fuel flow yields a mode-specific CO_2e rate in units of kilograms or tonnes per second.

CO_2e is the term used for describing different GHGs in a common unit. For any quantity and type of GHG, CO_2e signifies the amount of CO_2 which would have the equivalent global warming potential.

The aggregation of GHG emissions was then calculated based on the projected fleet mix and number of flight operations at WSI. Figure 12.4 illustrates the approach to calculate the aircraft engine GHG emissions.

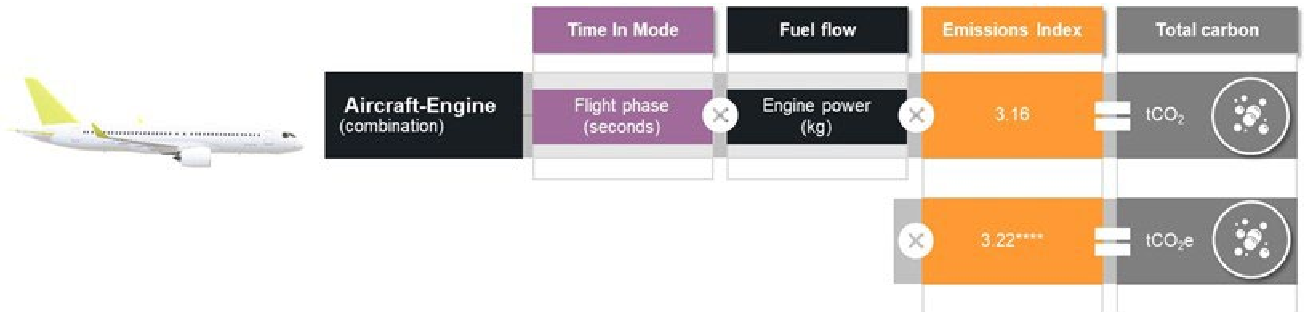


Figure 12.4 Calculation approach for GHG emissions from aircraft main engine use

The following CO_2e emissions scenarios were considered as part of the assessment:

- total GHG emissions for all phases of flight (both arriving and departing) below 3,000 ft (914 m)
- total GHG emissions for all phases of flight (both arriving and departing) below 10,000 ft (3,048 m)
- total GHG emissions (expressed in tonne CO_2e): all projected one-way flights to each destination airport across WSI's anticipated route network (departures only).

Under the United Nations Framework Convention on Climate Change, domestic and international aviation is treated separately. Domestic aviation emissions are counted as part of the targets set at a national and state level in order to comply with the Paris Agreement and the transition to net zero economies by 2050. International aviation emissions are dealt with separately as part of Australia's participation in the ICAO's Carbon Offsetting Scheme for International Aviation (CORSIA). As such, only departing aircraft have been considered to avoid the risk of double counting emissions. However, greenhouse gas emissions from departing international aircraft have been presented alongside domestic aviation emissions to provide a total full flight emissions footprint for all flights departing WSI.

Further details regarding the methodology and assumptions associated with the GHG assessment are provided in Chapter 6 of Technical paper 3.

Section 8.5 of Technical paper 3 presents an assessment of climate change risk to the project. The assessment of climate change risk is used as a key control to identify and manage climate change risk over time and to manage the resilience of WSI operating under these scenarios. The assessment has been informed by climate change projections from the NSW Government, as well as the climate change scenarios published by the IPCC and the Network of Central Banks and Supervisors for Greening the Financial System (NGFS 2022). These projections were based on 4 selected climate-related scenarios that were defined by climate futures based on net zero 1.5°C warming, current trends with 2 to 3°C warming, delayed action with less than 2°C warming and global climate crisis with greater than 4°C warming.

12.3.4 Aircraft emissions and assessment scenarios

The different aircraft expected to be in operation at WSI would generate varying levels of emissions depending on the aircraft manufacturer, the size of the aircraft and the number of available engines, destination to be served, payload and weight, individual pilot techniques and meteorological conditions at the time of flight. Aircraft emissions arise from the operation of the aircraft engines and the rate of emissions are governed by the engine power (thrust) settings during the different phases of flight in the LTO cycle below an altitude of 3,000 ft (914 m). These phase of flight include:

- Taxi/idle mode – the taxiing and idling operations of arriving and departing aircraft on the ground
- Take-off mode – the period between commencement of acceleration on the runway and the aircraft reaching a height of 656 ft (200 m)
- Climb-out mode – period between 656 ft (200 m) and 3,000 ft (914 m) above ground level, and
- Approach mode – period between 3,000 ft (914 m) to ground level for arrivals.

12.3.4.1 Assessment scenarios

The assessment scenarios used for the assessment of emissions impacts (for air quality) were the same as those utilised for the noise impact assessment, comprising a total of 7 overall modes of operation (refer to Section 11.5.6.1 and Table 11.4 of Chapter 11 (Aircraft noise)). Similar to the noise assessment, the air quality modelling focused on 3 modes of operation comprising:

- **No preference** – No preference to Runway 05 or Runway 23. Aircraft emissions from flight path use in this scenario were considered only for 2033. This scenario was considered to be comparable with the previous 2016 EIS and was used to assess relative differences arising from the application of current aircraft fleet emissions to 50/50 runway split scenario of the 2016 EIS.
- **Prefer Runway 05** – Preference to the operation of Runway 05 (day) and preference to RRO (night). Aircraft emissions from flight path use under this scenario was considered for both 2033 and 2055 in the assessment.

- **Prefer Runway 23** – Preference to the operation of Runway 23 (day) and preference to RRO (night). Aircraft emissions from flight path use under this scenario was considered for both 2033 and 2055 in the assessment.

Their reasons for selection of these 3 scenarios were similar to those for the noise assessment being:

- where no preference was given to a runway mode, runway use is balanced in terms of runway use and runway-end exposure. This indicated that both runway ends are exposed to a similar proportion of arrivals and departures on an annualised basis
- the outer bounds of runway usage (and by implication the extents of the emissions exposure) is defined by Prefer Runway 23 (82 per cent on Runway 23) and Prefer Runway 05 (74 per cent on Runway 05). However, both runway ends would experience a balanced exposure based on total movements. This indicated that these scenarios would primarily vary in terms of the type of operation (arrival or departure), not in terms of total movements
- Prefer Runway 05 and Prefer Runway 23 introduce the RRO mode of operation during the night time (11 pm to 5:30 am) – arrivals on Runway 05 and departures on Runway 23
- all possible scenarios fell somewhere between the outer bounds in terms of runway use.

Only the more impacting scenarios from 2033 were selected for assessment in 2055 (i.e., the no preference scenario was not assessed in 2055).

12.4 Existing environment

12.4.1 Climatic and meteorological conditions

Long term climatic data collected at the Bureau of Meteorology weather station at Badgerys Creek Automatic Weather Station (Station Number 067108) were analysed to characterise the local climate in the proximity of the project. In summary, the weather data indicated that:

- January is the hottest month with a mean maximum temperature of 30.2 degrees Celsius and July is the coldest month with a mean minimum temperature of 4.1 degrees Celsius
- rainfall is higher during the first half of the year, with an annual average rainfall of 675 mm over 69.2 days, with March being the wettest month and July the driest
- for the period reviewed, winds are varied and predominantly occur from the southwest and the west-southwest and are typically influenced by the topography of the Sydney Basin.

Further detail regarding the existing climatic conditions is presented in Section 4.2 and 4.3 of Technical paper 2.

12.4.2 Ambient air quality

Background air quality levels from local DPE monitoring stations at Bringelly, St Marys and Camden were used to represent the background levels surrounding WSI (providing monitoring data between 2014 and 2021). The main sources of air pollutants in the wider area surrounding WSI include industrial and commercial operations and local anthropogenic activities such as wood heaters and motor vehicle exhaust. Historically, adverse air quality conditions arise from time to time due to extraordinary events such as dust storms and bushfires.

In general, the background levels indicate:

- the annual average PM_{10} concentrations for all monitoring stations reviewed across the monitoring period were below the relevant NSW EPA criterion of 25 µg/m³. Identified periods of elevated PM_{10} levels typically corresponded with regional dust events and bushfires, particularly evident in 2019/2020
- annual average $PM_{2.5}$ concentrations for all monitoring stations across the monitoring period reviewed were below the relevant NSW EPA criterion of 8µg/m³ except for all monitors in 2019 and the Bringelly monitor in 2020. The likely cause of the elevated annual levels at the monitors are attributed to bushfire events, wood smoke from domestic wood heaters and automobile exhaust

- the annual average NO_2 concentrations for all monitoring stations across the monitoring period reviewed were below the relevant NSW EPA criterion of 62 µg/m³
- the annual average SO_2 concentrations for the Bringelly monitoring station was below the NSW EPA criterion of 60 µg/m³
- the maximum 1-hour average CO concentrations for all monitors during the review period are well below the NSW EPA criterion
- there were 5 days in 2021 with O_3 levels recorded over the 8-hour O_3 standard at one or more stations within NSW.

Background air quality levels from the nearby DPE monitoring stations were used to represent the background levels surrounding WSI. Table 12.7 presents a summary of the applied background levels.

Table 12.7 Summary of background air quality levels

Pollutant	Averaging period	Background level	Source
$PM_{2.5}$	24-hours	21 µg/m³	Maximum value below the criterion of 25 µg/m³ recorded at the Bringelly monitor for 2020, excluding exceptional event days (NSW DPIE, 2021).
	Annual	7.6 µg/m³	Average level recorded at Bringelly monitor for 2017, 2018 and 2021. These years are not affected by significant bushfire events.
PM_{10}	24-hours	43.5 µg/m³	Maximum value below the criterion of 50 µg/m³ recorded at the Bringelly monitor for 2020, excluding exceptional event days (NSW DPIE, 2021).
	Annual	18.8 µg/m³	Annual average Bringelly monitor for 2020.
NO_2	1-hour	OLM Method [1]	NO_2 and O_3 data from Bringelly monitor for 2020 applied.
	Annual	OLM Method	NO_2 and O_3 data from Bringelly monitor for 2020 applied.
SO_2	1-hour	80 µg/m³	Maximum value recorded at the Bringelly monitor for 2020.
	24-hours	10.3 µg/m³	Maximum value recorded at the Bringelly monitor for 2020.
CO	1-hour	6,125 µg/m³	Maximum value recorded at the Camden monitor for 2020.

1. The USEPA's Ozone Limiting Method (OLM) may be used to predict ground-level concentrations of NO_2. This method assumes that all the available O_3 in the atmosphere will react with NO in the plume until either all the O_3 or all the NO is used up. This approach assumes that the atmospheric reaction is instant. In reality, the reaction takes place over a number of hours. (NSW EPA, 2022)

12.4.3 GHG emissions

GHGs are gases that trap heat in the atmosphere, with key contributors including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases. Water vapor is also a product of jet fuel consumption, making up about 30 per cent of the exhaust. The presence of water vapour in the exhaust plume from an aircraft has an indirect impact by contributing to the formation of contrails.

For a single, comparable value of GHG emissions, the total emissions of all emitted gases are converted to CO_2e. The combustion or burning of jet fuel (kerosene) emits various gases and particles referred to as GHGs. CO_2 is the largest component of aircraft engine GHG emissions, accounting for approximately 70 per cent of the engine exhaust. The amount of GHG emitted from aircraft engine use is directly related to the amount of fuel consumed.

12.5 Assessment of impacts

12.5.1 Air quality

12.5.1.1 Local air quality

The dispersion modelling predictions for each assessed scenario (refer to Section 12.3.4.1) in the local air quality assessment are summarised in this section. The results presented include those for:

- the project in isolation (incremental impact)
- the project with other approved sources (i.e., the ground-based operations approved in 2016) and background levels (cumulative impact).

No exceedances were identified for the 2033 scenario, with only minor exceedances identified for the 2055 scenario. The results indicate the project would not result in any tangible or significant impacts above the applicable criteria, noting that the recent, more stringent NSW EPA air quality criteria were applied to the assessment.

A summary of the results and discussion of the significance of the potential impacts is described in the following sections. This presents the maximum contribution from the project at an assessed residential receiver location (that is, the most impacted receiver). Further detailed assessment and modelling predictions, including the maximum contribution at other assessed receiver locations, are presented in Section 6.1 of Technical paper 2.

Particulate matter concentrations

Table 12.8 presents a summary of the predicted cumulative $PM_{2.5}$ concentrations for the project for 2033 and 2055. It is assumed that 100 per cent of the PM_{10} is assumed to be in the $PM_{2.5}$ size fraction, hence the PM_{10} and $PM_{2.5}$ incremental values are the same.

Predicted cumulative $PM_{2.5}$ concentrations for 2033 at the most impacted assessed receiver location indicates the predicted cumulative 24-hour average and annual average levels would be below all relevant criteria and the project would only make a small air quality contribution to the assessed receiver locations.

The predicted cumulative $PM_{2.5}$ annual average concentrations for 2055 at the most impacted receiver have been identified to be above the relevant criteria (refer to shaded boxes). This is primarily due to the assumed future background levels which are set at the current background levels and are already near to the criterion. The maximum annual average contribution of 0.32 µg/m^3 represents the effect of all flight activity associated with project.

The results indicate the effect of the project on annual average $PM_{2.5}$ is very small and would not result in any tangible effect on air quality.

Table 12.8 Summary of cumulative $PM_{2.5}$ concentrations (µg/m³)

	24-hour average					Annual average				
	2033 Scenarios			2055 Scenarios		2033 Scenarios			2055 Scenarios	
	No preference	Prefer Runway 05	Prefer Runway 23	Prefer Runway 05	Prefer Runway 23	No preference	Prefer Runway 05	Prefer Runway 23	Prefer Runway 05	Prefer Runway 23
Background level	21	21	21	21	21	7.6	7.6	7.6	7.6	7.6
Maximum value[1]	0.45	0.52	0.61	1.28	1.42	0.09	0.11	0.13	0.29	0.32
Estimated contribution from ground-based WSI operations	0.44	1.06	1.06	2.22	2.22	0.11	0.11	0.11	0.33	0.33
Cumulative level	21.9	22.6	22.7	24.5	24.6	7.8	7.8	7.8	**8.2**	**8.3**
Criterion	*25*	*25*	*25*	*25*	*25*	*8*	*8*	*8*	*8*	*8*

1. The maximum contribution from the project at the most impacted residential receiver

Table 12.9 presents a summary of the predicted cumulative PM_{10} concentrations for both 2033 and 2055. The results indicate the predicted cumulative 24-hour average and annual average levels would be below all relevant criteria for both average periods during both reference years.

Table 12.9 Summary of cumulative PM_{10} concentrations (µg/m³)

	24-hour average					Annual average				
	2033 Scenarios			2055 Scenarios		2033 Scenarios			2055 Scenarios	
	No preference	Prefer Runway 05	Prefer Runway 23	Prefer Runway 05	Prefer Runway 23	No preference	Prefer Runway 05	Prefer Runway 23	Prefer Runway 05	Prefer Runway 23
Background level	43.5	43.5	43.5	43.5	43.5	18.8	18.8	18.8	18.8	18.8
Maximum value[1]	0.45	0.52	0.61	1.28	1.42	0.09	0.11	0.13	0.29	0.32
Estimated contribution from ground-based WSI operations	0.51	1.13	1.13	4.18	4.18	0.11	0.11	0.11	0.63	0.63
Cumulative level	44.5	45.2	45.2	49.0	49.1	19.0	19.0	19.0	19.7	19.8
Criterion	*50*	*50*	*50*	*50*	*50*	*25*	*25*	*25*	*25*	*25*

1. The maximum contribution from the project at the most impacted residential receiver

NO_2 concentrations

Table 12.10 presents a summary of the predicted cumulative NO_2 concentrations for the project for both 2033 and 2055. The results indicate predicted cumulative 1-hour average and annual average levels would be below the relevant criterion in 2033. For 2055, the results indicate predicted cumulative 1-hour average levels would be above the relevant criterion of 164 µg/m³ at some receiver locations near the northern boundary and north-west of the WSI (refer to shaded boxes) and the annual average levels would be below the relevant criterion.

Table 12.10 Summary of cumulative NO_2 concentrations (µg/m³)

	1-hour average					Annual average				
	2033 Scenarios			2055 Scenarios		2033 Scenarios			2055 Scenarios	
	No preference	Prefer Runway 05	Prefer Runway 23	Prefer Runway 05	Prefer Runway 23	No preference	Prefer Runway 05	Prefer Runway 23	Prefer Runway 05	Prefer Runway 23
Maximum value[1]	113.8	112.1	112.9	185.3	238.1	10.9	12.1	12.8	19.8	21.0
Estimated contribution from ground-based WSI operations	8.2	8.2	8.2	16.1	16.1	1.5	1.5	1.5	3.6	2.9
Cumulative level	121.9	120.3	121.0	**201.5**	**254.2**	12.3	13.5	14.3	23.4	23.9
Criterion	*164.0*	*164.0*	*164.0*	*164.0*	*164.0*	*31.0*	*31.0*	*31.0*	*31.0*	*31.0*

1. The maximum contribution from the project at the most impacted residential receiver

The elevated NO_2 levels are predicted to occur in the 2055 year as the single runway approaches capacity for the Prefer Runway 05 and Prefer Runway 23 scenarios. A key contributor to the elevated NO_2 levels in 2055 would be to the higher NO_X emissions associated with the aircraft operating at WSI during this year. The predicted levels of NO_2 are likely to be conservative (i.e., an overestimate of the like potential impacts) due to the following factors:

- the modelling used the more conservative Ozone Limiting Method approach for chemical transformations to predict the NO_2 levels
- the modelling assumed the worst case scenario for every hour of the year (which in reality may not occur in the predicted hour of maximum impact)
- the predicted impacts are infrequent, arising for only a few hours out of 8,760 hours in a year
- the modelling did not account for any improvement in fuel or engine emission control which may occur in the future.

The combination of the above factors means these predicted impacts are unlikely to actually occur. As the predicted results are likely to be conservative and it is likely there would be improvements in fuel efficiency (for aircraft and motor vehicles) and decreases in aircraft emissions in the future, it is reasonable to conclude that no significant impacts would arise.

Isopleth diagrams of the modelling predictions showing the predicted maximum 1-hour average NO_2 concentrations for Prefer Runway 05 and Prefer Runway 23 scenario in 2055 are shown as Figure 12.5 and Figure 12.6. The modelling predictions indicate elevated levels would primarily occur to the north-west of the Airport Site aligning with the length of the runway. The intensification of residential receivers in this location would be limited as the land has been zoned for Agribusiness and the area largely corresponds to land within the ANEC 20 contour and above. As outlined in Chapter 14 (Land use), new residential development and other noise sensitive developments are prohibited on land within the ANEC 20 contour, except in limited circumstances.

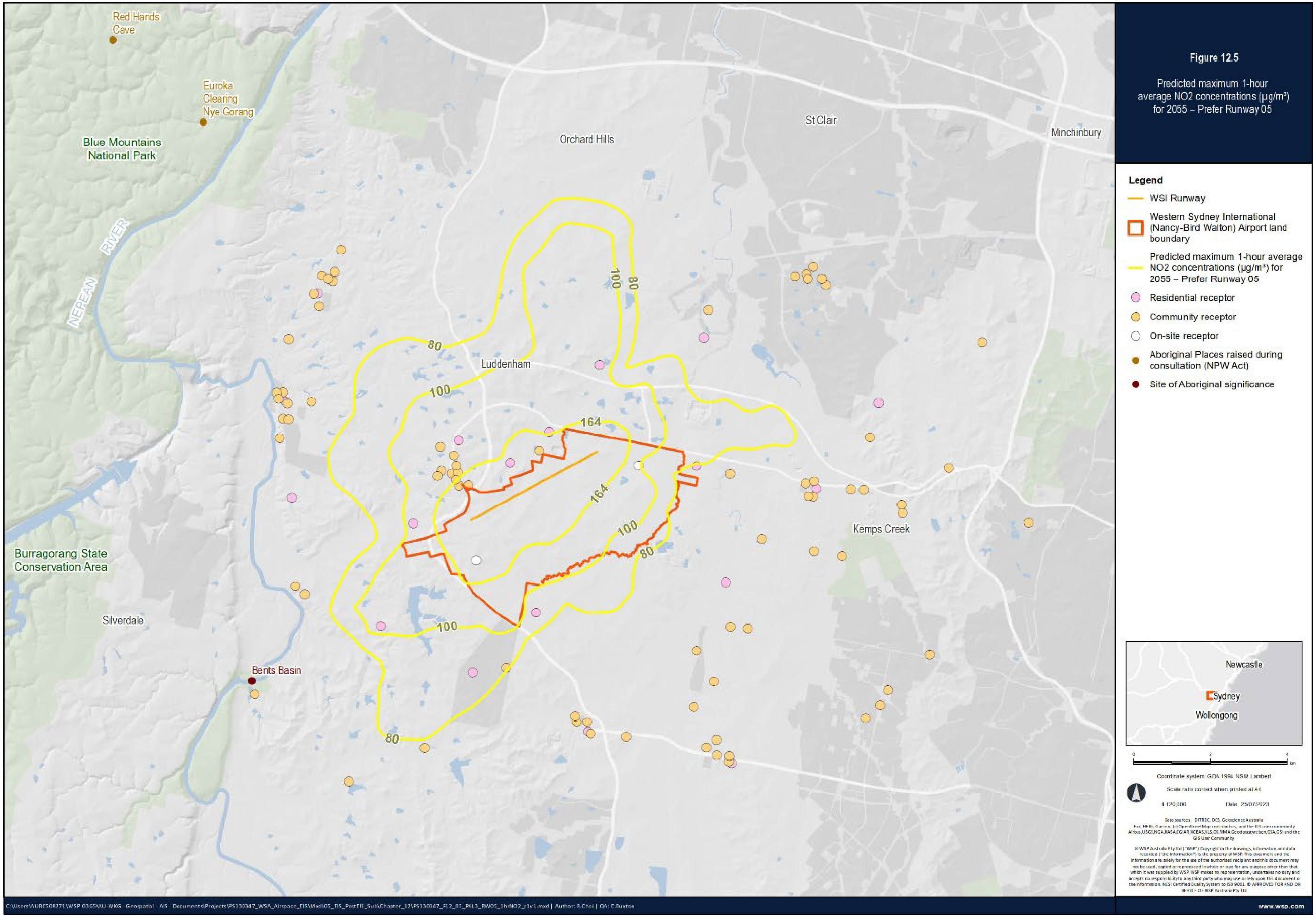


Figure 12.5

Predicted maximum 1-hour average NO2 concentrations (µg/m³) for 2055 – Prefer Runway 05

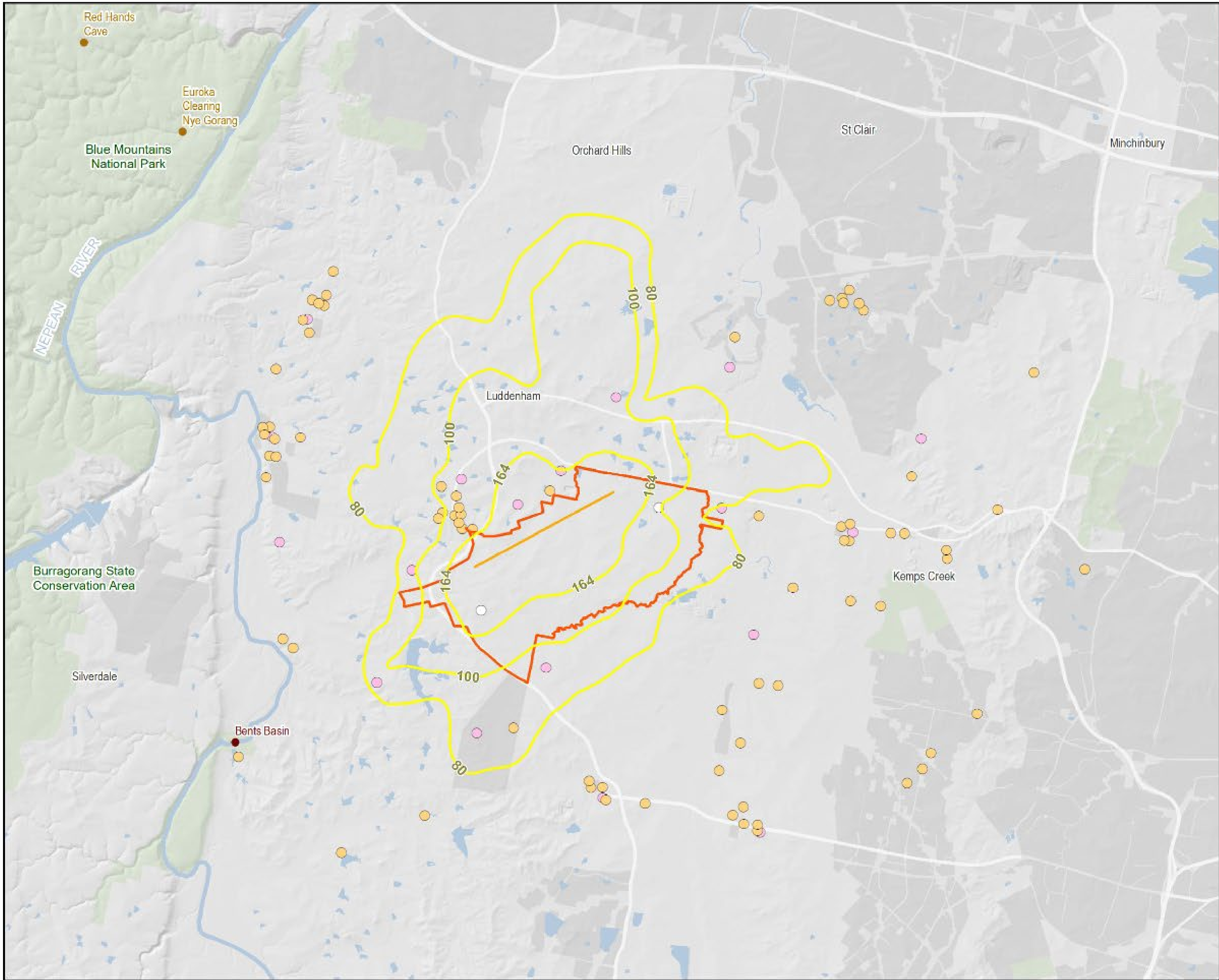


Figure 12.6

Predicted maximum 1-hour average NO2 concentrations (µg/m³) for 2055 – Prefer Runway 23

Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- Predicted maximum 1-hour average NO2 concentrations (µg/m³) for 2055 – Prefer Runway 23
- Residential receptor
- Community receptor
- On-site receptor
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

0 2 4 km

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:120,000 Date: 25/07/2023

SO_2 concentrations

Table 12.11 presents a summary of the predicted cumulative SO_2 concentrations for 2033 and 2055 in brackets. The results indicate predicted cumulative 1-hour average and 24-hour average levels are below the relevant criterion in 2033.

Table 12.11 Summary of cumulative SO_2 concentrations (µg/m³) – 2033 and (2055)

	1-hour average			24-hour average		
	No preference	Prefer Runway 05	Prefer Runway 23	No preference	Prefer Runway 05	Prefer Runway 23
Background level	80.0	80.0	80.0	10.3	10.3	10.3
Maximum value[1]	41.4	33.5 (101.3)	43.4 (116)	5.2	5.5 (15.9)	6.0 (18)
Estimated contribution from ground-based WSI operations	5.8	5.8	5.8	0.4	0.4	0.4
Cumulative level	127.2	119.4	129.2	15.9	16.1	16.7
Criterion	*286.0*	*286.0*	*286.0*	*57.0*	*57.0*	*57.0*

1. The maximum contribution from the project at the most impacted residential receiver

CO concentrations

Table 12.12 presents a summary of the predicted cumulative CO concentrations for 2033 and 2055 in brackets. The results indicate predicted cumulative 15-minute average and 1-hour average levels are below the relevant criterion in 2033.

Table 12.12 Summary of cumulative CO concentrations (µg/m³) – 2033 and (2055)

	15-minute average			1-hour average		
	No preference	Prefer Runway 05	Prefer Runway 23	No preference	Prefer Runway 05	Prefer Runway 23
Background level	–	–	–	6,125	6,125	6,125
Maximum value[1]	512.7	512.7 (1,343)	539.3 (1,360)	388.6	388.6 (1,018)	408.7 (1,031)
Estimated contribution from ground-based WSI operations	839.5	839.5	839.5	620.5	620.5	620.5
Cumulative level	1,352	1,352	1,379	7,134	7,134	7,154
Criterion	*100,000*	*100,000*	*100,000*	*30,000*	*30,000*	*30,000*

1. The maximum contribution from the project at the most impacted residential receiver

VOC and odour concentrations

The predicted VOC concentrations for the project, including concentrations of benzene, formaldehyde, toluene and xylene were all predicted to be below the acceptable criteria for all considered receivers. The results indicate predicted 1-hour average levels are below the relevant criterion in both 2033 and 2055. The odorous air pollutants are below the relevant criterion which indicates the odour would be acceptable.

Assessment of deposited matter

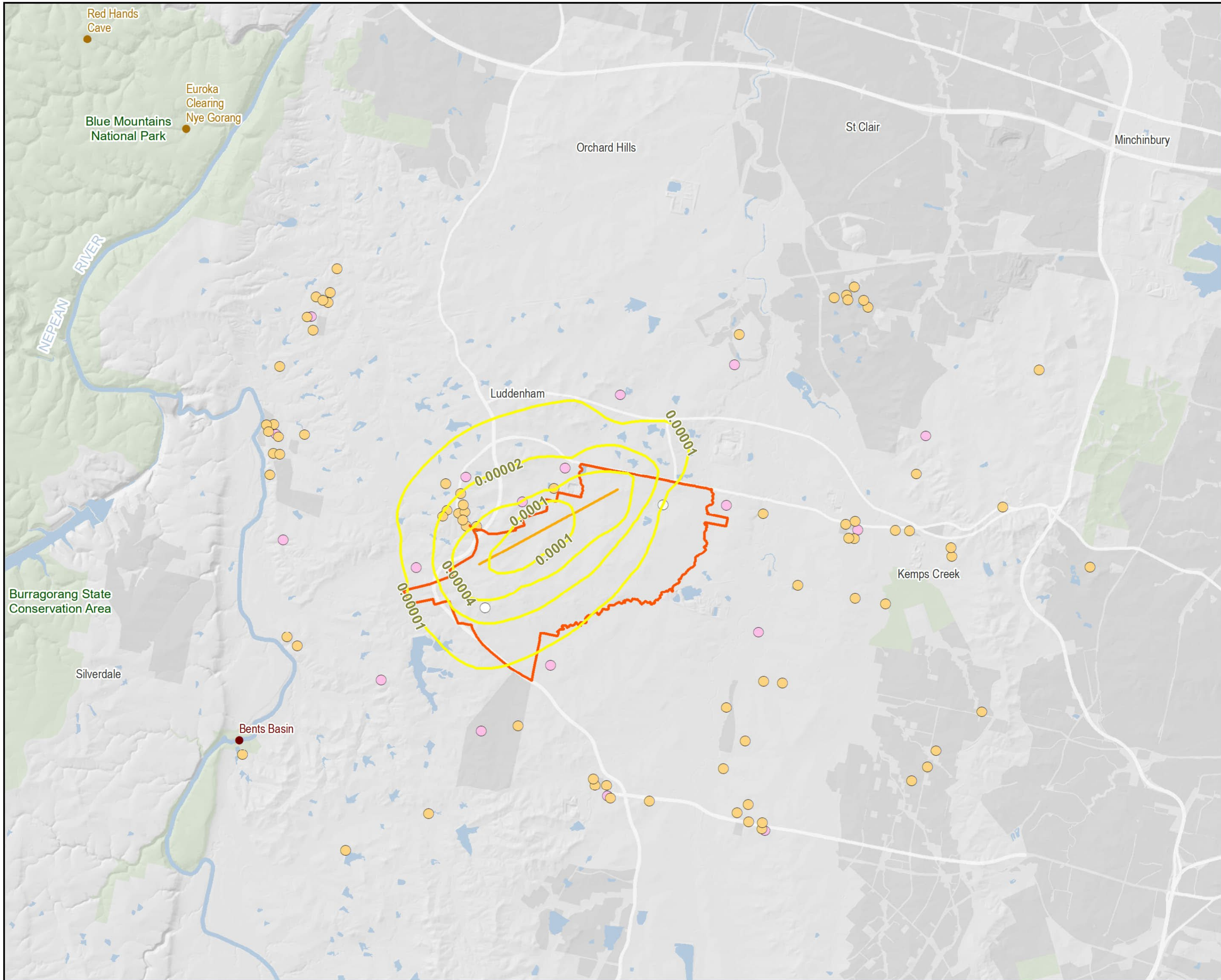
The predicted incremental deposited matter concentrations for the project in Prefer Runway 05 and Prefer Runway 23 scenarios during 2055 are presented as isopleths in Figure 12.7 and Figure 12.8, respectively. The levels due to the project range from 0.0001 to 0.00001 g/m²/month and are considered to be too low to be measurable or detectable.

Based on the total particulate matter emissions predicted for 2055, a dilution ratio was estimated and applied to other modelled pollutants (noting that the other modelled pollutants are gaseous, and no tangible deposition is likely, thereby representing a very large overestimate of potential surface deposition of these other pollutants). Despite this overestimation, the predicted likely maximum rates of deposition are very small and insignificant, with:

- 0.006 g/m²/month for CO
- 0.02 g/m²/month for NO_X
- 0.001 g/m²/month for SO_X.

Figure 12.7

Predicted incremental annual average deposited particulate matter concentrations from the project (g/m²/month) for 2055 – Prefer Runway 05



Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- Predicted incremental annual average deposited particulate matter concentrations from the project (g/m²/month) for 2055 – Prefer Runway 05
- Residential receptor
- Community receptor
- On-site receptor
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

0 2 4 km

Coordinate system: GDA 1994 NSW Lambert

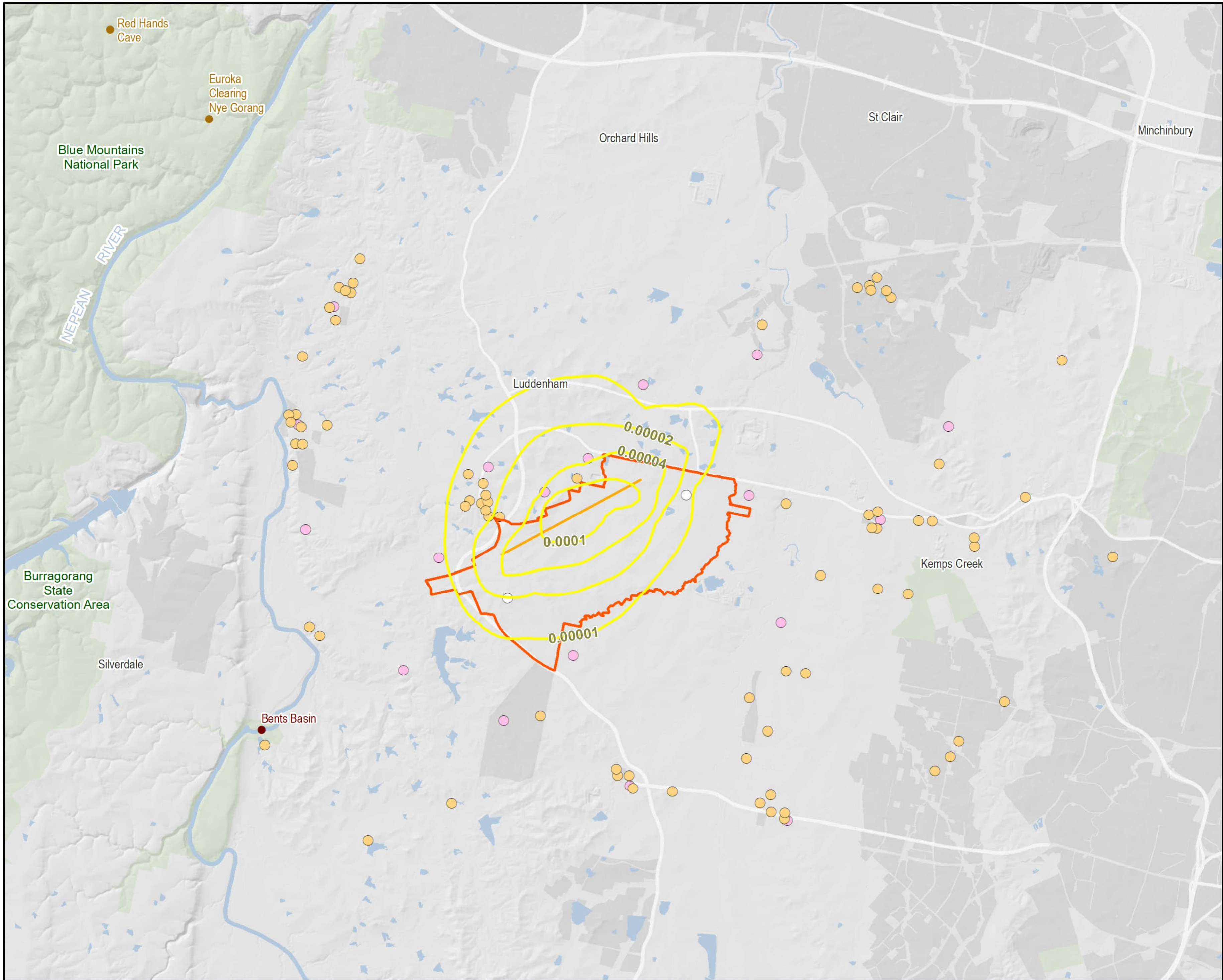
Scale ratio correct when printed at A4

1:120,000 Date: 25/07/2023

Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

Figure 12.8

Predicted incremental annual average deposited particulate matterconcentrations from the project (g/m²/month) for 2055 – Prefer Runway 23



Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- Predicted incremental annual average deposited particulate matter concentrations from the project (g/m²/month) for 2055 – Prefer Runway 23
- Residential receptor
- Community receptor
- On-site receptor
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:120,000 Date: 25/07/2023

Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

12.5.1.2 Regional air quality

The regional air quality assessment considered the results for the following modelled emission scenarios which were compared to an identified baseline level (i.e., existing emissions from all pollution sources across the Sydney Basin without the project) (refer to Section 6.2 of Technical paper 2) in order to determine the potential impacts of the project:

- 2033 – No Preference and Prefer Runway 05
- 2055 – Prefer Runway 05.

Maximum pollutant contours for O_3 (1-hour, 4-hour and 8-hour average), NO_2, SO_2, CO, $PM_{2.5}$ and PM_{10} for all assessed scenarios compared with the baseline are presented in Appendix D of Technical paper 2.

NO_2 concentrations

Figure 12.9 and Figure 12.10 presents the maximum 1-hour average NO_2 concentrations for the assessed 2033 and 2055 scenarios compared to the baseline scenario.

In 2033, the predicted emissions originating from the project would result in an increase in NO_2 concentrations in the vicinity of WSI. In 2033, the results of the No preference and Prefer Runway 05 scenarios are very similar which indicate that the runway mode of operation does not have any significant effect on the ground level concentrations. However, the choice of runway would ultimately concentrate emissions at one end of the runway or the other, and in certain prevailing wind conditions this could lead to slightly higher concentrations of pollutants in one area compared to another scenario. This effect however is highly localised and would not have significant bearing on the regional air quality.

Increases in NO_2 would generally be limited to a radius of around 5 to 6 km from WSI. This indicates that the contribution to ground level concentrations from the project is primarily due to aircraft near or at ground level during take-off and landing. Emissions released higher than a few hundred metres above ground level do not appear to have any significant influence on ground level concentrations.

In 2055, the assessment indicates emissions originating from the project would result in an increase in NO_2 concentrations in the vicinity of WSI. The assessment indicates that NO_2 concentrations are predicted to be above the criterion (0.08 ppm) adjacent to the runway, just outside the north-western section of WSI. This aligns with the local air quality modelling results (refer to Section 12.5.1.1) which show a similar scale of impact for NO_2.

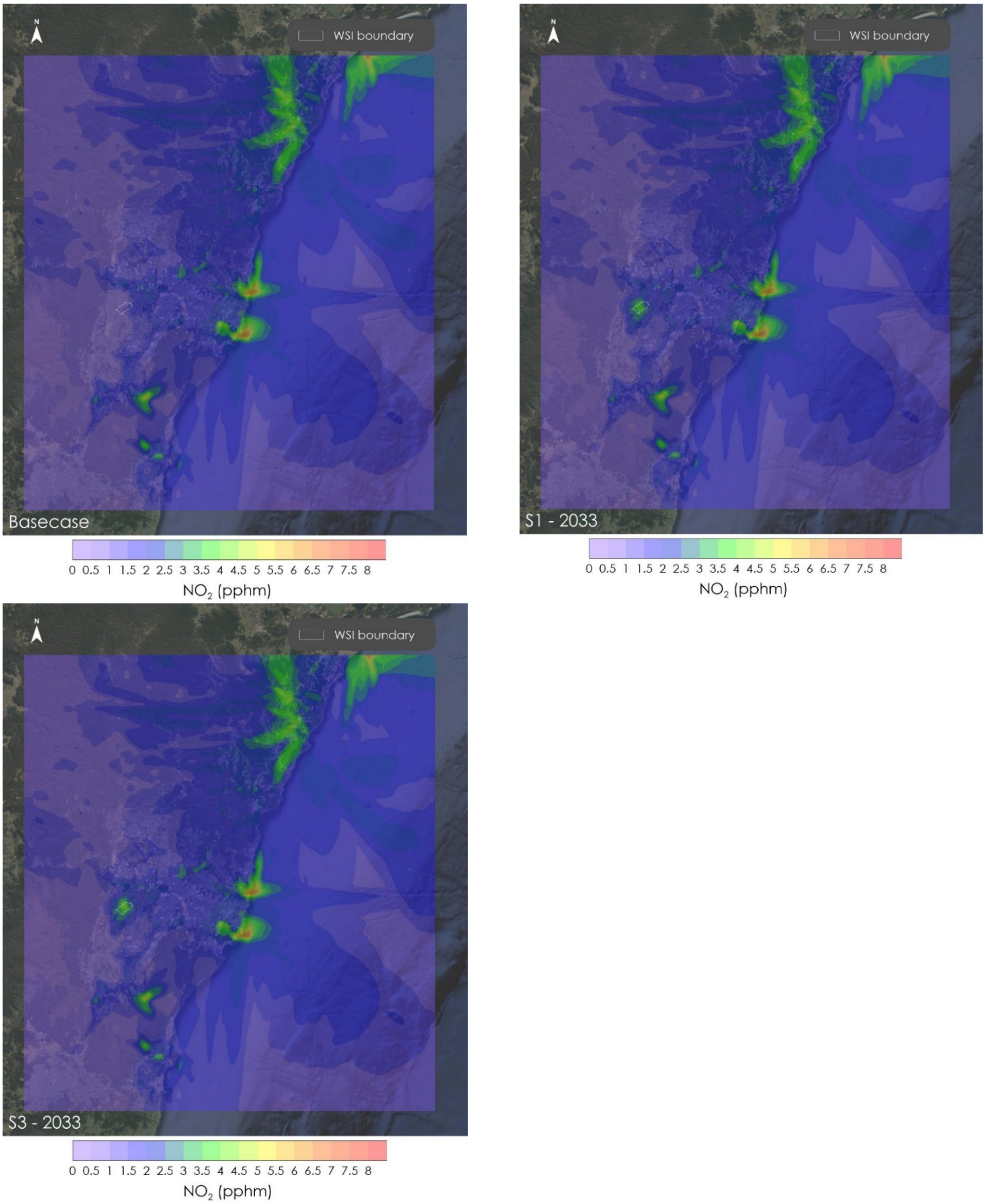


Figure 12.9 Maximum predicted 1-hour NO_2 concentrations for base case (without project) (top left), No preference (top right) and Prefer Runway 05 scenarios (bottom left) – 2033

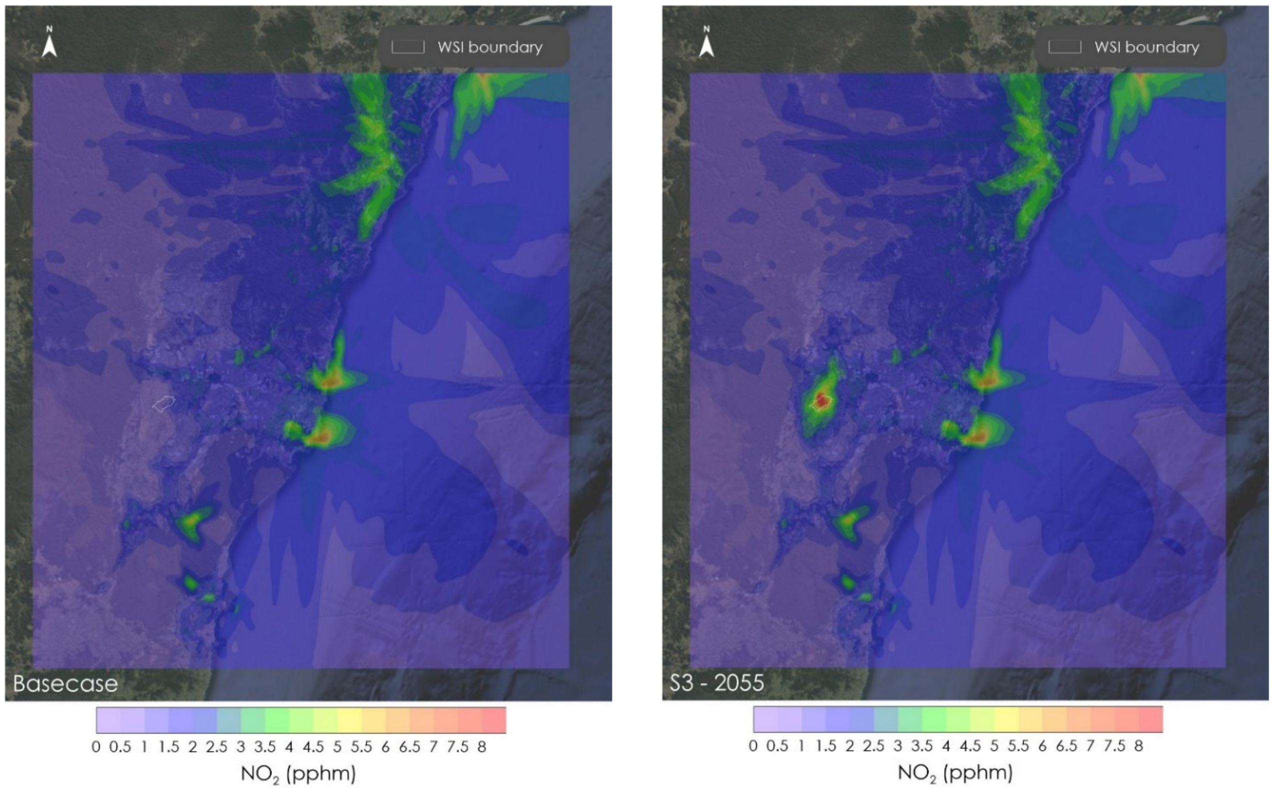


Figure 12.10 Maximum predicted 1-hour NO_2 concentrations for base case (without project) (left) and Prefer Runway 05 scenario (right) – 2055

O_3 concentrations

The assessment has considered the maximum O_3 concentration and change in O_3 concentrations due to the project for the modelled high O_3 period.

The results show that:

- in the locations where the maximum total O_3 concentration occurs, the project makes no significant difference to O_3 concentrations. The maximum change predicted with the project at these locations are:
  - in 2033, 0.1 parts per hundred million (pphm) for the maximum 4-hour and 8-hour averaging periods and 0.0 pphm for the maximum 1-hour average period in 2033
  - in 2055, up to 0.2 pphm for the 4-hour and 8-hour averaging periods, and 0.0 pphm for the maximum 1-hour average period
- on days where the maximum 8-hour average criterion is exceeded (6.5 pphm), the maximum change predicted with the project is 0.00 pphm in 2033 and 0.01 pphm in 2055
- in the locations where the maximum change occurs with the project (i.e., locations away from where the maximum total O_3 concentrations occur), the project would not result in the exceedance of the maximum 8-hour average criterion. The maximum change predicted with the project at these locations are:
  - in 2033, 0.4, 0.2 and 0.2 pphm for the 1-hour, 4-hour and 8-hour averaging periods, respectively
  - in 2055, 0.8, 0.6 and 0.6 pphm for the 1-hour, 4-hour and 8-hour averaging periods, respectively.

Other pollutants

For all other pollutants in 2033 and 2055, the impact of emissions from the project on the existing pollutant concentrations would be negligible and would be unlikely to be discernible above background concentrations.

12.5.2 GHG emissions

Aircraft engines produce GHG emissions with a significant proportion emitted at higher altitudes in the cruise phase of flight. They occur during all phases of flight and can alter the atmospheric concentration of GHGs, creating condensation trails (or contrails – temporary white, cloud-like plumes composed of ice crystals formed in aircraft engine exhaust) and cause cirrus clouds to form (on occasions) all of which contribute to climate change.

The following sections provide a summary of the assessment of potential aircraft engine GHG emissions from the project. All projections of aircraft engine CO_2e emissions do not account for future aircraft fuel and operational efficiency improvements, new aircraft and propulsion technologies or use of SAF.

12.5.2.1 LTO cycle emissions below 3,000 ft (914 m)

Table 12.13 presents the estimated GHG emissions footprint in the LTO cycle (phases of flight below 3,000 ft (around 914 m) exclusive of taxi operations on the ground) from aircraft movements projected in 2033 and 2055.

The projected total LTO cycle emissions of CO_2e from the approximate 81,190 aircraft movements forecast in 2033 is around 63,813 tonnes of CO_2e at an estimated intensity of 0.79 tCO_2e per air traffic movement. This correlates approximately to the LTO cycle emissions reported at Adelaide Airport in 2019. The passenger throughput, operations and aircraft movements at Adelaide Airport are within a similar range with future operations at WSI in 2033.

In 2055, total LTO cycle emissions of CO_2e are projected to increase to 220,331 tonnes CO_2e at an estimated intensity of 0.97 tCO_2e per air traffic movement). Air traffic movements are projected to increase by 146,309 aircraft movements (from 81,990 in 2033 to 227,499 in 2055) as WSI's single runway approaches capacity. Over 47 per cent of these flights are expected to operate services on international routes mostly by higher fuel consuming wide-body jets.

The initial climb-out phase of flight is responsible for more than 40 per cent of LTO cycle emissions in 2033 and 2055. This is because aircraft are at their heaviest at this point in the take-off cycle and need to be configured under a high level of engine power (thrust) to create the lift required to get airborne.

Table 12.13 LTO cycle emissions of CO_2e below 3,000 ft (914 m) – all WSI projected aircraft movements in 2033 and 2055

Flight phase	2033 (tCO_2e)	Percentage	2055 (tCO_2e)	Percentage
Take-off roll	18,200	28%	64,974	29%
Initial climb-out	27,989	44%	98,172	45%
Approach	15,115	24%	49,859	23%
Landing roll	2,508	4%	7,326	3%
Total	**63,813**	**100%**	**220,331**	**100%**

The results of the LTO cycle emissions calculations for the project indicate the following:

- emissions of CO_2e in 2055 are projected to grow significantly by 156,518 tonnes when compared to 2033. This is primarily driven by the growth in international flights at WSI
- emissions of CO_2e from domestic flights are projected to more than double by 2055, emitting around 66,834 tonnes of additional CO_2e compared to 2033 levels of 32,581 tonnes
- growth in international flights by 2055 was projected to increase by around 81,000 movements from 2033 (around 26,000 movements), accounting for around 47 per cent of all flight movements and almost 70 per cent of total emissions of CO_2e at 153,497 tonnes.

In 2019, the LTO cycle emissions reported at Sydney (Kingsford Smith) Airport were 431,445 tonnes of CO_2e, from 333,862 flights (or 1.29 tCO_2e per air traffic movement) carrying more than 44 million passengers (SAAH, 2022). By comparison, the estimated LTO cycle emissions from aircraft departing or arriving at WSI are anticipated to be significantly lower in absolute and intensity based CO_2e emissions for both 2033 and 2055.

12.5.2.2 Extended climb and descent cycle emissions below 10,000 ft (3,048 m)

Table 12.14 presents the estimated GHG emissions footprint in the extended climb and descent cycle below 10,000 ft (around 3,048 m) (exclusive of taxi operations on the ground) from aircraft movements projected in 2033 and 2055.

Table 12.14 Extended climb and descent cycle emissions of CO_2e below 10,000 ft (3,048 m) – all WSI projected aircraft movements in 2033 and 2055

Flight phase	2033 (tCO_2e)	Percentage	2055 (tCO_2e)	Percentage
Take-off roll	18,200	14%	64,974	15%
Initial climb-out	27,989	22%	98,172	22%
Extended climb	54,079	42%	190,012	43%
Descent from 10,000 feet	26,002	20%	81,451	18%
Landing roll	2,508	2%	7,326	2%
Total	**128,778**	**100%**	**441,935**	**100%**

The projected total emissions of CO_2e from all phases of flight in the extended climb and descent cycle below 10,000 ft (3,048 m) in 2033 are estimated to be around 128,778 tonnes of CO_2e from 81,190 flights. In 2055, these emissions of CO_2e are estimated to increase to approximately 441,935 tonnes CO_2e from more than 227,000 flights. On a flight intensity basis, this equates to an increase of around 0.3 tCO_2e per air traffic movement or 19 per cent above when comparing 2033 levels of around 1.6 tCO_2e per air traffic movement to 2055 levels of around 1.9 tCO_2e per air traffic movement.

12.5.2.3 Full flight emissions

In 2033, one-way flights (departures) to all 48 destination airports across WSI's anticipated route network are predicted to emit around 1.8 million tonnes of CO_2e (in total) from the point of departure to arrival. Almost half of WSI's air traffic movements are expected to be short haul flights operating on routes of less than around 500 nm (926 km). These flights were however only predicted to account for around 13 per cent of total emissions of CO_2e (approximately 0.42 million tonnes of CO_2e). Conversely, long haul flights operating to destinations over 4,000 nm (around 7,400 km), are predicted to represent around 10 per cent of total flights but account for 39 per cent of total emissions of CO_2e (approximately 0.70 million tonnes of CO_2e).

Figure 12.11 shows the full flight emissions of CO_2e estimated for all 40,595 flights departing from WSI to the 48 destination airports across the anticipated 2033 route network. The top 5 carbon emitting routes comprised operations by one domestic and 4 international RPT services (representing around 30 per cent of total departure movements in 2033) and accounted for 0.56 million tonnes of CO_2e. This represents around 31 per cent of total flight departure emissions (inclusive of domestic and international) in 2033 at an average flight intensity of 46.4 tCO_2e per air traffic movement.

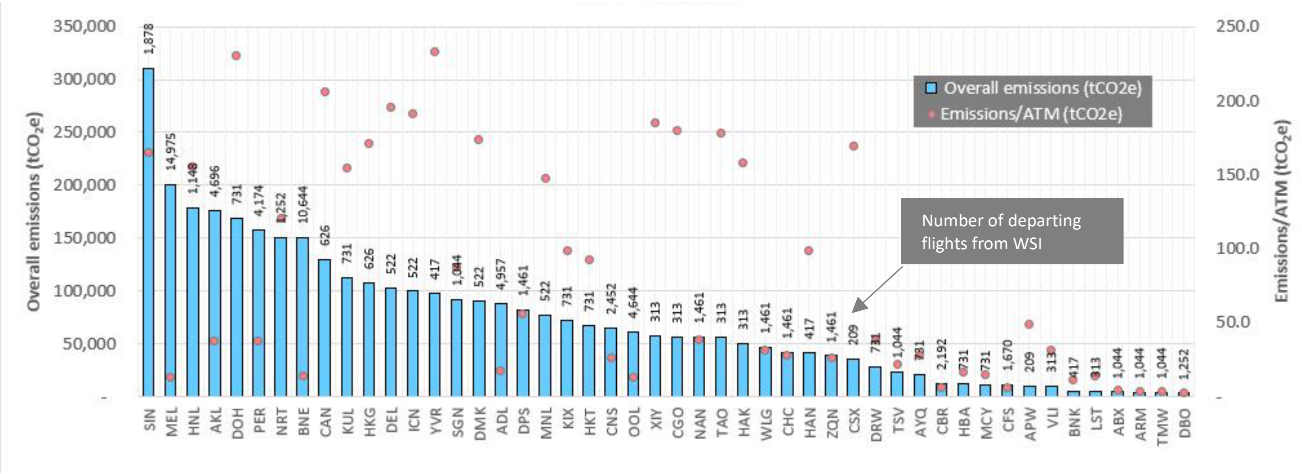


Figure 12.11 2033 full flight departure emissions – total tCO_2e and tCO_2e per air traffic movement

In 2055, all flights departing from WSI to all 86 destination airports across its anticipated route network are projected to emit around 8.65 million tonnes of CO_2e – an increase of around 6.85 million tonnes of CO_2e when compared to 2033 levels. Short haul flights on routes of less than 500 nm (around 915 km) only account for around 38 per cent of total flight activity (an 11 per cent drop from 2033 levels) and 6 per cent of total emissions of CO_2e (down 7 per cent). Long haul flights would comprise a slightly higher share of total movements at 23 per cent and accounted for 63 per cent of the total CO_2e emissions in 2055. Compared to 2033, total emissions of CO_2e from long haul flights are predicted to increase by around 4.8 million tonnes to 5.5 million tonnes. Steady growth emerged in the share of flights operating routes of between 500 nm (926 km) to 4,000 nm (around 7,400 km) in length accounting for 41 per cent of all traffic movements and around 30 per cent of total emissions of CO_2e, at 2.6 million tonnes.

Figure 12.12 shows the full flight emissions of CO_2e estimated for all flights serving the 86 destination airports from WSI in 2055. The top 5 carbon emitting routes are all international RPT services to long haul destinations over 4,000 nm (around 7,400 km) and account for around 2.0 million tonnes of CO_2e. This represents around 24 per cent of total flight departure emissions in 2055 at a flight intensity of around 209 tCO_2e per air traffic movement based on 9,757 departures. This increase is attributed to a combination of the projected route density and service frequency on these routes, of which most are to long haul destinations that tend to be operated by large, wide-body aircraft that use considerably more fuel and emit greater amounts of $C0_2e$ compared to other aircraft and destinations.

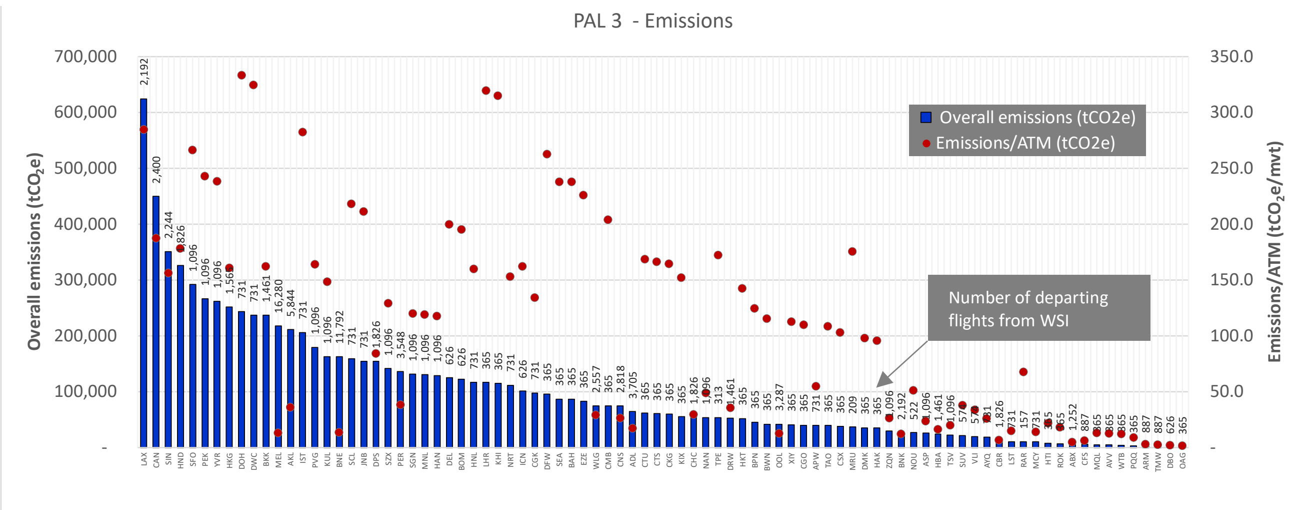


Figure 12.12 2055 full flight departure emissions – total tCO_2e and tCO_2e per air traffic movement

12.5.2.4 WSI contributions to broader emissions

Under the United Nations Framework Convention on Climate Change, domestic and international aviation are treated separately. Domestic aviation emissions are calculated as part of Australia's Paris Agreement target while international aviation emissions are dealt with separately as part of Australia's involvement in ICAO. To avoid the risk of double counting, only the flights departing from WSI have been modelled in the full flight assessment to calculate estimated emissions of CO_2e as all origin airports across the WSI route network would account for their flight departure emissions. These CO_2e emissions have been projected in 2033 and in 2055 and then compared to economy wide emissions projections by the Australian and NSW Governments in these years. The economy wide emissions account for emissions from several sectors including agriculture, energy, industrial processes, resources, transport (inclusive of commercial aviation) and waste.

These comparisons have been used to determine the potential significant impact of WSI's domestic flight departure emissions on the Australian and NSW Government's ability to comply with the Paris Agreement and transition to net zero economies by 2050. International flight departure emissions from WSI are excluded from these comparisons but are presented to provide a total full flight emissions footprint for all flight departures to all destinations across WSI's anticipated route networks in 2033 and 2055.

To that end, the following observations are noted for each assessed year:

- 2033: the project's domestic flight departure emissions of CO_2e would represent around 0.4 per cent for Australia's total projected economy wide emissions which is low whereas the project's intrastate flight departure emissions of CO2e would represent 0.04 per cent of NSW's total economy wide emissions, which is extremely low resulting in very minor adverse impacts to the Australian and NSW Governments decarbonisation plans and transition to net zero carbon economies by 2050.
- 2055: the project's domestic flight departure emissions of CO_2e are projected to increase to 0.95 million tonnes of CO_2e and would represent around 0.5 per cent of Australia's total projected emissions which is moderately low whereas the project's intrastate flight departure emissions of CO_2e would represent 0.2 per cent of NSW's total projected economy-wide emissions, remaining low despite the significant increase in air traffic growth and increase in the number of domestic flight destinations beings served.

The emissions of CO_2e attributed to aircraft departing from WSI to domestic destinations in either 2033 or in 2055 would be unlikely to result in significant impacts or inhibit the achievement of net zero economy targets set by the Australian or NSW Government for 2050. It is expected that these emissions of CO_2e would reduce over these time horizons as more fuel efficient, next-generation aircraft enter service and operate within the airline fleets serving WSI, improvements are made to air navigation and air traffic management infrastructure and operations and the anticipated availability and use of SAF progressively increases.

Table 12.15 presents the aircraft engine CO_2e emission projections for WSI's domestic flight departures in 2033 and in 2055. The CO_2e emissions are presented alongside projected economy wide emissions for Australia and NSW which includes their respective commercial aviation sectors.

Table 12.15 Comparison of WSI's domestic flight departure emissions footprint to Australia and NSW Government economy wide emissions (reported and projected)

Parameter	**2019** (Mt CO_2e)	**2033** (Mt CO_2e)	**2055** (Mt CO_2e)
Australia total economy wide emissions			
All sectors	505.8	340.1	175.8
Transport	100.3	101.3	81
% contribution of transport	20	30	46
% contribution of aviation	5	9	31

Parameter	2019 (Mt CO_2e)	2033 (Mt CO_2e)	2055 (Mt CO_2e)
Australia commercial aviation emissions			
Domestic	8.3	11.2	18.6
International	15.4	18.8	36.1
Total	23.7	30	54.7
NSW total economy wide emissions			
Total	136.6	55.9	25.6
Transport	27.6	19.9	5.7
Aviation	2.4	1.8	2.8
% contribution of aviation	1.7	3.2	11
WSI			
Full flight emissions (all domestic flight departures)	–	0.45	0.95
% contribution of Australia total (economy wide) (domestic full flight emissions)	–	**0.13**	**0.5**
Full flight emissions (all NSW flight departures)	–	0.02	0.05
% contribution of NSW total (economy wide) (NSW full flight emissions only)	–	**0.04**	**0.2**
Full flight emissions (all domestic and international flight departures)	–	**1.75**	**8.65**

12.5.2.5 Climate change risks

The main climate change-related risks to WSI and future flight operations are associated with increased frequency and intensity of storms and heavy rainfall events, variable wind pattern, high wind speed spurts or changes to the prevailing wind direction, rising mean temperatures and bushfires. A number of future possible controls have been identified in Table 8.10 of Technical paper 3.

12.6 Mitigation and management

12.6.1 Existing management

12.6.1.1 Air quality

Emissions from aircraft movements are predominantly due to the engine emissions, which are required to meet Australian (and international) performance specifications. As discussed in Section 12.6.1.2, fleet renewal, improved technologies, operational procedures, and alternative fuels can reduce air emissions.

Measures to help reduce emissions from aircraft operations generally involve procedures and techniques to optimise the vertical profiles of aircraft climbing or descending to an airport engine power (thrust) settings (such as continuous climb operations (CCO) and continuous descent operations (CDO)) and the configuration of flight paths relative to terrain. The measures tend to result in lower air emissions from the aircraft. These are discussed in Chapter 11 (Aircraft noise).

WSA Co is responsible for ground level activities, which are not the subject of this EIS. Mitigation measures were provided in the 2016 EIS to address emissions generated by ground-based activities. Air quality monitoring, initially established at WSI to establish baseline air quality conditions, will continue during future operations at WSI as per the 2016 EIS. Existing air quality monitoring in the vicinity of WSI is undertaken by WSA Co as part of the 2016 EIS approval.

Once operational, emissions from aircraft will be captured by these monitors in addition to existing ground level sources. As this study did not identify any significant change in the approved ground level impacts per the 2016 EIS, no additional monitoring for aircraft engine emissions is required.

12.6.1.2 GHG emissions

An efficient airspace system with supporting air traffic management procedures can deliver significant savings of fuel and CO_2e emissions. Approaches to minimise CO_2e emissions through airspace architecture and flight path design have been included in the project. This is premised primarily through ensuring the efficient separation of aircraft in the Sydney Basin and maximising opportunities for CCO and CDO in the take-off, initial and extended climb and descent phases of flight. These operating techniques allow aircraft to follow an optimum flight path using optimum engine power (thrust) and speed control to reach cruising flight levels or the final approach fix prior to touchdown. CCO and CDO can deliver significant economic and environmental benefits through reduced fuel burn, greenhouse gas emissions, noise and fuel costs without any compromise of safety.

There are many available options to minimise the emissions of CO_2e from aircraft engine use, however, many of these are outside of the control of this project.

Significant opportunity lies in the optimisation of aircraft operations, including the LTO and extended climb and descent cycles. Generally, aircraft CO_2e emissions can be reduced through activities such as:

- minimising taxiing time
- flying at optimal cruise altitudes
- optimising climb gradients and continuous climb profiles
- flying minimum-Greater Circle Distance routes, considering prevailing winds
- minimising or eliminating holding and stacking around airports.

In general aircraft emissions can be reduced in one of 4 ways:

- fleet renewal with cleaner, more fuel-efficient next-generation aircraft (i.e., Airbus A32N and Boeing B73M)
- retrofit aircraft for improved efficiency
- operational streamlining to reduce fuel consumption (such as use of CDO, CCO and RNP procedures)
- fuel substitution with less carbon intensive alternatives.

Wide-ranging measures will be required to manage and reduce emissions of CO_2e from engine use by aircraft operating along WSI's flight paths and route network, many of which are dependent on other stakeholders. A collaborative approach is required amongst aviation stakeholders including WSA Co, Airservices Australia, airlines, aerospace manufactures and fuel companies to help WSI operate with the lowest carbon footprint possible.

An Operational Sustainability Strategy and Operational Sustainability Plan for WSI is currently under development by WSA Co, which will be released prior to the commencement of operations at WSI. A core component of this strategy and plan will be a roadmap to progress WSI along a 'Carbon Neutral Pathway' that will be supported by participation in ACI's *Airport Carbon Accreditation* programme, and a strategy to support aviation partners to reduce scope 3 emissions, including those produced by aircraft engine use in the LTO cycle.

WSA Co is planning to join ACI's *Airport Carbon Accreditation* programme at one of the 2 highest available levels (being Transformation level (4) or Transition level (4+)). This means that WSA Co is required to set a policy commitment that will achieve absolute emissions reductions of CO_2e and implement a Carbon Management Plan. This plan will define the emissions reduction trajectory, interim milestones and the measures required to achieve a future science-based target in line with the IPCC's 1.5 degrees Celsius pathway. It will also help WSI operate with the lowest carbon footprint possible as it closely works with all its stakeholders to address third party emissions of CO_2e, particularly for sources that are outside its direct control and ownership (i.e., aircraft engine emissions).

At a national level, the Australian Government is developing a comprehensive framework of measures to drive decarbonisation across the economy to achieve the net zero target by 2050 in a way that minimises costs and shares the effort across the economy. These measures include:

- annual emission reduction requirements for Australia's largest emitters (including Australia's largest airlines) through Safeguard Mechanism reforms
- public monitoring and reporting of emissions over time through the National Greenhouse and Energy Reporting Scheme
- financial support for clean energy projects through the Clean Energy Finance Corporation and the Australian Renewable Energy Agency, as well as a range of other initiatives such as the Research and Development tax incentive.

Approaches to support reductions specific to the transport sector will be outlined in the Transport and Infrastructure Net Zero Roadmap and Action Plan, and forms part of the Australia's Net Zero 2050 plan. Alongside the Net Zero Plan, the Australian Government will set an ambitious 2035 emissions reduction target. In September 2024, the Climate Change Authority advised the Australian Government on the technologies to cut emissions in each sector, including aviation.

The Australian Government is also participating in the ICAO's CORSIA to address greenhouse gas emissions from the international aviation sector. This scheme is a global market-based measure reliant on a cooperative approach by the aviation industry to stabilise net CO_2 emissions from international aviation to 2019 levels. It also requires operators to purchase 'emission units' to offset growth in carbon emissions from international routes covered by the scheme. Offsetting under CORSIA will support the aviation sector achieve its short and medium term climate targets by complementing other emission reduction initiatives.

No project specific greenhouse gas emissions mitigations or monitoring is proposed.

Chapter 13 Aircraft hazard and risk

This chapter describes the aircraft hazards and risks relevant to the project. The potential impacts of WSI's operations are described, together with the associated assessment methodology and, where relevant, measures to avoid, manage, mitigate or monitor these impacts are included.

The refinements to the preliminary flight path design since the exhibition of the Draft EIS would not change the conclusions of the overall hazards and risk assessment as presented in this chapter and supporting technical papers. Further detail is provided in Appendix G (Assessment of the refinements to the project) of the EIS.

This assessment has considered airspace conflicts, risks to people and critical infrastructure from aircraft crashes as well as other aircraft related risks associated with fuel jettisoning, meteorological hazards, objects falling from aircraft, aircraft wake vortex strike and wildlife strike.

In respect to airspace conflicts, the adopted safety aspects of the design process means that the proposed airspace is expected to be safe by design, meets the key goals of reducing aircraft conflict risk to 'as low as reasonably practicable' and achieves an acceptable level of safety.

Aircraft crash risks

The assessment of risk to people living, working or otherwise congregating in areas that may be subject to potential risks from aircraft crashes (also called third party risk) has considered the individual risk and the societal risk.

The individual fatality risk refers to the annual probability of fatality for a hypothetical resident present at any given location relative to the runway threshold and flight path to and from it. This is presented as risk contour plots at the north-east and south-west ends of the runway for 2033 and 2055. A risk of:

- 1 in 100,000 per annum is considered to be a risk that is of potential concern but one that can be considered acceptable, provided that the risk is managed to be as low as reasonably practicable
- 1 in 1,000,000 per annum is considered to be a low risk that is a generally acceptable level of exposure for members of the public.

For most residential properties in the vicinity of the Airport Site, the risks would be negligible which reflects the position of the runway and the design of the flight paths. For 2033, no dwellings are located within the 1 in 100,000 per annum risk contour and there are 6 dwellings housing 22 people within the 1 in 1,000,000 per annum risk contour. These risks are classified as slight effects, when considering the risk level and the number of people exposed to this risk. In 2055, a small number of people (5) are within the 1 in 100,000 per annum contour and 108 people are located between the 1 in 100,000 per annum and 1 in 1,000,000 per annum risk contour. As the number of people exposed to risks would increase, these risks are classified as being of moderate effect but are not significant based on the criteria applied.

Societal risk considers the annual probability of accidents causing any given number of fatalities in any area of development, taking account of the nature of the development, in particular the density of occupancy. The assessment found that societal risks in 2033 and 2055 are within the middle to lower risk part of the 'as low as reasonably practicable' region. These risks are considered acceptable, provided no further practicable means for mitigating these residual risks is available. In this regard, based on the runway location, airspace design requirements and the relative location of developed areas within Sydney, the preliminary airspace design has minimised these risks, as far as is practicable.

Critical infrastructure, such as hospitals, transport links, water storage and the Defence Establishment Orchard Hills, are located in the vicinity of the Airport Site. The typical event frequencies and scale of fatalities associated with aircraft crashes are consistent with risks that would be considered acceptable when assessed against the societal risk criteria that have been employed more generally to evaluate the significance of third-party fatality risks.

Operation of flight paths over the Greater Blue Mountains Area (GBMA) presents a very low risk of introducing fire through aircraft accidents. This is based on an estimate for the crash rate from aircraft during flight over the Blue Mountains ranging between approximately 1 in 1,700 to 1 in 2,400 years in 2055. The range in the crash rate risk reflects the likely distribution of traffic movements using the flight paths over the GBMA.

Fuel jettisoning

Fuel jettisoning is a rare occurrence in Australia. It is a relatively uncommon non-standard operational requirement that will generally have no ground level impacts if carried out in accordance with appropriate procedures. There are very limited occurrences of impacts at ground level associated with fuel jettisoning in the wider international incident record, confirming that the risk is very small. Fuel jettisoning associated with WSI operations will be carried out in accordance with the Aeronautical Information Publication Australia, Part 2 – En Route (AIP ENR), as per mitigation measure HR3. If possible, except in the case of emergencies, fuel jettisoning will be conducted at an altitude of at least 6,000 feet (ft) (approximately 1.8 kilometres (km)) above ground level to ensure total dissipation into the atmosphere prior to contacting the ground. There would be no significant adverse impact associated with fuel jettisoning associated with WSI operations. While it cannot be guaranteed that such impacts could never occur, the historical record indicates that they would be very rare events.

Objects from falling aircraft

Occurrences involving objects falling from aircraft are uncommon and typically involve small objects with limited hazard potential. Taking account of the relative size of the objects concerned and frequency of these occurrences compared with aircraft crashes, it may readily be concluded that the risks to people and sites on the ground are very small compared with the risks associated with aircraft crashes and hence can similarly be considered to be low and acceptable.

Wake vortex impacts

The number of properties located in areas where vortex damage would be expected is very limited and the risks of wake vortex damage due to WSI operations is low, given the limited number of buildings where wake vortex damage could occur and the nature of the buildings within this area. In the unlikely event of damage occurring, this can be effectively addressed by the compensation scheme operated by Airservices Australia.

Meteorological hazards

Compared with other airports which operate with an acceptable level of safety, there are no exceptional meteorological conditions at WSI that might lead to significant risks to operational safety. The most significant weather related factor is turbulence and windshear. However, the severity of the consequences of these occurrences is normally relatively limited, in particular for turbofan and turboprop powered aircraft of the types that would operate at WSI. The risks to safety and operational efficiency from meteorological hazards can be mitigated by provision of improved forecasting. The implementation of an Automated Thunderstorm Alert Service (ATSAS) at WSI would also provide improved thunderstorm forecasting.

Wildlife hazards

Wildlife strike risk mitigation for WSI providing an acceptable level of safety is achievable, provided that a site-specific wildlife management program is implemented.

Mitigation and management

Risk mitigation is provided by a wide variety of general measures adopted across the aviation industry that apply to operations at WSI. In particular, risks are mitigated by established operational measures supporting safe air traffic control and the design process would deliver an inherently safe design. Third party risks are also effectively mitigated by the location of the runway and associated flight paths which limits exposure to these risks and is further mitigated by the mode of operation, as well as through land use controls guided by the National Airports Safeguarding Framework (NASF) principles and guidelines and set within State Environmental Planning Policy (Precincts – Western City Parklands) 2021.

Additional project-specific mitigation measures have been identified to further mitigate the airspace conflicts, residual off-airport aircraft crash risks to third parties and critical infrastructure, aircraft fuel jettisoning, local meteorological hazards and local bird and bat strike hazards.

In conclusion, operations at WSI and the associated airspace in the Sydney Basin are being introduced within a well-established regulatory and management framework that places the utmost importance on safety, underpinned by key requirements that risks should be 'as low as reasonably practicable' and meet appropriate levels of safety. Assessment of the residual risks associated with WSI operations indicate that those key requirements would be met.

13.1 Introduction

This chapter considers the aircraft hazards and risks associated with the project. The full risk assessment is provided in Technical paper 4: Hazard and risk (Eddowes Aviation Safety Ltd) (Technical paper 4) and is supported by Technical paper 5: Wildlife strike risk (Avisure) (Technical paper 5). The purpose of the assessment is to demonstrate that the project achieves an acceptable level of safety when it becomes operational and to address the EIS Guidelines for the project.

Achievement of an acceptable level of safety means that any risks that may be associated with airspace operation have:

- been minimised so far as is reasonably practicable
- any residual risks are sufficiently small to be considered acceptable in return for the benefits associated with the activities giving rise to them.

The term 'so far as is reasonably practicable' is used in defining an obligation under the relevant safety legislation, whereas in related guidance and in the practical implementation of this legislation reference is often made to a requirement that risks are managed to be 'as low as reasonably practicable'. In general, the terms 'so far as reasonably practicable' and 'as low as reasonably practicable' are synonymous, and the latter term was employed in the remainder of this chapter, pursuant to its use in safety documentation supporting the design process.

While aircraft accidents are relatively rare events, those that do occur take place predominantly during landing and take-off and are more concentrated along flight paths and close to the ends of runways. It is therefore appropriate to give particular attention to these hazards and risks when considering the siting of new runway facilities and the associated flight paths. In that context, consideration of 2 distinct aspects of hazard and risk is required:

- review of potential hazards associated with the site specific environment and assurance that these are identified and appropriately managed, as far as practical by design
- assessment of any residual risks to people and other components of the environment and assurance that these risks are acceptable, given the benefits associated with WSI.

An overall account of hazards and risks associated with the project was provided in the 2016 EIS. This EIS builds on the 2016 EIS, focusing on hazards associated with airborne aircraft beyond the Airport Site boundary and having regard to the design of the proposed airspace. Technical paper 4 considers the following:

- airspace conflicts between aircraft and potential threats to safe inter-operability associated with the introduction of additional flight operations into the existing Sydney Basin airspace
- risks to people living, working or otherwise congregating in areas that may be subject to potential risks from aircraft crashes (also called third party risk)
- risks to critical infrastructure from aircraft crashes
- aircraft jettisoning of fuel and potential contamination events
- objects falling from aircraft

- aircraft wake vortex strikes
- meteorological hazards
- wildlife (bat and bird) strikes.

13.2 Legislative and policy context

13.2.1 Legislation

13.2.1.1 Work health and safety legalisation

The *Work Health and Safety Act 2011* (Cth) and *Work Health and Safety Act 2011* (NSW) place duties on persons responsible for facilities that may give rise to risks to eliminate risks to health and safety, so far as is reasonably practicable.

These Acts do not prescribe specific measures to be taken but instead identify a duty to take whatever measures are available and practicable. In addition to adhering to any technical measures identified in the *Civil Aviation Safety Regulations 1998* (Cth), it is necessary to demonstrate that there are no further practicable measures to further reduce the risks and that any residual risks are maintained at an acceptable level.

13.2.1.2 Aviation legislation

The primary legislation relating to aviation safety in Australia is set at the Commonwealth level and is overseen by the Civil Aviation Safety Authority (CASA). Requirements relating to the safety of all aspects of civil aviation are set out in the *Civil Aviation Safety Regulations 1998* (Cth).

The *Civil Aviation Safety Regulations 1998* (Cth) implement the standards and recommended practices of the International Civil Aviation Organization (ICAO), which regulates and supports international civil aviation worldwide.

Australia is a contracting State under the 1944 Convention on International Civil Aviation (also known as the Chicago Convention) and has an obligation to adopt these ICAO standards and practices. Licensing of aerodromes in accordance with these technical standards ensures that airports provide safe environments for the operation of the types of aircraft that they intend to serve.

Further regulations apply to the operation of aircraft and to air traffic management services to ensure safe and efficient air transport, including (but not limited to):

- *Civil Aviation Act 1988* (Cth)
- *Civil Aviation Regulations 1988* (Cth)
- *Air Navigation Act 1920* (Cth)
- *Airports Act 1996* (Cth) (Airports Act)
- *Airports (Protection of Airspace) Regulations 1996* (Cth)
- *Air Navigation Regulation 2016* (Cth)
- *Airport (Environment Protection) Regulations 1997* (Cth)
- *Airports Regulations 1997* (Cth)
- *Airports (Control of On-Airports Activities) Regulations 1997* (Cth)
- *Airports (Ownership and Interests in Shares) Regulations 1996* (Cth)
- *Aviation Transport Security Act 2004* (Cth)
- *Aviation Transport Security Regulations 2005* (Cth).

13.2.2 National Airports Safeguarding Framework

International standards and guidance seek to ensure that airports and associated flight paths are appropriately safeguarded in respect of future development. To address these requirements, the National Airports Safeguarding Advisory Group developed the NASF. The NASF provides guidance on planning requirements for development that affects aviation operations. It consists of the NASF principles and 9 topic-specific guidelines.

The NASF's main focus is controlling new development that might adversely affect the safety and efficiency of aircraft operations. This is achieved through:

- the physical safeguarding of flight paths from intrusion by new obstacles
- the technical safeguarding of navigational aids and radar systems from interference
- control of development that may attract wildlife and associated hazards
- control of potential distractions
- control of building and terrain induced wind shear.

The NASF principles and the 9 supporting guidelines can be found on the Department of Infrastructure, Transport, Regional Development, Communications and the Arts (DITRDCA) website.

13.2.3 Airport public safety area policy

International standards for airport design do not prescribe requirements for controlling new development near runways to manage the aircraft crash risk to the public. However, ICAO guidance advises that specific methodologies can be developed by contracting States for that purpose.

A risk based approach was adopted in Australia under the NASF *Guideline I: Managing the Risk in Public Safety Areas at the End of Runways* (NASF Guideline I) by the then Ministers at the Transport and Infrastructure Council in 2018. A Public Safety Area is a designated area of land at the end of an airport runway within which development may be restricted in order to control the number of people on the ground around runway ends. It places development restrictions in areas where an individual is exposed to an estimated fatality risk of 1 in 100,000 per annum. This quantitative risk standard defines the outer limit of Public Safety Areas. New residential development is generally discouraged within Public Safety Areas but some low density uses may be allowed.

The use of this risk criterion is generally consistent with the practical interpretation of the principle under the *Work Health and Safety Act 2011* (NSW) that risks should be eliminated so far as is reasonably practicable. The NASF Guideline I identifies an individual risk of 1 in 100,000 per annum as a relatively low level of risk compared with other risks of daily life more familiar to the community. For example, the risk to an individual being killed in a road accident in Australia is about 5 times that level.

It should be recognised that the Public Safety Area approach to the control of new development in the vicinity of airports does not explicitly address the issues associated with a new runway development within an established built environment (as is the case with WSI). Nevertheless, this policy provides a useful reference point for this assessment.

13.2.4 Other policies and guidance

13.2.4.1 Hazardous Industry Planning Advisory Papers

Integrated land use planning has been an essential part of risk management in NSW. To manage safety risks from potentially hazardous developments, the NSW Government has released a series of advisory papers (the Hazardous Industry Planning Advisory Papers (HIPAP)). The HIPAPs guide the planning and design phases of potentially hazardous developments in NSW to ensure safety issues are thoroughly assessed and that controls are in place to give assurance that a project can be safely operated throughout its life. The papers include guidance and methods on:

- land use safety planning (HIPAP 10: Land Use Safety Planning (NSW Department of Planning, 2011a))
- risk assessments, including quantitative assessments where appropriate (HIPAP 4: Risk Criteria for Land Use Planning (NSW Department of Planning, 2011b))
- evaluation of risk against well-defined objective criteria (HIPAP 3: Risk Assessment (NSW Department of Planning, 2011c)).

The quantitative criteria provided in HIPAP 4 has been considered in this assessment to support the evaluation of the significance of estimated risks and their acceptability, in accordance with international best practice. This is discussed further in Section 13.3.2.

13.2.4.2 NSW planning documents

The *State Environmental Planning Policy (Precincts – Western Parkland City) 2021* (NSW) (Western Parkland City SEPP) and the supporting Western Sydney Aerotropolis Development Control Plan includes a number of airport safeguards that surrounding development or consent authorities must consider when seeking approval for future development. This includes requirements relating to the Public Safety Area, lighting, wind shear and turbulence, wildlife hazard management, and obstructions into airspace.

13.3 Methodology

13.3.1 Study area

The study area is the Sydney Basin. It includes the various established airports, heliports, military airports and associated flight paths in the Sydney Basin, as well as the enroute flight paths that cross the Sydney Basin and restricted airspace. The Sydney Basin encompasses airspace that extends out to Katoomba to the west, the Hawkesbury River to the north, the southern boundary of the Royal National Park to the south and the coastline to the east.

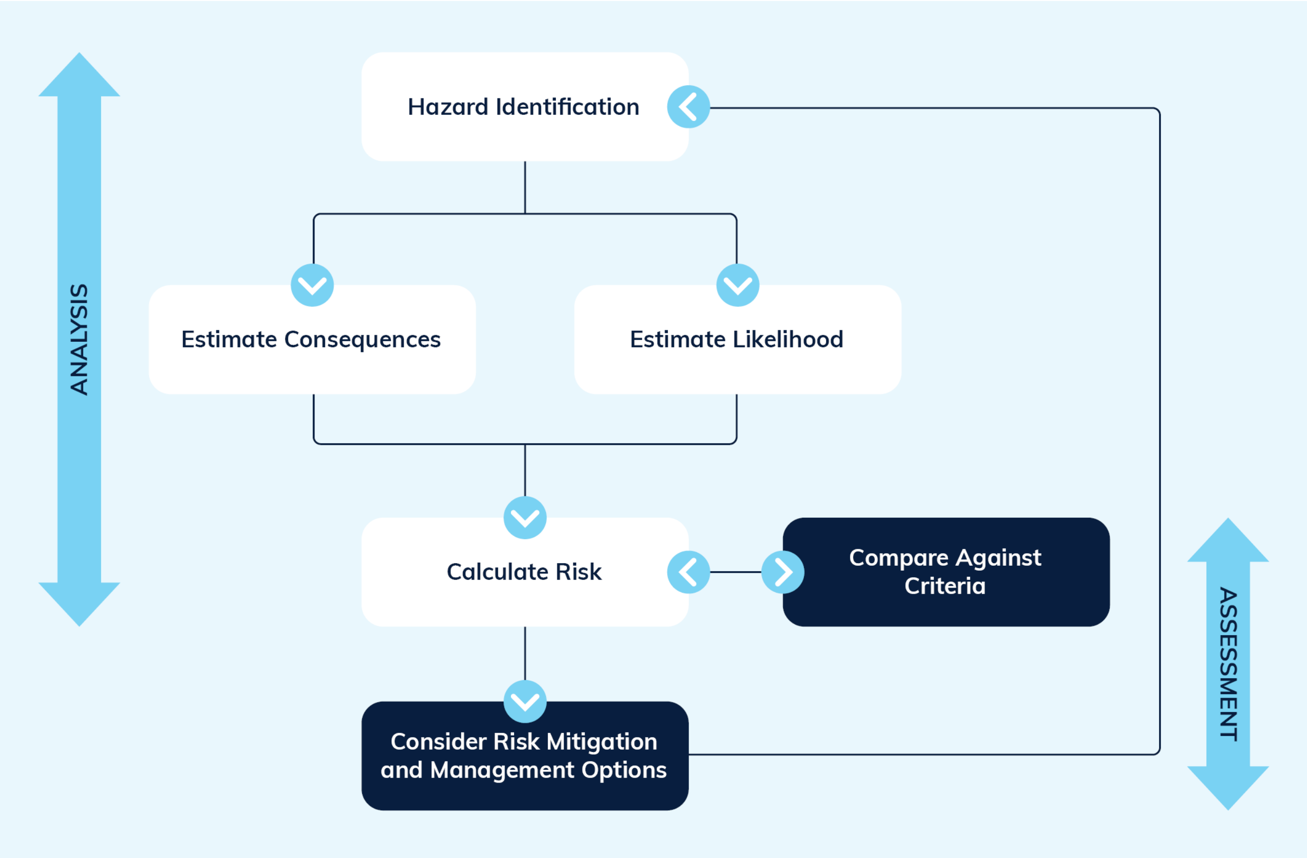
A more discrete study area was applied in the assessment of wildlife strike risks, being the Airport Site in addition to natural or human made structures or land uses within a 13 kilometre (km) radial distance from the runway boundary. The 13 km distance aligns with the NASF's safeguarding limit to manage risks to airport operations. The study area was extended up to 30 km from the runway boundary due to the foraging behaviour and/or the potential strike risk of Flying-foxes and the Australian White Ibis.

13.3.2 Approach

13.3.2.1 Methodology outline

The hazard analysis process that provides the basis for this assessment is summarised in Figure 13.1. While this process is derived from the HIPAP, equivalent processes are identified in aviation-specific risk assessment guidance including:

- CASA 2014 Safety Risk Management SMS 3 Second Edition (CASA, 2014)
- ICAO 2018 Safety Management Manual Fourth Edition Doc 9859 AN/474 (ICAO, 2018).



Source: reproduced from State of Hazardous Industry Planning Advisory Paper No 3 Risk Assessment (NSW Department of Planning, 2011c)

Figure 13.1 Generic hazard analysis and risk assessment process

This EIS is focused on hazards associated with airborne aircraft beyond the Airport Site and having regard to the proposed airspace and flight path design. It builds upon the assessment completed in the 2016 EIS and considered the EIS Guidelines issued for the project. This identified the following hazards as requiring consideration:

- airspace conflicts between aircraft that might result in mid-air collisions and other potential threats to safe inter-operability associated with:
  - the introduction of additional flight operations into the existing Sydney Basin airspace
  - interfaces with military and emergency services operations
  - current commercial and private civil aircraft operations
  - concerns relating to mid-air collision with other aircraft

- general off-airport aircraft crash risks to people and critical infrastructure (referred to as third-party risks)
- aircraft fuel jettisoning
- objects falling from aircraft
- aircraft wake vortex strikes
- local meteorological hazards
- local bird and bat strike hazards.

It has not considered the following hazards, which were considered in the 2016 EIS:

- airspace obstruction and high velocity gas discharges on the basis that these matters have been safeguarded by current arrangements and controls
- drone and model aircraft operations on the basis that appropriate arrangements would apply so that they do not adversely impact the safety of aircraft operations
- targeted terrorism incidents. However, a terrorist incident that may lead to off-site aircraft impacts has been treated as part of the off-airport aircraft crash risk model as one of many factors that may lead to aircraft impacts with the ground.

Further detail on the assessment methodology is provided in Sections 13.3.2.2 to 13.3.2.4.

13.3.2.2 Aircraft crash risk assessment

Site specific risks to the public in the vicinity of airports can be estimated quantitatively using an empirical model, based on historical accident data. For this assessment, the UK Department for Transport (DfT) model, with limited modification, has been applied. This risk assessment is informed by 3 key parameters:

- The likelihood or probability (frequency per annum) of an aircraft crash occurring during landing or take-off operations, anywhere in the vicinity of an airport, having regard to the number of movements and different aircraft types. Based on the crash rates per movement for each aircraft type and the anticipated annual number of movements at WSI, the model provides an estimated annual crash rate for operations.
- The probability of impact at any specific location at or near an airport relative to the runway ends and flight paths, using crash location information from historical accident data (involving aircraft types that are generally representative of those expected to operate at WSI).
- The severity of the consequences of an impact on the ground, according to the size of the aircraft and using historical accident data. The crash consequences for the anticipated operations at WSI are expected to cover a range of severities.

One runway mode of operation at WSI in 2033 and 2055 was assessed. The selected mode of operation assumes no preference being given to the use of Runway 05 or Runway 23, and no reciprocal runway operations (RRO) during the night. This was selected as it was considered the worst case of the 7 scenarios developed for the assessment.

Further details on the selected model and methodology can be found in Section 3.1.3 of Technical paper 4.

The following section provides further information on the 2 measures applied in the assessment (individual and societal risk).

Individual and societal risk

Two measures have been applied to characterise the risks as a result of aircraft crashes to the health and safety of persons on the ground whose presence is not associated with the activities of WSI (also known as third parties):

- individual risk: the annual probability of fatality for a hypothetical resident present at any given location relative to the runway threshold and flight path to and from it
- societal risk: the annual probability of accidents causing any given number of fatalities in any area of development, taking account of the nature of the development, in particular the density of occupancy.

Individual risk

Individual risk is the measure employed for the definition of Public Safety Areas. Three different levels of risk are typically used in the assessment of individual risk:

- a risk of 1 in 10,000 per annum, considered to be a relatively high risk and at the limit of what is an acceptable level of risk exposure for members of the public
- a risk of 1 in 100,000 per annum, considered to be a risk that is of potential concern but one that can be considered acceptable in return for the economic benefits derived from the activity giving rise to the risk, provided that the risk is managed to be as low as reasonably practicable
- a risk of 1 in 1,000,000 per annum, considered to be a low risk that is a generally acceptable level of exposure for members of the public.

These identified risk levels provide a well-defined set of internationally recognised quantitative criteria. In addition to the risk levels, the relative number of people exposed to these risk levels can also provide a further criterion for evaluating risk significance.

As such, this assessment has applied criteria for individual risk significance that combine these 2 factors (refer to Table 13.1).

Table 13.1 Assessment criteria for individual risk significance

Significance of impact	Topic specific criteria
Negligible[1]	Individual fatality risk < 1 in 1,000,000 per annum across all areas of development and major transport links
Slight effects	1 in 1,000,000 per annum < Individual fatality risk < 1 in 100,000 per annum Low numbers (up to a few tens) of people exposed
Moderate effects[2]	1 in 1,000,000 per annum < Individual fatality risk < 1 in 100,000 per annum High numbers (hundreds to thousands) of people exposed Or 1 in 100,000 per annum < Individual fatality risk < 1 in 10,000 per annum Low numbers (up to a few tens) of people exposed
Significant effects	1 in 100,000 per annum < Individual fatality risk < 1 in 10,000 per annum High numbers of people exposed
Very Significant effects	Individual fatality risk > 1 in 10,000 per annum Low numbers (up to a few tens) of people exposed
Profound effects	Individual fatality risk > 1 in 10,000 per annum High numbers (hundreds to thousands) of people exposed

1. The term negligible is typically employed in safety regulation for risk levels that are below regulatory concern and this category can be considered to equate essentially with the not significant impact significance category often employed in environmental assessment.
2. There will be some overlap between scenarios meeting the criteria identified for moderate effects, according to the level of risk within the identified bands and the numbers of people exposed.

Societal risk

Societal risk is characterised quantitatively in terms of the estimated frequency of accidents leading to a defined number of fatalities. Societal risk estimates typically consider the wide range of potential outcomes of an accident from the more common scenarios (relatively few fatalities) to less common scenarios (larger numbers of fatalities).

Societal risks have been determined by reference to the following parameters:

- the likelihood of a crash at any given location relative to the runway and associated flight paths
- the area impacted on the ground in the event of a crash for each different aircraft type
- the density of occupancy at any given location subject to crash risk.

This modelling approach provides estimates for the frequency (f) of scenarios causing a wide range of numbers of fatalities (n) up to a maximum number associated with an impact of the largest aircraft type into the area of highest population density. These estimates are then used to derive estimates for different societal risk measures for comparison with appropriate acceptability criteria. Usual practice is to present societal risk estimates graphically in terms of an 'FN curve', which summaries the full range of potential outcomes by means of a plot on a logarithmic scale of the number of fatalities against the event frequencies for all foreseeable scenarios.

The criteria available to assess the significance of societal risk are broadly similar to one another in that:

- risk is considered increasingly significant at any given frequency with the increasing number of fatalities associated with it, and
- risk giving rise to any given number of fatalities is considered increasingly significant with the increasing frequency of the event.

However, the criteria are not consistent in how the level of concern (or aversion) about a risk with the increase in the number of fatalities is considered. Some criteria adopt no specific aversion, whereas some apply differing levels of increasing aversion to multiple fatality events.

Given the uncertainty in determining the significance of societal risk, this assessment has made reference to 3 criteria identified by the following jurisdictions:

- the UK, which does not add additional importance to events giving rise to higher number of fatalities. The UK has adopted the view that any differential risk aversion must be done explicitly and that there is already an element of high fatality aversion inherent in its FN criterion
- Australia, within Safe Work Australia (SWA) and NSW guidelines. The SWA guideline includes a substantial aversion to risks giving rise to higher numbers of fatalities within its FN criterion, whereas NSW guidance adopts some aversion within its FN criterion.

Reference has also been made to the following:

- A 'scaled risk integral' which has been adopted by the Republic of Ireland for hazardous land use planning and is not expressed in an FN curve. This represents the sum over all scenarios of the accident frequency multiplied by the number of fatalities. A value of 2,000 is considered broadly acceptable and a value of 500,000 is considered significant. This guidance identified that it should only be used for initial assessments of societal risk given the debate on scale aversion, and that the FN curve remains a more robust approach.
- The expectation value, which represents the average number of fatalities per annum associated with a hazardous event and can be used as an alternative societal risk criterion which is neutral to high fatality risk aversion. Events leading to one fatality at a frequency of 1 in 10,000 years is the upper limit of negligible risk. The limit for 10 fatality events is 1 in 100,000 years.

The crash risk frequency and area impacted have been determined using the available empirical models. The density of occupancy has been estimated by reference to the available census data.

Further detail on the methodology and a detailed discussion of the criteria applied in this assessment is provided in Section 3.1.3 of Technical paper 4.

13.3.2.3 Wildlife strike risk assessment

On-airport risks

Risks due to wildlife strike from wildlife within the Airport Site are reported as a Species Risk Index. This index considers the likelihood (based on population size, position on the Airport Site, time spent in the air and the ability of the species to avoid collision) and consequence (fauna size (mass) and flock size). Based on these factors, the Species Risk Index rating ranges from very low to very high.

The assessment provides for a systematic approach to identify and treat wildlife related risks at an airport.
The assessment also assists in identifying high risk species to allow for suitable management practices to be targeted in areas where the maximum reduction in risk may be achieved while conserving native wildlife populations.

To inform the assessment, surveys were completed across July, August, September and October 2022 at the Airport Site. Further detail on the methodology and risk assessment method is provided in Chapter 3 and Appendix D of Technical paper 5.

Off-airport risks

Airspace risk level posed by wildlife within the Airport Site or in the vicinity of WSI has been determined with an assessment of:

- species risk, which considers the probability (based on the population size, location, time spent in the air and the species ability to avoid collision) and the consequence to the aircraft (based on the size of the animal and flock size). This assists in the identification and treatment of wildlife related risks at WSI
- off-airport risk, which considers sites located off-site that could contribute to aviation strike risk at WSI. This considers the likelihood of a species being present, the attractiveness of a location for wildlife (specifically food, shelter and water resources), proximity to WSI and flight paths, as well as the connectivity of other relevant wildlife attracting sites.

Further detail on the methodology and risk assessment method is provided in Chapter 3 and Appendix D of Technical paper 5.

To inform the assessment, surveys were completed:

- across July, August, September and October 2022 at the 76 wildlife-attracting sites within 13 km of the Airport Site
- on 4 occasions at the 8 Flying-fox camps located within 30 km of the Airport Site. These surveys were augmented by surveys completed by Avisure or others at the camp sites over 2018 to 2022.

Not all off-airport sites were surveyed in each survey round due to land access constraints. Further detail on the survey methods are provided in Appendix B of Technical paper 5.

13.3.2.4 Assessment of other hazards

Risks associated with the other identified hazards have been characterised by reference to operational experience, provided through the Australian Transport Safety Bureau (ATSB) accident and incident database and wider international experience. This includes use of the US National Transportation Safety Board (NTSB) dataset to characterise each identified hazard in terms of frequency and severity.

The potential impacts have then been assessed by reference to the environments along the flight paths to provide a basis for evaluating the scale of the anticipated risks.

13.3.2.5 Assumptions and limitations

The aircraft crash hazard assessment is based on an empirical model developed by reference to recent historical accident data. It provides generic insight into:

- the likelihood of aircraft crashes
- the likely locations of events in relation to flight paths
- the impact consequences on the ground.

Future risks associated with operations at WSI are estimated on forecasts for future operations, in terms of:

- the numbers of aircraft movements following the available departure and approach paths
- the aircraft types involved.

There will inevitably be limitations to the reliability of any quantitative risk model based on this empirical approach, due to inherent modelling uncertainties and uncertainties in the forecasts for future operations.

Careful consideration has been given to the possible limitations of the modelling approach used, as described in Appendix A of Technical paper 4. This modelling approach is consistent with current best practice and provides a sound basis for assessing the implications for public safety of WSI's airspace and flight path design.

With respect to the wildlife strike risk assessment, the risk is dynamic and is likely to change in response to landscape changes as WSI is developed and as land use surrounding the Airport Site undergoes significant change.

The assessment of other hazards is similarly based on empirical evidence from operational experience and is subject to similar limitations and assumptions.

13.3.3 Dependencies and interactions with other study areas

This assessment interacts with other study areas, including:

- aircraft noise: flight path design has sought to minimise noise impacts on people, in part through avoiding overflight of areas that would give rise to impacts on larger number of individuals
- biodiversity: wildlife strike risk management involves a balance between aeronautical safety and biodiversity objectives.

Further detail on the interactions is found in Section 3.2 of the Technical paper 4.

13.4 Existing environment

As outlined in Section 4.1 of the EIS, the Sydney Basin airspace encompasses an extensive network of flight paths associated with existing airports, Defence facilities, flying training, recreational aviation activities (gliders, ballooning and parachuting), emergency aviation activities (for example, medical or bushfire), helicopter activity and transiting flights. A number of restricted areas and danger areas are also present in the Sydney Basin airspace where flying is restricted.

Most of the land immediately surrounding WSI currently comprises low density rural residential and agricultural land uses. There are a few residential areas adjacent to The Northern Road and Park Road intersection and further south of The Northern Road. The primary sensitive receivers for consideration in the aircraft crash hazard assessment fall within the following categories:

- areas of development along flight paths where people live, work or otherwise congregate that may be impacted by aircraft crash
- critical built infrastructure such as transport links
- major hazard industrial facilities, for example nuclear facilities and chemical processing and storage facilities at which an aircraft crash may lead to serious knock-on consequences
- water supplies that may be contaminated, either by a crash or by fuel jettisoning in an emergency
- any other facilities or environmental assets of notable value that may be harmed by the identified hazard scenarios.

Fauna in the region is supported by remnant and disturbed native vegetation, as well as resources provided by agricultural and urban development. Based on current land uses, 76 sites that attract or potentially attract wildlife (if left unmanaged) were identified within the Airport Site or within 13 km of Runway 05/23. This includes artificial and natural waterbodies (including basins), waste resource recovery facilities and landfills, recreational sites and reserves, the Luddenham Showground, golf courses and water reservoirs (such as the Warragamba Dam), as well as commercial and agricultural operations (such as landscaping supplies and horticultural operations). The Lake Gillawarna Ibis colony is located around 23 km from Runway 05/23.

Eight Flying-Fox camps are located within 30 km of Runway 05/23. Monitoring completed by Avisure over 2022 found that 6 of the 8 Flying-fox camps (as of October 2022) were active with populations ranging from 15 to around 15,000 individuals. No individuals were recorded at the Emu Plains or Wetherill Park camps.

13.5 Assessment of impacts

13.5.1 Airspace conflicts and system operability

Safe and efficient airspace design is underpinned by technical standards developed by the international aviation community. A well-defined safeguarding process ensures that safe and efficient operations can be maintained and will not be compromised by future developments, as set out in NASF guidance. It is further supported by risk assessment and the ‘as low as reasonably practicable’ principle. This approach was followed during the design of the project and its interfaces with the existing airspace uses. The eventual outcome is an overall airspace system that:

- is safe by design within the various constraints inherent in it
- minimises airspace conflicts
- maximises system inter-operability.

The project is expected to be safe by design, achieves the ‘as low as reasonably practicable’ principle and achieves an acceptable level of safety, due to the following key features in the design process outlined in Chapter 6 (Project development and alternatives):

- the project has been designed within a safety regulatory and management framework in which the safety of air navigation is regarded as the most important consideration and where management systems are in place to ensure that such a commitment is met
- the airspace and flight path design is underpinned by defined goals established at the outset that all risks will be managed to be as low as reasonably practicable and that any residual risk will be acceptable
- the airspace and flight path design is further underpinned by 2 design principles supporting inherent safety: systemic separation of aircraft and air traffic controller workload minimisation
- the identification and evaluation of options for airspace and flight path design, and the selection of the preferred concept option has followed a rigorous process which can be expected to deliver an optimum solution within the inherent constraints of the existing operational requirements that is safer by design
- the subsequent development of the preliminary airspace design from the selected concept option follows established industry practice and has delivered a more detailed operational specification that can be expected to deliver an eventual outcome meeting the identified objectives, minimising airspace conflicts and maximising system operability.

The consideration of airspace conflicts and other threats to operational safety is a complex and ongoing process. As outlined in Section 6.4 (Future phases) of the EIS, the consideration of safety will continue as the project advances to detailed design and implementation. This includes safety and hazard assessments to ensure that risks have been identified and managed to the lowest practicable level.

13.5.2 Aircraft crash incidents

While aviation regulations and the requirements that guide airspace and flight path design are intended to primarily provide for the safety of aircraft and their occupants, it also supports the safety of those living and working in the vicinity of an airport by ensuring that aircraft crashes are very rare events.

The assessment considers the risk posed to the health and safety of persons living and working in the vicinity of an airport whose presence is not associated with the activities of WSI. For example, aircraft workers and passengers are not considered in the assessment. While aircraft crashes are uncommon, the majority occur along flight paths and close to the runway ends where the crash risk is more concentrated. The consequence of an aircraft crash incident on the ground would include property damage, injuries and fatalities.

13.5.2.1 Individual risk

The assessment of individual risk in the 2033 and 2055 assessment years at the ends of Runway 05/23 found that:

- the 1 in 10,000 per annum contours are contained entirely within the Airport Site for both assessment years and are located at both ends of Runway 05/23
- the 1 in 100,000 per annum contours in 2033 at the south-west runway end is fully contained within the Airport Site. The majority of the 1 in 100,000 per annum contour at the north-east runway end is also contained within the Airport Site. Around 20 per cent of the area (1.64 hectares (ha)) is located outside the Airport Site (beyond Elizabeth Drive)
- the majority of the 1 in 100,000 per annum contours are contained in the Airport Site in 2055. Around 37 per cent (23.06 ha) is located outside the Airport Site
- the 1 in 1,000,000 per annum contours for the 2033 and 2055 assessment years extend beyond the Airport Site at both runway ends, with a greater extent of areas outside the Airport Site occurring in 2055. The shape of this risk contour is also influenced by turns on some departure flights.

The individual risk contours are shown in Figure 13.2 (2033) and Figure 13.3 (2055).

The extent to which the operations at WSI would represent a real threat to people and other facilities on the ground is dependent on the extent to which developments are located within them. A limited number of people and dwellings occur within the individual risk contours that extend beyond the Airport Site (refer to Table 13.2).

Table 13.2 Summary of the number of dwellings and persons estimated within individual risk contours

Assessment year	Dwellings	Persons
2033		
1 in 100,000 per annum	0	0
1 in 1,000,000 per annum	6	22
2055		
1 in 100,000 per annum	2	5
1 in 1,000,000 per annum	30	108

Figure 13.2

2033 risk contours

Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal

Risk contours

- 1 in 10,000 per annum
- 1 in 100,000 per annum
- 1 in 1,000,000 per annum

0 1 2 km

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:100,000 Date: 27/06/2023

Data sources: - DITRDC, DCS, Nearmap, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

Figure 13.3

2055 risk contours

Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

Risk contours

- 1 in 10,000 per annum
- 1 in 100,000 per annum
- 1 in 1,000,000 per annum

0 1 2 km

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:100,000 Date: 27/06/2023

Data sources: - DITRDC, DCS, Nearmap, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

Based on the criteria provided in Table 13.1, the risks for the:

- 2033 assessment year are classified as 'slight effects', which corresponds with low numbers (up to a few tens) of people exposed to an individual fatality risk between 1 in 1,000,000 per annum and 1 in 100,000 per annum
- 2055 assessment year is classified as 'moderate effects', towards the lower end of the classification. This corresponds with low numbers (up to a few tens) of people exposed to an individual risk above 1 in 100,000 per annum or high numbers (hundreds to thousands) exposed to an individual risk between 1 in 1,000,000 per annum and 1 in 100,000 per annum.

Except for 2 dwellings in the 2055 assessment year, the risk impacts are consistent with the NASF Guideline I public safety area criterion of an individual risk of 1 in 100,000 per annum.

13.5.2.2 Societal risk

The societal risk impacts have been determined by consideration of the full range of accident scenarios involving aircraft of different sizes from the fleet mix anticipated in 2033 and 2055 and impacts in different locations with different densities of occupation. The FN curve method summarises the full range of potential outcomes, by means of a plot on a logarithmic scale of the number of fatalities against the event frequencies for all foreseeable scenarios. This is shown in Figure 13.4. The available criteria typically identify levels of societal risk defined in terms of the FN curve measure below which risks can generally be considered negligible, generally acceptable and not of any regulatory concern. Similarly, the criteria identify risks levels that may be considered of substantial regulatory concern and perhaps intolerable. The primary focus of safety regulation is on ensuring that risks between these 2 limits, identified in FN curve terms as the 'as low as reasonably practicable' region, are appropriately managed so as to meet the 'as low as reasonably practicable' requirement. A summary of the societal risk assessment estimates for 2033 and 2055 is further described in Table 13.3.

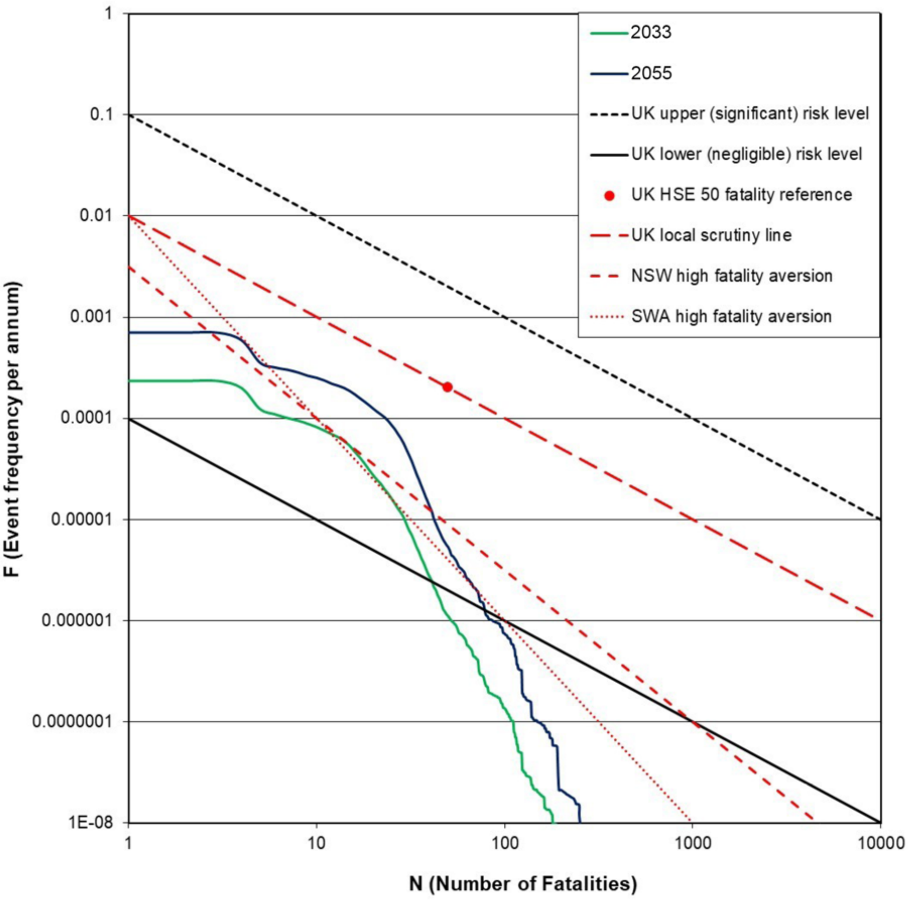


Figure 13.4 Societal risk FN curve for 2033 and 2055 assessment years

Table 13.3 Summary of societal risk assessment estimates for 2033 and 2055

Risk measure	2033	2055
Crashes involving one or more fatalities	0.000236 per annum, or 1 in 4,245 years	0.000706 per annum, or 1 in 1,416 years
Average number of fatalities per crash[1]	9.6	10.7
Expectation value	0.00227 per annum, or 1 in 441 years	0.00755 per annum, or 1 in 132 years
Scaled risk integral value	6,770	24,244

1. As outlined in Section 13.3.2.2, the assessment of societal risk considers the risk posed to the health and safety of persons living and working in the vicinity of an airport, and does not account for aircraft passengers or workers at WSI.

The assessment found that:

- on average, crashes involving one or more fatalities can be expected to occur at a frequency of 1 in 4,245 years and 1 in 1,416 years in 2033 and 2055, respectively
- the average number of fatalities estimated for the full range of scenarios involving crashes of different sized aircraft into the range of population densities encountered along flight paths is around 9.6 and 10.7 for 2033 and 2055, respectively. Incidents resulting in fatalities of 100 or more third parties, which would occur as a result of a larger aircraft crashing into a more densely populated area, are expected to be very uncommon with estimated rates of 1 in 7.3 million years and 1 in 1.3 million years for 2033 and 2055, respectively
- for the 2033 assessment year (refer to Figure 13.4), the total societal risk would:
  - be above the UK criterion level for negligible risk, but well below the UK criterion for significant risk
  - meet the more stringent criteria for additional aversion to high fatality incidents as identified in Australian guidance (NSW and SWA)
- for the 2055 assessment year (refer to Figure 13.4), the societal risks would be broadly similar to the 2033 scenario but somewhat greater, reflecting the increased number of aircraft movements. Specifically that societal risk would:
  - exceed the UK criterion level for negligible risk, but would be well below the UK criterion for significant risk
  - exceed the more stringent criteria for additional aversion to high fatality incidents as identified in Australian guidance (NSW and SWA) for incidents that result in 5 to 50 fatalities. For a higher number of third-party fatalities (in the order of 100 or more), the risk for the project in 2055 is below the Australian guidance criteria (NSW and SWA).

The FN curves for both the 2033 and 2055 assessment years are within the middle to lower risk part of the 'as low as reasonably practicable' region. These risks are considered acceptable, provided no further practicable means for mitigating these residual risks are available. In this regard, based on the runway location, airspace design requirements and the relative location of developed areas within the Sydney Basin, the flight path design has minimised these risks, as far as is practicable.

While the more stringent additional aversion to high fatality incidents criterion would be exceeded in the 2055 assessment year, the comparison to the scaled risk integral (as defined in Republic of Ireland guidance to account for high fatality risk aversion) indicates a relatively moderate societal risk and that this would be below the significant risk threshold of 500,000. This is generally consistent with the conclusions when considering the UK criteria, in that the risks would not be considered entirely negligible but would be below the upper limit in which risks might be considered unacceptable.

Further consideration has been given to the NSW and Australian guidance criteria, noting that the average number of third-party fatalities is estimated at 10. This is substantially below the average number of passenger and crew fatalities that could be expected based on the typical numbers onboard an aircraft. As such, the Australian guidance criteria are not particularly representative of societal risks that are accepted and do not warrant application in this case to assess high fatality risk aversion. Third-party risks at similar levels, if not higher, would be expected at other airports serving comparable numbers of movements.

Expectation values, representing the number of fatalities on average in a year to be expected from the range of identified crash scenarios in terms of the number of fatalities (n) and event frequencies (F), are shown in Table 13.3. This measure provides a relatively simple means of combining the 2 elements of societal risk into one number for comparison with other risks. The estimated fatality rates of 1 in 441 years (2033) and 1 in 132 years (2055) represent relatively low risks, however the expectation value is not employed formally as a basis for defining any risk acceptability criteria.

13.5.2.3 Risks to critical infrastructure

A list of infrastructure has been identified for assessment:

- transport links that cross the extended centreline of the runway or are in the more immediate vicinity of flight paths, such as Elizabeth Drive, the A9, M7, M4 and Nepean River Bridge crossing
- Defence Establishment Orchard Hills, which serves as a munitions store
- major hospitals
- reservoir facilities, from the perspective of structural integrity and contamination risk to water supplies in the event of a crash or by fuel jettisoning in an emergency
- fire initiation risk, in particular in relation to the GBMA.

The areas in the vicinity of WSI subject to relatively high risk are located along flight paths towards the runway ends. The individual risk contours provide a guide to the areas that are subject to more elevated levels of risk and those areas where risks at any individual site can normally be considered to be negligible and acceptable. No infrastructure that might be considered particularly sensitive or critical is located within the area of elevated risk delineated by the 1 in 1,000,000 per annum individual risk contour for 2055.

Transport links

Elizabeth Drive and the A9 pass through the area covered by the 1 in 100,000 per annum contour for the 2055 assessment year at each runway end. Given that an individual motorist or road user is not expected to spend a significant amount of time within the area of elevated risk, no individual is subject to an individual risk above the negligible level of 1 in 1,000,000 per annum. It is nevertheless recognised in NASF Guideline I that many people may be using a transport link at any given time and should be assessed in terms of the density of people using them that might be exposed to the risk.

Three transport routes have been quantitatively assessed (Table 13.4). Other transport routes at similar distances or further away from flight paths would have comparable levels of risk or lower (such as the Nepean River Bridge). These risks were estimated by reference to the crash risks that are predicted across the carriageways out to distances of several kilometres either side of the runway extended centreline. Risks would reduce along these transport links as the distance to the centreline increases.

Table 13.4 Transport link impact risk

Transport link	2033	2055
Elizabeth Drive	4.28×10^{-5} per annum, or 1 in 23,367 years	1.23×10^{-4} per annum, or 1 in 8,137 years
A9	5.36×10^{-5} per annum, or 1 in 18,641 years	1.54×10^{-4} per annum, or 1 in 6,495 years
M7	3.37×10^{-6} per annum, or 1 in 296,742 years	9.14×10^{-6} per annum, or 1 in 109,396 years

The potential impact consequences include fatalities to road users and infrastructure damage. The area affected in the event of an aircraft crash is estimated to be in the order of 0.5 to 0.6 ha in 2033 and 2055, respectively (equivalent to a circle of 40 metre radius).

The number of fatalities for typical densities of use of road links can be expected to be in the order of tens or fewer, on the assumption that several vehicles with several occupants are impacted. This value is generally consistent with the average number of fatalities identified for impacts in residential areas in the societal risk assessment. The overall risk is not particularly significant when assessed against the available societal risk criteria.

The disruption of roads can be expected to be limited (such as repairs over a short period during which alternative routes from the wider network provide mitigation). Longer term disruption could include damage to bridge structures at motorway interchanges. There is limited scope for such events, given the proximity of motorway interchanges to flight paths.

Defence Establishment Orchard Hills

Some Runway 05 departure routes pass close by the Defence Establishment Orchard Hills site, which has been assessed given its munitions storage function. Crash risks across the site are estimated to be 1 in 100,000 years in 2033 and 1 in 43,000 years in 2055. However, much of the site is open space and the risk of impact with site infrastructure would be lower than these estimates. The risks of an impact with a munitions storage building are estimated to be 1 in 2,000,000 years in 2033 and 1 in 835,000 years in 2055.

Crashes can normally be expected to affect a single building only or in the case of impacts of larger aircraft 2 buildings. Protocols for munitions storage at the site will limit the knock-on impacts to other storage buildings in the event of an explosion at one building. The consequences of an impact are expected to be those resulting directly from an impact only.

Major hospitals

Three major hospitals are located in the general vicinity of WSI (Penrith, Liverpool and Westmead hospitals). They represent relatively large potential exposure areas for an aircraft crash (of between around 15 to 25 ha, compared with the estimated crash impact area of 0.5 to 0.6 ha). A crash can therefore be expected to affect only a small proportion of these sites, estimated to be around 2 per cent to 4 per cent.

The highest overall site crash risk probabilities are estimated for Penrith Hospital, which is closer to higher levels of flight activity. Crash risks at Penrith Hospital are estimated to be 1 in 19 million years in 2033 and 1 in 7 million years in 2055. Flight activity near Liverpool and Westmead Hospitals is much lower and lower crash risks have been estimated.

Given the densities of occupation of these sites, high levels of fatalities may potentially arise in the event of an aircraft impact. However, the scale of the fatalities is unlikely to exceed the upper levels that have been estimated according to the societal risk assessment. Taking account of the low event frequencies, the risk associated with these scenarios are low and acceptable when assessed against the available societal risk criteria.

Warragamba Dam and Prospect Reservoir

A limited number of Runway 23 departures pass close to the Warragamba Dam barrage. The probability of an impact directly on the barrage of the Warragamba Dam is estimated to be 1 in 40 million years in 2033 and 1 in 13 million in 2055. A substantially larger area of water at Lake Burragorang is exposed to a crash risk. The frequency of impacts in the lake are estimated to be 1 in 240,000 years in 2033 and 1 in 87,000 years in 2055.

While the contamination of the water is a possibility in the event of a crash, it is expected that significant adverse impacts would not necessarily occur in all instances. The capacity of Lake Burragorang is 3 million tonnes. Fuel spillages may have limited impacts on water quality given the dilution involved.

Prospect Reservoir lies relatively close to (but not directly beneath) the Runway 23 approach path. The event frequencies for Prospect Reservoir are similar to those estimated for Warragamba Dam and Lake Burragorang.

Blue Mountains and other fire initiation risks

Given the fuel load on aircraft, particularly during and shortly after take-off, fuel fires are a potential concern in the event of a crash. Commonly encountered fire impacts following impacts are taken into account in the consequence model used for the assessment of fatality risks. The potential for wider knock-on bushfires in the event of a post-impact fire also merits attention. Jet aviation fuel is of relatively low volatility and requires a fairly powerful ignition source for fire initiation which may be present in some impacts. Analysis of historical incidents indicated around 50 per cent of crashes involve post-impact fire.

The estimated crash rate during take-off and landing for 2055 operations is estimated to be around 1 in 50 years. The corresponding post-impact fire rate is therefore estimated to be around 1 in 100 years. This rate applies in the more immediate vicinity of the runway and covers the majority of the crash events. An additional but relatively small risk applies along airways, beyond the immediate runway, and has been estimated using the available airways model (as described in Appendix C of Technical paper 4). Given its importance, specific attention has been given to the crash risk in the GBMA.

Operation of flight paths over the GBMA is found to present a low risk of introducing fire through aircraft accidents. This is based on an estimate for the crash rate from aircraft during flight over the GBMA ranging between approximately 1 in 1,700 to 1 in 2,400 years in 2055 (as set out in Appendix C of Technical paper 4), and a post-impact fire rate of around half that value (1 in 3,400 to 1 in 4,800 years in 2055). The range in the crash rate risk reflects the likely distribution of traffic movements using the flight paths over the GBMA. This estimate covers all events throughout the year, including events outside the season of primary bushfire risk. Compared with the current fire initiation rates from other causes, this risk can be seen to be very small.

13.5.3 Fuel jettisoning

Fuel jettisoning (or fuel dumping) would be carried out in accordance with the AIP ENR. Fuel jettisoning is a rare occurrence in Australia and only occurs after authorisation from air traffic control. There are very limited occurrences of impacts ground level. Fuel jettisoned at a sufficient altitude would volatise (change from liquid to vapour) as it falls and is completely dispersed as vapour before any liquid reaches ground level. If possible, except in the case of emergencies, fuel jettisoning will be conducted at an altitude of at least 6,000 ft (approximately 1.8 km) above ground level to ensure total dissipation into the atmosphere prior to contacting the ground (as per the AIP ENR).

A total of 145 events (occurrences where an aircraft jettisons or burns off fuel in order to reduce its landing weight to an acceptable limit) in Australian airspace have been recorded in the ATSB National Aviation Occurrence Database between 2003 and 2022. While this database documents accidents and incidents that have been reported to the ATSB since 1 July 2003, systematic reporting and recording of these events did not begin until 2010 and only one recorded incident is from before 2010. For this assessment, the period between 2010 to 2022 has been considered where 144 incidents were reported.

The review of available data indicates that:

- based on the aircraft type or on the information provided, 43 per cent of the occurrences are understood to have involved fuel jettisoning. The occurrences were mostly relatively minor incidents, although there is limited information in the database and only around 78 per cent of the entries identified whether fuel burn off or jettisoning occurred
- the majority of the fuel jettisoning or fuel burn off events occurred shortly after take-off or during the climb (around 77 per cent of occurrences) and one occurred during landing. All other occurrences were enroute incidents.

A review of available ATSB safety investigations on fuel jettisoning incidents or related incidents (noting that only a portion of incidents are investigated) found that:

- 6 incidents of fuel jettisoning occurred over the sea and at altitudes of 7,000 feet (ft) or more. One of the 6 cases involved a deliberate flight path diversion
- one incident occurred during take-off which required the aircraft to return to the departure airport. In this incident, the aircraft remained under 2,000 ft and fuel was not jettisoned as an overweight landing was executed.

The general conclusions to be drawn from the review of incidents identified in the ATSB National Aviation Occurrence Database is that fuel jettisoning can be carried out safely and without any impacts at ground level when appropriate procedures are followed. This is supported by a review of the wider international data.

Further detail is provided in Section 8.1.1 of Technical paper 4.

With respect to potential risks to land in the vicinity of WSI, fuel jettisoning events associated with failures during take-off and climbing phases of flight is of primary relevance. Of the 144 incidents between 2010 and 2022, 43 per cent involved fuel jettisoning and 77 per cent occurring on take-off, representing around 48 fuel jettisoning incidents following take-off.

Based on the operational statistics presented in Appendix A of Technical paper 4, a total of 9,281,707 commercial air transport take-off operations are estimated to have taken place over the period 2010 to 2022 from which an incident rate of 5.17×10^{-6} per take-off movement is estimated. When considering the annual aircraft movements at WSI in 2055 (around 226,000 aircraft movements), this rate translates to slightly less than one fuel jettisoning event per annum.

There are limited occurrences only of impacts at ground level associated with fuel jettisoning in the wider international incident record, confirming that this is a very small risk. The likelihood of a fuel jettisoning event that results in ground level impacts is expected to be less than the likelihood of an aircraft crash during take-off or landing at WSI.

In terms of the potential risks to sensitive receiving environments (e.g., water supplies), analysis indicates that fuel jettisoning represents less of a threat than a direct aircraft crash impact. As a fuel jettisoning incident that results in ground level impacts in the vicinity of WSI is estimated to be extremely remote, events with tangible impacts on potentially sensitive receiving environments would be even less likely and therefore would be exceedingly remote.

Overall, fuel jettisoning is a relatively uncommon non-standard operational requirement that would not have ground level impacts if carried out in accordance with appropriate procedures. There would be no significant adverse impact from fuel jettisoning associated with the project. While it cannot be guaranteed that such impacts could never occur, the historical record indicates that any such incident would be a very remote event.

13.5.4 Objects from falling aircraft

A total of 189 occurrences of objects falling from aircraft involving commercial air transport movements between 2003 and 2022 have been identified from a search of the ATSB National Aviation Occurrence Database. Across all phases of flight, 115 occurrences were associated with commercial air transport movements that may be considered representative of future operations at WSI. Approximately 50 per cent of these occurrences took place in the general vicinity of airports during take-off, initial climb, approach and landing. With consideration to the number of flights over that period of time, it is estimated that this type of incident during these phases of flight occurs around 1 in 300,000 flights (1 in 600,000 take-off and landing movements). On that basis, it is estimated that such incidents would be 1 in 3 year events for the level of activity forecast in 2055.

Two of the identified occurrences affecting fixed wing commercial air transport movements are identified as serious incidents and the remainder are identified as incidents. No injuries are reported to have occurred in any of these occurrences and those classified as serious incidents were evidently given that classification due to the potential threat to aircraft safety associated with the loss of the falling object rather than any identified threat to third parties. A wide variety of objects were involved in these reported occurrences, including maintenance inspection panels (as a relatively common item), baggage from aircraft holds following cargo door failure events, and various smaller items such as windscreen wipers and VHF antennas. While small, falling objects may lead to a significant injury to an individual on the ground.

The consequence of an impact would be substantially smaller than the consequence of an aircraft impact, but the frequency of such an event is greater. The frequency of an aircraft crash is around 1 in 50 years compared to a risk of 1 in 3 years for an object falling from aircraft in 2055. However, the risk of an object falling from aircraft is small compared to the risks of an aircraft crash when considering the consequence and frequency of such an event. As outlined in Section 8.2 of Technical paper 4, the impact area associated with the largest object would not be greater than 1 m^2 or around 6,000 times smaller than the average aircraft crash areas in 2055. Considering the different scale in consequence and rate of incidence, the risk associated with an object falling from aircraft is estimated to be more than 300 times smaller than the risk associated with an aircraft crash.

Given that the risks associated with aircraft crashes have been shown to be low and acceptable, it is concluded that the lesser risks associated with objects falling from aircraft are low and acceptable. Further detail is provided in Section 8.2 of Technical paper 4.

13.5.5 Wake vortex impacts

In generating the lift forces necessary to allow an aircraft to fly, its wings generate movements in the volume of air through which the aircraft passes. The most significant of these are spiralling movements of air flowing from each wingtip leading to a pair of wake vortices that trail behind the aircraft and tend to descend as they rotate. Vortices are an unavoidable consequence of aerodynamic lift and are generated by all aircraft in all phases of flight. Vortices generally dissipate without causing any physical impacts. However, when aircraft are relatively close to the ground during landing (i.e., shortly before touchdown), vortices sometimes reach the ground and have sufficient power to cause building damage. The strongest vortices are generated by heavy aircraft flying at low speed, during approach.

Vortex damage incidents typically involve the disturbance of tiles or slates on the roofs of traditionally constructed houses. Vortex damage is more frequently encountered at busier airports serving larger wide-bodied jets where housing is located close to the flight paths and runway ends.

The likelihood of vortex damage is dependent upon several different factors:

- the size of the aircraft operating at WSI
- the distance between the approach path and buildings along it (vertical and lateral)
- weather conditions at the time of the operation
- the susceptibility of a building to damage (based on its construction).

The statistics for London Heathrow Airport (Heathrow Airport) provide a reasonable basis for assessing the potential for wake vortex impacts at WSI as there is a broad similarity of the fleet mixes anticipated at WSI and those operating at Heathrow Airport. However, it is acknowledged that the possible differences in meteorological conditions may influence the relative rates and location of occurrence.

