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Appendix E1
Aircraft overflight noise

ACOUSTICS AND AIR

WESTERN SYDNEY AIRPORT EIS

AIRCRAFT OVERFLIGHT & OPERATIONAL NOISE

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EXECUTIVE SUMMARY

This report presents an assessment of aircraft overflight and operational noise from the proposed Western Sydney Airport which is described in detail in the Western Sydney Airport Environmental Impact Statement (EIS).

EIS investigations are centred upon two principal stages of proposed airport development; an initial development and a possible long term development. For the purposes of the EIS, the initial (or Stage 1) development of the airport includes a single runway and corresponding facilities to handle up to approximately 10 million annual passenger movements. It is considered this level of demand could nominally occur in 2030.

Subject to any further approvals required, a long term development of the Western Sydney Airport could include parallel runways and additional associated infrastructure sufficient to facilitate approximately 82 million annual passenger movements. It is predicted that this level of travel demand could be reached around 2063.

This aircraft noise assessment considers the likely impacts of aircraft overflights in the vicinity of the proposed Western Sydney Airport occurring at these two key stages. It also considers an additional scenario when the first runway is considered to be near its nominal capacity, which could be reached around 2050. This reflects the change in noise impact as airport usage grows, and also illustrates the change in impact that would be brought about by the commencement of second runway operations. This change would result in a major reconfiguration of airport operations, and therefore also changes in the pattern of noise impact. While this scenario is based on the runway to be constructed as part of the Stage 1 development, a number of other stages of development would need to occur in the lead up to the 2050 scenario, including a requirement for additional taxiways, aprons and terminal space that would be subject to separate approvals under the Airports Act.

Calculation & Assessment Procedures

Noise assessment is based on information and projections from a number of sources, including projected air traffic volumes, aircraft flight tracks, airport operating modes, assumed fleet mix and scheduling, expected noise emissions from future aircraft types, and future population densities in areas around the proposed airport. The basis of the information used in this report is described in the body of the report.

Noise impact from aircraft in flight and operating on the runway is assessed in this study in terms of a number of measures, including the following descriptors:

- N70: The average number of aircraft noise events per day (i.e. over 24 hours) with maximum noise levels exceeding 70 dBA, this descriptor is used to indicate potential daily noise impacts from aircraft operations;
- N60: The average number of aircraft noise events per day with maximum noise levels exceeding 60 dBA during the night time period 10pm-7am, this descriptor is used to indicated potential night time noise impacts from aircraft operations;
- 90th percentile N70 and N60: Values of N70 and N60 calculated for the 90th percentile day. Noise impacts would be expected to exceed these values on only 10% of days, and hence they can be considered as the "N70 or N60 on a typical worst-case day"; and

- ANEC: A standard measure of aircraft noise exposure used in Australia used to define land use planning around airports based on hypothetical operating scenarios. In the Australian Noise Exposure Forecasting (ANEF) system areas outside the 20 ANEF contour are "acceptable" for new residential development. Between ANEF 20 and 25, new residential development is considered "conditionally acceptable". Above ANEF 25, new residential development is considered "unacceptable".

Calculations were performed using the industry-standard INM calculation program and involved calculation of noise levels from all relevant aircraft types on all indicative flight tracks. The number of operations on each track depends in part on assumptions regarding the airport's operating strategy and a number of strategies are compared in terms of their outcomes for noise impact.

Airservices Australia has assessed the airspace implications and air traffic management approaches for Sydney basin airspace arising from the potential introduction of operations at the proposed Western Sydney Airport.[1] The principal objective was to establish whether safe and efficient operations could be introduced at the airport by developing indicative proof-of-concept air traffic management designs. Importantly, this work does not present a comprehensive airspace and air route design, nor does it consider all of the essential components that would be necessary to implement an air traffic management plan for the Sydney basin.

While the formal flight path design for the proposed airport would be undertaken much closer to the commencement of operations – within several years of the first flights occurring – indicative flight paths for Stage 1 (single runway) and long-term (parallel runway) operations have been prepared based on Airservices Australia's preliminary analysis. This report is based on the indicative flight path design.

The indicative design incorporates a "point merge" system for arrivals, under which all arriving aircraft pass over a single point before commencing their final approach to the airport. The "point merge" system promotes "continuous descent approaches", which result in savings in fuel, as well as reduced noise emissions. Assessment in this report assumes that all arrivals at the proposed airport would use a continuous descent approach track passing through a single "merge point".

Noise impact around the airport would depend on the airport operating strategy that was adopted by Air Traffic Control. This report considers two basic operating strategies – "Prefer 05" in which aircraft approach and depart the airport in a south-west to north-east direction (unless this is not possible due to wind or other conditions), and "Prefer 23" in which the opposite direction is preferred. A "Head-to-Head" mode of operation, in which aircraft both approach and depart from / to the south-west, is also considered for night time operations.

Impacts on land use planning are assessed in terms of ANEF system, in accordance with Australian Standard 2021:2015. In particular, this Standard indicates that areas outside the 20 ANEF contour are "acceptable" for new residential development. Alternative land use planning assessment methodologies have been proposed, but are not implemented in any relevant planning documents.

The following sections summarise the findings of aircraft noise modelling for the proposed initial airport development and subsequent future indicative stages of development, which would be the subject of future assessments and approvals.

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[1] Airservices Australia – Western Sydney Airport – Preliminary airspace management analysis – Final report, April 2015.

Stage 1 Development (2030)

For this first stage of airport development, the analysis focusses on the nominal year 2030 when operations allowing 10 million annual passenger movements would occur on one (northern) runway. The conclusions from the assessment can be summarised as follows.

Maximum noise levels:

Maximum noise levels are described by combined single event noise contours for the loudest and most common aircraft, being B747 and A320 aircraft, respectively.

In the case of departure noise levels, the contours follow the main departure flight paths. The associated maximum noise contours for departure to the north extend over the residential areas of St Marys and Erskine Park. In the case of departures to the south, contours extend towards The Oaks, Lake Burragorang and Bringelly. Noise contours also extend to the village of Luddenham.

The predicted departure noise contours of the B747 are significantly larger than those of the A320 aircraft; for example, the 70 dBA contour extends approximately 15 km from the runway end to St Marys for a B747, whilst the same contour extends only 5 kms for an A320 aircraft.

In the case of arrivals, the noise contours follow arrival tracks from a merge point over the lower Blue Mountains. The arrival noise contours of the B747 are also significantly larger than the same contours for the A320 aircraft; for example the 70 dBA contour extends approximately 15-17 km from the runways ends for a B747, whilst the same contour extends only 8-10 kms for an A320.

It is determined that;

- For the loudest aircraft operations (medium-range departures by Boeing 747 aircraft or equivalent), maximum noise levels over 85 dBA would be experienced at a small number of residential locations close to the airport site, in the area of Badgerys Creek. Maximum noise levels of 70 – 75 dBA could be expected within built-up areas in St Marys and Erskine Park due to these worst-case operations, which are predicted on average to occur once per day in Stage 1.

- Maximum noise levels due to more common aircraft types, such as the Airbus A320 or equivalent, are predicted to be 60 – 70 dBA in built-up areas around St Marys and Erskine Park and over 70 dBA in some adjacent areas to the south-west of the airport, notably the area of Greendale on a "Prefer 05" operating strategy.

Noise impact over 24 hours:

N70 contours for the initial stage of the airport extend well beyond the runway ends. Typically, the N70=5 contour extends approximately10 kms to the north and 14 kms to the south west of the runway. Depending on the strategy priority, either "Prefer 05" or "Prefer 23", the contours include "lobe" towards St Marys and Greendale respectively. To the side of the runway the contours would extend approximately 1.5 kms into parts of Luddenham.

However, these "lobes" do not extend into major population centres.

It is determined that;

- In Stage 1, the choice of airport operating strategy is predicted to have a minor effect on the total number of residents affected at various noise levels over 24 hours, although the location of the affected residents differs. The "Prefer 23" strategy results in fewer people being affected at lower noise levels (generally to the north of the airport), but this is offset by more people being affected at higher noise levels – generally in rural residential areas to the south and west of the airport.

- Under any of the considered scenarios, approximately 1,500 people are predicted to be exposed to at least 5 aircraft operations per day with maximum levels exceeding 70 dBA. None of these are in built-up residential areas.

Night time noise impact:

N60 night time contours for the initial stage of the airport extend out from the runway ends. Typically, the N60=5 contour extends approximately 15 km to the north to St Marys and 20 km to the south-west of the runway when the "Prefer 05" strategy is implemented. The contour to the north of the runway is predicted to extend into the population centres around St Marys.

The adoption of a "Prefer 23" priority strategy results in the contours extending to the north-east for a distance of approximately 17 km and to the south-west for 24 km. The contours would include a "lobe" towards Greendale.

To the side of the runway, the contours extend into Luddenham.

The adoption of Head-to-Head operations results in a significant reduction in the size of the contours to the north of the airport , particularly for the "Prefer 05" strategy.

It is determined that;

- The extent of night time noise impact depends strongly on the airport operating strategy and, in particular, the adoption of a "Head-to-Head" operating mode when practicable. Use of a 'Head-to-Head" strategy results in an estimated 4,300 residents being exposed to more than 5 aircraft noise events per night above 60 dBA in Stage 1. An outside noise level of 60 dBA corresponds to an internal level of approximately 50 dBA if windows are open to a normal extent, which is the design criterion for aircraft noise in sleeping areas under Australian Standard 2021. Under the above strategy, the affected residents would be largely in rural residential areas to the south-west of the airport, including Greendale and parts of Silverdale. However, some residents to the north-east of the airport around Horsley Park would also be affected.

- Airport operating strategies that do not include a "Head-to-Head" mode are predicted to result in substantially greater numbers of residents impacted by night time noise and, in particular, a "Prefer 05" strategy would result in large parts of St Marys experiencing more than 5 aircraft noise events per night above 60 dBA in Stage 1.

Land use planning:

The ANEC contours extend beyond the runway ends for a distance of approximately 7 km. To the sides of the runway the contours extend approximately 1 km from the runway centreline.

- In ANEC contours produced for the Stage 1 scenario, the area covered by the 20 ANEC contour is located closely around the airport, with only an estimated 200 – 240 residents living within the contour. However, because land use planning guidelines are intended to address long-term planning issues, ANEC contours for long term scenarios, as described below, are considered more relevant. An ANEF chart based on further formal flight path design would be produced for endorsement by Airservices Australia prior to the commencement of airport operations to inform land use planning.

Based on airport usage patterns projected for this report, 20 ANEC contours cover areas that are currently largely rural residential in nature, with some industrial use. No areas of built-up residential development are included in the 20 ANEC contour under any scenario. The "Prefer 23 with Head-to-Head" operating scenario results in the smallest area being covered. One point of interest is that an area to the west of the airport site, including the townships of Warragamba and Silverdale, although relatively close to the airport, is not included in the 20 ANEC contour under any scenario. This is due to the fact that, although a departure track is located over this area, the track is designated as being for use by non-jet aircraft only. The ANEC contours presented in this report should not be used for land use planning purposes until the validity of all underlying assumptions has been confirmed.

Greater Blue Mountains Area:

- Based on the indicative airspace design for the proposed airport, large areas of the Greater Blue Mountain World Heritage property would not experience significant aircraft noise. However, some parts of the property would be subjected to a substantial increase in aircraft overflights. The aircraft would be at heights generally greater than 5,000 feet above ground level. Maximum noise levels may occasionally reach 60 dBA at some points, but levels directly under a flight track would typically be below 55 dBA, and often much lower. The periodic intrusion of aircraft noise may result in occasional disturbance to recreational and other visitors to the property.

- At locations directly under the indicative flight tracks, the number of audible aircraft overflights (typically at levels of 55 dBA or below) could be over 70 per day in Stage 1. Worst-case locations would be under one of two approach paths that emanate from a "merge point" in the area of the lower Blue Mountains.

- The nominal location of this merge point based on the indicative flight tracks would be almost directly over the township of Blaxland, meaning that in Stage 1, residents could expect to experience aircraft overflights at significant altitude (typically over 5000 ft above ground level) almost 100 times per day, with maximum noise levels ranging up to 55 dBA.

- Alternative locations for this merge point were considered within about 3 nautical miles from the nominated location. Use of these alternative merge points would substantially reduce the number of overflights passing over populated areas, but would result in other locations within the World Heritage Area experiencing a similar number of overflights to those currently predicted for Blaxland.

Additional Capacity (2050)

Demand for air travel would continue to grow following the proposed initial stage of airport development. This noise assessment therefore includes a subsequent assessment scenario, notionally at the capacity of the first runway, when total passenger demand is estimated to be approximately 37 million passengers per annum. This scenario provides an indication of potential change in noise impacts associated with the growth of aircraft movements on the proposed first runway over time.

Conclusions from the assessment of this scenario can be summarised as follows.

Maximum noise levels:

Maximum noise levels are the same as those described for the Stage 1 (2030), with the exception of B747 aircraft that depart on long haul international routes. In this case, the noise contours extend up to 50 kms from the runway ends. Noise contours also extend to the village of Luddenham.

- Predicted aircraft operations for the 2050 scenario include longer-range departures by B747 or equivalent aircraft. B747 aircraft are currently being phased out of operations and replaced with quieter aircraft. This scenario has modelled a worst-case scenario and for these operations, maximum noise levels over 85 dBA would be experienced at a small number of residential locations close to the airport site, in the area of Badgerys Creek. Maximum noise levels of 75 – 80 dBA could be expected within built-up areas in St Marys and Erskine Park due to these worst-case operations, which are predicted on average to occur once every two days in 2050. These operations may occur during day or night periods.

- Maximum noise levels due to more common aircraft types, such as Airbus A320 or equivalent, would be the same as those described above for Stage 1.

Noise impact over 24 hours:

N70 contours would extend from the runway ends. The N70=5 contour would extend approximately 15 km to the north and 19 km to the south-west of the runway. Depending on the strategy, either "Prefer 05" or "Prefer 23", the contours would "lobe" towards St Marys and Greendale / Bringelly respectively.

In the case of the "Prefer 05" priority strategy, the noise contours would cover the densely populated areas around St Marys. However, the Greendale / Bringelly "lobes" would not extend into population centres.

It is determined that;

- In 2050, there would be a very substantial difference between the "Prefer 05" and "Prefer 23" operating strategies in terms of noise impact.

- Most residents predicted to be affected under the "Prefer 05" strategy are in suburbs to the north around St Marys and Erskine Park. In terms of total population affected, the "Prefer 05" strategy is predicted to have a greater impact with an estimated 30,000 residents experiencing more than 5 events per day over 70 dBA in 2050, compared with 5,000 residents for the "Prefer 23" strategy. These numbers are reduced slightly if a "Head-to-Head" mode is also adopted.

Under the "Prefer 23" strategy, the residents predicted to experience the greatest number of overflights over 70 dBA are in rural residential areas to the south-west, including Greendale and parts of Silverdale. These residents would be affected to a greater extent than those to the north – an estimated 700 residents in this area would experience more than 100 events per day above 70 dBA, compared with 300 residents under the "Prefer 05" scenario.

Night time noise impact:

For the additional capacity stage of the airport, the N60=5 contour extends approximately 20-22 km to the north to St Marys and 25 km to the south-west of the runway when a "Prefer 05" strategy is implemented. The contour to the north of the runway would extend into the population centres around St Marys.

The adoption of a "Prefer 23" priority strategy would result in the contours extending to the north-east for a distance of approximately 20 km into the Blacktown area and to the south-west for more than 40 km into a southern part of the Blue Mountains National Park. The contours would lobe towards Greendale.

The adoption of Head-to-Head operations would result in a significant reduction in the size of the contours to the north of the airport, particularly under the "Prefer 05 Head-to-Head" strategy.

To the side of the runway, the contours extend into Luddenham.

It is determined that;

- The extent of night time noise impact would also depend strongly on the airport operating strategy. The most favourable strategy from the point of view of noise impact would be "Prefer 23 with Head-to-Head", which would result in an estimated 40,000 residents being exposed to more than 5 aircraft noise events per night above 60 dBA. The affected residents would be largely to the north-east of the airport around Horsley Park, Blacktown and St Marys. However, the bulk of these receivers would be in the 5 – 10 noise event range.
- Airport operating strategies that do not include a "Head-to-Head" mode are predicted to result in substantially greater numbers of residents impacted by night time noise, and in particular, a "Prefer 05" operating strategy would result in large parts of St Marys experiencing more than 20 aircraft noise events per night above 60 dBA in 2050.

Land use planning:

Under the 2050 assessment scenario the ANEC contours would extend along the runway alignment for a distance of approximately 12-15 km . In the case of the "Prefer 05" strategy, the contours would extend towards the north, but would not reach the major population areas.

To the sides of the runway, the contours extend approximately 1.5 km from the centreline of the runway.

It is determined that;

- Based on airport usage patterns projected for this report, 20 ANEC contours for the 2050 scenario would cover areas that are currently largely rural residential in nature, with some industrial use. No areas of built-up residential development would be included in the 20 ANEC contour under any scenario. The "Prefer 23 with Head-to-Head" operating strategy results in the smallest area being covered

- One point of interest is that an area to the west of the airport site, including the townships of Warragamba and Silverdale, although relatively close to the airport, would not be included in the 20 ANEC contour under any operating strategy. This is due to the fact that although a departure track would be located over this area, the track is designated as being for use by non-jet aircraft only.
- The ANEC contours presented in this report should not be used for land use planning purposes until the validity of all underlying assumptions has been confirmed. As noted above, an ANEF chart, based on further formal flight path design would be produced for endorsement by Airservices Australia prior to the commencement of airport operations to inform land use planning.

Greater Blue Mountains Area:

- Parts of the Greater Blue Mountains World Heritage Area would be subjected to larger numbers of aircraft overflights compared to the Stage 1 scenario. As in Stage 1, the aircraft would be at heights generally greater than 5,000 feet. Maximum noise levels may occasionally reach 60 dBA at some points, but levels directly under a flight track would typically be below 55 dBA, and often much lower. The intrusion of aircraft noise may result in some disturbance to recreational and tourist visitors to the property in areas under a flight track.
- At locations directly under indicative flight tracks, the number of audible aircraft overflights could be over 200 per day in 2050. Worst-case locations would be under one of two approach paths that emanate from a "merge point" in the area of the lower Blue Mountains.
- As for the Stage 1 scenario, the nominal location of this merge point based on the indicative flight tracks would be almost directly over the township of Blaxland, and in 2050 residents could expect to experience aircraft overflights at significant altitude (typically over 5000 ft) some 230 times per day with maximum noise levels ranging up to 55 dBA.
- As for the Stage 1 scenario, the use of alternative merge points would substantially reduce the number of overflights passing over populated areas, but would result in other locations within the World Heritage Area experiencing a similar number of overflights to those currently predicted for Blaxland.

Long Term Airport Development (2063)

- In considering future projected impacts from an airport comprising two runways, nominally in 2063, the proposed airport's operating strategy would again have a significant bearing on the noise outcomes. A number of alternative airport operating modes may be available under conditions of low traffic volume, and these may result in reduced noise impacts, particularly at night. However, at the time of production of this report, it was not possible to identify which modes could be available and under what conditions. Hence in this report, only the two basic operating strategies – "Prefer 05" and "Prefer 23" are considered.
- Predicted noise impacts for the long term development are similar to those described above for the modelled single runway scenarios and occur in similar areas. However, the total number of residents affected is generally higher, largely as a result of expected population growth and ongoing housing development. For example, under a "Prefer 23" operating strategy, the number of residents experiencing more than 5 events per day above 70 dBA is estimated at 17,000 (compared with 5,000 nominally in 2050).

- ANEC contours for this case would be similar to those for the 2050 scenario, although somewhat larger. Once again, the 20 ANEF contour would not enclose any existing built-up residential areas and does not include the townships of Warragamba and Silverdale.

Options for Noise Mitigation

There are three fundamental options for mitigation of aircraft noise:

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

With respect to the first point, the use of continuous descent approaches has already been adopted in noise assessments for this report and, at this time, there appear to be no other feasible options by which noise emissions from aircraft in flight could be reduced through alternative operating procedures.

It is difficult to foresee the magnitude of future reductions in aircraft noise emission levels as this is primarily the role of aircraft designers and manufacturers, and while reduced noise levels are highly desirable, they are one of many outcomes that aircraft designers strive to achieve in newer aircraft.

In fact, aircraft noise emissions have reduced very substantially over the past 30 years. Although it is very likely that noise emission from future aircraft will also be lower than from current aircraft due to the absence of specific information, this report has adopted a conservative approach by modelling future aircraft types on the basis of existing noise emission levels. This is reflected in the inclusion of B747 or equivalent aircraft in the assumed fleet mix in all scenarios. The B747 is being phased out of operations and by 2030 the number of operations by this aircraft type at the proposed airport is expected to be very low (see Joint Study on aviation capacity in the Sydney region, 2012, p.123).

The mitigation measures most relevant to the EIS process, and for which detailed preliminary noise impact information has been provided in this report, are related to airspace design and airport operating modes. While both these issues are subject to their own specific objectives and legislation, consideration of environmental impact is one important consideration in the future design process. This report canvasses a number of options and considers the range of possible outcomes for each.

The indicative airspace design, and particularly the location of the "merge point" for arriving aircraft, provides some flexibility for reducing the noise exposure of residents in the lower Blue Mountains.

However, in considering both airspace design and the selection of operating modes, it should be noted that competing interests will include the safety of all aircraft, consideration of other airspace users, and aircraft fuel consumption. Some of these may compete with the aim of lowering environmental noise impact.

With respect to planning issues, since approximately the 1980s the NSW Government and local governments have been actively planning for an airport at Badgerys Creek and have undertaken a number of steps aimed at limiting future noise exposure of the residential population. These have included zoning land near the airport as appropriate for less sensitive uses, as well as ensuring that local government has planning procedures in place to limit sensitive uses in areas potentially affected by aircraft overflight noise. This has limited the potential noise impact from an urban greenfield airport to a level that is lower than would otherwise be expected for a development of this type and scale.

One important form of mitigation for aircraft noise impacts is the provision of information to both existing and potential residents in areas likely to be affected by noise. This allows potential residents who are particularly sensitive to noise impacts to choose not to move into the area. Information presented in this report provides a starting point for this process, but other tools, including the website information tool, can help to facilitate a greater understanding of the likely impacts at specific locations.

Should the Government decide to proceed with development of the proposed airport, more detailed planning of the airspace design and operating procedures, including consideration of noise and mitigation measures, would be undertaken in consultation with industry and stakeholders.

The current design for both the proposed airport and airspace is indicative, and the noise modelling presented in this report would be subject to further detailed design and assessment closer to the commencement of operations. When operations did commence, some aspects of airport operations could be introduced to mitigate noise impacts on the community such as flight path planning, preferred runway directions and continuous descent approaches.

It is important to note that the proposed airport has a lengthy construction period and current planning is for the airport to commence operations in about 2025. In this timeframe, technological improvements, including the upgrading of airline fleets, are expected to continue to reduce the industry’s noise impacts on communities. These and other potential improvements would be considered in formal airspace design and assessment processes in the future.

The Government would pursue the development of a noise management plan in consultation with appropriate stakeholders. This plan would be developed in parallel with the detailed airport design and future airspace review to provide the local community and other important stakeholders with the chance to be consulted and fully informed of the final expected impacts before the airport commences operations.

1 INTRODUCTION

1.1 Background

Planning investigations to identify a site for a second Sydney airport first commenced in 1946, with a number of comprehensive studies—including two previous environmental impact statements for a site at Badgerys Creek—having been completed over the last 30 years.

More recently, the Joint Study on Aviation Capacity in the Sydney Region (Department of Infrastructure and Transport, 2012) and A Study of Wilton and RAAF Base Richmond for civil aviation operations (Department of Infrastructure and Transport, 2013) led to the Australian Government announcement on 15 April 2014 that Badgerys Creek will be the site of a new airport for Western Sydney. The airport is proposed to be developed on approximately 1,780 hectares of land acquired by the Commonwealth in the 1980s and 1990s. Airport operations are expected to commence in the mid-2020s.

The proposed airport would provide both domestic and international services, with development staged in response to demand. The initial development of the proposed airport (referred to as the Stage 1 development) would include a single, 3,700 metre runway coupled with landside and airside facilities such as passenger terminals, cargo and maintenance areas, car parks and navigational instrumentation capable of facilitating the safe and efficient movement of approximately 10 million passengers per year as well as freight operations. To maximise the potential of the site, the airport is proposed to operate on a 24 hour basis. Consistent with the practice at all federally leased airports, non-aeronautical commercial uses could be permitted on the airport site subject to relevant approvals.

While the proposed Stage 1 development does not currently include a rail service, planning for the proposed airport preserves flexibility for several possible rail alignments including a potential express service. A joint scoping study is being undertaken with the NSW Government to determine rail needs for Western Sydney and the airport. A potential final rail alignment will be determined through the joint scoping study with the New South Wales Government, with any significant enabling work required during Stage 1 expected to be subject to a separate approval and environmental assessment process.

As demand increases, additional aviation infrastructure and aviation support precincts are expected to be developed until the first runway reaches capacity at around 37 million passenger movements. At this time, expected to be around 2050, a second parallel runway is expected to be required. In the longer term, approximately 40 years after operations commence, the airport development is expected to fully occupy the airport site, with additional passenger and transport facilities for around 82 million passenger movements per year.

On 23 December 2014, the Australian Government Minister for the Environment determined that the construction and operation of the airport would require assessment in accordance with the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act). Guidelines for the content of an environmental impact statement (EIS) were issued in January 2015.

Approval for the construction and operation of the proposed airport will be controlled by the Airports Act 1996 (Cth) (Airports Act). The Airports Act provides for the preparation of an Airport Plan, which will serve as the authorisation for the development of the proposed airport.

The Australian Government Department of Infrastructure and Regional Development is undertaking detailed planning and investigations for the proposed airport, including the development of an Airport Plan. A draft Airport Plan was exhibited for public comment with the draft EIS late in 2015.

Following receipt of public comments, a revised draft Airport Plan has been developed. The revised draft Airport Plan is the primary source of reference for, and companion document to, the EIS. The revised draft Airport Plan identifies a staged development of the proposed airport. It provides details of the initial development being authorised, as well as a long-term vision of the airport's development over a number of stages. This enables preliminary consideration of the implications of longer term airport operations. Any airport development beyond Stage 1, including the construction of additional terminal areas or supporting infrastructure to expand the capacity of the airport using the first runway or construction of a second runway, would be managed in accordance with the existing process in the Airports Act. This includes a requirement that, for major airport developments (defined in the Airports Act), a major development plan be approved by the Australian Government Minister for Infrastructure and Regional Development following a referral under the EPBC Act.

The Airport Plan will be required to include any conditions notified by the Environment Minister following this EIS. Any subsequent approvals for future stages of the development will form part of the airport lessee company's responsibilities in accordance with the relevant legislation.

1.2 Terms of Reference

Guidelines for the EIS have been issued in accordance with the *Environment Protection and Biodiversity Conservation Act 1999*. Requirements relevant to aircraft noise are as follows:

> *Impacts to the environment (as defined in section 528) should include but not be limited to the following:*
>
> *Aircraft noise and vibration impacts on everyday activities and on sensitive environmental receptors (all sensitive receptors within the community and natural environment). Discussion and quantification/modelling of aircraft noise impacts should include consideration of all potential flight paths, height of flights, noise exposure patterns, noise contours, the range of frequencies of the noise, cumulative exposure, peak noise, frequency of overflights and temporal variability of this (including long term trends), varying aircraft types, varying aircraft operating procedures, and variations in noise patterns due to seasonal and meteorological factors*

This assessment has been prepared in accordance with the EIS guidelines.

1.3 Scope of this Report

This report seeks to document the likely impact of aircraft overflight noise resulting from the proposal using information that is currently available.

This report considers only noise associated with aircraft overflights from the proposed Western Sydney Airport. It does not consider any potential change in noise exposure at other airports, including Sydney and Bankstown Airports, which may arise as a result of operations at the proposed airport. Changes to operations at other airports are not anticipated as a result of the initial development at Badgerys Creek.

The introduction of operations at the proposed airport would result in significant changes to the pattern of aircraft noise in Western Sydney, due to required new aircraft flight paths and airport operating modes. The changes would result in noise impacts which may be significant in some areas. In addition, projected future growth in air traffic beyond the proposed initial airport development would result in increased numbers of aircraft operations, and noise impacts would also generally increase in the future, although the level of impact would likely be mitigated to some extent by the introduction of new, quieter aircraft into the fleet.

The pattern of noise exposure that would result from operation of the proposed airport is complex, and depends on time of day, season and other factors. In some cases, alternative airport operating modes would be available, each with differing impacts on different areas.

This report considers aircraft overflight noise, defined as being from the start-of-roll on departures and until an aircraft exits the runway (i.e. enters a taxiway) on arrivals. This includes noise produced whilst the aircraft is on the ground, such as elevated thrust during take-off procedures and reverse thrust during landing procedures. The separation of these noise sources from other on-ground sources such as engine ground runs, aircraft taxiing and aircraft at the terminal is consistent with the noise classification in the Airports (Environment Protection) Regulations 1997.

Noise associated with construction of the proposed airport, and noise from aircraft on the ground including noise while taxiing and standing at a terminal are addressed in a separate report. That report also addresses the potential noise impact from additional airport-induced road traffic.

The remainder of this report is structured as follows:

Chapter 2 – Methodology

Chapter 3 – Assessment of Stage 1 Development

Chapter 4 – Assessment of Additional Capacity Scenario

Chapter 5 – Assessment of Long Term Airport Development

Chapter 6 – Noise-induced Vibration

Chapter 7 – Greater Blue Mountains World Heritage Area

Chapter 8 – Mitigation and Management Measures

Chapter 9 – Summary and Conclusions

The appendices to this report also contain other relevant information including the indicative flight tracks for the proposed single runway and long term parallel runway airport developments, comparison of summer, winter and annual noise contours and flight density figures for the assessment of impact on the Greater Blue Mountains World Heritage Area.

2 NOISE ASSESSMENT METHODOLOGY

2.1 Descriptors of Aircraft Noise Impact

A number of acoustic units are available to describe the level of aircraft noise in an area, each being useful for a different purpose. The most important are described in the sections below.

2.1.1 ANEF

For land use planning in Australia, the accepted measure of aircraft noise exposure is the Australian Noise Exposure Forecast (ANEF). Australian Standard 2021 provides guidance on the acceptability of areas around an airport for certain types of development, in terms of the ANEF level in the area. For example, in Table 2.1 of the Standard, residential development is considered "acceptable" in areas with ANEF lower then 20, "conditionally acceptable" in areas with ANEF between 20 and 25, and "unacceptable" in areas with ANEF greater than 25. (In "conditionally acceptable" areas the Standard recommends that new buildings should incorporate acoustic treatment to achieve specified internal noise levels.)

The ANEF unit was developed on the basis of social survey data, and is relatively well correlated with the proportion of people who would describe themselves as "seriously affected" by the noise. However, its definition is complex, and as a single-number index, it does not provide the level of information generally sought by interested members of the public. In addition, it is not used outside Australia, and is therefore not generally used in describing the findings of overseas research. Most importantly, the studies underpinning the use of this and similar units are of reaction to noise that has been relatively constant over at least a number of years. Reaction to newly-introduced aircraft noise is known to be greater than the reaction of a community that has been exposed to the noise for some time. The relationship between ANEF values and the proportion of people "seriously" or "moderately affected" by aircraft noise is shown in Figure 2-1.

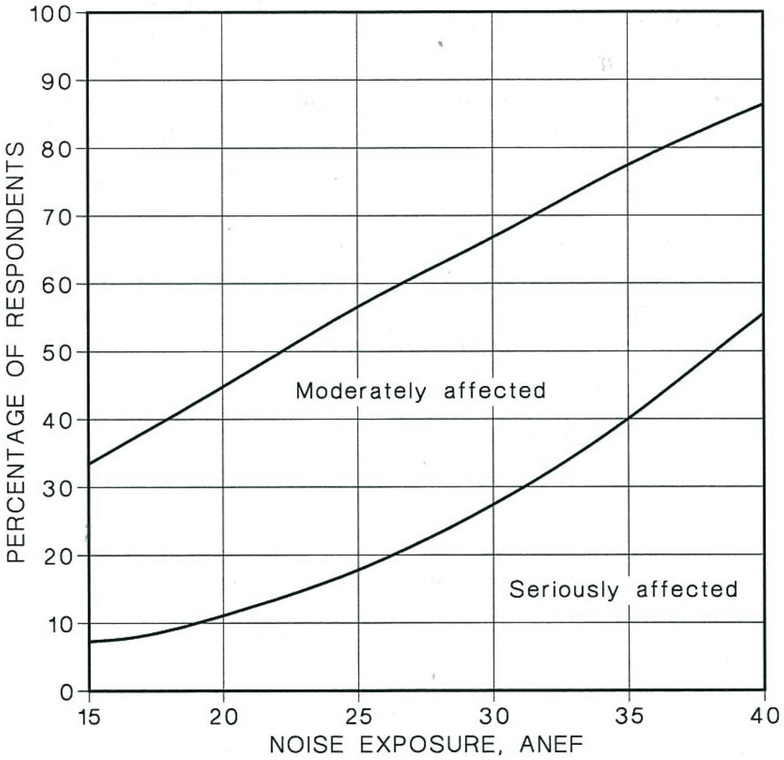
An "ANEF chart" is a set of land use planning contours for a specific airport which has been formally endorsed for technical accuracy by Airservices Australia, after a period of public consultation. The production of an ANEF chart for all major airports is a requirement of the *Airports Act 1996*.

2.1.2 ANEC

The Australian Noise Exposure Concept (ANEC) uses indicative data on aircraft types, aircraft operations and flight paths to provide a measure of aircraft noise exposure. The results are calculated using the same methods as the ANEF, but the ANEC is indicative and is therefore typically used in an environmental impact assessment. It represents a preliminary noise forecast produced for a hypothetical future usage pattern, and is useful for considering the land use planning consequences of alternative strategies.

ANEC contours for various airport operating scenarios are presented in this report. Final ANEF contours will not be produced until subsequent regulatory processes have been undertaken. Indicatively, if construction of the proposed airport proceeds, ANEF contours for the airport may not be known for several years.

Figure 2-1 Relationship between ANEF & Proportion of People "Seriously Affected" by Aircraft Noise (from Australian Standard 2021)



NOTE: This graph was derived from the National Acoustic Laboratories Report No. 88.

2.1.3 N70

Over the last 15 years, a system of describing aircraft noise has been developed by the Australian Government through industry and community consultation, which is oriented toward providing information in a form that can be understood more readily by interested members of the public, and provides a comprehensive description of the nature of aircraft noise exposure at any point. The information is presented in terms of a number of descriptors, and is intended to provide sufficient detail to allow members of the public to understand the likely impact of the noise.

This system is described in the discussion paper "Expanding Ways to Describe and Assess Aircraft Noise" published in 2000 by the then Commonwealth Department of Transport and Regional Services. The most commonly-used noise descriptor in this system is N70 – the number of aircraft noise events per day with maximum levels exceeding 70 dBA.

A noise level of 70 dBA outside a building would generally result in an internal noise level of approximately 60 dBA, if windows are open to a normal extent. This noise level is sufficient to disturb conversation, in that a speaker would generally be forced to raise their voice to be understood, or some words may be missed in speech from a television or radio. If external windows are closed, such effects would be experienced at an external noise level of approximately 80 dBA. N70 values indicate the average number of times per day when such events would occur. N70 contours can be calculated for different periods, indicating the average number of events experienced per day in that period.

In this project, N70 contours are calculated for six separate periods, representing combinations of:

- Whole Day (24hr) or Night (10pm-7am); and
- "Summer", "Winter" or Annual, representing differing ambient meteorological conditions. Inspection of meteorological data for the site indicated that from the point of view of noise impacts the "Summer" period was best defined as being from September to March, and "Winter" from April to August.

2.1.4 90th Percentile N70

Standard calculations of N70 represent an average over all days (or all days in a specified season), and may potentially be misleading if the number of events above 70 dBA varies significantly between days. To address this, this report also provides contours of 90th percentile N70, representing the N70 value exceeded on only 10% of days. This gives an indication of the value of N70 on days when there is a particularly high number of movements.

2.1.5 N60

For assessment of night time noise impacts, it is customary to consider N60 values, representing the number of events with maximum noise levels exceeding 60 dBA. An external noise level of 60 dBA represents approximately an internal level of 50 dBA if windows are open to a normal extent. An internal noise level of 50 dBA is commonly used as a design criterion for noise in a bedroom, to protect against sleep disturbance (for example in Australian Standard 2021), and hence N60 values represent the average number of times per night when this criterion would be exceeded (with open windows). N60 contours are presented in this report for the night time period 10pm-7am.

Similarly to N70, contours showing 90th Percentile N60 values are also presented representing the N60 value exceeded on only 10% of nights.

2.1.6 Respite Period

An associated measure of noise impact is "respite" – the proportion of days when there are no aircraft movements within a flight zone. This has been found to be a useful indicator in areas where noise exposure is highly variable, generally due to meteorological variability, and airport operations can be flexibly managed. This is less relevant at the proposed Western Sydney Airport, where the absence of a cross runway means that at most points around the airport there will be relatively few days with no overflights. For the proposed airport, the difference between 90th Percentile and average values of N70 is suggested to be a more useful indicator of variability.

It is noted that respite at night time will be a relevant measure depending on runway mode of operations.

2.1.7 Single-Event Noise Contours & Flight Path Density Charts

Single-event noise contours show the maximum noise level resulting from a single movement by a specified aircraft type, using a single flight track. Thus, they provide information on the highest noise level experienced, but not how often it is experienced. Single-event contours for movements on several tracks are often combined to show the maximum noise level experienced due to a movement by the selected aircraft type on any of the selected tracks. These are known as L_{Amax} contours.

Conversely, flight path density charts show the number of movements, by any aircraft type, for which the aircraft's flight path passes close to any point on the ground (measured horizontally). Thus they provide information on the number of aircraft movements experienced, but not on their noise level.

These two forms of presentation are often used to describe aircraft noise in areas that are more remote from the airport, for which N70 and related contours may be less meaningful and subject to greater uncertainties. For residences, flight path density charts in these areas indicate the number of aircraft per day that may be visible and that would be audible under conditions of low background noise.

In this report, a form of flight path density chart is used to describe aircraft noise exposure over the Greater Blue Mountains World Heritage Area (GBMWHA). This area is relatively remote from the airport, but is considered sensitive to potential noise impacts. Flight path density charts visually describe both the existing and the projected future number of movements within the GBMWHA. Movements can be segregated at different heights as an approximate way of differentiating between potential noise levels.

2.1.8 Health Related Noise Descriptors

Assessment of specific health impacts related to aircraft noise is addressed in a separate report. The impacts considered in that report include:

- effects on educational facilities and other noise sensitive facilities or population groups (including potential impacts on student learning etc.);
- sleep disturbance (number of awakenings, sleep latency etc.);
- effects on amenity (e.g. speech interference, annoyance, enjoyment of natural areas);
- cumulative noise impacts (e.g. associated with new noise sources or changed noise environment – new roads, ground based noise etc.); and
- community response and adaptation to a new noise source.

However, to allow assessment of these impacts it was necessary to provide measures of predicted noise exposure in units that are consistent with those used in health studies. The relevant units are:

- $L_{night,outside}$: This is simply the equivalent-continuous noise level between 11pm and 7am, or $L_{Aeq,11pm-7am}$. It is used to describe night time noise exposure in a number of documents produced by the World Health Organisation;
- $L_{Aeq,9am-3pm}$: This unit is used in a number of studies of the impact of noise on school students and teachers; and

- for assessment of night time noise impacts, the number of occurrences of L_{Amax} noise levels at various levels is required. This can be described by a set of 'number-above' metrics as described in Sections 2.1.3 to 2.1.5.

These units were calculated at specific nominated locations, using the same assumptions and procedures described below for the descriptors considered in this report.

2.2 EIS Assessment Scenarios

Consistent with other environmental impact assessments documented in the EIS, it was necessary to define a number of scenarios on which to base the impact assessment. For noise impact assessment, three stages of passenger demand were modelled:

- 10 million annual passengers – This represents the initial stage in the airport's development and is nominally forecast to occur in 2030. At this stage, the proposed airport has been operating for approximately 5 years and comprises a single (northern) runway that is accommodating about 63,000 aircraft movements.
- 37 million annual passengers – This represents a later stage of development at which the single runway is likely to be approaching its maximum capacity and further demand growth would require construction of an additional runway. The EIS considers the capacity of the first, single runway could be reached about 2050.
- 82 million annual passengers – This represents a long-term stage of development when the airport comprises two operating parallel runways and the second runway is operating close to capacity. This equates to approximately 370,000 aircraft movements per year. This is nominally forecast to occur in 2063.

Note that the dates outlined in the above assessment scenarios are based on forecasts by the business advisory team engaged by DIRD. The assessment scenarios should be thought of as representing noise exposure at certain hypothetical stages in the airport's development – the exact time when those stages are reached will depend on factors that are difficult to predict. The nominal years give some indication of time frames that are currently considered likely, however, the noise impact predictions are based more fundamentally on passenger movement forecasts than specific forecast dates.

In this report, aircraft overflight noise is considered for each of the above assessment scenarios. Within each scenario, a number of options are considered, representing summer/winter and various alternative operating procedures. In addition, for each of these options, impact is considered separately for the day and night periods.

Information for all noise exposure metrics and scenarios is included in this report and its appendices. In addition, an on-line noise information tool is available on the Department's website. This provides interested readers with the ability to explore potential impacts in a more detailed and flexible manner, specific to their circumstances. Given the nature of the proposed development, this would not be possible in a report format.

2.3 Aircraft Noise Calculation Procedures

Detailed calculation of future aircraft overflight noise levels at any airport requires estimates of the number of future aircraft operations, broken down by:

- aircraft type (as defined in the INM noise calculation program);
- flight track (including several flight tracks for arrivals and departures on each runway);
- stage length for departures (representing distance to destination); and
- time of day at which the operation occurs.

The number and mix of operations on each flight track will be different for each scenario considered. Given the above information, values of all the above noise descriptors can be calculated, either at specific points or in terms of contours, using noise levels calculated using the industry-standard INM calculation program (version 7d).

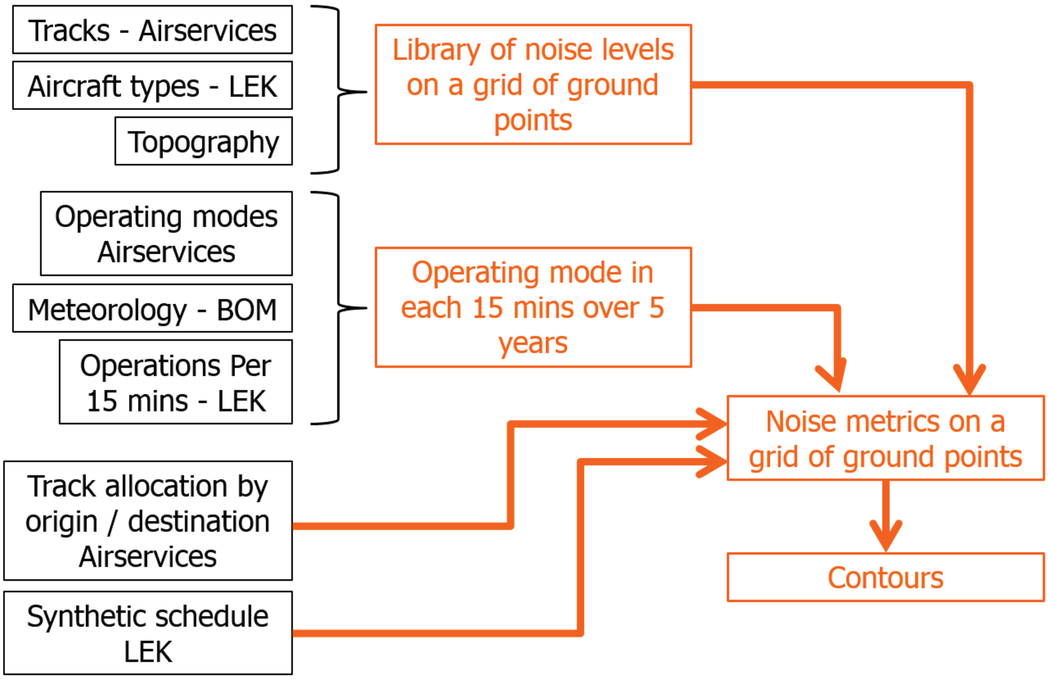
The INM is a computer model that evaluates aircraft noise impacts in the vicinity of airports. It was developed based on the algorithm and framework from the SAE AIR 1845 standard, which used noise-power-distance (NPD) data to estimate noise accounting for specific operation mode, thrust setting, and source-receiver geometry, acoustic directivity, and other environmental factors. The INM can output either noise contours for an area or noise level at pre-selected locations. The noise output can be exposure-based, maximum-level-based, or time-based.

The INM focusses mainly on aircraft overflight noise, but also includes departure noise and landing and reverse thrust noise when the aircraft is on the runway.

It is noted that the US Federal Aviation Administration, which developed the INM, has recently superseded the INM with the Aviation Environmental Design Tool (AEDT). At the time of writing of this report, AEDT had not been evaluated for Australian conditions. On this basis the INM was selected for the aircraft noise predictions in the current assessment. It is noted that the calculation and prediction algorithms relating to aircraft noise are understood to be equivalent in both calculation programs.

Figure 2-2 shows the general process which was used to derive this input data, using movement forecasts, aircraft flight tracks, airport operating modes and other data. Each step in this process is described in detail in the following sections. Sources of data are provided in Section 2.11.

Figure 2-2 Noise Calculation Methodology



2.4 Aircraft Types used in Calculations

Projections of aircraft movements for future years were provided in terms of “families” of aircraft types. Each family was represented by one or a number of aircraft types that are included in the standard INM aircraft noise modelling program (see Section 2.9), with the representation of types within a family potentially changing between years. For passenger movements, Table 2-1 shows the aircraft families, and the INM types used to represent them, for each modelling year.

For freight movements, individual aircraft types were nominated and the range of types is shown in Table 2-2.

The aircraft types shown in Table 2-1 and Table 2-2 were used for noise level calculations in all scenarios. They were selected to be representative of the aircraft types expected to use the proposed Western Sydney Airport, including potential future aircraft types. Understandably, the noise emission characteristics of aircraft types decades into the future are not currently known, but it can reasonably be assumed that they will not be higher than those of current equivalent types, and in general they are expected to be lower. Approximately 70% of freight is carried on passenger aircraft and dedicated freight are often the same type of aircraft as those used for passenger services. However, for modelling purposes and to provide a worse-case scenario, dedicated freight aircraft are assumed to be older and noisier aircraft types, and to be phased out more slowly. In particular, the model includes 747-400 freight aircraft (or aircraft with equivalent noise emissions) even in the Long Term scenario. Hence the adopted procedure of representing future aircraft types by reference to only current aircraft types and emissions is considered conservative.

Table 2-1 Aircraft Types Modelled – Passenger Movements

		Proportion of Family Represented by INM Type		
Aircraft Family	**INM Aircraft Type**	**Stage 1**	**2050**	**Long Term**
Airbus A320	A320-211	60%	0%	0%
	A320-232	40%	100%	100%
Airbus A330	A330-301	45%	5%	0%
	A330-343	55%	95%	100%
Airbus A380	A380-861	-	100%	100%
Boeing 737	737-800	80%	0%	0%
	737-700	20%	100%	100%
Boeing wide-body general	777-200	-	40%	40%
	787-8R	-	15%	15%
	A330-343	-	40%	40%
	747-8	-	5%	5%
Boeing 777	777-200	48%	85%	85%
	777-300	37%	0%	0%
	787-8R	15%	15%	15%
De Haviland DHC8	DHC830	25%	75%	100%
	DHC8	75%	25%	0%
Saab 340	SF340	100%	100%	100%

Note: - indicates there are no movements of this family in the schedule for this year.

Table 2-2 Aircraft Types Modelled – Freight Movements

Aircraft Family	**INM Aircraft Types Represented**
Airbus A330	A330-301
Boeing 737	737400
Boeing 747	747400
Boeing 767-400	767400
Boeing 767-300	767300
Boeing 777-300	777300
Boeing 777-200	777200
Small Freight	SF340

Note: Modelling conservatively assumes freight aircraft types are maintained across all forecast periods.

2.5 Aircraft Movements

Predicted future numbers of aircraft movements have been based on modelling supplied by the DIRD business advisory team. This was in the form of "synthetic schedules" which detail a list of aircraft operations for a typical busy day in each EIS assessment year, including aircraft family, operation type (arrival or departure), time of operation and port of origin or destination for each operation. These schedules form the basis of all modelling described below.

Table 2-3 shows predicted total aircraft movements per day for each EIS assessment year, while Table 2-4 shows a breakdown by aircraft family. Figure 2-3 shows the predicted number of movements for each hour of the day.

Note that because the synthetic schedules represent a typical busy day, the number of movements is slightly greater than an annual average for the relevant scenario. For example, in Stage 1 the estimated 63,000 movements per year represents an annual average of approximately 173 per day, compared with 198 in the schedule. This provides some conservatism in estimates of noise exposure.

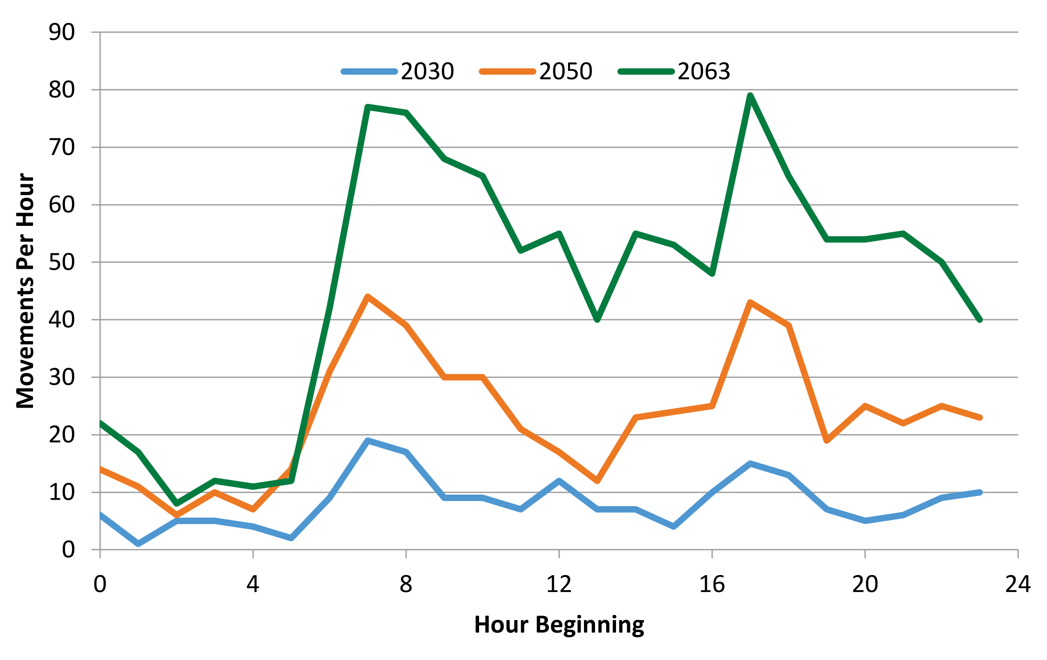
Table 2-3 Total Predicted Daily Aircraft Movements by Type by Year

Assessment Year	Movements Per Day		
	Freight	Passenger	Total
Stage 1	28	170	198
2050	74	480	554
Lonh Term	104	1006	1110

Table 2-4 Predicted Daily Aircraft Movements by Aircraft Family by Year

Aircraft Family	Movements Per Day		
	Stage 1	2050	Long Term
Passenger Movements			
Airbus A320	100	176	378
Airbus A330	18	128	286
Airbus A380	-	4	8
Boeing 737	28	104	196
Boeing wide-body general	-	20	40
Boeing 777	4	26	78
DeHaviland DHC8	8	12	10
Saab 340	12	10	10
Freight Movements			
Airbus A330	2	2	2
Boeing 737	2	6	6
Boeing 747	10	28	38
Boeing 767-400	4	8	10
Boeing 767-300	-	4	6
Boeing 777-300	-	2	4
Boeing 777-200	-	4	6
Small Freight	10	20	32

Figure 2-3 Predicted Aircraft Movements per Hour for Each Assessment Year



Each operation in each synthetic schedule is assigned a port of origin or destination. This allows:

- assignment of the movement to a flight track, based on the direction of the port. (Note that this applies only to departures, because as described below arrival tracks are assumed to be determined using a "point merge" system); and
- for departures, assignment of a "stage length" based on the distance to the port. (This affects the assumed fuel load and hence noise emission from the aircraft.)

Table 2-5 shows the way in which nominated ports were assigned to directions for determination of flight tracks.

Table 2-5 Assignment of "Direction" to Airports in Synthetic Schedules

Direction	Airport Name
Domestic North	Darwin, Brisbane, Cairns, Coffs Harbour, Gold Coast
International North	Singapore, Hong Kong
Domestic West	Adelaide, Karratha, Perth
International West	Dubai
Domestic South	Melbourne, Canberra, Hobart, Avalon, Albury
International South	Johannesburg
International East	Auckland, Fiji (Nandi), Los Angeles, Santiago

2.6 Flight Tracks

Airservices Australia has assessed the airspace implications and air traffic management approaches for Sydney basin airspace arising from the potential introduction of operations at the proposed Western Sydney Airport. The principal objective was to establish whether safe and efficient operations could be introduced at the airport through developing indicative proof-of-concept air traffic management designs.

Importantly, this work does not represent a comprehensive airspace and air route design, nor does it consider all of the essential components that would be necessary to implement an air traffic management plan for the Sydney basin. These indicative flight tracks have been developed to demonstrate the feasibility of flight paths for the airport.

While the formal flight path design for the proposed airport would be undertaken much closer to the commencement of operations – within several years of the first flights occurring – indicative flight paths for Stage 1 (single runway) and long-term (parallel runway) operations have been prepared based on Airservices Australia's preliminary analysis.

These tracks have been confirmed as being appropriate for the purposes of the EIS. The report in which the tracks are presented contains the following disclaimer:

"The design and analysis presented in this report is intended to meet a narrow scope focussed on demonstrating a proof of concept. It does not present a comprehensive airspace and air route design and does not consider all essential components that would be necessary to implement an air traffic management plan for the Sydney basin. Certain assumptions have been made and significant additional steps would be required to develop air traffic management plans suitable for implementation*".*

The indicative flight tracks are shown in Appendices A and B and are described in more detail in the following sections.

