

7 Airspace architecture and operation

7.1 Airspace overview

A preliminary airspace management analysis was conducted to establish whether safe and efficient operations could be introduced at the proposed Western Sydney Airport through the development of indicative air traffic management designs and flight paths. The analysis indicates there are no known physical impediments that would prevent safe and efficient operations for aircraft arriving at or departing from the proposed airport.

The indicative flight paths developed through the preliminary analysis were used to model and assess the impacts of aircraft operations in the EIS. The flight paths assessed in the EIS represent one possible airspace design — aircraft operations on different flight paths would result in different noise outcomes from those presented. For the purposes of an EIS, the use of indicative flight paths is a valid approach for identifying and assessing the nature and scale of impacts arising from operations at the proposed airport and is generally consistent with the environmental assessment approach for runway infrastructure developments at other airports. The EIS has provided the opportunity for the community and stakeholders to consider the indicative flight paths and express views about their assessed impacts at an early stage in the airspace design process.

While the analysis based on the modelled indicative flight paths found that peak aircraft noise levels in the lower Blue Mountains would be below generally accepted thresholds for day and night time operations, comments in response to the draft EIS indicated significant community concern about the potential for flight paths to concentrate over a single point above the town of Blaxland.

The Australian Government has announced that the airspace design to be implemented for the proposed Western Sydney Airport will not converge arriving aircraft at a single point over the community of Blaxland. There is substantial scope to develop new flight paths for arrivals and departures that minimise the overflight of residential areas and reduce the impact of aircraft noise on the communities of Western Sydney and the Blue Mountains. Consistent with the Government's announcement, the detailed airspace and flight path design for the proposed airport will apply international best practice for managing airspace design and its associated environmental impacts.

The flight path design process will optimise flight paths on the basis of safety, efficiency, capacity, and noise and environmental considerations, while minimising changes to existing airspace arrangements in the Sydney basin. The use of relatively new satellite-based navigation technologies at the proposed airport will provide greater flexibility in planning flight paths and will allow a larger range of options to be considered for managing noise from both night and daytime operations. Extensive community and stakeholder engagement will occur throughout the flight path design process, which will commence after the Airport Plan is determined by the Infrastructure Minister. An overview of the design process is presented in Section 7.8.

Key principles that will apply to the comprehensive airspace and flight path design process for single runway operations include:

- overflights of residential areas and noise sensitive facilities will be avoided to the maximum extent possible;
- aircraft arrivals will not converge through a single merge point over any single residential area;

- the use of head-to-head operations to and from the south-west, when it is safe to do so, is an important preferred option for managing aircraft noise at night. This preferred option will be thoroughly evaluated through further detailed assessment; and
- in determining the final flight paths, the community, aerodrome operators and airspace users will be consulted extensively and flight path designs will be subject to referral under the Environment Protection and Biodiversity Conservation Act 1999.

The Department of Infrastructure and Regional Development will be responsible for delivering the flight path design for the proposed Western Sydney Airport, working in close collaboration with Airservices Australia and the Civil Aviation Safety Authority (CASA). The proposed airspace design arrangements will be formally referred under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). CASA would ultimately approve the proposed airspace management arrangements, including the authorisation of final flight paths, before the commencement of operations.

7.1.1 Regulatory context

Airspace is the term used for the three dimensional space in which aircraft are able to fly. Elements of airspace include terminal airspace, controlled airspace and restricted airspace.

Terminal airspace generally encompasses the area within 55 to 90 kilometres (30 to 50 nautical miles) from a major airport. The height of terminal airspace varies depending on the operational parameters at an airport. In the case of Sydney (Kingsford Smith) Airport (Sydney Airport), terminal airspace extends from ground level up to about 6,000 metres (20,000 feet) close to the airport. As the distance from the airport increases, the lower boundary of this zone rises in steps, beginning at 300 metres (1,000 feet) and increasing to typically about 2,300 metres (7,500 feet) at the outer edges of the Sydney region.


Controlled airspace includes the terminal airspace area and also the airspace along the flight paths between airports.

Restricted airspace includes all airspace that has restrictions placed on its use. This is generally associated with military installations or other situations where additional precautions are warranted to enhance safe operations (for example, explosives storage facilities such as the Defence Establishment Orchard Hills).

Flight paths define the anticipated routes of aircraft arriving and departing from an airport when operating on standard instrument departures or conducting approaches under instrument guidance, or under visual meteorological conditions. If the only factors to consider were those of operating efficiency, aircraft would fly by the most direct route and at the optimum altitude for reasons of economy and efficiency of flight operations. However, when other factors are taken account of, such as noise and safety considerations and the competing demands of other airspace users, the optimum route will not necessarily be the most direct one.

When departing from an airport, an aircraft follows a predetermined flight path from the end of the runway until it is established on a route that leads ultimately to its destination. Because of the greater manoeuvring options available for aircraft after take-off, there is greater flexibility in determining flight paths for departing aircraft than for aircraft landing at an airport.

Australian airspace is largely available for civil aviation use, with overall responsibility for management of the airspace shared by Airservices Australia and the Department of Defence.



CASA is responsible for airspace regulation, while Airservices Australia manages the airspace and provides the necessary air traffic control services and equipment to maintain a safe and efficient flow of air traffic.

Day to day management of the airspace is achieved through air traffic controllers who direct the various phases of flight. Air traffic management procedures are published for each airport including standard instrument departures, standard arrival routes as well as associated noise management procedures.

The efficient use of airspace in the Sydney basin is influenced by the geographic location of airport sites. The relative proximity, in airspace terms, between the proposed Western Sydney Airport, Sydney Airport and other existing facilities, such as Bankstown Airport, means that aircraft operations need to be carefully coordinated.

Runway orientation at the proposed airport is the major factor influencing the design of aircraft traffic flow patterns and flight path arrangements. Wherever operationally feasible, it is also desirable that aircraft traffic flow patterns are sufficiently flexible to minimise the effects of aircraft noise on surrounding residential and other noise sensitive areas.

7.2 Potential airspace parameters in the Sydney basin

7.2.1 Existing Sydney basin airspace

A review of the existing airspace arrangements in the Sydney basin was undertaken in March 2015 by CASA⁷. The review considered the airspace within 45 nautical miles (83 kilometres) of Sydney Airport. High levels of private operations, flight training activity, military operations and a range of other general and sports aviation activity combine to make the Sydney region one of the busiest and most complex volumes of Australian airspace, supporting Australia's busiest international airport and a number of satellite airports and aerodromes. While the commencement of operations at the proposed airport is outside of CASA's current study period, the new airport is likely to trigger a separate airspace study before the commencement of operations.

The locations of prominent existing airports and aerodromes in the Sydney region are shown in Figure 7–1.

7.2.2 Existing Sydney region airspace controls

The Sydney region airspace comprises a number of zones that are set to control the safe and efficient function of the airspace. These include:

- Class C and D control zones;
- Class C and A control areas;
- Class G uncontrolled airspace;
- Restricted areas; and
- Danger areas.

There are no prohibited areas (no-fly zones) in the Sydney region airspace.

⁷ The Sydney Basin Aeronautical Study (CASA 2015)

Sydney region airspace controls would be reviewed and varied, as necessary, to accommodate the requirements of the proposed airport and ensure the safe and efficient function of the airspace. These issues will be important considerations for the future airspace and flight path design process described in Section 7.8.

Australian airspace architecture

| | |
|-----------------|---|
| Class A: | This high-level en route controlled airspace is used predominately by commercial and passenger jets. Only Instrument Flight Rule (IFR) flights are permitted and they require an air traffic control (ATC) clearance. All flights are provided with an ATC service and are positively separated from each other. |
| Class C: | This is the controlled airspace surrounding major airports. Both IFR and Visual Flight Rule (VFR) flights are permitted and must communicate with air traffic control. IFR aircraft are positively separated from both IFR and VFR aircraft. VFR aircraft are provided traffic information on other VFR aircraft. |
| Class D: | This is the controlled airspace that surrounds general aviation and regional airports equipped with a control tower. All flights require ATC clearance. |
| Class E: | This mid-level en route controlled airspace is open to both IFR and VFR aircraft. IFR flights are required to communicate with ATC and must request ATC clearance. |
| Class G: | This airspace is uncontrolled. Both IFR and VFR aircraft are permitted and do not require ATC clearance. |

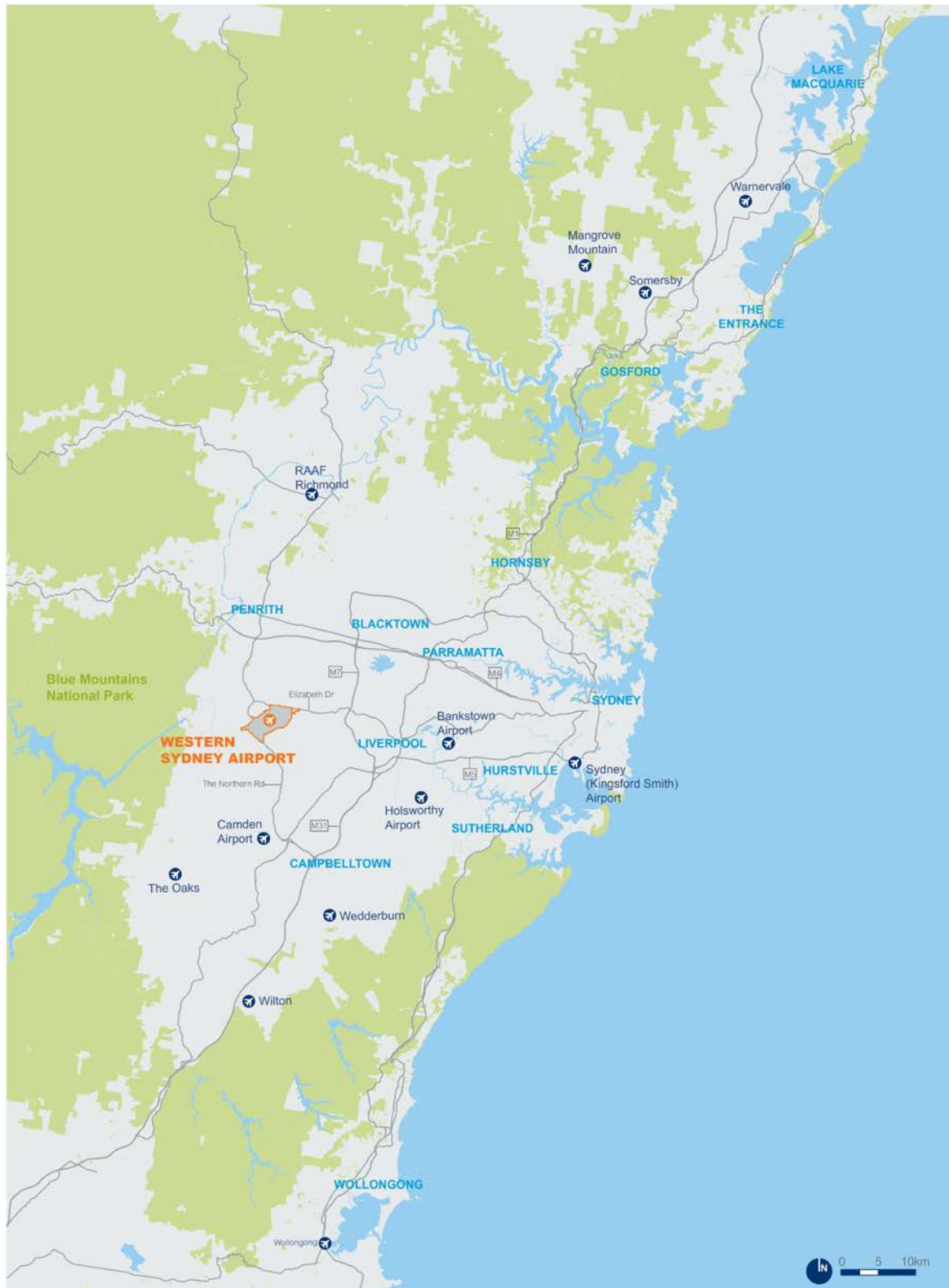


Figure 7–1 Airports and aerodromes in the Sydney region

Control zones

Control zones extend from surface level to a specified altitude in airspace surrounding major airports. There are three existing control zones within the Sydney region located at Sydney Airport, Bankstown Airport and Camden Airport. These control zones, labelled as 'CTR' are illustrated in Figure 7–2.

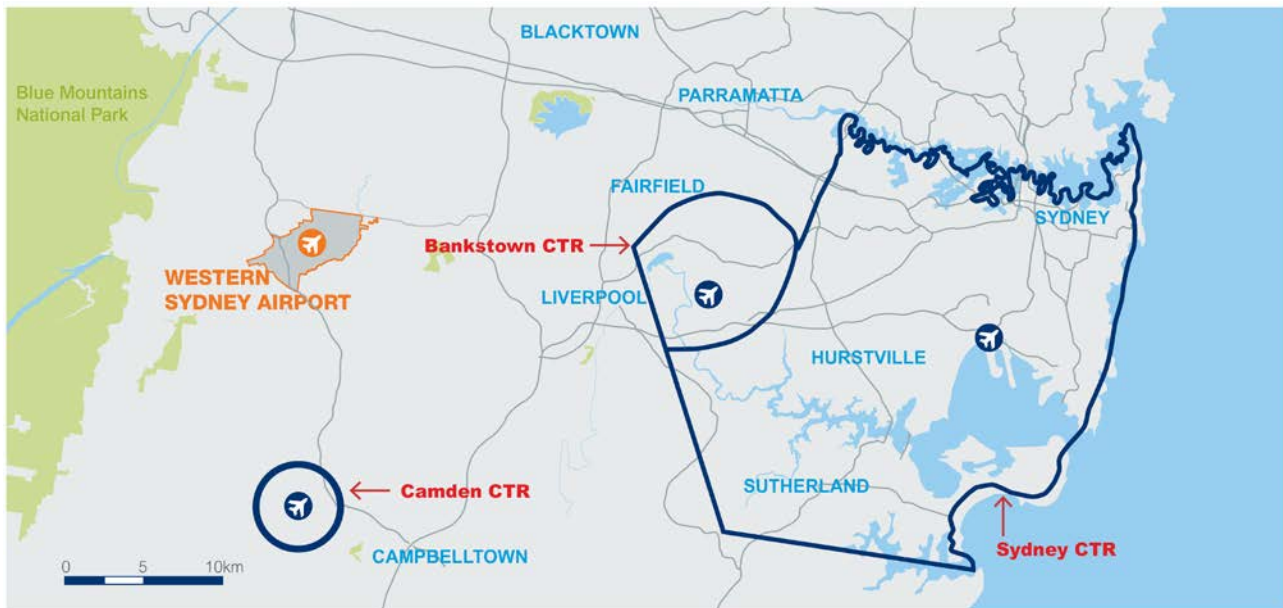


Figure 7–2 Control zones in the Sydney region

The Sydney control zone is Class C airspace from the surface to 2,500 feet (750 metres) above mean sea level (AMSL). It has an irregular boundary design extending four nautical miles to the north and up to 11 nautical miles to the south west of the airport. Sydney has a large number of published terminal instrument flight procedures that allow aircraft to safely navigate to and from the airport at times of low visibility. The Bankstown control zone is Class D airspace (controlled airspace that surrounds general aviation and regional airports equipped with a control tower) that extends from the surface to 1,500 feet (450 metres) AMSL and abuts the Sydney control zone.

The Bankstown control zone extends three nautical miles north and two nautical miles south of the aerodrome. The control zone at Bankstown also has terminal instrument flight procedures published to allow safe navigation during low visibility conditions.

The Camden control zone is also Class D airspace from the surface to 2,000 feet (600 metres) AMSL. Centred on Camden airport, the control zone has a radius of two nautical miles and includes published terminal instrument flight procedures to allow safe navigation during low visibility conditions.

Control areas

Control areas extend upwards from a specified altitude. The control areas within the Sydney region are Class C airspace. The control areas within 45 nautical miles of Sydney make up the Sydney terminal control area, which has a number of different control area steps at different altitudes. The Sydney terminal control area is controlled by Airservices Australia.

Class G airspace

Class G (uncontrolled) airspace exists below the control areas and extends from the surface to the control area lower limits. The total volume of Class G airspace within 45 nautical miles of Sydney varies depending on the activation of various restricted areas and control zones.

The Sydney basin Class G airspace supports a range of typically smaller aircraft operations including flight training (fixed wing and helicopters), parachute operations, emergency services and sports and private general aviation.

A clearance from air traffic control to enter Class G airspace is not required. Aircraft equipped with instrument flight rule equipment receive a flight information service from air traffic control including movement information on other instrument flight rule aircraft.

To aid visual flying in the Sydney region, CASA has developed an online pre-flight visualisation tool called *OnTrack*. The *OnTrack* tool replaces Visual Pilot Guides and includes all the location-specific information previously in the guides.

In order to support light aircraft and helicopter flights between the control zones and for operations over the Sydney Central Business District and along the coast, 'rules of entry' have been established for VFR aircraft in Class G airspace.

Restricted areas

The declaration of a restricted area in most cases creates airspace of defined dimensions within which the flight of aircraft is restricted, in accordance with specified conditions. Restricted areas are also allocated a conditional status (restricted area 1 – RA1, restricted area 2 – RA2, or restricted area 3 – RA3) which provides an indication as to the likelihood of obtaining a clearance to fly through the airspace (RA1 being the most likely to obtain a clearance from air traffic control).

In accordance with the Airspace Regulations 2007, CASA must not declare an area to be a restricted area unless, in the opinion of CASA, it is necessary in the interests of public safety or the protection of the environment to restrict the flight of aircraft over the area to aircraft flown in accordance with specified conditions.

Twenty restricted areas are located within 45 nautical miles of Sydney. The main restricted areas can be grouped as follows:

- RAAF Base Richmond;
- Army Range Holsworthy/Lucas Heights; and
- Tasman Sea Military Flying Training.

Other restricted areas within 45 nautical miles of Sydney are located in the vicinity of Sydney Harbour and Defence Establishment Orchard Hills (approximately 4 kilometres from the Western Sydney Airport site). Indicative locations of these restricted areas are identified as red in Figure 7–3. Outside of the 45 nautical mile radius, there are also restricted areas associated with RAAF Base Williamtown at Newcastle.