A review of vortex strike records for Heathrow Airport indicates an annual average of around 102 verified strikes between 2006 and 2010. Annual aircraft movements during that period were around 470,000. Given the prevailing westerly wind conditions, most approach operations at Heathrow Airport (typically 75–80 per cent) take place over predominantly urban development. A relatively high probability of wake vortex events at Heathrow Airport is therefore expected. The records also indicate that most events are contained within 4 km from the end of the runway (runway threshold) in a funnel of around 14 degrees extending either side of the approach path. Observations from Heathrow Airport and the number of annual movements at WSI in 2055 suggest that around 50 wake vortex events that have the potential to cause roof damage could occur annually, if the vortices occur at a building that is susceptible to damage. Based on observations at Heathrow Airport, it is expected that most of these events would be contained within an area that extends from the runway threshold for around 4 km in a funnel shape of around 14 degrees either side of the approach path (refer to Figure 13.5).

There is a limited number of buildings located in the area where possible wake vortex damage from WSI operations could occur. From the available satellite images only one building with a tiled roof was identified that may be susceptible to wake vortex damage. This building is located towards the periphery of the area subject to potential wake vortex damage, therefore the probability of impact is expected to be low.

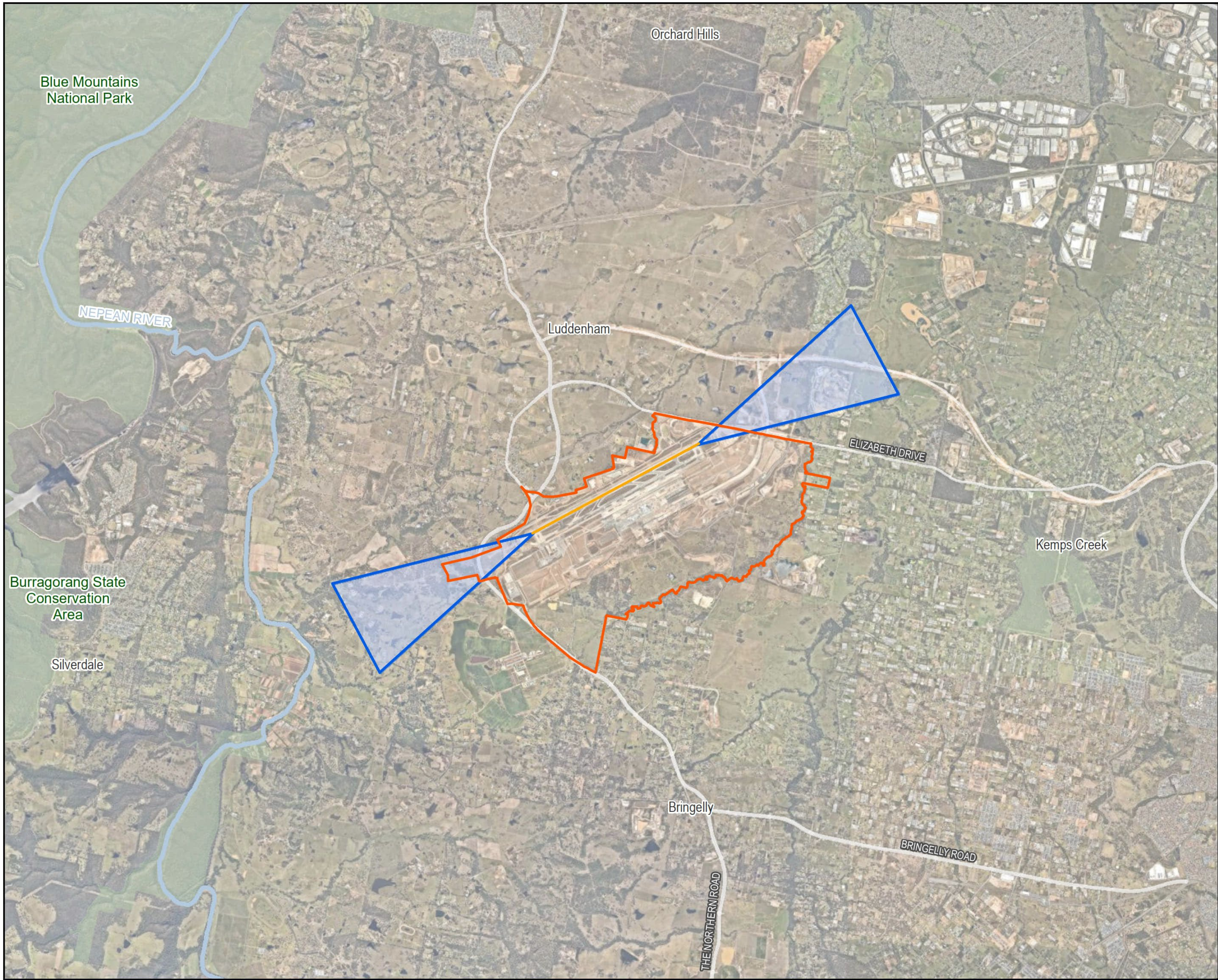
Overall, there is a low risk of wake vortex damage associated with the project due to:

- the limited number of buildings located in areas where wake vortex damage is identified as a possibility
- the type of roof construction adopted for most of the buildings
- the low probability of impacts in the area where potentially susceptible roofs are located.

In the unlikely event of damage occurring, this can be effectively addressed by the compensation scheme operated by Airservices Australia in accordance with the *Air Services Regulation 1995* (Cth).

Figure 13.5

Areas subject to potential wake vortex damage



Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- Wake vortex

0 1 2 km

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:100,000 Date: 21/04/2023

Data sources: - DITRDC, DCS, Nearmap, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

NASF principles and guidelines *Guideline B: Managing the Risk of Building Generated Windshear and Turbulence at Airports* (NASF Guideline B) refers to wake vortex as a component of overall turbulence impacts and provides some high-level guidance for building design to minimise future impacts, in the event new development is proposed in the identified wake vortex area. At WSI, there are no off-airport planning controls that relate specifically to the management of risk to buildings due to wake vortex associated with the Western Parkland City SEPP. However, in regard to most land uses, other planning controls are already in place which would serve to reduce development within the wake vortex area and minimise impacts to buildings from turbulence. This includes the Obstacle Limitation Surface, Public Safety Areas and the ANEC contours which restrict certain land use types within the ANEC 20 and above contours (refer to Technical paper 6 (Land use and planning) (Technical paper 6)). These are all in proximity to the wake vortex area identified for WSI and would to some extent address the associated impacts.

13.5.6 Meteorological hazards

The extent to which potential adverse meteorological conditions may represent hazards to aircraft operations at WSI and lead to real risks to operational safety has been assessed by reference to the ATSB National Aviation Occurrence Database and site-specific assessment of local conditions at WSI provided by the Western Sydney Airport Usability Report (Bureau of Meteorology, 2015).

Around 5,097 weather-related occurrences since 2003 have been identified in the ATSB database, with turbulence and windshear accounting for around 68 per cent of occurrences, and lighting strike accounting for 25 per cent. The majority of these occurrences were classified as incidents, 49 as serious incidents and 28 as accidents, 2 of which resulted in fatalities. Both accidents that resulted in fatalities involved relatively small piston-engine powered aircraft operating charter passenger flights.

Of the 28 occurrences identified as accidents, 12 involved turbofan powered aircraft or turboprop powered aircraft. 10 of these 12 occurrences were classified in the turbulence, windshear and microburst category.

Weather related occurrences were reported across the full range of phases of flight. Around 20 per cent were in the cruise phase and 80 per cent spread across take-off, initial climb, climb, descent, approach and landing.

Weather related factors have potentially significant implications for the safety and efficiency of aircraft operations. The most significant factor was identified as turbulence and windshear. However, the severity of the consequence is normally relatively limited.

The types of turbofan and turboprop aircraft that would operate at WSI are normally expected to be resilient to turbulence and windshear. The historical records indicate that the consequences of such encounters are typically limited to injuries to low numbers of aircraft occupants not using seat belts. Nevertheless, it is evident from the wider international dataset that such weather phenomena may lead to aircraft crashes when they are encountered relatively close to the ground, near airports.

Weather phenomena that may adversely affect operations at WSI have been considered in detail in the Western Sydney Airport Usability Report (Bureau of Meteorology, 2015). Meteorological characteristics considered in the usability report include wind, temperature, rainfall, fog and low cloud, turbulence and thunderstorms. The report focuses on the operational implications of meteorological conditions at WSI, based on recent historical weather records and concludes:

- the runway configuration would be usable approximately 99.5 per cent of the time based on crosswinds alone
- other weather phenomena, such as fog, low cloud and low visibility conditions, may lower the usability of WSI but that these impacts could be mitigated through navigational systems and aids
- WSI would be less susceptible to turbulence and wind shear than Sydney (Kingsford Smith) Airport and identifies no particular concerns about these weather phenomena
- the proximity (around 20 km) of the Airport Site to the Great Dividing Range (Blue Mountains) means that a short lead time for thunderstorm aerodrome warnings would be available and recommended that an Automated Thunderstorm Alert Service (ATSAS) is implemented at WSI to improve the accuracy of thunderstorm forecasting.

The potential for adverse meteorological conditions, in particular turbulence, wind shear and thunderstorm activity, is evident. The available historical evidence indicates that the risk of these types of occurrences leading to a real threat to aircraft safety is limited. Compared with other airports which operate with an acceptable level of safety, there are no exceptional meteorological conditions at WSI that might lead to significant risks to operational safety.

Measures to identify and avoid adverse weather conditions are applied generally in the air transport industry to limit the risk to aircraft safety. Airservices Australia works with the Bureau of Meteorology to advise pilots of hazards as appropriate, such as haze or smoke caused by bushfires or controlled burning. Where smoke does reduce visibility at an airport, usual procedures for flying in low-visibility conditions would apply. The implementation of an ATSAS at WSI would help mitigate the identified site-specific susceptibility to potential thunderstorm activity.

While these measures are primarily directed towards the provision of aircraft safety, they would support the achievement of acceptable levels of safety for third parties in the vicinity of WSI. The generic aircraft crash risk model that has been used to determine the level of risks to third parties takes account of a wide range of causal factors, including weather-related accident scenarios. No specific weather related risks to aircraft operations at WSI were identified that would suggest that the risk estimates provided by the available generic model do not adequately represent the risk to third parties in the vicinity of WSI.

Climate related risks to aviation associated with WSI flight paths are discussed in Chapter 3 of Technical paper 3 (Greenhouse gas) (Technical paper 3). Higher temperatures and more severe heat waves are climate related risks for WSI (refer to Table 3.1 of Technical paper 3), however the assessment did not find evidence to demonstrate that increased temperatures associated with climate change would have a material impact on the rate of operational failures as a result of adoption of the flight paths. Previous international operational experience covers a wide range of temperatures, including those expected to be at WSI under anticipated climate change scenarios, and operational practices are in place to ensure safe operations under those conditions.

13.5.7 Wildlife hazards

Wildlife strikes with aircraft can present a significant risk to aircraft safety. Consequences can be very serious, resulting in human fatalities and loss of aircraft. They can also result in significant costs due to the repair of damaged aircraft or operating costs due to downtime. Strike risk depends on the probability of colliding with wildlife and the consequence to the aircraft if collision occurs. The probability is determined by a number of factors including the number of wildlife and aircraft operating in the same airspace, the airspeed, and altitude. The consequence of a strike is influenced by the number and size of the animals struck, the combined closing speed, the phase of flight and the part of the aircraft hit.

Wildlife strikes rarely have catastrophic outcomes for aircraft in Australia. The ATSB received 22,526 wildlife related occurrences for civil aircraft operations between 2003 and 2022. Of these occurrences that involved wildlife strike, one of these occurrences was classified as an accident (due to the scale of aircraft damage) and 2 were classified as serious incidents which resulted in minor damage. These were a result of kangaroo or bird strike during aircraft landing. None resulted in human fatalities or injury.

Most of the reported incidents involved bird strikes and resulted in minor or no aircraft damage and no injuries.
Bird strike hazards that have potential implications for third party safety are concentrated at and in the immediate vicinity of an airport with 75 per cent of incidents occurring during take-off or landing and 22.5 per cent during the initial climb and approach.

In civil aviation, around 93 per cent of strikes occur at or below 3,500 ft (Dolbeer, 2011). As such, the primary concern for wildlife strikes occurs along the approach and departure paths at or below this altitude. While strikes above 3,500 ft can occur with thermal soaring species, such as the Australia Pelican and Wedge-tailed Eagle, the frequency of high-altitude strikes is comparatively low.

Managing wildlife hazards on airports is regulated by Civil Aviation Safety Regulations (CASR) (1998) Part 139 (Aerodromes) Manual of Standards (MOS) as defined by the *Civil Aviation Act 1998*. A number of other State, national and international legislation, regulations, policies and guidance documents also guide the management of wildlife hazards on- and off-airports. This includes the various ICAO documents, the *NASF Guideline C: Managing the Risk of Wildlife Strikes in the Vicinity of Airports*, the Western Parkland City SEPP, and the Western Sydney Aerotropolis Development Control Plan (DCP).

As such, safeguarding WSI against wildlife hazards requires a multi-stakeholder approach. WSA Co will prepare, in accordance with civil aviation regulations, a wildlife management program that focuses on the Airport Site, however land users and relevant consent authorities within the vicinity of WSI must adhere to the safeguarding principles set out in the Western Parkland City SEPP and Western Sydney Aerotropolis DCP.

Based on the available survey data of the Airport Site, one species (the Eastern Grey Kangaroo) was identified as a very high species risk. The risk posed by this species would be minimal once WSI is fully contained by perimeter fencing and the existing population is removed. Eight avian and terrestrial fauna species were identified as a high species risk (Straw-necked Ibis, Australian White Ibis, European Brown Hare, Red Fox, Wood Duck, Pacific Black Duck, Little Black Cormorant and Chestnut Teal).

Birds flying over the runway and not using the airside area accounted for almost half of the in-air observations, and the Australian White Ibis accounted for 62 per cent of these observations. The Australian White Ibis was also the most observed species during on-airport surveys. This was attributed to active breeding colonies and access to resources in the vicinity of WSI. Australian White Ibis populations close to other Australian airports have created significant strike risks and have resulted in some serious strike events.

Based on the species recorded, habitat values and location of off-airport habitat relative to Runway 05/23, 6 of the 76 potential habitat sites within 13 km of Runway 05/23 were rated as having a very high land use risk (Duncan Creek) or high land use risk (ponds near Elizabeth Drive and Wolstenholme Avenue, Kemps Creek Resource Recovery Park, Western Sydney Parklands and the Lake Gillawarna Ibis Colony).

Bats (recorded as fruit bat, bat and Flying-fox) were the most reported species group struck at Australian airports between 2008 and 2017 (1,240 strikes) and over 10 per cent of these strikes resulted in damage to aircraft (ATSB, 2019). The primary conflict with aircraft with Flying-foxes would occur when they infringe on the airspace when travelling to or from foraging and roosting sites. Ninety-six per cent of Flying-fox collisions with aircraft occur at or below 1,000 ft above ground level (AGL), with the majority below 500 ft (Parsons et al., 2008) which indicates that areas within flight paths and at airports have the greatest strike risk from Flying-foxes. The conflict with WSI aircraft would depend on the altitude of the Flying-fox and aircraft. However, Flying-fox strikes are likely once WSI is operational given the high number of Flying-fox camps in the vicinity of WSI. To practically minimise the likelihood of collision, further understanding of foraging patterns is required in order to notify air traffic control if collision probability is high.

While wildlife presents a potential significant threat to aircraft safety, it can be effectively managed so that, for the most part, wildlife-related occurrences primarily give rise to financial costs to the commercial civil aviation industry (in respect to repair of damaged engines and airframes) rather than significant safety risks. Acceptable wildlife strike risk mitigation for WSI is achievable with the implementation of a rigorous and integrated wildlife management program that recognises site-specific characteristics alongside the effective implementation of safeguarding principles on land within 13 km of Runway 05/23. Any contribution to third party risks resulting from wildlife hazards can be expected to be small with the implementation of these measures. The likelihood of a wildlife strike leading to a ground impact in the vicinity of WSI would be negligible, compared with the overall crash probability which is itself very small. In the unlikely event of a wildlife strike compromising aircraft safety to the extent that a ground impact were to occur, the most likely locations affected will be within or close to the runway where harm to third parties would not arise.

Species recorded during the surveys are also indicative of the suite of species likely to occur at WSI and surrounds once WSI is operational. Changes to the landscape, including the objective of increasing tree canopy cover by 40 per cent in the Western Sydney Aerotropolis, means that it is difficult to accurately quantify how wildlife populations would respond. Ongoing monitoring would be critical to identify trends and ensure the early detection of wildlife issues. This is discussed further in Section 13.6.

13.6 Mitigation and management

13.6.1 Existing management

Strategic planning in the vicinity of WSI has considered and incorporated the operational needs of WSI into land use planning in accordance with guidance provided in the NASF. This has been ongoing for over a decade in conjunction with planning for WSI and is well established in existing planning instruments. The NSW Department of Planning and Environment's *Aviation Safeguarding Guidelines – Western Sydney Aerotropolis and surrounding areas* were also developed with input from DITRDCA and seek to ensure planning authorities consider WSI operations when undertaking land use planning for the Aerotropolis and surrounding areas of influence. Current planning provisions for land associated with the Aerotropolis has been developed in conjunction with the NASF specifically to support the operation of WSI and limit potential restrictions on surrounding land uses (and therefore risks to third parties or surrounding development).

With respect to aircraft wake vortex impacts, in the unlikely event of building damage occurring, mitigation is available through the compensation scheme operated by Airservices Australia which provides for repairs under the *Air Services Regulations 1995* (Cth).

13.6.2 Project specific mitigation measures

Consideration has been given to management and mitigation measures for the following hazards:

- airspace conflicts
- residual off-airport aircraft crash risks to third parties and critical infrastructure
- aircraft fuel jettisoning
- local meteorological hazards
- local bird and bat strike hazards.

Risk mitigation is provided by a wide variety of general measures adopted across the aviation industry that will apply to operations at WSI. WSI specific recommendations for mitigation have been identified, and are summarised in Table 13.5 and supported by the proposed monitoring program in Table 13.6.

Table 13.5 Proposed mitigation measures – aircraft hazard and risk

ID No.	Issue	Mitigation measure	Owner	Timing
HR1	Airspace conflicts	Airservices Australia will continue to address hazard identification and risk mitigation during the remainder of the design process and prioritise on-going safety performance monitoring.	Airservices Australia	**Pre-operation** (Detailed design, 2024–2026)
HR2	Contingency planning	WSA Co will implement contingency planning to respond to the impacts of crash events as per Part 139 Aerodromes Manual of Standards 2019.	WSA Co	**Operation** (Implementation, 2026–ongoing)
HR3	Aircraft fuel jettisoning	Airservices Australia will apply existing procedures to deal with aircraft fuel jettisoning occurrences as per AIP ENR.	Airservices Australia	**Operation** (Implementation, 2026–ongoing)
HR4	Local meteorological hazards	Automated Thunderstorm Alert Service (ATSAS) will be implemented by the Bureau of Meteorology (BoM) to provide improved thunderstorm forecasting. Implementation of a Doppler LIDAR, if required, will support the identification of turbulence and wind shear (subject to the conclusions of an appropriate cost-benefit study).	WSA Co (in coordination with BoM)	**Operation** (Implementation, 2026–ongoing)
HR5	Wildlife strike	WSA Co will monitor and control the presence of birds and other wildlife on or in the vicinity of WSI in accordance with Civil Aviation Safety Regulations (CASR) Part 139 MOS requirements and National Airports Safeguarding Framework (NASF) Guideline C (See Table 24.2).	WSA Co	**Operation** (Implementation, 2026–ongoing)
HR6	Wildlife strike	WSA Co will liaise with planning authorities on matters related to the development of, or modifications to, off-airport land uses that have the potential to attract hazardous numbers or types of wildlife.	WSA Co	**Pre-operation** (Detailed design, 2024–2026) and **Operation** (Implementation, 2026–ongoing)
HR7	Wildlife strike	WSA Co will establish a WSI Wildlife Hazard Management Committee (WHMC) that will likely comprise Western Sydney local government representatives, NSW Department of Planning and Environment and other relevant aviation stakeholders.	WSA Co	**Operation** (within 6 months of Implementation, 2026–ongoing)

ID No.	Issue	Mitigation measure	Owner	Timing
HR8	Wildlife strike	The WHMC will contribute to the preparation of regional species management programs (including Australian White Ibis) as required. Regional species management plans will build on any existing management programs (e.g. the Canterbury-Bankstown Council Australian White Ibis Management Program). The regional programs will aim to: • reduce species impacts on aviation and the community in general • provide advice to landowners on how they can contribute to species management programs on non-council land • establish measurable targets for species management • maintain the long-term sustainability of the local species populations.	WSA Co	**Operation** (Implementation, 2026–ongoing)

Table 13.6 Proposed monitoring program – aircraft hazard and risk

ID No.	Issue	Monitoring measure	Owner	Timing
M2	Wildlife strike	A bird and bat strike monitoring program will be conducted to monitor for the presence of wildlife on the WSI site and in vicinity of WSI. The monitoring program will: • identify wildlife hazards which must be assessed to reduce potential risk to aircraft operations • be conducted in accordance with relevant Commonwealth and State guidelines and standards including any recovery plans for threatened species • carried out under the direction of a suitably qualified person • be carried out in liaison with local government in relation to plans for proposed developments within 13 km of WSI that are likely to increase bird and bat strike • identify locations where reasonable and feasible mitigation measures to manage wildlife strike risk are required • be reviewed annually to determine its effectiveness.	WSA Co	**Operation** (Implementation, 2026–ongoing)

Chapter 14 Land use

This chapter provides an overview of the existing planning framework and land uses in the vicinity of WSI and assesses the potential impact to existing and future land use that may occur during operation of the project.

The refinements to the preliminary flight path design since the exhibition of the Draft EIS would not change the conclusions of the land use assessment as presented in this chapter and the supporting technical paper. Further detail is provided in Appendix G (Assessment of the refinements to the project) of the EIS.

The study area for the assessment comprises the land surrounding WSI where aircraft movements would have an impact on land uses through implementation of planning restrictions on future development.
The Obstacle Limitation Surface (OLS) has been identified as the most suitable boundary to assess potential impacts and forms the basis of the study area.

The study area encompasses an area of Western Sydney, where growth is being driven by major infrastructure growth areas and land use initiatives. Western Sydney International and Aerotropolis will be the key catalyst for driving further growth and development in the region.

Key land uses within the study area, subject to this assessment include residential, agricultural, recreational, industrial, commercial, health and education. Defence Establishment Orchard Hills (DEOH) (aside from WSI itself) is the dominant Commonwealth Land parcel within the study area and is located to the north of WSI.

There are several International and Australian publications and policies which provide strategic guidance on land use management in proximity to airport operations. The National Airports Safeguarding Framework (NASF) in particular, provides guidance on planning requirements for developments that could potentially affect aviation operations including (but not limited to) measures for managing impacts of aircraft noise, managing risks of intrusion into protected airspace and managing risks of wildlife strike near airports.

The assessment of land use impacts is based on the potential for 3 key aspects of the project and how they affect key land uses in the study area:

- aircraft noise, and the impact they could have on existing land use and future planning or approvals
- the potential for restricted development due to protected airspace (OLS and PANS-OPS)
- wildlife buffers and framework for how to manage the risk of wildlife strike on aircrafts in the vicinity of WSI.

The NSW planning framework takes a precautionary approach to residential land use in regard to WSI operations and has adopted an approach which relies on ANEC/ANEF contours and *Australian Standard AS 2021:2015 Acoustics – Aircraft Noise Intrusion Building Siting and Construction* (AS 2021:2015) to inform planning decisions for residential land uses in areas affected by aircraft noise.

The *State Environmental Planning Policy (Precincts – Western Parkland City) 2021* (NSW) (Western Parkland City SEPP) outlines that no new noise sensitive development (including residential development) will be permitted within the ANEC 20 and above contours (except in limited circumstances for certain applications for dwelling houses and subdivision that were permissible prior to the SEPP coming into effect). The consent authority for any such development would need to be satisfied that indoor noise levels set in AS 2021:2015 are met.

Under existing use rights established in the *Environment Planning and Assessment Act 1979* (NSW) (EP&A Act) and its regulations, it remains possible to enlarge or modify an existing use with the approval of the relevant consent authority. Any such development would need to give consideration of AS 2021:2015.

A small additional area of land in the vicinity of WSI is predicted to be within the 20 ANEC contour for the assessed noise scenarios, when reviewed in comparison to the published ANEC mapping within the Western Parkland City SEPP.

WSI's protected airspace was prescribed by declaration on 19 October 2017. Land use controls associated with OLS ensure that developments around airports do not impede on airspace and that planning authorities consider airspace requirements when determining applications surrounding WSI. Future developments with the potential to exceed the OLS must be referred to WSI's operator and the Department of Infrastructure, Transport, Regional Development, Communications and the Arts (DITRDCA) for review prior to the development being approved to proceed.

The PANS-OPS surface is generally above the OLS and is designed to safeguard an aircraft from collision with obstacles when the aircraft's flight may be guided solely by instruments, in conditions of poor visibility. A PANS-OPS for WSI will be prepared once flight paths have been finalised.

NASF Guideline C provides a framework for how to manage the risk of wildlife strike on aircrafts. That framework has been incorporated into the Western Parkland City SEPP and Aerotropolis Precinct Plans. Land use planning around WSI has incorporated the implementation of wildlife buffer zones to mitigate risks of wildlife hazards. There are a range of existing land uses within the study area which have the potential to attract wildlife. These existing land uses can continue in the future due to existing use rights however mitigation of potential wildlife risks may be required in consultation with WSI and NSW Department of Planning, Housing and Infrastructure (DPHI). Any new development classed as 'relevant development' under the SEPP and within the 13 kilometre (km) wildlife buffer of WSI will be subject to the wildlife management controls contained within the Western Parkland City SEPP.

Land use planning in the vicinity of WSI has considered and incorporated the operational needs of WSI into land use planning in accordance with guidance provided in the NASF. DITRDCA (formally Department of Infrastructure and Regional Development) liaised with State government agencies and relevant local councils concerning the adoption of the necessary guidelines into the applicable environmental planning instruments. The range of existing planning controls in place in the vicinity of WSI have been an effective means of providing appropriate controls over land use planning and development.

Further, project-specific mitigations have been identified, including continuing liaison between DITRDCA, State government agencies and relevant local councils to ensure applicable environmental planning instruments have regard to any changes to WSI's protected airspace and noise exposure contours.

14.1 Introduction

This chapter considers land use and planning impacts resulting from the project on current and future land uses. The assessment focusses on potential land use implications associated with airspace movements as well as land use impacts as a result of safeguarding measures for WSI overflight operations, having regard to the design of the proposed airspace. A detailed land use and planning assessment has been carried out for the project and is provided in Technical paper 6: Land use and planning (Technical paper 6).

In terms of the land use impacts associated with the broader development of WSI (including land use within the WSI, and impacts associated with ground-based airport activities), the 2016 EIS remains the relevant source of information.

14.2 Legislative and policy context

The Australian airspace is governed by Commonwealth legislation, specifically the *Airspace Act 2007* (the Airspace Act), the *Civil Aviation Act 1988* (the Civil Aviation Act), and their associated regulations, whereas the on-ground development of certain airports and protection of the airspace is primarily governed by the *Airports Act 1996* (the Airports Act) (and its regulations). Further information on these Acts and supporting regulations is provided in Chapter 5 (Statutory context).

New South Wales planning laws do not apply in relation to the management of controlled airspace. They also do not apply to the assessment of a plan for aviation airspace management by virtue of Section 160(5) of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). However the NSW Government and local councils are responsible for setting strategic land use direction and land use controls and as such, consideration has been given to relevant NSW legislation and environmental planning instruments where considered appropriate (such as land use beyond the WSI boundary).

The National Airports Safeguarding Framework (NASF) has been developed by the National Airports Safeguarding Advisory Group to provide guidance on planning requirements for development that affects aviation operations (such as aircraft noise, intrusions into prescribed airspace, and wildlife management). This is discussed further in Section 14.3.2.2.

The NASF has been implemented primarily through the land use controls provided in the Western Parkland City SEPP.

The NSW planning framework takes a precautionary approach to residential land use development in regard to WSI operations and has adopted a policy which relies on ANEF contours and AS 2021:2015 (Standards Australia, 2015) to inform planning decisions for residential land uses in areas affected by aircraft noise. AS 2021:2015 is discussed further in Section 14.3.2.4.

A summary of the legislative framework which guides land use planning in the project is provided in Technical paper 6.

14.3 Policy relevant to land use planning

14.3.1 Protected airspace

The airspace at and around airports is protected under Part 12 of the Airports Act and the Airports (Protection of Airspace) Regulations 1996 (APAR). International standards have been adopted which define 2 sets of invisible surfaces above the ground around an airport. The airspace above these surfaces forms WSI's protected airspace. These 2 surfaces are the Obstacle Limitation Surface (OLS) and Procedures for Air Navigational Services—Aircraft Operations (PANS-OPS) surface.

The OLS is intended to provide protection for aircraft flying into or out of WSI 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.

14.3.1.1 Obstacle Limitation Surface (OLS)

Structures and other activities that intrude into protected airspace have the potential to impact safe aviation operations at airports. As such, land use controls associated with Obstacle Limitation Surface (OLS) ensure that developments around airports do not impede on airspace and that planning authorities consider airspace requirements when determining applications surrounding WSI.

Western Sydney International's (WSI) protected airspace was prescribed by declaration on 19 October 2017 under the provisions of the Airports Act and the APAR. Declaration of the OLS enabled local councils and land use planning authorities to incorporate the protected airspace as appropriate in their land use planning instruments. Regardless, intrusions into prescribed airspace that do not have prior approval under the APAR or present an unacceptable impact on airport operations are not permitted.

A consent authority is required to consult with WSA Co as part of its assessment of a development application for development that intrudes into the WSI prescribed airspace. In addition, separate approvals under the APAR are required for activities that intrude into airspaces that is prescribed for WSI. Those activities, referred to as 'controlled activities' are listed in section 182 of the Airports Act and include:

- permanent structures, such as buildings or antennas plumes intruding into prescribed airspace
- temporary structures such as cranes intruding into prescribed airspace (information for crane operators)
- any activities causing intrusions into prescribed airspace through glare from artificial light or reflected sunlight, air turbulence from stacks or vents, smoke, dust, steam or other gases or particulate matter.

Some proposed permanent and temporary structures around WSI may be temporarily exempt until 2026 (prior to WSI becoming operational). These are:

- buildings, structures or things that penetrate the OLS but are no taller than 10 m above ground level
- temporary penetrations less than 12 months in duration
- activities authorised in the Airport Plan.

The OLS map for the WSI is shown on Figure 14.1. DITRDCA is in the process of engagement with State government agencies and local councils as part of the process of declaring a new OLS under the APAR.

14.3.1.2 Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS)

The PANS-OPS surface is generally above the OLS and is designed to safeguard an aircraft from collision with obstacles when the aircraft's flight may be guided solely by instruments, in conditions of poor visibility.

Under the Airports Act and the APAR airport operators must refer short-term PANS-OPS infringements (less than 3 months) to DITRDCA for approval. Long term intrusions of the PANS-OPS surface are prohibited.

A PANS-OPS for WSI will be prepared once flight paths have been designed and finalised.

14.3.1.3 Maximum building heights

Building height controls within the study area (and generally) are outlined in the relevant LEPs unless otherwise specified within an overriding SEPP.

Principle development standards within LEPs generally seek to establish maximum height limits for building based on broad principles such as maximising urban form, minimise shadowing, protecting views and supporting the existing and desired future character of the locality. LEPs also provide 'height of building' maps which outline heights that are not to be exceeded for varying land use zones. For example, development consent may be granted for residential purposes, in the appropriate land zoning if a dwelling does not exceed 9.5 m in height above ground level (existing).

The Western Parkland City SEPP contains provisions related to building height for specific growth precincts outlined within the SEPP including areas (Aerotropolis Precinct and Oran Park and Turner Road Precinct) within the study area.

Notwithstanding the above maximum building height controls, all buildings and structures, including equipment used during construction (such as cranes) are required to be contained within OLS limits established under the Western Parkland City SEPP.

14.3.2 Aircraft noise guidelines

Land use planning is an effective means to ensure that the activities nearby airports are compatible with aviation activities. Its main goal is to minimize the population affected by aircraft noise by introducing land use planning measures, such as land use zoning around airports.

Within the study area, expanding residential and other noise sensitive development of land surrounding WSI has the potential to create increased conflicts between airport operations and the community.

There are several key international and Australian publications which provide strategic guidance on land use management in the proximity to aviation activities.

14.3.2.1 International Civil Aviation Organization – Guidance on the Balanced Approach to Aircraft Noise Management

The International Civil Aviation Organization (ICAO) is a specialised agency of the United Nations that coordinates 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 *Doc 9829 Guidance on the Balanced Approach to Aircraft Noise Management* (ICAO, 2010) provides guidance on alleviating the problem of noise in the vicinity of airports. The Balanced Approach consists of identifying the noise problem at an airport and then analysing the various measures available to reduce noise through the exploration of 4 elements - reduction at source, land use planning and management, noise abatement operational procedures and operating restrictions (ICAO, 2010). The guidance outlines that there are substantial benefits to be gained from the correct application of land use planning techniques in the development of airports. The guidelines outline preventative measures that should be considered (where possible) including:

- locate new airports at an appropriate place, such as away from noise-sensitive areas
- take the appropriate measures so that land use planning is taken fully into account at the initial stage of any new airport or of development at an existing airport
- define zones around airports associated with different noise levels considering population levels and growth as well as forecasts of traffic growth and establish criteria for the appropriate use of such land, taking account of ICAO guidance
- enact legislation, establish guidance or other appropriate means to achieve compliance with those criteria for land use
- ensure that reader-friendly information on aircraft operations and their environmental effects is available to communities near airports.

The guidelines also state that airport authorities should work closely with local planning authorities responsible for land use management to educate them regarding the noise impact of aviation operations and encourage these authorities to develop and implement land use planning control measures in affected areas (ICAO, 2010).

14.3.2.2 National Airports Safeguarding Framework

The National Airports Safeguarding Framework (NASF) provides guidance on planning requirements for developments that could potentially affect aviation operations. The framework aims to improve community amenity by minimising aircraft noise-sensitive developments near airports; 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. This includes building activity around airports that might penetrate operational airspace and/or affect navigational procedures for aircraft. The NASF is a national land use planning framework that aims to:

- improve community amenity by minimising aircraft noise-sensitive developments near airports
- 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 establishes land use planning controls to protect aviation operations that extend beyond the Aerotropolis boundary. The NASF Guidelines are used by relevant planning authorities to help inform land use planning decisions and by proponents to prepare applications on land impacted by aviation safeguarding controls.

The NASF currently comprises 9 guidelines:

- Guideline A: Measures for Managing Impacts of Aircraft Noise
- Guideline B: Managing Risks of Building Windshear and Turbulence at Airports
- Guideline C: Managing Risks of Wildlife Strike in the Vicinity of Airports
- Guideline D: Managing Risks Associated with Wind Turbines
- Guideline E: Managing Risks of Distractive Lighting in Vicinity of Airports
- Guideline F: Managing Risks of Intrusion into Protected Airspace
- Guideline G: Protecting Aviation Facilities – Communications, Navigation and Surveillance
- Guideline H: Protecting Strategically Important Helicopter Landing Sites
- Guideline I: Managing the Risks in Public Safety Areas at the ends of Runways.

14.3.2.3 Aviation Safeguarding guidelines

The Aviation Safeguarding Guidelines – Western Sydney Aerotropolis and surrounding areas (October 2021) (NSW DPE, 2022a) provide guidelines for managing land use impacts related to aircraft noise and were developed by the former DPE (now DPHI) with input from DITRDCA. The guidelines seek to ensure planning authorities consider the aircraft noise guidelines and noise exposure contour maps when undertaking land use planning for the Aerotropolis and surrounding areas of influence.

The NSW Government supports the NASF with the exception of Guideline A and uses the existing policy of DPHI which relies on ANEF contours and AS 2021:2015. The NSW Government has endorsed the use of ANEF for land use planning, not the N-above contours (NSW DPE, 2022a).

Until the ANEF contour is approved for WSI, the Western Parkland City SEPP ANEC contour (based on the runway direction and proposed flight paths) is to be used to inform land use planning. The ANEC presented in the Western Parkland City SEPP represents the long-term development of WSI, including parallel runways and facilities for up to 82 million passengers annually (nominally occurring in 2063).

Planning instruments such as Western Parkland City SEPP and LEPs contain controls to ensure that incompatible development (particularly noise sensitive development, such as schools and hospitals etc) is not approved in the vicinity of WSI, specifically within ANEC 20. As such, planning authorities may not grant consent to development unless it is demonstrated to be in accordance with AS 2021:2015 based upon the ANEC contours in the Western Parkland City SEPP.

14.3.2.4 AS 2021:2015 Acoustics – Aircraft noise intrusion – Building siting and construction

AS 2021:2015 (Standards Australia, 2015) provides guidance on the siting and construction of new buildings with regard to aircraft noise intrusion. The assessment of potential aircraft noise exposure at a given site is based on the ANEF contours. AS 2021:2015 also provides guidelines for determining the type of building construction necessary to provide a given noise reduction.

All levels of Government give effect to AS 2021:2015 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 vicinity of airports.

The AS 2021:2015 provides details on the uses which are acceptable in the different ANEF contours as described in Table 14.1.

Table 14.1 AS 2021:2015 – Acceptability Based on ANEF Zones (in conjunction with Table 3.3 of AS 2021:2015)

Building type	ANEF zone of site		
	Acceptable	Conditionally acceptable	Unacceptable
House, home unit, flat, caravan park	Less than 20 ANEF[1]	20–25 ANEF[2]	Greater than 25 ANEF
Hotel, motel, hostel	Less than 25 ANEF	25–30 ANEF	Greater than 30 ANEF
School, university	Less than 20 ANEF[1]	20–25 ANEF[2]	Greater than 25 ANEF
Hospital, nursing home	Less than 20 ANEF[1]	20–25 ANEF	Greater than 25 ANEF
Public building	Less than 20 ANEF[1]	20–30 ANEF	Greater than 30 ANEF
Commercial building	Less than 25 ANEF	25–35 ANEF	Greater than 35 ANEF
Light industrial	Less than 30 ANEF	30–40 ANEF	Greater than 40 ANEF
Other industrial	Acceptable in all ANEF zones		

Notes from AS 2021:2015:

1. The actual location of the 20 ANEF contour is difficult to define in aircraft flight paths.
2. Within 20 ANEF to 25 ANEF, some people may find that the land is not compatible with residential or educational uses. Land use authorities may consider that the incorporation of noise control features in the construction of residences or schools is appropriate.

Section 4.65 of the NSW EP&A Act includes 'existing use rights' protections in which landowners are allowed to continue the use of their land if that use was lawfully commenced at the time of the rezoning under the SEPP or the use has not been abandoned. It is possible to enlarge, expand or intensify, alter, or extend an existing use but only with the approval of the relevant consent authority.

14.4 Methodology

14.4.1 Study area

The land use and planning study area (study area) for the project comprises the land surrounding WSI where aircraft movements would have an impact on land uses related to the following aspects:

- Aircraft noise, which can potentially impact the range of land uses that can be undertaken in future (specifically residential and other noise-sensitive land uses). The extent of land affected by noise is considered for the purposes of this assessment to be land within the Western Parkland City SEPP ANEC 20 contour – a boundary beyond WSI within which noise levels would place a material impact on land use.
- Aviation safety, which requires restrictions in certain development for aviation safety purposes, such as limits on building heights and restrictions on activities that increase the risk of bird strike. These airspace protection controls are established for the project by the OLS and the implementation of wildlife buffer zones.

While each type of impact are relevant, the ANEC 20 contour and wildlife buffer is wholly contained within the OLS and as such the OLS has been applied as the study area. The study area for the land use assessment is shown on Figure 14.1.

14.4.2 Approach

The assessment of the potential impacts on land use and planning involved:

- a review of the following legislation, policies, guidelines and assessments relevant to the project and/or the study area:
  - Commonwealth and NSW planning legislation
  - key strategic planning polices and documents to identifying future land uses, planning controls and developments
  - relevant technical papers supporting this EIS
- assessment of the potential impacts to existing land uses including those that would need to be acquired to operate the project
- assessment of the potential impacts of the project on future land uses
- identifying mitigation measures to minimise the potential impacts of the project on existing and future land uses.

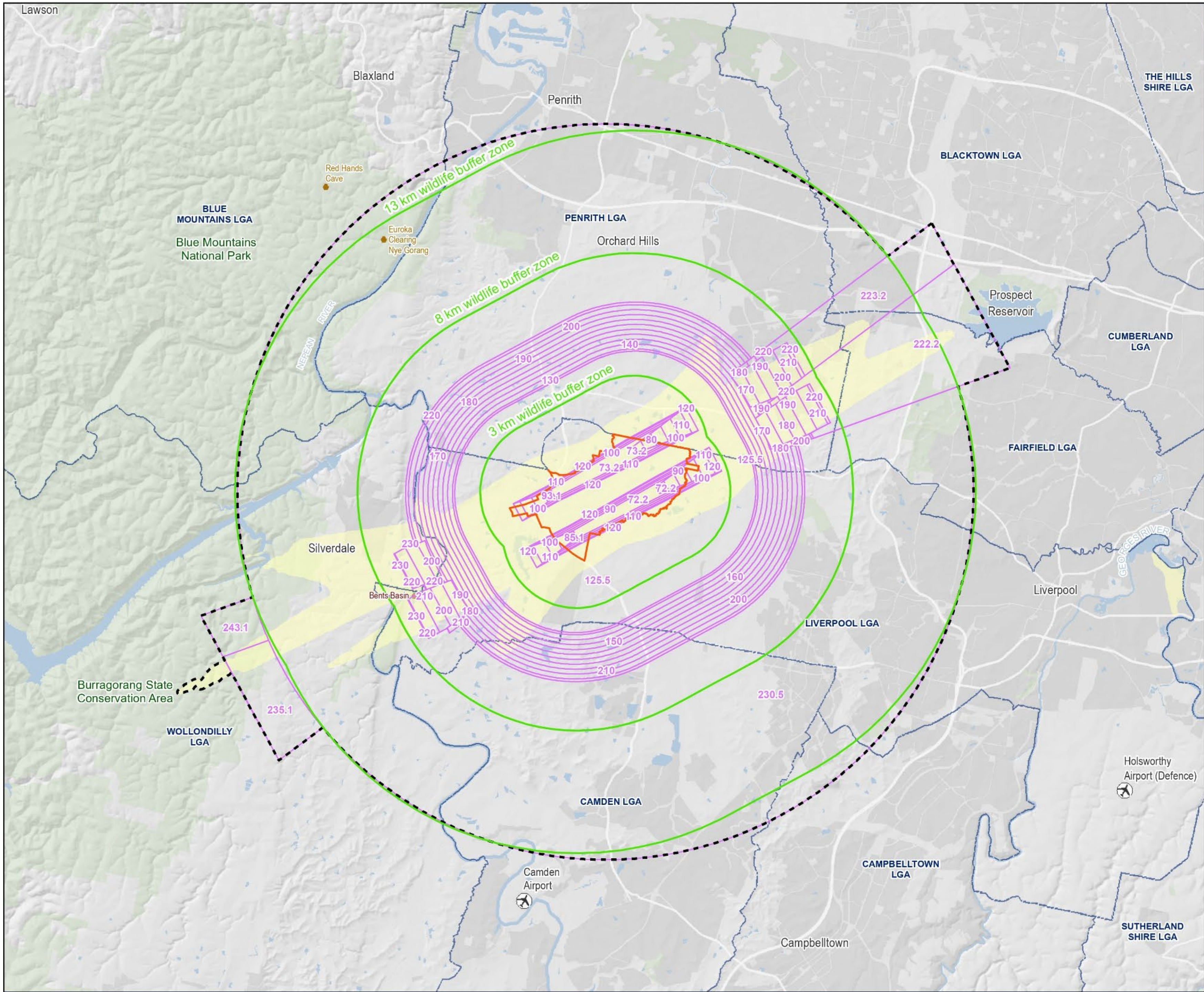


Figure 14.1

Land use study area (incorporation OLS and ANEC)

Legend

- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- Land use study area
- Local Government Area
- Wildlife buffer zones
- State Environmental Planning Policy (Precincts - Western Parkland City) 2021 Obstacle Limitation Surface
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

State Environmental Planning Policy (Precincts – Western Parkland City) 2021 Noise Exposure Concept (units)

- ANEC 20 and above

Newcastle
Sydney
Wollongong

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A3

1:150,000 Date: 16/07/2024

Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User

14.5 Existing environment

14.5.1 Regional context

Western Sydney is one of Australia's fastest growing regions and is Australia's third-largest economy. Two million people currently live in Western Sydney with the expectation of another million people moving into the region by the 2030s.

The study area encompasses a large area of Western Sydney, traversing parts of the Liverpool, Penrith, Wollondilly, Fairfield, Blacktown, Camden and Blue Mountains local government areas (LGAs). Large population centres within these LGAs, such as Penrith and Liverpool are experiencing significant population growth that is being driven by major infrastructure and land use initiatives. Western Sydney International and Aerotropolis will be the key catalyst for driving further growth and development in the region.

In addition to WSI and the Aerotropolis, the region supports a diverse and competing range of current and proposed land uses. Growth areas, urban renewal corridors, economic corridors and large infrastructure projects are planned or currently under construction.

North of WSI, land use is primarily a mix of urban residential, commercial and industrial uses with scattered areas of rural and agricultural areas. The Greater Penrith to Eastern Creek Investigation Area (GPEC) incorporates approximately 19,000 hectares (ha) from the Nepean River in the west to the M7 Motorway in the east and is comprised of parts of the Blacktown and Penrith LGAs. The GPEC area was identified in the Greater Sydney Region Plan as an area for growth and change due to its access to infrastructure and services associated with WSI.

Adjacent to GPEC is the Western Sydney Employment Area (WSEA). The WSEA was established to supply employment land close to major road transport and the Aerotropolis and to provide jobs for Western Sydney.

The Defence Establishment Orchard Hills site (located about 5 km to the north of WSI) is primarily used for defence purposes, however plays an important conservation role with much of the vegetation on the site protected as an offset to the impacts of WSI. Commercial and industrial hubs are located at Erskine Park, Eastern Creek, St Marys and Wetherill Park.

To the west of WSI, rural land uses such as primary production and agriculture along with large rural residential properties are the primary land use.

The South West Growth Area (SWGA) lies directly to the south of WSI. This area comprises approximately 10,000 ha adjoining the Western Sydney Aerotropolis and aims to connect new suburbs with WSI and the broader WSEA to the north.

East of WSI, land uses progressively change from a mix of rural residential and agriculture (near WSI) to higher density residential, manufacturing and industrial land uses (within the Liverpool LGA) near Hoxton Park, Prestons and Liverpool. The large Western Sydney Parklands provides a green, recreational corridor stretching from the M7 Motorway in the north to Bringelly Road in the south.

A summary of key planning strategies and corridors in the Western Sydney region are shown on Figure 14.2.

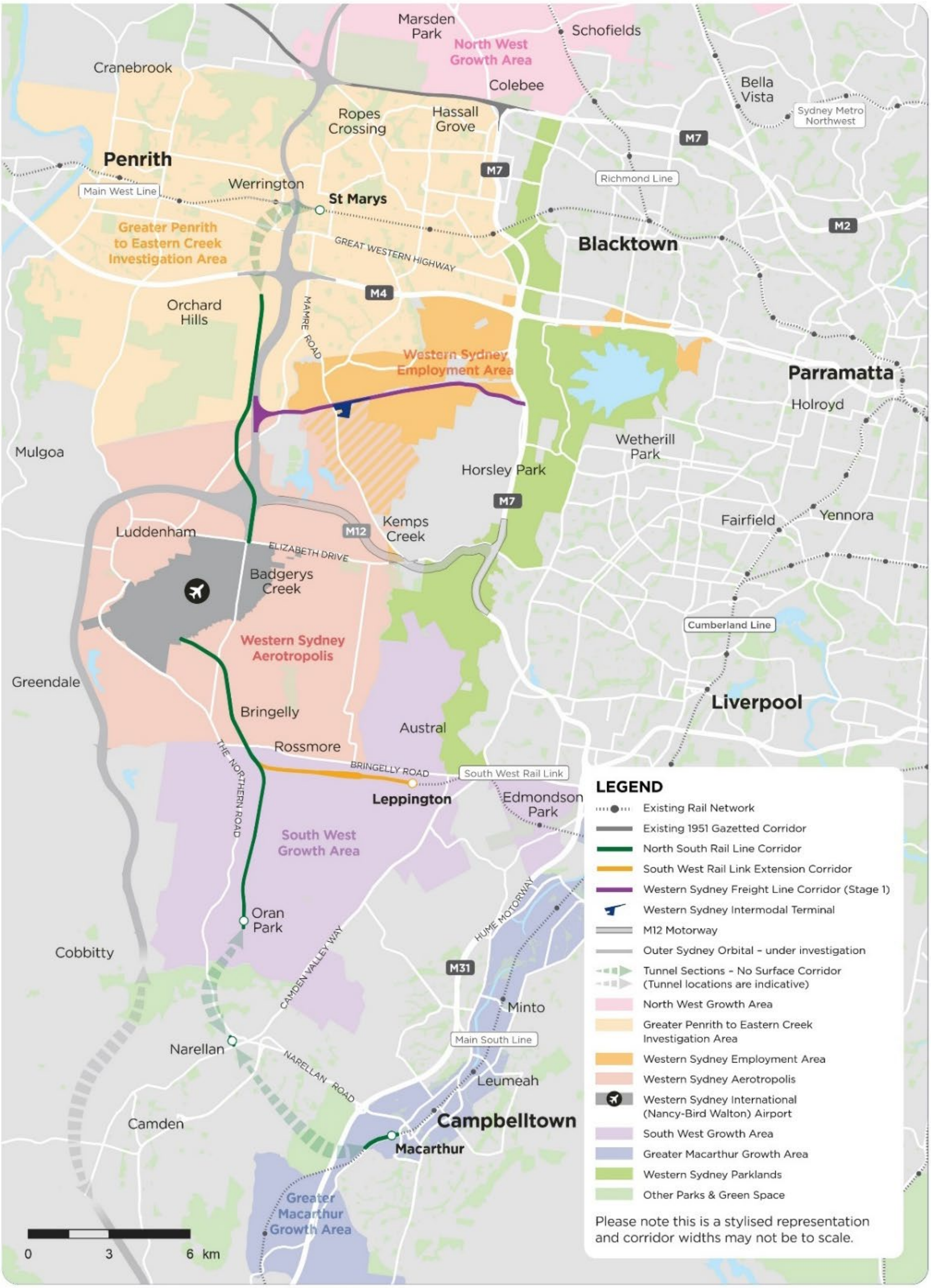


Figure 14.2 Regional context and strategic planning (source: Transport for NSW, 2020a)

14.5.2 Residential land use

The major urban and residential centres of Liverpool, Camden and Campbelltown all sit outside of the study area and land uses within those centres are not discussed in this assessment. Penrith's southern suburbs of South Penrith, Jamison Town, Glenmore Park and Regentville represent some of the highest density residential areas within the study area, with residential development in a linear corridor along the Great Western Highway and the Main Western Railway. Other key residential areas within the study area, to the north of WSI include St Marys, St Clair and Erskine Park. The residential community of Twin Creeks Golf and Country Club is located directly north of WSI and includes about 200 residential dwellings.

The villages of Luddenham, Wallacia and Mulgoa are located immediately west of WSI, generally straddling the Northern Road between Park Road and Adams Road, and Mulgoa Road, north and south of the intersection of Park and Silverdale Roads. Further to the west of WSI in the Wollondilly LGA, Silverdale and Warragamba are small villages with primarily low density and large lot residential areas.

Developing residential areas in the SWGA such as Oran Park and Leppington sit in the south of the study area in the Camden LGA and are experiencing rapid growth in conjunction with increased transport infrastructure. Beyond the residential areas discussed above, the study area contains large rural areas that serve as locations for people to live in a rural-residential or bushland setting (Greater Sydney Commission, 2018a).

14.5.3 Agricultural land use

Western Sydney has an important historical attachment to agricultural and horticultural land uses associated with Australia's early agricultural industries, including the wool industry, and its role in early colonial settlement. Significant agricultural land use is still present in the study area.

Agricultural uses in the study area support a broad range of activities including (but are not limited to) grazing, dairy, production of eggs and poultry, cut flowers, turf and mushroom farms to name a few. Agricultural industries also provide produce, employment and tourism opportunities to communities within the study area.

The landscape to the north-west of WSI includes the Mulgoa Valley and Wallacia Significant Rural Landscape (Penrith City Council, 2020), characterised by its predominantly rural landscape and undulating agricultural land. Luddenham Village is surrounded by agricultural production areas. The southern part of the study area, between WSI and Bringelly Road includes large lot rural residential and small lot agricultural uses.

14.5.4 Recreational land use

A small part of the Greater Blue Mountains Area (GBMA) sits within the study area, which is a World Heritage Area and National Heritage area. The GBMA was inscribed on the UNESCO World Heritage List in 2000 and its biodiversity values are complemented by numerous other values, including wilderness, recreation and natural beauty. Technical paper 14: Greater Blue Mountains World Heritage Area, has been prepared to address the requirements relating to impacts that may occur to or on the GBMA and provided further detail on the existing recreational and tourism values of the GBMA.

Western Sydney Parklands is located to the north-east and east of WSI, stretching for 27 km over 3 LGAs (Blacktown, Liverpool and Fairfield), creating a large area of recreational and open space for western Sydney. Under the *2030 Plan of Management* (Western Sydney Parklands, 2018), the parklands will remain mostly bushland (40 per cent), with 30 per cent set aside for recreation and tourism facilities and 5 per cent designated for urban farming.

The Wianamatta - South Creek corridor, to the east of WSI provides a significant green corridor to local communities in the study area. Approximately 5 km north of WSI is the Twin Creeks Golf and Country Club, a 340-ha estate comprising an 18-hole golf course, function centre and a restaurant. Other golf courses located in the study area include Wallacia Panthers Country Club, Penrith Golf Course and Camden Lakeside Golf Course. Bents Basin State Conservation Area (located in Silverdale and Greendale) is a popular swimming hole with a camping area and an education centre used by local school groups. The Silverdale Rifle Range is located approximately 6 km to the south-west of the Airport Site. Numerous small, local, recreation assets such as parks, playgrounds, skate parks and picnic areas are also located within the urban parts of the study area. Key recreational land uses are shown on Figure 14.3.

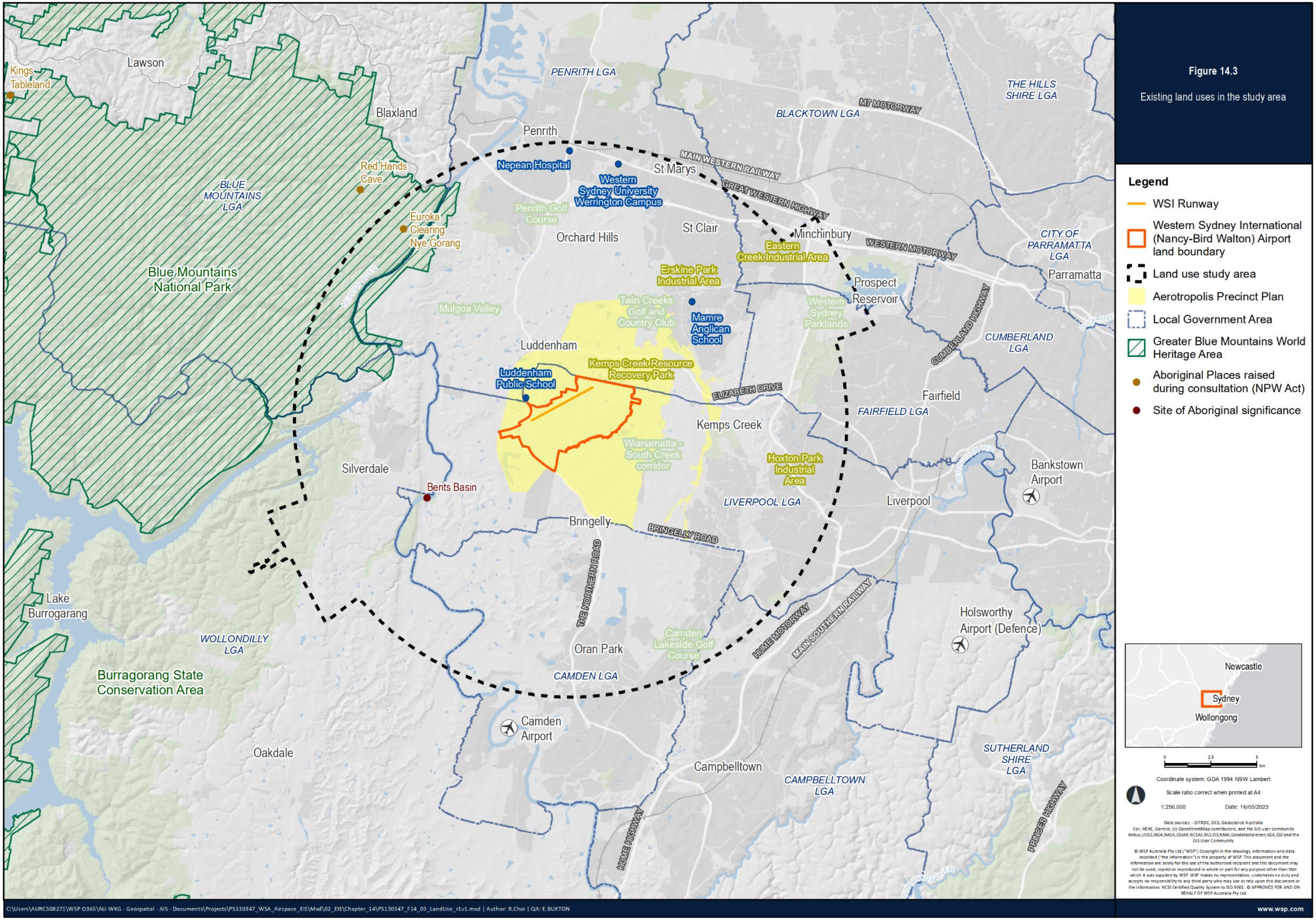


Figure 14.3

Existing land uses in the study area

14.5.5 Industrial and commercial land uses

The study area includes expansive industrial and commercial land uses to the north and east of WSI, supporting a range of industrial activities including advanced manufacturing, trade and freight logistics. The industrial hubs located at Erskine Park, Eastern Creek and Hoxton Park are significant contributors to the economic outcomes of Western Sydney.

There are extractive industries based on construction material resources in the study area, with major concentrations of construction sand around Londonderry and the Hawkesbury River, as well as clay and shale resources for brick and tile manufacture, particularly around Horsley Park (Greater Sydney Commission, 2018a).

The Kemps Creek Resource Recovery Park is located immediately to the north of WSI.

An array of small-medium commercial enterprises are scattered throughout the study area including shopping precincts, commercial agribusiness services, hospitality services and retail. The location of key industrial and commercial uses within the study area are shown on Figure 14.3.

14.5.6 Health and education

The Penrith health and education precinct is the major cluster of health and educational land uses in the study area and is based around Nepean Hospital, the Western Sydney University Werrington Campus and Nepean College of TAFE Allied Health Facility.

Education and health facilities such as high schools, primary schools, specialist and general practitioner surgeries are located throughout the study area, generally in proximity to residential areas. A complete list of health and education facilities is provided in the study area is provided in Technical paper 6.

Luddenham Public School (Primary), is the nearest education land use, located adjacent to WSI within Luddenham Village. The school consists of 3 multi-aged classes accommodating the 53 students (as of 2021). Holy Family Catholic Primary School is also located in Luddenham and has 230 students (as of 2022). Both schools are located within the Western Parkland City SEPP ANEC 20 contour. Key health and education facilities in the study area are shown on Figure 14.3.

14.5.7 Transport infrastructure

Western Sydney International is the catalyst for much of Western Sydney's planned road and public transport projects. Strategic planning for WSI and the Aerotropolis has been prepared concurrently with the NSW Government's *Future Transport Strategy 2056* and Infrastructure NSW's *State Infrastructure Strategy 2018–2038* to integrate land use, transport and infrastructure across the region.

Existing major transport infrastructure in the study area includes:

- The M4 Western Motorway and the Great Western Highway which run east-west in the north of the study area
- The M7 Motorway which runs north-south in the east of the study area
- The Northern Road (A9) (currently being upgraded) which runs north-south, past WSI from the M4 Western Motorway to Camden Valley Way
- Elizabeth Drive, which runs east-west from Luddenham to the M7 Motorway
- Bringelly Road, which runs east-west from The Northern Road (Bringelly) to Camden Valley Way
- Main Western Rail Line, which connects Sydney and the Blue Mountains
- South West Rail link, currently terminating at Leppington.

In addition, there are a large network of State, Regional and Local Roads connecting suburbs and communities within the study area.

14.5.8 Commonwealth land

The Commonwealth Government acquired approximately 1,780 ha of land at Badgerys Creek for the proposed Western Sydney Airport in the 1980s and 1990s and all land within the Airport Site boundary will be used for airport operations.

Defence Establishment Orchard Hills (DEOH) is a large (about 1,740 ha) Commonwealth Government (Department of Defence) land holding located about 4 km to the north of WSI. The site provides storage, maintenance and disposal of explosive ordnance along with ordnance training to meet Service capabilities. The DEOH, while primarily used for defence purposes, plays an important conservation role with much of the vegetation on the site protected as an offset to the impacts of WSI.

The DEOH is vegetated with remnants and regenerating areas of Cumberland Plain Woodland, listed as a critically endangered ecological community at both State (Cumberland Plain Woodland in the Sydney Basin Bioregion) and Commonwealth levels. The DEOH acts as a refuge and reservoir of regional conservation significance for species that are dependent on low levels of agricultural and urban development. The Heritage Management Plan for the DEOH site outlines management guidelines related to both natural and historic heritage values.

Holsworthy Military Reserve and the Defence Royal Australian Air Force (RAAF) bases at Richmond and Glenbrook sit beyond the study area for this assessment.

14.6 Future land use

Significant strategic planning is underway within Western Sydney, with much of the study area going to experience substantial transformation and growth over the coming decades. Key planning initiatives that will drive development in the study area and how they are related to the project are outlined below.

14.6.1 Western Sydney Aerotropolis

The Western Sydney Aerotropolis is a 11,200-ha area surrounding WSI. The Aerotropolis will become a hub of industry and innovation, attracting local and global companies drawn to the Western Parkland City and WSI. Western Sydney Aerotropolis is made up of several precincts (refer Figure 14.4) including:

- Aerotropolis Core
- Bradfield Centre
- Badgerys Creek and adjoining areas of Wianamatta-South Creek
- Northern Gateway
- Agribusiness
- Luddenham Village.

The supporting Western Sydney Aerotropolis Precinct Plan (NSW DPE, 2023) is in force under the provisions of the Western Parkland City SEPP. The Precinct Plan provides the place-based objectives and requirements to guide future development in the Aerotropolis in a consistent and sustainable manner over time. The Precinct Plan outlines specific objectives for ensuring that development is responsive to the WSI's operational constraints including aircraft noise and OLS.

Planning for the Luddenham Village precinct is ongoing and the NSW Government released the Luddenham Village Interim Strategy in 2022 (NSW DPE, 2022b). The interim strategy will inform the Luddenham Village Plan which will outline land use planning provisions and controls (including development within the ANEC 20 contour) relating to Luddenham Village and will be incorporated into the Aerotropolis Precinct Plan.

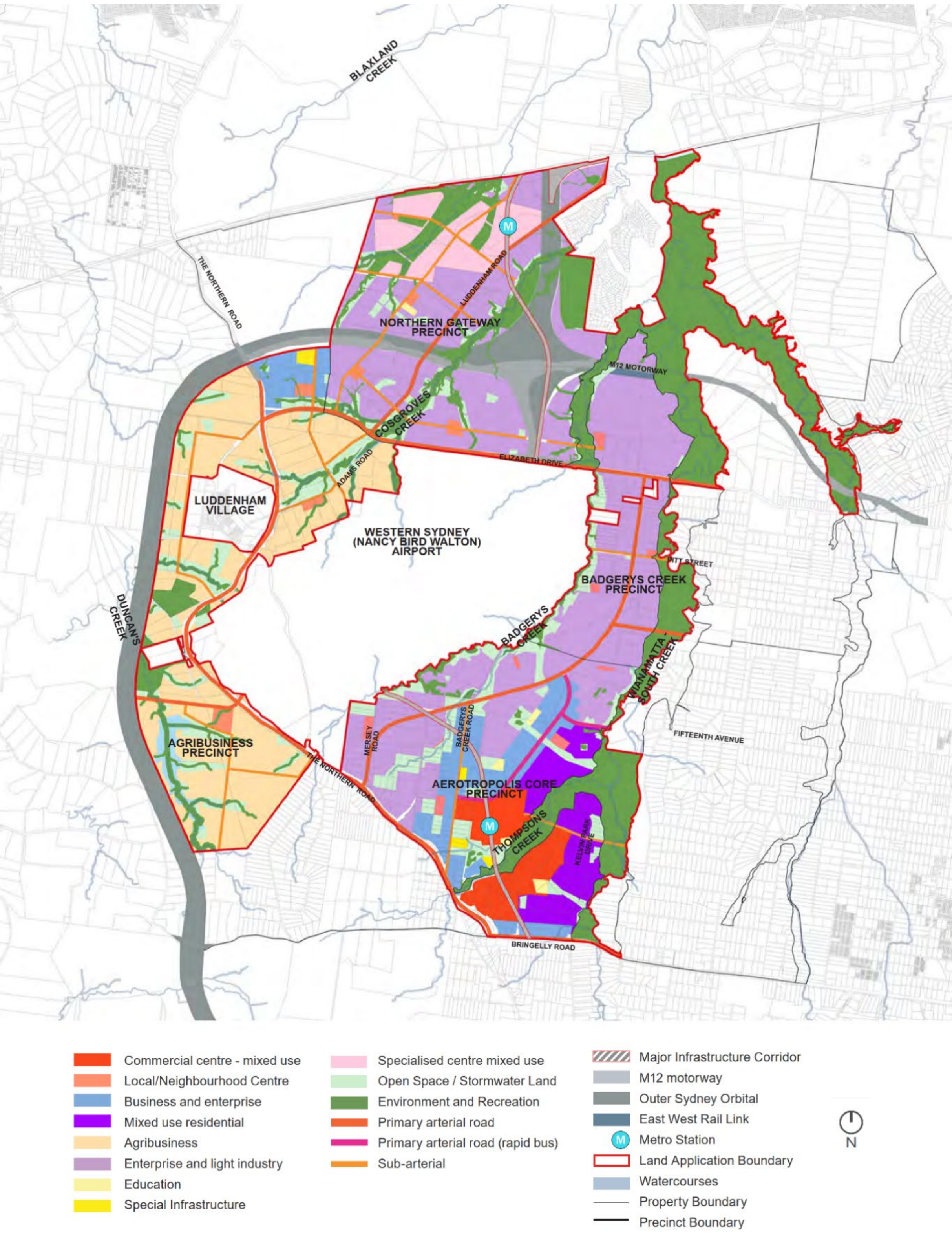


Figure 14.4 Aerotropolis land use and structure plan (Source: NSW DPE, 2023a)[2]

[2] Additional Metro stations located within the WSI (Airport Terminal and Airport Business Park) have been approved since the development of this figure and are not represented

14.6.2 Greater Penrith to Eastern Creek Investigation Area

Greater Penrith to Eastern Creek Investigation Area (GPEC) spans approximately 19,000 ha from the Nepean River in the west to the M7 Motorway in the east and is comprised of parts of the Blacktown and Penrith LGAs.

The draft GPEC Strategic Framework (the draft Strategic Framework), released for public exhibition in late 2022, identified 6 key precincts for growth up to 2056, being Orchard Hills, St Marys, Penrith centre, Kingswood and Werrington, Mount Druitt and Rooty Hill, and Luxford. This aligns with areas where there is capacity for future housing and urban renewal, and supports growth aligned to investment in transport infrastructure. The majority of the growth would be in the form of urban renewal around major transport infrastructure.

The draft Strategic Framework will guide future detailed planning for the area and supports local planning to achieve a shared vision for the GPEC area, by guiding precinct planning and planning proposals, and informing new or revised local planning controls like LEPs and DCPs. Once finalised, a Ministerial direction will require future planning to be consistent with the Strategic Framework (e.g. LSPSs, planning proposals and precinct plans).

14.6.3 South West Growth Area

The SWGA lies directly to the south of WSI (refer to Figure 14.2). This area comprises approximately 10,000 ha adjoining the Aerotropolis and aims to connect new suburbs with WSI and the Aerotropolis to the north. The SWGA is comprised of 14 precincts and several sub precincts. To date, 9 precincts have been rezoned with a focus on providing new residential areas to support Western Sydney's growth. The NSW Government updated the Structure Plan for the SWGA in December 2022 to reflect current planning for the area (including the Aerotropolis). The SWGA Structure Plan is outlined in Technical paper 6.

14.6.4 Infrastructure

A number of large-scale transport and infrastructure projects and initiatives are in varying stages of strategic planning (as yet not funded or committed to) or construction within the study area. Further planning and assessment of these projects will need to be integrated into land use planning within the study area and consider the requirements of WSI and the project.

Key transport infrastructure projects in the region include:

- North South Rail Link between Cudgegong Road and St Marys and Badgerys Creek Aerotropolis and Macarthur
- Western Sydney Airport – Badgerys Creek Aerotropolis to Parramatta train link
- Leppington to Western Sydney Airport –Badgerys Creek Aerotropolis train link
- Outer Sydney Orbital road and freight rail
- Sydney Metro City & Southwest extension between Bankstown and Liverpool
- M5 Motorway extension between Liverpool and the Outer Sydney Orbital
- upgrades to The Northern Road, Bringelly Road and the M12 Motorway.

14.6.5 Land zoning

Land zoning within NSW identifies the type of land uses that are permitted (with or without consent) or prohibited in each zone on any given land as designated by the relevant NSW environmental planning instrument under the Environmental Planning and Assessment Act (NSW) (EP&A Act). Each zone will typically have a series of objectives outlined in the planning instrument, which provide for the desired outcomes of development that will occur within the zone and therefore set the future land use in the study area. Land zoning within the study area is shown on Figure 14.5.

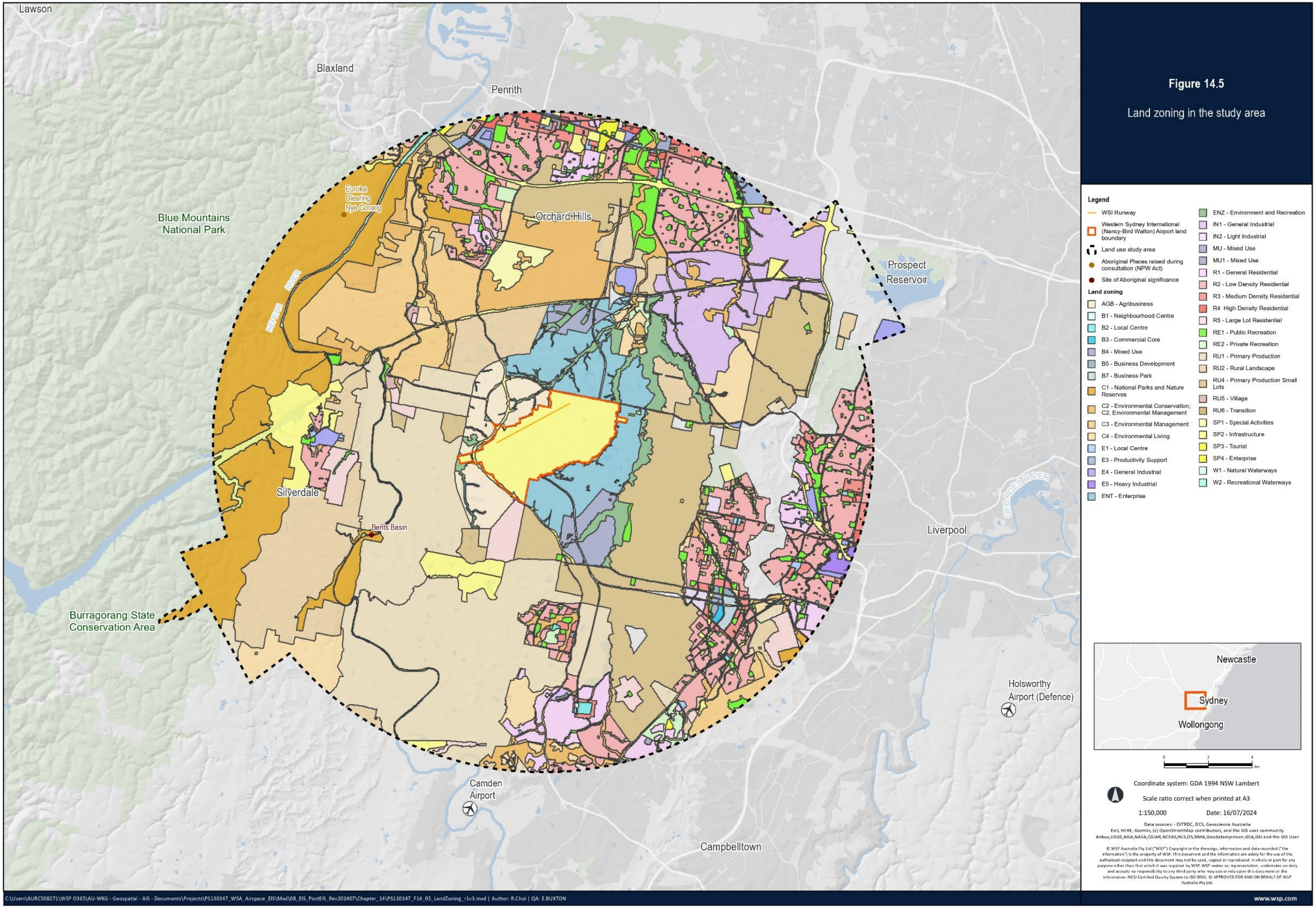


Figure 14.5

Land zoning in the study area

14.7 Assessment of impacts

Potential impacts to existing and future land uses associated with airspace operations extend well beyond the WSI boundary. The assessment of impacts to land use has been limited to land surrounding WSI (the study area) where aircraft movements may have an impact on land uses. Key land use impacts that could arise from the project are related to:

- aircraft noise contours (ANEC), and the impact they could have on existing land use and future planning or approvals
- the potential for restricted development due to protected airspace (OLS and PANS-OPS)
- wildlife buffers and framework for how to manage the risk of wildlife strike on aircraft in the vicinity of WSI.

The project does not include any physical infrastructure or construction work and as such, the following assessment is limited to operational impacts only.

Facilitated impacts associated with the project are assessed in Chapter 21 (Facilitated impacts).

14.7.1 Aircraft noise contours

Aircraft noise in the vicinity of flight paths is an unavoidable consequence of aircraft operations at WSI. Areas subject to flight paths would experience varying levels of aircraft noise, depending on a range of operational and meteorological factors. Potential impacts related to aircraft noise including noise exposure forecasts associated with aircraft operations, is provided in Technical paper 1: Aircraft noise.

14.7.1.1 Residential

The NSW planning framework takes a precautionary approach to residential land use development in regard to WSI operations and has adopted an approach which relies on ANEF contours and AS 2021:2015 to inform planning decisions for residential land uses in areas affected by aircraft noise. Until the ANEF contour is approved for WSI, the long-term, dual-runway ANEC contour presented as the Noise Exposure Contour Map in the Western Parkland City SEPP is to be used to inform land use planning (NSW DPE, 2022a).

Residential dwellings are currently located within the prescribed ANEC 20 contour and are in:

- Luddenham Village, generally south-east of Blaxland Avenue
- the eastern fringes of Silverdale
- Twin Creeks Golf and Country Club
- scattered rural-residential properties within the suburbs of Luddenham, Badgerys Creek and Greendale.

Existing residential land uses within the ANEC 20 contour can continue in the future due to existing use rights. The Western Parkland City SEPP also includes provisions for new residential dwellings associated with existing residential areas or land already approved for residential development. Clause 4.17 *Aircraft noise* states:

> *(4) development consent may be granted to development for the purposes of dwelling houses on land that is in an ANEF or ANEC contour of 20 or greater if—*
>
> *(a) immediately before the commencement of this Chapter—*
>
> *(i) there were no dwellings on the land, and*
>
> *(ii) development for the purposes of dwelling houses was permitted on the land, and*
>
> *(b) the consent authority is satisfied that the development will meet the indoor design sound levels.*
>
> *(4A) Subsection (2) does not apply to development for the purposes of subdivision of land in an ANEF or ANEC contour of 20 or greater if the development application was made before 1 October 2020.*

With regard to future residential development, the Western Parkland City SEPP outlines that no noise sensitive development (including residential development) will be permitted within the ANEC 20 and above contours. For example, dual occupancies, secondary dwellings and the subdivision of land for residential purposes that have not already been approved, will not be permitted.

If a development site is found to be 'conditionally acceptable' (as per Table 3.3 of AS 2021:2015) this typically means that any proposed buildings could require an improved level of building fabric above standard or light-weight materials to achieve internal noise goals set by AS 2021:2015 and development consent may be granted for those purposes if the consent authority is satisfied that the development will meet the indoor design sound levels as detailed in AS 2021:2015 (refer acceptability based on ANEF zones in Table 14.1) and outlined in Table 14.3.

Table 14.2 Residential indoor design sound levels for determination of aircraft noise reduction (AS 2021:2015)

Building type (and activity)	Indoor design sound level (dB(A))
Houses, home units, flats, caravan parks	
• Sleeping areas, dedicated lounges	50
• Other habitable spaces	55
• Bathrooms, toilets, laundries	60

The *Western Sydney Aerotropolis Precinct Plan* identifies the suitability of precincts for residential land uses within the Aerotropolis due to aircraft noise and Airport operational constraints.

The ANECs presented in this EIS are a forecast of future aircraft noise exposure for a range of planning concepts and show the concentration of noise around WSI for single runway operations only. This is different to the ANEC in the Western Parkland City SEPP and used as the basis of this assessment. As outlined in Section 14.3.2.3, the ANEC presented in the Western Parkland City SEPP represents the long-term development of WSI.

It is important to note that the ANEC figures for the Stage 1 Development of WSI 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 be based on longer-term forecasts of noise exposure and an ANEF developed for the long-term WSI development strategy including a parallel runway system.

A comparison of forecast ANEC 20 contours for the key operating scenarios against the Western Parkland City SEPP ANEC 20 contour is shown on Figure 14.6. The 2 project operating scenarios considered were the composite scenario for:

- 2033 – when single runway operations handle up to 10 million annual passengers and around 81,000 air traffic movements per year by 2033
- 2055 – when single runway operations approach capacity at around 37 million annual passengers and around 226,000 air traffic movements per year in 2055.

These scenarios were chosen as the composite noise contours associated with scenarios No preference, Prefer Runway 05 and Prefer Runway 23 (refer to Chapter 11 (Aircraft noise)) provide a level of confidence around the likely 'worst case' annual average of the potential operating scenarios for noise exposure of communities in the vicinity of WSI.

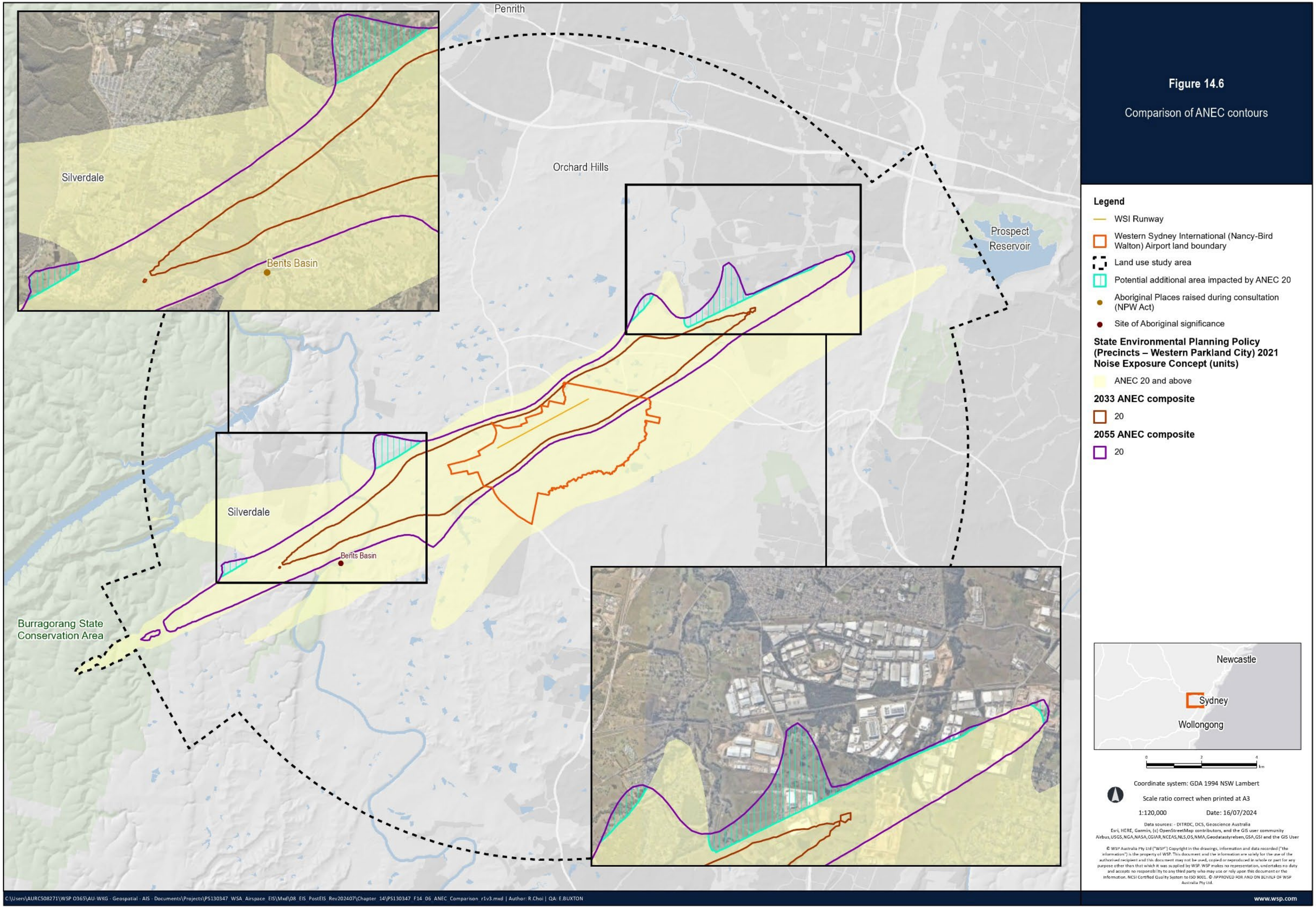


Figure 14.6
Comparison of ANEC contours
Legend
WSI Runway
Western Sydney International (Nancy-Bird Walton) Airport land boundary
Land use study area
Potential additional area impacted by ANEC 20
Aboriginal Places raised during consultation (NPW Act)
Site of Aboriginal significance
State Environmental Planning Policy (Precincts – Western Parkland City) 2021 Noise Exposure Concept (units)
ANEC 20 and above
2033 ANEC composite
20
2055 ANEC composite
20
Penrith
Orchard Hills
Prospect Reservoir
Silverdale
Bents Basin
Silverdale
Bents Basin
Burragorang State Conservation Area
Newcastle
Sydney
Wollongong
0
2
4
km
Coordinate system: GDA 1994 NSW Lambert
Scale ratio correct when printed at A3
1:120,000
Date: 16/07/2024
Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User
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Comparison of the 2 contours against the SEPP contour shows the following:

- The ANEC 20 contour for 2033 sits wholly within the prescribed ANEC 20 contour. Based on this contour, no additional land would be subject to planning restrictions based on aircraft noise from scheduled flight operations between 2026 and 2033.
- The ANEC 20 contour for 2055 extends slightly beyond the prescribed ANEC 20 contour in several locations in the vicinity of Erskine Park, Eastern Creek and to the south of Wallacia. These areas are currently zoned 'general industrial' (Penrith City Council, 2010) and 'primary production' (Liverpool City Council, 2008) and include a small number of semi-rural residential dwellings and around 6 residential dwellings located within the Twin Creeks Golf and Country Club (refer to Figure 14.6). The ANEF contour for WSI will be prepared during the detailed airspace design phase. Until an ANEF contour is prepared and approved for WSI, the prescribed WSI ANEC is to be used to inform land use planning. Any changes to relevant planning instruments as a result of adopting an ANEF could see planning conditions imposed on these additional areas.

14.7.1.2 Agricultural

Much of the study area currently comprises agricultural uses and is characterised by predominantly a rural landscape and undulating agricultural land.

There are no specific provisions for protecting agricultural land uses from aircraft noise in the Western Parkland City SEPP. Additionally, AS 2021:2015 also does not have specific guidance for agriculture, however the standards do identify that light industrial use (which could include some agricultural activities) is acceptable in ANEF 30 and below. Residential dwellings on agricultural land, however, would need meet the requirements of Clause 14.7 of Western Parkland City SEPP (as relevant) and the indoor design sound levels as detailed in the AS 2021:2015 (refer to Table 14.2).

As such, aircraft noise from WSI would not have any specific planning or land use impacts on existing agricultural areas.

The *Western Sydney Aerotropolis Precinct Plan* identifies the Agribusiness Precinct to the west of WSI and surrounding Luddenham Village. The Agribusiness Precinct is proposed to increase agricultural and agribusinesses uses, building on successful agricultural operations and developing new agribusiness opportunities while protecting and embracing important vegetation within the landscape (NSW DPE, 2023a).

14.7.1.3 Recreation

The Twin Creeks Golf Club and Wilmington Reserve in Luddenham Village are located within the Western Parkland City SEPP ANEC 20 contour north-east of the WSI.

There are no specific provisions for protecting recreational land uses from aircraft noise in the Western Parkland City SEPP and AS: 2021-2015 does not have specific guidance for recreation land uses.

The National Airports Safeguarding Framework's (NASF), *Guideline I: Managing the Risks in Public Safety Areas at the ends of Runways* aims to limit the number of people living, working or congregating within Public Safety Area (PSAs) through appropriate land use planning. PSAs include the area immediately at the end of runways where the risk to the public is highest. Certain developments and land uses are prohibited in the PSA for WSI including many indoor and outdoor recreational uses. Beyond the relatively small PSA area (which is not specific to aircraft noise), there are no other land use and planning restrictions to recreational areas as a result of aircraft noise from the project.

The *Western Sydney Aerotropolis Precinct Plan* identifies a range of future recreational areas and land uses within the Aerotropolis. *The Luddenham Village Interim Strategy* identifies open space and recreational areas planned as part of the village's revitalisation.

Beyond the Aerotropolis, land use planning associated with strategic planning initiatives (such as the SWGA) also have specific provisions to provide additional recreational areas to support future population growth although these are located beyond the ANEC contours for WSI and are unlikely to be affected planning provisions related to aircraft noise.

14.7.1.4 Industrial and commercial

The Erskine Park industrial estate and the Kemps Creek Resource Recovery Park is located within the ANEC contours to the north of WSI.

The AS 2021:2015 provides guidance for industrial and commercial land uses in relation to aircraft noise as outlined in Table 14.3.

Table 14.3 Industrial and commercial land use acceptability based on ANEF zones

Building type	ANEF zone		
	Acceptable	Conditionally acceptable	Unacceptable
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 zones		

Consent authority would consider the acceptability of the development based on the whether the indoor design sound levels are met as detailed in AS 2021:2015 and outlined in Table 14.4.

Table 14.4 Commercial and industrial indoor design sound levels for determination of aircraft noise reduction (AS 2021:2015)

Building type (and activity)	Indoor design sound level (dB(A))
Commercial buildings, offices and shops	
Private offices, conference rooms	55
Drafting, open offices	65
Typing, data processing	70
Shops, supermarkets, showrooms	75
Industrial	
Inspection, analysis, precision work	75
Light Machinery, assembly, bench work	80

The *Western Sydney Aerotropolis Precinct Plan* identifies a range of future commercial and industrial areas and land uses within Aerotropolis supporting industrial, office and employment uses with a diversity of commercial spaces, community and public places.

Beyond the Aerotropolis, industrial and commercial land uses are likely to continue to expand to support population growth in the region including areas potentially within the ANEC contours for WSI (such as the Erskine Park area) and future planning approval will need to consider impacts from aircraft noise.

14.7.1.5 Health and education

The Penrith health and education precinct is well beyond the limits of the ANEC contours.

Luddenham Public School and Holy Cross Catholic Primary School are both located within the Western Parkland City SEPP ANEC 20 contour.

Mamre Anglican School is located just beyond the Western Parkland City SEPP ANEC 20 contour to the north of WSI. The school does, however, sit within the forecast ANEC 20 (2055 composite) contour for the project.

Each of the schools can continue to operate due to 'existing use rights' under Section 4.65 of the NSW EP&A Act. It is possible to enlarge, expand or intensify, the existing facilities with approval of the relevant consent authority, in consideration of indoor sound requirements and in accordance with the provisions of Part 7, Division 4.11 of the *Environmental Planning and Assessment Regulation 2021* (NSW).

Similar to residential areas, health and education facilities are deemed to be noise sensitive developments and the Western Parkland City SEPP outlines that new noise sensitive developments will not be permitted within the ANEC 20 and above contours. Development consent may be granted however if the consent authority is satisfied that the development will meet the indoor design sound levels as detailed in AS 2021:2015 and outlined in Table 14.5.

Table 14.5 Health and education indoor design sound levels for determination of aircraft noise reduction (AS 2021:2015)

Building type and activity	Indoor design sound level, dB(A)
Schools, universities	
Libraries, study areas	50
Teaching areas, assembly areas	65
Workshops, gymnasia	75
Hospitals, nursing homes	
Wards, theatres, treatment and consulting rooms	50
Laboratories	65
Service areas	75
Public buildings	
Churches, religious activities	50
Theatres, cinemas, recording studios	40
Court houses, libraries, galleries	50

The *Western Sydney Aerotropolis Precinct Plan* identifies specific land use areas designed for health and education services, mainly within the Aerotropolis Core precinct. Certain areas, specifically located within ANEC 20 would not be suitable for these future land uses due to elevated aircraft noise.

14.7.2 Impacts of the protected airspace

Structures and other activities that intrude into protected airspace have the potential to impact safe aviation operations at WSI. The prescribed OLS for WSI is shown on Figure 14.1 and extends outwards approximately 15 km from the centre of WSI. Any development, including permanent and temporary structures which intrude on WSI's protected airspace is called a controlled activity. Controlled Activities that do not have prior approval under the APAR or present an unacceptable impact on airport operations are not permitted.

The maximum height for building types in different precincts of Aerotropolis is outlined Technical paper 6.

Building height controls within the study area (and generally) are outlined in the relevant LEPs unless otherwise specified within an overriding SEPP, or specific planning provision such as OLS. LEPs also provide 'height of building' maps which outline heights that are not to be exceeded for varying land use zones.

The Western Parkland City SEPP also contains provisions related to building height for specific growth precincts outlined within the SEPP including areas (Aerotropolis Precinct and Oran Park and Turner Road Precinct) within the study area and the maximum building heights are required to be contained within OLS limits established under the Western Parkland City SEPP.

The OLS applies to both building obstacles (e.g. antennae, masts or tall buildings) and hot or high velocity air emission (e.g. smokestacks, cooling towers) which may cause a potential hazard to aircraft. Emissions above certain velocities, or chimneys above specified heights, are considered potential hazards in accordance with the APAR. Developments with the potential to exceed the OLS must be referred to WSI's operator and DITRDCA for review prior to the development being approved to proceed.

DITRDCA is in the process of engagement with state and local planning authorities as part of the process of declaring a new OLS under the APAR. Once declared, the new prescribed OLS will be enforceable under the APAR and any amendments made to NSW planning instruments.

A PANS-OPS for WSI will be prepared once flight paths have been finalised. Once this occurs, consent authorities are required under the Airports Act and the APAR to review all building and development applications they receive for any infringements into PANS-OPS. If an infringement is likely to occur, Regulation 8 provides that the local council must refer the application to WSI's operator. Airport operators must refer short-term PANS-OPS infringements (less than 3 months) to the DITRDCA for approval. Long-term controlled activities (longer than 3 months) penetrating the PANS-OPS airspace are not permitted and WSA Co can notify the refusal of such controlled activities.

14.7.3 Impacts from wildlife buffers

Wildlife strikes, or sudden avoidance of wildlife can cause major damage to aircraft and/or reduction of safety. Certain land uses have the potential to attract wildlife which can then migrate onto WSI or into flights paths.

Land use planning decisions and the way in which existing land use is managed in the vicinity of airports, can significantly influence the risk of wildlife hazards. As examples, land uses such as agriculture, wildlife sanctuaries, wetlands and land fill sites can attract a high number of birds which increase the risk of interference with aviation activity (DITRDCA, 2012).

NASF Guideline C provides a framework for how to manage the risk of wildlife strike on aircrafts. That framework has been incorporated into the Western Parkland City SEPP and Aerotropolis Precinct Plans. Land use planning around WSI has incorporated the implementation of wildlife buffer zones to mitigate risks of wildlife hazards.

There are a range of existing land uses within the study area which have the potential to attract wildlife including livestock production and commercial livestock feed businesses, turf farms and landscaping businesses and waste management facilities such as the Kemps Creek Resource Recovery Park.

These existing land uses can continue in the future due to existing use rights however mitigation of potential wildlife risks may be required in consultation with WSI and DPHI.

Any new development classed as 'relevant development' under the Western Parkland City SEPP and within the 13 km wildlife buffer of WSI will be subject to the wildlife management controls contained within the Western Parkland City SEPP.

Under the Western Parkland City SEPP:

- certain land uses are prohibited within the 3 km buffer zone including livestock processing industries, turf farming and management facilities
- development applications for specified uses on land within the 13 km buffer zone must be referred to WSA Co and accompanied by a wildlife hazard assessment and wildlife management plan, incorporating relevant mitigation and monitoring measures
- development applications for specified uses on land within the 13 km buffer zone must be accompanied by a waste management plan for the operation of the use of the land; and
- appropriate landscape species should be planted within these buffer zones.

WSA Co also has an obligation to monitor up to a 13 km radius around WSI for any potential wildlife hazards which may impact the 24-hour operations of WSI. WSA Co will negotiate with existing landowners to mitigate these risks.

14.8 Mitigation and management

14.8.1 Existing management

Strategic planning in the vicinity of WSI has considered and incorporated the operational needs of WSI into land use planning in accordance with guidance provided in the NASF. This has been ongoing for over a decade in conjunction with planning for WSI and is well established in existing planning instruments.

DITRDCA (formerly Department of Infrastructure and Regional Development) undertook liaison with relevant state and local agencies to seek adoption of the necessary guidelines in applicable State environmental planning instruments to ensure development in the vicinity of WSI does not impede protected airspace. WSI's protected airspace was prescribed by declaration on 19 October 2017 under the provisions of the Airports Act and the APAR. Since then, land use and development restrictions related to WSI's protected airspace has been factored into, relevant state and local planning instruments.

Land use planning has also been an effective means to ensure that land use near WSI is compatible with noisy aviation activities, with a primary goal of minimising the population affected by aircraft noise, through implementation of land use planning measures, such as land use zoning around WSI. Appropriate noise management controls referencing the NASF and AS 2021:2015 have also been included in applicable planning instruments in advance of WSI's airport operations.

Until the ANEF contour is approved for WSI, the ANEC contour presented as the Noise Exposure Contour Map in the Western Parkland City SEPP, representing the long-term, dual-runway for WSI will continue to inform land use planning. The ANEF contour would ultimately be prepared for WSI (based on the long-term runway operations) and endorsed by Airservices Australia. In the future, WSA Co under the Airports Act will have the responsibility of publishing endorsed Aircraft Noise Exposure Forecast (ANEF) information as part of the 5-yearly Master Plans. These ANEFs may be standard (up to 20 years), long range (20 year +) or ultimate capacity.

NASF Guideline C provides a framework for how to manage the risk of wildlife strike on aircrafts including adoption of wildlife buffer zones. That framework has also been incorporated into the Western Parkland City SEPP and Aerotropolis Precinct Plans.

The NSW Department of Planning and Environment's *Aviation Safeguarding Guidelines – Western Sydney Aerotropolis and surrounding areas* were also developed with input from DITRDCA and seek to ensure planning authorities consider the aircraft noise guidelines and noise exposure contour maps when undertaking land use planning for the Aerotropolis and surrounding areas of influence. Current planning provisions for land associated with Aerotropolis has been developed in conjunction with the Safeguarding Guidelines specifically to support the operation of WSI and limit potential restrictions on surrounding land uses.

To date, the range of existing planning controls in place in the vicinity of WSI have been an effective means of providing appropriate controls over land use planning and development.

14.8.2 Project specific mitigation measures

Table 14.6 provides a summary of mitigation and management measures identified for the proposal, indicating the relevant impact area and applicable mitigation measure.

Table 14.6 Proposed mitigation measures – land use

ID No.	Issue	Mitigation measure	Owner	Timing
LUP1	Aircraft noise	DITRDCA and WSA Co will liaise with State and local government agencies to ensure applicable environmental planning instruments have regard to ANEC forecasts produced for the project.	DITRDCA and WSA Co	**Pre-operation** (Detailed design, 2024–2026) and **Operation** (Implementation, 2026–ongoing)
LUP2	Protected airspace	DITRDCA will coordinate with relevant State and local government agencies to implement appropriate PANS-OPS requirements in applicable planning instruments to ensure future development does not impeded safe aircraft operations in accordance with the National Safeguarding Framework.	DITRDCA	**Pre-operation** (Detailed design, 2024–2026) and **Operation** (Implementation, 2026–ongoing)
LUP3	Wildlife buffers	WSA Co will liaise with State and local government agencies to establish mechanisms that will identify land uses and prevent the creation of land uses that would cause hazardous wildlife attraction within the wildlife buffers.	WSA Co	**Pre-operation** (Detailed design, 2024–2026) and **Operation** (Implementation, 2026–ongoing)
LUP4	Wildlife buffers	WSA Co will negotiate with State and local government agencies and land owners if required on agreed action plans for monitoring and, where necessary, reducing wildlife attraction to areas in the vicinity of WSI.	WSA Co	**Operation** (Implementation, 2026–ongoing)

Chapter 15 Landscape and visual amenity

This chapter describes the existing landscape and visual conditions and the applicable legislation and policy requirements. The potential impacts of the project on the existing landscape and views in the day-time and night-time have been assessed. The full assessment of impacts to landscape and visual amenity is provided in Technical paper 7: Landscape and visual amenity (Technical paper 7).

The refinements to the preliminary flight path design since the exhibition of the Draft EIS would not change the conclusions of the overall landscape and visual amenity assessment as presented in this chapter and supporting technical paper. Further detail is provided in Appendix G (Assessment of the refinements to the project) of the EIS.

Background and method

The assessment considered the potential impacts of the project on landscape character and visual amenity (day-time and night-time hours), using a representative viewpoint approach. It considered the landscapes and views of Western Sydney and the Blue Mountains, including impacts on the aesthetic values of the Greater Blue Mountains Area (GBMA) which is listed as a World and National Heritage place. The assessment considered impacts in 2033 and 2055 alongside the planned land use change in the surrounding landscape. The years were chosen to represent the early years of airport operation (2033) and impacts as the single runway approaches capacity (2055).

A range of guidance documents were drawn upon in the assessment, including the *Guideline for Landscape Character and Visual Impact Assessment EIA-N04* (Transport for NSW, 2020b), *Guidance Note for Landscape and Visual Assessment* (Australian Institute of Landscape Architects Queensland, 2018) and *Guidelines for Landscape and Visual Impact Assessment* (Landscape Institute and Institute of Environmental Management and Assessment, 2013).

The study area for the assessment comprised 2 geographic areas:

- an area of about 15 kilometres (km) from WSI (centre of the runway), covering the areas of Western Sydney where the preliminary flight paths are at lower altitudes and at higher frequencies
- beyond this the study area expands to about 50 km north-west, west and south-west from WSI (centre of the runway), to consider the potential landscape character and visual impacts on the Blue Mountains.

Existing environment

The study area includes several important environmental, cultural and historic places and routes, which have varying levels of sensitivity. Key receptors that have an elevated landscape character or visual sensitivity include:

- the GBMA, including the many scenic lookouts (such as Echo Point, Portal, Nepean and The Rock Lookouts)
- lookouts, including in protected areas (for example, National Parks and State Heritage or Conservation Areas)
- campgrounds and day-use areas in the GBMA and other protected areas
- scenic and tourist drives
- State and Local heritage register places.

Key findings

Western Sydney

Based on similar topography, vegetation type and cover, land use and built form (existing and emerging), 12 landscape character zones were considered within Western Sydney. Generally, the landscape character of Western Sydney would be transformed by intended changes facilitated and planned for through a number of strategic planning projects. While there would be some landscape character and visual impacts to Western Sydney, these would generally be of a moderate or lower impact level. The level of landscape character impact on the Luddenham village and agricultural landscape character zone would increase from moderate in 2033 to high-moderate in 2055 due to the proximity of the runway and increase in flights arriving and departing the runway.

Eight (8) viewpoints were also considered within Western Sydney. Viewpoints from the public domain that would experience visual impacts ranging from moderate to high-moderate include those with elevated vantage points with views to recreational areas (George Maunder Lookout at Prospect Reservoir and Warragamba Dam Lookout) and/or locations in close proximity to WSI (Kemps Creek) and Luddenham village.

Blue Mountains

Three (3) landscape character zones within the Blue Mountains landscape were assessed. While the introduction of multiple high altitude and low frequency flights would result in a low magnitude of change to each of the landscape character zones, the variation in landscape sensitivity influences the resulting level of impact. There would be:

- high-moderate landscape character impact in 2033 and 2055 on the Blue Mountains iconic features landscape character zone
- moderate landscape character impact in 2033 on the Blue Mountains forested hills and valleys landscape character zone, increasing to high-moderate in 2055 due to the increase in flight frequency
- moderate-low landscape character impact in 2033 and 2055 on the Blue Mountains township spine landscape character zone.

Of the 8 views assessed in the Blue Mountains, there would be:

- high-moderate visual impact in views from Walls lookout and Echo Point lookout due to the very high sensitivity of these views and the introduction of flights that would be perceptible moving across these views
- moderate visual impact in views from Burragorang Lookout, The Rock Lookout, Wynnes Rocks Lookout and Clearys Memorial Lookout, with the visual impact from Burragorang Lookout increasing to high-moderate in 2055 due to the increase in flight frequency at relatively low altitudes
- moderate-low visual impact in the view from the Hawkesbury Lookout. This view has an urban outlook and a moderate sensitivity, allowing it to absorb the aircraft activity with less of an impact.

From campgrounds and day-use areas within the Blue Mountains there would be a moderate visual impact in 2033 and 2055, as views of aircraft overhead would not be highly visible. If seen overhead, however, they would detract from the amenity of views.

There would be a moderate-low visual impact experienced in the views from scenic routes within the Blue Mountains, including the Great Western Highway and Bells Line of Road, during 2033 and 2055. These impacts would be intermittent and experienced particularly in locations where the flights pass over and across these views.

Overall, the project would not directly alter any natural landscape features on the ground. However, the contribution of the sky to landscape character and its appreciation in views make the sky (in some locations) a landscape feature. This includes locations in the Blue Mountains and also where the naturalness of the sky contributes to landscape character. There is a real chance or possibility that the project would substantially alter the appreciation of the sky in views from the following viewpoints:

- south of Katoomba (represented in the assessment by the view from Echo Point Lookout)
- from lookouts along the Grose Valley (represented by the assessment of the view from Walls Lookout).

This alteration would be intermittent, not permanent and is reversible.

Mitigation and management

The design of the preliminary flight paths aimed to minimise noise and other environmental impacts, including visual impacts, to the extent practical while still achieving safe and efficient operations. These considerations were had at various stages of the design process and included sensitive tourist, recreational and wilderness areas.

Based on the nature of the potential impacts, no other reasonable or feasible project specific mitigations are considered to be available that would reduce the potential landscape and visual impacts from the project.

15.1 Introduction

This chapter considers the landscape character and visual impacts of the project. It considers the impacts of the project on landscape character and scenic values by defined landscape character zones, and the visual impacts of the project during the day- and night-time. The full assessment is provided in Technical paper 7: Landscape and visual amenity (Technical paper 7).

The assessment does not consider aircraft within the Airport Site (e.g. aircraft manoeuvring on the runway or taxiways) or the construction and operation of physical ground infrastructure associated with the Stage 1 Development. These impacts have been addressed in the 2016 Environmental Impact Statement (EIS).

15.2 Legislative and policy context

The landscape character and visual impact assessment was undertaken to address the EIS Guidelines and with reference to the following guidelines, policies or standards:

- *Guideline for Landscape Character and Visual Impact Assessment EIA-N04* (Transport for NSW, 2020b)
- *The Guidance Note for Landscape and Visual Assessment* (Australian Institute of Landscape Architects Queensland, 2018)
- *The Guidelines for Landscape and Visual Impact Assessment, Third Edition* (Landscape Institute and Institute of Environmental Management and Assessment, 2013)
- *The Significant Impact Guidelines 1.2 – Actions on, or impacting upon, Commonwealth land and Actions by Commonwealth Agencies* (Commonwealth of Australia, 2013b)
- *Wind Energy: Visual Assessment Bulletin* (NSW DPE, 2016)
- AS/NZS4282:2019 Control of the obtrusive effects of outdoor lighting (Standards Australia, 2019).

A range of legislation, policies and planning strategies from State and local governments were also considered in the assessment of potential landscape character and visual impacts, including:

- State Environmental Planning Policy (Precincts – Western Parkland City) 2021
- *Greater Blue Mountains World Heritage Area Strategic Pla*n (NSW DECC, 2009) and *Greater Blue Mountains World Heritage Area Strategic Plan Addendum 2016* (NSW Office of Environment and Heritage, 2018)
- *The Blue Mountains National Park Plan of Management* (NSW National Parks and Wildlife Services, 2001)
- *The Greater Sydney Region Plan – A Metropolis of Three Cities* (Greater Sydney Commission, 2018b)
- *Western City District Plan* (Greater Sydney Commission, 2018a)
- *Western Sydney Aerotropolis Precinct Plan 2022* (NSW DPE, 2023a)
- Western Sydney Aerotropolis Development Control Plan (DCP) (NSW DPE, 2022c)
- *The Luddenham Village Interim Strategy* (NSW DPE, 2022b)

- Local strategic planning statements and local environment plans for the Penrith, Liverpool and Blue Mountains local government areas (LGAs)
- *Penrith Scenic and Cultural Landscapes Study* (Penrith City Council, 2019) and *Penrith Rural Lands Strategy* (Penrith City Council, 2022)
- *Western Sydney Parklands Plan of Management 2030* (Western Sydney Parklands, 2018).

15.3 Methodology

15.3.1 Study area

The landscape and visual study area (the study area) comprises 2 geographic areas:

- an area of about 15 km from WSI (centre of the runway), covering the areas of Western Sydney where the preliminary flight paths would be at lower altitudes and at higher frequencies. In this area aircraft movements are likely to be more visually prominent and more likely to affect landscape character and visual amenity
- a broader study area up to about 50 km north-west, west and south-west from WSI (centre of the runway), in order to consider the potential landscape character and visual impacts on the wider region, in particular the Greater Blue Mountains Area (GBMA). In this broader study area, the landform rises and the landscape character and visual amenity values are more sensitive to change.

15.3.2 Approach

Landscape character and visual impacts were assessed to identify the likely impacts arising from the project. The assessment methodology generally involved:

- identification of landscape character areas
- division of the study area into broad landscape character zones that reflect the qualities of the built, natural and cultural environment, including geology, topography, vegetation, waterways, built form, patterns and types of land use. Due to the scale of the project and study area, the identification of landscape character zones has been approached as follows:
  - in Western Sydney, the area within 15 km of WSI has been divided into landscape character zones that are based on the 2016 EIS and refined to reflect changes to the landscape and strategic planning strategies for these areas
  - for the GBMA, the landscape character zones have been described but not spatially defined. These zones reflect the landscape types that are characterised by particular geology, topography and other natural features, built form and land use types
- identification of significant viewpoints and vistas identified in the review of relevant planning instruments, strategies and from field observations
- selection of views representative of the site, including views from areas where the greatest number of viewers are likely to congregate (such as lookouts, road corridors and scenic routes) and locations in sensitive recreational and natural areas
- identification of day-time sensitivity of each landscape character area and viewpoint, and identification of night-time visual sensitivity for each environmental zone(s)
- preparation of photomontages for selected viewpoints to support the assessment of impact. The selected viewpoints represent:
  - a range of viewing locations, from a distance and orientation where the project would be most visible, and
  - views from areas with the greatest visual sensitivity and where the greatest number of viewers would be located

For each photomontage, an image was prepared that includes a line showing the flight path and multiple aircraft in silhouette located along each flight path. The spacing of the aircraft does not represent aircraft frequency, but is intended to illustrate the effect of aircraft that may be moving across the sky. A3-sized versions of the photomontages are provided in Appendix A of Technical paper 7.

- assessment of the likely magnitude of change expected as a result of the project, which is then combined to make an overall assessment of landscape or visual impact (refer to Table 15.1)
- providing management and mitigation measures.

The assessment has considered impacts in 2033 and 2055 alongside the planned land use change in the surrounding landscape. The years were chosen to represent the early years of airport operation (2033) and impacts as the single runway approaches capacity (2055).

Further detail on the sensitivity and magnitude of change applied in the landscape and visual impact assessment is provided in Section 15.3.2.1 to Section 15.3.2.3.

Table 15.1 Landscape and visual impact levels

		Sensitivity				
		Very high	High	Moderate	Low	Very low
Magnitude	Very high	Very high	Very high	High	High-Moderate	Moderate
	High	Very high	High	High-Moderate	Moderate	Moderate-Low
	Moderate	High	High-Moderate	Moderate	Moderate-Low	Low
	Low	High-Moderate	Moderate	Moderate-Low	Low	Negligible
	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

15.3.2.1 Landscape character impact assessment

The *Guideline for Landscape Character and Visual Impact Assessment EIA-N04* (Transport for NSW, 2020b) defines landscape as 'all aspects of a tract of land, including landform, vegetation, buildings, villages, towns, cities and infrastructure' and defines landscape character as the 'combined quality of built, natural and cultural aspects which make up an area and provide its unique sense of place'.

Landscape sensitivity reflects the frequency and volumes of users and the valued characteristics such as scenic amenity, its contribution to sense of place and rarity. It also considers the scenic quality of the landscape. For example, areas with more distinctive terrain, greater vegetation cover, natural waterbodies, heritage or cultural landscape and built form features would have a higher landscape sensitivity and greater susceptibility to change compared to landscapes with less terrain, fewer trees, human created farmland and areas with a more dominating presence of development.

Table 15.2 sets out the landscape sensitivity levels applied in this assessment.

Table 15.2 Landscape sensitivity levels

Sensitivity	Description
Very high	• Landscape feature or place protected under national legislation or international policy. For example, World Heritage Areas and National Parks. • Typically includes distinctive, unique and landscape features which are uncommon across the nation and internationally. Comprises a high sense of tranquillity and wilderness with minimal evidence of human presence.
High	• Landscape feature or place that is iconic to NSW. Typically includes some unique and landscape features which are uncommon within NSW. • Comprises a sense of tranquillity and wilderness but may include some human presence. For example, small scale built development.
Moderate	• Landscape or place that is heavily used, and/or valued by residents of a major portion of a city or a non-metropolitan region, and/or places with regionally important scenic value or landscape features. • May include urban areas with a greater density of urban development where character and amenity is important, or landscape features that are uncommon within the region.
Low	• Landscape valued and experienced by concentrations of residents, and/or local recreational users, and/or places of local scenic value or local landscape features. • May include regionally common landscapes and features, and may be a landscape transitioning to urban development.
Very low	• Places without any particular scenic value or local landscape features, or which are common across the region and beyond.

The magnitude of change refers to changes to the landscape character that would occur as a result of the project. It considers both direct and indirect changes. The magnitude of change relates to the entire landscape character zone or area and is assigned a level based on the categories described in Table 15.3.

Table 15.3 Landscape magnitude of change levels

Magnitude of change	Description
Very high	• The landscape is altered such that the project dominates and/or transforms its character, and results in an extensive and/or severe change in landscape character.
High	• The project substantially changes and/or is not compatible with the character of the landscape, and may result in considerable change in landscape character.
Moderate	• The project noticeably changes and/or is not compatible with the character of the landscape. • This may include the introduction of elements that are visible from some areas and/or contrasts somewhat with the characteristics of the existing landscape character.
Low	• The project slightly changes and/or is compatible with the landscape character. • This may include the introduction of elements that have minimal visibility, influence a small extent of the landscape character area, and/or contrasts noticeably with the characteristics of the existing landscape character.
Negligible	• The project would not change the existing landscape character.

Although the project would not result in direct impacts on the landscape (for example, the removal of trees and tree canopy), it is likely to result in indirect impacts. This could be changes to the characteristics of the landscape that form its sense of place and unique identity. The magnitude of change relates to the entire landscape character zone or area, not just changes to a small area or localised changes. Visibility is a part of landscape character and areas which are more widely seen would have a greater influence on landscape character.

15.3.2.2 Day-time visual impact assessment

The day-time visual amenity impact assessment considers visual amenity as experienced by people (referred to as receivers) and aims to identify the range of views to the site that may be impacted and where the greatest number of receivers are likely to congregate. This includes views from residential areas, lookouts, road corridors and scenic routes, as well as locations in sensitive recreational and natural areas.

Visual sensitivity refers to the nature and duration of views. Locations from which a view would potentially be seen for a longer duration, where there are higher numbers of potential viewers and where visual amenity is important to viewers can be regarded as having a higher visual sensitivity. To ensure the impacts are attributed fairly, the sensitivity of each viewpoint is considered in the broadest context of possible views, including those of national importance through to those considered to have a neighbourhood importance.

Table 15.4 sets out the day-time sensitivity levels applied in this assessment.

Table 15.4 Day-time sensitivity levels

Sensitivity	Description
Very high	• Heavily experienced view to a national icon, for example, view from lookouts within the GBMA. • Views to areas with a scenic value of national importance or to landscape features of NSW. • Views that are generally unique and uncommon nationally.
High	• Heavily experienced view to a feature or landscape that is iconic to NSW. • Views to areas with a scenic value recognised by NSW. • Views that are generally unique or uncommon within NSW.
Moderate	• Heavily experienced view to a feature or landscape that is iconic to a major portion of a city or a non-metropolitan region, or an important view from an area of regional open space. • Views to areas of regionally important scenic value or to landscape features of the region. • Views that are generally unique or uncommon within the region.
Low	• High quality view experienced by concentrations of residents, local recreational users and/or large numbers of road or rail users. • Views to areas of local scenic value or to local landscape features. • Views that are somewhat common within the landscape.
Very low	• Views where visual amenity is not as important to the wider community (such as lower quality views briefly glimpsed from roads). • Views that are likely to be common within the landscape.

The magnitude of change refers to the change to the landscape that would occur as a result of the project from a given viewpoint. Magnitude of change describes the extent of change and identifies elements which are removed or in this case added, changes in remoteness and tranquillity, and compatibility of new elements with the existing landscape.

Table 15.5 sets out the magnitude of change levels applied in the assessment for day-time visual impacts. A high magnitude of change would result if a project contrasts strongly with the existing landscape. Whereas a low magnitude of change occurs if there is visual compatibility or minimal visual contrast between the project and the landscape in view. In this situation, the project may be noticeable but does not noticeably contrast with the existing modified and transitioning landscape surrounding WSI.

Table 15.5 Day-time magnitude of change levels

Magnitude of change	Description
Very high	• The view is altered such that the project visually dominates and transforms the character of the view. • The project would result in a substantial change in the amenity of the view.
High	• The project is visually prominent, and/or contrasts with the character of the view. • The project would result in a considerable change in the amenity of the view.
Moderate	• The project is somewhat prominent, and/or is not compatible with the character of the view. • The project would result in a noticeable change in the amenity of the view.
Low	• The project is not visually prominent, and/or is visually compatible with the character of the view. • The project would result in a slight change in the amenity of the view.
Negligible	• The project is not visible, is not visually prominent in the view, and/or is compatible with the character of the view. • The project would result in no perceived change in the amenity of the view.

There are some general principles regarding the relationship between the project and the landscape which determine the magnitude of change level. These principles, or assumptions, relate to how well a flight path can be absorbed into the landscape setting and what is considered to be more or less visually harmonious. These principles have been applied generally to the viewpoint assessment (refer to Figure 15.1) and include:

- vertical and horizontal distance – the greater the distance, the less prominent the aircraft are likely to be
- area of sky occupied – for example, frequency of flights and number of flight paths visible
- visibility of the sky – for example, open and expansive skyline where the sky is a critical feature in views, versus an enclosed sky where buildings or vegetation screen and reduce visibility
- development context and character – the presence of other existing infrastructure of a similar character (for example, vehicular traffic and existing flight paths) can increase the compatibility of development within a view.

Figure 15.2 and Figure 15.3 shows the visible scale of aircraft (B777 and A320) based on distance and altitude.

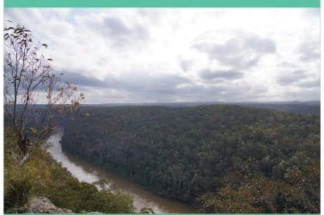
	Very high	High	Moderate	Low
Horizontal distance	Planes seen less than 1 kilometre away (horizontal distance).	Planes seen at around 2 km away.	Planes seen at around 5 km away.	Planes seen at around 10 km away.
Altitude	Planes seen under 1000 metres (about 1,600 - 3,200 ft)	Planes seen under around 1-2km (3,200 - 6,500ft altitude).	Planes seen at 3-5 kilometres (10,000 - 16,500ft altitude).	Planes seen at 5-10 kilometres altitude (16,600 - 32,000ft).
Frequency	Continiuous stream of flights throughout a given day	Numerous flights visible per day	Many flights visible per day	Several flights visible per day
Area of sky occupied by planes	Numerous flight paths visible.	Several flight paths visible.	Several flight paths visible.	One flight path visible.
Visibility of the sky	 Open and expansive skyline. Sky is a critical feature in view.	 Sky mostly open	 Sky partly enclosed by built form.	 Sky not prominent and / or enclosed by built form.

Figure 15.1 Visual magnitude principles

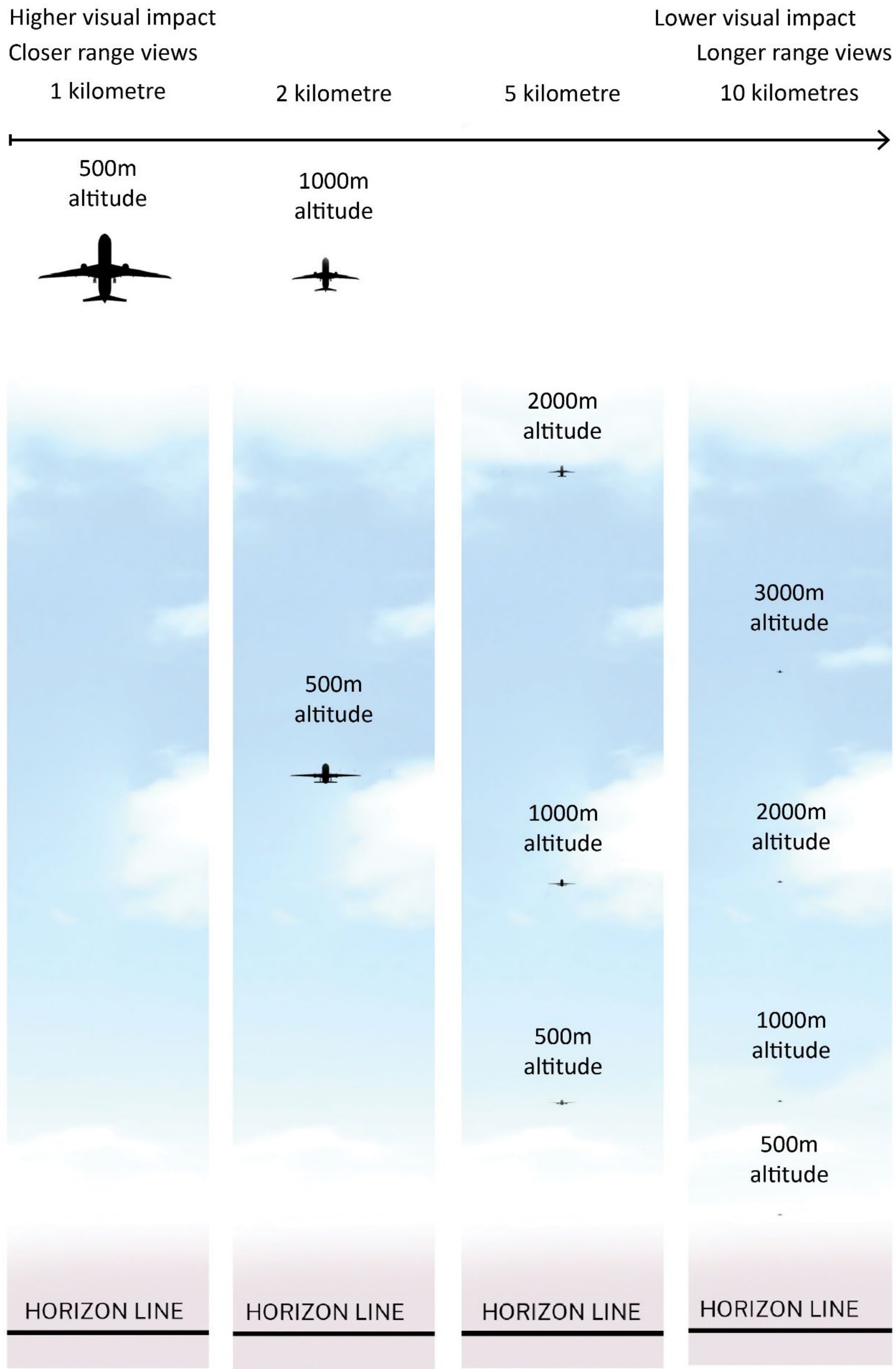


Figure 15.2 Visible scale of aircraft based on distance and altitude (B777 aircraft shown)

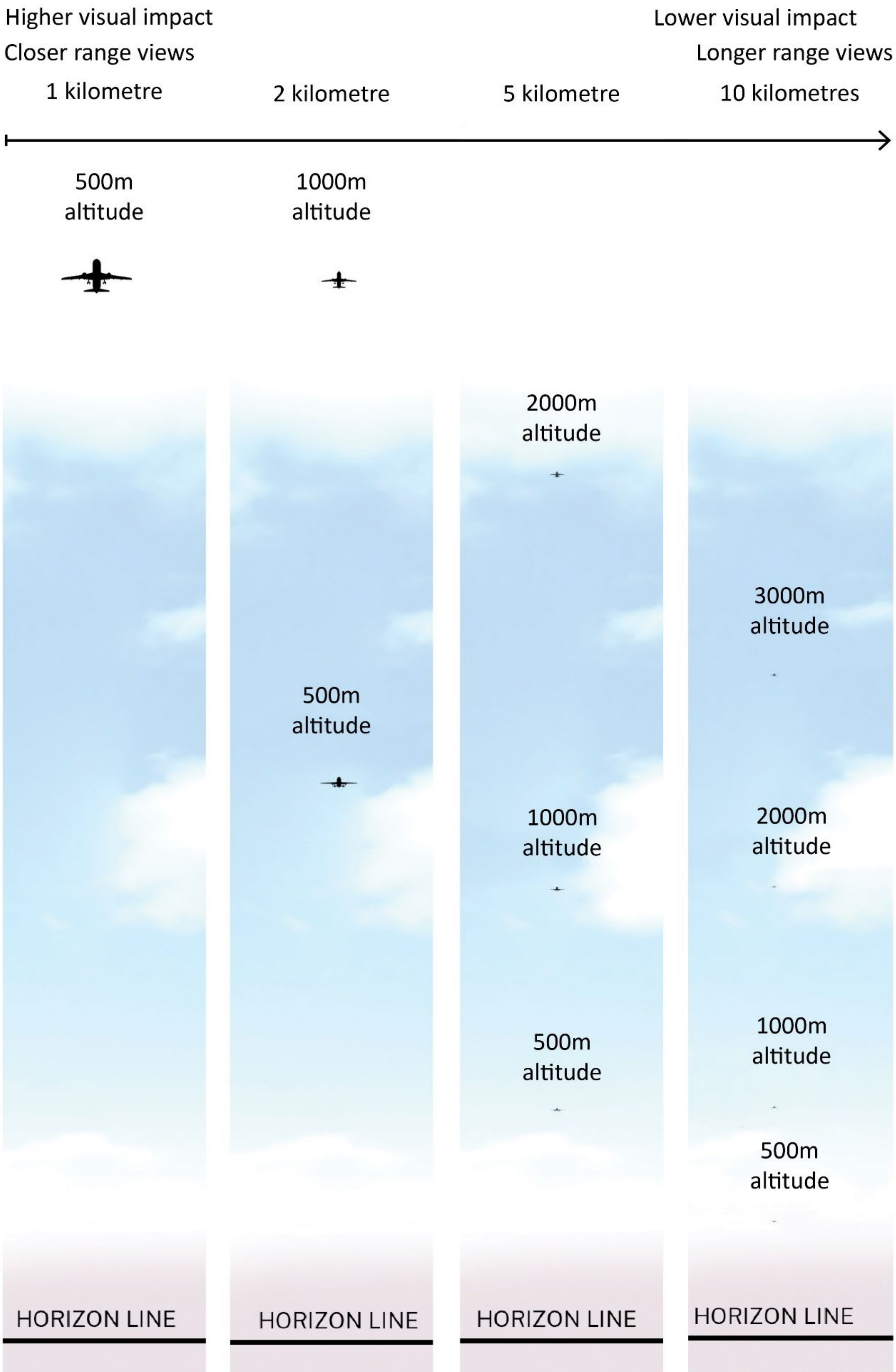


Figure 15.3 Visible scale of aircraft based on distance and altitude (A320 aircraft shown)

15.3.2.3 Night-time visual impact assessment

An assessment of the potential visual impacts of the project at night was undertaken using the broad environmental zones that occur within the study area. Night-time hours for this assessment are between 11 pm and 5:30 am.

The assessment of visual impacts at night has been undertaken based on the 'night-time' flight paths (between 11 pm and 5.30 am), as well as the 'day-time' flight paths which would be used during periods of darkness (between sunset and 11 pm) for Runway 05, Runway 23 and the RRO runway mode of operation (as described in Chapter 7 (The project)).

The assessment of night-time impact was carried out with a similar methodology to the day-time assessment and also draws upon the guidance contained within AS/NZS4282:2019 Control of the obtrusive effects of outdoor lighting (Standards Australia, 2019). This assessment has considered the effects of lighting on the visual amenity of residents and transport system users and astronomical observations.

AS4282 identifies environmental zones used to categorise night-time landscape settings in the study area. These environmental zones have been used to describe the existing night-time visual condition and assign a level of sensitivity as shown in Table 15.6.

Table 15.6 Environmental zone sensitivity – night-time

	Environmental zones (AS4282:2019)	
Sensitivity level	**Description**	**Examples**
Very high	A0: Intrinsically dark	• UNESCO Starlight Reserve • IDA Dark Sky Parks • Major optical observatories • No road lighting (unless specifically required by the road controlling authority).
High	A1: Dark	• Relatively uninhabited rural areas • No road lighting (unless specifically required by the road controlling authority).
Moderate	A2: Low district brightness	• Sparsely inhabited rural and semi-rural areas.
Low	A3: Medium district brightness	• Suburban areas in towns and cities.
Very low	A4: High district brightness areas	• Town, city centres and other commercial areas • Residential areas abutting commercial areas.

The magnitude of change that would be expected within each environmental zone at night is described in Table 15.7, with reference to the following key terms (as defined in AS4282:2019 (Standards Australia, 2019)):

- skyglow – the brightening of the night sky that results from radiation (visible and non-visible), scattered from the constituents of the atmosphere (gaseous, molecules, aerosols and particulate matter), in the direction of observation, and comprises natural sky glow and artificial sky glow
- glare – condition of vision in which there is discomfort or a reduction in ability to see, or both, caused by an unsuitable distribution or range of luminance, or to extreme contrasts in the field of vision
- light spill – light emitted by a lighting installation that falls outside of the design area, and may or may not be obtrusive depending on what it affects.

Table 15.7 Magnitude of change levels – night-time

Magnitude of change	Night-time visual
Very high	• Substantial change to the level of skyglow, glare or light spill expected. • The lighting of the project would transform the character of the surrounding setting at night. • The effect of lighting would be experienced over an extensive area.
High	• Considerable change to the level of skyglow, glare or light spill. • The lighting of the project would noticeably contrast with the surrounding landscape at night. • The effect of lighting would be experienced across a large portion of the landscape.
Moderate	• Alteration to the level of skyglow, glare or light spill would be expected. • The lighting of the project would contrast with the surrounding landscape at night. • The effect of lighting would be experienced across a moderate portion of the landscape.
Low	• Alteration to the level of skyglow, glare or light spill would be expected. • The lighting of the project would not contrast substantially with the surrounding landscape at night. • The effect of lighting would be experienced across a small portion of the landscape.
Negligible	• The level of skyglow, glare and light spill is unchanged or if it is altered, the change is generally unlikely to be perceived by viewers. • Compatible with the existing or intended future use of the area.

15.3.3 Dependencies and interactions with other study areas

This assessment is associated with other EIS studies as outlined in Table 15.8.

Table 15.8 Dependencies and interactions with other technical papers

Technical paper	Relevance
Technical paper 1: Aircraft noise	This assessment considers the flight frequencies relied upon in Technical paper 1. The altitudes used in this assessment are assumed based on the mapping provided in Technical paper 1.
Technical paper 9: Heritage	There is the potential for interactive effects between Aboriginal cultural heritage and non-Aboriginal cultural heritage, where the values of these places relies on landscape character or views, particularly where these places offer views to the sky.

15.3.4 Assumptions and limitations

15.3.4.1 Limitations

This assessment has considered distances from flight paths, however for operational and safety reasons, aircraft may operate within wider flight path corridors that could bring aircraft closer than assumed in this assessment. This is more likely to affect views further from the Airport Site, such as across the GBMA.

The scheduling and therefore the frequency of flights is not yet known. This assessment considered the flight frequencies relied upon in Technical paper 1 and has assumed these flights occur evenly across either day- or night-time operating hours. There is, however, likely to be peak hours when more flights would occur.

All altitudes vary by aircraft type, weight, destination, weather, individual pilot technique, air traffic control instructions and other factors. The altitudes used in this assessment are assumed based on the mapping provided in Technical paper 1.

The night-time assessment has utilised the AS/NZS4282:2019 Control of the obtrusive effects of outdoor lighting, which aims to manage lighting on the ground and does not contemplate aerial light sources.

15.3.4.2 General assumptions

The assumptions that have been applied in this assessment concerning the movement and type of aircraft are detailed in Table 15.9.