The following matters described below would be taken into account in determining final flight tracks.

- In designing airspace management arrangements for the airport, flight paths and procedures would be optimised for noise management purposes as part of the work that Airservices Australia would undertake before the airport became operational.
- Under the *Air Services Act 1995*, Airservices Australia is required to exercise its functions, as far as practicable, so as to protect the environment. It has published a document called 'Airservices commitment to noise management' which outlines the considerations which are taken into account in designing flight paths and procedures. http://www.airservicesaustralia.com/wp-content/uploads/Aircraft_Noise_Management_WEB.pdf
- The Civil Aviation Safety Authority (CASA) would also need to approve proposed flight paths and procedures. Under the Civil Aviation Act 1988, CASA is also required to exercise its functions so as to, as far as practicable, protect the environment.
- It is expected that a referral to the Minister for the Environment under the *Environment Protection and Biodiversity Conservation Act 1999* would be required before flight paths for the airport are put into place.

2.6.1 Arrivals

For the Stage 1 and 2050 assessments, arrival tracks are assumed to follow a "point merge" configuration in which all aircraft approaching the airport pass over a single point, located to the north-west of the airport, and then move to a final approach in either of the two runway directions. Airservices Australia (Airservices Australia 2015) nominates one location for the merge point. However, subsequent advice from Airservices indicated that the merge point could be moved by up to 3 nautical miles without significant impacts to the preliminary airspace design.

The location of this point makes little difference to analysis of noise impacts relatively close to the airport. However, when considering impacts within the GBMWHA and nearby residential areas, the location is significant. Analysis of impacts in these areas includes consideration of two alternative merge points (see Section 1.1).

For the Long Term development, arrivals are assumed to use four separate merge points, all located generally to the north of the airport – one point for each runway and each runway direction.

In the Stage 1 assessment, arriving aircraft were allocated to each of the arrival tracks that approach the "merge point" on an 80/20/10/10 percentage basis. That is, when aircraft movements are relatively low, most presenting aircraft would use the shortest approach track. In the 2050 and Long Term, when movement numbers are greater than even allocation of aircraft to all tracks approaching the merge point was adopted.

Airservices Australia nominates a single arrival track from the merge point to the proposed airport, which represents the "ILS" track and would be used when instrument landing conditions prevail. However, under visual meteorological conditions, a series of tracks may be used, allowing aircraft to be sequenced more efficiently. In noise modelling, five or six additional "visual" arrival tracks were defined from the initial development merge points, with the following rules:

- under instrument meteorological conditions, all aircraft follow the ILS track; and
- under visual meteorological conditions, aircraft are assigned in equal proportions to the ILS track and each of the visual tracks.

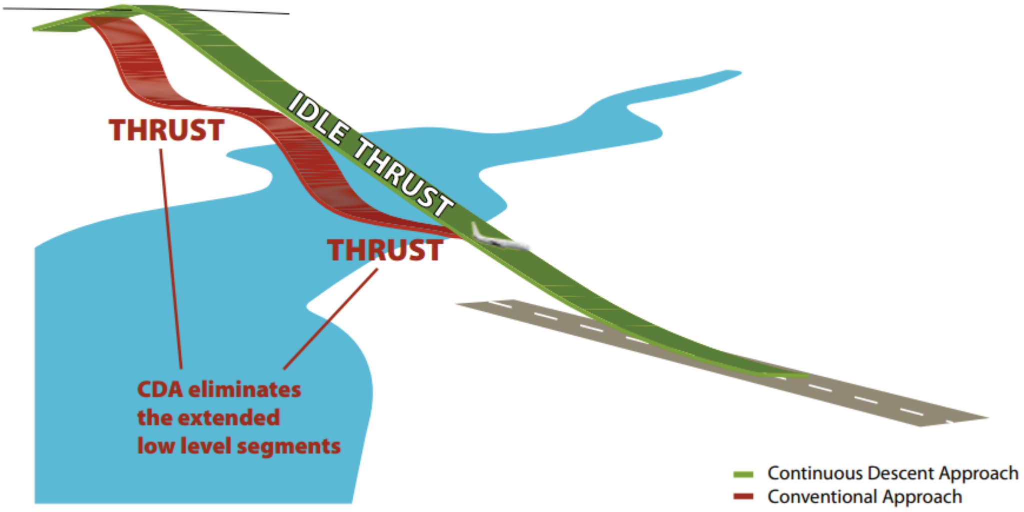
Visual meteorological conditions are defined by:

- visibility > 10 km; and
- cloud height > 4000 ft,

Meteorological data was obtained from Camden Airport as the nearest representative location to the proposed Western Sydney Airport with visibility observations available. See the discussion in Section 2.8.

When using the point merge system, aircraft would adopt a "continuous descent" approach (CDA), in which the aircraft begins its approach from well beyond the merge point and continues at a constant rate of descent until landing. CDA is defined as "an aircraft operating technique aided by appropriate airspace and procedure design and appropriate ATC clearances enabling the execution of a flight profile optimized to the operating capability of the aircraft, with low engine thrust settings and, where possible, a low drag configuration, thereby reducing fuel burn and emissions during descent." Figure 2-4 illustrates the concept of "CDA".

Figure 2-4 Concept Diagram of "CDA"



The adoption of CDA results in reduced noise emission compared with a profile in which the aircraft is required to maintain a constant height for a section of the approach. Noise emission reduction is possible because the aircraft can be configured to reduce the need for power settings above flight idle. Modelling in this report assumes that all arrival profiles will be "continuous descent".

2.6.2 Departures

For Stage 1 and 2050 assessments, the flight tracks depict two major departure tracks in each direction, which each branch into other tracks at distances that are sufficiently far from the airport that they are not relevant for noise assessment.

For departures to the south-west (the 23 direction) there is a third track passing roughly over the township of Warragamba that is nominated to be used by non-jet aircraft only. The current nomination of this track for non-jet aircraft results in a significant reduction in predicted noise exposure in areas beneath this track compared to the previous EIS study.

2.6.3 Track Dispersion

Dispersion refers to the assumed variability of actual flight tracks around a nominated flight track. In modelling for this project, dispersion for departure tracks is modelled using one main track and four sub-tracks, two on either side of the main or median track. The extent of dispersion, and proportional allocation of operations to the sub-tracks, uses INM defaults (being 38.6% on main track, 24.4% on each of the inner subtracks and 6.3% on each of the outer subtracks), with the exception that some adjustments are made close to the runway end points to be more representative of typical flight paths.

No dispersion is added for arrival tracks, including the section of track prior to the merge point, on the basis that these would be strictly controlled. However, the use of a number of tracks for visual approaches, as described above, provides a form of dispersion over the relevant areas.

2.7 Airport Operating Modes

2.7.1 Initial Development (Stage 1) and Additional Capacity Scenario (2050)

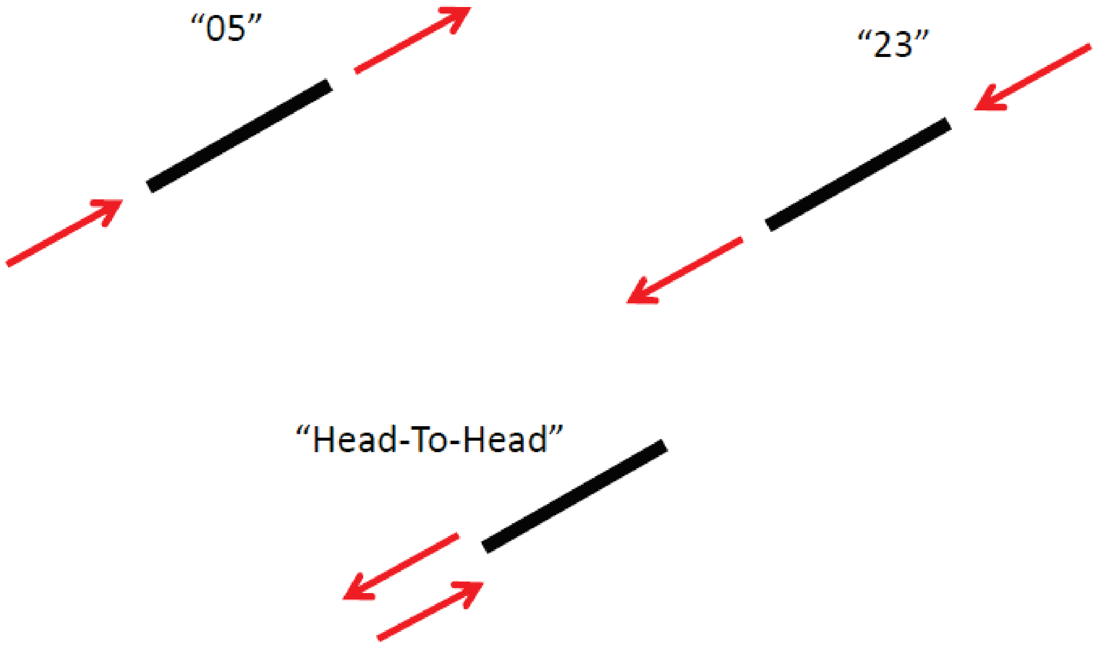
Three operating modes have been considered for the proposed initial single-runway airport development, namely "05", "23" and "Head-to-Head" modes as follows:

- Mode 05: Aircraft arrive from the South-West and depart to the North-East.
- Mode 23: Aircraft arrive from the North-East and depart to the South-West.
- Head-to-Head Mode: Aircraft arrive from the South-West and depart to the South-West.

Figure 2-5 illustrates these modes.

Each of these modes may or may not be available at any time, depending on meteorological conditions, particularly wind, the number of presenting aircraft, airspace management procedures (including any potential noise amelioration policies), and time of day. However, the assumed order for selection of the modes has a significant effect on the overall predicted noise impact from the proposed airport. Four strategies were considered in this report, as described below.

Figure 2-5 Stage 1 Development – Operating Modes



Strategy 1 – "Prefer 05"

- Mode 05 to be used unless wind conditions indicate the runway is unavailable, according to the Civil Aviation Safety Authority's Manual of Standards (MOS) Part 172. In this case, mode 23 will be adopted.
- If mode 23 is in use, the mode will revert to 05 under the following conditions:
  - the use of mode 05 has been allowed for at least 2 hours before the change time; and
  - the use of mode 05 will be allowed for at least 2 hours after the change time.

Strategy 2 – "Prefer 23"

- Mode 23 to be used unless wind conditions (as per MOS Part 172) indicate the runway is unavailable, in which case mode 05 will be adopted.
- If mode 05 is in use, the mode will revert to 23 under the following conditions:
  - the use of mode 23 has been allowed for at least 2 hours before the change time; and
  - the use of mode 23 will be allowed for at least 2 hours after the change time.

Strategy 3 – "Prefer 05 with Head-to-Head"

- As per "Prefer 05" except that during the night hours of 10pm and 7am, Head-to-Head mode will be used when:
  - there are no more than a total of 20 aircraft movements in the hour following the relevant time; and
  - wind conditions (as per MOS Part 172) allow the use of both runway directions.
- If mode 05 or mode 23 is in use during the night time period, the mode will revert to Head-to-Head under the following conditions:
  - the use of Head-to-Head has been allowed for at least 2 hours before the change time; and
  - the use of Head-to-Head will be allowed for at least 2 hours after the change time.

Strategy 4 – "Prefer 23 with Head-to-Head"

- As per "Prefer 05 with Head-to-Head" except that when Head-to-Head mode is not in use, the rules of "Prefer 23" apply rather than those of "Prefer 05"

The restriction that Head-to-Head mode can be used only when total movements are less than 20 per hour is based on advice from Airservices Australia.

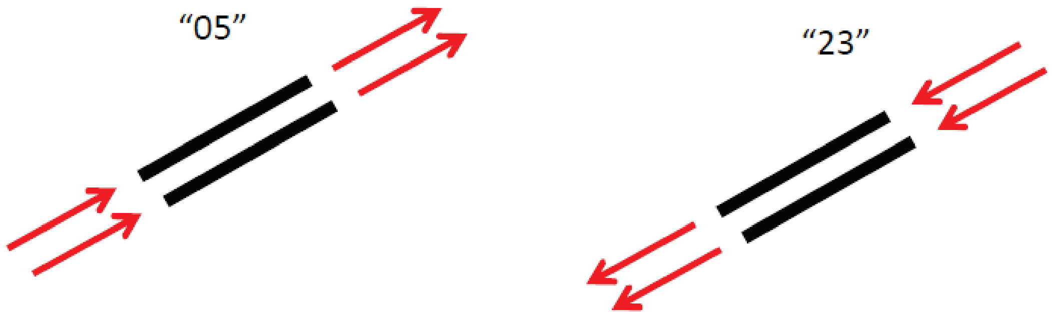
The 2 hour "waiting period" before changing to a higher-priority mode represents a relatively conservative model of decision making by Air Traffic Control. A more "aggressive" regime would allow the higher-priority mode to be used for longer periods.

2.7.2 Long Term Development

In the Long Term development, only modes 05 and 23 are considered. These are illustrated in Figure 2-6. A number of alternative modes would be possible, including "head-to head" and the use of a single runway for arrivals or departures, which may have advantages in terms of noise impact. However, rules for the use of such modes are not expected to be developed until closer to parallel runway operations. Hence, predictions of noise impact for this assessment year should be treated as strategic, and probably conservative.

The "Prefer 05" and "Prefer 23" strategies for this assessment year are defined exactly as described above for the Stage 1 and 2050 strategies.

Figure 2-6 Long Term Airport Development – Operating Modes



2.8 Meteorological Data

As described above, the mode of operation of the airport depends primarily on meteorological conditions and also for a given mode, different approach tracks may be assigned depending on whether visual or instrument meteorological conditions apply.

Meteorological data were collated from both the Bureau of Meteorology (BOM) site at Badgerys Creek and the site at Camden Airport for the period 26 August 2010 through 3 March 2015 (approximately 4.5 years). Data from Badgerys Creek gives mean wind speed, maximum wind gust, mean wind direction and rainfall over the 15 minutes before the time of the reading. This allows determination of whether various operating modes are available. Data from Camden Airport includes cloud cover and visibility, and allows determination of whether instrument or visual meteorological conditions apply. (Camden was chosen as the nearest representative site to Badgerys Creek with available data).

Together, these two data sets allow determination of the modes and flight tracks that would have applied for each 15-minute period of the sample period. This can be combined with the synthetic flight schedules for various assessment years to predict numbers of operations by track.

2.9 Calculation of Aircraft Noise Levels

The INM aircraft noise prediction program, produced by the U.S. Federal Aviation Administration, was used to predict noise levels from each of the 22 aircraft types on each of the 346 flight tracks (245 tracks for the initial development and 101 tracks for the long term development). INM Version 7d was used, as this was the latest available version at the time of performing the calculations.

Parameters used in the calculations are:

- temperature: 20 °C (reasonable and conservative value for most operations at the site);
- atmospheric pressure: 1017.2 hPa (standard, and typical);
- average headwind: 0 kts. This conservative setting was determined based on low average headwinds at the site, meaning that on most occasions, the actual headwind would be determined by the airport's mode priority; and
- topography: 10 m contours covering the area of interest – at least 25 NM to the north, east, south and west of the airport centre.

Predicted noise levels are not very sensitive to any of the above parameters – for example, reducing the temperature to 10 °C, increasing atmospheric pressure to 1030 hPa or increasing the average headwind to 5 kts all result in a change of less than 1 dB in the calculated noise level from typical operations.

The INM model does not allow for calculation of the effect of atmospheric conditions such as wind and temperature inversions on sound propagation. These factors are known to have a strong influence on noise generated at ground level. However, for sources that are significantly elevated, such as an aircraft in flight, their influence on sound propagation is much lower, and has not been as thoroughly studied. In many cases, the major impact of adverse wind and temperature gradient conditions on noise from ground level sources comes through the removal of intervening barriers. This can result in very significant enhancement of noise at the receiver location. However, this effect is obviously not relevant for noise from a source such as an aircraft in flight.

As described in Section 2.3, INM's "standard" height-vs-distance profiles were used for all departures, while a "continuous descent approach" was used for all arrivals. Departures by most aircraft types are defined for several "stage lengths", representing different distances to the destination, and hence different assumed fuel loads. Noise levels on departure were initially calculated for all possible stage lengths for each aircraft type.

For each aircraft type, each track and (for departures) each possible stage length, custom-designed software was used to control INM's operation, calculating noise levels at each point on a grid of size 185 m x 185 m, covering the area of interest. The unit that was calculated is L_{Amax} – the maximum noise level during the overflight in dBA, which is used in calculating N70 and similar units. The results from this calculation form the "library of noise levels" referred to in Figure 2-2.

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

Unlike N70 and similar units, both ANEC and units derived from L_{Aeq} can be calculated directly in INM. These descriptors were calculated in this way, based on the average number of events per day during the relevant time periods, calculated as described above.

2.10 Sensitive Receivers & Noise Exposure Calculation

Noise-sensitive receivers in the area around the proposed airport include residences, schools and other educational facilities, and hospitals and other health care facilities. In this report, the potential impact of the proposal on these receivers is assessed in terms of a number of descriptors of noise exposure, as set out in Section 2.1. One indicator of impact is the number of receivers experiencing a given level of noise exposure, measured by the various descriptors.

Existing and forecast population estimates were developed by GHD, based on the September 2014 release of the NSW Bureau of Transport Statistics population forecasts. These forecasts take into account metropolitan planning development forecasts for future land use in Sydney as well as NSW Department of Planning and Environment population forecasts. The limit of these forecasts is currently 2041; therefore, in order to project to 2063 and beyond, Series B population growth rates estimates used by the Australian Bureau of Statistics in their long-term population forecasts were applied.

The forecast of existing and future populations potentially exposed to different levels of noise from the proposed airport utilised GIS databases and was developed by GHD. The databases were developed based on the above population forecasts and address point data provided by NSW Land and Property Information.

The address point dataset provided a set of co-ordinates for each registered address point within the area covered by the data and was therefore used to represent the spatial distribution of population. The address point data was then divided into subareas based on statistical local area (SLA) boundaries developed for the Census. By matching the population estimates and address points to a common SLA, a population per SLA and average population per address point was calculated.

The noise contours generated by this study were then overlaid with the address point population for each forecast year enabling a count of future population potentially affected by each airport operational scenario.

2.11 Sources of Key Information

Table 2-6 summarises the sources of all key data discussed above and used in the calculation of noise descriptors for this report.

Table 2-6 Sources of Key Information Used

Information	Source
Forecast future annual aircraft movements and synthetic flight schedule	LEK
Current aircraft types used to represent future types	LEK
Selection of representative INM aircraft types	Wilkinson Murray
Indicative aircraft flight tracks	Airservices Australia
Rules for availability of runways by meteorology	Airservices Australia
Maximum possible movements in "Head-to-Head" mode	Airservices Australia
Historical meteorological records at Badgerys Creek and Camden Airport	Bureau of Meteorology (BoM)
Allocation of operations on a runway to flight tracks	Wilkinson Murray in consultation with Airservices Australia
Co-ordinates of runway ends and runway thresholds	Landrum and Brown/GHD
Heights of runway ends	Landrum and Brown/GHD
Meteorological conditions used in noise modelling	Wilkinson Murray, based on BoM data
Population exposure forecasts	GHD

3 ASSESSMENT OF STAGE 1 DEVELOPMENT

3.1 Development Overview

The initial stage (Stage 1) of the proposed Western Sydney Airport project would involve construction and operation of a single runway, approximately 3700 m long and additional landside and airside infrastructure sufficient to facilitate air travel by approximately 10 million passengers per annum. The airport is proposed to operate without a curfew, and projected air traffic volumes include operations throughout the night. An important component of the initial stage noise impact assessment is the acknowledgement that demand for air travel will grow over time following opening of the airport.

The assessment of the initial airport development is the key focus of this report as it is the location which has been referred under the EPBC Act. Subsequent stages of airport development would be subject to their own separate approvals processes as required by the relevant legislation.

3.2 Single-Event Noise Contours

Single-event noise contours indicate the maximum (L_{Amax}) noise level resulting from a single operation of a specific aircraft type on a specific flight track. In this section, composite single-event contours are shown indicating the outer envelope of L_{Amax} noise level contours for a specific aircraft operation on all possible tracks.

In the INM modelling program, departures are defined for several ‘stage lengths’, representing different distances to the destination, and hence different assumed fuel loads. Noise levels on departure can be calculated for various stage lengths for each aircraft type. Table 3-1 presents the various INM departure stage lengths.

Table 3-1 INM Aircraft Departure Stage Lengths – Nautical Miles

Stage Length	From	To
1	0	500
2	501	1000
3	1001	1500
4	1501	2500
5	2501	3500
6	3501	4500
7	4501	5500
8	5501	6500
9	over 6500	

Figure 3-1 shows single-event L_{Amax} noise level contours for the loudest noise event predicted to occur at the airport under this scenario – a 747 departure with INM stage length 5, corresponding to a departure for Singapore. According to the nominal schedule, these events would occur once per day. They may occur on any of a number of tracks. However, note that although contours are shown for these events on tracks heading south from the airport, it is very unlikely that a Stage 5 departure would occur on these tracks as there are no destinations for which this would be a preferred departure direction. Figure 3-1 is in a scale so that all contours in this report can be easily compared. Figure 3-2 shows the same contours in a larger scale and it is clear from these contours that the noise of the aircraft whilst on the runway is included.

At the most-affected residences, close to the airport, L_{Amax} noise levels from these events would be in the range 80 – 90 dBA. There are less than 10 existing residences within the 85 dBA L_{Amax} contour for these events, located to the south-west of the airport.

When these events occur on the track leading north in the 05 direction, L_{Amax} noise levels exceeding 70 dBA can be expected over densely-populated areas around St Marys, with levels above 75 dBA in some parts of Erskine Park.

Figure 3-3 and Figure 3-4 show L_{Amax} noise levels from a 747 arrival on any track. In this case, noise levels of 60 – 70 dBA can be expected over sections of Erskine Park and St Marys, extending to parts of Blacktown. Noise levels from this event also reach 60 dBA at Blaxland, beneath the "merge point" for arrivals. In Stage 1, there are expected to be five such arrivals per day.
Figure 3-4 exhibits the characteristic contour bulge around the runway as a result of reverse thrust.

Figure 3-5 to Figure 3-10 show L_{Amax} noise levels from much more common events – departures (Stage 4 and Stage 1) and arrivals by A320 and similar aircraft types. Stage 3 or 4 departures by A320 aircraft (on any track) are predicted to occur 12 times per day in Stage 1. When these events occur to the north in the 05 direction, maximum noise levels in parts of St Marys would be up to 64 dBA. For Stage 1 or 2 departures (for example, to Brisbane or Melbourne), the maximum noise level over built-up areas is not predicted to exceed 60 dBA.

Arrivals by A320 aircraft, when they occur in the 23 direction, are predicted to produce L_{Amax} noise levels exceeding 60 dBA over areas between Erskine Park, St Marys and Blacktown, and also (when they occur in the 05 direction) over areas in the Blue Mountains National Park and GBMWHA.

Figure 3-1 Combined Single Event B747 Departure – Stage 5 (Macro Scale)

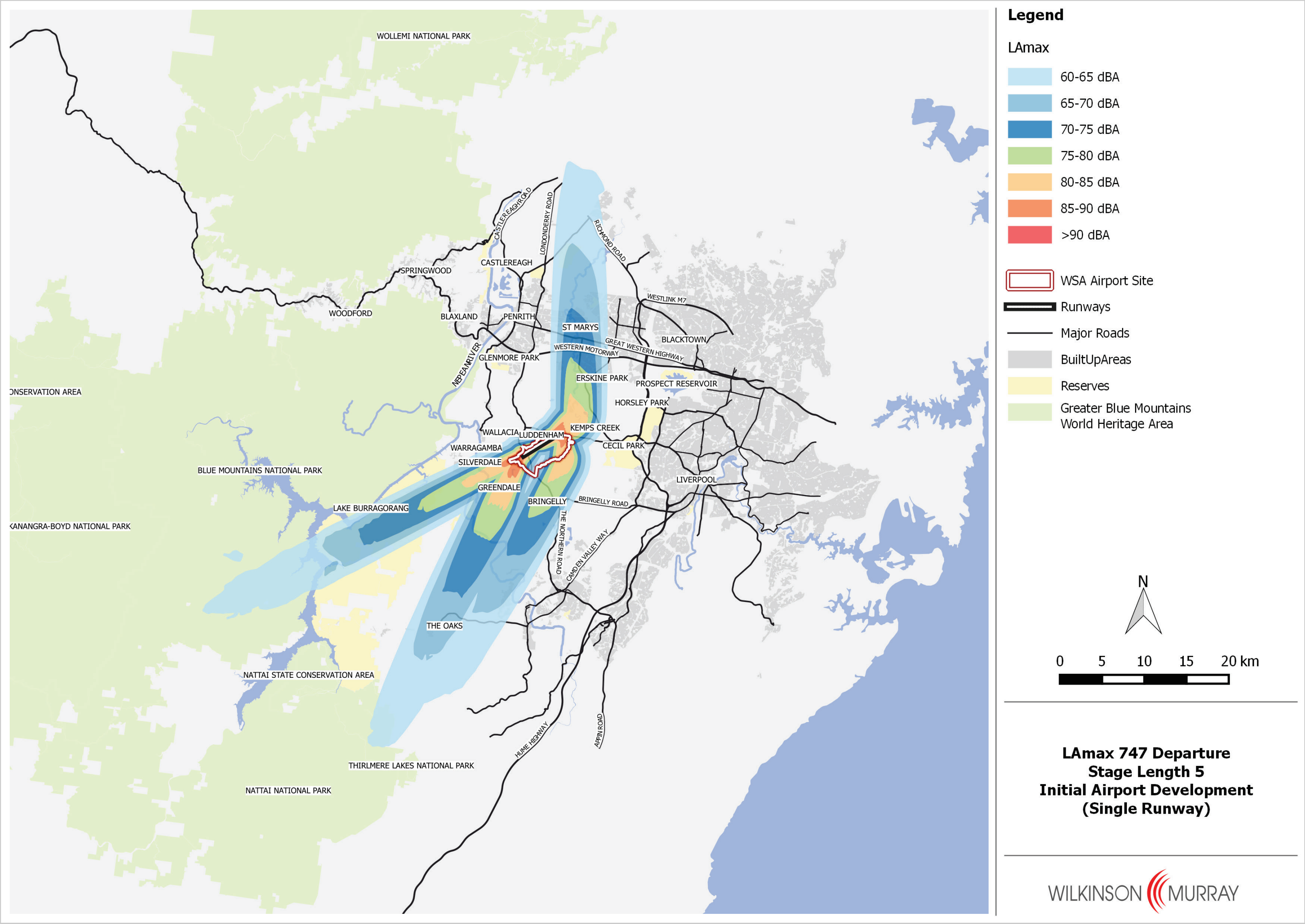


Figure 3-2 Combined Single Event B747 Departure – Stage 5 (Meso Scale)

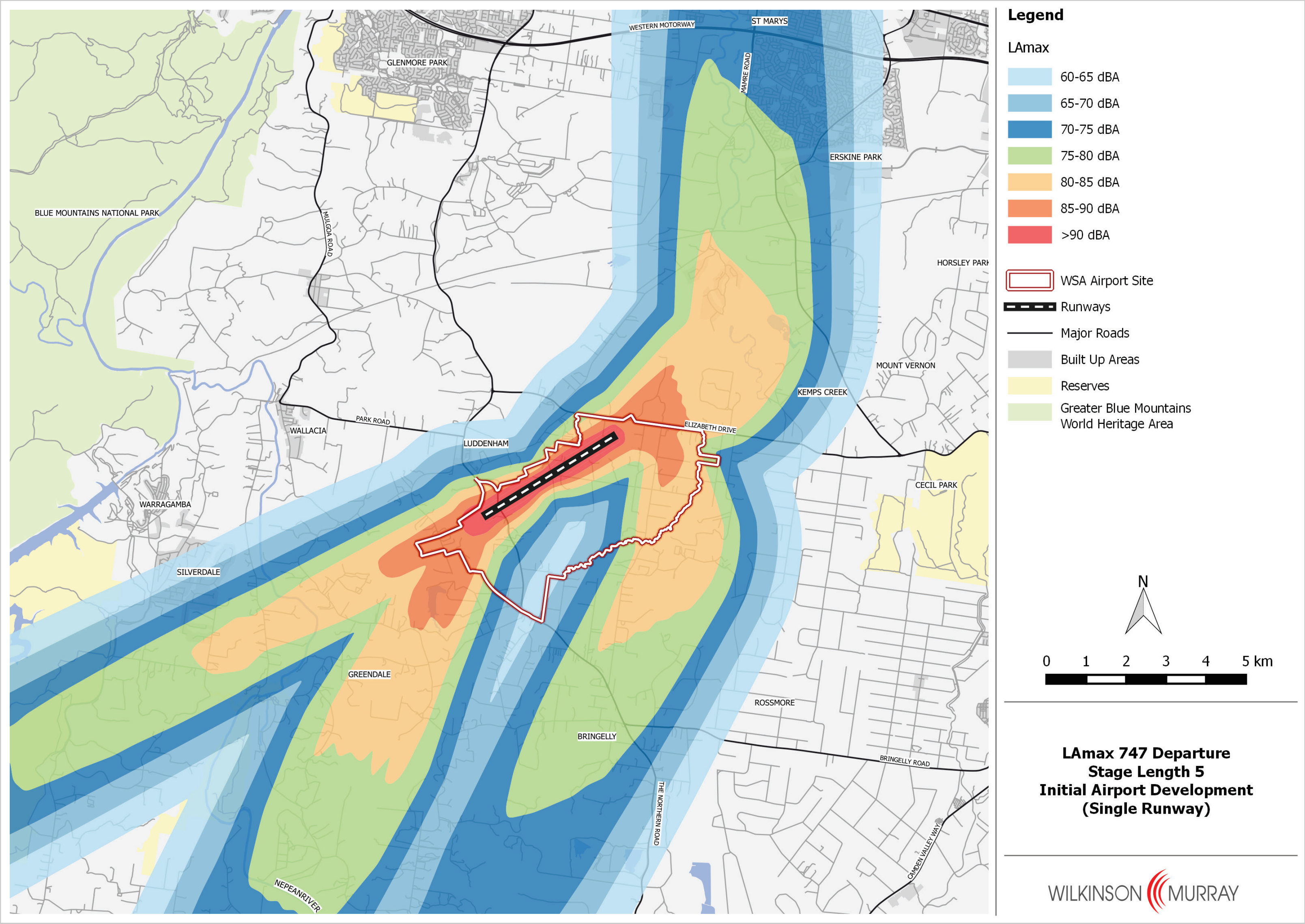


Figure 3-3 Combined Single Event B747 Arrival (Macro Scale)

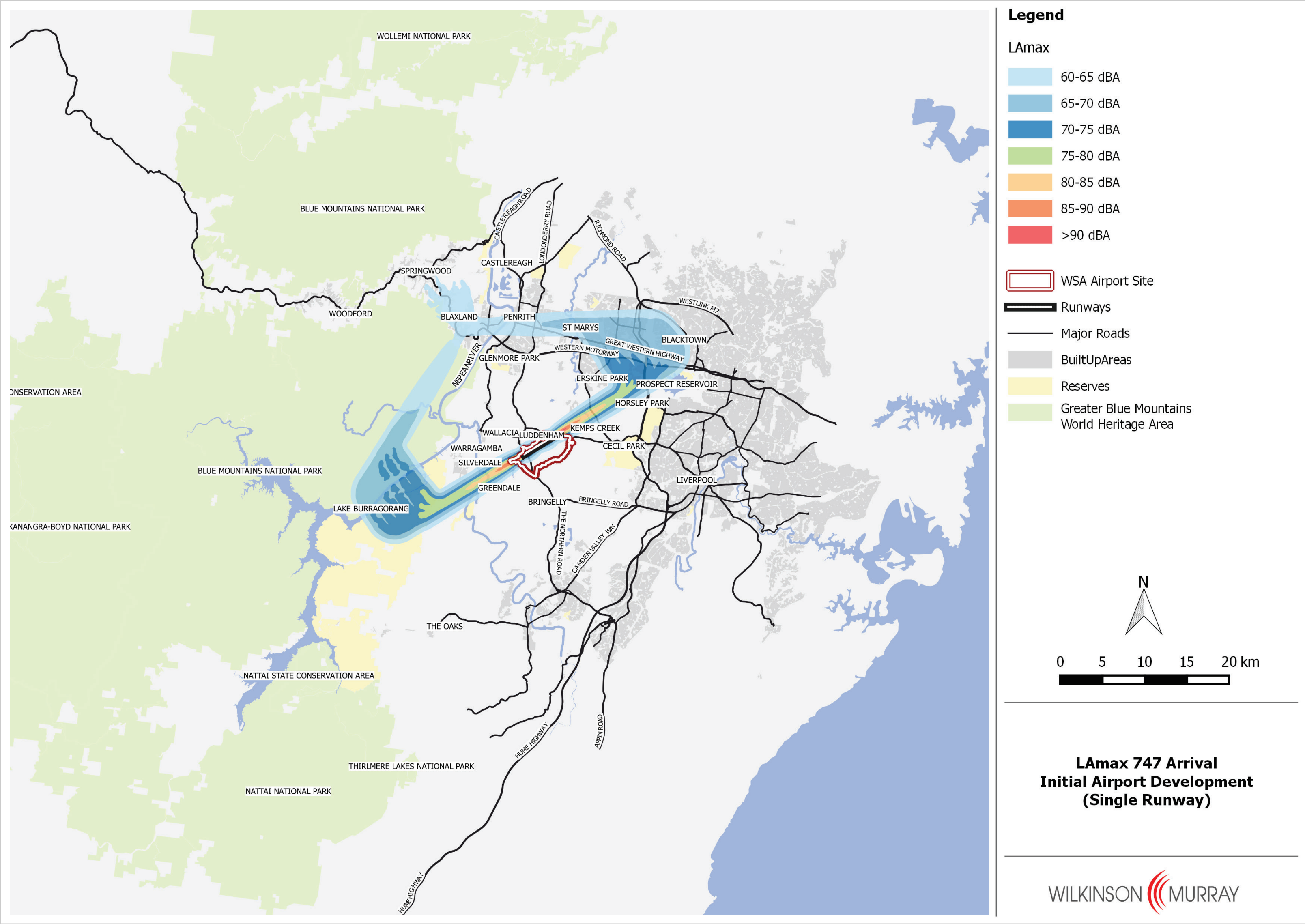


Figure 3-4 Combined Single Event B747 Arrival (Meso Scale)

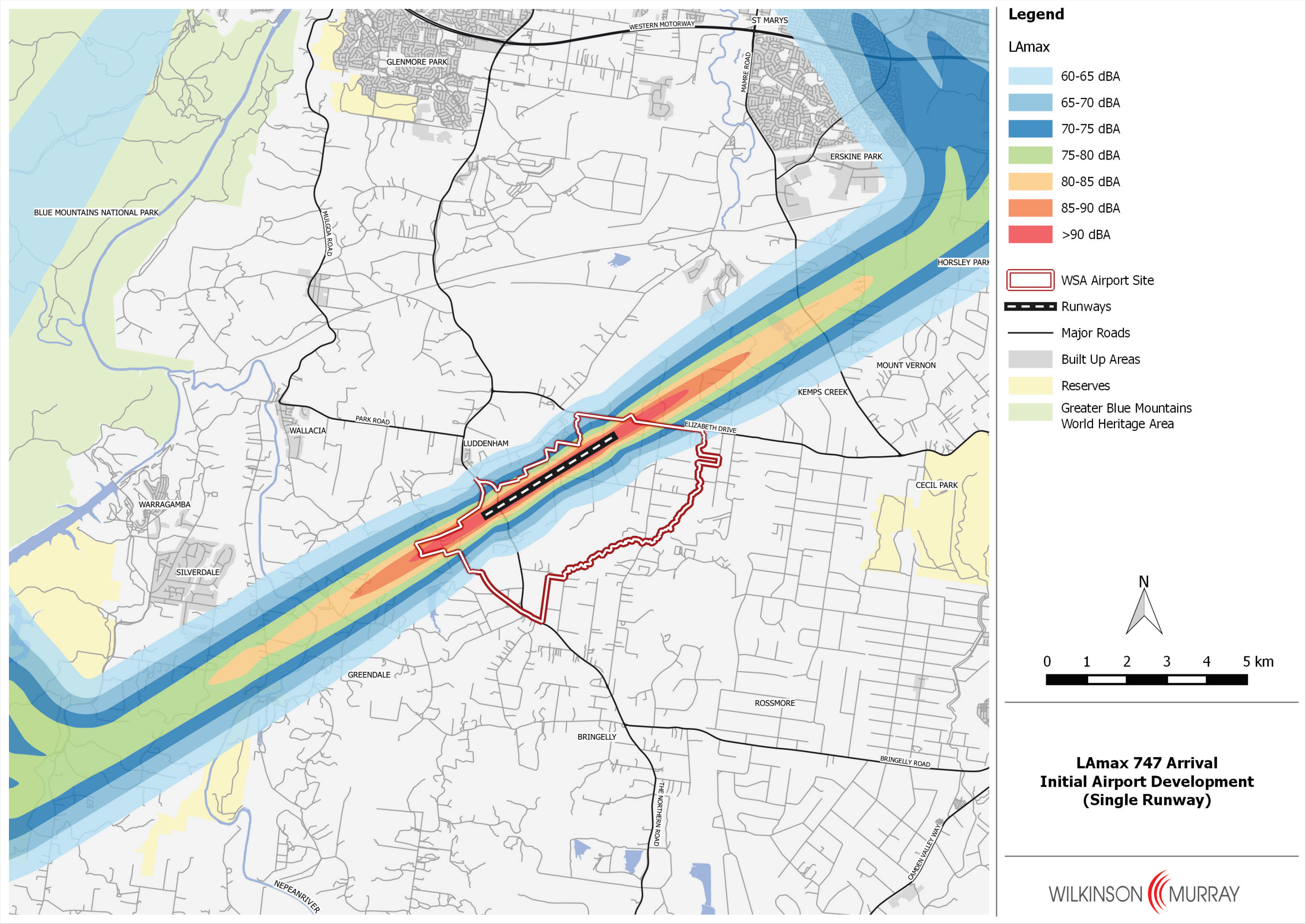


Figure 3-5 Combined Single Event A320 Departure – Stage 4 (Macro Scale)

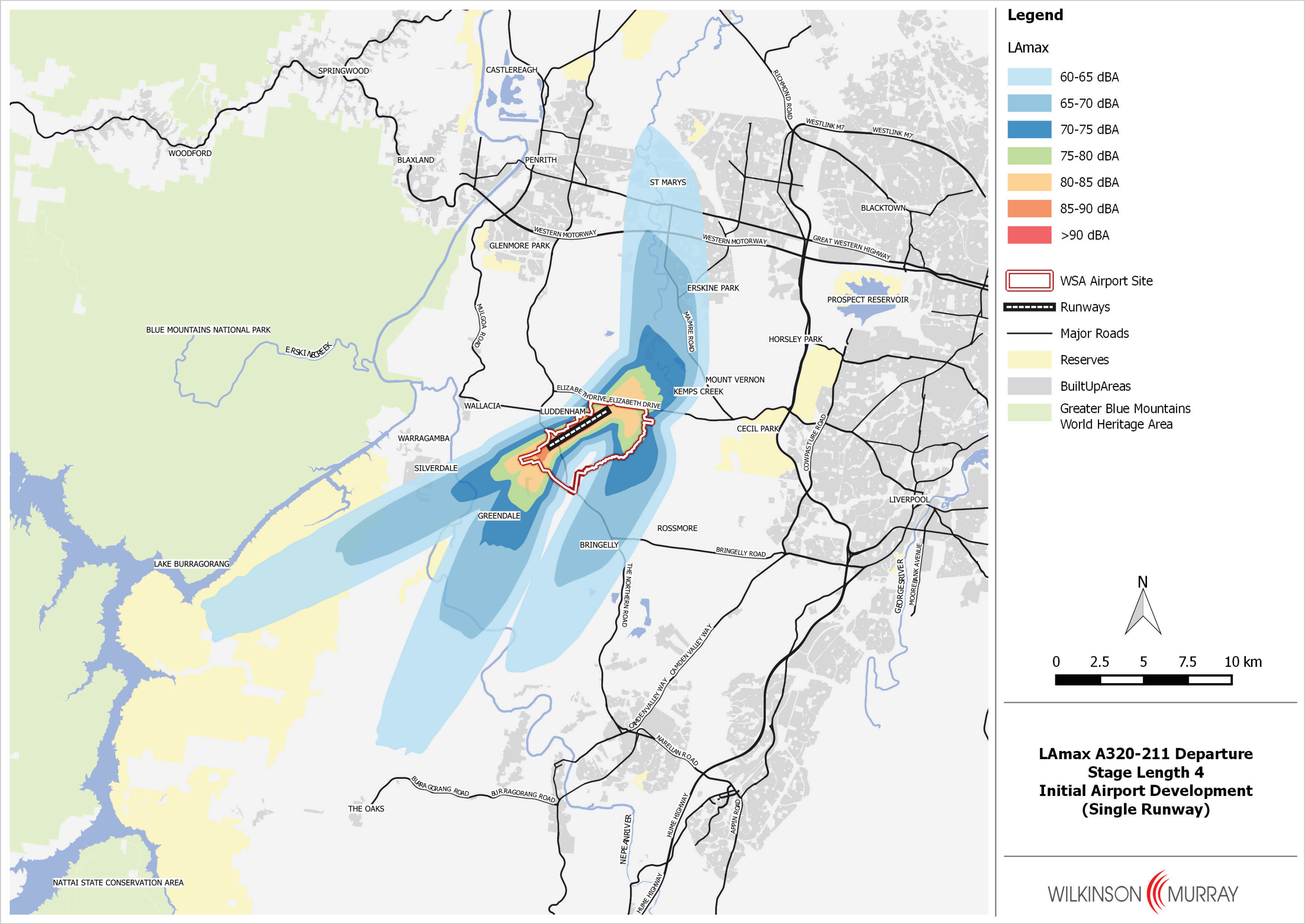


Figure 3-6 Combined Single Event A320 Departure – Stage 4 (Meso Scale)

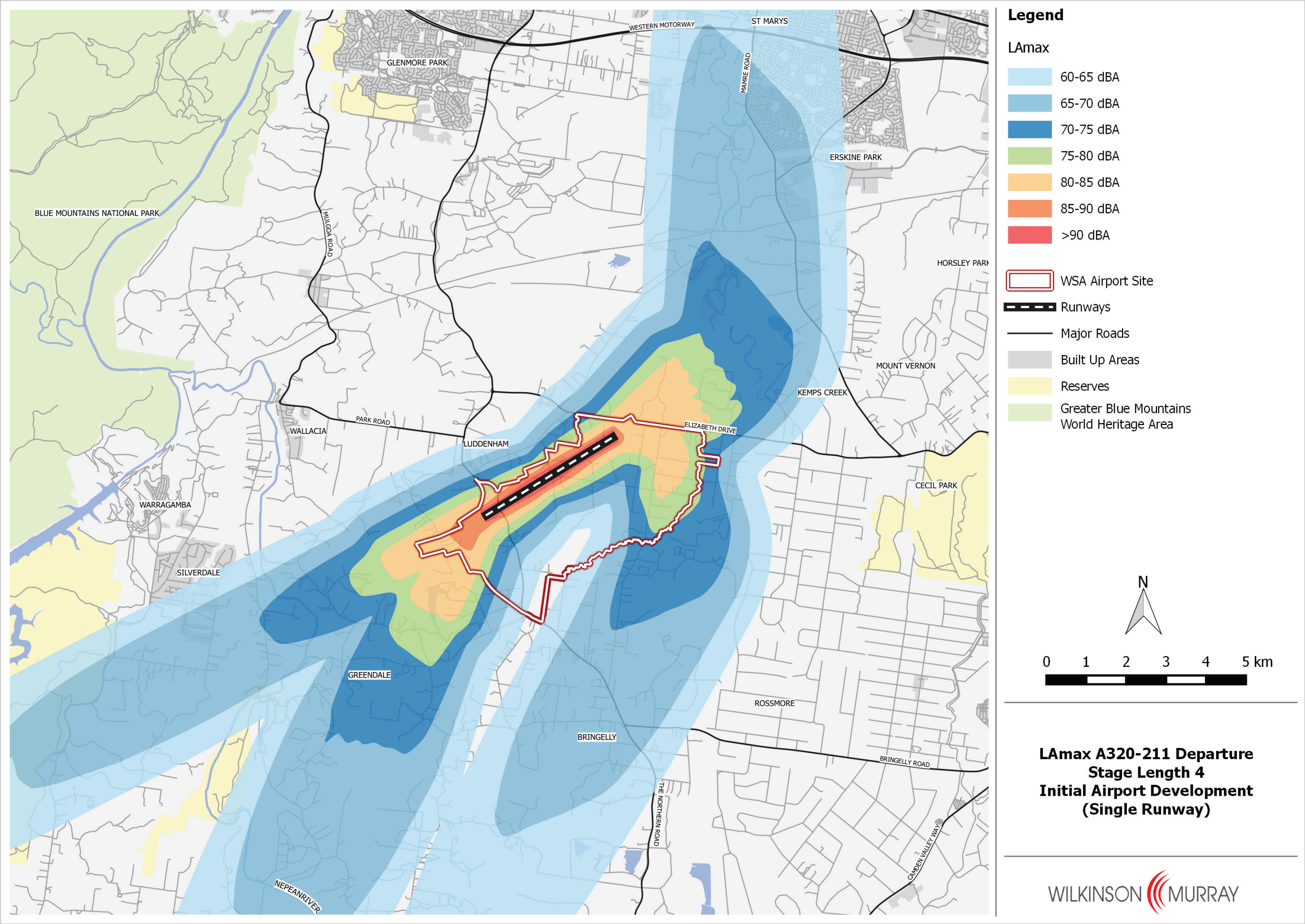


Figure 3-7 Combined Single Event A320 Departure – Stage 1 (Macro Scale)

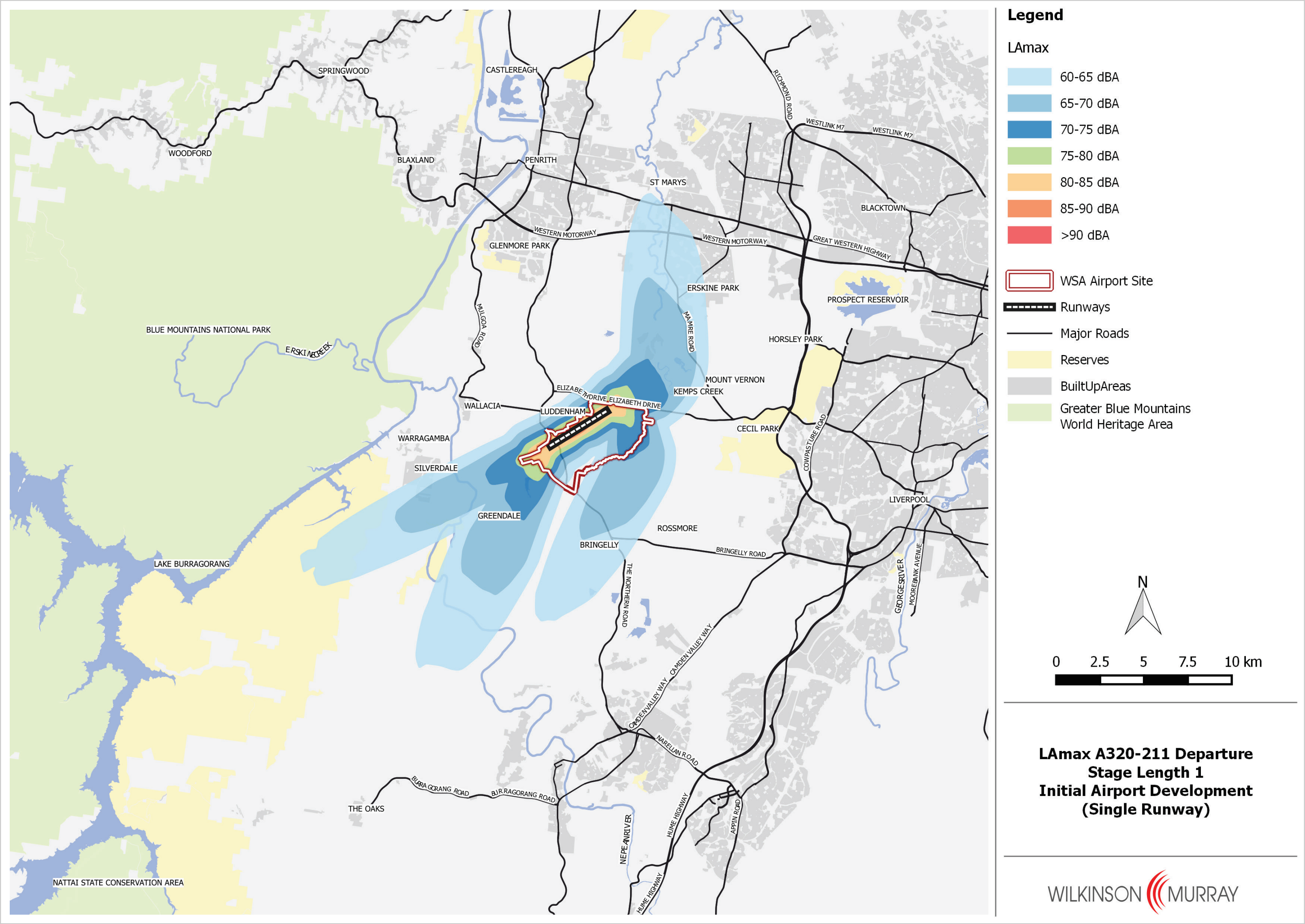


Figure 3-8 Combined Single Event A320 Departure – Stage 1 (Meso Scale)

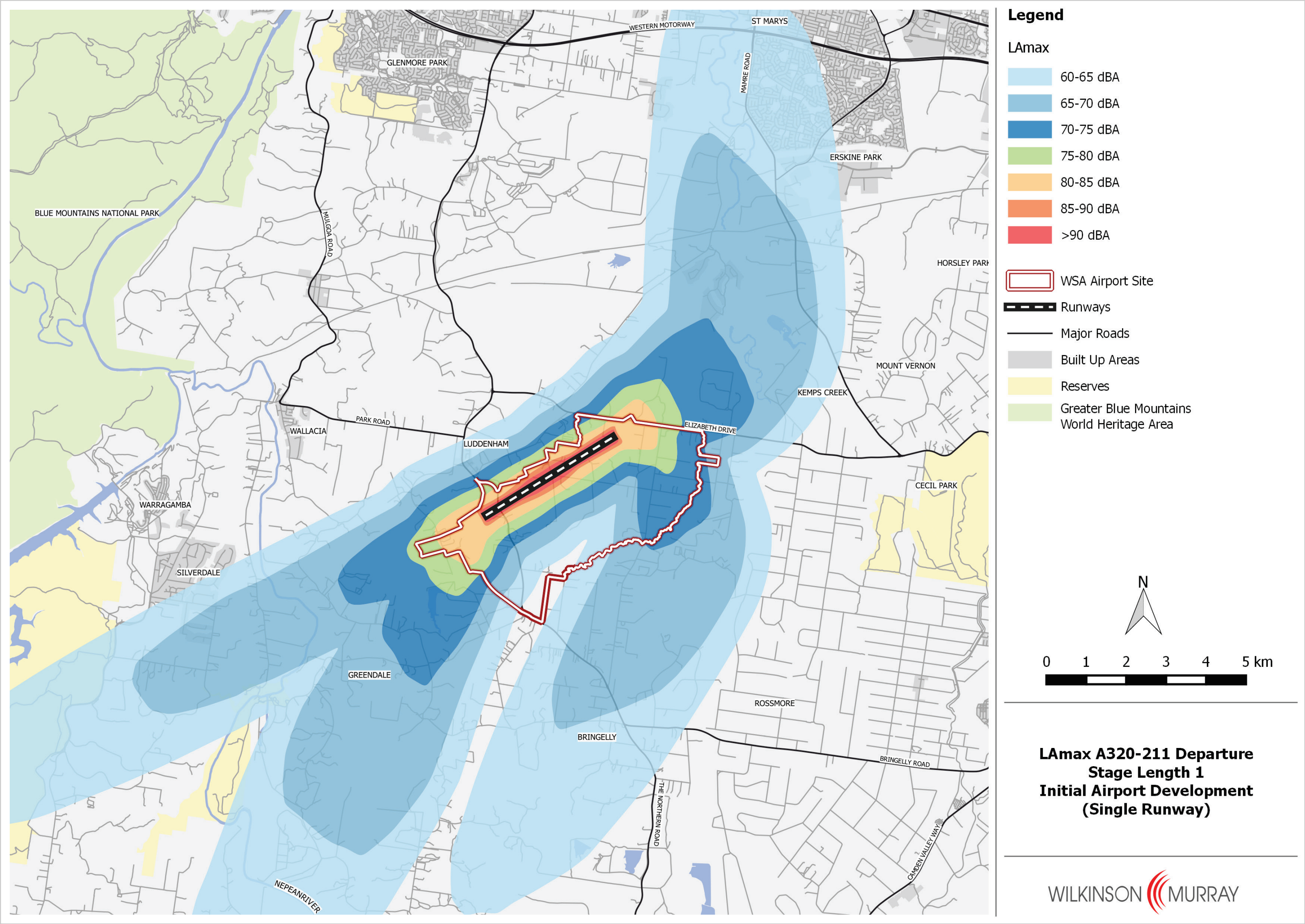


Figure 3-9 Combined Single Event A320 Arrival (Macro Scale)

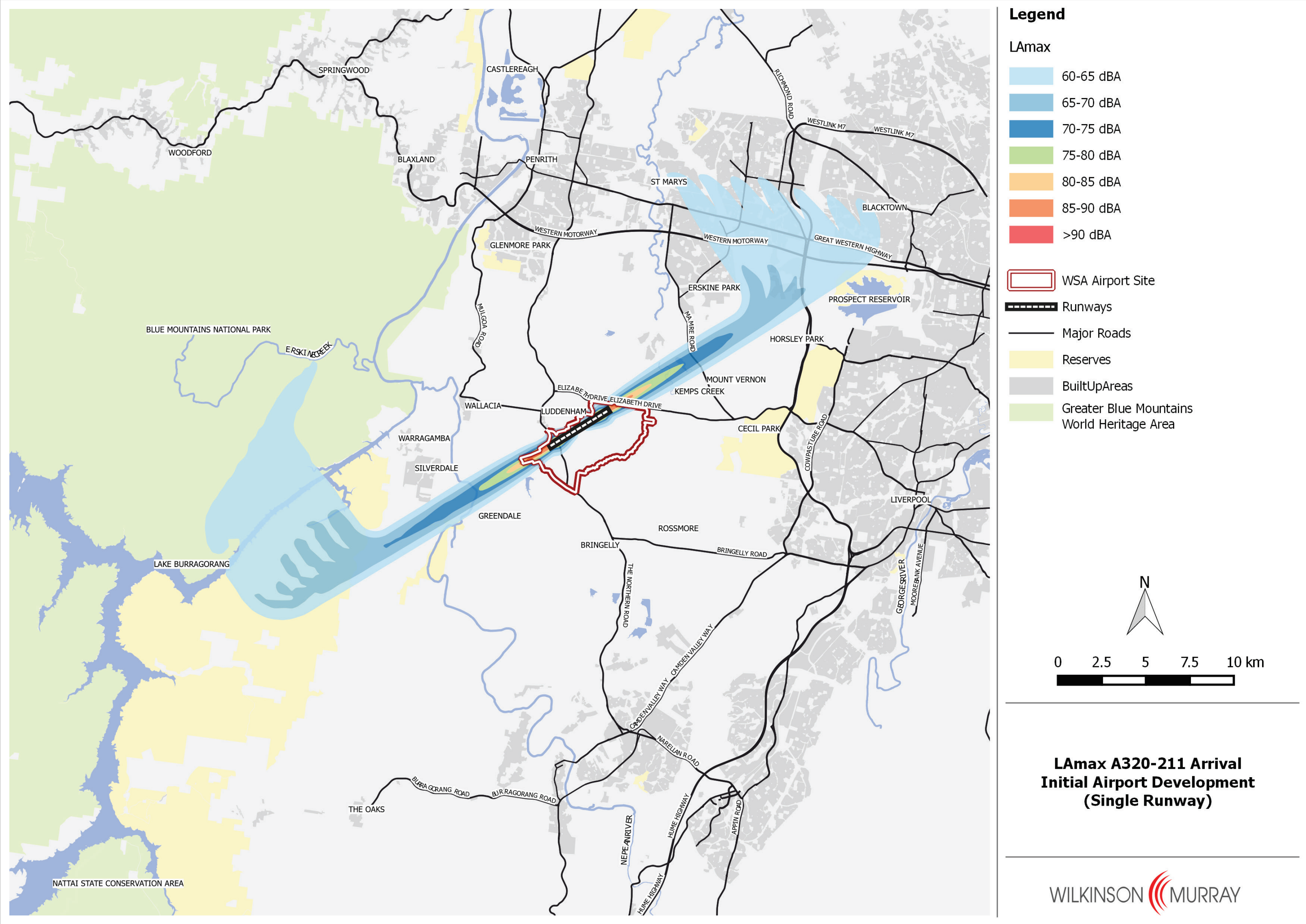
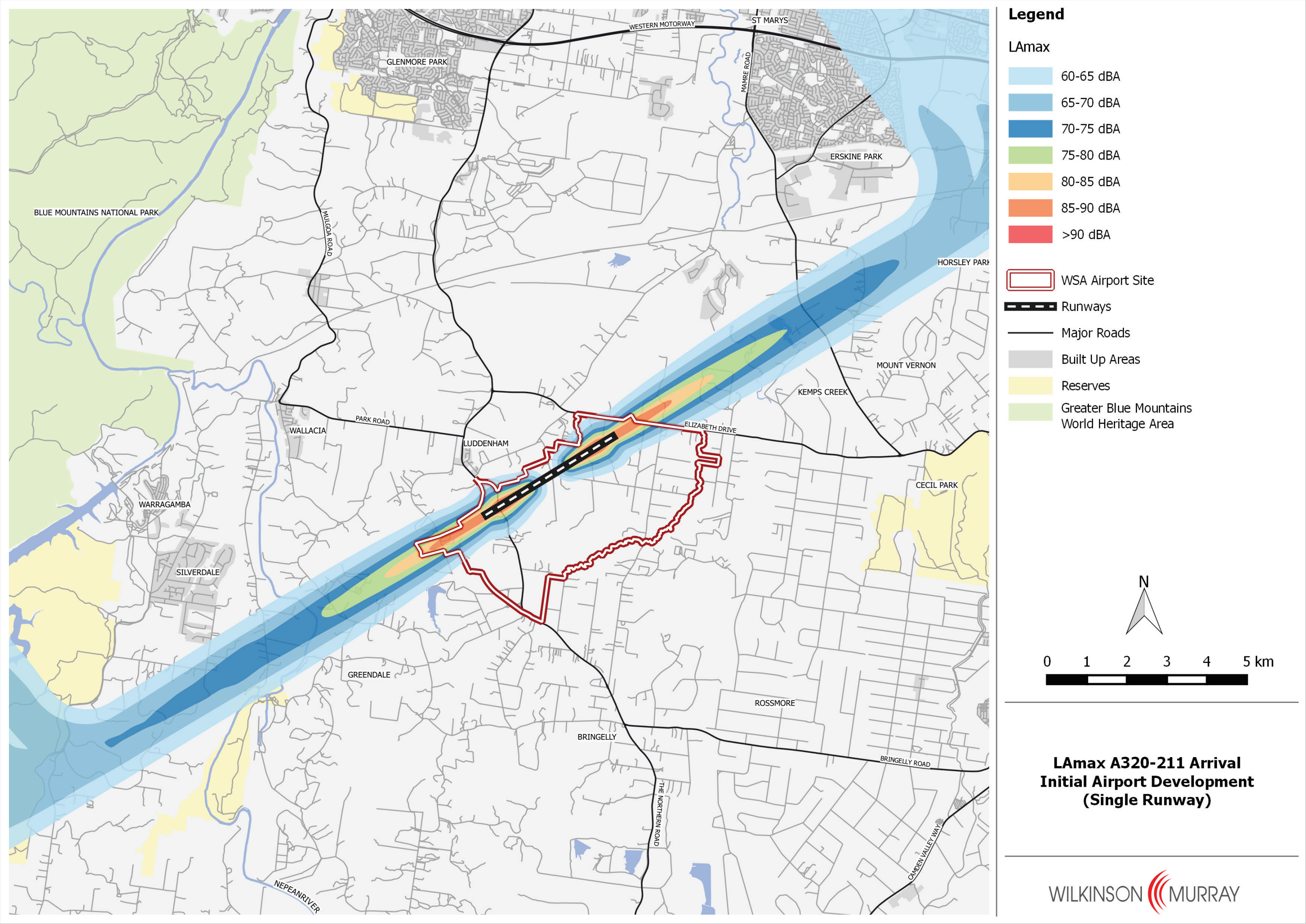


Figure 3-10 Combined Single Event A320 Arrival (Meso Scale)



3.3 Summer & Winter Operations

For noise metrics that respond to the number of noise events, including N70 and N60, there will potentially be a difference between values in the summer and winter periods due to differing meteorological conditions (wind strength and direction, visibility etc). This difference was investigated, and Appendix C shows N70 and N60 contours for summer, winter and annual movements for different assessment years.