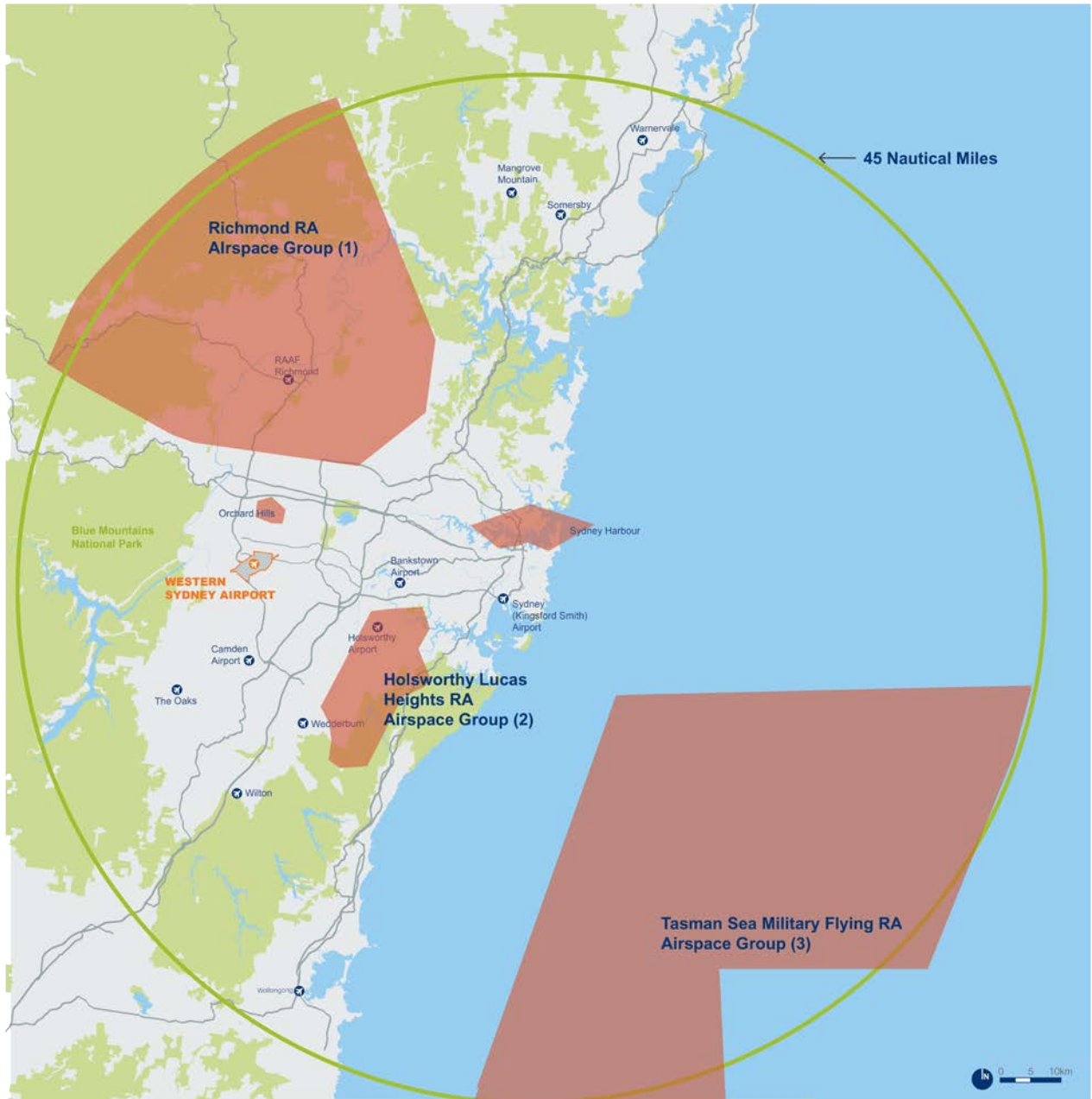


Figure 7-3 Sydney region restricted areas

The hours of operation of restricted areas can vary to accommodate a range of activities. Most restricted areas are activated by the issue of a Notice to Airmen (NOTAM) and some can be activated at standard times or based on defined conditions. Two restricted areas in the Sydney region are active 24-hours per day — these are R521 (Lucas Heights) and R555A (Military flying area, Holsworthy).

Danger areas

CASA may declare a danger area where, in its opinion, there exists an activity that is a potential danger to overflights. Approval for flight through a danger area outside controlled airspace is not required. However, pilots are expected to check the status of danger areas (its operational hours and altitude upper and lower limits) and maintain a high level of vigilance when transiting a danger area.

There are 10 danger areas located within 45 nautical miles of Sydney. Five of these encompass visual flight rule flying training areas and lanes of entry supporting operations to and from Bankstown and Camden airports. Other danger areas support parachuting and unmanned aerial vehicle testing activities. Indicative locations of the danger areas within 45 nautical miles of Sydney are identified as red in Figure 7–4.

7.2.3 Defence airspace operations

RAAF Base Richmond is the home of Air Mobility Group and supports locally based C130J and, temporarily, C27J aircraft as well as visiting aircraft. The airspace architecture consists of three main restricted areas.

R470 is the terminal area airspace and also supports two parachute zones which are active several times a week. Other flying operations include circuit and low flying training. R469 lies outside R470 and supports low flying and additional training areas. It is activated in conjunction with R470. Both of these are RA1, which allows civilian traffic to use these areas for instrument training and transit, if a clearance is available.

R494 is the upper air airspace overlying RAAF Base Richmond and is primarily used as air-test airspace. Activation is by NOTAM only. RAAF Base Richmond also serves as an alternate aerodrome for military fast jet operations at RAAF Base Williamtown. R469 and R470 are generally activated 15-hours per day, seven days a week.

A visual flight rule lane exists to the west of Richmond to provide support to civilian operations. It is designed to provide separation from drop zones and circuit traffic in the RAAF Base Richmond terminal area; however, a clearance through the terminal areas may be available subject to traffic. Defence is conducting a scoping study to identify whether the restricted areas can be reduced in volume to better support civilian operations while not compromising Defence activities.

The Orchard Hills restricted areas exist to prevent aircraft overflying an explosive risk area. The status is RA3 due to the explosive risk and activation times may vary. The Orchard Hills restricted areas are two nautical miles in diameter and are not expected to change from the present design.

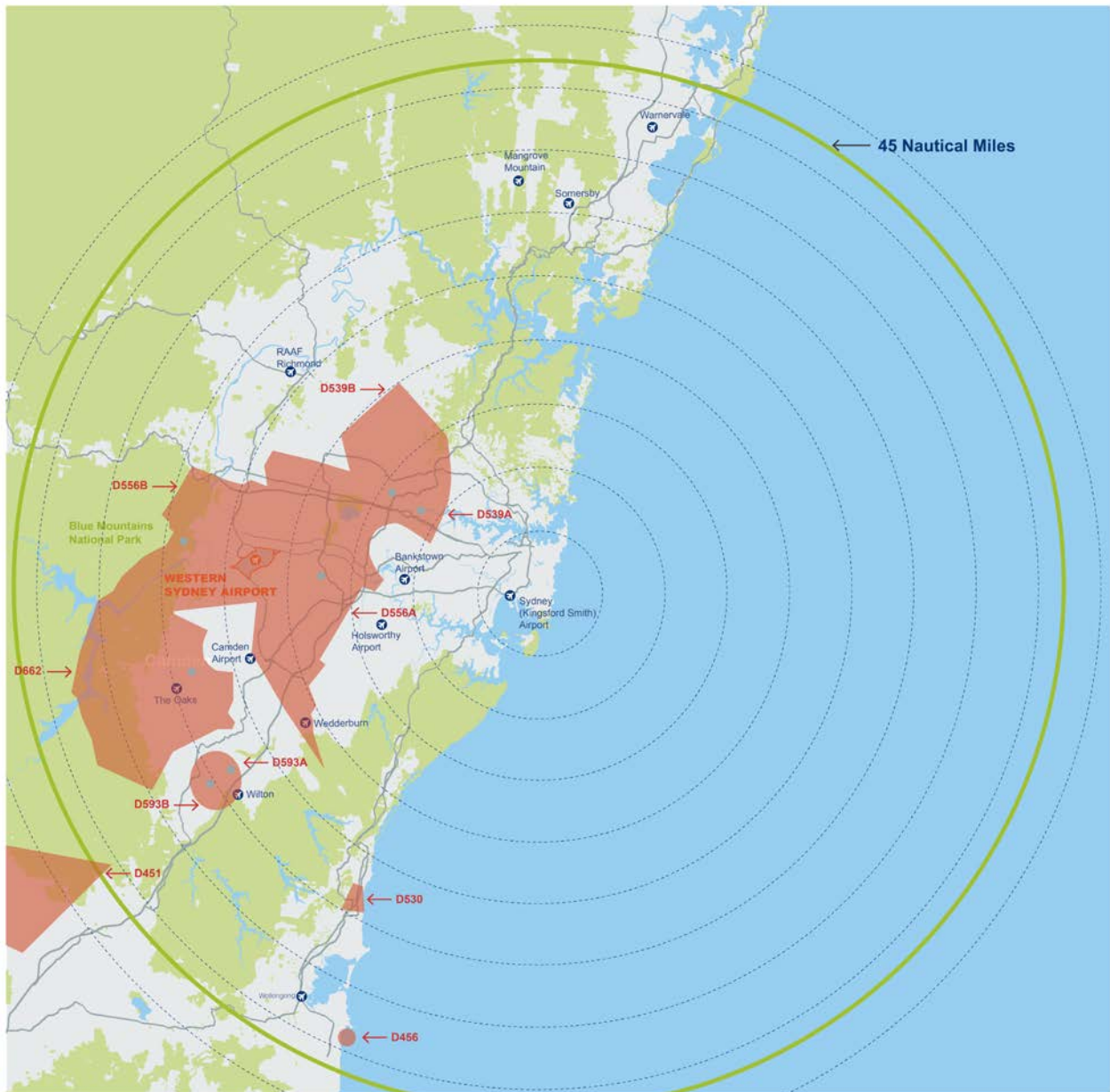


Figure 7-4 Sydney region danger areas

Holsworthy restricted areas are provided to protect activities in support of both flying and non-flying operations. Holsworthy is home to special operations personnel and includes helicopter support located at the barracks. Additionally, firing and demolition activities occur at this site.

A minor portion of the restricted area is active 24-hours per day and has a RA3 conditional status to prevent civilian entry to potentially hazardous military airspace. The other portions are a combination of RA2 and RA3. These statuses exist to protect non-participants from the dangerous operations in the areas. A local arrangement is in place which allows rescue and police operations into specific areas with prior notice.

7.3 Preliminary assessment of airspace

The Western Sydney Airport - Preliminary Airspace Management Analysis report (Airservices Australia, 2015) provides a preliminary assessment of airspace implications and air traffic management arrangements for airspace in the Sydney region associated with the potential introduction of flights to and from the proposed airport.

Because Stage 1 operations are potentially about ten years away (and construction for the long term second parallel runway development potentially 30 to 40 years away), the preliminary assessment undertaken by Airservices Australia is at a conceptual level of airspace management design.

The principal objective of the preliminary assessment was to establish whether safe and efficient operations could be introduced at the proposed airport through the development of indicative air traffic management designs. The analysis was conducted in two stages and included the development of three assessment models as shown in Figure 7–5.

An important aspect to note relevant to this EIS is that a proof-of-concept design does not take into account other influences on air traffic movement such as consideration of noise impacts. As discussed further in Section 7.8, these factors will be incorporated into the final design of the airspace, which will also be subject to community and industry consultation and referral under the EPBC Act. In the meantime, this EIS provides an assessment of noise and other impacts based on the preliminary design information currently available.

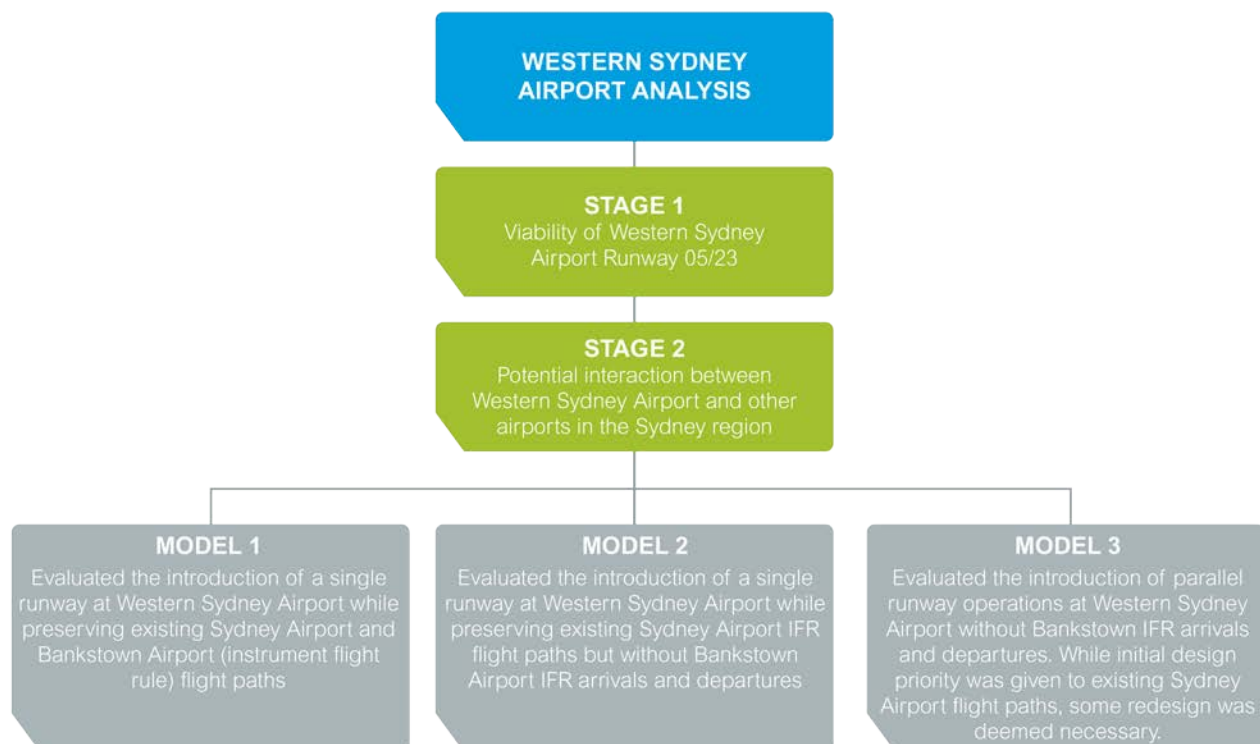
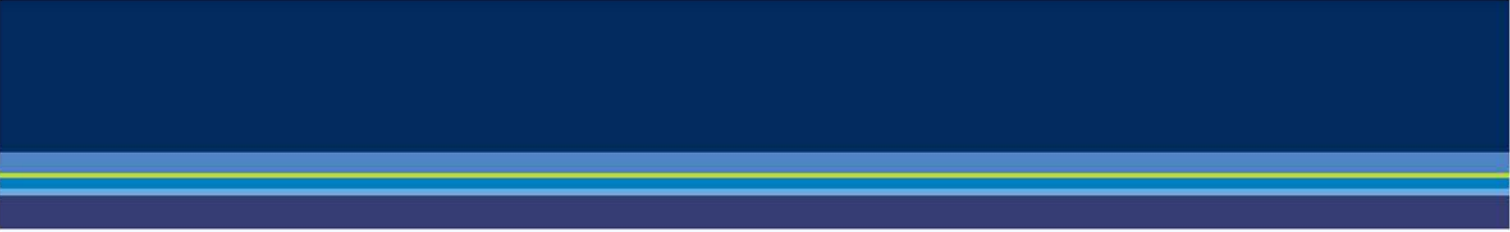


Figure 7–5 Scope of the analysis to develop the indicative airspace architecture



The Stage 1 assessment evaluated the safety, efficiency and viability of the proposed airport operations with a single runway orientation of 05/23. It included consideration of terrain and man-made objects and their implications on airport operations and potential solutions to these where required.

The Stage 2 assessment analysed the potential interactions between the proposed airport's indicative flight paths and the operation of other airports in the Sydney region including Sydney Airport and Bankstown. Three models were developed for this Stage 2 assessment.

- Model 1 evaluated the introduction of a single runway at the proposed airport, whilst preserving the existing Bankstown Airport and Sydney Airport flight paths. The objective of this model was to inform a potential scenario for the opening day operation of Western Sydney Airport to identify potential significant operating restrictions caused by the proximity of the flight paths to and from Sydney Airport and Bankstown Airport.
- Model 2 evaluated the introduction of a single runway at the proposed airport, whilst preserving the existing Sydney Airport flight paths. This model removed instrument flight rules arrivals and departures at Bankstown Airport.
- Model 3 evaluated the increased airspace activity associated with the introduction of a second runway at the proposed airport including the removal of instrument flight rules arrivals and departures at Bankstown Airport. While initial design priority was given to existing Sydney Airport flight paths, some redesign was deemed necessary.

Airservices Australia's preliminary assessment demonstrates a proof of concept and confirms the basic viability for the operation of the proposed airport for both single and parallel runway operations. The assessment indicates that there are no known physical impediments that would interfere with safe and efficient operations at the airport site.


In the long term, the operation of parallel runways at the proposed airport would also be viable, although they would require the redesign of flight paths at Sydney Airport. With parallel runways, the proposed airport could potentially achieve aircraft movement rates of around 100 movements per hour (one landing or one take-off constitutes an aircraft movement).

7.4 Interactions with Sydney Airport and the broader Sydney region airspace

7.4.1 Airspace architecture and potential impacts on air traffic movement

Airservices Australia's *Western Sydney Airport - Preliminary Airspace Management Analysis* considered the potential interactions between the proposed airport and other airports in the Sydney basin including Sydney (Kingsford Smith) Airport and Bankstown Airport.

Indicative concept designs for approach and departure flight paths demonstrate that the Stage 1 Western Sydney Airport and Sydney Airport could safely operate independently as high capacity airports. They also show that an airspace design could be implemented for single runway operations at the proposed airport without changing the current design and flight path structure for Sydney Airport or Bankstown Airport.



However, as demand for aviation services grows at the proposed airport beyond Stage 1 operations, instrument flight rule operations at Bankstown Airport are expected to be incrementally constrained. This is because aircraft arriving at the proposed airport on Runway 23 and aircraft arriving at Bankstown Airport on Runway 11 would operate on overlapping flight paths and would need to be sequenced between the two airports.