Table 15.9 General assumptions

Feature	Assumption
General	Views of aircraft flying overhead are transient, typically of short duration and viewed at varying distances. It is assumed that the greater the distance from WSI, the higher aircraft would be and therefore the less visually prominent these aircraft are in views toward them. Based on the orientation of Runway 05/23, aircraft would typically move on a generally north-east to south-west axis. A considerable number of aircraft would be viewed across Western Sydney, or along a corridor to the north-east and south-west. The patterns of movement would be relatively consistent but would alter day to day according to weather conditions.
Flight path corridors	There will be some variation as to where different aircraft will be on the flight path because aircraft perform slightly differently or may be affected by weather conditions. The variation of aircraft around a nominated flight path is referred to as dispersion. This broad band of dispersion is known as the flight path corridor. This caters for aircraft dispersion either side of the nominal centreline. The flight path corridor will progressively widen as the distance increases from the runway.
Hours	Day-time operations at WSI occur between 5.30 am and 11 pm, extending beyond daylight hours. Night operations are between 11 pm and 5.30 am. The assessment of visual impacts at night has been undertaken based on the 'night-time' flight paths (between 11 pm and 5.30 am), as well as the 'day-time' flight paths which would be used during periods of darkness (between sunset and 11 pm). Aircraft typically have at least 3 flashing red and white navigation lights, which are more visible at night. Actual lighting, however, can vary and include red, green and white lights on the wingtips and tail which may be steady or flashing, appearing visible at night. During final approach there are also landing lights which can be steady or pulse/strobe and can be visible at some distance. These lights may be used during low visibility conditions and not necessarily only at night.
Frequency	The frequency of flights has been based on the data used for Technical paper 1. The distribution of flights throughout the day and detailed flight scheduling is not yet known.
Altitude and existing landform	The description of flight altitude is usually an above sea level measurement. In Western Sydney, the landform varies up to 100 meters (m) above sea level, which is not a material viewing height when considering the altitude of visible flights. At the Blue Mountains, however, where there is substantial increase in the height of the landform, relative to sea level, assumptions have been made in relation to flight path altitudes. For further detail on elevation and altitude, refer to Section 6.3 in Technical paper 7.

Feature	Assumption
Aircraft type	This assessment has considered views to jet aircraft only. In particular, a typical large aircraft and a smaller aircraft representing the likely aircraft size that would most frequently operate at WSI: • B777 – typical of the wide-body type of aircraft predicted to fly at WSI (about 73 m long) • A320 – expected to be the most flown aircraft at WSI (about 37.6 m long). Whilst not the most frequently flown, the B777 was selected as it is one of the largest aircraft and would be likely to cause the greatest landscape character and visual impact.
Contrails	Contrails form when aircraft are at very high altitudes (normally above 26,000 ft or 8,000 m), the air is very cold and there is a large amount of water vapor in the air (high humidity). At the altitudes contrails are formed, they form a small part of the view to the sky and can be seen in the context of clouds (which can reduce their visibility). Contrails typically form straight lines, and can be especially noticeable in sensitive natural areas such as the GBMA because they are linear features, unlike most natural clouds. While the formation of contrails is variable, when present they can draw attention to and increase the visibility of distant aircraft, particularly when there is heavy flight traffic. Contrails can also remain for long periods of time after the aircraft has passed depending on atmospheric conditions.

15.4 Existing environment

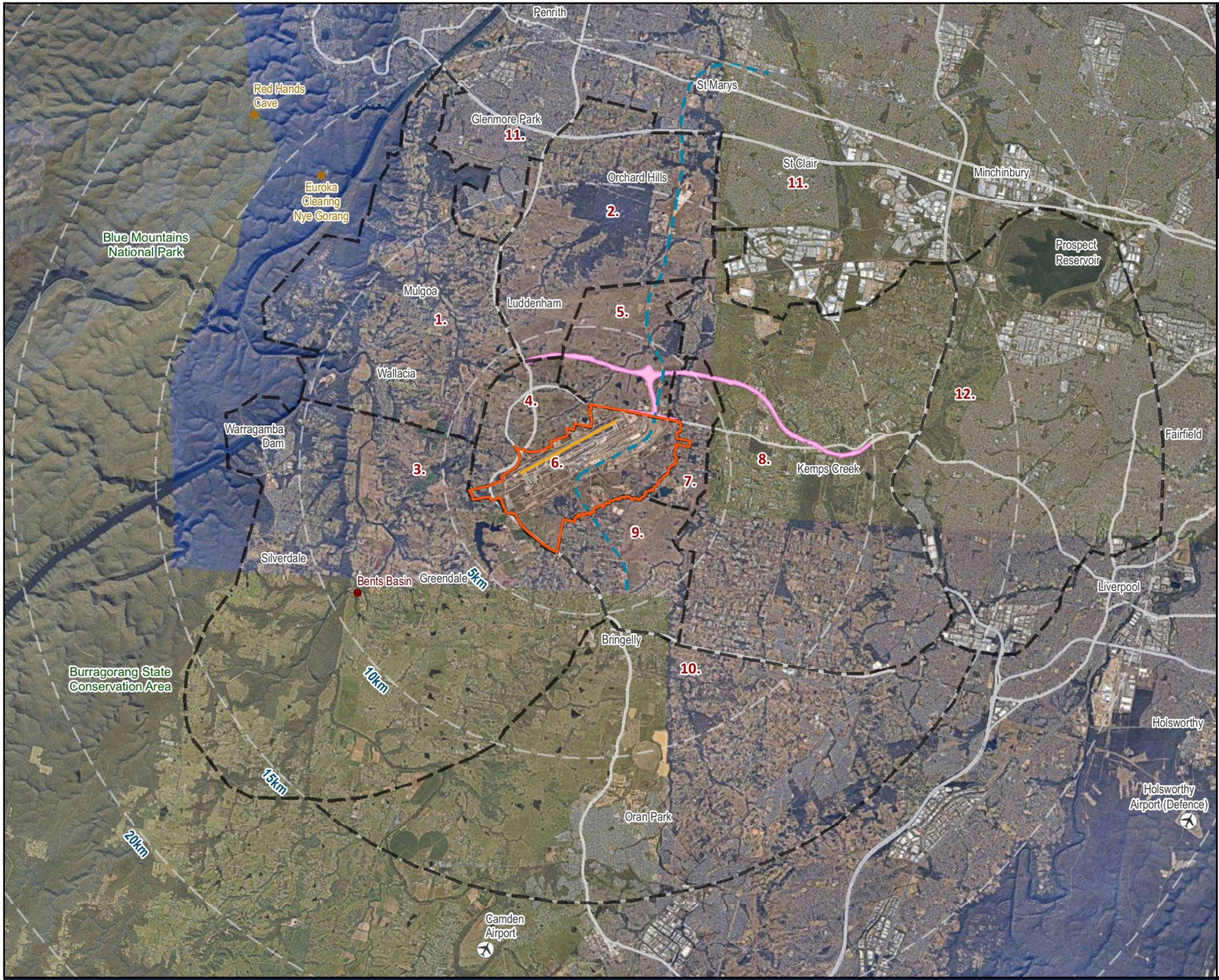
15.4.1 Landscape character zones

Based on similar topography, vegetation type and cover, land use and built form (existing and emerging), 12 landscape character zones have been identified. The zones were also based on the landscape character zones identified in the 2016 EIS and have been updated to reflect recent changes in the landscape and planned future landscape character. The location of these landscape character zones are shown in Figure 15.4, and are described further in Section 15.4.1.1.

The Blue Mountains landscape has been considered in addition to the 12 landscape character zones, and is described in Section 15.4.1.2. Three (3) landscape character zones within the Blue Mountains landscape have been assessed and illustrated with representative photographs. The impacts assigned to each type of landscape can be assumed to apply to all areas where the features, unique to each character area are located.

Figure 15.4

Landscape character plan - Western Sydney



Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- Radial distances
- Proposed M12 Motorway
- Draft landscape character zones
- Railway
- Proposed Sydney Metro
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

The corresponding character zones

1. Penrith rural south-west landscape
2. Penrith south-east rural transition landscape
3. Greendale and Silverdale rural and residential landscape
4. Luddenham village and agricultural precinct
5. Northern Gateway precinct
6. WSI
7. Badgerys Creek landscape
8. Kemps Creek and Rossmore rural residential landscape
9. Aerotropolis core precinct
10. Leppington rural residential landscape
11. South Penrith urban area
12. Western Sydney Parklands landscape

0 2 4 km

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:175,000 Date: 10/08/2023

Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

15.4.1.1 Western Sydney

Penrith rural south-west landscape character zone (LCZ1)

Landscape character zone LCZ1 is broadly located along the eastern foothills of the Blue Mountains, encompassing the Nepean River valley. The landscape has significant environmental conservation lands which shape its character, including the Blue Mountains National Park and Mulgoa Nature Reserve.

This entire landscape character zone is identified in the Penrith Rural Lands Strategy as a Metropolitan Rural Area and within the rural edge of Penrith. Dwellings and villages are scattered through the landscape with modified waterways and scattered or sparsely vegetated areas (beyond the conservation lands).

Several features in the landscape character zone are recognised as having scenic and cultural landscape values, including the Nepean River, several State and local heritage sites in the Mulgoa Valley and The Northern Road corridor.

LCZ1 is overflown by flights from Sydney (Kingsford Smith) Airport, Bankstown Airport, Camden Airport and other airports in the region, as well as flying training areas. Whilst some of these overflights are high, flying training activity at lower altitudes is allowed in this area. Aircraft are likely to be seen in the airspace over this area, which influences the character of LCZ1.

The landscape character zone is presently of low sensitivity. It would remain as low sensitivity in 2033 and 2055, noting the zone is within the Metropolitan Rural Area and should remain predominantly rural.

Penrith south-east rural transition landscape character zone (LCZ2)

Landscape character zone LCZ2 consists of established and planned urban areas of Penrith as well as areas of rural-residential with local heritage places. It broadly encompasses the suburbs of Orchard Hills, Kemps Creek, Mount Vernon, Badgerys Creek and Luddenham. While currently rural land, a large part of this zone would eventually develop into urban areas with associated infrastructure, including:

- residential development emerging within the Orchard Hills Urban Investigation Area
- major infrastructure projects such as Sydney Metro Western Sydney Airport (including the Orchard Hills Metro Station), Western Sydney freight line and the Outer Sydney Orbital.

Vegetation is mostly scattered or sparsely distributed through the landscape. South Creek would provide a green break within the zone. The Defence Establishment Orchard Hills site also plays an important conservation role with much of the vegetation on the site protected.

LCZ2 is currently overflown by flights from Sydney (Kingsford Smith) Airport, Bankstown Airport and other airports in the region, as well as flying training areas. Whilst some of these overflights are high, there is some flying training activity at lower altitudes. Aircraft are likely to be seen in the airspace over this area, which influences the character of LCZ2.

The landscape character zone is presently of moderate sensitivity, and would remain as moderate sensitivity in 2033 and 2055.

Greendale and Silverdale rural and residential landscape character zone (LCZ3)

Landscape character zone LCZ3 is located to the south-west of WSI, comprising the rural and suburban areas of Greendale, Warragamba and Silverdale along the Nepean River valley. The majority of this landscape is zoned for primary production and is characterised by acreage lots and small farms on gently undulating landform. The southern part of this landscape includes the University of Sydney's Camden farm. Gulguer Nature Reserve and Bents Basin State Conservation Area are located along the Nepean River comprising dense native bushland and walking trails.

LCZ3 is overflown by flights from Sydney (Kingsford Smith) Airport, Bankstown Airport and other airports in the region, as well as flying training areas. The suburbs of Greendale and Silverdale are located under a departure flight path from Bankstown Airport and flights arriving at Camden Airport. There would also be flying training activity of smaller aircraft at lower altitudes in the area. Combined, these aircraft would influence the character of LCZ3.

The landscape character zone is presently of low sensitivity, and would remain as low sensitivity in 2033 and 2055.

Luddenham village and agricultural precinct landscape character zone (LCZ4)

Landscape character zone LCZ4 is located to the west of WSI and includes the historic village of Luddenham, surrounded by agricultural production areas. Luddenham Village is located on a ridgeline and contains several local heritage items. Strategic planning for the village is ongoing, but is envisioned that the village would grow as a local centre to support WSI and to provide the tourist and cultural hub for the Aerotropolis.

The area surrounding the Luddenham Village Precinct is designated in strategic plans as the Agribusiness Precinct. An enterprise zone is also proposed at the northern end of the landscape character zone, adjacent to the Northern Gateway. This would include developments such as logistics, food production and processing. A network of open space and parkland is also proposed to follow existing creek lines. Duncans Creek reservoir would also be rehabilitated, providing passive recreation. The Northern Road (a 4-lane divided road) is located to the east of Luddenham village, bypassing the village.

There is air traffic across LCZ4 with flights from Sydney (Kingsford Smith) Airport, Bankstown Airport and other airports in the region. Part of this area is also overflown by flying training areas based around Bankstown Airport and Camden Airport. While some of these overflights are high, the flying training activity can occur at lower altitudes. Luddenham is located under a departure flight path from Bankstown Airport. Combined, these aircraft would influence the character of LCZ4.

The landscape character zone is presently of moderate sensitivity. While the future enterprise zone would reduce the sensitivity of this landscape character zone, it would remain as moderate sensitivity in 2033 and 2055 due to the density of residential development.

Northern Gateway precinct landscape character zone (LCZ5)

Landscape character zone LCZ5 is located to the north of WSI, between Elizabeth Drive and the Warragamba pipeline. Dwellings and villages are scattered through the landscape with modified waterways and scattered or sparsely vegetated areas. Although it is largely rural, this landscape would develop as the Northern Gateway. The Northern Gateway is a future employment precinct that would support WSI (including warehousing, distribution and manufacturing developments) with an open space network aligned with existing creek lines (referred to as the Northern Gateway). The Northern Gateway would expand from the approved Sydney Science Park and transition into an employment precinct, with supporting residential areas.

The approved Sydney Metro Luddenham Station would be located near Luddenham Road, and the M12 Motorway (under construction) is located in the centre of this landscape.

There is air traffic across LCZ5 with flights from Sydney (Kingsford Smith) Airport, Bankstown Airport and other airports in the region. Part of this area is also overflown by flying training areas based around Bankstown Airport and Camden Airport. While some of these overflights are high, the flying training activity occurs at lower altitudes. The Northern Gateway precinct is located under an arrival and departure flight path to Bankstown Airport. Combined, these aircraft would influence the character of LCZ5.

The landscape character zone is presently of low sensitivity and would be of very low sensitivity in 2033 and 2055, given the area would transition to an employment precinct.

WSI landscape character zone (LCZ6)

Landscape character zone LCZ6 is changing from a largely undulating rural area to a major international airport. Construction commenced in 2018. This landscape would include 2 Metro stations. The Airport Business Park Station precinct would become a major employment and services hub and key interchange for customers working in the local area.

There is air traffic currently operating across LCZ6 with flights from Sydney (Kingsford Smith) Airport and Bankstown Airport, as well as flying training areas. Whilst some of these overflights are high, there is some flying training activity at lower altitudes in the area influencing the character of LCZ6.

The landscape character zone is a highly modified landscape and is of very low sensitivity now and in the future (2033 and 2055).

Badgerys Creek landscape character zone (LCZ7)

Landscape character zone LCZ7 is generally located to the east of WSI, between Badgerys Creek and Wianamatta-South Creek corridors. This landscape currently includes large lot rural residential and small lot agricultural uses. This zone is planned to transform to intensive technology, manufacturing and industry uses adjacent to WSI.

There is air traffic across LCZ7 with flights from Sydney (Kingsford Smith) Airport and Bankstown Airport, as well as flying training areas. Whilst some of these overflights are high, there is flying training activity at lower altitudes in the area. Badgerys Creek is also located under a departure flight path from Bankstown Airport. These flights influence the character of LCZ7.

The landscape character zone is presently of low sensitivity. As this area would transition to business and industrial uses, the area would be of very low sensitivity in 2033 and 2055.

Kemps Creek and Rossmore rural residential landscape character zone (LCZ8)

Landscape character zone LCZ8 is located to east of WSI. It includes the Wianamatta-South Creek and Kemps Creek corridors, and surrounding rural and residential areas of Kemps Creek and Rossmore. Under the Aerotropolis Precinct Plan, the Wianamatta-South Creek corridor would provide a green break between surrounding urban development and would include sporting fields, walking trails and community facilities.

The northern part of this landscape would change from rural landscape character to industrial, forming part of the Western Sydney Employment Area. The southern part of this landscape character zone would likely transition to urban development as part of the South West Growth Area.

There is air traffic across LCZ8 with flights from Sydney (Kingsford Smith) Airport and Bankstown Airport, as well as flying training areas. Whilst some of these overflights are high, there is flying training activity at lower altitudes in the area. Kemps Creek is also located under a departure flight path from Bankstown Airport. Aircraft are operating in the airspace over this area, which influences the character of LCZ8.

The landscape character zone is presently of low sensitivity. While it would transition to industrial uses in the southern part of the landscape character zone (thereby lowering the sensitivity of some areas), there are existing and planned areas of parkland and residential uses elsewhere within the zone (thereby increasing sensitivity). Overall, the sensitivity would remain low in 2033 and 2055.

Aerotropolis core precinct landscape character zone (LCZ9)

Landscape character zone LCZ9 is generally located to the south-east of WSI, between WSI and Bringelly Road. This landscape currently includes large lot rural residential and small lot agricultural uses.

This zone would transform to a dense urban precinct planned around the future Aerotropolis Metro station (located east of Badgerys Creek Road). It would include a new regional park system along Thompsons Creek and the new Bradfield City Centre. While the land use focus is on employment and economic development, it would include residential development.

There is air traffic across LCZ9 with flights from Sydney (Kingsford Smith) Airport, Bankstown Airport and Camden Airport, as well as flying training areas. Whilst some of these overflights are high, there is some flying training activity operating at lower altitudes. The Aerotropolis precinct is also located under arrival and departure flight paths from both Bankstown Airport and Camden Airport. Aircraft are visible in the airspace over this area, influencing the character of LCZ9.

The landscape character zone is presently of low sensitivity. As this area would transition to urban land uses, it would be of moderate sensitivity in 2033 and 2055.

Leppington rural residential landscape character zone (LCZ10)

Landscape character zone LCZ10 is located to the south of Bringelly Road. It is characterised by large, rural residential lots and farms on undulating topography. This landscape forms part of the South West Growth Area and would include major urban development in the future, such as a town centre, rail connections, low and medium density residential areas and major community facilities.

There is air traffic across LCZ10 with flights from Sydney (Kingsford Smith) Airport, Bankstown Airport and Camden Airport, as well as flying training areas. Part of this zone is also within the Camden airspace. Whilst some of the overflights are high, there are some flying training activity at lower altitudes. The Leppington area is also located under arrival and departure flight paths from both Bankstown Airport and Camden Airport. Aircraft are visible in the sky above this area, which influences the character of LCZ10.

The landscape character zone is currently of low sensitivity. As it would transition to urban land uses over time (including a town centre), it would be of moderate sensitivity in 2033 and 2055.

South Penrith urban area landscape character zone (LCZ11)

Landscape character zone LCZ11 is located to the north of WSI, south of Penrith. It is characterised by an undulating topography with mixture of urban uses (low density residential, industrial areas and parkland). This landscape forms part of the urban area of Penrith. Sydney Metro will extend through this landscape between Orchard Hills and St Marys.

There is air traffic across LCZ11 with flights from Sydney (Kingsford Smith) Airport, Bankstown Airport and other airports in the region, as well as flying training areas. This may include low altitude emergency services helicopter activity. The South Penrith precinct is also located under the arrival flight path to Bankstown Airport. Aircraft and helicopters would be seen in the airspace over this area, influencing the character of LCZ11.

The landscape character zone is of moderate sensitivity now and in the future (2033 and 2055).

Western Sydney Parklands landscape character zone (LCZ12)

Landscape character zone LCZ12 is located to the east of WSI, forming part of the Western Sydney Parklands. The parklands provide open space for the growing population in Western Sydney. It is characterised by large areas of open space, including park and bushland along Eastern Creek and the Prospect Reservoir.

There is air traffic across LCZ12 with flights from Sydney (Kingsford Smith) Airport, Bankstown Airport and Camden Airport, as well as flying training areas. Whilst some of these overflights are high, there would be flying training activity at lower altitudes. The Western Sydney Parklands are located under several arrival and departure flight paths to and from Bankstown Airport. There would be flights seen over this area and have some influence over the character of LCZ12.

The landscape character zone is of moderate sensitivity now and in the future (2033 and 2055).

15.4.1.2 Blue Mountains landscape

The Blue Mountains is located to the west of WSI and includes both natural and urban areas. The Blue Mountains landscape that has been considered in this assessment includes part of the GBMA and adjacent conservation lands as well as the towns, villages and bushland areas alongside the Great Western Highway. While there is a diverse mosaic of landscapes within the study area of the Blue Mountains, 3 broad landscape character zones have been identified for this assessment.

As outlined in Chapter 4 (Project setting), the GBMA is listed for its natural values. The *Greater Blue Mountains World Heritage Area Strategic Plan* (NSW DECC, 2009) does identify a number of other values and attributes which contribute to the GBMA. This is discussed further in Section 15.5.1.3.

Blue Mountains iconic features landscape character zone (LCZ13)

Landscape character zone LCZ13 includes the striking landscape formations that are unique to the GBMA, such as the dramatic landform (vertical cliffs, sandstone canyons, pedestals and pagoda rock formations) and native vegetation. It comprises a high level of tranquillity and wilderness with minimal evidence of human presence. Images of this landscape character zone is provided in Figure 15.5.

Aircraft presently pass over this landscape character zone. Generally, the larger aircraft are travelling at higher altitudes and some smaller aircraft and helicopters are seen generally at a lower altitude. Aircraft are visible but do not strongly influence the character of the zone. The landscape character zone is of very high sensitivity now and in the future (2033 and 2055).

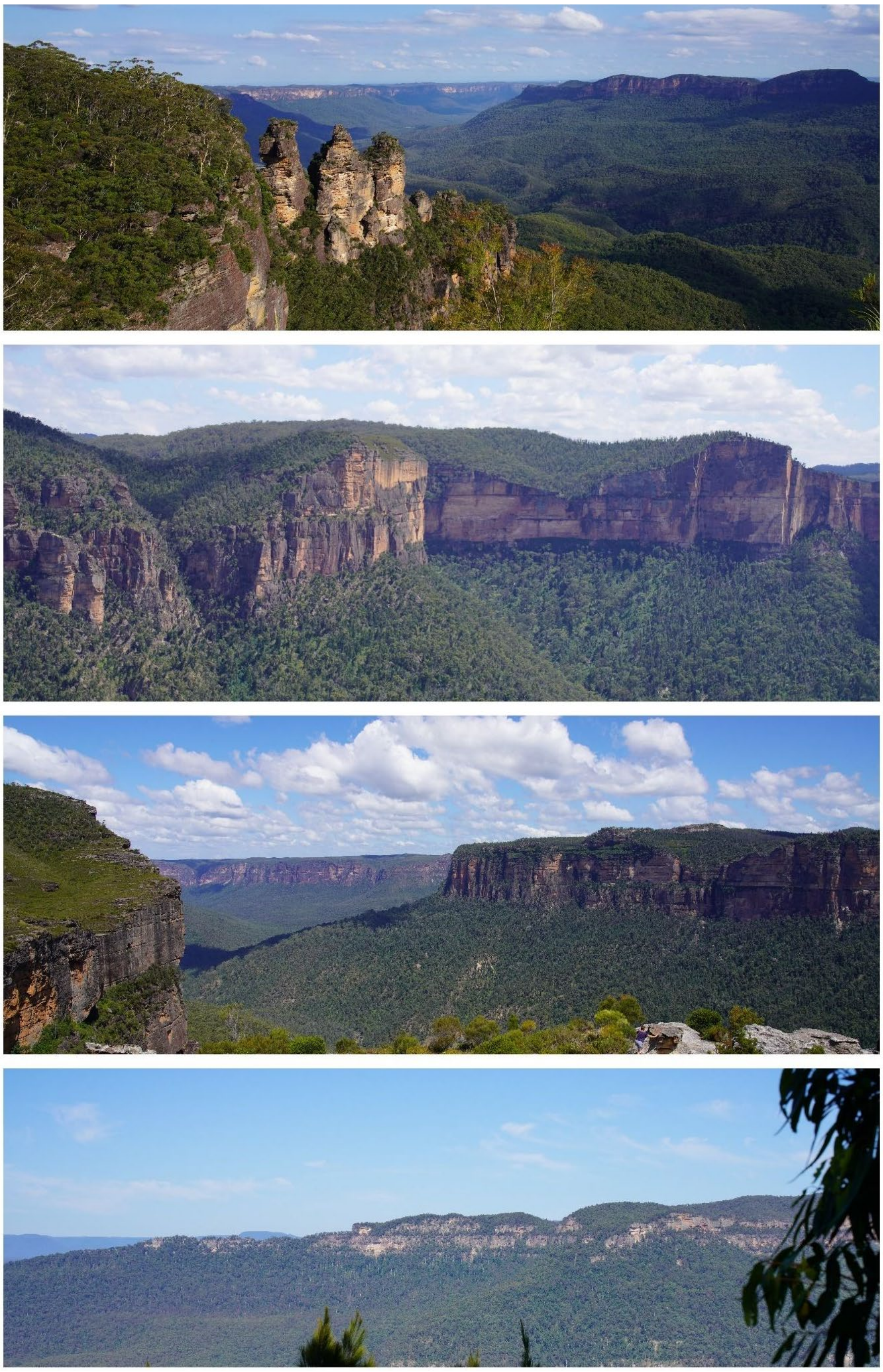


Figure 15.5 Examples of the Blue Mountains iconic features landscape character zone

Blue Mountains forested hills and valleys landscape character zone (LCZ14)

Landscape character zone LCZ14 includes the undulating forested hills and valleys located between and alongside the striking landscape formations. This zone includes landscape features such as steep hillsides, valleys, canyons and lakes. This area is dominated by eucalyptus species unique to the GBMA. The wide expanse of the forest and minimal built features also creates a strong sense of remoteness and tranquillity. It has some human presence, such as camp grounds, access roads and picnic areas. Images of this landscape character zone is provided in Figure 15.6.

There is air traffic visible across this landscape character zone, with flights from Sydney (Kingsford Smith) Airport, Bankstown Airport and other airports across the region. These overflights are high and do not strongly influence the character of this zone. The landscape character zone is of high sensitivity now and in the future (2033 and 2055).

Figure 15.6 Examples of the Blue Mountains forested hills and valleys landscape character zone

Blue Mountains township spine landscape character zone (LCZ15)

Landscape character zone LCZ15 includes the towns and villages within the Blue Mountains local government area either side of the Great Western Highway (such as Blaxland, Woodford and Katoomba). These towns and villages each contain a unique built form, character and sense of place, and are valued locally and regionally (Blue Mountains City Council, 2020). The residential areas accommodate most of the population of the Blue Mountains and are typically low density.

This zone also includes the land between the towns, outside of the GBMA, alongside the Great Western Highway. These vegetated areas are considered to be of high amenity and landscape value. Local strategic planning strategies and plans aims to retain the character of this zone.

Aircraft presently pass over this landscape character zone, which influence the character of the zone, particularly near Katoomba.

The landscape character zone is of moderate sensitivity now and in the future (2033 and 2055).

15.4.2 Viewpoints – Western Sydney

The viewpoints within Western Sydney for the assessment are described in Table 15.10 and identified in Figure 15.7. Figures showing the view from each of the viewpoints are included in Section 15.5.2.1 and further figures can be found in Section 8.1.1 of Technical paper 7.

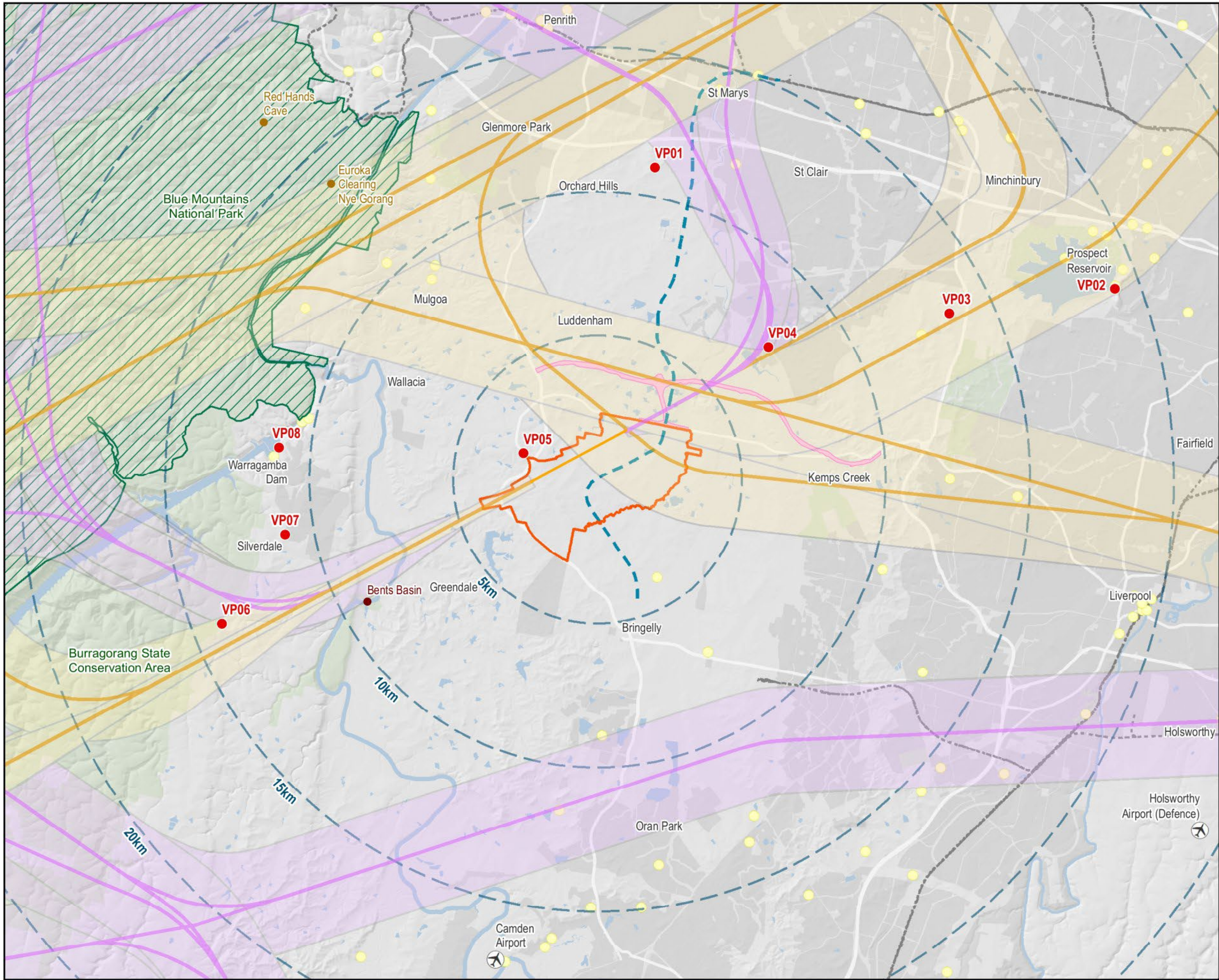
Table 15.10 Viewpoints – Western Sydney

Viewpoint	Description	Sensitivity
1 – View from Orchard Hills	An elevated view to a varied landscape comprising small lot farms and suburban development in Orchard Hills, low-lying rural areas along Blaxland and South creeks, and industrial development at Erskine Park. The vegetated ridgeline of Prospect Reservoir and vegetation within the Western Sydney Parkland is a scenic landscape feature. This view would be experienced by concentrations of residents and is of local scenic value. The area is planned to transition to urban uses.	Low (2022 baseline, 2033 and 2055)
2 – View from George Maunder Lookout, Prospect Reservoir	An elevated view at the eastern side of Prospect Reservoir (a heritage item). The reservoir and surrounding parkland have aesthetic and recreational values. The vegetated hills in the GBMA are a scenic landscape feature, providing a backdrop to the view. This view is from a regionally important recreational area and includes a regionally important area of open space in the view.	Moderate (2022 baseline, 2033 and 2055)
3 – View from Walworth Road, Horsley Park	An elevated view across rural areas of Horsley Park including small lot farms with scattered dwellings, rural structures and transmission lines. The partly vegetated ridgeline conceals views to low lying industrial areas of Kemps Creek and construction of WSI and beyond. The vegetated hills in the GBMA are a scenic landscape feature, providing a backdrop to the view. This is a view experienced by a concentration of residents and includes some areas of local and regional scenic value. In future years, planned urban development would be seen in this view.	Low (2022 baseline, 2033 and 2055)

Viewpoint	Description	Sensitivity
4 – View from Mamre Road, Kemps Creek	View across rural areas in Kemps Creek and Mount Vernon, including small lot farms with scattered rural dwellings and sheds as well as transmission line structures. The vegetated valleys of Kemps and South creeks conceal the areas under construction at WSI. The vegetated hills in the GBMA are a scenic landscape feature. This view is experienced by some residents and passing traffic and includes some glimpses to areas of local and regional scenic value. In future years, planned urban development would be seen in this view.	Low (2022 baseline, 2033 and 2055)
5 – View from Luddenham Village	View from the southern edge of the Luddenham village centre, a heritage place with attractive scenic qualities. The Northern Road separates the undulating rural area surrounding Luddenham from WSI. The vegetated valley of Badgerys Creek is a scenic landscape feature, providing a backdrop to the view. This view would be experienced by a dense concentration of residents and includes some glimpses to areas of local scenic value.	Moderate (2022 baseline, 2033 and 2055)
6 – View from Orangeville	An elevated view across rural lands from Silverdale Road, which includes the low-lying rural areas along the Nepean River valley. The undulating terrain and mature vegetation along Bushrangers Creek is a landscape feature with local scenic value. This view would be experienced by a small number of residents and includes landscape areas of local scenic value.	Low (2022 baseline, 2033 and 2055)
7 – View from Silverdale	An elevated view from the top of Kalangara Road, which includes the low density residential areas of Silverdale and low-lying rural areas along the Nepean River valley. The mature vegetation along the Nepean River is a landscape feature in this view, with local scenic value. This view would be experienced by a concentration of residents and includes landscape areas of local scenic value.	Low (2022 baseline, 2033 and 2055)
8 – View from Warragamba Dam Lookout	An elevated view from Warragamba Dam Lookout, with views to the water body, the dam wall and spillway, surrounded by dense bushland. The vegetation to the west of the dam forms part of the GBMA and is a scenic landscape feature in the background of the view. This view would be experienced by a concentration of recreational users and includes landscape areas of regional scenic value.	Moderate (2022 baseline, 2033 and 2055)

Figure 15.7

Viewpoints - Western Sydney



Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- Proposed M12 Motorway
- Greater Blue Mountains World Heritage Area
- Railway
- Proposed Sydney Metro
- Viewpoint locations
- State Heritage Register location
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

Day time flight paths and swathes

- Arrivals
- Departures

VP01 - Homestead Rd, Orchard Hills
VP02 - George Maunder Lookout, Prospect Reservoir
VP03 - Walworth Road, Horsley Park
VP04 - Mamre Road, Kemps Creek
VP05 - St James Anglican Church, Luddenham Village
VP06 - Silverdale Road, Orangeville
VP07 - Kalangara Road Silverdale
VP08 - Warragamba Dam Lookout

0 2 4 km

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

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Data sources: - DITRDC, DCS, Geoscience Australia
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Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

15.4.3 Viewpoints – Blue Mountains

The Blue Mountains region is a popular destination that offers highly scenic views to the GBMA from lookouts and other vantage points as well as when travelling along the major routes in the region (such as the Great Western Highway and Bells Line of Road). Within the bushland areas, there are scattered facilities for hiking, swimming and picnicking as well as campgrounds.

The viewpoints within the Blue Mountains region for the assessment are described in Table 15.11 and identified in Figure 15.8. Figures showing the views are included in Section 15.5.2.2 and further figures can be found in Technical paper 7 (Section 8.1.2).

Views from campground and day-use areas (Figure 15.9) and scenic routes (Figure 15.10) are also included in Table 15.11.

Table 15.11 Viewpoints – Blue Mountains

Viewpoint	Description	Sensitivity
Lookouts		
9 – View from the Burragorang Lookout, The Bluff	An elevated view that overlooks the deep waters of the Burragorang Valley and the Warragamba Dam. Surrounded by rocky escarpments and dense bushland, the lookout provides expansive views containing landscapes of high scenic value. It includes forested wilderness covered by natural vegetation but does not include the iconic landforms of the Blue Mountains (being the striking vertical cliffs, waterfalls, ridges and escarpments, narrow sandstone canyons and pagoda rock formations). This is a unique view to an area with scenic values recognised by the State.	High (2022 baseline, 2033 and 2055)
10 – View from The Rock Lookout	An elevated view that includes views of the Nepean River valley and surrounding dense bushland. The lookout provides views of areas containing high scenic value within an area of national importance. It includes forested wilderness covered by natural vegetation but does not include the iconic landforms of the Blue Mountains. This is a unique view to an area with scenic values recognised by the State.	High (2022 baseline, 2033 and 2055)
11 – View from Portal Lookout	An elevated view overlooking the junction between Glenbrook Gorge and the Nepean River. The lookout provides expansive views containing very high scenic value of national importance. While this view includes forested wilderness covered by natural vegetation, it does not include the iconic landforms of the Blue Mountains. This is a unique view to an area with scenic values important to the region and State.	High (2022 baseline, 2033 and 2055)
12 – View from Hawkesbury Lookout	A roadside lookout that provides an elevated view to the south-west across the Cumberland Plain (including the Nepean River, Wianamatta Park and Penrith). It is a popular rest-stop enroute to the Blue Mountains and is of regional importance. This is a unique view to an area with scenic values important to the region.	Moderate (2022 baseline, 2033 and 2055)

Viewpoint	Description	Sensitivity
13 – View from Wynnes Rocks Lookout	An elevated view that provides expansive views south-east across Bowen's Creek to the Blue Mountains and Mounts Tomah, Hay and Banks. This view includes forested wilderness covered by natural vegetation but does not include the iconic landforms of the Blue Mountains. This is a unique view to an area with scenic values important to the State.	High (2022 baseline, 2033 and 2055)
14 – View from Walls Lookout	An elevated view overlooking the Grose Valley. Surrounded by rocky escarpments and bushland defining the Little Blue Gum canyon, the lookout is representative of several other lookouts in the immediate area. These lookouts provide expansive views containing very high scenic value of national importance. This view includes iconic landforms of the Blue Mountains including striking vertical cliffs, sandstone canyons. This is a unique and heavily experienced view to an area with scenic values of national and international importance.	Very high (2022 baseline, 2033 and 2055)
15 – View from Echo Point Lookout	An elevated view that offers panoramic views across the GBMA, including the Three Sisters, Jamison Valley, Mount Solitary and Narrow Neck. The lookout provides views of areas containing very high scenic value of national importance. This view includes iconic landforms of the Blue Mountains including striking vertical cliffs, sandstone canyons and pagoda rock formations. This is a unique and heavily experienced view to an area with scenic values of national and international importance.	Very high (2022 baseline, 2033 and 2055)
16 – View from Cleary Memorial Lookout, Kedumba Pass	An elevated view offering limited views across GBMA. The lookout offers glimpsed views of areas containing high scenic value including views to Mount Solitary. This viewpoint is not formalised and would attract a relatively small number of visitors compared to more accessible viewing locations. Aircraft flying over Katoomba and this part of the Blue Mountains are visible from this location. This is an infrequently experienced view to an area with scenic values of importance to the Nation.	High (2022 baseline and 2033) Moderate (2055)
Campgrounds and day-use areas		
Views from campgrounds and day-use areas	There are many camp sites and day-use areas within the Blue Mountains offering a variety of activities and experiences, including overnight stays, picnicking, hiking and swimming. Some of the remote wilderness areas do not have designated camp grounds. These sites vary in what they have to offer, but are generally scenic landscapes. Examples of these types of sites include Murphys Glen campground, Euroka campground, Wentworth Falls and Katoomba Falls, Mount Banks Picnic Area and lookout.	High (2022 baseline, 2033 and 2055)
Scenic routes		
Views from scenic routes	The winding, undulating roads of the Great Western Highway and Bells Line of Road offer opportunities for open or semi-enclosed views to the Blue Mountains landforms. Views from these routes are experienced by large numbers of people and are used with the intention of appreciating views.	Moderate (2022 baseline, 2033 and 2055)

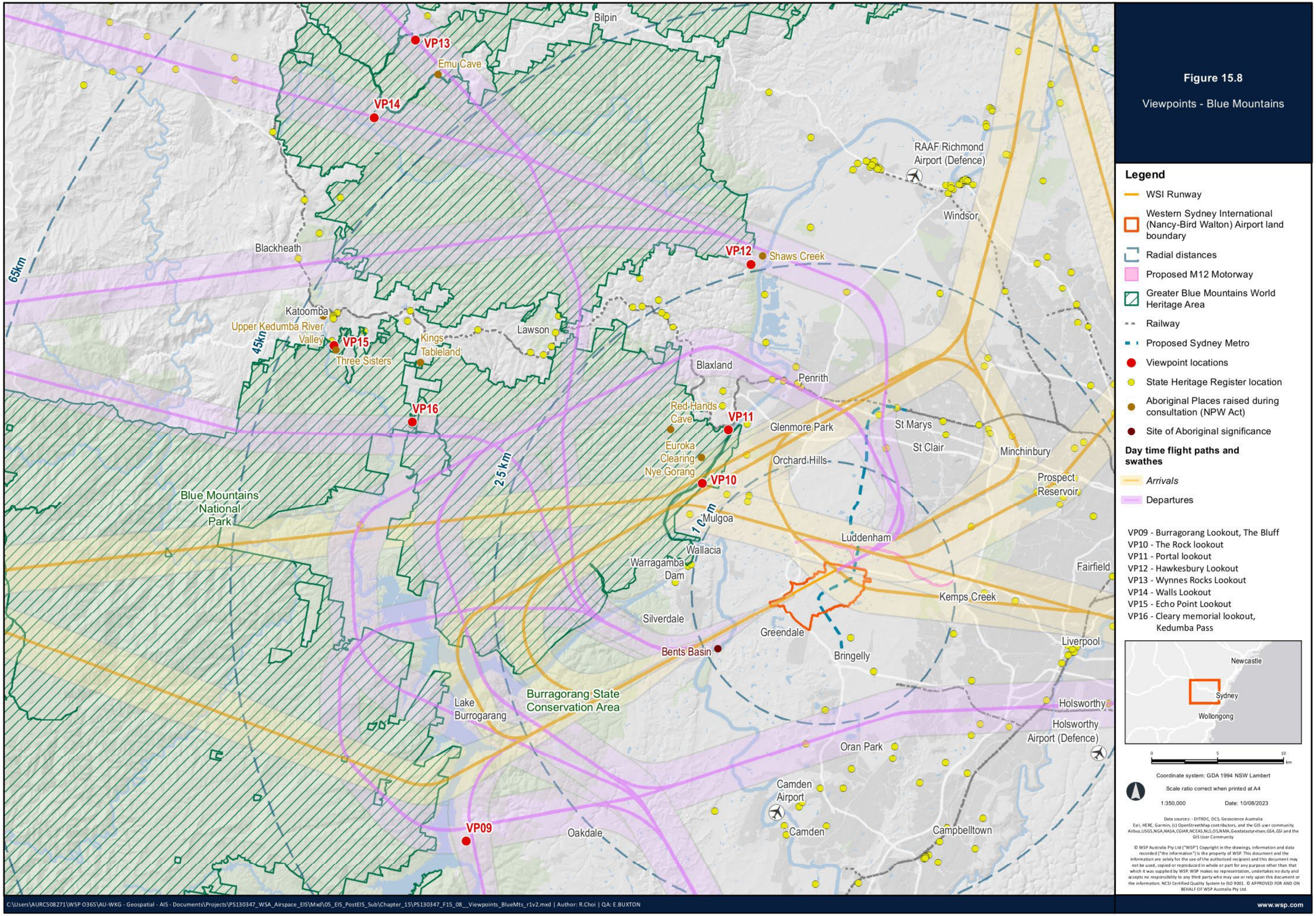
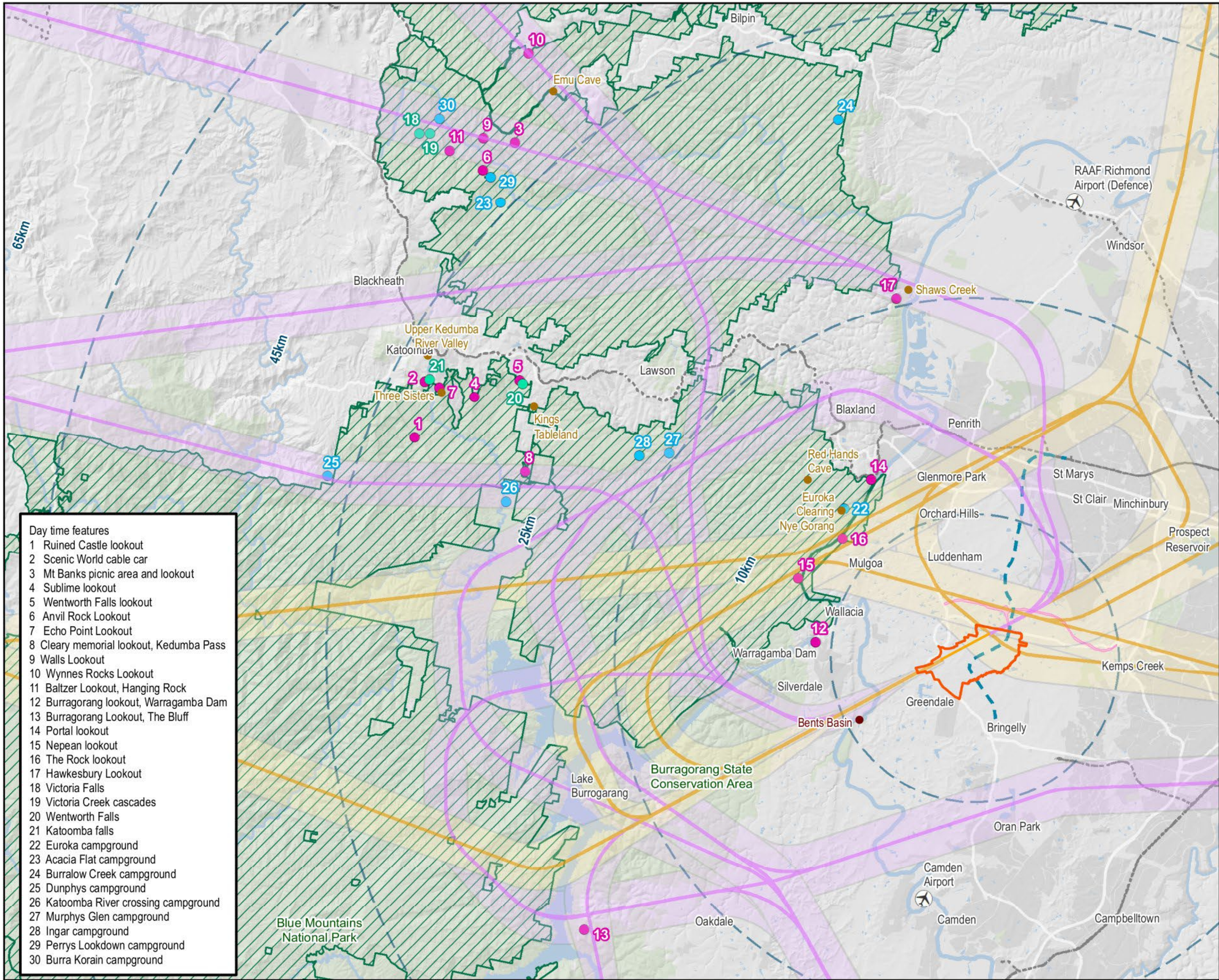


Figure 15.8
Viewpoints - Blue Mountains
Legend
WSI Runway
Western Sydney International (Nancy-Bird Walton) Airport land boundary
Radial distances
Proposed M12 Motorway
Greater Blue Mountains World Heritage Area
Railway
Proposed Sydney Metro
Viewpoint locations
State Heritage Register location
Aboriginal Places raised during consultation (NPW Act)
Site of Aboriginal significance
Day time flight paths and swathes
Arrivals
Departures
VP09 - Burragorang Lookout, The Bluff
VP10 - The Rock lookout
VP11 - Portal lookout
VP12 - Hawkesbury Lookout
VP13 - Wynnes Rocks Lookout
VP14 - Walls Lookout
VP15 - Echo Point Lookout
VP16 - Cleary memorial lookout, Kedumba Pass
Newcastle
Sydney
Wollongong
Coordinate system: GDA 1994 NSW Lambert
Scale ratio correct when printed at A4
1:350,000
Date: 10/08/2023
VP09
VP10
VP11
VP12
VP13
VP14
VP15
VP16
Bilpin
Emu Cave
RAAF Richmond Airport (Defence)
Windsor
Blackheath
Shaws Creek
65km
45km
25km
10km
Katoomba
Upper Kedumba River Valley
Three Sisters
Kings Tableland
Lawson
Blaxland
Penrith
Red Hands Cave
Glenmore Park
St Marys
St Clair
Minchinbury
Euroka Clearing
Nye Gorang
Orchard Hills
Prospect Reservoir
Blue Mountains National Park
Mulgoa
Luddenham
Wallacia
Warragamba Dam
Fairfield
Kemps Creek
Silverdale
Greendale
Bents Basin
Bringelly
Liverpool
Lake Burrogarang
Burragorang State Conservation Area
Holsworthy
Holsworthy Airport (Defence)
Oran Park
Camden Airport
Camden
Campbelltown
Oakdale
www.wsp.com

Figure 15.9

Daytime features



Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- Radial distances
- Proposed M12 Motorway
- Greater Blue Mountains World Heritage Area
- Railway
- Proposed Sydney Metro
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

Daytime features

- Campgrounds
- Lookouts
- Waterfalls

Day time flight paths and swathes

- Arrivals
- Departures

0 5 10 km

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:350,000 Date: 10/08/2023

Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

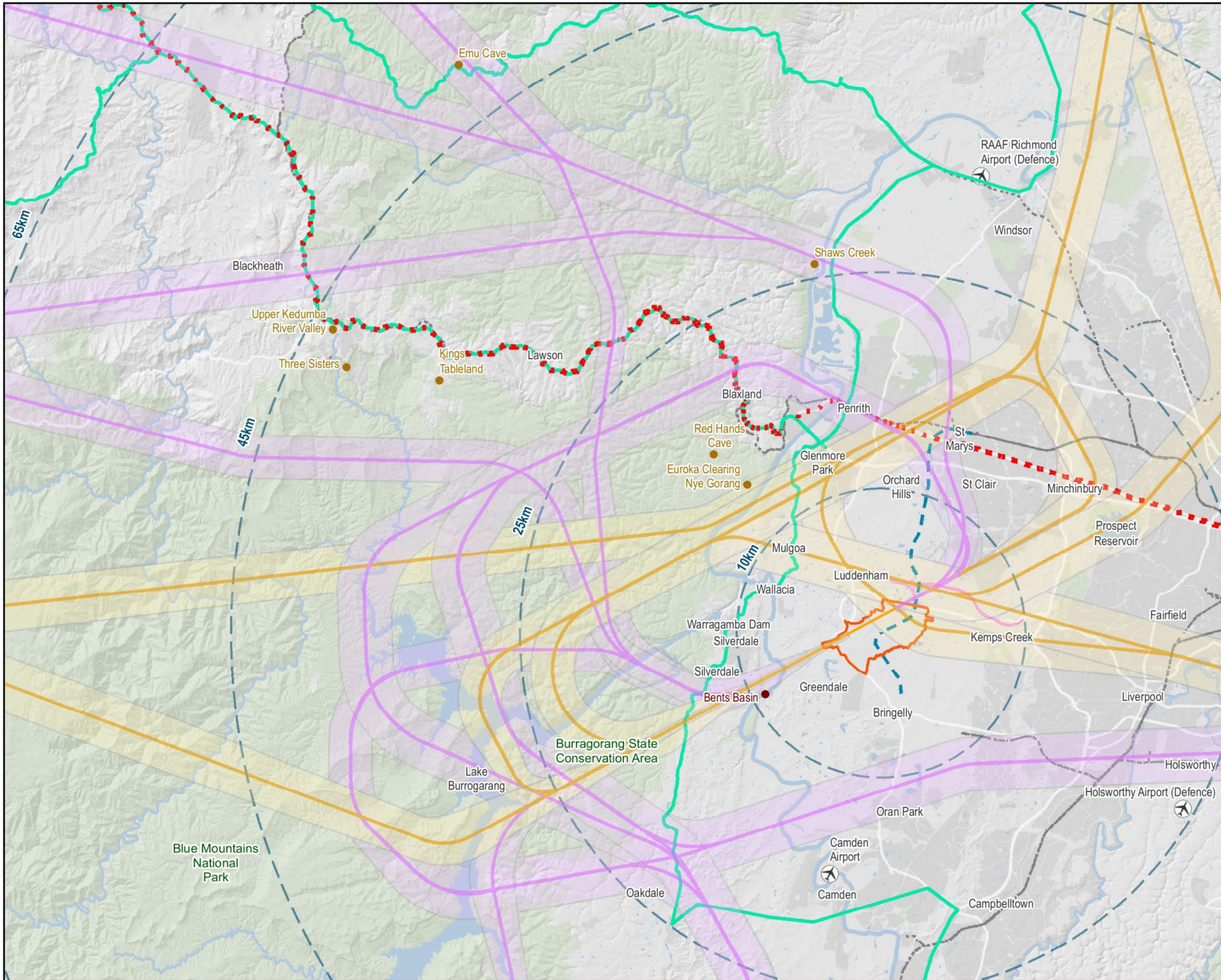


Figure 15.10

Scenic routes

Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- Radial distances
- Proposed M12 Motorway
- Railway
- The Great Western Highway
- Proposed Sydney Metro
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

Scenic Routes

- Greater Blue Mountains Drive

Day time flight paths and swathes

- Arrivals
- Departures

0 5 10 km

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:350,000 Date: 10/08/2023

Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

15.4.4 Night-time visual environment

The night-time visual environment within the study area is described in Table 15.12 and night-time features are shown in Figure 15.11.

Table 15.12 Night-time sensitivity

Environmental zone	Areas	Sensitivity
Intrinsically dark landscape (A0)	National parks and reserves near WSI (Blue Mountains and Nattai National Park, Burragorang State Conservation Area). These areas generally do not contain light sources such as dwellings, with only lights from vehicles travelling along local roads or access tracks, and very low lighting from camp grounds. Occasional aircraft at night may be visible but are generally flying at higher altitudes.	Very high (2022 baseline, 2033 and 2055)
Medium district brightness (A3)	*Western Sydney:* The urban and semi-urban areas in the Western Sydney study area, with areas of general sky glow associated with concentrations of lighting within urban areas. This area also includes towns along the semi-rural and rural residential areas near WSI such as Silverdale, Warragamba and Greendale.	Low (2022 baseline, 2033 and 2055)
	Blue Mountains: Urban and semi-urban areas, such as towns along the Great Western Highway. This includes the Katoomba Falls Night-lit Walk and around Echo Point which provides night-time viewing of several natural features (lit until 11 pm).	Low (2022 baseline, 2033 and 2055)
	Linden Observatory: The Linden Observatory is a dark site used by the Western Sydney Amateur Astronomy Group. It is a State heritage listed place and offers members and the public to explore the night sky using their own telescopes.	High (2022 baseline, 2033 and 2055)
High district brightness (A4)	The brightly lit urban areas such as Penrith and St Marys, as well as the future Aerotropolis surrounding WSI which would be brightly lit once developed (including the Bradfield city centre).	Very low (2022 baseline, 2033 and 2055)

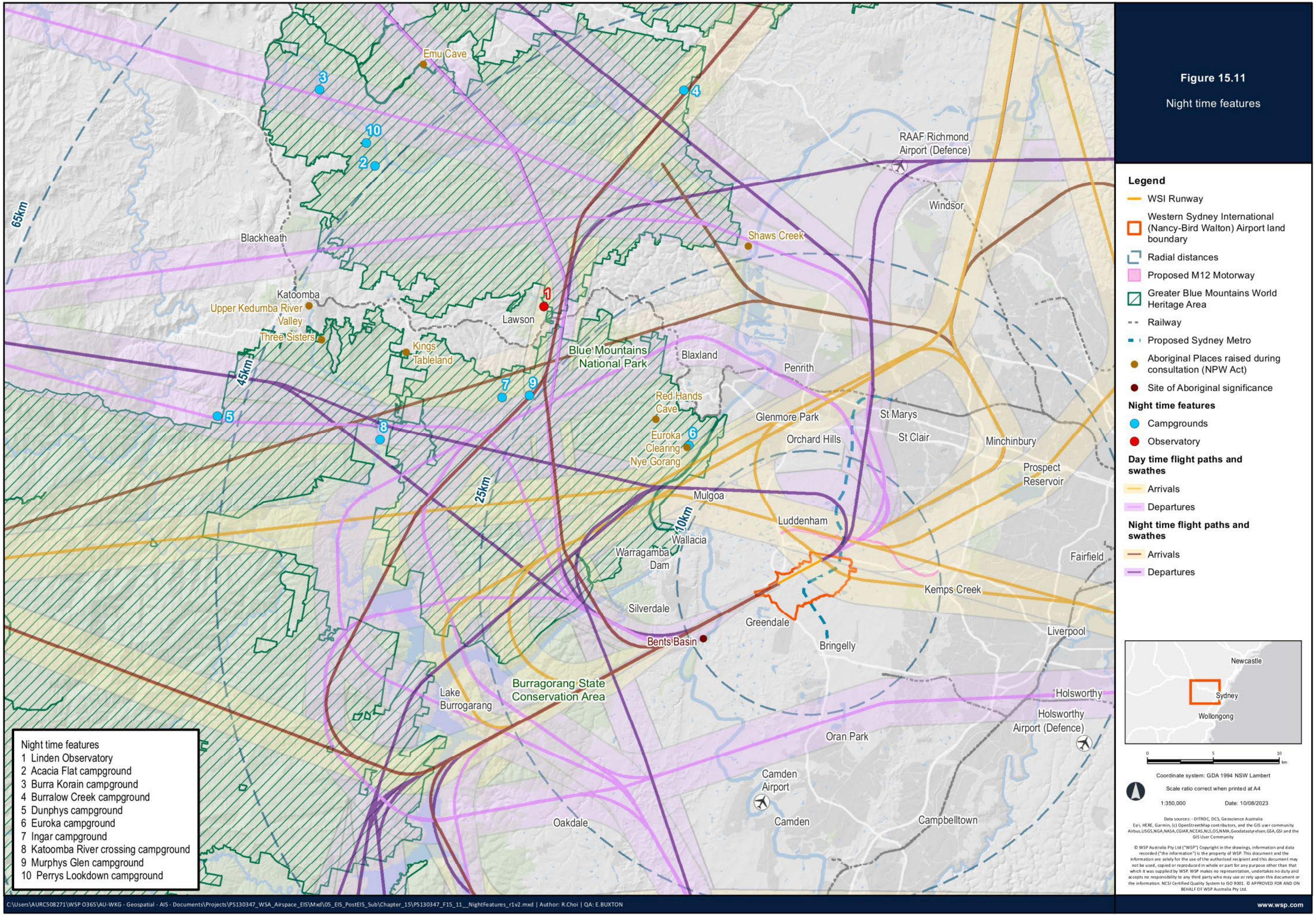


Figure 15.11

Night time features

15.5 Assessment of impacts

15.5.1 Landscape character impacts

15.5.1.1 Western Sydney

Penrith rural south-west landscape character zone (LCZ1)

The landscape character impact for LCZ1 is detailed in Table 15.13.

In 2033, there would be several arrival flight paths over this landscape character zone. There would be up to a maximum of 55 and 68 flights per day for Runway 05 and Runway 23, respectively. Aircraft would be at an altitude of about 5,000 to 8,000 ft (1.5 to 2.4 km). No departure flights would pass over this landscape character zone.

In 2055, the number of flights would increase up to a maximum of around 138 and 184 flights per day for Runway 05 and Runway 23, respectively. The height of aircraft would reduce the influence on the landscape character zone, but there would be a steady stream of flights as multiple arrival flight paths converge upon approach to WSI.

Overall, there would be a slight change to the character of this zone in 2033 and a noticeable change in 2055.

Table 15.13 Landscape character impact – LCZ1

Assessment year	Sensitivity	Magnitude of change	Landscape impact
2033	Low	Low	Low
2055	Low	Moderate	Moderate-low

Penrith south-east rural transition landscape character zone (LCZ2)

The landscape character impact for LCZ2 is detailed in Table 15.14.

The majority of this landscape character zone would not be overflown by WSI aircraft. In 2033, the south-west and north-eastern corner of this landscape character zone would be overflown by several flight paths (up to a maximum of 55 and 37 flights arriving and departing per day on Runway 05, respectively, and up to a maximum of 17 flights per day arriving on Runway 23). Aircraft in the north-east would be relatively low in the sky and have a greater influence over the character of the zone. This would result in a slight change to the landscape character.

In 2055, aircraft would follow the same flight paths at the same altitudes, with the frequency of flights increasing (up to a maximum of 138 and 104 flights arriving and departing per day on Runway 05, respectively, and up to a maximum of 48 flights per day arriving on Runway 23). The presence of aircraft would increase and would result in a noticeable change to the landscape character.

Table 15.14 Landscape character impact – LCZ2

Assessment year	Sensitivity	Magnitude of change	Landscape impact
2033	Moderate	Low	Moderate-low
2055	Moderate	Moderate	Moderate

Greendale and Silverdale rural and residential landscape character zone (LCZ3)

In 2033, the central part of this landscape character zone would be overflown by arriving aircraft (up to a maximum of about 87 flights per day on Runway 05) and departing aircraft (up to a maximum of about 95 flights per day on Runway 23). The aircraft along these flight paths would likely be at lower altitudes (less than about 2,500 ft or 760 m). The frequency and lower altitudes of aircraft would result in a noticeable change to the character of this zone.

In 2055, the frequency of flights would increase in the central part of this zone (up to a maximum of about 274 flights arriving per day on Runway 05 and up to a maximum of about 267 flights departing per day on Runway 23). The increase in flight numbers would result in a substantial change to the character of this zone.

The landscape character impact for LCZ3 is detailed in Table 15.15.

Table 15.15 Landscape character impact – LCZ3

Assessment year	Sensitivity	Magnitude of change	Landscape impact
2033	Low	Moderate	Moderate-low
2055	Low	High	Moderate

Luddenham village and agricultural precinct landscape character zone (LCZ4)

This area is in close proximity to WSI but would only be overflown in the north-east of Luddenham village, including up to a maximum of about 17 flights arriving per day on Runway 23 in 2033. Aircraft are likely to be at an altitude of about 5,000 to 8,000 ft (1.5 to 2.4 km). While there are few overflights, there would be views to low flying aircraft from some areas of this landscape character zone. This would result in a noticeable change to the character of this zone.

Aircraft would follow the same flight paths in 2055. The frequency of flights would increase, including up to a maximum of about 48 flights arriving per day on Runway 23. While this landscape character area is not overflown by many flight paths, due to the proximity of the runway and increase in flights, there would be a substantial change to the landscape character.

The landscape character impact for LCZ4 is detailed in Table 15.16.

Table 15.16 Landscape character impact – LCZ4

Assessment year	Sensitivity	Magnitude of change	Landscape impact
2033	Moderate	Moderate	Moderate
2055	Moderate	High	High-moderate

Northern Gateway precinct landscape character zone (LCZ5)

This landscape character zone would be overflown by several flight paths, including:

- Runway 05 arrivals – up to a maximum of about 36 and 93 flights per day in 2033 and 2055, respectively
- Runway 05 departures – up to a maximum of about 92 and 262 flights per day in 2033 and 2055, respectively
- Runway 23 arrivals – up to a maximum of about 105 and 273 flights per day in 2033 and 2055, respectively.

Aircraft in the southern part of this zone would be at lower altitudes (less than about 2,500 ft or 760 m), whereas flights in the central part of this zone would be at higher altitudes (8,000 to 10,500 ft or 2.4 to 3.2 km). This would result in a noticeable change to the character of this area in 2033 and 2055.

The landscape character impact for LCZ5 is detailed in Table 15.17.

Table 15.17 Landscape character impact – LCZ5

Assessment year	Sensitivity	Magnitude of change	Landscape impact
2033	Very Low	Moderate	Low
2055	Very Low	Moderate	Low

WSI landscape character zone (LCZ6)

Aircraft arriving and departing from WSI would be consistent with the character of WSI and would have a negligible impact on the landscape character.

The landscape character impact for LCZ6 is detailed in Table 15.18.

Table 15.18 Landscape character impact – LCZ6

Assessment year	Sensitivity	Magnitude of change	Landscape impact
2033	Very low	Negligible	Negligible
2055	Very low	Negligible	Negligible

Badgerys Creek landscape character zone (LCZ7)

The northern part of this zone would be overflown by:

- Runway 05 arrivals – up to a maximum of about 36 and 93 flights per day in 2033 and 2055, respectively, with aircraft likely to be at an altitude of 10,500 to 13,300 ft (3.2 to 4 km)
- Runway 05 departures – up to a maximum of about 92 and 262 flights per day in 2033 and 2055, respectively, with aircraft likely to be at an altitude of 750 to 2,500 ft (230 to 760 m)
- Runway 23 arrivals – up to a maximum of about 105 and 273 flights per day in 2033 and 2055, respectively, with aircraft likely to be at an altitude of 750 to 2,500 ft (230 to 760 m).

The central part of this zone would be overflown by:

- Runway 23 arrivals – up to a maximum of about 17 and 48 flights per day in 2033 and 2055, respectively, with aircraft likely to be at altitudes of 8,000 to 10,500 ft (2.4 to 3.2 km).

While the project would introduce lower flying aircraft, there would be a slight change to the character of this zone in 2033 and 2055 as this activity would be consistent with the character of airport associated development.

The landscape character impact for LCZ7 is detailed in Table 15.19.

Table 15.19 Landscape character impact – LCZ7

Assessment year	Sensitivity	Magnitude of change	Landscape impact
2033	Very low	Low	Negligible
2055	Very low	Low	Negligible

Kemps Creek and Rossmore rural residential landscape character zone (LCZ8)

The northern part of this zone would be overflown by:

- Runway 05 arrivals – up to a maximum of about 19 and 45 flights per day in 2033 and 2055, respectively, with aircraft likely to be at an altitude of 10,500 to 13,300 ft (3.2 to 4 km)
- Runway 05 departures – up to a maximum of about 92 and 262 flights per day in 2033 and 2055, respectively, with aircraft likely to be at an altitude of about 2,500 ft (or 750 m)
- Runway 23 arrivals – up to a maximum of about 105 and 273 flights per day in 2033 and 2055, respectively, with aircraft likely to be at an altitude of 750 to 2,500 ft (230 to 760 m).

The central part of this zone would be overflown by:

- Runway 05 arrivals – up to a maximum of about 17 and 48 flights per day in 2033 and 2055, respectively, with aircraft likely to be at an altitude of 13,300 ft (about 4 km)
- Runway 23 arrivals – up to a maximum of about 17 and 48 flights per day in 2033 and 2055, respectively, with aircraft likely to be at an altitude of 8,000 to 10,500 ft (about 2 to 3.2 km).

This would result in a noticeable change to the character of this zone in 2033 and 2055.

The landscape character impact for LCZ8 is detailed in Table 15.20.

Table 15.20 Landscape character impact – LCZ8

Assessment year	Sensitivity	Magnitude of change	Landscape impact
2033	Low	Moderate	Moderate-low
2055	Low	Moderate	Moderate-low

Aerotropolis core precinct landscape character zone (LCZ9)

This landscape character zone would not be overflown by WSI aircraft but would have views to arriving and departing aircraft in the distance, around 2 km to Runway 05/23. Overall this would result in a slight change to the landscape character of the zone in 2033 and 2055.

The landscape character impact for LCZ9 is detailed in Table 15.21.

Table 15.21 Landscape character impact – LCZ9

Assessment year	Sensitivity	Magnitude of change	Landscape impact
2033	Moderate	Low	Moderate-low
2055	Moderate	Low	Moderate-low

Leppington rural residential landscape character zone (LCZ10)

This landscape character zone would be overflown by

- Runway 05 departures – up to a maximum of about 17 and 57 flights per day in 2033 and 2055, respectively, with aircraft likely to be at a height of 20,000 ft (6 km)
- Runway 23 departures – up to a maximum of about 17 and 57 flights per day in 2033 and 2055, respectively, with aircraft likely to be at a height of 20,000 ft (6 km).

No arrival flights would pass over this zone.

This would not appreciably change the character of this zone in 2033 and 2055.

The landscape character impact for LCZ10 is detailed in Table 15.22.

Table 15.22 Landscape character impact – LCZ10

Assessment year	Sensitivity	Magnitude of change	Landscape impact
2033	Moderate	Negligible	Negligible
2055	Moderate	Negligible	Negligible

South Penrith urban area landscape character zone (LCZ11)

This landscape character zone would be overflown by several flight paths, including:

- Runway 05 arrivals – up to a maximum of about 19 and 45 flights per day in 2033 and 2055, respectively, with aircraft likely to be at a height of 8,000 to 10,500 ft (about 2.4 to 3.2 km)
- Runway 05 departures – up to a maximum of about 92 and 262 flights per day in 2033 and 2055, respectively, with aircraft likely to be at a height of 5,000 to 8,000 ft (1.5 to 2.4 km)
- Runway 23 arrivals – up to a maximum of about 105 and 273 flights per day in 2033 and 2055, respectively, with aircraft likely to be at a height of 2,500 to 5,000 ft (760 to 1,524 m).

This would result in a noticeable change to the character of this zone in 2033 and 2055.

The landscape character impact for LCZ11 is detailed in Table 15.23.

Table 15.23 Landscape character impact – LCZ11

Assessment year	Sensitivity	Magnitude of change	Landscape impact
2033	Moderate	Moderate	Moderate
2055	Moderate	Moderate	Moderate

Western Sydney Parklands landscape character zone (LCZ12)

This landscape character zone would be overflown by several arrival and departure flight paths, including:

- Runway 05 arrivals – up to a maximum of about 36 and 93 flights per day in 2033 and 2055, respectively, with aircraft likely to be at an altitude of about 13,300 ft (4 km)
- Runway 23 arrivals – up to a maximum of about 17 and 48 flights per day in 2033 and 2055, respectively, with aircraft likely to be at an altitude of about 13,300 ft (4 km).

One Runway 05 arrival flight path crosses directly over Prospect Reservoir. No departure flights would pass over this zone.

This would result in a slight change to the character of this zone in 2033 and a noticeable change in 2055.

The landscape character impact for LCZ12 is detailed in Table 15.24.

Table 15.24 Landscape character impact – LCZ12

Assessment year	Sensitivity	Magnitude of change	Landscape impact
2033	Moderate	Low	Moderate-low
2055	Moderate	Moderate	Moderate

15.5.1.2 Blue Mountains

Blue Mountains iconic features landscape character zone (LCZ13)

Some of the landscape features in this landscape character zone would be overflown or in close proximity to the preliminary flight paths. For example:

- Mount Solitary (927 m above sea level) would be overflown by one Runway 23 departure flight path with up to a maximum of about 19 flights per day in 2033 and 62 flights per day in 2055. Aircraft would be at an altitude of about 10,500 to 13,300 ft (about 3.2 to 4 km) above sea level and about 7,500 ft (2.2 km) above Mount Solitary.
- Kings Tableland (about 700 m above sea level) would be overflown by:
  - Runway 05 departures – up to a maximum of about 20 flights per day in 2033 increasing to 47 flights per day in 2055, with aircraft at an altitude between 13,300 to 17,500 ft (4 to 5.3 km) above sea level and about 10,900 to 15,400 ft (3.3 to 4.3 km) above the tableland
  - Runway 23 arrivals – up to a maximum of about 51 flights per day in 2033 increasing to 136 flights per day in 2055, with aircraft at an altitude of about 8,000 to 10,500 ft (2.5 to 3.2 km) above sea level and about 5,900 ft (1.8 km) above the tableland
- The Grose Valley and surrounding escarpments (about 920 m above sea level) would be overflown by Runway 05 departure flight paths with up to a maximum of about 8 and 42 flights per day in 2033 and 2055, respectively. Aircraft would be at an altitude of about 13,300 to 17,500 ft (about 4 to 5.3 km) above sea level and about 10,000 to 14,500 ft (3 to 4.5 km) above the escarpments.

The character of aircraft, and at times contrails, would contrast with the natural forms of clouds in the sky and natural features of the land. Overall, there would be several flight paths over this landscape character zone. Aircraft would be relatively high and passing over at a relatively low frequency. This would slightly alter the character of this zone in 2033 and 2055.

The landscape character impact for LCZ13 is detailed in Table 15.25.

Table 15.25 Landscape character impact – LCZ13

Assessment year	Sensitivity	Magnitude of change	Landscape impact
2033	Very high	Low	High-moderate
2055	Very high	Low	High-moderate

Blue Mountains forested hills and valleys landscape character zone (LCZ14)

Areas north of the Great Western Highway would be overflown by 4 departure flight paths. Areas south of the Great Western Highway would be overflown by several departure and arrival flight paths.

Aircraft would vary in altitude, with lower altitudes in eastern and central parts of the landscape character zone (up to about 2,500 to 8,000 ft or 0.75 to 2.5 km above sea level), including over Burragorang State Conservation Area, Lake Burragorang and the Erskine Range. Aircraft would be at higher altitudes in the western and northern parts of this zone (up to about 8,000 to 17,500 ft or 2.5 to 5 km above sea level), including over Kanangra-Boyd National Park.

The character of aircraft, and at times contrails, would contrast with the natural forms of clouds in the sky and natural features of the land. Overall, there would be multiple flight paths over this zone. Aircraft would be relatively high across the majority of this zone. This would slightly alter the character of this zone in 2033. In 2055, the project would result in a moderate magnitude of change to the character of this zone due to the increase in frequency.

The landscape character impact for LCZ14 is detailed in Table 15.26.

Table 15.26 Landscape character impact – LCZ14

Assessment year	Sensitivity	Magnitude of change	Landscape impact
2033	High	Low	Moderate
2055	High	Moderate	High-moderate

Blue Mountains township spine landscape character zone (LCZ15)

LCZ15 would be overflown by several departure flight paths:

- Runway 05 departures crossing over the Great Western Highway between Blaxland and Warrimoo, at a height of about 8,000 to 15,000 ft (2.4 to 3.2 km) – up to a maximum of about 37 flights per day in 2033 increasing to 104 flights per day in 2055
- Runway 05 departures crossing over Medlow Bath, at a height of about 17,500 ft – up to a maximum of about 11 flights per day in 2033 increasing to 19 flights per day in 2055
- Runway 23 departures crossing over the Great Western Highway east of Linden, at a height of about 10,500 to 13,300 ft (3.2 to 4 km) – up to a maximum of about 36 flights per day in 2033 increasing to 97 flights per day in 2055.

No arrival flights would pass over this landscape character zone during the day.

The character of aircraft, and at times contrails, would contrast with the natural forms of clouds in the sky and natural features of the land. Overall, there would be several flight paths over this zone. Aircraft would be relatively high and pass over at low frequencies. This would slightly alter the character of this zone in 2033. There would be a noticeable change to the character of this zone in 2055 due to the increase in frequency of aircraft movements.

The landscape character impact for LCZ15 is detailed in Table 15.27.

Table 15.27 Landscape character impact – LCZ15

Assessment year	Sensitivity	Magnitude of change	Landscape impact
2033	Moderate	Low	Moderate-low
2055	Moderate	Low	Moderate-low

15.5.1.3 Greater Blue Mountains Area landscape values

The landscape character related values of the GBMA as described in the *Greater Blue Mountains World Heritage Area Strategic Plan* (NSW DECC, 2009) and the assessment of the potential impacts of the project against these values is provided in Table 15.28.

Table 15.28 Potential impact on the GBMA Strategic Plan values

Landscape related value	Potential impact
Scenic and aesthetic values	
Striking vertical cliffs and waterfalls, ridges and escarpments	Views to vertical cliffs and waterfalls, ridges and escarpments may include distant aircraft where they are overflown by air traffic.
Extensive caves in the Jenolan Karst Conservation Reserve	No direct or indirect impact as views to caves do not rely on views of the sky.

Landscape related value	Potential impact
Spectacular complex of narrow sandstone canyons and pagoda rock formations	Aircraft would be at least 5,000 ft (1.5 km) above the Blue Mountains in the vicinity of key views and would not obstruct views to the sandstone canyons and pagoda rock formations. There are currently aircraft visible intermittently over the Blue Mountains, however there would be more frequent flights and flights seen in key viewpoints and campgrounds across the GBMA. Views to narrow sandstone canyons and pagoda rock formations (such as in views to the Three Sisters lookout at Echo Point, Katoomba) would include distant aircraft (and potentially their contrails) crossing views at a high altitude in the background. The scenic value of these views would be altered slightly. Due to the very high sensitivity of these views, a low magnitude of change would result in a high-moderate adverse visual impact.
Recreation and tourism values	
Vantage points on ridges and escarpments, offering outstanding vistas, from uninterrupted views of forested wilderness covered by natural vegetation to the contrasts of steep forested slopes surrounding cleared valleys	There are numerous vantage points on ridges and escarpments. While the line of sight between these vantage points to the forested wilderness would not be interrupted due to the height of the aircraft, there would be views where additional aircraft would be seen flying overhead and across these views. The aircraft would range in height and distance from these locations. They would be at least 5,500 ft (1.5 km) high and therefore of a relatively small scale. There may be locations where multiple aircraft would be seen together, as the flight numbers increase over time, and where multiple flight paths intersect or overlap.
Historic lookouts and walking tracks along the central Blue Mountains ridgeline	There are numerous historic lookouts and walking tracks along the central Blue Mountains ridgeline. This includes many lookouts between Wentworth Falls and Katoomba which are oriented to the south and towards WSI.
Canyoning, bushwalking, rock climbing, nature observation, scenic driving and photography are popular activities	The visual amenity and wilderness experience of recreational activities may be reduced by increased visual intrusion by aircraft movements. Aircraft would be at an altitude of over one km (5,000 ft) and the assumed typical aircraft (most frequently flown being the A320) would be of a small scale in the sky.
Wilderness values	
Extensive natural areas	No direct or indirect impact
Opportunities for solitude and self-reliant recreation	No direct or indirect impact
Unroaded except for management trails and largely free of exotic species	No direct or indirect impact

It was determined that there were no direct or indirect impact on the wilderness values. This is because:

- the project during operation would not alter directly or otherwise the extensive natural areas of the Blue Mountains. There is no vegetation removal proposed, and the operation of aircraft above these areas would not indirectly result in any changes to the extensive natural areas that currently exist
- the project would not reduce the opportunity for solitude and self-reliant recreation as the preliminary flight paths operate at high levels above the wilderness areas
- the project does not involve any further road development nor have any potential to introduce exotic species to the area, as the flights would operate well above these wilderness areas.

15.5.2 Day-time visual impacts

15.5.2.1 Western Sydney viewpoints

Viewpoint 1: View from Orchard Hills

This view (refer to Figure 15.12) is oriented towards several arrival and departure flight paths. Some aircraft would be visible travelling across the view at lower elevations. Aircraft would also be visible in the background of the view.

Due to the proximity of this view to the runway, there would be a greater concentration of flights around the runway and then dispersing across the surrounding sky. The aircraft would be viewed above the valley within a predominantly open sky increasing the prominence in the view. The increase in flight frequency from 2033 to 2055 would not alter the magnitude of impact.

This would result in a moderate magnitude of change in 2033 and 2055, resulting in a moderate-low visual impact.

Figure 15.12 View south-east from Homestead Road, Orchard Hills

Viewpoint 2: View from George Maunder Lookout, Prospect Reservoir

Due to the proximity of this view to the runway, there would be a greater number of aircraft seen across this view (refer to Figure 15.13 and Figure 15.14). This would include a large number of arriving aircraft which may be visible overhead or passing across the middle ground (about 5 km away) and relatively low in the sky. These aircraft, together with aircraft visible in the background, would be viewed within an open and expansive skyline against the distant backdrop of the Blue Mountains. The increase in flight frequency from 2033 to 2055 would not alter the magnitude of impact.

As this view also contains natural and aesthetic features of heritage significance, there would be a moderate magnitude of change in 2033 and 2055. This would result in a moderate visual impact.

Figure 15.13 View from George Maunder Lookout, Prospect Reservoir, Runway 05 photomontage (top) with flight paths shown (bottom)

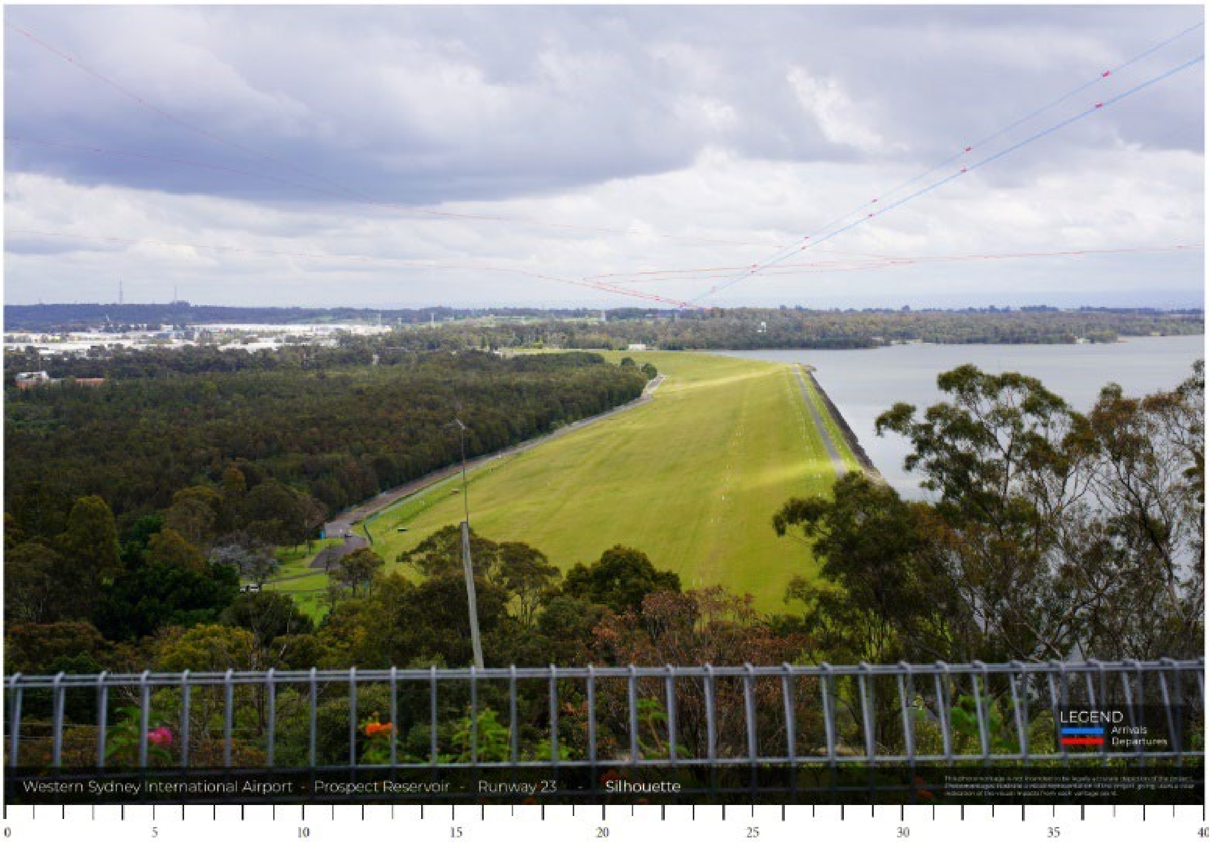


Figure 15.14 View from George Maunder Lookout, Prospect Reservoir, Runway 23 photomontage (top) with flight paths shown (bottom)

Viewpoint 3: View from Walworth Road, Horsley Park

This view would include some arrival flights high overhead and crossing the view (refer to Figure 15.15). There would also be aircraft visible in the background of the view. The aircraft would be viewed in a predominantly open sky, however future urban development and infrastructure may enclose the open sky somewhat. The increase in flight frequency from 2033 to 2055 would not alter the magnitude of impact.

The project would result in a moderate magnitude of change in 2033 and 2055, resulting in a moderate-low visual impact.

Figure 15.15 View south-west from Walworth Road, Horsley Park

Viewpoint 4: Views from residential areas in Kemps Creek

This view includes several arrival and departure flight paths and is located at close range to WSI (refer to Figure 15.16), with some flights at low altitude. These aircraft movements would be prominent in the view. There would also be some aircraft visible in the background as they depart from or arrive at WSI.

In 2033, this would result in a considerable change to the amenity of this view, representing a high magnitude of change. In 2055, the prominence of aircraft in this viewpoint, along with the low altitude and considerable increase in flight frequency, would result in a very high magnitude of change.

This would result in a moderate visual impact in 2033 and a high-moderate impact in 2055.

Figure 15.16 View south-west from Mamre Road, Kemps Creek

Viewpoint 5: View from Luddenham Village

This view is located in close proximity to WSI and would capture views of arriving and departing aircraft to the south and south-west (refer to Figure 15.17 and Figure 15.18). Two (2) to 3 additional flight paths for departing flights would be seen at varying altitudes in the mid to background views in the south-west. The aircraft would be seen in an open and expansive sky increasing their prominence in the view.

Due to the close proximity to WSI and frequency of flights at low altitudes, there would be a moderate magnitude of change in 2033 and increasing to a high magnitude of change in 2055 as the frequency of flights increase.

This would result in a moderate visual impact in 2033 and a high-moderate impact in 2055.

Figure 15.17 View south from St James Anglican Church, Luddenham Village, Runway 05 photomontage (top) with flight paths shown (bottom)

Figure 15.18 View south from St James Anglican Church, Luddenham Village, Runway 23 photomontage (top) with flight paths shown (bottom)

Viewpoint 6: View from Orangeville

This view (refer to Figure 15.19) would capture aircraft arriving and departing WSI. Aircraft may be seen overhead or passing across the middle ground at lower altitudes. Aircraft would be seen in an open and expansive sky increasing their prominence in the view.

Due to the close proximity to WSI and frequency of flights at low altitudes, there would be a moderate magnitude of change in 2033 and increasing to a high magnitude of change in 2055 as the frequency of flights increase.

This would result in a moderate-low visual impact in 2033 and a moderate impact in 2055.

Figure 15.19 View south-east from Silverdale Road, Orangeville

Viewpoint 7: View from Silverdale

This view is oriented towards WSI and overlooks several arrival flight paths approaching both Runway 05 and Runway 23 (refer to Figure 15.20 and Figure 15.21). The closest flight paths would be seen approaching and departing the runway from the south-west. Aircraft would be viewed at lower altitudes and within 2 km. The frequency of flights would increase in 2055.

There would also be flights visible in the background, approaching and departing from the north-east. This elevated position and orientation of the view increases the potential for multiple aircraft being visible during peak periods and seen within a predominantly open sky.

Due to the frequency and proximity of the aircraft in this view, there would be a moderate magnitude of change in 2033 and 2055. This would result in a moderate-low visual impact.

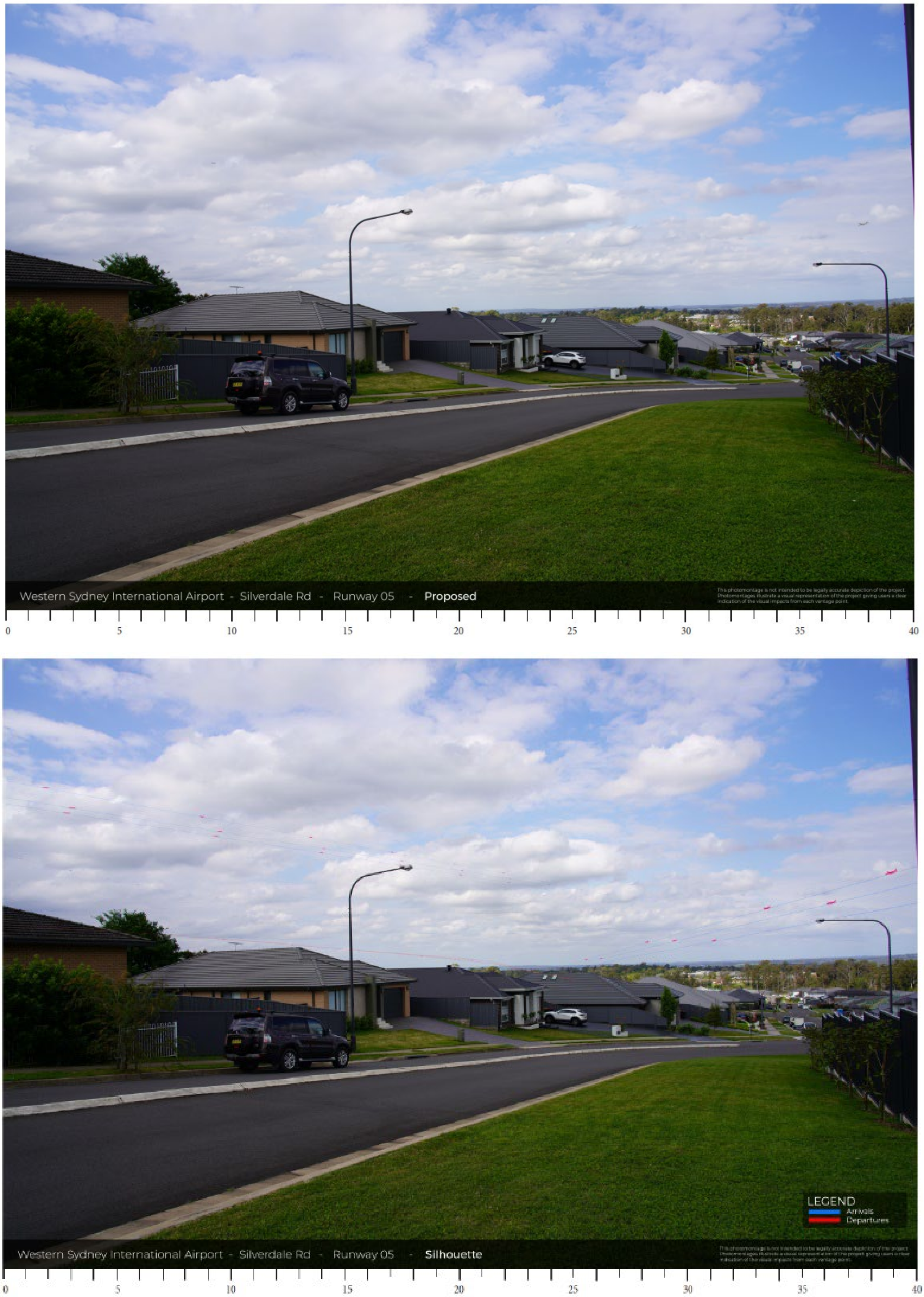


Figure 15.20 View east from Kalangara Road, Silverdale, Runway 05 photomontage (top) with flight paths shown (bottom)

Figure 15.21 View east from Kalangara Road, Silverdale, Runway 23 photomontage (top) with flight paths shown (bottom)

Viewpoint 8: View from Warragamba Dam lookout

This viewpoint (refer to Figure 15.22) would capture views of aircraft arriving and departing Runway 05/23.

This view would include:

- Runway 05 arrivals – up to a maximum of 55 flights per day in 2033 increasing to 138 flights per day in 2055, and may be seen at a distance of about 11 km
- Runway 05 departures – up to a maximum of 37 flights per day in 2033 increasing to 104 flights per day in 2055, and may be seen at a distance of about 5.5 km
- Runway 23 departures – up to a maximum of 92 flights per day in 2033 increasing to 263 flights per day in 2055, and may be seen at a distance of about 4 km. Four (4) flight paths branch out over the downstream waters of the dam and will be seen in the background of the view, about 6 km away.

While these flights would be seen in an open and expansive sky (increasing the prominence of the aircraft), the high altitude and distance would reduce the magnitude of change so that they would not noticeably reduce the amenity of the view. As a result, the project would result in a low magnitude of change in 2033 and a moderate magnitude of change in 2055 due to the increase in flight frequency. This would result in a moderate-low visual impact in 2033 and a moderate impact in 2055.

Figure 15.22 View south-west from Warragamba Dam lookout

15.5.2.2 Blue Mountains viewpoints

Table 15.29 provides a summary of the day-time visual impacts for the selected representative views of the Blue Mountains, including lookouts, campgrounds and day-use areas, and scenic routes.

Table 15.29 Summary of day-time visual impacts – Blue Mountains viewpoints

Viewpoint	Sensitivity	Magnitude of change	Visual impact
Lookouts			
9 – View from the Burragorang Lookout, The Bluff	High	Low (2033) Moderate (2055)	Moderate (2033) High-moderate (2055)
10 – View from The Rock Lookout	High	Low	Moderate
11 – View from Portal Lookout	High	Negligible	Negligible
12 – View from Hawkesbury Lookout	Moderate	Low	Moderate-low
13 – View from Wynnes Rocks Lookout	High	Low	Moderate
14 – View from Walls Lookout	Very high	Negligible (2033) Low (2055)	Negligible (2033) High-moderate (2055)
15 – View from Echo Point Lookout	Very high	Low	High-moderate
16 – View from Cleary Memorial Lookout, Kedumba Pass	High (2033) Moderate (2055)	Low	Moderate
Campgrounds and day-use areas			
Views from campgrounds and day-use areas	High	Low	Moderate
Scenic routes			
Views from scenic routes	Moderate	Low	Moderate-low

Lookouts

The project would result in negligible impacts at viewpoints 11 (all years) and 14 (2033) as aircraft would be viewed at high altitudes in an open and expansive sky or viewed in the backdrop of a rural and urban fringe (in the case of Viewpoint 11). This would reduce the prominence of the aircraft and would not noticeably intrude on the character or amenity of the view.

At Viewpoint 9, the project would result in a moderate visual impact in 2033 and high-moderate visual impact in 2055. This view would include Runway 23 departures at an altitude of about 6,200 ft (1.9 km) above the surrounding hills, and Runway 05 arrivals at a distance of about 3.5 km and altitude of about 3,200 ft (1 km) above the surrounding hills. The frequency of flights would increase from 2033 to 2055. Due to the proximity of flights to the surrounding hills and frequency of flights there would be a noticeable change to the amenity of this view.

At Viewpoint 10 (refer to Figure 15.23 and Figure 15.24), the lookout is located under several arrival flight paths and there may also be some departure flights visible in the background of this view. The project would result in a moderate visual impact in 2033 and 2055. Aircraft would be seen crossing the Nepean River valley. However, the aircraft would be at higher altitudes (over 7,000 ft or 2.3 km) and would be less visually prominent. The addition of aircraft would somewhat intrude upon the wilderness character of the view and result in a low magnitude of change in 2033 and 2055.

Figure 15.23 View north from The Rock lookout, Blue Mountains National Park

Figure 15.24 View south from The Rock lookout, Blue Mountains National Park

At Viewpoint 12 (refer to Figure 15.25), the project would result in a moderate-low visual impact in 2033 and 2055. The view would include aircraft departing Runway 05 at a height of about 10,500 ft (about 3.2 km). In 2033, there would be up to a maximum of around 55 flights per day and would increase to 158 flights per day by 2055. Aircraft would be seen intermittently, crossing over the Cumberland Plain as they ascend steeply towards a cruising altitude. Aircraft would be somewhat prominent in the view due to distance and altitude. There would also be aircraft visible in the background, as they come into land on several flight paths from the north and east. This would result in a noticeable reduction in the amenity of the view.

Figure 15.25 View to the north-west from Hawkesbury lookout, Yellomundee Regional Park

At Viewpoint 13 (refer to Figure 15.26) the project would result in a moderate visual impact in 2033 and 2055. The view would include aircraft departing Runway 05 and Runway 23 at a height of about 13,300 to 17,500 ft (4 to 5 km) above sea level and about 10,100 ft (3 km) above Mount Tomah. In 2033 there would be up to a maximum of around 72 flights per day and this would increase to 194 flights per day by 2055. Aircraft would be seen intermittently overhead at relatively high altitudes in 2033. While this lookout would be frequently overflown by aircraft in 2055, due to the altitude these aircraft would not be prominent in this view. Aircraft would not noticeably intrude upon the wilderness character of this view in 2033. In 2055 aircraft would slightly intrude upon the wilderness character of this view.

Figure 15.26 View south-east from Wynnes Rocks Lookout

At Viewpoint 14 (refer to Figure 15.27) the project would result in a high-moderate visual impact in 2055. The view would include aircraft departing Runway 05 at a height of about 17,500 ft (5.3 km) above sea level, and about 15,100 ft (4.6 km) above the escarpments. In 2033 there would be up to a maximum of around 8 flights per day and this would increase to 42 flights per day by 2055. Aircraft would be seen at a relatively high altitude and be viewed in an open and expansive sky. Aircraft would not noticeably intrude upon the wilderness character of this view in 2033. In 2055, due to the increased frequency, there would be a noticeable reduction in the amenity of this view.

Figure 15.27 View from Walls Lookout

At Viewpoint 15 (refer to Figure 15.28 and Figure 15.29), aircraft would be seen intermittently crossing this view, over and beyond Mount Solitary (about 927 m above sea level). Aircraft would be viewed in an open and expansive sky, from an elevated vantage point, increasing their prominence in the view. Whilst aircraft would be visible moving across the view, the scale of the aircraft at this distance and their infrequency in 2033 reduces the potential for them to noticeably intrude upon the wilderness character of this view. By 2055, the frequency of aircraft visible would more than double and their prominence in this view would increase. These flights have the potential to intrude upon the wilderness character of this view. Overall, there would be a low magnitude of change in 2033 and 2055. However, as this view is of very high sensitivity, this would result in a high-moderate visual impact in 2033 and 2055.

Figure 15.28 View south-east from Echo Point Lookout to The Three Sisters and Mount Solitary, Runway 05 photomontage (top) with flight paths shown (bottom)

Figure 15.29 View south-east from Echo Point Lookout to The Three Sisters and Mount Solitary, Runway 23 photomontage (top) with flight paths shown (bottom)

At Viewpoint 16 (refer to Figure 15.30), aircraft would be seen departing or arriving WSI. Aircraft on the departing flight path from Runway 23 would be visible overhead or passing across the middle ground of views from this lookout. However, aircraft would be at a high altitude and relatively infrequent. These flights would be seen in between overgrown vegetation, which currently partly encloses the lookout, restricting views out. Due to the close proximity and contrast with the wilderness view, the project would result in a low magnitude of change in 2033 and 2055. However, as this view is of high sensitivity, this would result in a moderate visual impact in 2033 and 2055.

Figure 15.30 View from Cleary Memorial Lookout, Kedumba Pass

Campgrounds and day-use areas

From most of the campground locations, views are enclosed by trees so that the opportunity to view aircraft would be restricted to those directly overhead and within the area of visible sky. Aircraft are more likely to be visible from the Murphys Glen campground, Euroka campground, Wentworth Falls and Katoomba Falls. Some areas in the north-eastern parts of the Blue Mountains would be overflown by aircraft (for example the Mount Banks Picnic Area and lookout), but aircraft would be less frequent and at high altitudes (about 17,500 ft or 5.3 km).

There would be a slight reduction in the amenity of views in 2033. Due to the increase in the frequency of flights in 2055, there would potentially be more flights seen from campgrounds and day-use areas that are open and/or elevated. Overall, the project would result in a low magnitude of change in 2033 and 2055. Due to the high sensitivity, there would be a moderate visual impact in 2033 and 2055.

Scenic routes

The winding, undulating roads of the Great Western Highway and Bells Line of Road offer opportunities for open or semi enclosed views to the Blue Mountains landforms. At the Great Western Highway, there are some flight paths which will fly over sections of the highway at Warrimoo, Linden and Hartley. At Bells Line of Road, aircraft may be visible at Mount Tomah and near Grose Valley.

Overall, aircraft flying over sections of the feature routes may be visible passing overhead (assuming there is no intervening vegetation), however they would generally be seen at high or very high altitudes between 8,000 to 20,000 ft (2.5 to 6 km) by few people, resulting in a low magnitude of change in 2033 and 2055. Due to the moderate sensitivity, there would be a moderate-low visual impact in 2033 and 2055.

15.5.3 Night-time visual impacts

15.5.3.1 Intrinsically dark landscapes (A0)

The scenic and aesthetic values of the nature reserve landscapes are generally experienced during the day-time from lookouts, picnic areas and walking trails. Recreational activities in the GBMA, such as canyoning and rock climbing, would also occur during the day-time. Apart from designated campgrounds, there would not be much activity in these areas at night.

There are a number of camp sites within this landscape that the preliminary flight paths may be seen at night, including:

- Euroka campground south of Glenbrook
- Katoomba River crossing campground in the Jamison Valley
- Ingar and Murphys Glen campgrounds south of Woodford
- Burralow Creek campground in the Lower Grose Valley area west of Kurrajong.

Aircraft may be viewed occasionally from these locations as a series of small moving lights in the sky. Murphys Glen campground would have the greatest number of overflights and is in closer proximity to WSI than the other campgrounds that are overflown. Aircraft along this flight path are likely to be at higher altitudes.

Eastern parts of these reserves would experience views to flight paths, with aircraft at lower altitudes (due to the closer proximity to WSI). Such areas include the north-eastern parts of Burragorang National Park near Silverdale Road and the GBMA west of Mulgoa. These areas, however, do not have any designated camp sites and would not be experienced by many people at night-time.

In 2055 there would be an increase in the frequency of early evening and night flights where they pass over the intrinsically dark landscapes.

Overall, the effect of the project lighting would be experienced across a small portion of the landscape by few people, resulting in a negligible magnitude of change and a negligible visual impact in 2033 and 2055.

15.5.3.2 Areas of medium district brightness (A3)

Western Sydney

Semi-rural and rural residential areas that would experience views of aircraft at low altitude (less than 5,000 ft) due to take-off and landing include Mulgoa, Wallacia, Silverdale and Greendale.

In the early evening, areas south of Silverdale are overflown by arrival and departure flight paths in 2033, with aircraft at low altitude (less than 5,000 ft). Aircraft would follow the same paths and at the same altitude in 2055, with the frequency of flights increasing.

At night, areas of medium district brightness would experience views to aircraft at low altitudes (less than 5,000 ft) including:

- Runway 05 arrivals over areas south of Silverdale, up to a maximum of 23 and 57 flights per night in 2033 and 2055, respectively
- Runway 05 departures over Mulgoa and Wallacia, up to a maximum of 14 and 28 flights per night in 2033 and 2055, respectively
- Runway 23 departures, up to a maximum of 22 and 57 flights per night in 2033 and 2055, respectively.

Overall, the lighting of the project would contrast with the surrounding landscape at night, resulting in a moderate magnitude of change in 2033 and 2055. Due to the low visual sensitivity, there would be a moderate-low visual impact in 2033 and 2055.

Blue Mountains

Urban and semi-urban areas include towns along the Great Western Highway such as Woodford and Katoomba.

These residential areas generally include street lighting, and lighting from vehicles and dwellings. There is lighting associated with the night trails and lit features of the Katoomba Falls Night-lit Walk and around Echo Point and the Three Sisters. There would also be occasional night-time flight paths contributing to the light level.

In the early evening, areas of medium district brightness would experience views to aircraft at higher altitudes (between 8,000 to 17,500 ft) including Runway 05 departures over Blackheath and Runway 23 departures over Lawson.

At night, areas of medium district brightness would experience views to aircraft at higher altitudes including:

- Runway 05 arrivals over Lawson, up to a maximum of 8 and 14 flights per night in 2033 and 2055, respectively
- Runway 23 departures over Lawson, up to a maximum of 6 and 25 flights per night in 2033 and 2055, respectively.

There would be a low magnitude of change at night in 2033 due to the low frequency and high altitude of aircraft. While there would be a slight increase in flight frequency in 2055, there would continue to be a low magnitude of change at night due to the relatively high altitude of aircraft. Due to the low visual sensitivity, there would be a low visual impact in 2033 and 2055.

Linden Observatory

In the late evening, the Linden Observatory may be overflown by arrival flights on Runway 05, up to a maximum of 8 and 14 flights per night in 2033 and 2055, respectively.

Aircraft may also be viewed in the night sky to the east of the Linden Observatory departing on Runway 23, up to a maximum of 14 and 25 flights per night in 2033 and 2055, respectively. Aircraft along these flight paths are likely to be at relatively high altitudes of 8,000 to 10,500 ft (2.4 to 3.2 km).

Overall, the effect of the project lighting would be experienced across a small portion of the sky and seen as distant flashing lights at high altitudes, resulting in a low magnitude of change (noting this is an assessment of night-time visual amenity). Any obstruction to astronomical observations would be brief and intermittent. Due to the high sensitivity, there would be a moderate-low visual impact in 2033 and 2055.

The Linden Observatory is a State heritage item and is considered further in the heritage assessment, including the impact on cultural values and amateur astronomy (refer to Technical paper 9: Heritage and Chapter 17 (Heritage)).

Further assessment of the impacts to activities at this observatory has been completed since exhibition of the Draft EIS (refer to Appendix A of the Submissions Report). This found that most of the activities at the Linden Observatory should still be able to occur, potentially at a reduced capacity. Most of the impacts of the project would require a temporary pause in activities on a given night and/or adaptation to activities conducted at the site. The light emitted by passing aircraft is short-term with the sky reverting to being dark once the aircraft passes. The entire sky would not be impacted.

15.5.3.3 Areas of high district brightness (A4)

All areas of high district brightness within the study area have the potential to be overflown or have a view to flights at night, either by aircraft on a night-time or day-time scheduled flight path in the early evening (before 11 pm).

In the early evening in 2033, areas of high district brightness that would experience views to aircraft at low altitudes (less than 5,000 ft) include:

- Runway 05 departures from St Marys, Penrith and Orchard Hills
- Runway 23 arrivals from Minchinbury, Glenmore and Penrith.

During the early evening in 2055, aircraft would follow the same flight paths and at the same altitude, with the frequency of flights increasing.

At night, areas that would experience views of aircraft at low altitude (less than 5,000 ft) include:

- Runway 05 departures – up to a maximum of 6 and 25 flights per night in 2033 and 2055, respectively, over Orchard Hills, St Marys and Penrith
- Runway 23 arrivals – up to a maximum of 23 and 57 flights per night in 2033 and 2055, respectively, over Orchard Hills, St Marys, Eastern Creek and suburban areas on the western outskirts of Blacktown.

Overall, the lighting of the project would not contrast substantially with the surrounding landscape at night due to the existing brightly lit setting. Generally, this would result in a low magnitude of change in 2033 and 2055. Due to the very low visual sensitivity, there would be a negligible visual impact in 2033 and 2055.

15.6 Mitigation and management

15.6.1 Mitigation measures already incorporated into the project

The design of the flight paths aimed to minimise noise and other environmental impacts, including visual impacts, to the extent practical while still achieving safe and efficient operations. These considerations were had at various stages of the design process and included sensitive tourist, recreational and wilderness areas.

In addition to airspace design constraints (such as technical and flight constraints (which includes safety) and other aircraft activity in the Sydney Basin), the airspace design considered the following areas as constraints as far as practicably and reasonably possible:

- residential built-up areas within the Sydney Basin and Blue Mountains region
- sensitive tourist and recreation areas associated with the GBMA.

Many of these locations are areas of higher landscape character and visual sensitivity.

15.6.2 Additional proposed mitigation measures

Based on the nature of the potential impacts, no reasonable or feasible project specific mitigations are considered to be available that would reduce the potential landscape and visual impacts from the project.

Chapter 16 Biodiversity

This chapter evaluates the impacts to biodiversity values within and around the Western Sydney International (Nancy-Bird Walton) Airport (WSI) potentially affected by the preliminary flight paths and airspace design (the project). The impacts of the project on Greater Blue Mountains Area biodiversity values are addressed in Chapter 23 (Matters of National Environmental Significance).

The full assessment of impacts to biodiversity values is provided in Technical paper 8: Biodiversity (Technical paper 8). Other EIS studies informed the assessment, notably Technical paper 1: Aircraft noise (Technical paper 1) and Technical paper 5: Wildlife strike risk (Technical paper 5).

Background and method

The biodiversity study area (study area) was comprised of a nominal 45 nautical miles (83 kilometre (km)) radius from WSI to capture the general features of the environment where the project would take place.

The assessment has considered potential direct impacts due to wildlife strike, and potential indirect impacts associated with the project, such as aircraft noise, changes in air and water quality, increased light and fuel jettisoning. To inform the assessment of these impacts, the assessment has considered the land uses relative to the Airport Site (site as defined in the *Airports Act 1996*), flight paths and associated predicted noise levels, and biodiversity values contained within these areas. For aircraft noise, the 2055 assessment year was selected as it represents the worst-case scenario for aircraft noise when the single runway is operating close to capacity.

The impact assessment approach included a desktop review of databases, relevant literature including research papers, spatial data and an assessment of the significance of potential impacts.

Existing environment

There are a wide variety of habitats that support biodiversity values in the study area, including the Greater Blue Mountains Area and other large tracts and isolated pockets of native vegetation (predominantly Dry Sclerophyll Forests), wildlife corridors and wetlands. These provide habitat for *Biodiversity Act 1999* (EPBC Act) listed threatened species including 92 fauna species such as the Regent Honeyeater, Swift Parrot and Grey-headed Flying-fox and 79 migratory species including migratory shorebirds.

Fifty-eight (58) wildlife attractants (such as permanent basins, ponds, non-native ecosystems, waste management facilities, Flying-fox camps and Ibis colonies) were identified within a 30 km buffer of WSI runway boundary.

Key findings

The key potential impacts on biodiversity values as a result of the project and measures to address them are:

- Direct impacts from wildlife strike leading to mortality. Impacts associated with wildlife strike are likely to be intermittent during WSI’s operation but this would not significantly affect the viability of local populations of any species. Flying-foxes are particularly susceptible to wildlife strike. There would be no other direct impacts on biodiversity values.
- Indirect impacts including potential changes to noise, light, air quality, water quality and ecosystems associated with aircraft overflight:
    - Noise can impact behavioural changes and communication interference in wildlife. Most noise related impacts on biodiversity would be concentrated in proximity to WSI (where the highest noise impacts are) and to a lesser degree areas where aircraft are at higher altitudes at distances from WSI. Overall, impacts from noise were assessed as low and unlikely to significantly modify species behaviours or use of habitats that are locally or regionally available.

- – Light spill and pollution can have adverse impacts on wildlife including behavioural and physiological changes which make them more prone to predation or wildlife strike. The project's operational light would be limited to lights on aircraft as they travel along the flight paths during nocturnal hours. This slight increase in light is unlikely to significantly affect biodiversity.
- – Emissions from aircraft operating along the flight paths could result in local and regional reductions in air quality. Habitats for wildlife in proximity to the Airport Site are already highly disturbed and likely to be subject to similar emission types associated with urban development and other aircraft. Any alterations to air quality would be temporary, localised and unlikely to impact biodiversity values.
- – Deposition of aircraft pollutants and subsequent potential impacts on water quality are unlikely and negligible.
- – Fuel jettisoning has the potential to introduce harmful contaminants into the sensitive environments within the study area such as native terrestrial and aquatic ecosystems, if not appropriately managed. Fuel jettisoning can be carried out safely and without any impacts at ground level when appropriate procedures are followed. Fuel jettisoning would occur in accordance with the Aeronautical Information Publication Australia, Part 2 – En Route (AIP ENR) (Airservices Australia, 2022a). Fuel jettisoned at a sufficient altitude would volatise (change from liquid to vapour) as it falls and is completely dispersed as vapour before any liquid reaches ground level.

In addition, the project:

- is unlikely to have a significant impact on Commonwealth heritage places listed under the EPBC Act
- is unlikely to have a significant impact on threatened or migratory species listed under the EPBC Act or on native plants and animals
- would not breach or raise inconsistences with any of Australia's obligations under the various biodiversity related international agreements to which it is a signatory
- is unlikely to compound impacts on biodiversity associated with the 2019-2020 bushfires.

The refinements to the preliminary flight path design since the exhibition of the Draft EIS would not change the conclusions of the assessment on biodiversity as presented in this chapter and the supporting technical paper. Further detail is provided in Appendix G (Assessment of the refinements to the project) of the EIS.

Significance of impacts

The project is not likely to have significant impacts (residual or otherwise) in relation to biodiversity.

Aircraft strike risk from WSI traffic can be minimised through measures such as continuing work with planning authorities to minimise wildlife attraction; preparation of regional species management plans and implementation of a bird and bat monitoring program. However, residual impacts associated with the project would include occasional aircraft strike and alterations to existing noise levels. These cannot be avoided or minimised due to the nature and extent of the project, other airport flight paths requirements and the design specifications required to safely operate aircraft associated with WSI.

As the project is not likely to have significant impacts the project is not obligated to provide offsets in accordance with the EPBC Act Offsets Policy.

The biodiversity offsets already provided for Stage 1 are adequate for all components of WSI.

16.1 Introduction

This chapter outlines the existing biodiversity values within and around the Western Sydney International (Nancy-Bird Walton) Airport (WSI) potentially affected by the preliminary flight paths and airspace design (the project). Biodiversity values are defined by flora and fauna habitats and communities, threatened species, and migratory species, including entities listed as Matters of National Environmental Significance (MNES) under the EPBC Act. The full assessment of impacts to biodiversity values is provided in Technical paper 8.

Elsewhere in this EIS, the wildlife hazard risk to aircraft operations is addressed in Chapter 13 (Aircraft hazard and risk) and impacts on the Greater Blue Mountains Area (GBMA) including biodiversity attributes are described in Chapter 23 (Matters of National Environmental Significance). This chapter has been developed to specifically address the remaining biodiversity assessment requirements of the EIS Guidelines (Appendix C), notably impacts to fauna.

An overall account of biodiversity impacts associated with Stage 1 Development of WSI (as described in Chapter 1 (Introduction)) was provided in the 2016 EIS. This included the anticipated extent of vegetation clearing and grubbing, earthworks, drainage works and the permanent infrastructure that would be constructed for the Stage 1 Development. The 2016 EIS also provided a high-level assessment of operational impacts including bird and bat strike, noise, light and fuel jettisoning associated with aircraft flight for Stage 1 Development scenario (nominally 2030) and a longer-term dual-runway scenario (nominally 2063). A biodiversity offset delivery plan (BODP) was developed to compensate for residual significant impacts associated with the Stage 1 Development. The BODP takes into account specific species such as the Southern Myotis (*Myotis macropus*) roosting habitat, the Cumberland Land Snail (*Meridolum corneovirens*) and various species of flora.

In line with the EIS Guidelines, this assessment considers the direct and indirect impacts the project would have, or is likely to have on biodiversity values for the preliminary flight paths for single runway operations consistent with the Stage 1 Development of WSI.

Facilitated and cumulative impacts on biodiversity impacts are discussed in Chapter 21 (Facilitated impacts) and Chapter 22 (Cumulative impacts) respectively.

16.1.1 Assessment years

The 2055 assessment year was selected to assess impacts to biodiversity values from aircraft noise. This assessment year represents the worst-case scenario for biodiversity as it is when the single runway is operating close to capacity.

Refer to Chapter 7 (The project) for further information on assessment years.

16.2 Legislative and policy context

The relevant legislation, guidelines and standards for the assessment of biodiversity include:

- EPBC Act (Section 16.2.1) and associated significant impact guidelines and policies:
  - *Matters of National Environmental Significance, Significant impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999* (Significant impact guidelines 1.1) (Commonwealth of Australia, 2013a).
  - *Actions on, or impacting upon Commonwealth land, and actions by Commonwealth agencies, Significant impact guidelines 1.2 Environment Protection and Biodiversity Conservation Act 1999* (Significant impact guidelines 1.2) (Commonwealth of Australia, 2013b).
  - *EPBC Act Environmental Offsets Policy* (EPBC Act Offsets Policy) (Department of Sustainability, Environment, Water, Population and Communities, 2012).
- National Airports Safeguarding Framework (NASF) *Managing the Risk of Wildlife Strikes in the Vicinity of Airports* – provides guidelines to land users and planners regarding the management of wildlife hazards.

- *ICAO Annex 14, Volume 1 (Aerodrome Design and Operation); ICAO Airport Services Manual Doc. 9184: Part 2 Land Use and Environmental Control; ICAO Airport Services Manual Doc. 9137: Airport Services Manual Part 3, Wildlife Control and Reduction* (ICAO Guidelines) – all relate to the wildlife management responsibilities of airports.
- *Environmental Management of Changes to Aircraft Operations National Operating Standard* (NOS) – AA-NOS-ENV2.100 Version 16: Effective 08 March 2022 (Airservices Australia, 2022b) – prescribes the requirements for environmental impact assessment of changes to aircraft operations, including criteria for assessing the significance of impacts to biodiversity sensitive receptors (BSRs) (refer to Section 16.3.3.4) as a result of a change in aircraft overflights.
- *Biodiversity Conservation Act 2016* (NSW) (BC Act) – allows breeding disruption and lethal control of hazardous native wildlife (by means of shooting by authorised shooters) for the purpose of aircraft hazard reduction under a 'Licence to Harm Protected Animal'.
- *Environmental Planning and Assessment Act 1979* (NSW) – describes the Ministerial Directions that relate to safeguarding aviation and the Western Sydney Aerotropolis, including the implementation of an interim land use and infrastructure plan (Direction 7.8).
- *State Environmental Planning Policy (Resilience and Hazards) 2021* (NSW) (Resilience and Hazards SEPP) – identifies coastal wetlands and proximity area for coastal wetlands on the Coastal Wetlands and Littoral Rainforests Area Map. These areas were used to identify potential suitable habitat for MNES biodiversity entities as part of this assessment.

16.2.1 EPBC Act

The EPBC Act provides the national framework for protecting and managing nationally (and internationally) important flora and fauna, ecological communities and heritage places (including World heritage) that are defined under the EPBC Act as MNES. An overview of the EPBC Act, including MNES and relevance to the project is provided in Chapter 5 (Statutory context).

In accordance with the EPBC Act and the EIS Guidelines, this EIS requires an assessment of impacts on biodiversity to provide an understanding of the nature, extent and significance of potential impacts on the environment associated with the project. As the project is being undertaken by a Commonwealth agency, this includes consideration of the impacts on the 'whole of the environment'. That is, the assessment will assess impacts to MNES but it will not be limited to those considerations.

The MNES biodiversity entities (biodiversity MNES) considered in this chapter are:

- nationally threatened flora and fauna species
- nationally threatened ecological communities
- species listed under international agreements including:
  - Japan-Australia Migratory Bird Agreement (JAMBA)
  - China-Australia Migratory Bird Agreement (CAMBA)
  - Korea-Australia Migratory Bird Agreement (ROKAMBA)
  - Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)
  - Biodiversity Convention, the Convention on Conservation of Nature in the South Pacific (Apia Convention)
  - Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
- wetlands of international importance listed under the Ramsar Convention (Ramsar wetlands)
- biodiversity attributes contained within world heritage areas (for the purposes of determining habitat value).

The assessment considers these treaties and whether the project may breach any of the agreements signed by Australia. It also assesses the impacts on plants and animals as part of the whole of the environment.

16.2.1.1 Part 13 Permit

A permit may be required under Part 13 of the EPBC Act if a project occurring on Commonwealth land may impact a listed threatened species, ecological community, migratory species or marine species, regardless of whether that impact is significant or not.

Potential impacts on biodiversity relating to the project are consistent with those assessed as part of the 2016 EIS. The Part 13 Permit applied for and approved as part of the Stage 1 development (E2017-0138) is considered adequate to address the project's impacts.

16.3 Methodology

To assess impacts on biodiversity, the key tasks were to:

- ascertain dependencies and interactions with other EIS technical papers (Section 16.3.1)
- determine appropriate study area/assessment zone for the assessment of direct and indirect impacts on biodiversity (Section 16.3.2)
- complete a desktop assessment including research to describe the biodiversity values of the assessment zone, including native vegetation types, flora and fauna species and their habitats (Section 16.3.3)
- develop suitable severity assessment criteria for the assessment of biodiversity (Section 16.3.3.7)
- identify and describe suitable and preferred habitat that supports biodiversity values relevant to the project (Section 16.5)
- assess the direct and indirect impacts of the project on biodiversity values relevant to the project (Sections 16.6.1 and 16.6.2), consistency with Australia's international agreements (Sections 16.6.3 and 16.6.4) and bushfire impacts (Section 16.6.5)
- complete significant impact assessments (SIAs) pursuant to Significant impact guidelines 1.1 and 1.2 (Section 16.7)
- recommend mitigation measures to assist in further minimising impacts to biodiversity values (Section 16.8)
- identify appropriate biodiversity offsets to compensate for residual significant impacts on protected matters arising from the proposed airport in accordance with the Offsets Policy (Section 16.8.3).

16.3.1 Dependencies and interactions with other studies

Other EIS studies were reviewed to scope and inform the biodiversity assessment as described in Table 16.1.

Table 16.1 Dependencies and interactions with other Technical papers

Technical paper	Relevance
Technical paper 1: Aircraft noise	To inform the study area for this assessment and assess the noise impacts on biodiversity. Additional assessment of project refinements was also completed based on a review of Addendum Technical paper 1: Aircraft noise.
Technical paper 2: Air quality	To inform the assessment of air quality on biodiversity.
Technical Paper 3: Greenhouse gas emissions	Assesses potential impacts relating to greenhouse gases (GHGs) and climate change and therefore biodiversity.
Technical paper 4: Hazard and risk	To inform the mitigation measures for wildlife strike.

Technical paper	Relevance
Technical paper 5: Wildlife strike risk	To inform the study area, to inform biodiversity impacts arising from wildlife strike within a 13 kilometre (km) radius of the runway and to inform the effects of aircraft noise on wildlife.
Technical Paper 7: Landscape and visual amenity	To inform the assessment of light impacts on biodiversity.
Technical paper 12: Human health	Assesses potential impacts relating to water quality and therefore resultant impacts to biodiversity.
Technical paper 14: Greater Blue Mountains World Heritage Area	To inform the description of the existing environment. Technical paper 8 informs the assessment of biodiversity attributes in Technical paper 14.

16.3.2 Study area

The biodiversity study area (study area) is comprised of a nominal 45 nautical miles (83 km) radius from WSI to capture the general features of the environment where the action would take place (refer to Figure 16.1).

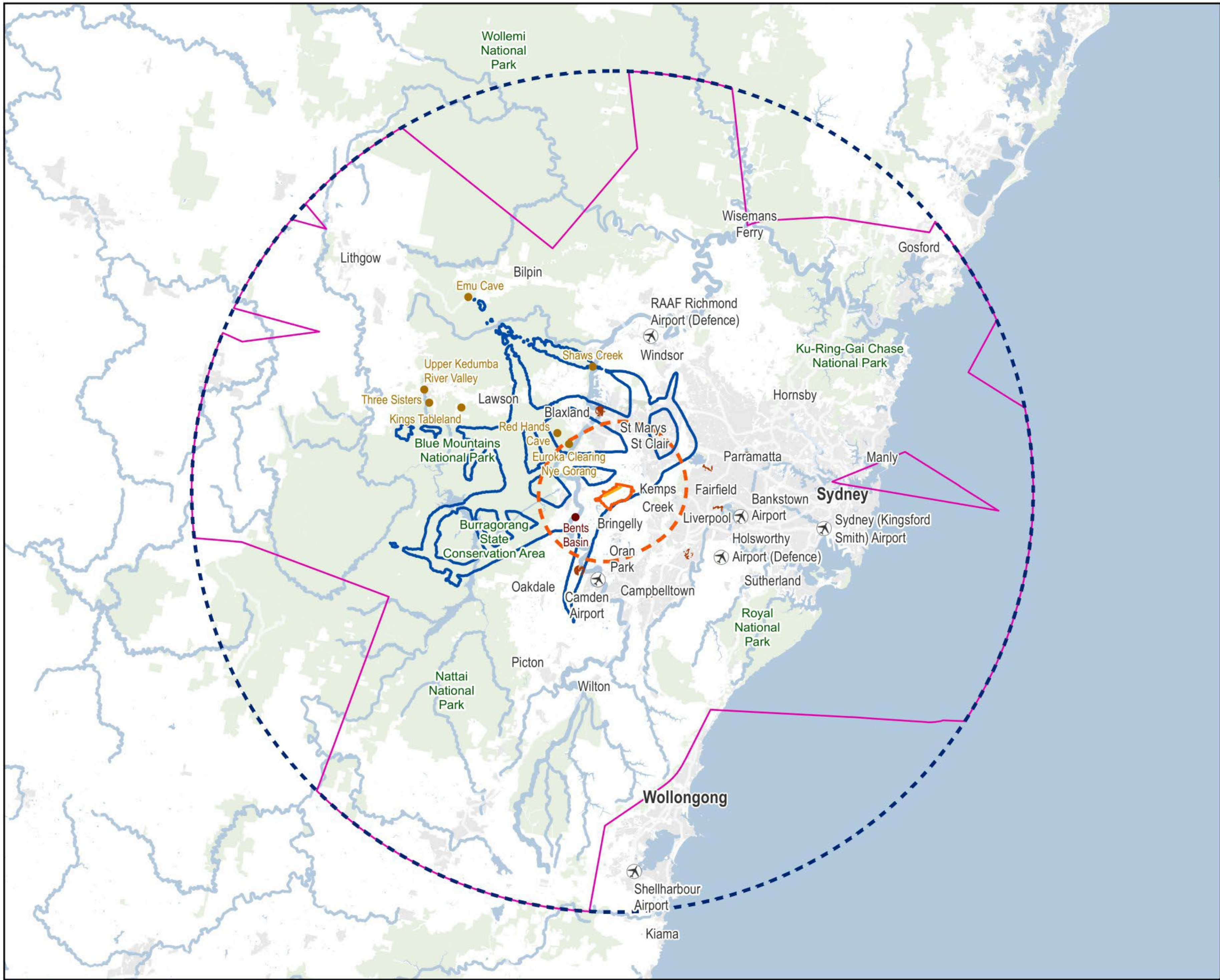
Four separate components within the study area were used to determine an 'assessment zone' for capturing the extent and nature of likely impacts on biodiversity values. These are described in Table 16.2. Justification for the extent of impacts is provided in Section 16.3.3.5.

Table 16.2 Study area components

Components	Description	Purpose
Wildlife buffer (Figure 16.1)	Includes any natural or anthropogenic (created by people or caused by human activity) structure or land use within 13 km of the WSI runway boundary, including WSI's landside areas identified as an actual or potential wildlife attractant (as per Technical paper 5). Technical paper 5 also identified additional wildlife attractants outside the 13 km buffer (up to 30 km buffer). These values occur within, and are included in the flight path buffer component for this assessment.	Evaluates extent of **direct** impacts on biodiversity values.
Flying-fox camps and buffers	All remnant vegetation mapped (NSW DPE, 2022f) within a 1 km buffer of the 8 flying-fox colonies, or 'camps' that were monitored to inform Technical paper 5. Mapped in Figure 16.4.	Evaluates extent of **direct** impacts on biodiversity values.
Noise contours	Defined by 2055 N60 24-hour and N70 24-hour composite contours from Technical paper 1. Mapped in Figure 1.1 of Technical paper 8. Refer to Section 16.3.3.5 for justification.	Evaluates extent of **indirect** impacts on biodiversity values from aircraft noise.
Flight path buffer (Figure 16.1)	The concept of flight paths is introduced in Section 3.3.2 of Chapter 3 (Introduction to airspace). WSI flight path descriptions are provided in Chapter 7 (The project). A 10 km buffer around each flight path's centreline is included to define the locality of the project's impacts on BSRs in accordance with the NOS (refer to Section 16.3.3.4).	Determines the extent of **direct** and **indirect** impacts on biodiversity values.

Figure 16.1

Study area for biodiversity



Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

Assessment zones

- Biodiversity study area
- Wildlife buffer
- Flying-fox camps and buffers
- Noise contours
- Flight path buffer (10km)

0 10 20 km

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:1,000,000 Date: 3/08/2023

Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

16.3.3 Impact assessment approach

The assessment included a desktop review of databases, relevant literature, and spatial data. Impact calculations and an assessment of the significance of impacts were undertaken to determine the effect of the project on biodiversity values.

16.3.3.1 Desktop review

Existing information relating to biodiversity values was assessed during a desktop review, including:

- relevant legislation, guidelines and standards as listed in Section 16.2
- previous biodiversity studies undertaken for WSI or related to the GBMA
- previous studies and plans relating to the Cumberland Plain
- other relevant technical papers prepared for the project (Section 16.3.1)
- searches of existing databases including the EPBC Act Protected Matters Search Tool (PMST) (DCCEEW, 2022a) and the BioNet Atlas of NSW Wildlife (NSW DPE, 2022d) to identify biodiversity values relating to the study area
- plant community type profiles contained in the BioNet Vegetation Classification Database (NSW DPE, 2022e)
- spatial data, including on vegetation and habitat mapping (Section 16.5.2) and fire extent and severity (Section 16.6.5)
- national recovery plans, threat abatement plans and conservation advice for MNES (Section 16.6.3)
- research papers on the various impacts of aircraft operations on biodiversity (as referenced throughout).

The complete list of data and documents reviewed for this assessment is in Appendix A and Chapter 12 of Technical paper 8.

16.3.3.2 Likelihood of occurrence

Following the desktop review, 'likelihood of occurrence' assessments were prepared for EPBC Act threatened flora, threatened ecological communities and threatened fauna and migratory species to determine 'candidate' species or communities (those with potential to be impacted upon by the project and requiring further assessment).

Likelihood of occurrence assessments for threatened flora and threatened ecological communities were limited to those with potential to occur within the wildlife buffer. Outside of the wildlife buffer within the assessment zone, these entities are unlikely to be impacted due to their location in relation to the preliminary flight paths and the altitudes at which aircraft would be flying.

Likelihood of occurrence assessments for threatened fauna and migratory species were conducted for the assessment zone as a whole and separately for the wildlife buffer. These threatened species were appropriate surrogates for NSW listed threatened species and other non-threatened native species which may be sensitive to impacts associated with the project.

The likelihood of occurrence for these entities was classified as 'recorded', 'high', 'moderate' or 'low' using criteria and based on desktop review in Section 16.3.3.1 above, Appendix A of Technical paper 8, and the assessor's professional judgement. Candidate species were those determined as having 'moderate' to 'high' likelihood of occurrence or utilising habitats available. The approach is detailed in Section 4.4.2 of Technical paper 7.

16.3.3.3 Vegetation communities and habitat determination

Vegetation communities and associated habitat types for the wildlife buffer were determined during the desktop review (refer to Section 16.3.3.1). The NSW State Vegetation Type Map (NSW DPE, 2022f) was primarily used to determine the Plant Community Types (PCTs) considered likely to be present. As the suitability, size and configuration of fauna habitat types correlate broadly with the structure of PCTs, each PCT was assigned a surrogate broad fauna habitat type. Habitat types for flora species and threatened ecological communities were determined using each PCT's profile contained in the BioNet Vegetation Classification Database (NSW DPE, 2022e).

16.3.3.4 Biodiversity sensitive receptors

Biodiversity sensitive receptors as defined by the NOS includes:

- MNES listed under the EPBC Act. These are considered as surrogates for other non-EPBC Act threatened native species which may be sensitive to impacts associated with the project
- other sensitive areas which are likely to contain important habitat for EPBC Act listed threatened biota and migratory species or state-listed threatened biota (including nationally important wetlands, State forests, national parks, other conservation reserves listed under State legislation).