However, as seen in Appendix C, differences between results for different seasons are relatively minor, and do not influence the overall noise assessment to any significant extent. For this reason, noise level contours shown in the body of this report are all based on annual values of the relevant noise descriptor.

It should be noted that ANEC contours are defined to represent annual average noise levels (except under special circumstances that do not apply here) and hence in this case, comparison between seasons is not relevant.

3.4 Noise Levels Over 24 Hours

3.4.1 N70 Results

Aircraft noise impact over a full day can be described by the number of noise events exceeding 70 dBA, or N70. Calculated N70 noise contours for each of the four airport operating strategies described in Section 2.7.1, and for Stage 1 development, are presented in Figure 3-11 to Figure 3-14. These represent the predicted annual average number of movements per day with L_{Amax} noise levels exceeding 70 dBA. While N70 charts typically show numbers of events down to 10 events per day, this report shows N70 contours down to 5 events per day, to allow lower level impacts to be better understood.

The analysis shows that there are differences between noise impacts from different airport operating strategies. In particular, the Prefer 05 strategy results in greater impact on residents to the north-east of the airport. However, in Stage 1 no densely-populated residential areas are predicted to experience more than five events per day above 70 dBA. In addition, only very limited areas within the Blue Mountains National Park and GBMWHA are predicted to experience this level of noise impact.

Inclusion of a "Head-to-Head" mode at night makes an almost imperceptible difference to overall N70 values. This is because night time operations are only a small fraction of total operations. The importance of this mode will be seen below in results that focus only on night time noise.

Figure 3-11 N70 Contours – Stage 1 – Prefer 05

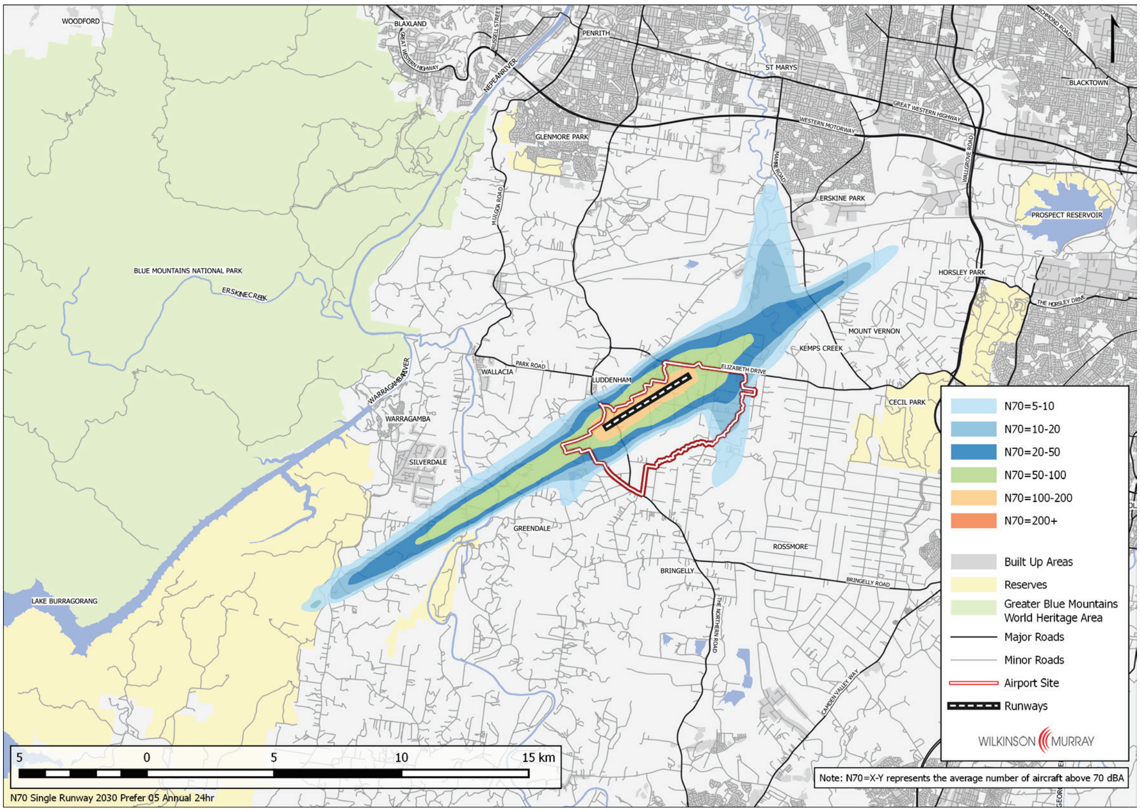


Figure 3-12 N70 Contours – Stage 1 – Prefer 23

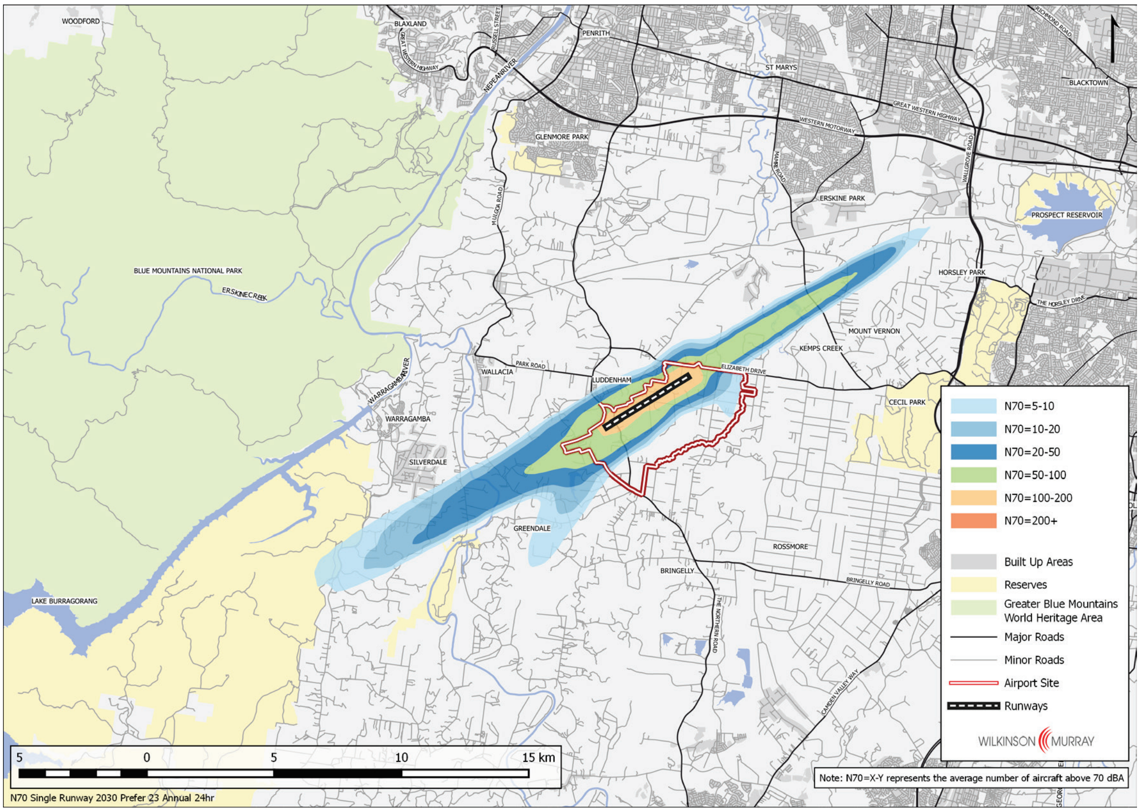
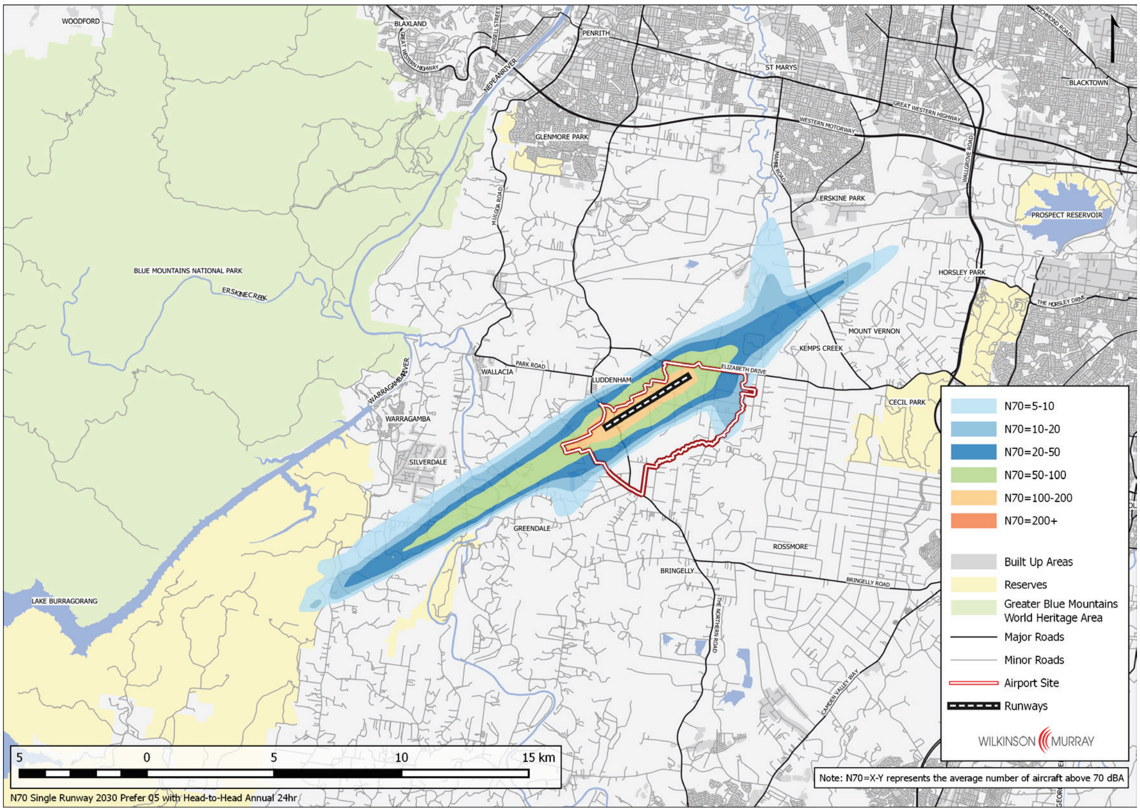


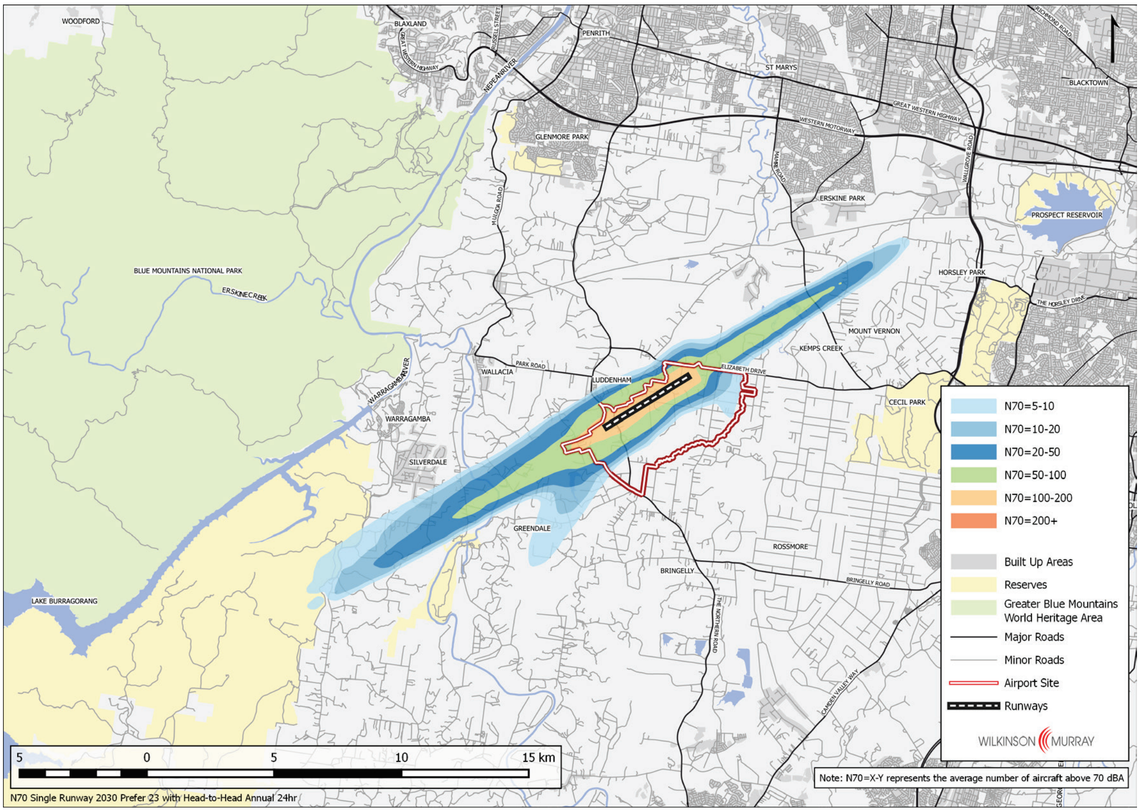
Figure 3-13 N70 Contours – Stage 1 – Prefer 05 with Head-to-Head



N70 Single Runway 2030 Prefer 05 with Head-to-Head Annual 24hr

Note: N70=X-Y represents the average number of aircraft above 70 dBA

Figure 3-14 N70 Contours – Stage 1 – Prefer 23 with Head-to-Head



N70 Single Runway 2030 Prefer 23 with Head-to-Head Annual 24hr

Note: N70=X-Y represents the average number of aircraft above 70 dBA

3.4.2 90th Percentile N70 Results

Figure 3-15 and Figure 3-16 show 90th percentile values of N70 calculated over all days – that is, the number of daily aircraft noise events over 70 dBA that would be exceeded on only 10% of days. This can be thought of as a "typical worst-case" day. Values are shown for Stage 1, Prefer 05 and Prefer 23. (Head-to-Head strategies are not shown as this mode makes very little difference to the results.) The figures also show the "average day" N70 values as depicted in the figures above.

The most noticeable feature of these figures is that generally, the difference between predicted noise impact on "average" and "typical worst-case" days is not large. This is due to the relatively low and consistent wind speeds at the site, which mean that the airport's "preferred" mode of operation can be selected over 80% of the time.

Figure 3-15 Mean & 90th Percentile N70 Contours – Stage 1 – Prefer 05

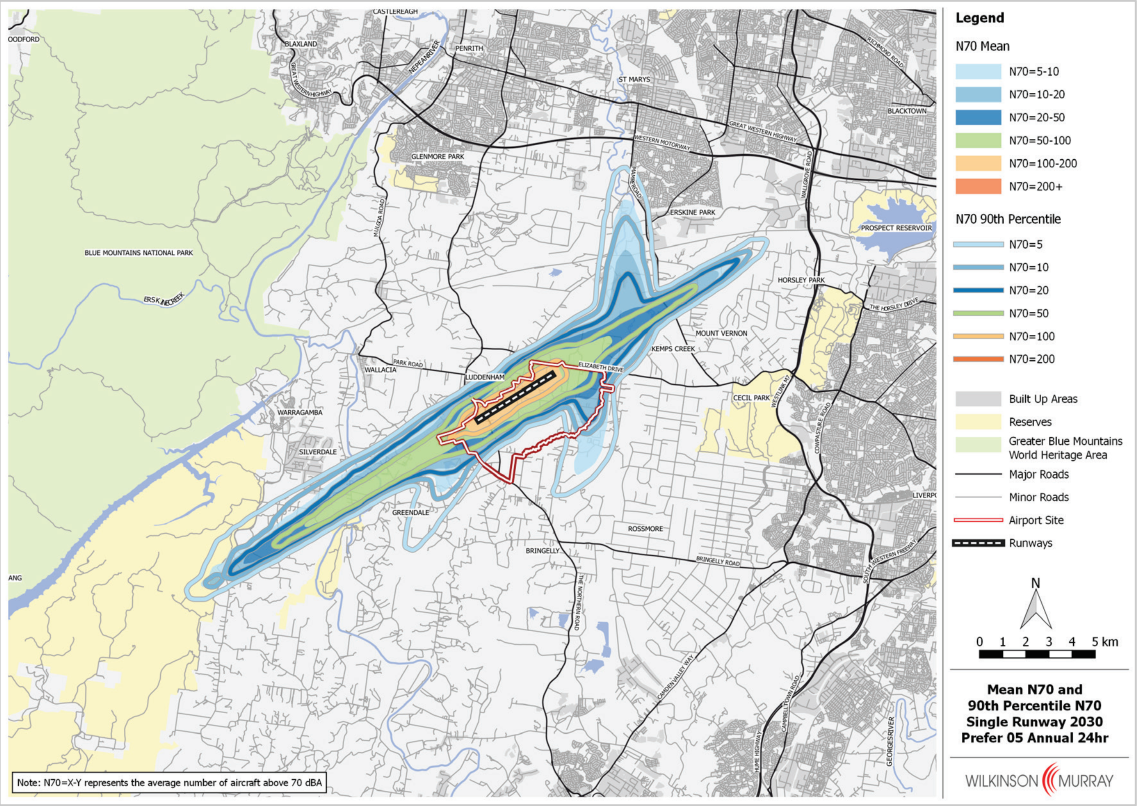
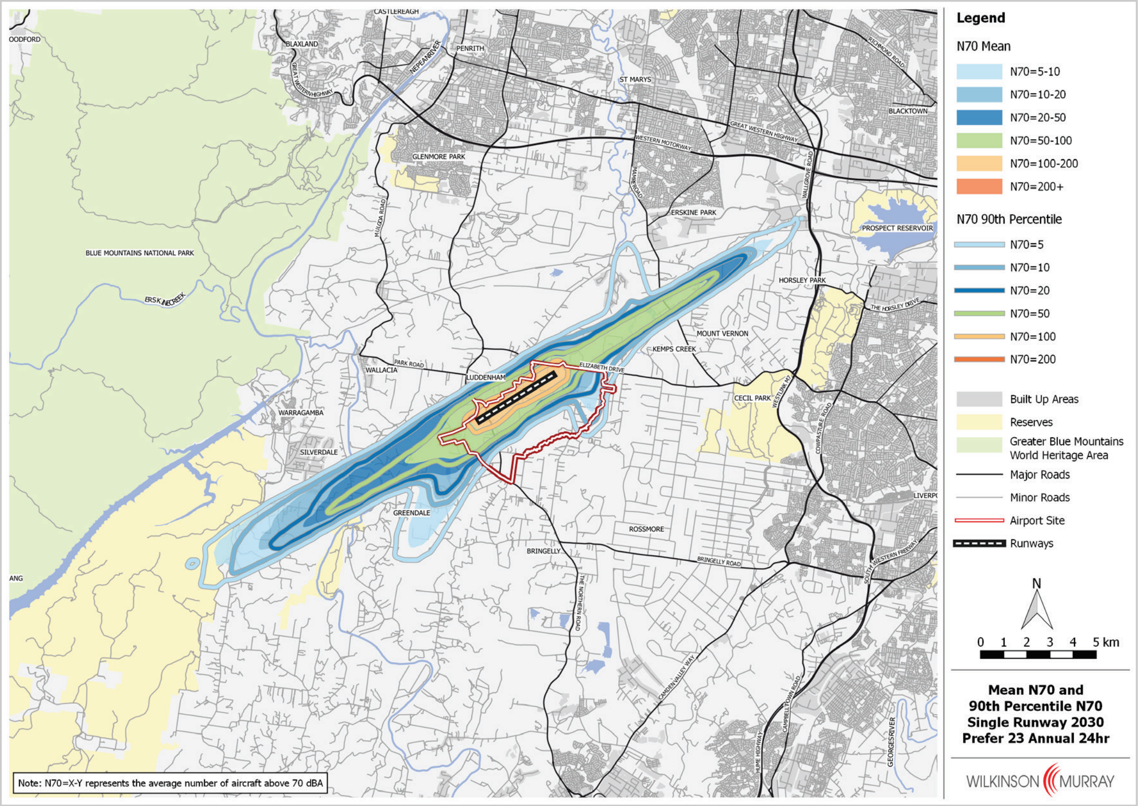


Figure 3-16 Mean & 90th Percentile N70 Contours – Stage 1 – Prefer 23



3.4.3 Population Exposure Estimates

The future population experiencing various levels of daytime noise impact has been estimated using procedures described in Section 2.9. Results for an "annual average day" are shown in Table 3-2.

Table 3-2 Estimated Population within N70 Contours – Stage 1; 2030 Population

N70	Operating Strategy			
	Prefer 05	Prefer 23	Prefer 05 + H_2H*	Prefer 23 + H_2H*
5-10	563	399	852	405
10-20	581	450	326	439
20-50	192	426	258	431
50-100	152	192	167	178
100-200	5	0	10	10
>200	0	0	0	0
Total	*1,493*	*1,467*	*1,613*	*1,463*

Note: * H2H = "Head-to-Head"

In Stage 1 (2030), the number of people predicted to experience five or more aircraft noise events per day above 70 dBA would be roughly 1,500 – 1,600. This outcome depends very little on the operating strategy adopted. The Prefer 23 operating strategy results in fewer people being affected at lower noise levels (generally to the north of the airport), but this is offset by more people being affected at higher noise levels – generally in rural residential areas to the south and west of the airport.

3.5 Night Time Noise

3.5.1 N60 Results

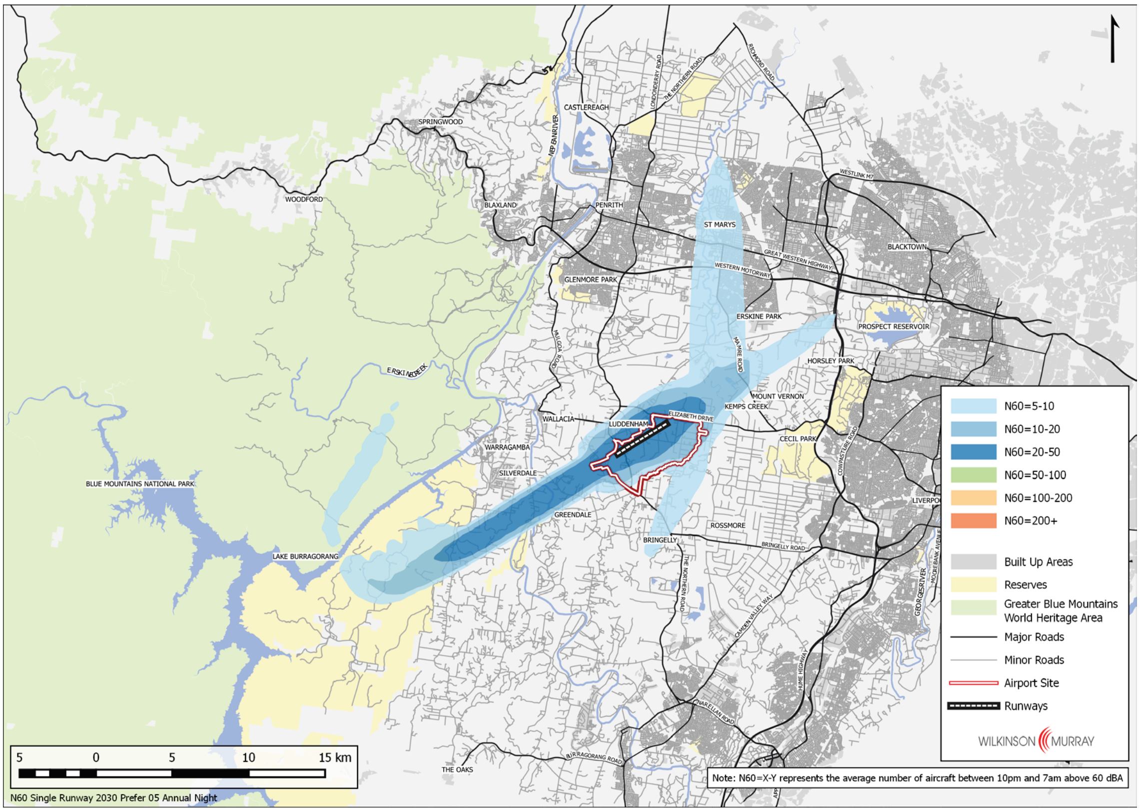
The number of noise events exceeding 60 dBA is often used to describe the impact of noise at night. In this report, predicted N60 values are shown for the standard night time period 10pm-7am. Figure 3-17 to Figure 3-20 show these values for the four operating strategies considered, for Stage 1 development. Calculations are shown down to a value of five events per night.

The difference between Prefer 05 and Prefer 23 strategies is significant, with Prefer 05 having greater impact on built-up areas around St Marys while Prefer 23 has a greater impact on rural residential areas around Greendale. In Stage 1, with Prefer 05, large areas with significant population density are predicted to experience more than five noise events per night exceeding 60 dBA. With Prefer 23, this level of impact would be experienced only in rural residential areas and a small area to the south of Blacktown.

This night time noise impact can be mitigated by use of the "Head-to-Head" mode where available. As demonstrated in Figure 3-19 and Figure 3-20, this results in no built-up residential areas being exposed to more than five events per night above 60 dBA.

It is notable that in Stage 1, the impact for "Prefer 05 with Head-to-Head" is exactly the same as for "Prefer 23 with Head-to-Head". This is because in Stage 1, Head-to-Head mode can be used throughout the night, unless wind conditions dictate otherwise, because the number of operations per hour never exceeds 20. If wind conditions dictate that "Head-to-Head" cannot be used, then the mode used would be determined based on wind direction, and would not depend on whether 05 or 23 is preferred.

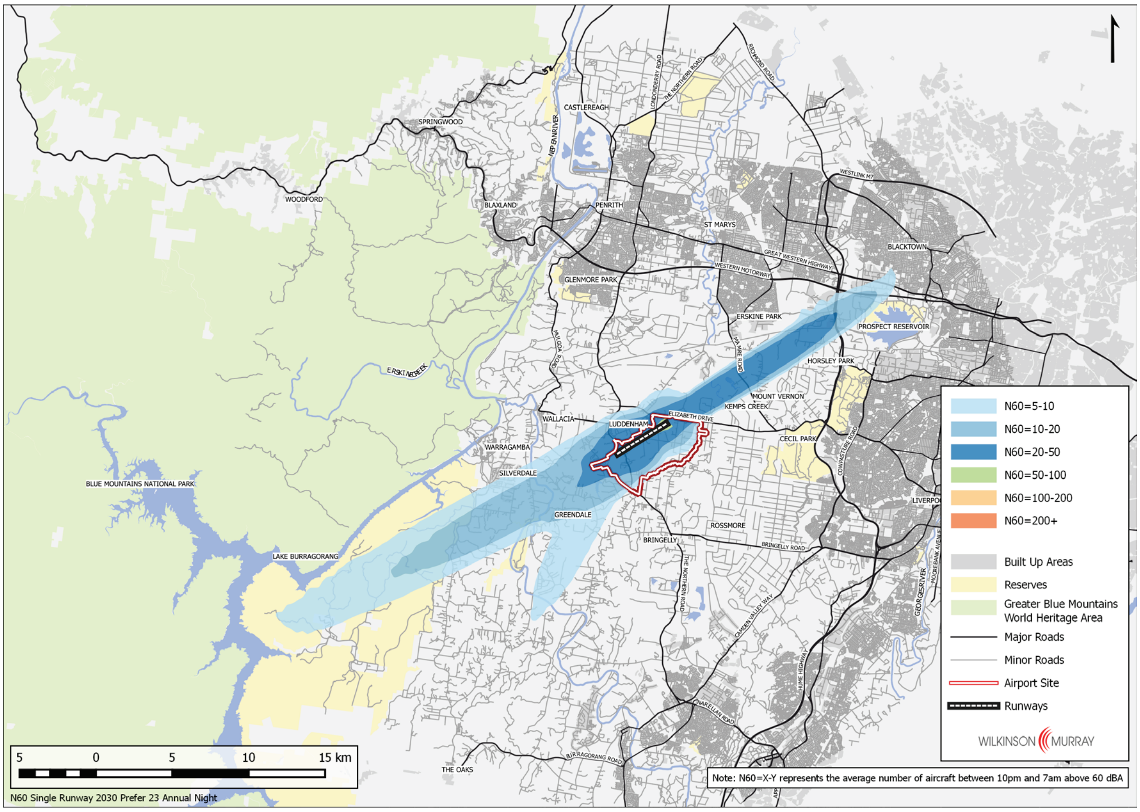
Figure 3-17 N60 Contours – Stage 1 – Prefer 05



Note: N60=X-Y represents the average number of aircraft between 10pm and 7am above 60 dBA

N60 Single Runway 2030 Prefer 05 Annual Night

Figure 3-18 N60 Contours – Stage 1 – Prefer 23



Note: N60=X-Y represents the average number of aircraft between 10pm and 7am above 60 dBA

N60 Single Runway 2030 Prefer 23 Annual Night

Figure 3-19 N60 Contours – Stage 1 – Prefer 05 with Head-to-Head

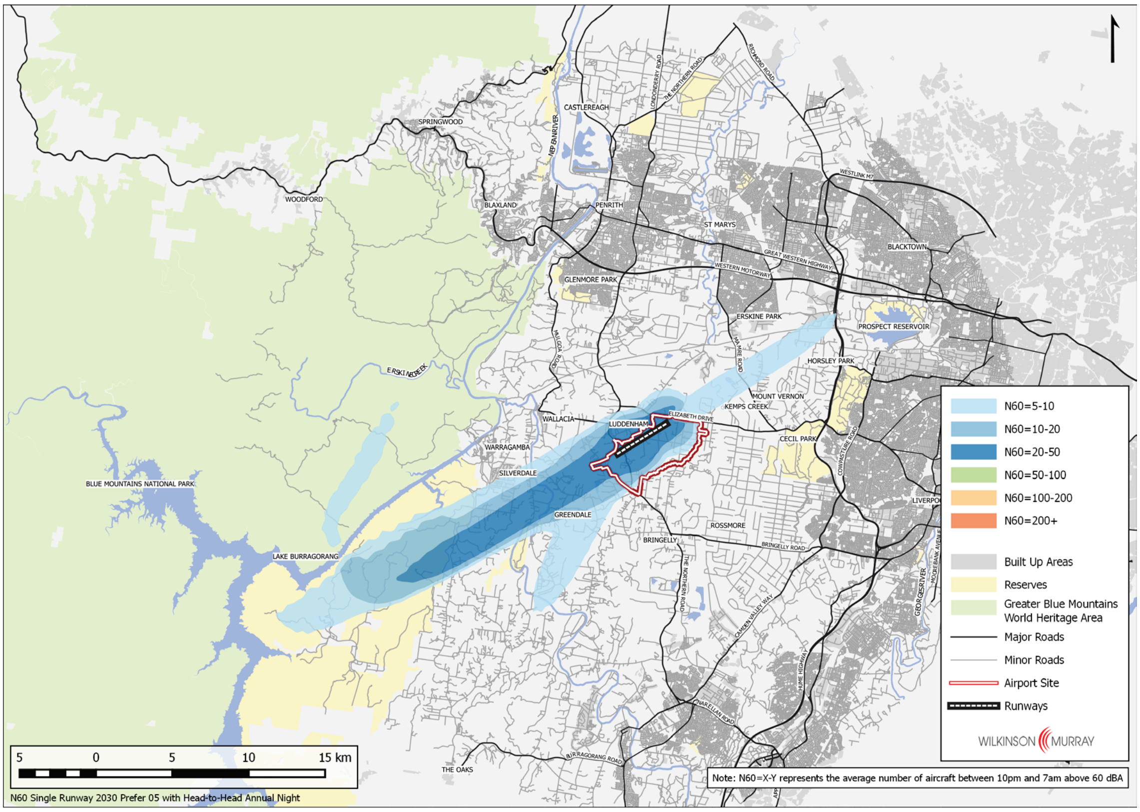
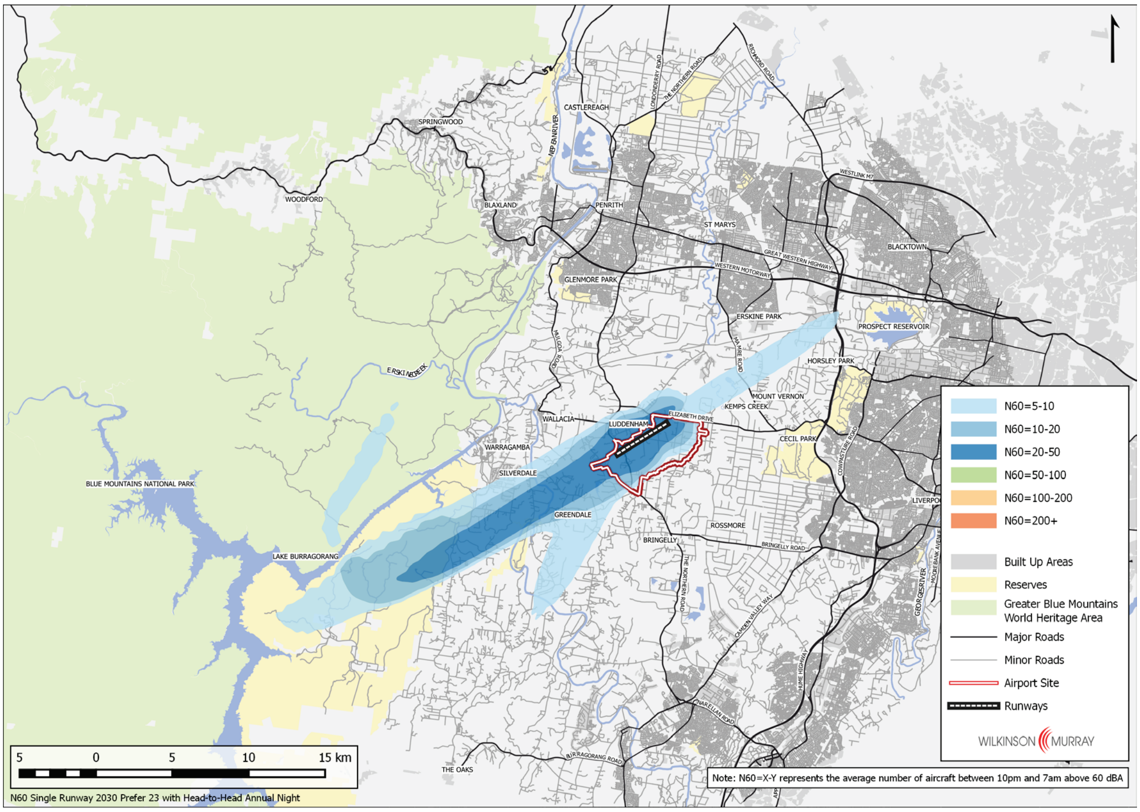


Figure 3-20 N60 Contours – Stage 1 – Prefer 23 with Head-to-Head



3.5.2 90th Percentile N60 Results

As for N70 values, 90th percentile night time N60 values give an indication of the number of events per night exceeding 60 dBA on a "typical worst-case" night. These are shown in Figure 3-21 to Figure 3-24.

Once again, differences between "average" and "typical worst-case" days are generally not large.

Figure 3-21 Mean & 90th Percentile N60 Contours – Stage 1 – Prefer 05

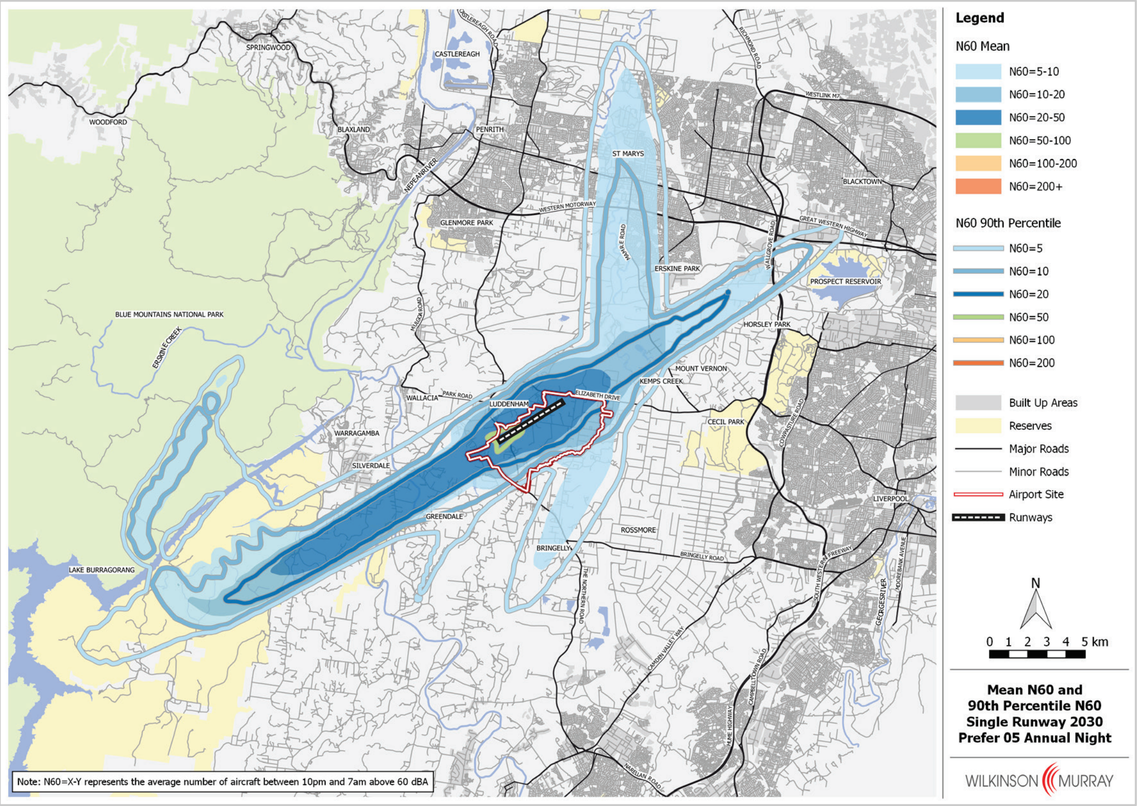
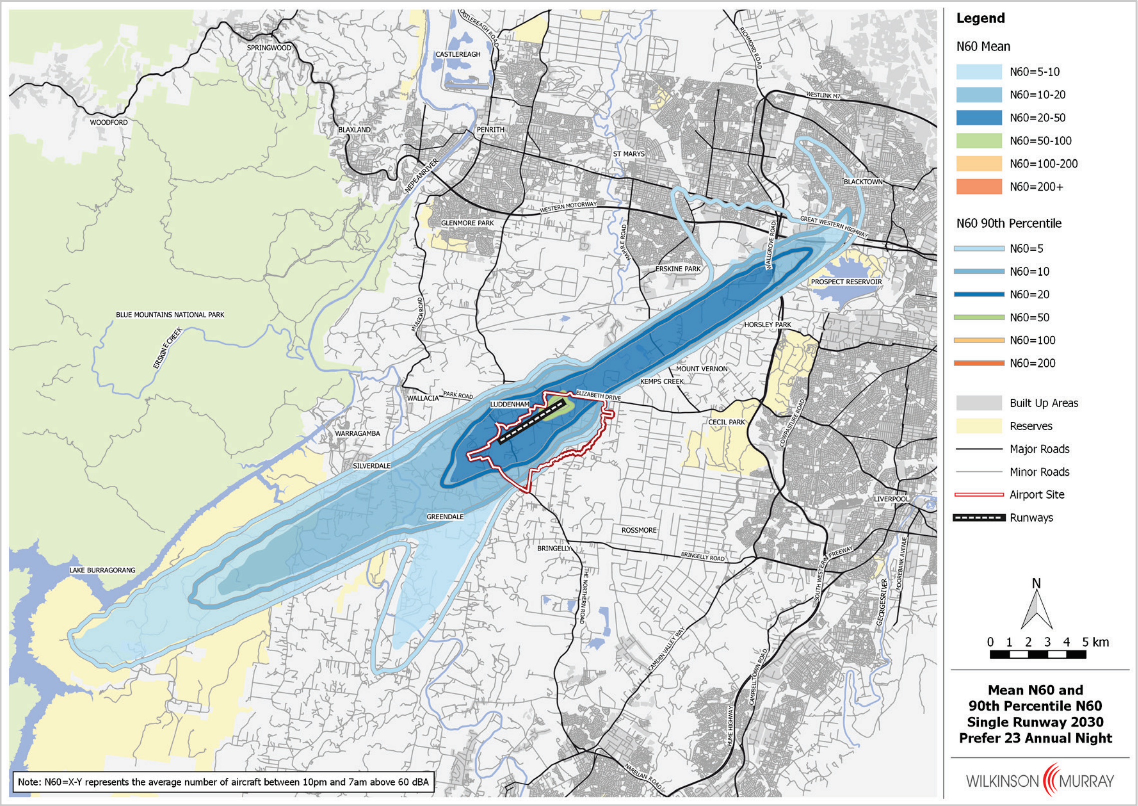


Figure 3-22 Mean & 90th Percentile N60 Contours – Stage 1 – Prefer 23



Note: N60=X-Y represents the average number of aircraft between 10pm and 7am above 60 dBA

Figure 3-23 Mean & 90th Percentile N60 Contours – Stage 1 – Prefer 05 with Head-to-Head

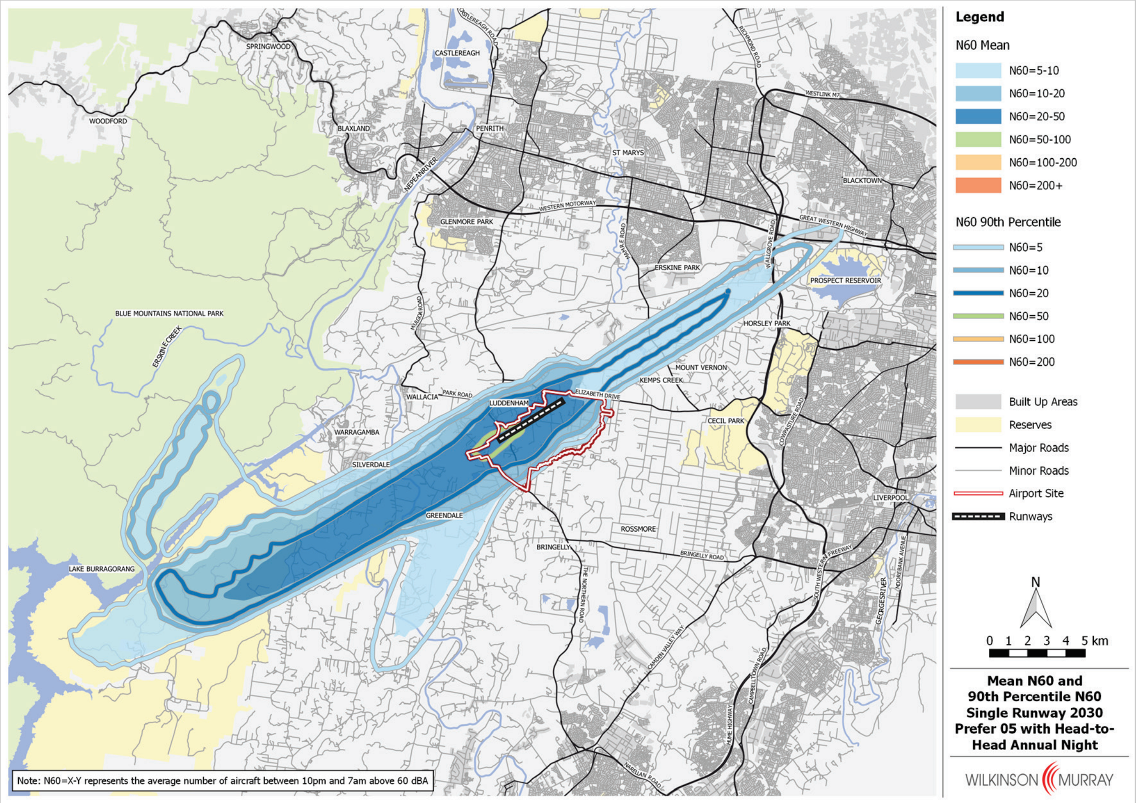
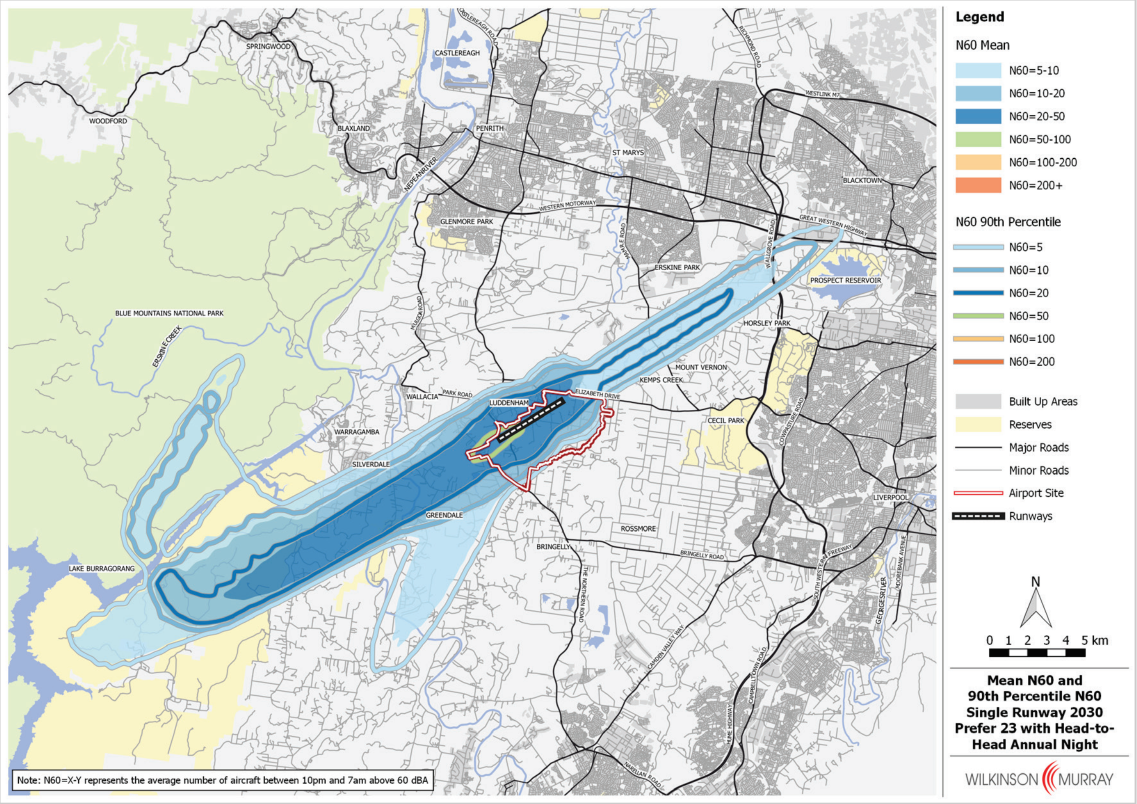


Figure 3-24 Mean & 90th Percentile N60 Contours – Stage 1 – Prefer 23 with Head-to-Head



3.5.3 Population Exposure Estimates

The future population experiencing various levels of night time noise impact has been estimated using procedures described in Section 2.9. Results are shown in Table 3-3.