The findings of a preliminary high-level assessment of the impacts upon visual flight rule (VFR) general aviation activities in the Sydney basin from introducing single runway operations at a Western Sydney Airport include:

- operations in the Bankstown Control Zone are not expected to be affected;
- operations in the Bankstown VFR lane of entry (D539A and D539B) would be affected;
- sections of the Bankstown Flying Training Area (D566A and D556B) and the northern section of the existing Camden Flying Training Area (D552) would be affected; and
- the Bankstown instrument flight rule (IFR) arrival YSBK RNAV would have a dependency with Western Sydney Airport runway 23 arrivals.

CASA regulates Australian-administered airspace and undertakes regular reviews of existing airspace arrangements.

Amending the Sydney basin airspace architecture to accommodate alternative general aviation flight training arrangements would be a complex task requiring detailed consideration of many safety and operational factors, and extensive consultation with airspace users and other stakeholders. This work is beyond the scope of the current assessment and would need to be considered in the context of CASA's periodic review of airspace management in the Sydney basin. Any contemporaneous review conducted by CASA would be integrated with the detailed airspace design process for Western Sydney Airport (see Section 7.8).

Potential implications for aviation safety

The *Sydney Basin Aeronautical Study* undertaken by CASA (CASA 2015) reported an improving safety trend in total airspace related incidents in the Sydney region. An airspace 'incident' includes events such as operational non-compliance with an air traffic control instruction, a missed approach and 'go-around', airspace infringements and non-compliance with aircraft separation standards. The rate of airspace incidents in relation to total recorded basin movements declined consistently over the five-year period between 2008 and 2013. The number of airspace related incidents more than halved (a reduction of 56.4 per cent) over this period.

Compared to other Australian capital city airports including Melbourne, Brisbane, Adelaide and Perth, Sydney has experienced the largest reduction in the rate of airspace incidents per 1,000 aircraft movements. The data indicate that despite increasing traffic at Sydney, airspace related safety has improved in the past six years.

Future considerations

Future airspace arrangements for a long term parallel runway concept would be developed much closer to the commencement of parallel runway operations. Issues that would need to be addressed as part of any future airspace design process for parallel runway operations include:

- harmonising Sydney Airport's existing flight paths with those for the proposed Western Sydney Airport to maintain independent operations at both airports and to achieve expected demand capacity;
- changes to flight paths serving Bankstown Airport, in particular for instrument flight rule operations, in order to maintain independent operations at the proposed airport and Bankstown Airport, and achieve expected demand capacity; and
- resolution of a potential constraint associated with the restricted airspace over Defence Establishment Orchard Hills.

7.5 Operating modes

Aircraft operations are allocated to a runway, which determines both the physical runway to be used for take-off and landing and the direction in which that runway is to be used. Allocation of the runway to be used is normally determined by air traffic control personnel and is based on a combination of meteorological conditions and airport operating policy. Safety is the most important consideration for operating an airport. The selection of a runway at any given time is dependent on a combination of factors including:

- weather conditions such as wind direction and speed, rain, visibility and level of cloud base;
- the number of aircraft presenting for arrival at the airport;
- the number of aircraft seeking to depart from the airport; and
- any airport policies governing the preferential use of a particular operating direction.

Standard airport operating procedures (CASA 2011) indicate that a runway may not be selected for either approach or departure if the wind has a downwind component greater than five knots, or a crosswind component greater than 20 knots. If the runway is wet, it would not normally be selected if there is any downwind component at all. Wind conditions at the airport site therefore limit the times when a particular runway orientation may be selected and the direction in which landings and take-offs occur (see Section 5.4.1).

Based on the 05/23 runway orientation for the proposed Stage 1 development, there are two main ways the single runway would be able to be used, commonly referred to as “operating modes”.

The two principal operating modes are described below.

- ‘Operating mode 05’, whereby aircraft will take-off and land in the 05 direction. Under this operating mode, all aircraft will be directed to approach the proposed airport to land from the south-west and directed to take-off to the north-east, before redirecting towards their ultimate destination. The concept of operating mode 05 is shown in Figure 7–6.
- ‘Operating mode 23’, whereby aircraft will take-off and land in the 23 direction. Under this operating mode, all aircraft will be directed to approach the proposed airport to land from the

north-east and directed to take-off to the south-west, before redirecting towards their ultimate destination. The concept of operating mode 23 is shown in Figure 7–6.

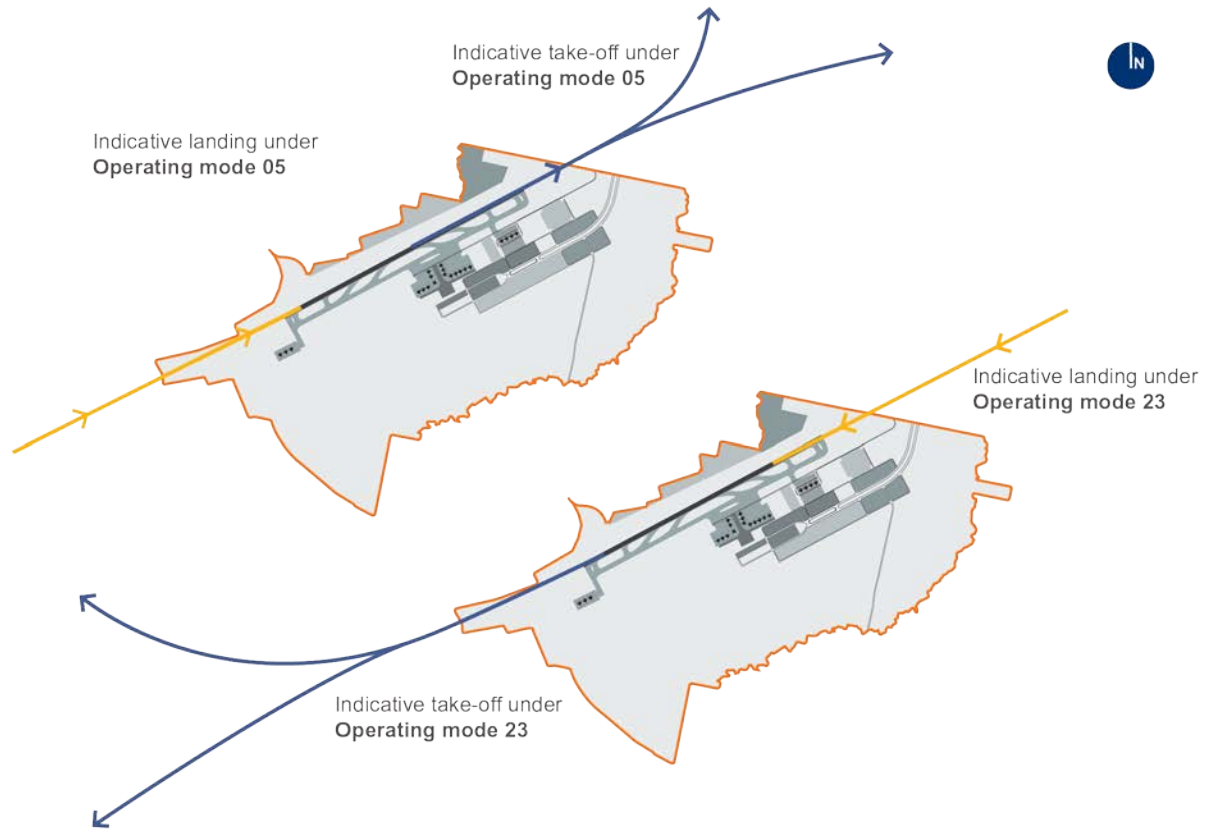


Figure 7–6 Operating modes '05' and '23'

A third operating mode, 'head-to-head' — also sometimes referred to as 'Runway Reciprocal Operations' — may be feasible following further detailed assessment prior to the commencement of operations. This would involve all take-offs and landings occurring in opposing directions, either to and from the south-west of the airport site, which, if feasible, may result in a preferred mode, particularly late at night through to early morning, or to and from the north-east of the airport site. Under this mode all aircraft operations would effectively occur only on one side of the airport site for a period of time and therefore offer a period of no aircraft operations for other areas during that time.

A head-to-head operating mode could be used when it is safe to do so and specifically when:

- the number of arriving and departing aircraft is not more than 20 per hour to permit the safe separation of aircraft; and
- the weather conditions — principally a dry runway and light downwind component — mean that it is safe to take-off or land.

This strategy is most often employed at airports that operate without a curfew as a means of minimising night time aircraft flights over residential areas. It is already in place at other airports in Australia. In Brisbane, the preferred operating mode for night hours (10.00 pm – 6.00 am) is for all arrivals and departures to occur over Moreton Bay. Head-to-head operations over Botany Bay currently occur during curfew hours at Sydney (Kingsford Smith) Airport. No passenger flights can occur during curfew hours at Sydney Airport with the exception of a limited number of international arrivals between 5.00 am and 6.00 am (no more than 24 movements per week), although take-offs and landings of certain medium-sized freight aircraft, up to 74 per week, and other noise-compliant aircraft under 34,000 kg, without quota, are permitted during curfew periods.

Winds at inland locations such as Badgerys Creek are typically more predictable and lighter than those experienced at airports on the coast, suggesting that a high proportion of night flights could theoretically operate this way at the proposed Western Sydney Airport.

The concept of head-to-head operations is shown in Figure 7–7.

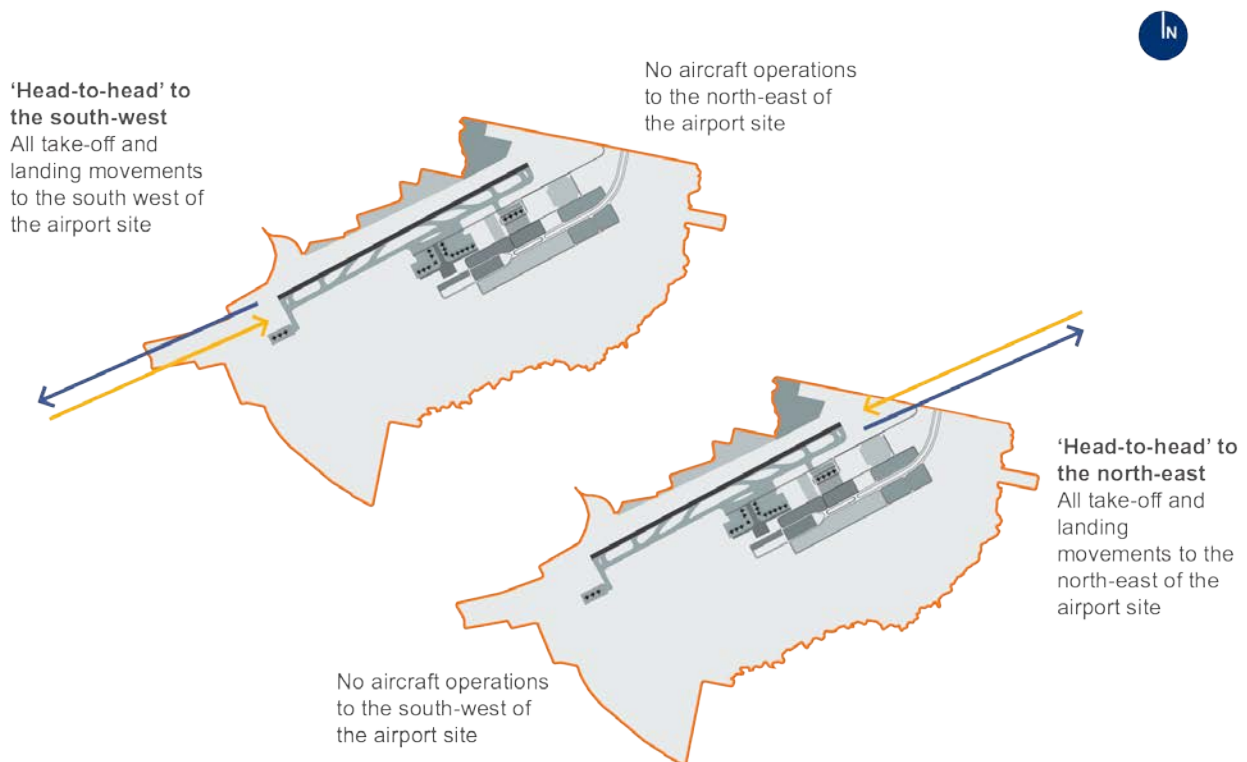



Figure 7–7 Head-to-head operating modes

Operation of the proposed airport would change the pattern of aircraft movements in the airspace above Western Sydney due to the introduction of new aircraft flight paths and airport operating modes. The changes would result in increased noise exposure levels in some areas, particularly those locations closer to the airport under or near the standard aircraft departure and arrival flight paths. In addition, the projected future growth in air traffic beyond Stage 1 operations would generally increase total noise exposure in the future.

The use of head-to-head operations to and from the south-west, when it is safe to do so, is an important preferred option for managing aircraft noise at night that will be thoroughly evaluated through further detailed assessment.



The pattern of noise impacts that would result from operation is complex and depends on the operating mode, time of day, season and other factors. In some cases, alternative airport operating modes would be available, each with differing impacts on different areas. For example, the operation of head-to-head arrivals and departures when it is safe to do so may provide a respite for noise sensitive receivers in some areas for a period of time. Potential noise abatement opportunities, such as the selection of preferred operating modes for different times of day, will form an important part of the work required to finalise the airspace design prior to implementation (see Section 7.8).

7.6 Indicative flight paths

The EIS depicts indicative flight paths for Stage 1 operations at the proposed Western Sydney Airport. The principal objective of the preliminary flight path assessment was to establish whether safe and efficient operations could be introduced at the proposed airport. Figure 7–8 and Figure 7–9 show the draft EIS Stage 1 indicative flight paths for this proof of concept, including a single indicative merge point location for aircraft arrivals, for the 05 and 23 operating modes respectively.

The Australian Government has announced that the airspace design to be implemented for the proposed Western Sydney Airport will not include a single merge point that would converge arriving aircraft over Blaxland.

Final airspace and flight path planning for the proposed airport will assess different systems for sequencing arriving aircraft and alternative flight path options. This future airspace planning and design will evaluate each system and flight path option against the key criteria of safety, aircraft operation efficiency, capacity, and noise and other environmental impacts. Further details about the system options for managing air traffic and the future airspace design process are provided in Section 7.7 and Section 7.8 respectively.

7.6.1 The design of indicative flight paths and their use in this EIS

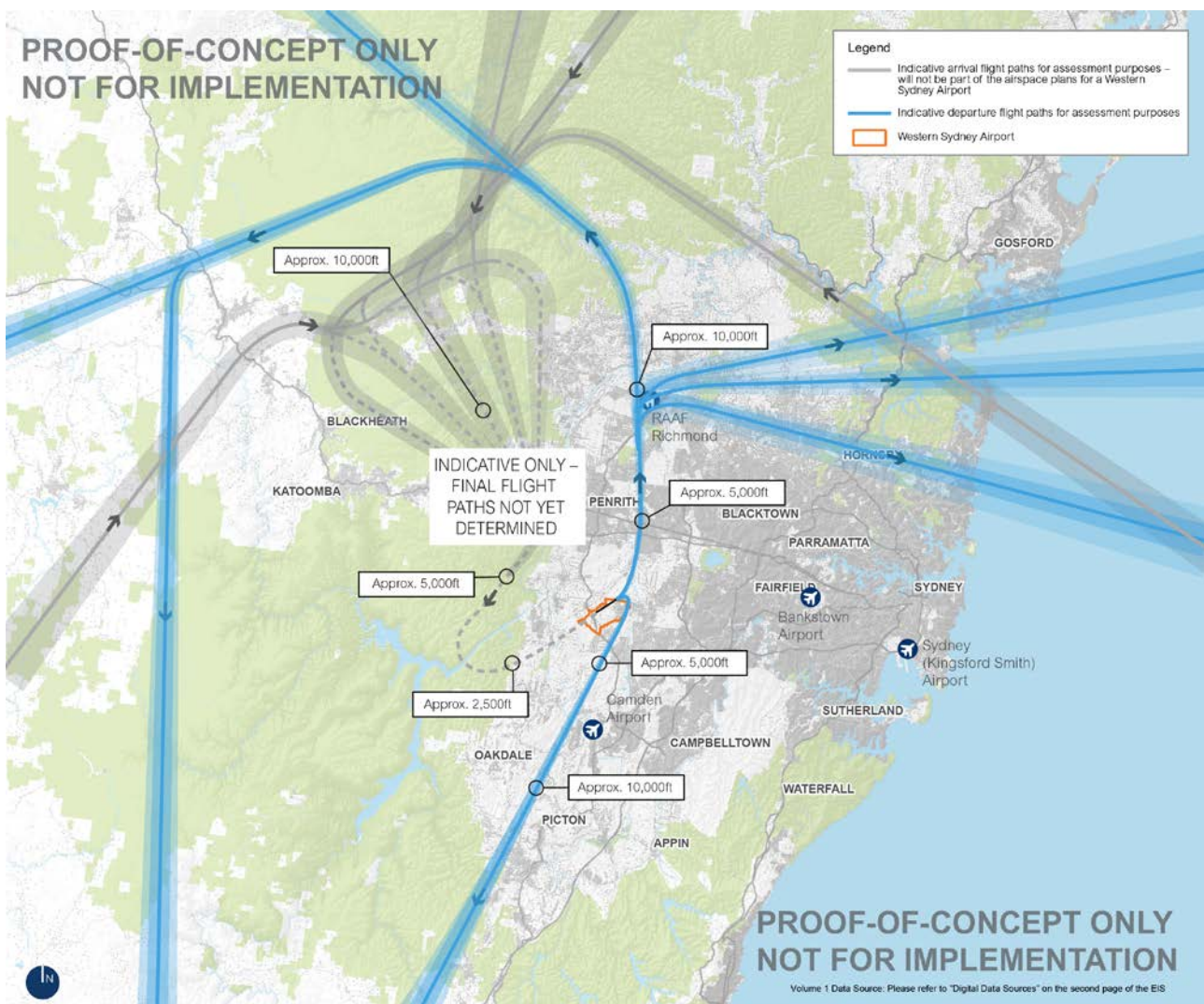
The main consideration when designing the indicative flight paths presented in the EIS was air traffic management, particularly how aircraft using the flight paths would interact with aircraft operating to and from Sydney Airport. The indicative flight paths developed by Airservices Australia were designed on the premise that the proposed airport would operate independently of Sydney Airport in all cases. This ensures the selection of runways or operating modes at one airport could be made to suit local conditions without affecting the operating mode at the other.