These have been located and classified using a 10 km buffer on flight paths (as guided by the NOS) as the basis to assess the extent of noise impacts and presence or otherwise of key potential habitats (refer to Table 16.2).

16.3.3.5 Consultation

Extensive consultation was undertaken to identify key heritage values, including those relating to biodiversity, and their importance to the community. The consultation completed for the project is detailed in Chapter 9 (Consultation and stakeholder engagement) and Chapter 17 (Heritage).

16.3.3.6 Determining the extent of impacts

This section outlines the extent of the direct and indirect project impacts relevant to biodiversity values.

Direct impacts

Direct impacts on biodiversity values are limited to wildlife strike leading to injury or mortality of fauna species.
The extent of direct impacts is restricted to 3 components of the assessment zone (Table 16.2) for reasons described below. The methodology and assessment of the risk of bird and bat strike is provided in Technical paper 5 as summarised in Chapter 13 (Aircraft hazard and risk).

Wildlife buffer

International Civil Aviation Organization (ICAO) guidelines relating to radial distances from an airport, Civil Aviation Safety Authority (CASA) and the NASF recognise land uses within 13 km of an airport are potential risk contributors. As such, biodiversity values within this distance that attract, or have the potential to attract, wildlife relevant to the project may contribute to WSI's potential wildlife strike risk/direct impact potential.

In civil aviation, 93 per cent of wildlife strikes occur at or below 3,500 feet (ft) (1 km) Above Ground Level (AGL) (Dolbeer, 2011). The project's flight paths typically reach 3,500 ft (1 km) AGL within 13 km of the Airport Site, as captured by the wildlife buffer.

Flying-fox camps and buffers

The flying-fox hazard risk to aircraft, and the reasons for including flying-fox camps outside the 13 km wildlife buffer are described in Chapter 13 (Aircraft hazard and risk).

The 'National Flying-fox monitoring viewer' (DCCEEW, 2022b) only provides a centre point of each camp. Using a 1 km buffer from each centre point ensures that the entirety of each camp is included in the flying-fox camps and buffers.

Flight paths

While direct impacts to wildlife below 3,500 ft AGL (1 km) were assessed using the wildlife buffer and flying-fox camps and buffers, direct impacts to bird species known to occur at altitudes of greater than 3,500 ft AGL (1 km), such as Australian Pelican and Wedge-tailed Eagle, were assessed using the flight path buffer. This is where aircraft may intersect with aerial habitats for these species.

Indirect impacts

Indirect impacts on biodiversity values include potential changes to noise, light, air quality, water quality and ecosystems associated with aircraft overflight. The extent of indirect impacts was limited to the noise contours and flight path buffer for reasons described below.

Noise contours

The N60 24-hour and N70 24-hour noise contours were used as a proxy to assess the extent of aircraft noise impacts on biodiversity values as they reflect the proposed number of aircraft movements where a BSR is exposed to noise levels at or above 60 dB(A) and 70 dB(A) within the flight path buffer. This is considered an appropriate approach given the literature reviewed as provided in Technical paper 8 and summarised as below:

- The N60 and N70 noise thresholds represent levels above which aircraft noise would be considered a regular feature of the ambient noise environment. N70 values of 5 or more are considered to provide sufficient resolution for describing aircraft noise in areas currently experiencing aircraft noise, as well as areas which would be newly affected by aircraft overflights. Therefore, changes in existing noise levels will be concentrated within these contours and other areas (beyond these contours) should remain relatively unaffected (or affected to a less degree) by noise associated with the project (refer to Chapter 11 (Aircraft noise).
- Literature based on 20 years of international research documenting the effects of anthropogenic noise suggests that the range of noise levels, including aircraft noise, reported to induce annoyance in humans and trigger responses in terrestrial wildlife are similar, that is, between 40 and 100 dB(A) (Shannon et al. 2016). Limitations of the literature are discussed in Section 16.3.4.
- The noise level threshold of 60 dB(A) represents a reasonably conservative noise threshold based on the findings of the published literature (that is, this threshold captures 60 per cent of studies that have shown adverse responses in terrestrial wildlife, including impacts on physiology and fitness) and given the large variability in responses between species and individuals and at different locations (Shannon et al. 2016).
- It has been found that the lateral distance between aircraft and wildlife is an important parameter when predicting animal behaviour due to aircraft noise exposure. For example, Delaney et al. (1999) noted that Mexican Spotted Owls were not flushed or visibly irritated by aircraft noise stimuli if they were located 100 m or further away from the WSI runway. The assessment zones encompass all areas within the locality of the project including the wildlife buffer (representing 13 km from the WSI runway).
- The NOS methods (which apply N60 and N70 noise thresholds) have been validated through consultation and negotiations with key stakeholders and ongoing analysis of Airservices Australia aviation noise complaint data and flight path changes since 2013.

Given the above, the use of the 2055 N60 24-hour and N70 24-hour noise contours were considered an appropriate approach to determining the extent and concentration of changes in noise levels associated with the project. Areas outside of the N60 24-hour and N70 24-hour contours were considered as likely to remain relatively unaffected (or affected to a minor degree) by noise associated with the project and would therefore likely result in negligible impacts. Further information on research findings is found in Section 4.7.1 of Technical paper 8.

Flight path buffer

The flight path buffer was used to determine the extent of light, air quality and fuel jettisoning indirect impacts on biodiversity values as this area would be the primary source of such impacts.

Quantification

Given the nature of these direct and indirect impacts, their extent cannot be quantified by the area of impacted habitat, nor can the total number of individuals affected be reliably estimated without long term baseline studies and operational monitoring (refer to Technical paper 5). As such, the direct and indirect impact extent is limited to qualitative extents.

For this assessment, the extent of indirect impacts was used to inform the SIAs and whether biodiversity offsetting would be required for the project.

Other factors

There were a range of other factors considered to determine the extent of the project's impacts on biodiversity values. These included whether the impact is likely to be temporary, permanent, direct, indirect, unknown, unpredictable or irreversible, altitudinal ranges of aircraft (refer to Section 16.5.4) and the results of the project's other environmental assessments to inform impacts on biodiversity values (refer to Section 16.3.1). Further detail is provided in Section 4.6.1.3 of Technical paper 8.

16.3.3.7 Significance criteria

Significant impact assessments must consider the likelihood of an impact occurring, in addition to the severity of the impact if the impact were to occur. Under the EPBC Act, significant impact criteria are provided in Significant impact guidelines 1.1 and 1.2. This criterion has been integrated into project's impact significance assessment framework as presented in Chapter 10 (Approach to impact assessment) and below.

Likelihood of a significant impact

An action is considered 'likely' to have a significant impact if there is a real or not remote chance or possibility of a significant impact. The likelihood of an impact is deemed 'possible' if it could occur during the lifetime of the project (probability 70 to 90 per cent) and 'unlikely' if the impact is unlikely to occur, but is possible during periods of the project (probability 10 to 30 per cent).

Severity of impact

A set of impact severity assessment criteria were developed taking into consideration the significant impact guidelines 1.1 and 1.2 to identify and evaluate the scale, intensity, timing, duration and frequency of the project's impacts on biodiversity. The severity criteria were aligned to an impact order of magnitude which acted as a threshold to assist in determining whether the project was likely to have a significant impact on a biodiversity value (whether on MNES or the environment as a whole).

For the purposes of this assessment impacts with a major impact severity were considered to have a significant impact. A description of the significance criteria used for this assessment is provided in Table 16.3.

Table 16.3 Severity assessment criteria for assessing impacts on biodiversity

Severity	Description
Major	Detectable adverse impacts considered likely to result in a significant impact on a biodiversity value in accordance with the Significant impact guidelines 1.1 and 1.2. These impacts could include a potential decline of a population and/or reduction in an area of occupancy such that it would affect a species status under the EPBC Act or International Agreements. These effects tend to be permanent, or irreversible, or otherwise long term of high intensity.
High	Detectable adverse impact on a biodiversity value protected under state, federal or international legislation/agreements that is not considered to be significant in accordance with the Significant impact guidelines 1.1 and 1.2. These impacts tend to be permanent, or otherwise medium to long-term of high intensity.
Moderate	Detectable adverse impact on a biodiversity value not protected under state, federal or internal legislation/agreements that is not considered to be potentially significant at a local, regional, state or federal level. These impacts tend to range from short to long-term and be of medium intensity. Nevertheless, the cumulative effects of such impacts may lead to an increase in the overall effect upon a biodiversity value.
Minor	Minor adverse impacts that are detectable at a local scale only but not significant at a regional, state or federal level. These impacts tend to be short term or of low intensity.
Negligible	No or minimal adverse impacts on biodiversity values within the normal bounds of variation or below levels of detection that are not significant at a local, regional, state or federal level. These impacts tend to be short term, temporary or of low intensity.

16.3.4 Assumptions and limitations

This assessment, including determining the extent of impacts (Section 16.3.3.5) has relied upon data, surveys, analyses, designs, plans and other information provided by DITRDCA and other organisations. Wildlife surveys including monitoring of 8 flying-fox camps were undertaken to inform Technical paper 5, as described in Chapter 13 (Aircraft hazard and risk).

No other ecological field surveys were conducted to verify data for this assessment. This is because the biodiversity of the assessment zone has been intensively surveyed over decades due to its occurrence within and adjoining the urban area of western Sydney and is well understood. Together with the wildlife strike surveys undertaken in Technical paper 5, this survey effort is considered to provide a sufficient and appropriate level of baseline knowledge to inform the assessment, particularly given the aerial nature of the impacts and that only highly mobile aerial fauna species are likely to be impacted directly.

There are no thresholds strictly identified for assessing aircraft noise, light, air quality and water quality impacts on biodiversity values and there is limited research of these impacts on individual Australian species likely to be impacted by the project. Further, past research in wildlife responses to noise have shown large variability between species and individuals at different locations even between individuals in the same population, making multi-species-based risk assessments difficult (Busnel and Fletcher, 1978; Radle, 2007; Duquette et al. 2021). Where possible, available guidelines, standards and literature have been used to determine an appropriate approach to assessing the extent, concentration and severity of these impacts associated with the project.

Limitations of the wildlife surveys are described in Appendix B of Technical paper 5. Databases used have inherent limitations that must be considered when interpreting the results of database searches, and site conditions, including the presence of threatened species, can change with time.

16.4 Avoidance and minimisation of impacts

The development of the preliminary airspace and flight path design is described in Chapter 6 (Project development and alternatives). This included the avoidance and minimisation of impacts to biodiversity through early consideration of environmental constraints in the planning phase, including the GBMA and associated sensitive recreation/wilderness areas, as input into the initial concept design options.

Further opportunities to minimise impacts to biodiversity are considered in this chapter (refer to Section 16.8).

16.5 Existing environment

This section describes the existing biodiversity values across the study area, including:

- interim Biogeographic Regionalisation for Australia (IBRA) region characteristics (Section 16.5.1)
- World heritage, National heritage and Commonwealth heritage places, notably the Greater Blue Mountains Area (GBMA) (Section 16.5.2.1)
- vegetation communities and associated broad fauna habitat types (Section 16.5.2.2)
- important habitats, for Regent Honeyeater, Swift Parrot, migratory shorebirds and the flying-fox (Section 16.5.2.3).
- wetlands, including Ramsar wetlands, SEPP coastal wetlands and nationally important wetlands (Section 16.5.2.4)
- key local and regional wildlife corridors (Section 16.5.2.5)
- conservation initiatives (Section 16.5.2.6)
- wildlife attractants (Section 16.5.2.7).

These attributes are mapped across the study area as presented in in the following sections.

16.5.1 Regional overview

The study area extends across 2 IBRA regions (Sydney Basin and South Eastern Highlands) and their associated 16 IBRA subregions (refer to Figure 16.2). The extent of this figure also captures another IBRA region/subregion – NSW South Western Slopes/Capertee Valley – which occurs outside the north-west of the study area.

A general description of the regions within the study area is provided in Table 16.4.

Key characteristics of ecosystems which occur within these IBRA subregions are provided in Appendix A3 of Technical paper 8.

Table 16.4 Overview of IBRA bioregions in the study area (Australian Government 2019)

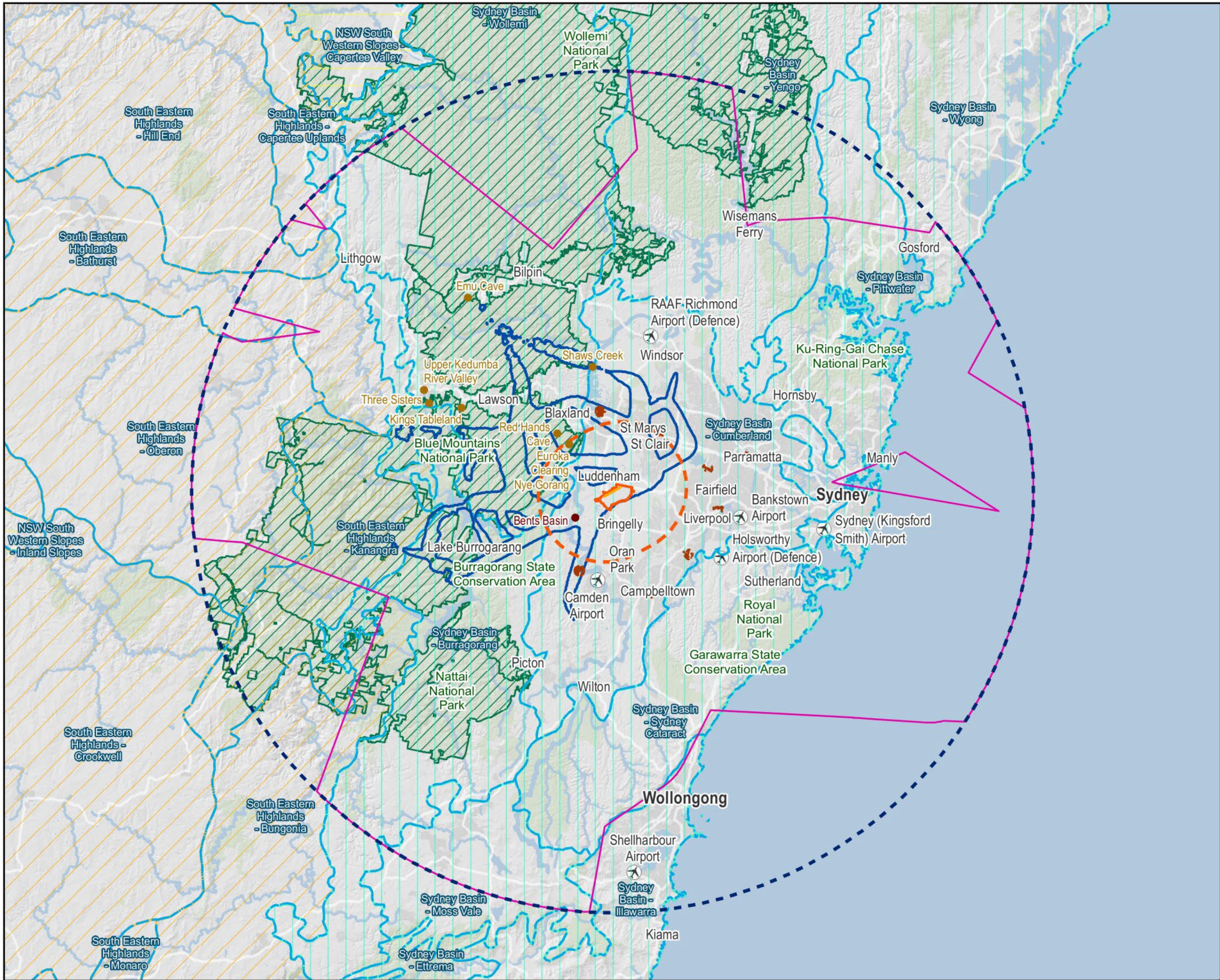
IBRA bioregion	Description	Biodiversity	Associated bioregions
Sydney Basin	Covers a large part of the catchments of the Hawkesbury-Nepean, Hunter and Shoalhaven river systems. Dominated by a temperate climate characterised by warm summers with no dry season. Areas around the Blue Mountains falls in a montane climate zone. The most significant feature is the Great Escarpment, with its reversed drainage, and entrenched meander patterns and high level terrace gravels; the Blue Mountains are part of this feature.	One of the most species diverse in Australia. This is a result of the variety of rock types, topography and climates in the bioregion. Just over 40 per cent of the bioregion is used for conservation, including the Blue Mountains National Park, Wollemi National Park and Morton National Park.	Burragorang Cumberland Illawarra Moss Vale Pittwater Sydney Cataract Wollemi Wyong Yengo
South-Eastern Highlands	Covers the dissected ranges and plateau of the Great Dividing Range that are topographically lower than the Australian Alps, which lie to the south-west. Dominated by a temperate climate characterised by warm summers and no dry season. Areas in the north and south are at higher elevations in a montane climate zone, where summers are much milder. Topographically, the dominant features are plateau remnants, granite basins with prominent ridges.	Both soils and vegetation vary across the bioregion in relation to altitude, temperature and rainfall. Temperature affects the vertical distribution of species and can be observed in inverted sequences in frost hollows.	Bathurst Bungonia Capertee Uplands Crookwell Hill End Kanangra Oberon

The wildlife buffer and flying-fox camps and buffers occur within the Cumberland Plain of western Sydney and the wildlife buffer extends west to Nepean-Hawkesbury River before intersecting the foothills of the Blue Mountains National Park and the Burragorang State Conservation Area. The existing land uses within the wildlife buffer largely consist of urban development including a combination of residential development, commercial development, agriculture, town centres, parklands, reserves and supporting road, rail, waste and power infrastructure. A large portion of the area occurs as a highly fragmented mosaic landscape retaining small to medium sized vegetation remnants and waterbodies having been subjected to pressures associated with urban development.

The Great Dividing Range occurs to the immediate west of the wildlife buffer and includes the vast wild remnant native forests and native vegetation of the GBMA and surrounds, which extend from the Hunter Valley in the north (Wollemi National Park) to the Shoalhaven in the south (Morton National Park) and the western edge of Blue Mountains National Park. Further afield and generally on the flat plains and valleys is dominated by agriculture in all directions except to the east, which are purely oceanic environments off the NSW coast.

Figure 16.2

IBRA bioregions and heritage values across the study area



Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- Greater Blue Mountains World Heritage Area
- IBRA Subregions
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

IBRA Regions

- NSW South Western Slopes
- South Eastern Highlands
- Sydney Basin

Assessment zones

- Biodiversity study area
- Wildlife buffer
- Flying-fox camps and buffers
- Noise contours
- Flight path buffer (10km)

0 10 20 km

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:1,000,000 Date: 7/08/2023

Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

16.5.2 Habitat values

This section identifies the suitable and preferred habitat that supports biodiversity values in the study area.

16.5.2.1 World heritage, National heritage and Commonwealth heritage places

The PMST search (refer to Section 16.3.3.1) identified one World Heritage Area, 3 'natural' National Heritage places and 3 'natural' Commonwealth Heritage Places as occurring within the study area (refer to Figure 16.2).

The GBMA was identified as a World Heritage Area and a National Heritage Place. The National Heritage values identified for the GBMA listing are the same as the values recognised for the World Heritage Area.

The GBMA makes up a significant representation of Australia's biodiversity supporting 10 per cent of the country's vascular flora and significant numbers of rare or threatened species, including endemic and evolutionary relict species within its boundaries (UNESCO, 2022b). It is large and botanically diverse representing a wide range of eucalypts habitats that support approximately 152 plant families, 484 genera and approximately 1,500 species.

Most of the remnant vegetation and associated habitats within the GBMA is of high wilderness quality and remains close to pristine. The impacts to its World Heritage and Natural Heritage values from the project, including its biodiversity, are assessed in Chapter 23 (Matters of National Environmental Significance).

The 2 remaining Natural Heritage Places identified within the study area were: Ku-ring-gai Chase National Park, Lion, Long and Spectacle Islands Nature Reserves; and the Royal National Park and Garawarra State Conservation Area. These are not considered further as they occur outside the wildlife buffer and flying-fox camps and buffers and are unlikely to be directly affected by the project. They are unlikely to be indirectly affected as they would be overflown by WSI aircraft at high altitudes and are already substantially overflown by Sydney (Kingsford Smith) Airport aircraft activity (refer to Chapter 23 (Matters of National Environmental Significance)).

Two of the Commonwealth Heritage Places identified by the PMST are considered likely to be potentially influenced by the project; being the Orchard Hills Cumberland Plain Woodland and the Shale Woodland Llandilo.

The Orchard Hills Cumberland Plain Woodland Commonwealth Heritage Place is comprised of some of the largest, least disturbed, and regenerating remnants of Cumberland Plain vegetation communities. It has been listed for its outstanding examples of Cumberland Plain Woodland and Sydney Coastal River-flat Forest threatened ecological communities, large area of continuous habitat, among the least disturbed catchments in western Sydney (primarily Blaxland Creek and its tributaries) and populations and/or habitat for regionally significant flora and fauna species. The low disturbance of Blaxland Creek has been identified as containing a high representation of macro-invertebrate genera including some disturbance-sensitive species that appear to be confined to Orchard Hills such as stoneflies, leptophlebiid mayflies and pollution-sensitive caddisflies. Due to this, it sets a valuable benchmark to measure water quality degradation in western Sydney (DCCEEW, 2023).

The Shale Woodland Llandilo Commonwealth Heritage Place is comprised of one of the largest remnants of Cumberland Plain vegetation characteristic of Wianamatta shale, Tertiary alluvium and low-lying recent alluvium that support large areas of Cumberland Plain Woodland, Coastal River-flat Eucalypt Forest, Cooks River Ironbark Forest and Shale Gravel Transition Forest which are all listed under both the BC Act and EPBC Act as threatened. These areas comprise populations of many threatened flora species and provide habitat for threatened fauna species (DCCEEW, 2023).

16.5.2.2 Vegetation communities and associated broad fauna habitat types

A review of DPE's NSW State Vegetation Type Map (NSW DPE, 2022f) identified 312 PCTs within the assessment zone. These PCTs were aligned to 12 broad fauna habitat types using the vegetation formations described by Keith (2004) to assess potential impacts and risks associated with the project on fauna species. The total extent of these fauna habitat types in the assessment zone was around 1,471,441 hectares (ha) – with the breakdown across assessment zone categories provided in Table 16.5.

Table 16.5 Broad habitat classifications located within the assessment zone

Broad habitat classification	Extent within wildlife buffer (ha)	Extent within flying-fox camps and buffers (ha)	Extent within noise contours (ha)	Extent within assessment zone (ha)*
Dry Sclerophyll Forests (Shrub/grass sub-formation)	619	–	6,130	122,325
Dry Sclerophyll Forests (Shrubby sub-formation)	5,438	–	34,313	557,032
Forested Wetlands	3,566	219	3,399	24,715
Freshwater Wetlands	13	7	257	17,616
Grasslands	–	–	–	183
Grassy Woodlands	12,164	70	6,900	88,026
Heathlands	–	–	821	38,963
Rainforests	72	1	601	25,788
Saline Wetlands	–	–	–	2,568
Wet Sclerophyll Forests (Grassy sub-formation)	1,042	–	1,143	49,220
Wet Sclerophyll Forests (Shrubby sub-formation)	379	59	5,121	74,702
Non-native/unattributed	39,511	2,157	29,067	470,303
Total	**62,804**	**2,513**	**87,752**	**1,471,441**

*Equates to the extent of the flight path buffer

The percentage portion of these broad fauna habitat types in the assessment zone is presented in Figure 16.3.

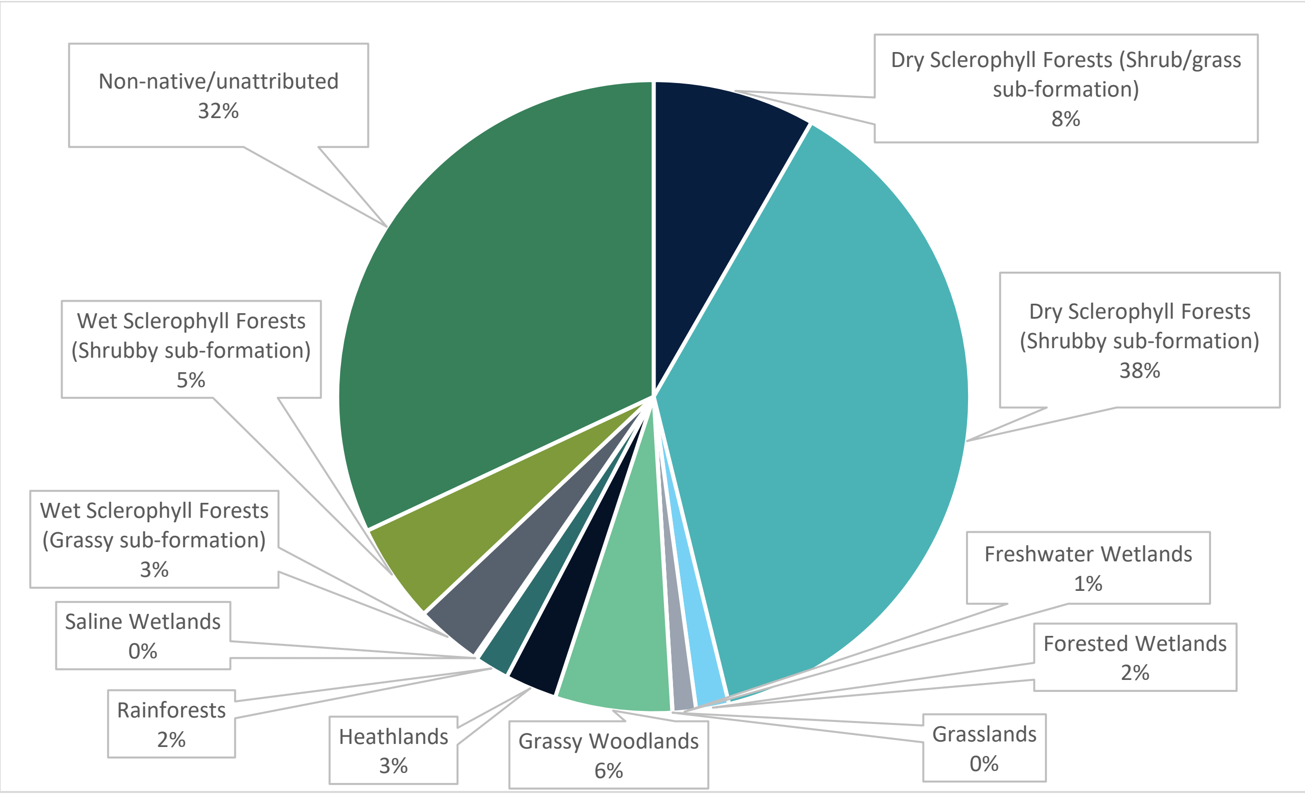


Figure 16.3 Percentage portion of broad fauna habitat types in the assessment zone

The dominant fauna habitat types mapped by NSW DPE (2022f) within the assessment zone include Dry Sclerophyll Forest (Shrub/grass sub-formation) followed by Non-native/unattributed disturbed areas each occupying approximately 557,000 ha (38 per cent) and 470,000 ha (32 per cent) respectively of the assessment zone. The Dry Sclerophyll Forest (Shrub/grass sub-formation) was predominantly located within the GBMA and the Non-native/unattributed disturbed areas were predominantly located in the wildlife buffer.

All other broad fauna habitat types typically equated to less than 10 per cent of the assessment zone, with 2 equating to between 0–0.2 per cent. These habitats are likely to provide a range of microhabitats for all fauna guilds including birds, reptiles, amphibians, fish, invertebrates and mammals.

16.5.2.3 Important habitats and breeding and foraging habitats

Important habitat

Important habitat maps have been developed by NSW DPE for a subset of threatened species which have habitat constraints essential to support critical life stages for the species, for example breeding areas or locations important for foraging/over-wintering of migratory species.

Of these maps, important habitat for the Regent Honeyeater, Swift Parrot and Migratory shorebird species exists and has been mapped across the proximity of WSI in Figure 16.4. The extent within the assessment zone and 2 of its components is provided in Table 16.7.

Table 16.6 Important habitat mapped within the assessment zone

Species	Extent within wildlife buffer (ha)	Extent within flying-fox camps and buffers (ha)	Extent within noise contours (ha)	Extent within assessment zone (ha)*
Regent Honeyeater	149	–	149	8,496.01
Swift Parrot	3,269	92	2,672	15,495.43
Migratory Shorebirds	–	–	–	13,145

*Equates to the extent of the flight path buffer

Breeding and foraging habitat

There are 8 flying-fox camps included in the flying-fox camps and buffers as shown in Figure 16.4.

As of October 2022, 6 of the 8 flying-fox camps monitored were active. Full details on the activity and numbers of individuals recorded within each monitored camp are provided in Technical paper 5. While individual species of flying-fox were not identified, according to the National flying-fox monitoring viewer (DCCEEW, 2022b), these particular camps contain, or did contain Grey-headed Flying-fox and Black Flying-fox (not threatened) co-occurring, and numbers and proportion fluctuate over time.

Two of the camps monitored (Parramatta Park and Macquarie Fields Flying-fox camps) are classified as nationally important camps (DCCEEW, 2022b). These are defined as camps containing ‘greater than 10,000 Grey-headed Flying-foxes in more than a single year in the last 10 years or being occupied by more than 2,500 Grey-headed Flying-foxes permanently or seasonally every year for at least 10 years’ (Department of the Environment, 2015). These 2 camps occur outside the wildlife buffer.

Approximately 872,651 ha of Grey-headed Flying-fox foraging habitat has been mapped as occurring within the assessment zone, of which 46,434 ha occurs within the wildlife buffer, 232 ha occurs within the flying-fox camps and buffers and 68,540 ha has been mapped within the noise contours (NSW DPE, 2011).

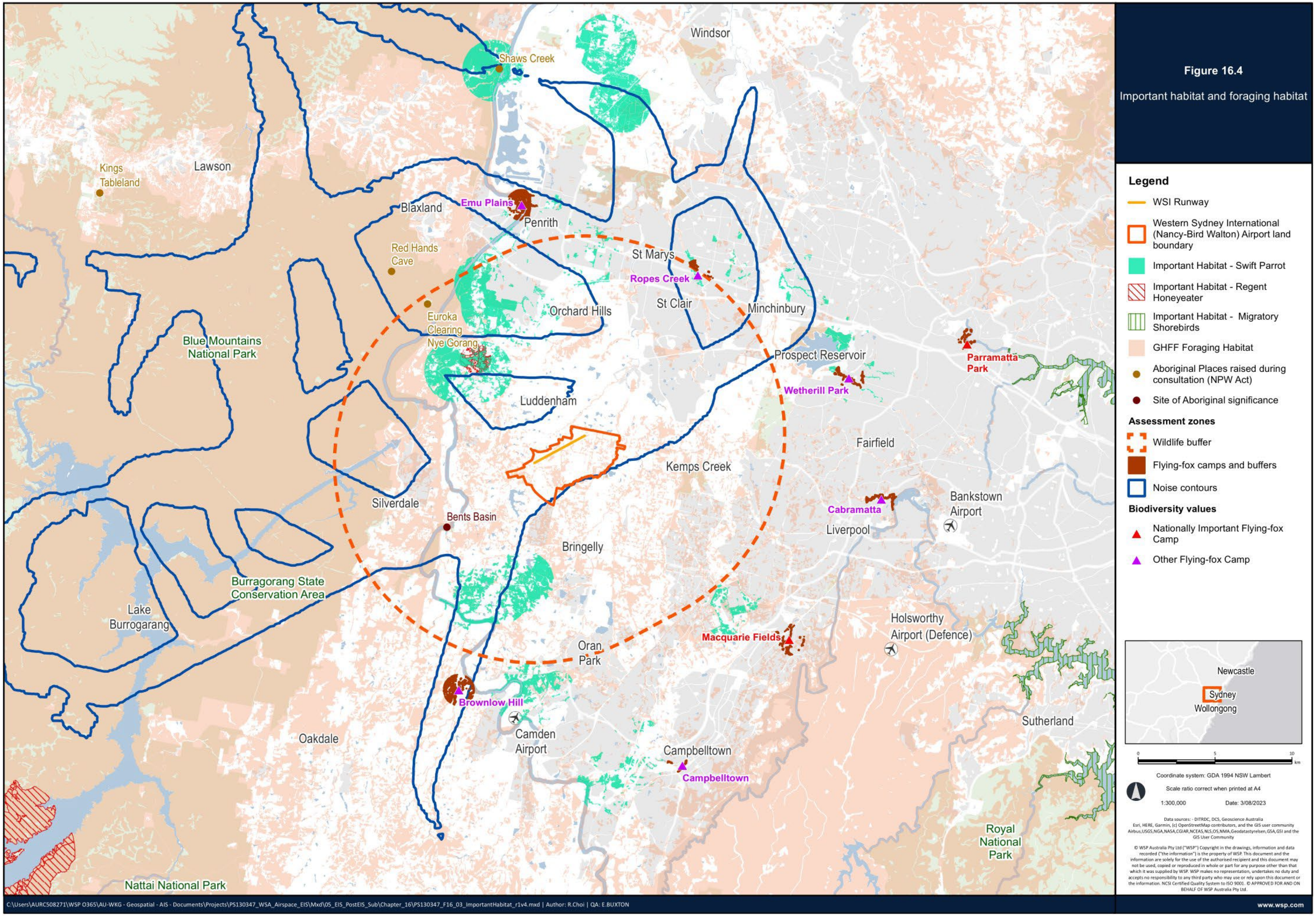


Figure 16.4

Important habitat and foraging habitat

16.5.2.4 Wetlands

Approximately 5,436 ha of coastal wetlands protected under the Resilience and Hazards SEPP occurs within the assessment zone, mapped as SEPP Coastal Wetlands (refer to Figure 16.5). Of this total, 3.70 ha occurs within the wildlife buffer, 7.15 ha occurs within the flying-fox camps and buffers and none occurs within the noise contours. These areas are likely to provide suitable roosting and foraging habitat for many MNES threatened and Migratory fauna species. No direct impacts to these areas would occur.

The PMST search (refer to Section 16.3.3.1) did not identify any Ramsar wetlands included on the List of Wetlands of International Importance developed under the Ramsar Convention as having potential to occur within or in proximity to the wildlife buffer. The closest Ramsar wetlands are the Towra Point Estuarine Wetlands, located 45 km to the east of the WSI runway, and at which point WSI aircraft would be in excess of 10,000 ft (3 km). These Ramsar wetlands are also directly across Botany Bay from Sydney (Kingsford Smith) Airport, whose operation is likely to affect the wetlands and associated species to a much greater degree than the operation of WSI (refer to Chapter 23 (Matters of National Environmental Significance)).

A wetland may be considered nationally important if it meets criteria agreed to by the ANZECC Wetlands Network in 1994, including being a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex (DAWE, 2021). These important wetlands are primarily located outside of the wildlife buffer and in the coastal regions of the assessment zone (refer to Figure 16.5 and Figure 5.2 of Technical paper 8).

16.5.2.5 Local and regional wildlife corridors

Wildlife corridors can be defined as ‘retained and/or restored systems of (linear) habitat which, at a minimum enhances connectivity of wildlife populations and may help them overcome the main consequences of habitat fragmentation’ (Wilson and Lindenmayer, 1995). Corridors can provide a range of ecological functions such as providing increased foraging areas for wide-ranging species, providing refuge from disturbances such as fire and reducing genetic isolation.

The functionality of wildlife corridors for different fauna (that is, the degree to which a corridor fulfils the abovementioned roles) will depend on a range of factors including dispersal behaviour, mode of movement (for example, flying, crawling, hopping, etc.), predation risk, and how these interact with landscape attributes (for example topography, vegetation cover and density) (Recher et al., 1987). In most cases this will differ between species, so that not all corridors will function equally well for all species. Inter-specific interactions, such as competition and/or predation, can also affect corridor function differently in different species (Catteral et al., 1991).

The wildlife buffer occurs within a generally open, highly degraded landscape comprised of agricultural pastures as well as land occupied by residential and urban development which is intersected by occasional patches of moderately to highly disturbed vegetation. The exception to this is along the western boundary of the wildlife buffer which intersects with the Great Dividing Range (along which the GBMA exists). This forms part of a large remnant tract of high condition vegetation that creates a large wildlife corridor providing connectivity with other remnants along the east coast and into central parts of NSW.

Key local and regional wildlife corridors which occur across the study area (refer to Figure 16.6) include:

- Biodiversity Investment Map (BIO Map) Cumberland Subregion Regional Corridors
- Cumberland Plain Priority Conservation Lands (Priority Conservation Lands).

Approximately 40,289 ha of BIO Map Cumberland Subregion Regional Corridors and 25,515 ha of Priority Conservation Lands occur within the assessment zone. These considerable areas are largely confined to linear areas of riparian remnant vegetation that intersect a landscape which is otherwise cleared and fragmented. Other patches of remnant vegetation within these corridors of the assessment zone include the large parcel at Defence Establishment Orchard Hills (refer to Section 16.5.2.6).

Figure 16.5

Wetland values

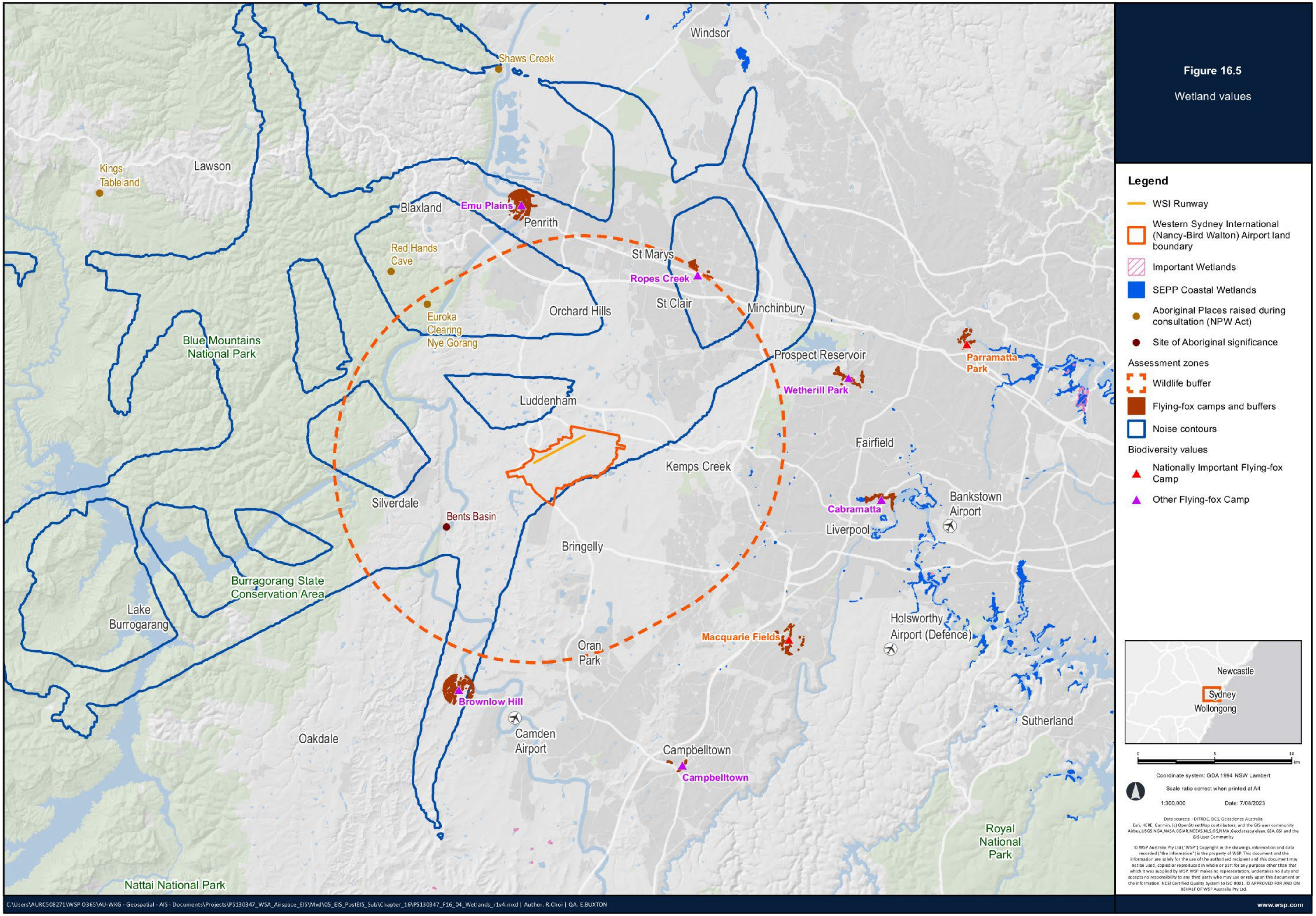
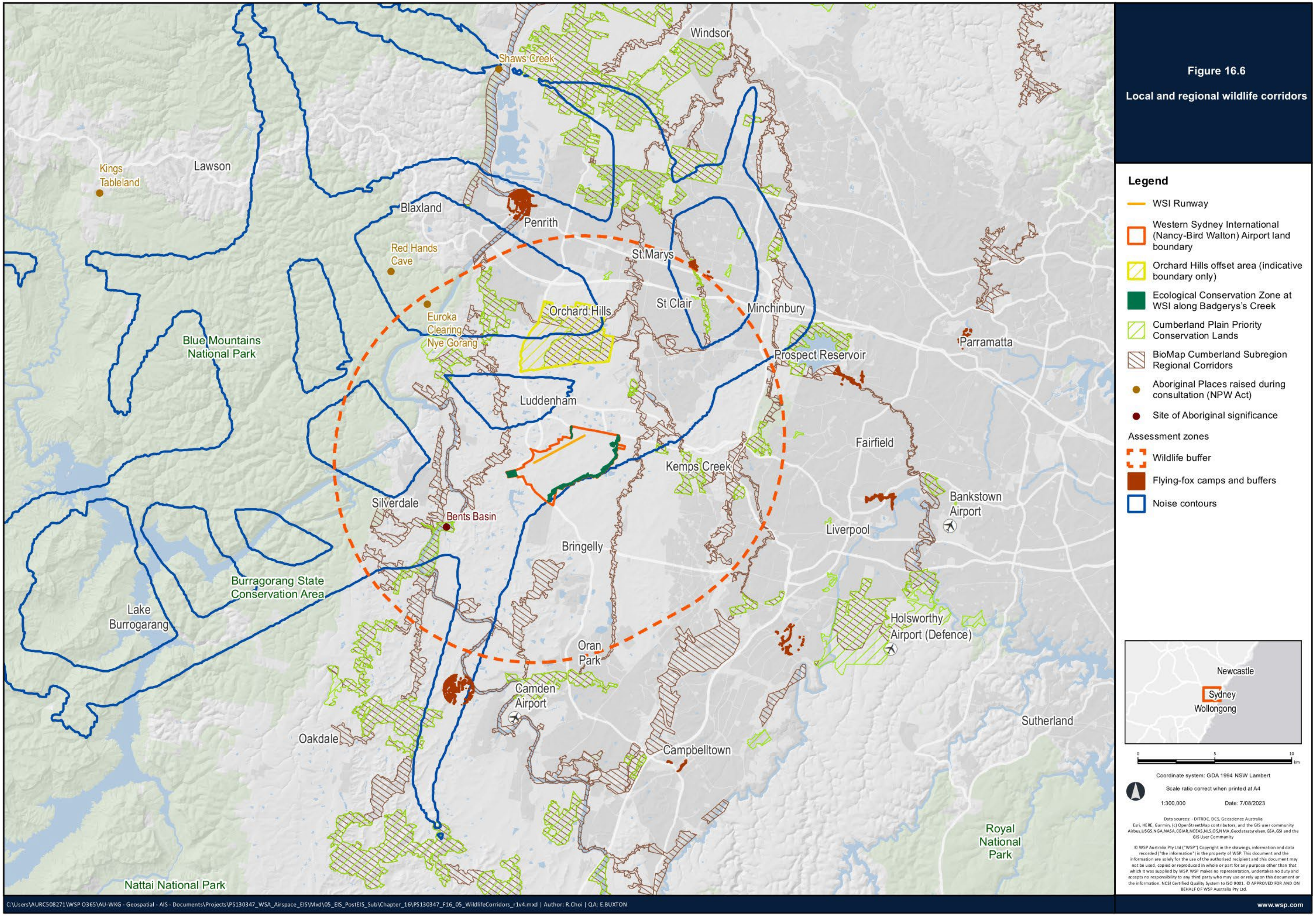


Figure 16.6

Local and regional wildlife corridors



16.5.2.6 Conservation initiatives

Two conservation initiatives that occurred as part of the Stage 1 Development were:

- Environmental Conservation Zone (ECZ) – consisting of 117 ha of retained native vegetation around the perimeter of the Airport Site to mitigate potential impacts on habitat fragmentation. This area will remain undeveloped and managed for biodiversity conservation through the Land Use Plan detailed in the Airport Plan. The ECZ includes large areas of Cumberland Plain Woodland and riparian habitats.
- Biodiversity Offset Delivery Plan – this includes approximately 979 ha of land at the Defence Establishment Orchard Hills set aside as a biodiversity offset to compensate for WSI's residual impacts on biodiversity on the ground. The site is being managed by the Department of Defence under a Memorandum of Understanding and in accordance with the Orchard Hills Offset Area Offset Plan (GHD, 2022).

These conservation initiatives occur within the wildlife buffer and their areas form part of local and regional wildlife corridors and values, as captured in Section 16.5.2.5.

16.5.2.7 Wildlife attractants

Wildlife attractants identified as potential risk contributors for the project include all biodiversity values and other land uses with potential to provide suitable habitat within a 13 km buffer of the runway in accordance with the ICAO guidelines (the wildlife buffer). Within the wildlife buffer there were 58 sites identified as mapped in Appendix E of Technical paper 5, including permanent basins, ponds, non-native ecosystems, waste management facilities and Ropes Creek Flying-fox camp.

Technical paper 5 also identifies 15 additional sites (greater than 13 km up to 30 km of the runway) that act as wildlife attractants based on wildlife present and capacity of the species utilising these sites to travel more than the 13 km to access foraging and roosting/breeding habitat. Among these are 7 Flying-fox camps, 2 Ibis colonies and Prospect Reservoir.

16.5.3 Nationally listed threatened species and ecological communities

16.5.3.1 Threatened ecological communities

The PMST search identified 15 threatened ecological communities listed under the EPBC Act that are known or predicted to occur within the wildlife buffer. Of these, 10 are considered to have a moderate to high likelihood of occurring based on the broadscale vegetation mapping (NSW DPE, 2022f) and likelihood of occurrence assessment (refer to Table 5.4 of Technical paper 8).

The project would not have any direct impacts on any of these communities in the wildlife buffer as the project is limited to the above airspaces (that is, no vegetation or habitats would be removed) and indirect impacts would be negligible. As such, these threatened ecological communities have not been considered further in this report because none are considered candidate communities requiring further assessment.

A further 20 EPBC Act listed threatened ecological communities were predicted to occur across the remainder of the assessment zone. Impacts on threatened ecological communities within the remainder of the assessment zone are expected to be negligible due to their location in relation to the preliminary flight paths and the altitudes at which aircraft would be. They were deemed to not require further assessment.

While the impacts to threatened ecological communities would be negligible, the assessment considers the impacts to fauna species (and their habitats).

16.5.3.2 Threatened fauna species

The database searches identified 92 threatened fauna species listed under the EPBC Act that are known or predicted to occur within the study area and wildlife buffer. Of these, 16 are considered to have a moderate to high likelihood of occurring or utilising the habitats available within the assessment zone and have been determined as candidate species requiring further assessment (refer to Table 16.7). An additional species, Red Knot*,* has been included as it has a high likelihood of occurring outside the wildlife buffer but within the assessment zone.

Table 16.7 Candidate EPBC Act listed threatened fauna species

Common name	Scientific name	EPBC Act Status	Likelihood of occurrence within assessment zone	Likelihood of occurrence within wildlife buffer
Alaskan Bar-tailed Godwit	*Limosa lapponica baueri*	Vulnerable	High	Moderate
Australian Painted Snipe	*Sternula nereis nereis*	Endangered	High	Moderate
Australasian Bittern	*Botaurus poiciloptilus*	Endangered	High	High
Curlew Sandpiper	*Calidiris ferruginea*	Critically Endangered	High	Moderate
Eastern Curlew	*Numenius madagascariensis*	Critically Endangered	High	Moderate
Eastern Hooded Plover	*Thinornis cucullatus cucullatus*	Vulnerable	High	Moderate
Gang Gang Cockatoo	*Callocephalon fimbriatum*	Endangered	High	Moderate
Greater Sand Plover	*Charadrius leschenaultii*	Vulnerable	High	Moderate
Great Knot	*Calidris tenuirostris*	Critically Endangered	High	Moderate
Grey-Headed Flying Fox	*Pteropus poliocephalus*	Vulnerable	High	High
Large-eared Pied Bat	*Chalinolobus dwyeri*	Vulnerable	High	High
Painted Honeyeater	*Grantiella picta*	Vulnerable	High	High
Red Knot	*Calidiris canutus*	Endangered	High	Low
Regent Honeyeater	*Anthochaera phrygia*	Critically Endangered	High	Moderate
South -eastern Glossy Black-Cockatoo	*Calyptorhynchus lathami lathami*	Vulnerable	High	Moderate
Swift Parrot	*Lathamus discolor*	Critically Endangered	High	Moderate
White -throated Needletail	*Hirundapus caudacutus*	Vulnerable	High	Moderate

A detailed description of these candidate threatened fauna species characteristics, and suitable and preferred habitat within the assessment zone under the EPBC Act is provided in Appendix B of Technical paper 8.

The preferred altitudinal range of select candidate species is provided in Section 16.5.4.

16.5.3.3 Threatened flora species

The database searches identified 46 threatened flora species listed under the EPBC Act that are known or predicted to occur within the wildlife buffer. Of these, 17 are considered to have a moderate to high likelihood of occurring and utilising habitats available (refer to Appendix B of Technical paper 8). Although these species are likely to occur within the wildlife buffer, none are considered to be candidate species requiring further assessment due to similar reasons to threatened ecological communities being excluded (refer to Section 16.5.3.1).

16.5.3.4 Migratory species

The desktop assessment identified 79 migratory species listed under the EPBC Act that are known or predicted to occur within the study area and wildlife buffer. Of these, 28 are considered to have a moderate to high likelihood of occurring or utilising the habitats available within the assessment zone and have been determined as candidate species requiring further assessment (refer to Table 16.8). An additional species, Red Knot, has been included as it has a high likelihood of occurring outside the wildlife buffer but within the study area.

Table 16.8 Candidate EPBC Act listed migratory species

Common name	Scientific name	EPBC Act status	Likelihood of occurrence in assessment zone	Likelihood of occurrence in wildlife buffer
Bar-tailed Godwit	*Limosa lapponica*	Migratory	High	Moderate
Black-faced Monarch	*Monarcha melanopsis*	Migratory	High	Moderate
Black-tailed Godwit	*Limosa limosa*	Migratory	High	Moderate
Caspian Tern	*Hydroprogne caspia*	Migratory	High	Moderate
Common Greenshank	*Tringa nebularia*	Migratory	High	Moderate
Common Sandpiper	*Actitis hypoleucos*	Migratory	High	Moderate
Curlew Sandpiper	*Calidiris ferruginea*	Migratory	High	Moderate
Double Banded Plover	*Charadrius bicinctus*	Migratory	High	Moderate
Eastern Curlew	*Numenius madagascariensis*	Migratory	High	Moderate
Fork-tailed Swift	*Apus pacificus*	Migratory	High	Moderate
Glossy Ibis	*Plegadis falcinellus*	Migratory	High	High
Great Knot	*Calidris tenuirostris*	Migratory	High	Moderate
Greater Sand Plover	*Charadrius leschenaultii*	Migratory	High	Moderate
Grey-tailed Tattler	*Tringa brevipes*	Migratory	High	Moderate
Gull-billed Tern	*Gelochelidon nilotica*	Migratory	High	Moderate
Lathams Snipe	*Gallinago hardwickii*	Migratory	High	Moderate
Little Curlew	*Numenius minutus*	Migratory	High	Moderate
Marsh Sandpiper	*Tringa stagnatilis*	Migratory	High	Moderate
Oriental Plover	*Charadrius veredus*	Migratory	High	Moderate

Common name	Scientific name	EPBC Act status	Likelihood of occurrence in assessment zone	Likelihood of occurrence in wildlife buffer
Osprey	*Pandion haliaetus*	Migratory	High	High
Pacific Golden Plover	*Pluvialis fulva*	Migratory	High	Moderate
Pectoral Sandpiper	*Calidiris melanotos*	Migratory	High	Moderate
Red Knot	*Calidiris canutus*	Migratory	High	Low
Red-necked Stint	*Calidiris ruficollis*	Migratory	High	Moderate
Rufous Fantail	*Rhipidura rufifrons*	Migratory	High	High
Satin Flycatcher	*Myiagra cyanoleuca*	Migratory	High	Moderate
Sharp-tailed Sandpiper	*Calidiris acuminata*	Migratory	High	High
White-throated Needletail	*Hirundapus caudacutus*	Migratory	High	Moderate
Wood Sandpiper	*Tringa glareola*	Migratory	High	Moderate

A detailed description of these candidate migratory species characteristics, suitable and preferred habitat within the assessment zone under the EPBC Act is provided in Appendix B of Technical paper 8.

The preferred altitudinal range of select migratory species is provided in Section 16.5.4.

16.5.4 Altitudinal range of fauna species

Chapter 7 (The project) presents the flight path figures which depict the altitude ranges of each WSI flight path during the day and night. The altitude range was used to determine species with potential to be impacted by wildlife strike within and outside of the wildlife buffer.

The aircraft altitudinal ranges can be categorised as:

- 0 to 1,000 ft (0 to 300 m) AGL: take-off and wheels up (96 per cent of flying-fox strikes recorded at or below 1,000 ft (300 m) AGL (Parsons et al. 2008))
- >1,000 to 3,500 ft AGL (>300 to 1 km): initial ascent (3,500 ft (1 km) AGL is the height at which 93 per cent of strikes occur at or below (Dolbeer, 2011)) – species could include Fork-tailed Swift
- >3,500 to 10,000 ft (> 1 km to 3 km) AGL: final ascent to cruising altitude – thermalling species such as Australian Pelican and Wedge-tailed Eagle
- >10,000 to 20,000 ft (>3 km to 6 km) AGL: cruising and maximum altitude.

The altitude figures show that aircraft take off and ascend relatively quickly in the scale of the assessment zone and that aircraft take-off and ascend primarily within the wildlife buffer and the immediately adjoining environs.

16.6 Assessment of impacts

16.6.1 Direct impacts

Direct impacts of the project are limited to wildlife strike on biodiversity values as summarised in Table 16.9 and described in Section 16.3.3.5. This impact is discussed in this section and detailed in Technical paper 5.

Table 16.9 Impact summary – direct

Impact	Nature	Term of impact	Extent of impact	Likelihood	Impact severity	Impact rating
Wildlife strike	Direct – intermittent	Ongoing	Known, unpredictable/ irreversible	Possible	Minor	Low/not significant

16.6.1.1 Overview

Wildlife strike potential and risk are directly linked to the habitat values present within the vicinity of the WSI which would attract species to the location, such as for roosting and foraging opportunities (refer to Section 16.5.2.7). Within the wildlife buffer, these would include several waterbodies and the Elizabeth Drive Resource Recovery Facility (approximately 2 km to the north-east of the runway). In the future, the Western Sydney Aerotropolis would also increase tree canopy cover to 40 per cent, enhance riparian zones and wetlands and generally increase biodiversity values across the area which will further attract wildlife.

Technical paper 5 identified that the species with the highest overall risk of being impacted by wildlife strike are common (not listed under the EPBC Act) mammal and bird species such as Eastern Grey Kangaroos and waterfowl. The assessment does however identify one threatened (Grey-headed Flying-fox) and one Migratory (Glossy Ibis) species as having potential to be affected. Additional threatened and migratory species considered to have a moderate to high likelihood of occurrence are summarised in Section 16.5.3.2 and Section 16.5.3.4.

Flying-foxes

As a group, Flying-foxes are particularly susceptible to wildlife strike due to their large body mass and their tendency to fly out from camps in large groups which increases the risk of multi-strike events. The highest risk for flying-foxes is being struck when enroute to and from foraging and roosting sites within the locality of WSI.

Around 96 per cent of flying-fox collisions occur below 1,000 ft AGL (300 m) , with most strikes occurring below 500 ft AGL (150 m) (Parsons et al. 2008). Further, flying-foxes were reported as being the most struck fauna species group at Australian airports between 2008 and 2017 (1,240 strikes nationally) (ATSB, 2019). This indicates that these species have a higher risk of wildlife strike within the flight paths of airports.

As of October 2022, airside (on-airport) surveys conducted for Technical paper 5 recorded no flying-foxes using WSI airspace as part of the 4 field survey sessions completed (in July, August, September and October 2022). These surveys were completed during early morning, middle of the day, late afternoon, and post-dusk over a single day at 15 survey points within the Airport Site.

However, survey limitations (4 surveys over 4 months using human observation from static locations) mean the use of WSI airspace by Flying-foxes cannot be excluded as Flying-foxes (likely comprised of Grey-headed Flying-fox and other non-threatened Flying-foxes) were observed in the fly-out surveys (off-airport) from the Flying-fox camps and buffers. Due to this, existing available information relating to impacts to Flying-foxes from other airports in the Sydney Basin have been used to assess the impacts of the project on these species.

The impacts of the project on the Flying-fox behaviour, reproduction and nutritional status and the overall population is difficult to predict without long term baseline studies of movement and foraging ecology. Past strike data from Sydney (Kingsford Smith) Airport and Bankstown Airport, which are surrounded by similar foraging and roosting habitats, can be used to provide an indication of future WSI wildlife strike impacts.

Technical paper 5 details that over the past 5 years around 75 Flying-foxes (including an estimated 13 Grey-headed Flying-foxes listed as Vulnerable under the EPBC Act) have been struck by aircraft arriving and departing from the Sydney (Kingsford Smith) Airport. This averages out to around 15 Flying-foxes (including 2–3 Grey-headed Flying-fox) strikes a year. Comparatively, at Bankstown Airport 2 Flying-foxes have been recorded as being struck over the past 5 years, and none of these were identified as Grey-headed Flying-foxes. There is high potential that additional Grey-headed Flying-fox strike at Sydney (Kingsford Smith) Airport occurs amongst the data for unidentified Flying-foxes, however the overall strike rate is still relatively low compared to overall populations of Flying-foxes in these areas.

Aircraft wildlife strike typically results in the mortality of a Flying-fox. For species that disperse in flocks, such as the Grey-headed Flying-fox, there is the rare occasion when more than one individual may be hit. Based on past strike data however it has been observed that these events are still limited to only a couple of individuals being hit.

The limited use of WSI airspace by Flying-foxes observed to date and the low mortality rate of the species at other Sydney-based airports indicate that while wildlife strike impacts are likely to be possible, the impact would be low/not significant.

Ibis species

Ibis species include the Straw-necked Ibis, Australian White Ibis and the Glossy Ibis, the latter of which is listed as a migratory species under the EPBC Act and assessed under Section 16.7.1.

As with Flying-foxes, Ibis species are particularly susceptible to wildlife strike due to their large body mass, their tendency to fly out from areas of suitable habitat in large groups and suitable habitat being in aircraft movement areas. These areas include the key foraging and roosting sites for Australian White Ibis within the locality of the WSI runway (refer to Section 16.5.2.7).

Technical paper 5 identified the Australian White Ibis and Straw-necked Ibis as having a high risk of wildlife strike as surveys conducted for that paper recorded high numbers of Australian White Ibis and Straw-necked Ibis transitioning through the WSI airspace representing the 2 most observed species during the diurnal (day-time) airside (on-airport) surveys.

These Ibis species have historically been recorded to be less susceptible to aircraft strike than Flying-foxes (ATSB, 2019). The low mortality rate at other Sydney based airports indicate that while wildlife strike impacts to these species are likely to be possible, the impact would low/not significant.

Additional species

While some other native or introduced species are likely to be struck on occasion by aircraft (for example, Eastern Grey Kangaroo, microchiropteran bats, waterfowl or raptors), these impacts would be minimised by implementing the recommended mitigation measures proposed in Technical paper 5. Land use controls and requirements have also been set in the SEPP Western Sydney Parklands and associated DCP for the Aerotropolis, which would assist in managing the risk of wildlife strike (refer to Section 16.8).

Wildlife strikes above 3,500 ft AGL (1 km) can occur with thermalling species such as Australian Pelican and Wedge-tailed Eagle, however according to Technical paper 5 the frequency of high-altitude strikes is comparatively low. It is estimated that approximately 7 per cent of wildlife strikes occur above this altitude (Dolbeer, 2011). This suggests that wildlife strike would be largely limited to the wildlife buffer however it is possible that it may occasionally occur to thermalling species within the greater assessment zone. This impact, however, would be low.

Impacts are unlikely to be of a magnitude that would threaten the viability of local populations of any species.

16.6.2 Indirect impacts

Indirect impacts are summarised in Table 16.10 most impacts associated with the project would be minor or negligible in severity.

Table 16.10 Impact summary – indirect

Impact	Nature	Term of impact	Extent of impact	Likelihood	Impact severity	Impact rating
Noise	Indirect – intermittent/ continuous	Ongoing	Known – nocturnal and diurnal periods	Possible	Minor	Low/ not significant
Light spill and pollution	Indirect – intermittent	Ongoing	Known – limited to nocturnal hours only	Possible	Negligible	Negligible/ not significant
Air quality	Indirect – intermittent/ continuous	Ongoing	Known – nocturnal and diurnal periods	Possible	Negligible	Negligible/ not significant
Water quality	Indirect – intermittent/ continuous	Ongoing	Known – nocturnal and diurnal periods	Possible	Negligible	Negligible/ not significant
Fuel jettisoning	Indirect – intermittent/ rare	Temporary	Unpredictable however scarce in occurrence (limited to emergency situations) and localised	Unlikely	Negligible	Negligible/ not significant

16.6.2.1 Aircraft noise

Alterations to existing noise levels would occur during the operation of the project's flight paths. The nature of noise and potential noise impacts on the environment are described in Chapter 11 (Aircraft noise) as supported by Technical paper 1. A literature review of the effects of noise impacts on wildlife is provided in Section 16.3.3.5, expanded on in this section and detailed by Technical paper 5.

Key impacts of noise on wildlife that have been observed include (Ecosure, 2021):

- behavioural changes such as avoidance of areas affected by noise
- communication interference such as hindering of signals
- physiological impacts such as elevated levels of stress hormones that may affect breeding
- hearing loss.

Existing ambient noise levels within vicinity of the Airport Site would be influenced by surrounding land uses including roads, agriculture and other aircraft operating in the airspace within the locality (refer to Chapter 11 (Aircraft noise)). As such, the biodiversity values in the region are already subject to current low to moderate levels of ambient anthropogenic noise. Literature suggests that some species are susceptible to disturbance from noise and will become habituated to the change over time while others less tolerant may be displaced as a result of the constant aircraft noise (refer to Section 7.4.1 of Technical paper 5). It is likely that species present have already become habituated to current levels of aircraft noise and some species may have already relocated into adjacent habitat due to vegetation clearing associated with Stage 1 Development.

WSI would operate 24-hours a day, 7 days a week. It therefore has potential to impact both diurnal and nocturnal species. Noise would be generated by aircraft arriving and taking-off, ascending and cruising at various altitudes along the WSI flight paths. The periods of noise are also highly predictable, with a sudden peak when aircraft arrive and depart (Mato and Mufuruki, 1999). Research by Pepper et al. (2003) indicates that the most important consideration with regard to aircraft noise and wildlife is proximity to WSI (where the highest noise impacts are) and frequency of overflights.

Wildlife previously exposed to noise may be less affected than those who have not, and the time it takes for wildlife to adapt to noise is species-specific. Therefore, species considered most likely to be impacted by the project's aircraft noise would be those that occur or utilise habitats in proximity to the Airport Site and those less tolerant of changes to noise.

Most of the habitats within the locality of the Airport Site have been heavily modified and fragmented. Most of the remnant vegetation that remains occur as linear patches of vegetation along riparian areas that form corridors to adjoining larger remnants. The exception to this is to the west where the subject site encroaches on the GBMA. Given this, the key biodiversity values likely to be affected by aircraft noise include but are not limited to:

- Wildlife corridors – noise from the project would not cause significant indirect impacts to wildlife corridors. The value of these habitats would remain, and the wildlife corridors would continue to function so that fauna species are able to disperse between remnants throughout the region.
- Orchard Hills Offset Area would be directly overflown at an altitude of approximately 3,500 to 5,000 ft (1 to 1.5 km) AGL, experiencing noise levels of around 70–80 dB(A) (the sound of a washing machine or the sound of a hair dryer respectively) in a single event. The overflight will only occur during nocturnal hours when Runway 05 is in operation. The impact from noise would have minor impacts on species that utilise habitats within this area because these species are likely to adapt to changes in noise levels given the site is already located in an area subject to aircraft overflight and is surrounded by highly disturbed areas with poorer habitat.
- Important habitat for Regent Honeyeater and Swift Parrot (refer to Table 16.6) – although there is no research on the impacts of noise on these species, these types of birds (blossom specialists) may be impacted by aircraft noise (refer to literature in Technical paper 8). Despite impacts being possible, impacts would be low as both species have been recorded using modified habitats within urban areas subject to anthropogenic noise and no habitat would be directly removed by the project. Aircraft would be too high (typically be above 1,500 ft (0.5 km) AGL for the Swift Parrot and above 8,000 ft (2.4 km) AGL for the Regent Honeyeater) at locations where flight paths intersect areas of mapped important habitat for these species to affect them. At this altitude the noise level would equate to approximately 60–80 dB(A) (the noise of a normal conversation at 1 m or the sound of a hair dryer respectively) but in a single event rather than as a constant change.
- Flying-fox camps and foraging resources – these species are likely to show resistance to noise disturbance as they have adapted well to urban environments (Coffey, 2014). Aircraft would typically fly at altitudes of greater than 3,000 ft (0.9 km) AGL equating to approximately 70 dB(A) (the sound of a washing machine) in a single event over Flying-fox camps. Although noise may have minor impacts on the species, they are considered likely to continue using foraging habitats present within the locality (refer to Section 16.5.2.3) based on their presence in proximity to other airports throughout the Sydney Basin and tolerance of urban environments.
- Protected wetland habitats – these habitats occur surrounding heavily populated areas which would be subject to substantial existing anthropogenic noise levels. Further, most flight paths do not pass over these areas except for those which typically exceed 8,000 ft (2.4 km) AGL equating to approximately 60 dB(A) (normal conversation at 1 m) in single-event – where noise levels are unlikely to impact fauna within these habitats.
- Suitable habitat for numerous native animal species including urban adapted species (for example Australian Magpie), waterfowl species, and raptors (for example White-bellied Sea-eagle) – noise from the project would have minor impacts on habitats that support urban adapted species and waterfowl as these species have demonstrated their ability to adapt to changes in noise levels. This is supported by Pepper et al. 2003, who collated literature which identified waterfowl spent less than 1.4 per cent of their time responding to aircraft.
- Raptors such as White-bellied Sea-eagle and Little Eagle may abandon nest sites near WSI and relocate and breed in neighbouring areas. These impacts are likely to be localised and concentrated to areas immediately adjacent the Airport Site based on research by Pepper et al. (2003) which found that raptors have been shown to be non-responsive to aircraft when greater than 500 m away.

- Commonwealth Heritage Places – the Orchard Hills Cumberland Plain Woodland and Shale Woodland Llandilo Commonwealth Heritage Places occur within the flight path buffers of the project. Potential noise Impacts on the Orchard Hills Cumberland Plain Woodland would be consistent with those described above for the Orchard Hills Offset Area. The Shale Woodland Llandilo Commonwealth Heritage Place is located outside the wildlife buffer but within the flight path buffer and will be directly overflown at an altitude of approximately 7,000 to 8,000 ft (2.1 km to 2.4 km) AGL, experiencing noise levels of around 60 dB(A) in a single event (or a normal conversation at 1 m). No direct impacts would occur on the vegetation and associated habitats present and therefore wildlife connectivity values of the site would remain and continue to function. Similar to the Orchard Hills Offset Area, species present are likely to adapt to changes in noise levels and continue using habitats present given the site is already located in an area subject to existing flight paths and is surrounded by highly disturbed areas with poorer habitat. Given this, impacts are likely to be low on Commonwealth Heritage Places.

This assessment is detailed in Section 7.4.1 of Technical paper 8.

Literature suggests that fauna species are likely to show varying responses to these impacts between species and individuals within populations (refer to Section 16.3.4). The noise generated by the aircraft may affect less-tolerant species which may relocate or be disrupted in response to the operation of the WSI. More noise tolerant species may also be initially affected by increases in noise however are likely to become habituated over time and continue to use habitats within the assessment zones. The predicted noise levels are unlikely to result in changes at magnitudes that would threaten the viability of local populations of any species. Further assessment of impacts on these MNES and the environment is provided in the SIAs (Appendix C of Technical paper 8).

16.6.2.2 Light spill and pollution

Natural light conditions act as a stimulus that influence the behaviour and physiology of organisms (Blackwell et al. 2015). Artificial light, including sources associated with the project such as aircraft light, can have adverse impacts on wildlife. The key impacts associated with light spill are behavioural changes that may be critical for a species life cycle for example migration or breeding. Physiological changes such as delays in reproduction or feeding patterns may occur in response to changes in light levels (DEE, 2020; Ecosure, 2021). These changes can lead to some species being more vulnerable to predation, wildlife strike via disorientation or other disturbances.

Light from the project would be limited to lights on aircraft as they travel along the flight paths outside daylight hours. Technical paper 7 concluded that the magnitude of visual impacts at night (including light spill) would be experienced across a small portion of the urban area and would not contrast substantially with the surrounding landscape at night, resulting in a low magnitude of change. Nocturnal species such as possums and bats may avoid the habitat in the wildlife buffer during these periods. The severity of this impact would be negligible given the high level of light pollution already present in the locality and surrounds which has likely led to biodiversity being somewhat habituated to periodic light disturbance from human activity. Formal research is yet to confirm light impacts on blossom specialists (including the Grey-headed Flying-fox), however based on their predicted behavioural response to artificial light and their ability to camp in areas drenched in artificial light the species is considered to be a light tolerant species (DAWE, 2021).

Within the intrinsically dark landscapes, aircraft may be viewed occasionally from these locations as a series of small moving lights in the sky. For example, Murphys Glen campground (a location within the GBMA) would be overflown by one arrival flight path, including up to about 6 and 27 flights per night in total in 2033 and 2055 respectively. Aircraft along this flight path are likely to be at higher altitudes. Fauna in these areas would currently experience minimal existing light and could be sensitive to changes in light. However, noting the potential level of impact (i.e. a series of small moving lights in the sky), the severity of change and impact has been assessed as being negligible in response to the project.

In summary, even though there may be a slight increase in light in the sky in these intrinsically dark landscapes, biodiversity is unlikely to be significantly affected by the project’s operational light impacts.

16.6.2.3 Air quality

Aircraft operating along the flight paths would produce emissions that could result in local and regional reductions in air quality. The most critical aircraft emission pollutants include oxides of nitrogen (NO_x) due to the transformation into nitrogen dioxide (NO_2) and ozone (O_3), and $PM_{2.5}$.

In terms of local air quality, Technical paper 2 found that elevated NO_2 levels are predicted to occur in 2055 and elevated levels would primarily occur to the north-west of the Airport Site aligning with the runway. The assessment however uses conservative assumptions, and actual NO_2 impacts are unlikely to be significant. The project's impact on the concentrations of all other assessed pollutants would be negligible (noting there are exceedances for $PM_{2.5}$ but these have no tangible impact). As it is likely there will be improvements in fuel efficiency (for aircraft and motor vehicles) and decreases in aircraft emissions in the future, no significant impacts on air quality are anticipated to arise.

Technical paper 2 found the regional air quality results aligned with those of local air quality for NO_2 in 2055 with any discernible increases NO_2 generally limited to a radius of approximately 5–6 kilometres of the Airport Site (primarily attributable to aircraft near or at ground level, during take-off and landing). For all other pollutants the impact of emissions from the project on the existing pollutant concentrations would be negligible and would be unlikely to be discernible above background concentrations.

The results also indicate that in the locations with the maximum ozone concentrations, the project makes no significant difference to the impact that would arise in any case without the project in 2055.

Habitats for wildlife in proximity to the Airport Site are already highly disturbed and likely to be subject to similar emission types associated with urban development and other aircraft. Any alterations to air quality would be temporary, localised and unlikely to impact biodiversity values. Ecosystems in the region would not be directly impacted upon and impacts are unlikely to result in a long-term decline that would threaten the viability of any of these ecosystems.

16.6.2.4 Water quality

Aircraft pollutants are comprised of vapours, gases, and fine particles which are not expected to deposit to the ground. Despite this, there has been concerns raised relating to the deposition of these pollutants and the potential for them to impact on water quality and subsequently aquatic ecosystems including those contained within the Orchard Hills Cumberland Plain Woodland Commonwealth Heritage Place which provide habitat for disturbance-sensitive macroinvertebrate species such as stoneflies, leptophlebiid mayflies and pollution-sensitive caddisflies.

Technical paper 12 estimated the deposition rates of the key pollutants relevant to project and their potential impacts on water quality using a highly conservative approach. It identified that aircraft pollutants likely to be generated are dominated by PM2.5 which essentially act like a gas in the atmosphere with little or no deposition. Due to this, it is expected that the deposition of pollutants to the ground are highly unlikely to ever occur. Technical paper 12 identified that the project's potential impacts on water quality would be negligible and so low that they would not be measurable.

Based on the results of Technical paper 12, aquatic habitats within proximity to the Airport Site (such as those within the Orchard Hills Cumberland Plain Woodland Commonwealth Heritage Place) are considered to be negligible and unlikely to impact on aquatic biodiversity values.

16.6.2.5 Fuel jettisoning

Fuel jettisoning (also known as fuel dumping) is discussed in Chapter 13 (Aircraft hazard and risk) and Technical paper 4. This procedure may introduce harmful contaminants into the sensitive environments within the study area such as native terrestrial and aquatic ecosystems, if not appropriately managed. If required, fuel jettisoning can be carried out safely and without any impacts at ground level when appropriate procedures are followed. Fuel jettisoning would occur in accordance with the AIP ENR (Airservices Australia, 2022a). Given the strict regulations associated with its implementation and the high evaporation rate of the fuel at high altitudes potential impacts would be negligible and unlikely to have an immediate or future impact on biodiversity values identified in this assessment.

16.6.3 International agreements, recovery plans and threat abatement plans relating to biodiversity protection

16.6.3.1 International agreements

Australia has international obligations for EPBC listed fauna (refer to Section 16.2.1), including those under the Apia Convention and the CITES. Australia's obligations for EPBC migratory fauna are described in Section 16.6.4.

The Apia Convention safeguards the creation of protected areas, making a commitment not to alter national parks, maintain lists of indigenous flora and fauna in danger of extinction and provide these species with protection. The project is consistent with this agreement because:

- national parks in the study area, including those such as the Ku-ring-gai Chase National Park, Royal National Park and the various National Parks that make up the GBMA (refer to Figure 16.1) would not be significantly altered by the project. Refer to Section 16.5.2.1 and Chapter 23 (Matters of National Environmental Significance)
- relevant recovery and threat abatement plans for candidate species are aligned to the Apia Convention
- in accordance with the agreement, there are no known protected areas within the wildlife buffer which may lead to detrimental impacts on candidate species. Where a management plan is in place for these species, such as under the Wildlife Conservation Plan for Migratory Shorebirds (Commonwealth of Australia, 2015a), this would be aligned with the objectives of the Apia Convention
- the project is unlikely to result in any direct conflicts to any species conservation advice, and this advice is consistent with the Apia Convention.

16.6.3.2 CITES

CITES is an international agreement between governments that aims to ensure that the international trade in wildlife does not threaten wild populations of plants and animals. As the project does not involve international trade in wildlife and would not breach the CITES agreement signed by Australia in 1976, it has not been considered further in this assessment.

16.6.3.3 Recovery and threat abatement plans

Australia has National recovery plans (recovery plans) and threat abatement plans for the protection of certain species, made and adopted under the EPBC Act:

- recovery plans set out the research and management actions necessary to stop the decline of, and support the recovery of, listed threatened species or threatened ecological communities
- threat abatement plans provide for the research, management, and any other actions necessary to reduce the impact of a listed key threatening process on native species and ecological communities.

The assessment found that of the 17 candidate species, 6 were associated with either a recovery plan or threat abatement plan – the Australasian Bittern, Grey-headed Flying-fox, Painted Honeyeater, Regent Honeyeater, Swift Parrot and Large-eared Pied-Bat. The project is consistent with prescribed national recovery plans and threat abatement plans for candidate species because:

- the project would not conflict with the recovery actions outlined in the relevant national recovery plans
- the project would not lead to a change in the pre-existing distribution and density of any species covered by relevant threat abatement plans and therefore, would not be inconsistent with the management details outlined in the plans.

Full details are provided in Table 7.3 of Technical paper 8.

For the remaining species:

- there are no prescribed threat abatement plans and recovery plans are not relevant for the Alaskan Bar-tailed Godwit, Australian painted Snipe, Eastern Curlew, Gang-gang Cockatoo, Great Knot or Greater Sand Plover
- there are no prescribed threat abatement plans and a recovery plan is not required for the Curlew Sandpiper, Eastern Hooded Plover, Red Knot, and White-throated Needletail. There is deemed to be sufficient conservation advice to implement priority actions and mitigate against key threats
- for one species, the South-eastern Glossy Black-Cockatoo, a recovery plan is required, but has not yet been completed and/or published (as at the time of preparation of this document).

16.6.4 International agreements protecting migratory species

Australia's migratory bird agreements are listed in Section 16.2.1 and include the bilateral CAMBA, JAMBA and ROKAMBA. These agreements provide for the protection and conservation of migratory birds and their important habitats, protection from take or trade except under limited circumstances, the exchange of information, and building cooperative relationships. Details of the objectives of these agreements are provided in section 6.7 of Technical paper 8.

In addition to the bilateral migratory bird agreements, Australia has also agreed to the following multilateral agreements:

- Bonn Convention
- Ramsar Convention.

The East Asian – Australasian Flyway Partnership is a Ramsar Convention initiative which forms a voluntary collaboration of effort focusing on protecting migratory waterbirds, their habitat and the livelihoods of people dependent on them. Its objectives align with those objectives cited in the separate bilateral agreements (CAMBA, JAMBA, ROKAMBA, Bonn Convention and Ramsar Convention)

Section 7.6 of Technical paper 8 includes an assessment against the East Asian – Australasian Flyway Partnership and found the project does not raise inconsistencies with Australia's obligations under the migratory bird agreements when taking key objectives of this partnership into consideration.

16.6.5 Bushfire impacts

The 'Black Summer' bushfires of spring and summer 2019-2020 were catastrophic and unprecedented, having large impacts on the biodiversity within the GBMA (around 80 per cent burnt) and surrounds. Impacts of the fires were largely due to the drought, fire and shortage of food, shelter and water following the fire event (Smith, 2021).

The Department of Planning Industry and Environment (DPIE) (NSW DPIE, 2020) used fire extent and severity mapping to assess the status of ecological condition, carry capacity and persistence of ecosystems across NSW postfire compared to their initial assessment in 2013 as part of the NSW Biodiversity Outlook Report. The analysis identified that in fire affected areas:

- both ecological condition and ecological carrying capacity had decreased by 39 per cent since 2013 which reflects the immediate post-fire effects on vegetation condition. Regeneration and growth in subsequent years will be captured as part of future assessments by the NSW Government
- ecological persistence had decreased by 4 per cent since 2013 which reflects the loss of unique diversity which may increase in a post-fire environment.

According to the 2020 DPIE fire extent and severity mapping, approximately 2,184,952 ha of vegetation within the assessment zone was affected by the Black Summer bushfires in 2019-2020. Of this around 532,427 ha occurs within the GBMA.

Fauna species within areas subject to the 2019-2020 bushfires may have relocated or dispersed into similar neighbouring habitat within the wildlife and Flying-fox buffers. As the bushfire affected areas recover and habitats regenerate, these species would likely redisperse back into the burnt areas.

In considering the above and the nature of the project's impacts it is considered unlikely that the project would compound impacts on biodiversity associated with the 2019-2020 bushfires. As there would be no direct on-ground impacts, direct impacts would largely be limited to occasional wildlife strike and indirect impacts would be negligible to low, it is unlikely that the project would affect immediate or long-term post-fire recovery within these areas.

16.7 Significant impact assessments

In accordance with Significant impact guidelines 1.1, SIAs were completed for all biodiversity MNES known to occur or considered to have a moderate or higher likelihood of occurring in the assessment zone and to be impacted upon by the project as described in Section 16.3.3.2. A SIA was also completed for impacts on the whole of the environment, specifically biodiversity (plants and animals) in accordance with Significant impact guidelines 1.2.

The outcomes of the SIAs are summarised below and provided in full in Appendix C of Technical paper 8.

16.7.1 Threatened and migratory species

The SIAs completed for the 41 threatened and migratory candidate species (13 threatened, 24 migratory, 4 both threatened and migratory) concluded that the project is unlikely to have a significant impact on threatened or migratory species listed under the EPBC Act as:

- potential direct impacts would be restricted to occasional wildlife strike, no vegetation or associated habitats would require removal. This impact would be low, and largely limited to airspaces within the wildlife buffer
- indirect impacts are unlikely to result in the loss or significant modification of habitats or populations as:
  - potential noise impacts are unlikely to result in changes that would alter fauna species behaviour or use of habitats available
  - potential changes in light spill and pollution, air quality and water quality, are likely to be negligible.

Given the extent of potential impacts and biodiversity values within the region already being exposed to varying degrees of these impacts the project is unlikely to lead to a long-term reduction in the size of a population, reduce the area of occupancy of a population or adversely affect critical habitat to a species. Nor would the project fragment a population in 2, disrupt the breeding cycle of a population, introduce invasive species or pathogens that may cause a species to decline, impact on habitat to the extent that it would cause a species to decline, or significantly interfere with recovery plans actions.

16.7.2 National heritage and Commonwealth heritage places

The National Heritage place determined to be of particular relevance to the project is the GBWA and this is assessed in Chapter 23 (Matters of National Environmental Significance).

The Commonwealth Heritage Places determined to be of particular relevance to the project are the Orchard Hills Cumberland Plain Woodland and Shale Woodland Llandilo (refer to Section 16.5.2.1).

For both of these properties there is unlikely to be a significant impact on the biodiversity attributes as:

- there would be no direct impact on the biodiversity attributes
- indirect impacts are unlikely to result in the loss or significant modification of biological diversity or biological process within these properties as:
  - potential wildlife strike impacts on fauna are only likely to be minor, infrequent, rare and limited to a small number of bird species which occur at altitudes greater than 1,000 ft (300 m) AGL
  - potential noise impacts are unlikely to result in changes that would alter fauna species behaviour or use of habitats available
  - potential changes in air quality and water quality are likely to be negligible.

This is consistent with the evaluation of impacts to GBWA and the whole of the environment.

In support of the protection of values of Orchard Hills Cumberland Plain Woodland Commonwealth Heritage Place is the Biodiversity Offset Delivery Plan (refer to Section 16.5.2.6).

16.7.3 Impacts on plants, animals and their habitat

The significance impact assessment on plants and animals identified that there is unlikely to be a significant impact on native plant or animal species as:

- direct impacts would be the same as for biodiversity MNES (refer to Section 16.7.1)
- air quality and water quality impacts are likely to be negligible and the project would not involve controlled burning activities that could harm native plants or animals
- given the extent and nature of potential impacts and similar impacts already existing within the study area to varying degrees, the project is unlikely to lead to a long-term decrease in or threaten the viability of a native plant or animal species population, displace or substantially limit the movement of a species, lead to the introduction of invasive species or reduce or fragment available habitat.

16.8 Mitigation and management

This section provides information on proposed safeguards and mitigation measures to deal with the relevant impacts of the project on biodiversity. A key aspect of managing biodiversity is through the application of the 'avoid, minimise, mitigate and offset' hierarchy as follows:

- avoid and minimise impacts on biodiversity as a priority
- mitigate impacts where avoidance or minimization is not feasible or practicable given the circumstance
- offset where residual impacts are unavoidable in accordance with the relevant offset guidelines.

A description of how this hierarchy has been applied to the project is provided below.

16.8.1 Avoid and minimise

The development of the preliminary flight path design is described in Chapter 6 (Project development and alternatives). This included the avoidance and minimisation of impacts to biodiversity through:

- early consideration of environmental constraints in the planning phase, including the GBMA and associated sensitive receptors/wilderness areas, as input into the initial concept design options
- implementation of wildlife hazard safeguards prior to and during the operation of the project such as the *Western Sydney Aerotropolis Development Control Plan 2* (NSW DPE, 2022g).

Not all potential impacts associated with the project could be reasonably avoided or minimised due to the nature and extent of the project, other airport flight paths requirements and the design specifications required to safely operate aircraft associated with the WSI.

16.8.2 Project specific mitigation measures

16.8.2.1 Existing management

Technical paper 5 provides existing mitigation measures in relation to wildlife management. These include off-airport requirements to mitigate wildlife strike risk for aircraft operating in and out of WSI in land use planning instruments, along with recommendations and guidelines detailed in NASF Guideline C.

Of key importance is the implementation of monitoring programs which underpin all wildlife hazard mitigation and airport safeguarding. Robust standardised monitoring programs that regularly collect meaningful data will inform decisions relating to wildlife management programs, identify emerging risks, and determine wildlife activity trends over time.

As impacts to wildlife strikes and management of wildlife buffers have been considered in Chapter 13 (Aircraft hazard and risk) and Chapter 14 (Land use) respectively, there are no other project specific mitigations related to biodiversity. The key measures identified as part of these chapters are summarised in Section 16.8.2.2.

16.8.2.2 Dependencies and interactions with other mitigation measures

Mitigation measures outlined elsewhere throughout the EIS are relevant to the minimisation and management of biodiversity impacts. These relate to:

- Chapter 13 (Aircraft hazard and risk), specifically those to manage potential wildlife strike impacts – including the requirement to:
  - continue to liaise with planning authorities on matters related to the development of, or modifications to, off-airport land uses that have the potential to attract hazardous numbers or types of wildlife
  - establish a WSI Wildlife Hazard Management Committee that will contribute to the preparation of regional species management programs.

  These measures are supported by a proposed bird and bat monitoring program to monitor for the presence of wildlife on the WSI site and in vicinity of WSI in accordance with Civil Aviation Safety Regulations (CASR) Part 139 Manual of Standards (MOS) requirements and NASF Guideline C.
- Chapter 14 (Land use), specifically those related to wildlife buffers – including the requirement to:
  - liaise with State and local government agencies to establish mechanisms that will identify land uses and prevent the creation of land uses that would cause hazardous wildlife attraction within the wildlife buffers
  - negotiate with State and local government agencies and land owners if required on agreed action plans for monitoring and, where necessary, reducing wildlife attraction to areas in the vicinity of WSI.

16.8.3 Biodiversity offsets

The EPBC Act Offset Policy states that for '*assessments under the EPBC Act, offsets are only required if residual impacts are significant*' or '*could reasonably be avoided or mitigated*.'

The outcomes of the impact assessment in Section 16.6 and SIAs in Section 16.7 confirmed that the project is not likely to have a significant impact on biodiversity values or on the broader environment, specifically plants, animals and their habitat.

A description on how the project has avoided and minimised impacts to biodiversity values is provided in Sections 16.4 and 16.8. Biodiversity offsets in the form of 2 conservation initiatives (totalling approximately 1,096 ha) also occurred as part of the Stage 1 Development, as described in Section 16.5.2.6.

Residual impacts associated with the project would include occasional aircraft strike and alterations to existing noise, light, air and water quality values. These cannot be avoided or minimised due to the nature and extent of the project, other airport flight path requirements and design specifications required to safely operate aircraft associated with the WSI.

As the project is not likely to have significant impacts the project is not obligated to provide offsets in accordance with the EPBC Act Offsets Policy.

The biodiversity offsets already provided for the Stage 1 Development are considered to be adequate for all components of WSI.

Overall, the project is not likely to have significant impacts (residual or otherwise).

Chapter 17 Heritage

This chapter describes the assessment that has been undertaken to evaluate the Aboriginal and historic heritage impacts of the project. While this assessment has informed the Greater Blue Mountains Area (GBMA) assessment, the full assessment for the GBMA is located in Chapter 23 (Matters of National Environmental Significance).

The assessment has been informed by desktop assessments alongside engagement with First Nations knowledge holders and stakeholders. Heritage sites and places considered have been identified through statutory lists compiled under Commonwealth and New South Wales (NSW) State legislation.

The refinements to the preliminary flight path design since the exhibition of the Draft EIS would not change the conclusions of the overall heritage assessment as presented in this chapter and supporting technical paper. However, the refinements would result in increased aircraft altitudes or reduced aircraft movements at night in Linden and Falconbridge when the refined flight paths or the RRO-NAP are in operation. This would provide some visual and noise amenity improvement at night for heritage sites located in Linden and Falconbridge, such as the emu rock engraving site at Ticehurst Park and the Linden Ridge sites. Further detail is provided in Section G2.9 of Appendix G (Assessment of the refinements to the project) of the EIS.

Existing environment

There are a significant number of items, places and areas within the heritage study area, with around 13,500 Aboriginal heritage sites/places and around 19,000 listed historical sites/areas. For Aboriginal heritage, this is likely to be an underestimate given the lack of systematic survey for sites within protected areas (such as the GBMA). As such, engagement with First Nations knowledge holders and stakeholders has assisted in identifying areas of particular high cultural value. For historic heritage, there are several World Heritage Areas (notably the GBMA), 19 National Heritage items, and numerous State and local heritage items. Of these places, most occur at a distance greater than 10 kilometres (km) from WSI.

Key findings

The preliminary flight paths would fly over a large number of significant sites and places, however in many cases existing flight paths already traverse the airspace above these sites and places. Many types of heritage places are also considered robust in the face of impacts such as air pollution, noise and visual impacts. In most cases aircraft would be at such a distance as to render the impact from these factors as minimal. However, the places closest to WSI are likely to experience higher impacts.

Aboriginal heritage

There is general acknowledgement that air pollution is likely to be detrimental to sandstone heritage buildings and Aboriginal rock art, however there has been little direct research on sites within or close to Sydney. It is impossible to evaluate the risk presented by these processes, or indeed to identify and quantify any resulting damage due to a lack of previous research and comparative data, as well as the difficulty in differentiating aircraft emission derived deterioration from other anthropogenic pollution sources via the same processes (such as acidity, nutrients and dust). However, there remains a potential impact that increased emissions to these environments may potentially result in some impact, though the likelihood of this is considered to be generally minimal.

The project would not physically impact or restrict use of an Aboriginal heritage site or place. However, it is acknowledged that noise and visual intrusion are factors that could potentially impact cultural values. In particular, noise does have the potential to disrupt cultural practices at a site, which could lead to its use being discontinued. Aircraft on WSI flight paths could potentially result in detrimental indirect impacts to the cultural values of sites connected to the Emu in the Sky constellation at Faulconbridge and Emu Cave Aboriginal Place.

Due to the position of flight paths, frequency of overflight and the predicted noise levels, the project would significantly impact the Aboriginal cultural values of Bents Basin, Linden Ridge sites and the Shaws Creek – Yellomundee Aboriginal Place, which are places of cultural importance with values associated with peace, tranquillity and connection to nature. Impacts to other key sites of cultural significance identified through engagement would have low to moderate impacts due to noise and/or visual intrusion.

Mitigation measures have been developed that require DITRDCA to ensure that the detailed design phase for flight paths considers Aboriginal places and values, where safe and feasible. There is the likelihood that many other Aboriginal sites are located in protected valleys within the GBMA that are overflown by WSI aircraft. Due to the complexity of terrain height and orientation of rock shelters in the rugged sandstone country, it is not possible to predict to what extent this will be an issue for many of the unknown sites.

Other mitigation measures include undertaking a research program to investigate the potential impact of aircraft emissions on Aboriginal heritage sites, and establishment of a Community Aviation Consultation Group (CACG) for WSI which will facilitate consultation with stakeholders and community on a range of matters including heritage matters.

Historic heritage

Many historic properties are located in town centres. The flight path design principles seek to avoid population centres and the flight paths design has sought to protect such places from significant impacts, although in some cases aircraft may still be visible in the distance or would be heard. It is inevitable that some properties would suffer some impact from noise, given that in many cases to the west and south-west of WSI the properties are located in rural contexts. This includes items within the towns of Mulgoa, Luddenham and Wallacia, noting that Luddenham is not directly overflown by the preliminary flight paths. Impacts to these items would depend on the lateral distance to the flight path corridor, aircraft altitude, aircraft noise impacts and the type of heritage values for which the items are listed.

Outside the GBMA, there is no discernible impact on the cultural values of nationally listed places. Of the 89 places on the Commonwealth Heritage list, only 2 are within close proximity to WSI and/or are likely to be adversely impacted by the flight paths; Orchard Hills Cumberland Plain Woodland, and Shale Woodland Llandilo.

At greater distances from WSI, noise and visibility of aircraft begins to diminish, and emissions are likely to disperse and be less concentrated. However, some cultural values remain sensitive to additional aircraft noise, while the frequency of flights can exacerbate this. This applies to the GBMA and those heritage places within it that are valued for their serenity and their ability to connect people to the spirituality of nature.

17.1 Introduction

This chapter considers the potential impacts of the project on Aboriginal and historic (non-Aboriginal) heritage. As the project would not directly impact heritage values, this assessment considers the potential for the project to negatively indirectly impact heritage values and/or cultural practices (e.g., due to noise). It also considers the potential for the project to physically exacerbate conservation issues that could result in a loss of value (due to air quality changes). The assessment has been informed by desktop assessments alongside engagement with First Nations knowledge holders and stakeholders.

The full assessment is provided in Technical paper 9: Heritage (Navin Officer Heritage Consultants Pty Ltd) (Technical paper 9).

17.2 Legislative and policy context

The heritage impact assessment was undertaken to address the EIS Guidelines and with reference to the following legislation, guidelines, strategies or standards:

- *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act). The EPBC Act provides the legal framework for the protection and management of nationally and internationally important heritage places, including World Heritage properties. It also establishes:
  - the National Heritage List, which lists Indigenous, historic and natural heritage places of outstanding significance to Australia
  - the Commonwealth Heritage List, which lists Indigenous, historic and natural heritage places owned or controlled by the Australian Government.
- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth). This Act can protect areas and objects that are of particular significance to Aboriginal and/or Torres Strait Islander people. The Australian Minister for the Environment and Water also has powers under this Act to protect an area, object or class of objects that have been identified as being of particular significance and is under threat of injury or desecration.
- *National Parks and Wildlife Act 1974* (NSW) (the NPW Act). This Act provides the legal framework for the protection of Aboriginal cultural objects and places in NSW. All Aboriginal sites are protected in NSW whether they are known or not. The Act also provides for the declaration of Aboriginal Places, which are places of special significance with respect to Aboriginal culture. For the purposes of this assessment, Aboriginal Places are considered as places of demonstrable high cultural value to NSW First Nations people.
- *Heritage Act 1977* (NSW). This Act provides for the listing and protection of items of State heritage significance, as well as relics (archaeological items of local or state heritage significance) and for NSW Government agencies and State Owned Corporations to maintain a register of heritage assets (known as Section 170 heritage and conservation register).
- Local Environmental Plans (LEPs) that apply to local government areas within the study area. LEPs provide for the listing and protection of items of local heritage significance.
- *Australian National Heritage Strategy 2015* (Commonwealth of Australia, 2015b). This strategy applies to the identification, protection and management of heritage places across all jurisdictions.
- *Engage Early – Guidance for proponents on best practice Indigenous engagement for environmental assessments under the EPBC Act* (Department of the Environment, 2016). This guideline has been applied to the engagement completed for the project with First Nations knowledge holders and stakeholders.
- *Ask First: A guide to respecting Indigenous heritage places and values* (Australian Heritage Commission, 2002). This guideline has applied to the engagement completed for the project with First Nations knowledge holders and stakeholders. It complements the Burra Charter.
- Airservices Australia's Environmental management of changes to Aircraft Operations Standard (AA-NOS-ENV2.100) (Airservices Australia, 2022b).
- *The Burra Charter: The Australian ICOMOS charter for places of cultural significance* (Australia ICOMOS, 2013) (the Burra Charter). The Burra Charter and its associated practice notes provide best practice standards for managing cultural places in Australia. The Burra Charter has been adopted by the Australian Government, NSW Government and most local governments.

17.3 Methodology

17.3.1 Study area

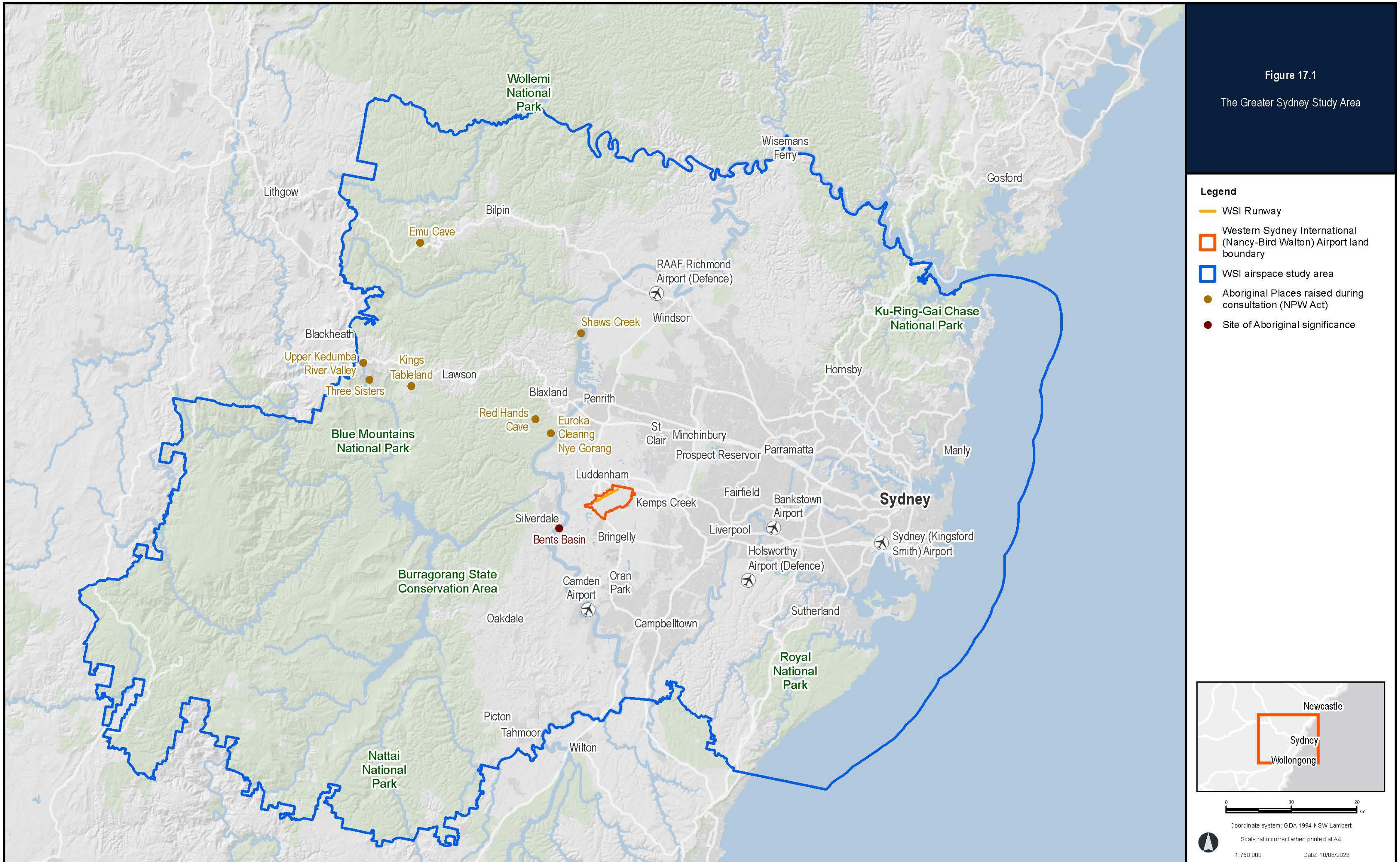
The heritage study area (study area) for the assessment is shown in Figure 17.1. The boundaries broadly defining this area are:

- north – the Hawkesbury River in the vicinity of Pitt Town, Wilberforce and East Kurrajong
- north-east – the NSW coast in the vicinity of Palm Beach and Barrenjoey Headland
- east – the NSW coastline where aircraft on WSI flight paths operate at altitudes generally above aircraft from other Sydney Basin airports
- south-east and south – the Bargo River in the vicinity of Tahmoor
- south-west, north-west and west – the western boundary of the Greater Blue Mountains Area (as listed on the World Heritage List and National Heritage List).

When flying at altitudes above 10,000 feet (ft) (3 km), it is unlikely that aircraft noise levels heard on the ground would be above 60 dB(A). Nevertheless, there is potential for aircraft overflights to result in environmental effects between 10,000–20,000 ft in altitude above ground level (AGL). Aircraft could be audible and/or visible beyond these notional study area boundaries. Due to low ambient noise levels during night-time hours or in rural (residential) communities or non-residential areas under some flight paths, aircraft noise is likely to be noticeable and, combined with visual contact, could be a source of annoyance for some people. For this reason, the assessment considers the potential of such impacts to determine their materiality to the assessment.

Figure 17.1

The Greater Sydney Study Area



Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

17.3.2 Approach

The heritage impact assessment methodology generally involved:

- review of existing information in relation to Aboriginal and historic cultural heritage values within the study area to identify areas of high cultural value, including:
  - previous cultural heritage studies undertaken for WSI
  - previous cultural heritage studies related to the GBMA
  - selected heritage assessments and heritage values studies within the study area
  - existing databases such as the National Heritage List, Commonwealth Heritage List, State Heritage Register, State Heritage Inventory, Aboriginal Heritage and Information Management System (AHIMS) and National Trust (NSW) database to identify places with significant cultural values
  - local government area wide heritage studies
- engagement with First Nations knowledge holders and stakeholders to understand cultural values, the places associated within them and concerns about the potential impacts of the project. Direct engagement was focused on individuals and organisations amongst the Aboriginal Nations that are closest to the Airport Site, being the Dharug, Tharawal and Gundungurra nations (which is the equivalent of the combined lands of the Deerubbin, Gandangara and Tharawal Local Aboriginal Land Councils (LALCs)). This included:
  - Traditional Owners, Native Title claimants or Indigenous land use agreement parties
  - individual knowledge holders recognised as native title claimants with cultural heritage knowledge
  - knowledge holders (descended from other Nations, but who have lived in the area a long time and who have the cultural authority to speak)
  - Individuals recognised as holding cultural heritage knowledge from previous studies and who are accepted by at least one of the organisations listed below
  - LALCs – Deerubbin, Gandangara, Tharawal, Metropolitan and La Perouse LALCs
  - Local Government Advisory committees
  - other organisations – Murru Mittigar, Darug Tribal Aboriginal Corporation, Darug Custodian Aboriginal Corporation, Dharug Ngurra Aboriginal Corporation, Western Sydney Aboriginal Regional Alliance, Tharawal Aboriginal Corporation, Cubbitch Barta, Gundungurra Tribal Council Aboriginal Corporation, Gundungurra Aboriginal Heritage Association, and Blue Mountains Aboriginal Culture and Resource Centre.
- consideration of issues raised during engagement activities completed for the project, as well as engagement with heritage officers at the NSW Department of Planning and Environment (Environment and Heritage Group) concerning any relevant cultural values
- analysis of the results of the desktop assessment and engagement outcomes to identify:
  - places of high cultural value
  - risks to places of high cultural value and/or cultural practices (including perceived impacts) as a result of the project

  Sites of archaeological value were not carried forward for assessment as these would not be indirectly impacted by the project
- assessment of potential impacts with a focus on items located in areas that are more likely to be overflown by aircraft at lower altitudes, and/or places where cultural values might be more vulnerable to impacts due to air, noise and visual changes resulting from the project. For historic heritage, this was defined as an area within 10 kilometres (km) of the Airport Site. For Aboriginal heritage, this was defined as sites of cultural value (rock art sites, stone arrangements, burials, massacre sites, dreaming or spiritual sites, and places of contemporary use) within the boundaries of Deerubbin, Gandangara and Tharawal LALCs.
- identification of mitigation and/or management measures to address potential heritage impacts.

Chapter 9 (Community and stakeholder engagement) and Section 3.1.3 of Technical paper 9 provides further detail on the engagement activities completed for the heritage impact assessment and the project.

17.3.2.1 Significance assessment

Assessing impact on cultural values is somewhat easier when dealing with physical impacts that can be measured and seen. However, when considering intangible values, such as spirituality, wellbeing, connectedness with nature, a more qualitative approach is needed. A consideration of impact must consider what the tipping point might be in determining whether or not a place remains suitable for or can sustain the cultural practices and belief systems that are associated with that place.

For the purpose of this assessment the following terms have been used to describe the potential impacts:

- **Negligible to low** – an impact on the cultural value of a place is considered negligible to low where those impacts will not cause physical damage and are unlikely to affect the cultural practices undertaken at a place.
- **Moderate** – an impact is considered moderate where it may have an impact on the values of the place, or the cultural practices carried out at the place but where these impacts may be tolerated or mitigated in some way.
- **Severe** – an impact is considered severe where it would damage or compromise the values of the place or heritage item and/or render the cultural practices associated with the place no longer practical or possible.

For the purposes of this assessment a predicted noise level of 70 dB(A) and above is classed as a severe impact, particularly where those heritage places were otherwise located in a tranquil rural or bushland location. The N70 contour is typically used to assess day-time noise impacts. Other factors that may affect the severity of noise related impact relate to the frequency of flights (and therefore frequency of disturbance) and whether or not flights occur at night when background noise in rural areas is at its lowest. The assessment also took into consideration the predicted maximum noise levels (including those below 70 dB(A)) as well as other factors in addition to noise, such as visual intrusion.

17.3.3 Dependencies and interactions with other study areas

Technical paper 9 was informed by other technical papers as outlined in Table 17.1.

Table 17.1 Dependencies and interactions with other Technical Papers

Technical paper	Relevance
Technical paper 1: Aircraft noise	This assessment was used to understand the likely impact to cultural values caused by noise related to the preliminary flight paths.
Technical paper 2: Air quality	This assessment was used to understand the likely impact to cultural values caused by emissions related to aircraft using the preliminary flight paths.
Technical paper 4: Hazard and risk	This assessment was used to understand the likely incidence and potential impact to cultural values caused by fuel jettisoning related to aircraft using the preliminary flight paths.
Technical paper 10: Social	This heritage assessment was used to inform Technical paper 10.
Technical paper 11: Economic	This assessment provided context regarding the dependency between heritage values and the local economic drivers.
Technical paper 14: Greater Blue Mountains World Heritage Area	This heritage assessment was used to inform Technical paper 14.

17.3.4 Assumptions and limitations

Assumptions and limitations for the assessment are outlined in Table 17.2.

Table 17.2 Assumptions and limitations

Area	Assumptions and limitations
Engagement	Not all knowledge holders and stakeholders identified were available for interview within the project time frame. To address this, multiple opportunities were provided to the First Nation knowledge holders to connect with the study team and to provide input (see Technical paper 9 for details on the First Nations engagement). Multiple opportunities for engagement were provided to individuals regarding opportunities to meet and have input. Over the course of the project in excess of 120 phone calls, emails, virtual meetings and face to face meetings with First Nations people and organisations were held. Following the release of the online Aircraft Overflight Noise Tool, an online briefing of First Nations people was held and a demonstration of the tool was provided. Further contact was made following the release of the Draft EIS, providing information on the exhibition period, how the Draft EIS could be viewed and how submissions could be made.
Listing of heritage places	The process of identifying and assessing heritage places for listing on the National Heritage List, Commonwealth Heritage List, State Heritage Register and LEPs should result in all cultural values being identified and robustly substantiated. This depends on the quality and depth of the documentation and thoroughness of the original nomination dossier. Listings are also rarely updated.
Rock art sites	It should be assumed that the number of rock art sites overflown across the sandstone topographies of the GBMA are likely to be much greater than indicated by the current database of known sites. However, the distances to the nearest rock art sites from WSI (across the Cumberland Plain shale topographies) are likely to be accurate given the absence of suitable sandstone exposures for rock art in these areas.

17.4 Existing environment

17.4.1 Known heritage sites and places

There are a significant number of listed heritage sites within the study area (refer to Table 17.3), however the majority of these listed historic (non-Aboriginal) heritage items are located over 10 km from the Airport Site. Some items are listed on multiple registers.

Table 17.3 Listed heritage items within the study area

Nationally listed place	Number of items within study area	Items within 10 km of the Airport Site
World heritage	3	1
National heritage	19	1
Commonwealth heritage	89	1
State heritage	273	10
Local heritage	>18,800	63
Gazetted Aboriginal Places	21	0
Aboriginal sites (registered on AHIMS)	>13,500	3 culturally significant site types (note there are around 870 sites – mainly artefact scatters)

17.4.1.1 World Heritage sites

The 3 World Heritage sites located within the study area are:

- GBMA, located within 8 km of the Airport Site
- Sydney Opera House, located around 43 km to the east of the Airport Site
- The Australian Convict Sites, of which 4 of the 11 complementary sites are located within the study area (being the Old Government House and Domain (Parramatta), the Old Great North Road (Wiseman's Ferry), Cockatoo Island Convict Site and Hyde Park Barracks). The closest site is around 20 km to the north-east of the Airport Site.

As outlined in Chapter 23 (Matters of National Environmental Significance), the GBMA has been listed for its natural values. The Statement of Integrity for the listing recognises the conservation of the natural beauty of the area alongside the Aboriginal cultural associations with the area and the physical evidence of this connection. Aboriginal sites and values within this area is discussed further in Section 17.4.1.4.

The boundary of the GBMA excludes the existing townships and settlements, and the majority of the recorded significant historical heritage places lie outside the GBMA. However, there are also historic heritage places, many of which have not been formally recorded on lists and registers, which have cultural values. These include places connected with the early conservation movement in Australia such as the early network of cliff face walking tracks linking the east-west chain of Blue Mountains towns to their adjacent protected valleys and gorges, staircases and lookouts.

Given the size of the GBMA and the many hundreds of known Aboriginal and historic heritage places plus the understanding that there will be hundreds of others that exist but have not been recorded, this assessment does not claim to have assessed impacts on each site individually. Instead, this assessment has focused on understanding what sort of impacts flight paths could possibly have on heritage values of the range of heritage places that occur. These potential impacts are discussed in detail in Technical paper 9. Some types of heritage items are likely to be robust in the face of those impacts. For example, the heritage values of Aboriginal stone artefact scatters are unlikely to be impacted by the flight paths, unless those places also hold other values; whereas Aboriginal rock art sites often have a spiritual value and sometimes a ceremonial value that might be affected by noise, visual intrusion and/or physically by emissions.

Similarly historic heritage places range from places of memory and commemoration to heritage gardens and physical buildings some of which may be susceptible to emissions and some of which may not. While heritage items may be subjected to increased noise, they may or may not have current or proposed compatible uses that are sensitive to noise impacts.

A values-based approach is consistent with the Burra Charter (Australia ICOMOS, 2013).

Cultural significance means aesthetic, historic, scientific, social or spiritual value for past, present or future generations. Cultural significance is embodied in the place itself, its fabric, setting, use, associations, meanings, records, related places and related objects. (Article 1.2).

Flight paths for the project do not fly directly over the Sydney Opera House or the Australia Convict Sites located within the study area. As such, these sites are not considered further in the assessment.

17.4.1.2 National and Commonwealth heritage items

Of the 19 National Heritage items within the study area, 16 are located over 40 km from the Airport Site. The closest items to the Airport Site are the GBMA, Old Government House and Domain (Parramatta), and the Parramatta Female Factory and Institutions.

Items on the Commonwealth Heritage List are places owned or controlled by the Commonwealth and are typically places that reflect Australia's development as a nation (such as places connected to defence, maritime, communications and customs). Items include indigenous, historic and natural heritage places. The majority of Commonwealth heritage items within the study area are located within eastern Sydney. The closest listed item is the Orchard Hills Cumberland Plain Woodland, located around 4 km to the north of the Airport Site.

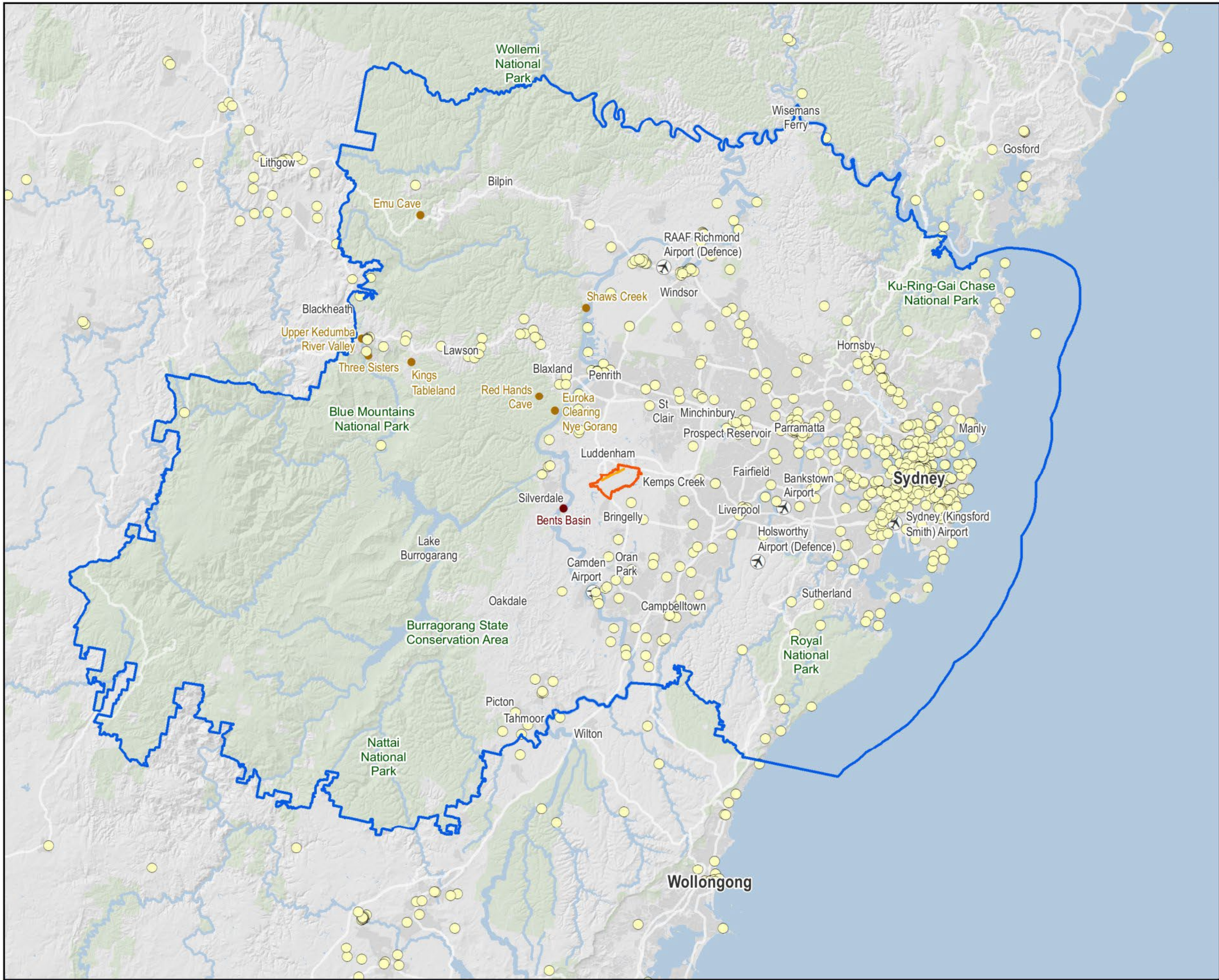
17.4.1.3 State and local heritage items

The NSW State Heritage Register currently has 273 records of heritage places located within the study area for WSI, and 72 heritage items are located under the preliminary flight paths. The majority of State heritage listed items are located in the eastern areas of the study area (refer to Figure 17.2). The closest item (Kelvin, a historic rural estate) is located around 2 km to the south-east of the Airport Site. Within the Blue Mountains local government area (LGA), there are 28 State heritage items. These items include (but are not limited to) residences (and associated gardens), infrastructure (bridges, historic roads, railway stations and dams), an art gallery, bush walking tracks, educational establishments and places of worship. Some of these sites are now used for other purposes – such as accommodation, retail and museums purposes. Further information is provided in Section 4.1.4 of Technical paper 9.

More than 18,800 local heritage items are located within the study area (refer to Figure 17.3). Locally listed heritage places are significant within the context of a local area, contributing to the uniqueness of a streetscape, townscape or landscape of a region or community.

Figure 17.2

State Heritage Register Places



Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- WSI study area boundary
- State Heritage Register places
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal

0 10 20 km

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:750,000 Date: 29/06/2023

Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

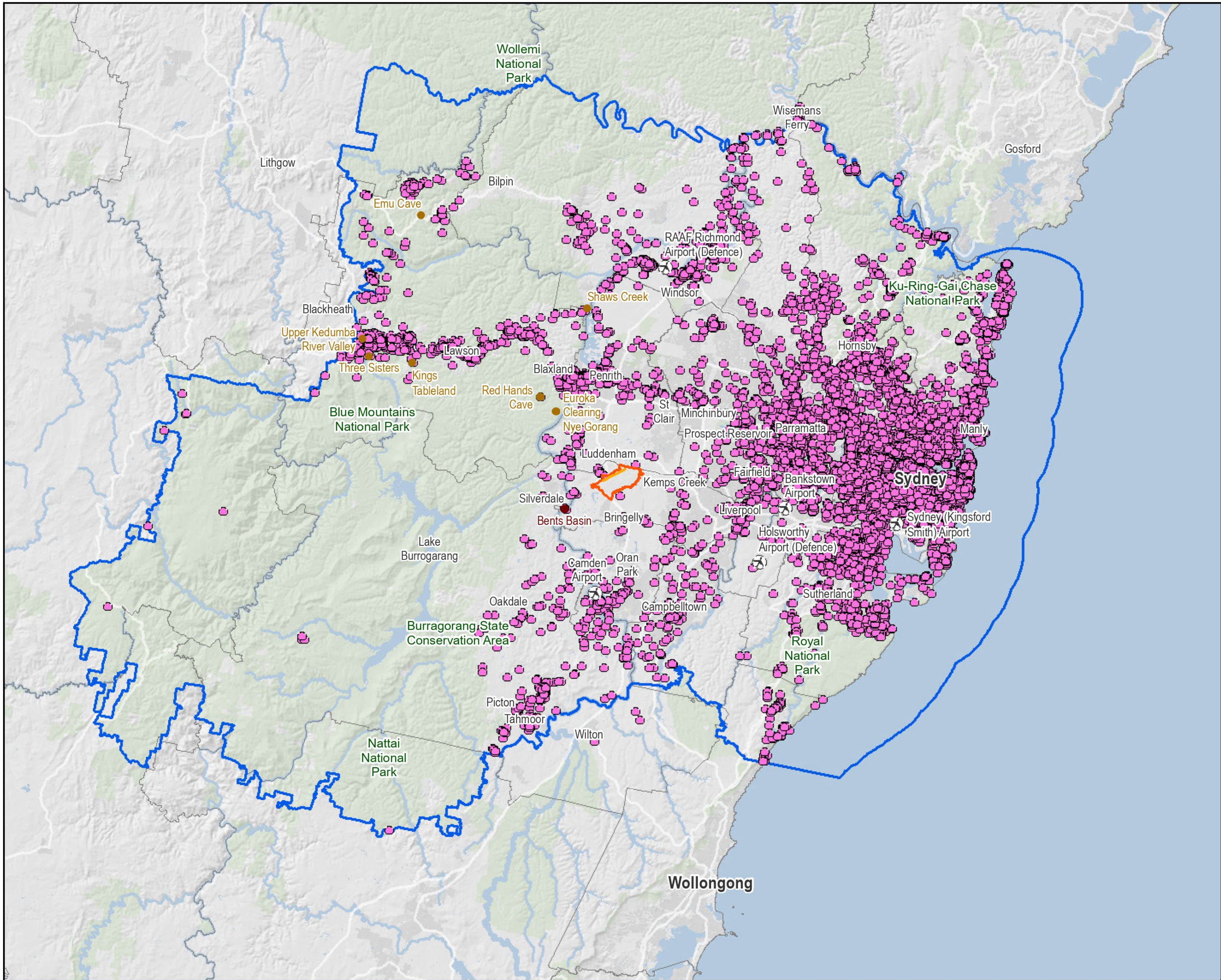


Figure 17.3

LEP Registered Items within WSI Airspace Study Area

Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- WSI study area boundary
- NSW LGA boundaries
- Locally significant heritage items
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

0 10 20 km

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:750,000 Date: 13/08/2024

Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

17.4.1.4 Aboriginal sites and gazetted Aboriginal Places

There are more than 13,500 sites recorded on AHIMS, which is a database maintained by the NSW Department of Planning and Environment. However, this database only has sites recorded through archaeological survey with concentrations of recorded sites in areas subject to urban or infrastructure development. It is likely that additional, unrecorded sites are present where surveys have not occurred. Many recorded sites have also since been destroyed and/or subject to archaeological salvage.

The majority of sites recorded on AHIMS comprise artefact scatters and isolated finds. Shell middens occur along the coastal area and occasional burial sites have been recorded. The Sydney Basin is surrounded on 3 sides by national parks which largely coincide with the distribution of Hawkesbury Sandstone. Areas associated with Hawkesbury Sandstone are known to contain a wide range of Aboriginal sites given the combination of food, fresh water and shelter (such as rock shelters) resources in these areas. These areas were also relatively undesirable by Europeans and provided refuge for First Nations people in the early years of European settlement.

The distribution of recorded rock art (pigmented and/or engraved) also coincides with sandstone-based topographies that support open sandstone platforms and overhangs. The closest rock art sites are located around 11 km to the west and south-west of the Airport Site. The distribution of rock art sites within areas up to 64 km of the Airport Site is shown in Figure 17.4.

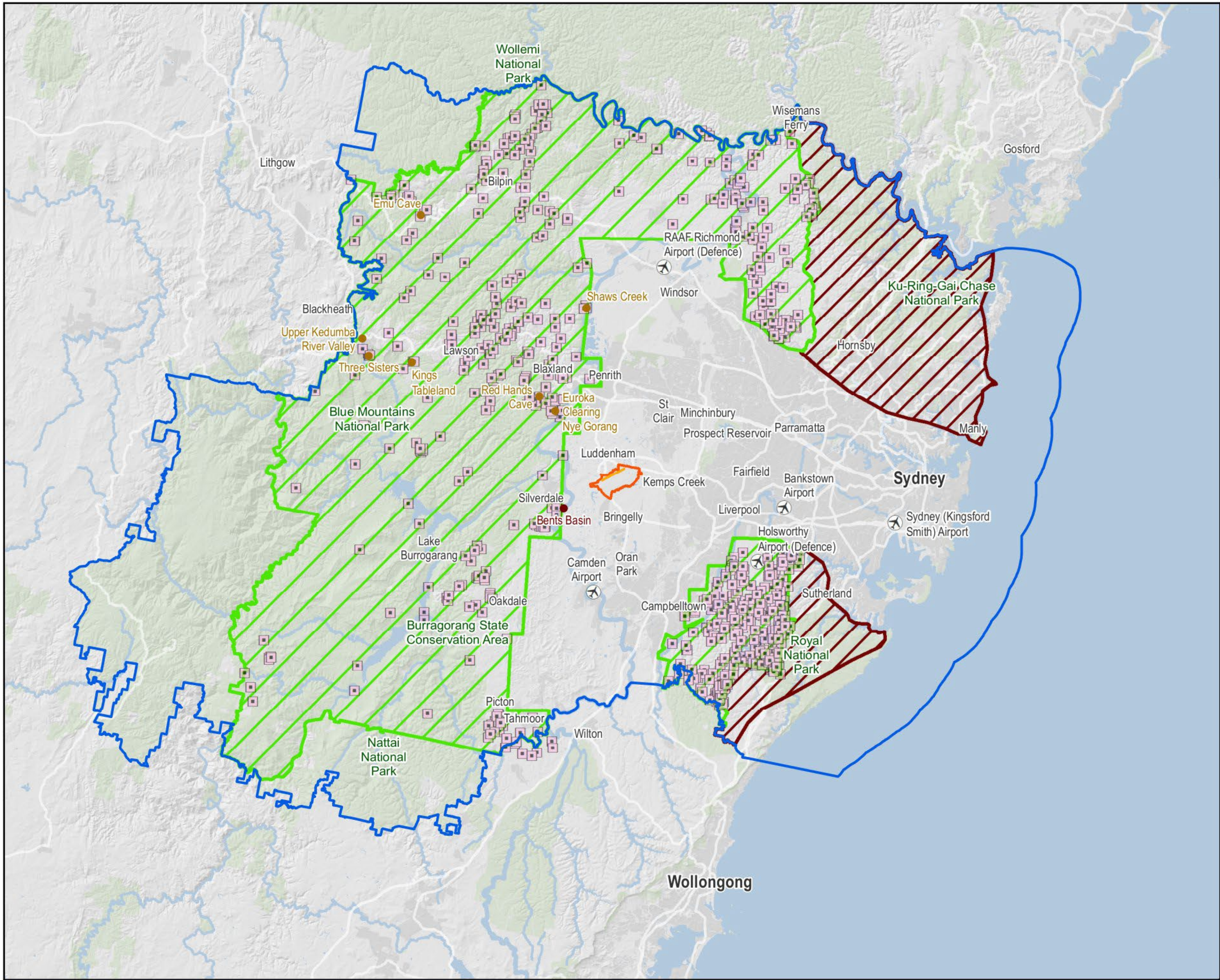
The GBMA contains around 1,400 recorded Aboriginal sites, however the area has not been systematically surveyed. A wide range of site types have been identified where surveys have occurred, such as:

- sites associated with spiritual and/or ceremonial values
- shelters with pigment rock art, rock engravings, mythological sites or story places.

Some Aboriginal sites within the GBMA include landscape features of sacred or mythological significance.

Figure 17.4

Rock Art Sites



Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- WSI airspace study area boundary
- Rock art distribution AHIMS sites mapped
- Rock art distribution AHIMS unmapped
- Rock Art Sites (Pigment and/or Engraved)
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

0 10 20 km

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:750,000 Date: 6/07/2023

Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

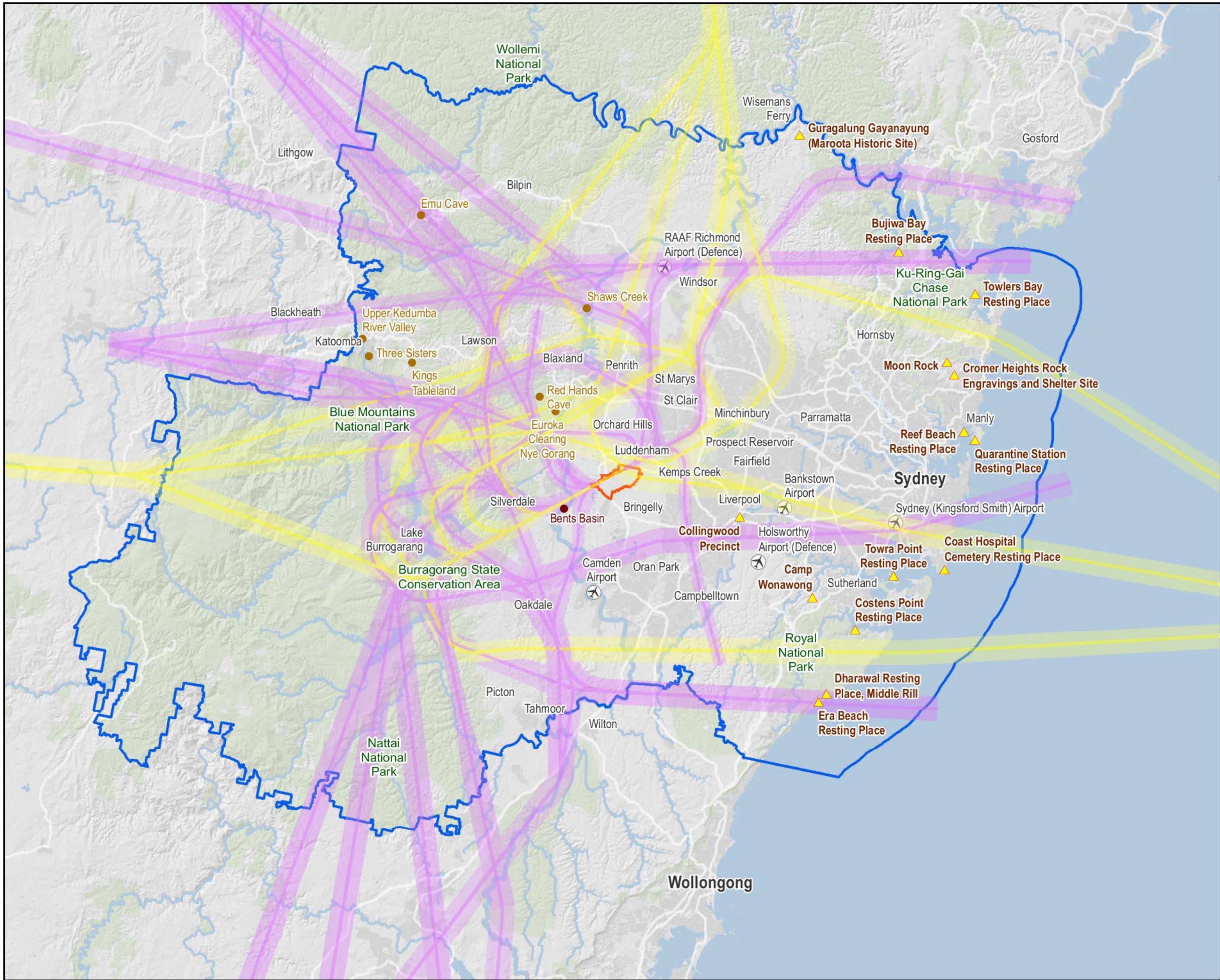
17.4.1.5 Gazetted Aboriginal Places

Gazetted Aboriginal Places are places that have received statutory recognition under the NPW Act and are places of state significance. There are 21 gazetted Aboriginal Places with the study area, ranging from small ceremonial sites to lagoons and mountains of spiritual significance. Seven (7) of the gazetted Aboriginal Places are located within the GBMA, these are:

- The Three Sisters at Katoomba, connected to Aboriginal spirituality and ceremony, and provides a visual testament to the dreamtime stories
- Emu Cave, an important rock art site that continues to be of special significance to First Nations people
- Euroka Clearing Nye Gorang, located at Glenbrook within the Blue Mountains National Park and of significance to the Darug people
- Kings Tableland near Wentworth Falls, a camping and meeting place of significance to Gundungurra people
- Red Hands Cave, near Glenbrook and situated within the Blue Mountains National Park. It was named because of red, orange and white First Nations people's hand stencils located within the cave
- Shaws Creek Aboriginal Place, located in Yellomundee Regional Park. Known for a number of Aboriginal engravings and significant cultural values associated with the rock engravings and significant rock shelters/occupation sites. In the past it was an important gathering and/or ceremonial place for First Nations people. Today it is an important place for connection with their ancestors. Yellomundee Regional Park is used as a contemporary place to camp, gather resources and teach younger generations about their culture
- Upper Kedumba River Valley – The Gully a former Aboriginal fringe settlement.