Table 3-3 Estimated Population within N60 Contours – Stage 1; 2030 Population

N60	**Operating Strategy**			
	Prefer 05	**Prefer 23**	**Prefer 05 + H_2H***	**Prefer 23 + H_2H***
5-10	46731	3436	2245	2287
10-20	1065	1474	841	844
20-50	609	1269	1200	1200
50-100	0	0	0	0
>100	0	0	0	0
Total	*48405*	*6179*	*4286*	*4331*

Note: * H2H = "Head-to-Head"

- In Stage 1 (2030), a "Prefer 05" operating strategy at night would result in an estimated 48,000 people experiencing more than five events above 60 dBA at night. This is reduced to approximately 6,000 with a "Prefer 23" operating strategy, or 4,000 if a "Head-to-Head" mode is included. However, as for daytime noise, "Prefer 23" or "Head-to-Head" result in slightly more people experiencing higher noise impacts (i.e. a larger number of significant noise events). Once again these will be residents in rural residential areas to the south and west of the airport.

- It is also notable that night time noise impacts over some areas of the Blue Mountains National Park and GBMWHA are significantly higher with "Prefer 23" and "Head-to-Head" operating strategies. These impacts are described in more detail in Section 7 of this report.

3.6 Land Use Planning Impacts

3.6.1 ANEC Contours

Figure 3-25 to Figure 3-28 show the ANEC contours calculated for Stage 1 development, for the four operating strategies considered above.

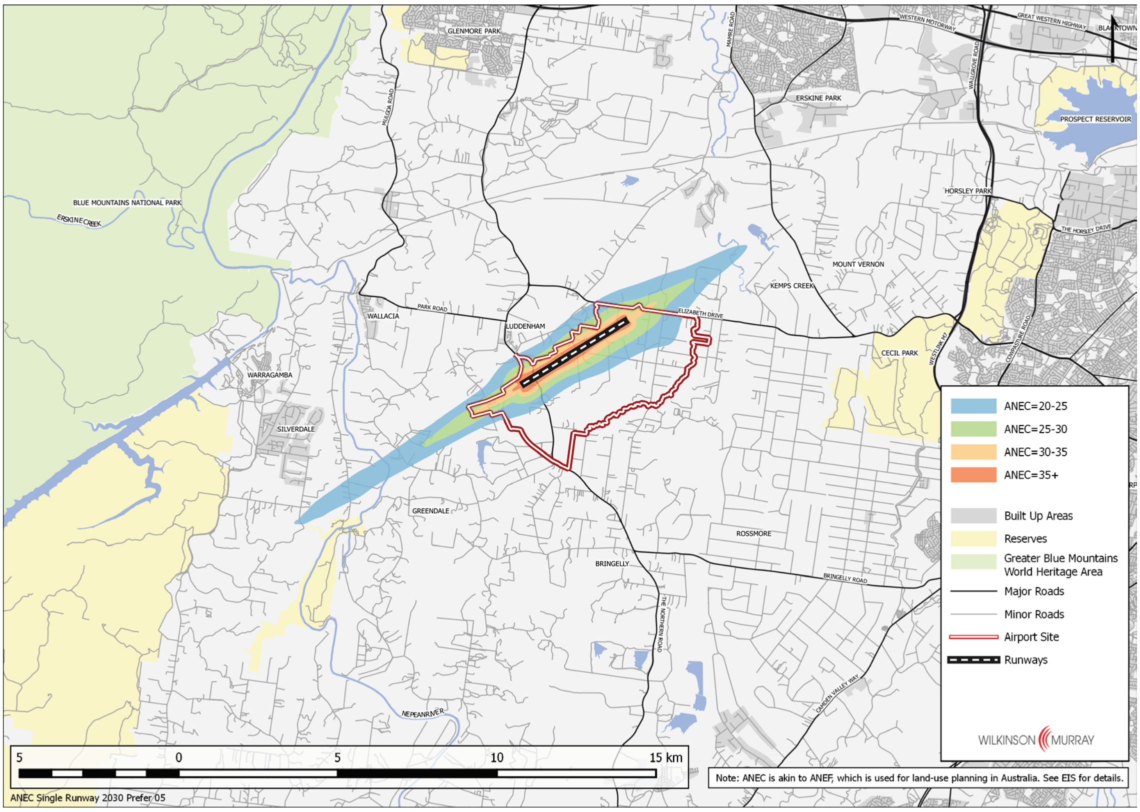
As for N70 contours, it is notable that while there are differences between "Prefer 05" and "Prefer 23", the introduction of "Head-to-Head" operations at night does not greatly influence the contours. This is because even with a heavier weighting for night time noise events, as included in the ANEF formula, overall noise exposure is still dominated by daytime events.

The 20 ANEF contour represents the area outside which new residential development is described as "acceptable" under Australian Standard 2021. Between 20 and 25 ANEF, the Standard recommends that new residential development is "conditionally acceptable" and should incorporate acoustic insulation to meet certain maximum internal noise levels, while in areas inside the 25 ANEF contour new residential development is described as "unacceptable".

As seen in Figure 3-25 to Figure 3-28, the area enclosed by the 20 ANEC contour for Stage 1 is largely rural residential in nature, under all operating strategies.

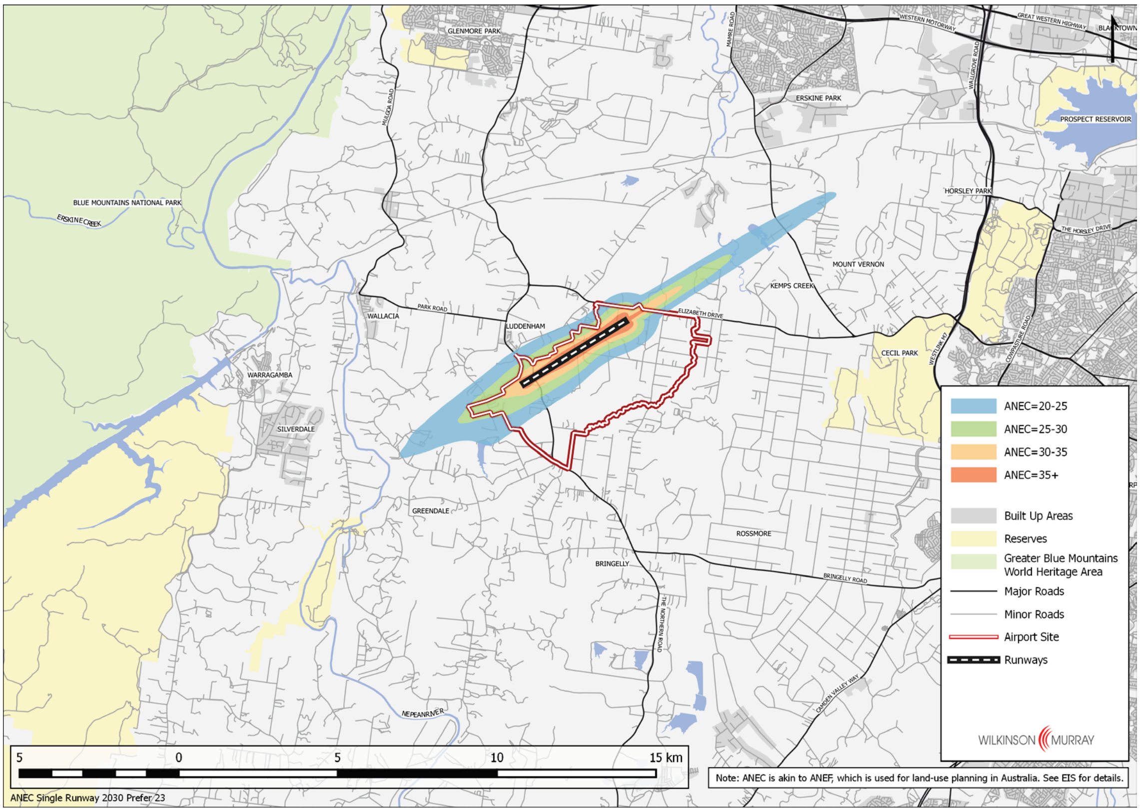
The estimated population within these contours in Stage 1 is shown in Table 3-4. The total population within the 20 ANEC contour is similar for all operating strategies, although the exact areas represented are slightly different.

Figure 3-25 ANEC Contours – Stage 1 – Prefer 05



Note: ANEC is akin to ANEF, which is used for land-use planning in Australia. See EIS for details.

Figure 3-26 ANEC Contours – Stage 1 – Prefer 23



Note: ANEC is akin to ANEF, which is used for land-use planning in Australia. See EIS for details.

Figure 3-27 ANEC Contours – Stage 1 – Prefer 05 with Head-to-Head

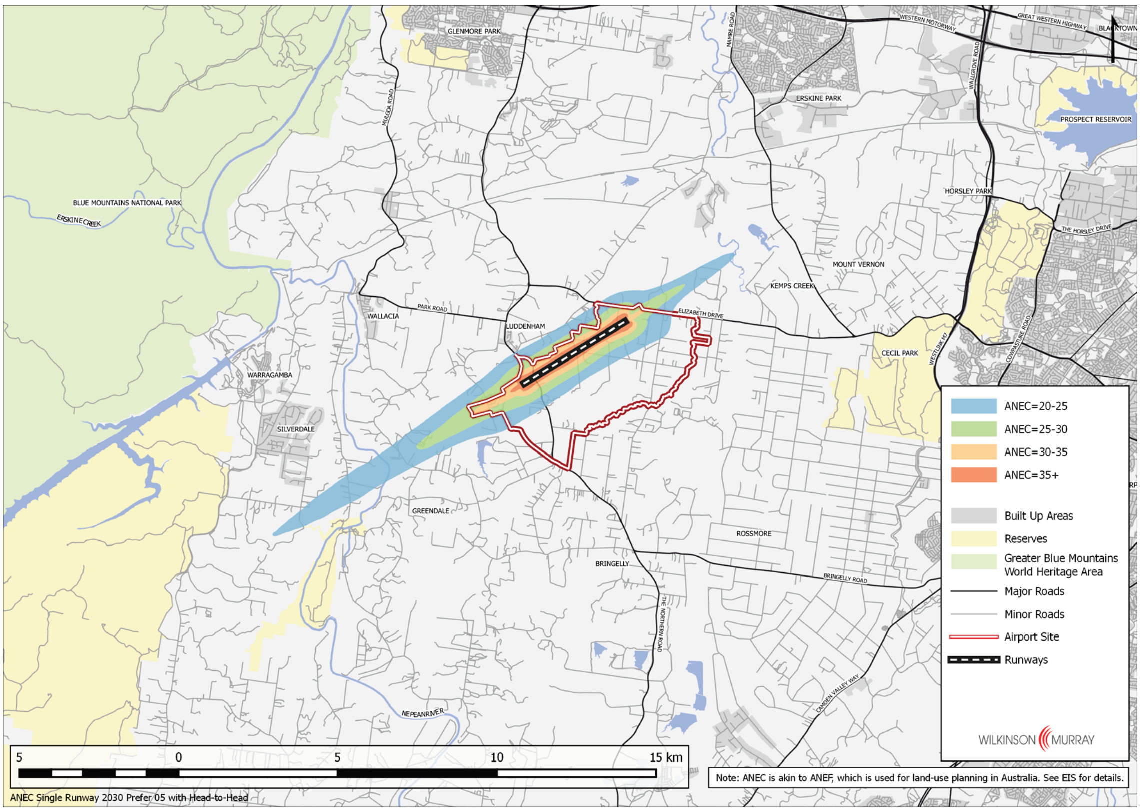


Figure 3-28 ANEC Contours – Stage 1 – Prefer 23 with Head-to-Head

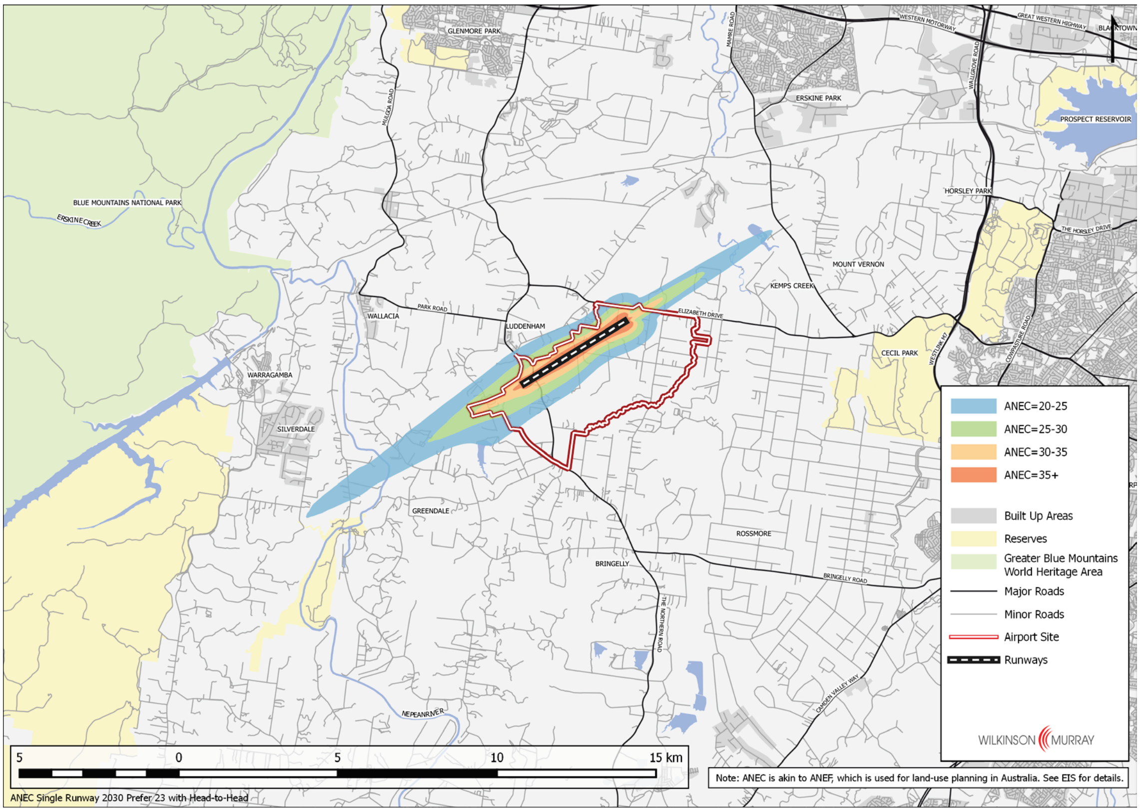


Table 3-4 Estimated Population within ANEC Contours – Stage 1; 2030 Population

ANEC Band	Operating Strategy			
	Prefer 05	Prefer 23	Prefer 05 + H_2H*	Prefer 23 + H_2H*
20-25	198	228	235	224
25-30	13	39	28	30
30-35	0	0	0	3
>35	0	0	0	0
Total	*211*	*266*	*264*	*258*

Note: * H2H = "Head-to-Head"

3.7 Aircraft Noise Levels in Recreational Areas

The Blue Mountains National Park and GBMWHA is an area used for recreational purposes that is located some distance from the proposed airport. The impact of aircraft overflights in these areas is considered in Section 7 of this report.

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

As for residences, the impact of aircraft noise in these areas can be quantified by the number of events per day with maximum noise levels exceeding 60 dBA, and exceeding 70 dBA. Where a noise level exceeds 60 dBA, a person may need to raise their voice to be properly heard in conversation. This magnitude of noise would be unlikely to cause disruption to active sporting pursuits. However, the noise would be noticeable, and could impact on the acoustic amenity of areas used for passive recreation, for the duration of the aircraft overflight.

Noise levels above 70 dBA would require increased voice effort (although not shouting) for conversation to be understood, and would certainly be considered to be acoustically intrusive in passive recreation areas, for the duration of the aircraft overflight.

Table 3-5 and Table 3-6 shows the identified recreation areas, and the predicted values of N60 and N70 for the Prefer 05 and Prefer 23 operating strategies. The values shown are for the period 7am-6pm, representing the times when these areas would most likely be used with the exception of Bents Basin State Conservation area which is also used for public camping.

Table 3-5 **Average Number of Daily Noise Events with L_{Amax} Exceeding 70 dBA (N70) at Recreational Receivers**

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

Table 3-6 **Average Number of Daily Noise Events with L_{Amax} Exceeding 60 dBA (N60) at Recreational Receivers**

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

A review of the results presented in Table 3-5 and Table 3-6 indicates the following:

- Most of the identified recreational receivers would not be subjected to aircraft overflight noise events with maximum levels exceeding 70 dBA – or their exposure would be significantly less than 1 event per day on average.
- **Twin Creeks Golf & Country Club** – Flyover noise levels from aircraft at this location would be noticeable out of doors and at times a raised voice effort would be required for effective communication. However it is noted that the sensitivity of receivers at this location is likely to be lower due to the active use of the area.
- **Bents Basin State Conservation Reserve & Gulguer Nature Reserve** would be subject to a number of flyover event noise levels exceeding 60 dBA, which would be noticeable to passive users of this area. Bents Basin State Conservation Reserve is used for camping, and would be subject to less than five night time noise events exceeding 60
- **At Twin Creeks Golf & Country Club**, noise exposure would be significantly reduced under a Prefer 23 operating strategy. However, at Bents Basin State Conservation Reserve it would be lower under a Prefer 05 operating strategy.

4 ASSESSMENT OF ADDITIONAL CAPACITY SCENARIO (2050)

4.1 Development Overview

It is important to acknowledge that following the initial stage of airport development, which is the proposal referred under the EPBC Act, demand for air travel will grow. This noise assessment therefore includes a subsequent assessment scenario, notionally at the capacity of the first runway when total passenger demand is estimated to be approximately 37 million passengers per annum. This scenario provides an indication of potential noise impacts which reflects the forecast likely maximum number of aircraft operations associated with the single runway development.

4.2 Single-Event Noise Contours

The aircraft types used in modelling for this additional capacity scenario are generally the same as those used for the Initial Airport Development scenario (Chapter 0), and hence single-event noise contours will be the same as those shown in Section 3.2. However, one exception is that the synthetic schedule for the Stage 1 scenario included B747 (or equivalent) aircraft departures with a maximum stage length of 5 (corresponding to a departure for Singapore) whereas the Additional Capacity, or 2050, scenario includes Stage 9 departures (corresponding to departures for Los Angeles).

In the Extended Capacity scenario, Stage 9 departures by 747 aircraft are predicted to occur once every two days, on average, and may occur on any of a number of tracks. However, note that although contours are shown for these events on tracks heading south from the airport, it is very unlikely that a Stage 9 departure would occur on these tracks as there are no destinations for which this would be a preferred departure direction.

Maximum noise level contours for this additional event type are shown in Figure 4-1 and Figure 4-2. At the most-affected residences, close to the airport, L_{Amax} noise levels from these events would be in the range 85 – 95 dBA. There are less than 10 existing residences within the 90 dBA L_{Amax} contour for these events, located to the south-west of the airport Maximum noise levels in the most-affected areas are shown in greater detail in Chapter 6.

When these events occur on the track leading north in the 05 direction, L_{Amax} noise levels exceeding 75 dBA can be expected over densely-populated areas around St Marys, with levels above 80 dBA in some parts of Erskine Park.

Maximum noise levels from other aircraft operations would be as described in Section 3.2 for the Initial Airport Development scenario.

Figure 4-1 Combined Single Event B747 Departure – Stage 9 (Macro Scale)

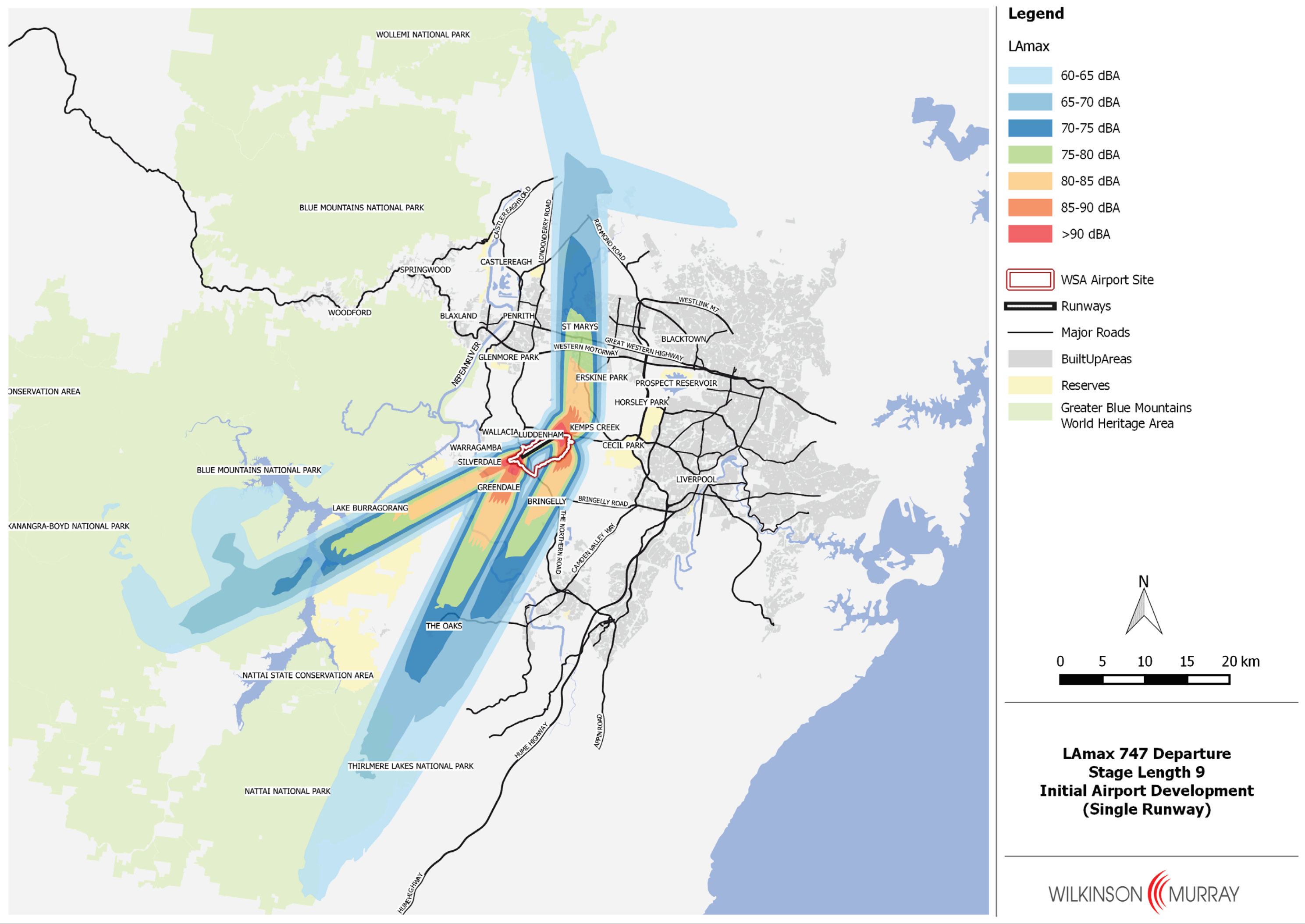
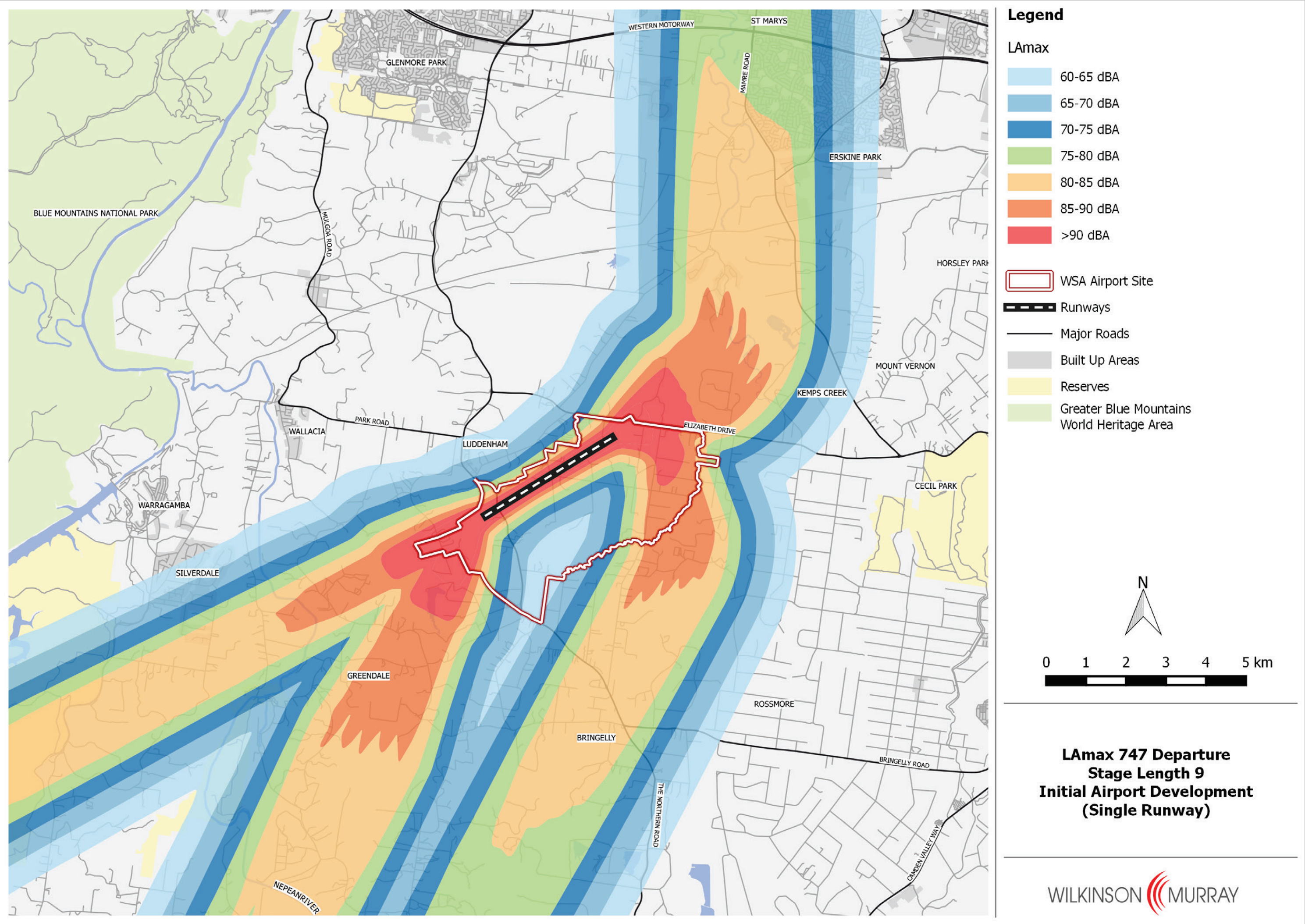


Figure 4-2 Combined Single Event B747 Departure – Stage 9 (Meso Scale)



4.3 Noise Levels Over 24 Hours

4.3.1 N70 Results

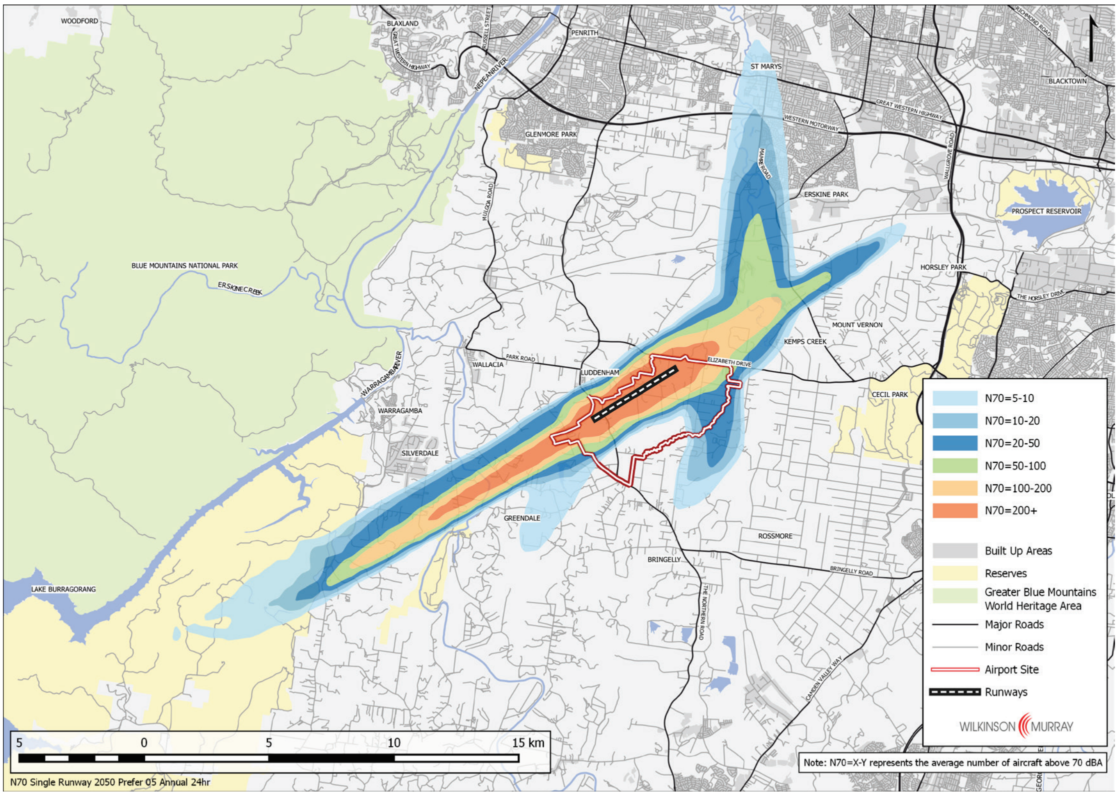
Aircraft noise impact over a full day can be described by the number of noise events exceeding 70 dBA, or N70. Calculated N70 noise contours for each of the four airport operating strategies described in Section 2.7.1, and for nominal year 2050, are presented in Figure 4-3 to Figure 4-6. These represent the predicted annual average number of movements per day with L_{Amax} noise levels exceeding 70 dBA.

Comparison with Figure 3-25 to Figure 3-28 indicates that impacts in Stage 1 are significantly lower than for year 2050. Impacts would be expected to increase gradually to the levels shown for 2050 as aircraft movements at the airport approach capacity for a single runway configuration.

As for Stage 1, there are significant differences between noise impacts from different airport operating strategies. In particular, the Prefer 05 strategy results in greater impact on residents in densely-populated areas the north-east of the airport – in 2050 there are predicted to be 5-10 events per day above 70 dBA over developed areas in St Marys, whereas in the Prefer 23 operating strategy, the impact is less than 5 events per day in all these areas. For Prefer 23, the impact is predicted to be greater in less densely populated areas to the north of Horsley Park, and also in rural residential areas around Greendale. Prefer 23 also results in somewhat greater impact in some parts of the Blue Mountains National Park and GBMWHA.

As in Stage 1, inclusion of a "Head-to-Head" mode at night makes an almost imperceptible difference to overall N70 values.

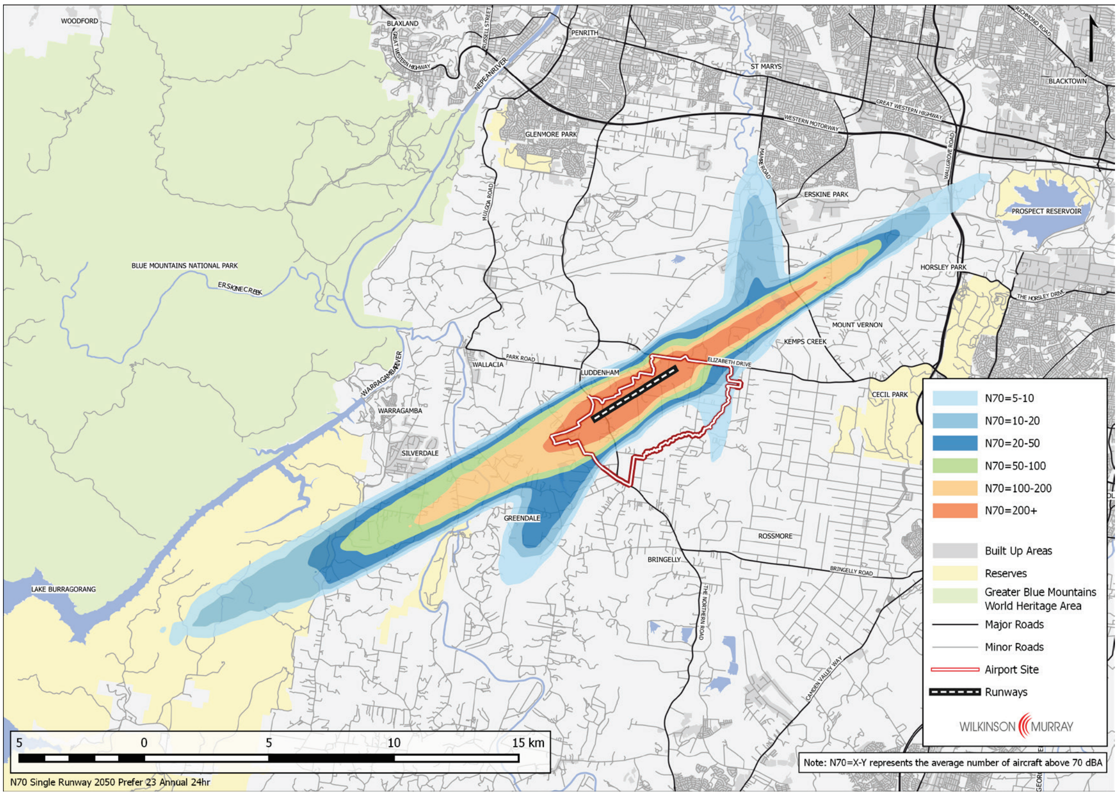
Figure 4-3 N70 Contours – 2050 – Prefer 05



N70 Single Runway 2050 Prefer 05 Annual 24hr

Note: N70=X-Y represents the average number of aircraft above 70 dBA

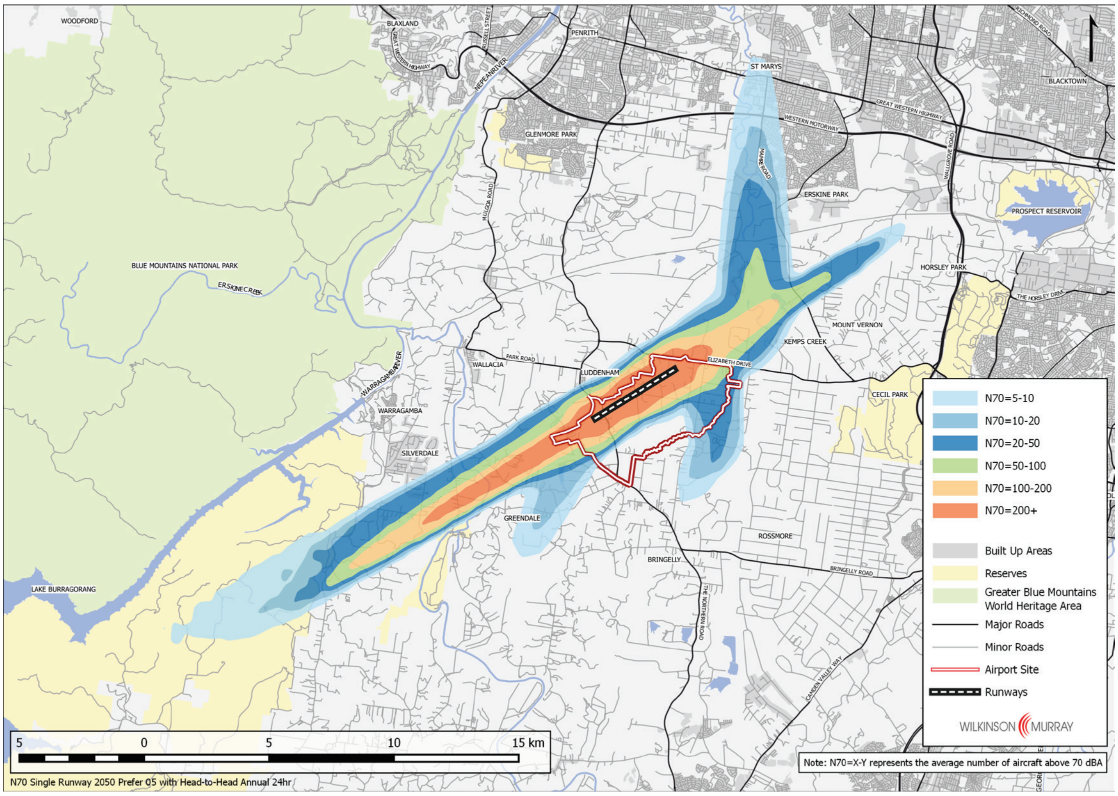
Figure 4-4 N70 Contours – 2050 – Prefer 23



N70 Single Runway 2050 Prefer 23 Annual 24hr

Note: N70=X-Y represents the average number of aircraft above 70 dBA

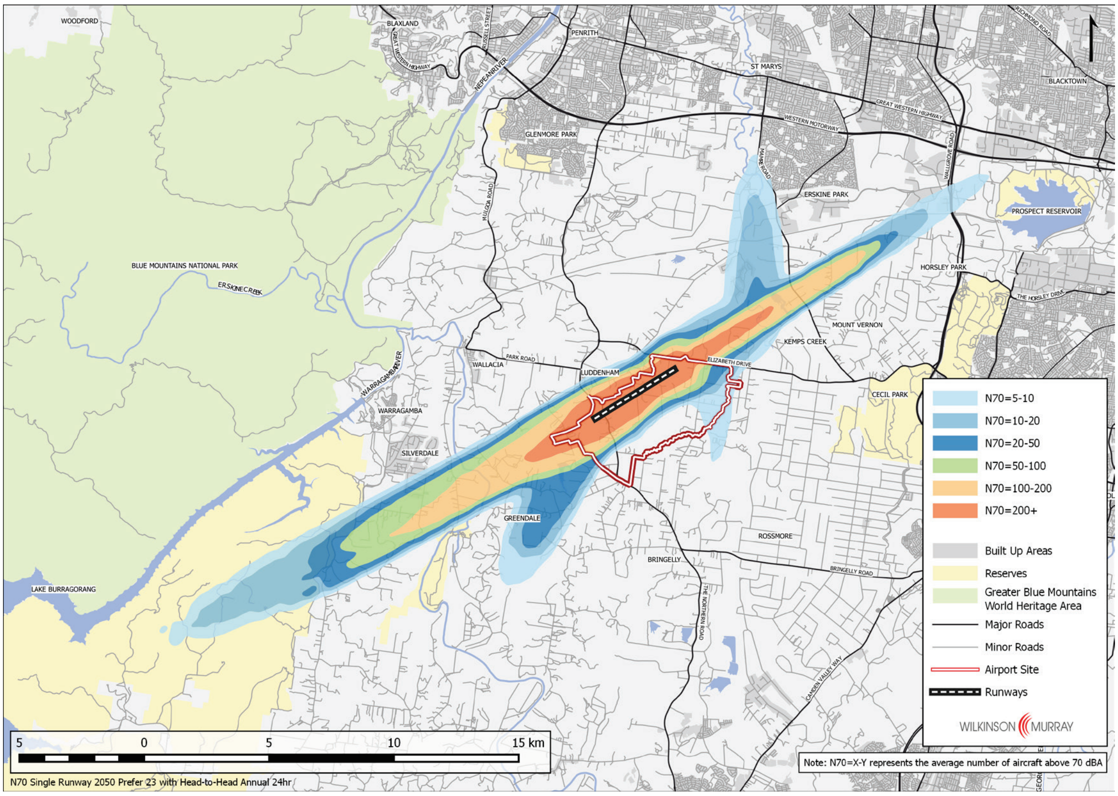
Figure 4-5 N70 Contours – 2050 – Prefer 05 with Head-to-Head



Note: N70=X-Y represents the average number of aircraft above 70 dBA

N70 Single Runway 2050 Prefer 05 with Head-to-Head Annual 24hr

Figure 4-6 N70 Contours – 2050 – Prefer 23 with Head-to-Head



Note: N70=X-Y represents the average number of aircraft above 70 dBA

N70 Single Runway 2050 Prefer 23 with Head-to-Head Annual 24hr

4.3.2 90th Percentile N70 Results

Figure 4-7 and Figure 4-8 show 90th percentile values of N70 calculated over all days – that is, the number of daily aircraft noise events over 70 dBA that would be exceeded on only 10% of days. This can be thought of as a "typical worst-case" day. Values are Prefer 05 and Prefer 23. (Head-to-Head strategies are not shown as this mode makes very little difference to the results.) The figures also show the "average day" N70 values as depicted in the figures above.

Generally, as for Stage 1, the difference between noise impact on "average" and "typical worst-case" days is not large. This is due to the relatively low and consistent wind speeds at the site, which mean that the airport's "preferred" mode of operation can be selected over 80% of the time.

The most important difference shown in these figures is for the Prefer 23 strategy. Figure 4-8 demonstrates that although established built-up areas do not experience more than five events per day over 70 dBA on an "average" day, there are areas to the south of St Marys that would do so on a "typical worst-case" day, and in fact, in these areas a "typical worst-case" day for the Prefer 23 operating strategy is similar to an "average day" for Prefer 05.

Figure 4-7 Mean and 90th Percentile N70 Contours – 2050 – Prefer 05

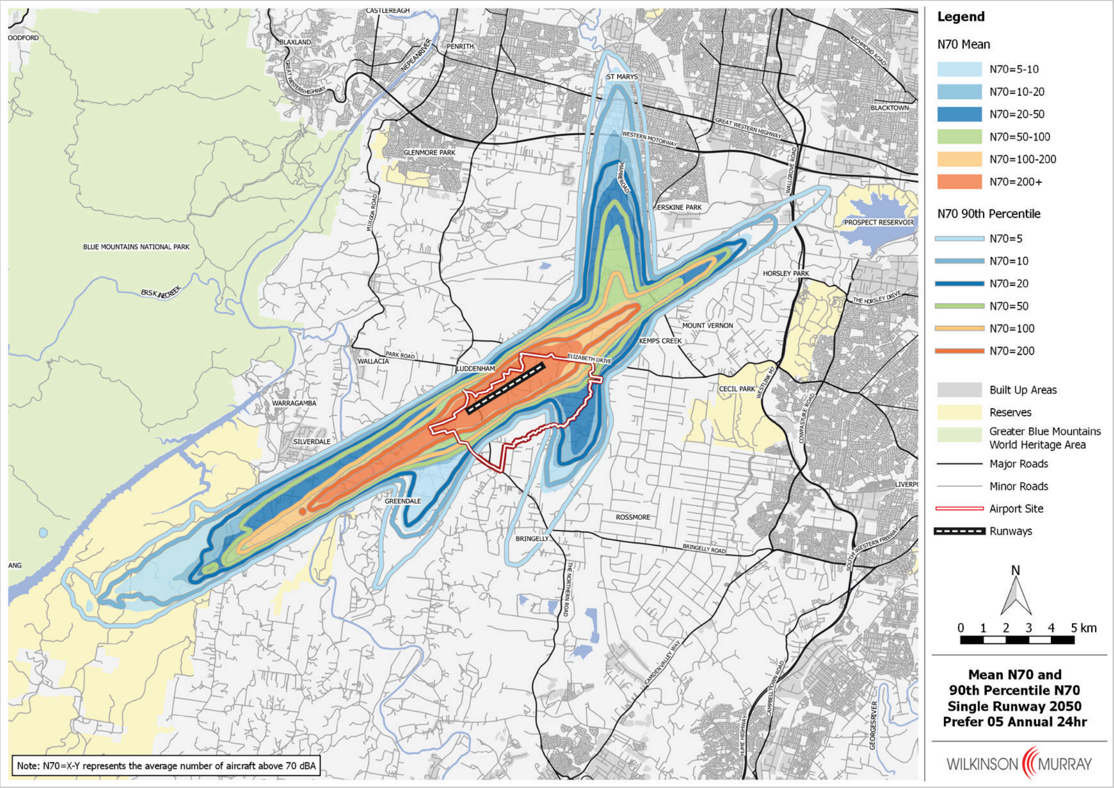
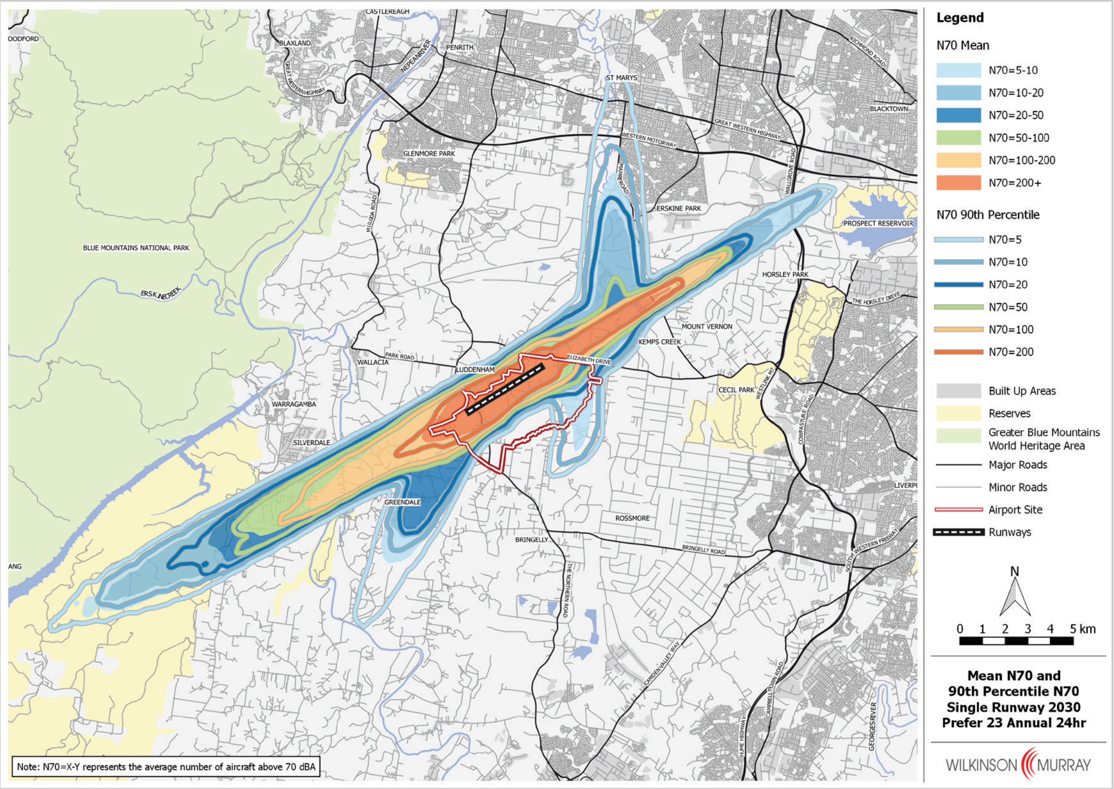


Figure 4-8 Mean and 90th Percentile N70 Contours – 2050 – Prefer 23



4.3.3 Population Exposure Estimates

The future population experiencing various levels of daytime noise impact has been estimated using procedures described in Section 2.9. Results for an "annual average day" are shown in Table 4-1.

Table 4-1 Estimated Population within N70 Contours – 2050; 2050 Population

N70	Operating Strategy			
	Prefer 05	Prefer 23	Prefer 05 + H_2H*	Prefer 23 + H_2H*
5-10	20,193	2,232	17,358	2,262
10-20	7,101	1,024	5,425	992
20-50	1,448	636	1,392	649
50-100	767	590	685	594
100-200	265	662	228	665
>200	139	145	180	141
Total	*29,913*	*5,289*	*25,268*	*5,303*

Note: * H2H = "Head-to-Head"

Compared with Stage 1, in 2050 noise impacts at the lower levels have spread into areas of greater residential development. With the Prefer 05 operating strategy, this results in approximately 30,000 people being exposed to at least five noise events per day above 70 dBA, compared with 1,600 in Stage 1. In Prefer 23, this number is predicted to be dramatically lower at approximately 5,000 people. However, it is notable that Prefer 23 still results in greater impact at higher noise levels – generally in rural residential areas to the south and west of the airport.

4.4 Night Time Noise

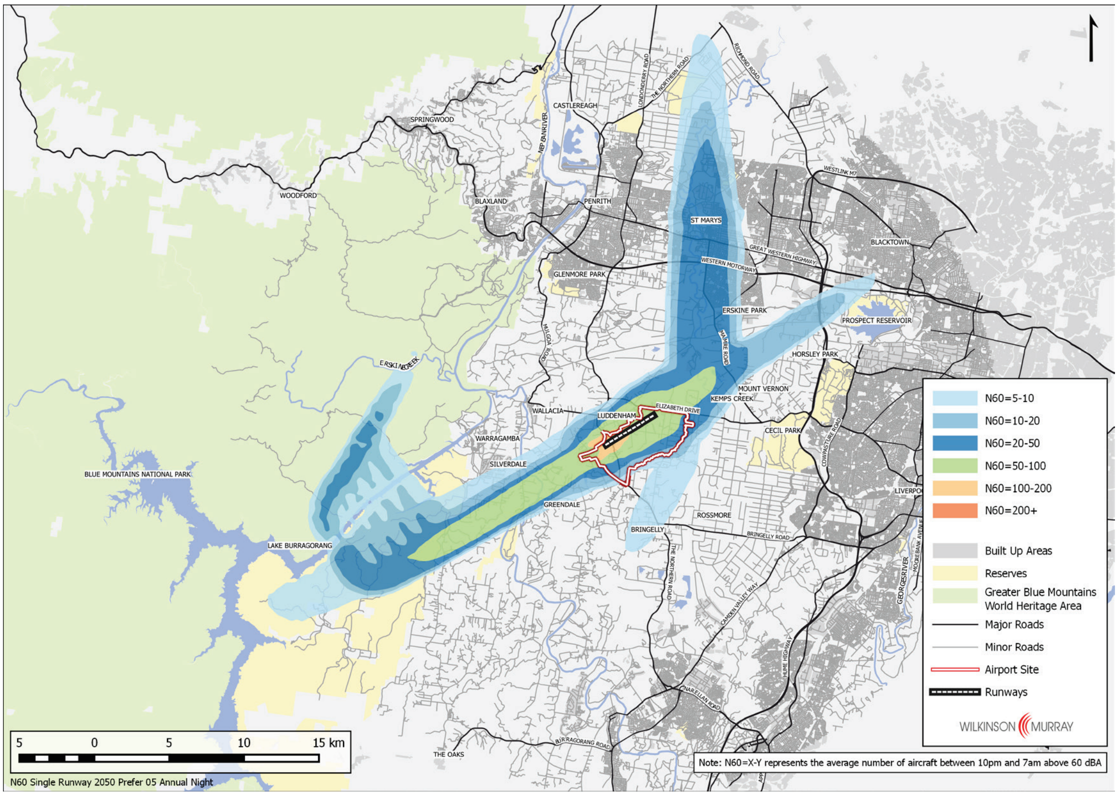
4.4.1 N60 Results

Figure 4-9 to Figure 4-12 show the predicted number of noise events per night (10pm-7am) exceeding 60 dBA for the four operating strategies considered, for the assessment year 2050. Calculations are shown down to a value of five events per night.

Once again, the difference between Prefer 05 and Prefer 23 strategies is significant, with Prefer 05 predicted to have greater impact on built-up areas around St Marys while Prefer 23 has a greater impact on rural residential areas around Greendale. By 2050, with Prefer 05, large areas with significant population density are predicted to experience over 20 noise events per night exceeding 60 dBA. With Prefer 23, large areas of residential development would also experience night time noise impact, but at a lower level of 5-10 events per night.

This night time noise impact can be mitigated by use of the "Head-to-Head" mode where available. As demonstrated in Figure 4-12, with "Prefer 23 Plus Head-to Head" this results in almost no built-up residential areas being exposed to more than five events per night above 60 dBA, even in 2050.