The Airservices Australia design work and analysis was conducted using the current standards and procedures that apply to air traffic management, including:

- relevant provisions of the Civil Aviation Safety Regulations 1998;
- Procedures for Air Traffic Management (ICAO Doc 4444);
- Procedures for Aircraft Operations (ICAO Doc 8168); and
- the *Airspace Act 2007* and relevant regulations.

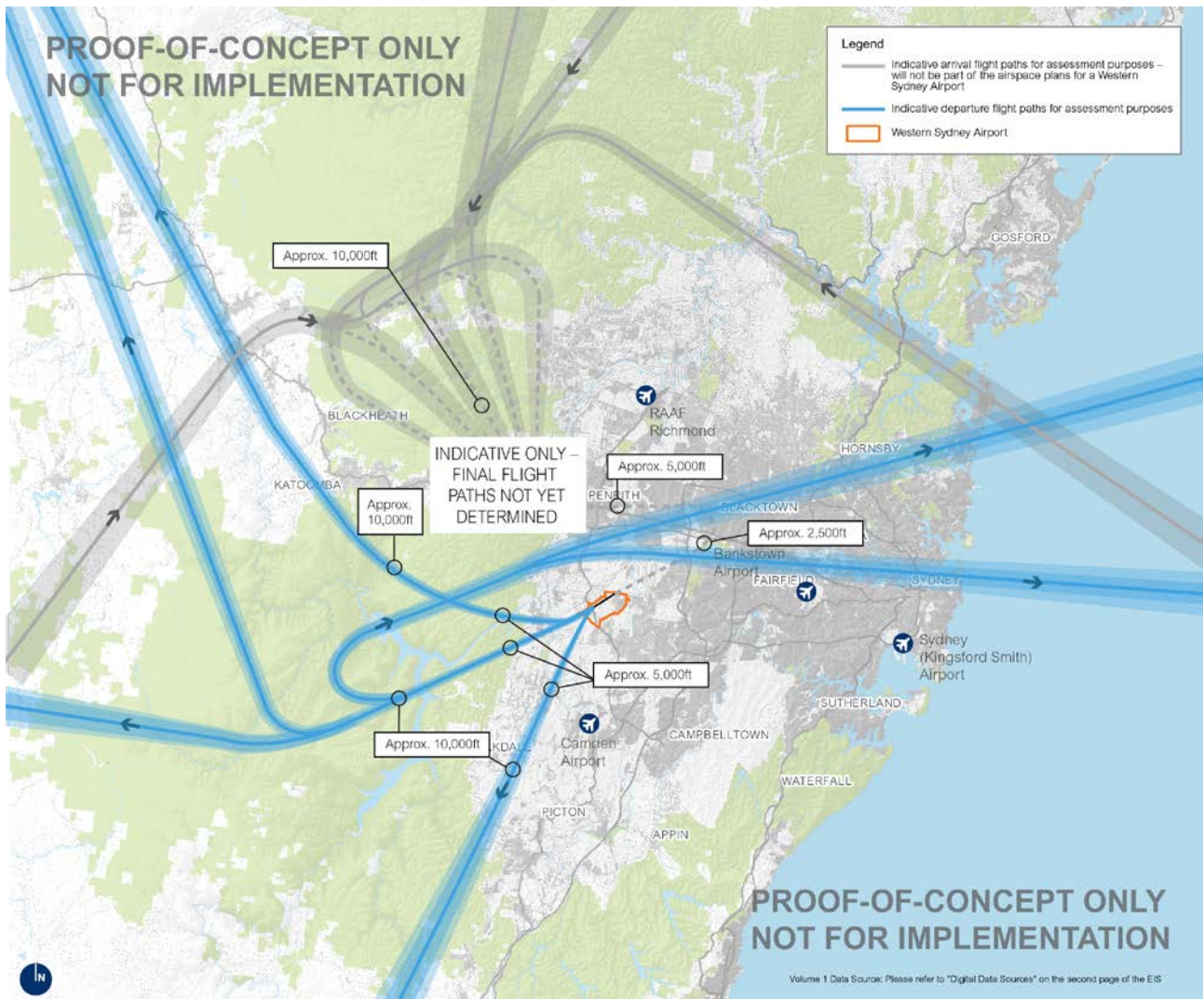
The increasing use of new satellite-based navigation technologies means that suitably equipped aircraft are able to fly more accurate and predictable flight paths than their predecessors. The expected adoption of these technologies and associated operating procedures at the proposed Western Sydney Airport is likely to result in less dispersal of aircraft around authorised flight paths compared to navigation based on conventional technologies.

The indicative flight path design prepared by Airservices Australia assumes the adoption of new navigation technologies. While flight paths are depicted in the design as single lines of travel, it is not always possible for each aircraft to fly precisely along the same line. The variation of aircraft around a nominated flight path is referred to as dispersion. The concept of dispersion is illustrated in Figure 7–8 and Figure 7–9.



Note: Indicative flight paths as presented in this figure are based on Airservices Australia's Western Sydney Airport: Preliminary Airspace Management Analysis, that provides a preliminary assessment at a conceptual level of airspace management design. The Australian Government has announced that aircraft arrivals for the proposed Western Sydney Airport will not converge through a single merge point over Blaxland or any other single residential area. The formal flight path design process will start from determination of the Airport Plan and optimise flight paths on the basis of safety, efficiency, capacity, and noise and environmental considerations.

Figure 7–8 Stage 1 indicative flight paths for the 05 operating mode



Note: Indicative flight paths as presented in this figure are based on Airservices Australia's Western Sydney Airport: Preliminary Airspace Management Analysis, that provides a preliminary assessment at a conceptual level of airspace management design. The Australian Government has announced that aircraft arrivals for the proposed Western Sydney Airport will not converge through a single merge point over Blaxland or any other single residential area. The formal flight path design process will start from determination of the Airport Plan and optimise flight paths on the basis of safety, efficiency, capacity, and noise and environmental considerations.

Figure 7–9 Stage 1 indicative flight paths for the 23 operating mode

The modelling of aircraft noise in this EIS accounted for the dispersion of departing aircraft by assigning them to one main flight path and four sub-paths — two on either side of the main flight path. No dispersion was assumed for instrument-guided arrival flight paths, on the basis that aircraft on these flight paths would be strictly controlled. It should also be noted that the use of a number of flight paths for visual approaches provides a form of dispersion for aircraft turning onto final approach before landing.

The environmental assessment of aircraft operations is based on the indicative flight paths illustrated in the EIS with some modifications as outlined in the Aircraft Overflight & Operational Noise technical report (Appendix E1, Volume 4). While the Government has announced that a single merge point over Blaxland will not be implemented, the indicative flight paths presented in the EIS provide a valid and contemporary basis for assessing the potential extent and intensity of impacts associated with aircraft operations at a Western Sydney Airport. In addition, the assessment of the head-to-head operating mode is a practical illustration of the reduction in noise impact that could be achieved if this operating mode was determined to be feasible. Using preliminary flight paths for this purpose is consistent with other environmental assessments of new runway infrastructure, including the 1997-1999 Second Sydney Airport Proposal EIS and recent proposals such as the Brisbane Airport New Parallel Runway (NPR).

Nevertheless, it is important to note that the conceptual and preliminary airspace design illustrated in the EIS has not been developed to a level of detail necessary for implementation and would require further analysis prior to the commencement of airport operations (see Section 7.8). Importantly, the conceptual designs have not been developed to consider all potential noise abatement opportunities and this would form an important part of the subsequent design work leading up to implementation.

The indicative flight paths and operating procedures described and modelled in the EIS have been used for the purposes of modelling noise exposure and other consequential impacts of aircraft overflights. No decisions have been made on a preferred approach for managing aircraft arrivals and departures.

7.6.2 Indicative arrival flight paths

In developing the preliminary flight paths, consideration was given to potential options for the management of multiple aircraft approaching the airport. Different arrivals management systems offer different benefits depending on the needs of the airport and can provide flexibility in air traffic control, efficiency, and fuel and noise management.

Major airports are served by one or more Standard Terminal Arrival Routes (STARs), which are routes established by air traffic control to direct arriving aircraft to an airport. The three STARs options considered as part of the preliminary flight path design were:

- open standard terminal arrival routes with radar vectoring to final (Open STARs) — this model is a method of processing aircraft that achieves consistent arrival spacing by allowing air traffic control personnel to adjust the approach path (using radar vectoring) and aircraft speed;
- runway connected standard terminal arrival routes (Closed STARs) — this model is a method of processing terminal arrivals that enables aircraft to use a continuous descent profile defined by the aircraft's on-board flight management system with limited air traffic control intervention; and

- Point Merge system — this is a hybrid of the Open and Closed STARs models (“Open-Closed hybrid”) that provides a simple, predictable and standardised procedure for sequencing and spacing aircraft arrivals with limited air traffic control intervention.

It is important to recognise that ‘Point Merge’ is a description of a type of flight path design. A feature of such a design is that arrivals flight paths merge together into one or more merge points prior to aircraft landing.

A key principle of the detailed airspace and flight path design process is that aircraft arrivals will not converge through a single merge point over any single residential area (see Section 7.8).

Taking into account the future air traffic management requirements of the proposed Western Sydney Airport and the potential advantages and disadvantages of each system option, Airservices Australia selected the Open-Closed hybrid system as the basis for developing indicative flight paths for the proposed airport because it was capable of achieving maximum airport capacity. It is a relatively new approach for managing aircraft arrivals that has been implemented successfully at several busy international airports where it has been shown to enhance safety, efficiency and environmental outcomes.

While this system has been adopted for current proof-of-concept modelling and assessment purposes, no decision has been made about the preferred arrivals management system for implementation. All three STARs options (i.e. Open STARs, Closed STARs and Point Merge) will be examined rigorously as part of the detailed airspace design process. A description of the three options is provided in Section 7.7.2.

The future airspace design process will comprehensively evaluate a range of options for managing arrivals to ensure that the location of flight paths is optimised in terms of safety, efficiency, capacity and environmental impact (see Section 7.8)

7.6.3 Indicative departure flight paths


The proof-of-concept design shows two major departure flight paths in each direction from the proposed airport. Both of these would branch off to other flight paths at distances that are relatively distant from the proposed airport (approximately 35 km to 45 km).

For departures to the south-west (the 23 direction) there is an indicative third flight path passing in the vicinity of the township of Warragamba that then extends in a north-west direction. This flight path has been designed for use by non-jet aircraft only, which would limit predicted noise exposure in areas beneath this route.

7.7 System options for managing aircraft arrivals and departures

The airspace model and indicative flight paths prepared by Airservices Australia provide a preliminary indicative airspace design for safe and efficient operations in the Sydney basin taking into account the introduction of flights to and from the proposed Western Sydney Airport. They are conceptual and represent one of several options for managing air traffic at the proposed airport.

Submissions on the draft EIS called for consideration of different systems to manage aircraft arrivals and departures and for flight paths to be located away from residential areas in western Sydney and the Blue Mountains. As noted in Section 7.6, the Government has announced that a single merge point for arriving aircraft as depicted over Blaxland will not be implemented. Further



detailed technical work will be undertaken to optimise the design of flight paths for the proposed airport so that noise and environmental impacts are reduced as far as practicable.

The location of standard arrival and departure flight paths and options to sequence aircraft approaches will be developed in consultation with the public.

Alternative systems for sequencing arriving aircraft in a safe, predictable and standardised manner will be evaluated during the detailed airspace and flight path design process for the proposed airport. System options will be assessed within Airservices Australia's national framework for airspace and air route planning, known as the Future Airspace System. This system will modernise Australia's airspace and incorporate world's best design and practice.

7.7.1 Australia's Future Airspace System

Staged implementation of the Future Airspace System over the next 10 years is being driven by a number of factors including:


- the expected growth of air traffic across the nation;
- the need to design airspace to accommodate new runways at Brisbane, Melbourne and Perth airports;
- the development of the proposed Western Sydney Airport; and
- the commissioning of a new joint civil/military air traffic control system in the early 2020s.

Under the Future Airspace System, the current Terminal Area (i.e. the area of controlled airspace) for major Australian cities will be extended to accommodate the majority of the climb and descent phases for modern aircraft operations. For each city, the coordination of aircraft movements within this area, or Extended Manoeuvring Area (EMA), will enhance capacity and allow aircraft to operate on more efficient climb and descent paths with fewer constraints and less intervention by air traffic control. The EMAs will be designed to accommodate a range of modern air traffic control technology that has the capability of managing aircraft more efficiently and safely while reducing aircraft noise.

The Future Airspace System will transition Australia to a new air traffic management approach under which air routes are designed based on Performance Based Navigation (PBN) specifications. Unlike conventional aircraft navigation, which employs fixed ground-based beacons to guide aircraft along published routes via waypoints, PBN uses global navigation satellite systems and computerised on-board flight management systems to navigate aircraft.

A growing number of modern aircraft are fitted with navigation systems that employ satellite-assisted guidance. These systems allow aircraft to use GPS information to fly with a high degree of accuracy and efficiency. Within the EMA, airspace architecture will be designed to contain the position of an aircraft to within one nautical mile of its planned route, thereby allowing more precise tracks to be followed and less dispersion of aircraft compared to conventional navigation methods. Operationally, reduced dispersal means improved predictability. This contributes to improvements in safety and a reduced likelihood of delay for arriving aircraft.

The improved precision of satellite-based navigation technology also enables flight paths to be designed to avoid noise sensitive areas in favour of overflying industrial land or non-residential areas. Airservices Australia refers to flight paths designed for satellite navigation technology as



Smart Tracking. It is also known in the aviation industry as Required Navigation Performance-Authorisation Required, or RNP-AR.

The potential benefits of Smart Tracking include:

- the ability for suitably equipped aircraft to fly certain flight paths that they would otherwise be unable to use at night or in poor weather conditions such as low cloud. This has the potential to provide respite to noise-affected communities by enabling the use of flight paths and noise sharing procedures that would normally only be available in high-visibility, daytime conditions. It also means fewer aircraft delays for passengers and fewer diversions of arriving flights to other airports;
- the ability for aircraft to fly with greater accuracy, with only a small variation in the actual paths flown from one aircraft to another. While this has the benefit of minimising the overall noise footprint, it can also concentrate noise impacts underneath the RNP-AR flight path. Management of community noise impacts could include consideration of the periodic use of alternative flight paths to provide respite for those under a Smart Tracking path;
- greater capacity for aircraft to use continuous descent approaches and reduce their noise footprint. A continuous descent approach minimises level flight segments prior to an aircraft intercepting the runway's Instrument Landing System (ILS) and enables the aircraft to be operated with low engine thrust settings and, where possible, a low drag configuration that reduces fuel use and noise. Aircraft making an ideal continuous descent approach can essentially glide from cruising altitude to the runway in one smooth and uninterrupted descent. These approaches have been shown to reduce community noise exposure by about 4 dBA to 6 dBA in those areas under the arrivals flight path before the ILS is intercepted;
- the ability for departing traffic to utilise RNP-AR flight paths with the minimum possible restrictions thereby enabling the aircraft's flight management system to manage fuel consumption efficiently as the aircraft climbs to its cruising altitude; and
- greater flexibility in the design of arrival and departure routes and increased noise management options for both night and daytime operations.

Smart Tracking technology is fitted in most new aircraft and can be retrofitted into some older aircraft. Over the next decade, more airlines will start using Smart Tracking procedures as they receive new aircraft, retrofit older aircraft with the necessary technology and train their pilots. Smart Tracking was implemented permanently in Brisbane for all aircraft that have this capability in early 2012. The technology has subsequently been adopted at several other airports across the country and is planned for use at the proposed Western Sydney Airport.

Another integral part of Australia's next-generation satellite-based air navigation system is the Ground Based Augmentation System (GBAS), known in Australia as SmartPath. It is a satellite-based precision landing system supplemented with on-ground units that is a potential replacement for current ILSs. The system improves the accuracy of aircraft positioning and allows for a safer, more efficient descent and landing. SmartPath has been operational at Sydney Airport for several years. It is one of a number of navigational aids identified for installation at the proposed Western Sydney Airport.

Satellite technologies such as RNP-AR and GBAS provide a relatively new way of conducting precision instrument approaches that are currently equivalent to ILS Category I (CAT I). SmartPath is expected to eventually support precision approach and landing to Category III (CAT III)

standards. SmartPath has the potential to overcome many ILS technical and operational limitations which currently constrain flight path flexibility (e.g. reliance on straight-line radio waves — see Figure 7–14). In contrast, suitably equipped aircraft using RNP-AR/GBAS procedures are capable of making curved approaches under minimal power that avoid long, straight-in approaches. Figure 7–11 compares theoretical RNP 1⁸ approaches with a conventional ILS approach.