Figure 17.5

Aboriginal Places (NPW Act) within the Airspace Study Area



Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- WSI airspace study area
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance
- Other aboriginal places

Flight paths and swathes

- Arrivals
- Departures

0 10 20 km

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:750,000 Date: 5/07/2023

Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

17.4.2 Aboriginal community values

All Aboriginal sites have cultural value for First Nations people as tangible connections to their ancestors. These sites do not necessarily hold scientific or archaeological value or have elements such as artefacts. Types of sites that hold cultural value include:

- places of current or past ceremonial activity
- spiritually important places created during the Dreaming
- burial or massacre sites associated with spirits of ancestors
- places currently used by the Aboriginal community for resource gathering and culture camps to refresh and maintain cultural connections, are important for cultural revival and/or for intergenerational transmission of culture.

Through engagement with First Nations knowledge holders, the following places were identified as being of particular importance to the Aboriginal community. Some are located outside the study area. These are:

- Emu rock engraving site, Faulconbridge (AHIMS #45-9-4910) (a site with spiritual connections)
- Emu rock engraving site, Ticehurst Park, Faulconbridge (AHIMS #45-5-0015) (a site with spiritual connections)
- Yellomundee Aboriginal Place (this place is closely associated with the nearby Shaws Creek Aboriginal Place and has a number of important rock shelter sites with art and deposits)
- Shaws Creek Aboriginal Place
- Bents Basin. Clans are reported as coming together in the past at this location and is where Aboriginal families from Darug, Gandangarra and Tharawal people still gather today
- Linden Ridge (multiple sites)
- The Three Sisters (Seven sisters) Aboriginal Place, Katoomba (a place of spiritual/dreaming cultural value)
- Kings Tableland (rock art)
- Mt Yengo (outside the study area)
- Emu Cave Aboriginal Place
- Balgenny Farm – Koobawilla (a place where stars are reflected in the water)
- Walls Cave, Blackheath
- Red Hands Cave (AHIMS #45-5-0103) (a site with spiritual connections)
- Wianamatta (South Creek)
- the Nepean River
- traditional walking tracks (now roads, often connecting significant sites). Examples include Bells Line of Road and a ceremonial circuit encompassing this road, The Northern Road, Putty Road, Parramatta Road, Cowpastures Road, Blacktown Road, Queens Road, Lawson
- Possum dreaming site, Little Hartley
- The Mirror Shelter, Woodhouse Creek (where the sky is reflected in the water)
- Appin Massacre Site – now protected as the Appin Massacre Cultural Landscape (outside the study area)
- Thirlmere Lakes (outside the study area)
- Mermaid Pools.

Of these sites, some were identified by knowledge holders as being places where visual and/or noise intrusions were considered likely to impact the cultural values of a place. This includes Yellomundee, Bents Basin, the Three Sisters Dreaming site, Emu rock engraving sites, Emu Cave and Red Hands Cave.

For the Three Sisters Dreaming site, it was noted that the relatively unmarred view of the cultural landscape was important to an appreciation and understanding of the cultural values of the site. While aircraft are currently visible, knowledge holders noted that this was not a significant impact as flights were relatively infrequent, at a high altitude and at some distance. However, knowledge holders were of the view that increases in noise and visual intrusions would impact the cultural values of the site and were concerned to minimise these. Tourism activities at Echo Point are considered to be detrimental to the cultural values.

The Emu Rock engraving sites at Faulconbridge and the Emu Cave Aboriginal Place were identified by knowledge holders as important sites due to the association with the Emu in the sky constellation. Stories about the emu and the corresponding constellation are held by several First Nations peoples across Australia. The sites on the ground associated with these stories include engravings, stone arrangements and rock painting sites. The astronomical sites associated with Aboriginal cosmology have received renewed research attention in the past decade. Such sites have been and continue to be of high importance to First Nations people.

Some places are culturally significant because of the connection they provide to the recent historical past. Such connections can sometimes be traumatic or bittersweet. One example is the Upper Kedumba River Valley Aboriginal Place, also known as ‘The Gully’. This is an example of a place that prior to invasion served as a popular camping place for First Nations people and there are sites that physically attest to this early occupation of the area. Post invasion it evolved into a place of refuge for First Nations people avoiding and resisting government control. It is a former fringe settlement of the Gundungurra people.

17.5 Assessment of impacts

The project would not have direct impacts on heritage items, however, there is the potential for indirect impacts. Potential indirect impacts that have been considered in this assessment (including perceived impacts identified through community engagement) are:

- noise and visual impacts on heritage or cultural values of heritage items or places. This would be dependent on the height of the aircraft above ground level and frequency of flights
- disruption of land – sky connection
- changes in air quality due to emissions from aircraft or physical impacts due to fuel jettisoning.

17.5.1 Aboriginal heritage

Many Aboriginal sites within the study area would not be negatively impacted by the preliminary flight paths, as they would not be overflown by aircraft on the preliminary flight paths, are archaeological sites that would not be indirectly impacted by the project and/or have potentially been salvaged or destroyed (in the case of sites registered on AHIMS).

However, a number of culturally significant places are located below the preliminary flight paths and have the potential to be indirectly impacted (refer to Figure 17.6) as:

- noise can impact cultural values including the need for peace, tranquillity, and spiritual connection. Noise can also impact the value of intergenerational cultural education sites (e.g., Shaws Creek Aboriginal Place, Yellomundee which is used as a venue for cultural education of Aboriginal youth)
- certain sites (rock engravings, painting sites, stone arrangements, ceremonial sites and natural mythological sites) may have intangible spiritual values that could be vulnerable to noise, visual intrusion and/or spiritual disruption
- Aboriginal rock engravings and paintings on sandstone surfaces may be affected physically through dust or chemical interaction of pollutants on rock surfaces.

Knowledge holders that were engaged during the preparation of the Draft EIS have acknowledged that designing flight paths to avoid flying over all Aboriginal sites of cultural value would be impossible, however this is not taken to imply that any impacts were acceptable to the knowledge holders consulted. Some places are significant for their spiritual values and were of particular concern to knowledge holders. For example, the Emu in the sky constellation which is associated with several places on the ground.

17.5.1.1 Impact of noise and visual intrusion

It is acknowledged that noise and visual intrusion can impact cultural values. In particular, noise does have the potential to disrupt cultural practices at site, which could lead to its use being discontinued. A key concern expressed by First Nations knowledge holders was the impact of aircraft noise on their spiritual connection with the landscape and/or the disruption on their continuing cultural practices. For example, at a camp for young people at Yellomundee, loud aircraft noise passing over would disrupt the connection between people and country and their ability to transmit culture to the younger generations. However, if cultural practices at a place are discontinued due to aircraft noise, this would be a profound impact on the cultural values associated with the place.

Visual intrusion can also have a negative impact, depending on the position of the flight path relative to the features on the ground and the frequency of use.

The estimated noise and visual intrusion at a selection of high cultural value sites is summarised in Table 17.4. The assessment of impacts is based on composite contours and reflect 3 different runway operating scenarios. Actual impacts at a given location may be lower, depending on the operating scenario that is ultimately adopted.

Due to the position of flight paths, frequency of overflight and the predicted noise levels, the project would significantly impact the Aboriginal cultural values of Bents Basin and the Shaws Creek – Yellomundee Aboriginal Place, which are places of cultural importance with values associated with peace, tranquillity and connection to nature. There are also many Aboriginal sites that are located along Linden Ridge. The expected frequency of flights varies between the various flight paths however most flights are expected during the day. The visual and noise disruption at these sites would be moderate, increasing to severe as the frequency overflight increases over time. Impacts to other key sites of cultural significance identified through engagement would have low to moderate impacts due to noise and/or visual intrusion. Mitigation measures have been included in Section 17.6 in response to these impacts.

Table 17.4 Estimated noise and visual intrusion at a selection of Aboriginal heritage sites of high cultural value[3]

Heritage item	Noise range L_{Amax} (dB(A))	Visual intrusion	N60 (24-hours) – number of movements (2055)	Comment
The Three Sisters	50–55 dB(A)	Aircraft would be visible in the distance less than 5 km away. They would be at an approximate height greater than 10,000 ft (3 km) (above runway).	No movements at or above 60 dB(A)	While the expected noise levels are low, given the sweeping views from the lookout the visual impact is likely to be more noticeable than for other parts of the Blue Mountains. First Nations participants were concerned about any increase in noise or visual intrusion. Impact on cultural values is expected to be low to moderate given expected altitude and noise projections.
Bents Basin	80–85 dB(A)	The area would be directly overflown. Aircraft would be relatively low. Aircraft arriving into WSI Runway 05 during the day – evening period and overnight will be descending between 2,500 ft (760 m) and 750 ft (230 m). Aircraft departing from WSI Runway 23 during the day-evening period and overnight will be climbing between 2,500 ft (760 m) and 5,000 ft (1.5 km). Some aircraft may fly at a lower altitude depending on weather and operational conditions.	>200 movements above 60 dB(A)	The impact on values is expected to be extremely high. The frequency of flights during peak hours (6–8 am and 4–6 pm) is expected to be every 3 minutes. Impact on cultural values is severe.

3 The estimated noise and visual intrusion assessment does not account for off-procedure manoeuvring areas. Sites within a departure or arrival transition area may sometimes be overflown as runway modes of operation change.

Heritage item	Noise range L_{Amax} (dB(A))	Visual intrusion	N60 (24-hours) – number of movements (2055)	Comment
Shaws Creek Aboriginal Place, Yellomundee Regional Park	60–65 dB(A)	The place will be directly overflown when Runway 05 is in use. Aircraft would be frequent and visible (approx. 8,000 ft (2.4 km) to 10,500 ft (3.2 km) (above runway) and climbing). Overnight aircraft into WSI on Runway 23 will be descending between 8,000 ft (2.4 km) and 5,000 ft (1.5 km) above runway level at this location. Some aircraft may fly at a lower altitude depending on weather and operational conditions.	10–20 movements above 60 dB(A)	The main north south flight paths overfly Yellomundee. It is expected that only 1–2 overnight flights into Runway 23 would occur. Departing from Runway 05 an average of 23, up to a maximum of 55, departures could overfly this location during the day – evening period. The impact on cultural values is expected to be severe.
Emu Engraving, Ticehurst Park, Faulconbridge AHIMS #45-5-0015	60–65 dB(A)	An average of 18 departures up to a maximum of 36 departures could overfly this location during the day evening period using Runway 23 Departure north day (in 2033). Aircraft will be between 10,500 (3.2 km) and 13,300 ft (4 km) above the runway level. Several nighttime flight paths also over fly this location. During the night when Runway 05 is in use, an average of 3 arrivals up to a maximum of 8 arrivals could overfly this location (in 2033). Altitude of aircraft would range Runway 05 arrival north Night 13,300 ft (4 km) to 17,500 ft (5.3 km) and Runway 05 (RNP) North Night 8,000 ft (2.4 km) to 10,500 ft (3 km).	10- 19 movements above 60 dB(A) (day) 2-4 movements above 60 dB(A) (night)	Noise is likely to be a minor issue, however the link to the Emu in the Sky constellation is strongest in March–May, and likely to be impacted by flight during the night during this time. Expected impact is moderate. As discussed in Appendix G (Assessment of the refinements to the project) of this EIS, changes have been made to the preliminary flight path design which would reduce movements or increase the altitude of aircraft on certain flight paths at night.

Heritage item	Noise range L_{Amax} (dB(A))	Visual intrusion	N60 (24-hours) – number of movements (2055)	Comment
		When Runway 23 is in use – an average of 3 departures up to maximum of 6: Runway 23 departure Northeast Night and Runway 23 Departure North Night both at 10,500 ft (3.2 km) to 13,300 ft (4 km).		
Emu Engraving Faulconbridge (AHIMS #45-5-4910)	~42 dB(A)	Flight paths are 1.2 km – 2.1 km away and aircraft would be visible. Altitude of aircraft 8,000 ft AMSL (2.4 km) or more.	No movements at or above 60 dB(A)	Noise is likely to be a minor issue and the site is not directly overflown. Impact – low.
The Mermaid Pools	Under 60 dB(A)	Aircraft would be less than 5 km away but flying at greater than 10,000 ft (3 km) (AMSL).	No movements at or above 60 dB(A)	Aircraft may be visible but noise would be relatively low. The expected impact on cultural values is negligible to low.
Red Hands Cave Aboriginal Place	60 dB(A)	Flight path Runway 05 arrival North Night (RRO) overflies this location with an average of 4 arrivals up to a maximum of 8 during the overnight period (in 2033). Aircraft would be at 10,500 ft (3.2 km) to 13,300 ft (4 km) above runway level. Daytime flightpaths do not overfly these locations although when Runway 23 is in use (Runway 23 Departure North (Non-Jet) Day) is less than 1 km away so aircraft are likely to be visible.	No movements above 60 dB(A)	The park gates are closed during the evening and therefore the expected impact from noise and visibility is low to moderate. The long-term impact of emissions on pigment and engraved art is currently unable to be estimated.

Heritage item	Noise range L_{Amax} (dB(A))	Visual intrusion	N60 (24-hours) – number of movements (2055)	Comment
Euroka Clearing	~42 dB(A)	The site would be directly overflown with aircraft at an expected height ranging from 8,000 (2.4 km) to 13,300 ft (4 km) above runway. When Runway 23 Arrival West Day is in use an average of 24 arrivals up to a maximum of 51 arrivals could overfly this location during the day-evening period. At night when Runway 05 Arrival North Night (RRO) is in use, an average of 4 flights and up to 8 arrivals could overfly this location (in 2033).	No movements at or above 60 dB(A)	Even though noise levels are not expected to be high, overflight is expected to be relatively frequent and impact to the current First Nations cultural use of the site which includes mourning and smoking ceremonies is likely to be noticeable. Impact to cultural values is expected to be low to moderate.
Linden Ridge sites	60–65 dB(A)	Linden Ridge is overflown by the following flight paths Runway 23 Departure North Day; Runway 05 Arrival North Night, Runway 05 Arrival (RNP) North Night and Runway 23 Departure North Night. Aircraft on flight paths during the day would be at an altitude between 10,500 (3.2 km) and 13,300 ft (4 km) above runway. At night, aircraft would be at an altitude of 5,000 ft (1.5 km) to 13,300 ft (4 km). The expected frequency of flights varies between the various flight paths however most flights are expected during the day i.e. an average of 18 departures up to a maximum of 36 during the day – evening period when Runway 23 is used (in 2033).	10–19 movements above 60 dB(A)	There are many Aboriginal sites that are located along the Linden Ridge walking trail. There would be a visual and noise disruption at these sites, increasing over time. There are multiple rock shelters with pigment art e.g. AHIMS #45-04-0220, and AHIMS #45-4-0244; and ridge top engravings sites e.g. AHIMS #45-5-0008, and AHIMS #45-5-2272; stone arrangements e.g. AHIMS #45-4-0222, AHIMS #45-4-0223 as well as other site types including artefact scatters and axe grinding grove sites. Impact is expected to be moderate increasing to severe by 2055. The long-term impact of emissions on pigment and engraved art is currently unable to be estimated. As discussed in Appendix G (Assessment of the refinements to the project) of this EIS, changes have been made to the preliminary flight path design which would reduce movements or increase the altitude of aircraft on certain flight paths at night.

Heritage item	Noise range L_{Amax} (dB(A))	Visual intrusion	N60 (24-hours) – number of movements (2055)	Comment
Emu Cave Aboriginal Place. AHIMS #45-4-0018	60 dB(A)	The Aboriginal Place is directly overflown by aircraft on the following flight paths: Runway 05 Departure North Day, Runway 23 Departure North Day, Runway 23 Departure North Night. Aircraft would be visible but relatively high climbing between 13,300 ft (4 km) and 17,500 ft (5.3 km) above runway.	No movements above 60 dB(A)	This site is a deep rockshelter, with the engravings inside on the cave walls. There is no direct visual connection between the engraved emu tracks and the sky as is the case with the emu engraving. The site is of spiritual significance – and given the frequency of flights the impact is expected to be low to moderate. As discussed in Appendix G (Assessment of the refinements to the project) of this EIS, changes have been made to the preliminary flight path design to increase the lateral separation with this Aboriginal Place.
Kings Tableland Aboriginal Place	~42 dB(A)	Aircraft would be less than 5 km away and visible from this Aboriginal Place but do not fly overhead. Aircraft would be at an altitude of greater than 10,500 ft (3.2 km) above runway.	No movements at or above 60 dB(A)	Impact is expected to be negligible to low.
Mt Yengo sacred site	Negligible ≤ 42 dB(A)	The nearest flight path (Runway 23 Arrival North Day) is 2.8 km away and aircraft will be high descending between 20,000 ft (6 km) and 17,500 ft (5.3 km) above runway.	No movements at or above 60 dB(A)	Aircraft may be visible but at high altitude, and noise will be negligible ~42 decibels. First Nations knowledge holders expressed concern over disruption of spiritual values if overflown – however the Aboriginal Place/sacred site is not overflown. There is expected to be no impact.
Thirlmere Lakes	~42 dB(A)	The lakes are not directly over flown. The closest flight path to the lakes is 3.1 km away Aircraft departing Runway 23 during the day – evening will also fly over this area at an altitude of between 13,300 ft (4 km) and 17,500 ft (5.3 km).	No movements at or above 60 dB(A)	The closest flight paths are Runway 23 Departure south (Hot) Day, and Runway 23 Departure south day. Aircraft may be visible but at a high altitude. Impact is expected to be no impact to cultural values.

17.5.1.2 Disruption of land-sky connection

Some Aboriginal sites are connected to the Dreaming and have spiritual value extending beyond their physical fabric. This is most clearly reflected in sites that are connected to stories that link places on the land with the constellations. They have always been of high importance to First Nations people as part of their complex cosmology and knowledge system. The Dreaming is not simply in the past, rather it continues to guide, influence and impact the day to day lives of First Nations people.

As discussed in Section 17.4.2, knowledge holders identified 3 sites that are associated with the Emu in the sky story, being:

- The emu rock engraving site at Ticehurst Park (AHIMS #45-5-0015). Knowledge holders noted that around March to May was the most important time for the connection between the emu in the sky and this site. Five (5) flight path corridors would pass over the site in Ticehurst Park (one day and 4 night flight paths) at altitudes between 10,500 ft to 17,500 ft. Aircraft movements would vary with an average of 18 aircraft and a maximum of 36 aircraft movements in 2033 during the day and evening, increasing to an average of 51 to a maximum of 97 aircraft by 2055. At night, an average of 3 aircraft and a maximum of 8 aircraft across the night period in 2033, increasing to an average of 10 and a maximum of 25 aircraft movements depending on the flight path. Given the altitudes the impact on cultural values is expected to vary seasonally. The maximum predicted noise levels would be around 60 decibels with around 10–19 movements across the day exceeding 60 decibels (N60 (day)) and around 2–4 movements across the night exceeding 60 decibels by 2055 (N60 (night)). Overall, the impact on cultural values is expected be moderate
- The emu rock engraving site at Faulconbridge (AHIMS #45-5-4910). Again, Knowledge holders noted that around March to May was the most important time for the connection between the emu in the sky and this site. No flight path corridors pass above this site, with flight paths around 1.2 km to 2.2 km away from the site with aircraft at altitudes between 8,000 ft and 13,300 ft. However the location is close to a proposed departure transition area for WSI which means that it could be overflown depending on conditions. Aircraft noise would be around 42 decibels. The impact on the cultural values is expected to be low.
- The Emu Cave Aboriginal Place (AHIMS #45-4-0018). Emu Cave is a deep sandstone shelter, part of a small sandstone formation covered in a fairly open eucalypt forest. The innermost recess and entire western wall is covered with track-like engravings. A recording of the site undertaken in 2003 recorded 172 engraved figures as well as 5 faint red hand stencils. Most engravings resemble bird tracks but there are also macropod tracks (kangaroo and wallaby), grooves, ovals, Y-shapes and a single U-shape. A 2007 study found that Emu Cave was one of 31 art sites within the GBMA evoking the emu, and that the cave's panel of mostly emu tracks is of a distinctive style of engraving, which contributes to the very diverse body of art sites within the GBMA – showing a long duration of art practice, and influences from a wide catchment of styles (Tacon et al., 2007). The Aboriginal Place would be overflown by aircraft departing from Runway 05 and Runway 23 during the day – evening period. Aircraft will be climbing between 13,300 ft and 17,500 ft above runway level at this location. Some aircraft may fly at a lower altitude depending on weather and operational conditions. There will be some, but less frequent flights overnight from Runway 23.

17.5.1.3 Impacts to Aboriginal rock art sites

Air quality

There has been little direct research on sites within or close to Sydney on the impacts to Aboriginal rock art sites from air pollution. International research findings (such as Giesen et al., 2014 and Tzanis et al., 2009) suggest that air pollution can accelerate the rate of stone deterioration in urban settings, by weakening the fabric of the stone and making it more susceptible to other stresses (such as physical weathering).

The majority of known rock art sites occurs in 3 major groupings relative to WSI:

- to the north-west and south-west within the GBMA, starting from a distance of around 18 and 11 km respectively
- to the south-east on the Woronora Ramp (south-east of Campbelltown), extending from around 36 km away
- to the north-east in the Lower Hawkesbury catchments, extending from around 55 km to the north.

The assessment has found:

- relatively high concentrations of atmospheric pollutants associated with WSI are most likely to occur within a 5 km radius and unlikely to extend into the proximity of the rock art sites
- winds are varied but predominantly occur from the south-west and the west-south-west. Winds of lesser speed predominantly occur from the east in summer. The prevailing trend is for potential airborne pollutants to be moved away from the closest rock art sites situated in the Blue Mountains
- the potential for WSI aircraft emissions to impact upon rock art sites is most likely under the more frequently flown sections of flight paths (especially close to WSI and to the west of WSI)
- to a much lesser extent, WSI emissions would contribute to the potential impact of accumulated air pollution within the Sydney Basin on rock art sites.

Aircraft emissions from the project would contribute to the general air quality of the Sydney Basin. International studies have shown that emissions from airport operations are small when compared to the regional context of emission inventories (Ratliff et al., 2009). This is supported by the air emissions inventory for the Greater Metropolitan Region in NSW (NSW EPA, 2012), which shows that emissions from existing airport operations in Sydney in 2008 were less than 3 per cent of total emissions for the region. On the western side of the study area there are large tracts of national park and minimal industrial development in the past. The evidence relating to potential emission effects on rock art, particularly pigment art, is considered in detail in Technical paper 9. It can be concluded that any potential for WSI aircraft emissions to impact upon rock art sites is probably situated:

- under the more frequently flown sections of flight paths, especially close to WSI, notably to the west of WSI
- to a lesser extent, WSI emissions will contribute to the potential impact of the net air pollution from the Sydney Metropolitan area on Sydney Basin art sites.

There is general acknowledgement that air pollution is likely to be detrimental to Aboriginal rock art, however, there has been little direct research on sites within or close to Sydney. It is not possible to quantify the cumulative long-term risk presented by these processes, or indeed to identify and quantify any resulting damage due to a lack of previous research and comparative data. There is also the difficulty in differentiating aircraft emission derived deterioration from other anthropogenic pollution sources via the same processes (such as acidity, nutrients and dust). While increased emissions may potentially result in some impact to these environments, the likelihood of this is generally considered to be minimal. As a precautionary approach the assessment recommends the identification of sample sites from which baseline condition data would be recorded and which would then be monitored over time (see mitigation measure H2).

Fuel jettisoning

Most jet fuel is highly volatile and when jettisoned readily breaks up into small droplets which subsequently vaporise.

The evaporation of unburnt fuel droplets releases volatile organic compounds (such as benzene and carbon dioxide) into the atmosphere, some of which can remain in a vapour phase with a residence time of 24-hours to 2 weeks (Pacific Environment Limited, 2016).

Fuel jettisoning would occur in accordance with the Aeronautical Information Publication Australia, Part 2 – En Route (AIP ENR) (Airservices Australia, 2022a). If required, fuel jettisoning would occur at an altitude of at least 6,000 ft (around 1.8 km) above ground level to ensure total dissipation into the atmosphere prior to contacting the ground, except in the case of emergencies (Airservices Australia, 2023). Most fuel evaporates within the first few hundred metres, and fuel jettisoning occurs only very rarely. The likelihood of fuel reaching the ground is very low and it is unlikely that cultural heritage values of Aboriginal rock art sites would be impacted.

17.5.2 Historic heritage

As outlined in Section 17.4.1, there are a number of heritage items that are of world, national, state and/or local heritage significance within 10 km of the Airport Site (refer to Figure 17.6).

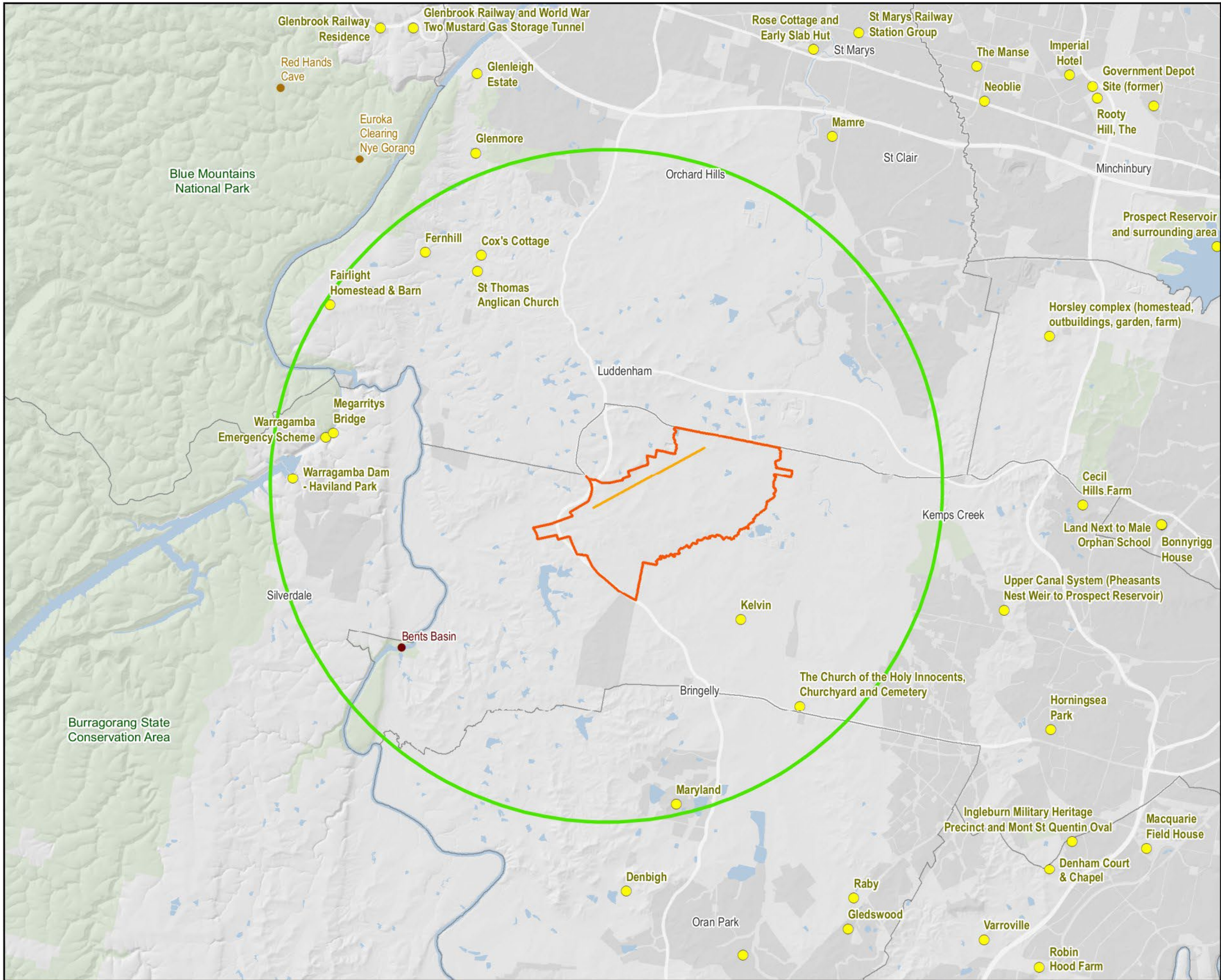
The project has the potential to impact the historic heritage items due to:

- noise and visual intrusion, which can diminish peace, serenity and wellbeing values, such as the GBMA and other rural and bushland sites. Noise from departing aircraft can be expected to be louder close to the Airport Site as they are climbing. For this reason, consideration was given to places that occurred within a 5 km radius of the Airport Site and then within a 10 km radius of the Airport Site
- changes in air quality
- contributions to greenhouse gas emissions and climate change and resulting impacts to historic gardens.

Many sites beyond 10 km from the Airport Site are already overflown by aircraft associated with Sydney (Kingsford Smith) Airport flight paths and are not considered further. Many types of heritage places are also considered robust in the face of impacts such as air pollution, noise and visual impacts.

Figure 17.6

SHR Items within a 10km Buffer



Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- 10km Buffer
- NSW LGA boundaries
- State Heritage Register places (SHR)
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

0 2 4 km

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:150,000 Date: 5/07/2023

Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

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17.5.2.1 Impact of noise and visual intrusion

The preliminary flight paths avoid all World Heritage and National Heritage sites, except for:

- the GBMA
- Royal National Park, Garawarra State Conservation Area.

In relation to the Royal National Park – Garawarra State Conservation Area, while aircraft will be visible, they will be much higher than the current aircraft overflying the area to and from Sydney (Kingsford Smith) Airport and noise is not expected to be significant at 42 decibels or lower. While aircraft may still be visible from other sites, even though they are not directly overflown noise and visual intrusion to these places would be minimal and have a negligible impact on their values.

Of the 89 Commonwealth heritage sites, only 2 are within close proximity to WSI and/or are likely to be adversely impacted by the flight paths – Orchard Hills Cumberland Plain Woodland and the Shale Woodland Llandilo (beyond 10 km from WSI). Both of these places have been listed for their natural values including both flora and fauna and potential impact on these values are addressed elsewhere in Chapter 16 (Biodiversity). These properties have not formally been assessed by the Australian Heritage Council for their cultural values, but reference is made in the listings to the probability of historical and Aboriginal cultural values. However, the features noted in relation to possible cultural values are industrial features and archaeological sites which are robust in relation to any likely impacts from the preliminary flight paths.

The long-term impact on cultural values due to noise is difficult to determine. If the noise disrupts the cultural practices at a site to the extent that its use is discontinued, this would be considered a profound impact on the cultural values associated with the place. This can be particularly important to historic heritage items such as buildings and building complexes which have existing sympathetic uses that are noise sensitive.

At greater distances from WSI, noise and eventually the visibility of aircraft begins to diminish, and emissions are likely to disperse over a greater area and therefore be less concentrated. However, some cultural values remain sensitive to any additional noise and the frequency of flights can exacerbate this. This applies to the GBMA and those historical heritage places within it that are valued for their serenity and their ability to connect people to the spirituality of nature. The significant value of other heritage places lies primarily in the fabric of the building or structure and such values will not be impacted directly by noise. The degree to which the fabric of heritage places would be directly impacted by aircraft emissions is expected to be low as it is anticipated that few (if any) emissions would reach the ground surface. A long-term research program has been recommended to gather quantitative data on this possible impact (see mitigation measure H2).

The estimated noise and visual intrusion at a selection of historic heritage items of cultural value is summarised in Table 17.5. These heritage items were selected as exemplars either because they:

- occur in close proximity to other heritage items and the likely impact on the example item will be typical of likely impacts on the proximal items. For example, impact on Fernhill Estate will be similar to impacts on St Thomas Church and other heritage items in Mulgoa; or
- because they are a type of item on which the potential impacts will be similar to others of that type. For example, in the case of Everglades historic gardens. The assessment on the GBMA is presented in Chapter 23 (Matters of National Environmental Significance).

The fact that many historic heritage places occur in populated areas such as Katoomba means that the first principle of flight path design has served to protect them from direct overflight, although in some cases aircraft may still be visible in the distance and may be heard. Windsor and Richmond townships are the exception to this. While the Richmond township contains a number of locally significant heritage items, there are a range of factors such as the proximity of the RAAF base that restrains the flight path options in this area. Aircraft would be relatively high by this point, however, at greater than 10,000 ft (above MSL) and noise would be below 60 dB(A).

It is inevitable that some properties would suffer some impact from noise or visual impacts, given that in many cases to the west and south-west of WSI, the properties are located in rural contexts. This includes properties within Mulgoa, Luddenham and Wallacia. These towns contain several local heritage items, and in the case of Mulgoa, several significant historic heritage properties such as Fernhill Estate and St Thomas's Church. Impacts to these heritage properties would range from no impact to moderate impact, depending on the values for which the places are listed for, and the indirect visual and noise impacts from the project, noting that not all heritage properties are directly overflown. The exception is for heritage listed schools in Luddenham and Wallacia. The continuous use as a school forms part of its heritage value and noise disruptions during the day would be frequent and are expected to increase in frequency over time, noting the internal noise levels would be dependent on the condition of the building fabric and/or recent additions/modifications to the buildings. The impact of high noise events on the heritage value is assessed as moderate to severe, depending on any modifications that the asset owner may implement in response to aircraft noise. Any such modifications would be subject to heritage approvals.

Blue Mountains walking tracks

The impact on the heritage values of the walking tracks was considered collectively and generally in the assessment. Tracks (by their very nature) wind through the landscape and in certain areas could traverse exposed and elevated contexts or open valleys, some of which may be under flight paths. In other areas, they would be situated below ridges, under sandstone overhangs and/or in deep narrow valleys. Many tracks in the Blue Mountains connect Aboriginal sites such as engravings, spiritual sites and shelters with pigment art. A walker would likely need to be in an exposed or ridgetop area under a flight path at the specific time when an aircraft is overhead to experience any potential impact.

Walking tracks within the GBMA have been further considered in Technical paper 10: Social (Technical paper 10) and Technical paper 14: Greater Blue Mountains World Heritage Area (Technical paper 14), and these assessments found that visitors may experience some changes to the use and enjoyment of walking tracks within the Blue Mountains.

People who visit and use walking tracks in the N60 and N70 contours are likely to experience moderate changes to their use and enjoyment. The majority of the broader GBMA is largely outside the area predicted to experience aircraft noise at or above 60 and 70 dB(A) (as per Technical paper 1). There are no walking tracks in the GBMA within the N70 contours, however some tracks have been identified to be within N60 contours.

Table 17.5 Estimated noise and visual intrusion at a selection of historic heritage items of cultural value[4]

Item name	Sensitivity issues	Noise range L_{Amax} (dB(A))	N60 (24-hours) number of movements	Potential Impacts
Fernhill Mulgoa SHR 54	Sandstone buildings – possible impact of emissions on building fabric. Noise Visual Emissions – effect on sandstone	~70 dB(A)	10–20 movements per 24 hrs at or above 60 dB(A)	The homestead is currently in a quiet rural setting. The property would be directly overflown by some night-time departures when Runway 05 is in use. Altitude of departing aircraft is around 2,500–5,000 ft. There will be some day-evening incoming flights to Runway 05 descending from 8,000 ft to 5,000 ft. Some aircraft (overnight or day-evening) may fly lower altitude depending on weather and operations conditions. Likely impact of noise on the cultural values will be moderate given the tranquil rural setting. Impacts will be similar to St Thomas Church (SHR 426) and locally significant places in Mulgoa.
Lilianfels SHR 431	The maintenance is supported through its sympathetic reuse as a wellness spa. Noise Visual	50–55 dB(A)	No movements at or above 60 dB(A)	Not underneath the flight paths but less than 5 km away. The altitude of aircraft would be >10,000 ft (AMSL). Impact is low.
Everglades gardens SHR 1498	Air pollution/cumulative pressures added emissions and climate change	50–55 dB(A)	No movements at or above 60 dB(A)	Not underneath the flight paths but less than 5 km away. The altitude of aircraft would be >10,000 ft. Sydney (Kingsford Smith) Airport aircraft already overflies the property. Noise and visual impacts expected to be low.

4 The estimated noise and visual intrusion assessment does not account for off-procedure manoeuvring areas. Sites within a departure or arrival transition area may sometimes be overflown as runway modes of operation change.

Item name	Sensitivity issues	Noise range L_{Amax} (dB(A))	N60 (24-hours) number of movements	Potential Impacts
Linden Observatory SHR 1807	Dark sky proposal; visual, sensitive to noise night-time flights	60–65 dB(A)	10–20 flights per 24 hrs at or above 60 dB(A)	Day and night flight path corridors pass over this heritage item. Aircraft will be visible. The altitude of aircraft will be 5,000–13,300 ft, depending on the flight path. Some aircraft may fly at a lower altitude depending on weather and operational conditions. Noise levels and visual impacts are expected to impact cultural values especially ‘dark sky’ and amateur astronomy. Impact expected to be moderate. Further assessment of the impacts to activities at this observatory has been completed since exhibition of the Draft EIS. This found that most of the activities at the Linden Observatory should still be able to occur, potentially at a reduced capacity. Most of the impacts of the project would require a temporary pause in activities on a given night and/or adaptation to activities conducted at the site. The light emitted by passing aircraft is short-term with the sky reverting to being dark once the aircraft passes. The entire sky would not be impacted. The project is not anticipated to result in the loss of the State Heritage listing for this item or significantly diminish the significant values for which the site is recognised.
Wynstay Estate 1875 SHR 1520	Significant buildings; combination of materials brick, sandstone, corrugated iron	Under 60 dB(A)	No movements at or above 60 dB(A)	Aircraft would be less than 2 km away to the south-west and flying at more than 10,000 ft. Noise and visual impact is expected to be low.
Kirkham Stables and Precinct c1816 SHR 1411	Building complex Masonry, iron roof, rough cast cement on stone foundations Effects of emissions on building fabric and treatments	Under 60 dB(A)	No movements at or above 60 dB(A)	Flight path avoids direct over flight but would be distantly visible less than 5 km away to the north. The altitude of aircraft would be greater than 10,000 ft (3 km). Likely impact is negligible.

Item name	Sensitivity issues	Noise range L_{Amax} (dB(A))	N60 (24-hours) number of movements	Potential Impacts
Thompson Square Windsor SHR 126	Cumulative impacts after major impact of TfNSW – Windsor Bridge	Under 60 dB(A)	No movements at or above 60 dB(A)	Thompson Square would be directly overflown. The expected altitude of aircraft would be greater than 10,000 ft (3 km). Proposal impact alone is likely to be minor but cumulative impact on liveability of historic homes may be significant given other recent impacts.
The Carrington, Katoomba SHR 00280	Building fabric – unknown impacts of emissions on building fabrics Noise sensitivity for patron/guests	50–55 dB(A)	No movements at or above 60 dB(A)	Katoomba would be avoided as a residential area. Flight path avoids direct over flight but would be distantly visible less than 5 km away to east and north. The altitude of aircraft will be greater than 10,000 ft (3 km). Impact is negligible to low.
Hobartville, Richmond SHR 00035	Complex of buildings from early colonial period. Sandstock brick mansion, slate roof, stone elements	Under 60 dB(A)	No movements at or above 60 dB(A)	Example for Richmond township. Due to restrictions posed by RAAF Base Richmond, the township would be overflown as main north–south flight path. Flight paths run above the RAAF flight paths. The property would be directly overflown. Aircraft are expected to be at an altitude of greater than 10,000 ft (3 km). Noise and visual impacts expected to be minor.
Camden Park Estate/ Belgenny Farm SHR 01697	Cultural landscape/cultural complex – any features. Camden Park house – stuccoed sandstock brick, local cut stone detail, sandstone Effects of emissions on building fabric and treatments Noise visual	Under 60 dB(A)	No movements at or above 60 dB(A)	Would not be overflown. Flight path avoids direct over flight but would be distantly visible less than 5 km. The altitude of aircraft will be greater than 10,000 ft (3 km). Low impact.

17.5.2.2 Impacts to historic heritage places from air pollution and climate change

There are few studies on the impact of air pollution on historic heritage places and its mitigation. While some studies have looked at air pollution generally, there is little specific information available regarding aviation pollution. Available information includes:

- anthropogenic air pollution (caused by humans or their activities) is a major cause of damage to heritage buildings, including 19th Century sandstone structures in Sydney
- Sydney (yellow block) sandstone (building material employed in many 19th Century buildings) is a highly porous and friable building material. It is vulnerable to weathering from natural and anthropogenic pollution
- main sources of anthropogenic ambient pollution in Sydney include emissions from motor vehicles and coal fired power stations (Paton-Walsh et al. 2019)
- air pollution is generally known to increase the rate of natural weathering by about one to 2 times (Varotsos et al. 2009)
- aircraft engines contribute to ambient air pollution in general, especially when flying at altitudes below one km (Masiol and Harrison, 2014)
- sulfuric and nitric acid (derived from sulfur dioxide and nitrogen oxides from motor vehicles and aircraft) decreases the pH of rain causing acid rain (Sesana et al. 2021)
- acid rain and secondary minerals (salts) are major contributors to the destruction of the outer layers of sandstone architecture in urban areas (Marszalek et al. 2014)
- recent changes in air pollution standards internationally have led to a shift in the causes of damage to stone heritage buildings away from traditional sources of air pollution to increased activity by algae (Smith et al. 2008)
- no known published studies have linked pollution from aircraft directly to the destruction of heritage items.

Emissions can have an impact on the physical fabric of buildings and are known to have an impact on sandstone (a material used in many significant historical buildings). It is likely that other fabrics and finishes are also affected over time. It is not currently possible from the available data to quantify that impact, as there have been no long-term baseline studies undertaken to monitor impacts of such industrial emissions.

It is not currently possible to provide any quantifiable assessment of the likely cumulative impact of any emission related to the project in addition to the existing and emerging climate change impacts on heritage gardens because no baseline data exists regarding the current climate change impacts. As such, the introduction of new or increased airborne pollutants would have an unknown impact on the ability of these gardens to cope and adapt to environmental changes. Further discussion is provided in Section 6.2 of Technical paper 9.

17.6 Mitigation and management

17.6.1 Project specific mitigation measures

The design of the flight paths has been an iterative process with consideration given to significant cultural places and the values which might be impacted by aircraft flying overhead. Further consideration has been given to avoid and minimise impacts on Aboriginal cultural heritage during detailed design and operation. Mitigation measures to address the key impacts identified in the assessment are summarised in Table 17.6.

Table 17.6 Proposed mitigation measures – heritage

ID No.	Issue	Mitigation measure	Owner	Timing
H1	Aboriginal heritage	DITRDCA will ensure that the detailed design phase considers Aboriginal cultural places and values, noting that safety is not negotiable and that capacity, environment and efficiency factors must also be considered in the flight path design.	DITRDCA	**Pre-operation** (Detailed design, 2024–2026)
H2	Heritage	A research program will be undertaken to investigate the potential impact of aircraft emissions on historic and Aboriginal heritage sites (including rock art sites), with a particular focus on sites within the Greater Blue Mountains Area. The research program will be designed and implemented in consultation with Heritage NSW and include participation of local First Nations stakeholders.	DITRDCA/ Airservices/ WSA Co	**Pre-operation** (Detailed design, 2024–2026) and **Operation** (Implementation, 2026–ongoing)
H3	Heritage consultation	WSA Co will establish a CACG for WSI which will facilitate consultation with stakeholders and community on a range of matters including heritage issues.	WSA Co	**Pre-operation** (Detailed design, 2024–2026)

Separate mitigation measures have been identified to manage risks of aircraft noise, wildlife strike and fuel jettisoning, and further detail on these measures can be found in Chapter 24 of the EIS.

Chapter 18 Social

This chapter describes the existing social characteristics of the study area, the applicable legislative and policy framework relevant to social issues and provides an assessment of pre- and post-mitigation impacts from the project.

The assessment considered the social impacts of the project in 2033 and 2055 in areas close to WSI (being within 10 km) and at a regional level (encompassing Blacktown, Blue Mountains, Camden, Fairfield, Hawkesbury, Liverpool, Penrith and Wollondilly LGAs). The assessment is based on NSW Department of Planning and Environment's (DPE) *Social Impact Assessment Guideline for State Significant Projects 2023* (NSW DPE, 2023b). It considers the actual and perceived impacts of the project and has been informed by community engagement.

Operations at WSI and the associated airspace in the Sydney Basin sit within a well-established regulatory and management framework. Mitigation measures outlined in this Draft EIS, and the existing controls (specific to WSI or more broadly to the management of federally leased airports) will generally reduce the significance of potential social impacts from a High significance rating to Medium or Low significance.

Due to the raft of existing planning measures in place surrounding WSI, the assessment has identified that the potential increase of inequality for vulnerable groups located in areas within the ANEC 20, N60 and N70 contours for both the 2033 and 2055 scenarios would remain as the only potential residual (post-mitigation) impact with a High significance rating.

All other potential social impacts have a Medium or Low impact within the local and regional study areas for the 2033 and 2055 assessment years.

To further manage social impacts associated with the project, the WSI Community Aviation Consultative Group (CACG) will undertake consultation with stakeholders and community, including social organisations, to seek feedback on social issues and promote the social and economic welfare of the community.

The refinements to the project since the exhibition of the Draft EIS would not change the assessed magnitude of impact or the assessed residual impact level as presented in the Draft EIS. There would be no change to impacts to community (increased inequality), way of life (loss of residential amenity, and use and enjoyment of social infrastructure), health and wellbeing (changes to amenity), and surroundings (social values associated with the Blue Mountains). Further detail is provided in Section G2.10 of Appendix G (Assessment of the refinements to the project) of the EIS.

18.1 Introduction

Social impacts generally refer to the consequences that individuals, households, groups, communities or organisations experience when a project brings change (NSW Department of Planning and Environment (NSW DPE), 2023b). Social impacts may be direct or indirect, positive or negative, and tangible or intangible.

This chapter considers the potential social impacts resulting from the project in accordance with the EIS Guidelines and with consideration of the *Social Impact Assessment Guideline for State Significant Projects* (NSW DPE, 2023b) (as updated in October 2022). The assessment has been informed by engagement completed for the social impact assessment and the broader engagement undertaken for the Draft EIS. The full assessment is provided in Technical paper 10: Social Impact Assessment (WSP Australia Pty Ltd) (Technical paper 10).

The potential social impacts have been grouped into the following categories – way of life, community, culture, accessibility, health and wellbeing, surroundings, livelihoods and decision-making systems. The definition of these categories is discussed further in Section 18.4.

18.2 Legislative and policy context

There is no specific legislation that guides social impact assessments. The social impact assessment was undertaken to address the EIS Guidelines and with reference to the following guidelines or standards:

- The *Social Impact Assessment Guideline* (NSW DPE, 2023b) and the supporting *Technical Supplement: Social Impact Assessment Guideline for State Significant Projects 2023* (NSW DPE, 2023c) (collectively referred to as the SIA Guideline). The methodology to evaluate the significance of a social impact as set out by this guideline has been applied in this assessment.
- Airservices Australia's Environmental management of changes to Aircraft Operations Standard (AA-NOS-ENV2.100) (Airservices Australia, 2022b), which outlines the requirements for a social impact analysis for proposed airspace changes.

A range of policies and planning strategies were also considered in the assessment of potential social impacts, including:

- National Airports Safeguarding Framework
- *The Greater Sydney Region Plan – A Metropolis of Three Cities* (Greater Sydney Commission, 2018b)
- *Western City District Plan* (Greater Sydney Commission, 2018a)
- *State Environmental Planning Policy (Precincts – Western Parkland City) 2021*
- *Western Sydney Aerotropolis Precinct Plan 2022* (NSW DPE, 2023a)
- Western Sydney Aerotropolis Development Control Plan (DCP) (NSW DPE, 2022c)
- Local strategic planning statements and community strategic plans for the Penrith, Liverpool, Camden, Blacktown, Wollondilly, Fairfield and Blue Mountains local government areas (LGA).

Further detail can be found in Chapter 3 of Technical paper 10.

18.3 Methodology

The methodology for this SIA has been designed specifically in response to the requirements of the Ministerial Guidelines for the project and followed the process outlined in Figure 18.1.

Figure 18.1 Overview of social impact assessment methodology

18.3.1 Approach

The social impact assessment methodology involved:

- the scoping of potential social impacts was conducted to inform the SIA by reviewing comparable project SIAs and relevant literature on predicted social impacts, including social impact assessments for 2016 EIS and the new parallel runway at Brisbane Airport, and publicly available media sources
- determining an appropriate study area (see Section 18.3.2)
- describing the existing social environment by reviewing:
  - the 2021 and 2016 ABS census data
  - NSW DPIE's 2020 Population, Household and Implied Dwelling Projections by LGA to illustrate the 8 social impact categories: community, way of life, accessibility, culture, health and wellbeing, surroundings, livelihoods and decision-making systems
  - other data indicators such as health data, local government planning policies and local government consultation and online mapping tools
  - review of other technical papers that support the Draft EIS
- community and stakeholder consultation, including:
  - review of existing consultation from September 2022 to June 2023 – face to face briefings and community pop-up events. An online survey was also completed among stakeholders and external to the community pop-up events
  - SIA specific consultation between November 2022 and March 2023 – interviews with key stakeholders and community representatives, and residents

  Further detail is available in Chapter 9 (Community and stakeholder engagement)
- predicting, identifying and evaluating potential social impacts of the project and the social implications of impacts identified in other technical assessments. The assessment focuses on the 8 social impact categories: community, way of life, accessibility, culture, health and wellbeing, surroundings, livelihoods and decision-making systems

  To determine the significance of a social impact, the magnitude and likelihood is considered. Table 18.1 defines the magnitude of impact outcomes and Table 18.2 defines the likelihood levels as applied in the assessment. The social risk matrix to determine the social impact significance, prior to mitigation, is set out in Table 18.3
- identification of appropriate mitigation and management measures to mitigate negative social impacts or maximise benefits of the project
- the identification and assessment of residual impacts after the implementation of proposed project mitigation measures.

Table 18.1 Defining magnitude levels for social impacts

Magnitude criteria	Definition
Transformational	• Substantial change experienced in community wellbeing, livelihood, amenity, infrastructure, services, health, and/or heritage values. • Permanent displacement or additional of at least 20 per cent of a community.
Major	• Substantial deterioration/improvement to something that people value highly, either lasting for an indefinite time or affecting many people in a widespread area.
Moderate	• Noticeable deterioration/improvement to something that people value highly, either lasting for an extensive time or affecting a group of people.
Minor	• Mild deterioration/improvement, for a reasonably short time, for a small number of people who are generally adaptable and not vulnerable.
Minimal	• Little noticeable change experienced by people in the locality.

Source: Technical Supplement to SIA Guideline (NSW DPE, 2023c)

Table 18.2 Defining likelihood levels of social impacts

Likelihood level	Definition
Almost certain	Definite or almost definitely expected (for example, has happened on similar projects)
Likely	High probability
Possible	Medium probability
Unlikely	Low probability
Very unlikely	Improbable or remote probability

Source: Technical Supplement to SIA Guideline (NSW DPE, 2023c)

Table 18.3 Social impact significance matrix

	Minimal	Minor	Moderate	Major	Transformational
Almost certain	Low	Medium	High	Very high	Very high
Likely	Low	Medium	High	High	Very high
Possibly	Low	Medium	Medium	High	High
Unlikely	Low	Low	Medium	Medium	High
Very unlikely	Low	Low	Low	Medium	Medium

Source: Technical Supplement to SIA Guideline (NSW DPE, 2023c)

18.3.2 Study area

The study area for this assessment was divided into a local area and a regional area.

The local study area includes the communities most likely to be most affected by impacts of the project, including changes to noise, air quality and visual impacts. The regional study area includes the communities that would possibly be affected by visual and noise impacts of the project.

Noise impacts are identified as per noise metrics applied within Technical paper 1: Aircraft noise (Technical paper 1). Key noise metrics considered by this assessment are:

- Australian Noise Exposure Concept (ANEC), which informs land use planning around airports and describes the cumulative aircraft noise for an annual average day
- N-above contours of N60 (24-hour), N60 (Night-time) and N70 (24-hours). These describe aircraft noise impacts by the number of noise events that exceed a certain noise level. N-above contours provide cumulative-event descriptor which provide as assessment of the sustained exposure to aircraft noise.

18.3.2.1 Local study area

The local study area (refer to Figure 18.2) includes the Australian Bureau of Statistics (ABS) Suburbs and Localities (SALs) within a 10 kilometre (km) radius from the centre of the runway. This represents residential communities that are within the ANEC 20 and noise contours (N60 and N70), as well as potentially affected by visual impacts and changes to air quality.

The following SALs are included in the local study area:

- Austral
- Badgerys Creek
- Bringelly
- Cobbitty
- Cecil Park
- Horsley Park
- Glenmore Park
- Greendale
- Kemps Creek
- Luddenham
- Mulgoa
- Mount Vernon
- Orchard Hills
- St Clair
- Rossmore
- Silverdale
- Wallacia
- Warragamba.

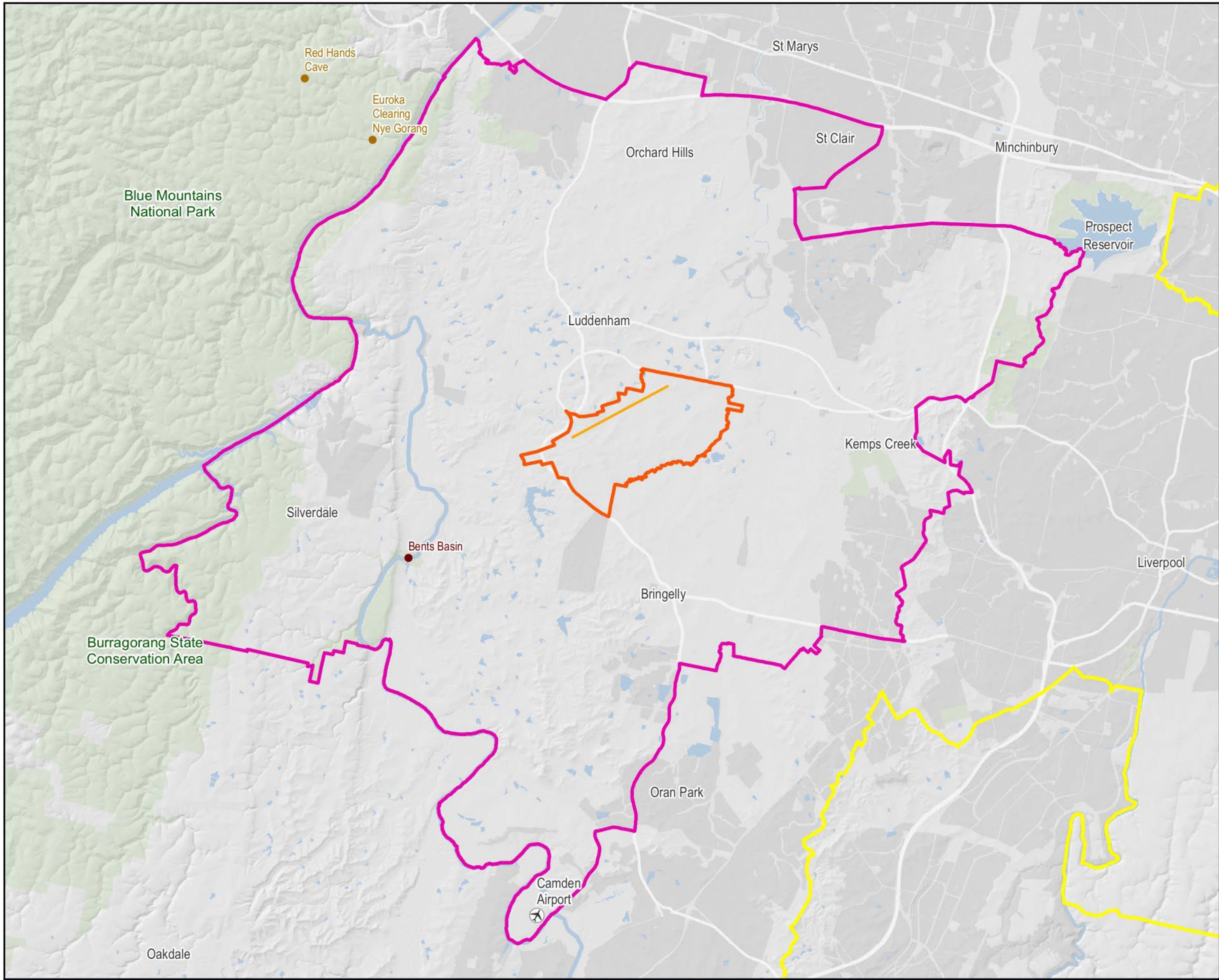
18.3.2.2 Regional study area

The regional study area (see Figure 18.3) includes the LGAs in which residential areas are intersected by noise contours (N60 and N70). The following LGAs are included in the regional study area:

- Blacktown LGA
- Blue Mountains LGA
- Camden LGA
- Fairfield LGA
- Hawkesbury LGA
- Liverpool LGA
- Penrith LGA
- Wollondilly LGA.

Figure 18.2

Local study area



Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- Regional study area
- Local study area
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

Coordinate system: GDA 1994 NSW Lambert

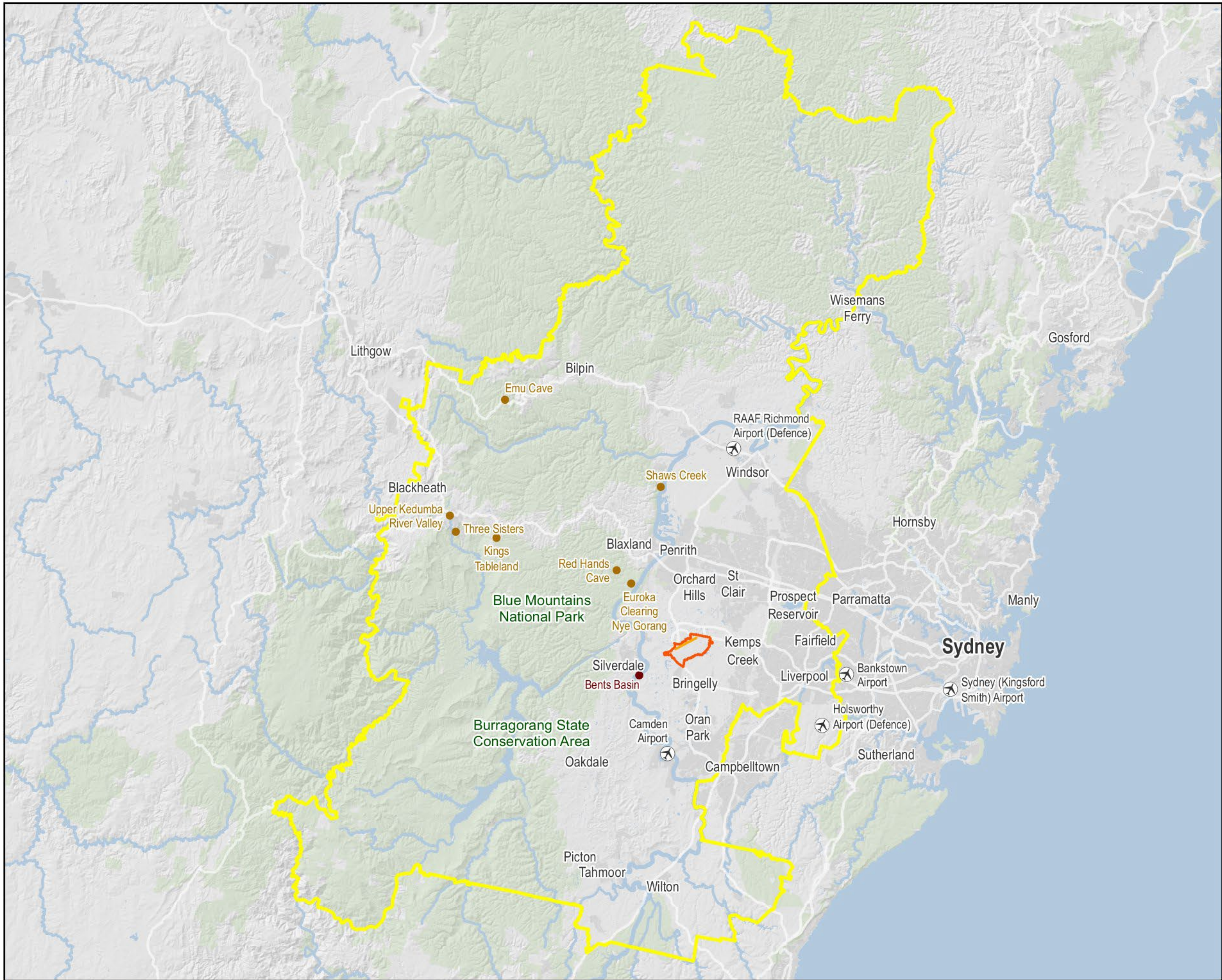
Scale ratio correct when printed at A4

1:175,000 Date: 28/06/2023

Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

Figure 18.3

Regional study area



Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- Regional study area
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:800,000 Date: 1/08/2023

Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

18.3.3 Dependencies and interactions with other study areas

This assessment has been informed by the technical papers in Table 18.4.

Table 18.4 Dependencies and interactions with other Technical Papers

Technical paper	Relevance
Technical paper 1 – Aircraft noise	Informs the assessment of social impacts derived from changes to noise exposure, including enjoyment of private and public space, community wellbeing and sense of belonging.
Technical paper 2 – Air quality	Informs the assessment of social impacts derived from changes to air quality, including sense of clean environment, enjoyment of private and public space, and community wellbeing.
Technical paper 4 – Hazard and risk	Informs the assessment of social impacts related to community wellbeing and surroundings.
Technical paper 5 – Wildlife strike	Informs the assessment of potential wildlife strike risk that may impact community wellbeing.
Technical paper 6 – Land use and planning	Informs the assessment of social impacts related to land use.
Technical paper 7 – Landscape and visual amenity	Informs the assessment of social impacts derived from changes to landscape and visual, including enjoyment of private and public space, community wellbeing and surroundings.
Technical paper 8 – Biodiversity	Informs the assessment of potential biodiversity impacts on community wellbeing.
Technical paper 9 – Heritage	Informs the impact assessment of social impacts related to Indigenous culture and wellbeing, as well as impacts to non-indigenous heritage.
Technical paper 11 – Economic	Informs the assessment of social impacts related to livelihoods.
Technical paper 12 – Human health	Informs the assessment of social impacts related to community wellbeing and accessibility.
Technical paper 14 – Greater Blue Mountains World Heritage Area	Informs the impact assessment of social values related to the GBMA and conversely this SIA informs the impacts to social values for Technical paper 14.

18.3.4 Limitations

The limitations of this assessment are included in Table 18.5.

Table 18.5 Limitations

Feature	Limitation
Reflection of the impacts of COVID-19 data	While data from the 2021 Census is the most up to date and comprehensive source of demographic data for the local and regional study area, it should be noted that these results may have been impacted by the COVID-19 pandemic and may not be illustrative of typical statistics shown in previous census data. This limitation has been addressed by implementing a comprehensive engagement plan with Councils, residents, and community representatives.
Use of composite noise contours	Composite noise contours are considered in this report to identify the extent of potential noise impacts. It is acknowledged that the actual numbers of people and dwellings within each noise contour could be lower depending on the choice of operating scenario.
People's knowledge and understanding of the project	Details pertaining to the location and potential impacts of the flight paths were not used during consultation for this SIA, as these had not been released at the time of preparing this report. As a result, the contribution that the community and key stakeholders have been able to make to assessing social impacts resulting from the project has been limited to speculation and details from previous flight paths released in the 2016 EIS process, which have since changed.
Limited consultation with First Nations groups	SIA engagement with First Nations groups was informed by findings from the Cultural Heritage consultant as part of their engagement with First Nations community members and Local Aboriginal Land Councils for Technical paper 9. To further assist in the assessment of social impacts associated with First Nations groups, a WSP Indigenous Services specialist reviewed the content and provided feedback, which has been incorporated accordingly.
Distinction between WSI and flight path social impacts	During both Draft EIS engagement and SIA consultation, feedback about the approvals, construction, and operation of WSI was provided. This SIA acknowledges that people's experience with the WSI 2016 EIS process and current construction shape the views, concerns and aspirations of residents, community representatives and key stakeholders. At the time of consultation, many people conflated the perceived impacts of WSI and the impacts of the flightpaths.
Statistical significance of consultation	The local study area is composed of 80,358 people, while the regional study area had a total population of 1,379,196 people. Given the large population of both study areas, the SIA approach is based on a qualitative method of data analysis rather than a quantitative method. The findings are understood to be true for the specific groups consulted. The findings are not assumed to be representative of the study area as a whole. This limitation was addressed by ensuring the SIA was informed by the EIS engagement, which included the participation of 2,681 people in pop-ups across the LGAs within the regional study area, and also a review of the EIS engagement survey which included the responses of 804 people.
Limited consultation to communities who have experienced changes to flight paths	At the time of writing this report, consultation with people who have been through changes to their airspace was not possible. This limitation was addressed by triangulating consultation findings with the technical studies conducted for the project, as well as the findings from published research on this specific subject matter.
Management measures	Operations at WSI and the associated airspace in the Sydney Basin are being introduced within a well-established regulatory and management framework. The feasibility of management measures was reviewed by DITRDCA, who refined and prioritised the measures applicable to this project.

18.4 Existing environment

18.4.1 Local study area

18.4.1.1 Population

At the time of the 2021 Census the population in the local area was a total of 80,358 people. The largest proportion of the total population are located in Glenmore Park (31.1 per cent), St Clair (24.8 per cent) and Austral (11.2 per cent). The smallest populations in the local study area are Badgerys Creek and Greendale.

The greatest changes in population between 2016 and 2021 were:

- Austral, an increase of 126.4 per cent (an average annual increase of 25.3 per cent)
- Cobbitty, an increase of 103.9 per cent (an average annual increase of 20.8 per cent)
- Badgerys Creek, a decrease of 25.3 per cent (an average annual decrease of 5.1 per cent), likely due to changes in land zoning in the area and property acquisitions for the numerous infrastructure projects in the suburb to support the future airport
- Silverdale, an increase of 23.4 per cent (4.7 per cent average annual growth rate).

The available population forecast data for the local study area indicated extreme growth (452.9 per cent) by 2041. The majority of this growth will be experienced in:

- Austral, an estimated 55,204 people (406.9 per cent growth)
- Rossmore area, an estimated 65,654 people
- Liverpool's portions of Greendale, Luddenham, Silverdale and Wallacia, with an estimated 29,190 people (454.0 per cent growth).

The average median age in the local study area ranged from 31 to 47 years old. The Blue Mountains LGA had the highest median age (45 years), while Camden, Liverpool and Blacktown LGAs had the lowest age (33–34 years). The highest median ages in the local area are Orchard Hills (47), Horsley Park (45 years) and Kemps Creek (44 years). Suburbs with highest proportions of older age groups (60+) are Badgerys Creek (30.4 per cent), Horsley Park (28.6 per cent) and Orchard Hills (27.9 per cent).

Around 56.3 per cent of people were residing in the same place in 2021 as they were in 2016, 30.9 per cent of people lived elsewhere in Australia in 2016 and 1.6 per cent lived overseas in 2016.

The suburbs in the local study area with the most consistent population (least mobility) are Orchard Hills, Mount Vernon and Horsley Park. Austral and Cobbitty, on the contrary, had the most population mobility (only 19.1 per cent and 36.5 per cent, respectively, were residing in the same place in 2021 as in 2016). All other suburbs had between 55 to 69.9 per cent of people living in the same place in 2021 as in 2016. Overall, this indicates potentially high levels of community connection to place, which is likely to grow when people live longer in a certain area.

Engagement with community and key stakeholders indicated that communities were experiencing changes in community composition due to acquisition for infrastructure projects and development in and around WSI. Stakeholders indicated that smaller households were moving out, whereas households on agricultural properties were remaining.

18.4.1.2 Housing and household composition

Housing

Within the local study area:

- most median weekly rent payments in the local study area are higher than the NSW average, except for Warragamba, Wallacia, and Cecil Park
- median monthly mortgage repayments are more expensive than NSW average ($2,167) in all areas except Warragamba, Badgerys Creek, Kemps Creek and Rossmore
- around one third of households across the study local area are experiencing rental affordability stress (rent payments greater than or equal to 30 per cent of household income). Areas with the greatest proportion of households suffering rental affordability stress include Austral, Rossmore, Bringelly, Warragamba, Kemps Creek and Badgerys Creek
- most areas within the local study area have around one fifth of its households experiencing mortgage affordability stress (mortgage payments greater than or equal to 30 per cent of household income). Areas with the greatest proportion of households suffering mortgage affordability stress are Badgerys Creek, Horsley Park, Austral and Cecil Park. Greendale had no households suffering from mortgage affordability stress, according to Census data.

There are a total of 25,094 private dwellings in the local study area, of which 92.7 per cent are occupied and 3.9 per cent are unoccupied. The area with the greatest proportion of occupied private dwellings are Glenmore Park and St Clair (97.3 per cent).

The majority of occupied private dwellings are detached dwellings (94.4 per cent). There are small proportions of semi-detached houses (3.4 per cent) and apartments (1.4 per cent), suggesting that the majority of population in the local study area lived in low to medium density housing. This is consistent with the more rural nature of the areas surrounding the WSI site.

In the local study area there are 127 social housing tenures. The majority of social housing is located in Glenmore Park (52.8 per cent), St Clair (39.4 per cent), Cobbitty (3.1 per cent), Austral (2.4 per cent) and Kemps Creek (2.4 per cent).

Consultation with Blue Mountains City Council highlighted impacts to housing availability for residents due to competition with the short-term rental and holiday market. This is reflected in a significantly lower residential vacancy rate in the Blue Mountains, which has been below 3 per cent since January 2022 (SQM Research, 2022) and indicates an undersupply of rental options in the area.

Engagement with the Wallacia Progress Association highlighted the long-term use of caravan parks by residents and impacts to these residents by recent flooding events. Concerns were raised that this housing type, alongside older housing stock, would be difficult to acoustically treat.

Family composition

Family and household composition in the local study area is relatively similar to the NSW average with the largest proportions of households being families, of which most are couples with children. Within the local study area:

- Luddenham has the highest proportion of couple families with children (60.4 per cent) Badgerys Creek and St Clair have greater proportions of couple families without children
- Warragamba, Greendale and Badgerys Creek have higher percentages of single parent families compared to the NSW average (15.8 per cent)
- single or lone person households across the local study area are generally lower than the NSW average (25 per cent), except at Warragamba (28.8 per cent)
- Greendale and Badgerys Creek have a higher proportion of group households (around 8.2–8.8 per cent) compared to other locations within the local study area and the NSW average (8 per cent).

Future residential development

Camden, Wollondilly and Fairfield City councils commented on implications to future growth areas and requirements on residential development to address aircraft noise. Fairfield City Council expressed concern that changes recently made by NSW Government that restrict certain land uses in the ANEC contour was unreasonable and inequitable.

18.4.1.3 Workforce

Employment and income

Within the local study area:

- in the 2021 Census, a large proportion of people worked from home (around 20.8 per cent). As with other areas of Australia and the world, this has increased significantly following 2020 with the COVID-19 pandemic causing many people to work from home during lockdowns. It should be noted that the 2021 Census was undertaken during a lockdown period in the local area and therefore should not be taken as representative of the ordinary level of people working from home, either pre-COVID or currently. Within the study area, Badgerys Creek, Horsley Park, Cecil Park and Austral had higher percentages of people working from home (around 31.7 to 41.5 per cent)
- median weekly incomes are mostly higher than the NSW average ($1,829) throughout the local study area, except at Rossmore, Cecil Park, Bringelly, Warragamba, Badgerys Creek and Kemps Creek which are lower. The proportion of low-income households is greatest in areas such as Greendale, Kemps Creek and Badgerys Creek. The proportion of high-income households is greatest in Mulgoa, Glenmore Park, Cecil Park and Orchard Hills.

18.4.1.4 Advantage and disadvantage

The ABS Socio-Economic Index for Areas (SEIFA) assesses the economic and social conditions of households within an area. SEIFA consists of 4 indexes measuring relative advantage and disadvantage. Areas ranking in the lowest 10 per cent of areas are deemed most disadvantaged and the highest 10 per cent least disadvantaged.

Key findings from analysis of the indexes for communities within the local study area include:

- Greendale, Badgerys Creek, Kemps Creek, Austral, Rossmore and Warragamba ranked within the bottom 50 per cent of communities in all indexes, suggesting:
  - higher numbers of households with low income, no qualifications or in low skill occupations
  - few households with high incomes, or few people in skilled occupations
  - many households paying low rent and few with owned homes
  - many unemployed people and few people with a high level of qualification or in highly skilled occupations
- Cobbitty, Glenmore Park, Luddenham, Silverdale, Mount Vernon and Mulgoa ranked within the highest 25 per cent of communities in all indexes, suggesting these communities are among the relatively most advantaged and least disadvantaged communities in Australia
- Austral, Badgerys Creek, Bringelly, Kemps Creek, Rossmore, St Clair, Wallacia and Warragamba ranked in the bottom 30 per cent of areas for Index of Education and Occupation (IEO). This is consistent with the rural/semi-rural character of the region and lack of professional employment opportunities. Warragamba has the lowest ranking within the local study area.

18.4.1.5 Community identity and values

Indigenous cultural heritage

The local study area is within the Deerubbin, Tharawal and Gandangara Local Aboriginal Land Councils on Dharug Country. Within the local study area there is a total of 2,658 First Nations people, accounting for 3.3 per cent of the total population, which is similar to the NSW average (3.4 per cent). Areas with the largest First Nations population are Warragamba, Silverdale, Wallacia, St Clair and Glenmore Park.

There are 2 active native title claims that intersect the regional study area, the Warrabinga-Wiradjuri #7 claim intersects the Blue Mountains LGA to the north, and the South Coast People claim intersects the Liverpool and Wollondilly LGAs to the South. These claims are both active and have not yet been determined.

Cultural diversity

Greater Western Sydney is well known as having a large cultural and linguistically diverse population.

The local study area is much less culturally diverse compared to the regional study area and is characterised by a greater proportion of people born in Australia (79.7 per cent). The largest proportion of people born overseas in the local study area were born in England (2.0 per cent), India (1.5 per cent), New Zealand (1.2 per cent) and Italy (1.1 per cent). Suburbs with relatively low proportions of people born in Australia include Badgerys Creek (51.2 per cent) and Austral (50.3 per cent).

In the local study area 23.5 per cent of people speak a language other than English at home. Communities within the local area with the greatest levels of language diversity include Austral (52.7 per cent), Badgerys Creek (45.8 per cent), Cecil Park (41.7 per cent) and Rossmore (40.4 per cent). The most commonly used languages (other than English) within the local study area are Arabic (3.6 per cent), Italian (1.5 per cent), Tagalog (0.8 per cent) and Punjabi (0.7 per cent).

Community values

A review of local council strategies and engagement with stakeholders identified that the following values are consistently held across the local study area:

- environmental values – valuing and a desire to preserve and enhance the natural environments in the region, as well as access to green open spaces for fitness and recreation
- rural to semi-rural lifestyle – large portions of all of the LGAs (Fairfield excepted) are rural/semi-rural and the communities value the character and amenity afforded by the rural setting. The amenity of Luddenham village was commented on during consultation (for example, beautiful country town, peaceful and quiet)
- sense of belonging – the feeling of belonging in their community was highlighted in several of the LGAs
- First Nations culture – Local councils highlighted the value of First Nations culture within their LGAs
- transport and connectivity – access to quick and easy public transport infrastructure, and the importance of safety on roads were noted in many of the council's documents.

These values will also apply to those who identify as Indigenous or culturally diverse.

Greater Blue Mountains Area (GBMA) values

The GBMA is an area of significant cultural value for Australia and the world and was listed in 2000 for its natural values. The GBMA has both Indigenous and non-Indigenous cultural values. Intrinsic cultural values of the GBMA include connections to Country for 6 Indigenous language groups through ongoing custodial relationships with the area. Physical evidence of cultural connections is present in rock art and occupation sites throughout the GBMA.

The Blue Mountains was often described during engagement as peaceful, serene and wild. Wilderness values were most commonly noted, closely followed by biodiversity values, Indigenous heritage, scenic values and the overall value of the area's status as a UNESCO World Heritage Area. Recreation activities, including bushwalking, hang-gliding and more passive forms of recreation, were also considered important.

Other values

Community and stakeholder engagement also identified values concerning the environment (soil, air and water), and impacts by the future airport on water quality and agricultural production due to changes in air quality and/or fuel dumping. This included Warragamba Dam and waterways within the GBMA.

18.4.1.6 Health and wellbeing

Need for assistance

There are 3,796 people in the local study area needing assistance within the 3 core activity areas (self-care, mobility and communication). Areas with proportions of the population with need for assistance greater than the NSW average are Badgerys Creek, Kemps Creek, Rossmore, Horsley Park and Orchard Hills.

Long-term health conditions

The leading causes of death in South-Western Sydney and Nepean Blue Mountains Local Health Districts are cancers and circulatory diseases, and respiratory diseases (SWSLHD, 2019; NBMLHD, 2013).

The most prominent long-term health conditions are asthma (7.5 per cent), arthritis (7.3 per cent) and mental health conditions (including depression or anxiety) (6.7 per cent). The predominant existing long-term health conditions in the local study area are:

- high prevalence of asthma in Glenmore Park (8.4 per cent), Silverdale (8.6 per cent), Wallacia (8.6 per cent) and St Clair (8.6 per cent)
- high prevalence of mental health conditions (including depression or anxiety) in Warragamba (10.6 per cent) and Glenmore Park (8.0 per cent)
- high prevalence of heart disease (including heart attack or angina) in Linden, Horsley Park, Greendale, Wallacia, Orchard Hills, Kemps Creek, Bringelly, Mount Vernon and Mulgoa
- high prevalence of lung conditions (including COPD or emphysema) in Warragamba (2.9 per cent) and Luddenham (2.2 per cent).

18.4.1.7 Community facilities and services

This section provides a description of the community facilities and services present in the local study area, or that service communities in the local study area.

Engagement with community stakeholders raised concern with the sustainability of Luddenham village in terms of the continuity of services (education, shopping etc) and community, given the uncertainty about aircraft noise impacts and loss of households due to property acquisition for WSI and other developments.

Education

Within the local study area there are 41 schools (18 government-run and 23 private), including 23 primary schools, 5 secondary schools, 11 combined schools (primary and secondary) and 2 special needs schools.

There are 51 registered childcare centres in the local study area (ACECQA, 2023). The largest proportion of these centres are located in the suburbs of Austral and Glenmore Park.

Health and aged care

There are no hospitals in the local study area.

There are 26 medical centres in the local study area, with the highest numbers in St Clair, Glenmore Park and Austral. Eight out of the 18 suburbs in the local study area do not have medical centres, requiring travel to neighbouring suburbs.

There are 9 aged care facilities in the local study area. The suburbs that have such facilities are Austral (4 aged care facilities), Cobbitty (3), Glenmore Park (one) and Kemps Creek (one).

Recreation

Near WSI is the Twin Creeks Golf and Country Club, Robert Green Oval, Wilmington Reserve, Downes Park, Mulgoa Park and the Workers Hubertus Country Club.

The Blue Mountains is a significant recreation area for residents in Greater Sydney and tourists visiting from elsewhere in NSW, Australia and overseas. The Nepean River in Penrith provides opportunities for boating, fishing, rowing, kayaking and numerous walking tracks along the river.

The Warragamba Dam allows primary and secondary school children to visit on guided excursions to learn about modern water supply and take part in hands-on water activities in the visitor centre.

Places of worship

There are 46 places of worship in the local study area, including 38 churches, 6 temples and 2 mosques. Badgerys Creek and Mount Vernon have no places of worship.

Community centres

There are 12 community centres within the local study area. St Clair and Glenmore Park have the highest number of community centres (4 and 3, respectively). Most of the suburbs do not have any community facilities.

Transport infrastructure

The network of main roads serving the local study area include the M4, M7 and M12 Motorways, Elizabeth Drive, The Northern Road and Badgerys Creek Road. As described in Chapter 4 (Project setting), Sydney Metro – Western Sydney Airport is under construction and would provide connections to St Marys with Orchard Hills, Luddenham, WSI and the Aerotropolis. Longer term planning includes the proposed Outer Sydney Orbital (M9 Motorway). Community engagement identified concerns with public transport connectivity for the northern parts of the local study area through to WSI and further south.

18.4.1.8 Decision-making systems

Decision-making systems is a reference to people's capacity to participate in decision-making systems and accessibility to complaint, remedy and grievance mechanisms. Engagement with key stakeholders and the community within the local study area found that:

- there is uncertainty around the zoning and development controls for land in the Aerotropolis and lack of communication to landowners to understand the implications to their land. The NSW Government has appointed an Independent Community Commissioner for Orchard Hills and the Aerotropolis to work with communities and to raise any issues or concerns with government
- dissatisfaction with the land acquisition process and compensation being offered to landowners impacted by development
- dissatisfaction with the engagement carried out during and following the 2016 EIS and involvement with the decision-making process. Stakeholders expressed their expectation that engagement on this project would enable the community to be better informed and involved in the decision-making process
- the level of detail available to the community prior to the release of this Draft EIS has meant a lack of understanding of the project and its impacts. This has increased the sense of powerlessness and people's capacity to make decisions.

18.4.2 Regional study area

18.4.2.1 Population

At the time of the 2021 Census, the total population in the regional study area was 1,379,196 people, which is just over one quarter (26.4 per cent) of the population in Greater Sydney (5,231,147). Population projections shows that all LGAs are anticipated to experience net growth. The largest population growth is anticipated in Blacktown LGA with a projected 95,465 new residents from 2021–2041, and the largest proportionate change in population is anticipated to occur in Wollondilly (67.4 per cent total growth, 3.4 per cent average annual growth) and Camden (65.7 per cent total growth, 3.3 per cent average annual growth).

The regional study area experienced higher growth than NSW between 2016 and 2021, with an increase of 14.2 per cent compared to 7.9 per cent in NSW. Camden LGA experienced the highest growth of population (52.6 per cent). The Blue Mountains and Hawkesbury LGAs experienced the lowest growth (1.6 per cent and 4 per cent respectively).

The average median age in the regional study area is 37 years old.

Over a half of residents in the regional study area (52.5 per cent) lived in the same place in 2021 as in 2016, 30.4 per cent lived elsewhere in Australia in 2016 and 4.7 per cent lived overseas in 2016. The LGA with the least population mobility is Blue Mountains, with 61.2 per cent of people residing in the same place. The LGA with the most population mobility is Blacktown, with 31.6 per cent of people living elsewhere in Australia in 2016 and 6.8 per cent living overseas. Fairfield had the most people across the regional study area living overseas in 2016.

18.4.2.2 Housing and household composition

Housing

There are a total of 479,566 dwellings in the regional study area, of which 94 per cent are occupied and 6 per cent unoccupied.

Social housing in the regional study area is most prevalent in Fairfield (7.3 per cent) and Liverpool (6.1 per cent), followed by Blacktown LGA (5.9 per cent) and Penrith LGA (3.9 per cent), compared to 3.6 per cent in NSW.

Median weekly rental payments in the regional study area vary between $390 and $500. All LGAs had lower median weekly rents than the NSW average ($420), except for Camden LGA ($500). Fairfield LGA has the lowest rental payment ($390).

Median mortgage repayments vary between $2,00 and $2,500. The lowest mortgage repayment is in Fairfield LGA while the highest is at Camden LGA.

The sales prices for non-strata properties also experienced growth during 2018–2021. As of 2021 the Hawkesbury and Wollondilly LGAs had the highest median sales prices ($1,162,000 and $1,062,000, respectively), while Penrith LGA had the lowest ($949,000).

Family composition

Average household size in the regional study area is 3.2 people. Fairfield and Liverpool LGAs have the highest average household size (3.2 for each LGA), while Blue Mountains LGA is the lowest (2.4 people).

18.4.2.3 Workforce

Employment and income

In the regional study area 26.3 per cent of households are low-income, compared to the average of 25.9 per cent for NSW. Fairfield and Liverpool LGAs have the highest proportions of low-income households (41.4 per cent and 29.8 per cent, respectively). Camden LGA has the lowest (17.2 per cent). At the same time, most LGAs in the regional study area have higher mortgage repayments compared to average NSW.

The rate of unemployment across all LGAs in the regional study area increased from 2018 to 2021 (LMIP, 2022), however has since declined from late 2021 to December 2022. Unemployment is highest in the Fairfield LGA with 8.3 per cent unemployment in December 2022 compared to between 2 per cent and 5.4 per cent in all other LGAs.

The regional study area has similar employment industry profiles to NSW with construction, retail trade, health care and social assistance among the top 5 industries of employment in these areas. The regional study area also has high proportions of persons employed in manufacturing.

In the regional study area 24 per cent worked from home in 2021. LGAs in the regional study area with the highest work from home proportions include Blue Mountains, Camden and Blacktown (around 27.1 to 29.7 per cent).

Tourism

Tourism is an important part of the regional study area economy, particularly in the Blue Mountains. According to the Blue Mountains City Council (2021), tourism:

- brings approximately 4.4 million visitors annually to the Blue Mountains
- provides 2,400 jobs ($121 million in local wages and salaries)
- supports 800 registered tourism businesses
- generates $484 million in turnover ($169 million for supply chains)
- supports $221 million in gross regional product.

Tourism is the second largest employment industry in the Blue Mountains, with two-thirds of these jobs (68.2 per cent) being supported within the accommodation and food services sector. Prior to 2020, the main type of visitor to the Blue Mountains consisted of domestic day-trips (72 per cent), followed by domestic overnight (25 per cent) and international overnight (3 per cent). In 2020, the domestic overnight visitors increased to 34 per cent, with declines in domestic day-trips and international overnight visitation.

COVID-19 and recent natural disasters have had a damaging effect on the tourism industry in the Blue Mountains, with visitation dropping from over 4 million people per year since 2016 to around 2.8 million in 2020. There was a direct loss in revenue of $118 million over 2019/20 – 2020/21, a total gross revenue loss of $186 million (including direct, supply chain, and consumption effects) and a loss of 599 jobs from the workforce.

18.4.2.4 Advantage and disadvantage

Key findings from analysis of the indexes for communities (refer to Section 18.4.1.4) within the regional study area include:

- Fairfield LGA ranked worst with decile one rankings for all indexes, denoting communities who are among the most disadvantaged within NSW
- Liverpool LGA also ranked low for Index of Relative Socio-economic Disadvantage (IRSD) and Index of Education and Occupation (IEO) (4 and 5 deciles, respectively), followed by the Blacktown LGA scoring slightly higher (6 deciles)
- all other LGAs were in the top 30 per cent of least disadvantaged communities in NSW.

18.4.2.5 Community identity and values

Indigenous cultural heritage

In the regional study area there are 39,686 people identifying as Aboriginal and/or Torres Strait Islander people, accounting for 2.9 per cent of the total population. The LGAs within the regional study area with the greater proportions of people identifying as Aboriginal and/or Torres Strait Islander people than the NSW average are Penrith, Hawkesbury and Wollondilly.

Cultural diversity

In the regional study area 34.7 per cent of the population was born overseas. Fairfield LGA has the largest percentage of people born overseas (61.4 per cent), followed by Blacktown LGA (49.6 per cent) and Liverpool LGA (48.8 per cent). The LGAs with lowest percentage of people born overseas are Wollondilly (15.8 per cent), Blue Mountains (21.8 per cent), Camden (25.9 per cent) and Penrith (28.7 per cent).

In the regional study area 20 per cent of households speak a language other than English at home, compared to 29.5 per cent in NSW. The highest proportion of such households include Fairfield (49.8 per cent), Liverpool (32.2 per cent) and Blacktown (25.5 per cent) LGAs.

18.4.2.6 Health and wellbeing

Need for assistance

In the regional study area 5.9 per cent of the population have need for assistance within the 3 core activity areas (self-care, mobility and communication). This is due to long-term health conditions (lasting 6 months or more), a disability, or old age. The LGA in the regional study area with the highest proportion of people needing assistance is Fairfield (9.3 per cent).

Long-term health conditions

The most prominent long-term health conditions in the regional study area are asthma (7.4 per cent), arthritis (7.1 per cent), and mental health conditions (including depression or anxiety) (6.8 per cent), as well as other long-term health condition (7.7 per cent).

The most common long-term health conditions for First Nations communities in the regional study area include asthma (16.0 per cent), mental health conditions (14.9 per cent), other long-term conditions (9.8 per cent), and arthritis (6.9 per cent).

18.4.2.7 Community facilities and services

Education

There are 428 schools in the regional study area, including 287 primary schools, 99 secondary schools, and 42 combined schools (primary and secondary). In addition, there are 82 childcare, long day and preschool facilities within the regional study area. This includes 61 long day care, 13 government funded preschools and 8 government run preschools.

Health and aged care

The regional study area has 12 hospitals.

There are around 19 residential care facilities within the regional study area. These facilities provide an estimated 1,462 residential places and 76 restorative care places (Technical paper 11: Economic).

Recreation

There is a significant number of outdoor recreational spaces across the regional study area, for example:

- Penrith LGA has around 144 parks and reserves
- Liverpool LGA has 512 parks and 217 sporting fields, ovals and courts.

18.5 Assessment of impacts

This chapter provides a summary of the potential residual social impacts derived from the project for the 2033 and 2055 scenarios. Technical paper 10 provides a detailed assessment of the potential pre-mitigated social impacts of the project which also considers the strategic planning context of the study area, including planning strategies, environmental planning instruments, precinct plans, and development controls plans.

18.5.1 Community

The definition of community covers the composition, cohesion and character of communities, how that community functions, its values and resilience and sense of place.

The assessment of community considers the actual or perceived impacts of the project on the community composition and character, and impacts to equality.

18.5.1.1 Changes to community composition and cohesion

An increase in noise levels experienced by those in the local and regional study area may lead to a decision to relocate to maintain their current lifestyle. This can often result in changes to community composition and cohesion for those people who will stay, and those who will leave.

During consultation, local councils and residents raised concerns about the potential loss of community cohesion, noting that communities are experiencing changes to community composition due to rezoning.

Community representatives indicated that even though some people will choose to leave, this may not be an option for others. As such, people leaving the area may result on an altered sense of belonging and community cohesion, especially for those deciding to stay.

By 2033, 74 people may be living within the ANEC 25 contours and 310 people may be living within ANEC 20. These populations are located within parts of the localities of Luddenham, Badgerys Creek, Kemps Creek, Greendale and Silverdale.

Considering people's values to peace and quiet lifestyle it is possible that a portion of people living within those contours may decide to relocate to maintain their lifestyle. Given the larger populations with the LGAs in the regional study area, it is considered unlikely that people deciding to relocate would have a significant impact on community cohesion or sense of place for those deciding to stay.

The changes to community composition and sense of belonging are summarised in Table 18.6 and further explained in Technical paper 10. The assessment has identified that the potential for ongoing impacts to community composition and cohesion would be Medium within the local study area in 2033, reducing to Low by 2055.

Table 18.6 Summary of changes to community composition and sense of belonging

Scenario	Extent	Likelihood	Magnitude	Residual impact
2033	Changes to community composition and sense of belonging in Luddenham, Badgerys Creek, Kemps Creek, Greendale and Silverdale	Possibly	Moderate	Medium
	Changes to community composition and sense of belonging in the local study area (outside the areas identified above)	Unlikely	Minor	Low
	Changes to community composition and sense of belonging in the regional study area	Very unlikely	Minor	Low
2055	Changes to community composition and sense of belonging in Luddenham, Badgerys Creek, Kemps Creek, Greendale and Silverdale	Very unlikely	Minor	Low
	Changes to community composition and sense of belonging in the local study area (outside the areas identified above)	Very unlikely	Minor	Low
	Changes to community composition and sense of belonging in the regional study area	No impact anticipated		

18.5.1.2 Increased inequality

There are several ways in which aircraft noise can impact population inequality, leading to creating and or exacerbating inequality, such as health, economic and educational disparities.

The extent of aircraft noise-related disturbance on inequality in this assessment was achieved through:

- understanding existing vulnerability conditions
- consulting with affected communities
- understanding people's exposure to aircraft noise.

Vulnerability conditions within both the local and regional study area were identified in census data and during consultation. The number and loudness of flight movements expected to occur arguably corresponds to the magnitude of the inequality impact expected.

Given the different vulnerability conditions to which the populations in the local and regional study areas are exposed, it can be argued that the impacts of noise would be experienced more acutely within the overall study area. As such, it is possible that aircraft noise could lead to a minor increase of socio-economic disadvantage.

WSI, the Aerotropolis and Bradfield City Centre, together with new infrastructure and services associated to those developments, are expected to improve the socio-economic conditions within the regional study area.

The inequality impact is summarised in Table 18.7 and further explained in Technical paper 10 (Section 6.1.2). The assessment has identified that the potential increase of inequality for vulnerable groups located in areas within ANEC 20, N60 and N70 contours for both the 2033 and 2055 scenarios would remain as the only potential impact with a High significance rating in both 2033 and 2055.

Table 18.7 Summary of increased inequality

Scenario	Extent	Likelihood	Magnitude	Residual impact
2033	Increased inequality for vulnerable groups under ANEC 20, N60 and N70 contours	Likely	Moderate	High
	Increased inequality within the local study area	Possibly	Minimal	Low
	Increased inequality within the regional study area	Possibly	Minimal	Low
2055	Increased inequality for vulnerable groups under ANEC 20, N60 and N70 contours	Likely	Moderate	High
	Increased inequality within the local study area	Possibly	Minimal	Low
	Increased inequality within the regional study area	Not possible to be determined at this point		

18.5.2 Way of life

Way of life is defined as how people live, get around, work, play and interact each day.

The assessment of way of life considers the actual or perceived impacts of the project on the amenity of residential areas as well as other private open spaces and community infrastructure.

18.5.2.1 Changes to way of life as a result of loss of residential amenity

Aircraft noise and/or potential changes to air quality during the day or night could result in changes to way of life via a loss of residential amenity. Changes to way of life might include disruption to working from home and changes in the way people use and enjoy residential indoor and outdoor space (backyards).

During consultation it was raised that noise impacts should be considered from an indoor and outdoor space perspective, noting that the enjoyment of recreational space is a key reason people choose to live in the area.

By 2033 there would be about 310 people located in the ANEC 20 contour, and 74 people located within the ANEC 25. Around 132,000 people would be exposed to an average of more than 10 daily movements above 60 decibels daily, and around 5,100 people would be exposed to an average of more than 5 daily movements above 70 decibels within the regional study area. This level of noise is associated with events that can impact a normal conversation, even in urban areas.

By 2055 the number of people living within the ANEC 20 and 25 contours would increase. It is possible that the increased frequency of aircraft movements by 2055 would lead to loss of residential amenity for those within the local study area who were living on existing dwellings outside ANEC 20 and 25 in 2033. For the regional study area, it is anticipated that new residential developments will meet higher noise insulation standards and people would become accustomed to aircraft noise.

No unacceptable impacts for the local air quality are expected in 2033, meaning the project would not result in any tangible or significant impact to air quality including odour (refer to Chapter 12 (Air quality and greenhouse gas)). Minor exceedances of nitrogen dioxide (NO_2) and particulate matter 2.5 ($PM_{2.5}$) are forecast by 2055 in locations very close to the Airport Site.

The changes to way of life due to residential amenity loss (with mitigation) is summarised in Table 18.7 and further explained in Technical paper 10. The assessment has identified that changes to way of life as a result of loss of amenity would be Medium in the local study area in 2033 and 2055.

Table 18.8 Summary of changes to way of life due to residential amenity loss

Scenario	Extent	Likelihood	Magnitude	Residual impact
2033	Changes to way of life due to residential amenity loss within the local study area	Possibly	Moderate	Medium
	Changes to way of life due to residential amenity loss within the regional study area	Unlikely	Minor	Low
2055	Changes to way of life due to residential amenity loss within the local study area	Unlikely	Moderate	Medium
	Changes to way of life due to residential amenity loss within the regional study area	Unlikely	Minimal	Low

18.5.2.2 Changes to the use and enjoyment of social infrastructure

Research has documented that noise and visual impacts can change the way people enjoy the use of public and private infrastructure. For example, making it difficult for people to have conversations or simply enjoying the views and quietness.

There are several large recreation and tourism-based land use assets within the study area. Based on the median age of the local and regional study area, plus the large proportion of children and young families, there may be a large percentage of the population who actively use and enjoy the social infrastructure within the study area.

During consultation, concerns were raised about the reduction in quality of open space from noise. The magnitude of this impact is gauged by understanding the predicted levels of noise and visual change to be experienced within the study area. Within the GBMA, visitors may experience changes to the use and enjoyment of walking tracks and lookouts. Technical paper 1 identified that the majority of the broader GBMA is largely outside the area predicted to experience aircraft noise at or above 60 dB and 70 dB.

It can be anticipated that users of public and private infrastructure within noise contours and the landscape impact study area (up to 15 km from WSI) are likely to see diminished enjoyment and use of those spaces, and possibly will increase their usage of other spaces within the local and regional study area. However, for the broader GBMA changes are assessed as being Low.

The changes to the use and enjoyment of social infrastructure (with mitigation) is summarised in Table 18.9 and further explained in Technical paper 10. The assessment has identified that changes to way of life as a result of loss of amenity would be Medium in the local study area and Low in the GBMA and regional study area in 2033, reducing to Low in 2055.

Table 18.9 Summary of changes to the use and enjoyment of social infrastructure

Scenario	Extent	Likelihood	Magnitude	Residual impact
2033	Changes to the use and enjoyment of social infrastructure within the local study area	Possibly	Moderate	Medium
	Changes to the use and enjoyment for GBMA visitors to lookouts and walking tracks under N60 and N70 contours	Possibly	Moderate	Medium
	GBMA	Possibly	Minimal	Low
	Changes to the use and enjoyment of social infrastructure within the regional study area	Unlikely	Minor	Low
2055	Changes to the use and enjoyment of social infrastructure within the local study area	Very unlikely	Minor	Low
	Changes to the use and enjoyment for GBMA visitors to lookouts and walking tracks under N60 and N70 contours	Possibly	Moderate	Medium
	GBMA	Possibly	Minimal	Low
	Changes to the use and enjoyment of social infrastructure within the regional study area	Unlikely	Minor	Low

18.5.3 Culture

Culture refers to Indigenous and non-Indigenous culture, including shared beliefs, customs, practices, obligations, values and stories, and connection to Country, land, waterways, places and buildings.

The assessment of culture considers the actual or perceived impacts of the project on the Indigenous community's connections to Sky.

18.5.3.1 Effect to Aboriginal cultural values due to impacts tangible and intangible Aboriginal cultural heritage

Impacts to Aboriginal culture are understood by analysing the potential negative effects to tangible and intangible aspects of cultural heritage, and changes to First Nations people's experience and enjoyment during the exercise of cultural practices.

During consultation, concerns about impacts to the cultural and spiritual aspects of Country were raised by the Blue Mountains City Council and Wollondilly Shire Council.

The project would not result in any impacts to Native Title claims. However, Native Title claimants together with First Nations groups residing and connected to the regional study area may experience changes to Aboriginal cultural values. Engagement with First Nations communities identified a list of places of high cultural value.

As discussed in Chapter 17 (Heritage), noise and visual intrusion can impact cultural values where those values include the need for peace, tranquillity, and spiritual connection. In particular, noise does have the potential to disrupt cultural practices at site, which could lead to its use being discontinued. Aircraft on WSI flight paths could also be detrimental to sites connected to the Emu in the Sky constellation at Faulconbridge and Emu Cave Aboriginal Place. Due to the position of flight paths, frequency of overflight and the predicted noise levels, the project would significantly impact Aboriginal cultural values of Bents Basin and the Shaws Creek – Yellomundee Aboriginal Place, which are places of cultural importance with values associated with peace, tranquillity and connection to nature. These are not located within the GBMA. Impacts to other key sites of cultural significance identified through engagement would have low to moderate impacts due to noise and/or visual intrusion.

It is acknowledged that flight paths affect a limited area within the broader GBMA, which overlaps with sections of the Blue Mountain National Park boundaries. One site within the GBMA (Yellomundee) has been identified as having a potential significant impact from noise intrusion and visual impacts and therefore the social impact to the GBMA Aboriginal cultural values is Medium.

Impacts to Aboriginal culture is summarised in Table 18.10 and further explained in Technical paper 10 . The assessment has identified that potential impacts to Aboriginal culture as a result of the project would be Medium in the local and regional study area in 2033 and 2055.

Table 18.10 Summary of effect to Aboriginal culture

Scenario	Extent	Likelihood	Magnitude	Residual impact
2033	Impacts to Aboriginal cultural values within the regional study area	Possibly	Minor	Medium
	Impacts to Aboriginal cultural values linked to GBMA	Possibly	Minor	Medium
2055	Impacts to Aboriginal cultural values within the regional study area	Possibly	Minor	Medium
	Impacts to Aboriginal cultural values linked to GBMA	Possibly	Minor	Medium

18.5.3.2 Non-Aboriginal cultural impacts

Impacts to historic heritage places are largely limited as the first principle of flight path design was limiting direct overflights in populated areas (such as Katoomba), although some aircraft may still be visible in the distance and will be heard.

As discussed in Chapter 17 (Heritage), Mulgoa is a historic rural village with several significant historic heritage properties such as Fern Hill Estate and St Thomas Church. These properties would be subject to moderate impacts as they could be directly overflown at relatively low altitudes by 10 to 20 flights per day that reach 60 dB(A) by 2055. This level of noise exposure is associated with the use of RWY05 departures at night and may be lower depending on the choice of runway operating scenario.

During consultation, no specific concerns about historic heritage places were raised by respondents during interviews and a survey. Consequently, it can be argued that while some visual and noise impacts could impact the way people enjoy historical places, it is very unlikely this would cause impact to non-Aboriginal cultural values for the local social locality and regional social localities for both 2033 and 2055 scenarios.

18.5.4 Accessibility

Accessibility refers to how people access and use infrastructure, services and facilities, where provided by a public, private or not-for-profit organisation.

The assessment of accessibility considers the actual or perceived impacts of the project on the housing affordability and availability, the socio-economic sustainability of Luddenham village and schools due to changes to population composition and density.

18.5.4.1 Constrained housing availability and affordability

Flight paths could affect the extent of areas suitable for residential development and therefore limit the availability of housing in some areas. Limited availability may be associated with reduced affordability for some communities, noting existing housing stress was identified in the baseline analysis (Section 18.4).

During consultation, local councils and community organisations raised concerns about how flight paths could limit residential land uses and result in new building requirements for new residential developments.

For the 2033 scenario, the aircraft noise assessment predicts that 93 dwellings would be located within the ANEC 20 contour, while for the 2055 scenario a total of 320 dwellings are anticipated. No new residential development would be permitted within the ANEC 20 and above contours that have not already been approved.

The *Western Sydney Aerotropolis Precinct Plan* (Aerotropolis Precinct Plan) identifies that only a few centres in the Aerotropolis would be suitable for residential uses because of aircraft noise and other airport operational constraints. Badgerys Creek precinct is not suitable for residential development. The Luddenham Village Interim Strategy will inform the Luddenham Village Plan which will outline land use planning provisions and controls (including development within the ANEC 20 contour) relating to Luddenham Village and will be incorporated into the Aerotropolis Precinct Plan.

Considering existing planning controls, estimated population growth and potential changes to land use provisions in Luddenham, it is possible that residing within the ANEC 20 would experience increased housing affordability stress. For the rest of the local and regional study area, it is unlikely that the project would cause significant changes to housing availability and affordability for the 2033 and 2055 scenarios.

The potential impact to housing affordability is summarised in Table 18.11 and further explained in Technical paper 10. The assessment has identified that potential impacts to housing affordability and availability as a result of the project would be Low in the local and regional study area in 2033 and 2055.

Table 18.11 Summary of impacts to housing affordability

Scenario	Extent	Likelihood	Magnitude	Residual impact
2033	Impacts to housing affordability to communities under ANEC 20	Unlikely	Minor	Low
	Impacts to housing affordability to population within broader local study area	Very unlikely	Minimal	Low
	Impacts to housing affordability to population within broader regional study area	Very unlikely	Minimal	Low
2055	Impacts to housing affordability to population within broader local study area	Very unlikely	Minimal	Low
	Impacts to housing affordability to population within broader regional study area	Very unlikely	Minimal	Low

18.5.4.2 Socio-economic sustainability of Luddenham and accessibility to social services

During consultation, Penrith City Council officers and the Luddenham Progress Association raised concerns about how the uncertainty about flight paths is affecting the ongoing socio-economic sustainability of the Luddenham community, including the continuity of school, shopping and other services (for example, IGA supermarket, post office, doctors, chemist, butcher and bakeries).

Concerns were also raised during consultation about the socio-economic sustainability of the Luddenham and Wallacia public schools due to potential increase of families leaving the area as a result of noise.

It is likely that some people residing locally would decide to relocate as a result of aircraft noise. However, the Aerotropolis Precinct Plan and associated developments are expected to result in an influx of new residents and workers to the local study area, who may access services provided in Luddenham. Prior to the development of the Western Sydney Aerotropolis, however, a decrease of population in Luddenham might occur as a result of uncertainty and changes brought up by the project.

It is possible that Luddenham would experience constraints to the socio-economic sustainability of its village for a moderate period of time. It is expected that, once the Aerotropolis and WSI are fully operational, the sustainability of the Luddenham Village would stabilise and grow.

The impacts to the sustainability of Luddenham Village are summarised in Table 18.12 and further explained in Technical paper 10. The assessment has identified that potential impacts to the socio-economic sustainability of the Luddenham community as a result of the project would be Medium in 2033, reducing to Low by 2055.

Table 18.12 Summary of impacts to the sustainability of Luddenham Village

Scenario	Extent	Likelihood	Magnitude	Residual impact
2033	Sustainability of Luddenham and accessibility to social services	Possibly	Moderate	Medium
2055	Sustainability of Luddenham and accessibility to social services	Very unlikely	Minimal	Low

18.5.5 Health and wellbeing

Health and wellbeing includes physical and mental health, especially for people vulnerable to social exclusion or substantial change, psychological stress resulting from financial or other pressures, access to open space and effects on public health.

The assessment of health and wellbeing considers the actual or perceived impacts of the project on the community wellbeing and learning environments due to changes to the noise, air and/or visual environments. This also considers effects due to the uncertainty of impacts, resulting in anxiety, annoyance and stress, as well as concerns for impacts to water supply and food produce grown in the vicinity of WSI.

18.5.5.1 Effects to wellbeing as a result of changes to amenity

Changes to wellbeing are determined by understanding the existing health and vulnerability conditions of people potentially affected by changes to amenity, including noise, air quality and night-light, as well as their level of concern regarding the specific issue. The composite contours are considered to identify potential noise exposure to population, noting that the actual numbers could be lower depending on the choice of operating scenario.

Noise and air emissions associated with the project have the potential to affect the physical and mental health and wellbeing of residents, sensitive receivers and users of the area. During consultation, over 200 people selected impacts on health as a key concern in consultation surveys.

For the 2033 scenario, the noise and air quality assessments identified that:

- up to 132,000 people would be exposed to an average of more than 10 daily movements above 60 dB(A)
- up to 31,700 people would be exposed to an average of more than 2 movements above 60 decibels between 11 pm and 5.30 am daily within the regional study area, which might result in sleep disturbance
- up to 5,100 people would be exposed to an average of more than 5 daily movements above 70 dB(A) within the regional study area and this level of noise is associated with events that can impact a normal conversation
- increases in NO_2 are generally limited to a radius of approximately 5–6 km of the Airport Site
- air emissions released higher than a few hundred metres above ground level do not appear to have any significant influence on ground level air quality concentrations

- residents in Luddenham, Greendale, Silverdale, Wallacia and Kemps Creek are likely to experience moderate changes to their wellbeing as a result of changes to amenity (sleep disturbance and annoyance). For residents living elsewhere in the local study area, it is possible they may experience minor changes to wellbeing
- residents located within the regional study area and who may also be frequent visitors to the GBMA are unlikely to experience noticeable changes to their wellbeing.

For the 2055 scenario, Technical paper 1 and Technical paper 2 identified that:

- up to 1,120 people may be living in ANEC 20 contour
- up to 175,000 people within the regional study area would be exposed to an average of more than 10 daily movements above 60 dB(A)
- up to 91,600 people would be exposed to an average of more than 2 movements above 60 dB(A) between 11 pm and 5.30 am daily within the regional study area, which might result in sleep disturbance
- up to 13,000 people would be exposed to an average of more than 5 daily movements above 70 dB(A) within the regional study area
- increases in NO_2 concentrations are predicted in the vicinity of the Airport Site
- for all other pollutants, the impact of emissions from the project on the existing pollutant concentrations would be negligible and would be unlikely to be discernible above background air quality concentrations
- residents in Luddenham, Greendale, Silverdale, Wallacia and Kemps Creek are almost certain to experience moderate changes to their wellbeing as a result of changes to amenity (sleep disturbance and annoyance). For residents living elsewhere in the local study area, it is possible they would experience minor changes to wellbeing
- GBMA visitors to lookouts and walking tracks under N60 and N70 contours would possibly experience minimal changes to wellbeing.

The effects to wellbeing due to aircraft operation noise and emissions are summarised in Table 18.13 and further explained in Technical paper 10. The assessment has identified that potential detrimental impacts to wellbeing would be Medium in the local study area in both 2033 and 2055.

Table 18.13 Summary of effects to wellbeing because of aircraft operation noise and emissions

Scenario	Extent	Likelihood	Magnitude	Residual impact
2033	Detrimental effects to wellbeing as a result of changes to amenity to populations of Luddenham, Greendale, Silverdale, Wallacia and Kemps Creek	Possibly	Moderate	Medium
	Detrimental effects to wellbeing as a result of changes to amenity to population within the local study area (excluding above)	Unlikely	Minor	Low
	Detrimental effects to wellbeing as a result of changes to amenity for GBMA visitors to lookouts and walking tracks under N60 and N70 contours	Unlikely	Minimal	Low
	Detrimental effects to wellbeing as a result of changes to amenity to those within the regional study area	Unlikely	Minimal	Low

Scenario	Extent	Likelihood	Magnitude	Residual impact
2055	Detrimental effects to wellbeing as a result of changes to amenity to populations of Luddenham, Greendale, Silverdale, Wallacia and Kemps Creek	Possibly	Moderate	Medium
	Detrimental effects to wellbeing as a result of changes to amenity to population within the local study area (excluding above)	Unlikely	Minor	Low
	Detrimental effects to wellbeing as a result of changes to amenity for GBMA visitors to lookouts and walking tracks under N60 and N70 contours	Unlikely	Minor	Low
	Detrimental effects to wellbeing as a result of changes to amenity to those within the regional study area	Unlikely	Minor	Low

18.5.5.2 Wellbeing for First Nations people

First Nations people may experience diminished wellbeing issues from changes to environmental conditions (noise, air quality, night-light), as well as from changes to cultural values and their enjoyment and continuous exercise of cultural practices.

The identified prevalence of underlying long-term health conditions on Aboriginal and/or Torres Strait Islander communities could be exacerbated by changes in the environment and to cultural heritage.

Technical paper 9 noted that Knowledge Holders expressed they felt emotionally drained and, in some cases, overwhelmed by the cumulative impacts of successive developments in Western Sydney. While it is not possible to determine the location of First Nations people in relation to noise exposure, it can be argued that it is possible First Nations people living under the ANEC, N70 and N60 noise contours are likely to experience moderate changes to their wellbeing, considering potential underlying health conditions that could be exacerbated.

The effects to wellbeing for First Nations populations are summarised in Table 18.14 and further explained in Technical paper 10 (Section 6.5.2). The assessment identified that the potential for diminished wellbeing for First Nations people would be Medium in the local study area in 2033 and 2055.

Table 18.14 Summary of effects to wellbeing for First Nations populations

Scenario	Extent	Likelihood	Magnitude	Residual impact
2033	Diminished wellbeing for First Nations people living under ANEC 20, N60 and N70 noise contours	Possibly	Moderate	Medium
	Diminished wellbeing for First Nations people living elsewhere in the local and regional study area	Unlikely	Minimal	Low
2055	Diminished wellbeing for First Nations people living under ANEC 20, N60 and N70 noise contours	Possibly	Moderate	Medium
	Diminished wellbeing for First Nations people living elsewhere in the local and regional study area	Unlikely	Minimal	Low

18.5.5.3 Changes in children's behaviour, attentiveness and cognitive learning as a result of aircraft noise

A total of 41 schools with a total of 19,185 enrolments in 2022–2023 are located within the local study area, 2 of which are special needs schools. Additionally, there are 51 registered childcare centres in the local study area.

Aircraft-related noise, emissions and vibrations may affect children's behaviour and attentiveness at school, also affecting the staff's ability to teach and overall educational and wellbeing outcomes for students, families and staff. Literature suggests that exposure to aircraft noise can have negative impacts on children's cognitive performance, including attention, memory and academic achievement.

Consultation identified that around a quarter of children in some LGAs are developmentally vulnerable. Aircraft noise may affect students' sleep but also affect students and staff when at school. Distraction may arise from noise, as well as visually with children looking at planes, which may affect children with mental disabilities or sensory issues more than others. There were fewer concerns raised during consultation about impacts on play time. Consultation also identified that learning occurs outside schools, and the impact on learning and teaching will also be within homes if these are impacted by noise.

Technical paper 12 identified areas where learning delays are considered to be of potential significance, with many of these areas consistent with those identified as of potential significance in relation to sleep disturbance and annoyance. However, no schools or childcare centres are located within these areas. It is possible that children attending educational facilities under the N60 and N70 noise contours in the broader local study area and regional study area would experience some level of distraction that could affect their attentiveness and cognitive learning, resulting in a Low pre-mitigated impact. However, this impact would be experienced more acutely by children with cognitive disability.

For 2055, Technical paper 12 identified potential learning delays relevant to childcare and schools located within Luddenham, Greendale, Silverdale, Wallacia and Kemps Creek. However, none of the noise impacts associated with the project at these locations are high enough to be of concern in relation to community health (i.e., learning delays are all less than 30 days). It is anticipated that by 2055, children within ANEC 20 (at Mamre Anglican School) and N60 and N70 contours would have adapted to some extent to aircraft noise, and that schools would have adopted some measures to mitigate noise. Children attending the schools that were not previously under noise contours may encounter some level of distraction that could affect their attentiveness and cognitive learning, which would be experienced more acutely by children with cognitive disability.

The changes to children's behaviour, attentiveness and cognitive learning as a result of aircraft noise is summarised in Table 18.15 and further explained in Technical paper 10. The assessment identified that the potential for changes to children's behaviour as a result of aircraft noise would be Medium in 2033 and 2055.

Table 18.15 Summary of changes to children's behaviour, attentiveness and cognitive learning in educational settings as a result of aircraft noise

Scenario	Extent	Likelihood	Magnitude	Residual impact
2033	Changes in behaviour, attentiveness, and cognitive learning of children with cognitive disability as a result of aircraft noise for those who attend educational facilities under N60 and N70 24-hr noise contours	Possibly	Minor	Medium
2055	Changes in the behaviour, attentiveness, and cognitive learning of children with cognitive disability attending Mamre Anglican School	Possibly	Moderate	Medium

Scenario	Extent	Likelihood	Magnitude	Residual impact
	Changes in the behaviour, attentiveness, and cognitive learning of children with cognitive disability as a result of aircraft noise for those who attend educational facilities under N60 and N70 24-hr noise contours	Possibly	Minor	Medium

18.5.6 Surroundings

Surroundings includes ecosystem services such as shade, pollution control, public safety and security, access to and use of the natural and built environment, aesthetic value and amenity.

The assessment of surroundings considers the actual or perceived impacts of the project on the amenity of the local study area, the aesthetic and amenity values of the GBMA, risk to water quality within natural environments and the biodiversity values of the natural environment.

18.5.6.1 Social values associated with the Blue Mountains

A section of the GBMA was listed as a World Heritage Area in 2000, recognising the area's outstanding natural beauty, unique geological formations and rich biodiversity. The area is also recognised for its cultural significance to First Nations communities, who have inhabited the region for over 22,000 years and continue to maintain strong cultural connections to the land.

During consultation, stakeholders highlighted the importance of recreational and touristic values, as well as heritage and ecological values associated with the GBMA. Much of the area’s value lies in the wilderness and quietness, with significant associated heritage and ecological values recognised in the World Heritage listing. The Blue Mountains is also a significant economic asset and a key contributor to the tourism and visitor economy.

Technical paper 14 concluded that while some noise and visual impacts may potentially occur to the wilderness areas, these are considered to be generally insignificant for a vast majority of wilderness areas and are not considered to be such that they would interfere with the values attributed to the wilderness nature of the GBMA. Potential indirect impacts may be observed for tourism and recreation values.

Based on the altitude of aircraft overflying scenic areas and the distance of WSI from vantage points within the GBMA, it is not expected that a significant impact would occur because of the project (refer to Technical paper 7).

Aircraft noise can result in changes to the social values associated with the GBMA for the 2033 and 2055 scenarios including:

- recreation and tourism values manifested on a medium pre-mitigated impacts to the way people enjoy and use open space within GBMA
- cultural values resulting on medium pre-mitigated impacts to First Nations cultural values
- social and economic values resulting on low pre-mitigated impacts to the tourism and livelihoods
- bequest, inspiration, wilderness values resulting on low pre-mitigated impacts to wellbeing.

It is possible the combined effects on GBMA associated values would result in moderate changes to the way people enjoy, use and value the GBMA.

The diminished social values associated with the Blue Mountains is summarised in Table 18.16 and further explained in Technical paper 10. The assessment has identified that the potential for diminished social values associated with the Blue Mountains would be Low in 2033, increasing to Medium in 2055.

Table 18.16 Summary of social values associated with Blue Mountains

Scenario	Extent	Likelihood	Magnitude	Residual impact
2033	Diminished social values associated with Blue Mountains within the regional study area	Unlikely	Minor	Low
2055	Diminished social values associated with Blue Mountains within the regional study area	Unlikely	Moderate	Medium

18.5.6.2 Sense of safety and clean environment concerns due to air quality changes

There would potentially be an increase in aircraft that fly over the catchment of the Lake Burragorang/Warragamba Dam and Prospect Reservoir as a result of the project.

During consultation, stakeholders and community representatives raised concerns about flight paths going over the Lake Burragorang/Warragamba Dam potentially affecting water quality. There are a number of residential and agricultural properties within the local area who rely on rainwater collected in water tanks, raising concerns on drinkable water and agricultural production. At a smaller scale, residents who grow vegetables in their garden were also concerned about the future quality of their products.

Fuel jettisoning is conducted only in emergency situations and in accordance with appropriate procedures. There are limited occurrences of impacts at ground level associated with fuel jettisoning in the wider international incident record, confirming that the risk is very small (refer to Chapter 13 (Aircraft hazard and risk)).

Chapter 12 (Air quality and greenhouse gas) identified that for 2033 scenario there are no tangible or significant impact to air quality from the project. Increases in NO_2 are generally limited to a radius of approximately 5–6 km of the Airport Site. Emissions released higher than a few hundred metres above ground level do not appear to have any significant influence on ground level air quality concentrations. For the 2055 scenario, the impact of emissions from the project on the existing pollutant concentrations would be negligible and would be unlikely to be discernible above background concentrations, except for NO_2 which increases in the vicinity of the Airport Site.

The reduced sense of safety and clean environment concerns due to air quality changes is summarised in Table 18.17 and further explained in Technical paper 10. The assessment has identified that the potential for a reduced sense of safety and clean environment concerns due to air quality changes would be Low in 2033 and 2055.

Table 18.17 Summary of safety and clean environment concerns due to air quality changes

Scenario	Extent	Likelihood	Magnitude	Residual impact
2033	Reduced sense of safety and clean environment due to air quality changes in the local areal	Unlikely	Minor	Low
	Reduced sense of safety and clean environment within the regional study area	Unlikely	Minimal	Low
2055	Reduced sense of safety and clean environment due to air quality changes in the local areal	Unlikely	Minor	Low
	Reduced sense of safety and clean environment within the regional study area	Unlikely	Minimal	Low

18.5.6.3 Environmental values resulting from concerns about biodiversity affected by noise and air quality

During consultation, community representatives raised concerns about diminished environmental values as a result of noise impacts on fauna and especially on endangered species. The concerns were largely focussed on diminished environmental values in the GBMA. Concerns about potential changes to air quality affecting biodiversity were also raised.

Environmental values associated with impacts on biodiversity were largely limited to wildlife impacts. The impacts were noted to be highest where aircraft generate the most noise, which is generally when aircraft are flying low or taking off/landing. Therefore, most noise-related impacts would be limited to near the runway/s, and the predicted noise levels are unlikely to result in changes at a magnitude that would threaten the viability of local populations of any species (refer to Chapter 16 (Biodiversity)).

Any alterations to air quality would be temporary, localised and unlikely to impact biodiversity values. Ecosystems in the region would not however be directly impacted upon and impacts are unlikely to result in a long-term decline that would threaten the viability of any of these ecosystems.

Consequently, it can be argued that no impacts to biodiversity values would occur for the broader local and regional social localities given that impacts to wildlife are likely to be minimal and that limited concerns about biodiversity outside the GBMA were raised. The social-environmental values attached to the GBMA are assessed separately in Section 18.5.6.1.

18.5.7 Livelihoods

Livelihoods includes people's capacity to sustain themselves through employment or business.

The assessment of livelihoods considers the actual or perceived impacts on property and impacts to the livelihoods of people who participate in the Blue Mountains tourism economy.

18.5.7.1 Impacts on residential property values

As outlined in Chapter 19 (Economic), operation of the project may result in potential loss in property values for residential properties that may be more adversely impacted by the operation of the project. Total impacts have been estimated at around $53 million loss in total residential values in 2033, increasing to a cumulative value of around $147 million by 2055 (measured in 2022 dollars). While the impact appears high, it is important to realise that residential values in Western Sydney have increased considerably over the past 10 years. Dwellings within the N70 contour (and outside the ANEC 20) are expected to have a low level of impact resulting in a loss in residential values of 3 per cent average. In all likelihood, this loss would be 'made good' by 6 months growth in real capital gain.

During consultation, stakeholders raised concerns about property prices, additional changes to land use, additional costs for property modifications and potential for property acquisition.

The impacts on property values are summarised in Table 18.18 and further explained in Technical paper 10. The assessment has identified that the potential impact to residential property values would be Low in 2033 and 2055.

Table 18.18 Impacts on residential property values

Scenario	Extent	Likelihood	Magnitude	Residual impact
2033	Impacts on residential property values within the local study area	Unlikely	Minor	Low
	Impacts on residential property values within the regional study area	Unlikely	Minimal	Low
2055	Impacts on residential property values within the local study area	Unlikely	Minor	Low
	Impacts on residential property values within the regional study area	Unlikely	Minimal	Low

18.5.7.2 Potential risk to the visitor economy and livelihoods associated with GBMA World Heritage Listing

During consultation, concerns were raised about how outdoor activities in the Blue Mountains area would be affected, impacting visitation and the visitor economy in the area. Concerns were raised about the potential loss of the UNESCO heritage listing and its impacts on visitation numbers, particularly national and international visitors.

There have not been cases in which a UNESCO heritage site has lost its status due to aircraft noise. The process of a site losing its World Heritage status is rare and typically involves significant concerns related to the site's conservation or management, and the decision to remove a site from the list is made by the UNESCO World Heritage Committee after careful evaluation.

Negative impacts to the tourism economy resulting from aircraft noise in Australia have been documented (for example, a 2018 University of Technology Sydney study and 2015 Gold Coast Tourism Corporation report on aircraft noise and impact on tourism).

Technical paper 11 identified a number of short-stay accommodations inside the N60 contour and none inside the N70 contour, located in the St Marys to Penrith urban corridor with only one in the Blue Mountains. Consequently, the technical paper determined that it is not expected any of those places would lose any revenue in any measurable way. Moreover, the visual impacts are not considered significant enough to result in any measurable economic impacts in terms of visitation numbers to the Blue Mountains area. As a result, there would be no loss in tourism spend in the area and hence no impacts on the local economy.

The potential risk to the visitor economy and livelihoods associated with GBMA World Heritage Listing is summarised in Table 18.19 and further explained in Technical paper 10. The assessment has identified that the potential risk to the visitor economy and livelihoods associated with the GBMA World Heritage Listing would be Low in 2023 and 2055.

Table 18.19 Potential risk to the visitor economy and livelihoods associated with Blue Mountains World Heritage Listing

Scenario	Extent	Likelihood	Magnitude	Residual impact
2033	Impact to the tourism and livelihoods associated with Blue Mountains World Heritage Listing for Leura, Katoomba, Springwood, Winmalee, Blaxland, Warrimoo, Lapstone, Mount Irvine, Blackheath, and Mount Victoria	Very unlikely	Minimal	Low
	Impact to the tourism and livelihoods associated with Blue Mountains World Heritage Listing for the Regional study area	Very unlikely	Minimal	Low
2055	Impact to the visitor economy and livelihoods associated with Blue Mountains World Heritage Listing for the Local study area	Very unlikely	Minimal	Low
	Impact to the visitor economy and livelihoods associated with Blue Mountains World Heritage Listing for the Regional study area	Very unlikely	Minimal	Low

18.5.8 Decision-making systems

As outlined in Section 18.4.1.8, decision-making systems is a reference to people's capacity to participate in decision-making systems and accessibility to complaint, remedy and grievance mechanisms.

The assessment of decision-making systems considers the community's level of distrust and level of participation in the project based on its understanding of the project and its impacts.

18.5.8.1 Limited capacity to participate due to a lack of understanding of flight paths and potential impacts

Communication, transparency and education about flight paths and associated impacts was consistently raised by stakeholders and community representatives as a key concern. A lack of understanding and limited flight path information publicly available has resulted in an increased sense of uncertainty, affecting people's capacity to decide over their future.

SIA consultation identified:

- a limited understanding of noise impacts
- limited information available results in limited feedback
- a lack of understanding of noise meant some people believed they could continue to live at their residences with no major change
- scepticism about how genuine the consultation process is, though some mentioned they appreciated the level of consultation.

After SIA consultation and prior to the display of the Draft EIS, the WSI Aircraft Overflight Noise Tool allowed people within the local and regional study areas to have a better understanding of the noise exposure at their residences and in places of interest more broadly.

In addition, an extended period for EIS public exhibition and targeted engagement during the extended EIS public exhibition period with those eligible for amelioration has been provided to further the opportunity for those affected to give feedback to the project.

Project engagement has taken place within the local and regional study area and there has been additional opportunities for engagement during Draft EIS public exhibition. However, it is possible that some residents and service providers within the local and regional study areas could still have limited understanding about the flight paths, impacting their capacity to effectively engage and influence decision-making over issues that may affect their lives.

The limited capacity to participate due to a lack of understanding of flight paths and potential impacts (based on engagement prior to the EIS display) is summarised in Table 18.20 and further explained in Technical paper 10. The assessment has identified that the potential risk to the visitor economy and livelihoods associated with the Blue Mountains World Heritage Listing would be Medium in 2023 and 2055.

Table 18.20 Summary of capacity to participate due to a lack of understanding of flight paths and potential impacts

Scenario	Extent	Likelihood	Magnitude	Residual impact
2033	Limited capacity to participate due to a lack of understanding about preliminary flight paths and potential impacts within the local study area	Unlikely	Moderate	Medium
	Limited capacity to participate due to a lack of understanding about flight paths and potential impacts within the regional study area	Possibly	Minor	Medium

Scenario	Extent	Likelihood	Magnitude	Residual impact
2055	Limited capacity to participate due to a lack of understanding about flight paths and potential impacts within the local study area	Unlikely	Moderate	Medium
	Limited capacity to participate due to a lack of understanding about flight paths and potential impacts within the regional study area	Unlikely	Minor	Medium

18.5.9 Refinements to the project

The introduction of the RRO noise abatement procedure (RRO-NAP) and the reallocation of jet aircraft from Runway 23 Departure Northeast Night (RRO) (D28) flight path to the Runway 23 Departure Southeast Night (RRO) flight path (D32) would result in a change in noise impacts at night. The key social impact categories relevant to these refinements relate to community (increased inequality), way of life (loss of residential amenity), health and wellbeing (changes to amenity), and surroundings (social values associated with the Blue Mountains). Changes in impact would be limited to when the RRO mode of operation is in use (11pm and 5:30 am). These key social impact categories are considered in Table 18.21. Further assessment is provided in Section G2.10 of Appendix G (Assessment of the refinements to the project) of the EIS.

Table 18.21 Consideration of key social impact categories – RRO-NAP and reallocation of D28 to D32

Social impact category	Assessment
Community – increased inequality	The issue considers the understanding of existing vulnerabilities within the community, exposure to aircraft noise and the number of flights expected to occur. For vulnerable groups within the N60, N70 and ANEC contours, the assessment as presented in the Draft EIS acknowledged a moderate magnitude resulting in a high residual impact. Given the low levels of aircraft traffic associated with this runway mode of operation, and restricted timing at which it can occur (i.e. only under certain weather and air traffic conditions), it is not expected that the implementation of the refinements would change the overall magnitude of impact or the resulting residual impact for people under vulnerable conditions as presented in the Draft EIS.
Way of life – loss of residential amenity	This issue considers disruptions to indoor and outdoor activities that may occur due to aircraft noise. While the refinements would shift noise impacts from one population to another, the overall magnitude of impact would not change given the low levels of traffic and restricted timing for when the runway mode of operation or the RRO-NAP is in place.
Health and wellbeing – changes to amenity	This issue considered impacts to physical and mental health and wellbeing due to changes in amenity (noise, air and light). The Draft EIS acknowledged that, among other areas, the suburbs of Luddenham, Greendale, Silverdale, and Wallacia would be likely to experience some level of sleep disturbance and annoyance, and that these areas would experience a moderate change to wellbeing as a result of changes to amenity. While the refinements would shift amenity impacts within each specific suburb, it is expected that the overall magnitude of the impact would generally remain the same as assessed in the Draft EIS.
Surroundings – social values associated with the Blue Mountains	This issue considered a range of elements, such as cultural values, recreation, tourism, wilderness and aesthetic values. Given the low levels of traffic and restricted timing for when the runway mode of operation or the RRO-NAP is in place, the refinements would result in a limited change to the impacts as presented in the Draft EIS. It is noted however that during the operation of the RRO-NAP, there may be some minor to negligible positive impacts to areas of the Blue Mountains that are no longer overflown, which may provide some benefit to users of camping sites or similar recreation areas during this time.

For the other refinements to the preliminary flight paths, the social impact assessment outcomes as presented in the Draft EIS would not worsen as these would result in the removal of a flight path, or marginal changes in the position of a flight path where aircraft would be at high altitudes (over 9,000 ft (2.7 km) to 10,000 ft (3km)).

Further detail is provided in Section G2.10 of Appendix G (Assessment of the refinements to the project) of the EIS.