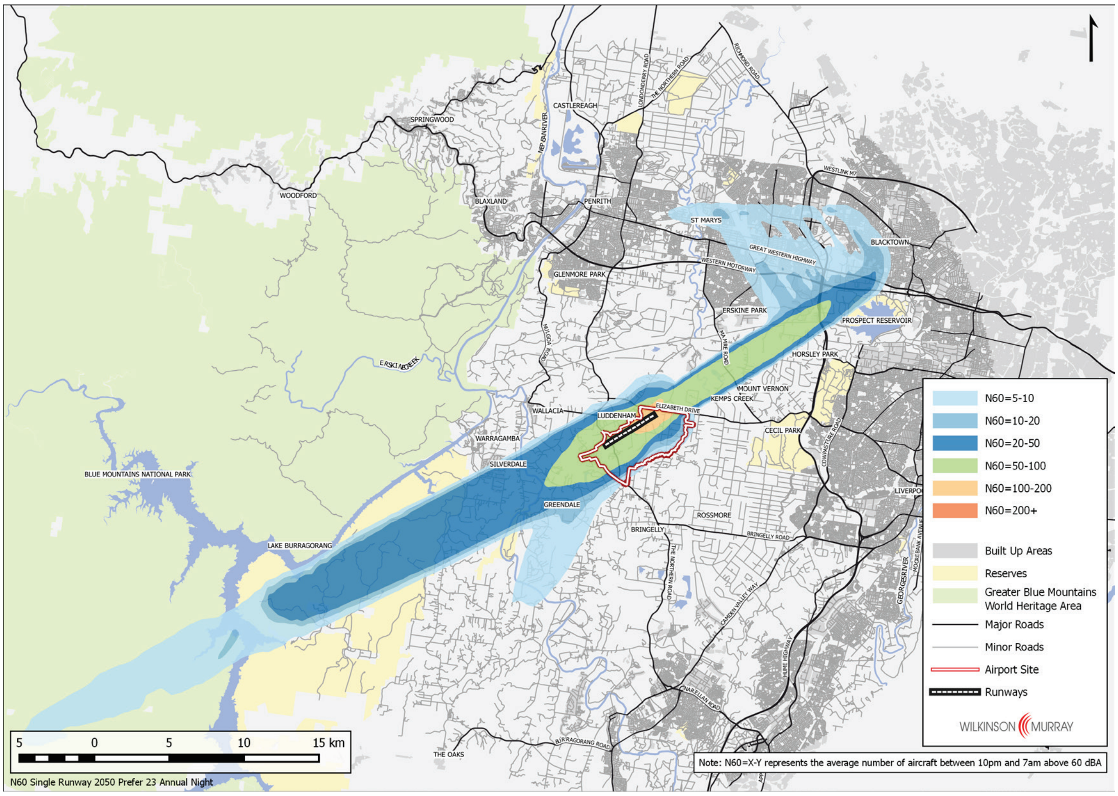
Figure 4-9 N60 Contours – 2050 – Prefer 05



Note: N60=X-Y represents the average number of aircraft between 10pm and 7am above 60 dBA

N60 Single Runway 2050 Prefer 05 Annual Night

Figure 4-10 N60 Contours – 2050 – Prefer 23



Note: N60=X-Y represents the average number of aircraft between 10pm and 7am above 60 dBA

N60 Single Runway 2050 Prefer 23 Annual Night

Figure 4-11 N60 Contours – 2050 – Prefer 05 with Head-to-Head

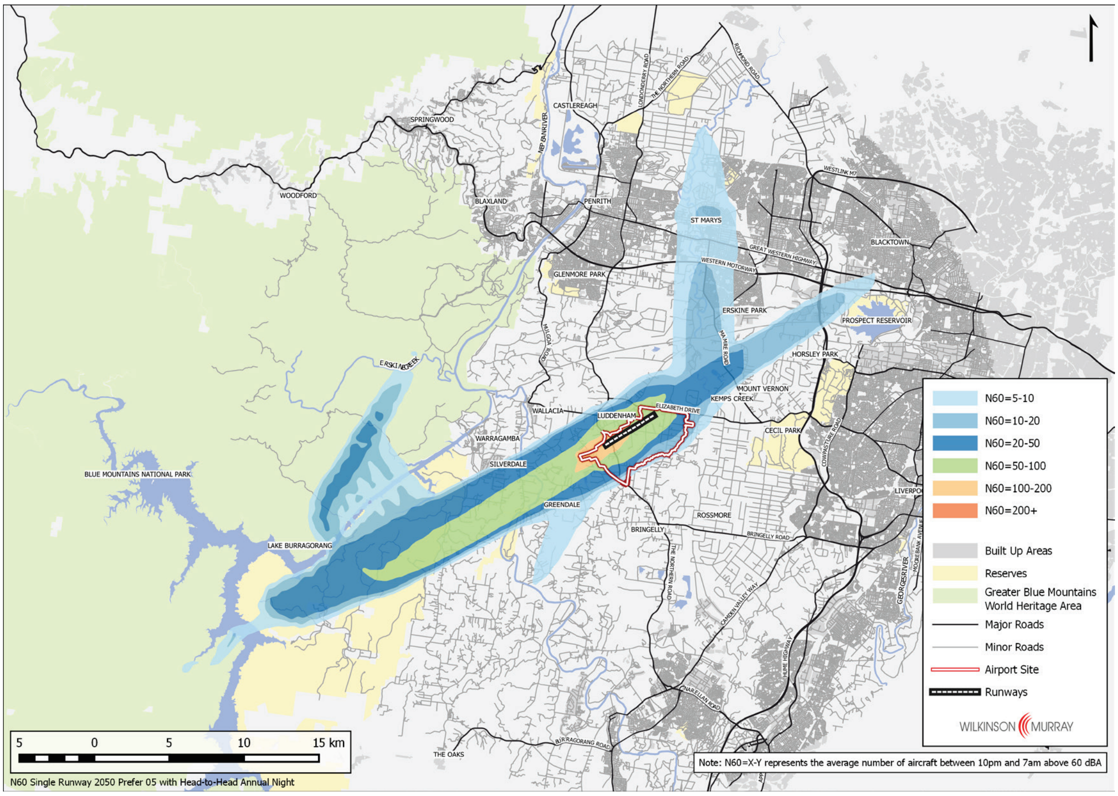
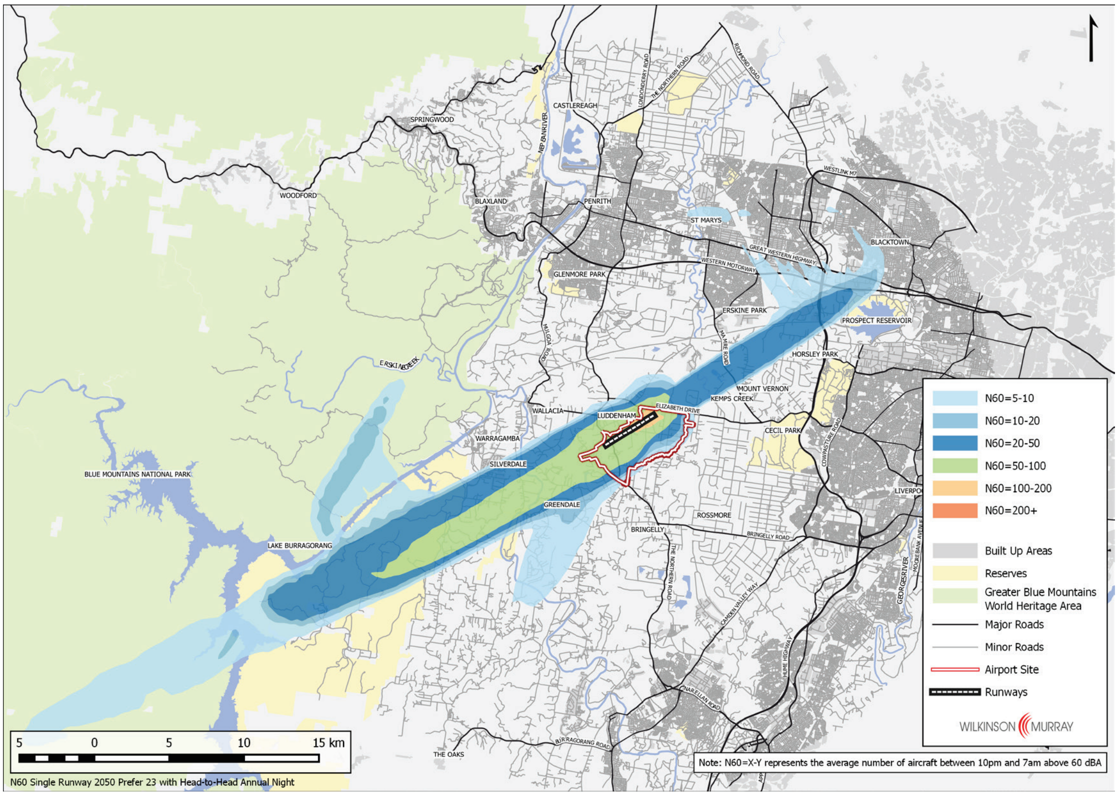


Figure 4-12 N60 Contours – 2050 – Prefer 23 with Head-to-Head

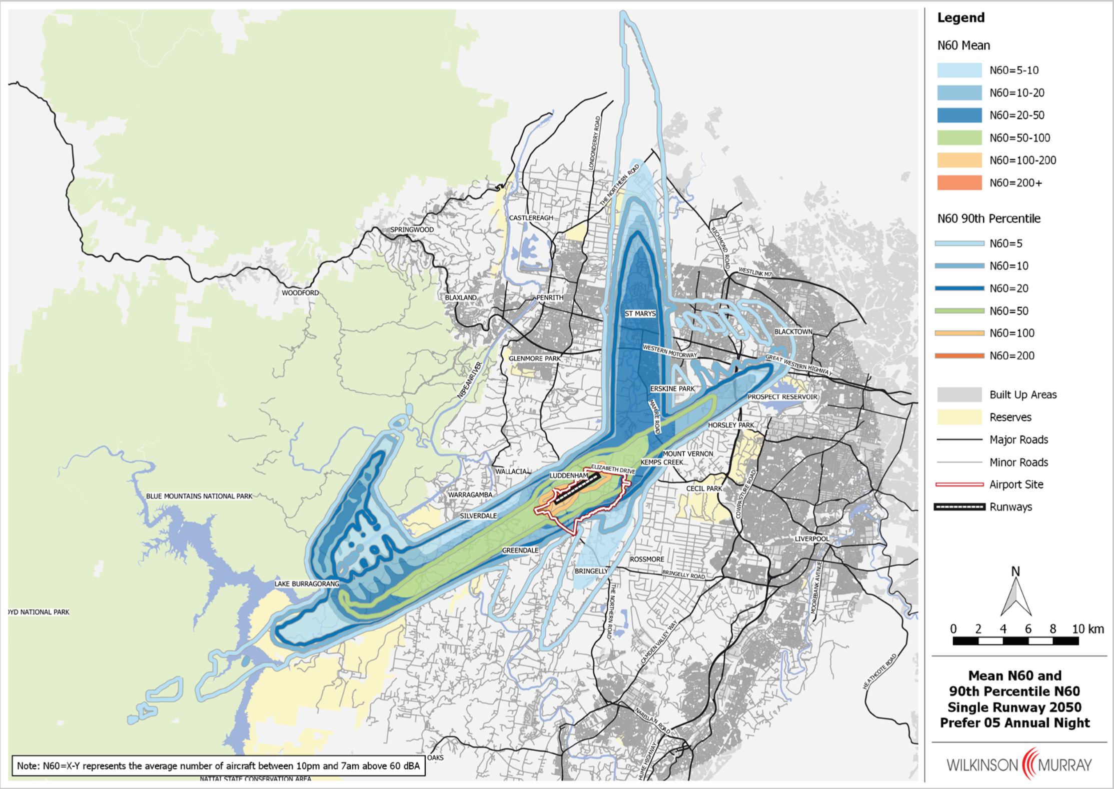


4.4.2 90th Percentile N60 Results

As for N70 values, 90th percentile night time N60 values give an indication of the number of events per night exceeding 60 dBA on a "typical worst-case" night. These are shown in Figure 4-13 to Figure 4-16.

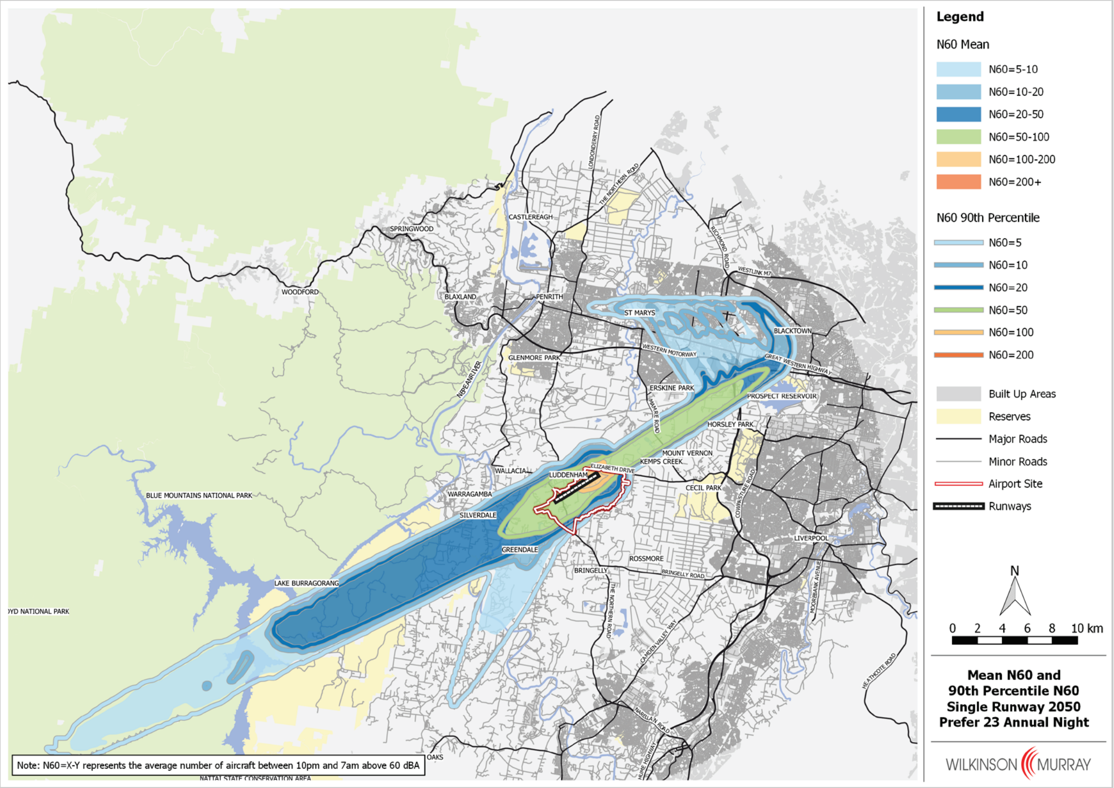
In 2050, and particularly with "Head-to-Head" mode, significant developed residential areas are predicted to be exposed to more than five events per night on a "typical worst-case" night but not on an "average" night.

Figure 4-13 Mean and 90th Percentile N60 Contours – 2050 – Prefer 05



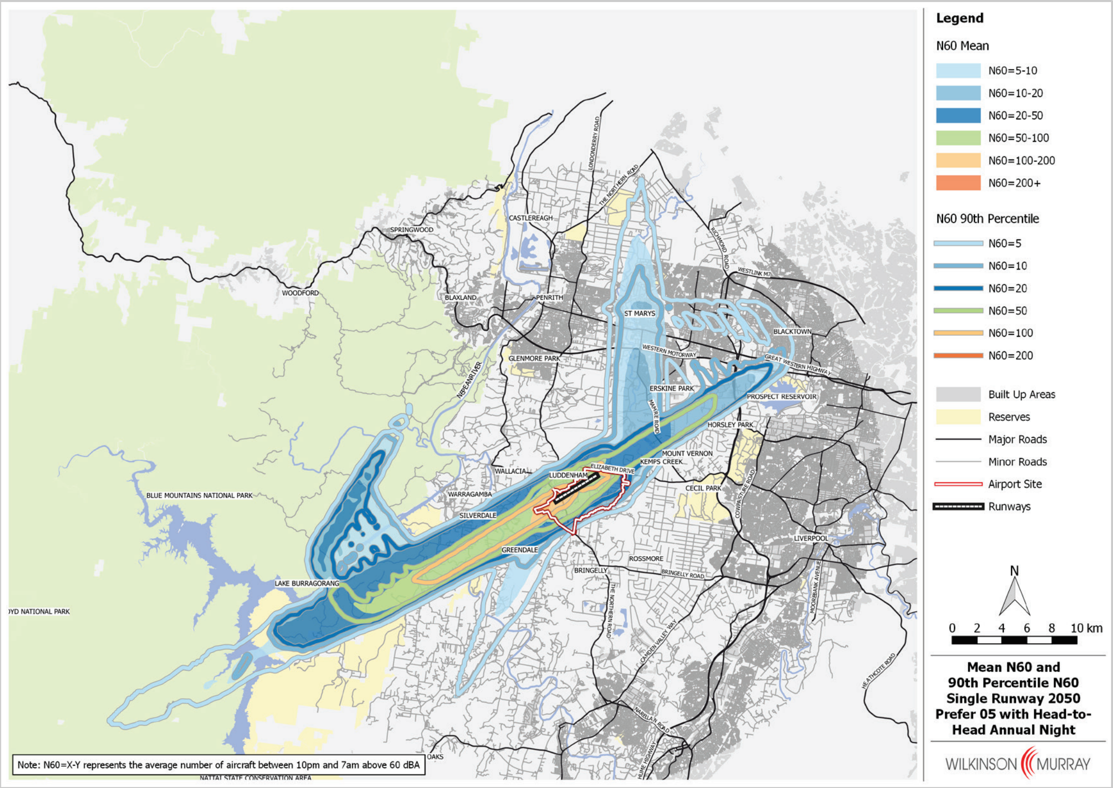
Note: N60=X-Y represents the average number of aircraft between 10pm and 7am above 60 dBA

Figure 4-14 Mean and 90th Percentile N60 Contours – 2050 – Prefer 23



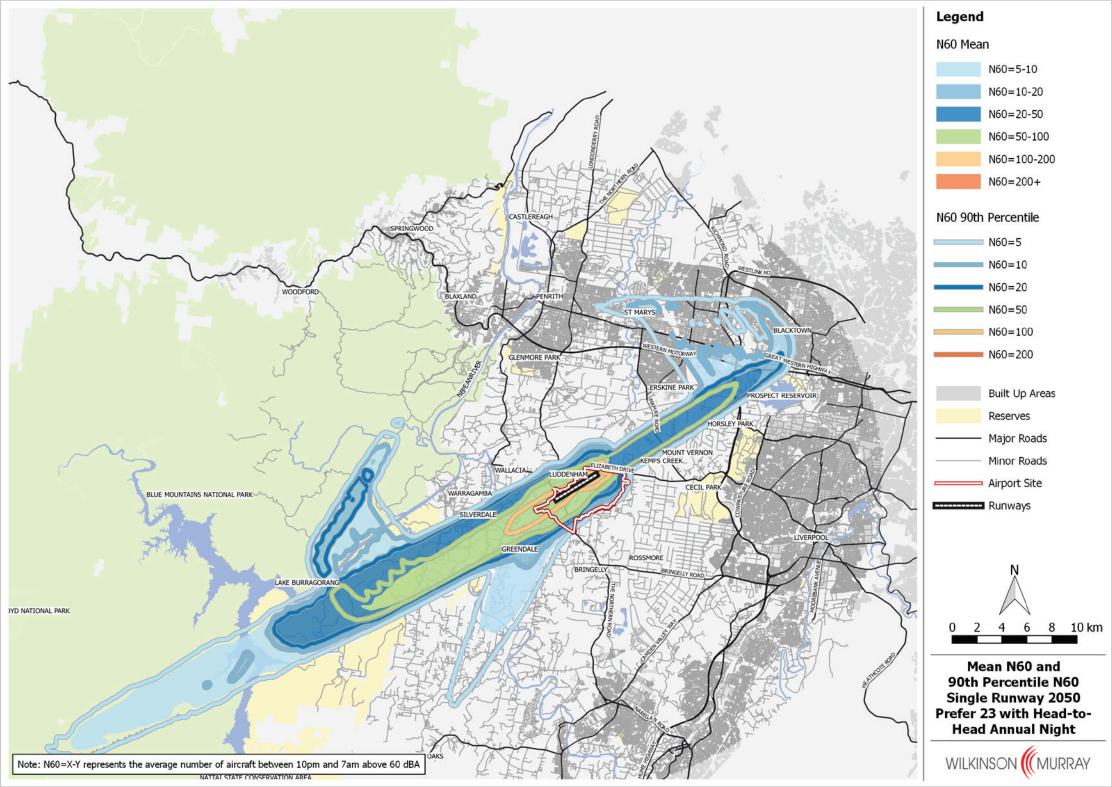
Note: N60=X-Y represents the average number of aircraft between 10pm and 7am above 60 dBA

Figure 4-15 Mean and 90th Percentile N60 Contours – 2050 – Prefer 05 with Head-to-Head



Note: N60=X-Y represents the average number of aircraft between 10pm and 7am above 60 dBA

Figure 4-16 Mean and 90th Percentile N60 Contours – 2050 – Prefer 23 with Head-to-Head



4.4.3 Population Exposure Estimates

The future population experiencing various levels of night time noise impact has been estimated using procedures described in Section 2.9. Results are shown in Table 4-2.

Table 4-2 Estimated Population within N60 Contours – 2050; 2050 Population

N60	Operating Strategy			
	Prefer 05	Prefer 23	Prefer 05 + H_2H*	Prefer 23 + H_2H*
5-10	29,128	143,827	81,187	30,560
10-20	34,552	18,211	15,513	1,987
20-50	72,138	4,953	3558	4,111
50-100	1,600	3,395	2,664	3,440
>100	13	5	144	0
Total	*137,431*	*170,391*	*103,066*	*40,098*

Note: * H2H = "Head-to-Head"

By assessment year 2050, the population experiencing night time noise impacts at some level is predicted to expand. At this stage, the use of "Prefer 23 with Head-to-Head" offers clear benefits in terms of the population exposed to night time noise.

It is also evident that predicted number of night time noise events exceeding 60 dBA over parts of the Blue Mountains National Park and GBMWHA is notably higher with "Prefer 23" and "Head-to-Head" operating scenarios. This impact is described in more detail in Section 7 of this report.

4.5 Land Use Planning Impacts

4.5.1 ANEC Contours

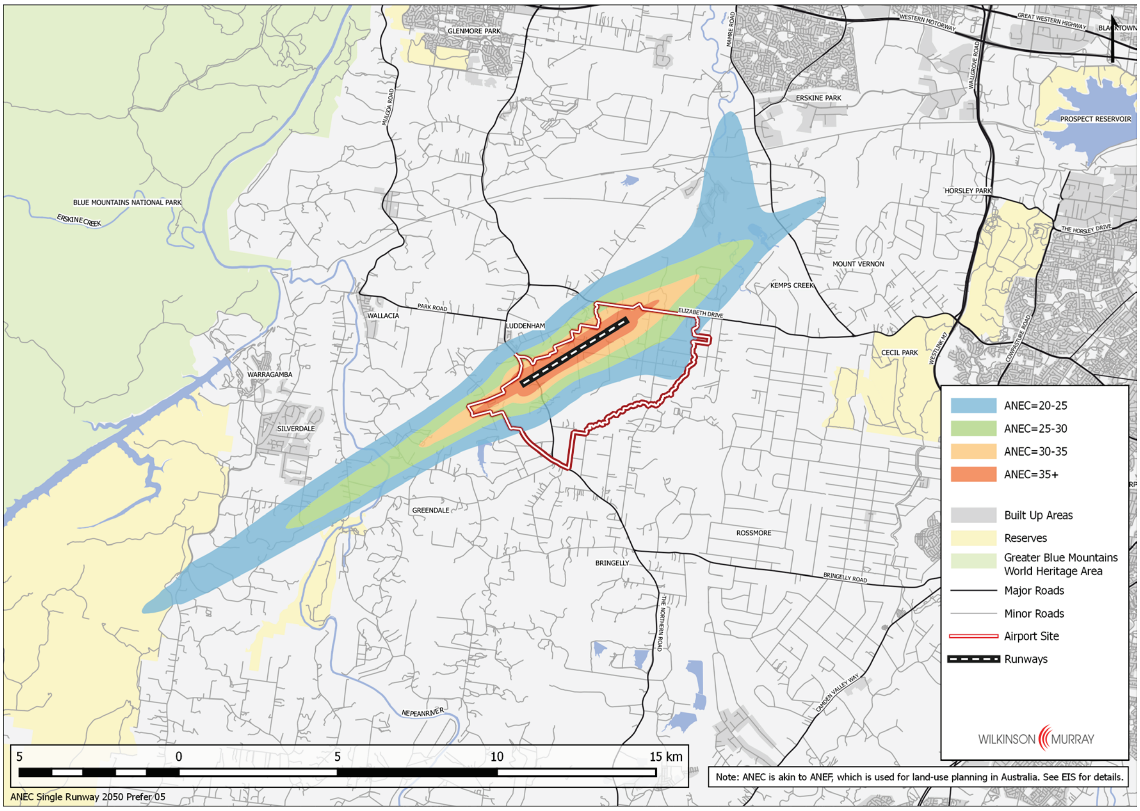
Figure 4-17 to Figure 4-20 show the ANEC contours calculated for the year 2050, for the four operating strategies considered above. Calculations are for the 2050 assessment year because these contours are more likely to be representative of noise contours to be used for planning purposes and represent aircraft overflight noise impacts when the first runway is approaching its maximum capacity.

As for N70 contours, it is notable that while there are differences between "Prefer 05" and "Prefer 23", the introduction of "Head-to-Head" operations at night does not greatly influence the contours. This is because even with a heavier weighting for night time noise events, as included in the ANEF formula, overall noise exposure is still dominated by daytime events.

The 20 ANEF contour represents the area outside which new residential development is described as "acceptable" under Australian Standard 2021. Between 20 and 25 ANEF, the Standard recommends that new residential development is "conditionally acceptable" and should incorporate acoustic insulation to meet certain maximum internal noise levels, while in areas inside the 25 ANEF contour new residential development is described as "unacceptable".

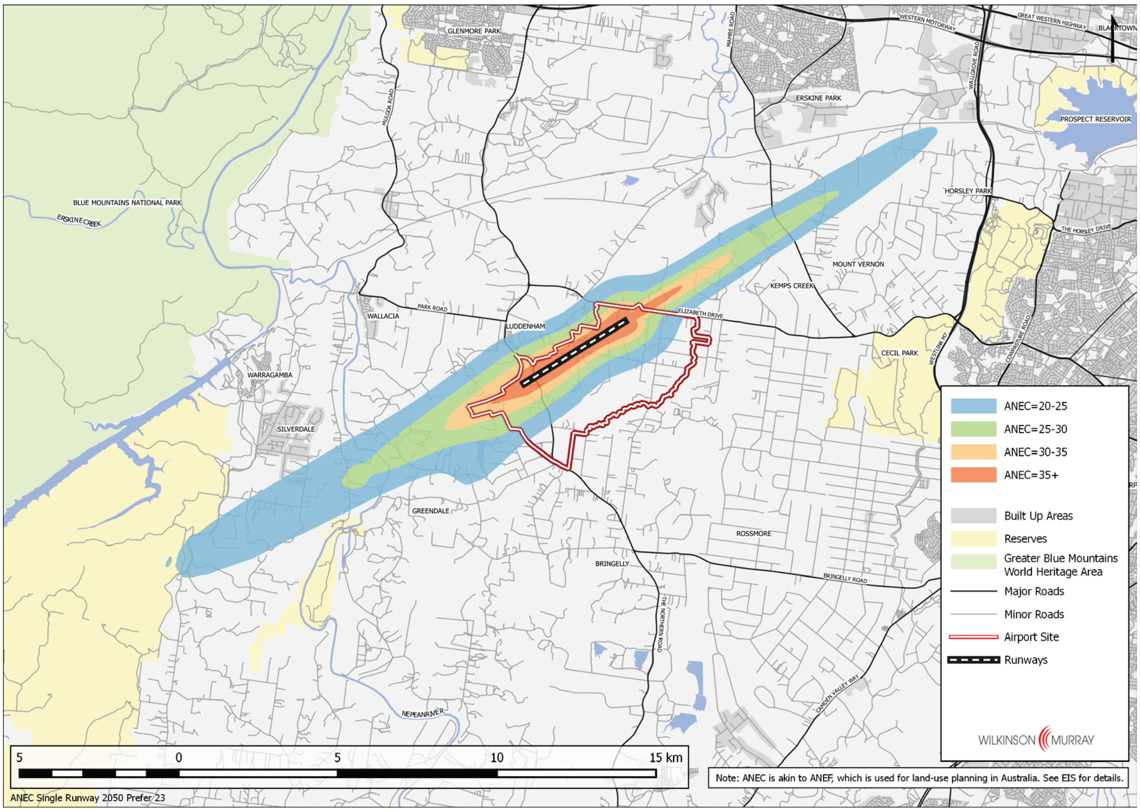
The estimated population within these contours in 2050 is shown in Table 4-3. As in Stage 1, the total population within the 20 ANEC contour is similar for all operating strategies, although the exact areas represented are slightly different.

Figure 4-17 ANEC Contours – 2050 – Prefer 05



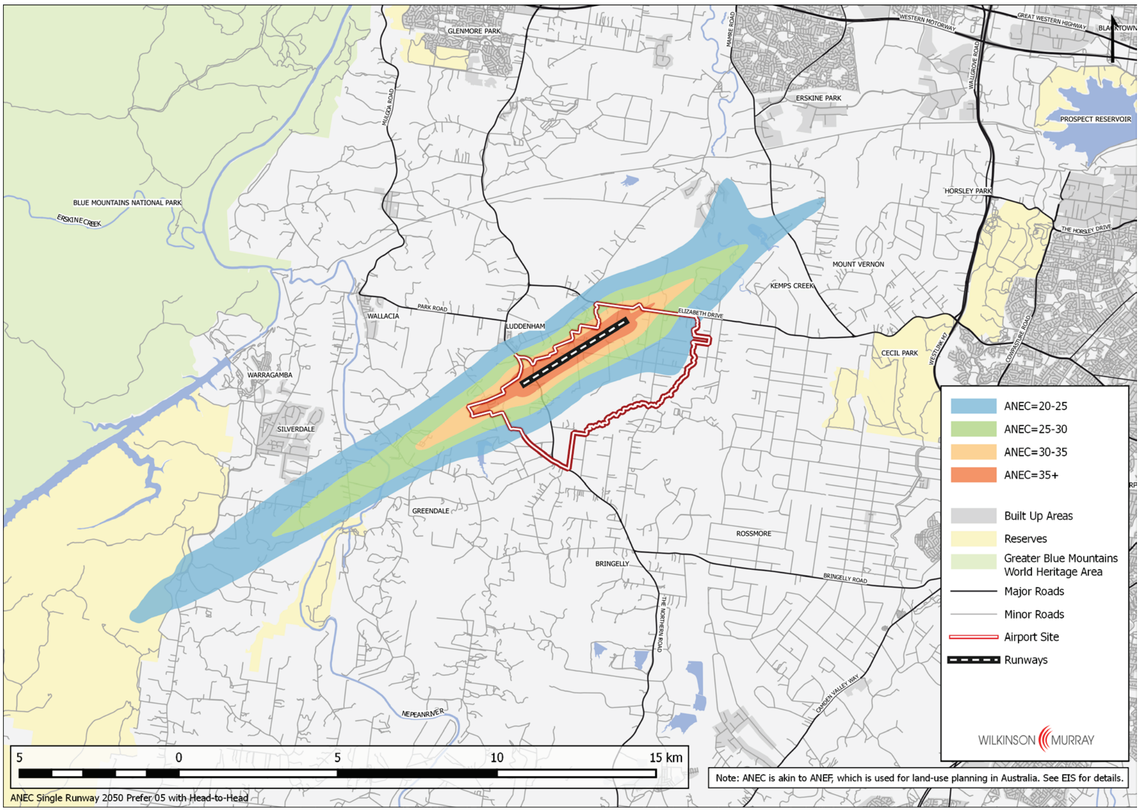
Note: ANEC is akin to ANEF, which is used for land-use planning in Australia. See EIS for details.

Figure 4-18 ANEC Contours – 2050 – Prefer 23



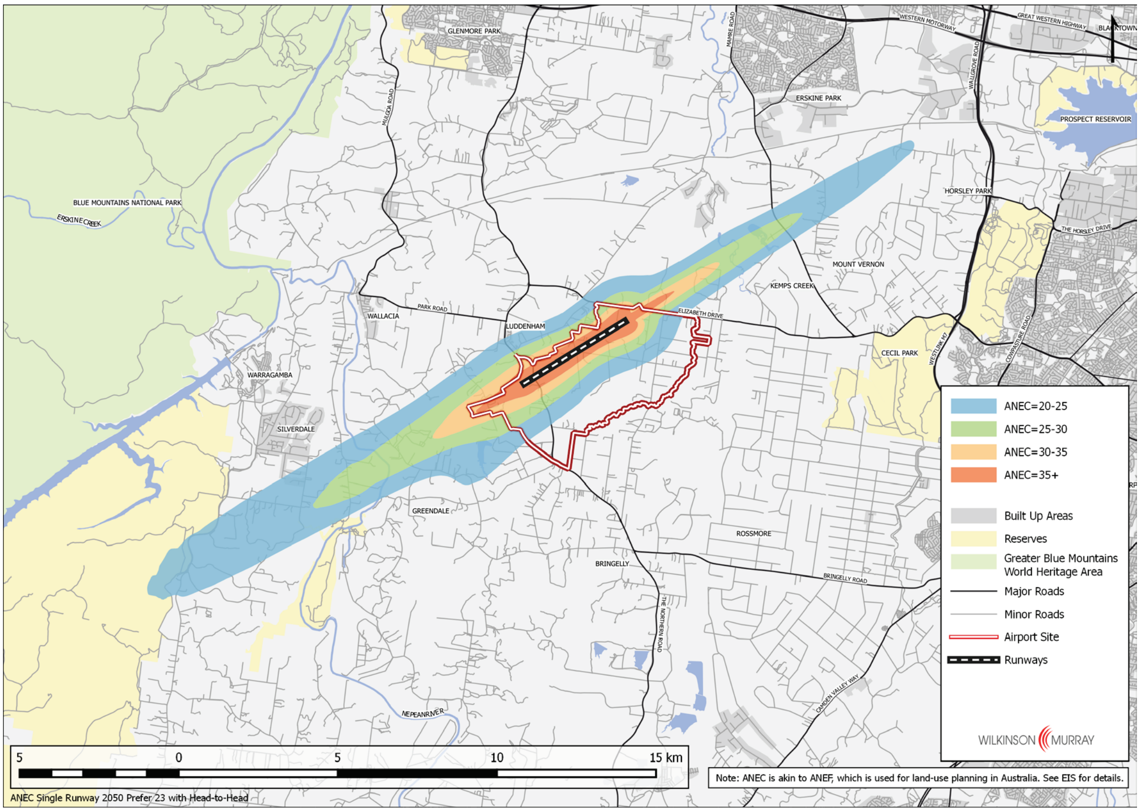
Note: ANEC is akin to ANEF, which is used for land-use planning in Australia. See EIS for details.

Figure 4-19 ANEC Contours – 2050 – Prefer 05 with Head-to-Head



Note: ANEC is akin to ANEF, which is used for land-use planning in Australia. See EIS for details.

Figure 4-20 ANEC Contours – 2050 – Prefer 23 with Head-to-Head



Note: ANEC is akin to ANEF, which is used for land-use planning in Australia. See EIS for details.

ANEC Single Runway 2050 Prefer 23 with Head-to-Head

Table 4-3 Estimated Population within ANEC Contours – 2050; 2050 Population

ANEC Band	**Operating Strategy**			
	Prefer 05	**Prefer 23**	**Prefer 05 + H_2H***	**Prefer 23 + H_2H***
20-25	1502	1645	1367	1672
25-30	295	390	353	379
30-35	34	77	38	77
>35	0	4	0	4
Total	*1831*	*2116*	*1758*	*2132*

Note: * H2H = "Head-to-Head"

4.6 Aircraft Noise Levels in Recreational Areas

The Blue Mountains National Park and GBMWHA is an area used for recreational purposes that is located some distance from the proposed airport. The impact of aircraft overflights in these areas is considered in Section 7 of this report.

As noted in Section 3.7, a number of smaller recreational areas, located closer to the proposed airport, have been identified within the area potentially affected by aircraft overflight noise. These range from sports areas used for activities, such as horse riding, bowling or golf to nature reserves which may be used for more passive pursuits, including camping.

Table 4-4 and Table 4-5 show the identified recreation areas, and the predicted values of N70 and N60 for the Prefer 05 and Prefer 23 operating strategies. The values shown are for the period 7am – 6pm, representing the times when these areas would most likely be used.

Table 4-4 Average Number of Daily Noise Events with L_{Amax} Exceeding 70 dBA (N70) at Recreational Receivers

Recreational Receiver	2050	
	Prefer 05	Prefer 23
Bents Basin State Conservation Reserve & Gulguer Nature Reserve	0	0
Kemps Creek Nature Reserve	0	0
Rossmore Grange	0	0
Horsley Park Reserve	0	0
Twin Creeks Golf & Country Club	28	11
Sydney International Equestrian Centre	0	0
Whalan Reserve, St Marys	0	0

Table 4-5 Average Number of Daily Noise Events with L_{Amax} Exceeding 60 dBA (N60) at Recreational Receivers

Recreational Receiver	2050	
	Prefer 05	Prefer 23
Bents Basin State Conservation Reserve & Gulguer Nature Reserve	24	49
Kemps Creek Nature Reserve	0	0
Rossmore Grange	11	2
Horsley Park Reserve	0	0
Twin Creeks Golf & Country Club	78	27
Sydney International Equestrian Centre	0	0
Whalan Reserve, St Marys	4	10

A review of the results presented in Table 4-4 and Table 4-5 indicates the following:

- Most of the identified recreational receivers would not be subjected to aircraft overflight noise events with maximum levels exceeding 70 dBA – or their exposure would be significantly less than 1 event per day on average.

- **Twin Creeks Golf & Country Club** – Flyover noise levels from aircraft at this location would be noticeable out of doors and at times a raised voice effort would be required for effective communication. However it is noted that the sensitivity of receivers at this location would likely to be lower due to the active use of the area.

- **Bents Basin State Conservation Reserve & Gulguer Nature Reserve** are predicted to be subject to a number of flyover event noise levels exceeding 60 dBA, which would be noticeable to passive users of these areas. Bents Basin State Conservation Reserve is used for camping, and would be subject to less than five night time noise events exceeding 60 dBA.

- At Twin Creeks Golf & Country Club, noise exposure are predicted to be significantly reduced under a Prefer 23 operating strategy. However, at Bents Basin State Conservation Reserve noise exposure would be lower under a Prefer 05 operating strategy.

5 ASSESSMENT OF LONG TERM AIRPORT DEVELOPMENT

5.1 Development Overview

The long term development of the proposed Western Sydney Airport could involve construction and operation of a second runway which would be the subject of a separate future environmental impact assessment. However, a preliminary assessment of noise impacts from this development has been included in this report to provide an indication of potential future noise impacts. These predicted impacts are based on operational projections, best estimates of likely flight path configurations, and conservative assumptions regarding noise emission from future aircraft.

As noted in Section 2.6, the tracks and procedures to be used by aircraft using the proposed airport (either for the single runway or the long term two runway configuration) are indicative and are required to undergo further detailed consideration before being finalised. Acknowledgement of this uncertainty is particularly important in the case of the long term development. Other sources of uncertainty in this scenario are noise emission levels from future aircraft types, and the role and pattern of movements at a dual runway airport.

As noted in Section 2.7.2, in the long term scenario, a number of alternative airport operating modes may be available under conditions of low traffic volume, and these may result in reduced noise impacts. However, at the time of production of this report, it was not possible to accurately ascertain which modes would be possible at a time so far into the future, and their capacities. Hence, in this section of the assessment, only the two basic operating modes – 05 and 23 – are considered, with corresponding operating strategies Prefer 05 and Prefer 23.

Nevertheless, this section provides a strategic indication of potential noise impacts that may assist in developing land use and other long-term plans for surrounding areas.

Figure 5-1 to Figure 5-10 show composite, single-event L_{Amax} noise level contours for departures and approaches by B747 and A320 aircraft, based on nominal flight tracks for the indicative long term airport development.

Comparison of Figure 4-1 with Figure 5-1 indicates that although the aircraft types are exactly the same in the two cases, noise events would be experienced over a wider area due to the additional flight tracks that are proposed (refer Appendix A and B). In particular, a B747 aircraft (or a future type with equivalent noise emission) operating on certain departure tracks would result in noise levels exceeding 60 dBA over a larger area of the Blue Mountains National Park, and in some areas, the maximum noise level would exceed 70 dBA.

Maximum noise levels from other operations would affect similar numbers of residents compared to the proposed initial development, but the pattern of exposure would be different. Large numbers of residents would be newly exposed to noise levels exceeding 60 dBA, and some, notably in Silverdale, would be newly exposed to noise events over 70 dBA from A320 departures.

Figure 5-1 Combined Single Event B747 Departure Long Term Assessment Scenario – Stage 9 (Macro Scale)

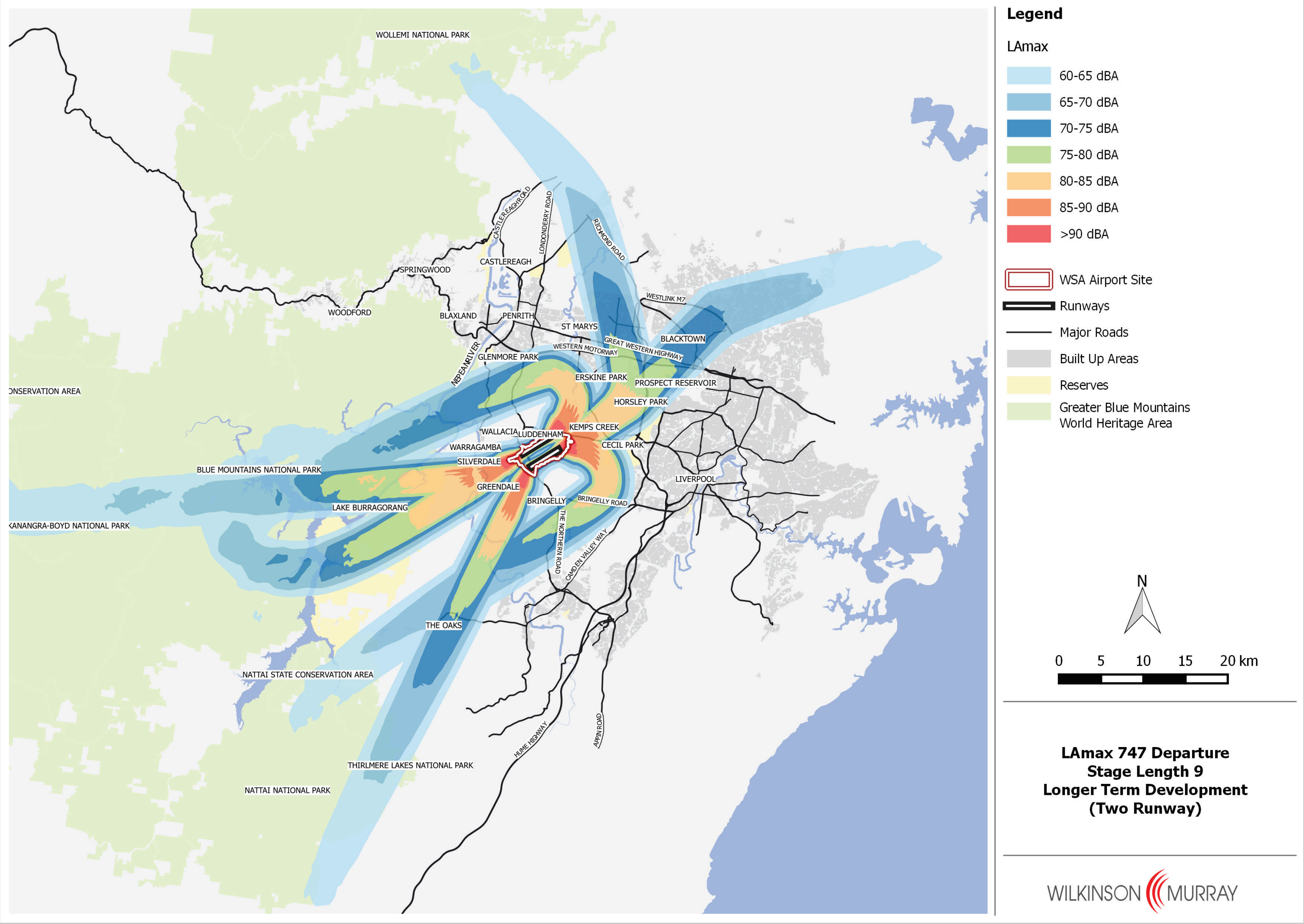


Figure 5-2 Combined Single Event B747 Departure Long Term Assessment Scenario – Stage 9 (Meso Scale)

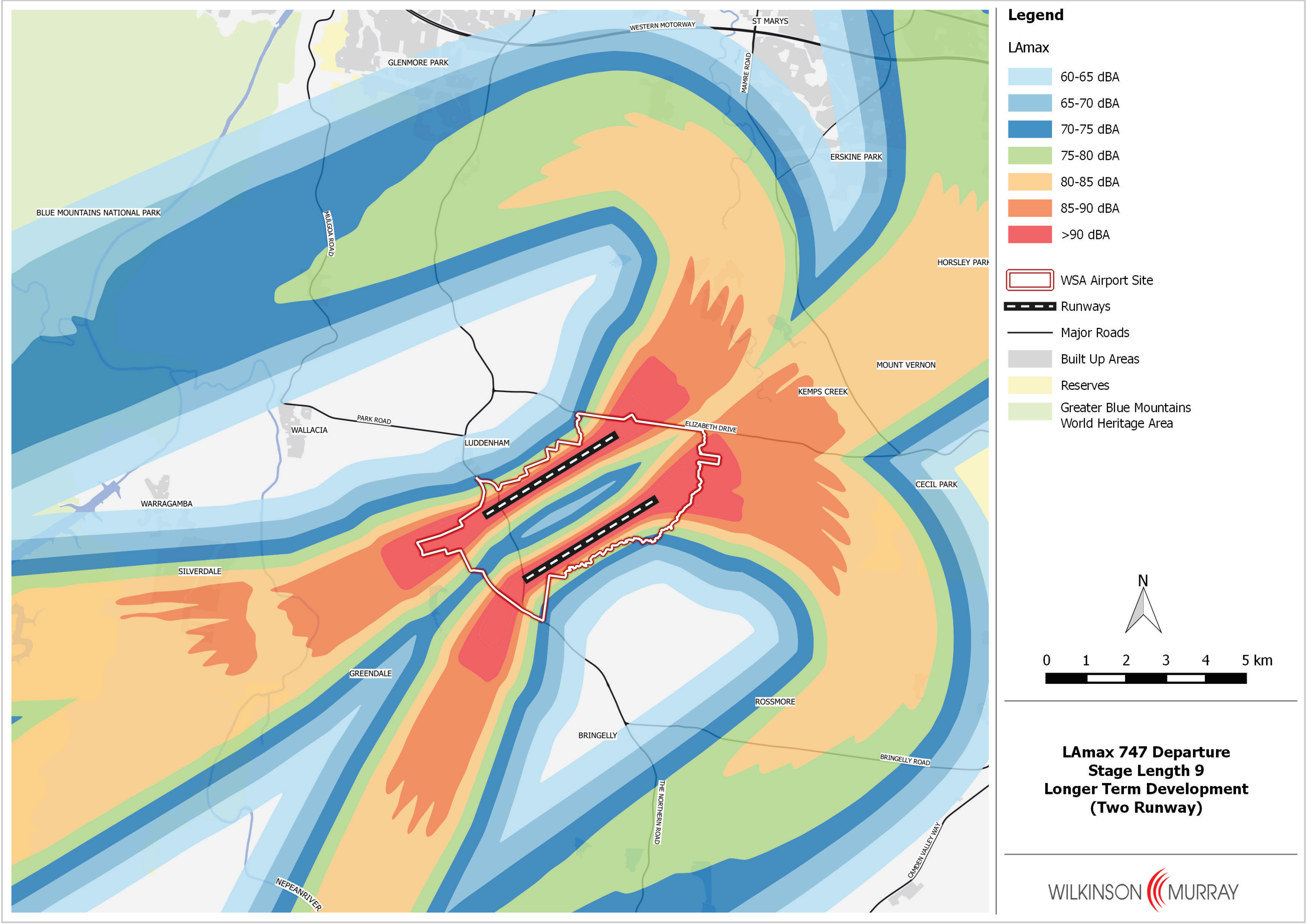


Figure 5-3 Combined Single Event B747 Arrival – Long Term Assessment Scenario (Macro Scale)

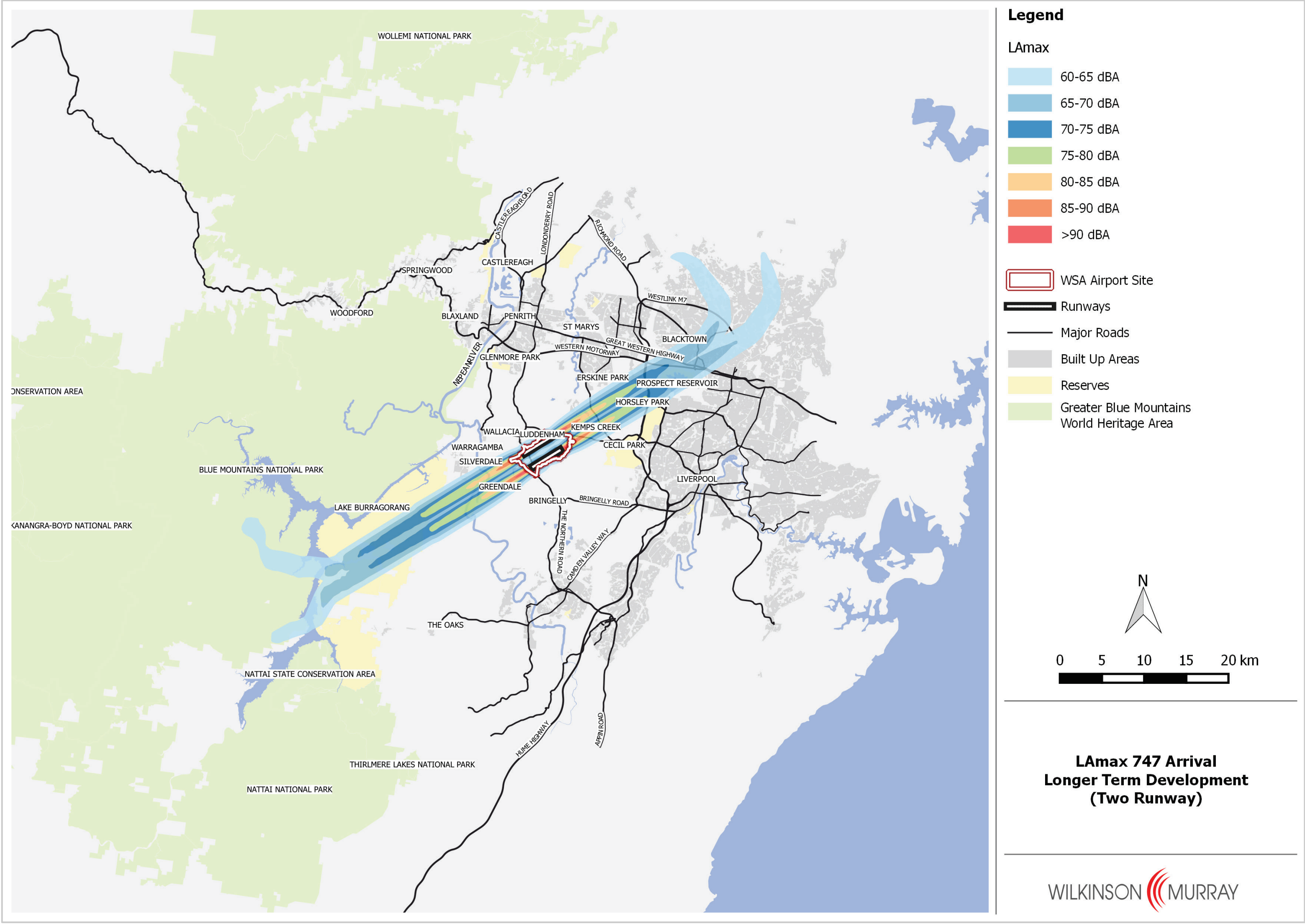


Figure 5-4 Combined Single Event B747 Arrival – Long Term Assessment Scenario (Meso Scale)

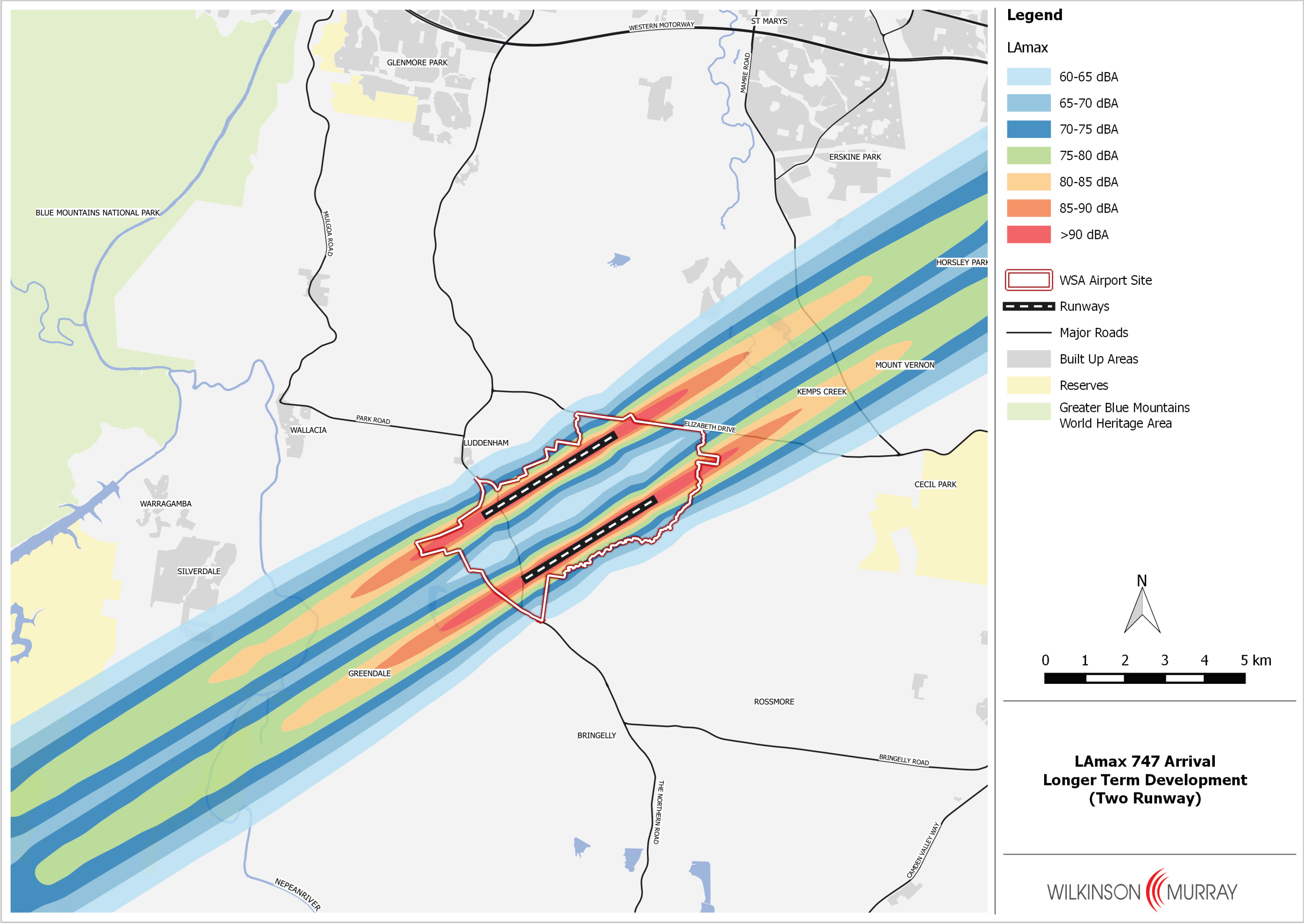


Figure 5-5 Combined Single Event A320 Departure – Stage 4 – Long Term Assessment Scenario (Macro Scale)