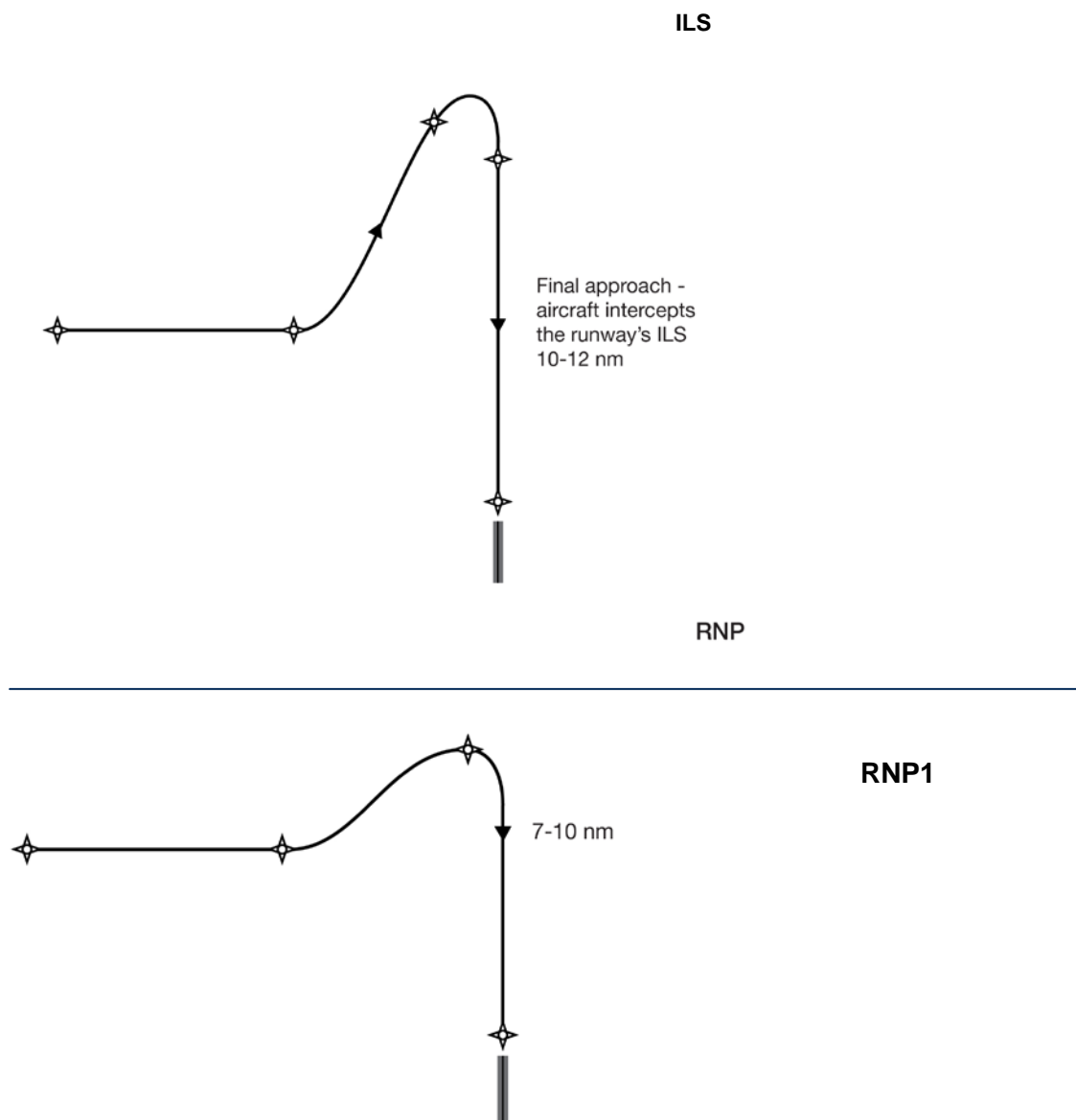


Figure 7–10 Comparison of traditional ILS approaches and potential RNP 1 approaches

⁸ RNP 1 is a Required Navigation Performance specification that is applicable to terminal area arrival and departure phases of flight and to instrument approach procedures up to the final approach fix. An RNP 1 operation is conducted to a navigation accuracy of ± 1 nautical mile lateral deviation from the specified flight path. RNP 1 standards require on-board performance monitoring and alerting, and verification that the aircraft and operating crew are approved for RNP 1.

Aircraft are not able to fly pre-planned tracks while being radar vectored by air traffic control. This means that fuel management is not accurate and fuel burn during descent can vary and energy management can become less predictable.

The Open STARs arrival management system is an effective method for achieving maximum runway capacity. It is used at Sydney Airport where runway demand is consistently high. The system provides accurate final spacing of aircraft and maximises runway capacity, but does not enable continuous descent operations because aircraft are always managed by radar vectors with variable tracking to final. Low altitude vectoring can result in increased aircraft noise levels. Figure 7–11 depicts a conceptual Open STARs arrivals system.

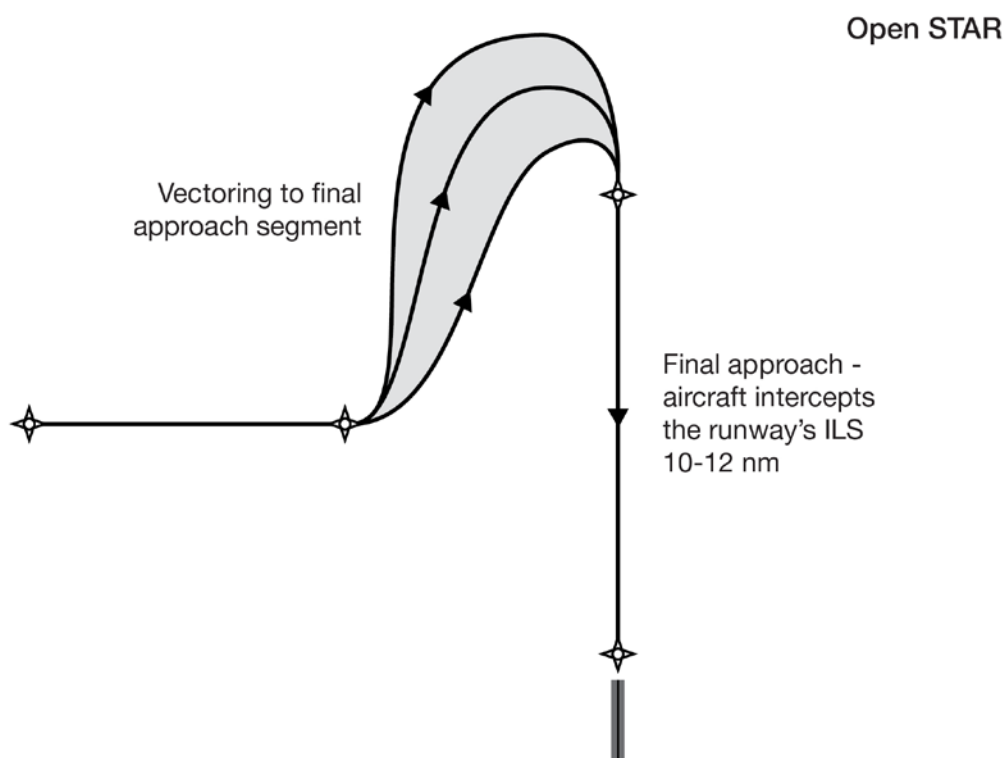


Figure 7–11 Open STARs arrivals management system

Runway connected Standard Terminal Arrival Routes (Closed STARs)

Runway connected STARs is a method of processing terminal arrivals that enables aircraft to adopt a continuous descent profile because the vertical and lateral path from the top of descent to the runway threshold is defined accurately in the aircraft's on-board flight management system. Runway connected (Area Navigation) RNAV STARs, also known as Closed STARs, are used at Brisbane, Melbourne and Perth airports. Figure 7–13 depicts a conceptual Closed STARs arrivals system.

Closed STAR

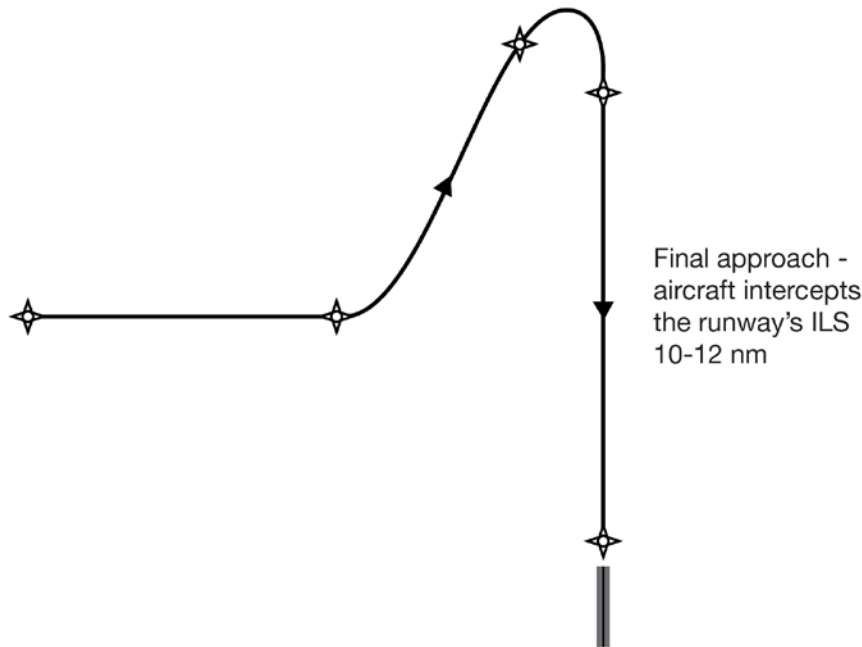


Figure 7–12 Closed STARs arrivals management system

The Closed STARs model enables accurate fuel time and energy management for aircraft with flight management system capability but it may not provide the flexibility required to maximise runway capacity. Consequently, this model of air traffic synchronisation is generally used when runway capacity is not a constraint and the use of continuous descent profile arrival procedures is a priority. These procedures are generally associated with reduced fuel consumption and lower noise levels, particularly in areas further away from the airport before aircraft intercept the runway's ILS (typically 10 nautical miles from the runway's landing threshold).

Point Merge system

Point Merge is a relatively new and innovative method for synchronising arriving aircraft that has been introduced internationally since 2011 at airports in Oslo, Dublin, Seoul, Kuala Lumpur, Lagos, Hannover, the Canary Islands, Paris (Charles de Gaulle) and London (London City and Biggin Hill). This system has been demonstrated to be an effective method of finely controlling the spacing between arrivals and for balancing the competing priorities of runway capacity and fuel efficiency (e.g. through minimising track miles) at these busy international airports. Point Merge provides a simple, predictable and standardised procedure for sequencing aircraft arrivals that can reduce noise impacts compared to alternative arrival management systems that involve more air traffic control intervention. It may also provide the easiest and most flexible method for ensuring fully independent operations can occur at the proposed Western Sydney Airport and Sydney (Kingsford Smith) Airport.

By directing aircraft through a series of predictable routes, the vertical and lateral path taken on approach is more accurate and can result in a reduction in the number of level flight segments — which require more power and hence produce more engine noise — at low altitude. Utilising the

capabilities of an aircraft's on-board flight management system, Point Merge promotes the use of a continuous descent path, which can reduce fuel consumption, emissions and noise impacts.

The concept of the Point Merge system is presented in Figure 7–13 and can be seen on the indicative flight paths presented in Figure 7–8 and Figure 7–9.

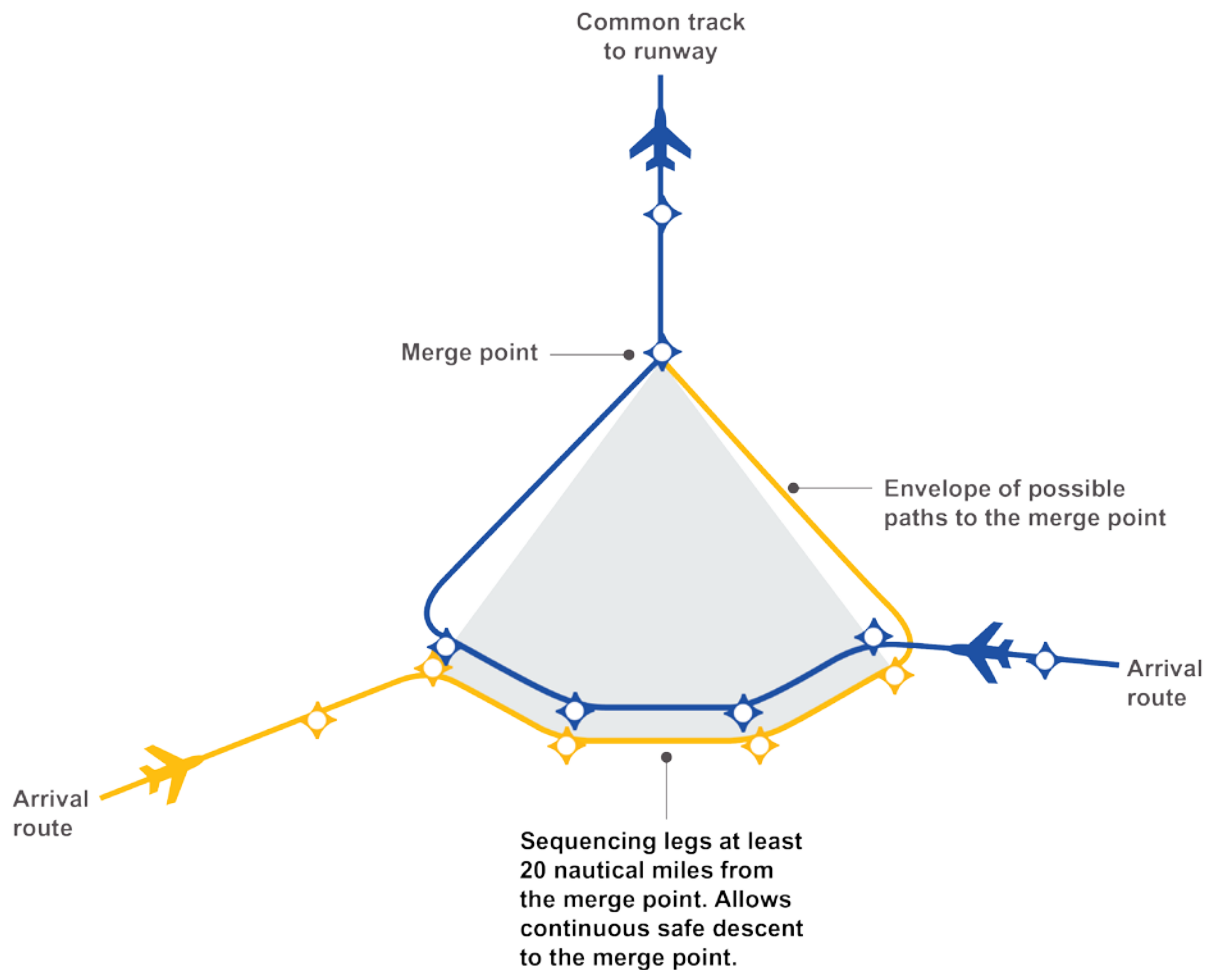


Figure 7–13 Point Merge arrivals management system

The manner in which aircraft are managed through a Point Merge system is largely dependent on the number of presenting aircraft. In the initial years of operation at the proposed airport — or during periods of the day when aircraft numbers are relatively low in later years — aircraft arrivals would be expected to use predominantly the outside tracks of the system as these represent the most direct and efficient arrival paths. As such, a Point Merge system may have few immediate advantages over traditional arrival management systems, but this needs to be assessed as part of the detailed design process.

As aircraft movement numbers increase in the future, and in particular during busy periods, aircraft approaching the proposed airport would fly an extended flight path along one of two sequencing legs (or Point Merge arcs) instead of being vectored to extend their flight path at low altitudes. The arcs for sequencing arriving aircraft from opposite directions are separated vertically by at least 1000 feet (300 metres). Aircraft fly along the appropriate arc to achieve the correct spacing with preceding aircraft, at which time air traffic control would direct the aircraft off the arc into the landing sequence. This sequencing means that aircraft are initially spread out as they fly from different points in the arc towards a merge point. Similar to procedures used at all major airports, aircraft on an instrument approach would adopt a fixed route to the operating runway after leaving the merge point.

The conceptual airspace design presented in the EIS identifies a single merge point location for managing aircraft arrivals under both the 05 and 23 modes of operation. For areas relatively close to the airport, the location of this point makes little difference to the analysis of environmental impacts, particularly noise impacts. This is because all aircraft passing over these areas are assumed to be making a straight-in final approach from 10 nautical miles (18.5 kilometres) from touchdown, guided by the runway's ILS. Figure 7–14 shows how a terrestrial localiser beacon and ILS glide path work together to provide vertical and horizontal guidance to pilots making a typical straight-in approach.

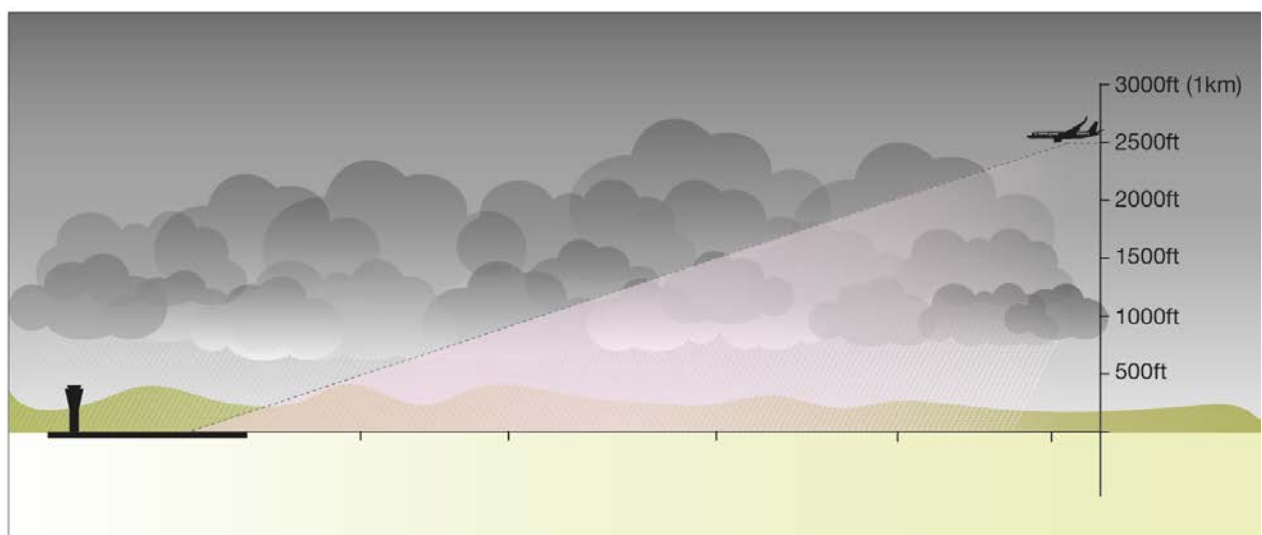



Figure 7–14 Conventional straight-in approach using a ground-based Instrument Landing System



This standard approach procedure would apply irrespective of the location of the merge point. However, the merge point location is important when considering impacts closer to the merge point and along the single arrival path extending from it. Upon reaching the merge point, aircraft and their consequent impacts are effectively concentrated along the respective 05 and 23 arrivals tracks to touchdown.

No decision has been made on a preferred approach for managing aircraft arrivals at the proposed airport. Different arrivals systems, and their associated impacts and appropriate mitigations, will be continually assessed during the future airspace design (see Section 7.8).

7.7.2 Departures

The use of new satellite-based technologies will also provide the opportunity to design departure flight paths in a more flexible way. The ability of aircraft to fly a predetermined departure route more accurately means that flight paths can be designed to reduce the impact on residential areas. For example, to avoid the overflight of residential areas, Heathrow Airport (London) has introduced operating procedures called “Noise Preferential Routes” that require departing aircraft to follow specific paths up to an altitude of 4,000 feet.