18.6 Mitigation and management

18.6.1 Existing management measures relevant to the mitigation of social impacts

The 2016 EIS proposed management measures related to Stage 1 Development of WSI, which are relevant to the social impacts identified in this report. These included:

- aligning the Australian Government, NSW Government, and Western Sydney local government's economic and employment policies, strategies and plans to realise the full benefit from the proposed airport and other projects in the Western Sydney region
- continuing liaison with relevant agencies that may include local and state government agencies, tourism agencies, agencies responsible for affordable housing, Western Sydney Business Chamber and educational facilities including universities and TAFE, to inform agency planning activities and allocation of funding to programs that may benefit or otherwise be affected by the proposed airport
- continuing engagement with key stakeholders through the ongoing WSI Communication and Engagement Strategy
- implementing mitigation and management measures that would also address social amenity impacts as detailed in the relevant Draft EIS technical studies including aircraft and ground-based operational noise assessments; surface transport and access assessment; local air quality and greenhouse gases assessment; landscape character and visual impact assessment; community health risk assessment; and regional air quality assessment
- finalising, communicating, and implementing a proposed noise mitigation policy to address landowner anxiety regarding noise impacts
- implementing other mitigation measures that may address community concerns, including measures such as air quality and water quality monitoring within or in the vicinity of the proposed airport.

In addition, strategic planning in the vicinity of WSI has considered and incorporated the operational needs of WSI into land use planning in accordance with guidance provided in the National Airport Safeguarding Framework (NASF) Guidelines. This has been ongoing for over a decade in conjunction with planning for WSI and is well established in existing planning instruments. This has been an effective means to ensure that land use near WSI is compatible with noisy aviation activities, with a primary goal of minimising the population affected by aircraft noise, through implementation of land-use planning measures, such as land use zoning around WSI. Appropriate noise management controls referencing the NASF and AS 2021:2015 have also been included in applicable planning instruments in advance of WSI's airport operations.

18.6.2 Mitigation measures

Table 18.22 provides preliminary management and mitigation measures to avoid, minimise or mitigate negative impacts and to maximise the positive impacts identified.

Table 18.22 Proposed mitigation measures – social

ID No.	Issue	Mitigation measure	Owner	Timing
S1	Social impacts	The WSI CACG will undertake consultation with stakeholders and community, including social organisations, to seek feedback on social issues and to promote social and economic welfare of the community.	WSA Co	**Pre-operation** (Detailed design, 2024–2026)
S2	First Nations employment	WSA Co will implement a program to ensure opportunities for First Nations employment.	WSA Co	**Operation** (Implementation, 2026–ongoing)

The implementation of the mitigation measures outlined in this Draft EIS, and the existing controls (specific to WSI or more broadly to the management of federally leased airports) would reduce high or very high (pre-mitigated) impacts to medium except for the potential increase of inequality for vulnerable groups within areas contained within ANEC 20, N60 and N70 contours for the 2055 scenarios.

18.6.3 Dependencies and interactions with other mitigation measures

Interactions among mitigation measures relevant to social impacts in the following technical papers include:

- Chapter 11: Aircraft noise, specifically those relating to the finalisation of the noise insulation and property acquisition (NIPA) policy, noise abatement procedures, noise complaints handling, the post-implementation review of the project and the establishment of a CACG to ensure appropriate community engagement on airport planning and operations.
- Chapter 12: Air quality and greenhouse gas, specifically that WSA Co will continue to monitor ambient air quality in the vicinity of the Airport Site to quantify the existing levels and monitor trends in pollutant concentrations over time and identify any exceedances or improvements. This will be undertaken in accordance with the requirements set out for the WSI Stage 1 Development Air Quality OEMP.
- Chapter 13: Aircraft hazard and risk, specifically measures concerning fuel jettisoning and wildlife strike.
- Chapter 14: Land use, specifically, the requirement for DITRDCA and WSA Co will continue to liaise with State and local government agencies to ensure applicable environmental planning instruments have regard to ANEC forecasts produced for the project, and the management of wildlife strike.

Chapter 19 Economic

This chapter provides an overview of the potential economic impacts and benefits that may occur during operation of the project.

The refinements to the preliminary flight path design since the exhibition of the Draft EIS would not change the overall conclusions of the economic assessment as presented in this chapter and supporting technical paper. Further detail is provided in Appendix G (Assessment of the refinements to the project) of the EIS.

The study area for the assessment aligns with the N60 24-hour composite noise contour and extends across 8 local government areas (LGAs), including Camden, Blacktown, Blue Mountains, Fairfield, Hawkesbury, Liverpool, Penrith and Wollondilly. The combination of these LGAs form the study area for the economic assessment study area.

The assessment of economic impacts is focused on:

- economic activity and employment in the LGAs
- property values and land use
- social and tourism
- facilitated changes.

Demand for aviation services is predicted to continue to increase to service Sydney's ongoing growth in population and business activities. Any shortage in capacity to meet the rising demand will affect the future economic growth, productivity, employment, lifestyle and amenity of the Sydney Basin. The operation of the proposed airport is expected to generate significant economic and employment effects for the local and regional economy. The project is an integral part of WSI, ensuring that the benefits of WSI are realised. These benefits will grow commensurate with the forecast increase in passenger demand over time.

Overall, WSI (and the associated flight paths that allow for its operation) will be a major catalyst for investment and jobs growth in the Western Sydney region and will deliver benefits to the Australian economy more broadly. WSI will provide direct connections across the world, allowing for opportunities to enhance Western Sydney's connection to other parts of the world economy. The operation of WSI will also allow for improved access to tourism opportunities, providing better accessibility to destinations across Western Sydney and the Greater Blue Mountains. New or upgraded transport infrastructure that would be built to service WSI would also provide benefit to local communities.

It is estimated that WSI itself will generate a significant number of jobs for Western Sydney and contribute significantly to gross regional product. Ernst and Young (2016) concluded as part of the 2016 EIS that airport operations would directly generate around 8,730 jobs in 2031 increasing to 61,500 jobs by 2063. It is noted that that these jobs would be generated by WSI itself and not specifically generated by the flight paths, however the project is an essential part of the overall operation of WSI.

The flight paths of the project have the potential to affect the tourism industry both positively (through increased tourist access) and adversely (if it results in loss in amenity to sensitive land uses). While the location of the flight paths over significant tourist destinations, in particular the Greater Blue Mountains, has the potential to negatively affect the amenity of tourist experiences in the area, either through the visual location of aircraft or the noise they will generate, the location and access to an international airport closer to these destinations is also expected to provide a boost to this industry. The increased access to key tourist destinations, in particular for tourists visiting areas such as the Greater Blue Mountains, is considered to outweigh the potential adverse amenity impact of the flight paths.

WSI and the proposed flight paths would impact the use of the airspace. Currently the area is used by Bankstown and Camden airports for flying training, emergency services and other operations. As a result of the facilitated changes required to accommodate WSI, greater distances would need to be travelled to reach new flying training areas resulting in increased 'transit' flight durations, extended training schedules and increased costs including increased flying training times and increased fuel and maintenance costs. The cost of this was estimated at around $15 million in 2026 increasing at a rate of around one per cent per annum.

Operation of the project may result in potential loss in property values for residential properties that may be more adversely impacted by the operation of the project. Total impact have been estimated at around $56 million loss in total residential values in 2033, increasing to a cumulative value of around $148 million by 2055 (measured in 2022 dollars). While the impact appears high it is important to realise that residential values in Western Sydney have increased considerably over the past 10 years. Dwellings within the N70 contour (and outside the ANEC 20) are expected to have a low level of impact resulting in a loss in residential values of 3 per cent average. Any impacts to property values are expected to be temporary and are not expected to have a significant long term negative impact. In all likelihood this loss would be 'made good' by 6 months growth in real capital gain.

Project-specific mitigations have been identified, including continuing consultation with aerodrome operators and airspace users during the ongoing airspace design for WSI to consider the impacts to operators at Bankstown and Camden airports. Consultation with emergency services operators regarding priorities of airspace in order to minimise risks and associated economic costs will also continue.

19.1 Introduction

The economic impact of the flight paths has been assessed in relation to the defined study area. The economic impact has been focused on the economic impacts on existing airspace users and balances this against the broader economic costs and benefits of the project. The assessment looks at the flight paths and their impact on employment and economic output, tourism impacts and property values within the study area. The assessment also details the net present value of the flight paths within the study area.

In 2016, JLL undertook an economic assessment of WSI as part of the previous 2016 EIS, which dealt with the economic impact of the physical airport and associated infrastructure within Western Sydney.

That assessment evaluated the potential impact on land and property values around WSI (Western Sydney Airport EIS – Potential impacts on property values (JLL, 2016)) and the economic impact of WSI (Western Sydney Airport Environmental Impact Statement – Economic Impact Analysis (Ernst and Young, 2016)). The property value impact assessment considered the impact associated with aircraft noise exposure and found that:

- previous studies found a relatively consistent adverse effect of aircraft noise on residential prices, of between 0.4 per cent and 1.1 per cent per unit of ANEF (Australian Noise Exposure Forecast), with a greater impact at higher ANEF levels and for higher priced properties
- none of the previous studies sought to explore the impact on large lot land holdings comparable to those around Badgerys Creek, where few existing dwellings fall within areas expected to be exposed to noise levels in excess of ANEF 20
- the analysis undertaken in the 2016 JLL study encompassed over 1,800 residential sales transactions for suburbs in the vicinity of 4 main Australian international airports found:
  - no statistically significant relationship between noise exposure and housing prices in Melbourne or Sydney
  - in Adelaide and Brisbane, noise exposure was a more significant factor influencing residential prices
  - in the case of Brisbane, prices for houses exposed to aircraft noise between 20 and 25 ANEI/ANEF, experienced a -10.7 per cent reduction compared with dwellings outside the noise affected area
  - in Adelaide, a statistically significant impact was found ranging from -8.3 per cent (20-25 ANEI/ANEF); -14.7 per cent (25-30 ANEI/ANEF); and -19.8 per cent (30-35 ANEI/ANEF) compared with prices in areas less than 20 ANEI/ANEF

- at Sydney (Kingsford Smith) Airport, analysis of long run house prices since 1991 found no appreciable difference in growth rate between median prices in suburbs subject to in excess of ANEI 20 (Australian Noise Exposure Index) and those in similar areas not exposed to aircraft noise. Possible reasons may be:
  - housing pressures restrict housing choices
  - the benefits of living close to the city outweigh possible noise effects in the minds of potential purchasers
  - noise attenuation measures to dwellings with above ANEI 20 may have reduced the impact of noise on residents
  - aircraft noise sharing protocols and rising ambient noise levels in many suburbs may reduce the perceived impact of noise
- examination of sales of large lot land holdings in the vicinity of Melbourne, Perth and Avalon airports failed to establish a statistically significant relationship between noise exposure and property prices. Possible reasons for the lack of clear effect may include:
  - the lesser significance of the dwelling in the context of large land areas, compared with established urban areas
  - land used primarily for primary production may be less affected by noise
  - the wider range of factors influencing price that cannot be analysed from the available sales data, e.g. aspect, topography, soil and micro-climate
- analysis of long run growth rates of residential sales in the suburbs around Badgerys Creek indicates that despite short term fluctuations, property prices have grown at a similar rate to the wider Western Sydney and metropolitan regions
- rather than suffering a slowing of growth as a result of possible fears of noise or other impacts, residential prices in the suburbs around Badgerys Creek grew strongly in the period following the announcement in April 2014 that Badgerys Creek would be the site of the proposed airport, increasing by almost 24 per cent and substantially faster than both Western Sydney and the Sydney metropolitan regions, although it is not possible to attribute this growth to the announcement
- overall, the analysis failed to establish conclusive evidence of an adverse impact on large lot land property prices as a result of aircraft noise at levels of 20-25 ANEF that would suggest the development of WSI may have a major adverse impact on property prices in the vicinity.

The assessment presented in this EIS focuses on the economic impacts of the project (being the introduction of flight paths for WSI). This assessment, in conjunction with other information sources, considers the land and property value assessment as presented in the 2016 EIS as it relates to the potential impacts arising from aircraft noise exposure.

19.2 Legislative and policy context

There is no specific legislation that guides economic impact assessments. The economic impact assessment was undertaken to address the Minister's EIS Guidelines and with reference to Airservices Australia's Environmental management of changes to Aircraft Operations Standard (AA-NOS-ENV2.100) (Airservices Australia, 2022b) and the *Environment Protection and Biodiversity Conservation Act 1999* (Cth).

19.3 Methodology

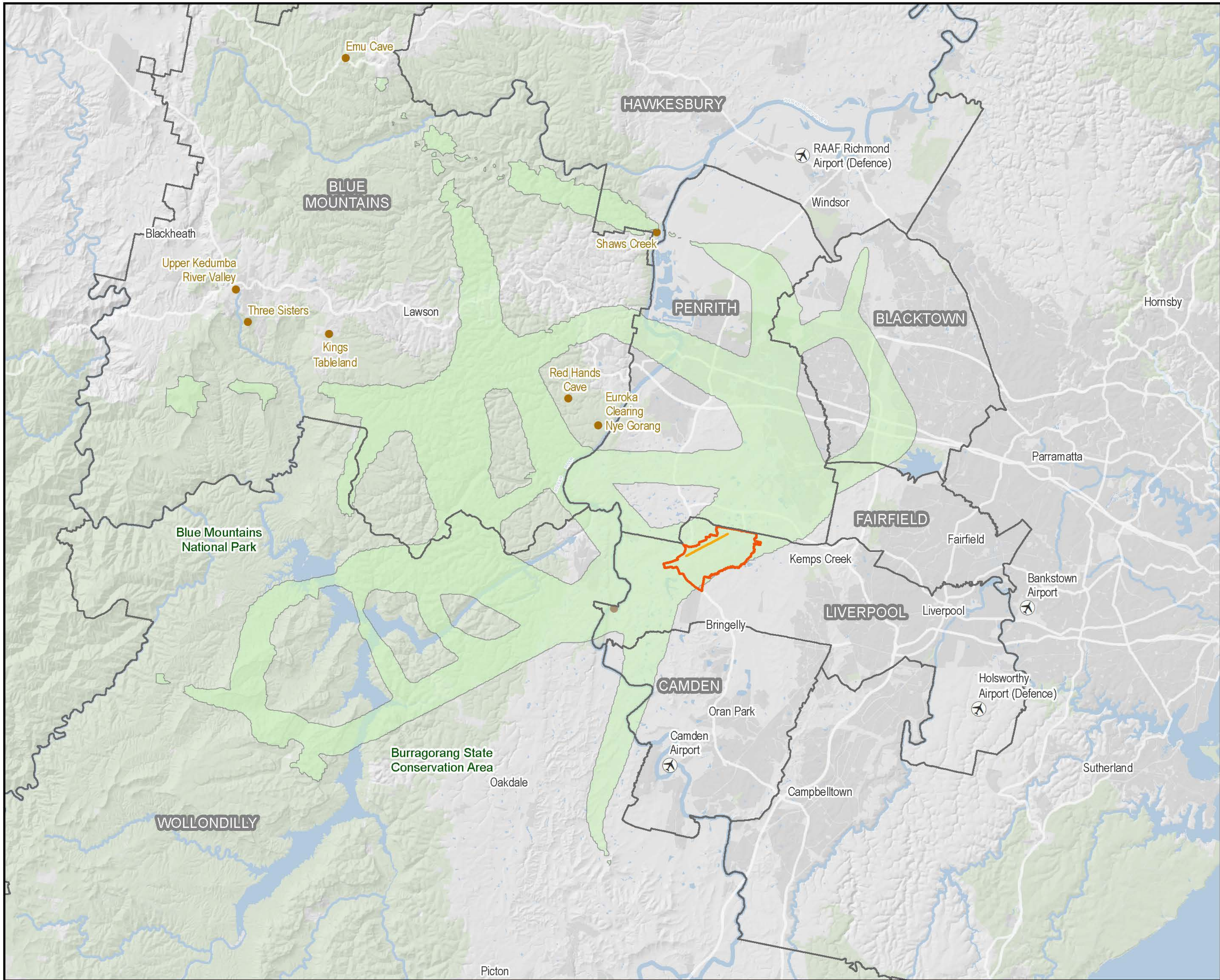
19.3.1 Study area

The economic impact assessment study area (study area) covers the local government areas (LGA) that align with the predicted composite N60 24-hour noise contour (as exhibited). The study area is shown on Figure 19.1.

The N60 24-hour composite noise contour shows the number of events over 60 decibels with a frequency of 10 or more movements over a 24-hour period, across any of the 3 runway operating scenarios considered in the noise assessment. This noise contour primarily extends across 8 LGAs, these being Camden, Blacktown, Blue Mountains, Fairfield, Hawkesbury, Liverpool, Penrith and Wollondilly. For residential dwellings and population statistics, only those within the N60 24-hour contour have been reported.

Figure 19.1

The economic study area



Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- 2055 Scenarios 1,3 and 4 ANEC N60 contours 10 events
- LGAs covered by the N60 contour
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

0 3 6 km

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:400,000 Date: 27/07/2023

Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

19.3.2 Approach

The economic impact assessment methodology generally involved:

- reviewing the 2016 EIS (including supporting technical papers), other comparable economic impact assessments and technical papers that support this EIS
- describing the existing economic environment by reviewing:
  - the 2021 Australian Bureau of Statistics (ABS) census data for the 8 LGAs within the study area
  - land use zoning established under relevant environmental planning instruments (EPI)
  - databases or other sources of information to identify sensitive land uses or receptors, including sources maintained by Core List, the Australian institute of Health and Welfare, the NSW Department of Education, Data NSW, data was also collated from Profile.id and REMPLAN
- determining the land use types and/or sensitive receivers within the study area – including the number of residential dwellings, rural lots, population, health and educational uses, businesses from the 2021 ABS census grouped according to the Australian and New Zealand Standard Industrial Classification (ANZSIC) and workers by occupation
- assessment of impacts on property values, supported by 2016 EIS assessments and other similar studies to quantify the total impacts of the project on property values
- highlighting particular employment uses that may be impacted by aircraft noise, such as tourism land uses
- quantifying the impacts from the other technical reports including social impacts in monetary terms where possible (using surrogate markets, cost estimates of mitigation measures and/or other techniques)
- identification of appropriate mitigation and management measures to mitigate negative economic impacts or maximise benefits of the project.

For the purposes of this assessment, land uses or sensitive receivers are defined as:

- sensitive land use zones: residential (all zones), parkland, recreation, and conservation, agricultural and primary production
- sensitive receivers: educational establishments, early education and child care facilities, places of worship, residential care facilities, health facilities, accommodation providers, commercial office space, libraries, courthouses, cinemas and theatres.

19.4 Existing environment

19.4.1 Economic employment, activity and value

The ABS 2021 employment data provides an understanding of the employment structure and economic value of the study area. The analysis has considered employment, gross revenue output and gross value added within the study area and compared this to the Sydney Basin as defined by the ABS.

As of 2021, the study area accommodated around 427,550 jobs. This represented 18 per cent of the 2.39 million jobs in Sydney Basin and 12 per cent of the 3.67 million jobs in NSW. The top 5 largest industries in terms of job numbers were:

- Health care and social assistance (14 per cent of jobs)
- Retail trade (11 per cent of jobs)
- Construction (10 per cent of jobs)
- Education and Training (10 per cent of jobs)
- Manufacturing (9 per cent of jobs).

In 2021 gross output in the study area was $137.9 billion. This represented 16 per cent of the gross output of the Sydney Basin and 11 per cent of NSW.

The top 5 largest output industries in the study area, as of 2021, were:

- Manufacturing – $24.7 billion
- Construction – $24.4 billion
- Transport, Postal and Warehousing – $12.7 billion
- Wholesale Trade – $12 billion
- Rental, Hiring and Real Estate Services – $9 billion.

Based on the industries and employment present in 2021, it is estimated that the study area generated $58.10 billion in Gross Value Added (GVA). This represented 15 per cent of GVA generated across the Sydney Basin and 10 per cent of NSW's industry GVA in 2021.

The top 6 largest GVA industries in the study area, as of 2021, were:

- Construction – $7.7 billion
- Manufacturing – $7.3 billion
- Wholesale Trade – $6.1 billion
- Transport, Postal and Warehousing – $5.7 billion
- Health Care and Social Assistance – $5.5 billion.

The study area has a high representation of industries involved in construction, manufacturing, wholesaling, transport and warehousing. These industries comprise 32 per cent of all jobs compared to 22 per cent in the Sydney Basin. The study area has an underrepresentation of industries involved in information, media and telecommunications, financial and insurance services, rental, hiring and real estate services and professional, scientific and technical services.

19.4.2 Residential areas

Some of the most sensitive receivers to aircraft noise are residential uses. There are a number of residential properties throughout the study area and a large variation in the lot sizes and housing typology.

Rural-residential and rural areas broadly surround WSI. Residential areas in the vicinity of WSI include:

- the villages of Luddenham, Wallacia, Mulgoa and Cobbitty, with Luddenham village located immediately west of the Airport Site, and the residential estate associated with the Twin Creeks Golf and Country Club, located directly north of WSI
- residential suburbs to the west (such as Silverdale and Warragamba), north (such as Glenmore Park, St Clair, Erskine Park), east (such as Middleton Grange, Hoxton Park, Cecil Hills and Abbotsbury) and south (such as Oran Park and Camden).

Within the Greater Blue Mountains Area (GBMA), low density development is concentrated along ridgelines and alongside the Great Western Highway, with scattered apartment buildings (such as at Katoomba and Leura).

As detailed in Chapter 11 (Aircraft noise):

- around 132,000 people would reside in the areas that correspond with the N60 24-hour composite noise contour in 2033 and 175,000 people by 2055. This equates to a 33 per cent increase in people living within these areas
- around 5,100 people would reside in the areas that correspond with the N70 24-hour composite noise contour in 2033 and 13,000 by 2055. This equates to a 155 per cent increase in people living within these areas.

It is estimated that 50,000 private dwellings would be within areas that correspond with the N60 24-hour composite noise contour in 2033 and 65,600 by 2055. Of these total dwellings, it is estimated that:

- 75 per cent are detached houses
- 13 per cent are townhouses
- 11 per cent are apartment style dwellings.

19.4.3 Non-residential uses

The study area encompasses a number of non-residential uses including agribusiness, industrial, environmental and commercial. The most concentrated urban area is located to the north and north-east of the study area. These areas have a number of industrial and commercial buildings (including bulky good retail stores). The site area to the west encompasses the environmental conservation and tourist uses of the GBMA. The uses to the south and closer to the WSI site boundary are focused mainly on agribusiness such as cut flowers, turf and mushroom farms. These agricultural uses provide employment opportunities to Western Sydney.

19.4.4 Tourism

Due to the impact COVID-19 has had on the tourist numbers, data has been used from the 2018/2019 year for a more accurate representation of the tourist use within the study area. Economic impacts can be split into direct and indirect effects. The indirect effect is known as a multiplier impact. This multiplier effect covers any additional economic impact created as a result of the initial direct impact.

In 2018/2019, there were 24,960 jobs in the tourism industry within the study area, which presents 17 per cent of tourism jobs within the Sydney Basin. In addition to these directly employed positions, a further 20,160 jobs were generated and/or supported in production and consumption impacts, representing 14 per cent of all employment directly generated and/or supported by tourism activities across the Sydney Basin.

Tourism in the study area directly contributed a total of $1.79 billion to Greater Sydney's Gross Regional Product (GRP), representing 11.4 per cent of the Sydney Basin's total. A further $2.61 billion was generated and/or supported through multiplier impacts.

In 2018/19 the total number of tourists and visitors to the study area was estimated at just over 11 million. This represented 21.5 per cent of the 51.5 million tourists and visitors to the Sydney Basin and 9.6 per cent of NSW's tourists and visitors in that year. Of the total number of tourist and visitors to the study area, the largest category was domestic day visitors. They recorded 8.3 million visitors in 2018/19, representing 75 per cent of all visitors to the study area in that year.

The main tourist and visitor attractor within the study area is the Blue Mountains region with 4.6 million tourists and visitors being recorded in the locality in 2019. This represented 42 per cent of all tourists and visitors estimated to have visited the study area.

19.5 Assessment of impacts

Potential economic impacts to the study area are difficult to quantify from the flight paths themselves. It has been widely stated in the 2016 EIS that the airport building, and associated infrastructure provided a positive impact to Western Sydney. The flight paths are an integral component of WSI, and some quantifiable impacts are detailed within this section of the EIS.

19.5.1 Impacts on employment and economic output

WSI would generate a significant number of jobs for Western Sydney and contribute significantly to gross regional product. The conclusions from the economic impact assessment in the 2016 EIS was that airport operations would directly generate 8,730 jobs in 2031 increasing to 61,500 jobs by 2063.

Additional jobs on the Airport Site could be accommodated in retail, hospitalities, business park and airport related industries. The EY study estimated an additional 4,439 jobs in 2031 increasing to 27,148 jobs by 2063.

Further to this are indirect jobs that are generated and/or supported. There are 2 types of indirect jobs:

- production induced jobs that relate to industries in the supply chain (providing the inputs to the industries on the Airport Site)
- consumption induced jobs which relates to jobs meeting the demand for additional goods and services due to increased spending by the wage and salary earners arising from employment on the Airport Site.

An additional study, the *Western Sydney Airport Labour Market Analysis* (Ernst and Young, 2017), estimates further indirect jobs at 14,777 in 2031 and 23,428 in 2041.

Flight paths are a consequential impact of WSI itself and do not directly generate jobs or create economic value when considered in isolation. However, it is acknowledged that the project is an integral part of WSI, ensuring that the jobs and economic value of WSI are realised. At the same time, flight paths can affect house value or reduce gross regional product due to potentially negative impacts of the flight paths such as noise.

The study area currently accommodates around 428,000 jobs and significant growth is expected in jobs over the next several decades with another 180,000 plus jobs at WSI and in the Aerotropolis by 2063. This growth is expected regardless of the selection of flight paths.

19.5.2 Tourism impacts

WSI and the associated infrastructure generate the benefits to the tourism industry. The flight paths can potentially affect the tourism industry if it results in loss in amenity to sensitive land uses.

The location of the flight paths over the Greater Blue Mountains could negatively affect the tourist experience of the area either through the visual location of aircraft or the noise they generate. These impacts are further discussed within Chapter 11 (Aircraft noise), Chapter 15 (Landscape and visual amenity) and Chapter 18 (Social).

With respect to the potential impact on tourism due to aircraft noise and/or visual intrusion, it is noted that:

- the flight paths generally avoid the primary tourist destinations in the Blue Mountains. The main tourist area is the Upper Blue Mountains from Lawson to Mount Victoria with Wentworth Falls, Leura, Katoomba and Blackheath being the primary destinations for staying overnight and for daytime tourist activities such as sightseeing, bushwalking, adventure and other activities. Springwood in the mid-Blue Mountains is also a popular destination although to a lesser extent. Springwood is 3 km from the nearest N60 contour. In the Upper Blue Mountains, all the towns, lookouts and nearby bushwalks are more than 5 km from any N60 contour
- views of planes from WSI at the main lookouts would be very distant at more than 5 km away during the day and the number of flights would not be frequent
- flight paths to and from Sydney (Kingsford Smith) Airport currently fly over the Blue Mountains, albeit at higher altitudes
- flight paths are a necessary component of the operating airport. The selection of flight paths appears to have been done with the deliberate intention to minimise impacts to built-up areas, and communities in the townships in the Upper Blue Mountains have largely been avoided. However, it is acknowledged that parts of Blaxland, Warrimoo and Mt Riverview in the Lower Blue Mountains and a small area on the east side of Linden are inside the N60 contour
- there is no evidence or data that would implicate the flight paths as causing a loss to tourism in the Blue Mountains whether that be the number of overnight visitors, the number of day visitors or the level of enjoyment in undertaking tourist activities in the Blue Mountains including bush walking and camping.

Given the above, there would be no loss in tourism spend in the area and hence no impacts on the local economy. On the contrary, WSI itself provides some potential for positive impacts on tourism in the Blue Mountains due to its proximity.

19.5.3 Property values

One of the primary methods used to determine economic value change due to flight paths is through property values. The impact to property values is usually through a combination of social and economic impacts rather than a direct impact to the value simply because the flight paths exist. In this case, the noise impact on the amenity of a property is one of the deciding factors for value change.

The analysis for Brisbane Airport, Sydney (Kingsford Smith) Airport and Melbourne Airport indicates that property values are impacted negatively in the short term of airport construction and operation, but there were stronger land value gains for neighbouring properties in the years following operations commencing. Within international studies, most found some negative impact on residential properties but not for commercial or industrial properties, and that it generally showed that there would be no impact on residential property values for those located beyond the 60 dB(A) noise contour. In the 2016 EIS, the assessment by JLL (JLL, 2016) of the N60 and N70 contours on property sales price data showed lower levels of impact and were considerably less statistically valid. As there was a higher level of uncertainty with the results, it was excluded.

The value of commercial, industrial and employment related land uses are considered to be less impacted than residential uses. The non-residential uses are likely to find an increase in value due to the boost in economy that WSI itself brings. This benefit outweighs the impact from the noise associated with the aircraft flight paths.

In the 2016 EIS, JLL derived the potential impact of noise on property values by land use type based on the analysis of the Brisbane and Adelaide airports and other supporting studies. The JLL study did not find any statistically significant relationships between noise exposure and housing prices in Melbourne and Sydney. At Sydney (Kingsford Smith) Airport, analysis of long run house prices since 1991 found no appreciable difference in growth rate between median prices in suburbs subject to 20 ANEI/ANEF or more and those in similar areas not exposed to aircraft noise. Examination of sales of large lot land holdings in the vicinity of Melbourne, Perth and Avalon airports failed to establish any statistically significant relationship between noise exposure and property prices.

In the 2016 EIS, JLL estimated the percentage discount on residential properties having primary consideration to the statistically significant results from the Brisbane and Adelaide airports, with support from academic literature and professional studies (refer to Table 19.1). This found a decrease in values for residential properties within the ANEI/ANEF 20-25 contour and above have an average loss of between 9.5 per cent to 19.8 per cent.

Table 19.1 Summary of assessment of noise impact on property values by land use type (JJL, 2016)

Land use	ANEI/ANEF 20-25	ANEI/ANEF 25-30	ANEI/ANEF 30-35
Residential	-9.5%	-14.7%	-19.8%
Large lot land holdings	No discernible impact	No discernible impact	No discernible impact

For WSI, only 0.5 per cent of properties in the study area are located within this ANEI/ANEC boundary. An earlier study by JLW Advisory in 1997 (for the Badgerys Creek Airport EIS) concluded a 3 per cent reduction in residential values in the ANEC 15 to ANEC 20 range (which for this study has been approximated to the N70 (24-hours) contour).

Using the above assumptions, the total loss in value of residential property is forecast as follows:

- Year 2033: $56m
- Year 2040: $77m
- Year 2055: $148m.

The above impacts are cumulative (and hence should not be added together). Total impact is a $53 million dollars loss in total residential values in 2033 increasing to a cumulative level of $148 million dollars by 2055 (measured in 2022 dollars).

While the impact appears high, it is important to recognise that residential values in Western Sydney have increased considerably over the past 10 years. Following the announcement of the location of WSI at Badgerys Creek in April 2014, residential prices in the suburbs around Badgerys Creek increased by almost 24 per cent and substantially faster than both Western Sydney and the Sydney Metropolitan regions. The median house price in Blacktown and Penrith LGAs have both increased by 130 per cent (more than doubled) since September 2012 (NSW Department of Communities and Justice, 2023). When converting the median house price in 2012 into 2022 dollars (using the CPI index) real growth remains high at 80 per cent. This calculates to an average real growth rate of 6.3 per cent per annum. Further, these are the maximum impacts that can be expected.

As outlined in Chapter 11 (Aircraft noise), a noise insulation and property acquisition (NIPA) policy would be implemented for eligible properties.

19.5.4 Social impacts

Social impacts were covered in Technical paper 10: Social. Social impacts include:

- changes to community composition and cohesion
- increased inequality (as lower income households are likely to be more impacted)
- loss of residential amenity
- use and enjoyment of social infrastructure (such as parks).

All these impacts (with exception to increased inequality) can be quantified by loss in residential land values since land values reflect the desirability of living in the area. There are other social impacts identified but quantifying these are difficult and includes impacts such as impact on cultural heritage (Aboriginal and historic). In some incidences, impacts can be mitigated, such as noise impacts on children’s education which can be mitigated by noise insulation measures. The cost of these measures can be internalised in any quantitative assessment – that is they can form part of the capital cost whether it be for new buildings or existing buildings.

19.5.5 Economic impacts to Bankstown and Camden airports

Due to the introduction of flight paths for WSI, there will be a change in the overall airspace configuration within the Sydney Basin available for Camden and Bankstown Airports. According to Aeria Management Group (the airport operator) during the preparation of the Draft EIS, both airports will contribute around $1.6 billion and around 10,000 jobs by 2024/2025. Transport for NSW (2022) and .id Consulting Pty Ltd (2022) indicate there are around 3,500 jobs at Bankstown Airport, and around 350 people work in retail and food services on the fringe sites.

Both airports provide essential flying training capacity in the context of the global shortfall in pilots. Pilot shortages can constrain the economy with wide ranging impacts. Flying training at Bankstown and Camden airports provides capacity for more than 600 student pilots per annum. The trainee pilots use 3 flying training areas within the vicinity of WSI. With the introduction of the proposed airspace design, these flying training areas are anticipated to be restricted to the residual portions of the flying training areas as well as 2 possible areas to the north and south of the Sydney Basin. This means that the pilots would need to travel further to reach the new flying training areas which would translate to increased “transit” flight durations, extended training schedules and increased costs including increased flying training times and increased fuel maintenance costs.

The majority of training flights for the CASA Recreational Pilot Licence (RPL) are based on a one hour start-up to shutdown sortie length. According to operators at Bankstown Airport this is likely to increase to 1.2 hours due to longer transit times to and from what is anticipated to be the new training area resulting in a marginal cost of $91.80 per lesson. Training flights for the issue of a CASA Private Pilot Licence (PPL) would increase flight time by around 10 per cent at a marginal cost of $50.60 per lesson. Joy flight sorties would face an increase in flying time of approximately 20 per cent at a marginal cost of $222.

This assessment has assumed that half of all aircraft movements (being around 150,000 per annum) are affected by extending flight times at an average cost of $100, resulting in around $15 million in additional costs each year. This would increase over time with rising demand at around one per cent per annum.

The EIS has identified future possible flying training areas for use by the local General Aviation community. These possible training areas have been the subject of consultation by Aeria Management Group, the owners of Bankstown and Camden Airports, who have committed to working with the local General Aviation community to refine the details of these areas and have them promulgated in time for the opening of WSI. The final proposed detail and ultimate procedures will not be confirmed until completion of a separate airspace change proposal, depending on the extent of the change.

There are several emergency service operators including, NSW Police, NSW Ambulance, AirMed, Royal Flying Doctor and Fire and Rescue NSW. Aircraft participating in a Search and Rescue (SAR), Medical (MEDEVAC), or Fire and Flood Relief (FFR) flights shall be granted priority as necessary (Airservices Australia, 2022a).

19.5.6 Net present value

Net Present Value is how much an investment is worth throughout its lifetime, discounted to today's value. The 2016 EIS estimated a Net Present Value of negative $308 million for the flight paths presented in that EIS.

It is important to recognise that the flight paths are a necessary component of WSI itself, and WSI generates huge benefits to Western Sydney, Sydney Basin and NSW. The economic and financial impact of the flight paths cannot be separated from that of the broader airport project. There will be a total of 8,730 jobs in airport operations in 2031 increasing to 61,500 by 2063 (Ernst and Young, 2016). These jobs will provide a range of services in airport administration, retail, food services, travel services, customs and other government services, airline operations, freight, baggage handling, security, etc. There will be further jobs on the Airport Site in airport related businesses, industrial, commercial office jobs, food and hotel services and the like. At an average GVA of $135,000 per worker in airport operations and $102,000 per worker in other services on the Airport Site total GVA generated in Year 2033 is expected to be $1.976 billion increasing to $8.3b in Year 2055. The net present value of GVA over a project life out to 2055 is estimated at $45 billion dollars – 147 times higher than the NPV of the total quantified costs.

This GVA excludes GVA from other businesses outside WSI in the Aerotropolis, as well as any input/output multiplier impacts. Inclusion of these impacts would further increase the GVA.

19.6 Mitigation and management

19.6.1 Project specific mitigation measures

The below mitigation measures have been identified (refer to Table 19.2).

Table 19.2 Proposed mitigation measures – economic

ID No.	Issue	Mitigation measure	Owner	Timing
E1	Existing airspace users	DITRDCA will continue to consult with aerodrome operators and airspace users at Bankstown and Camden Airports regarding airspace requirements in order to minimise risks and associated economic costs.	DITRDCA	**Pre-operation** (Detailed design, 2024–2026)
E2	Emergency services	DITRDCA and Airservices Australia will continue to consult with emergency services operators regarding priorities of airspace in order to minimise risks and associated economic costs.	DITRDCA and Airservices Australia	**Pre-operation** (Detailed design, 2024–2026) and **Operation** (Implementation, 2026–ongoing)

Chapter 20 Human health

This chapter describes the assessment that has been undertaken to evaluate the potential community health impacts from the project. This assessment has focused on community health impacts resulting from changes in air quality, noise and other hazards and risks associated with the operation of aircraft from WSI. Based on the assessment undertaken, with consideration of the population located in the community surrounding WSI, the following is concluded in relation to potential impacts on community health:

Changes in air quality

The assessment undertaken has not identified any risk issues of concern in relation to impacts on community health in the local study area. More specifically the assessment has identified the following:

- impacts on community health as a result of exposure to fine particulates (as $PM_{2.5}$) are low
- impacts on community health as a result of exposure to nitrogen dioxide (NO_2) are considered to be low. While there may be the potential for elevated exposures to occur close to WSI, further review of these impacts indicates that the potential impact on respiratory health is considered to be low. It is noted that the areas where elevated exposures are identified are expected to be rezoned such that residential use is no longer relevant
- impacts on community health as a result of exposure to carbon monoxide (CO) are low, and essentially negligible
- impacts on community health as a result of exposure to sulfur dioxide (SO_2) are low, and essentially negligible
- impacts on community health as a result of exposure to individual volatile organic compounds (VOC) derived from aircraft emissions are low, and essentially negligible
- emissions to air derived from the operation of aircraft would have a negligible impact on water quality in Prospect Reservoir or rainwater tanks in the community. Potential impacts on these water supplies would be so low they would not be measured.

In addition to the above, no risk issues of concern in relation to community health has been identified in relation to changes in regional air quality.

Changes in noise

This assessment has addressed potential impacts on community health associated with aircraft noise derived from the operation of the project. The assessment has identified that there is the potential for noise from the project to result in potentially significant increases in sleep disturbance, noise annoyance (and therefore complaints) and, to a lesser extent, cognitive impairment for children (as learning delays). These impacts have been identified at a number of receivers located close to the runway as well as beneath the approaches and take off routes away from the runway. However, not all the locations identified as being potentially significant are used for residences, schools or childcare centres and have been used as an indicator of where issues may arise.

Most of the impacts on community health that are considered to be potentially significant are located within the existing or predicted Australian Noise Exposure Concept (ANEC) 20 contours. Existing land use planning controls are in place to prevent future noise sensitive development from occurring with the ANEC 20 contours, including new residential development, childcare centres and schools. The Department of Infrastructure, Transport Regional Development, Communications and the Arts (DITRDCA) and WSA Co will continue to liaise with State and local government agencies to ensure applicable environmental planning instruments have regard to ANEC forecasts produced for the project, where differences occur with the predicted ANEC as presented in this EIS.

By 2055 there would be some additional locations, outside of the modelled ANEC 20 contours where impacts on community health may be of significance. Changes in noise as a result of operations between 2033 and 2055 would be expected to be gradual, and hence the significance of the impacts identified may be influenced by community adjustment to the presence of aircraft noise in the environment. These changes, however, may remain of significance to some members of the community.

For existing residential properties located in the existing ANEC 20 contours, there is the potential for the community in these areas to experience increased and significant levels of annoyance and sleep disturbance.

Changes in hazard and risks

A range of hazards and risks have been identified that relate to the operation of aircraft in the airspace above and around WSI and within the Sydney Basin. A range of mitigation measures have been identified to manage these hazards and risks, consistent with the way such risks are managed for all aircraft and airports. Where these are implemented, risks to community safety and health would be considered low and acceptable.

Refinements to the project

The key health impact related to night-time noise is sleep disturbance. The introduction of the RRO noise abatement procedure (RRO-NAP) and the reallocation of jet aircraft from Runway 23 Departure Northeast Night (RRO) to the Runway 23 Departure Southeast Night (RRO) flight path would result in a change in noise impacts at night. This change in night-time noise impacts would result in some sensitive receivers no longer exceeding thresholds for L_{max} or L_{night}, or very small changes in the percentage of the population that is highly sleep disturbed. Overall, the changes are small and do not result in changes to the conclusions presented in the Draft EIS in terms of sleep disturbance. For the other refinements to the preliminary flight paths, these generally do not occur over populated areas and/or further increase the distance to or altitude above populated areas. Further detail is provided in Section G2.12 of Appendix G (Assessment of the refinements to the project) of the EIS.

20.1 Introduction

This chapter considers the potential human health impacts of the project at a local and regional scale. It considers the noise and air emissions resulting from the project as well as other hazards and risks associated with the project that could impact the health and wellbeing of the community. The full human health impact assessment is provided in Technical paper 12: Human health (Technical paper 12).

The health impact assessment considers the baseline human health profile of the region and identifies key health risks from the operation of the proposed airspace and flight paths. The implementation of mitigation measures associated with noise and air quality described in the relevant chapters of this EIS would reduce the predicted risks.

20.2 Legislative and policy context

The human health impact assessment was carried out in accordance with national and international guidance that is endorsed or accepted by Australian health and environmental authorities.

Guidance used for the assessment of human health impacts include the following:

- *National Environmental Protection (Air Toxics) Measure, Impact Statement for the National Environment Protection (Air Toxics) Measure, 2003* (National Environment Protection Council (NEPC), 2003)
- *National Environmental Protection (Ambient Air Quality) Measure 2021* (NEPC, 2021)
- *Schedule B8 Guideline on Community Engagement and Risk Communication, National Environment Protection (Assessment of Site Contamination) Measure, 1999* (NEPC, 2013)
- *Health Impact Assessment Guidelines* (Environmental Health Committee, 2017)

- *State Environmental Planning Policy (SEPP) (Resilience and Hazards) 2021* (NSW Government, 2021)
- *Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards, 2012* (Environmental Health Committee, 2012)
- *Health Impact Assessment: A Practical Guide, Centre for Health Equity Training, Research and Evaluation* (CHETRE) (Harris et al. 2007).

In addition, there are a range of more specific guidance relevant to the assessment of health impacts from changes in air quality and noise, in particular, that are available from Australian and key international organisations or reviews. These include the following:

- NEPC reviews on the health effects of air pollution (*Exposure Assessment and Risk Characterisation for the Development of a PM2.5 Standard* (Burgers and Walsh, 2002))
- World Health Organization (WHO) reviews on the health effects of air pollution (*Outdoor Air Pollution: Assessing the environmental burden of disease at national and local levels* (Ostro, 2004))
- USEPA reviews on the health effects of NO_2 and particulates
- guidance on the assessment of environmental noise, including *Environmental Noise Guidelines for the European Region* (WHO, 2018).

20.3 Methodology

20.3.1 Impact assessment approach

The methodology for the human health impact assessment is aimed at assessing impacts and risks to human health from the operation of the project. The human health assessment has focused on health-related impacts associated with key air quality, noise, and hazard and risk aspects. The human health impact assessment for the project has been undertaken as a desktop assessment.

Broadly, the methodology and legislative requirements to assess health impacts/risks follow a standard risk assessment and management-type approach, shown in Figure 20.1.

Figure 20.1 Approach to assessing human health impacts and benefits

This assessment of impacts on human health has been undertaken in accordance with the guidelines outlined in Section 20.2 and consideration of the impacts identified in other relevant technical studies.

20.3.1.1 Health impact assessment approach

Broadly, the impact assessment of health impacts consisted of:

- the identification of risk issues of concern
- assessment of the potential significance of community exposures (or the benefits of the project) on health outcomes
- identification of measures to manage impacts or enhance benefits and review risks and benefits with the implementation of these measures.

The assessment considered a wide range of factors with the potential to affect human health, both direct and indirect factors that affect community health and wellbeing.

To inform the assessment of potential health impacts, relevant information on the community or population in areas surrounding the project was reviewed. Information reviewed regarding the existing environment included:

- community profile(s), which comprises information on the population that may be impacted by the project, specifically the demographics, lifestyle factors and baseline health, and the social environment that have the potential to determine the vulnerability of various aspects of the community to impacts form the project
- existing conditions of key environments in which the community reside that affect and are of importance for the human health impact assessment, including existing air quality and noise.

Figure 20.2 provides an overview of the key aspects that are considered in the assessment of impacts on community health.

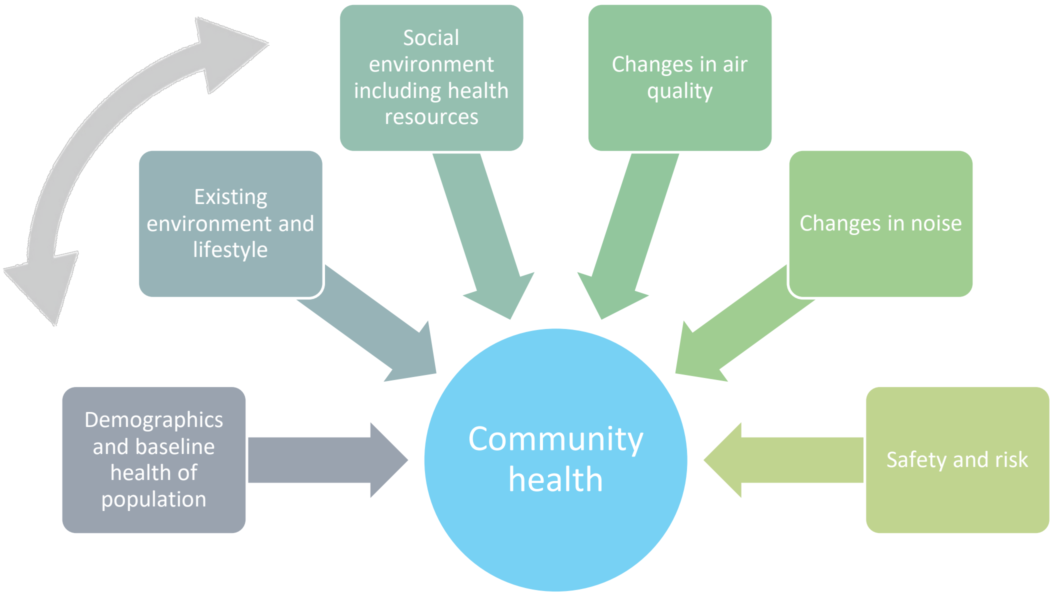


Figure 20.2 Key aspects relevant to the conduct of the health impact assessment

20.3.1.2 Characterising health impacts

The assessment of health impacts involved a combination of quantitative and qualitative approaches.

Where a quantitative assessment was undertaken, the following terminology has been used:

- **No health impacts of concern or negligible.** This means that all exposure levels or concentrations quantified are below guidelines that are protective of all adverse health effects in the community or are so low that they are effectively considered to be indistinguishable from zero
- **Low.** Exposure levels or concentrations quantified are equal to guidelines that are protective of all adverse health effects in the community or at a level that may result in some amenity impacts but no health impacts (e.g., visible dust deposition).

Where exposure levels or concentrations are not described as above, they are considered to be elevated and potentially unacceptable.

Where a qualitative assessment is undertaken, the following terminology has been used:

- **No health impacts of concern or negligible.** Impacts evaluated or considered would not result in a health effect that would be different to the variability typically experienced within normal urban or suburban environments.
- **Low.** Impacts evaluated or considered may be noticeable or result in a short-term increase in stress and anxiety, however the level of impact can be managed through normal daily coping mechanisms just as are common when there is a change in our normal environment, e.g., new building works occurs nearby or a common travel route change.

Where impacts have the potential to result in the development of or exacerbation of disease or result in levels of stress and anxiety that cannot be managed through normal daily coping mechanisms, they are considered to be elevated and potentially unacceptable.

20.3.2 Dependencies and interactions with other technical papers

This report has been informed by the technical reports identified in Table 20.1. The health impact assessment has drawn on information provided in these reports and, in some areas, provides a summary of key (and relevant) aspects.

Table 20.1 Dependencies and interactions with other technical papers

Technical paper	Relevance
Technical paper 1: Aircraft noise	The assessment methodology for health impacts related to aircraft noise involved: • review of Technical paper 1 including identification of sensitive receivers within potentially impacted communities surrounding the project, and modelled noise impacts relevant to the project • assessment of potential human health impacts from noise during operation of the project. Additional assessment of project refinements was also completed based on a review of Addendum Technical paper 1: Aircraft noise.
Technical paper 2: Air quality	The assessment methodology for health impacts related to air quality involved: • review of Technical paper 2 including identification of sensitive receivers within potentially impacted communities surrounding the project, and modelled air quality impacts relevant to the project • assessment of potential human health impacts from key pollutants during operation of the project.
Technical paper 3: Greenhouse gas emissions	The assessment methodology for health impacts related to air quality involved: • review of Technical paper 3 including review of the assumptions and methodology and the establishment of the greenhouse gas (GHG) emissions assessment boundary for aircraft operating along WSI's flight paths • assessment of potential human health impacts from key pollutants during operation of the project.
Technical paper 4: Hazard and risk	The assessment methodology for health impacts related to hazards and risks involved: • review of Technical paper 4 and assessment of potential human health impacts from identified hazards and risks associated with operation of the project.

Technical paper	Relevance
Technical paper 10: Social	The assessment methodology for health impacts related to social aspects involved: • review of all available information relevant to the assessment including: – Technical paper 10 – data from the Australian Bureau of Statistics (ABS) – information relevant to local government areas (LGAs) and health districts (in particular Sydney Local Health District and Northern Sydney Local Health District) • identification of sensitive receivers within potentially impacted communities surrounding the project, and assessment of the current health metrics for those communities • assessment of potential human health impacts associated with visual amenity, and stress and anxiety issues during operation of the project, including short-term and long-term impacts.

20.4 Existing environment

This section outlines the existing environment as it relates to human health including:

- potentially impacted receivers within the communities surrounding the project
- the current health status of these communities.

The existing environment for air quality, noise, hazard and risks, and social aspects are detailed in the following chapters:

- Chapter 11 (Aircraft noise)
- Chapter 12 (Air quality and greenhouse gas)
- Chapter 13 (Aircraft hazard and risk)
- Chapter 18 (Social).

20.4.1 Population profile and health status of the community

The health of the community is influenced by a complex range of interacting factors including age, socio-economic status, social networks, behaviours, beliefs and lifestyle, life experiences, country of origin, genetic predisposition and access to health and social care. Information in relation to health-related behaviours (that are linked to poorer health status and chronic disease including cardiovascular and respiratory diseases, cancer, and other conditions that account for much of the burden of morbidity and mortality in later life) is available for the larger populations within the local area health services in Sydney and NSW.

It is important to understand the demographics of the population in the study area to determine if the population has the potential to be more or less vulnerable to environmental stressors relevant to the project. The relevant statistics relate to the age distribution of the population, housing, unemployment rate, level of socioeconomic disadvantage, availability of economic resources and cultural and linguistic diversity of the population.

In terms of the key statistics presented for the human health study area the following is:

- There are some populations that have a higher proportion of young children or older individuals, that also include a higher proportion of social housing and/or are under rental or mortgage stress. These areas include Blacktown, Camden, Liverpool and Penrith LGAs; and Austral, Badgerys Creek, Bringelly, Cecil Park, Glenmore Park, Horsley Park, Kemps Creek, Orchard Hills, Rossmore, Silverdale and Warragamba suburbs and localities. These populations can typically be more vulnerable to environmental stressors than other populations. Conversely, there are also some populations in the study areas that may be less vulnerable, where there is a smaller proportion of the population that comprises young children or older individuals and there are lower levels of rental and/or mortgage stress. These areas include Mount Vernon and Luddenham.

- Factors such as socio-economic disadvantage, the availability of economic resources and availability of education and employment are important factors in relation to community health and wellbeing. The available data indicates that:
  - Fairfield LGA is considered more disadvantaged in terms of socio-economic disadvantage or availability of economic resources and availability of education and occupation resources, and also has a higher rate of unemployment. The populations in Blue Mountains, Camden and Hawkesbury LGAs and the suburbs and localities of Cobbitty, Luddenham, Mulgoa, Mount Vernon and Silverdale are considered the least disadvantaged
  - much of the population in the study area are in locations with lower rates of unemployment, with only populations in Blacktown LGA and Greendale reporting higher rates of unemployment (noting that unemployment is a key determinant in evaluating community health and wellbeing and is linked with socio economic disadvantage and the availability of resources).
- With respect to population health:
  - changes in air quality and noise within an environment can result in impacts on community health. For the key air pollutants considered (derived from aircraft emissions) and noise sources (aircraft), there are numerous other sources in urban areas that include these emissions
  - the rate of mortality in the study area is generally similar to that of NSW. Higher rates of mortality from cardiovascular disease has been reported in South Western Sydney Local Health District and higher rates of mortality including respiratory and cardiovascular causes presented in the Nepean Blue Mountains Local Health District
  - the rate of hospitalisations in the study area is generally similar to that of NSW for respiratory and cardiovascular disease, however the rate of respiratory hospitalisations is higher in the South Western Sydney and Nepean Blue Mountains Local Health Districts.

Further information regarding statistics relevant to the study area are summarised in Section 4.1 to Section 4.5 of Technical paper 12.

20.4.2 Potentially impacted communities

The study area applicable to the assessment of health impacts and consideration of potentially impacted communities has been established to align with the study areas identified and evaluated in relation to changes in air quality, noise, hazard and risk, and social impacts. More specifically the study area considered in the assessment of health impacts is consistent with the social impact assessment, which has divided the study area into a local area and regional area, with the State of NSW and the Greater Sydney area adopted as points of comparison.

The potentially impacted communities considered in the assessment have been divided into 2 areas consisting of a local study area and a regional study area. The local study area showcases the communities most likely to be most affected by impacts of the project, including changes to noise, air quality and visual impacts. The regional study area showcases the communities that would possibly be affected by visual and noise impacts of the project. The human health impact assessment study area is an amalgamation of these study areas.

A local study area was defined to include ABS suburb and localities within 10 km from the centre of the runway, and a regional study area was defined to include LGAs in which residential areas were predicted to be intersected by N60 and N70 noise contours (as identified in Chapter 11 (Aircraft noise) and Technical paper 1). Overall, the total study area included areas contained within a total of 8 LGAs including Liverpool, Camden, Blacktown, Penrith, Blue Mountains, Hawkesbury, Fairfield and Wollondilly. The extents of the local and regional study areas are shown in Figure 4.1 and 4.2 respectively within Technical paper 12.

20.4.2.1 Sensitive receivers

Within the study area, the air quality and aircraft noise impact assessments have identified and evaluated impacts at specific residential and community receiver locations where sensitive members of the community are more likely to be present. In terms of evaluating health impacts sensitive groups include infants and young children, the elderly and individuals who are unwell or with health conditions. Hence residential homes, childcare centres, schools, hospitals and aged care facilities are considered to be sensitive receiver locations. Other sensitive receiver locations may include recreational areas and religious premises. Details of the sensitive or community receivers included in the assessment are consistent with those identified for the air quality assessment as previously identified in Chapter 12 (Air quality and greenhouse gas) and Technical paper 2.

20.5 Assessment of impacts

Impacts on human health as a result of the operation of the preliminary flight paths have been assessed in relation to the following:

- health impacts resulting from changes in air quality
- health impacts resulting from changes in noise
- health impacts resulting from changes to existing hazards and risks.

20.5.1 Health related air quality impacts

Emissions to air from the operation of aircraft have been summarised in Chapter 12 (Air quality and greenhouse gas). The assessment to the community focused on key pollutants relevant to aircraft emissions, as follows:

- particulates, as fine particulates PM_{10} and $PM_{2.5}$
- oxides of nitrogen, with NO_2 of key importance for the assessment of health
- CO
- SO_2
- VOCs, with the key individual VOCs identified as benzene, toluene, xylenes and formaldehyde.

This assessment has assessed potential community exposures to these key pollutants with a summary of each presented below. Further details of the potential health impacts resulting from changes in air quality associated with the project, and the metrics used to determine the potential impacts, is provided in Section 5.5 of Technical paper 12.

20.5.1.1 Potential for exposure

The key air pollutants identified and assessed in relation to the operation of aircraft within the air space are either vapours/gases or fine particulates that would be expected to behave as a gas, as is the case for $PM_{2.5}$. For PM_{10}, which includes some slightly larger, but still very fine, particulates, most of these particulates would stay suspended in air. The potential for these particles to deposit to the ground is very small. Therefore, the key pathway of exposure relevant to the community exposed to aircraft emissions would be through inhalation.

20.5.1.2 Particulates

Dust or particulate matter (PM) is a widespread air pollutant (that has and will always be present in air) with a mixture of physical and chemical characteristics that vary by location (and source). The assessment assessed potential impacts on community health on the basis of an assessment of cumulative exposures (i.e. project plus background) and incremental exposures (i.e. from the project alone) from increases in PM.

The size of particulates is important as it determines how far from an emission source the particulates may be present in air (with larger particulates settling out close to the source and smaller particles remaining airborne for greater distances) and also the potential for adverse effects to occur as a result of exposure (how far the particles can infiltrate into the respiratory system). Only particulates that are small enough can penetrate into the lungs where there is the potential for effects to occur. If the particles are too large, they will be captured high up in the respiratory tract, trapped and flushed out and eventually swallowed. Typically, $PM_{2.5}$ and smaller are the particle size that may reach the lower parts of the respiratory tract (the smaller bronchioles and alveoli). This is the area of the lungs where gaseous exchange takes place and the area that may be impacted by fine particles.

In relation to exposure to PM, effects are primarily related to the respiratory and cardiovascular system and include:

- aggravation of existing respiratory and cardiovascular disease (as indicated by increased hospital admissions and emergency room visits)
- changes in cardiovascular risk factors such as blood pressure
- changes in lung function and increased respiratory symptoms (including asthma)
- changes to lung tissues and structure
- altered respiratory defence mechanisms.

Assessment of cumulative exposure impacts

The assessment of cumulative exposures to $PM_{2.5}$ is based on a comparison of the cumulative concentrations predicted with the current air quality standards and goals presented in the NEPC(Ambient Air Quality) Measure (NEPM) (NEPC, 2021), and have been adopted in NSW (NSW EPA, 2022). These standards and goals are total concentrations in ambient air, within the community, that are based on the most current science in relation to health effects.

A review of cumulative exposure to $PM_{2.5}$ indicates that the maximum predicted 24-hour average air concentration, including the project would remain below the NEPC air standard. In relation to the annual average air concentrations, impacts predicted in 2033 would not result in exceedance of the NEPC air standard, however the cumulative concentration predicted in 2055 may exceed the NEPC air standard in some locations. This would occur at the most impacted residential receiver (at a location near the northern boundary of the Airport Site) and the assessment has assumed background air quality, which dominates the impacts identified, remains unchanged in 2055. The impact of emissions from aircraft is very low, comprising around 4 percent of the NEPM air standard.

Assessment of incremental exposures (changes in air quality)

The assessment of incremental impacts associated with exposure to $PM_{2.5}$ has evaluated the maximum increase in annual average $PM_{2.5}$ predicted from community receivers evaluated each of the suburbs and localities in the local study area. Assessment of incremental impacts considered the attributable cases relevant to increased exposure to $PM_{2.5}$ from aircraft emissions to the following primary and secondary indicators:

- primary indicators:
  - mortality – all causes, long-term
  - hospitalisations – cardiovascular, short-term
  - hospitalisations – respiratory, short-term
- secondary indicators:
  - mortality – all causes, short-term
  - mortality – cardiovascular, short-term
  - mortality – respiratory, short-term
  - morbidity – asthma Emergency Department (ED) admissions, short-term.

The predicted number of attributable cases, relevant to all indicators is considered to be very low, well below one case per year. Assuming the maximum impacts always occurred each year, and the population was at that same location all day every day for a lifetime, the number of cases may be up to around 2 attributable cases over a 100-year period, within the whole population evaluated. For Luddenham, the most impacted suburb, the calculations presented indicate the number of cases may be up to around one attributable case over a 100-year period. Such a low level of impact would be negligible in relation to the health statistics relevant to the study area.

On the basis of the calculations presented in terms of cumulative and incremental impacts of exposure to $PM_{2.5}$, there are no health risk issues of concern in relation to $PM_{2.5}$ derived from the operation of aircraft associated with the project.

20.5.1.3 Oxides of nitrogen

Nitrogen oxides (NOx) refer to a collection of highly reactive gases containing nitrogen and oxygen, most of which are colourless and odourless. Nitrogen oxide (NOx) gases form when fuel is burnt including when residual waste is used as fuel. Motor vehicles, along with industrial, commercial and residential (e.g., gas heating or cooking) combustion sources, are primary producers of NOx. This assessment considered the potential impacts of exposure to NO_2 from aircraft emissions on community health on the basis of an assessment of cumulative exposures (i.e. project plus background) and incremental exposures (i.e. from the project alone).

In terms of health effects, NO_2 is considered to be the only oxide of nitrogen that may be of concern (WHO, 2000). Nitrogen dioxide (NO_2) can cause inflammation of the respiratory system and increase susceptibility to respiratory infection. Exposure to elevated levels of NO_2 has also been associated with increased mortality, particularly related to respiratory disease, and with increased hospital admissions for asthma and heart disease patients.

Assessment of cumulative impacts

Review of the NO_2 impacts predicted from the project (and summarised in Chapter 12 (Air quality and greenhouse gas)) indicates that, in relation to the assessment of short-term exposures, the maximum 1-hour average concentrations predicted in 2055 are anticipated to exceed the NEPC standard (predicting a cumulative maximum 1-hour average (residential) range of around 201 to 254 µg/m^3 compared to the NEPC standard of 164 µg/m^3). In relation to the assessment, the review indicates the following:

- the predicted levels of NO_2 are likely to be conservative (i.e., potentially overstated), due to:
  - the modelling has used a conservative approach for assessing chemical transformations to predict NO_2 levels
  - the modelling assumes the worst-case scenario occurs for every hour of the year
  - the modelling does not take into account future improvements in emissions due to better fuel or engine emission controls
- as a result, the predicted impacts detailed above are unlikely to actually occur
- the impacts identified relate to a few hours of the year and only at a few locations close to the WSI, specifically a residential receiver at a location near the northern boundary of the Airport Site in Luddenham
- the next highest impact is at a second receiver in Luddenham where the maximum 24-hour average concentration of NO_2 is below the NEPC standard.

The residential receiver in Luddenham is located north-west of the Airport Site. This is in an area that has been rezoned by the State Government as per the planning initiatives for Aerotropolis. Specifically, the area of this receiver is now zoned for agribusiness, which includes restrictions on the intensification of residential development. Where the area assessed associated with this receiver is no longer used for residential purposes, but is redeveloped for business purposes, that does not include childcare uses, the potential for impact on respiratory health is low.

Assessment of incremental impacts

The predicted number of attributable cases, relevant to all scenarios is low, below one case per year. Assuming the maximum impacts always occurred each year, and the population was at that same location all day every day for a lifetime, the number of cases may be up to 40 over a 100-year period. This is considered to be overly conservative particularly within Luddenham, where the calculated health incidence is dominated by the maximum impact identified at the residential receiver in Luddenham. Where the land use of this area is changed, consistent with the rezoning of the land adjacent to the Aerotropolis (excluding childcare uses) the potential health impacts would be significantly lower.

As detailed in Chapter 12 (Air quality and greenhouse gas) and Technical paper 2, the incremental impacts identified at the residential receiver in Luddenham only occur for a few hours each year, under worst-case assumptions. Review of the hourly concentrations predicted indicates only a few hours where an hourly-average concentration between 200 $\mu g/m^3$ and 240 $\mu g/m^3$ may occur. These concentrations are below a level at which respiratory effects, including asthma, would be expected to occur within the population. Hence the potential for health impacts to occur as a result of these predicted worst-case limited, short duration elevated NO_2 concentrations is considered to be negligible.

20.5.1.4 Carbon monoxide

Carbon monoxide (CO) is produced during combustion when there is a limited supply of oxygen. This includes combustion engines in vehicles. The sorts of effects that can be expected due to exposure to CO are those linked with carboxyhaemoglobin in blood (where CO replaces oxygen in the blood preventing oxygen from being transported around the body). In addition, association between exposure to CO and cardiovascular hospital admissions and mortality, especially in the elderly for cardiac failure, myocardial infarction and ischemic heart disease; and some birth outcomes (such as low birth weights) have been identified (NEPC, 2010).

All concentrations of CO predicted in the local study area are well below the relevant air standards. Hence there are no health risk issues of concern in relation to CO emissions from the operation of aircraft associated with the project.

20.5.1.5 Sulfur dioxide

Sulfur oxides are formed during combustion when chemicals present in fuels (such as coal, gas, petrol etc) containing sulfur react with oxygen to form sulfur oxides. Sulfur dioxide (SO_2) is the main sulfur oxide that can have impacts on people. Exposure to elevated levels can result in irritation of the respiratory system and can make breathing difficult. The most affected by exposure to these chemicals are people with asthma.

All concentrations of SO_2 predicted as a result of the project are well below the relevant air standards. Hence there are no health risk issues of concern in relation to SO_2 emissions from the operation of aircraft associated with the project.

20.5.1.6 Volatile organic compounds

As described in Chapter 12 (Air quality and greenhouse gas) VOCs can comprise a large number of individual chemicals. The key individual VOCs related to aircraft emissions, namely benzene, toluene, xylenes and formaldehyde. Health risk issues of concern in relation to VOCs can include increased risk of cancer (specifically leukaemia), respiratory and neurological symptoms and other carcinogenic-type effects.

Overall, impacts on community health as a result of exposure to individual VOCs derived from aircraft emissions are considered to be low to essentially negligible.

20.5.1.7 Impacts on drinking water quality

In terms of drinking water supplies, Prospect Reservoir is the closest potable water reservoir to the site. The concentration of pollutants in Prospect Reservoir depends on the deposition rate of dust onto the surface of the water and onto the surrounding catchment, the volume of the reservoir and the volume of rainfall each year.

Fine particles as $PM_{2.5}$ (and PM_{10}) and gases would remain in the atmosphere and would not deposit to the ground. However, concern has been raised in relation to aircraft emissions impacting on drinking water supplies and hence for the purpose of this assessment it has been assumed that deposition does occur. Where this occurs, these pollutants may deposit to the ground or to roof areas, where impacts on drinking water quality in drinking water catchments and rainwater tanks may occur. Impacts on drinking water quality, where such water may be used as potable water by the community has also been considered in this assessment. It is noted that advice from NSW Health indicates that rainwater tanks in urban areas, which includes the local and regional study areas, should not be used as potable water supply. The study area is supplied with reticulated water, from Sydney Water, and hence rainwater tanks would not be expected to be used for potable water. Other non-potable uses such as toilet flushing, filling swimming pools, garden watering, washing cars and firefighting may occur.

As detailed above, it has been conservatively assumed that key chemicals such as benzene, toluene, xylenes and formaldehyde that may occur as a result of the aircraft utilising WSI will be absorbed to particulates in the air, and these will be large enough to deposit to the ground. While in fact such chemicals are not expected to deposit at all (as they are formed from vapours and would typically degrade in air), a highly conservative approach has been adopted to predict concentrations that may be present in Prospect Reservoir and in residential rainwater tanks.

Based on the assessment (refer to Section 5.5.7 of Technical paper 12 for details), emissions to air derived from the operation of aircraft would have a negligible impact on water quality in Prospect Reservoir or rainwater tanks in the community. Potential impacts on these water supplies would be so low they would not be measurable.

20.5.2 Health related noise impacts

A detailed assessment of noise impacts associated with the project are presented in Chapter 11 (Aircraft noise). Sound is a natural phenomenon that only becomes noise when it has some undesirable effect on people or animals. Noise and vibration can potentially have both short-term and long-term adverse effects on people. These health effects can include:

- hearing impairment
- sleep disturbance (sleep fragmentation that can affect psychomotor performance, memory consolidation, creativity, risk-taking behaviour and risk of accidents)
- annoyance (which can be a major consideration because it reflects the community's dislike of noise and their concerns about the full range of potential negative effects from a project. It also affects the greatest number of people in the population)
- cognitive impairment in children (effects on reading and oral comprehension, short and long-term memory deficits, attention deficit)
- cardiovascular health
- interference with speech and other daily activities.

Other potential effects which may occur, but for which the evidence is weaker, include:

- effects on mental health (usually in the form of exacerbation of existing issues for vulnerable populations rather than direct effects)
- some evidence of indirect effects such as impacts on the immune system.

This assessment has assessed potential community exposures to these key noise-related impacts with a summary of the key issues presented below. Further details of the potential health impacts resulting from changes in noise associated with the project, and the metrics used to determine the potential impacts, is provided in Section 6.5 of Technical paper 12.

20.5.2.1 Hearing impairment

Where significantly elevated levels of noise are present, there is the potential for such noise levels to result in hearing impairment. Review of the predicted noise levels from aircraft operations against WHO thresholds relevant to hearing impairment indicates the following:

- L_{max}: there are no predicted maximum levels of noise for all scenarios evaluated in 2055 at any of the noise sensitive receivers that exceed the threshold of 110 dB(A)
- L_{day}, $L_{evening}$ or L_{night}: there are no L_{Aeq} levels of noise for all scenarios evaluated in 2033 and 2055 at any of the noise sensitive receivers that exceed the threshold of 70 dB(A).

On the basis of the above, noise derived from aircraft operations would not be expected to result in hearing impairment in any of the areas surrounding the WSI.

20.5.2.2 Sleep disturbance

Sleep serves to facilitate vital functions in our body. It is relatively well-established that night time noise exposure can have an impact on sleep (Environmental Health Committee, 2018; WHO, 2009; WHO, 2011). Noise can cause difficulty in falling asleep, awakening and alterations to the depth of sleep, especially a reduction in the proportion of healthy rapid eye movement sleep. Other primary physiological effects induced by noise during sleep can include changes in glucose metabolism and appetite regulation, impaired memory consolidation and a dysfunction in blood vessels. Long-term sleep disturbance can also lead to cardiovascular health issues (WHO, 2011; WHO, 2018).

Exposure to night-time noise also may induce secondary effects, or so-called after-effects. These are effects that can be measured the day following exposure, while the individual is awake, and include increased fatigue, depression and reduced performance.

Assessment of potential sleep disturbance impacts associated with aircraft noise have been assessed on the basis of calculating the percentage of populations located in specific areas that are highly sleep disturbed. The assessment has identified areas, as suburbs and localities, where sleep disturbance as a result of aircraft noise is considered to be of potential significance. This is where the calculated percentage of the population in the area as a result of aircraft noise is 3 per cent or more higher than the percentage of people highly sleep disturbed from existing environmental noise. Utilising this approach, the assessment identified that the areas of highest potential for increases in sleep disturbance impacts would occur in areas closest to WSI being Luddenham, Greendale, Silverdale, Wallacia and Kemps Creek. The maximum percentage of these populations that are highly sleep disturbed as a result of aircraft noise ranged from between around 19 per cent in Kemps Creek (in 2033) to 40 per cent in Luddenham (by 2055).

20.5.2.3 Annoyance

Annoyance is a feeling of displeasure associated with any agent or condition known or believed by an individual or group to adversely affect them. It is one of the most prevalent responses to noise, and it is described as a stress reaction that encompasses a wide range of negative feelings, including disturbance, dissatisfaction, distress, displeasure, irritation and nuisance. The individual response to noise depends not only on exposure levels but also on contextual, situational and personal factors. It can initiate physiological stress reactions that, if long-term, could trigger the development of cardiovascular disease.

The assessment of annoyance requires some consideration of what may be of concern in terms of health, and complaints. Where noise levels change, community reaction to these changes can vary. For example, reaction to a newly introduced noise source (such as new aircraft noise) may be considerably higher than a source that has been present for a long time. There are no specific guidelines available for determining what would be an acceptable, or unacceptable increase in annoyance from a specific project. Most health-based noise guidelines are set at a level that corresponds with 10 per cent of the residents highly annoyed (NSW, DECCW 2011; WHO, 2018), however, when evaluating noise annoyance in an urban environment, where there are a number of existing sources, the application of a total 10 per cent highly annoyed criteria is not considered appropriate. As such, criteria that may be considered for evaluating noise annoyance identified a change of 5 dB as a level that would be considered an acceptable change in noise levels in a residential home. A change in noise level of 5 dB results in 5 per cent of the population being highly annoyed. On this basis, significant levels of the population considered highly annoyed as a result of the project are identified as the calculated percentage of people highly annoyed that is 5 percent or higher than existing levels of noise annoyance in the community (from existing/background levels of noise).

Utilising this assessment criteria, the assessment identified that the areas of highest potential for increases in noise generating high annoyance would (similar to sleep disturbance) occur in areas closest to the WSI being Luddenham, Greendale, Silverdale and Wallacia. Increases in the percentage of these population areas ranged from between around 34 per cent in Silverdale and Wallacia (in 2033) to 58 per cent in Luddenham (in 2055).

20.5.2.4 Cognitive impairment

Noise in classrooms can affect children in many ways, including lowering their motivation, reducing speech intelligibility, listening comprehension and concentration, producing annoyance and disturbance, and increasing restlessness. As a result, children exposed to noise at school may experience poorer reading ability, memory and performance. Cognitive impairment could also be linked to noise exposure at home during night-time hours, which can cause low mood, fatigue and impaired task performance the next day. Noise at home may also be linked to hyperactivity and inattention problems, which can cause lower academic performance (EEA, 2020). This assessment has assessed cognitive impairment on the basis of an exposure-response relationship established for long-term delays in reading and oral comprehension in children at the end of primary school as a result of chronic exposure to aircraft noise. The calculated delays in learning have been assumed to apply at the end of childhood learning, and more specifically (and conservatively) at the end of each developmental/learning phase, i.e., at the end of pre-school/childcare, primary school or high school.

The assessment of cognitive impairment/learning delays requires consideration of what may be of concern in terms of health and long-term outcomes (as delays in childhood can have an impact later in life). There are no specific guidelines available for determining what would be an acceptable, or unacceptable level of learning delays in a community from a specific project. The WHO (2018) has identified that a one-month delay (i.e. 30 days) in reading and oral comprehension should be adopted as the level of cognitive impairment for the purpose of establishing guideline levels for noise. Hence for this assessment, where the calculated learning delay is 30 days or more, and this differs from existing/background, the impacts from the project have been considered to be of potential significance.

The calculated learning delays in these areas is variable, with the highest levels (across the whole of the identified suburbs) estimated in Luddenham, Greendale, Silverdale, Wallacia and Kemps Creek. The more significant impacts typically relate to longer term operations (i.e. from 2055) and have been identified as potentially impacting the following representative existing facilities:

- Childcare centres:
  - Mamre After School and Vacation Care, Kemps Creek (between one and 11 days delay in 2055)
  - Little Smarties Childcare Centre, Kemps Creek (between one and 11 days delay in 2055)
  - Schoolies at Mulgoa, Luddenham (between 4 and 5 days delay in 2055).
- Schools:
  - Mamre Anglican School, Kemps Creek (between 2 and 11 days delay in 2055)
  - Luddenham Public School, Luddenham (between 18 and 24 days delay in 2055)
  - Holy Family Catholic Primary and Church, Luddenham (between 4 and 5 days delay in 2055).

Review of the potential impacts identified above indicates that for the schools and childcare centres located in the key suburbs and localities where learning delays may be of potential significance, none of the noise impacts associated with the project at these locations are high enough to be of concern in relation to community health (i.e. learning delays are all less than 30 days).

20.5.2.5 Cardiovascular health

Noise is an important risk factor for chronic diseases. Noise exposure activates stress reactions in the body, leading to increases in blood pressure, a changing heart rate and a release of stress hormones. Cardiovascular diseases are the class of diseases that involve the heart or blood vessels, both arteries and veins. Strokes reflecting cerebrovascular events and ischaemic heart disease or coronary heart disease are the most common representation of cardiovascular disease. High-quality epidemiological evidence on cardiovascular and metabolic effects of environmental noise indicates that exposure to environmental noise, including aircraft noise increases the risk of ischaemic heart disease.

Overall, the predicted number of attributable cases associated with the project is considered to be generally low. Assuming the predicted noise impacts always occurred each year, and the population was at that same location all day every day for a lifetime, the number of cases attributable to the project may be up to 270 over a 100-year period. Interpretation of this value should also consider the incidence of ischaemic heart disease in the same population, based on existing/background noise levels. For the same suburbs and localities evaluated, this is calculated to be 2.5 per year, which is up to 250 cases over a 100-year period. It should be noted that the calculated impacts from aircraft operations are not additive to the background, however the impacts on the incidence of ischaemic heart disease are similar. Therefore, it can be considered that the impact of the operation of the project on the incidence of ischaemic heart disease from project-related noise is considered to be low and/or similar to existing/background rates of ischaemic heart disease in the community.

20.5.2.6 Consideration of existing land use controls on health related noise impacts

The assessment has identified the potential for significant impacts on community health as a result of exposure to noise from the project, specifically in relation to sleep disturbance, noise annoyance and potentially cognitive impairment (as learning delays in children). These impacts are highest close to the ends of the runways, with other impacts identified in areas beneath departure and approach flight paths close to WSI. The assessment presented provides indicative locations where there is the potential for these impacts to be considered to be of significance, due to a range of uncertainties associated with the identification of potential health impacts. The potential for significant impacts is consistent with the conclusions of Technical paper 1, where significant and unavoidable levels of noise exposure have been identified.

Review of these impacts have been considered in the context of land use planning protections that are already in place. The indicative ANEC for WSI provided in the Airport Plan and NSW State Environmental Planning Policy (Precincts – Western Parkland City) 2021 (Western Parkland City SEPP) was generated based on the runway direction, dual runway operations and indicative flight paths as presented in the 2016 EIS.

In the lead up to WSI becoming operational, a formalised Australian Noise Exposure Forecast (ANEF) (as a more refined ANEC) would be generated for WSI based on the final approved single-runway flight path design and longer-term dual runway operations. The ANEC 20 contour defined in the Airport Plan and Western Parkland City SEPP, and updates based on the assessment of noise impacts for this project, is used for the purpose of managing land use in the vicinity of WSI, in areas where noise impacts may be of significance.

This includes the following:

- existing residential land uses can continue, however developments such as dual occupancies, secondary dwellings and subdivision of land for sensitive uses not already approved would not be permitted
- no new noise sensitive development can be developed (including residential, schools and childcare centres) if a development site is found to be ‘conditionally acceptable’ this means that any proposed buildings would be required to be designed to result in a reduced noise level indoors in accordance with *AS2021:2015 Acoustics – Aircraft noise intrusion – building siting and construction* (AS 2021: 2015) (Standards Australia, 2015).

With consideration of the above, the following provides further discussion in relation to the predicted impacts of noise on community health presented in sections 20.5.2.2 to 20.5.2.4. Further details are provided in Section 6.5.7 of Technical paper 12.

Sleep disturbance

With respect to sleep disturbance:

- the most significant health impact identified, where there is the highest number of receivers potentially impacted, is sleep disturbance
- the potential for sleep disturbance impacts would depend on the sensitivity of individuals in the community
- the majority of the locations identified where sleep disturbance is of potential significance in 2055 sit within the existing Western Parkland City SEPP ANEC 20 contour and 2055 ANEC 20 contour. However, not all the locations identified as being potentially significant are used for residences, schools or childcare centres and have been used as an indicator of where issues may arise. These are all areas where existing planning controls limit future developments including residential developments. The exceptions are as follows:
  - 2 areas located to the north-west, one of which is located outside of all the ANEC contours, and the other located outside of the 2033 and 2055 ANEC 20 composite contours
  - a group of receivers located in Wallacia to the north-west of the runway, and further distant from all the ANEC contours.

These additional locations were not identified as potentially significant, in terms of sleep disturbance, for the 2033 period. It is expected that by 2055 the presence of aircraft noise in the local study area would have been present for a significant period of time, where some members of community may have adjusted to the presence of aircraft noise at night. In addition, changes in night time noise levels between 2033 and 2055 would be gradual and hence it is expected that the community would adjust to these changes over time.

Annoyance

With respect to annoyance:

- receivers where annoyance, as percentage of the population considered highly annoyed, has been identified as of potential significance are a subset of those identified for sleep disturbance
- increased levels of noise annoyance is expected to result in increased levels of noise complaints from the community
- the majority of the locations identified, where the percentage of high annoyance is of potential significance in 2055 sit within the existing Western Parkland City SEPP ANEC 20 contour and 2055 ANEC 20 contour. However, not all the locations identified as being potentially significant are used for residences, schools or childcare centres and have been used as an indicator of where issues may arise. These are all areas where existing planning controls limit future developments including sensitive developments, noting that DITRDCA and WSA Co will continue to liaise with State and local government agencies to ensure applicable environmental planning instruments have regard to ANEC forecasts produced for the project. The exception is one location in Wallacia to the north-west just outside of the ANEC contours. This location is not identified as potentially significantly impacted, in the 2033 period.

It is expected that by 2055 the presence of aircraft noise in the local study area would have been present for a significant period of time, where some members of the community may have adjusted to the presence of aircraft noise in the environment. In addition, the change in noise levels between 2033 and 2055 would be expected to be gradual where adjustment to changes in noise levels would be expected to occur.

Changes in percentage of the population considered highly annoyed between 2033 and 2055 may not be considered significant given the uncertainty in relation to assessing changes in background/ambient noise and predicting impacts on sleep disturbance. However, the assessment undertaken suggest that by 2055 some additional residential areas adjacent close to the existing ANEC contours may experience aircraft noise at levels that are considered highly annoying.

For existing residential homes in the area of the ANEC 20 contours, there is the potential for a higher proportion of the population to be considered highly annoyed by noise.

Changes in the levels of highly annoyed members of the community are expected to result in a higher level of noise complaints, particularly at the start of the project where aircraft noise was a new source of noise in the environment.

Cognitive impairment (children)

With respect to sleep disturbance:

- sensitive receivers where cognitive impairment (in children) has been identified as of potential significance are a further smaller subset of both sleep disturbance and annoyance
- while there are no impacts that are considered to be significant at existing childcare centres and schools in the community, it is important to evaluate whether the existing ANEC 20 contours that define planning controls surrounding WSI are sufficient
- it is also important to note that both Luddenham Public School (Primary) and Mamre Anglican Schools are either located within the Western Parkland City SEPP ANEC 20 contour or the predicted 2055 ANEC 20 contour. In terms of cognitive impairment, the impacts predicted at these schools is not considered to be of significance and these schools would be expected to continue to operate due to 'existing use rights' under the *Environmental Planning and Assessment Act 1979* (NSW). However future developments at these schools would require approval of the relevant consent authority and consideration of the indoor sound requirements relevant to these areas
- the majority of the locations identified where cognitive impairment is of potential significance in 2055 sit within the existing Western Parkland City SEPP ANEC 20 contour and 2055 ANEC 20 contour. However, not all the locations identified as being potentially significant are used for residences, schools or childcare centres and have been used as an indicator of where issues may arise. These are all areas where existing planning controls limit future developments including sensitive developments, such as future childcare and schools, noting that DITRDCA and WSA Co will continue to liaise with State and local government agencies to ensure applicable environmental planning instruments have regard to ANEC forecasts produced for the project. The exception is one location in Wallacia to the north-west just outside of the ANEC contours. This location is not identified as potentially significantly impacted, in relation to cognitive impairment, in 2033.

Based on the above the existing planning controls, existing and proposed ANEC 20 contours would prevent the development of new childcare centres and schools in areas where impacts on children's learning would be of significance – the exception to this being a location just outside of the 2055 ANEC 20 contour where the development of any new childcare centre or school should be considered in more detail at the time using measured noise levels from the operation of the project. As identified above, DITRDCA and WSA Co will continue to liaise with State and local government agencies to ensure applicable environmental planning instruments have regard to ANEC forecasts produced for the project.

20.5.3 Health related hazard and risk impacts

Chapter 13 (Aircraft hazard and risk) provides a summary of the potential hazards and risks related to the operation of the airspace. This section provides an overview of the outcomes of the hazard and risk assessment, with specific reference to impacts on community health.

The assessment considered any potential hazards that have the potential to result in injury or death, damage to health infrastructure and contamination of the environment such that the community may be exposed to elevated levels of contamination. The assessment evaluated individual risks as well as societal or community risks.

Based on the detailed assessment presented in Technical paper 4 (Hazard and risk), a summary of the potential hazards identified and assessed relevant to community health and safety is provided in Table 20.2.

Table 20.2 Summary of community impacts – hazard and risk

Hazard evaluated	Potential consequence – community health	Outcomes in terms of community health
Airspace conflicts	Airspace conflicts relates to the safety of the whole airspace and the potential for mid-air collisions.	The broader Sydney Basin airspace has been redesigned to meet operational needs and provide an acceptable level of safety for the community.
Off-airport crash risks		
Off-airport crash risks, which may impact:	Whilst aircraft crashes are rare events, the majority occur during take-off and landing operations such that crash risks are more concentrated along flight paths close to runway ends. Accordingly, people and critical infrastructure located in the vicinity of airports can be expected to be exposed to an elevated risk.	
• People	Aircraft crashes can cause significant injury and fatalities within the community.	A limited number of people reside close to the runway ends. The overall risks (as individual and societal) are considered negligible for most of the study area, however close to the runway ends the risk increases to slight, but are considered as low as reasonably practicable.
• Critical infrastructure, (e.g. hospitals and water reservoirs supplying drinking water)	Incidents that impacts on critical health facilities (such as hospitals) and drinking water reservoirs are of particular relevance.	Overall, taking further account of the low event frequencies, the risk associated with these scenarios can be considered to be low and acceptable when assessed against the available societal risk criteria.
Other hazards		
Aircraft fuel jettisoning	Where fuel jettisoning occurs over a populated area, there is the potential for fuel exposures and contamination to occur. Such events are rare and when conducted in accordance with procedures (that recommend controlled jettison of fuel at altitude) do not impact the community. Relevant procedures include the Aeronautical Information Publication Australia, Part 2 – En Route (AIP ENR). (Airservices Australia, 2022a).	Potential risks to land from such incidents, principally related to take-off and climbing were evaluated, in conjunction with historical incident data and the likelihood that fuel would reach or impact the ground during such events. The risk assessment did not identify any significant impacts to land from such incidents. Hence risks to community health are considered low and acceptable.

Hazard evaluated	Potential consequence – community health	Outcomes in terms of community health
Objects falling from aircraft	This relates to objects falling from airborne aircraft and causing injury or fatalities to individuals on the ground.	The historical incident record shows that occurrences involving objects falling from aircraft are uncommon and typically involve small objects with limited hazard potential. Taking account of the relative size of the objects concerned and frequency of these occurrences compared with aircraft crashes, it may readily be concluded that the risks to people and sites on the ground are very small compared with the risks associated with aircraft crashes. Given that the risks associated with aircraft crashes have been shown to be low and acceptable, it may be concluded that the lesser risks associated with objects falling from aircraft can similarly be considered to be low and acceptable.
Aircraft wake vortex strikes	This relates to vortices from the wingtips that, during landing when aircraft are close to the ground, shortly before touchdown, can reach the ground and have sufficient power to cause damage to buildings (roof structures/tiles in particular).	There are a limited number of buildings in areas where wake vortex damage may be a possibility and given the type of roof construction and the low probability of impacts. Risk of damage is considered to be low, and with the potential for injury to people being much lower, risks to community safety are expected to be negligible.
Local meteorological hazards	This relates to events such as windshear, lightning strike, unforeseen weather and icing that have the potential to result in accidents, with injury and fatalities occurring.	While there is the potential for turbulence, windshear and thunderstorm activity to occur, the historical evidence indicates the threat to aircraft safety is limited. Measures to avoid adverse weather conditions are applied in the aviation industry to limit safety risks. An Automated Thunderstorm Alert Service is proposed to be implemented to improve the accuracy of thunderstorm forecasting for WSI. No significant weather related risks were identified for WSI operations where appropriate mitigation measures were implemented. Where this occurs risks to the community would be low and acceptable.
Wildlife hazards	This particularly relates to bird strike that may result in aircraft damage and incidents, potentially resulting in injury or fatality.	Risks posed by wildlife has been assessed in detail in the Chapter 16 (Biodiversity). Where wildlife strike risk mitigation for WSI is implemented, an acceptable level of safety can be achieved. Where risks are managed, the potential impact on community safety is considered low and acceptable.

Further details of the potential health impacts resulting from changes in hazards and risks associated with the project is provided in Chapter 7 of Technical paper 12.

20.5.4 Refinements to the project

The introduction of the RRO noise abatement procedure (RRO-NAP) and the reallocation of jet aircraft from Runway 23 Departure Northeast Night (RRO) to the Runway 23 Departure Southeast Night (RRO) flight path would result in a change in noise impacts at night. The assessment of potential changes to sleep disturbance impacts was completed based on the predicted noise levels at modelled sensitive receivers as presented in the Addendum Technical paper 1: Noise. The health assessment considered the maximum noise level during the night-time period (L_{max}), L_{night} and change in the percentage of the population that is highly sleep disturbed (%HSD) for the Prefer Runway 05 and Prefer Runway 23 scenarios in 2055. These scenarios include the use of the RRO mode of operation and the RRO-NAP.

This assessment found that the change would:

- not result in any additional sensitive receivers exceeding the 40 dB(A) threshold for L_{night} or the 52 dB(A) threshold for L_{max}. Five (5) sensitive receivers would no longer exceed these thresholds
- the %HSD would essentially remain unchanged from the assessment presented in the Draft EIS and the extent where %HSD is of potential significance would not change. A very small increase in the average %HSD is noted for Greendale and Silverdale, and a very small decrease in the average %HSD is noted for Mulgoa and Wallacia. These changes are small and are not considered to be significant.

For the other refinements to the preliminary flight paths, these generally do not occur over populated areas and/or increase the distance to or altitude above populated areas.

Further detail is provided in Section G2.12 of Appendix G (Assessment of the refinements to the project) of the EIS.

20.6 Mitigation and management

20.6.1 Existing management

Future development in areas where potential noise impacts may be significant will include planning protections to prevent noise sensitive development.

Existing strategic planning in the vicinity of WSI has considered and incorporated the operational needs of WSI into land use planning in accordance with guidance provided in the National Airports Safeguarding Framework (NASF). This has been ongoing for over a decade in conjunction with planning for WSI and is well established in existing planning instruments. The NSW Department of Planning and Environment's *Aviation Safeguarding Guidelines – Western Sydney Aerotropolis and surrounding areas* (NSW DPE, 2022a) were also developed with input from DITRDCA and seek to ensure planning authorities consider WSI operations when undertaking land use planning for the Aerotropolis and surrounding areas of influence. Current planning provisions for land associated with the Aerotropolis has been developed in conjunction with the NASF specifically to support the operation of WSI and limit potential restrictions on surrounding land uses (and therefore risks to third parties or surrounding development). Protections are also included in the existing Airport Plan and Western Parkland City SEPP and revisions are expected to be made based on this project, with a formalised ANEF (as a more refined ANEC) chart generated and implemented. The Airport Plan is expected to be replaced by a Master Plan.

20.6.2 Project specific mitigation measures

There are no project specific mitigations related to human health. Mitigation measures related to aircraft noise are presented in Chapter 11 (Aircraft noise) and mitigations related to aircraft hazards and risk are presented in Chapter 13 (Aircraft hazard and risk).

Chapter 21 Facilitated impacts

This chapter presents the impacts of the proposed changes to Sydney Basin airspace required by the preliminary flight paths and airspace design (the project) and described in Chapter 8 (Facilitated changes). The full assessment is provided in Technical paper 13: Facilitated changes (Technical paper 13).

Background and method

The impact assessment approach included a review and categorisation of proposed changes, assessment using qualitative and/or quantitative approaches, and an assessment of the significance of potential impacts.

Potential impacts associated with the facilitated changes were those related to aircraft noise exposure, carbon emissions, visibility of aircraft and impacts on Commonwealth Matters of National Environmental Significance (MNES). Understanding the nature and source of aircraft noise is described in detail in Chapter 11 (Aircraft noise).

Existing environment

As supported by Chapter 4 (Project setting), the Sydney Basin is already congested by a range of aircraft overflight activity including within the study area. In many cases, it could be challenging for an observer to correlate an aircraft overflight's origin or destination to airports within the Sydney Basin.

The current operations associated with each proposed change are described in Chapter 8 (Facilitated changes).

Key findings

Changes to the Runway 25 SIDs (jets) for Sydney (Kingsford Smith) Airport would result in a considerable increase in area (square kilometres), dwellings, and population within the outer Number-above, N60 and N70 contours given the substantial lateral shift in the initial section of the western and north-western departure flight paths, and narrowing of the existing flight path creating an extension to the N60 and N70 contours. However, Runway 25 departures represent only around 4 per cent of annual operations at Sydney (Kingsford Smith) Airport and would be infrequently used. Aircraft would be visible, and would fly over different areas or over existing areas on a narrower path with increased frequency. For northern and eastern departures, the continuation of radar vectoring for northern and eastern departures via SHORE as well as the proposed new Standard Instrument Departure (SID) is expected to see little variation in the visibility of aircraft over these areas.

Changes to Runway 34L (waypoint KADOM) (jet) SIDs for Sydney (Kingsford Smith) Airport would predominately fly over suburbs that are already overflown by this SID. However due to the lateral shift in the departure flight path, and/or narrowing of the existing procedure, there would be an increase in the number of dwellings and population within the outer N60 and N70 contours (depending on the destination of departure). Aircraft would be visible, and would fly over different areas or over existing areas on a narrower path, or at higher frequencies and at marginally higher altitudes.

Changes to Runway 34L RICHMOND SIDs (jet) for Sydney (Kingsford Smith) Airport would result in marginal changes in N60 and N70 extents compared to the current procedure, and the very minor change would be located in areas in the vicinity of the airport. The proposed SID flight path is generally within the flight dispersion of the existing SID flight path but would narrow due to the safety requirements of the procedure. Aircraft would still be visible, but not necessarily in the same location due to the reduction in lateral dispersion.

The proposed SID for Sydney (Kingsford Smith) Airport non-jet departures is expected to be used by around 20 of the 30 non-jet aircraft per day departing for western and north-western destinations in 2030. A number of outer suburbs of the Sydney Basin that would currently experience overflight of non-jet departures would experience a concentration of non-jet flights due to this proposed procedure. However areas subject to 60 dB(A) or more aircraft noise levels would not change. Non-jet aircraft currently fly on a widely dispersed set of radar vectored flight paths to a westerly or north westerly destination. Aircraft would continue to be visible and due to the change from a wide radar vectored dispersion of tracks to a more confined track means some communities would see more aircraft, and some would see less.

Other changes to procedures at Sydney (Kingsford Smith) Airport would result in minimal changes from a noise or visual perspective.

Changes to Bankstown Airport Instrument Flight Rules (IFR) flight procedures would result in an increased frequency and concentration of overflight, particularly for arriving aircraft. Around 145 movements per day are expected to operate under IFR, noting areas overflown by the new procedures are already frequently used by IFR and Visual Flight Rules (VFR) flights. In the case of departures, air traffic control radar vectoring would provide some dispersion. These changes would result in new areas close to Bankstown Airport being subjected to overflight by aircraft undertaking IFR operations and flying at relatively low altitudes. There would be increased frequency of aircraft using the proposed SIDs but would be difficult to distinguish from the current operations from a visual perspective. Aircraft on proposed Standard Instrument Arrivals (STARs) would be visible and in areas not currently overflown by Bankstown Airport IFR aircraft.

New and adjusted STAR procedures for IFR aircraft arriving at Camden Airport are expected to be used by around 10 aircraft movements per day. These changes would have little or no material change to IFR operations at Camden Airport and no changes are proposed where the existing procedure flies over Sydney's urban and rural fringe. Changes would occur further west, over the Greater Blue Mountains Area (GBMA). Aircraft noise would vary according to altitude and the type of aircraft being flown. Aircraft using these procedures may also be subject to radar vectoring which should disperse arrival traffic in a similar fashion to current procedures.

The new SIDs and STARs for RAAF Base Richmond would not change the final approach or initial departures from Runway 10/28, and therefore there would be no changes in noise or local noise preferred procedures. The areas overflown by the new procedures are overflown with similar aircraft, would be used by a low number of aircraft (around 15 flights per day), and have been designed to closely replicate the current radar vectoring. The STARs are well north of the Sydney Basin and/or at high altitudes. The new proposed eastern SID and some continued radar vectoring when appropriate is expected to result in a similar track spread to current operations but at higher altitude. Aircraft would remain visible.

Changes to VFR operations in the Sydney Basin would impact the flying training areas, as well as increases in transit times for aircraft travelling to the future possible training areas. The change of activity cannot be accurately quantified. The most constrained corridor for VFR travel flight operations between WSI and RAAF Base Richmond – limited in lateral extents and with only a 1,500 feet (ft) (460 m) operating limit for some of its extent, is expected to have less than 10 flights daily and with the low growth forecast predictions (approximately one per cent for both Bankstown and Camden Airports) should not constitute a significant impact to overflown areas on its implementation or into the future.

The proposed western low altitude transit route for aircraft transiting north to south, or south to north at altitudes below 10,000 ft (3 km) is assumed to be used by a low number of aircraft per day. Noise levels would vary according to the position along the transit route, aircraft type and altitude being flown.

It is anticipated that the facilitated changes would not significantly impact biodiversity and other MNES values including sites of cultural and heritage value as they will occur within areas already subject to, or close to, routine flight paths by similar aircraft types associated with the existing Sydney Basin (refer to Section 21.4). This is particularly the case where there is a predicted low utilisation of those SIDS and STARs and because there is a low growth forecast of only one per cent or less for these movements.

An exception to this is the changes to Bankstown Airport flight paths which may result in some areas being overflown that have not been previously overflown. Despite this, these flight paths occur in areas which are heavily disturbed in nature and are unlikely to introduce further risk or impacts than that assessed in Chapter 16 (Biodiversity).

21.1 Introduction

This chapter:

- identifies and assesses potential environmental impacts of the proposed facilitated changes
- ensures the ongoing consideration of the proposed changes to flight paths and procedures are informed by environmental impact considerations.

The scope of environmental matters to be assessed for the facilitated changes were guided by Airservices Australia policies relating to airspace change proposals (refer to Chapter 6 (Project development and alternatives)).

As detailed in Chapter 8 (Facilitated changes), the changes proposed to be introduced include:

- new and adjusted IFR procedures
- introduction of new and adjusted airspace volumes
- modified climb and descent gradients
- new and modified procedure waypoints – position and altitude requirements
- changes to Sydney Basin VFR operations.

According to data provided by Airservices Australia from their noise flight path monitoring system (NFPMS), current aircraft movements in the Sydney Basin during night-time hours (11 pm to 5:30 am) are minimal in comparison to operations outside these hours as Sydney (Kingsford Smith) Airport is under curfew from 11 pm to 6 am. Due to the infrequent level of night-time movements (for example, for limited medical operations as explained in Chapter 4 (Project setting)), the potential impacts of these operations have not been considered.

21.2 Legislative and policy context

The relevant legislation, standards and assessment guidelines considered for the facilitated changes assessment include:

- *Airports Act 1996* (Cth) (Airports Act), specifically Condition 16 of the Airport Plan
- *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act).

21.3 Methodology

21.3.1 Overview

The methodology involved:

- categorising the selected changes into an assessment level and type (refer to Section 21.3.2)
- detailing the current operating conditions of the relevant flight paths in the Sydney Basin and sensitive areas (refer to Chapter 8 (Facilitated changes) and Section 21.4)
- preparing targeted assessments for each of the proposed changes in accordance with the selected approach, using qualitative and quantitative descriptors of potential impact (refer to Section 21.5). This considers noise, visual and carbon emissions impacts (as appropriate) and MNES.

21.3.2 Categorisation of changes

The proposed changes to the current Sydney Basin airspace were categorised into groups based on the availability of data, the significance of the level of change, and consideration of whether to apply either a quantitative or qualitative assessment. The 3 groups are:

- **Group A** – changes to undergo a quantitative assessment as the implications are expected to be noticeable and sufficient data is available to complete a quantitative assessment.
- **Group B** – changes to undergo a 'hybrid' quantitative/qualitative assessment, where changes are maybe noticeable in areas newly overflown at low levels. Qualitative assessments would be completed for the majority of the assessment given the limited data or expected low levels of use.
- **Group C** – changes to undergo a qualitative assessment. These changes are minor in nature, and/or would be used only by a small number of flight operations or time. There is likely to be insufficient data to complete any quantitative assessment, and use of L_{Amax} or Noise-Power-Distance (NPD) charts would be used to understand likely noise impacts.

The categorisation of the facilitated changes are outlined in Table 21.1. These are named along with a reference to where these are presented in Chapter 8 (Facilitated changes), assessed in this chapter and detailed in Technical paper 13.

Table 21.1 Facilitated changes categorisation and reference

Name of change	Description	Impact assessment chapter reference
Group A		
Sydney (Kingsford Smith) Airport Runway 25 (jet) SIDs	Section 8.2.1.1	Section 21.5.1
Sydney (Kingsford Smith) Airport Runway 34L (waypoint KADOM) (jet) SIDs	Section 8.2.1.2	Section 21.5.1.2, Figure 21.11
Sydney (Kingsford Smith) Airport Runway 34L (waypoint RICHMOND) (jet) SIDs	Section 8.2.1.3	Section 21.5.1.3
Sydney (Kingsford Smith) Airport non-jet departures	Section 8.2.1.6	Section 21.5.1.4
Group B		
All IFR changes proposed at Bankstown Airport	Section 8.3.2	Section 21.5.2.1
Group C		
ODALE/AKMIR STAR at Sydney (Kingsford Smith) Airport	Section 8.2.2.1	Section 21.5.3
Camden Airport IFR arrivals (STARs)	Section 8.4.2	Section 21.5.3.2
Departures and arrivals at RAAF Base Richmond	Section 8.5.2	Section 21.5.3.3
Runway 07 SID at Sydney (Kingsford Smith) Airport	Section 8.2.1.4	Section 21.5.3.4
Runway 07 IAF at Sydney (Kingsford Smith) Airport	Section 8.2.1.5	Section 21.5.3.4
RIVETT and BOREE STARs at Sydney (Kingsford Smith) Airport	Section 8.2.2.2	Section 21.5.3.4
Sydney Basin lower-level transit routes	Section 8.6.2	Section 21.5.3.4
VFR operations in the Sydney Basin airspace	Section 8.7.2	Section 21.5.3.5

21.3.3 Approach

The general approach to the assessment is outlined in Figure 21.1. Depending on the magnitude, duration and frequency of proposed change the approach varied according to depending on Figure 21.1, for example noise modelling was only undertaken for Group A and Group B and C involved qualitative analysis.

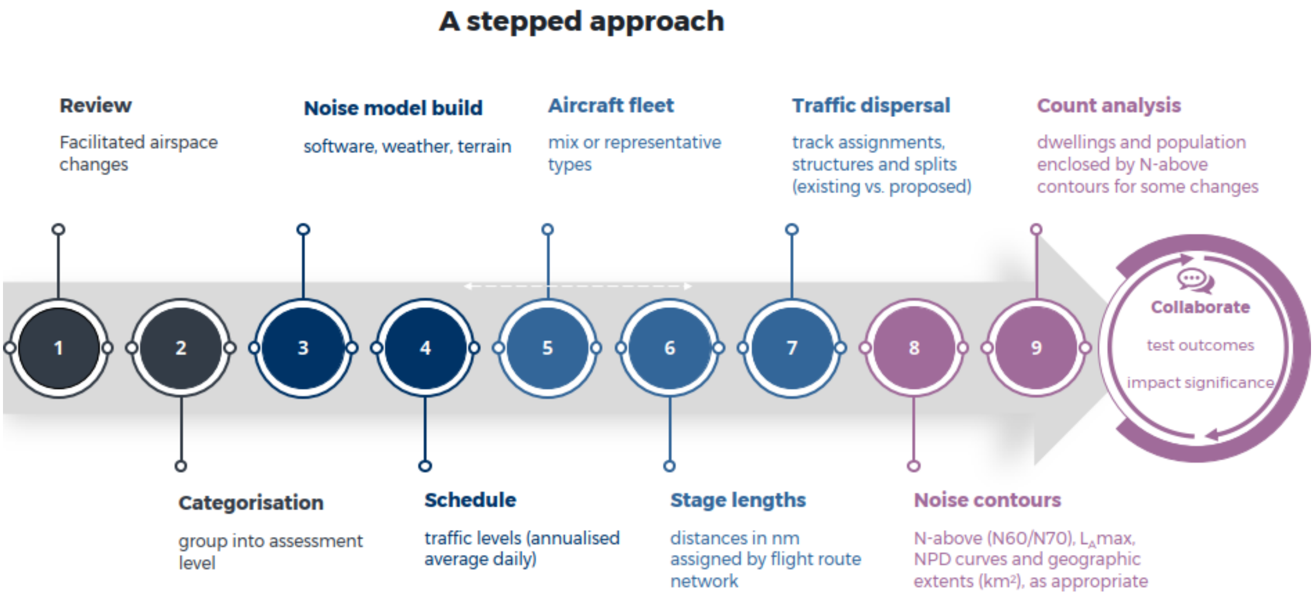


Figure 21.1 Approach to the facilitated changes assessment

The assessment of potential overflight for the facilitated changes describes the potential noise impacts of the proposed individual procedure adjustments and changes only, on a standalone basis. Other existing operations that may overfly the area are not included in the analysis. A robust cumulative impact analysis would involve a complete Sydney Basin airspace review (including comprehensive historical data, future activity forecast levels and other factors influencing airspace structures and management).

21.3.3.1 Traffic growth forecasts

Traffic growth forecasts were extracted from the current master plans available for Sydney Kingsford Smith, Bankstown and Camden Airports (refer to Chapter 4 (Project setting) and forecast to 2030. Further detail on the approach to forecasting specific to each change is provided in Technical paper 13.

21.3.3.2 Group A

The assessment approach taken for each Group A change is depicted in Steps 3 onwards on Figure 21.1.

Steps 3–7 define the assumptions and data inputs required for the Aviation Environmental Design Tool (AEDT) noise model (version 3e) used in the assessment. This model and these data inputs are detailed in Chapter 11 (Aircraft noise). Of note:

- noise modelling was based on the flight movements of the busiest day in October 2019 with the growth rates applied as appropriate. The analysis should therefore be considered a "worst case" scenario compared to an average or typical day of operations. Assumptions specific to each assessment is provided in the individual appendices to Technical paper 13.

A range of metrics, measurements and data were used to define the resulting potential noise impacts. The key outputs were:

- Number above (N-above) metrics – N60 and N70 results presented as standard contours for current and proposed procedures, including:
  - N60 (24-hour) for 10 to 20, 20 to 50, and 50 to 100 events
  - N70 (24-hours) for 5 to 10, 10 to 20, 20 to 50, and 50 to 100 events

  this was to enable a comparison between current and proposed areas in which number of movements or range of noise events with a modelled noise level of 60 or 70 A-weighted decibels (dB(A)) or louder is expected to occur. For context, an outside noise event of 70 dB(A) (such as aircraft flyover) can lead to in an indoor sound level of 60 dB(A) when windows are opened (enough to disturb conversation). N60 and N70 metrics are detailed in Chapter 11 (Aircraft noise)
- L_{Amax} – the highest noise level from an aircraft noise event, measured in dB(A) (refer to Chapter 11 (Aircraft noise). For example, a L_{Amax} single-event contour for a stage length 9 (greater than 6,500 nautical miles (nm) (12,000 kilometres (km)) (Sydney to Johannesburg) long-haul flight operated by a wide-body Boeing B787-9 was generated for Sydney (Kingsford Smith) Airport Runway 34L KADOM (jets) SIDs
- flight path corridor dispersion footprints – current versus where the future flight paths are expected to be due to the changes
- dwelling counts under N-above contours – current versus the number of dwellings that can expected to be exposed to future N60 and N70 noise levels
- nominal backbone track positioning – current versus where the nominal future proposed flight path backbone is located
- suburb boundaries and suburb names overflown – show the current and proposed flight path track dispersion corridors combined with a suburb boundary and suburb name overlay to aid stakeholders in identifying their location of interest associated with the proposed changes.

21.3.3.3 Group B

This approach was predominately qualitative as outlined in Section 21.3.3.4, but noise was assessed using NPD charts generated in AEDT (version 3e) as there was insufficient data available to support N-above contours. Further information on the NPD charts is provided in Section 21.3.3.4.

21.3.3.4 Group C

Each Group C change was subject to assessment using NPD charts generated in AEDT (version 3e). These were developed to provide an indication of what overflight noise from representative aircraft types could be expected on existing flight paths, or on flight paths that have either changed laterally or vertically or both.

NPD charts were used where N-above noise contours (N60 and N70) were not meaningful (for example, at altitudes above 9,000 ft (2.7 km) for jet and non-jet aircraft as the noise levels associated with overflight at these altitudes are well below 60 dB(A) and 70 dB(A) or where N60 and N70 contours did not extend to the point of the change being assessed.

Representative aircraft types included those used for commercial and military operations (for example, Boeing B777-300 and Hercules C130 – Military Aircraft respectively) and light business jets, medium turbo-prop and piston-engine aircraft.

The NPD charts were supplemented with 70 dB(A) and 60 dB(A) lines to aid in interpretation of potential noise exposure outcomes, where appropriate.

The qualitative analysis of the changes proposed to IFR and VFR operations is considered the best available representation of potential impacts. This assessment is heavily qualified due to the variability associated with noise generation from variations of even the same aircraft type, varying pilot technique and variations in meteorological conditions. Overflight noise levels would also vary with respect to the lateral offset positioning of the at-ground receiver to the aircraft operating above.

21.3.3.5 Population and dwellings

An estimate of the number of people and dwellings potentially impacted by aircraft noise was assessed based on N-above contours as described in Section 21.3.3.2. Dwelling counts are presented for the outer contour only – N60 for 10 to 20 overflights, and N70 for 5 to 10 overflights.

Population and dwelling counts were sourced from Australian Bureau of Statistics (ABS) 2021 census data (ABS, 2022). The assessment was undertaken by overlaying the different contours over census data using GIS software.

21.4 Existing environment

Although aircraft differ in operation, type, altitude, noise level and frequency, most areas of the Sydney Basin including the study area are currently overflown. This includes arrivals and departures from Sydney (Kingsford Smith) Airport, Bankstown and Camden Airports, and RAAF Base Richmond for all aircraft. For example, in 2019 there were more than 710,000 air traffic movements in the Sydney Basin airspace (refer to Figure 4.2 in Chapter 4 (Project setting)).

To support this chapter, figures depicting individual groupings of track movements of relevance to the facilitated changes assessment are provided in this section.

Figure 21.2 shows the current IFR flight paths for Sydney (Kingsford Smith) Airport runways in the 16 and 34 directions over a one-week period in March 2019. This supports the assessment of changes relating to Runway 34L from this airport (refer to Section 21.5.1.2 to Section 21.5.1.3). Figure 21.3 provides Runway 25 jet departure tracks from Sydney (Kingsford Smith) Airport for a 1-week period in October 2022. This supports the assessment of changes relating to Runway 25 (refer to Section 21.5.1).

Figure 21.4 shows radar tracks for a one-week period of March 2019 of non-jet operations. This supports the assessment of changes relating to Sydney (Kingsford Smith) Airport non-jet IFR tracks (refer to Section 21.5.1.4).

Figure 21.5 and Figure 21.6 shows the current flight tracks for Bankstown Airport. This supports the assessment for all changes required for Bankstown Airport related procedures (refer to Section 21.5.1.2 and Section 21.5.3.5) and lower level transit route changes (refer to Section 21.5.3.4).

Figure 21.7 shows the current flight tracks for Camden Airports for a one-week period of March 2019. This supports the assessment for all changes required for Camden Airport related procedures, specifically STARs at Camden Airport (refer to Section 21.5.3.2), lower level transit route changes (refer to Section 21.5.3.4) and VFR changes (refer to Section 21.5.3.5).

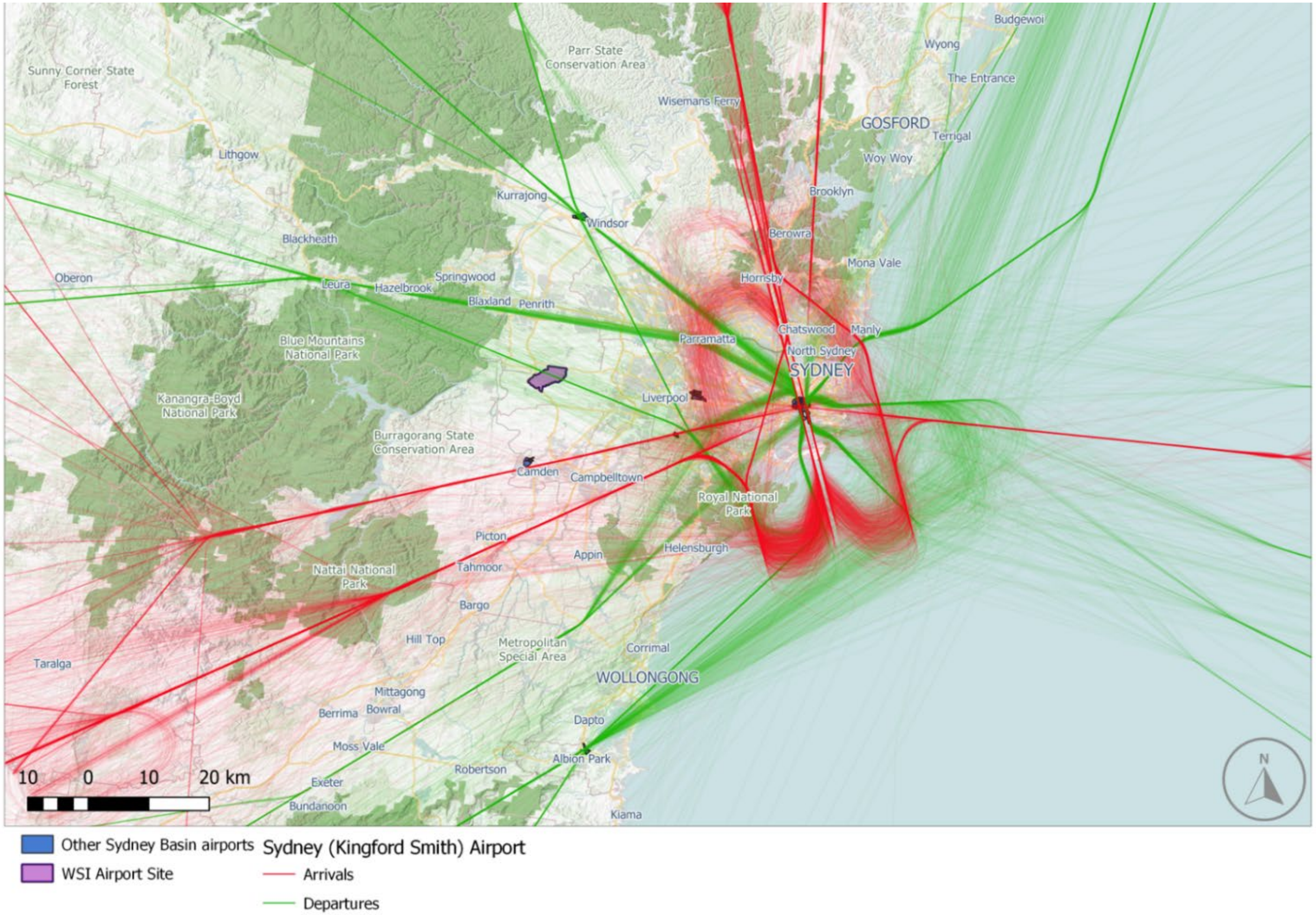


Figure 21.2 Current IFR flight paths for Sydney (Kingsford Smith) Airport runways – one-week period in March 2019

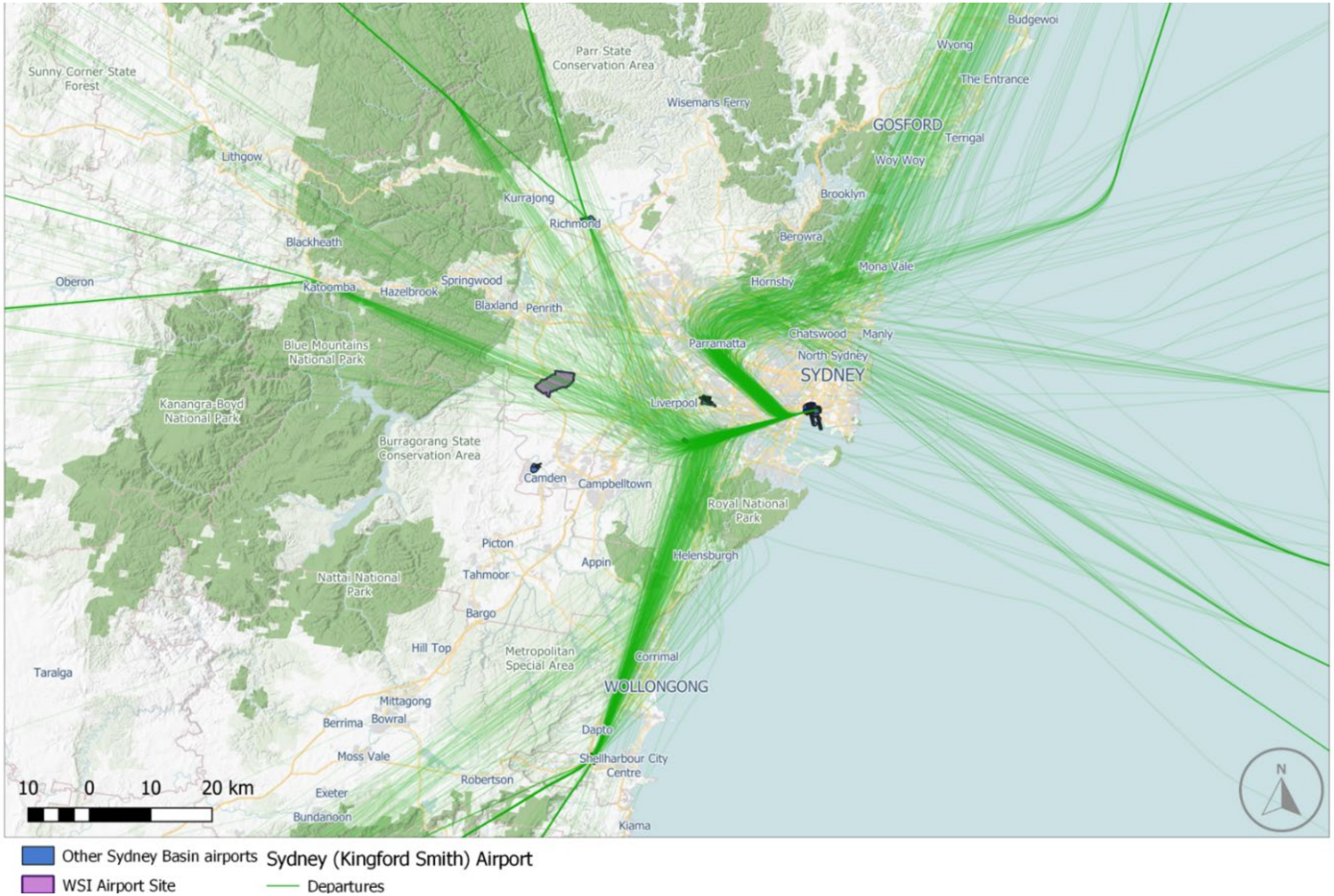


Figure 21.3 Current Sydney (Kingsford Smith) Airport Runway 25 jet departure flight tracks for October in 2022

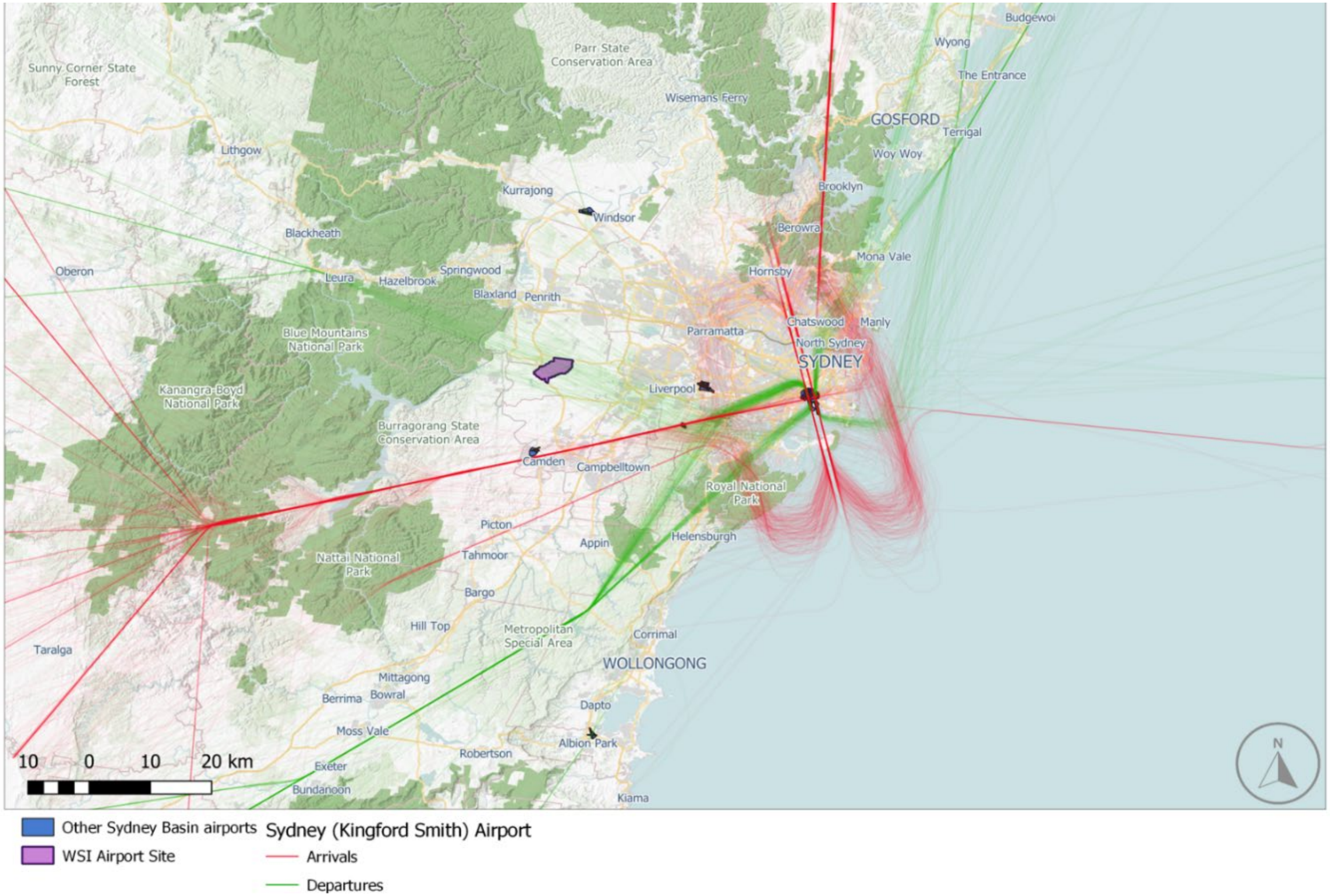


Figure 21.4 Current Sydney (Kingsford Smith) Airport non-jet IFR flight departure tracks (in green) to western and north-western destinations

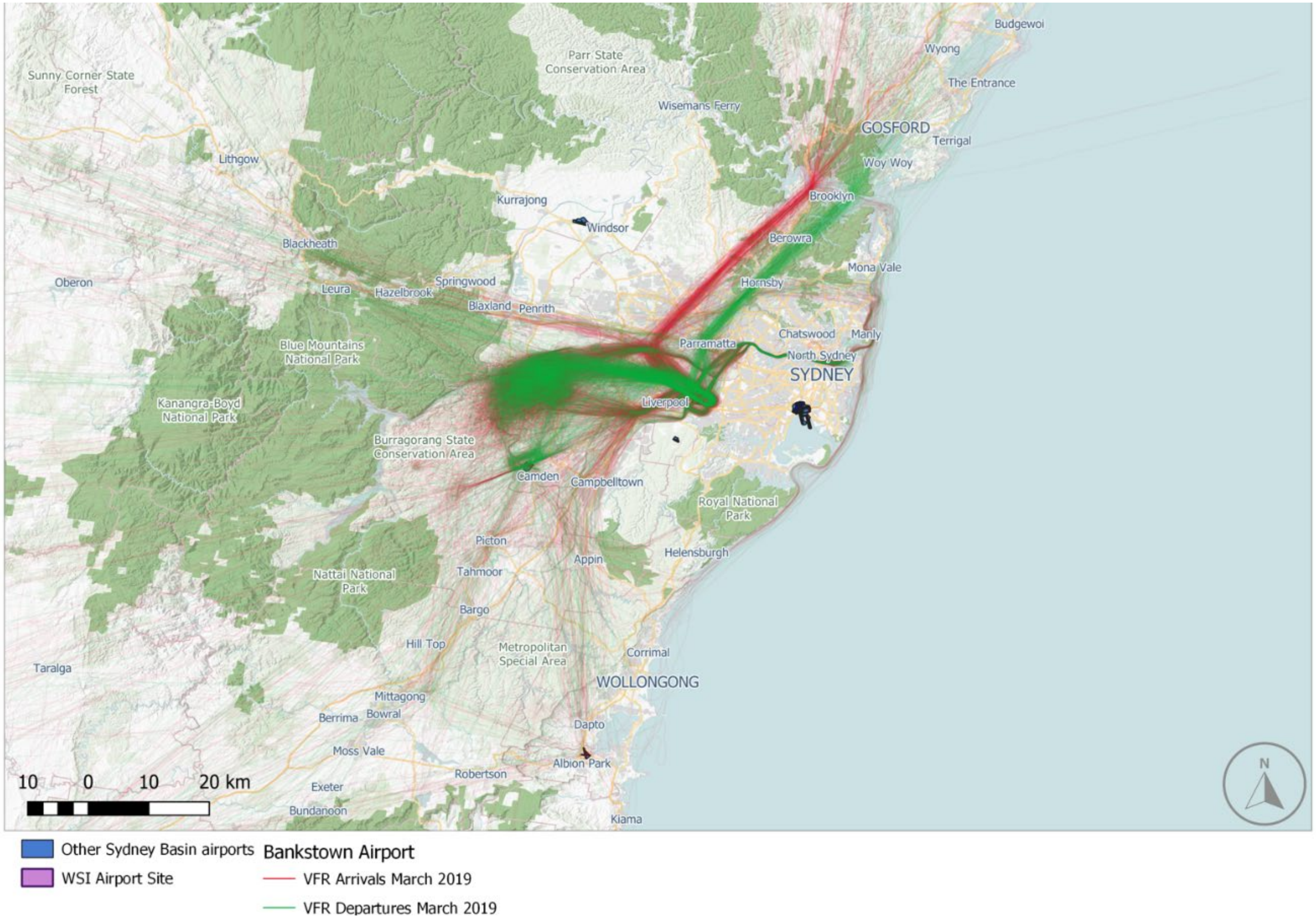


Figure 21.5 Current flight tracks for Bankstown Airport for a one-week period of March 2019

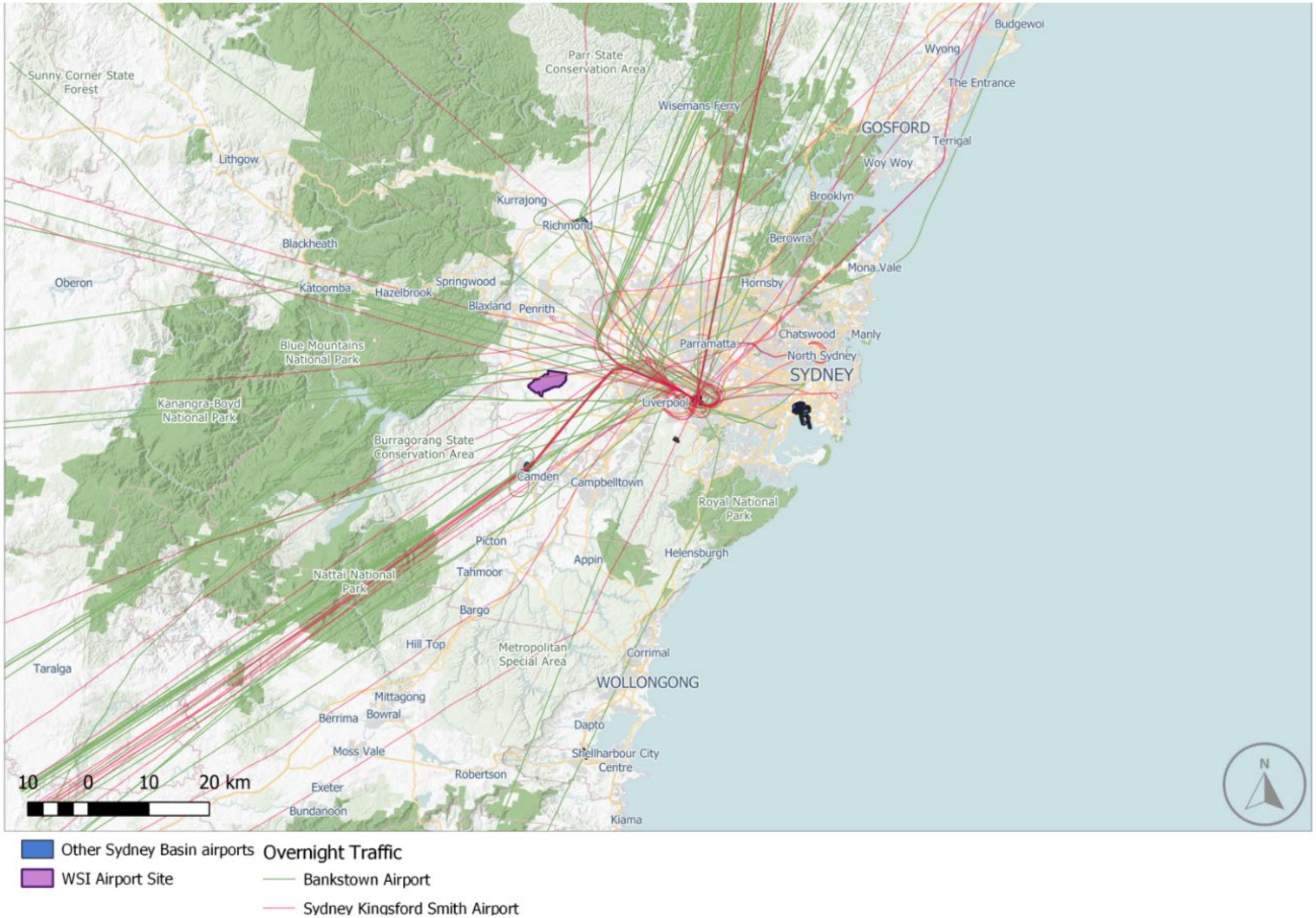


Figure 21.6 Current night flight tracks associated with Bankstown Airport (11 pm to 6 am) (one-week, March 2019)

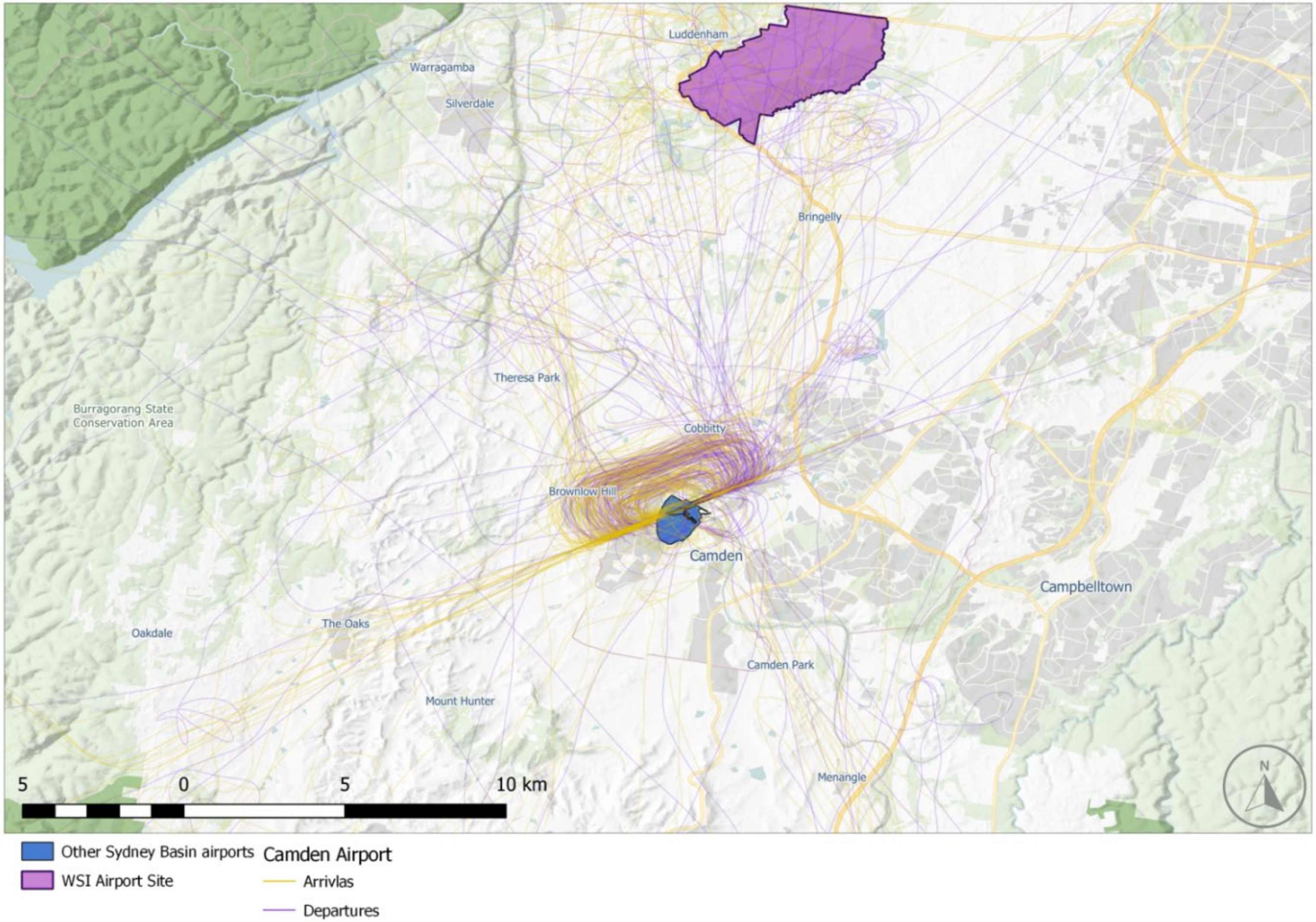


Figure 21.7 Current flight tracks for Camden Airport for a one week period of March 2019

21.5 Assessment of impacts

This section provides the key findings for each change, including changes in usage, changes in aircraft noise, and potential impacts on visual amenity and carbon emissions, as appropriate. Overall facilitated impacts to biodiversity and MNES are also described.