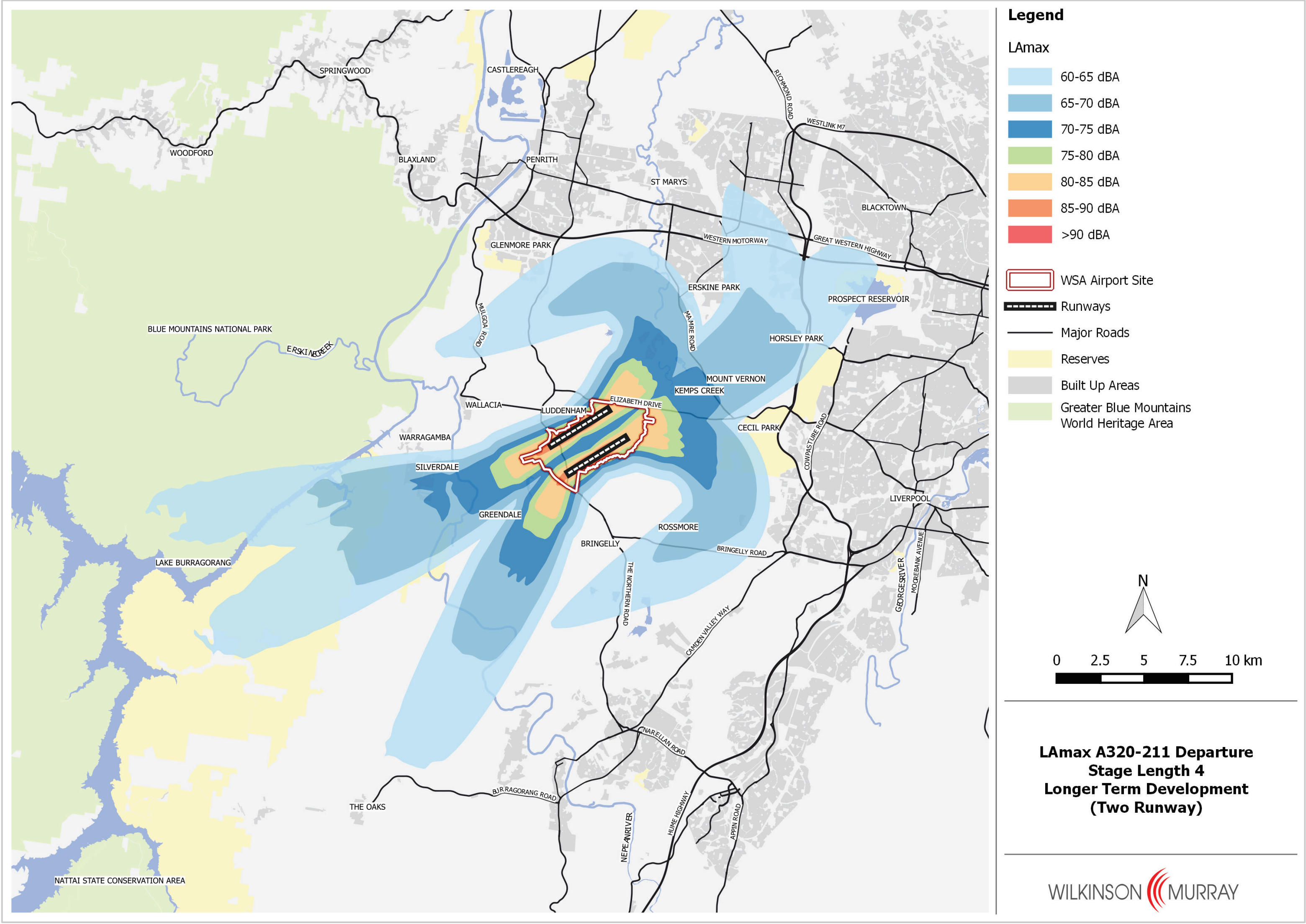


Figure 5-6 Combined Single Event A320 Departure – Stage 4 – Long Term Assessment Scenario (Meso Scale)

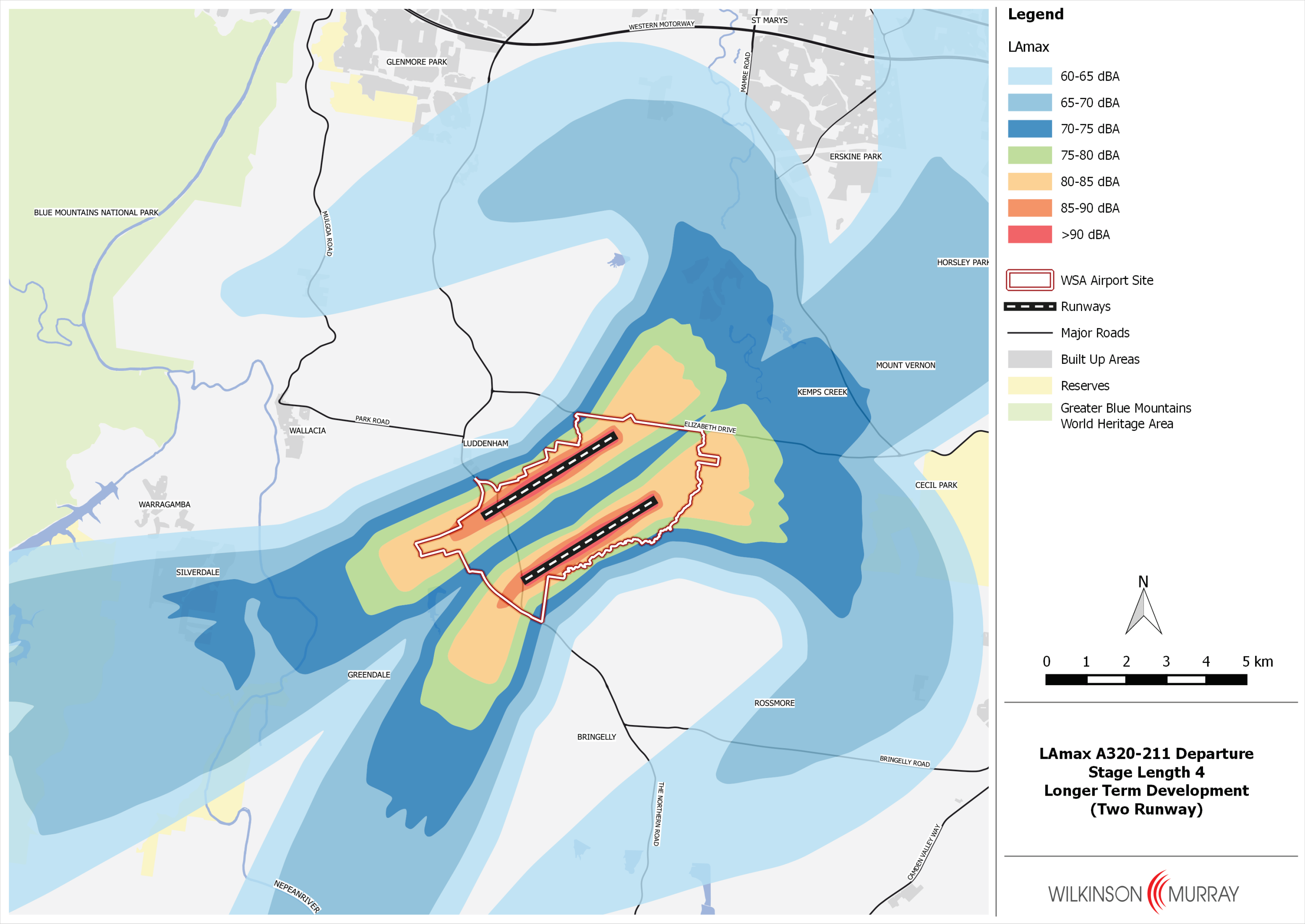


Figure 5-7 Combined Single Event A320 Departure – Stage 1 – Long Term Assessment Scenario (Macro Scale)

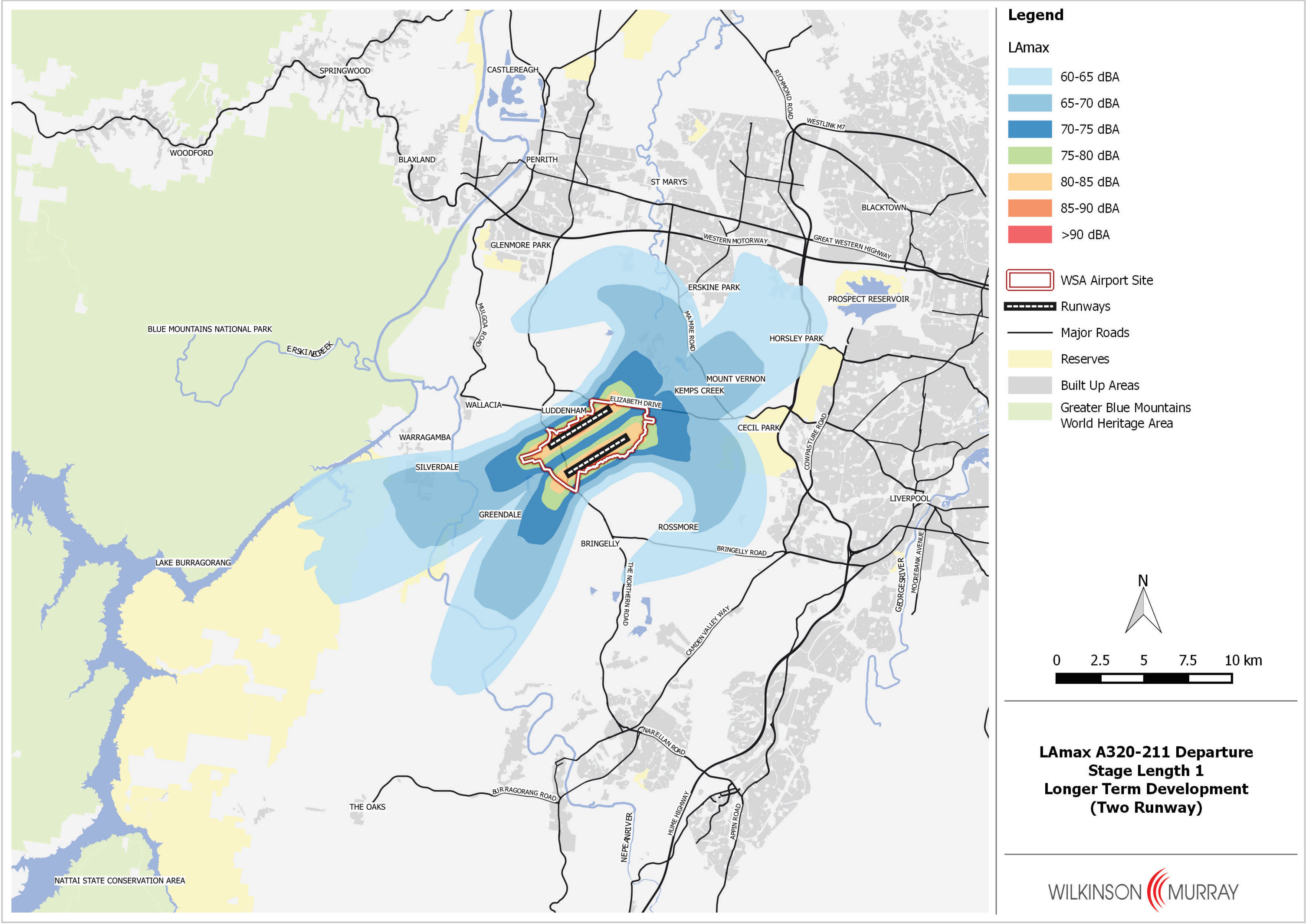


Figure 5-8 Combined Single Event A320 Departure – Stage 1 – Long Term Assessment Scenario (Meso Scale)

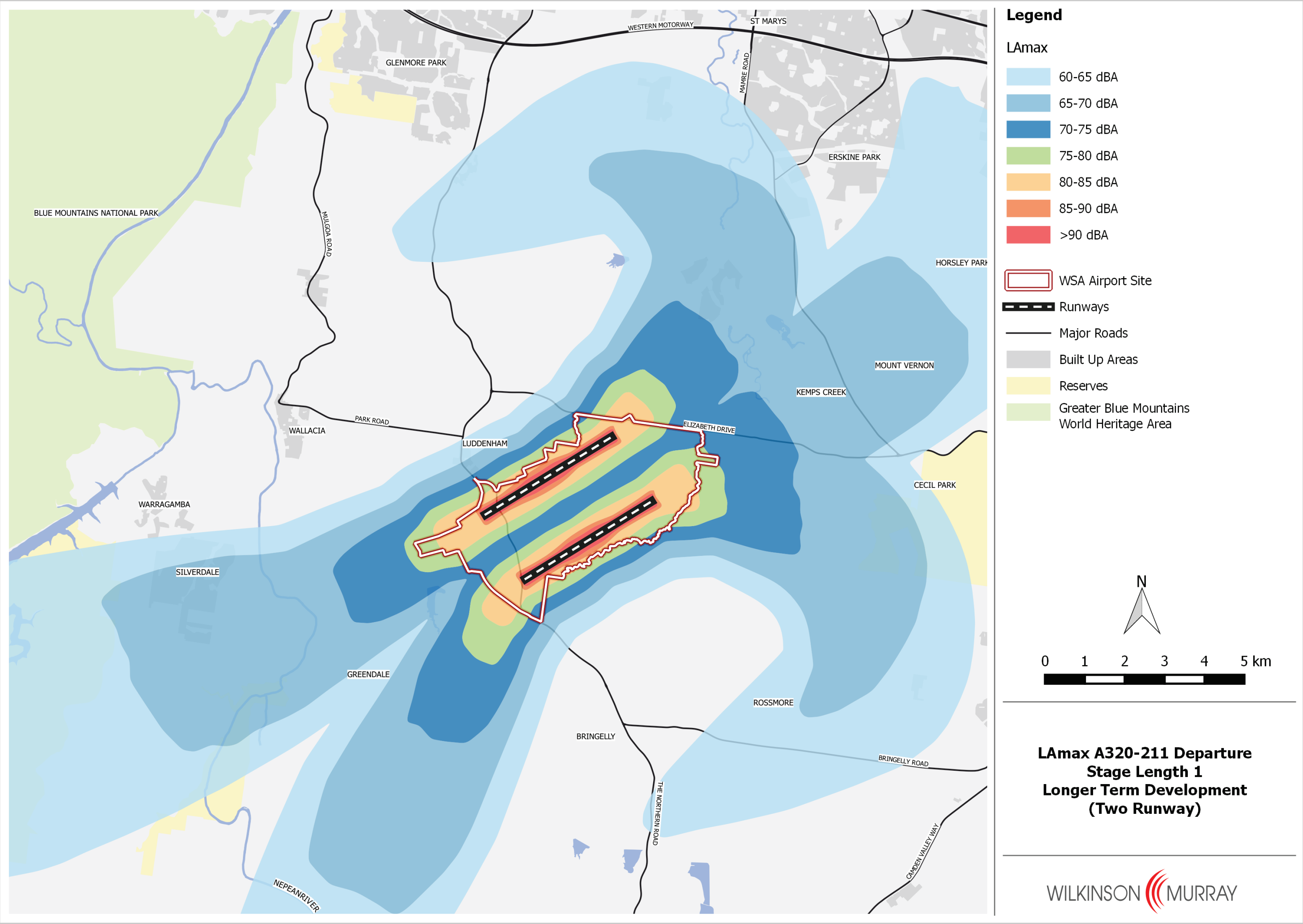


Figure 5-9 **Combined Single Event A320 Arrival – Long Term Assessment Scenario (Macro Scale)**

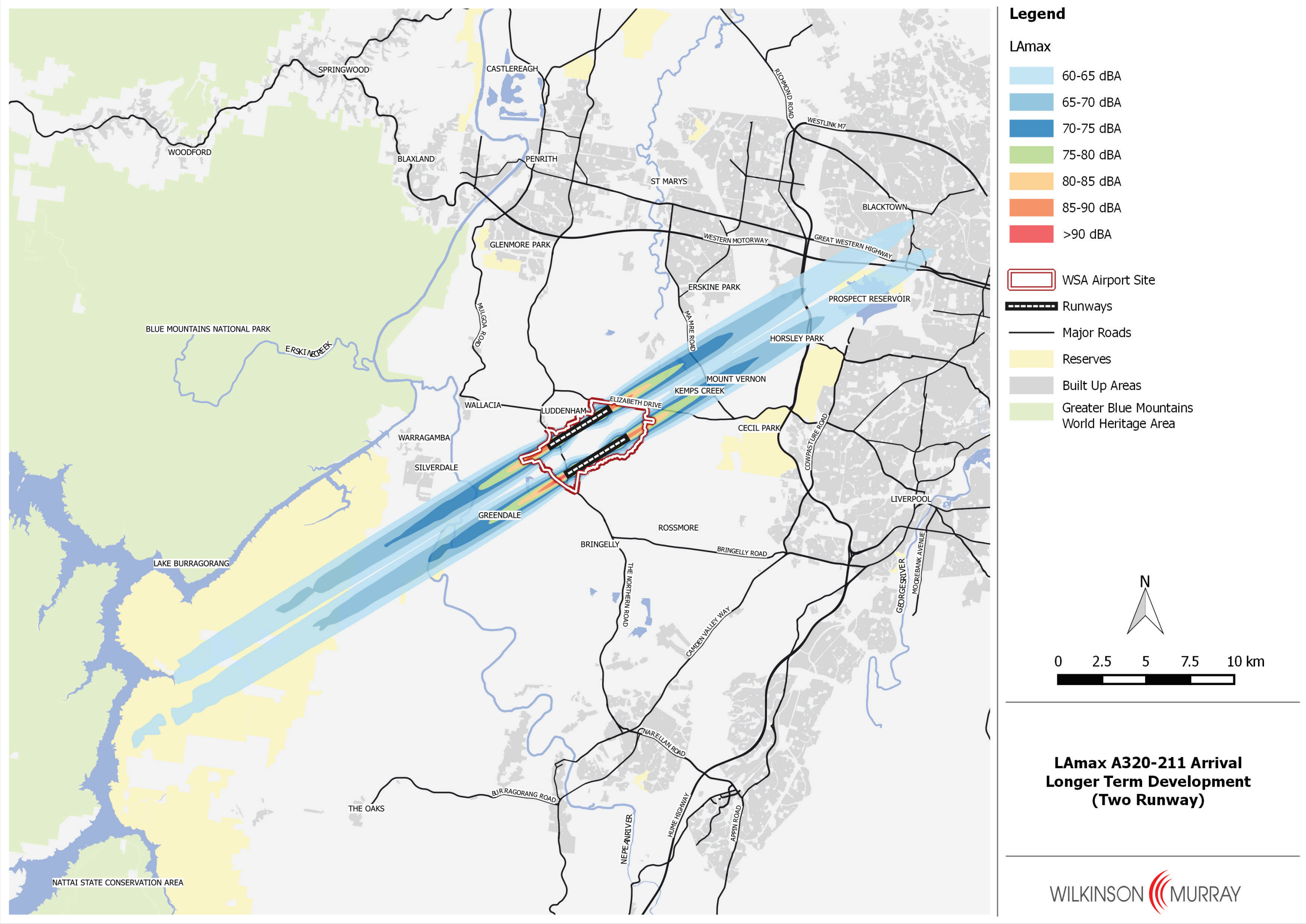
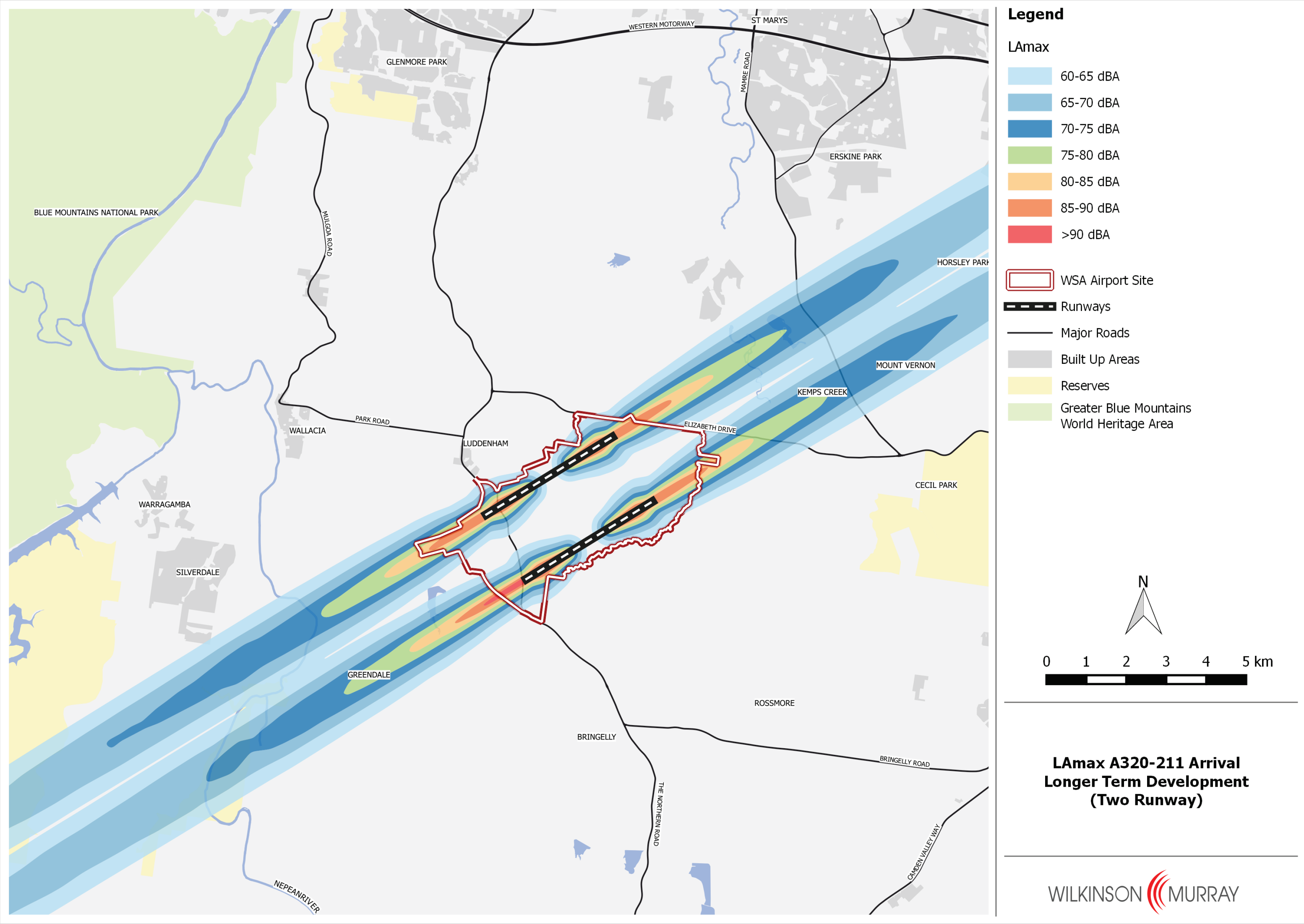


Figure 5-10 Combined Single Event A320 Arrival – Long Term Assessment Scenario (Meso Scale)



5.2 Noise Levels Over 24 Hours

5.2.1 N70 Results

As in the case of the proposed initial airport development, differences between noise impacts in summer and winter were found to be minor, and hence in this report, noise impacts will be presented on an annual basis.

Figure 5-11 and Figure 5-12 show N70 contours for the two operating strategies considered. The differences between areas of affectation for the two strategies are similar to those found for the initial development.

Comparing Figure 5-11 and Figure 5-12 with Figure 4-3 and Figure 4-4 for the 2050 strategy, there are fewer densely-populated areas within the N70 = 5 contour, despite the number of movements at the airport being approximately doubled between 2050 and Long Term. This is particularly true for the Prefer 05 operating strategy. The reason is that movements can be spread between two runways, and also the locations of flight tracks are less constrained in the two runway case.

Figure 5-11 N70 Contours – Long Term – Prefer 05

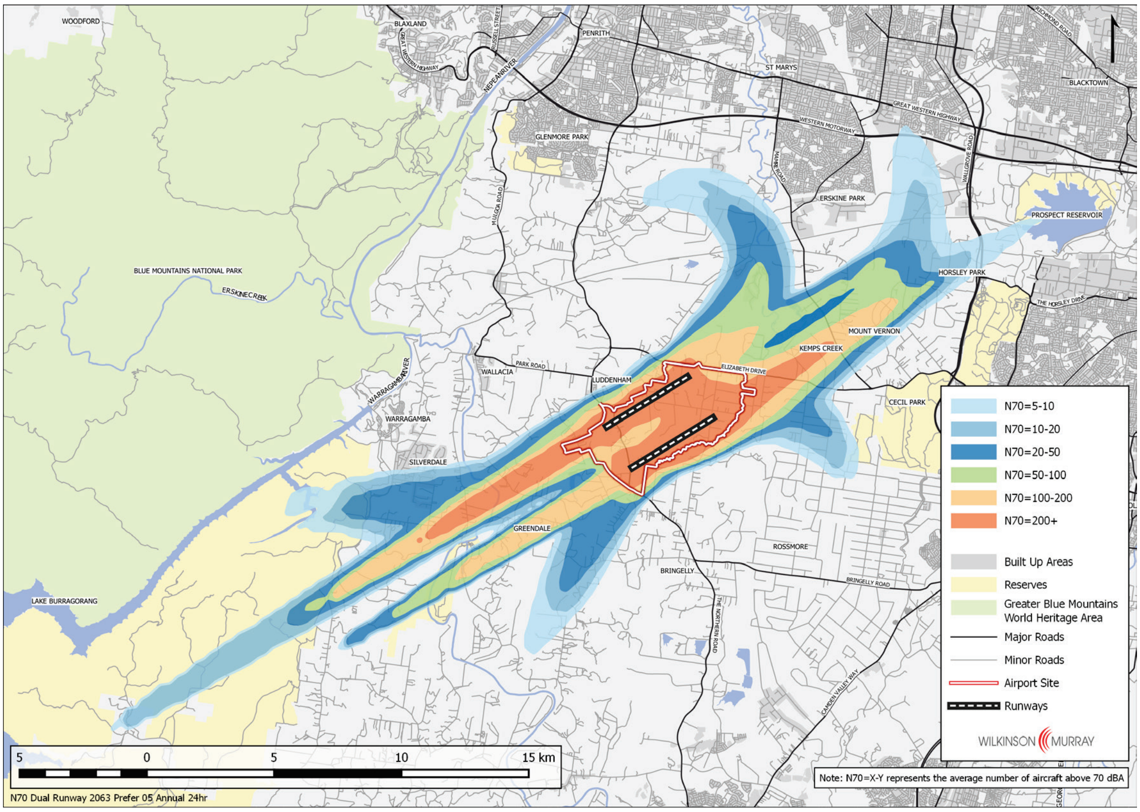
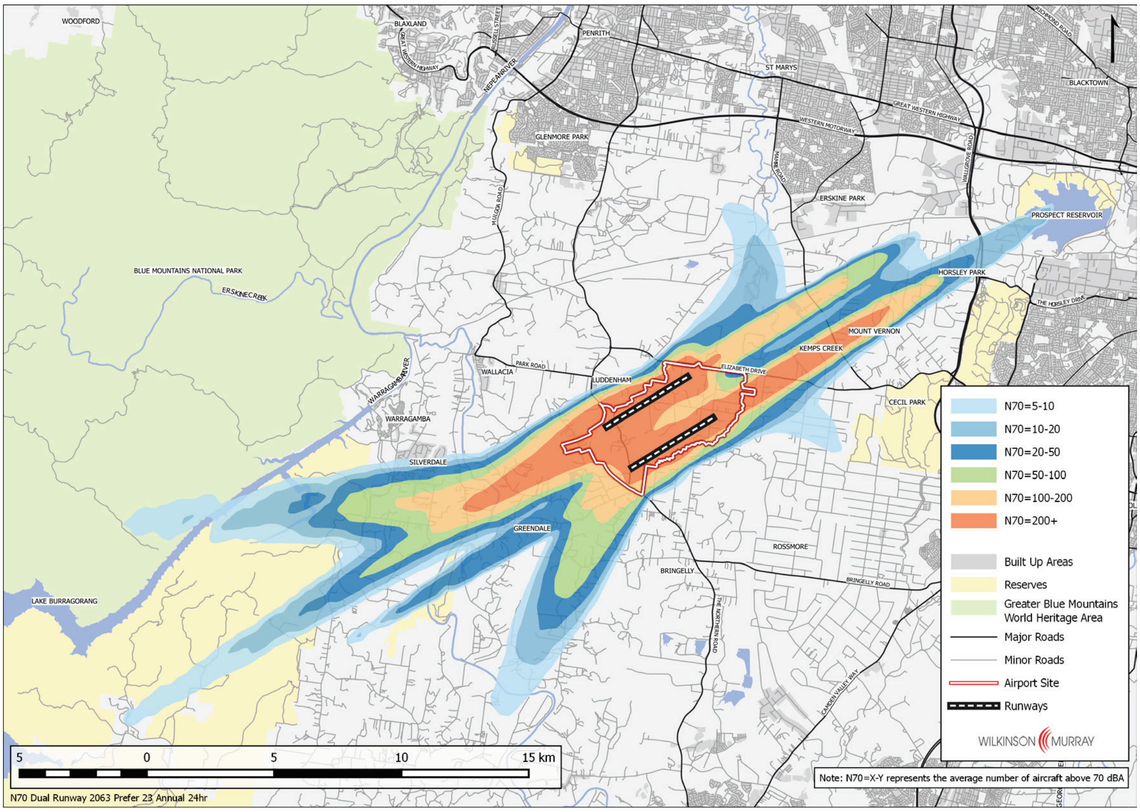


Figure 5-12 N70 Contours – Long Term – Prefer 23

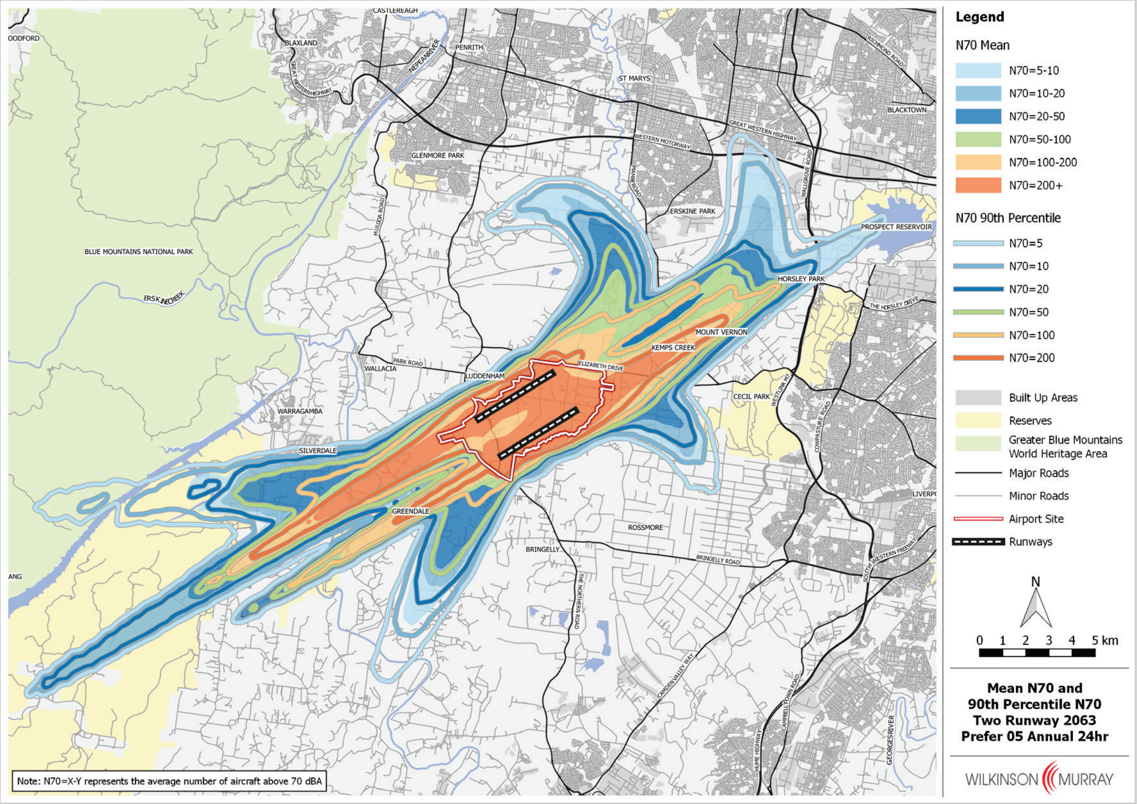


5.2.2 90^{th} Percentile N70 Results

Figure 5-13 and Figure 5-14 show calculated 90^{th} percentile N70 contours for the two relevant strategies.

In this case, comparing “typical worst-case” days, the difference between the two strategies is much less significant than when comparing “average” days, and also less significant than for the 2050 strategy.

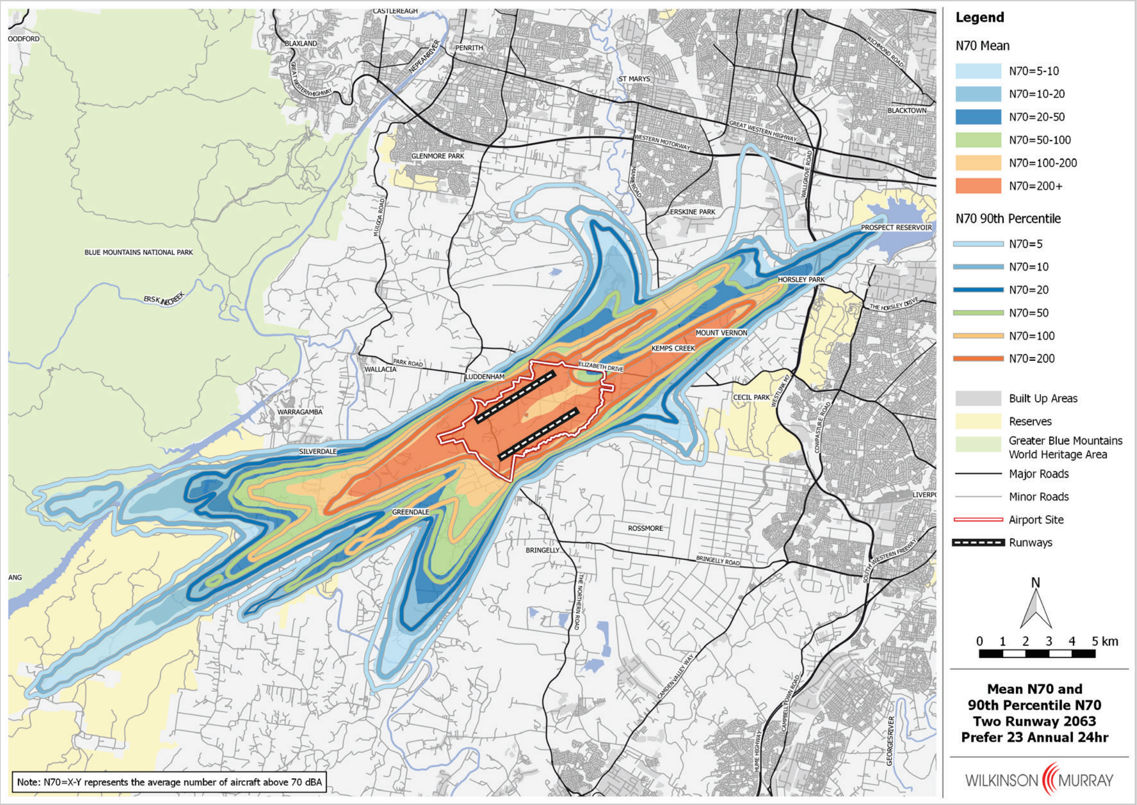
Figure 5-13 Mean & 90th Percentile N70 Contours – Long Term – Prefer 05



Mean N70 and
90th Percentile N70
Two Runway 2063
Prefer 05 Annual 24hr

Note: N70=X-Y represents the average number of aircraft above 70 dBA

Figure 5-14 Mean & 90th Percentile N70 Contours – Long Term – Prefer 23



Mean N70 and
90th Percentile N70
Two Runway 2063
Prefer 23 Annual 24hr

Note: N70=X-Y represents the average number of aircraft above 70 dBA

5.2.3 Population Exposure Estimates

The future population experiencing various levels of daytime noise impact was estimated using procedures described in Section 2.9. Results are shown in Table 5-1.

As noted above in the two runway case, there is little difference in the predicted number of people experiencing various levels of daytime noise exposure between a Prefer 05 and Prefer 23 strategy. Table 5-2 indicates that the total population affected by greater than 5, or greater than 10, events per day above 70 dBA is predicted to grow with time, with the exception of the Prefer 05 strategy for which the number of affected people decreases in the Long Term development compared to 2050. Under this strategy, the number of people affected in 2050 is disproportionately large, including large areas of St Marys and adjacent suburbs which are not impacted by noise levels exceeding 5 events above 70 dBA under the indicative Long Term airspace arrangements.

Table 5-1 Estimated Population within N70 Contours – Long Term; 2063 Population

N70	Operating Strategy	
	Prefer 05	Prefer 23
5-10	3,493	3,738
10-20	3,926	2,988
20-50	4,454	3,807
50-100	2,542	3,106
100-200	1,920	2,511
>200	1,083	1,321
Total	*17,418*	*17,471*

Table 5-2 Comparison of Population within N70 Contours by Operating Strategy and Assessment Year

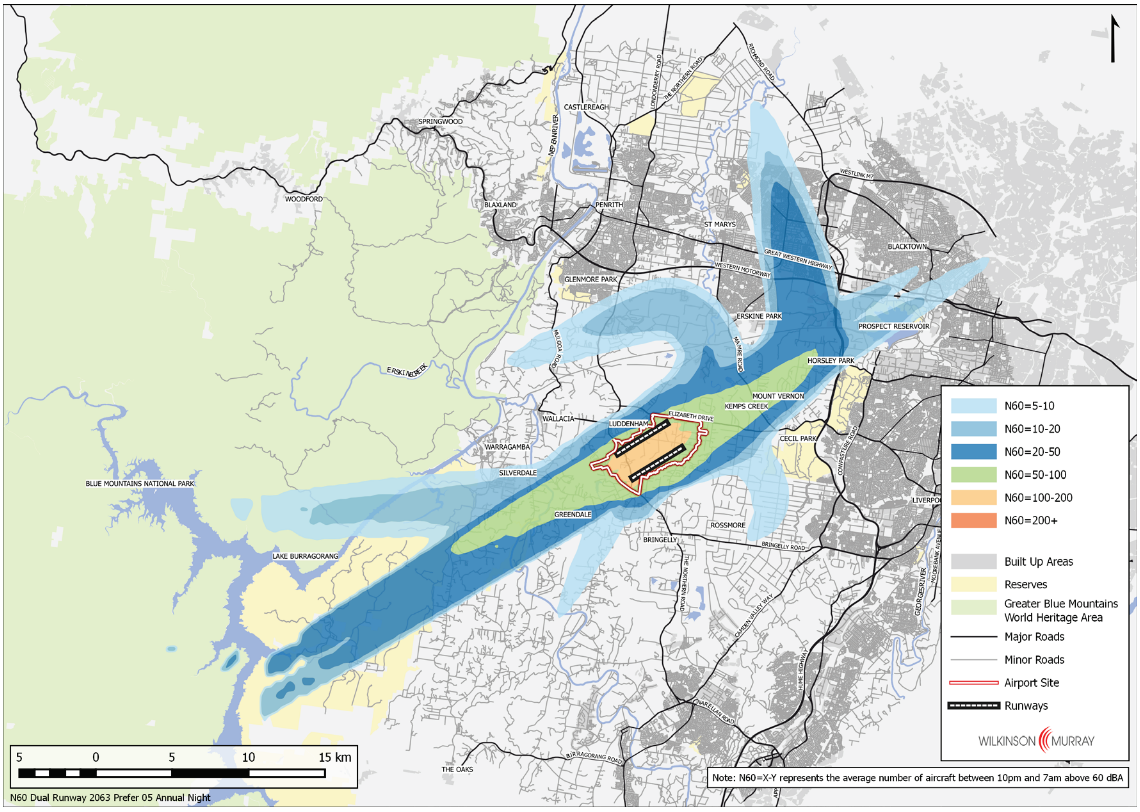
Assessment Year	Prefer 05		Prefer 23	
	N70 > 5	N70 > 10	N70 > 5	N70 > 10
Stage 1	1,493	930	1,468	1,068
2050	29,913	9,720	5,289	3,056
Long Term	17,418	13,925	17,471	13,733

5.3 Night Time Noise

5.3.1 N60 Results

Calculated average night time N60 contours for the Long Term are presented in Figure 5-15 and Figure 5-16. It is clear that for either operating strategy, extensive residential areas are predicted to be affected by more than 10 events per night exceeding 60 dBA, but the extent of impact is more severe in the Prefer 05 case. On the other hand, modelling indicates that rural residential areas to the south and west of the airport would be more affected in the Prefer 23 case.

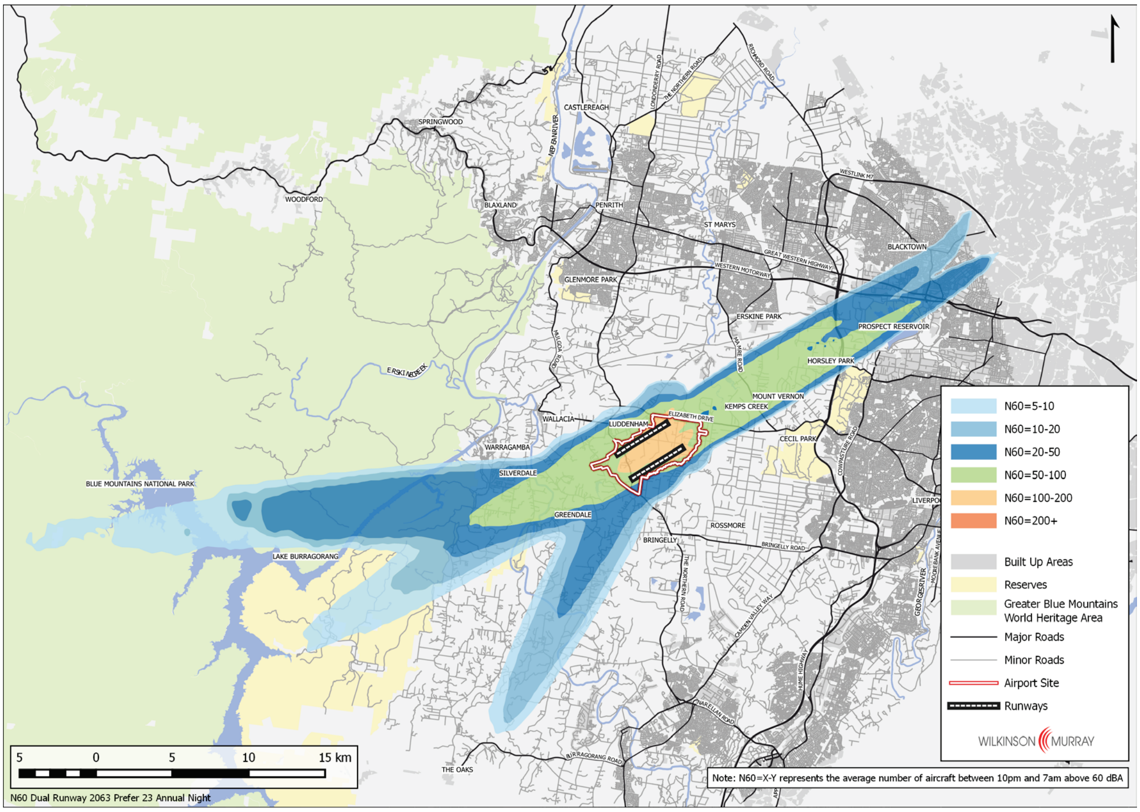
Figure 5-15 N60 Contours – Long Term – Prefer 05



Note: N60=X-Y represents the average number of aircraft between 10pm and 7am above 60 dBA

N60 Dual Runway 2063 Prefer 05 Annual Night

Figure 5-16 N60 Contours – Long Term – Prefer 23



Note: N60=X-Y represents the average number of aircraft between 10pm and 7am above 60 dBA

N60 Dual Runway 2063 Prefer 23 Annual Night

5.3.2 90th Percentile N60 Results

Figure 5-17 and Figure 5-18 show 90th percentile ("typical worst-case") night time N60 contours. The distinction between the two operating strategies is even clearer – in the Prefer 05 case, the "typical worst-case" contours cover significantly more area than the "average" contours, while in the Prefer 23 strategy, the areas are almost the same.

Figure 5-17 Mean & 90th Percentile N60 Contours – Long Term – Prefer 05

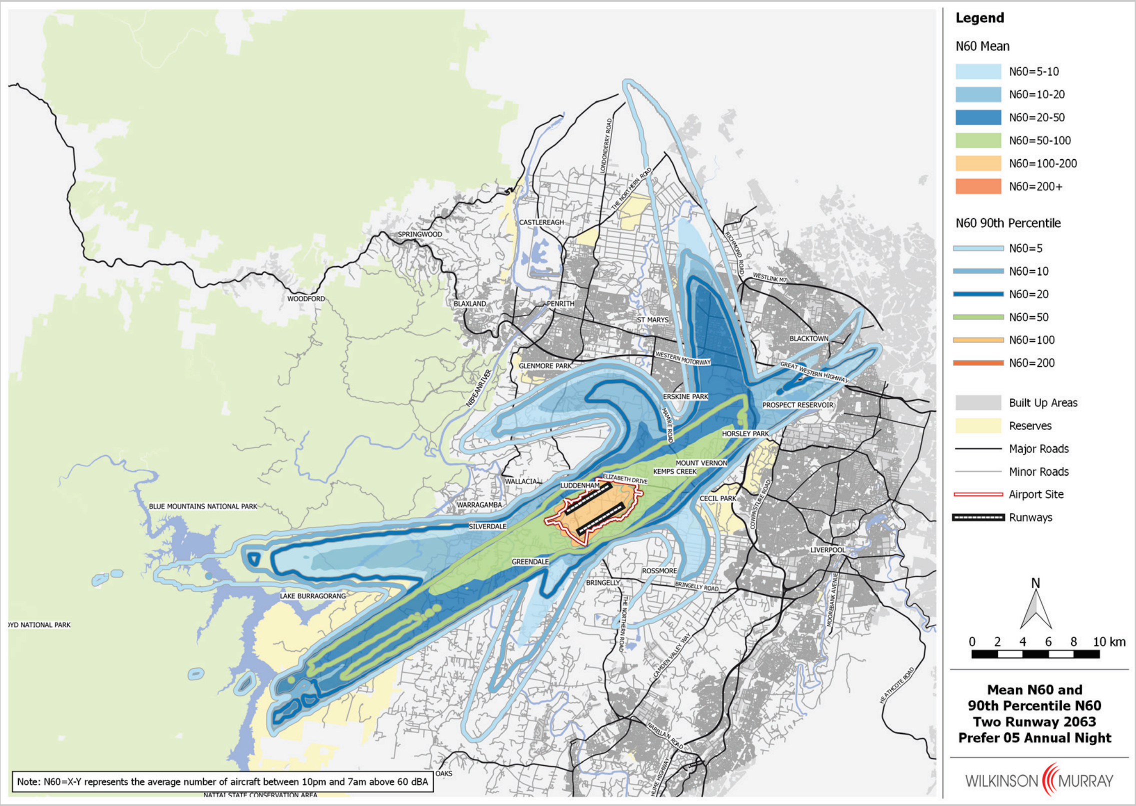
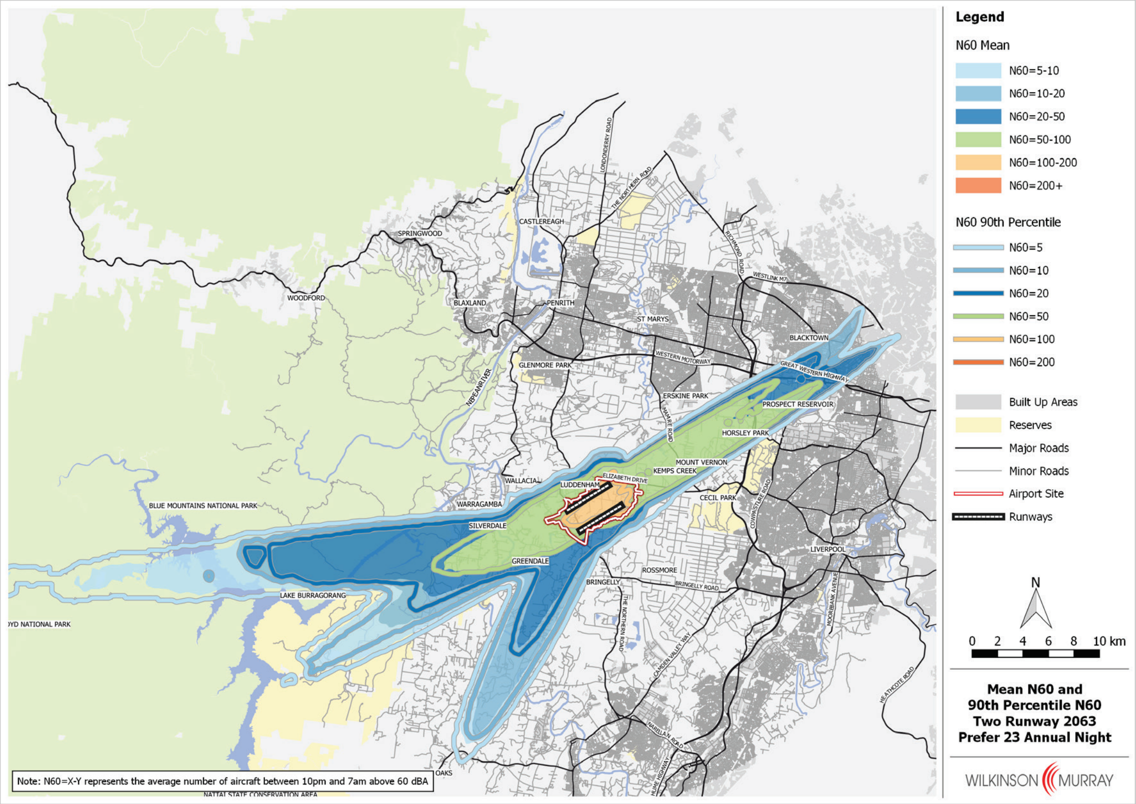


Figure 5-18 Mean & 90th Percentile N60 Contours – Long Term – Prefer 23



5.3.3 Population Exposure Estimates

The future population experiencing various levels of noise impact has been estimated using procedures described in Section 2.9. Results are shown in Table 5-3. This table shows that predicted night time impacts for Long Term development are significantly higher with the Prefer 05 operating strategy. Table 5-4 shows a comparison between night time noise impacts in each nominal year.

However, it should be remembered that analysis for Long Term development does not allow for noise mitigation by the use of alternative night time operating modes. For the Stage 1 and 2050 scenarios, a "Head-to-Head" mode could significantly reduce night time impacts, and it is likely that similar modes could be equally effective in the dual runway case.

Table 5-3 Estimated Population within N60 Contours – Long Term; 2063 Population

N60	Operating Strategy	
	Prefer 05	Prefer 23
5-10	81,333	10,509
10-20	45,372	43,963
20-50	68,963	42,097
50-100	5,313	8,236
>100	0	0
Total	*200,981*	*104,805*

Table 5-4 Comparison of Population within N60 Contours by Operating Strategy and Assessment Year

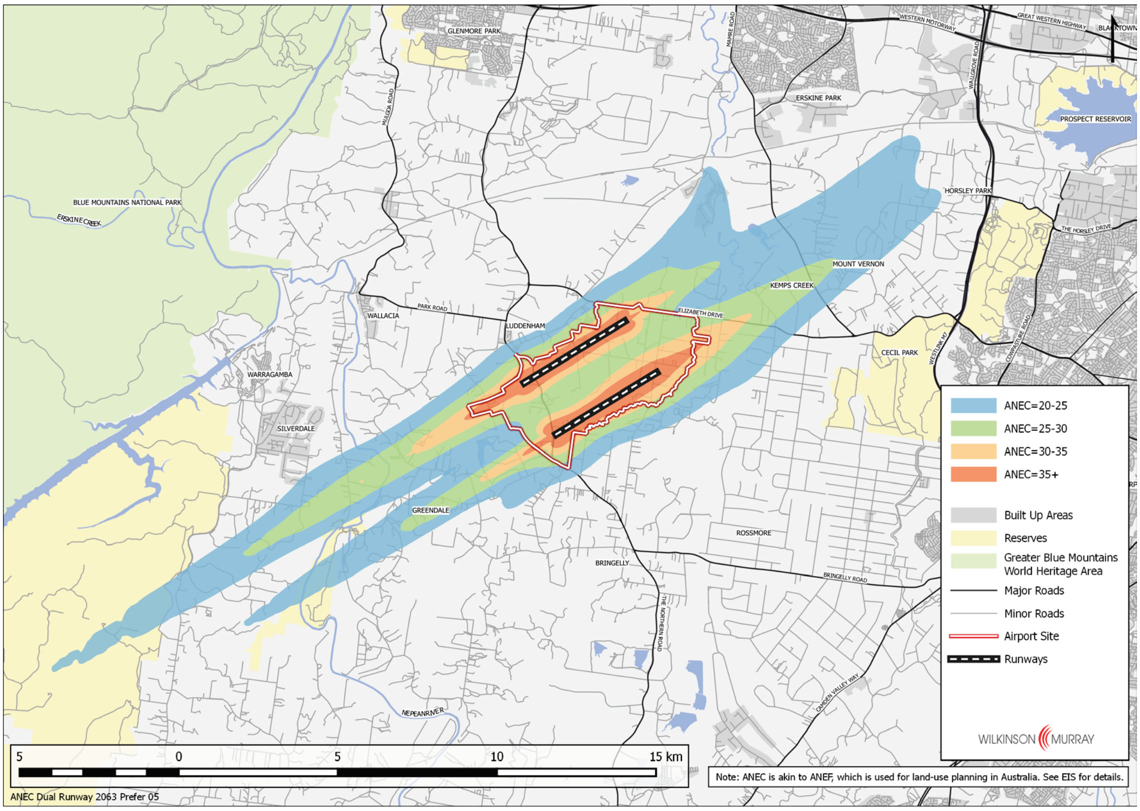
Assessment Year	Prefer 05		Prefer 23	
	N60 > 5	N60 > 10	N60 > 5	N60 > 10
Stage 1	48,405	1,674	6,179	2,743
2050	137,431	108,303	170,391	26,564
Long Term	200,981	119,648	104,805	94,296

5.4 Land Use Planning Impacts

5.4.1 ANEC Contours

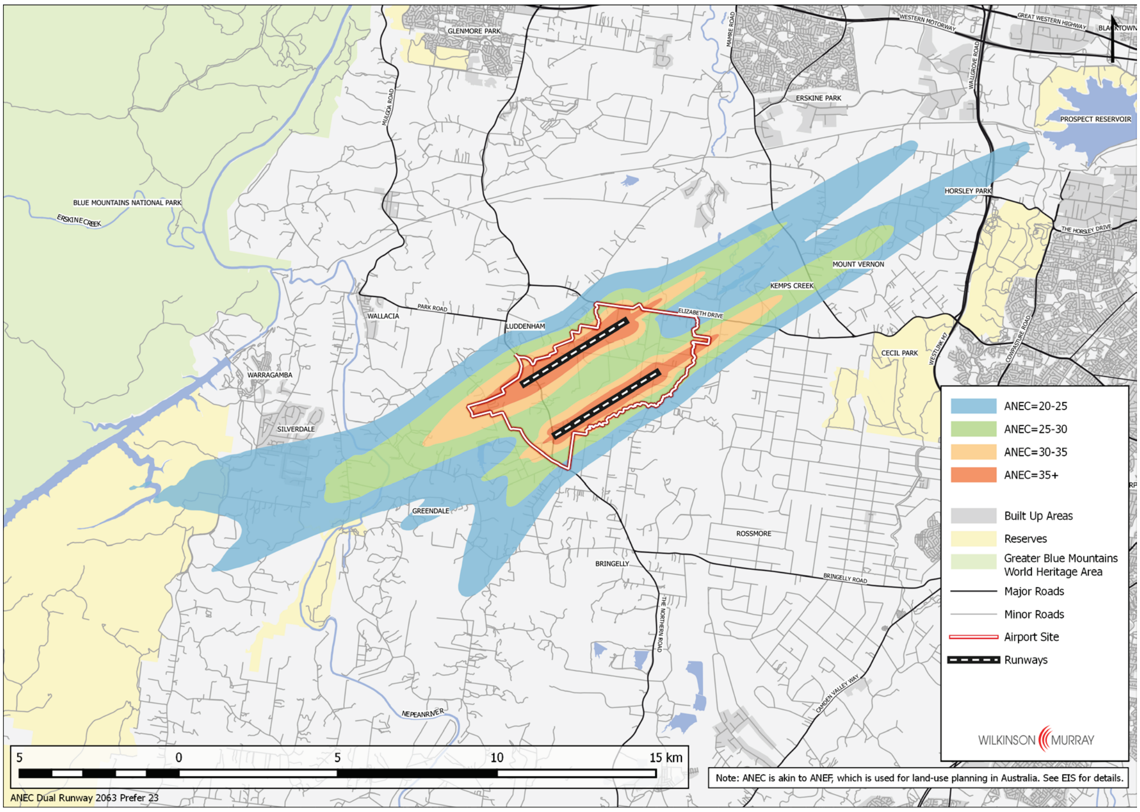
ANEC contours for the two operating strategies considered are shown in Figure 5-19 and Figure 5-20. As expected, these cover a larger area than for the 2050 assessment scenario and, as shown in Table 5-5, they cover a larger estimated population. However, they remain well separated from existing built-up residential areas.