Noise abatement climb procedures can also help reduce noise levels in areas close to the departure end of a runway. These procedures are designed to encourage aircraft to gain height as quickly as safely possible and then reduce engine power and noise at the earliest opportunity, usually once the aircraft has attained an altitude of between 800 feet and 1,000 feet. Where these types of procedure have been introduced, such as for northerly departures at Sydney Airport, an aircraft is expected to maintain its assigned route until it has attained the altitude or height that represents the upper limit of the noise abatement procedure or it is necessary to make a diversion for the safety of the aircraft (e.g. to avoid severe weather or to resolve a traffic conflict). While a standard departure procedure may be stipulated at an airport, there will always be differences in climb profiles due mainly to the variation in winds and the different performance parameters of each aircraft.

The potential benefits of utilising noise abatement climb procedures, when safe to do so, at the proposed Western Sydney Airport will be considered as part of the formal airspace design process.

7.8 Future airspace design

Designing air traffic management arrangements for a new runway or airport is a large, resource intensive and complex technical task that takes several years to complete. The Australian Government is committed to undertaking this task robustly. Prior to opening of the proposed Western Sydney Airport, the Department of Infrastructure and Regional Development, in collaboration with Airservices Australia and the Civil Aviation Safety Authority, will undertake a comprehensive airspace planning and design process for single runway airport operations. This process will allow the final airspace arrangements to better reflect the operating environment closer to the time the airport opens, taking account of factors such as new aviation technology and environmental impacts.

The Brisbane Airport New Parallel Runway (NPR) project is illustrative of the process by which final flight paths are developed by Airservices Australia and how long this process can take.

Brisbane Airport New Parallel Runway Project – Flight path design process

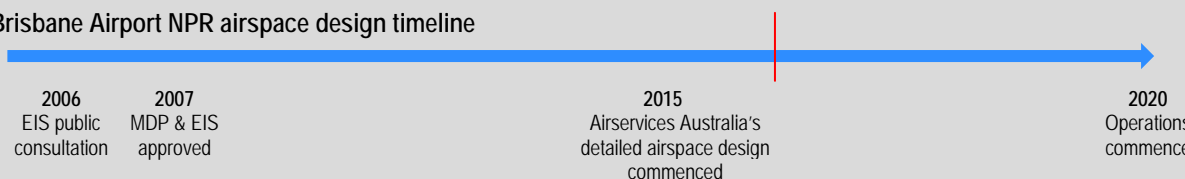
In November 2006 Brisbane Airport Corporation released a draft Major Development Plan (MDP) and draft EIS for its proposal to construct and operate a new parallel runway at Brisbane Airport. The New Parallel Runway (NPR) draft EIS included preliminary flight paths and modes of operation developed by Airservices Australia. It noted that “before any proposed flight path procedure and/or modes of operation can be finalised and implemented for the NPR system, an additional full and detailed safety case and environmental assessment will need to be completed by Airservices Australia”. The NPR project was approved in late 2007.

More than eight years on, Airservices Australia has developed high level airspace concepts for the introduction of NPR operations. Undertaking this work closer to the commencement of NPR operations has enabled design of the proposed final airspace arrangements and flight paths to be informed by the most current data, including developments in air traffic management procedures and aircraft using Brisbane Airport since the EIS was prepared.

The high level airspace concepts are being assessed against four key performance areas – safety, efficiency, capacity and environment. This complex task involves the iterative design and refinement of airspace concepts, detailed simulation modelling of aircraft operations for each concept option, and qualitative and quantitative assessment of those options against the key performance measures. The options review process has robustly tested the suitability of the modelled concepts and enabled stakeholders to better understand the merits of each concept.

Following further stakeholder consultation, the preferred flight paths and aircraft operating procedures will be finalised, approved and published before parallel runway operations commence in about 2020.

Brisbane Airport NPR airspace design timeline



An iterative flight path design and evaluation process similar to that used at other airports would occur before the introduction of operations at the proposed airport. The airspace design process provides insights that can be applied to the proposed airport development. These include:

- A comprehensive, methodical approach to airspace design is critical to ensure all relevant safety and environmental issues are taken into account before the selection of a final operational design. This requires an iterative process of design and validation testing that may take several years to complete.
- While a standard process can be applied to airspace design across Australia, each airport is unique in terms of its air traffic and user requirements, fleet mix, operating constraints, environmental context and geographic relationship to surrounding communities. Consequently, the optimal solution for one airport will not necessarily be the same for another.
- It is important that all of the factors identified above are understood and taken into account in assessing airspace and flight path concepts against the key performance criteria of safety, efficiency, capacity and environment. Fundamental questions to be considered include:
 - Safety – Are all potential risks identified and addressed in the design?
 - Efficiency – Is the design efficient for aircraft operations (e.g. in terms of fuel use) and air traffic management services within the terminal area?

- Capacity – Does the design allow the runway infrastructure to reach maximum capacity?
- Environment – Does the design account for relevant environmental values and impacts, including mitigating the impact of aircraft noise on communities through the modelling and assessment of noise exposure levels and the identification of potential noise abatement procedures?
- Comprehensive and regular community consultation and stakeholder engagement is essential to ensure interested parties are aware of the design process and are able to participate meaningfully in it.

The future airspace planning and design process for the proposed Western Sydney Airport will employ the same general methodology that has been used for developing airspace concepts and flight paths for other major Australian and international airports. This process, guided by the Future Airspace System, will involve extensive community and stakeholder consultation and will ensure alignment with international best practice, aviation industry expectations and Australia's obligations under international aviation agreements.

The detailed airspace design will consider the safety of all aircraft and airspace users across the Sydney basin, aircraft operation efficiency and opportunities to minimise noise and amenity impacts on all potentially affected communities, sensitive receivers and the environment. All feasible noise abatement and noise respite opportunities will be assessed throughout the design process.

Identifying flight paths and procedures that minimise aircraft noise impacts at night will be a critical component of this work. The change in air traffic complexity at night enables greater flexibility in designing arrival and departure routes for night operations at the proposed airport and improved scope to minimise aircraft noise impacts from these particularly sensitive operations.

The future airspace design and associated noise abatement procedures will be planned in accordance with *Airservices commitment to aircraft noise management* (Airservices Australia 2013) which aligns with the strategies developed by ICAO in its *Balanced Approach to Aircraft Noise Management*. The design of flight paths for the proposed Western Sydney Airport will be guided by the principles provided below (*Future airspace design principles*). These principles closely align with the above national and international benchmarks, which are discussed further in Chapter 10 (Volume 2a).

Available systems for managing aircraft will be thoroughly evaluated, culminating in the development of standard arrival and departure flight paths for implementation. Concepts and flight path options based on each of the methods identified in Airservices Australia's Future Airspace System will be modelled, compared and rigorously assessed against the key performance criteria of safety, efficiency, capacity and environment before final arrival routes for the proposed Western Sydney Airport are authorised by the Australian Government.

Any proposal to introduce a new airspace regime for the proposed airport will also comply with national environmental law. Accordingly, the proposed airspace design arrangements including nominated flight paths will be formally referred for consideration under the EPBC Act. This will be accompanied by comprehensive community and stakeholder consultation and engagement.

The steering group established to oversee the airspace and flight path design process (see Section 7.8.1) will report to the Infrastructure Minister on its progress, consultation activities, and key considerations and outcomes on a regular basis (at least once every six months).

Future airspace design principles

The following principles will apply to the comprehensive airspace design process for single runway operations:

1. Overflights of residential areas and noise sensitive facilities will be avoided to the maximum extent possible.
 - The most advanced satellite-based navigation technologies will be used to guide the design of flight paths that avoid residential and other noise sensitive areas as far as it is possible to do so.
2. Where flight paths are unable to avoid residential areas:
 - to the extent practicable, residential areas overflown by aircraft arrivals should not also be overflown by aircraft departing the airport; and
 - noise abatement procedures should be optimised to achieve the lowest possible overall impact on the affected community, taking into account safety and other operational factors.
3. Specific noise abatement procedures will be developed to minimise the community impacts of aircraft operations at night while not constraining airport operations and the economic benefits they would bring for Western Sydney.
 - When comparing options, operations that are conducted at night or on weekends will be treated as being more sensitive than those that occur during the daytime or on weekdays.
 - The use of head-to-head operations to and from the south-west, when it is safe to do so, is an important preferred option for managing aircraft noise at night. This preferred option will be thoroughly evaluated through further detailed assessment.
4. Noise mitigation measures will be developed consistent with *Airservices* commitment to aircraft noise management and the strategies developed by the International Civil Aviation Organization (ICAO) in its *Balanced Approach to Aircraft Noise Management*.
5. Aircraft arrivals will use a continuous descent approach where possible to keep aircraft at higher altitudes with low power settings and reduced noise (and greenhouse) emissions.
6. Aircraft arrivals will not converge through a single merge point over any single residential area.
7. Consideration will be given to the impacts of aircraft operations on natural and visually sensitive areas such as the Greater Blue Mountains World Heritage Area.
8. In determining the final flight paths, the community, aerodrome operators and airspace users will be consulted extensively and flight path designs will be subject to referral under the *Environment Protection and Biodiversity Conservation Act 1999*.
9. Changes to current noise sharing arrangements at Sydney (Kingsford Smith) Airport will be avoided.
10. Current airspace restrictions such as those associated with military establishments will be reviewed to improve efficiency and environmental impacts from commercial operations, while meeting Australia's future defence requirements.
11. The Australian Government will work with the New South Wales and local governments to ensure land use planning continues to prevent noise sensitive development in the highest noise exposure areas.
12. Safety is non-negotiable – only practical solutions that uphold Australia's long tradition of world-leading aviation safety will be implemented.

7.8.1 Overview of the airspace design process

The planning and design phases of the formal airspace design process for single runway operations are described below. Key activities and outputs are identified for each phase.

- **Planning phase.** Preliminary airspace design options would be developed and assessed during the planning phase based on existing Sydney basin airspace and air route arrangements and future user and stakeholder requirements. Activities and outputs include:
 - establishment of an expert steering group to oversee the detailed planning and design process. The steering group, to be led by the Department of Infrastructure and Regional Development, will include representatives from Airservices Australia, the Civil Aviation Safety Authority and the Airport Lessee Company (once appointed). It will confirm the objectives and principles for the design process, provide advice in the development of design options and ensure appropriate mechanisms are in place for ongoing consultation with airlines, aerodrome operators, Sydney basin airspace users and the community. The steering group will also be responsible for ensuring that the airspace design process integrates with related processes such as any contemporaneous review of Sydney basin airspace undertaken in accordance with the Airspace Act 2007 and other relevant legislation;
 - consideration of existing Sydney basin airspace and air route arrangements and the conduct of consultations with regulatory authorities, Sydney basin aerodromes and airspace users to consolidate future user requirements. Environment and land use information will also be obtained to inform the design process;
 - comprehensive and ongoing community and stakeholder engagement. A community and stakeholder reference group will be convened by the Department of Infrastructure and Regional Development to ensure community views are taken into account in the airspace design process. The reference group will provide a forum for stakeholder representatives to exchange information on issues relating to the proposed airspace design and flight path options and their impacts. It is expected that membership will include representatives from the aviation industry, community organisations, resident groups or individuals, State or local government bodies, and local tourism bodies and business groups; and
 - development of a range of conceptual air traffic management options (e.g. standard arrival and departure flight routes and procedures) and preliminary assessment of each option against the key performance criteria of safety, efficiency, capacity and environment. Potential noise exposure levels and noise abatement procedures will be considered for the airspace concept options. This iterative design and assessment process will lead to the identification of a preferred high-level airspace concept.
- **Preliminary design and environmental assessment phase.** During this phase, the preferred high-level airspace concept will be further developed and evaluated. The environmental impacts of the proposed airspace management design will be considered under national environmental law.

Key activities during the preliminary design phase include:

- development, evaluation and validation testing of the preferred preliminary airspace design;
 - referral of the preferred airspace design for consideration under the EPBC Act;
 - preparation and submission of any formal environmental assessment documentation required by the Environment Minister under Part 8 of the EPBC Act; and
 - comprehensive community and stakeholder consultation.
- **Detailed design phase.** This phase will include further evaluation and refinement of the selected airspace design for implementation and integrate, to the extent relevant, with the ALC's preparation of a noise management plan for the proposed airport. Activities during this phase include:
 - evaluation of noise abatement procedures identified through the preliminary design phase and considered in the EPBC Act process, including options for managing noise impacts from night time operations;
 - final development and testing of the proposed airspace design and flight paths based on the EPBC Act process, including comments received during community consultation, and input from all stakeholders to ensure the operating procedures are fit for purpose and suitable for implementation; and
 - preparation of a long term Australian Noise Exposure Forecast (ANEF) chart for parallel runway operations to inform land use planning in the vicinity of the airport site.
 - **Implementation phase.** This phase will include the regulatory certification and authorisation of the proposed airspace design and its implementation. Noise abatement procedures and noise management measures developed through the airspace and flight path design process will be recorded in the ALC's noise management plan for the proposed airport. Activities during this phase include:
 - submitting the final airspace design and flight paths (in the form of an airspace change proposal) for authorisation by CASA;
 - notifying airspace and flight path changes to aviation industry stakeholders and the community ahead of the commencement of air operations at the proposed Western Sydney Airport; and
 - commencing air operations at Western Sydney Airport in accordance with the authorised airspace design and operating procedures.
 - **Post implementation.** Consistent with arrangements at other major Australian airports, the ALC will establish a Community Aviation Consultation Group (CACG) and a Planning and Coordination Forum (PCF) before airport operations commence. These permanent forums will continue to operate following the commencement of airport operations, providing an ongoing mechanism for the ALC, residents affected by airport operations, local authorities, airport users and other interested parties to exchange information on issues relating to airport operations and their impacts.

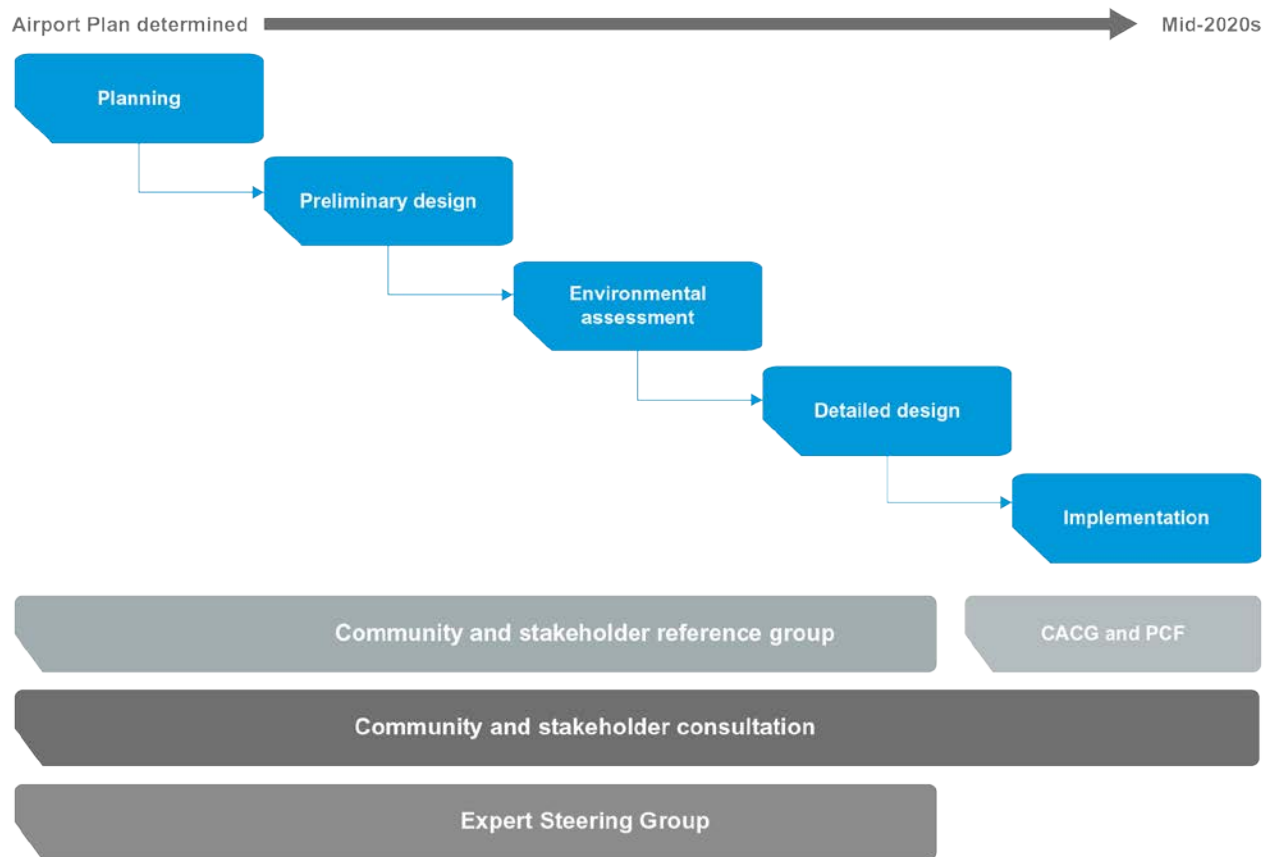
Table 7–1 summarises the phases, activities and outputs of the formal airspace and flight path design process. The table also shows the current proposed timing for the different stages of the process.

Table 7–1 Airspace and flight path design process

| Phase | Key activities | Key outcomes | Timing |
|---|---|---|---|
| Planning | <ul style="list-style-type: none"> Establish expert steering group Collect stakeholder views on system requirements, including community and environmental inputs Confirm Sydney basin airspace and air route requirements and constraints Establish community and stakeholder reference group Develop and undertake a preliminary environmental assessment of airspace concept options (i.e. standard arrival and departure routes) | <ul style="list-style-type: none"> Consultation conducted with interested parties, including regulatory authorities, government agencies, airlines, other Sydney basin aerodrome operators and airspace users, and the community Review of airspace concept options and potential noise abatement procedures including identification of a preferred high-level airspace concept option | Approx. 2 years starting from determination of Airport Plan |
| Preliminary design and environmental assessment | <ul style="list-style-type: none"> Evaluate the preliminary airspace design Refer preferred airspace design to the Environment Minister under the EPBC Act Prepare and submit any formal environmental assessment documentation required by the Environment Minister Public exhibition and community consultation Policy on property acquisition and noise insulation announced | <ul style="list-style-type: none"> Preferred airspace design concept | Approx. 1 year Approx. 2 years (c. 2019-2021) |
| Detailed design | <ul style="list-style-type: none"> Evaluate, validate and refine the detailed design taking account of the EPBC Act process | <ul style="list-style-type: none"> Final airspace design and noise abatement procedures for implementation Long term ANEF chart | Approx. 1 year |
| Implementation | <ul style="list-style-type: none"> Notify airspace and air route changes | <ul style="list-style-type: none"> Airspace change proposal approved by CASA. Commencement of air operations at Western Sydney Airport in accordance with specific noise abatement procedures and noise management measures identified in the airspace design process¹ | Approx. 2 years Mid-2020s |

¹ The specific noise abatement procedures and noise management measures developed through the airspace design process will be recorded in the ALC's Noise Operational Environmental Management Plan for the proposed airport.