21.5.1 Group A

21.5.1.1 Sydney (Kingsford Smith) Airport Runway 25 (jet) SIDs

This section relates to the proposed Runway 25 SIDs for jet departures to the west, north-west, north and east as presented in Section 8.2.1.1 of Chapter 8 (Facilitated changes). The key assessment findings are depicted by the track dispersion with suburb overlay results in Figure 21.8 to Figure 21.10.

Runway 25 is used around 4 per cent of the year. Flights on the KADOM and RICHMOND SIDs would now have a common segment with the SHORE SID to waypoint NB010. This would mean that suburbs below the segment to waypoint NB010 would experience around 72 additional flights over the busiest day (based on March 2019), or around 168 flights in total if Runway 25 was used for an entire day. In future years, this would only marginally increase due to the low forecast growth rate (around one per cent). The use of Runway 25 for a full day is dependent on strong westerly winds which are infrequent.

The initial track of the proposed SID for northern, eastern and now western and north-western destinations to NB010 are over parts of the inner north-western suburbs that are already overflown by the existing northern and eastern radar vectored departing aircraft (refer to Figure 21.3). Radar vectoring north of waypoint NB010 would result in a similar flight path distribution to current operations once aircraft are north of NB010 (refer to Figure 21.8 and Figure 21.9).

The new SID for aircraft to the north and east via new waypoints NB170 and NB065 to existing waypoint SHORE is anticipated to be used by around 50 per cent of aircraft with northern and eastern destinations. The remaining 50 per cent would continue to be radar vectored contingent on growth in demand within the Sydney Basin and would continue be dispersed over the north-eastern suburbs (refer to Figure 21.10).

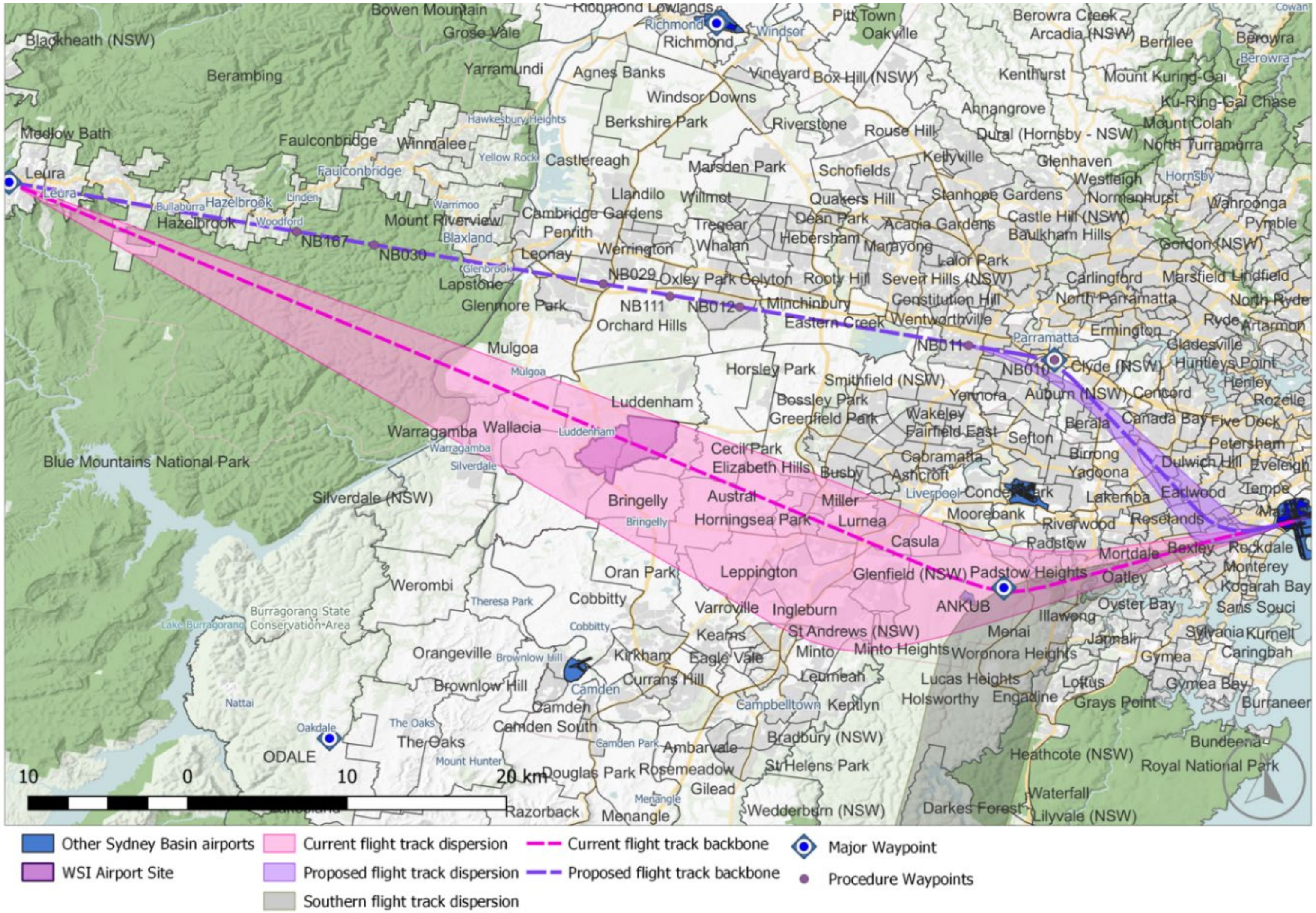


Figure 21.8 Sydney (Kingsford Smith) Airport – current and proposed Runway 25 KADOM SID with suburb overlay

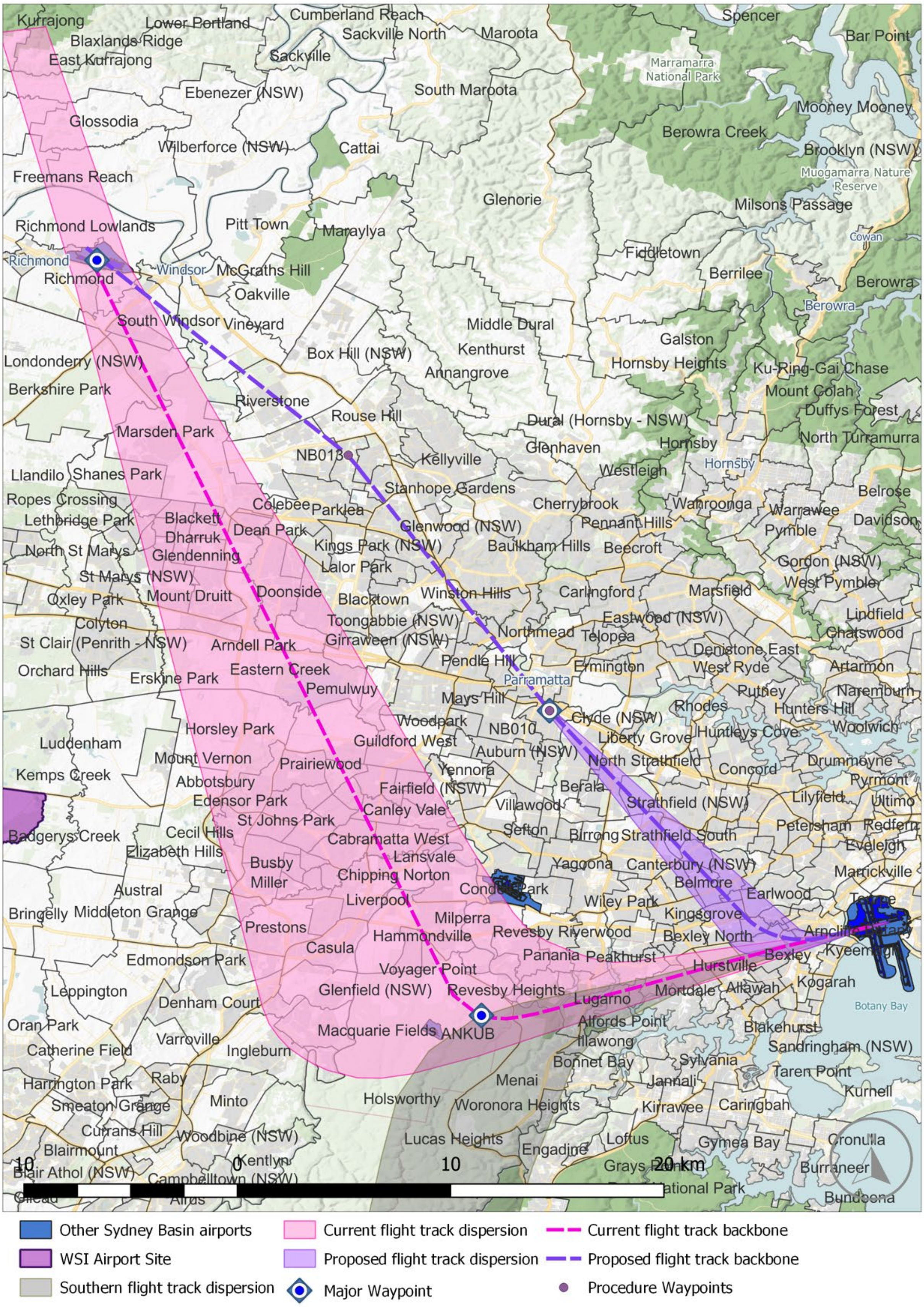


Figure 21.9 Sydney (Kingsford Smith) Airport – current and proposed Runway 25 RICHMOND SID with suburb overlay

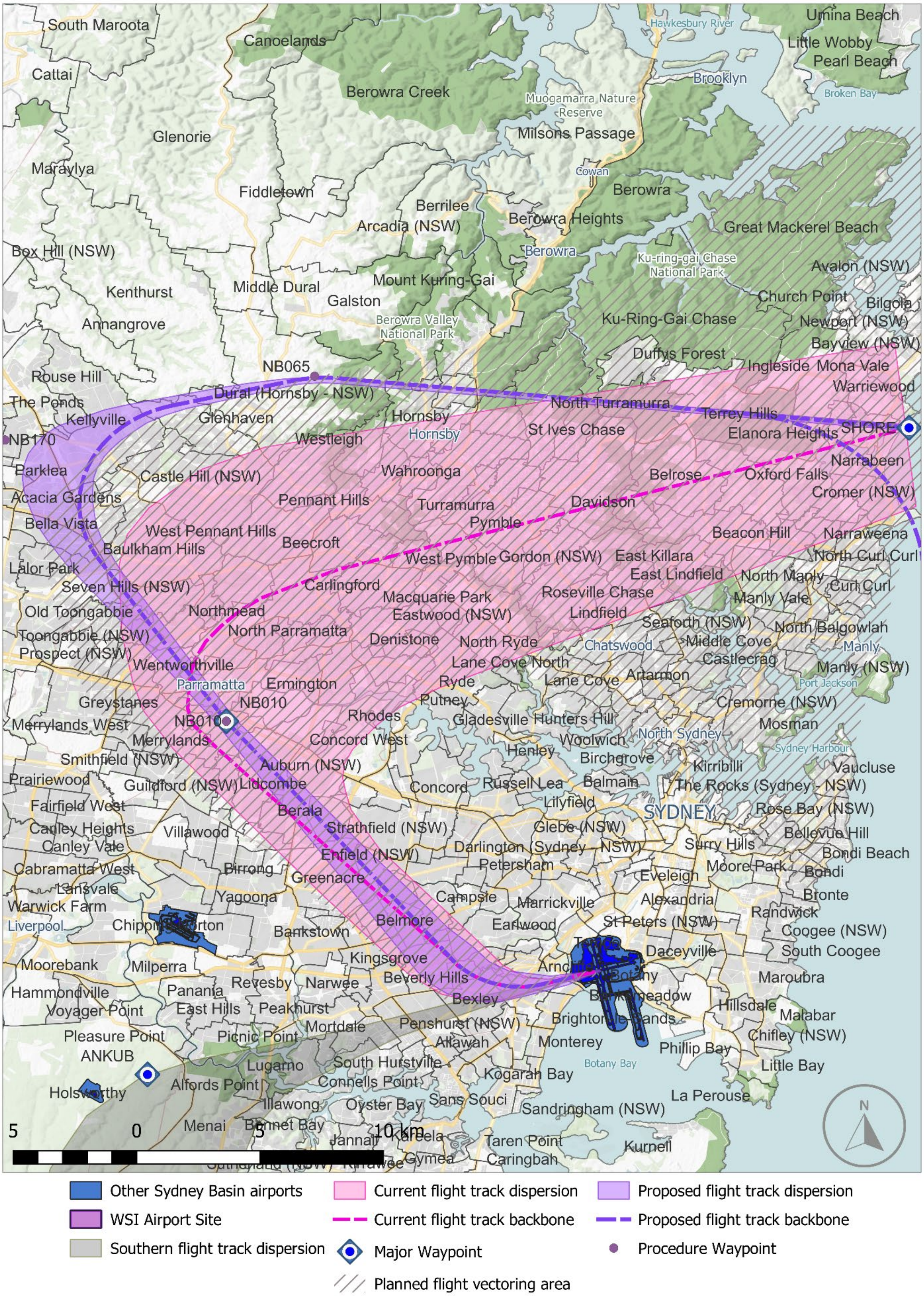


Figure 21.10 Sydney (Kingsford Smith) Airport – current and proposed Runway 25 SHORE SID with suburb overlay

The assessment found that:

- There is a considerable increase in area (square kilometres – km^2), dwellings, and population within the outer N60 and N70 contours as a result of the proposed Runway 25 SID changes (refer to Table 21.2). N60 contours are presented in Figure 21.11 to Figure 21.13, additional figures are presented in Technical paper 13, Appendix A. These increases are attributable to the early initial turn off the Runway 25 alignment (at 1,500 ft), particularly for the KADOM and RICHMOND SID segments. However, Runway 25 departures represent only around 4 per cent of annual operations at Sydney (Kingsford Smith) Airport.
- For the proposed new Runway 25 (waypoint RICHMOND) SID, a short reduction to track distances of around 6 nm (11 km) would result in widebody jet aircraft consuming about 0.1-0.2 per cent less fuel to destinations of 3,500 nm (6,482 km) and 6,500 nm (12,038 km). There would be a similar percentage reduction of carbon emissions per movement.
- In terms of visual amenity, due to the change proposed to Runway 25 SIDs:
  – a substantial area of Western Sydney currently overflown by departing jet aircraft from Runway 25 with western and north-western destinations would no longer be directly under these flight paths
  – areas overflown by aircraft heading to NB010 would experience an increase in frequency of aircraft within a narrower flight path corridor, when the SIDs are in use
  – aircraft tracking to the north-west via Richmond would be visible
  – the continuation of radar vectoring for northern and eastern departures via SHORE is expected to see little variation in the visibility of aircraft over the northern and north-eastern metropolitan area.

Table 21.2 Comparison of existing versus proposed within N60 and N70 contours – Runway 25 SID (only used around 4 per cent of the year)

Noise contour	Segment	Percentage change (%)		
		Area (km^2)	Dwelling count	Population count
N60 (24-hour) 10 movements or more	KADOM	+ 9.4 per cent	+ 67.6%	+73.9%
	RICHMOND	+ 18.1 per cent	+ 70.5%	+ 72.2%
	SHORE	No change	+ 2.4%	+ 0.5%
N70 (24-hour) 5 movements or more	KADOM	+ 22.2%	+ 16.3%	+ 17.1%
	RICHMOND	No change	+ 0.4%	- 0.1%
	SHORE	+ 16.2%	+ 4.6%	+ 4.5%

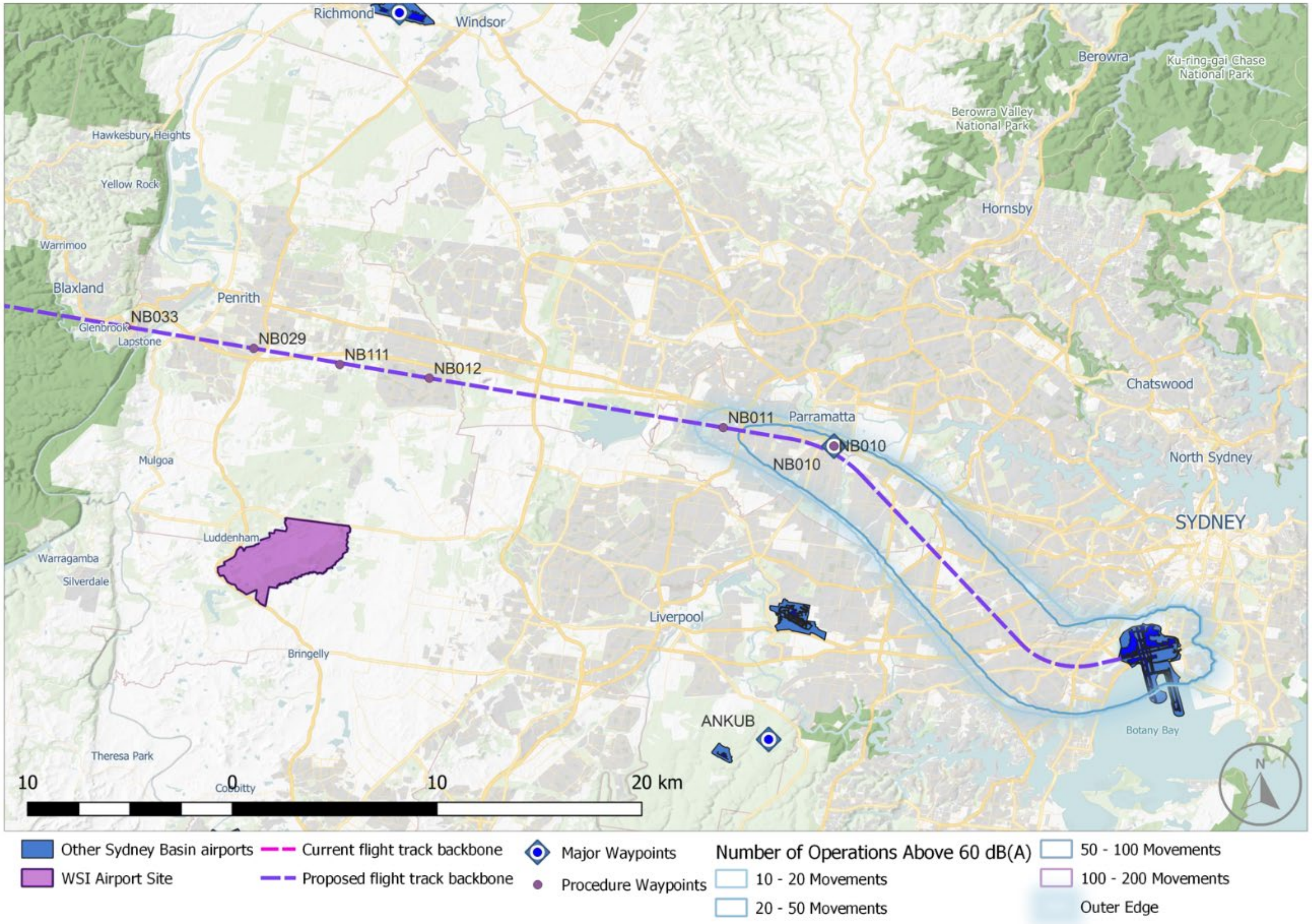


Figure 21.11 Proposed Runway 25 KADOM SID – jet departures - N60 contours

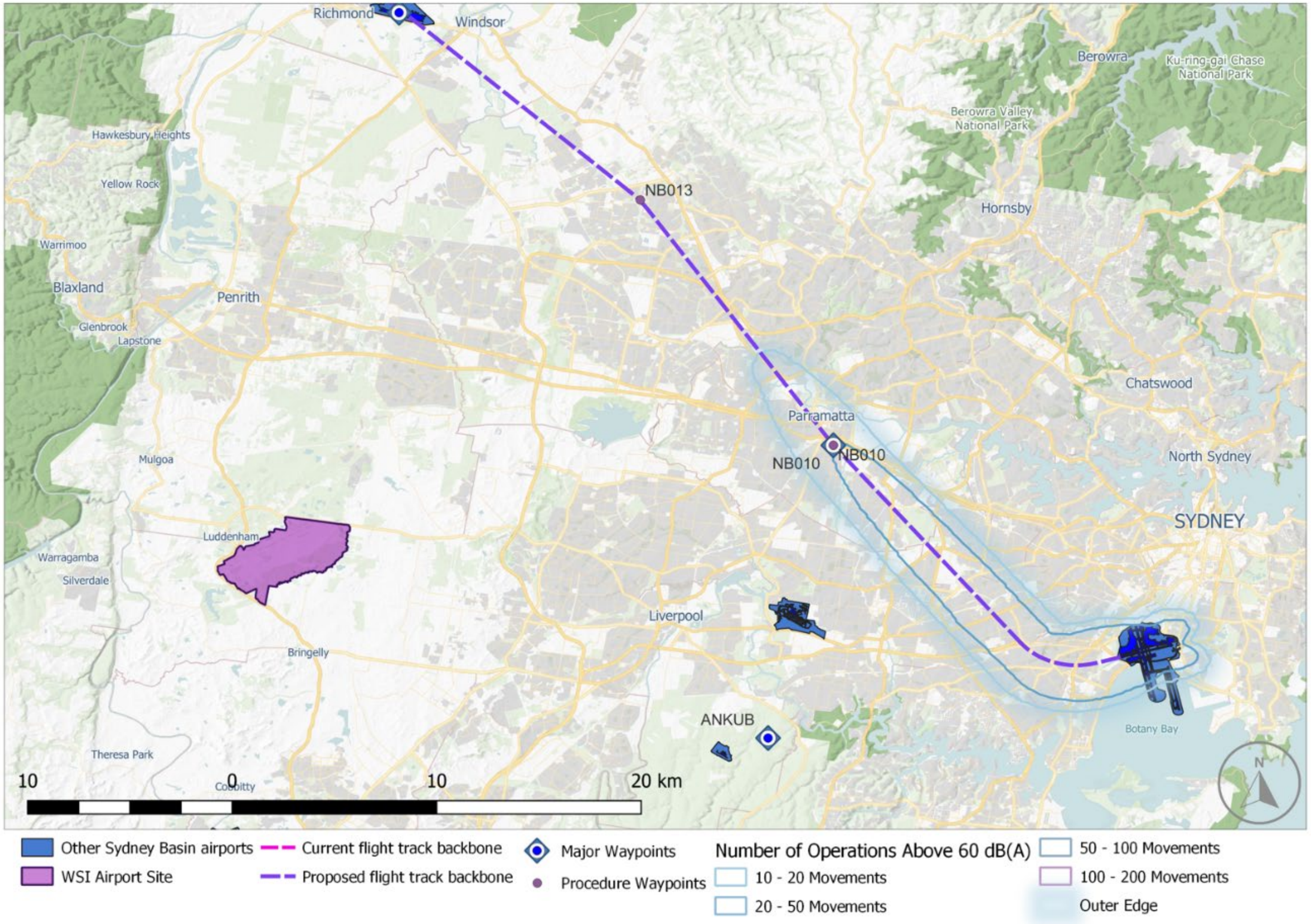


Figure 21.12 Proposed Runway 25 RICHMOND SID – N60 contours

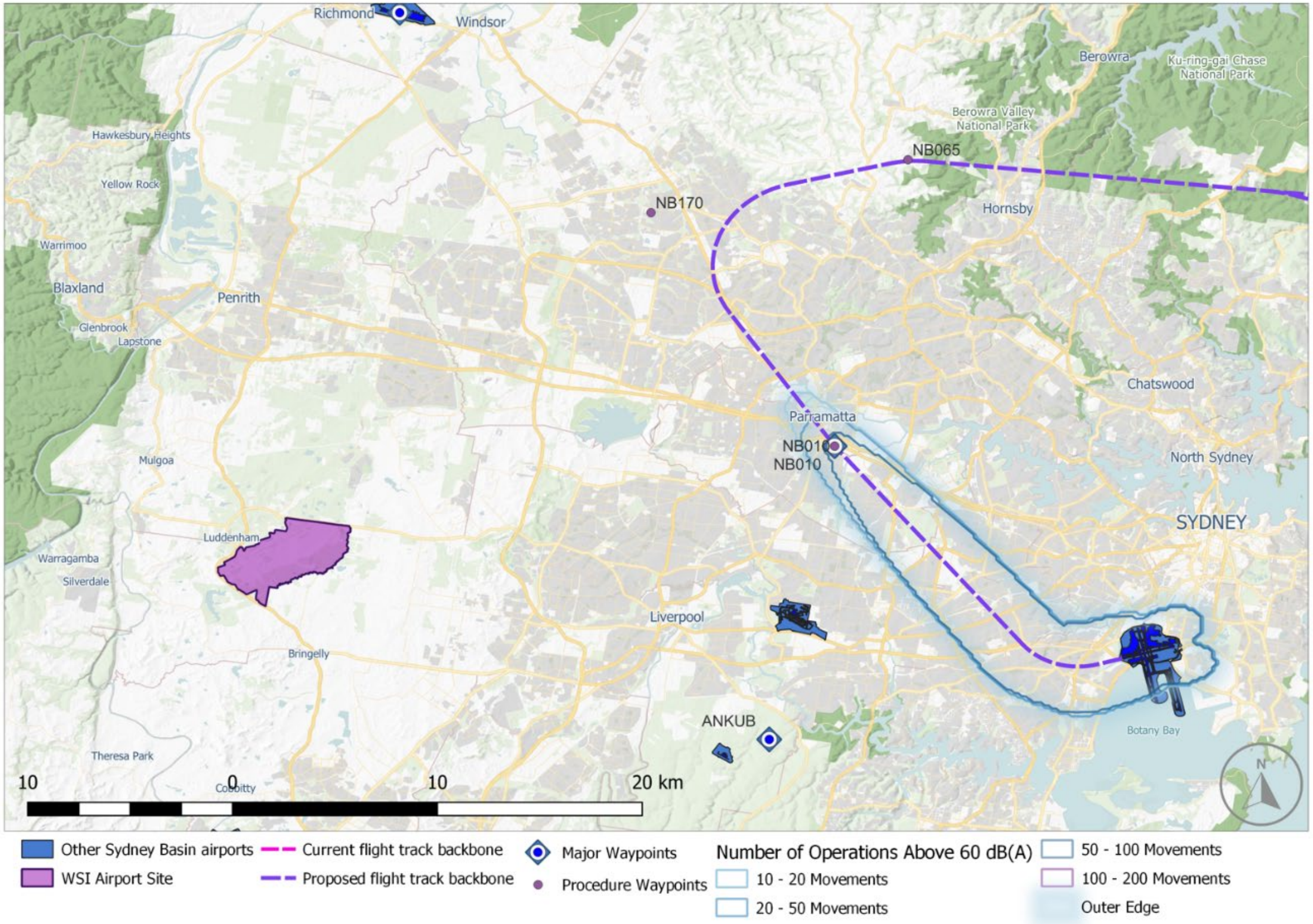


Figure 21.13 Proposed Runway 25 SHORE SID – N60 contours

21.5.1.2 Sydney (Kingsford Smith) Airport Runway 34L (waypoint KADOM) (jet) departures

This section relates to the proposed Runway 34L KADOM SID for jet departures from Runway 34L heading to the west, north-west, north and east as presented in Section 8.2.1.2 of Chapter 8 (Facilitated changes). The key assessment findings are depicted by the track dispersion with suburb overlay results in Figure 21.14 and Figure 21.15.

The flight path for the new Runway 34L KADOM SID as designed is predominantly over parts of the north-western suburbs that are already overflown by the existing SID (refer to Figure 21.2). This results in an additional 80 flights per day along the SID beyond waypoint NB010.

Further:

- the ongoing requirement for aircraft to turn left off Runway 34L runway heading at an altitude of 800 ft would continue to provide the track dispersion over the north-western suburbs
- the dispersion of aircraft created by the 800 ft left turn would narrow where the aircraft fly past new waypoint NB010 at approximately 10 nm (19 km) from Sydney (Kingsford Smith) Airport
- air traffic control radar vectoring is likely on the SHORE transition which replicates current practice
- aircraft heading north-west that would normally be allocated to Runway 34L RICHMOND SID would be reallocated to the KADOM SID when a military parachute training area is activated within the RAAF Base Richmond Restricted Airspace. Radar vectoring would also be used to vector these departures.

The assessment found that:

- In terms of noise:
  - for western departures, there are differences in the geographical extents of the N60 contours. There are differences for N70 contours, with a reduction in the width but an extension in the length of the contours. As a result, there is an associated slight reduction in the area, dwelling and population numbers for the expected noise impacts for departures to the west via the proposed future Runway 34L KADOM SID (Table 21.3). This reflects the expected changes in aircraft dispersion along the SID. N60 contours are presented in Figure 21.16, additional figures are presented in Technical paper 13, Appendix B
  - for northern and eastern departures (using KADOM TO SHORE SID via waypoint NB010), there are discernible differences in the shape of the N60 and N70 contours due to the change in geographic extents of the procedure, with these noise contours extending to the south-west, as well as the displacement of eastern Runway 34L departures off the current RICHMOND SID (which is current radar vectored). As a result, there is an associated change in the area, dwelling and population numbers for the N60 and N70 contours (Table 21.3). However, in practice, not all aircraft would fly on the SID procedure and radar vectoring would disperse aircraft (and aircraft noise). N60 contours are presented in Figure 21.17, additional figures are presented in Technical paper 13, Appendix B.

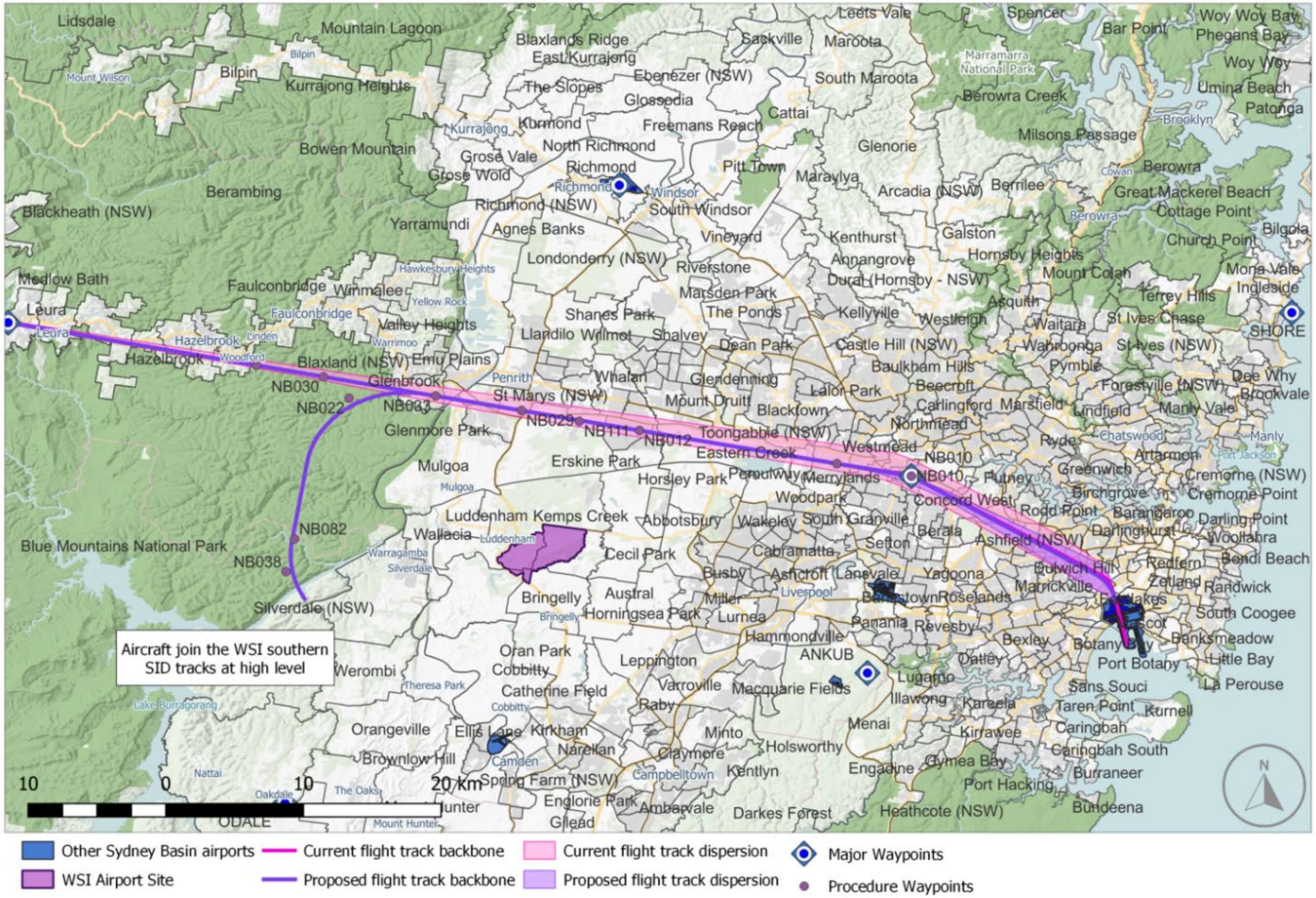


Figure 21.14 Sydney (Kingsford Smith) Airport – current and proposed Runway 34L KADOM SID (jet departures to the north-west) with suburb overlay and flight path dispersion

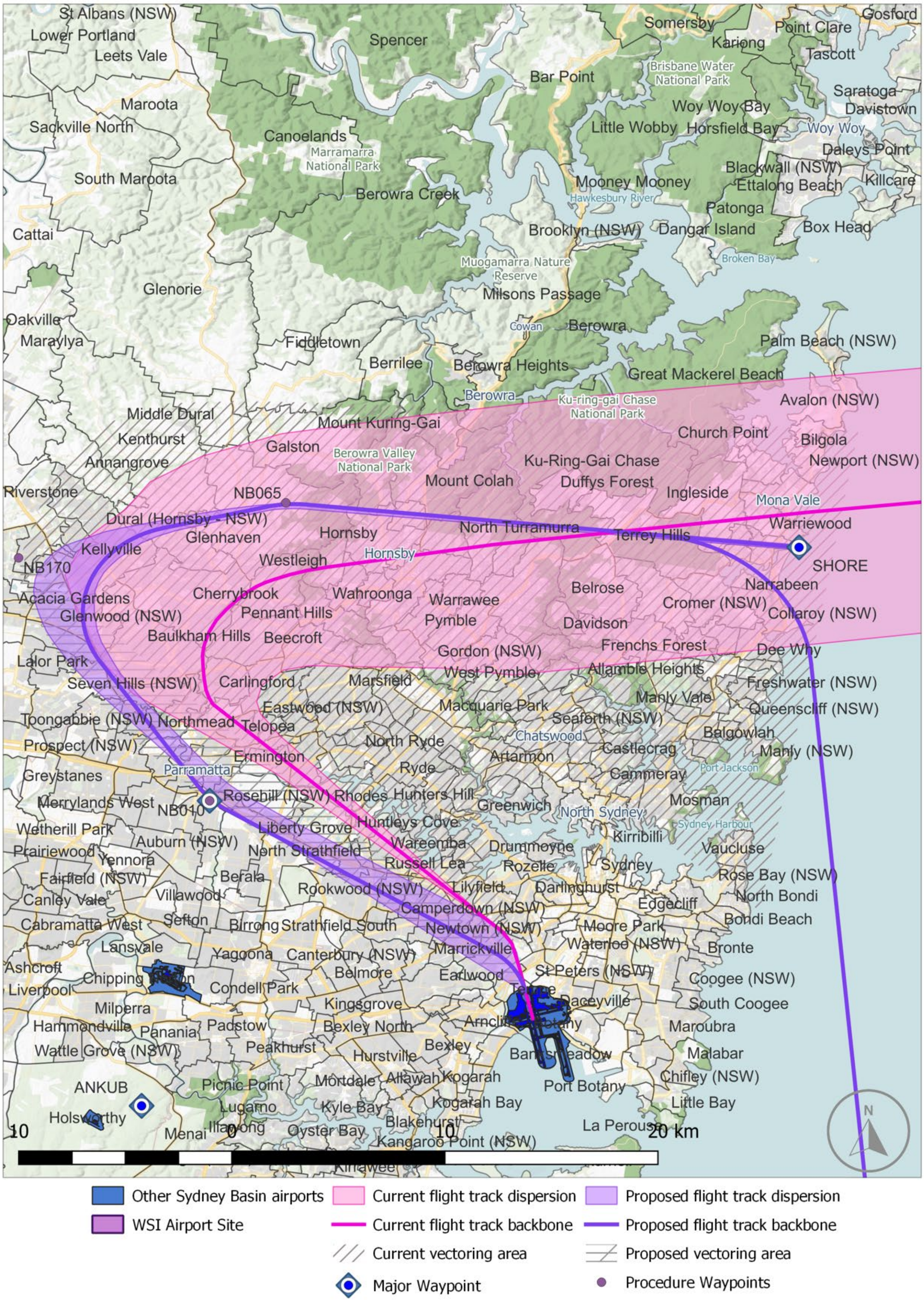


Figure 21.15 Sydney (Kingsford Smith) Airport – current and proposed Runway 34L KADOM SID with SHORE transition (jet departures to the east) with suburb overlay and radar vectoring areas

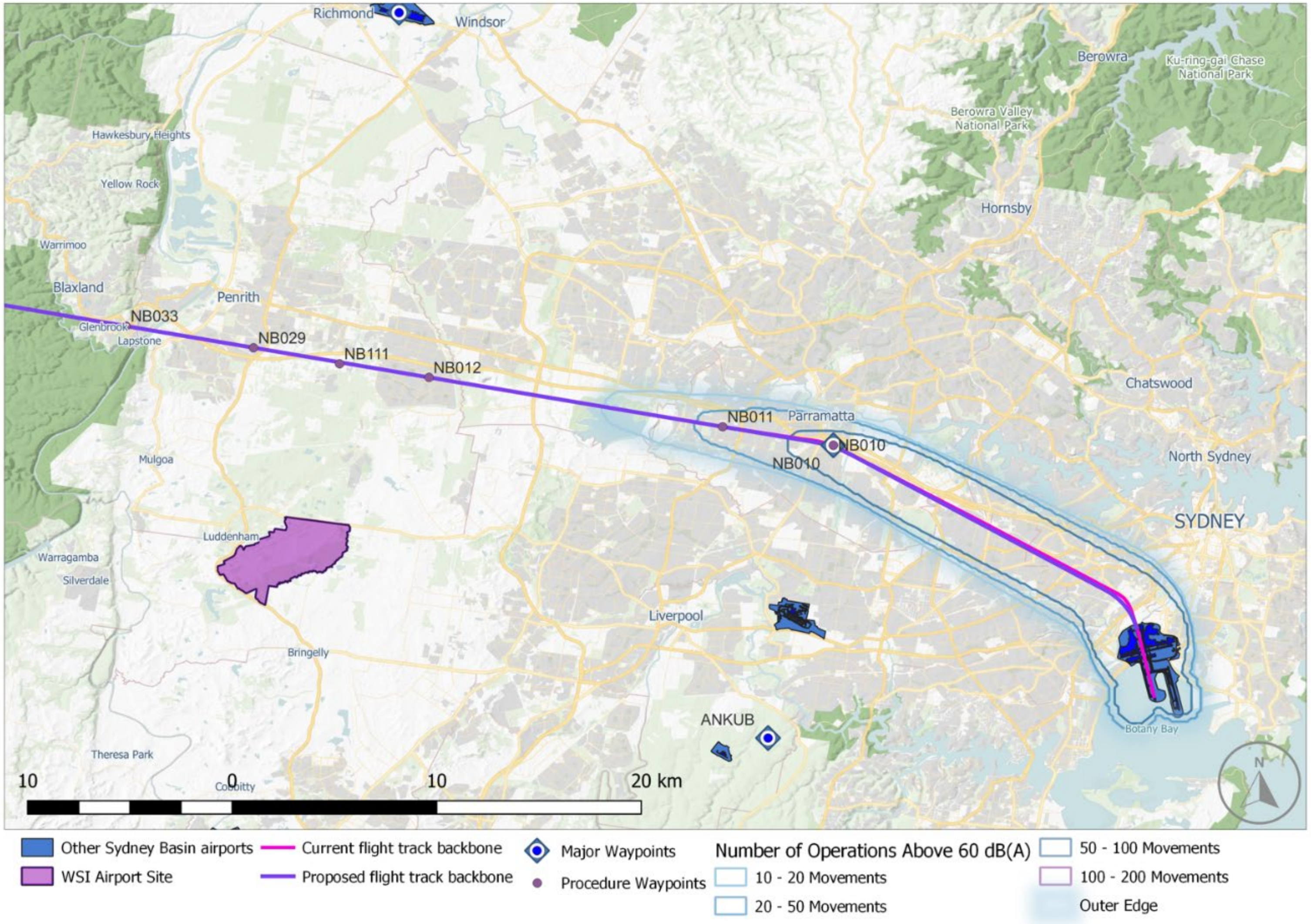


Figure 21.16 Proposed Runway 34L KADOM SID – N60 contours

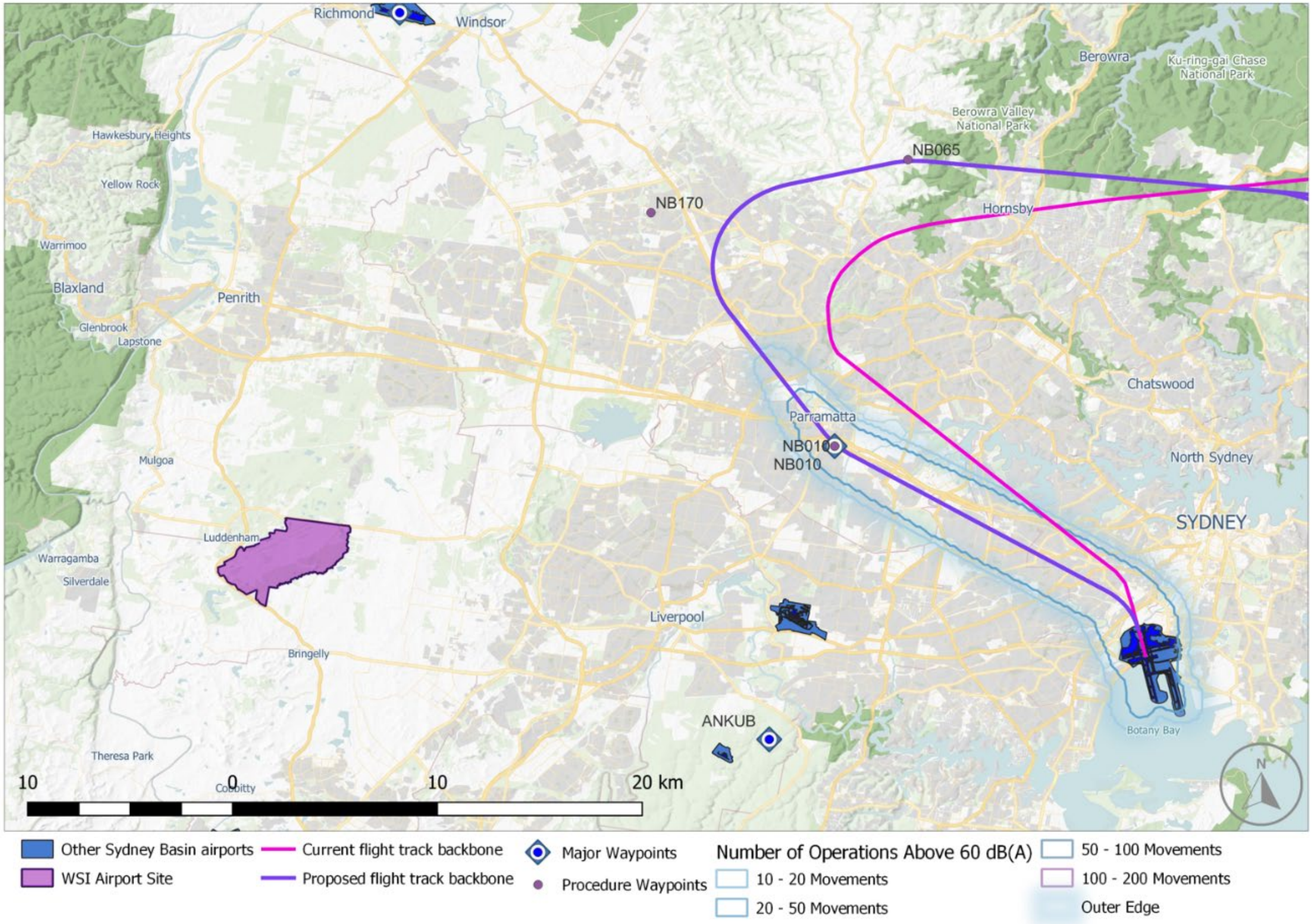


Figure 21.17 Proposed Future Runway 34L KADOM to SHORE SID to eastern/oceanic destinations - N60 contours

- For southern departures via waypoint TONTO, this would be infrequently used as per current practice with around one to 2 aircraft per day. For this change, L_{Amax} was considered which illustrated that the expected noise levels would be less than 50 dB(A) due to the increasing altitude achieved prior to that aircraft reaching the southern transition point at waypoint NB033 (refer to Technical paper 13). Noise levels of 60dB(A) and 70dB(A) for these events would not extend beyond the N60 or N70 contours associated with the KADOM SID for aircraft with western destinations.

Table 21.3 Comparison of existing versus proposed within N60 and N70 contours – Runway 34L SID

Noise contour	SID segment	Current versus proposed future procedure		
		Area (km^2) percentage change	Dwelling count percentage change	Population count percentage change
N60 (24-hour) 10 and above movements	**KADOM**	-6.7 per cent	-6.8 per cent	-6.6 per cent
N60 (24-hour) 10 and above movements	**SHORE**	+6.3 per cent	+8.4 per cent	+12.6 per cent
N70 (24-hour) 5 and above movements	**KADOM**	-10.7 per cent	-6.8 per cent	-7.8 per cent
N70 (24-hour) 5 and above movements	**SHORE**	+7.7 per cent	+29 per cent	+30 per cent

- Due to the minimal change in track distance (less than 0.3 nm or 0.56 km), there is almost no discernible change in the consumption of fuel and emissions of CO_2 from jet aircraft operating between the current and proposed SID all the way through to waypoint KADOM.
- In terms of visual amenity:
  - for aircraft continuing west to waypoint KADOM there would be minimal change in the visual perception of the dispersion of aircraft over the ground when using the proposed SID as compared to the current SID. From waypoint NB010, some aircraft may be slightly higher than the current procedure as the new SID would require aircraft to be 5,000 ft (1.5 km) or above by waypoint NB011. All communities overflown by the adjusted SID are currently overflown by current Runway 34L aircraft operating to western destinations. These aircraft would still be visible, but not necessarily in the same location due to the change in lateral dispersion
  - for aircraft proceeding east and north-east (via waypoint SHORE), the change would result in a maximum lateral shift to the south of approximately 5 km and to the west. Aircraft would be visible. Further, areas overflown by the KADOM procedure segment between Sydney (Kingsford Smith) Airport and waypoint NB010 is already overflown and visible but would be subjected to an increase in frequency of overflights of around 30 flights per day due to the reallocation of those flights off the Runway 34L RICHMOND SID. During the initial years and contingent on growth in demand within the Sydney Basin, dispersion via radar vectoring would also continue as per current practice for around half of the departures
  - for aircraft proceeding south, typically only one or 2 movements per day, they would be at an altitude of 10,000 ft (3 km) or more as they leave the KADOM SID at waypoint NB033. Aircraft would be visible over eastern areas of the GBMA and visible at above 10,000 ft (3 km) on a new low usage, high altitude flight path, between leaving the KADOM SID and joining the en-route network. Currently, these aircraft movements fly above different areas of Sydney at altitudes less than 7,000 ft (2.2 km). These aircraft would no longer be visible in this area of Sydney
  - for aircraft proceeding north-west via the KADOM SID when the military parachute training area is activated, aircraft would be visible leaving the Runway 34L KADOM SID flight path anywhere between waypoint NB033 and KADOM but would be at 10,000 ft or higher.

21.5.1.3 Sydney (Kingsford Smith) Airport Runway 34L RICHMOND SID (jet)

This section relates to the proposed Runway 34L RICHMOND SID for aircraft departures to the west and north-west as presented in Section 8.2.1.3 of Chapter 8 (Facilitated changes). The key assessment findings are depicted by the track dispersion with suburb overlay results in Figure 21.18.

The proposed adjusted Runway 34L RICHMOND SID from Sydney (Kingsford Smith) Airport represents a minimal change from the existing SID. The new SID tracks over parts of the north-western suburbs that are already overflown by the existing SID. The requirement for aircraft to turn left off the Runway 34L runway heading at an altitude of 1,500 ft (460 m) would continue to provide similar track dispersion over the suburbs closer to the airport but would increasingly narrow as the aircraft proceed to waypoint RICHMOND (refer to Figure 21.18).

As the proposed new SID flight path effectively replicates the current SID flight path and is the most direct path to Richmond it can be expected that minimal radar vectoring involving track shortening would take place on this SID. Radar vectors for safety and hazardous weather avoidance would still be possible.

The assessment found that:

- There would be no discernible change to the current track distance and, therefore, no additional fuel burn required by aircraft using the proposed Runway 34L RICHMOND SID or associated CO_2 emissions.
- There would be only very marginal changes in the N60 and N70 extents when compared to the current procedure. This results in a very minor increase in the area, dwelling and population counts. However, further along the SID, noise contours are generally similar (refer to Figure 21.19). N60 contours are presented in Figure 21.19, additional figures are presented in Technical paper 13, Appendix C.
- In terms of visual amenity, the proposed SID flight path is generally within the flight dispersion of the existing SID flight path but would narrow due to the safety requirements of the procedure. Aircraft would still be visible, but not necessarily in the same location due to the change in lateral dispersion.

Table 21.4 Comparison of existing versus proposed within N60 and N70 contours – Runway 34L RICHMOND SID

Noise contour	Segment	Change (%)		
		Area (km^2)	Dwelling count	Population count
N60 (24-hour) 10 movements or more	Richmond	+2%	+3%	+2.8%
N70 (24-hour) 5 movements or more	Richmond	+2.2%	+2.5%	+1.9%

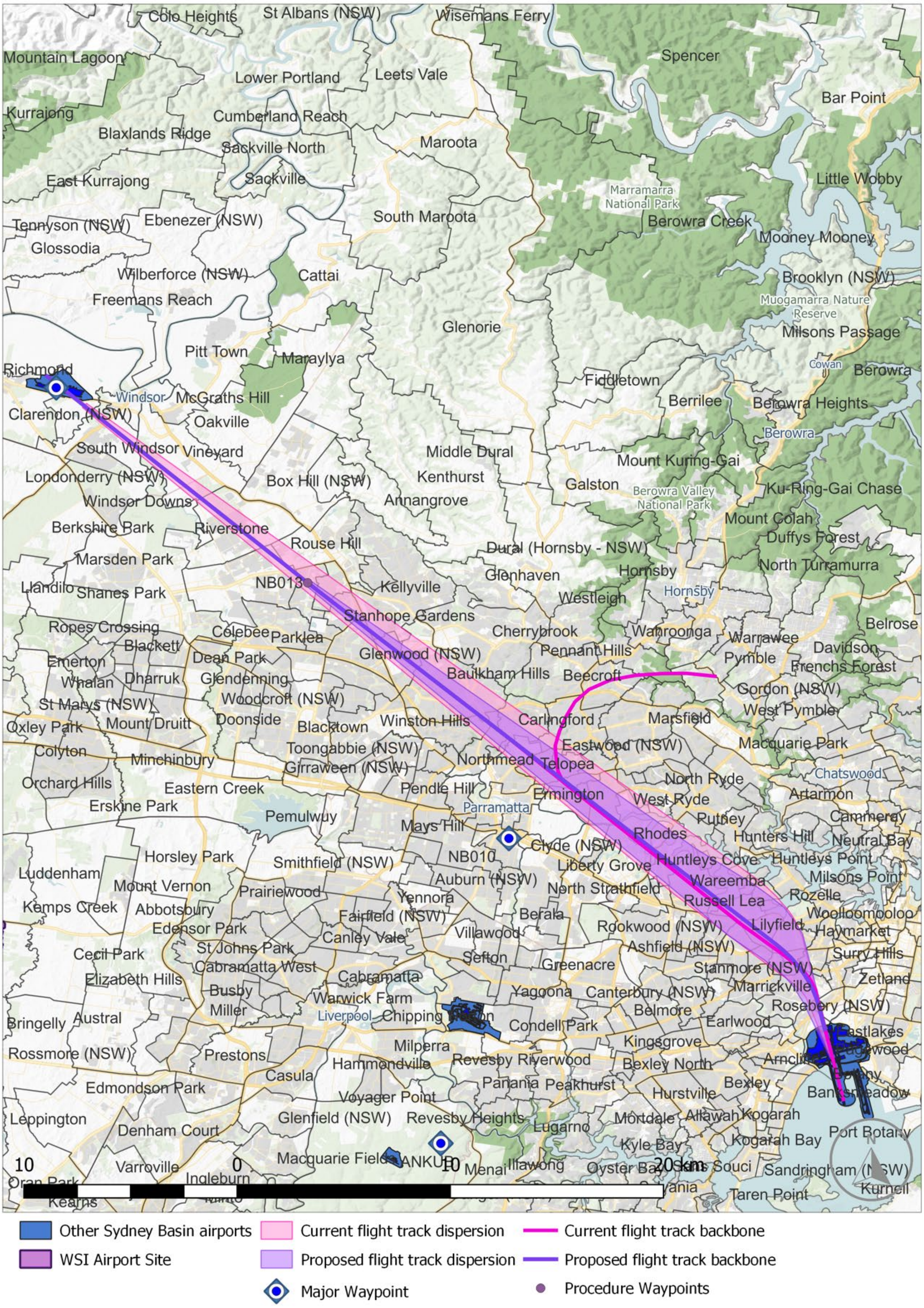


Figure 21.18 Sydney (Kingsford Smith) Airport – current and proposed Runway 34L RICHMOND SID with suburb overlay and flight path dispersion

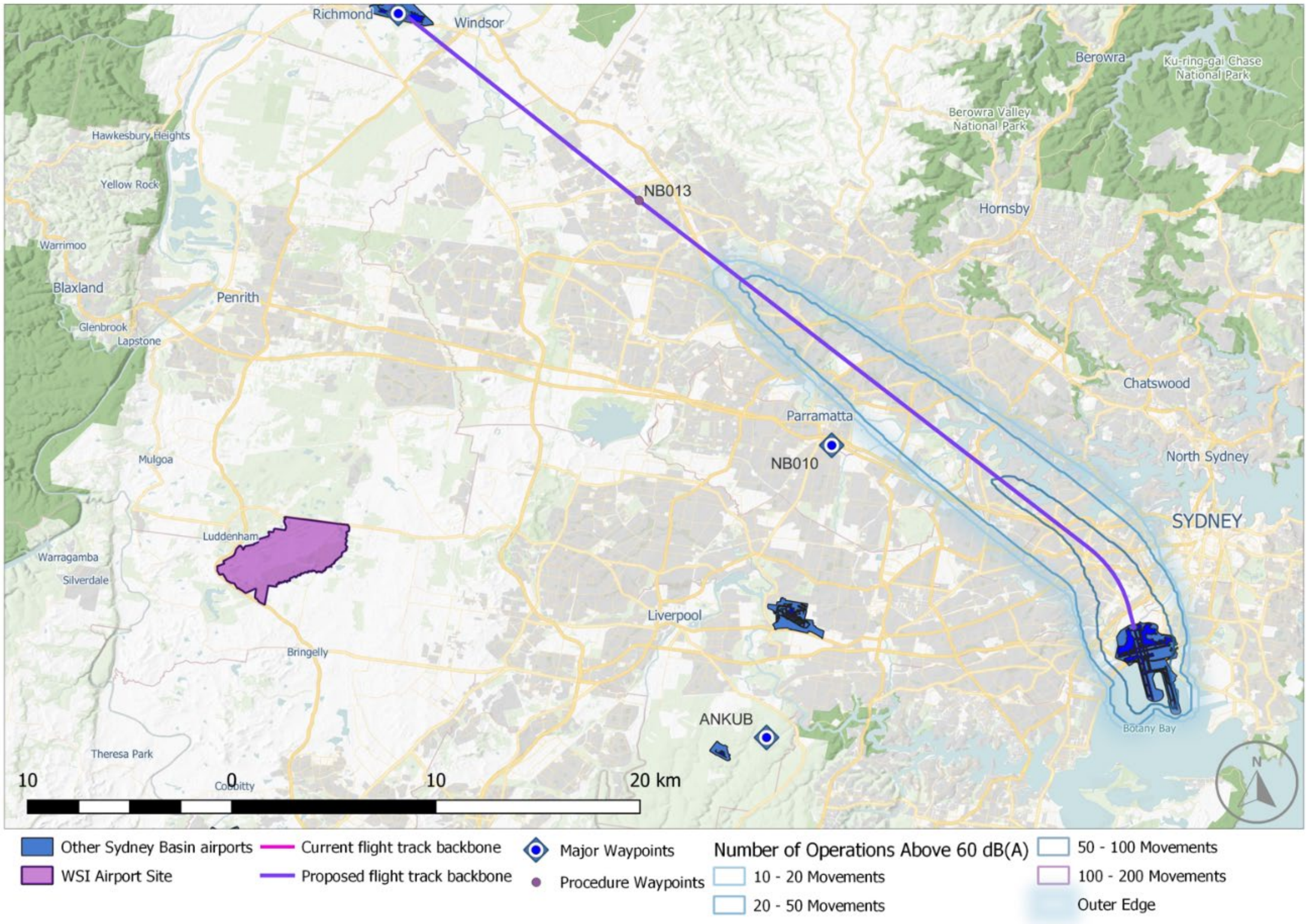


Figure 21.19 Proposed Runway 34L RICHMOND SID – N60 contours

21.5.1.4 Sydney (Kingsford Smith) Airport non-jet departures to the west and north west

This section relates to the proposed non-jet ANKUB SID which would apply to non-jet departures to the west and north-west, as presented in Section 8.2.1.6 of Chapter 8 (Facilitated changes). The key assessment findings are depicted by the flight path dispersion with suburb overlay results in Figure 21.20. A significant number of aircraft already track close to waypoint ANKUB and the new waypoint NB024. From the new waypoint NB024, the proposed new SIDs would vary from the current tracks.

It is expected that there would be around 20 of the 35 non-jet departures per day by 2030 with west and north-west destinations that would use the proposed SID. However, contingent on growth in demand within the Sydney Basin during the first year of implementation, the majority of departing aircraft may fly the new SID but the frequency of its use is expected to increase as operations at WSI increase. A variable proportion of non-jet departures to the west and north-west would continue to be radar vectored towards their first enroute waypoint.

The assessment found that:

- For aircraft that are expected to track along the new SID, there would be a marginal increase in track miles, with an increase of around 5.5 nm (10 km) for aircraft departing to KADOM and 10 nm (19 km) for aircraft departing to BENBU. As result, more CO_2 would be emitted.
- As aircraft would continue to disperse to waypoint ANKUB as per current practice, there are no changes to noise levels or the visibility of aircraft for underlying communities and suburbs between Sydney (Kingsford Smith) Airport and waypoint ANKUB. The 60 dB(A) contour does not extend to waypoint ANKUB. To consider noise beyond ANKUB, the L_{Amax} noise levels have been considered for a representative aircraft (refer to Table 21.5). Noise generated by aircraft can also vary between aircraft, or due to other factors such as pilot technique, different meteorological conditions, and/or lateral distance between the on-ground receiver and the aircraft.
- Different suburbs and communities would now be overflown by aircraft on this SID from waypoint ANKUB, with some benefits to communities currently overflown due to the lateral displacement of up to half the non-jet departure overflights to the south. A number of outer suburbs of the Sydney Basin that would currently experience overflight of non-jet departures would experience a concentration of non-jet flights due to this new procedure. However, this is expected to be around 20 flight per day, during a busy day.
- In relation to visual amenity, non-jet aircraft currently departing Sydney (Kingsford Smith) Airport from any runway fly on a widely dispersed set of radar vectored flight paths to a westerly or north westerly destination. These aircraft are visible to a large part of Western Sydney. Aircraft would continue to be visible and the change from a wide radar vectored dispersion of tracks to a more confined track from waypoint ANKUB for around 50 per cent of the departures means that communities overflown would see more aircraft, while other parts of the metropolitan area would see less overflight.

Table 21.5 Sydney (Kingsford Smith) Airport – predicted average overflight noise levels at waypoints on the proposed SIDs (non-jet departures)

Waypoint	Altitude	Noise level for Saab 340 – Regional twin turbo-prop (L_{Amax})[1]	
		Climb[2]	Cruise
ANKUB	5,000 ft	60 dB(A)	58 dB(A)
NB024	5,000 ft	58 dB(A)	n/a
NB037	9,000 ft	56 dB(A)	n/a
NB038	11,000 ft	54 dB(A)	n/a
NB055	13,000 ft	52 dB(A)	n/a

1. The dB(A) values presented the above table should be considered as a median value of a range of plus or minus 3 dB(A) – i.e., 50 dB(A) would indicate potential overflight noise of between 47 and 53 dB(A).
2. Under the proposed SIDs, aircraft do not climb above 5,000 ft until west of waypoint NB024. It is expected that the majority of aircraft would reach 5,000 ft close to ANKUB due to climb performance and would reduce thrust (noise) while maintaining 5,000 ft until able to climb past waypoint NB024.

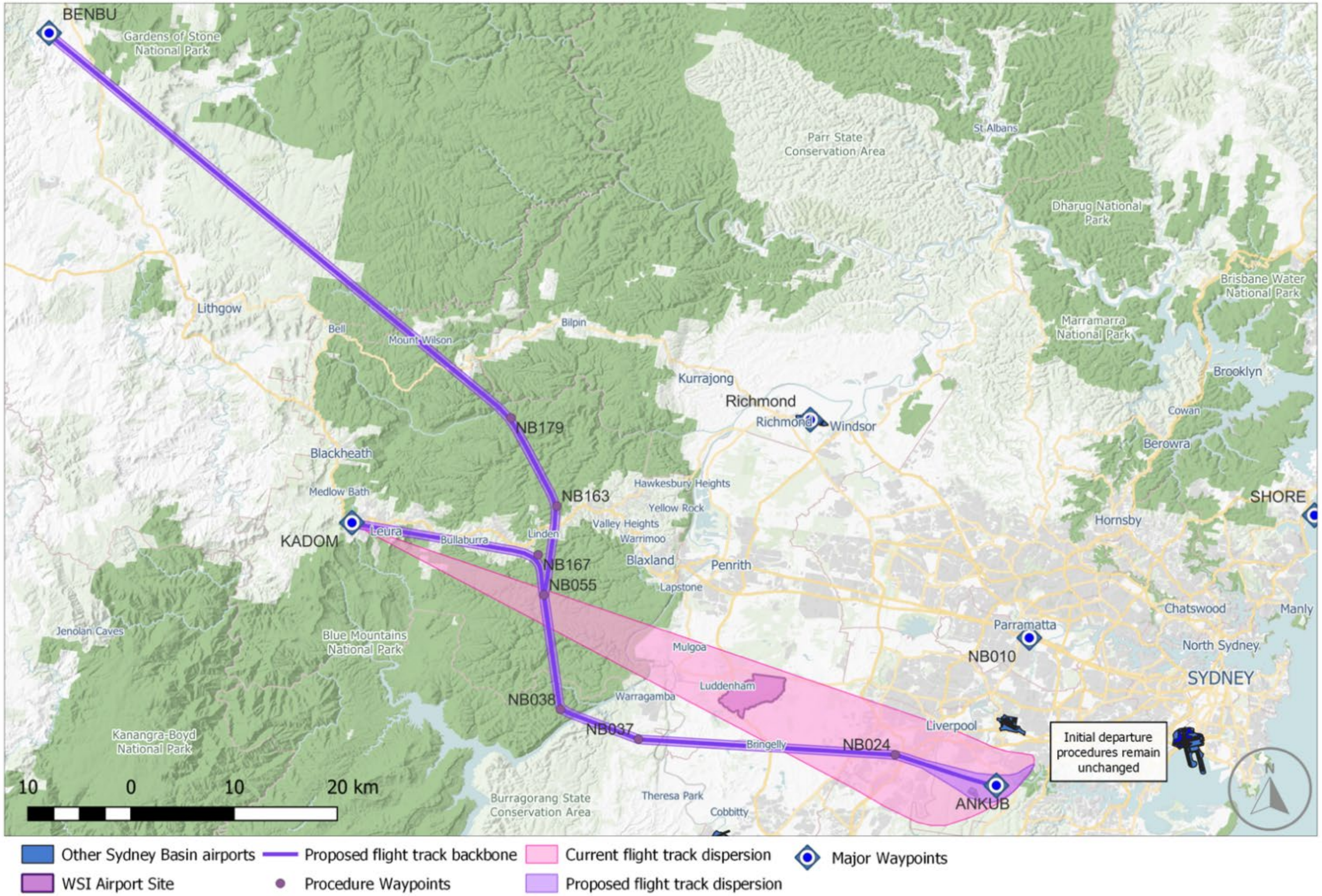


Figure 21.20 Sydney (Kingsford Smith) Airport – current non-jet departures versus proposed new non-jet SID with flight path dispersion

21.5.2 Group B

21.5.2.1 Bankstown Airport IFR changes

This section relates to the proposed IFR changes for aircraft arriving and departing Bankstown Airport, as presented in Section 8.3 of Chapter 8 (Facilitated changes). The key findings are depicted by the track dispersion with suburb overlay results in Figure 21.21 and Figure 21.22. Detailed information on the proposed change and assessment is provided in Appendix G of Technical paper 13.

Bankstown Airport is the most affected of all Sydney Basin airports by the proposed introduction of WSI operations. This is reflected by the need to introduce a suite of new IFR procedures including SIDs, STARs and new instrument approaches (RNP). Bankstown Airport currently handles on average around 700 flight movements per day. Around 145 movements per day are expected to operate under IFR, comprising of:

- turbo-prop and jet aircraft (38 movements), which would consistently operate under IFR
- all twin-engine aircraft movements and only 10 per cent of single-engine aircraft could also operate and train under IFR.

Aircraft movements are expected to grow around one per cent per annum, based on the Bankstown Airport Master Plan.

A set of noise abatement procedures are in place at Bankstown Airport, which detail the preferred runway and circuit directions, and limitations during the day and night time periods. The airport also has a voluntary Fly Neighbourly Procedures Program. This program assists in managing noise-related airport issues for fixed-wing aircraft and helicopters, as well as on-ground noise sources.

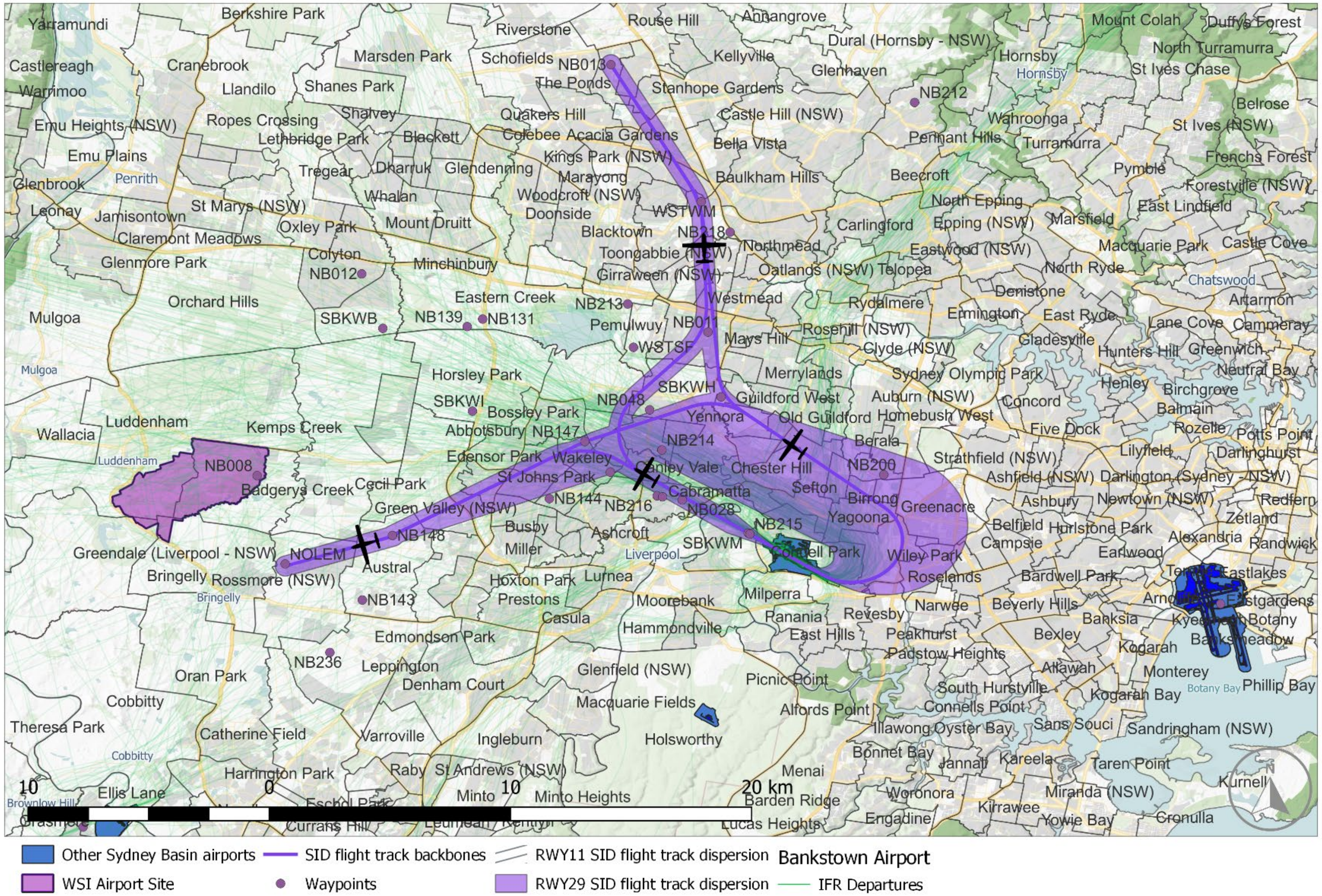


Figure 21.21 Proposed SIDs at Bankstown Airport – current (green) versus future track dispersion with suburb overlay

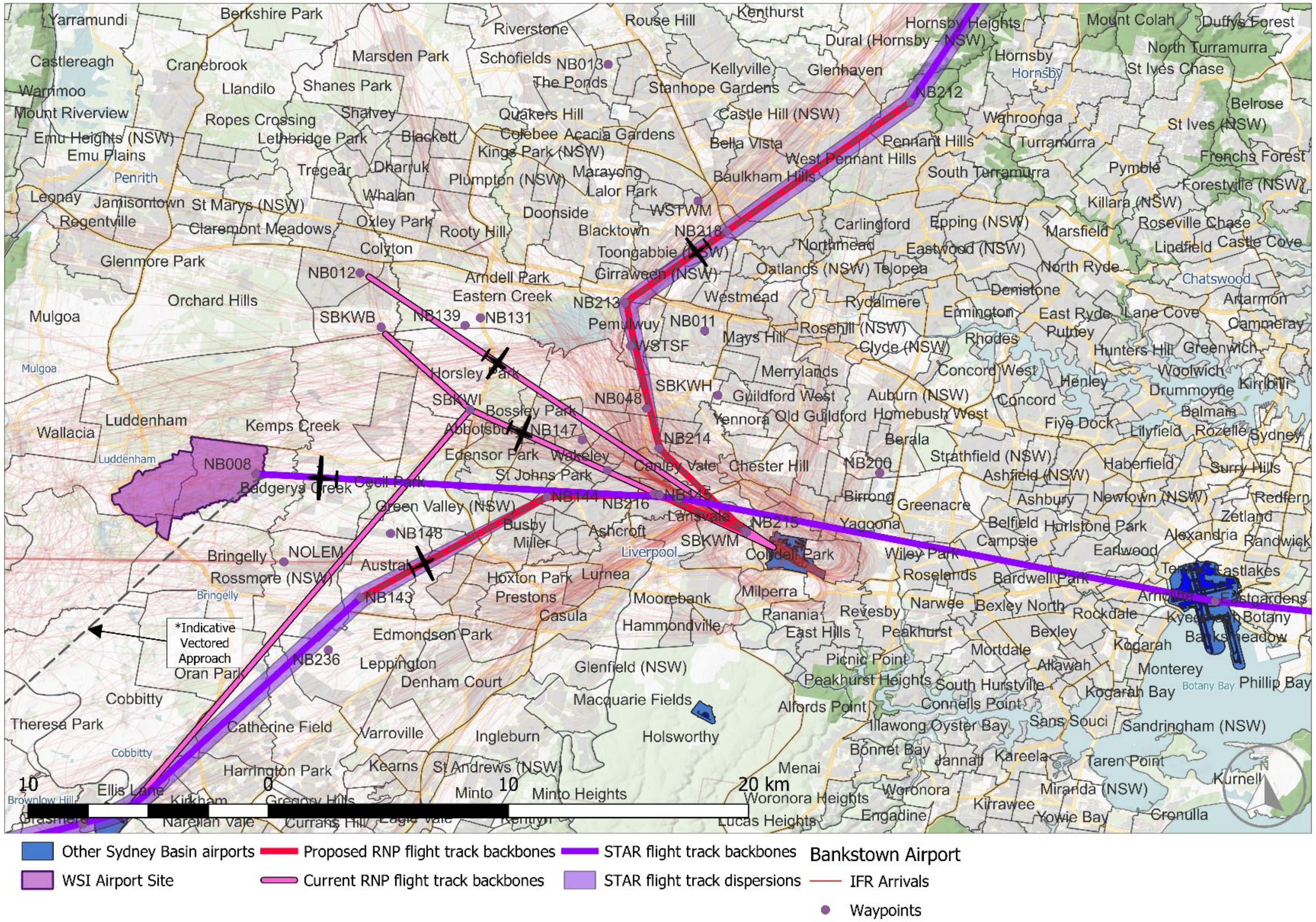


Figure 21.22 Proposed STARs at Bankstown Airport and integrated RNP approaches – Current (red) versus Proposed track dispersion with suburb overlay

The assessment found that:

- The area overflown by the proposed new SIDs and STARs for Bankstown Airport IFR operations is already frequently overflown with similar aircraft undertaking both IFR and VFR flights. Due to the close proximity of WSI, it is expected that IFR aircraft operating to and from Bankstown Airport would more frequently fly the new IFR procedures than is currently the case. This would result in an increased frequency and concentration of overflight, particularly for arriving aircraft. In the case of departures, air traffic control radar vectoring would provide some dispersion around the SID track
- The changes to IFR procedures would result in new areas close to Bankstown Airport being subjected to overflight by aircraft undertaking IFR operations and flying at relatively low altitudes. Noise generated by representative aircraft at various phases of flight are provided in Table 21.6 and Table 21.7. Noise generated by aircraft can also vary between aircraft, or due to other factors such as pilot technique, different meteorological conditions, and/or lateral distance between the on-ground receiver and the aircraft
- Given the variability of the departure points and the subsequent routes flown to connect with the STARs it is not possible to accurately estimate any track mile or emissions savings or increases. The south-western SID almost replicates the current IFR departure track to the south-west and as such no track distance differences are expected. The SID to the north-west will require some aircraft (particularly with destinations to the west) to fly a slightly increased track distance of less than 1 nm (2 km)
- In terms of visual amenity:
  - there will be increased visibility of aircraft on the 2 SID transitions, north-west and south-west. However, the coverage and random nature of the current significant number of flight operations as shown in Figure 21.21, particularly in the vicinity of Bankstown Airport would result in difficulty by observers on the ground to distinguish from a visual perspective, their origin or destination airport. Radar vectoring of IFR departures may take place prior to aircraft reaching the end point of the proposed new SIDs
  - aircraft on the transition from an enroute flight path via the proposed RNPs approaches will be visible on these new STARs. However not all aircraft will fly the relevant STAR and RNP approach. These aircraft, not on a STAR, but radar vectored, would be visible in the areas that are currently overflown by arriving IFR aircraft to Bankstown Airport
  - the minor change in alignment between the existing RNP final approach path and the 2 proposed new RNP final approach paths is sufficiently small that no change in visual amenity is anticipated for IFR operations within the Bankstown control zone.

Table 21.6 Bankstown Airport – predicted average overflight noise levels in dB(A) at SID waypoints

Flight altitude less terrain height	Waypoint	Aircraft	Noise level (L_{Amax})[1]	
			Level flight	Climb flight
1,450 ft	SBKW, WSTWM, NB013, SBKWH, NB147, NB011	Single engine propeller (Cessna Skyhawk)	63 dB(A)	66 dB(A)
		Twin-engine propeller (Beechcraft Baron)	74 dB(A)	77 dB(A)
		Twin turbo-prop (Saab 340)	73 dB(A)	75 dB(A)
		Jet (Cessna Business jet)	76 dB(A)	80 dB(A)
2,450 ft	NB147, NB148	Single engine propeller (Cessna Skyhawk)	56 dB(A)	60 dB(A)
		Twin-engine propeller (Beechcraft Baron)	68 dB(A)	71 dB(A)
		Twin turbo-prop (Saab 340)	67 dB(A)	69 dB(A)
		Jet (Cessna Business jet)	68 dB(A)	dB(A)

1. The dB(A) values represent a median value that has a range of plus or minus 3 dB(A) – i.e. 50 dB(A) would indicate potential overflight noise of between 47 and 53 dB(A).

Table 21.7 Bankstown Airport – predicted average overflight noise levels in dB(A) at STAR waypoints

Flight altitude less terrain height	Waypoint	Aircraft	Noise level (L_{Amax})[1]	
			Level flight	Descent flight
1,250 ft to 1,800 ft [2]	NB145, NB214, NB218, NB213, NB217, BEROW, NB212, NB144, NB143	Single engine propeller (Cessna Skyhawk)	65–60 dB(A)	59–55 dB(A)
		Twin-engine propeller (Beechcraft Baron)	76–72 dB(A)	71–66 dB(A)
		Twin turbo-prop (Saab 340)	75–71 dB(A)	72–68 dB(A)
		Jet (Cessna Business jet)	79–73 dB(A)	71–66 dB(A)
2,250 ft to 2,280 ft	RASKO, NB235 (in ascending order)	Single engine propeller (Cessna Skyhawk)	57 dB(A)	52 dB(A)
		Twin-engine propeller (Beechcraft Baron)	68 dB(A)	64 dB(A)
		Twin turbo-prop (Saab 340)	67 dB(A)	64 dB(A)
		Jet (Cessna Business jet)	69 dB(A)	62 dB(A)
3,000 ft	MEPIL	Single engine propeller (Cessna Skyhawk)	54	49
		Twin-engine propeller (Beechcraft Baron)	66 dB(A)	60 dB(A)
		Twin turbo-prop (Saab 340)	65 dB(A)	60 dB(A)
		Jet (Cessna Business jet)	66 dB(A)	58 dB(A)

1. The dB(A) values represent a median value that has a range of plus or minus 3 dB(A) – i.e. 50 dB(A) would indicate potential overflight noise of between 47 and 53 dB(A).
2. The upper and lower range has been provided. Predicted average noise levels at each waypoint is provided in Technical paper 13, Appendix G.

21.5.3 Group C

21.5.3.1 Sydney (Kingsford Smith) Airport – AKMIR STAR

This section relates to the proposed AKMIR STAR for non-jet arrival operations from the south and west as presented in Section 8.2.2.1 of Chapter 8 (Facilitated changes). The key assessment findings are depicted by the track dispersion with suburb overlay results in Figure 21.23.

The key findings are:

- The AKMIR STAR is predicted to be used up to 60 non-jet and 3 jet flights per day with only slight increases in these flight numbers over the initial 5 years of WSI operations. The limited number of jet aircraft via the AKMIR STAR are expected to be at a similar altitude as non-jet aircraft when overhead the AKMIR waypoint.
- By displacing the AKMIR STAR flight path up to 3.2 nm (5.9 km) south of the existing ODALE STAR a new area would be overflown by non-jet aircraft and the very limited number of jets that utilise the STAR. The new AKMIR STAR flight path re-joins the existing ODALE STAR flight path at waypoint MITSA, from where current procedures would be maintained to land on all the Sydney (Kingsford Smith) Airport runways.
- Noise levels at 60 dB(A) or more do not extend to waypoint MITSA from the airport. Noise levels extracted from the NPD charts for representative aircraft at the waypoints is provided in Table 21.8. Noise generated by aircraft can also vary between aircraft, or due to other factors such as pilot technique, different meteorological conditions, and/or lateral distance between the on-ground receiver and the aircraft.

- The deviation of the proposed AKMIR STAR from the current ODALE STAR represents an increased arrival distance of approximately 1 nm (2 km). This would mean a representative non-jet aircraft type, the Dash-8 400 operating a 250 nm (463 km) regional route, is projected to use an extra 5.5 kilograms (kg) of fuel emitting approximately 17.3 kg of CO_2 per movement. For jet aircraft like the Boeing B737-800, around 22 kg of CO_2 would be emitted per movement.
- As is the case with the current ODALE STAR, all aircraft arriving via the AKMIR STAR would be radar vectored to their final approach. This vectoring normally commences after MITSA.
- In terms of visual amenity:
  - due to the lateral difference between the current ODALE STAR and the proposed AKMIR STAR (refer to Figure 21.23) the aircraft (predominantly turbo-prop aircraft) that are currently visible between waypoints AKMIR and MITSA on the ODALE STAR flight path will no longer be as visible in that piece of airspace. Aircraft operating to and from Bankstown and Camden Airports will still be visible in this area
  - the proposed AKMIR STAR has a flight path corridor between AKMIR and MITSA which at its maximum is around 3.2 nm (5.9 km) south of the current ODALE STAR flight path. Aircraft on descent above 9,000 ft (2.7 km) using this flight path will be newly visible from the ground. But due to a lifting of the altitude requirement on the AKMIR STAR by 2,000 ft (610 m) aircraft will be perceptibly higher than aircraft at a similar distance from Sydney (Kingsford Smith) Airport on the current ODALE STAR.

Table 21.8 Sydney (Kingsford Smith) Airport - predicted average overflight noise levels in dB(A) at AKMIR STAR waypoints

Flight altitude	Waypoint	Aircraft	Noise level (L_{Amax})[2]
19,000 ft – 16,000 ft[1]	AKMIR	B777-300 widebody twin-jet	47 dB(A)
		Boeing 737-800 – Narrowbody twin-jet	43 dB(A)
		Saab 340 – regional twin turbo-prop	39 dB(A)
11,000 ft	NB285	B777-300 widebody twin-jet	53 dB(A)
		Boeing 737-800 – Narrowbody twin-jet	46 dB(A)
		Saab 340 – regional twin turbo-prop	44 dB(A)
9,000 ft	MITSA	B777-300 widebody twin-jet	57 dB(A)
		Boeing 737-800 – Narrowbody twin-jet	49 dB(A)
		Saab 340 – regional twin turbo-prop	47 dB(A)

1. Jets and turbo-props are assumed to be at 19,000 ft in descent, and turbo-props at 16,000 ft in cruise
2. The dB(A) values represent a median value that has a range of plus or minus 3 dB(A) – i.e. 50 dB(A) would indicate potential overflight noise of between 47 and 53 dB(A).

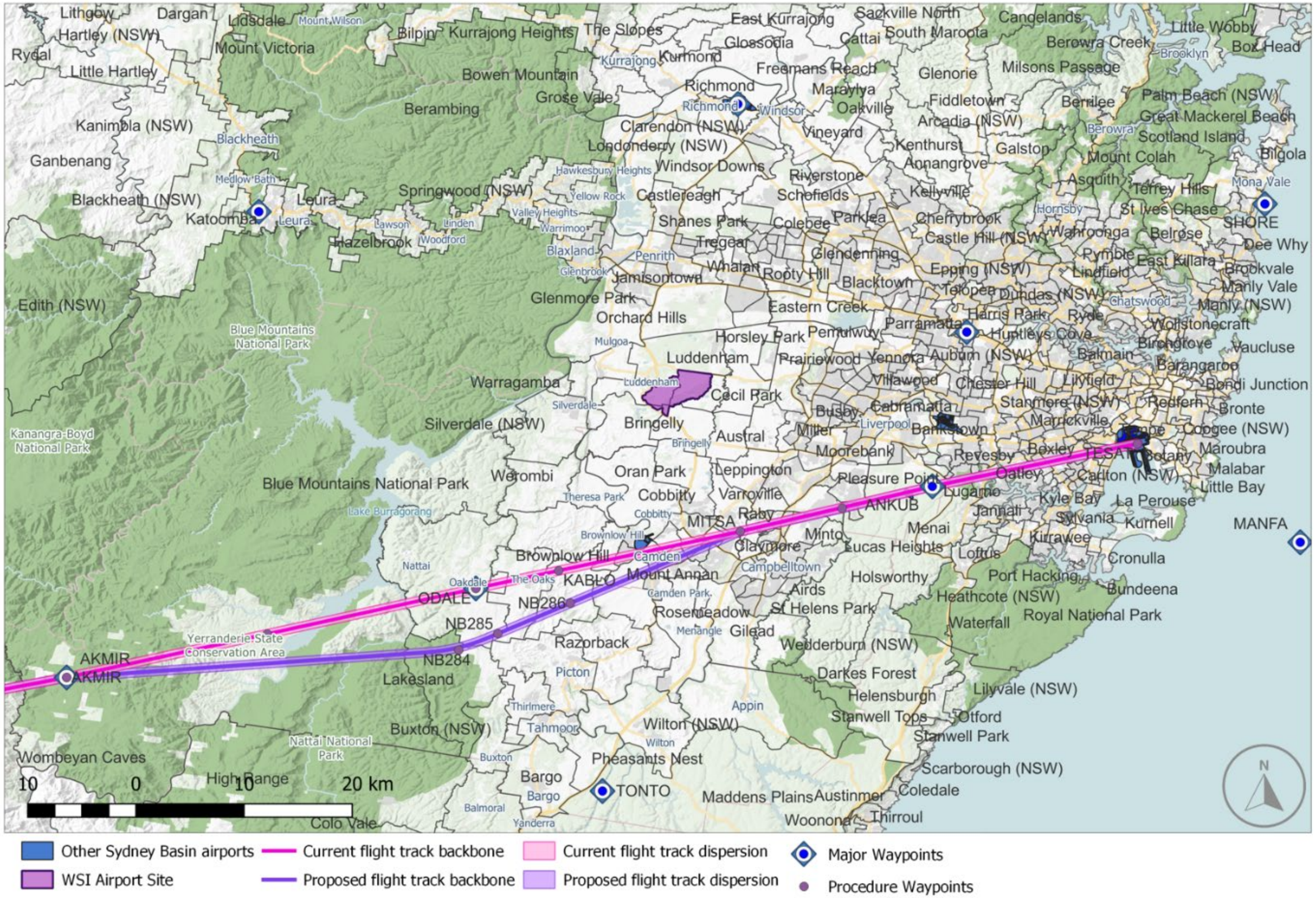


Figure 21.23 Sydney (Kingsford Smith) Airport – current and proposed AKMIR STAR with suburb overlay

21.5.3.2 Camden Airport IFR changes

This section relates to the proposed new STAR procedures for Camden Airport as presented in Section 8.4 of Chapter 8 (Facilitated changes). The key assessment findings are depicted by the suburb overlay results in Figure 21.24. More detailed information is provided in Appendix H of Technical paper 13.

As identified in Section 8.4.1, presently around 10 IFR movements operate to and from Camden Airport per day. Aircraft movements are expected to grow around one per cent per annum or less, based on the Camden Airport Master Plan. As such, IFR movements would remain very low into the future.

There would be little to no material change to current IFR operations at Camden Airport. Specifically:

- once past waypoint SCNWI, the new track to Camden Airport is the same as the current track (and is not subject to assessment). Populated areas are to the east of SCNWI
- the area of change between the waypoint NB234 (at which aircraft must be below 6,000 ft (1.8 km)) and the waypoint NB235 at the commencement of the RNP new approach leg are already overflown at similar altitudes in the current operation. The very small number of aircraft adopting this procedure is not considered to be significant in overflight noise exposure
- noise generated by representative aircraft at various phases of flight at selected waypoints with an assumed vertical profile are provided in Table 21.9 (refer to Appendix H of Technical paper 13 for the full results). Noise generated by aircraft can also vary between aircraft, or due to other factors such as pilot technique, different meteorological conditions, and/or lateral distance between the on-ground receiver and the aircraft
- aircraft using these newly proposed STARs may also be subject to radar vectoring. It is anticipated that this would result in a dispersion of arrival traffic over the ground much the same as today for aircraft from the south and west, and not too dissimilar to today for aircraft from the east, north and north-west
- given the variability of the departure points and the subsequent routes flown to connect with the STARs it is not possible to accurately estimate any track mile or emissions savings or increases
- given that the area under the new STARs is already overflown by a mix of aircraft types (refer to Figure 21.5) and there are low numbers of IFR aircraft expected to use the STARs inside controlled airspace, which are largely west of the metropolitan area, the visual impact to communities in the Sydney Basin area is expected to be negligible.

Table 21.9 Predicted average overflight noise levels in dB(A) at STAR waypoints

Flight altitude less terrain height	Waypoint	Aircraft	Noise level[1]	
			Level flight	Descent flight
2,500 ft	NB059, NB235, SCNWI	Single engine propeller (Cessna Skyhawk)	57 dB(A)	52 dB(A)
		Twin-engine propeller (Beechcraft Baron)	68 dB(A)	62 dB(A)
3,600 ft	NB234	Single engine propeller (Cessna Skyhawk)	50 dB(A)	47 dB(A)
		Twin-engine propeller (Beechcraft Baron)	65 dB(A)	59 dB(A)
7,000 ft	WYATT	Single engine propeller (Cessna Skyhawk)	43 dB(A)	39 dB(A)
		Twin-engine propeller (Beechcraft Baron)	57 dB(A)	52 dB(A)
9,000 ft	NB008	Single engine propeller (Cessna Skyhawk)	53 dB(A)	48 dB(A)
		Twin-engine propeller (Beechcraft Baron)	41 dB(A)	36 B(A)

1. The dB(A) values represent a median value that has a range of plus or minus 3 dB(A) – i.e. 50 dB(A) would indicate potential overflight noise of between 47 and 53 dB(A).

Figure 21.24 Camden Airport – proposed IFR STARs with suburb overlay

21.5.3.3 RAAF Base Richmond departures and arrivals

This section relates to the new SID and STARs for departures and arrivals at RAAF Base Richmond as presented in Section 8.5 of Chapter 8 (Facilitated changes). The key findings are depicted by the track dispersion with suburb overlay results in Figure 21.25.

The assessment found:

- As no changes are proposed for the final approach or initial departure paths to Runway 10/28, there would be no change in noise or the local noise preferred procedures for aircraft operating at this airport. The proposed STARs have been designed to closely replicate the existing radar vectoring that currently occurs. These STARs are well north of the Sydney Basin, and/or at high altitudes. The new proposed eastern SID is expected to result in a similar track spread to current operations but at higher altitude.
- The area overflown by the proposed new SID and STARs is currently frequently overflown with similar aircraft undertaking both IFR and VFR flights (refer to Figure 21.2), and there is a predicted low utilisation of the proposed new SID and STARs by up to 15 flights per day.
- Aircraft with eastern or southern destinations currently fly a more direct route, and the proposed SID would increase track distances by around 51 nm (95 km) for an eastern destination and 55 nm (102 km) for a southern destination. For a Lockheed Super Hercules C130J-30; this would result in around 2.8 to 3 tonnes of CO_2 emissions per flight. However it is likely that air traffic control would radar vector aircraft with southern destinations, when safe to do so. This would reduce track miles and emissions. Given the uncertainty around the frequency of the northern STARs, changes in track miles cannot be estimated.
- In terms of visual amenity, aircraft would still be visible in the same locations on approach as in the current operation. These STARs in broad terms replicate the radar vectoring employed today and are all well north and west of the Sydney Basin. The high-altitude low use STAR from the east and the high-altitude low use SID would be visible to suburbs in proximity to the flight path when in use.

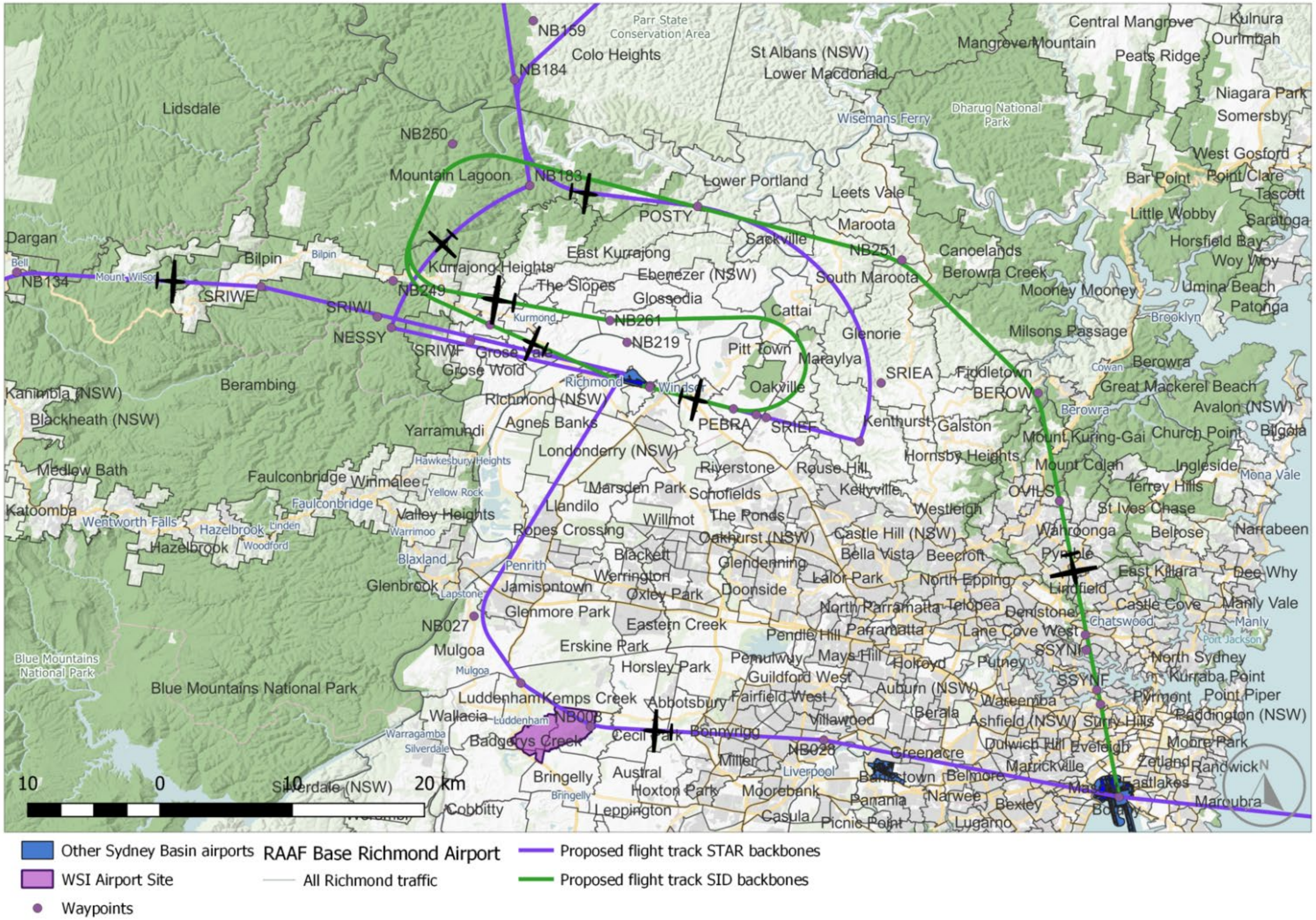


Figure 21.25 RAAF Base Richmond – proposed SID and STARs with suburb overlay

21.5.3.4 Miscellaneous and minor changes in the Sydney Basin

This section relates to the miscellaneous and minor changes at Sydney (Kingsford Smith) Airport (specifically, changes to RIVET and BOREE STARs, Runway 07 SIDs to the west and north-west, Runway 07 IAF) as well as Sydney Basin low altitude transit routes as presented in Section 8.2.2.2, Section 8.2.1.4, Section 8.2.1.5 and Section 8.7 of Chapter 8 (Facilitated changes).

The key findings are:

- The RIVET and BOREE STARs and Runway 07 IAF have no lateral or vertical change from the current procedures so there would be no change to the noise profiles. The proposed Runway 07 SIDs to the west and north-west are the same as the existing SID immediately after take-off from Runway 07, which is infrequently used (less than one per cent of the time). It would position aircraft above 10,000 ft (3 km) where aircraft would still be audible but not at levels considered to result in noise impacts. Aircraft operating on the procedure are expected to be considerably higher than the current radar vectored operation. This should deliver a reduction in overflight noise levels.
- The proposed western low altitude transit route for aircraft transiting north to south, or south to north at altitudes below 10,000 ft (3 km) is expected to be used by around 10 aircraft per day (in the absence of actual data). This transit route would be available 24-hours, 7 days a week, and used mostly by non-pressurised piston-engine aircraft. Indicative average overflight noise levels for aircraft in cruise (flying level at around an 80 per cent power setting) at an altitude of 5,000 ft (1.5 km) above sea level would be around 74 dB(A) at waypoint NB059 and around 63 dB(A) at RUTOS (by a Beechcraft “Baron” twin-engine propeller aircraft) (refer to Appendix J of Technical paper 13 for full results and assumptions). Aircraft could operate up to 10,000 ft (3 km) and would reduce the predicted noise levels.
- The proposed IFR transit route overhead WSI would be used at altitudes of 4,000 ft and above under air traffic control clearance. Depending on the altitude and aircraft, noise levels would vary. For Beechcraft “Baron” twin-engine propeller aircraft, noise could range from 77 dB (A) (at 1,000 ft (300 m)) to 60 dB(A) at 5,000 ft (1.5 km).
- Radar vectoring associated with the proposed adjusted RIVET and BOREE STARs, Runway 07 SIDs and Runway 07 IAF would remain and is consistent with current practice. Radar vectoring could also occur on the lower level transit route.
- There is little or no change expected to the current track distance and emissions when these proposed new minor changes are introduced. The proposed low altitude new western transit route may offer a reduction in track distances for some flights but have an increase for others.
- In general, with the exception of the RIVET and BOREE STARs, the areas overflown by the proposed minor adjustments are expected to have little use and are currently frequently overflown with similar aircraft undertaking both IFR and VFR flights (refer to Figure 21.2). Additionally:
  - there would not be any visual impacts associated with the RIVET and BOREE STARs and Runway 07 IAF, as these new procedures would not change the current procedures in terms of the lateral or vertical position of aircraft
  - the proposed Runway 07 SIDs to the west and north-west would be identical to the existing path over the eastern suburbs. Aircraft crossing the coastline at waypoint SHORE would be visible as aircraft track west at high altitudes, noting this flight path would be infrequently used
  - the proposed western low altitude transit route would have low visual impacts on areas overflown, given the small number of aircraft expected to use this route daily
  - the transit route over WSI would be visible and would mostly cross the WSI flight path at right angles.

21.5.3.5 VFR operations in the Sydney Basin airspace

This section relates to the proposed amendments to VFR operations in the Sydney Basin airspace as presented in Section 8.6 of Chapter 8 (Facilitated changes).

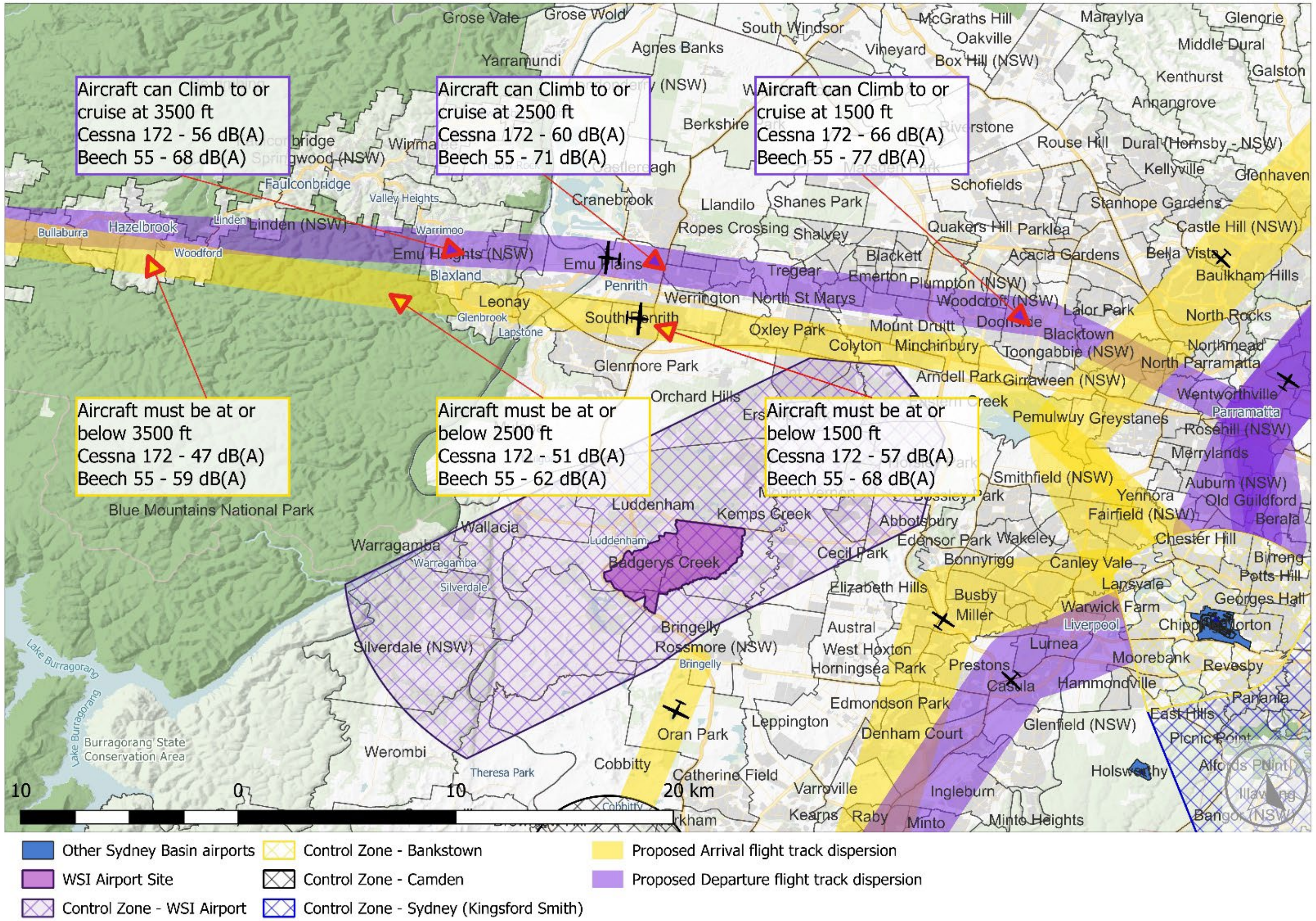
The assessment found that:

- Flying training activity is highly variable and potential overflight noise impacts from this activity cannot be accurately quantified in contrast with the presented potential impacts associated with the more predictable VFR travel flights. This is explained in detail in Appendix I of Technical paper 13.
- A significant component of circuit training activity and its associated impacts at both Bankstown and Camden Airports will not change and operations will continue consistent with current practice.
- The most constrained corridor for VFR travel flight operations between WSI and RAAF Base Richmond – limited in lateral extents and with only a 1,500 ft (460 m) operating limit for some of its extent, is expected to have less than 10 flights daily and with the low growth forecast predictions (approximately one per cent for both Bankstown and Camden Airports) should not constitute a significant impact to overflown areas on its implementation or into the future.
- The possible change in location for future flying training areas means that the pilots will need to be travel further to reach them which would translate to increased transit flight durations, extended training schedules and increased costs including increased flying training times and increased fuel maintenance costs. This is discussed further in Chapter 19 (Economic). As it is not possible to say how these organisations may choose to use the future possible flying training areas, changes to track distances and emissions from these VFR adjustments are difficult to estimate.
- In terms of visual amenity:
  - once WSI is operational the large number of aircraft that use the existing flying training areas over the WSI would have to relocate to other parts of the Sydney Basin. Flying training activity over the future possible flying training areas to the north of Bankstown and to the south of Camden would be visible from the ground
  - while already overflown currently, the compression of the available airspace for travel flights between WSI and Richmond restricted airspace would mean communities in this area would see the same types of aircraft that currently use this airspace but at lower altitudes (refer to Figure 21.26).

21.5.4 Impacts on biodiversity and MNES

It is anticipated that the facilitated changes will not significantly impact biodiversity and other MNES values as they will occur within areas already subject to, or close to, routine flight paths by similar aircraft types associated with the existing Sydney Basin (refer to Section 21.4). This is particularly the case where there is a predicted low utilisation of those SIDS and STARs and because there is a low growth forecast of only one per cent or less for these movements.

An exception to this is the changes to Bankstown Airport flight paths which may result in some areas being overflown that have not been previously overflown. Despite this, these flight paths occur in areas which are heavily disturbed in nature and are unlikely to introduce further risk or impacts than that assessed in Chapter 16 (Biodiversity) and Chapter 23 (Matters of National Environmental Significance).



Note: The dB(A) values presented the above figure should be considered as a median value of a range of plus or minus 3 dB(A) – i.e., 50 dB(A) would indicate potential overflight noise of between 47 and 53 dB(A).

Figure 21.26 Suburb overlay - NPD application example – VFR western arrivals and departures route

Chapter 22 Cumulative impacts

This chapter provides an overview of the potential cumulative impacts within the vicinity of WSI and also at a broader, regional scale. The assessment of cumulative impacts has been undertaken in accordance with the EIS Guidelines and has adopted an approach based on the NSW *Cumulative Impact Assessment Guidelines for State Significant Projects* (NSW DPE, 2022h).

The refinements to the preliminary flight path design since the exhibition of the Draft EIS would not change the conclusions of the overall cumulative impacts assessment as presented in this chapter and supporting technical papers.

Cumulative impacts are a result of incremental, sustained and combined effects of human action and natural variations over time and can be both positive and negative. The assessment provided considers potential impacts associated with the project in conjunction with other known and proposed developments. A single, large study area has been used which allows for a reasonable, qualitative assessment of impacts.

Given the size of the study area and operational timeframes of the project (between 2026 and 2055), other relevant projects or developments considered have been restricted to those of sufficient scale to contribute materially to cumulative impacts at a regional level with similar or overlapping spatial or temporal characteristics.

The assessment of cumulative impacts has considered each of the environmental aspects requiring assessment in the EIS Guidelines. In many cases, the quantitative assessment of issues is difficult, due to the large study area, the indirect nature of potential impacts and the lack of sufficient baseline data relative to some impacts.

A range of cumulative impacts have the potential to occur as a result of the project's location, in proximity to current and future large-scale infrastructure projects, strategic growth areas and economic corridors associated with rapid development in Western Sydney.

There are many factors that make it difficult to quantitatively assess the cumulative impact of aircraft noise from WSI in conjunction with other airspace operations. The cumulative effects of noise impacts would more likely manifest as a greater number of noticeable events over a given period of time. Aircraft operating from WSI concurrently with aircraft from other Sydney Basin airports have the potential to increase overall noise exposure to communities being directly overflown and/or immediately peripheral to other existing flight paths.

The cumulative impact of aircraft noise at locations where there are intersecting or parallel flight paths is widespread, and at these locations, cumulative noise impacts from overflights are likely to be most significant. The application of WSI's flight path design principles along with the necessary separation between flight paths would inherently reduce potential cumulative impacts. Additionally, the proportion of WSI flight paths relative to existing flight paths, and the existing and proposed complex of flight paths within the Sydney Basin, the cumulative impact of introducing WSI flight path noise is not considered high.

The air quality assessment included background air quality levels (i.e., including emissions from other, existing sources in the region) and found all pollutants were below regulatory criteria for 2033 with only minor, short term exceedances for nitrogen dioxide in 2055. On a regional level, contributions of ozone as a result of the project make no significant difference to a 'no project' scenario in both 2033 and 2055. The assessment also found that the cumulative greenhouse gas impacts associated with the project and related projects and developments are not considered to be significant.

Potential cumulative impacts related to wildlife strikes could result from the project operating in conjunction with other existing airports in the study area. A prediction of the cumulative impact of wildlife strikes from undertaking a comparative analysis of strike rates at other airports does not account for the site-specific variables at each airport, including the quality of wildlife management programs applied at each airport.

The assessment of cumulative aircraft related hazards and risks identified that WSI would introduce new elevated crash risks only into areas that are currently subject to entirely negligible risk from existing operations, however it would introduce no more than a trivial additional crash risk into areas that are currently subject to potentially significant risk from existing operations.

Potential cumulative impacts to landscape character and visual impact would include changes to landscape character and views in the vicinity of WSI, as a result of the project in conjunction with future large-scale infrastructure projects. There would also be the potential for cumulative effects on the landscape character zones across the Blue Mountains which are becoming increasingly influenced by air traffic, both from WSI and other airports within the Sydney Basin.

An analysis of the current and proposed network of flight paths in the Sydney Basin (including preliminary WSI flight paths), has identified that the majority of interactions between all flight path corridors that may generate cumulative impacts is at the location where they cross each other.

Despite the low estimates of the proportional contribution of WSI airspace emissions to the totality of air pollution within the Sydney Airshed, there is the potential that increased emission levels could have a negative impact on Aboriginal rock art sites and on some historical buildings over time. However, there is currently no comparative data or research to test this possibility. Despite this, it can be expected that additional emissions add to the general impact on heritage items and there is growing evidence that the deterioration will be accelerated by other anthropogenic factors such as climate change.

Positive and negative changes to composition of the community surrounding WSI may occur once the flight paths are operating in conjunction with other developments. Incremental increases in noise, alterations to air quality and light exposure may result in exacerbated effects to wellbeing, changes to the way people enjoy social infrastructure and their own properties.

The implementation of project specific mitigation measures would avoid, to the greatest extent possible, cumulative impacts with surrounding developments and other airspace users and reduce the potential cumulative impacts to acceptable levels.

22.1 Introduction

Cumulative impacts are a result of incremental, sustained and combined effects of human action and natural variations over time and can be both positive and negative. They can be caused by the compounding effects of a single project or multiple projects in an area, and by the accumulation of effects from past, current and future activities as they arise (NSW DPE, 2022h).

The cumulative assessment provided in this chapter considers all potential impacts associated with the implementation of the preliminary flight paths and a new controlled airspace for single runway operations at WSI, in combination with other major developments within a broad regional location.

22.1.1 EIS Guidelines

The EIS Guidelines as they relate to cumulative impacts requires (7.1 Describe and assess relevant impacts (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). This should include changes to noise levels arising from the proposed action in relation to on-ground sources such as road, rail and industry.

22.2 Methodology

The assessment of potential cumulative impacts has been undertaken in accordance with the EIS Guidelines. There are currently no Australian Government guidelines on carrying out cumulative impact assessments. As such, the methodology for the cumulative impact assessment for this project has adopted an approach based on the NSW *Cumulative Impact Assessment Guidelines for State Significant Projects* (NSW DPE, 2022h).

The assessment is focussed on the key matters addressed in the EIS that could be materially affected by the cumulative impacts of the project and other relevant future projects and developments within the study area and over similar timeframes. The assessment is predominantly qualitative and proportionate to the study area. The assessment matter draws on the findings of Chapters 11 to 20 as well as the publicly available impact assessments of projects deemed likely to contribute to a cumulative impact.

Cumulative impacts associated with the project and the range of screened projects are outlined in Section 22.4.1. Cumulative impacts are likely to be partially unpredictable due to the complexity and uncertainty of the exact timing associated with these developments. However, the mitigation measures outlined in Chapter 24 (Mitigation and management) have been developed to manage the cumulative impacts of project interfaces and mitigate uncertainty over these impacts.

The adopted approach to cumulative impact assessment is shown in Figure 22.1.

Chapter 8 (Facilitated changes) provides a description of facilitated changes required for other airports prior to the opening of WSI in 2026 to enable the new flight paths and airspace for WSI.

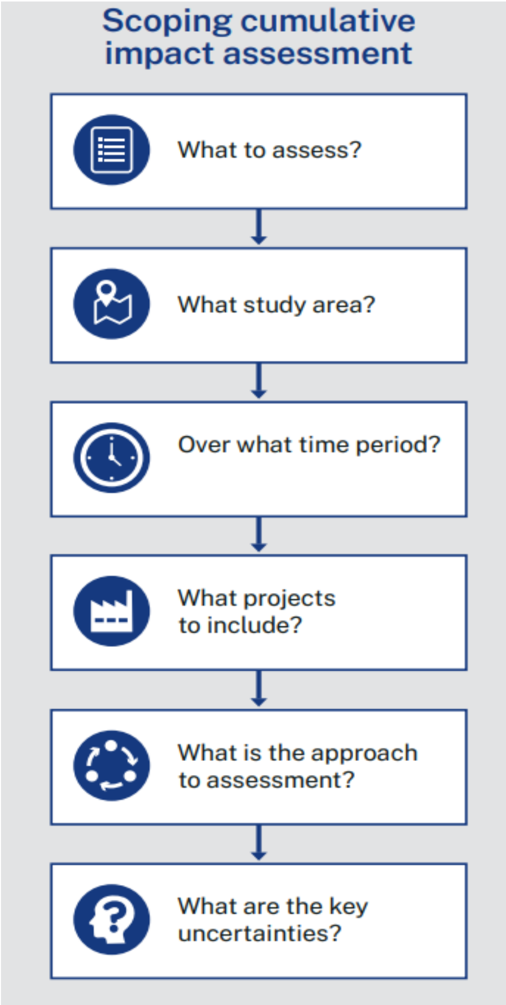


Figure 22.1 Approach to cumulative impact assessment (Source: NSW DPE, 2022h)

22.2.1 Study area

Cumulative impacts for the project have been considered within a single large study area, based on the study area used for assessing aircraft noise which considers potential impacts from aircraft overflights within a nominal 45 nautical mile (nm) (83 kilometres (km)) radius from WSI.

The study area has been identified for the purposes of defining the bounds of the cumulative impact assessment, such as screening of other projects and developments which could contribute to cumulative impacts and to allow for a reasonable, qualitative assessment of impacts.

The assessment of impacts within the study area, however, varies spatially for each environmental issue and takes into consideration the nature and scale of the impact, the environmental values which could be impacted, physical and geographical features, and community and social values.

22.2.2 Assessment time period

The project does not include any physical infrastructure or construction work. For the purposes of this assessment, cumulative impacts resulting from the interaction of the project with other projects have been considered between 2026 (when WSI would be ready for scheduled flight operations) and 2055 (which represents the year when the single runway is operating close to its movement handling capacity).

Like the study area, the time period selected for the cumulative impact assessment is broad and each matter will vary depending on the characteristics of the matter and the scale and nature of the potential impacts on the matter.

22.2.3 Project screening

Given the size of the study area and operational timeframes of the project, other relevant projects or developments considered have been restricted to those of sufficient scale to contribute materially to cumulative impacts at a regional level with similar or overlapping spatial or temporal characteristics. The process adopted for screening of projects included:

a. proposed or recently approved projects and developments within the study area

b. projects and developments which meet (a), and have the potential to contribute materially to cumulative impacts

c. projects that meet (a) and (b) and are likely to be constructed between 2026 and 2055.

A search of the following strategic development and policy documents and project registers was conducted to identify projects which meet the screening criteria:

- NSW State Infrastructure Strategy 2022–2042 (Infrastructure NSW, 2022)
- Greater Sydney Region Plan – A Metropolis of Three Cities (Greater Sydney Commission, 2018b)
- major infrastructure projects listed on the NSW Department of Planning and Environment's (DPE) Major Projects register
- the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) Public Portal
- relevant airport master plans within the Sydney Basin.

Strategic infrastructure projects have been included for consideration but have not been assessed in detail given the uncertainty of the status, timing and impacts of these projects. Major developments within economic corridors and growth areas have not been considered on an individual basis on the grounds that these are captured through the consideration of broader strategic land use changes.

22.3 Relevant projects and developments

Projects and proposed developments which met the screening criteria outlined in Section 22.2.3 and are considered to have the potential for cumulative impacts with the project are listed in Table 22.1 and shown in Figure 22.2.

Table 22.1 Screened projects with potential for cumulative impacts with the project

Ref #	Project/ development	Description and proposed timing	Potential interaction with the project
	Approved and committed projects		
1	**Western Sydney Airport Stage 1**	The Stage 1 Development of WSI has been approved and is limited to single runway operations. It will handle up to 10 million annual passengers and around 81,000 air traffic movements per year by 2033 including freight operations. The approval provides for the construction of the aerodrome (including the single runway), terminal and landside layout and facilities, and ground infrastructure such as the instrument landing systems (ILS) and high intensity approach lighting (HIAL) arrays. Construction of the Stage 1 Development commenced in 2018. The Australian Government has committed to developing and delivering WSI by the end of 2026.	Stage 1 of WSI.
2	**Sydney Metro – Western Sydney Airport**	Sydney Metro – Western Sydney Airport is a new 23 km metro rail link from St Marys through to WSI and the Western Sydney Aerotropolis. Construction has commenced and the line is expected to be completed in 2026 in time for the opening of WSI.	Adjacent to WSI with potential to contribute to local and regional cumulative impacts.
3	**Great Western Highway Upgrade Program**	Upgrade of the Great Western Highway between Katoomba and Lithgow is being delivered across 4 packages: • Central Package – Blackheath to Little Hartley (also subject to the EPBC Act) • East Package – Katoomba to Blackheath • Medlow Bath upgrade • West Package – Little Hartley to Lithgow. Construction of Medlow Bath upgrade commenced in 2023 and is expected to be completed by 2025. Transport for NSW has since announced that the remaining packages have been paused.	Within the study area and adjacent to the Greater Blue Mountains Area (GBMA), with the potential to contribute to regional cumulative impacts.
4	**M12 Motorway**	The M12 Motorway is a 16 km, 4-lane motorway between the M7 at Cecil Hills and The Northern Road at Luddenham. Construction began in 2022 and the Motorway is scheduled to open prior to WSI opening in 2026.	Adjacent to WSI with potential to contribute to local and regional cumulative impacts.
5	**Warragamba Dam Raising**	Warragamba Dam Raising is a project to provide temporary storage capacity for large inflow events into Lake Burragorang to facilitate downstream flood mitigation and includes infrastructure to enable environmental flows. WaterNSW (2023) has stated that dam rising for the purposes of flood mitigation is no longer proceeding and any required future work (and therefore impacts) are undefined.	Adjacent to WSI with potential to contribute to regional cumulative impacts.

Ref #	Project/ development	Description and proposed timing	Potential interaction with the project
	Strategic infrastructure priorities (with potential to be constructed prior to 2055)		
6	**Western Sydney Freight Line and Intermodal Terminal**	The Western Sydney Freight Line is a proposed, dedicated freight rail line connection between the Western Parkland City and Port Botany. The need for a dedicated freight rail line between Western Sydney and Port Botany was identified as part of the NSW Freight and Port Plan (2018–2023) (NSW Government, 2018). In 2020 the NSW Government announced and protected the final corridor for the western end of the freight line. Work on finalising and protecting the eastern end of the corridor is underway.	Adjacent to WSI with potential to contribute to local and regional cumulative impacts.
7	**Outer Sydney Orbital**	The Outer Sydney Orbital is a proposed corridor for a motorway and freight rail line in Western Sydney. Transport for NSW has consulted on a recommended corridor of land for the Outer Sydney Orbital for a possible future motorway and freight rail line.	Adjacent to WSI with potential to contribute to regional cumulative impacts.
8	**Sydney Metro expansions**	Future Sydney Metro extensions been identified (although remain uncommitted). The timing of these projects is unknown and subject to business cases. These could include: • the north-west line extending from St Marys to Schofields, connecting to the WSI line • a south-west line extending from the Aerotropolis to Macarthur. Prior to the Sydney Metro expansion announcement corridors for a north-west and south-west rail links had been identified by Transport for NSW in 2020.	Within the study area with the potential to contribute to regional cumulative impacts.
9	**Western Sydney fuel pipeline**	The NSW Government is undertaking preliminary work to identify route options for a fuel pipeline corridor to WSI and surrounds. Construction and operation unlikely until the 2030s.	Adjacent to WSI with potential to contribute to local and regional cumulative impacts.
	Proposed aviation developments		
10	**Sydney (Kingsford Smith) Airport**	A number of potential, future key developments have been identified in the Sydney Airport Master Plan (2039) (SACL, 2019). Proposed developments are within the 20-year planning horizons for aviation and non-aviation development and infrastructure. The Master Plan outlines potential and proposed developments via specific development plans, to support the forecast increase in passenger numbers and aircraft movements to 2039 including: • Terminal Development Plan • Airfield Development Plan • Commercial Development Plan • Ground Transport Development Plan • Utilities Development Plan.	Within the study area with the potential to contribute to regional cumulative impacts.

Ref #	Project/ development	Description and proposed timing	Potential interaction with the project
11	**Bankstown Airport**	A number of potential future key developments have been identified in the Bankstown Airport Master Plan (2019) (Bankstown Airport Limited, 2019). These are within the 5 and 20-year planning horizons for aviation and non-aviation development and infrastructure. Key, proposed developments which could contribute to cumulative impacts include: • staged developments within Bankstown Airport's commercial zone including community based retail, commercial and industrial developments • future extension of Centre Runway (11C/29C) to the south-east • intersection upgrades, widening of roads and major road improvements surrounding Bankstown Airport • Metro South-West Rail Extension - extended passenger rail between Bankstown and Liverpool CBDs • formalisation of the ring road surrounding Bankstown Airport.	Within the study area with the potential to contribute to regional cumulative impacts.
12	**Camden Airport**	A number of potential future key developments have been identified in the Camden Airport Master Plan (2020) (Camden Airport Limited, 2021). These are planned to be within the 8-year planning horizon. Key, proposed developments which could contribute to cumulative impacts include: • transition from a Registered to a Certified Aerodrome (Responding to CASA MOS 139) • taxiway and apron expansion (to service new hangars).	Within the study area with the potential to contribute to regional cumulative impacts.
13	**OneSKY Australia**	The OneSKY Program includes investment in critical air traffic infrastructure, facilities and services to enhance the safety, efficiency and capacity of the Australian air traffic network. It is a partnership between Airservices Australia and the Department of Defence and will replace the current independent civil and Defence air traffic management systems with an advanced integrated system known as the Civil Military Air Traffic Management System (CMATS).	Within the study area with the potential to contribute to regional cumulative impacts.

Ref #	Project/ development	Description and proposed timing	Potential interaction with the project
	Strategic plans and policies, growth areas and urban renewal corridors in proximity to WSI		
14	**Western Sydney Strategic Assessment**	The NSW Government has identified 4 areas for urban growth and other development ('nominated areas') and a series of major transport corridors within and outside the nominated areas to support the future growth of Western Sydney until 2056. The nominated areas comprise: • Western Sydney Aerotropolis (excluding where there is overlap with the existing South West Growth Area) • Greater Macarthur Growth Area (GMAC) • Greater Penrith to Eastern Creek Investigation Area (GPEC) • Wilton Growth Area (Wilton). The major transport corridors comprise major road or rail projects within identified corridors and are identified in this table. Further discussion on the Western Sydney Strategic Assessment is provided in Section 22.4.7.	Adjacent to WSI with potential to contribute to local and regional cumulative impacts.
15	**Aerotropolis**	The Western Sydney Aerotropolis is a 11,200-hectare area surrounding WSI. The Aerotropolis will become a hub of industry and innovation, attracting local and global companies drawn to the Western Parkland City and WSI. The Aerotropolis Precinct Plan (NSW DPE, 2023a) was finalised and announced as part of the Aerotropolis Planning Framework in March 2022. Following release of the Phase 2 Development Control Plan (DCP) (NSW DPE, 2022g), proponents can now prepare detailed development applications on land within the initial precincts of the Aerotropolis. Ongoing construction within the Aerotropolis is expected to continue beyond 2026.	Adjacent to WSI with potential to contribute to local and regional cumulative impacts.
16	**South West Growth Area**	The South West Growth Area (SWGA) is around 10,000-hectares adjoining the Western Sydney Aerotropolis where new greenfield communities are being established. To date, 9 precincts have been rezoned with a focus on providing new residential areas to support Western Sydney's growth. The NSW Government updated the Structure Plan for the SWGA in December 2022. In conjunction with the new Structure Plan, a new Ministerial Direction under section 9.1 of the *Environmental Planning and Assessment Act 1979* (NSW)has been issued. Ongoing development of the SWGA is expected to continue beyond 2026.	Adjacent to WSI with potential to contribute to local and regional cumulative impacts.

Ref #	Project/ development	Description and proposed timing	Potential interaction with the project
17	**Greater Macarthur Growth Area**	Greater Macarthur Growth Area (GMGA) is a Growth Area incorporating Glenfield to Macarthur urban renewal precincts and the land release precincts to the south of Campbelltown, including Gilead, North Appin and Appin. In the Greater Macarthur 2040 plan, there are not only plans for substantial land release areas south of Campbelltown, but also details on an urban renewal corridor along the railway line from Glenfield to Macarthur. The plans for several precincts have been finalised and planning proposals are currently being assessed for Gilead and Appin. Ongoing development of the SWGA is expected to continue beyond 2026.	Within the study area with the potential to contribute to regional cumulative impacts.
18	**Greater Penrith to Eastern Creek Growth Area**	Greater Penrith to Eastern Creek Investigation Area (GPEC) spans around 19,000-hectares from the Nepean River in the west to the M7 Motorway in the east. The GPEC Strategic Framework was finalised on 28 June 2023 and has been prepared to support strategic planning for the Western Parkland City. The framework identifies St Marys Town Centre and Orchard Hills (south of the M4) as priority areas. This means that these areas will be planned for in the short-term to leverage the potential for growth and investment arising from the Sydney Metro – Western Sydney Airport line.	Within the study area with the potential to contribute to regional cumulative impacts.
19	**Wilton Growth Area**	The Wilton Growth Area is positioned at the junction of the Hume Motorway and Picton Road in the Wollondilly Shire Local Government Area. There are 7 precincts within the Wilton Growth Area. Ongoing development of the SWGA is expected to continue beyond 2026.	Within the study area with the potential to contribute to regional cumulative impacts.