Figure 5-19 ANEC Contours – Long Term – Prefer 05



Note: ANEC is akin to ANEF, which is used for land-use planning in Australia. See EIS for details.

Figure 5-20 ANEC Contours – Long Term – Prefer 23



ANEC Dual Runway 2063 Prefer 23

Note: ANEC is akin to ANEF, which is used for land-use planning in Australia. See EIS for details.

Table 5-5 Estimated Population within ANEC Contours – Long Term; 2063 Population

ANEC Band	**Operating Strategy**	
	Prefer 05	**Prefer 23**
20-25	5803	7832
25-30	1486	1934
30-35	570	527
>35	0	26
Total	*7858*	*10319*

6 NOISE-INDUCED VIBRATION

At high noise levels, the low frequency components of aircraft noise can result in vibration of loose elements in buildings, notably windows. This effect is distinct from that of wake vortices, which result from aerodynamic turbulence caused by an aircraft as it passes through the air. At some airports, wake vortices have been known to dislodge roof tiles on residences very close to the runway end. Even at the highest expected noise levels the levels of vibration due to low frequency noise are well below those which may cause structural damage to buildings. However, they can result in secondary radiation from loose windows and other building elements.

With typical light building structures, noise induced vibration may begin to occur where the maximum external noise level reaches approximately 90 dBA. The effect is more common on take-offs than for landings, since the noise spectrum for a take-off close to the airport has stronger low frequency components.

Figure 6-1 to Figure 6-3 show 85 dBA and 90 dBA noise level contours for a B747 aircraft departure (stage length 5 for Stage 1 and stage length 9 for 2050 and Long Term). Only areas within the 90 dBA contour could expect to experience any noise-induced vibration of building structures, and then only during a departure of a B747 aircraft with maximum stage length. For Stage 1, there are estimated to be no existing residences within this contour, while for 2050 there are estimated to be fewer than ten. For the Long Term development, there are also estimated to be fewer than 10 existing residences within this contour.

Figure 6-1 85 dBA & 90 dBA L_{Amax} Contours – B747 Departure Stage 5 – Stage 1 Development

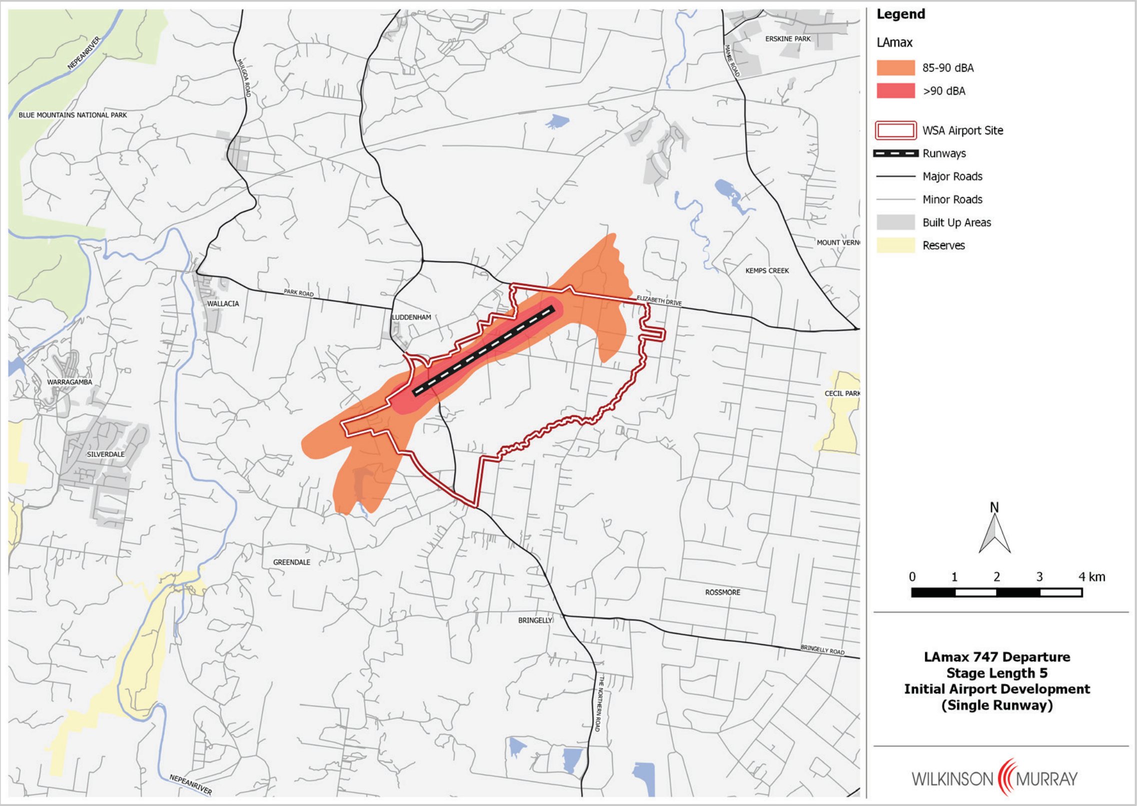


Figure 6-2 85 dBA & 90 dBA L_{Amax} Contours – B747 Departure Stage 9 – 2050

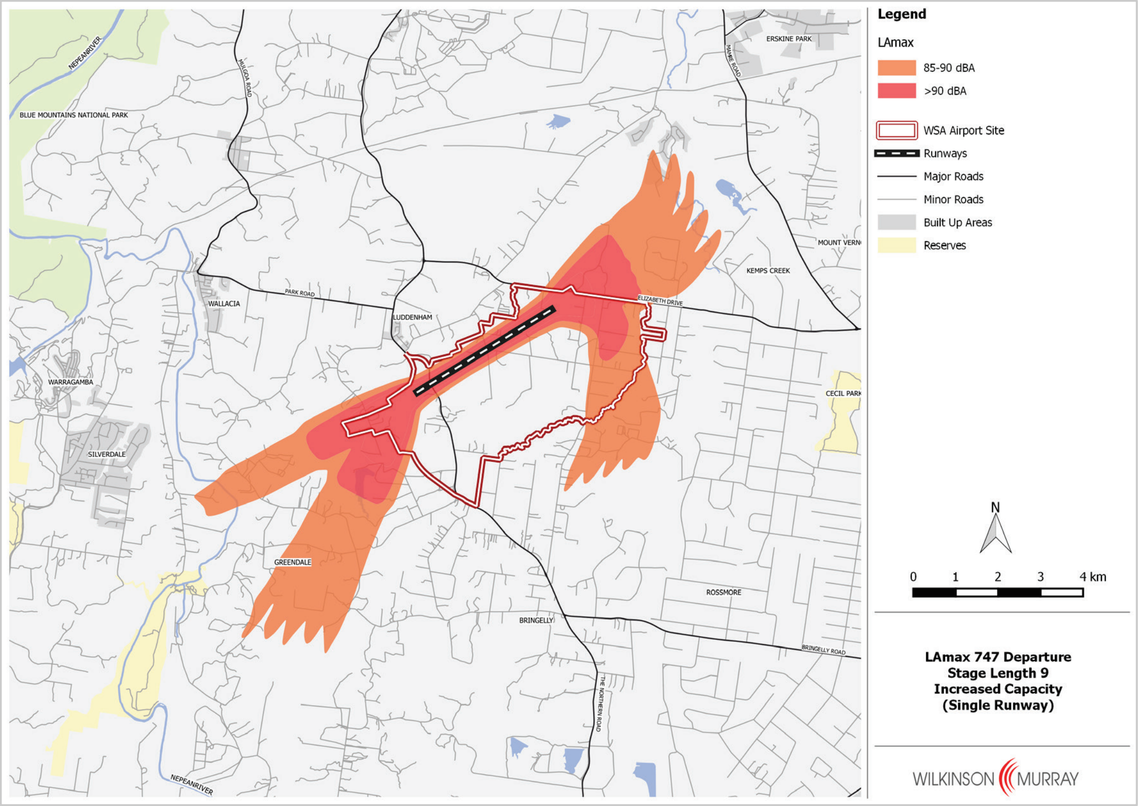
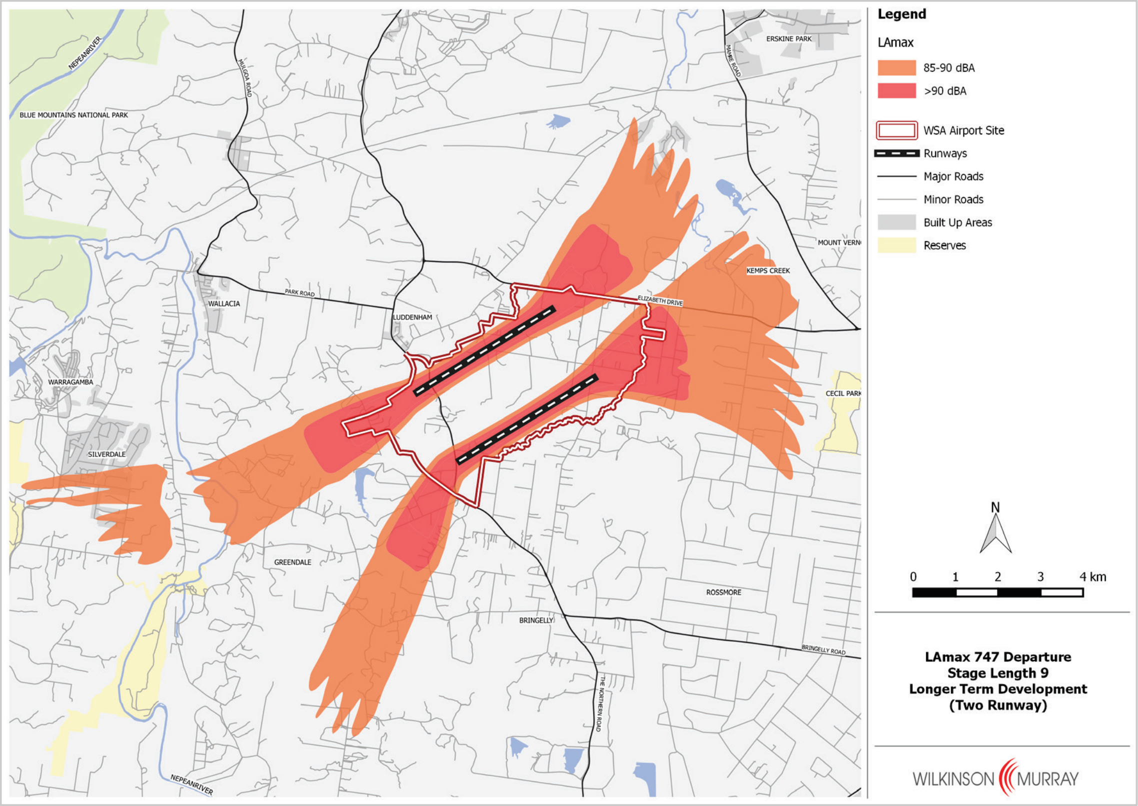


Figure 6-3 85 dBA & 90 dBA L_{Amax} Contours – B747 Departure – Long Term Airport Development



7 GREATER BLUE MOUNTAINS WORLD HERITAGE AREA

7.1 Track Density Methodology

Over the Greater Blue Mountains World Heritage Area (GBMWHA), noise levels due to aircraft operating at the proposed airport are expected to be lower than the levels described in the previous sections, as the GBMWHA is further from the airport. Although occasional noise events may reach 60 dBA at some points in the area, levels directly beneath a flight track will typically be below 55 dBA, and often much lower. In addition, this area is already subjected to low-level noise from aircraft using Sydney (Kingsford Smith) Airport and other aviation activities, including low-level sightseeing flights.

Nevertheless, given the various amenity issues that complement the biodiversity values and integrity of the GBMWHA, an increase in the number of audible overflights at certain locations within the area may be considered to be intrusive by recreational visitors and other users.

In order to illustrate the potential changes to the number of aircraft movements in the GBMWHA, track density plots have been prepared to provide a graphical representation of the number of existing and projected future operations in the area.

Existing average daily aircraft movements across the GBMWHA were determined from existing flight track data and are based on a sample of one day in every two over the year May 2014 – April 2015. These are plotted as a "heat map" showing the number of tracks per day that pass within 300 m (horizontally) of any point on the ground.

Future predicted operations in Stage 1 and 2050 were plotted in the same way, after adding these to the "existing" tracks. This is used to illustrate the areas in which additional aircraft would be seen overhead, and the degree of change involved.

Most of the "new" tracks over this area from the proposed airport in Stage 1 and 2050 are arrivals, and all arriving aircraft are assumed to pass through the designated airspace "merge point".

Results in this section focus on diagrams showing the total number of tracks, independent of aircraft operating height. However, in this area aircraft associated with the proposed airport will generally be lower than existing aircraft. Diagrams in Appendix D show the number of existing and future tracks for regular public transport (RPT) flights at heights of 5000 ft and below.

7.2 Track Density Diagrams – Original Merge Point

Figure 7-1 shows the density of existing RPT aircraft tracks over the GBMWHA. In most areas, this is about 1 per day, rising to 10 per day under certain specific tracks and almost 50 per day under one track to the south-east.

Figure 7-2 to Figure 7-5 show track densities including movements from the proposed airport, for the Prefer 05 and Prefer 23 operating strategies in Stage 1 and 2050. In many places the predicted difference in density is large, particularly under arrival paths where the number of events can be over 200 per day. Although noticeable, noise levels associated with the overflights are expected to be low and comparable with other sounds heard in the area. The fact that the predicted overflights are concentrated on specific tracks means that other parts of the GBMWHA would be relatively unaffected.

The location of the nominal “merge point” is almost over the township of Blaxland, meaning that residents could expect to experience some 230 overflights per day in 2050 passing directly overhead, albeit at typically more than 5000 ft above ground level and with maximum noise levels below about 55 dBA.

Given this, it was determined to investigate the impact of relocating the “merge point” for assessment purposes.

Figure 7-1 Track Density – Existing 2014 – 15 Aircraft Movements

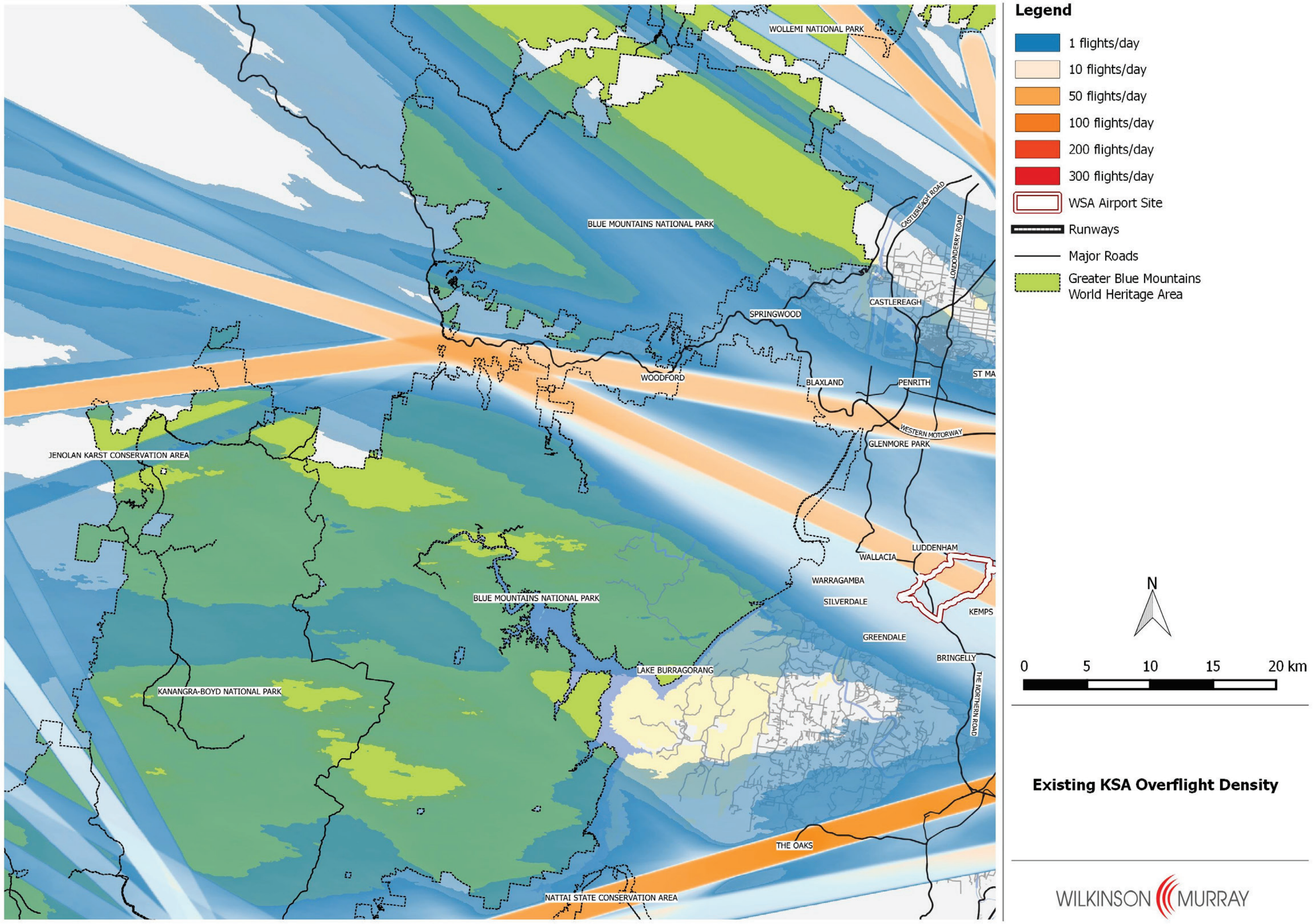


Figure 7-2 Track Density – Existing & WSA Stage 1 Aircraft Movements – Prefer 05

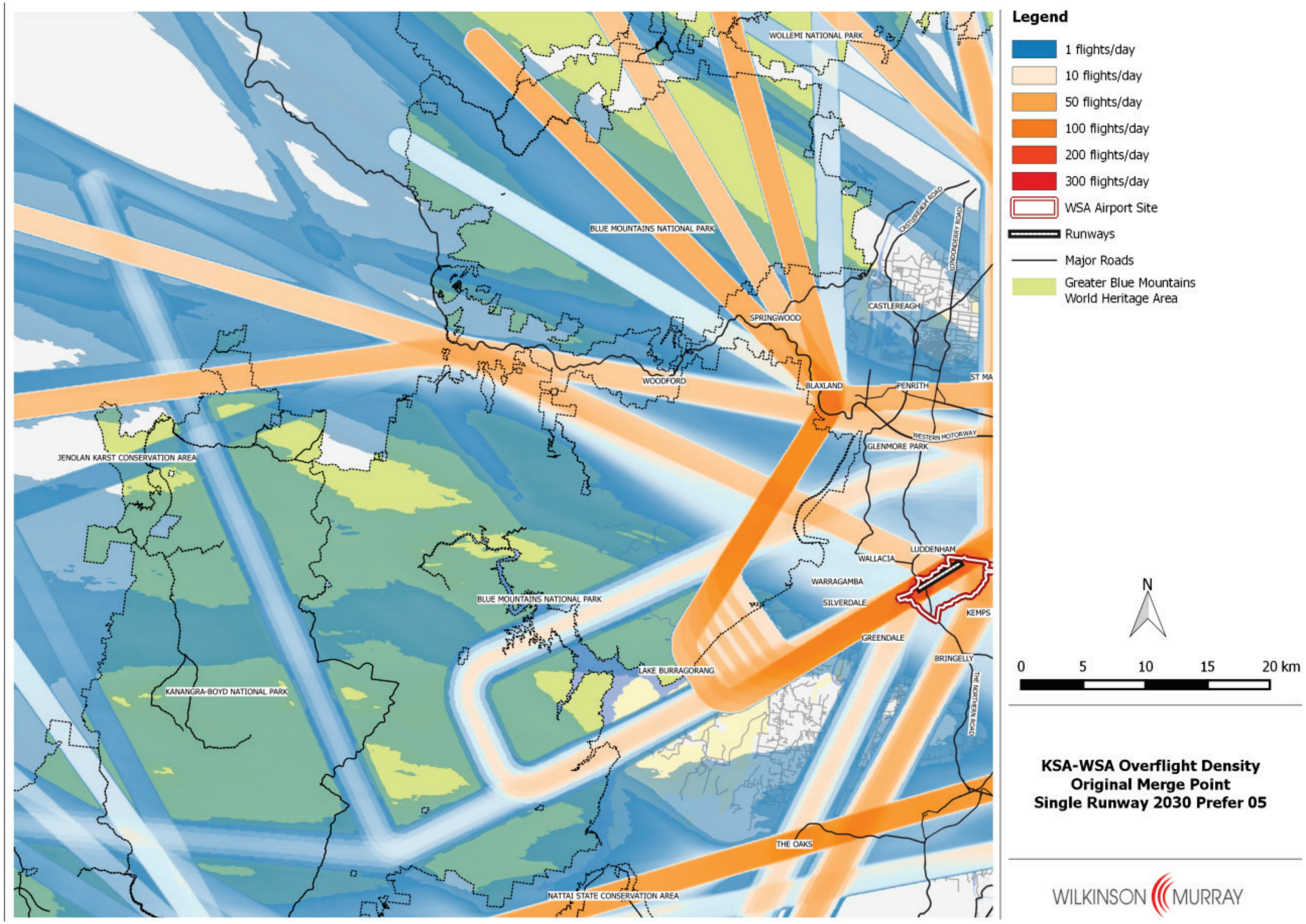


Figure 7-3 Track Density – Existing & WSA Stage 1 Aircraft Movements – Prefer 23

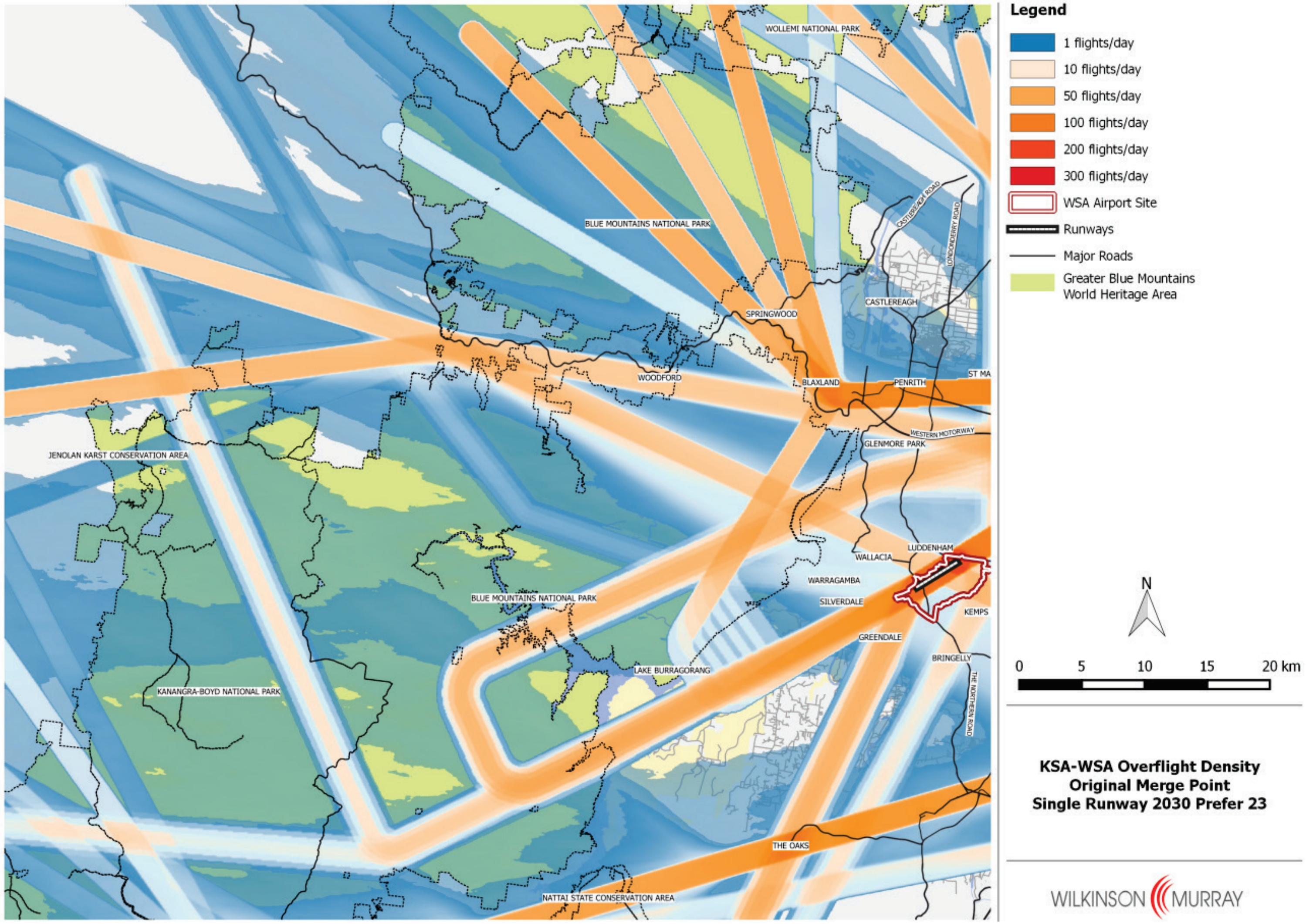


Figure 7-4 Track Density – Existing & WSA 2050 Aircraft Movements – Prefer 05

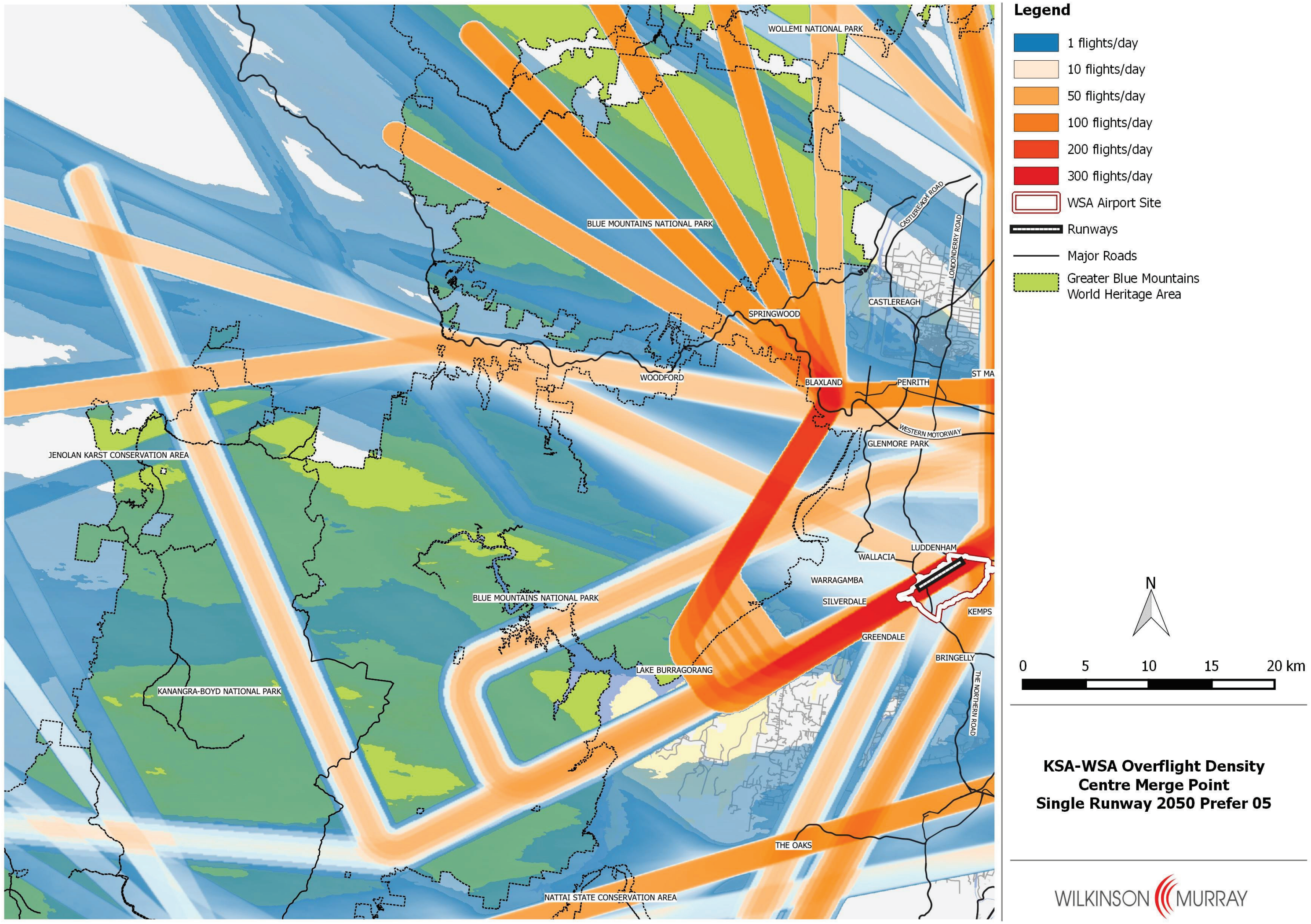
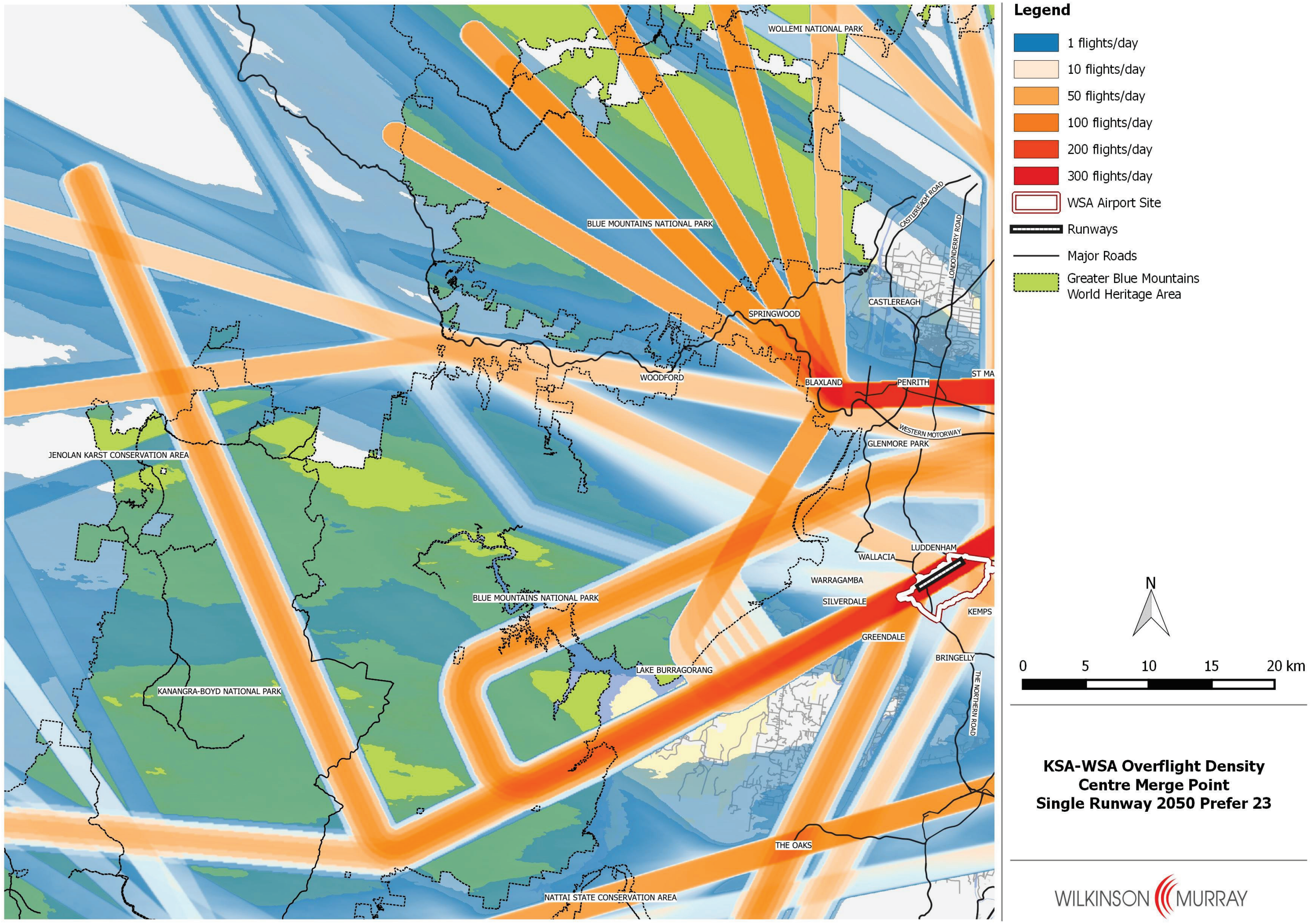


Figure 7-5 Track Density – Existing & WSA 2050 Aircraft Movements– Prefer 23



7.3 Track Density Diagrams – Alternative Merge Points

In consultation with Airservices Australia, two alternative merge points were considered at approximately 3 nautical miles north-east and south-west respectively of the nominal "central" merge point. This was suggested as the likely maximum distance that the point could be moved without disruption to the preliminary airspace design. However, it is emphasised that at the time of writing, no information is available that demonstrates that other possible merge points would not also be feasible. The alternative points considered in this analysis are shown in Figure 7-6.

Figure 7-7 to Figure 7-10 and Figure 7-11 to Figure 7-14 show track density plots for these alternative points, for Stage 1 and 2050 respectively. The results are predictable – in both cases track densities over Blaxland are reduced. In the case of the eastern merge point, the point moves closer to rural residential areas outside the GBMWHA, and track densities over Blue Mountains' communities slightly to the east are still predicted to be high, particularly under the Prefer 05 operating strategy. In the case of the western merge point, impacts on some areas within the GBMWHA are increased.

Figure 7-6 Location of Alternative Merge Points for Arrivals

Source: Google Maps

Figure 7-7 **Track Density – Existing & WSA Stage 1 Aircraft Movements – Prefer 05, East Merge Point**

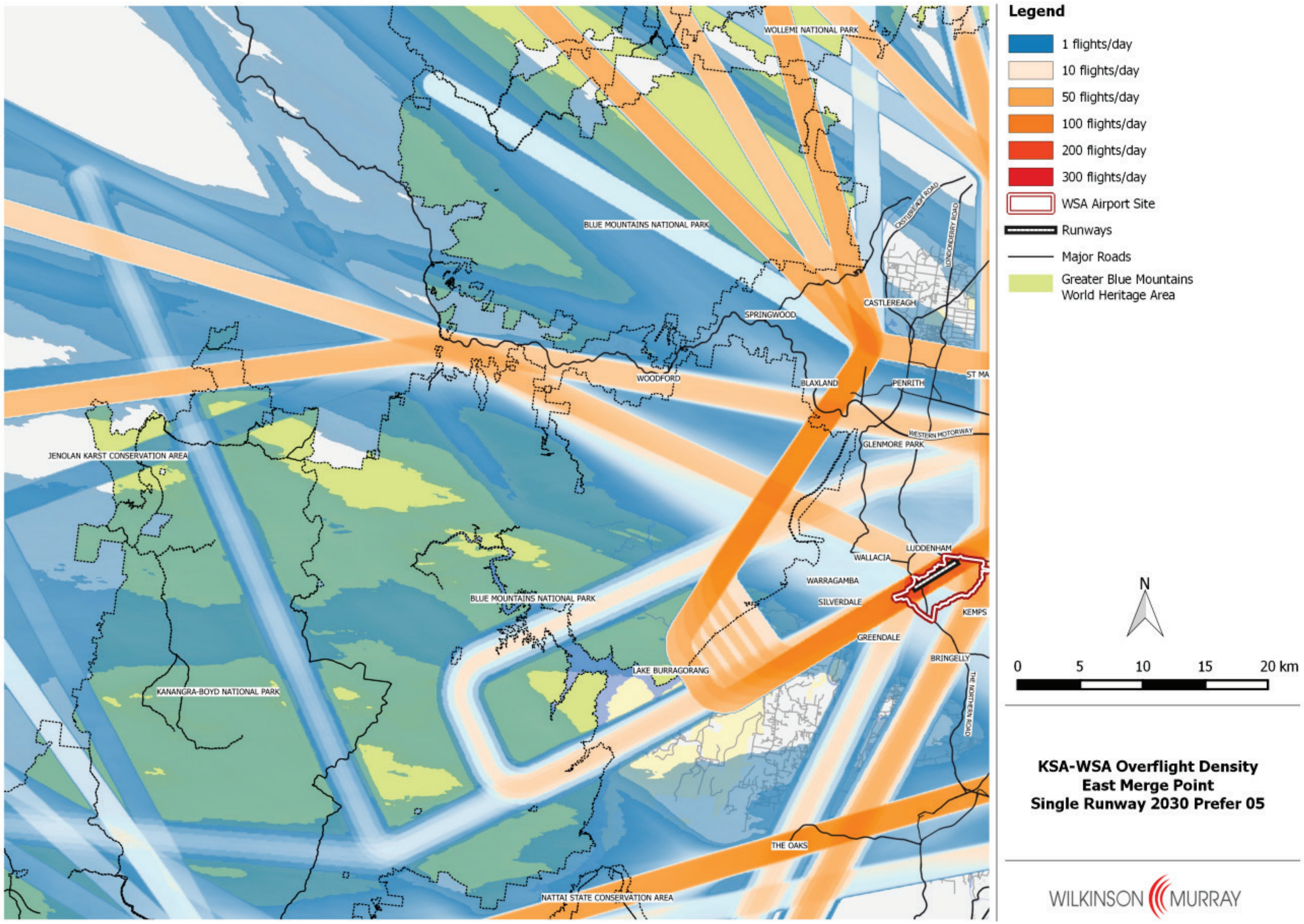


Figure 7-8 Track Density – Existing & WSA Stage 1 Aircraft Movements Prefer 05, West Merge Point

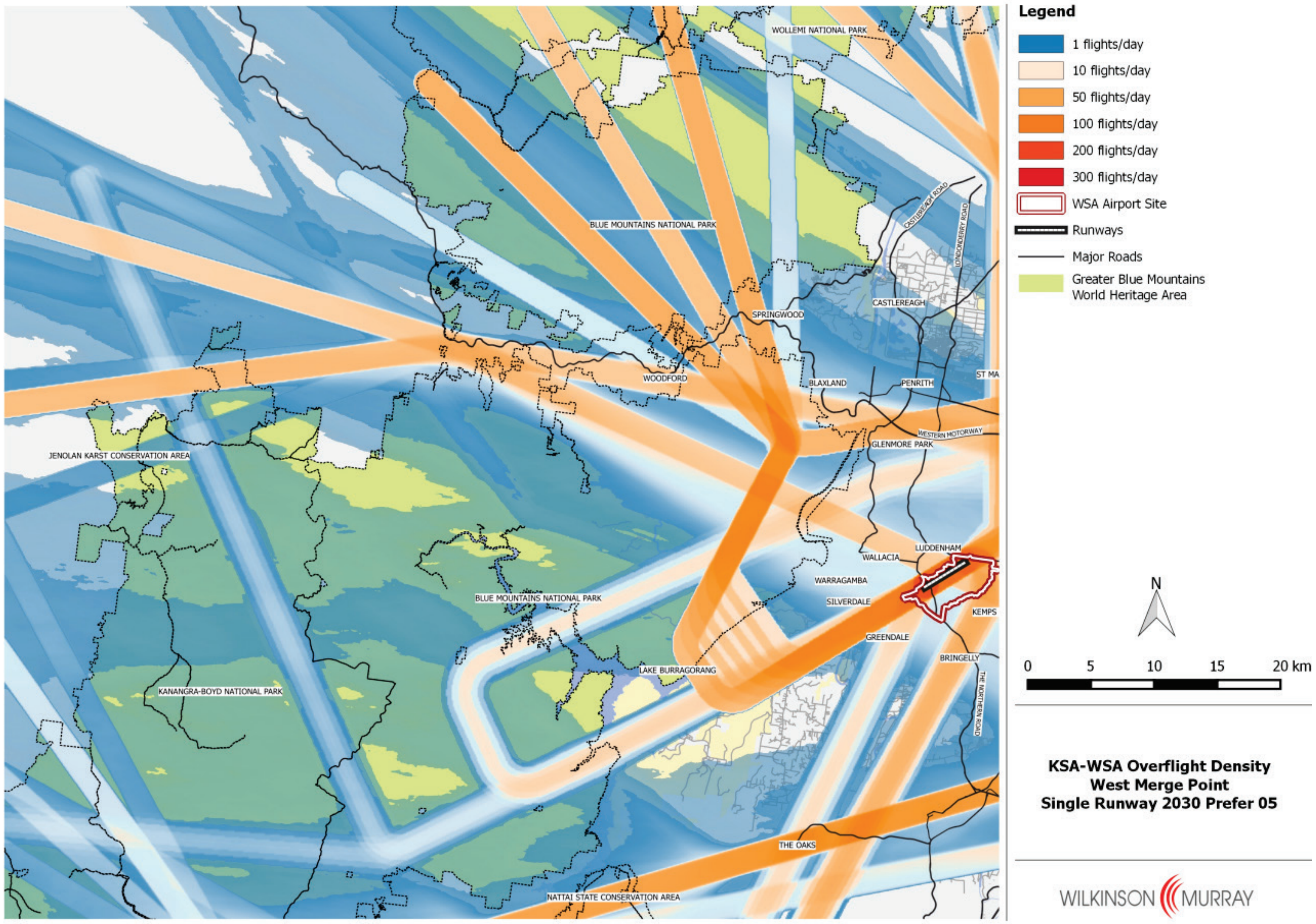


Figure 7-9 Track Density – Existing & WSA Stage 1 Aircraft Movements Prefer 23, East Merge Point

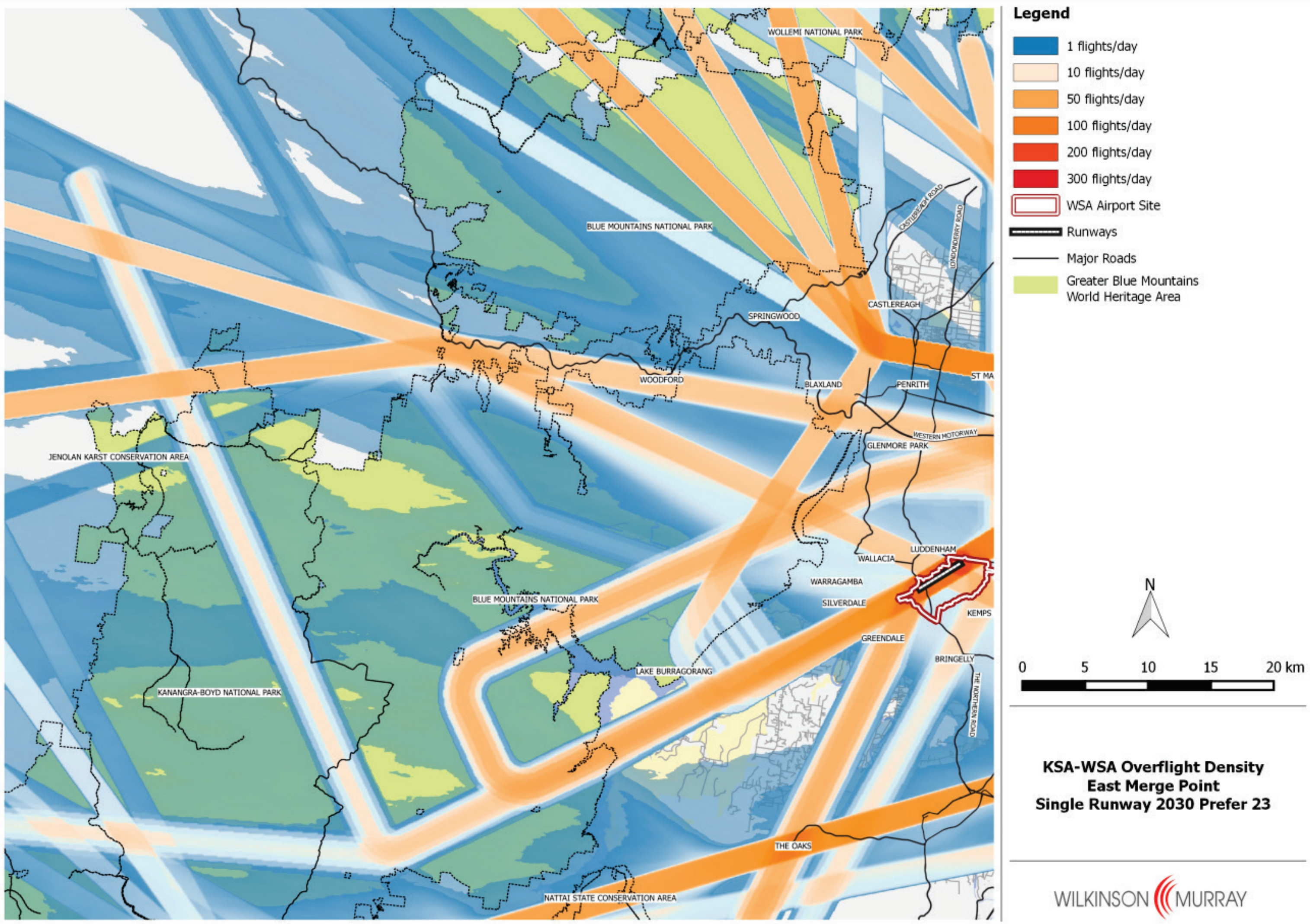


Figure 7-10 Track Density – Existing & WSA Stage 1 Aircraft Movements Prefer 23, West Merge Point

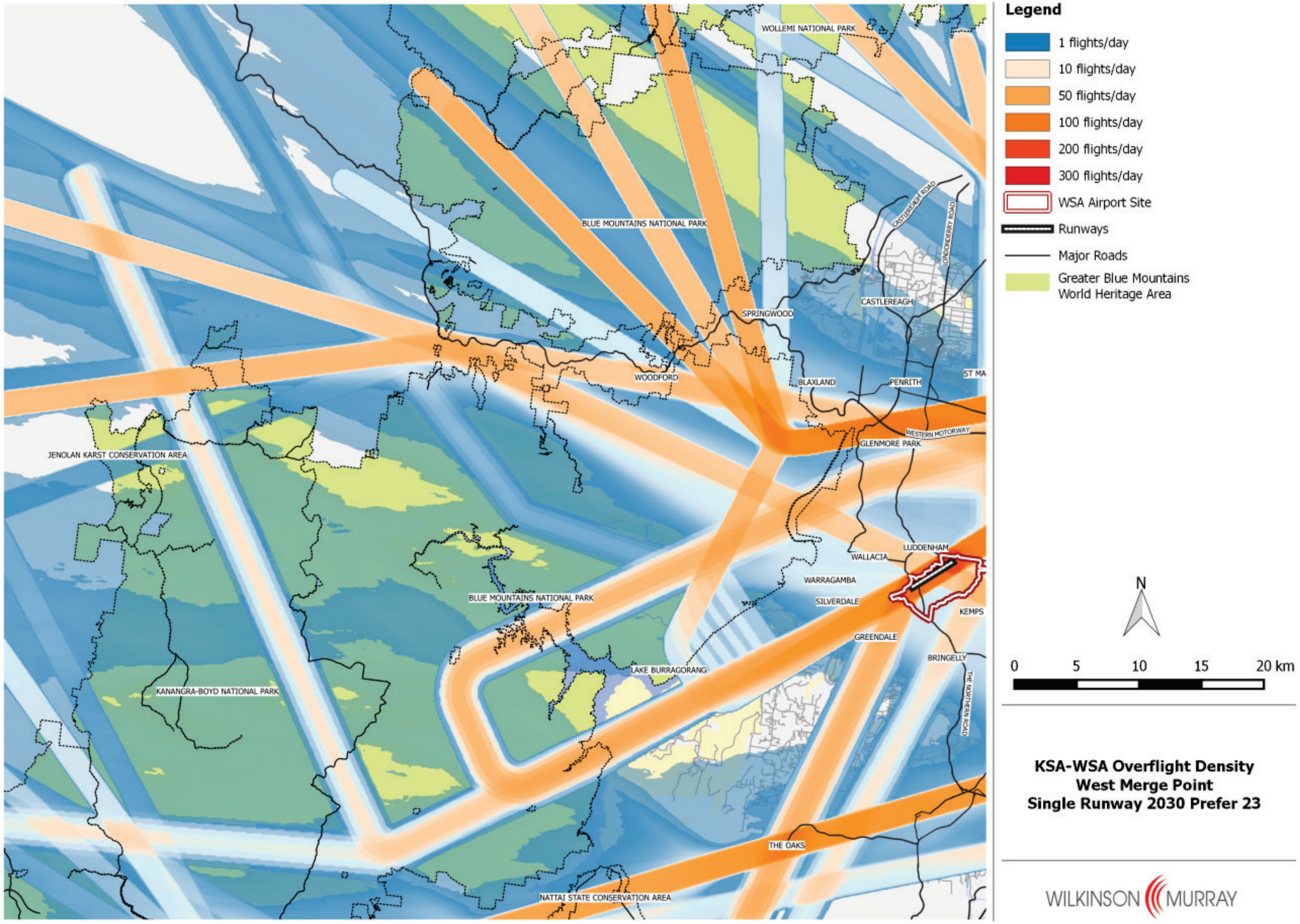


Figure 7-11 Track Density – Existing & WSA 2050 Aircraft Movements – Prefer 05, East Merge Point

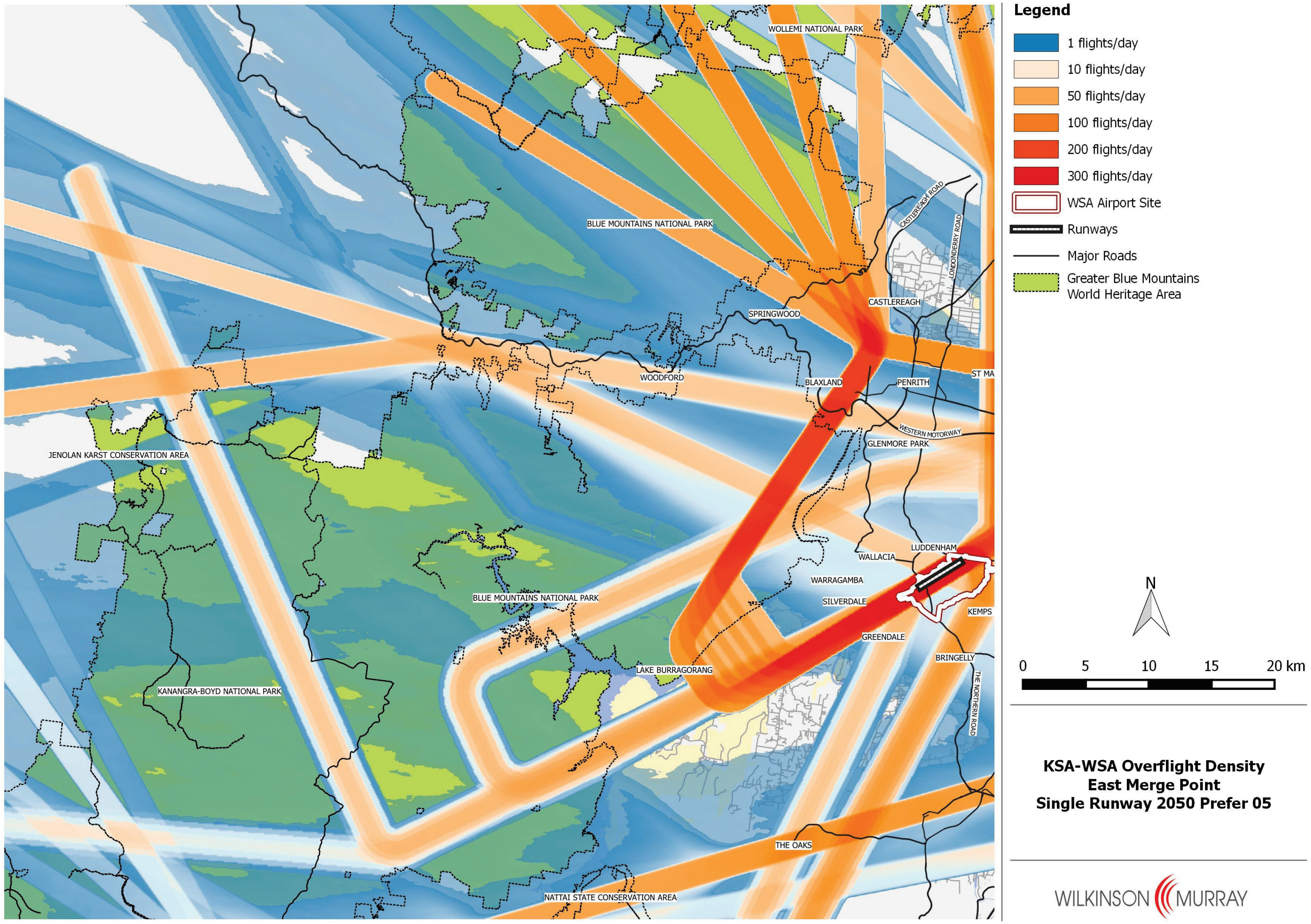


Figure 7-12 Track Density – Existing & WSA 2050 Aircraft Movements – Prefer 05, West Merge Point