Figure 7–15 illustrates the planning and design phases and their approximate timelines. While specific consultation activities and community engagement opportunities are identified, extensive and ongoing consultation with industry, government regulators and the community will occur throughout the planning and design phases.



Note:
CACG = Community Aviation Consultation Group
PCF = Planning and Coordination Forum

Figure 7–15 Conceptual airspace and flight path design process

7.9 Airspace protection

Obstructions in the vicinity of an airport, such as tall buildings and exhaust plumes from vent stacks, have the potential to create air safety hazards and to seriously limit the scope of aviation operations into and out of an airport. The most critical areas of concern are the immediate approach and take-off areas.

The airspace around the proposed airport will be protected in the interests of the safety, efficiency and regularity of future air transport operations. The airspace protection measures are described in terms of airspace surfaces at varying altitudes around the airport site, including:

- the Obstacle Limitation Surface (OLS); and
- Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS) Surfaces.

7.9.1 Obstacle Limitation Surface (OLS)

Protecting the immediate airspace around airports is essential to ensuring and maintaining a safe operating environment and to provide for future growth. An OLS is designed to provide protection for aircraft operating in visual flight conditions. It is a series of virtual surfaces around a runway, which establish the height limits for objects in and around an airport. It identifies the lower limits of an airport's airspace, which should be kept free of obstacles that may endanger aircraft during take-off, preparation to land and landing. Development of the OLS includes assessment of surrounding terrain and obstacles so as to provide protection to a height of 300 metres for take-off and landing.

The OLS will be protected under Part 12 of the Airports Act and the Airports (Protection of Airspace) Regulations 1996. The OLS is being developed based on the indicative long term layout as identified in the revised draft Airport Plan. The OLS is expected to be declared under the Airports (Protection of Airspace) Regulations in the second half of 2016.

Intrusions into the OLS can limit aircraft operations at an airport and will require approval from the Department of Infrastructure and Regional Development before they occur. The Declaration will also enable local councils and land use planning authorities to incorporate the protected airspace as appropriate in their land use planning instruments.

7.9.2 Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS)

The PANS-OPS are established to protect those stages of take-off, landing or manoeuvring when aircraft are operating in non-visual (instrument) conditions. Pilots must be assured of obstacle clearance in these circumstances. Obstacles cannot be permitted into the PANS-OPS. If an obstacle were within the PANS-OPS, the published approach or departure procedure would need to be withdrawn and redesigned to ensure safe operation of aircraft.

PANS-OPS surfaces are also protected from intrusions under the Airports (Protection of Airspace) Regulations. Once defined, the protected airspace for the proposed Western Sydney Airport will include PANS-OPS surfaces.

A full set of PANS-OPS based on the indicative long term layout will be developed and declared following the formal flight path design and prior to commencement of operations.

7.9.3 Obstruction analysis

A preliminary analysis of terrain around the airport site was undertaken as part of the development of indicative flight paths. A survey of obstructions penetrating the proposed OLS has also been undertaken. The Blue Mountains escarpment encroaches into the OLS airspace to the south-west and west of the airport site by between 0.6 metres and up to 95 metres in some places. Other potential encroachments in the area include various mobile telephone towers and power transmission lines. These include the existing TransGrid 330kV transmission line that currently crosses the airport site. This line will be relocated before the commencement of operations. Communications and electricity service providers will be consulted about any measures required for other infrastructure encroaching the OLS (e.g. safety lighting).

Vegetation in the vicinity of the airport site and close to the runway, such as tall trees, requires individual assessment and may need to be removed or lopped. Height limitations will also apply to airport buildings, street lighting and signage within the protected surfaces. Other airspace intrusions in the vicinity of the airport that remain may need to be lit or marked.

Turbulence from vertical exhaust plumes may pose a hazard to aviation and would be controlled under the Airports (Protection of Airspace) Regulations, subject to a plume rise assessment.

7.10 National Airports Safeguarding

Protection of operational airspace around airports is also covered by the National Airports Safeguarding Framework (NASF). The NASF is a nationally agreed set of guidelines implemented by each State and Territory that 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.

The NASF includes safety-related guidelines on building generated windshear and turbulence, wildlife airport buffers to prevent bird strike, lighting restrictions to prevent pilot distraction and wind turbine risks.

As discussed in Section 21.5.2 (Volume 2a), the NASF also covers noise from aviation activity and seeks to improve community amenity by minimising aircraft noise-sensitive developments near airports.

7.10.1 Windshear and turbulence

The shape, height and arrangement of buildings in relatively close proximity to a runway may adversely affect safe aviation operations. All elements of the airport development will need to be considered for their potential windshear and turbulence effects.

7.10.2 Wildlife airport buffer

A wildlife hazard management plan to control the risk of wildlife hazards on and near the airport site would be developed by the ALC, in consultation with local authorities prior to commencement of operations.

Considerations for the wildlife hazard management plan may include recommendations for the location of waste facilities in the vicinity of the airport site or the netting of standing water features such as detention basins. A bird and bat strike assessment has been undertaken as part of this EIS (see Chapter 14 Hazards and Risks and Chapter 16 Biodiversity (Volume 2a)).

7.10.3 Restrictions to lighting

CASA has the authority to determine the potential impact of surrounding ground lighting on pilots during take-off and landing operations and to control ground lights where they have the potential to cause confusion or distraction to pilots within a six kilometre radius of an airport. In particular, lighting intensities will need to be taken into account in the design of street lighting and signage.

7.10.4 Public Safety Zones

Public safety zones (PSZs) are areas of land at the ends of runways, within which development may be restricted in order to control the number of people on the ground at risk of injury or death in the event of an aircraft accident on take-off or landing. While Australia has an excellent aviation safety record there will always be some risk associated with flying and operation of aircraft at or around airports. The use of PSZs can further reduce the already low risk of an air transport accident affecting people near airport runways.

While there is no current ICAO standard for PSZs, some jurisdictions, such as Queensland, already have in place planning guidelines or policies that consider these risks. In the absence of any nationally agreed guidance, a nominal 1,000 m, trapezoid-shaped clearance off the end of each runway threshold is identified in the indicative layouts at Figure 5–1 and Figure 5–3 of Chapter 5 to cover the area of highest safety risk.

Where a PSZ is identified, additional scrutiny might be considered for new developments that:

- increase residential use and population density in the zone;
- attract large numbers of people, such as retail or entertainment developments;
- involve institutional uses, such as schools and hospitals;
- involve the manufacture or depot storage of noxious and hazardous materials; and
- attract significant static traffic.

7.11 Operational parameters

Based on the indicative layout of the airport site, operating parameters including the expected hours of operation, number of expected arrivals and departures, and the expected operating heights for aircraft need to be considered in designing the airspace architecture. These parameters affect not only operational and commercial viability, but also the safety of operations and the potential for environmental and social impacts.

7.11.1 Hours of operation

The development of the proposed airport is a rare opportunity to establish a major transport gateway in the Western Sydney region. As outlined in Chapter 2, the proposed airport is necessary for the continued success of Sydney as a global city and would provide substantial economic and employment opportunities to the region and the national economy. To maximise these opportunities and ensure long-term competitiveness with other major airports such as Brisbane, Melbourne and Canberra, the proposed airport has been planned to operate without a curfew and measures have been put in place at all levels of government to reflect this. Long-standing NSW Government planning restrictions — in particular Local Planning Direction 5.8 made by the NSW Planning Minister under section 117 of the NSW *Environmental Planning and Assessment Act 1979* — require local governments to limit noise-sensitive developments around the airport site.

7.11.2 Number of flights

Predicted future numbers of aircraft movements have been based on an estimate — or ‘synthetic schedule’ — of the expected number of aircraft operations for a typical busy day. This estimate breaks down each predicted movement by aircraft family, operation type (arrival or departure), time of operation and port of origin or destination. These schedules form the basis of modelling undertaken for this EIS such as noise and air quality modelling.

Predicted total aircraft movements per day for the proposed Stage 1 development and indicative long term independent operation of wide-spaced parallel runways are presented in Table 7–2. Note that these figures represent a typical busy day and the number of movements is, therefore, slightly greater than the annual average. For example, for Stage 1 operations the estimated 63,000 aircraft movements per year represents an annual average of approximately 173 aircraft movements per day, compared with 198 outlined in the schedules and Table 7–2.

Table 7–2 Total predicted daily aircraft movements by type by year

| Year | Aircraft movements per day (typical busy day) | | |
|---------------------------------|---|-----------|-------|
| | Freight | Passenger | Total |
| Stage 1 operations | 28 | 170 | 198 |
| First runway at capacity (2050) | 74 | 480 | 554 |
| Long term (2063) | 104 | 1,006 | 1,110 |

By comparison, in 2015 Sydney (Kingsford Smith) Airport handled on average 923 aircraft movements per day. Based on current forecasts, the proposed Western Sydney Airport would not reach this level of demand for several decades, after a second runway has been built. The number of aircraft movements predicted for Stage 1 operations is roughly the mid-range between the amount of air traffic currently accommodated at Canberra and Adelaide airports (165 and 242 aircraft movements per day on average, respectively).

Table 7–3 shows the predicted daily aircraft movements for Stage 1 operations and the long term — as summarised in Table 7–2 — categorised by aircraft family. Note that the breakdown by aircraft family is based on current generation aircraft. Not all types of aircraft listed in Table 7–3 are expected to be operating when the airport opens or in 2063. It is expected that aircraft technology will continue to improve and airlines will replace older aircraft with newer models which are generally quieter and more fuel efficient, as has been the trend over previous decades.

Table 7–3 Predicted average daily aircraft movements by aircraft family by year

| Aircraft family | Aircraft movements per day | |
|-------------------------------------|----------------------------|------------------|
| | Stage 1 operations | Long term (2063) |
| Passenger aircraft movements | | |
| Airbus A320 | 100 | 378 |
| Airbus A330 | 18 | 286 |
| Airbus A380 | | 8 |
| Boeing 737 | 28 | 196 |
| Boeing wide-body general | - | 40 |
| Boeing 777 | 4 | 78 |
| DeHaviland DHC8 | 8 | 10 |
| Saab 340 | 12 | 10 |
| Freight aircraft movements | | |
| Airbus A330 | 2 | 2 |
| Boeing 737 | 2 | 6 |
| Boeing 747 | 10 | 38 |
| Boeing 767-400 | 4 | 10 |
| Boeing 767-300 | - | 6 |
| Boeing 777-300 | - | 4 |
| Boeing 777-200 | - | 6 |
| Small Freight | 10 | 32 |

Although the airport is proposed to operate on a curfew-free basis, there are predicted to be relatively few aircraft movements occurring during the night time period, particularly for the Stage 1 operations. Indicative aircraft movements by hour are presented in Figure 7–16.

Aircraft movements per hour

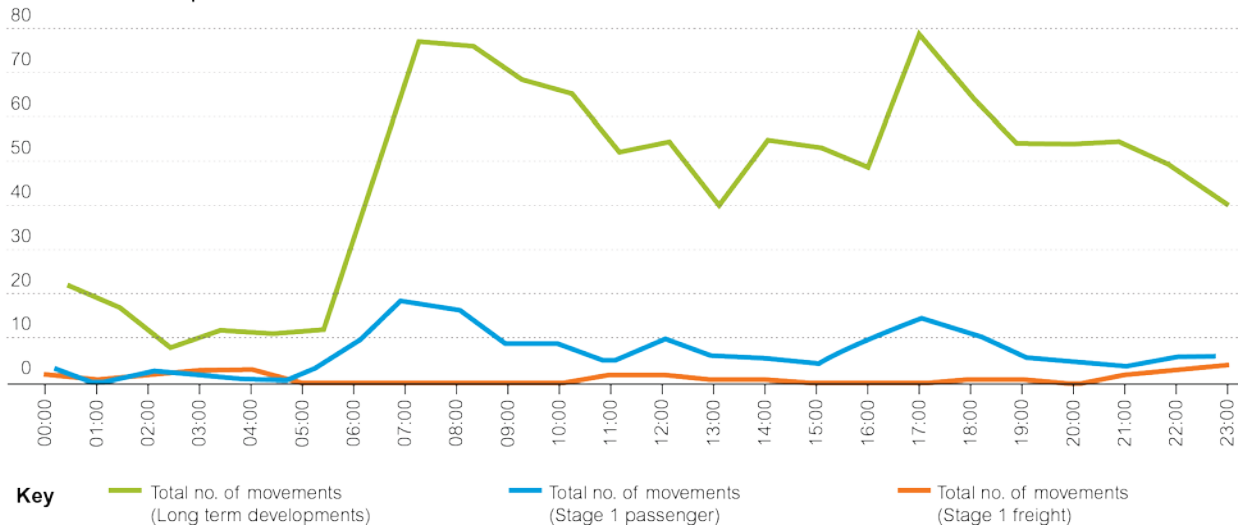


Figure 7-16 Predicted aircraft movements by hour

7.11.3 Flight altitude

The altitude of an aircraft at a particular point along a flight path will affect the degree of noise and other environmental impact on receivers beneath or in the vicinity of the flight path. At aircraft altitudes above 10,000 feet (three kilometres), the expected ground-level impacts are likely to be minor. The expected altitude of aircraft has been considered as part of the assessment required for this EIS. Further information regarding specific environmental and amenity impacts is provided in Volume 2.

7.11.4 Emergency fuel jettison (fuel dumping)

Emergency fuel jettison for civilian aircraft, commonly referred to as fuel dumping, is a rare procedure used in certain emergency situations to reduce an aircraft's weight to allow it to land safely. Aircraft do not jettison fuel as a standard procedure when landing. Indeed, most aircraft are unable to jettison fuel. Fuel jettisoning may occur if an aircraft is required to undertake an emergency landing before reaching its destination airport, or if it needs to return to its origin airport shortly after take-off (for example due to a mechanical problem or a passenger medical issue).

In these instances, and depending on the aircraft type and its intended destination, there may not be enough time to consume the amount of fuel required to get the aircraft below its maximum landing weight limit. For certain aircraft landing with a full fuel load may cause a safety issue and fuel jettison may be needed to reduce weight sufficiently and minimise the risk of structural damage.

As noted above, not all aircraft have the capacity to jettison fuel. For example, the most common types of civilian aircraft that perform the majority of domestic flights in Australia, such as the Boeing 737 and others of similar (or smaller) size, are not capable of jettisoning fuel as they do not need to reduce their weight in order to make an emergency landing. All international long haul aircraft, and some medium-to-long haul aircraft including the Boeing 777, Boeing 747 and Boeing 787, and the Airbus A330, Airbus A340 and Airbus A380, are able to jettison fuel.

If fuel is jettisoned, the exact evaporative characteristics of jettisoned fuel depend on a number of factors such as the altitude at which it was released, the atmospheric temperature and the dumping pressure. Most of the fuel evaporates rapidly within the first few hundred metres as it falls.

Instances of fuel jettisoning are extremely rare worldwide. In Australian airspace, where there is mandatory reporting of fuel jettisoning events, there were 10 reported instances of civilian fuel jettisoning in 2014 from 698,856 domestic air traffic movements and 31,345 international movements. This equates to emergency fuel jettisoning occurring in approximately 0.001 per cent of all aircraft movements.

The procedure for jettisoning fuel is specified in the En Route supplement of the Aeronautical Information Package published by Airservices Australia. When fuel jettisoning is required, the pilot in command requests authority from air traffic control before commencing the operation and must:

- take reasonable precautions to ensure the safety of persons or property in the air and on the ground;
- where possible, conduct a controlled jettison in clear air at an altitude of above 6,000 feet (approximately 1.8 kilometres) and in an area nominated by air traffic control; and
- notify air traffic control immediately after an emergency jettison.

The authority for fuel jettisoning is the Air Navigation (Fuel Spillage) Regulations 1999, which prescribe penalties for the unauthorised release of fuel from an aircraft other than in an emergency.

Given the rarity of fuel jettisoning globally, the known low occurrence in Australian airspace, the standards set out in the Aeronautical Information Package, and the high evaporation rates known to occur at high altitude, authorised fuel jettisoning associated with the operation of the proposed airport, is unlikely to cause environmental or social impacts.

7.12 Potential meteorological impacts on operation

Weather conditions at different locations across the Sydney region are largely influenced by topography in and around the Sydney Basin. Generally, the weather conditions experienced at a given location depend upon proximity to the ocean or some other body of water, elevation and the surrounding topography. These factors influence daily and seasonal temperature ranges and variability, humidity, rainfall, fog occurrence, and wind gustiness, direction and speed.

In 2014 the Bureau of Meteorology was engaged to provide a preliminary report on the meteorological parameters affecting the usability of the proposed airport and provide a comparison of expected conditions with Sydney Airport and other airports in the region. The *Western Sydney Airport Usability Report* (Bureau of Meteorology 2015) is provided at Appendix D of Volume 4.

The Bureau of Meteorology works closely with Airservices Australia and CASA in providing services for civil aviation, a role which is established through the *Meteorology Act 1995*. Under the Convention for International Civil Aviation (the Chicago Convention) the Bureau of Meteorology is the designated Meteorological Authority for Australia and provides meteorological services for civil aviation in Australia in accordance with the standards and practices set out in Annex 3 to the Convention.

7.12.1 Badgerys Creek automatic weather station

In 1995 the Bureau of Meteorology installed an automatic weather station at Badgerys Creek, which has recorded a continuous supply of meteorological information including wind, temperature, dewpoint temperature, pressure and rainfall. Owing to the location of the airport site in the Western Sydney basin, the climate and weather phenomena that may affect the proposed airport can be significantly different to those experienced at Sydney Airport.

Topography in the Sydney basin is likely to cause local disparities in temperature, moisture, pressure, rainfall and wind. Any combination of these factors will indirectly affect the frequency and severity of weather phenomena such as fog, thunderstorms, turbulence, wind shear and low cloud. A topographical map of the Sydney basin is provided in Figure 7–17.