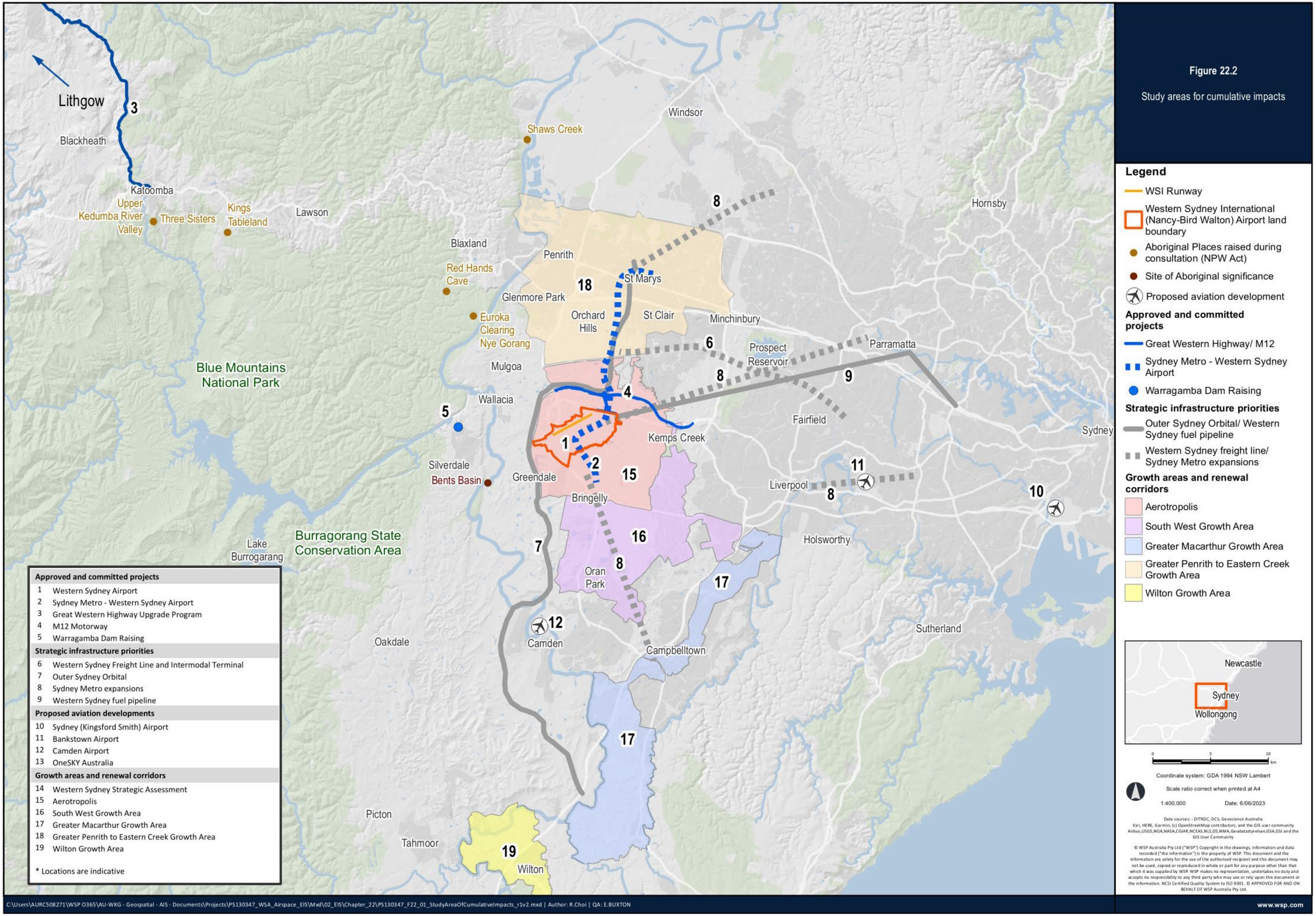


Figure 22.2

Study areas for cumulative impacts

22.4 Assessment of cumulative impacts

The cumulative impacts identified as having the potential to arise during operation of the project are outlined below.

22.4.1 Summary of potential cumulative impacts

Table 22.2 provides a brief summary of the potential cumulative impacts associated with the project and other major developments in the study area. Where a potential cumulative impact has been identified further discussion and assessment is presented in Section 22.4.2 to Section 22.4.10.

Table 22.2 Summary of potential cumulative impacts

Impact	Summary
Aircraft noise	• potential for a greater number of noticeable events over a given period of time in proximity to the intersection between existing and the preliminary flight paths • potential to increase overall noise exposure to communities being directly overflown and/or immediately peripheral to other existing flight paths.
Air quality and greenhouse gas	• potential increases in emissions from aircraft operations • a small increase in the total economy wide greenhouse gas emissions for NSW and Australia.
Aircraft hazard and risk	• increase in third party and infrastructure risks from aircraft crashes • increased risk of wildlife strike.
Land use	• additional land being subject to planning restrictions or controls from: – aircraft noise contours (Australian Noise Exposure Concept (ANEC)/ Australian Noise Exposure Forecast (ANEF)) – protected airspace (Obstacle Limitation Surfaces (OLS) and Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS)) – implementation of wildlife buffers.
Landscape character and visual impact	• changes to landscape character in the vicinity of WSI • effects to views seen in proximity to current and future large-scale infrastructure projects, when seen together with changes to the character of the sky due to increasing airspace activity • potential for increased air traffic across the Blue Mountains as a consequence of upgrades to airports and changes to the management of airspace above the Sydney Basin and Blue Mountains.
Biodiversity	• increased risk of wildlife strike • alterations to air quality and contributions to greenhouse gas emissions which could impact ecosystems affected by seasonal climatic fluctuations, such as wetlands and temperate forests which occur throughout the Sydney Basin and GBMA.
Heritage	• increased impact to Aboriginal and non-Aboriginal cultural places and values • impacts of new emissions and climate change on heritage gardens • impacts to cultural values due to additional noise and visual intrusion • further disruption to land-sky connection.
Social and economic	• incremental changes to community composition • effects to wellbeing from changes in noise, air quality and light exposure • constrained housing availability in the local area • increased business and employment opportunities and job generation.

22.4.2 Aircraft noise

Noise from aircraft using WSI's flight paths is of concern to those people most likely to experience its direct impact. This could relate to night noise and in proximity to WSI when aircraft are departing or arriving. Other noise concerns relate to the cumulative impact of aircraft overflight noise. There are many factors that make it difficult to quantitatively assess the cumulative impact of aircraft noise from WSI flight operations including the following:

- whether the effects from the different sources (other Sydney Basin airports and ongoing development and urbanisation of Western Sydney) would be likely to occur at the same time, or the same time of day
- the duration of any combined effects
- whether one effect dominates or whether effects might be additive
- whether the effects on individual noise sensitive receivers are likely to be on the same façade (if a residential dwelling or building) or location of the property.

The potential for WSI's flight paths and the facilitated changes to generate cumulative impacts has been assessed qualitatively in regard to aircraft noise.

For cumulative noise impact assessment, it is essential to understand the logarithmic nature of sound level. This means that adding a 60 dB(A) event to an area already experiencing 70 dB(A) does not result in an arithmetic addition of exposure (60 + 70 ≠130 dB(A)). The resulting addition of sound waves reaching the human ear will be less than 71[5] dB(A) and the difference not discernible to the human ear.

The cumulative effects of noise impacts will more likely manifest as a greater number of noticeable events over a given period of time (days, weeks or months) or different times of the day. Areas considered most sensitive and where people are most likely to experience direct and disruptive impacts from noise from aircraft using WSI's flight paths are subject to many interdependencies, variables and uncertainties, including:

- Sydney (Kingsford Smith), Bankstown and Camden Airports are all approaching their Master Plan update cycles which will likely contain a response to single runway operations at WSI from 2026 as well as post-COVID-19 activity forecasts
- flying training areas - the final proposed detail and ultimate procedures will not be confirmed until completion of a separate airspace change proposal, depending on the extent of the change
- the application of radar vectoring on some WSI flights and other Sydney Basin airport procedures may result in a noise sharing outcome that cannot be quantifiably presented
- varying meteorological influences across the Sydney Basin would result in different combinations of runway direction usage for the 5 major airport operations. Conditions in Western Sydney may be distinctly different to coastal conditions which would define Sydney (Kingsford Smith) Airport preferred runway nomination.

Aircraft using flight paths to arrive and depart from WSI may be noticeable (audible and/or visible) up to 45 nm (around 83 km) from WSI and beyond. These aircraft are expected to operate up to 20,000 feet and higher depending on the flight path in use, type of aircraft and its origin-destination, weather, pilot technique and other factors. While the measured volume of an aircraft noise event may be relatively low, there are many factors which will influence the degree of noticeability and possible annoyance to any individual. It is known that the reaction of any specific individual to a defined noise event can be very different and not necessarily dependent on the actual volume as measured on a sound level meter.

Aircraft operating from WSI concurrently with aircraft from other Sydney Basin airports have the potential to increase overall noise exposure of communities being directly overflown by WSI flight paths, immediately peripheral to and further surrounding WSI, and underneath or along the other flight paths in use. Overall noise exposure in a geographic area as large as the Sydney Basin does not necessarily translate into a quantifiable cumulative increase in impact. WSI will introduce additional aircraft into an already complex and heavily trafficked Sydney Basin airspace environment. In 2033, this additional traffic is projected to represent around 9 per cent of total projected Sydney Basin air traffic movements

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5 https://au.noisemeters.com/apps/db-calculator/

(estimated to be over 890,000 movements inclusive of the expected 81,000 movements projected at WSI in 2033). The flight paths and airspace structure for WSI have been designed to facilitate safe, efficient and independent airspace operations at each Sydney Basin airport.

Some adjustments are required to Sydney Basin operations prior to the opening of WSI in 2026 to facilitate WSI flight paths and airspace structure. Several of these adjustments are required to Sydney (Kingsford Smith) Airport departures for a range of destinations. WSI's flight paths will cross and interact with these departures, resulting in minor adjustments and changes to the lateral and vertical profiles of these flight paths to maintain safety assurance levels.

An analysis of existing flight paths in the Sydney Basin and the preliminary flight paths for WSI has identified that cumulative noise impacts are likely to be most significant where different flight paths cross each other.

Within 10 nm (around 19 km) from WSI there is some intersecting (with altitude separation) of WSI departures and arrival flight paths. Within the Sydney Basin airspace, WSI and Sydney (Kingsford Smith) Airport departure and arrival flight paths will typically have WSI procedures lower in the vicinity of WSI and higher in the vicinity of Sydney (Kingsford Smith) Airport.

The cumulative impact of aircraft noise at locations where there are intersecting or parallel flight paths is widespread, and at these locations, cumulative noise impacts from overflights are likely to be most significant. The application of WSI's flight path design principles along with the necessary separation between flight paths would inherently reduce potential cumulative impacts. Additionally, the proportion of WSI flight paths relative to existing flight paths, and the existing and proposed complex of flight paths within the Sydney Basin, the cumulative impact of introducing WSI flight path noise is not considered high.

A cumulative increase in background noise from the ongoing urbanisation and development of Western Sydney is anticipated to reduce the relative noise impacts associated with aircraft using WSI's flight paths in locations subject to urbanisation and development. Future infrastructure projects in Western Sydney, such as future rail or road projects, would be subject to separate environmental impact assessments and sector-specific requirements to mitigate noise contributions.

The assessment of vibration generated by aircraft is based on an assessment of the 90 dB(A) threshold. The occurrences of 90 dB(A) events are generally contained within Airport Site and as such any potential for cumulative vibration impacts is unlikely.

22.4.3 Air quality and greenhouse gas

The screened projects and developments in Table 22.1 would have emissions of similar air pollutants (combustion emissions, particulates, volatile organic compounds) and greenhouse gases to those produced by the project. Improvements in combustion technology and fuel efficiency in aircraft and on-ground vehicle fleets will continue to improve air emissions over time. The assessment of project related air quality and greenhouse gas impact is provided in Chapter 12 (Air quality and greenhouse gas).

22.4.3.1 Air quality

The air quality impact assessment assessed project emissions including background air quality levels (i.e., including emissions from other, existing sources in the region) and found all pollutants were below regulatory criteria for 2033. In 2055, there are few exceedances of the short term (1-hour) criterion for nitrogen dioxide (a combustion pollutant and ozone precursor) however, the annual average levels are below the relevant criterion. On a regional level, contributions of ozone as a result of the project make no significant difference to a 'no project' scenario in both 2033 and 2055.

The potential cumulative impacts associated with other projects are likely to occur as a result of emissions from aircraft, vehicles and other ground-based sources during construction and operation. The potential environmental impacts of adverse air quality include the release of air pollutants, greenhouse gas emissions and ozone depleting substances.

Construction emissions are generally transient in nature, particularly when following an alignment such as a road or pipeline, and would be subject to approval conditions to avoid, minimise and manage impacts. Combustion emissions and particulates from vehicles on roads, freight rail and aircraft are the key pollutants associated with operation, and would be subject to operational environmental management plans. It is expected that the construction and operational air quality impacts of all projects and developments would be minimised to the extent practicable. Any contributions from future infrastructure projects would be expected to be localised and associated with on-ground sources.

As the assessment has concluded that the project's impact on the concentrations of all other assessed pollutants would be negligible and unlikely to be discernible or measurable within the existing background concentration, the cumulative air quality impacts associated with the project and related projects and developments are not considered to be significant. Further, contributions from motor vehicles and aircraft are expected to reduce over time, given the improvements in combustion technology and fuel efficiency.

As existing aircraft operations and infrastructure developments occur throughout most of the Sydney Basin, including areas above the GBMA, the cumulative contributions of impacts from the project in addition to the impacts that are expected from other projects in areas adjacent to the GBMA are considered to be minimal to negligible.

22.4.3.2 Greenhouse gas

Growth and development associated with the screened projects (see Table 22.1) would produce greenhouse gas emissions, specifically in proximity to WSI, where development, infrastructure, land use, transportation and associated activity will intensify over time as the Aerotropolis transitions into a city.

All anthropogenic (human-induced) activity and development (existing and new) produce greenhouse gas emissions. Greenhouse gas emissions are expressed as carbon dioxide equivalent (CO_2e) emissions to enable comparisons on the basis of global warming potential. Greenhouse gas emissions associated with the project have been set in the context of projected CO_2e emissions from domestic commercial aviation activity in Australia. This is aligned to the commitments made by the Australian Government as a party to the United Nations Framework Convention on Climate Change (UNFCCC) and Paris Agreement, which include Australia's 2030 emissions reduction targets and an economy-wide 2050 trajectory to net zero emissions. Projections of CO_2e emissions were obtained from the Australian National Greenhouse Accounts (DCCEEW, 2022c); Australia's national inventory reports (NIR) and the Australian Government's growth rates for commercial aviation activities. This data formed the basis for longer-term greenhouse gas emissions extrapolated to 2055.

Direct impacts associated with the project have been accounted for in the total economy-wide greenhouse gas emissions for NSW and Australia. Greenhouse gas emissions associated with WSI flight paths would commence in the Sydney Basin airspace and continue enroute to all destinations across the WSI network. On an economy wide basis, the greenhouse gas emissions from WSI are small. In the years to 2040, these greenhouse gas emissions are unlikely to make material difference in the physical risk of future climate change projections, as historic greenhouse gas emissions have already been locked in global warming over this timeframe.

Beyond this date to 2055, WSI's greenhouse gas emissions would marginally contribute to potential climate change but not at a level expected to inhibit the Australian Government's commitment made under the Paris Agreement (including the NSW Government) to emissions reduction targets or a net zero emissions transition by 2050.

The project has been designed to reduce fuel burn through the provision of an efficient airspace system with supporting air traffic management procedures such as Continuous Climb Operations (CCO) and Continuous Descent Operations (CDO).

The cumulative greenhouse gas impacts associated with the project and related projects and developments are not considered to be significant.

22.4.4 Aircraft hazard and risk

There are potential impacts and risks associated with the operation of the existing aerodromes and airspace in the Sydney Basin, including risks to third parties. The assessment of project related hazards and risk is provided in Chapter 13 (Aircraft hazard and risk).

Potential cumulative impacts associated with aircraft hazards and risks would include:

- increase in third party and infrastructure risks from aircraft crashes
- increased risk of wildlife strike.

In accordance with the historical accident record and the third party risk model used to assess the third party risks associated with WSI operations, third party risks associated with other potential developments were concentrated along flight paths closer to each runway end. In these areas, individual risks may reach levels that would be considered potentially significant when assessed against recognised quantitative criteria for the evaluation of risk impact significance. Outside these areas, risks would be at levels that can be regarded as negligible.

Further from each runway end the risks associated with existing operations more generally in the Sydney Basin airspace can be expected to be considerably lower than the 1 in a million per annum individual risk level below which risks are considered to be acceptable and of no regulatory concern.

The risks that were determined for WSI and that are shown in the risk contour plots (refer to Chapter 13 (Aircraft hazard and risk)) would be introduced into an area that is a substantial distance from the existing aerodromes and where the existing background risk would be very low in comparison with the WSI-related risks. Closer to WSI, the cumulative risk associated with the new and existing operations would therefore be dominated entirely by the risks associated with WSI operations. That is to say, the background risk in the vicinity of WSI associated with existing operations would be so small (much lower than 1 in a million per annum) that it would not add significantly to the WSI-related risks which are adequately represented by the estimates made for WSI operations alone.

The areas that are currently subject to elevated risk levels associated with existing operations may be subject to an additional risk from WSI operations. Given the substantial distance from WSI and its associated flight paths to these areas of existing elevated crash risk, the additional risk can be expected to be very small and the cumulative impact only marginally above the existing risk level.

Potential cumulative impacts related to wildlife strikes could result from the project operating in conjunction with other existing airports in the study area. Major Australian airports between 2008 and 2017 averaged 4.8 strikes per 10,000 aircraft movements (ATSB, 2019). If WSI aligned with this rate, the addition of the project may result in increases in potential wildlife injury or mortality due to wildlife strike. This is estimated to be around 39 strikes per year by 2033 and 108 strikes per year by 2055.

However, it is important to note that a comparative analysis of strike rates at other airports does not account for the site-specific variables and nuances at each airport that contribute to the strike risk and the quality of wildlife hazard management programs applied on and off the Airport Site.

The species surveyed on and off the Airport Site to date may be indicative of the suite of species likely to occur at WSI and surrounds once WSI is operational. It is likely that known urban adaptors, particularly those known to occupy areas on and around other Australian airports (e.g., Australian White Ibis *Threskiornis moluccus*, Australian Magpie *Gymnorhina tibicen*, Masked Lapwing *Vanellus miles*, and Pacific Black Duck *Anas superciliosa*), will also occur at WSI. However, the upcoming changes to the Western Sydney landscape means that it is difficult to qualify, with accuracy, how wildlife populations would respond, and how this would impact the strike risk. As such, ongoing monitoring would be critical to identify trends and ensure the early detection of wildlife issues.

Overall, the project would introduce new potentially significantly elevated crash risks only into areas that are currently subject to entirely negligible risk from existing operations. It would introduce no more than a trivial additional crash risk into areas that are currently subject to potentially significant risk from existing operations.

22.4.5 Land use

Cumulative land use impacts are likely to occur as a result of the project's location, in proximity to a range of current and future large-scale infrastructure projects and ongoing strategic growth centre development areas in Western Sydney. The combined effect of the projects outlined in Table 22.1 are resulting in extensive land use changes in the vicinity of WSI.

The Western City District Plan (Greater Sydney Commission, 2018a) is a 20-year plan to manage growth in the context of economic, social and environmental matters to achieve the 40-year vision for Western Sydney. This growth will result in competing land use demands, with existing industrial, commercial and recreational land requiring safeguarding from competing pressures, especially residential and mixed-use zones.

Strategic land use planning in the vicinity of WSI has considered and incorporated the operational needs of WSI into land use planning. This has been ongoing for over a decade in conjunction with planning for WSI and is well established in existing planning instruments, and this has been an effective means of providing appropriate controls over land use planning and development. In developing the growth areas in proximity to WSI, the NSW Government and local councils have considered the potential cumulative opportunities and impacts of WSI. The assessment of project related land use impacts is provided in Chapter 14 (Land use).

Potential cumulative impacts associated with land use planning would include additional land being subject to planning restrictions or controls from:

- aircraft noise contours (ANEC/ANEF)
- protected airspace (OLS and PANS-OPS)
- implementation of wildlife buffers.

Planning controls for land surrounding WSI including the Aerotropolis and surrounding growth areas have adopted a precautionary approach to aircraft noise controls, particularly noise sensitive development within the ANEC 20. The adoption of the ANEC 20 contour around WSI has increased the area of land subject to planning restrictions based on aircraft noise. This includes more land on which noise sensitive developments are not permitted or where existing developments may be required to improve noise insulation.

WSI's OLS was prescribed by declaration on 19 October 2017 and since then building height restrictions on all land use types have applied within the OLS. OLS are also in place at all other airports in the Sydney Basin. The adoption of the OLS for WSI has increased the area of land in which specific height controls are in place to define the limits to which structures or objects may project into the airspace.

A PANS-OPS for WSI will be prepared once flight paths have been finalised. Once this occurs, consent authorities are required under the *Airports Act 1996* (Cth) and *Airports (Protection of Airspace) Regulations 1996* (Cth) to review all building and development applications they receive for any infringements into the PANS-OPS. This would increase the area of land in which long-term controlled activities (longer than 3 months) penetrating the PANS-OPS airspace are not permitted.

Any new development classed as 'relevant development' under the *State Environmental Planning Policy (Precincts – Western Parkland City) 2021* (NSW) (Western Parkland City SEPP) and within the 13 km wildlife buffer of WSI will be subject to the wildlife management controls contained within the Western Parkland City SEPP. Wildlife buffers resulting in land use restrictions and other wildlife controls are also in place at all other airports in the Sydney Basin and the addition of further wildlife buffers has increased the area of land in which wildlife controls are in place.

To date, the range of existing planning controls in the vicinity of WSI have been an effective means of providing appropriate land use controls and cumulative impacts related to land use and planning are not considered significant.

22.4.6 Landscape and visual amenity

Generally, planned land use changes around WSI have anticipated the potential for increased activity associated with WSI (including increased airspace activity). Consequently, the landscape character is considered lower in some areas in close proximity to WSI. The assessment of cumulative impacts has anticipated these land use changes as the baseline for landscape character and views, and sensitivity of future potential receivers over the time horizons assessed. The assessment of landscape character and visual impacts is provided in Chapter 15 (Landscape and visual amenity).

Potential cumulative impacts to landscape character and visual impact would include:

- changes to landscape character in the vicinity of WSI
- effects to views seen in proximity to current and future large-scale infrastructure projects, when seen together with changes to the character of the sky due to increasing airspace activity
- potential for increased air traffic across the Blue Mountains as a consequence of upgrades to airports and changes to the management of airspace above the Sydney Basin and Blue Mountains.

There would be cumulative effects on several landscape character zones near WSI, where there would be a greater concentration of flights and flights at lower altitudes. This includes the Penrith south-east rural transition landscape character zone (LCZ2), Greendale and Silverdale rural and residential landscape character zone (LCZ3), and Luddenham village and agricultural precinct landscape character zone (LCZ4), where the land use change together with increased airspace activity would transform the character of the landscape.

Cumulative visual impacts are likely to occur where views are seen in proximity to current and future large-scale infrastructure projects and ongoing strategic growth centre development areas in Western Sydney. This changing visual setting has been considered in the visual impact assessment as a changing baseline condition. There would be a cumulative effect on views from Luddenham village, Silverdale and Orangeville to the west of WSI, and Orchard Hills to the north, where the transformation of the landscape character of the land would be seen together with changes to the character of the sky due to increasing airspace activity.

There would also be a cumulative effect on views from recreational areas to the east of WSI, including George Maunder Lookout at Prospect Reservoir, where there would potentially be views to the development in areas surrounding the reservoir and increasing flights in the airspace across this elevated view.

There are no land use changes or major projects identified within the Blue Mountains that would influence the landscape character or views. However, in relation to landscape character, there is the potential for increased air traffic across the Blue Mountains as a consequence of upgrades to airports and changes to the management of airspace above the Sydney Basin and Blue Mountains.

There would be cumulative effects on the landscape character zones across the Blue Mountains which are increasingly influenced by air traffic, both from WSI and other airports within the Sydney Basin. These cumulative effects may occur where there are increased flights at other airports within the Sydney Basin flying over the Blue Mountains Landscape character zones (Blue Mountains iconic features landscape character zone (LCZ13), Blue Mountains forested hills and valleys landscape character zone (LCZ14) and Blue Mountains township spine landscape character zone (LCZ15)).

There is the potential for a cumulative effect on views from lookouts (including Echo Point and Walls Lookout), campgrounds and scenic routes throughout the Blue Mountains as flight frequency increases and flights related to other airports in the region have the potential to be seen in these views.

22.4.7 Biodiversity

Significant urbanisation and development in Western Sydney is placing increasing pressure on the biodiversity values of the Sydney Basin Bioregion, including threatened flora and fauna. The assessment of project related biodiversity impacts is provided in Chapter 16 (Biodiversity).

Potential cumulative impacts on biodiversity associated with the project and the screened projects (see Table 22.1) would include:

- incremental increases of noise and light exposure that may disrupt species within the vicinity of WSI and flight paths which may lead to species relocating or alter species behaviour and communication
- increases in potential wildlife strike (also refer Section 22.4.4)
- alterations to air quality and contributions to greenhouse gas emissions which could impact ecosystems affected by seasonal climatic fluctuations, such as wetlands and temperate forests which occur throughout the Sydney Basin and GBMA.

The Stage 1 Development of WSI has been approved and is limited to single runway operations. It will handle up to 10 million annual passengers and around 81,000 air traffic movements per year by 2033 including freight operations. The approval provides for the construction of the aerodrome (including the single runway), terminal and landside layout and facilities, and ground infrastructure such as the instrument landing systems (ILS) and high intensity approach lighting (HIAL) arrays. Construction of the Stage 1 Development commenced in 2018. These impacts are primarily limited to direct impacts on the ground. In terms of cumulative impacts, the indirect impacts overlapping with the airspace impacts (such as noise, air and light impacts) are negligible in the local and regional context.

The Western Sydney strategic assessment is a collaboration between the Australian and NSW Governments with the aim of safeguarding protected matters from the impacts of development within Western Sydney. Under the Western Sydney strategic assessment, the NSW Government is seeking approval for development in nominated growth areas and transport corridors. Development as a result of the implementation of the strategic assessment will likely increase the pressures on the same cumulative (indirect) impacts such as air quality, noise and light.

Ongoing development of the region will lead to additional cumulative impacts that are as yet unplanned and undefined and are therefore not quantifiable but will nonetheless increase pressures on biodiversity in the region. In a cumulative sense it is considered that a higher level of planning of development in Western Sydney will lead to better conservation outcomes and less 'ad-hoc' and unregulated cumulative impacts.

Although there are several recent and proposed projects in the locality that will incrementally exacerbate impacts on biodiversity, there are existing flight paths over the study area that generate similar impacts. Biodiversity values within the study area have been historically overflown to varying degrees by aircraft associated with Sydney (Kingsford Smith), Bankstown and Camden Airports as well as military flights from RAAF Base Richmond and Holsworthy Airfield. The study area is also likely to be intermittingly overflown by recreational and light aircraft in transit from private airstrips. As such, biodiversity within the region is already subject to varying degrees of impacts relevant to WSI.

Furthermore, impacts on biodiversity generated by most planned and proposed projects in the vicinity of WSI would be limited to on-ground impacts. These impacts include (but are not limited to) the direct removal of vegetation and the habitat it provides, introduction and spread of invasive species, barriers and habitat fragmentation, erosion and sedimentation, which are largely not consistent with the impacts associated with the project.

Despite this, the project is likely to incrementally increase wildlife strike, noise, light and alter air quality within the region which has the potential for impacts to biodiversity values. As existing aircraft operations and infrastructure developments occur throughout most of the Sydney Basin, including areas around the Airport Site, the project is likely to contribute to cumulative impacts on biodiversity within the locality.

The EPBC Act lists the 'loss of climatic habitat caused by anthropogenic emissions of greenhouse gases' as a Key Threatening Process (KTP). This KTP includes 'reductions in the bioclimatic range within which a given species or ecological community exists due to emissions induced by human activities of greenhouse gases' (Threatened Species Scientific Committee, 2001). The project has potential to contribute to long term climate change impacts via the production of greenhouse gases.

Chapter 12 (Air quality and greenhouse gas) identifies that the emissions from aircraft engines during all phases of flight alter the atmospheric concentration of greenhouse gases. The KTP lists several ecosystem types which are affected by anthropogenic greenhouse gases including wetlands and temperate forests which occur within the study area. These ecosystems would not be directly impacted by the project and are tolerant of seasonal climatic fluctuations. Although species within these ecosystems show resilience to harsh and variable environmental conditions such as bushfire and drought, this resilience is being tested by the extension and severity of these environmental conditions in response to climate change (Nolan et al. 2021).

22.4.8 Heritage

Despite a number of significant heritage sites existing for many years under the Sydney Basin flight paths there has been no specific consideration of the physical impacts of emissions on heritage items. Undertaking a study to consider this issue would be complex given the other contributors to airborne pollution nearby and the lack of a pre-flight path baseline. The assessment of project related heritage impacts is provided in Chapter 17 (Heritage).

Potential cumulative impacts related to Aboriginal and historic heritage places and values would result from the project operating in conjunction with other major developments and existing airports in the study area. Potential cumulative impacts include:

- increased impact to Aboriginal and non-Aboriginal cultural places and values
- impacts of new emissions and climate change on heritage gardens
- impacts to cultural values due to additional noise and visual intrusion
- further disruption to land-sky connection.

Given the range of current and proposed developments in Western Sydney it is difficult to calculate cumulative impacts with any degree of accuracy. This is exacerbated in the case of Aboriginal sites because for some decades Heritage NSW has not maintained an accurate record of destroyed sites as area wide Aboriginal Heritage Impact Permits are granted for development that cover the destruction of known and unknown sites within the area. It may be assumed that despite the large number of sites within the study area, that many of these have been destroyed since they were recorded.

This means that it is important to take a precautionary approach to approving impacts to Aboriginal heritage rather than basing assessment on the perceived commonness of site type.

The cumulative impacts of WSI related air pollution across WSI airspace are best understood as a contributing factor to the totality of air pollution present across the Sydney airshed. The air emissions inventory for the Greater Metropolitan Region in NSW (NSW EPA, 2012) showed that emissions from existing airport operations in Sydney in 2008 were less than 3 per cent of total emissions for the region. Despite the low estimates of the proportional contribution of WSI airspace emissions to the totality of air pollution within the Sydney Airshed, there remains the possibility that the cumulative impact of locally increased emission levels (such as for particulate matter, or the precursors of acid rain) in the proximity of flight paths with lower altitude aircraft, would have an impact on nearby rock art sites over time.

There is currently no comparative data or research to test this possibility. It is not known, for example, if air-borne pollutants from lower-altitude aircraft could raise rock-surface acidity levels at near-by or over-flown rock art sites beyond the natural acidity expected from the surrounding groundwater, soil and bedrock chemistry. Distinguishing local-area aircraft from other more generalised airshed sources of pollutants is also an issue in this context. Similarly, natural processes of surface mineralisation and case-hardening across natural rock surfaces may also offer some protection against raised acidity. The deposition of airborne particulate matter onto rock art panels appears a more clearly defined contender for a significant cumulative impact over time. Any increase in airborne dust content, whether above or below acceptable thresholds determined by human health risks, provides an opportunity for increased deposition of dust onto rock art panels. This would gradually impact their visibility and long-term conservation. It can be expected that all rock shelter sites within and around the Greater Sydney Metropolitan Region would be impacted by accumulated deposits of dust from the aerosol particulate matter of the Sydney airshed. It would be expected that within this general fall-out, and subject to local climatic conditions, heavier particulate matter may settle closer to its source than lighter fractions. A consequence of this expectation is that rock shelters under or close to flight paths used by low-altitude aircraft (such as during descent/arrival and ascent/departure) may experience greater dust fall-out, and therefore cumulative impacts.

While it is known that air pollution has a negative impact on some historical building fabric such as sandstone there has been little research into understanding the sources and contributory impact of emissions from industrial generators. It can be expected that additional emissions will add to the general impact on stone buildings and there is growing evidence that the deterioration will be accelerated by other anthropogenic factors such as climate change (Basu et al. 2020). Contemporary weathering is dependent on the constituents of the building materials and the past weathering history of the material, as well as on current pollution (Inkpen, 2004).

It is not possible to provide any quantifiable assessment of the likely cumulative impact of any emissions related to the project in addition to the existing and emerging climate change impacts on heritage gardens because no baseline data exists regarding the current climate change impacts (NSW DPE, 2023d). Little research has been undertaken regarding climate change impacts on the heritage gardens of the Blue Mountains area despite the focus on gardens as part of Blue Mountains tourism. Several of the State Heritage Register listed sites include significant gardens e.g., Everglades and Lilianfels. Heritage gardens in the Blue Mountains are particularly vulnerable to the impacts of climate change such as a warming environment (Bramwell, 2007).

The Blue Mountains region is predicted to experience fewer cold nights and frosty mornings and increased Autumn rainfall. Daytime temperatures in the region will become increasingly warmer. Wet and dry spells are likely to be longer and more severe (NSW Office of Environment and Heritage, 2014). These changes will not only increase risks associated with bushfires but are likely to also lead to plant disease and mildew and rust on leaves of exotic species like the rhododendrons, for which the gardens of the area are famous. The introduction of new or increased airborne pollutants will have an unknown impact on the ability of these gardens to cope and adapt to environmental changes.

During consultation with First Nations Knowledge holders it was clear that community accessibility of sites and places played a large part in the selection of the cultural places people were most concerned about. First Nations people carry out contemporary gatherings, ceremonies and transgenerational training at places that are historically important to them, provide the suitable mental and physical landscape conditions (i.e., connection to nature, sense of remoteness from urban life and tranquillity) and which are accessible to them. For this reason, should the visual, noise and frequency of aircraft render treasured places unsuitable for cultural practice then this would further restrict First Nations people from accessing country and revitalising their heritage. As accessible places become rarer the cumulative impact caused by the loss of such places becomes severe.

This is a concern in the case of Shaws Creek Aboriginal Place in Yellomundee Regional Park and Bents Basin where predicted impacts, particularly from noise and frequency of flights, poses a real risk that these places will no longer be suitable for the cultural practices for which they are currently used.

The preliminary flight paths would be visible from several spiritual sites. For example, while flights at high altitude can already been seen crossing the vista of the Three Sisters in their dramatic cultural landscape, adding more visual intrusions would over time continue to erode this iconic scene and produce a disconnect between the spiritual values and the landscape (refer Technical Paper 9: Heritage).

22.4.9 Social and economic

Recent and proposed changes in planning, such as that occurring within the broader Aerotropolis precinct, will result in changes to community composition, way of life and livelihoods over time as development surrounding WSI (such as the Aerotropolis) transforms the region. However, it is noted there are no other planned or potential airspace projects that have been identified that may introduce cumulative airspace direct or indirect impacts. The assessment of project related social impacts is provided in Chapter 18 (Social).

Potential cumulative social impacts resulting from the project and the screened projects and developments in Table 22.1 include:

- incremental changes to community composition. It is anticipated there would be in-and-out migration resulting from the interaction of the projects, as people would experience changes to their way of life and others would be interested in moving into the area due to increased employment opportunities. These changes to the community composition will affect both positively and negatively the existing social fabric and cohesion of the communities in the local study area
- incremental increases in noise, alterations to air quality and light exposure during construction of on-the-ground projects may result in changes to wellbeing and the way people enjoy social infrastructure and their own properties
- incremental acquisition of land and properties to construct the on-the-ground projects, paired with land use restrictions, may contribute to constrained housing availability within the local study area. However, it is acknowledged that within the regional study area there are a number of residential developments that would increase housing availability, such as Bradfield City Centre
- the sustainability of Luddenham may be enhanced due to the increased influx of people and business and employment opportunities within the local study area.

The assessment of project related economic impacts is provided in Chapter 19 (Economic). Potential economic cumulative impacts resulting from the project and the screened projects and developments in Table 22.1 include:

- the generation of jobs in Western Sydney and contribution to gross regional product. The conclusions from the 2016 EIS was that airport operations would directly generate 8,730 jobs in 2031 increasing to 61,500 jobs by 2063 (Ernst and Young, 2016). Additional jobs on the Airport Site could be accommodated in retail, hospitalities, business park and airport related industries. The 2016 EIS estimated an additional 4,439 jobs in 2031 increasing to 27,148 jobs by 2063 (Ernst and Young, 2016). Additional employment from the Aerotropolis will provide as many as 100,000 jobs by 2060 spread over 11,200 hectares of land surrounding the Airport Site. Flight paths are an integral element of WSI itself and do not directly generate jobs or create economic value
- potential for loss in the value of residential property in proximity to on-the-ground projects and WSI flight paths
- no loss in tourism spend in the regional area and hence no impacts on the local economy is expected. On the contrary, WSI itself provides some potential for positive impact on tourism in the Blue Mountains due to its proximity.

22.4.10 Human health

Impacts from the operation of the flight paths would occur following construction of WSI, where impacts associated with construction would no longer be relevant. Impacts related to ground operations of WSI were considered in the 2016 EIS. The 2016 EIS identified a number of localised impacts associated with surrounding roadways, particularly in relation to air quality. The assessment of project related human health impacts associated with the project is provided in Chapter 20 (Human health).

Cumulative impacts on community health cannot be assessed as insufficient information is available. It would be expected that future developments in the area would need to consider impacts derived from the operation of WSI.

The screened projects (identified in Table 22.1) would require the assessment of cumulative impacts and the implementation of associated mitigation measures. Impacts relating to the operation of new road and rail infrastructure would generally result in localised impacts close to on-ground construction and operational areas, and are considered unlikely to contribute to significant cumulative health impacts associated with WSI flight paths.

22.5 Conclusion

This chapter provides an overview of the potential cumulative impacts within the vicinity of WSI and also at a broader, regional scale. The assessment of cumulative impacts has been undertaken in accordance with the EIS Guidelines and has adopted an approach based on the NSW *Cumulative Impact Assessment Guidelines for State Significant Projects* (NSW DPE, 2022h).

The assessment of cumulative impacts has considered each of the environmental aspects requiring assessment in the EIS Guidelines. In many cases, the quantitative assessment of issues is difficult, due to the large study area, the indirect nature of potential impacts and the lack of sufficient baseline data relative to some impacts.

A range of cumulative impacts have the potential to occur as a result of the project’s location, in proximity to current and future large-scale infrastructure projects, strategic growth areas and economic corridors associated with rapid development in Western Sydney.

During operation of the project, WSA Co will liaise with Airservices Australia, the Civil Aviation Safety Authority (CASA), other Sydney Basin airport operators, NSW Government agencies and other key development stakeholders to identify measures to reduce the cumulative impacts of WSI operations, including airspace operation.

The implementation of project specific mitigation measures would avoid, to the greatest extent possible, cumulative impacts with surrounding developments and other airspace users and reduce the potential cumulative impacts to acceptable levels.

Chapter 23 Matters of National Environmental Significance

Overview

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides the national framework for protecting and managing nationally (and internationally) important flora and fauna, ecological communities and heritage places (including World heritage) that are collectively defined under the EPBC Act as 'matters of national significance' (MNES). The primary focus of the consideration of MNES was with respect to impacts on the World Heritage and National Heritage values and other values of the Greater Blue Mountains Area (GBMA) and National Heritage place.

Existing environment

The Greater Blue Mountains was inscribed on the World Heritage List in 2000 for both its fauna and flora values. This listing formally recognises that the area has Outstanding Universal Value under the World Heritage Convention.

At its closest point, the GBMA is around 4 nm (7 km) from WSI. It is a deeply incised sandstone tableland that encompasses around 1.03 million hectares of eucalypt-dominated landscape just inland from Sydney (UNESCO, 2022b). The GBMA comprises one of the largest and most intact regions of protected bushland in Australia and is noted for its representation of the evolutionary adaptation and diversification of the eucalypts in post-Gondwana isolation on the Australian continent (UNESCO, 2022b). It also supports an exceptional representation of the taxonomic, physiognomic and ecological diversity that eucalypts have developed: an outstanding illustration of the evolution of plant life. Several rare and endemic species, including relict flora such as the Wollemi Pine, also occur within its boundaries. The GBMA also includes an outstanding diversity of habitats and plant communities that support its globally significant species and ecosystem diversity.

Methodology

The assessment of the potential impacts of the project on MNES was undertaken in 2 key steps as follows:

- initial screening of MNES impacts
- assessment of applicable MNES identified as being potentially impacted by the project.

The assessment of significance was based on the guidance provided in the *EPBC Act Significant Impact Guidelines 1.1 – Matters of National Environmental Significance*, which state that an action is likely to have a significant impact on the World Heritage values of a declared World Heritage Area if there is a real chance or possibility that it would 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.

Summary of impacts to MNES

Four MNES have been identified as relevant to the project being potential impacts to:

- a World Heritage property
- a National Heritage place
- listed threatened species or communities
- listed migratory species.

World heritage Outstanding Universal Value criterion

Given the nature of the project, the proposed flight paths are expected to result in minimal direct impacts on the World Heritage or National Heritage values of the area, including the criterion which relate to the Outstanding Universal Value of the site and contribute to its World Heritage status.

The criterion that relate to the GBMA are:

- Criterion (ix) ongoing evolutionary processes
- Criterion (x) biological diversity.

Direct impacts would primarily be associated with the potential for wildlife strikes to species that utilise habitats within the GBMA and the potential for localised impacts in the unlikely event of an aircraft crash. It is considered that these potential impacts would result in negligible impacts on the attributes within the GBMA relevant to both the evolutionary processes or biological diversity of the property. Additionally, it is not considered that the operation of the proposed flight paths would result in any indirect impacts which may cause the World Heritage value to be lost, degraded or damaged, or notably altered, modified, obscured or diminished.

Accordingly, it is considered that the project would not have a significant impact on the attributes identified for each of the relevant World Heritage criterion that affords the site its Outstanding Universal Value.

Integrity

The integrity of the GBMA area is associated broadly with:

- the level of protection (e.g., National Parks and declared wilderness areas), size, topography and certain adjoining land uses (State Forests etc.)
- the size, condition (high wilderness quality) and connectivity of the natural bushland, plant communities and habitats. This extends to adaptation opportunities and ecological processes
- its geological, geomorphology and water systems, which require the same level of protection
- Aboriginal cultural values and custodial relationships.

The proposed flight paths would not result in the loss of any elements necessary for the GBMA to express its Outstanding Universal Value, including potential impacts to the size, condition, ability to maintain connectivity or provide protection to its geological, geomorphology and water systems. The proposed flight paths would not change the size or boundary of the GBMA and would not impact on any features and processes that convey the GBMA's Outstanding Universal Value or its existing integrity.

Overall, the project is unlikely to have a significant impact on the biodiversity values, and the integrity of those values (including Aboriginal cultural values), for which the GBMA was listed and which are identified in the Statement of Integrity for the site. It would not result in the loss of any elements necessary for the GBMA to express its Outstanding Universal Value with respect to its size, biodiversity condition, ability to maintain connectivity or provide protection to its geological, geomorphology and water systems.

The refinements to the preliminary flight path design since the exhibition of the Draft EIS would not change the conclusions of the assessment on MNES as presented in this chapter and the supporting technical paper.

Conclusion

Given the nature of the project, complete avoidance of potential impacts on the GBMA and MNES would not be possible. However, the design of the proposed flight paths is such that impacts expected to result from the project would have minimal direct impacts on the World Heritage or National Heritage values of the area, including the Outstanding Universal Value which contribute to its World Heritage status.

23.1 Introduction

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides the national framework for protecting and managing nationally (and internationally) important flora and fauna, ecological communities and heritage places (including World heritage) that are collectively defined under the EPBC Act as 'matters of national significance' (MNES). In particular, the EPBC Act is Australia's main legislative instrument for implementing its obligations under the World Heritage Convention. The EPBC Act also confers jurisdiction over actions that have the potential to make a significant impact on the environment where the actions affect Commonwealth land or are undertaken on behalf of Commonwealth agencies.

Under Part 3, Division 1 of the EPBC Act, a project (or action) that would or is likely to have a significant impact on MNES requires an approval from the Australian Minister for the Environment and Water (referred to as a 'controlled action'). As outlined in Chapter 5 (Statutory context), the project is subject to Section 160(2) of the EPBC Act and this approval is not required. While this approval is not required, the assessment of the project has still considered the impacts on the 'whole of the environment' (as documented in this EIS), which includes MNES.

This chapter summarises the assessment on MNES, as provided throughout this EIS. It primarily focuses on the consideration of impacts on the World Heritage and National Heritage values and other values of the Greater Blue Mountains Area (GBMA) and National Heritage place. The full assessment of the potential impacts of the project on the GBMA is provided in Technical paper 14: Greater Blue Mountains World Heritage Area (Technical paper 14).

The assessment has been carried out in accordance with the EIS Guidelines for the project issued by the Commonwealth Department of Climate Change, Energy, the Environment and Water.

23.2 Legislative and policy context

This section identifies the applicable legislation and policies relevant to the consideration of impacts to MNES by the project in addition to the EPBC Act, inclusive of the legislation applicable to the GBMA. While the NSW legislative requirements outlined below are not specific to Commonwealth airport activities or aircraft operations, the general provisions of this legislation have been included for completeness of consideration. Further detail of the relevant legislation and guidelines which have been considered is provided in Section 3.5 of Technical paper 14.

23.2.1 The World Heritage Convention

The Convention Concerning the Protection of World Cultural and Natural Heritage 1972 (the World Heritage Convention) aims to promote cooperation among nations to protect heritage around the world that is of such Outstanding Universal Value that its conservation is important for current and future generations. The World Heritage Convention also sets out the criteria that a site must meet to be inscribed on the World Heritage List.

The World Heritage Convention provides State Parties (i.e. the Australian Government) with direction regarding the identification of potential sites for inscription onto the World List, and what is required to be undertaken in order to preserve and protect such sites if they are added. Signatories to the World Heritage Convention agree to conserving World Heritage sites within their jurisdictions, and that they would take the required measures in order to protect their recognised National Heritage.

Both the Australian and NSW governments are responsible for managing and protecting World Heritage properties within NSW, with the NSW State Government being directly responsible for the day-to-day management of the GBMA through the Greater Blue Mountains World Heritage Area Advisory Committee.

23.2.2 International Union for Conservation of Nature

The International Union for Conservation of Nature (IUCN) is an international organisation involved in nature conservation and the sustainable use of natural resources. There are over 1,400 member organisations including a number from Australia such as DCCEEW, the Blue Mountains World Heritage Institute and the Australian Foundation for Wilderness (IUCN, 2022).

The IUCN in November 2013, published an Advice Note (IUCN, 2013) to provide guidance on integrating natural World Heritage sites into environmental assessments. Section 3 of the Advice Note states:

> *An Environmental Assessment for a proposal affecting, or with the potential to affect, a natural World Heritage Site is intended to ensure that the proposal's likely impacts on the <u>Outstanding Universal Value of the site</u> are fully considered in land-use planning decisions with the objective of preserving these exceptional places for future generations. The assessment should also consider the <u>site's links with the surrounding landscape</u> as a natural World Heritage Site cannot be considered separately from the wider ecosystem.*

Section 4 of the Advice Note states that the IUCN' position is that infrastructure and other development proposals located within, or outside the boundaries of a natural World Heritage Site, should be considered in terms of whether they are compatible with the long-term objective of preserving the Outstanding Universal Value of the site for future generations.

The section also notes that where developments affecting a natural World Heritage Site are under consideration, these should be subject to a rigorous environmental assessment in line with 8 World Heritage Impact Assessment Principles. Further details regarding the 8 World Heritage Impact Assessment Principles are provided in Section 3.5.2 of Technical paper 14.

23.2.3 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act provides the national framework for protecting and managing nationally (and internationally) important flora and fauna, ecological communities and heritage places (including World Heritage) that are defined under the EPBC Act as 'matters of national significance' (MNES). In particular, the EPBC Act is Australia's main legislative instrument for implementing its obligations under the World Heritage Convention. The EPBC Act also confers jurisdiction over actions that have the potential to make a significant impact on the environment where the actions affect Commonwealth land or are undertaken on behalf of Commonwealth agencies.

Under Section 160 of the EPBC Act, an Australian agency (or employee) must obtain and consider advice from the Australian Minister for the Environment and Water before a plan for aviation airspace management is adopted or implemented where the aircraft operations will have or is likely to have a significant impact on the environment. The preliminary airspace design for the project is a plan for aviation airspace management within the meaning of the EPBC Act.

A referral was made under Section 161 of the EPBC Act by the Department, Airservices Australia and CASA in 2021 (EPBC 2022/9143). Under Part 3, Division 1 of the EPBC Act, a project (or action) that will or is likely to have a significant impact on MNES requires an approval from the Australian Minister for the Environment and Water (referred to as a 'controlled action'). However, as the project is subject to Section 160(2) of the EPBC Act, this approval is not required. While this approval is not required, the assessment of the project has still considered the impacts on the 'whole of the environment'. That is, the assessment has assessed impacts to MNES but it will not be limited to those considerations.

23.2.3.1 World Heritage

Part 15, Division 1 of the EPBC Act sets out the requirements for the management of properties on the World Heritage List. This includes the identification of management principles and the requirement to prepare a management plan for a World Heritage property or area that is consistent with Australia's obligations under the World Heritage Convention or the Australian World Heritage management principles.

The *Greater Blue Mountains World Heritage Area Strategic Plan* (Department of Environment and Climate Change (DECC) 2009) and *Greater Blue Mountains World Heritage Area Strategic Plan Addendum 2016* (Office of Environment and Heritage, 2018) have been prepared to provide a framework for the area's management, protection and monitoring. The key management objectives set out in the Strategic Plan (NSW DECC, 2009) provide the basis for the management of the Greater Blue Mountains and guidance for operational strategies in accordance with requirements of the World Heritage Convention and its Operational Guidelines (UNESCO, 2021). The Strategic Plan and the 2016 Addendum are discussed further in Section 23.2.4 below.

23.2.4 NSW legislation

As described above, the EPBC Act provides for the development and implementation of management plans for World Heritage properties, which describe aspects of the Greater Blue Mountains Area and how it would be managed. The NSW Government, through the NSW Department of Planning and Environment (Environment and Heritage Group) is responsible for the day-to-day management of the GBMA. The GBMA is protected and managed primarily under the following State legislation:

- *National Parks and Wildlife Act 1974* (NSW) (NP&W Act) – The NP&W Act provides for the protection and reservation of certain lands, the protection of Aboriginal objects and places, the protection of fauna and the protection of native vegetation. It also provides for the declaration of wild rivers. Within the GBMA, the Grose River (Blue Mountains National Park), Colo River (Wollemi and Blue Mountains National Parks) and Kowmung River (Kanangra-Boyd National Park).
- *Wilderness Act 1987* (NSW) (Wilderness Act) – The Wilderness Act makes provisions for the identification, protection and management of wilderness areas in NSW. Kanangra-Boyd, Nattai, Yengo, Grose and Wollemi national parks, which form part of the GBMA, are declared wilderness areas. The management of wilderness areas is to restore and protect the unmodified state of wilderness areas, preserve its capacity to evolve in the absence of significant human interference and permit opportunities for solitude and appropriate self-reliant recreation.

These Acts cover the protection and management of areas such as national parks, nature reserves and wilderness. Other relevant legislation includes the NSW *Biodiversity Conservation Act 2016*, the *Environmental Planning and Assessment Act 1979*, and the *Heritage Act 1977*.

The *Greater Blue Mountains World Heritage Area Strategic Plan* (NSW Department of Environment and Climate Change (DECC), 2009) and *Greater Blue Mountains World Heritage Area Strategic Plan Addendum 2016* (NSW Office of Environment and Heritage, 2018) provide frameworks for the area's integrated management, protection, interpretation and monitoring. The key management objectives set out in the Strategic Plan (NSW DECC, 2009) provide the basis for the management of the Greater Blue Mountains and guidance for operational strategies in accordance with requirements of the *2021 World Heritage Convention and its Operational Guidelines* (UNESCO, 2021). The Strategic Plan and Addendum identifies the following threats to the integrity of the area that require protection measures to be identified for:

- 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
- lack of understanding of heritage values.

23.3 Methodology

The assessment of the potential impacts of the project on MNES was undertaken in 2 key steps as follows:

- initial screening of MNES impacts
- assessment of applicable MNES identified as being potentially impacted by the project.

A summary of the methodology for each of these steps is outlined in the following sections.

23.3.1 Initial screening of MNES impacts

The EPBC Act confers jurisdiction over actions that have impacts on 10 MNES. The potential impact of the project on each MNES was considered. A summary of the consideration is provided in Table 23.1.

Table 23.1 Consideration of potential MNES impacts from the project

MNES	Potential impact	Impact assessment required?
Any impact on a World Heritage property?	The study area includes the curtilages of 6 places listed on the World Heritage List being: • The Greater Blue Mountains • Australian Convict Sites (Old Great North Road and Buffer Zone) • Australian Convict Sites (Old Government House and Domain) • Australian Convict Sites (Cockatoo Island Convict Site) • Australian Convict Sites (Hyde Park Barracks) • Sydney Opera House. The GBMA is located around 7 km to the west of the Western Sydney International Airport (the Airport Site) and has the potential to be impacted by the project (refer to Section 23.4 for the assessment on the GBMA). Direct impacts to the remaining 5 World Heritage Sites are expected to be negligible due to the locations of these sites in relation to the proposed flight paths and the altitudes at which aircraft would be within the vicinity of these sites. Therefore detailed assessment of impacts to these sites has not been considered further as part of the MNES assessment. Further consideration of these sites is provided in Technical paper 9: Heritage (Technical paper 9).	Yes

MNES	Potential impact	Impact assessment required?
Any impact on a National Heritage place?	Three 'natural' National Heritage Places as occurring within the project study area, being: • Ku-ring-gai Chase National Park, Lion, Long and Spectacle Island Nature Reserves • Royal National Park and Garawarra State Conservation Area • the GBMA. Of these, only the GBMA is considered likely to be affected by the project. The GBMA was included on the National Heritage List in 2007. The National Heritage values identified for the listing are the same as the values recognised for the World Heritage Area (refer to Section 23.4 for the assessment on the GBMA). Detailed assessment of impacts to these other National Heritage Places is provided in Technical paper 9.	Yes
Any impact on a wetland of international importance?	Based on the potential impacts of the project, it is unlikely that any wetlands of international importance would be impacted. Refer to Chapter 16 (Biodiversity) for further information.	No
Any impact on a listed threatened species or communities?	The database searches identified 92 threatened fauna species listed under the EPBC Act that are known or predicted to occur within an area that may be impacted by the project. Of these, 16 are considered to have a moderate to high likelihood of occurring or utilising the habitats available and determined as candidate species requiring further assessment as they are considered to have potential to be impacted upon by the project. Of these, the key species of potential impact are the Grey-headed Flying-fox and Glossy Ibis. Additional threatened species and communities were also considered to have a moderate to high likelihood of being affected by the project. The significant impact assessments completed in Technical paper 8: Biodiversity (Technical paper 8) concluded that it is unlikely that the project would have a significant impact on the potential species that may be impacted by wildlife strikes (refer to Chapter 16 (Biodiversity) for further details).	Yes
Any impacts on listed migratory species?	The desktop assessment identified 79 migratory fauna species listed under the EPBC Act that are known or predicted to occur within an area that may be impacted by the project. Of these, 28 are considered to have a moderate to high likelihood of occurring or utilising habitats within the vicinity of the project potential to be impacted. Potential impact to these listed migratory species include direct impacts due to wildlife strike, and indirect impacts due to changes to noise, lighting and air quality. The significant impact assessments completed in Technical paper 8 concluded that it is unlikely that the project would have a significant impact on these species (refer to Chapter 16 (Biodiversity) for further details).	Yes
Does the Proposal involve a nuclear action (including uranium mining)?	The project does not involve a nuclear action.	No

MNES	Potential impact	Impact assessment required?
Any impact on a Commonwealth marine area?	The project would not impact on a Commonwealth marine area.	No
Any impact on the Great Barrier Reef Marine Park?	The project would not impact on The Great Barrier Reef Marine Park.	No
Does the Proposal involve development of coal seam gas and/or large coal mine that has the potential to impact on water resources?	The project is not related to coal seam gas or mining.	No
Any impact (direct or indirect) on Commonwealth land?	The project would not directly impact on Commonwealth land. The involvement of the Department of Defence (Defence) during the design of the preliminary airspace and flight path design has ensured that the current and future operational requirements for key Defence sites in the Sydney Basin (refer to Section 6.3.2.2 of Chapter 6 (Project development and alternatives)) are maintained with the implementation of the project. Co-ordination would continue to occur with Defence into the detailed design phase of the project. Indirect impacts (visual, noise, etc) on other Commonwealth land external to the Airport Site has been considered as part of the 'whole of environment' assessment as contained in this EIS.	No

23.3.2 Assessment of impacts

Based on the screening of potential impacts to MNES the assessment focused on the potential impacts of the project on the GBMA. The assessment was undertaken in consideration of the requirements outlined in the *Guidance and Toolkit for impact assessments in a World Heritage Context* (UNESCO, 2022a). Reflecting the guidance, the assessment of impact on the GBMA involved the following key processes:

- identification of the World Heritage and National Heritage values of the Greater Blue Mountains Area, as outlined in the Statement of Outstanding Universal Value
- identification of the other values that complement and interact with the World Heritage and National Heritage values of the Greater Blue Mountains Area
- collation of baseline environmental information including:
  - confirmation of existing ecological features of key significance that contribute to the Outstanding Universal Value of the site
  - baseline noise levels
  - identification of key social, recreation, and tourism attributes of the Greater Blue Mountains Area whose contributing values may be impacted as a result of the project
- identification of the potential impacts that may arise as a result of the proposed flight paths. This included screening of the potential elements that may be impacted as a result of the project (e.g. biodiversity, noise, air quality, heritage and visual)

- assessment of the impacts of the project against their potential to impact on the World Heritage and Natural Heritage values and integrity of the World Heritage property based on the Statement of Outstanding Universal Value for the GBMA
- assessment of impacts of the project against their potential to impact on the other values of the GBMA
- identification of recommended mitigation measures.

A summary of the process of an impact assessment conducted for World Heritage is shown in Figure 23.1.

Adapted from Figure 5.1 Guidance and Toolkit for impact assessments in a World Heritage Context (UNESCO, 2022a)

Figure 23.1 The process of an impact assessment conducted for World Heritage

23.4 Greater Blue Mountains Area

23.4.1 World Heritage Area

At its closest point, the GBMA is around 7 kilometres from the Airport Site. It is a deeply incised sandstone tableland that encompasses around 1.03 million hectares of eucalypt-dominated landscape just inland from Sydney (UNESCO, 2022b). The Greater Blue Mountains comprises one of the largest and most intact regions of protected bushland in Australia and is noted for its representation of the evolutionary adaptation and diversification of the eucalypts in post-Gondwana isolation on the Australian continent (UNESCO, 2022b). It also supports an exceptional representation of the taxonomic, physiognomic and ecological diversity that eucalypts have developed: an outstanding illustration of the evolution of plant life (refer to Section 23.4.1.1 for further details).

Several rare and endemic species, including relict flora such as the Wollemi Pine, also occur within its boundaries. Ongoing research continues to reveal the rich scientific value of the area as more species are discovered.

The GBMA was inscribed on the World Heritage List because it satisfies 2 of the criteria for natural values of Outstanding Universal Value related to both its fauna values as well as flora values. While the criteria for Outstanding Universal Value have changed over time, the underlying concepts have remained constant.

The GBMA comprises 8 protected areas (refer to Figure 23.2):

- 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
- Jenolan Caves Karst Conservation Reserve.

The geology and geomorphology of the site, which includes 300 metre cliffs, slot canyons and waterfalls, provides physical conditions and a visual backdrop to support these outstanding biological values. The Greater Blue Mountains Area includes large areas of accessible wilderness near Sydney's population of 4.5 million people. Its exceptional biodiversity values are complemented by numerous others, including Aboriginal and historic cultural values, geodiversity, water production, wilderness, recreation and natural beauty.

The Greater Blue Mountains makes up a significant representation of Australia's biodiversity with 10 per cent of the country's vascular flora and significant numbers of rare or threatened species (UNESCO, 2022b). Additional to its outstanding eucalypts, the area also contains relict species of global significance including the ancient Wollemi Pine, one of the world's rarest species that was thought to have been extinct for millions of years. The few surviving trees are known only from 3 small populations located in remote, inaccessible gorges within the Greater Blue Mountains (DCCEEW, 2022d).

Every World Heritage property is surrounded by a wider setting, which is the immediate and extended environment that is part of, or contributes to, its significance and distinctive character. While adjacent areas are acknowledged to be important in protecting the GBMA in the Statement of Outstanding Universal Value, the GBMA does not have a formal buffer zone included as part of the World Heritage listing. It is however noted that under the EPBC Act, any action that has, would have, or is likely to have an impact on the World Heritage values of a World Heritage property must be referred to the responsible Australian Minister for consideration (whether or not the action occurs inside the boundary of the World Heritage property or not). This allows potential projects to capture potential impacts to mobile species (e.g. birds, bats) that provide value to GBMA.

A number of areas outside of the designated boundary for the GBMA provide an informal buffer between the World Heritage item and its surrounding land uses. These include adjoining areas of:

- National Parks such as Goulburn River National Park, Capertee National Park and the Dharug National Park
- State Forests such as the Newnes, Pokolbin, Coricudgy, Nullo Mountain, Gurnang, Wolgan, Ben Bullen, Jellore, McPherson and Putty State Forests
- other Protected Areas such as the Bargo, Yerranderie, Natti, Burragorang and Parr State Conservation Areas.

These surrounding protected areas assist in maintaining and protecting the overall natural setting of the GBMA, thereby reducing pressure on the region from adjoining land uses which may cause negative impact(s) to the Outstanding Universal Value of the site.

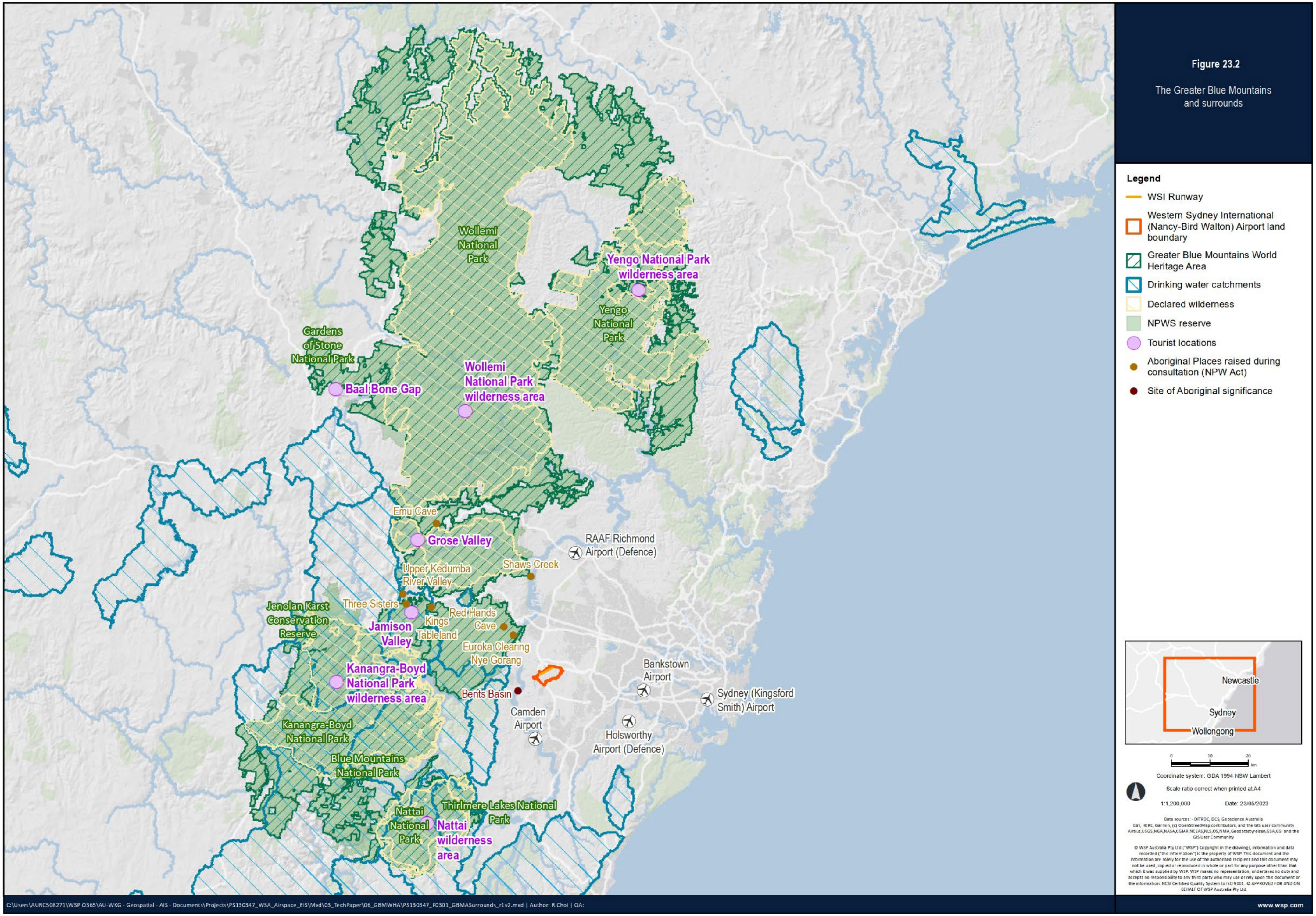


Figure 23.2

The Greater Blue Mountains and surrounds

23.4.1.1 World Heritage values

Outstanding Universal Value

The Greater Blue Mountains was inscribed on the World Heritage List because it satisfies 2 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, 2022b). The 2 criteria for which the Greater Blue Mountains are listed are described below.

Criterion ix

Criterion ix is defined in the Operational Guidelines for the Implementation of the World Heritage Convention (UNESCO, 2021) 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 Greater Blue Mountains include outstanding and representative examples in a relatively small area of the evolution and adaptation of the genus *Eucalyptus* and eucalypt-dominated vegetation on the Australian continent.

The site contains a wide and balanced representation of eucalypt habitats including wet and dry sclerophyll forests and mallee heathlands, as well as localised swamps, wetlands and grassland. It is a centre of diversification for the Australian scleromorphic flora, including significant aspects of eucalypt evolution and radiation. Representative examples of the dynamic processes in its eucalypt-dominated ecosystems cover the full range of interactions between eucalypts, understorey, fauna, environment and fire.

The site includes primitive species of outstanding significance to the evolution of the earth's plant life, such as the highly restricted Wollemi Pine (*Wollemia nobilis*) 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, 2022b).

Criterion x

Criterion x is defined in the Operational Guidelines for the Implementation of the World Heritage Convention (UNESCO, 2021) 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 Greater Blue Mountains includes an outstanding diversity of habitats and plant communities that support its globally significant species and ecosystem diversity (152 plant families, 484 genera and c. 1,500 species). A significant proportion of the Australian continent's biodiversity, especially its scleromorphic flora, occur in the area. Plant families represented by exceptionally high levels of species diversity here include Myrtaceae (150 species), Fabaceae (149 species), and Proteaeceae (77 species).

Eucalypts (*Eucalyptus*, *Angophora* and *Corymbia*, all in the family Myrtaceae) which dominate the Australian continent are well represented by more than 90 species (13 per cent of the global total). The genus *Acacia* (in the family Fabaceae) is represented by 64 species. The site includes primitive and relictual species with Gondwanan affinities (*Wollemia, Pherosphaera, Lomatia, Dracophyllum, Acrophyllum, Podocarpus* and *Atkinsonia*) and supports many plants of conservation significance including 114 endemic species and 177 threatened species.

The diverse plant communities and habitats support more than 400 vertebrate taxa (of which 40 are threatened), comprising some 52 mammal, 63 reptile, over 30 frog and about one third (265 species) of Australia's bird species. Charismatic vertebrates such as the platypus and echidna occur in the area. Although invertebrates are still poorly known, the area supports an estimated 120 butterfly and 4,000 moth species, and a rich cave invertebrate fauna (67 taxa) (UNESCO, 2022b).

Integrity

In addition to meeting at least one of the criteria for Outstanding Universal Value, a World Heritage Area that is 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, 2022b).

The *Greater Blue Mountains World Heritage Area Strategic Plan* (NSW DECC, 2009) states, with respect to objective of integrity, '… to maintain, and wherever possible improve, the current and future integrity of the Greater Blue Mountains World Heritage Area…' including, seeking 'to ensure that adjoining land uses are sympathetic to the conservation and presentation of World Heritage values'.

The Statement of Outstanding Universal Value for the GBMA (UNESCO, 2022b) states that the 7 adjacent national parks and single karst conservation reserve that comprise the Greater Blue Mountains Area are of sufficient size to protect the biota and ecosystem processes, although the boundary has several anomalies that reduce the effectiveness of its 1-million-hectare size. This is explained by historical patterns of clearing and private land ownership that preceded establishment of the parks. However, parts of the convoluted boundary reflect topography, such as escarpments that act as barriers to potential adverse impacts from adjoining land. In addition, much of the Greater Blue Mountains Area is largely protected by adjoining public lands of State Forests and State Conservation Areas. Additional regulatory mechanisms, such as the statutory wilderness designation of 65 per cent of the area, the closed and protected catchment for the Warragamba Dam and additions to the conservation reserves that comprise the area further protect the integrity of the Greater Blue Mountains Area.

Most of the natural bushland of the Greater Blue Mountains Area is of high wilderness quality and remains close to pristine. The plant communities and habitats occur almost entirely as an extensive, largely undisturbed matrix almost entirely free of structures, earthworks and other human intervention. Because of its size and connectivity with other protected areas, the area would continue to play a vital role in providing opportunities for adaptation and shifts in range for all native plant and animal species within it, allowing essential ecological processes to continue.

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 and which require the same level of protection.

First Nations people from 6 language groups, through ongoing practices that reflect both traditional and contemporary presence, continue to have a custodial relationship with the area. Occupation sites and rock art provide physical evidence of the longevity of the strong Aboriginal cultural connections with the land. The conservation of these associations, together with the elements of the area's natural beauty, contributes to its integrity.

The current statement of integrity (UNESCO, 2022b) says that since World Heritage listing, proposals for a second Sydney airport at Badgerys Creek, adjacent to the Greater Blue Mountains Area, have been abandoned. This statement is no longer current. In 2012, the Joint Study on Aviation Capacity in the Sydney Basin airspace (Department of Infrastructure and Transport, 2012) confirmed a second airport would be required and the location at Badgerys Creek was announced in 2014 by the Australian Government. In 2016, the then Australian Minister for Urban Infrastructure approved development for WSI. This comprised the Stage 1 Development works required for single runway operations including the terminal and landside layout and facilities, and ground infrastructure such as the instrument landing systems and high intensity approach lighting arrays.

23.4.2 National Heritage place

Under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act), all World Heritage properties in Australia were automatically included on the National Heritage List (NHL) for their World Heritage Outstanding Universal Value in 2007. The National Heritage values identified for the listing are the same as the values recognised for the World Heritage Area. As such the assessment against the World Heritage values is considered to be sufficient to address both the World Heritage and National Heritage values of the Greater Blue Mountains Area.

23.4.2.1 Proposed National Heritage Area extensions

The Australian Heritage Council is currently assessing whether the Greater Blue Mountains National Heritage place has additional nationally significant heritage values, and whether to expand it to include adjacent areas. The values relate to geodiversity, biodiversity and historic values that satisfy the National Heritage criterion of events and processes, rarity and aesthetic characteristics. The Australian Heritage Council has identified engagement with First Nations People is required before it can identify any Aboriginal cultural heritage values that satisfy National Heritage criteria. Consent would also be sought to list any such values.

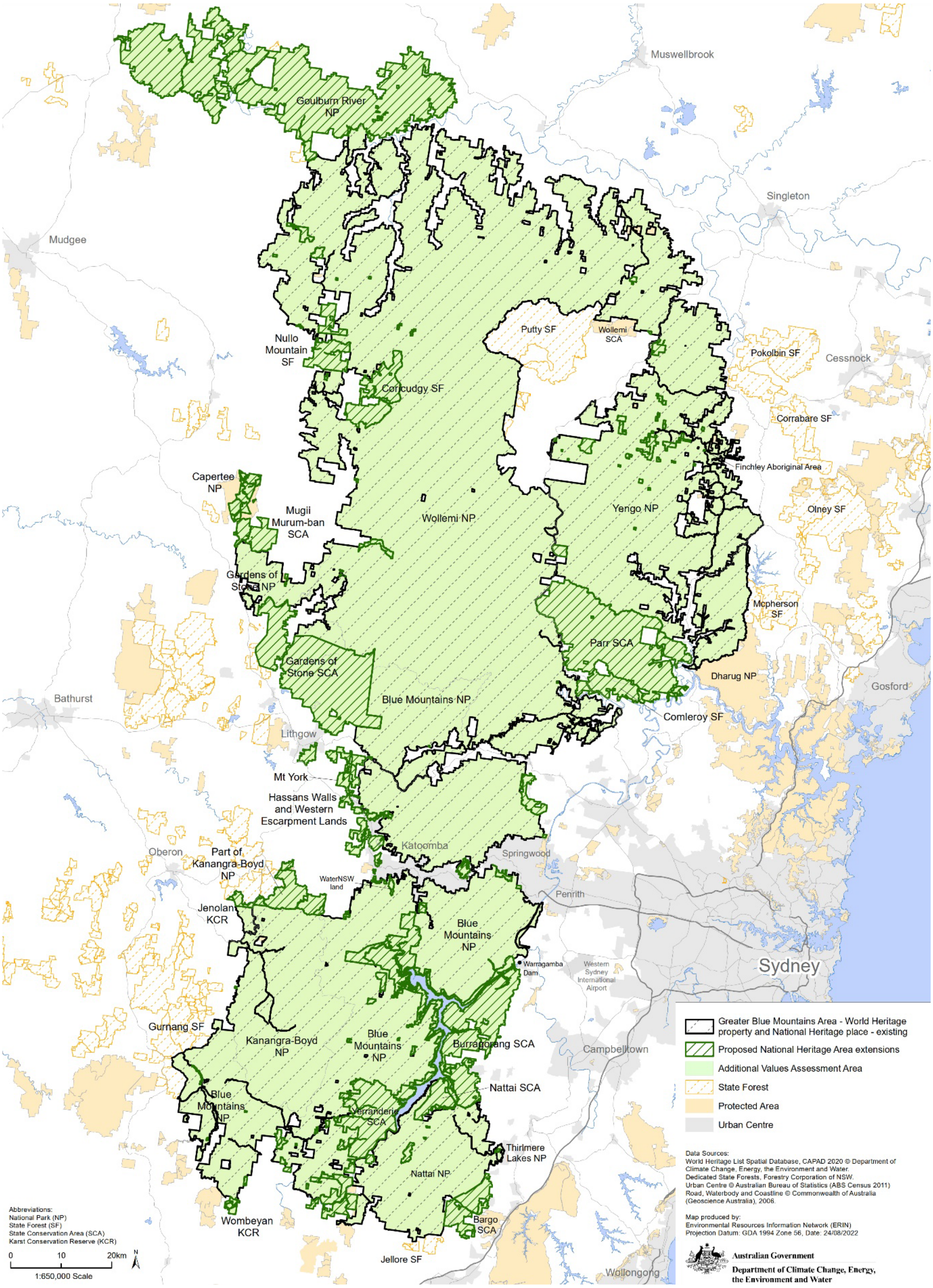
In 2014–15, the Greater Blue Mountains Area World Heritage Advisory Committee and the NSW Government recommended that the National Heritage List assessment be updated to include additional lands which are contiguous with or close to the GBMA and act as buffers to the GBMA. As listed in the *Greater Blue Mountains World Heritage Area Strategic Plan Addendum 2016* (NSW Office of Environment and Heritage, 2018), these additional areas included (refer to Figure 23.3):

- Bargo State Conservation Area
- Blue Mountains National Park
- Burragorang State Conservation Area
- Capertee National Park
- Comleroy State Forest
- Coricudgy State Forest
- Gardens of Stone State Conservation Area
- Goulburn River National Park
- Hassans Walls and Western Escarpment Lands
- Kanangra-Boyd National Park
- Mugii Murum-ban State Conservation Area
- Nattai State Conservation Area
- Nullo Mountain State Forest and Flora Reserve
- Parr State Conservation Area
- Wollemi National Park
- Wombeyan Karst Conservation Reserve
- Yengo National Park
- Yerranderie State Conservation Area.

The opportunity to provide comment on the proposed changes was made available to the public in late 2022 with comments closing in November 2022. As at the time of this assessment, the Australian Heritage Council was reviewing the information gathered during the consultation period. Based on the outcomes of this consultation, it is noted that additional (or refined) areas to those shown in Figure 23.3 may be confirmed for inclusion in the listing.

The final outcomes of this assessment would not change the World Heritage listing.

As WSI was a 'greenfield' development with no appointed ALC at the time of developing and assessing the proposal for WSI, the statutory process at that time did not appropriately cater for WSI. As such, the Airports Act was amended to provide an alternative approvals pathway for the initial development of the WSI through the approval of an Airport Plan and to exclude the approvals pathway under Part 9 of the EPBC Act.



Sourced from National Heritage assessment for the Greater Blue Mountains Area (DCCEEW, 2022e)

Figure 23.3 Greater Blue Mountains Area – proposed National Heritage Area extensions (under consideration)

23.4.3 Other values of the Greater Blue Mountains

In addition to the attributes recognised by the World Heritage Committee in 2000, the Greater Blue Mountains has several other important values that complement and interact with its World Heritage values. Protection of these values is integral in managing individual protected areas and the Greater Blue Mountains as a whole (NSW DECC, 2009).

Table 23.2 provides a summary of the values, identified by the NPWS in the GBMA Strategic Plan (NSW DECC, 2009), that contribute to the overall values of the area.

Table 23.2 Other important values of the GBMA

Value	Description
Geodiversity and biodiversity	In addition to the outstanding biodiversity features of the GBMA which form the basis of its listing, the area also contains karst landscapes with several cave systems including the world's oldest open cave system, Jenolan Caves. Other features include prominent basalt-capped peaks, quaternary alluvial deposits and a series of perched perennial freshwater lakes of considerable geomorphological and biological significance.
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. The catchments also make an important contribution to the maintenance of water quality and natural flow regimes in the Hawkesbury-Nepean and Goulburn-Hunter river systems.
Cultural values (Aboriginal)	Known sites provide evidence of at least 14,000 (and possibly 22,000) years of Aboriginal occupation of the area, but traditional beliefs connect First Nations people with the landscape even further. Numerous Aboriginal sites within the area are known to be widespread, diverse and include landscape features of spiritual significance and rock art sites. Recorded sites of archaeological significance include a widespread sample of the Sydney Region's distinctive Aboriginal rock art, on a scale unique in Australia.
Cultural values (historic heritage)	The GBMA includes a large number of places of historic significance some of which date back to the early years of European settlement and exploration in Australia. Recorded sites within the area demonstrate a range of 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 provides settings for recreation and tourism that are outstanding and increasingly rare by world standards. The high recreational values are primarily derived from the area's intrinsic beauty, natural features and accessibility from major population centres. The regional economy surrounding the GBMA is also heavily supported by tourism with the area contributing both directly and indirectly to the employment, income and output of much of the region (through elements such as forma accommodation and camping, food, nature-based tours and activities, visitor centres and other attractions).
Wilderness	The extraordinary wilderness quality of much of the GBMA considerably contributes to its World Heritage values, ensures the integrity of its ecosystems and the retention and protection of its heritage value. Protection of wilderness was one of the main reasons for the establishment of many of the national parks within the GBMA. The GBMA contains some of the largest forested wilderness areas in eastern mainland Australia. As noted in the Integrity statement for the GBMA, 65 per cent of the area is designated as statutory wilderness. These areas are located primarily in the northern section of the site. The Greater Blue Mountains park system includes 5 declared wilderness areas through formal recognition of the Wilderness Act (Wollemi, Kanangra-Boyd, Nattai, Yengo and Grose) which encompasses over 551,000 hectares of wilderness areas in the GBMA.

Value	Description
	The Blue Mountains wilderness areas also protect 3 of only 6 streams declared as 'Wild Rivers' in NSW under the NP&W Act: the Colo, Grose and Kowmung. As stated in the GBMA Strategic Plan, the wilderness qualities of the site also have many cultural values, providing not only opportunities for solitude and self-reliant recreation, but also aesthetic, spiritual and intrinsic value.
Social and economic	The regional economy surrounding the GBMA is substantially supported by various forms of tourism, in particular people accessing the various towns along the Great Western Highway and Bells Line of Road, as well as various recreational activities within the bushland areas. The reserves within the GBMA have considerable social and economic value and contribute directly and indirectly to the employment, income and output of the regional economy. Although visitation to specific locations can be highly variable, both in time (due to seasonal effects) and location (given the broad area of the property), overall visitation to the GBMA is considered to be generally increasing (outside the recent impacts of COVID) – reflecting the region's importance as a tourist destination for both day and longer trips.
Research and education	The GBMA is ideal for research and educational visits due to the variety of ecological communities, landscape and associated cultural sites. Information arising from the scientific research conducted within the GBMA was a key supporting component for its World Heritage nomination. The high scientific value reflects what has been discovered and what remains to be discovered, including large gaps in knowledge which still remain with respect to Aboriginal use and occupation in the area and the ecological needs of threatened species and communities.
Scenic and aesthetic	The GBMA includes some of the most dramatic scenery in Australia, with its best known landscapes dominated by striking vertical cliffs and waterfalls. With many vantage points on ridges and escarpments, the GBMA offers outstanding vistas, from uninterrupted views of forested wilderness covered by natural vegetation to the contrasts of steep forested slopes surrounding cleared valleys. The area's scenic and aesthetic values are demonstrated in a variety of ways, for example the large body of contemporary art and photography inspired by the landscape and the significant levels of visitation to scenic vantage points.
Bequest, inspiration, spirituality and existence.	One of the goals of World Heritage management is to ensure that future generations can experience and appreciate the uniqueness of these areas. This goal explicitly recognises an area's bequest values and the importance of Aboriginal cultural continuity. The wild and rugged landscapes, diverse flora and fauna, and opportunities for solitude and quiet reflection are attributes that promote inspiration, serenity and rejuvenation of the human mind and spirit.

23.4.4 Key sensitive tourist and recreation areas

While COVID impacted on the level of annual tourism to the Blue Mountains region generally, for the prior 12 months to December 2022, the Blue Mountains received around 3.8 million total domestic visitors, with around 1.4 million domestic overnight visitors (contributing to around 3.5 million total nights of visitation), and around 2.5 million total daytrip visitors (Destination NSW, 2022). Bushwalking/rainforest walks and visiting National Parks/State Parks were 2 of the top 5 activities identified by visitors to the Blue Mountains during this time.

Key sensitive tourism and recreation areas were selected for this assessment based on the identification of important attractions and associated viewing locations within the GBMA (Table 23.3). 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 23.3 Key sensitive tourist and recreational areas, viewing locations and accessibility

National park	Key attribute	Key viewing locations	Location
Blue Mountains National Park	Jamison Valley including the Three Sisters	Echo Point Lookout, Sublime Point Lookout, Perrys Lookdown, Evans Lookout, Mount 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, Mount Portal Lookout, Rileys Lookout, The Rock Lookout Greenfields Lookout, Melville Lookout, Wynnes Rocks Lookout, Point Pilcher Lookout, Du Faurs Lookout, Mount Banks Lookout, and Walls Lookout.	Katoomba
	Wentworth Falls waterfall	Wentworth Falls Lookout	Wentworth Falls
	Grose Valley	Evans Lookout; Govetts Leap Lookout	Blackheath
	Wilderness, bushwalking, rock-climbing, trail bike riding, picnicking and remote camping	Views from walking tracks such as National Pass, Federal Pass, Mount Solitary, and Narrowneck Fire trail	Southern section of the national park
Wollemi National Park	Wilderness, bushwalking, rock climbing, canoeing, picnicking	Deanes Lookout; Crawfords Lookout	Not identified
Yengo National Park	Wilderness, bushwalking, horse riding, trail bike riding, picnicking	Finchley Lookout; Mount Yengo Lookout	50 km south-west of Cessnock
Nattai National Park	Wilderness, bushwalking, remote camping	Kanangra-Boyd Lookout, Kowmung Lookout, Rigby Rock Lookout, Moorilla Lookout, Mount Dingo Lookout, and Kanangra Walls Lookouts	30 km north of Mittagong

National park	Key attribute	Key viewing locations	Location
Kanangra-Boyd National Park	Kanangra Walls Mount Cloudmaker	Wollondilly Lookout; Starlights trail; Couridjah Corridor walk	50 km south-east of Oberon
	Wilderness, bushwalking, rock-climbing, trail bike riding, picnicking and remote camping	Not applicable	Southern sections of the park
Gardens of Stone National Park	Baal Bone Gap, four-wheel driving	Baal Bone Gap picnic area	35 km north of Lithgow
Thirlmere Lakes National Park	Birdwatching, picnicking, walking and swimming	Werri Berri picnic area	Couridjah
Jenolan Caves Karst Conservation Reserve	Jenolan Caves	Not applicable	Jenolan
Burragorang State Conservation Area	Warragamba Dam	Burragorang Lookout, Warragamba Dam	Nattai
Prospect Reservoir	Prospect Reservoir	George Maunder Lookout, Prospect Reservoir	Prospect
Various	Scenic and tourist drives	Scenic and tourist drives including the: • Warragamba Waters scenic drive • Greater Blue Mountains scenic drive • Greater Blue Mountains Drive • The Bells Line of Road.	Various

23.4.5 Assessment of impacts

This chapter provides an evaluation of the significance of potential impacts on the attributes which sustain the GBMA's Outstanding Universal Value and other heritage/conservation values. It considers the potential positive and negative impacts of the proposed flight paths on the GBMA and National Heritage values, including cumulative impacts. A prediction of the characteristics of these potential impacts, including identification of any uncertainty with respect to the assessment, is provided.

23.4.5.1 Influence on existing threats

Table 23.4 provides a description of the proposed airport's influence on existing threats identified in the *Greater Blue Mountains World Heritage Area Strategic Plan Addendum 2016* (NSW Office of Environment and Heritage, 2018).

Table 23.4 Operational impacts on other important values of the GBMA

Threat	Project influence
Uncontrolled and inappropriate use of fire	Operation of the project would not result in any inappropriate use of fire. Operation of flightpaths over the GBMA would also present a very low risk of introducing uncontrolled fire to the GBMA. The main potential risk associated with the operation of the flight paths with respect to uncontrollable fire may occur as a result of an aircraft crash within the GMBA. This potential is however considered to be extremely rare and an unlikely event. As such, it is not considered to be a contributory factor in the overall threat of uncontrolled and inappropriate use of fire that may impact on the GBMA. Operation of the flight paths over the Blue Mountains are also not expected to impact on the ability of organisations such as the NPWS or Rural Fire Service to continue to undertake firefighting operations (for wild fires) or fire hazard reduction burns. With respect to the assessment of priorities, current regulations of flight (as identified in the Aeronautical Information Publication) notes that (among other conditions), if an aircraft is participating in an emergency action that has significant potential human and environmental consequences, including for life critical operations (such as firefighting operations or search and rescue operations) then they would have a nominated priority within the airspace they need to operate. This is consistent with the management of existing airspace for current flight paths across the Sydney Basin and GBMA.
Inappropriate recreation and tourism activities, including development of tourism infrastructure	The proposed flight paths are an integral part of the development of WSI, ensuring that the benefits of WSI are realised. The tourism industry is recognised as an important part of the regional economy which sites adjacent to, and for some aspects within, the GBMA, noting that around 3.8 million domestic visitors accessed the region in the 12 months to December 2022 (Destination NSW, 2022). Bushwalking/rainforest walks and visiting National Parks/State Parks were 2 of the top 5 activities identified by visitors to the Blue Mountains during this time. Tourism businesses in the Blue Mountains are mostly concentrated in Leura, Katoomba, Springwood, Winmalee, Blaxland, Warrimoo and Lapstone. Mount Irvine, Blackheath, and Mount Victoria are also important tourism areas for the region. The development of the WSI airport itself would provide an additional access point in closer proximity to key tourist and recreation sites within the GBMA. This is likely to result in an increase in the overall volume of tourists accessing the GBMA. Such an increase in tourism may influence the potential for inappropriate tourism development. However, it is very unlikely that the operation of the project would directly contribute to inappropriate development or uncontrolled visitor access. Development controls within the context of existing management plans and local and State government planning controls are in place that protect World Heritage Area.

Threat	Project influence
Invasion by pest species including weeds and feral animals	All aircraft using the proposed flight paths to access WSI from overseas would be subject to Australian biosecurity requirements that are currently administered for all Australian airports. No direct impacts or indirect threats associated with weed and/or pest species are expected as a result of the implementation of the proposed flight paths associated with WSI.
Loss of biodiversity and geodiversity	Where the project intersected areas above the GBMA, the flight paths would typically occur at altitudes of greater than 1,000 ft and would therefore limit the potential for loss or impact to existing biodiversity and geodiversity. Subsequently impacts to biodiversity within these areas would be potentially limited to: • potential direct impact in the (unlikely) event of an aircraft crash that may result in the localised loss of habitat or in the event of an aircraft striking a bird/wildlife • indirect negligible noise, light and air quality impacts. With respect to the potential for localised loss of habitat due to an aircraft crash, it is very unlikely but there is a chance that over the lifespan of the WSI an aircraft crash could occur within the GBMA. In this rare circumstance, impacts would be largely localised and include vegetation removal, mortality of some animals, the potential to introduce/spread of chemicals and potential bush fire event(s). With respect to the potential for wildlife strike, within the airspace of the GBMA, at these locations the potential for impact would be infrequent and limited to species that occur at altitude of greater than 1,000 ft. These species include the Fork-tailed Swift and Grey-headed Flying-fox. Impacts to bird species are likely to be minimised through implementation of the recommended mitigation measures (refer to Chapter 6 (Project development and alternatives)). It is not expected that there would be any other direct impacts on biodiversity that would lead to the loss of these values within the GBMA, or impact the values upon which the World Heritage Listing has been made.
Impacts of human enhanced climate change	Reflecting the fuel consumption rates in Australia's latest *State Action Plan* published in October 2022, *Managing the Carbon Footprint of Australian Aviation*, aviation emissions were estimated to be 23.7 million tonnes in 2019, based on 9,057 megalitres of fuel use nationally (DITRDCA, 2022). Broken down, domestic aviation in Australia emitted around 8.3 million tonnes of CO_2e accounting for around 35 per cent of Australia's total aviation emissions. In 2019, total GHG emissions from all sectors were reported by the NSW EPA to be around 136.6 million tonnes of CO_2e. GHG emissions from the NSW transport sector accounted for around 20 per cent of the state's carbon with 27.6 million tonnes of CO_2e. Approximately 1.7 per cent or 2.4 million tonnes of CO_2e emissions were attributed to the state's domestic aviation sector. The operation of the proposed flight paths is expected to make a minimal contribution to national transport-related GHG emissions. WSI's projected emissions of CO_2e from aircraft main engine use on domestic flights operating in Australia have been compared to Australia's total emissions (for all WSI domestic flights) and NSW's total emissions (for WSI flights in NSW and ACT only). This identified that: • in 2033, the project's domestic flight departure emissions of CO2e would represent 0.13 per cent for Australia's total projected economy wide emissions which is low whereas the project's intrastate flight departure emissions of CO2e would represent around 0.04 per cent of NSW's total economy wide emissions, which is extremely low resulting in very minor adverse impacts to Australian and NSW Government's decarbonisation plans and transition to net zero carbon economies by 2050

Threat	Project influence
	• in 2055, the project's domestic flight departure emissions of CO2e are projected to increase to 0.95 Mt CO2e and would represent 0.5 per cent of Australia's total projected emissions which is moderately low whereas the project's intrastate flight departure emissions of CO2e would represent around 0.2 per cent of NSW's total projected economy wide emissions, remaining low despite the significant increase in air traffic growth and increase in the number of domestic destinations being served. These changes are not expected to result in a noticeable impact to the GBMA.
Lack of understanding of heritage values.	This threat would be relevant if no assessment of potential impacts was undertaken. Technical paper 14: Greater Blue Mountains World Heritage Area, along with the preparation of other relevant supporting papers, including a separate heritage technical paper and this EIS has provided an assessment and considered all potential heritage values. As such the proposed flight paths are not considered to present a lack of understanding of the heritage values associated with the GBMA.

23.4.5.2 Impacts on World Heritage values

The assessment of significance is based on the guidance provided in the *EPBC Act Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* (Commonwealth of Australia, 2013a), which state that an action is likely to have a significant impact on the World Heritage values of a declared World Heritage Area if there is a real chance or possibility that it would 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.

Given the nature of the project, the proposed flight paths are expected to result in minimal direct impacts on the World Heritage or National Heritage values of the area, including the Outstanding Universal Value which contribute to its World Heritage status, with direct impacts primarily associated with the potential for wildlife strikes to species that utilise habitats within the GBMA and the potential for localised impacts in the unlikely event of an aircraft crash. Indirect effects on the Outstanding Universal Value of the Greater Blue Mountains Area are expected to be limited to potential noise, visual amenity, air quality and cultural/heritage impacts as a result of aircraft overflights of the GBMA. These potential impacts are described and their significance assessed in Table 23.5.

The project is also unlikely to have a significant impact on the integrity of the values (including Aboriginal cultural values) for which the GBMA was listed. While the project would not have a direct impact on the physical evidence of the cultural connection to the GBMA, it is inevitable that visual presence and aircraft noise would impact some Aboriginal sites within the GBMA, and the integrity of these areas with respect to custodial relationships. While flight paths associated with Sydney (Kingsford Smith) Airport already cross the Greater Blue Mountains Area, they currently do so at heights that minimise these intrusions. The proposed flight paths would mean that aircraft are lower over areas of the Blue Mountains National Park, as they approach and depart WSI. The project would not affect all Aboriginal cultural places and practices throughout the much larger expanse of the GBMA, and First Nations people will continue to have a custodial relationship with the area. Sites considered in this assessment that are located within the GBMA (identified through engagement with stakeholders on sites of high cultural value) would not be severely impacted, and assessed sites would not be comprised to the level that comprises the values of the place, or would result in discontinuation of cultural practices at these sites (with the exception of Aboriginal sites located at Linden Ridge which may, due to potential visual and noise disruption, result in moderate, increasing to severe, impacts over time).

23.4.5.3 Impacts on other values

Table 23.6 provides an assessment of the potential operational impacts of the proposed airport on the additional values of the GBMA identified in the Strategic Plan (NSW DECC, 2009). These values interact with and complement the World Heritage site values but are not part of the defined natural values for which the Greater Blue Mountains Area is listed (i.e. Outstanding Universal Value).

Table 23.5 Outstanding universal value impacts on the GBMA from the project

Criterion	Criterion description	Flight path impacts	Assessment of significance
Criterion (ix) ongoing evolutionary processes	The inscribed values of the GBMA for this criterion is associated broadly with: • outstanding and representative examples of: – evolution and adaptation of the genus *Eucalyptus* and eucalypt-dominated vegetation on the Australian continent – 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*) – Blue Mountains pine (*Pherosphaera fitzgeralii*).	The significant aspects of scleromorphic flora and the existence of primitive species (including the *Eucalyptus* and eucalypt-dominated vegetation) present are representative of evolutionary processes for which the GBMA has been identified. Impacts on these attributes would only be anticipated to occur in instances where there was a direct impact to this flora as a result of ground disturbance or significant pollution resulting in loss of habitat or alteration to the existing evolutionary processes. Potential direct impacts from the operation of the flight paths are expected to be limited to the potential for wildlife strike to some bird species whose habitat is within the GBMA, or potential impacts associated with the unlikely event of an aircraft crash (and resultant potential impacts such as loss of vegetation, fire or potential pollution resulting) noting that, in the unlikely occurrence of such an event, the impact would only occur at a localised level. Ecologically, no operational activities are anticipated to result in impacts such that they would affect the existing inscribed values of outstanding ecological diversity for the GBMA or contribute to a decline in the habitat of the area that supports a significant range of species. As such, it is considered that the operation of the proposed flight paths would result in no discernible impacts associated with the aspects of this criterion. Indirectly, noise and air emissions may result in some minimal impacts, however given the altitudes at which aircraft would be flying at the points at which they have the potential to impact on the GBMA, these impacts are not considered to present a threat to the values listed in this criterion values.	The proposed flight paths would not result in any direct impacts on the attributes demonstrated within the GBMA relevant to evolutionary processes or to the potential for direct impact of primitive plant life species of outstanding significance such as the Wollemi Pine or Blue Mountains pine. Additionally, it is not considered that the operation of the proposed flight would result in any indirect impacts which may cause the World Heritage value to be being lost, degraded or damaged, or notably altered, modified, obscured or diminished. Accordingly, it is considered that the project would not have a significant impact on the attributes identified for this World Heritage criterion.

Criterion	Criterion description	Flight path impacts	Assessment of significance
		Air emissions from the operation of aircraft utilising the proposed flight paths are not expected to result in material contribution to global climate or overall air emissions that may impact on the evolutionary processes, or adaptation, of the existing environment. Additionally, direct emissions from fuel jettisoning are rare and, where undertaken in line with strict regulations guiding this process, disperses rapidly and evaporates prior to reaching the ground. As such, air emissions are not anticipated to have an impact on evolutionary processes of the GBMA. The expected noise emissions from overflights is not expected to affect the evolutionary processes associated with the GBMA. Noise may indirectly result in some impacts to certain species currently existing within the GBMA, however given the altitudes at which aircraft would be flying at the points at which they have the potential to impact on the GBMA, the resultant noise impacts are not considered to present a threat to the biodiversity values for which the site was listed. Increases or changes to existing noise levels associated with the project within the GBMA would be largely limited and the predicted noise levels are unlikely to be of a magnitude that would threaten the viability of biodiversity attributes within the GBMA. The project's operational light would be limited to lights on aircraft as they travel along the flight paths during nocturnal hours. The magnitude of visual impacts at night (including light spill) would be experienced across a small portion of the urban area and would not contrast substantially with the surrounding landscape at night, and would not result in any impacts to the inscribed values of the GBMA for this criterion.	

Criterion	Criterion description	Flight path impacts	Assessment of significance
Criterion (x) biological diversity	The inscribed values of the GBMA for this criterion is associated broadly with: • 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 • habitat that supports 52 mammal species, 63 reptile species, over 30 frog species and about one third of Australia's bird species.	Ecologically, no operational activities are anticipated to impact on the existing outstanding ecological diversity of the GBMA or contribute to a decline in the habitat of the area that supports a significant range of species. As such, it is considered that the operation of the proposed flight paths would result in no discernible impacts associated with the aspects of this criterion. Air emissions from the operation of aircraft utilising the proposed flight paths are not expected to result in material contribution to global climate or overall air emissions that may impact on the evolutionary processes, or adaptation, of the existing environment. Additionally, impacts from fuel jettisoning are rare and, where undertaken in line with strict regulations guiding this process, disperses rapidly and evaporates prior to reaching the ground. As such, air emissions are not anticipated to have an impact on evolutionary processes of the GBMA. The assessment of potential noise emissions indicates that noise from overflights would not impact biological diversity values of the GBMA. Although the peak noise levels associated with direct overflight of the GBMA may temporarily disturb some species, flight paths associated with WSI would generally be between at least 1,500 and 10,000 ft (or more) above ground level at most locations over the GBMA. A majority of the area within the boundaries of the overall GBMA site would not be expected to have noise levels which exceed around 60 dB(A). Some smaller areas of the site (such as areas to the west of WSI and north of Lake Burragorang) may, at times, experience slightly higher levels of noise above 60 dB(A). These impacts are likely to be intermittent with generally low levels of aircraft movement and are unlikely to cause disturb to fauna within the GBMA, or affect the habitats of these fauna.	The proposed flight paths would not result in any direct impacts on the examples of biological diversity present within the GBMA. Additionally, it is not considered that the operation of the proposed flight paths would result in any indirect impacts which may cause the World Heritage value to be being lost, degraded or damaged, or notably altered, modified, obscured or diminished. Accordingly, it is considered that the project would not have a significant impact on the attributes identified for this World Heritage criterion.

Criterion	Criterion description	Flight path impacts	Assessment of significance
Integrity	The integrity of the GBMA area is associated broadly with: • the level of protection (e.g. NPs and declared wilderness areas), size, topography and certain adjoining land uses (State Forests etc) • the size, condition (high wilderness quality) and connectivity of the natural bushland, plant communities and habitats. This extends to adaptation opportunities and ecological processes • its geological, geomorphology and water systems, which require the same level of protection • Aboriginal cultural values and custodial relationships.	The implementation of the proposed flight paths would not result in any change to the boundaries of the GBMA or the physical size of the area or the adjoining lands and buffer zones. The operation of the proposed flight paths is not expected to have any impact on the plant communities and habitats within the Greater Blue Mountains Area to a level that would impact on the integrity of the existing environment. As the project would not result in any physical or direct impacts at ground level, the implementation of the proposed flight paths would result in any impacts to the size, condition or existing connectivity of the natural bushland, plant communities and habitats which currently existing within the GBMA. The GBMA contains numerous waterways and other water systems including major systems such as the Nepean, Hawkesbury and Grose Rivers in the east, Lake Burragorang and the Coxs, Kowmung and Abercrombie Rivers to the west and south, and the Wolgan, Wollangambe and Colo rivers towards the central area and the McDonald, Bylong and Goulburn Rivers to the north. Potential impacts on this value would be anticipated to occur in the unlikely event there was an aircraft crash or through other operational actions resulting in potential harm to a waterway or water catchment (such as through fuel jettisoning). The proposed flight paths would also not directly impact the existing use of or maintenance of existing Aboriginal cultural practices within the GBMA. The proposed flight paths would fly over a number of significant cultural sites and places, however in many cases existing flight paths already traverse the airspace above these sites and places. In addition, many of the types of heritage places identified are considered robust in the face of impacts such as air pollution, noise and visual impacts.	The proposed flight paths would not result in the loss of any elements necessary for the Greater Blue Mountains Area to express its Outstanding Universal Value, including potential impacts to the size, condition, ability to maintain connectivity or provide protection to its geological, geomorphology and water systems. The proposed flight paths would not change the size or boundary of the GBMA and would not impact on any features and processes that convey the Greater Blue Mountains Area's Outstanding Universal Value or its existing integrity. While the project would not have a direct impact on the physical evidence of the cultural connection to the GBMA, it is inevitable that visual presence and aircraft noise would have the potential to impact some Aboriginal sites within the GBMA, and the integrity of these areas with respect to custodial relationships. The project would not affect all Aboriginal cultural places and practices throughout the much larger expanse of the GBMA, and First Nations people will continue to have a custodial relationship with the area. Sites considered in this assessment that are located within the GBMA (identified through engagement with stakeholders on sites of high cultural value) would not be severely impacted, and assessed sites would not be compromised to the level that compromises the values of the place, or would result in discontinuation of cultural practices at these sites (with the exception of Aboriginal sites located at Linden Ridge which may, due to potential visual and noise disruption, result in moderate, increasing to severe, impacts over time).

Table 23.6 Impacts on other associated values GBMA from the project

Values	Criterion attributes	Flight path impacts	Assessment of significance
Geodiversity and biodiversity	• Extensive dissected sandstone plateaus • Karst landscapes with several cave systems • Prominent basalt-capped peaks • Quaternary alluvial deposits • Specific sites of international or national significance	Potential impacts on this value would only occur in the unlikely event of an aircraft crash or from significant pollution resulting in loss of biota at a localised level (such as through fuel jettisoning). Any such impacts would be localised and are unlikely to have a significant impact on biota and habitats. No operational activities would have an impact on the identified criterion attributes and as such no impact on this overall value is expected to occur as a result of the project.	The proposed flight paths are not anticipated to result in a significant impact on the geodiversity and biodiversity values associated with the GBMA.
Water catchment	• Wild rivers • Pristine and relatively undisturbed catchment areas • Substantial contribution to maintaining high water quality.	The GBMA contains numerous waterways and waterway catchments including major systems such as the Nepean, Hawkesbury and Grose Rivers in the east, Lake Burragorang and the Coxs, Kowmung and Abercrombie Rivers to the west and south, and the Wolgan, Wollangambe and Colo rivers towards the central area and the McDonald, Bylong and Goulburn Rivers to the north. Portions of the GBMA also includes part of the water catchment areas for the Warragamba Catchment. Four additional areas, which make up the Blue Mountains catchment (comprising the areas associated with Greaves Creek Dam, Medlow Dam, Cascade Dams and Woodford Dam) also adjoin areas of the GBMA. Potential impacts on this value would only be anticipated to occur in the unlikely event there was an aircraft crash or through other operational actions resulting in potential harm to a waterway or water catchment (such as through fuel jettisoning).	While the contamination of the water is a possibility in the event of a crash, it is expected that the probability of a crash impacting on water quality or occurring within a large body of water such as Lake Burragorang is very low. In the unlikely event of a fuel spillage from a crash, there may be some localised impacts to water quality, however these are expected to be minimal given the dilution which would be involved in such a large area of water, including portions of the Warragamba Catchment. Additionally, while aircraft crashes are uncommon, the majority also occur along flight paths and close to the runway ends where the crash risk is more concentrated (i.e. not within the boundary of the GBMA). While a crash could occur, it would be a remote possibility and the likelihood that it would result in a significant impact on water quality or other water catchments or rivers would be expected to be similarly minimal.

Values	Criterion attributes	Flight path impacts	Assessment of significance
			With respect to fuel jettisoning, this action is only required in extremely rare circumstances in the event of an emergency and is only relevant for certain types of aircraft. Fuel jettisoning may introduce harmful contaminants into the sensitive native terrestrial and aquatic ecosystems associated with the GBMA. If required, fuel jettisoning would be carried out safely in accordance with appropriate procedures. This would involve jettisoning fuel over the sea (where practicable) and at sufficient altitude so fuel would volatise (change from liquid to vapour) as it falls and be completely dispersed as vapour before any liquid reaches the ground. Given the strict regulations associated with its implementation and the high evaporation rate of the fuel at higher altitudes, potential impacts are considered to be negligible and unlikely to have an immediate or future impact on water catchment values. Overall, the project is not anticipated to result in a significant direct or indirect operational impact on the water catchment values (or the extensive waterways) associated with the GBMA.
Cultural values (Aboriginal)	• Prominent landscape features with spiritual significance: – Mt Yengo – Coxs River and Wollondilly River valleys • Aboriginal rock art • Potential for uncovering further significant sites.	The proposed flight paths would also not directly or indirectly impact the existing use of or maintenance of existing Aboriginal cultural practices within the GBMA. There are places just outside the GBMA where cultural practices will be impacted and in the case of Bents Basin, that place is linked to other places in the GBMA. These impacts are discussed in detail in Chapter 17 (Heritage) and Technical paper 9.	It is acknowledged that there are prominent landscape features with spiritual significance within the GBMA that are important places for contemporary ceremony and practice. While the project would not directly impact the existing use of or maintenance of Aboriginal cultural practices within the GBMA, it is acknowledged that the proposed flight paths would fly over a number of significant cultural sites and places. In many cases, existing flight paths already traverse the airspace above these sites and places.

Values	Criterion attributes	Flight path impacts	Assessment of significance
		The proposed flight paths would fly over a number of significant cultural sites and places, however in many cases existing flight paths already traverse the airspace above these sites and places, including prominent landscape features with spiritual significance as well as known Aboriginal rock art sites. The distribution of the majority of known rock art sites occurs across a number of areas within the Sydney Basin, including throughout the GBMA. In the Sydney Basin, art sites generally only occur in sandstone-based topographies (formed on the Hawkesbury and Narrabeen sandstones) which support open sandstone platforms and overhangs. It should be noted that the actual number and incidence of rock art sites within the GBMA is likely to be greater and higher than those which have been formally identified through previous studies. The operation of the proposed flight paths is also not expected to result in the potential for uncovering further significant sites.	In addition, it is acknowledged that designing flight paths to avoid all Aboriginal and non-Aboriginal sites of cultural value would be impossible. In most cases aircraft would be at such a distance as to render the impact from these factors as minimal and are not expected to impact the overall integrity of the GBMA in relation to Aboriginal cultural values and custodial relationships. Although it is possible to outline processes of potential rock art deterioration related to aircraft emissions, it is as yet, impossible to evaluate the risk presented by these processes, or indeed to identify and quantify any resulting damage. As a consequence of the relative location of the WSI on the distribution of rock art sites across the Sydney basin, it is considered that the higher concentrations of atmospheric pollutants associated with the proposal are most likely to occur within the local area of WSI (within a 5-kilometre radius). While a substantial number of both arrival and departure flightpaths overfly the sandstone ranges within the GBMA, given their height and distance from the WSI site, the impacts are unlikely to extend into the proximity of a majority of the rock art sites located within the GBMA.

Values	Criterion attributes	Flight path impacts	Assessment of significance
Cultural values (historic heritage)	• Small graziers' huts • Cedar logging roads and stock routes • Ruins of oil shale mines and coal/shale mines • Road and transport routes • Recreation and tourism.	Operation of the proposed airport would not directly impact sites within the GBMA that have historic heritage values. Indirect impacts on recreation and tourism are considered below.	The proposed flight paths are not anticipated to result in a significant impact on the historic heritage values associated with the GBMA. Of the listed non-Aboriginal heritage items, the greatest potential for impact to the value of the item would be on the Blue Mountains Walking tracks. There are 37 walking tracks listed on the SHR under this collective title. While the fabric and functionality of the tracks would not be impacted by overhead flightpaths, it is important to note that these tracks are a key to facilitating visitor access and are how most visitors experience them. The potential for intrusion (particularly noise but also to some extent visual) would have the potential to reduce the intangible values of these tracks (i.e. serenity, connection to nature, etc.). Visitors may experience some changes to the use and enjoyment of walking tracks within the Blue Mountains as a result of the project. People who visit and use these walking tracks where they fall within the N60 contours may be likely to experience moderate changes to their use and enjoyment, where some tracks have been identified. The majority of the broader GBMA is also largely outside the area predicted to experience aircraft noise at or above 60 and 70 dB(A). Indirect impacts on individual sites with historic cultural values (from impacts such as emissions and visual intrusion) are expected to be minimal.

Values	Criterion attributes	Flight path impacts	Assessment of significance
Recreation and tourism	• Vantage points on ridges and escarpments, offering outstanding vistas, from uninterrupted views of forested wilderness • Canyoning, bushwalking, rock climbing, nature observation, scenic driving, photography • Picnic sites and basic camping facilities • Catering, tours, accommodation	There are numerous vantage points on ridges and escarpments within the GBMA including: • Echo Point Lookout, Katoomba which offers panoramic views across GBMA including the Three Sisters, the Jamison Valley, Mount Solitary and Narrow Neck • Portal Lookout, offering views of the junction between Glenbrook Gorge and the Nepean River • Nepean Lookout, Nepean Lookout Trail • Walls Lookout, Bells Line of Road • The Rock Lookout, Mulgoa. Additionally, other recreation and tourism features which currently occur within the GBMA include: • campgrounds and day use areas such as: – Euroka Campground, Glenbrook – Perrys Lookdown, Blackheath – Dunphys Campground, Megalong Valley – Ingar, Wentworth Falls – Murphys Glen, Woodford	While the line of sight between these vantage points to the forested wilderness would not be interrupted due to the height of the aircraft, there would be views where additional aircraft (to those associated with existing flight paths over the GBMA) would be seen flying overhead and across these views. The aircraft would range in height and distance from these locations but would be at least 1.5 km (5,500 feet) high and therefore of a relatively small scale. There may be locations where multiple aircraft are seen together, as the flight numbers increase over time (i.e. 2055 scenario), and where multiple flight paths intersect or overlap. The visual amenity and wilderness experience of these recreational activities would generally not be substantively impacted by the project. The visual impacts of the project have been concluded as being likely to be negligible to moderate-high. Walls Lookout and Echo Point would experience a moderate-high visual impact due to the high sensitivity of these views and the introduction of flights that would be perceptible moving across the view even though the altitudes are high. However, within the more remote and wilderness areas of the GBMA, there are scattered day use facilities and campgrounds. The camp sites are generally located in areas of high scenic quality and are generally considered to have a high sensitivity to impact. The effect of the project on campgrounds and day use areas would result in a slight reduction in the amenity of views resulting in moderate overall visual impacts. However, it is noted, these aircraft would be at an altitude of over 1 kilometre (5,000 ft), and would generally be visible only at a small scale in the sky.

Values	Criterion attributes	Flight path impacts	Assessment of significance
		• scenic and tourist drives such as: – ‘Warragamba Waters scenic drive’ along Silverdale Road and part of the ‘Greater Blue Mountains Drive, identified by NSW NPWS. – ‘Greater Blue Mountains scenic drive’, including the Great Western Highway, from Sydney along the M4 towards the Blue Mountains and part of the ‘Greater Blue Mountains Drive’. There are also numerous historic Lookouts and walking tracks along the central Blue Mountains ridgeline. This includes many Lookouts between Wentworth Falls and Katoomba which are oriented to the south and towards the proposed WSI, including Echo Point Lookout, Wynnes Rocks Lookout, Walls Lookout (including the surrounding Victoria Falls, Mount Banks Picnic area and Lookout, Anvil Rock Lookout and the Baltzer Lookout).	Additionally, there would be some tourist and recreational areas of the GBMA that would experience maximum noise levels of 60 dB(A) and greater. These location would include sites such as The Rock Lookout, the Nepean Lookout, The Oaks area, Murphys Glen, Ingar Campground, Katoomba River campground, Clearly Memorial Lookout, Ruined Castle Lookout, Wynnes Rock Lookout, Mount Banks picnic area and Lookout, Anvil Rock Lookout, Baltzer Lookout, Victoria Creek Cascades, Victoria Falls, and Burra Korain campground. The level of visitation in these areas is much lower than the Upper Blue Mountains. The noise impacts are not considered significant enough to result in any measurable economic impacts in terms of tourist visitation numbers to Blue Mountains area. Overall, the experience of some of these recreational activities may be slightly reduced by increased visual or noise intrusion associated with by aircraft movements.

Values	Criterion attributes	Flight path 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 • Aesthetic, spiritual and intrinsic value.	As noted in the Integrity statement for the GBMA, 65 per cent of the area is designated as statutory wilderness. These areas are located primarily in the northern section of the site. The GBMA includes 5 declared wilderness areas through formal recognition of the Wilderness Act (Wollemi, Kanangra-Boyd, Nattai, Yengo and Grose) which encompasses over 551,000 hectares of wilderness areas in the GBMA. The Blue Mountains wilderness areas also protect 3 of only 6 streams declared as 'Wild Rivers' in NSW under the NP&W Act: the Colo, Grose and Kowmung. Access to these areas is predominantly limited to hikers and other low impact tourism activities. Aircraft operations would include various flight paths that would traverse above each of these wilderness areas. As a result of the operation of the flight paths, some areas of Wollemi National Park, Kanangra-Boyd National Park, Yengo National Park and Natti National Park (night time only) would have the potential to be affected by noise associated with infrequent overflights of aircraft. Aircraft over flying these areas would be able to be seen from these declared wilderness areas, including infrequent overflights at night.	The proposed flight paths are not anticipated to result in a significant impact on the wilderness values associated with the GBMA. While some noise and visual impacts may potentially occur to the wilderness areas, these are considered to be generally insignificant for a vast majority of wilderness areas and are not considered to be such that they would interfere with the values attributed to the wilderness nature of the GBMA. As a result of the proposed overflights, a small proportion of the wilderness areas may be impacted by visual and lighting changes (night time), however, these are considered to be insignificant for a vast majority of wilderness areas. The proposed lighting from aircraft at night is considered to be minimal when considered in the context of their contribution to urban sky glow within the broader Sydney Basin.

Values	Criterion attributes	Flight path impacts	Assessment of significance
Social and economic	• Regional economy largely supported by tourism • The GBMA has considerable social and economic value and contribute directly and indirectly to the employment, income and output of the regional economy.	The location of the flight paths over the GBMA have the potential to negatively affect the tourist experience of the area either through the visual location of planes or the noise they would generate, as well as the social and economic value that tourists contribute directly and indirectly to the employment, income and output of the regional economy. Negative (or perceived negative) impacts associated with the project could lead to a reduction to the number of tourists coming to the local area and in turn can reduce the tourist dollars being spent in the local economy.	While most tourists who visit the Greater Blue Mountains are day trippers, there are a number who stay overnight and longer. Noise affecting tourist accommodation such as hotels, motels and camping grounds would have the potential to lead to fewer tourists staying for more than a day which could have a marked impact on the local tourist accommodation. It is noted however that there is only one short stay accommodation place within N60 contour within the Blue Mountains, meaning the potential of impacts on this type of accommodation would be minimal. The key impact that may affect people visiting the Blue Mountains for a day could be impacted due to the noise while they are undertaking any outdoor pursuits (including overnight tourist activities such as camping). There could also be a reduction on the amount of tourists visiting local eateries, shops, and markets leading to a reduction in the indirect benefits of the GBMA tourist areas. Conversely, it is expected that the location of an international airport closer to the GBMA could also provide a boost to the tourists within the area outweighing the potential impact of the flight paths. As planes fly over such a distinct and unique area of Australia, tourists would be able to gain an appreciation over the area and could choose to stay in the area for longer. The flights that would use WSI could bring more people into Western Sydney who may have always flown into Sydney (Kingsford Smith) Airport and therefore not been close enough to the area for a visit.

Values	Criterion attributes	Flight path impacts	Assessment of significance
			Based on consideration of the potential social and economic impacts identified, it is expected that impact to the visitor economy and livelihoods associated with the Blue Mountains World Heritage Listing is low. The project is not expected to result in a substantial impact to the social and economic values that contribute directly and indirectly to the employment, income and output of the regional economy associated with the GBMA.
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 • Education value for schools and universities.	Operation of the proposed flight paths area is not expected to have an impact on the biological diversity of the GBMA or the availability of the area for scientific investigation and research.	The proposed flight paths are not anticipated to result in a significant impact on the research and education values associated with the GBMA.

Values	Criterion attributes	Flight path impacts	Assessment of significance
Scenic and aesthetic	• Vertical cliffs, waterfalls, ridges, escarpments. • Outstanding vistas, uninterrupted views of forested wilderness • Extensive caves • Sandstone canyons and pagoda rock formations.	Aircraft overflying key tourism and recreation areas would be more than 5,000 feet (1.5 km) above the relevant ground level and at this altitude, would have limited visual intrusion. Similarly, visual and lighting impacts of WSI are not considered to represent a significant change to existing conditions for scenic and aesthetic amenity.	Aircraft would be at least 1.5 km (5,000 feet) above the Blue Mountains, in the vicinity of key views and would not obstruct views to the sandstone canyons and pagoda rock formations. There are currently aircraft visible intermittently over the Blue Mountains, however, there would be more frequent flights and flights seen in key viewpoints and campgrounds across the GBMA including in views from Echo Point, Rock Lookout, Cleary Memorial Lookout and Portal Lookout. Views to narrow sandstone canyons and pagoda rock formations, such as in views to the 'Three Sisters' Lookout at Echo Point, Katoomba would include distant aircraft crossing views at a high altitude in the background. The scenic value of these views would be altered slightly reducing the visual amenity of these views. Due to the very high sensitivity of these views, a low magnitude of change would result in a high-moderate adverse visual impact. With respect to each of the other individual criteria attributes: • views to vertical cliffs and waterfalls, ridges and escarpments may include distant aircraft where they are overflown by air traffic, however these would not impact on the existing attributes of these features • there would be no direct or indirect impact on the cave networks as views to these features do not rely on views of the sky.

Values	Criterion attributes	Flight path impacts	Assessment of significance
Bequest, inspiration, spirituality and existence	• Opportunities for solitude and quiet reflection • Aboriginal cultural connections • Ensuring that future generations can experience and appreciate the uniqueness of the areas associated with the GBMA.	Operation of the proposed flight paths area is not expected to have a direct impact on the existing inspiration, spirituality and existence values of the GBMA. A key concern raised by First Nations knowledge holders and by owners and managers of heritage properties as part of the preparation of the impact assessment for the project did identify the potential for increased noise at heritage places especially where the cultural values relate to connecting with nature, spirituality (including but not limited to connections between the skyscape and landscape), experiencing a sense of serenity and well-being.	Overall, it is acknowledged that designing flight paths to avoid all Aboriginal and non-Aboriginal sites of cultural value would be impossible, including those associated with the GBMA. The proposed flight paths would fly over a large number of significant sites and places, however in many cases existing flight paths already traverse the airspace above these sites and places. In addition, many types of heritage places are considered robust in the face of impacts such as air pollution, noise and visual impacts. In most cases aircraft would be at such a distance as to render the impact from these factors as minimal. However, the places closest to WSI are likely to experience higher impacts.

23.4.5.4 Cumulative impacts

Cumulative impacts have the potential to occur when impacts from a project interact or overlap with impacts from other projects. These impacts can potentially result in a larger overall effect (positive or negative) on the environment.

Related actions, proposals and impacts

Table 23.7 summarises the proposals/projects or ongoing actions that have been identified, or are currently being taken within the broader vicinity of the project that may result in cumulative impacts on the GBMA.

Table 23.7 Related actions and proposals

Related action(s) or proposal	Overview
Warragamba Dam Raising project	The proposed Warragamba Dam Raising project proposes to increase the height of the existing Warragamba Dam wall in order to provide additional flood mitigation through increased temporary storage allowing for improved controlled water release. While not directly located within the GBMA site, the project would be located adjacent to the southern end of the GBMA within the Wollondilly Shire LGA. The project has been deemed to be a controlled action (reference number 2017/7940) and is subject to approval under the EPBC Act. Upstream areas that could be impacted by the project are located within the GBMA. On 8 June 2023, WaterNSW (as the proponent) provided an update on the status of Warragamba Dam on its website and stated that it is not NSW Government policy to raise the dam wall for flood mitigation or additional storage (WaterNSW, 2023). WaterNSW (2023) advised that it is now assessing what are the practical and reasonable ways to reduce risks to downstream communities associated with extreme floods and to adapt to climate change in line with contemporary dam safety regulatory standards. Investigations are now underway to explore what measures may be required to address these risks and as such the required work (which could be infrastructure or non-infrastructure related) is not known. As WaterNSW (2023) has stated that dam rising for the purposes of flood mitigation is no longer proceeding and any required future work (and therefore impacts) are undefined, this assessment has not considered this project further.
Great Western Highway upgrade program	Transport for NSW is currently working on a program to upgrade sections of the Great Western Highway throughout the Blue Mountains. The works currently in delivery include upgrades to locations such as Medlow Bath, Mount Victoria and between Little Hartley and Lithgow. These upgrades would provide important economic and safety benefits and would improve the connection between Central West NSW and Sydney for thousands of residents, commuters, tourists and freight operators who travel in, around and through the Blue Mountains. While providing important access improvements, the increased access is also likely to increase traffic within the region and may allow for increased urban development of the region. Additionally, the improved access may also result in increased levels of tourism accessing the region. These factors may result in indirect impacts to the GBMA (such as increased noise and air quality) and may potentially lead to contributing to diminishing of the values associated with the GBMA. Additional upgrade works have also been identified between Katoomba and Blackheath, and between Little Hartley and Lithgow that would generally split the existing road configuration into 2 lanes in each direction. Timing for the delivery of these works is however currently known.

<table>
<tr><th>Related action(s) or proposal</th><th>Overview</th></tr>
<tr><td>2019–2020 bushfire impacts</td><td>The 2019-20 bushfires in NSW were unprecedented in their extent and severity in recent history. They occurred during a period of record-breaking temperatures and extremely low rainfall with the Australian Government Bureau of Meteorology determining 2019 was Australia's warmest and driest year on record (DAWE, 2020).

The GBMA was affected by bushfire from late October 2019 to early February 2020. During this time, more than 60 per cent of the GBMA was fire-affected and more than half of this burnt with high or very high severity (DCCEEW, 2022f). While assessment of the overall impacts of the fires on the GBMA Outstanding Universal Value are still to be fully quantified, it is estimated that a number of ecological communities known to occur in the Greater Blue Mountains Area are at high risk of decline due to the combined effects of high fire frequency and drought.

Impacts of the fires identified to date have included impact to the following important environmental values within the Greater Blue Mountains Area (DCCEEW, 2022f):
• 10 Threatened Ecological Communities including Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion, Temperate Highland Peat Swamps on Sandstone and Lowland Rainforests of Subtropical Australia
• around 99 animals including the following threatened species (all of which have both NSW and Commonwealth status of either endangered and/or vulnerable): Blue Mountains Water Skink, Broad-headed Snake, Brush-tailed Rock-wallaby, Koala, Spotted-tail Quoll, Gang-gang Cockatoo and the Stuttering Frog
• around 101 plant species including the Wollemi Pine, Benson's Stringybark, Kowmung Hakea, Fletcher's Drumsticks, and Paddys River Box.</td></tr>
<tr><td>Mining</td><td>At its 43rd session in 2019 the World Heritage Committee requested the Australian Government undertake an assessment of the potential cumulative impacts of all existing and planned mining projects in the vicinity of the Greater Blue Mountains Area. In response to this request, the Australian Government commissioned CSIRO to undertake a comprehensive review of the potential risks from mining near the Greater Blue Mountains Area, releasing the Potential cumulative impacts of mining on the Outstanding Universal Value of the Greater Blue Mountains Area in 2022 (DAWE, 2022).

The report identified that at the time of preparation of the report, 15 existing and planned open-cut and underground coal mines and 3 sand mines within 20 km of the GBMA were identified as potential threats to its Outstanding Universal Value. The report identified a highly conservative potential cumulative impact area of 1,984-square km within the 10,438-square km GBMA, distributed across 6 discrete areas, where cumulative impacts from mining could occur in the absence of protection and management measures. Within the identified potential cumulative impact area, the risk of significant impacts to components of the property's Outstanding Universal Value is assumed to generally decrease with increasing distance from the mining areas.

The report identified that the greatest mining-associated risk to the Outstanding Universal Value was potentially to the 'water systems' of the GBMA via water table lowering and changes in streamflow, water quality and channel condition. Water systems of the GBMA include streams, riparian areas and many groundwater-dependent ecosystems, occupying about 400 square km potential cumulative impact area. The Australian Government used the independent CSIRO analysis to determine residual risk of the identified mining operations to the 8 high-level components of the Outstanding Universal Value. Overall, the residual risk to the Outstanding Universal Value of the GBMA was assessed as 'low' because most potential impacts are currently effectively mitigated by strict environmental conditions imposed on mine operators.</td></tr>
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Assessment of impacts

Potential cumulative impacts on the GBMA associated with the project and the related actions/impacts identified in Table 23.7 include:

- incremental increases in potential wildlife injury or mortality due to wildlife strike (in particular associated with cumulative impacts associated with Great Western Highway upgrades)
- incremental increases of noise and light exposure that may disrupt species within the locality for example lead to species relocating or alter species behaviour and communication
- alterations to air quality, greenhouse gas emissions and water quality (in particular associated with cumulative impacts associated with ongoing mining).

Potential cumulative impacts on the GBMA resulting from the project are considered to be minimal, as the project is not expected to result in significant on-ground impacts. Despite this, the project does however have the potential to result in contributing incremental increases in impacts such as wildlife strike, noise, light and alteration of the overall air quality within the GBMA.

Overall, aircraft operating from WSI concurrently with aircraft from other Sydney Basin airports have the potential to increase overall noise exposure of communities being directly overflown by the preliminary flight paths, immediately peripheral to and further surrounding WSI, and underneath or along the other flight paths in use. Overall noise exposure in a geographic area as large as the Sydney Basin does not necessarily translate into a quantifiable cumulative increase in impact. WSI will introduce additional aircraft into an already complex and heavily trafficked Sydney Basin airspace environment. In 2033, this additional traffic is projected to represent around 9 per cent of total projected Sydney Basin air traffic movements (estimated to be over 890,000 movements inclusive of the expected 81,000 movements projected at WSI in 2033). The cumulative contributions of impacts from the project, in addition to the impacts that are expected from projects such as the Great Western Highway upgrades and ongoing mining projects in areas adjacent to the GBMA, are considered to be minimal to negligible.

With respect to cumulative noise, it is also important to note that a 60 dB(A) event in an area already experiencing for example 70 dB(A) would not result in an arithmetic addition of exposure. Rather, the resulting addition of sound waves reaching the human ear will be less than 71 dB(A) and the difference not discernible to the human ear.

23.4.5.5 Assessment of design refinements

Some areas of the GBMA to the north of Lake Burragorang would be newly overflown as part of the RRO mode of operation during implementation of the RRO-NAP. Similarly, some areas of the GBMA to the south of the Great Western Highway and to the north and east of Blackheath would no longer be overflown during this runway mode of operation. The change would continue to allow non-jet aircraft to travel along the previously identified flight paths to the north and west during the implementation of the RRO-NAP. Overall, the refinements to the preliminary flight path design since the exhibition of the Draft EIS would not change the conclusions of the assessment on MNES as presented in this chapter and Technical paper 14.

Further details of the design refinement are provided in Chapter 24 of the Submissions Report. Further discussion of the potential impacts of the design refinements with respect to MNES are provided in Appendix G (Assessment of the refinements to the project).

23.5 Mitigation and management

23.5.1 Existing management of GBMA

Strategic planning and management for the GBMA is guided by a number of policies and guidelines relating to the consideration of management of World Heritage including:

- the provisions in the *2021 Operational Guidelines for the Implementation of the World Heritage Convention* (UNESCO, 2021) which outline Australia's obligations under the World Heritage Convention
- The *Greater Blue Mountains World Heritage Area Strategic Plan* (NSW DECC, 2009) and *Greater Blue Mountains World Heritage Area Strategic Plan Addendum 2016* (NSW Office of Environment and Heritage, 2018)
- The *2013 IUCN advice note on environmental assessments* (IUCN, 2013)
- The Australian World Heritage management principles (Schedule 5 of the EPBC Regulations).

Of particular importance to the ongoing management of the GBMA are the *Greater Blue Mountains World Heritage Area Strategic Plan* (NSW DECC, 2009) and *Greater Blue Mountains World Heritage Area Strategic Plan Addendum 2016* (NSW Office of Environment and Heritage, 2018). These plans provide the frameworks for the GBMA integrated management, protection, interpretation and monitoring. The key management objectives set out in the Strategic Plan (NSW DECC, 2009) provide the basis for the management of the Greater Blue Mountains and guidance for operational strategies in accordance with requirements of the World Heritage Convention and its Operational Guidelines (UNESCO, 2021).

The Strategic Plan and Addendum identifies the following threats to the integrity of the area that require protection measures to be identified for:

- 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
- lack of understanding of heritage values.

To date, these strategic plans and guidelines have been an effective means of guiding appropriate management of impacts to date.

23.5.2 Project specific mitigation measures

No MNES-specific management and mitigation measures have been identified, however, a number of measures identified as part of supporting technical papers have identified mitigation measures that would apply to impacts associated with the potential impacts on the GBMA (refer Chapter 24 (Mitigation and management)).

23.5.3 Dependencies and interactions with other mitigation measures

Mitigation measures outlined elsewhere throughout the EIS are relevant to the management of impacts on the GBMA and include:

- Noise (Chapter 11) including:
  - the development and review of noise abatement procedures in consultation with stakeholders, including aircraft operators, airlines, WSA and FoWSA/WSI Community Aviation Consultation Group (CACG) following a draft proposal developed by the Expert Steering Group
  - to establish a CACG to ensure appropriate community engagement on airport planning and operations
  - undertaking a post-implementation review (PIR) of the flight path design and implementation.
- Aircraft hazard and risk (Chapter 13) including:
  - implementation of contingency planning to respond to the impacts of crash events as per Part 139 Aerodromes Manual of Standards 2019
  - application of existing procedures to deal with aircraft fuel jettisoning occurrences as per the Aeronautical Information Publication Australia, Part 2 – En Route (AIP ENR) (Airservices Australia, 2022a)
  - monitoring and control the presence of birds and other wildlife on or in the vicinity of WSI in accordance with Civil Aviation Safety Regulations (CASR) Part 139 MOS requirements and National Airports Safeguarding Framework (NASF) Guideline C.
- Heritage (Chapter 17): including:
  - ensuring that the detailed design phase considers Aboriginal cultural places and values, where safe and feasible
  - undertaking a research program to investigate the potential impact of aircraft emissions on historic and Aboriginal heritage sites (including rock art sites), with a particular focus on sites within the Greater Blue Mountains Area.