It is expected that the proposed runway configuration for Stage 1 will 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 the proposed airport; however, mitigation is obtainable through navigational systems and aids. In addition, many of these other weather phenomena occur at other major airports (e.g. fog at Canberra Airport) demonstrating that these weather phenomena could be effectively managed at the proposed airport and do not preclude the safe operation of an airport.

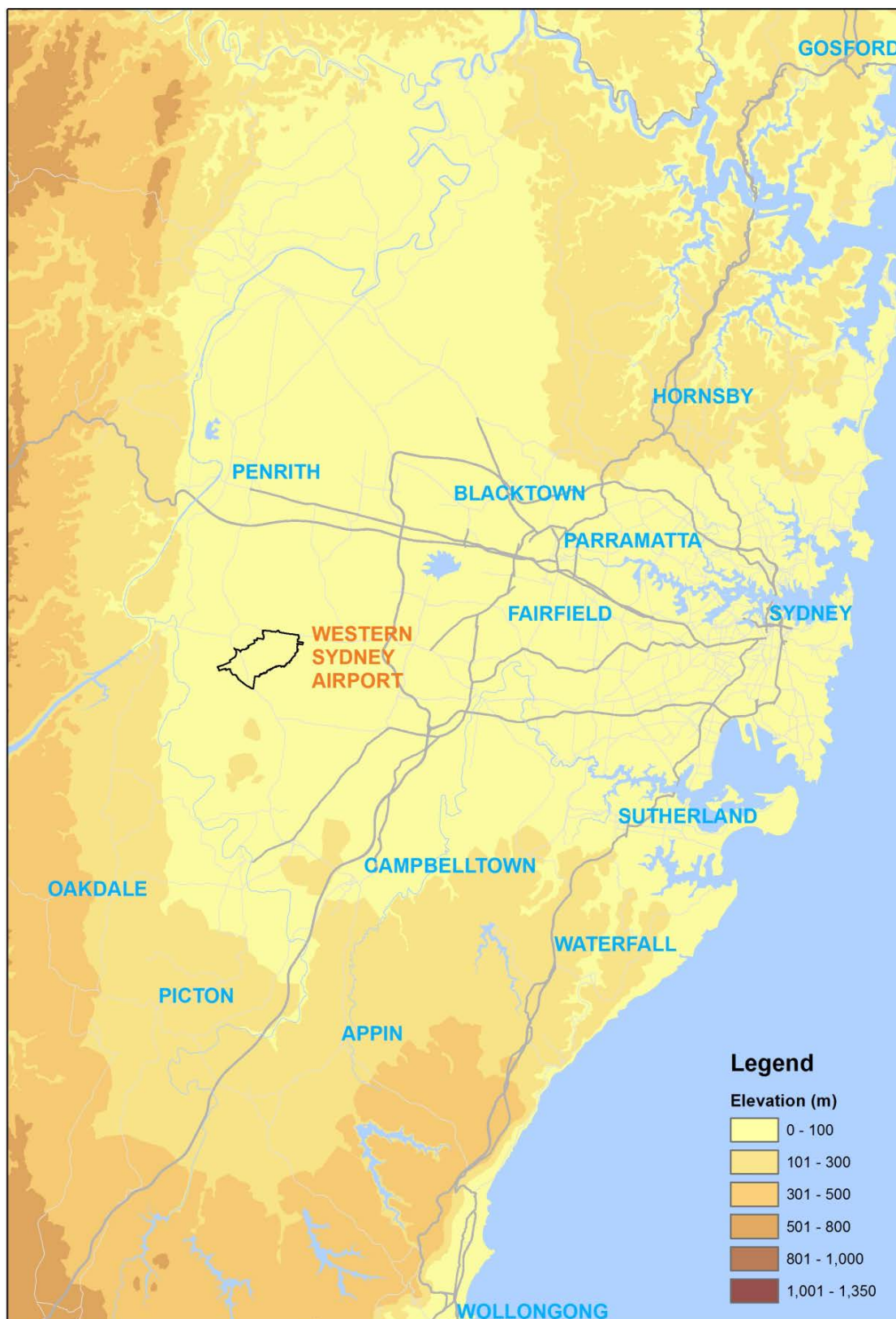


Figure 7-17 Topographic map of the Sydney basin

Turbulence and wind shear

Turbulence is caused by a disruption to air flow. Turbulence in the lower atmosphere is generally created by the flow of air around an obstacle such as topography or buildings. However, meteorological conditions such as boundaries between different air masses can also provide turbulent effects.

Moderate and severe turbulence at the proposed airport would be most common in the months of June to August. Analysis indicates that the proposed airport would experience slightly fewer turbulence events than Sydney Airport.

7.12.2 Temperature

Whilst average daily temperatures are important, it is the extremes in heat or cold that can have the most impact on airport operations generally.

A summary of the temperature information recorded at the Badgerys Creek weather station is presented in Table 7–4 and Table 7–5.

The month of January has the most days on average above 30 degrees Celsius ($^{\circ}\text{C}$) and 35 $^{\circ}\text{C}$ with 13.4 and 5.2 days respectively. July has the most number of days on average below 0 $^{\circ}\text{C}$ with 3.3 days.

Table 7–4 Temperature climatology at the airport site

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|------|------|------|------|------|------|------|------|------|------|------|------|
| Mean daily maximum temperature ($^{\circ}\text{C}$) | 29.9 | 28.5 | 26.7 | 23.9 | 20.6 | 17.8 | 17.3 | 19.3 | 22.7 | 24.7 | 26.1 | 28.1 |
| Highest temperature ($^{\circ}\text{C}$) | 45.5 | 42.6 | 40.0 | 34.6 | 27.9 | 25.2 | 25.4 | 28.8 | 34.8 | 37.2 | 41.9 | 42.5 |
| Mean daily minimum temperature ($^{\circ}\text{C}$) | 16.9 | 17.1 | 15.1 | 11.3 | 7.6 | 5.4 | 4.2 | 4.6 | 7.7 | 10.2 | 13.4 | 15.2 |
| Lowest temperature ($^{\circ}\text{C}$) | 8.2 | 8.5 | 6.4 | -0.1 | -1.1 | -3.0 | -4.5 | -1.9 | -0.5 | 2.2 | 5.3 | 6.6 |


Table 7–5 Temperature extremes at the airport site

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|--|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| Mean number of days over 30 $^{\circ}\text{C}$ | 13.4 | 9.6 | 4.8 | 0.8 | Nil | Nil | Nil | Nil | 1.7 | 5.1 | 6.8 | 10.2 |
| Mean number of days over 35 $^{\circ}\text{C}$ | 5.2 | 2.6 | 0.5 | Nil | Nil | Nil | Nil | Nil | Nil | 0.8 | 1.8 | 2.8 |
| Mean number of days below 0 $^{\circ}\text{C}$ | Nil | Nil | Nil | 0.1 | 0.3 | 2.0 | 3.3 | 2.1 | 0.2 | Nil | Nil | Nil |

High temperatures

High temperatures may affect airport operations. Temperature has an indirect relationship with air density - as temperature climbs the air becomes less dense which affects aero-dynamical lift.

High temperatures can also affect fuel, causing it to expand and restrict the capacity to adequately refuel aircraft in some cases. A temperature exceeding the flash point for jet fuel (approximately 38 $^{\circ}\text{C}$ for Jet A/A1) is important as liquid becomes a gas at this temperature and becomes extremely hazardous.



Data recorded at the Badgerys Creek weather station indicate that the temperature is equal to or greater than 30 °C regularly throughout the end of spring, summer and the start of autumn at the airport site. Temperatures exceeding 30 °C are most common during the middle to late afternoon. It is also not unusual to see temperatures exceed 35 °C in late spring and summer at these times of the day.

Whilst it is possible for temperatures to exceed 40 °C in late spring and summer, it is not common at the airport site. Temperatures are most likely to exceed 40 °C in January.

Low temperatures

Temperatures below zero degrees Celsius at surface level may produce adverse weather conditions that affect aircraft operations including hail, snow, sleet, frost, icing and freezing fog.

Data recorded at the Badgerys Creek weather station indicates that it is common for temperatures to drop below 0 °C from June to August. This occurs most commonly in July, on average for more than 75 hours a month. The early morning period before sunrise is the most common time for temperatures to be recorded below 0 °C at the airport site.

Frost

Frost and ice accumulation on ground surfaces can occur at temperatures below 0 °C. Records of temperatures below 0 °C were analysed by the Bureau of Meteorology to indicate the potential for frost at the airport site and compared to data for Canberra Airport.

Analysis found that frost could potentially form between the months of May to September at the proposed airport and that they were most likely in July when frost events can occur on average for over four hours. Frost is most likely to occur near sunrise.

In comparison, Canberra Airport experiences approximately 20 times more hours of frost than Badgerys Creek between the months of April to October.

7.12.3 Freezing fog

Conditions are conducive to the formation of freezing fog when the temperature is below zero degrees Celsius and the relative humidity is greater than or equal to 95 per cent. In these conditions the density of super-cooled liquid water suspended in the air would be high enough to potentially cause rime icing when an aircraft's surface temperature is below zero degrees Celsius. Rime icing is rough opaque ice, formed by supercooled drops rapidly freezing on impact producing 'horns' or protrusions. Rime icing can reduce the performance of aircraft operations by increasing the weight of an aircraft, decreasing thrust and increasing drag.

These atmospheric conditions are also conducive to the formation of black ice on paved areas such as runways and taxiways, especially after rain. Black ice or 'clear ice' refers to a thin coating of glazed ice that is often practically impossible to see and presents a risk of aircraft skidding due to loss of traction.

Conditions conducive to freezing fog could potentially occur in the months of May to September at the airport site; however, it is more common from June to August. On average there are 3.5 hours in July in which icing may impact surfaces at the airport site. In comparison, Canberra Airport experiences on average 10 times more hours a month of freezing fog conditions during the winter months.

Freezing fog would most commonly occur in the hours surrounding sunrise during the winter months. It would be possible, though rare, for events to initiate in the early morning hours. The availability of de-icing equipment will mitigate the impact of icing on aircraft and hard surfaces at the proposed airport.

7.12.4 Temperature inversions

Under normal conditions the air temperature reduces with height above a location. A temperature inversion occurs when there is an increase in temperature with height. The atmosphere beneath the inversion forms a stable layer of cold air trapped by the warm air above. Temperature inversions tend to be more significant during the cooler months where the air at the surface is cooler than the air above and the ability of the surface to heat during the early morning is diminished.

The main impact of a temperature inversion is on local air quality and noise propagation. The presence of a temperature inversion has a significant influence on the ability of the atmosphere to disperse pollutants. An inversion layer effectively forms a barrier in the lower atmosphere that restricts the mixing of air and causes a build-up of pollutants. Pollutants from the previous day and those advected overnight into the area can be trapped by the inversion causing morning pollution problems. Generally, the concentration of pollutants in the air is strongest during the early morning hours when a low-level temperature inversion exists and wind speeds are light. The effects of temperature inversions on air quality are discussed in more detail in Chapter 12 (Volume 2a).

7.12.5 Rainfall


An airport's operations can be affected by rainfall in many ways including aircraft landing distance, runway nomination and the type of approach due to poor visibility or low cloud. Additionally, heavy rainfall leading to flash flooding can affect aircraft operations by flooding taxiways and runways, damaging the runway, severely reducing tyre traction and in the worst case lead to aircraft hydroplaning. Such risks would be managed effectively through runway design and surface treatments at the proposed airport.

Rainfall climatology

Rainfall data for Badgerys Creek have been extracted and analysed by the Bureau of Meteorology and findings show that the average annual rainfall at Badgerys Creek is 680.9 millimetres with rain recorded on average on 117.8 days per year. The recorded monthly rainfall statistics are presented in Table 7–6.

Table 7–6 Rainfall statistics at the airport site

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|-------------------------------|-------|-------|-------|-------|-------|-------|------|-------|------|-------|-------|-------|
| Mean monthly rainfall (mm) | 77.4 | 108.0 | 77.3 | 43.2 | 40.1 | 52.1 | 23.0 | 35.9 | 33.9 | 52.7 | 74.5 | 63.6 |
| Highest monthly rainfall (mm) | 192.2 | 342.4 | 198.0 | 129.4 | 155.6 | 220.0 | 71.6 | 231.0 | 82.2 | 182.2 | 173.2 | 131.2 |
| Lowest monthly rainfall (mm) | 13.6 | 13.4 | 21.4 | 1.8 | 1.8 | 2.0 | 2.8 | 1.0 | 6.4 | 0.4 | 8.4 | 14.2 |
| Highest daily rainfall (mm) | 138.0 | 106.8 | 67.8 | 82.4 | 54.0 | 63.8 | 28.4 | 70.0 | 50.8 | 63.0 | 63.0 | 65.0 |



Average monthly rainfall in excess of 50 millimetres generally occurs in the months from October to March at Badgerys Creek.

Rainfall and the amount of rain days appear to be less variable at Badgerys Creek than at Camden and Sydney airports. Badgerys Creek experiences lower monthly highs and higher monthly lows in rainfall than the other two airports. This may be due to topographical effects or reflect the shorter length of rainfall records.

7.12.6 Fog and low cloud

Fog is caused by a suspension of water droplets in the air near the surface of the earth. Internationally, fog is reported when the horizontal visibility has dropped below 1,000 metres (ICAO 2007). However, in order to exclude smoke and other circumstances that may cause a reduction in visibility, the Bureau of Meteorology has applied an additional condition of relative humidity above 95 per cent to the data analysis.

For aviation purposes, a visibility of less than 1000 metres must be observed at a height of two metres above the ground or the fog is termed shallow fog. Instrumentation is currently unable to determine the difference between shallow fog and fog at an airport.

Most major Australian airports are equipped with ILSs which allow a pilot to attempt to approach an airport in reduced visual conditions. However, in the event of a fog it is the Runway Visual Range (RVR) system that becomes critically important. The RVR system may allow aircraft to land in dense fog provided the RVR is above specified thresholds for the aircraft that is landing, the aircraft has the required instrumentation and the pilot has valid certification.

The presence of a low cloud ceiling has the ability to affect airport operations and air traffic flow. To ensure that aircrew can adequately prepare for low cloud situations an 'alternate minima' is assigned depending on aircraft type. The alternate minimum represents the broken cloud height below which additional fuel must be carried to enable the aircraft to safely land at an alternative aerodrome.

The formation of low cloud is dependent on factors such as temperature, low-level moisture content, low-level wind direction, atmospheric stability and topography. From data recorded at the Badgerys Creek weather station it is possible to calculate the dewpoint depression, which is the difference between temperature and dewpoint. The dewpoint is the temperature to which the air must be cooled to reach saturation, or the temperature at which dew would form should the air temperature fall sufficiently.

The proposed airport will be designed to achieve CAT IIIB (or equivalent) instrumentation approach procedures on both runway ends. A CAT IIIB ILS provides the highest category of precision lateral and vertical navigational guidance to aircraft using a ground-based instrument approach for safe landing in poor visibility.

7.12.7 Thunderstorms

Regardless of size or intensity, any thunderstorm can be hazardous to aviation. Potential impacts include disruption to the management of air traffic both in the air and landside in the terminal area, and disruptions to airport ground operations. Aviation hazards encountered in and near thunderstorms include severe wind shear and turbulence, severe icing, downbursts, hail, lightning, heavy rain, tornadoes, low cloud, poor visibility and rapid air pressure fluctuations.

While most 'ordinary' thunderstorms individually have lifetimes of thirty minutes to an hour, under certain atmospheric conditions systems of thunderstorms or even individual storms may last for several hours.

The Bureau of Meteorology analysis suggests that the thunderstorm season in the vicinity of the proposed airport appears to start and finish earlier in the year by approximately one month when compared to Sydney Airport. Outside of the thunderstorm season, there is expected to be more thunderstorm activity at Sydney Airport when compared to the proposed airport.

Most thunderstorms in the region develop over the Great Dividing Range moving eastwards into the Sydney basin. The close proximity of the airport site to the mountain ridge would only allow for a relatively short lead-time for thunderstorm warnings at the proposed airport. For example, a thunderstorm that initiates over the Great Dividing Range and moving at 20 knots, would reach the proposed airport in approximately 30 minutes.


7.12.8 Summary of meteorological impacts on operation

The Bureau of Meteorology found that siting of the proposed airport at Badgerys Creek has many meteorological advantages compared to Sydney Airport namely the minor exposure to significant crosswind and headwind, the lack of low-level vertical wind shear and a lower frequency of thunderstorms.

Mitigation processes and equipment exist to deal with the operational effects of most weather phenomena that are expected to occur at the proposed airport. Crosswinds primarily determine runway availability and usability at the airport site. Based on the proposed runway alignment and the analysis of crosswind data, it is expected that the proposed airport would be usable approximately 99.5 per cent of the time.

There are factors which need consideration during the operational planning of the proposed airport that are more likely to occur at the airport site than at Sydney Airport. These include weather phenomena such as high temperatures, freezing fog and frost. In some cases, these weather phenomena would occur less frequently at the proposed airport when compared to other airports such as Canberra Airport. Through adequate planning and infrastructure, it is possible to mitigate the influences of most weather phenomena.

The study undertaken by the Bureau of Meteorology indicates that perhaps the most significant aspect of the airport site is likely to be the occurrence of fog. The development of fog overnight in the western Sydney basin is possible during all months of the year. It often occurs for extended periods of time during winter. An increase in pollutants in the adjacent atmosphere to the airport site could likely affect fog formation in the future. Additional equipment for monitoring visibility and cloud is required to better understand fog climatology at the airport site and for meteorologists to improve forecasting skills into the future. However, while fogs are relatively common, modern ILS and RVR systems allow aircraft to land safely in dense fog and when visibility is low.



Further meteorological studies are likely to be required in the following areas as part of the operational planning for the proposed airport:

- correlating low visibility statistics with ILS categories will likely aid airport planners in determining the navigational aids required for optimal usability of the proposed airport;
- estimating correlation between the occurrence of fog events at Sydney Airport and the proposed airport may inform decisions regarding network management;
- analysing different methods of detecting wind shear and rotors at the airport site;
- conducting a comparison study into the numerical modelling of turbulence at major airports such as Brisbane and Melbourne as required;
- researching the potential impact of freezing fog and associated management measures before implementation; and
- conducting further crosswind and headwind calculations as required.