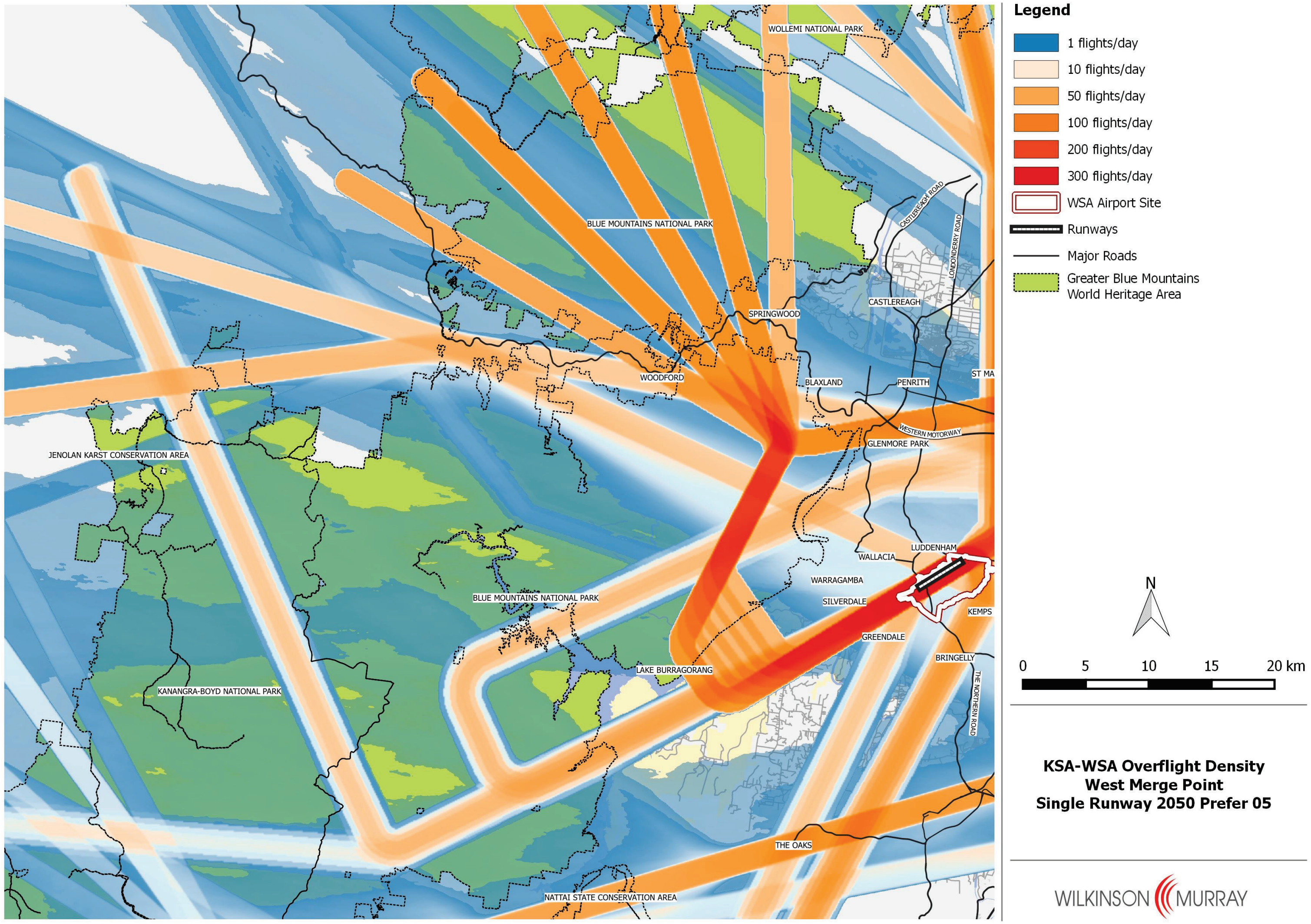


Figure 7-13 Track Density – Existing & WSA 2050 Aircraft Movements – Prefer 23, East Merge Point

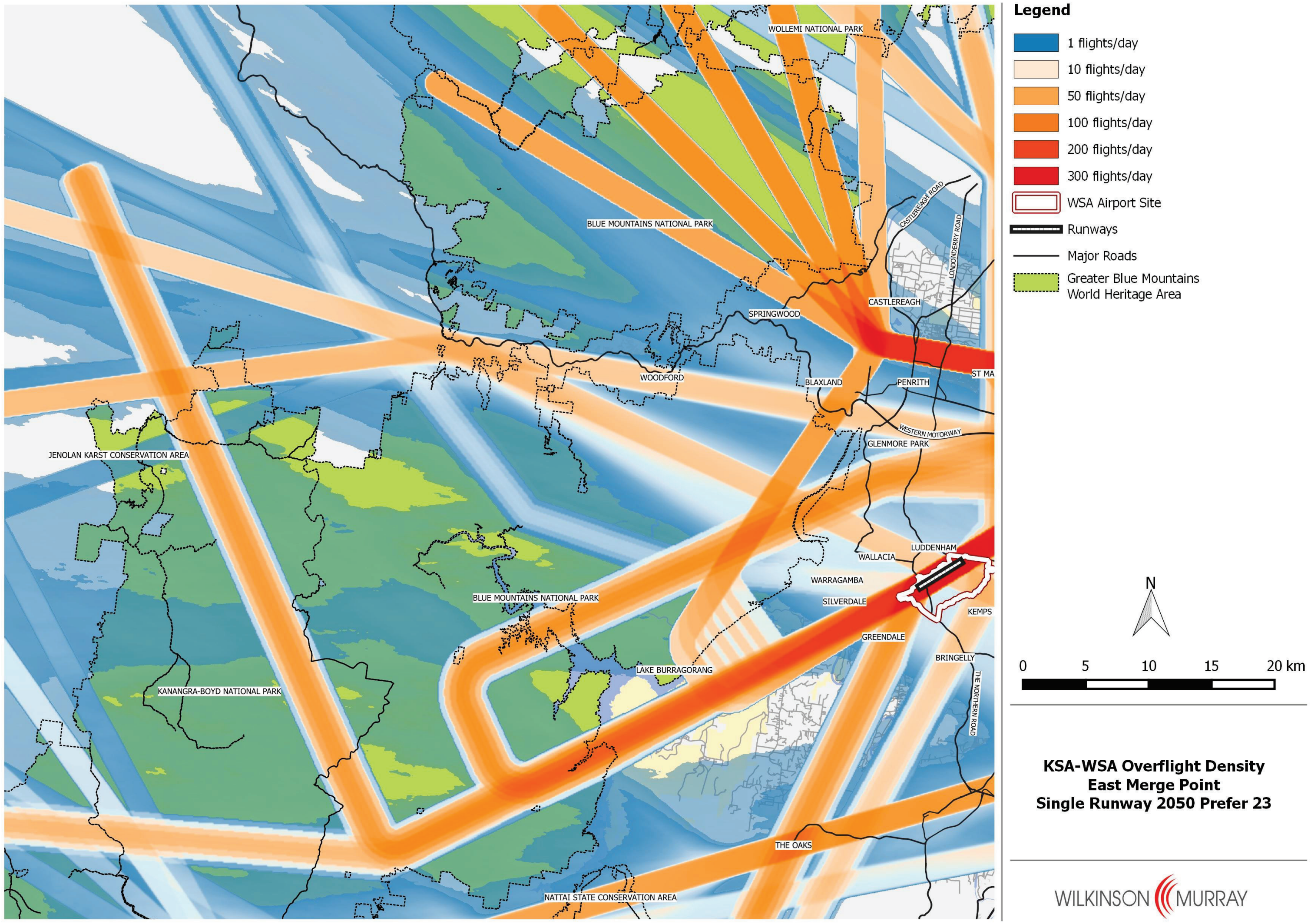
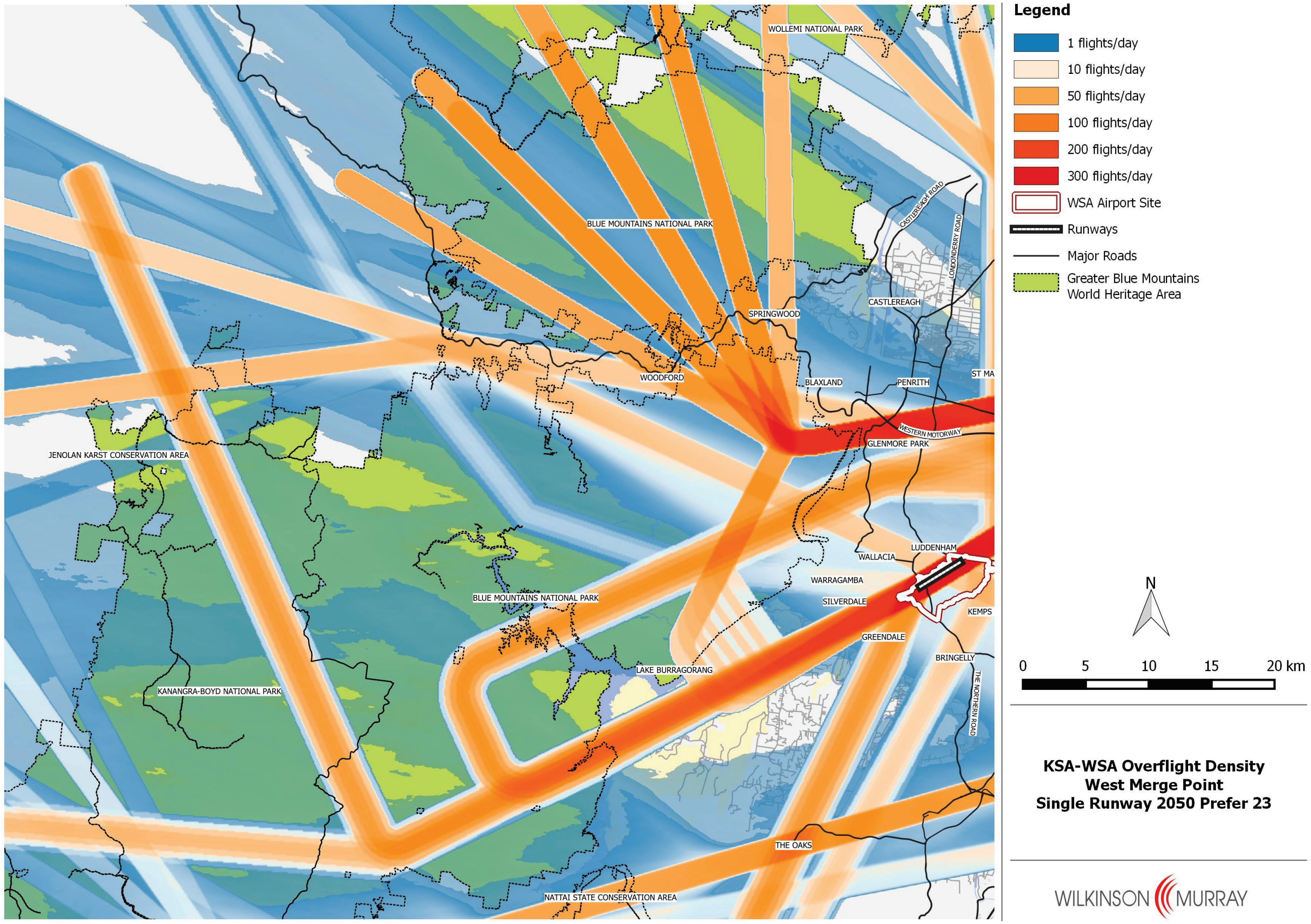


Figure 7-14 Track Density – Existing & WSA 2050 Aircraft Movements – Prefer 23, West Merge Point



8 MITIGATION & MANAGEMENT MEASURES

8.1 Mitigation of Aircraft Noise Impacts

There are three fundamental options for mitigation of aircraft noise:

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

Of these, the possibilities for ensuring reduced aircraft noise emissions are generally limited. However, predictions in this report do incorporate one such measure, namely the use of "continuous descent approach" for all aircraft on all approach paths. The reduction in noise level as a result of this measure depends on the aircraft type and the location of the receiver, but is estimated to be in the order of 0 – 5 dBA.

Aircraft noise emissions have reduced very substantially over the past 30 years. As such, some reduction in aircraft noise emissions over time has been incorporated into the predictions in this report, through altering the mix of aircraft types within "families". However, all aircraft types used in modelling are currently in use, and hence the assumed reduction is considered to be conservative – future noise levels are likely to be, if anything, lower than assumed. There is little opportunity for aircraft designers or regulatory authorities in Australia to directly influence the speed of this reduction.

Much of the analysis in this report is related to the differential impact of alternative airport operating strategies. While various strategies have differing impacts on different populations, it can generally be said that the use of a "Prefer 23" strategy with a "Head-to-Head" mode where possible at night would minimise the number of residents exposed to low-to-medium levels of aircraft noise.

Given the preliminary indicative airspace architecture, areas of the Greater Blue Mountains Area would experience a substantial increase in the number of audible aircraft, at relatively low noise levels. Within the GBMWHA, it is not possible to prevent this impact based on the flight track options modelled, but the locations where it is experienced may be susceptible to alteration. In particular, the location of a "merge point" for arrivals almost directly over the township of Blaxland, while potentially optimal for airspace management, should be reviewed in light of the findings of this report.

Land use planning controls around airports in Australia are based on the recommendations of AS 2021, and it is expected that land use planning around the proposed Western Sydney Airport would be based on a final ANEF chart for the airport. This chart would be prepared on the basis of more detailed planning of the airspace and operating procedures, including consideration of potential environmental impacts and mitigation measures, closer to the time of operations commencing at the proposed airport. This planning process would comply with any requirements for environmental assessment under the EPBC Act.

One important form of mitigation for aircraft noise impacts is the provision of information to both existing and potential residents in areas likely to be affected by noise. This allows potential residents who are particularly sensitive to noise impacts to choose not to move into the area. Information such as that presented in this report can provide a starting point for this process, but other tools, including on-line information systems, can allow greater understanding of the likely impacts at specific locations.

8.2 Monitoring of Aircraft Noise

In Australia noise impacts around major airports are monitored using a Noise and Flight Path Monitoring System (NFPMS) operated by Airservices Australia. As for other airports, a number of permanent monitors should be installed at locations around the proposed airport that are representative of noise impacts at surrounding communities, and monthly results from the monitoring should be available on-line, as are results from other airports.

Airservices' NFPMS collects noise and flight path data at Brisbane, Cairns, Canberra, Gold Coast, Sydney, Melbourne, Essendon, Adelaide and Perth airports. This system operates 24-hours-a-day, 7-days-a-week, collecting data from every aircraft operating to and from the airport. The NFPMS uses monitors located within local communities and is the world's largest, most geographically-spread system of its type.

Noise monitoring is not undertaken to determine compliance with aircraft noise regulations. Rather, it is undertaken to:

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

Airservices also produces quarterly reports that include monitoring information from the NFPMS.

8.3 Existing and Future Operational Framework

A number of planning protections are already in place around the Badgerys Creek airport site following the previous EISs. In the lead up to the airport becoming operational, the Australian Government would work closely with the NSW Government and local governments to identify additional long term planning protections that would be required to be put in place around the proposed airport to minimise incompatible development, including in areas expected to experience noise at the more significant ANEF levels.

Each airport is required to put in place an airport Master Plan which is updated every five years, is subject to public consultation and must be approved by the Minister for Infrastructure. The Master Plan is an important document for managing environmental matters including noise. An airport Master Plan is required to include a number of measures relevant to noise including an endorsed ANEF chart, flight paths and plans for managing aircraft noise intrusion in areas forecast to be subject to exposure above the significant ANEF levels.

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

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

Major developments that would significantly increase the capacity of the airport to handle additional aircraft movements beyond those accommodated by the Stage 1 development are likely to require a major development plan to be developed by the airport lessee company. This would be provided for public consultation and proposed for approval by the Infrastructure Minister. The current design for both the proposed airport and airspace is indicative, and the noise modelling presented in this report would be subject to further detailed design and assessment closer to the commencement of operations of the proposed airport. When it does commence, some aspects of airport operations could be introduced to mitigate noise impacts on the community such as flight path planning, preferred runway directions and continuous descent approaches.

It is important to note that the proposed airport has a lengthy construction period and current planning is for the airport to commence operations in about 2025. In this timeframe, technological improvements, including the upgrading of airline fleets, are expected to continue to reduce the industry's noise impacts on communities. These and other potential improvements would be considered in formal airspace design and assessment processes in the future.

Therefore, it is anticipated that the Government would pursue the development of a noise management plan in consultation with appropriate stakeholders. This plan would be developed in parallel with the detailed airport design and future airspace review to provide the local community and other important stakeholders with the chance to be consulted and fully informed of the final expected impacts before the airport commences operations.

9 CONCLUSIONS

Conclusions regarding noise impacts of aircraft overflights associated with the proposed Western Sydney Airport project of the Stage 1 development (nominally 2030), which is proposed for approval, and the subsequent future development (nominally 2050 and Long Term), being subject of future approvals, are as follows.

9.1 Stage 1 (nominally 2030)

For the initial stage of the proposed airport development – that is, nominal year 2030 – conclusions from the assessment may be summarised as follows.

Maximum noise levels:

- For the loudest aircraft operations (medium-range departures by Boeing 747 aircraft or equivalent), maximum noise levels over 85 dBA would be experienced at a small number of residential locations close to the airport site, in the area of Badgerys Creek. Maximum noise levels of 70 – 75 dBA could be expected within built-up areas in St Marys and Erskine Park due to these worst-case operations, which are predicted to occur on average once per day in Stage 1.
- Maximum noise levels due to more common aircraft types such as Airbus A320 or equivalent are predicted to be 60 – 70 dBA in built-up areas around St Marys and Erskine Park, and over 70 dBA in some adjacent rural residential areas to the south-west of the airport, notably the area of Greendale on a "Prefer 05" operating strategy.

Noise impact over 24 hours:

- In Stage 1, the airport operating strategy is predicted to have a minor impact on the total number of residents affected at various noise levels over 24 hours, although the location of the affected residents differs. The "Prefer 23" strategy results in fewer people being affected at lower noise levels (generally to the north of the airport), but this is offset by more people being affected at higher noise levels – generally in rural residential areas to the south and west of the airport.
- Under any of the considered operating strategies, approximately 1,500 people are predicted to be exposed to at least five aircraft operations per day with maximum levels exceeding 70 dBA. None of these are in built-up residential areas.

Night Time Noise Impact:

- The extent of night time noise impact depends strongly on the airport operating strategy, and in particular, the adoption of a "Head-to-Head" operating mode when practicable. This results in approximately 4,300 residents being exposed to more than 5 aircraft noise events per night above 60 dBA, none of whom are in built-up residential areas. An outside noise level of 60 dBA corresponds to an internal level of approximately 50 dBA if windows are open to a normal extent, which is the design criterion for aircraft noise in sleeping areas under Australian Standard 2021. Under the above strategy, the affected residents would be largely in rural residential areas to the south-west of the airport, including Greendale and parts of Silverdale. However, some residents to the north-east of the airport around Horsley Park would also be affected.

- Airport operating strategies that do not include a "Head-to-Head" mode are predicted to result in substantially greater numbers of residents impacted by night time noise, and in particular, a "Prefer 05" strategy would result in large parts of St Marys experiencing more than 5 aircraft noise events per night above 60 dBA in Stage 1.

Land Use Planning:

- In ANEC contours produced for the Stage 1 scenario, the area covered by the 20 ANEC contour is centred closely around the airport, with only an estimated 211 – 266 residents living within the contour. However, because land use planning guidelines are intended to address long-term planning issues, ANEC contours for long term scenarios are considered more relevant. An ANEF chart based on further formal flight path design would need to be produced for endorsement by Airservices Australia prior to the commencement of airport operations to inform land use planning.

Greater Blue Mountains Area:

- Based on the indicative airspace design for the proposed airport, large areas of the Greater Blue Mountain World Heritage property would not experience substantial aircraft noise. However, some parts of the property would be subjected to a substantial increase in aircraft overflights. The aircraft would be at heights generally greater than 5,000 feet above ground level. Maximum noise levels may occasionally reach 60 dBA at some points, but levels directly under a flight track would typically be below 55 dBA, and often much lower. The periodic intrusion of aircraft noise may result in occasional disturbance by recreational and other visitors to the property .

- At locations directly under indicative flight tracks, the number of audible aircraft overflights could be over 70 per day in Stage 1. Worst-case locations would be under one of two approach paths that emanate from a "merge point" in the area of the lower Blue Mountains.

- The nominal location of this merge point based on the indicative flight tracks would be almost directly over the township of Blaxland, meaning that in Stage 1, residents could expect to experience aircraft overflights at significant altitude (typically over 5000 ft above ground level) almost 100 times per day, with maximum noise levels ranging up to 55 dBA.

Alternative locations for this merge point were considered within about 3 NM from the nominated location. Use of these alternative merge points would substantially reduce the number of overflights passing over populated areas, but would result in other locations within the World Heritage Area experiencing a similar number of overflights to those currently predicted for Blaxland.

9.2 Additional Capacity Scenario (2050)

Maximum noise levels:

- Predicted aircraft operations now include longer-range departures by B747 or equivalent aircraft. For these operations, maximum noise levels over 85 dBA would be experienced at a small number of residential locations close to the airport site, in the area of Badgerys Creek. Maximum noise levels of 75 – 80 dBA can be expected within built-up areas in St Marys and Erskine Park due to these worst-case operations, which are predicted on average to occur once every two days in 2050. These operations may occur during day or night periods.

Maximum noise levels due to more common aircraft types, such as Airbus A320 or equivalent would be the same as those described above for Stage 1.

- In 2050, there is a very substantial difference between the "Prefer 05" and "Prefer 23" operating strategies in terms of noise impact.
- Most residents affected under the "Prefer 05" strategy are in suburbs to the north, around St Marys and Erskine Park. In terms of total population affected, the "Prefer 05" strategy has a greater impact, with approximately 30,000 residents experiencing more than five events per day over 70 dBA in 2050, compared with approximately 5,000 residents for the "Prefer 23" strategy. These numbers would be reduced slightly if a "Head-to-Head" mode was also adopted.
- Under the "Prefer 23" strategy, the residents predicted to experience the greatest number of overflights over 70 dBA are in rural residential areas to the south-west, including Greendale and parts of Silverdale. These residents would be affected to a greater extent than those to the north – approximately 700 residents would experience more than 100 events per day above 70 dBA, compared with 300 residents under the "Prefer 05" operating strategy.

Night Time Noise Impact:

- The extent of night time noise impact also depends strongly on the airport operating strategy. The most favourable strategy from the point of view of noise impact would be "Prefer 23 with Head-to-Head", which would result in approximately 40,000 residents being exposed to more than 5 aircraft noise events per night above 60 dBA. The affected residents would be largely in s to the north-east of the airport around Horsley Park, Blacktown and St Marys.
- Airport operating strategies that do not include a "Head-to-Head" mode are predicted to result in substantially greater numbers of residents impacted by night time noise, and in particular, a "Prefer 05" operating strategy would result in large parts of St Marys experiencing more than 20 aircraft noise events per night above 60 dBA in 2050.

Land Use Planning:

- Based on airport usage patterns projected for this report, 20 ANEC contours for the 2050 scenario cover areas that are currently largely rural residential in nature, with some industrial use. No areas of built-up residential development are included in the 20 ANEC contour under any operating strategy. The "Prefer 23 with Head-to-Head" strategy results in the smallest area being covered.
- One point of interest is that an area to the west of the airport site, including the townships of Warragamba and Silverdale, although relatively close to the proposed airport, is not included in the 20 ANEC contour under any operating strategy. This is due to the fact that although a departure track is located over this area, the track is designated as being for use by non-jet aircraft only. The ANEC contours presented in this report should not be used for land use planning purposes until the validity of all underlying assumptions has been confirmed. As noted above, an ANEF chart, based on further formal flight path design would need to be produced for endorsement by Airservices Australia prior to the commencement of airport operations to inform land use planning.

Greater Blue Mountains Area:

- Parts of the Greater Blue Mountains World Heritage Area would be subjected to larger numbers of aircraft overflights compared to the Stage 1 scenario. As in Stage 1, the aircraft would be at heights generally greater than 5,000 feet. Maximum noise levels may occasionally reach 60 dBA at some points, but levels directly under a flight track would typically be below 55 dBA, and often much lower. The intrusion of aircraft noise may result in some disturbance to recreational and tourist visitors to the property in areas – under a flight track.
- At locations directly under indicative flight tracks, the number of audible aircraft overflights could be over 200 per day in 2050. Worst-case locations would be under one of two approach paths that emanate from a "merge point" in the area of the lower Blue Mountains.
- As for the Stage 1 scenario, the nominal location of this merge point based on the indicative flight tracks would be almost directly over the township of Blaxland, and in 2050 residents could expect to experience aircraft overflights at significant altitude (typically over 5000 ft) some 230 times per day, with maximum noise levels ranging up to 55 dBA.
- As for the Stage 1 scenario, the use of alternative merge points would substantially reduce the number of overflights passing over populated areas, but would result in other locations within the World Heritage Area experiencing a similar number of overflights to those currently predicted for Blaxland.

9.3 Long Term Airport Development (nominally 2063)

- In considering future projected impacts from an airport comprising two runways, nominally in 2063, the proposed airport's operating strategy would again have a significant bearing on the noise outcomes. A number of alternative airport operating modes may be available under conditions of low traffic volume, and these may result in reduced noise impacts, particularly at night. However, at the time of production of this report, it was not possible to identify which modes could be available and under what conditions. Hence in this report, only the two basic operating strategies – "Prefer 05" and "Prefer 23" are considered.
- Predicted noise impacts for the long term development are similar to those described above for the modelled single runway scenarios and occur in similar areas. However, the total number of residents affected is generally higher, largely as a result of population growth and ongoing housing development. For example, under a "Prefer 23" operating strategy, the number of residents experiencing more than 5 events per day above 70 dBA is estimated at approximately 17,000 (compared with 5,000 nominally in 2050).
- ANEC contours for this case are similar to those for the 2050 scenario, although somewhat larger. Once again, the 20 ANEF contour does not enclose any existing built-up residential areas, and does not include the townships of Warragamba and Silverdale.

9.4 Options for Noise Mitigation

There are three fundamental options for mitigation of aircraft noise:

- reduce noise emissions from the aircraft themselves;
- plan flight paths and airport operating modes to achieve lower impacts over noise-sensitive areas; and

- develop land use planning or other controls to ensure that future noise-sensitive uses are not located in noise-affected areas.

With respect to the first point, the use of continuous descent approaches has already been adopted in noise assessments for this report, and at this time there appear to be no other feasible options by which noise emissions from an aircraft in flight could be reduced through alternative operating procedures.

It is difficult to foresee the magnitude of future reductions in aircraft noise emission levels, as this is primarily the role of aircraft designers and manufacturers, and while reduced noise levels are highly desirable, they are one of many outcomes that aircraft designers strive to achieve in newer aircraft.

In fact, aircraft noise emissions have reduced very substantially over the past 30 years. Although it is very likely that noise emission from future aircraft will also be lower than for current aircraft, due to the absence of specific information this report has adopted a conservative approach by modelling future aircraft types on the basis of existing noise emission levels. This is reflected in the inclusion of B747 or equivalent aircraft in the assumed fleet mix in all scenarios. By 2030 the number of operations by this aircraft type at the proposed airport is expected to be very low.

The mitigation measures most relevant to the EIS process, and for which detailed preliminary noise impact information has been provided in this report, are related to airspace design and airport operating modes. While both these issues are subject to their own specific objectives and legislation, consideration of environmental impact is one important consideration in the future design process. This report canvasses a number of options and considers the range of possible outcomes for each.

The indicative airspace design, and particularly the location of the "merge point" for arriving aircraft, provides some flexibility for reducing the noise exposure of residents in the lower Blue Mountains.

However, in considering both airspace design and the selection of operating modes, it should be noted that competing interests will include the safety of all aircraft, consideration of other airspace users, and aircraft fuel consumption. Some of these may compete with the aim of lowering environmental noise impact.

With respect to planning issues, since the 1980s the NSW Government and local governments have been actively planning for an airport at Badgerys Creek and have undertaken a number of steps aimed at limiting future noise exposure of the residential population. These have included zoning land near the airport as appropriate for less sensitive uses, as well as ensuring that local government has planning procedures in place to limit sensitive uses in areas potentially affected by aircraft overflight noise. This has limited the potential noise impact from an urban greenfield airport to a level that is lower than would otherwise be expected for a development of this type and scale.

One important form of mitigation for aircraft noise impacts is the provision of information to both existing and potential residents in areas likely to be affected by noise. This allows potential residents who are particularly sensitive to noise impacts to choose not to move into the area. Information presented in this report provides a starting point for this process, but other tools, including the website information tool, can help to facilitate a greater understanding of the likely impacts at specific locations.

It is understood that should the Australian Government decide to proceed with development of the proposed airport, more detailed planning of the airspace design and operating procedures, including consideration of potential environmental impacts and mitigation measures, would be undertaken in consultation with industry and stakeholders.

The current design for both the proposed airport and airspace is indicative, and the noise modelling presented in this report would be subject to further detailed design and assessment closer to the commencement of operations. When it does commence, some aspects of airport operations could be introduced to mitigate noise impacts on the community such as flight path planning, preferred runway directions and continuous descent approaches.

10 REFERENCES

- Airservices Australia 2015, *Preliminary Airspace Management Analysis, Final Draft Report, April 2015*

- Standards Australia, 2015. *Australian Standard 2021-2015, Acoustics – Aircraft noise intrusion – Building siting and construction*

- Department of Infrastructure and Transport, 2012 Joint Study on Aviation Capacity in the Sydney Basin,

  http://westernsydneyairport.gov.au/sydney_av_cap/index.aspx

- Department of Infrastructure and Transport, 2013 A Study of Wilton and RAAF Base Richmond for civil aviation operations,

  http://westernsydneyairport.gov.au/scopingstudy/index.aspx

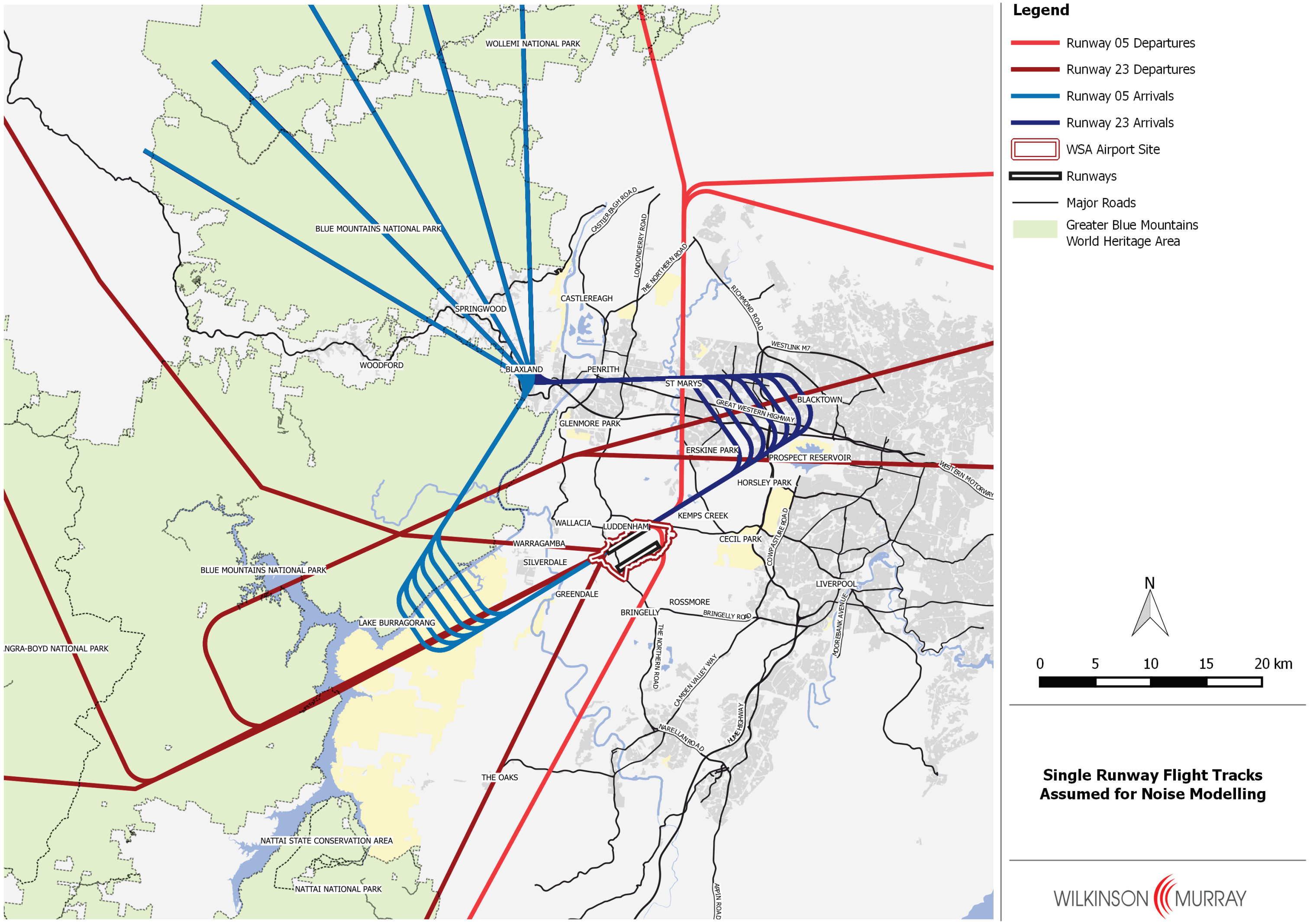
- Department of Transport and Regional Services 2002 *Expanding Ways to Describe and Assess Aircraft Noise*,

https://infrastructure.gov.au/aviation/environmental/transparent_noise/expanding/index.aspx

APPENDIX A

PRELIMINARY INDICATIVE FLIGHT TRACKS – STAGE 1

Figure-A1 Flight Tracks Modelled for Initial Development (Single Runway – All Operating Modes Combined)

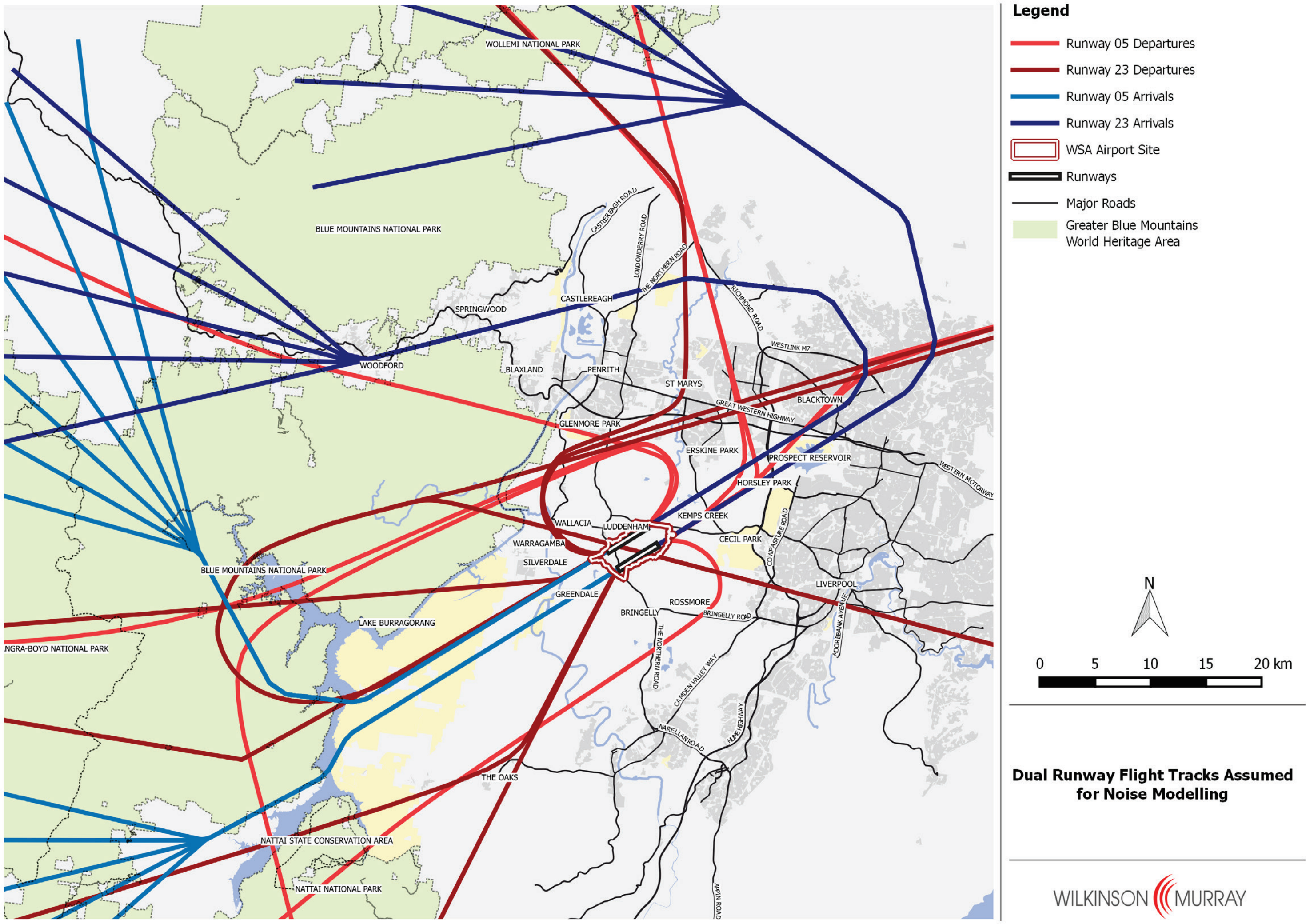


Single Runway Flight Tracks Assumed for Noise Modelling

APPENDIX B

PRELIMINARY INDICATIVE FLIGHT TRACKS – LONG TERM DEVELOPMENT

Figure-B1 Flight Tracks Modelled for Long Term Development (Dual Runway – All Operating Modes Combined)



APPENDIX C

COMPARISON OF SUMMER, WINTER & ANNUAL CONTOURS

Figure C-1 N70 Contours – Stage 1 – Prefer 05 – Summer

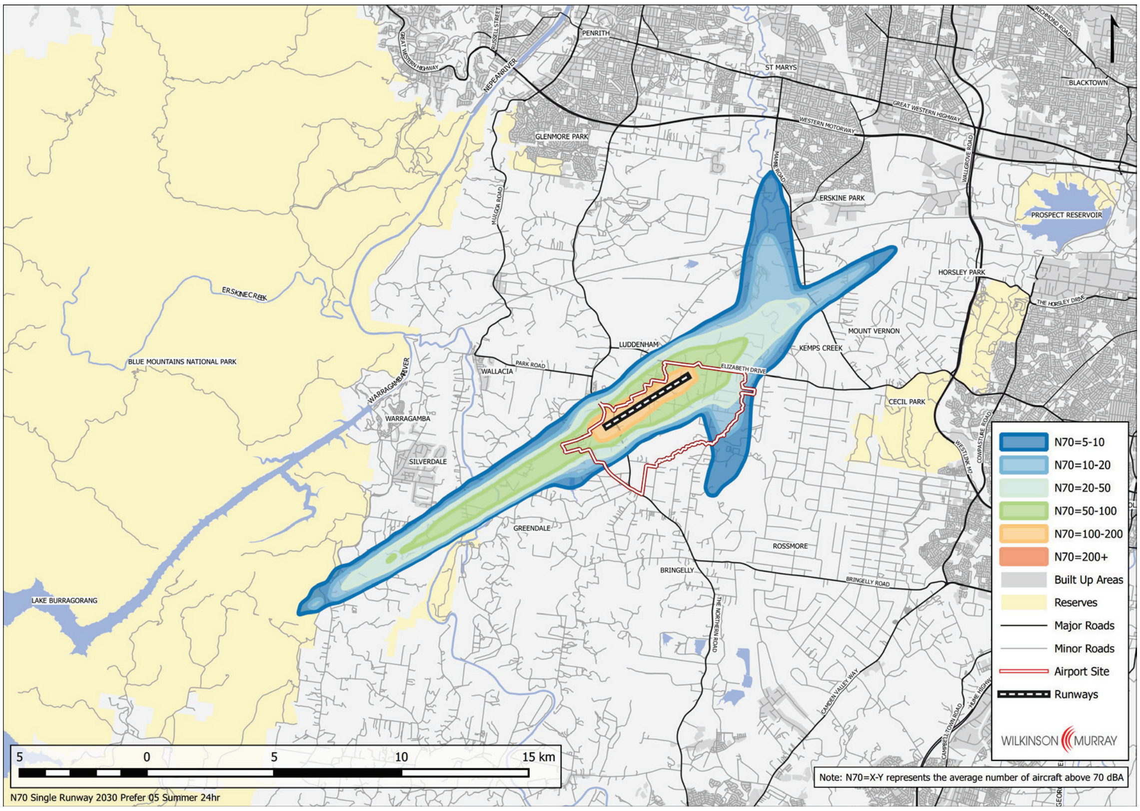


Figure C-2 N70 Contours – Stage 1 – Prefer 05 – Winter

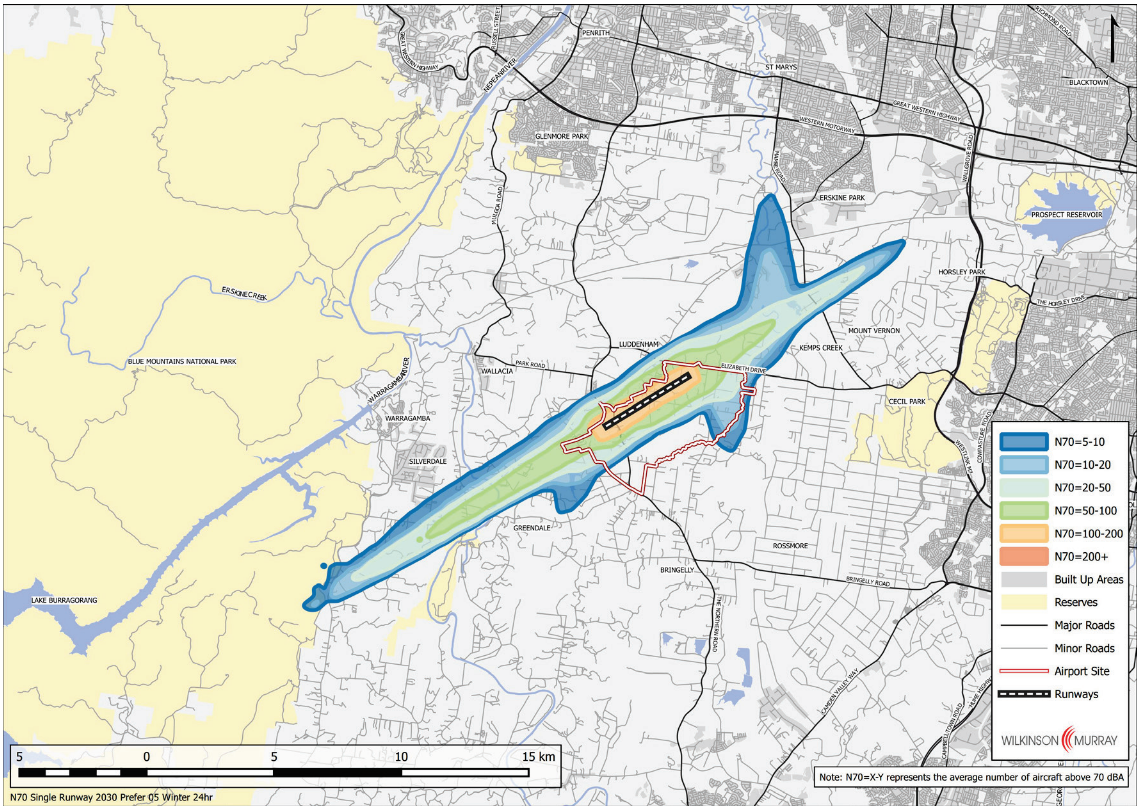
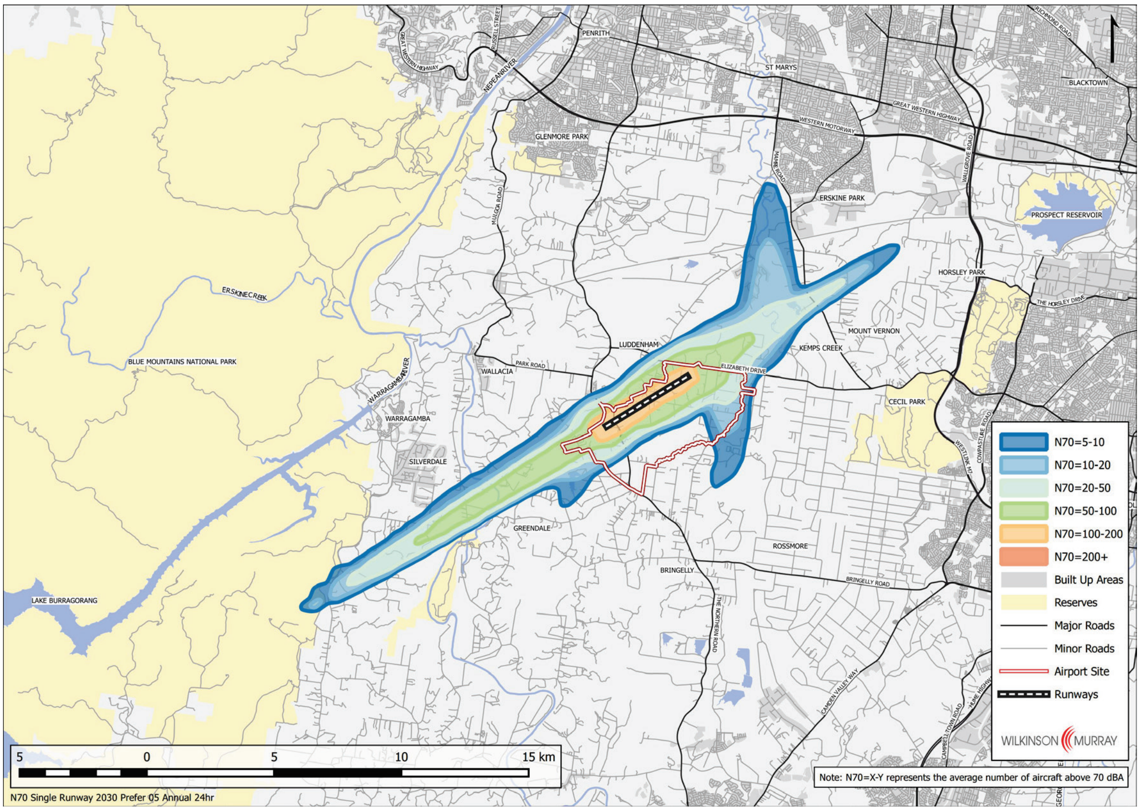
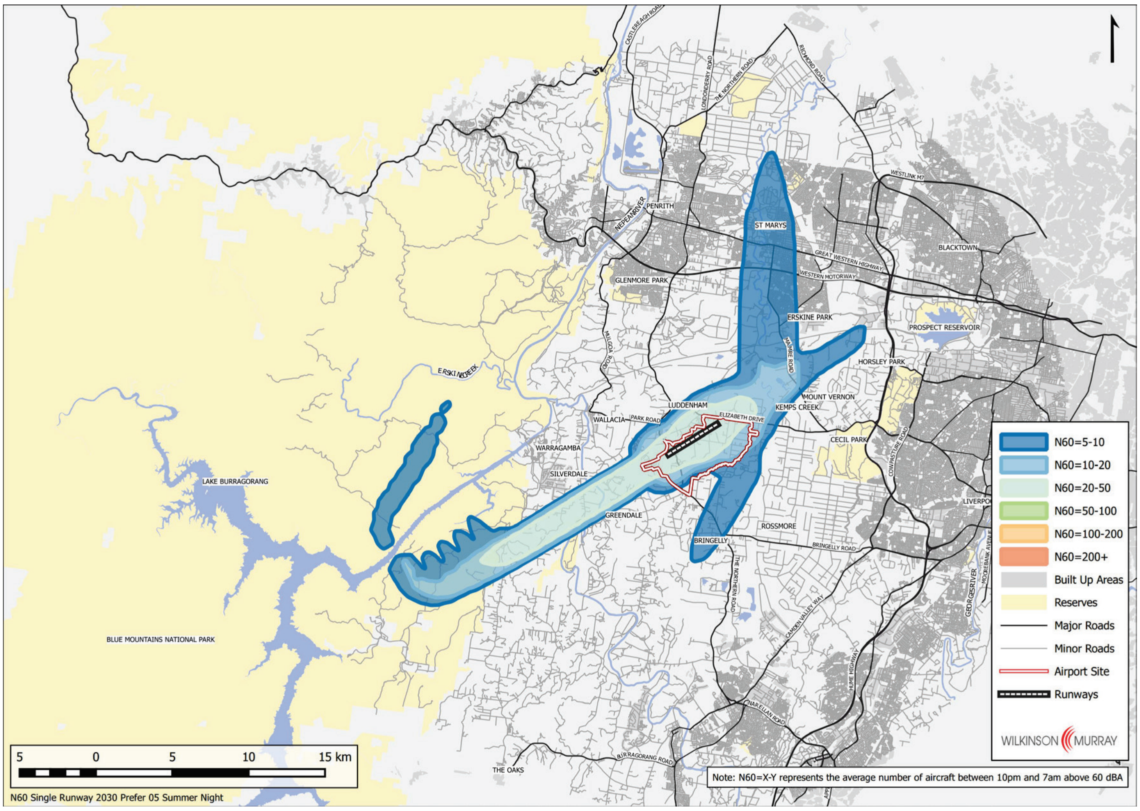


Figure C-3 N70 Contours – Stage 1 – Prefer 05 – Annual



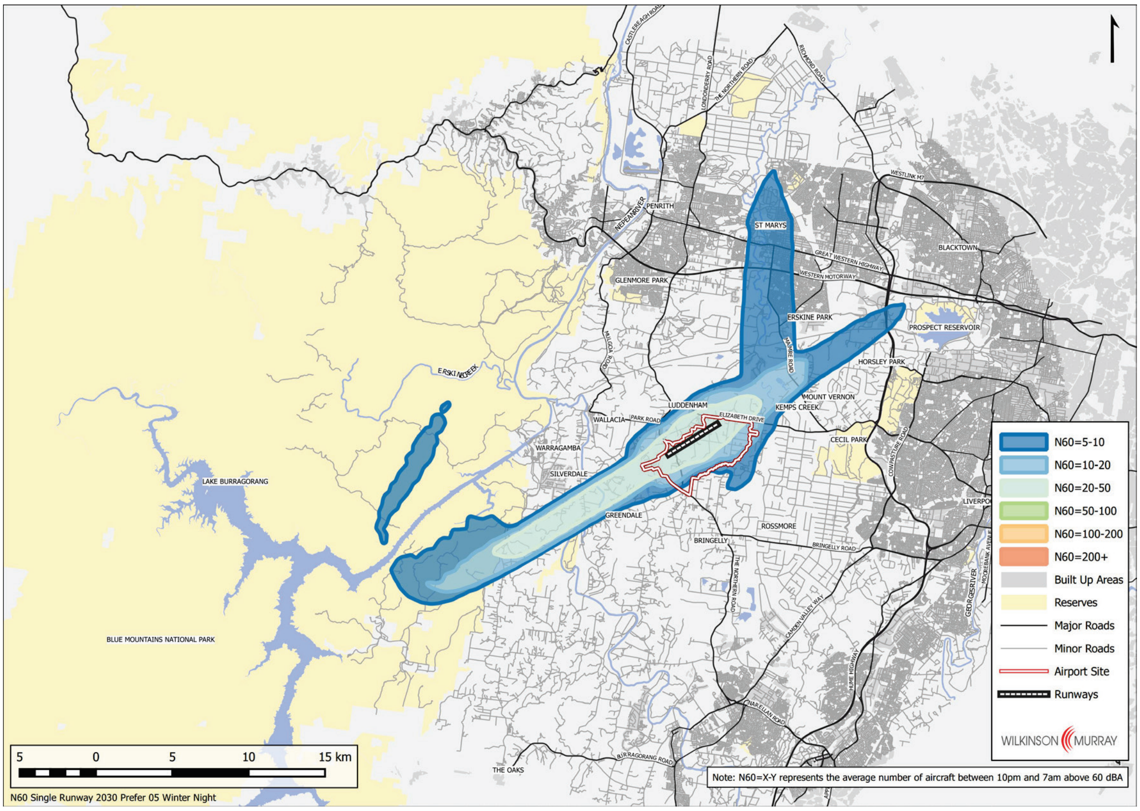
Note: N70=X-Y represents the average number of aircraft above 70 dBA

Figure C-4 N60 Contours – Stage 1 – Prefer 05 – Summer



Note: N60=X-Y represents the average number of aircraft between 10pm and 7am above 60 dBA

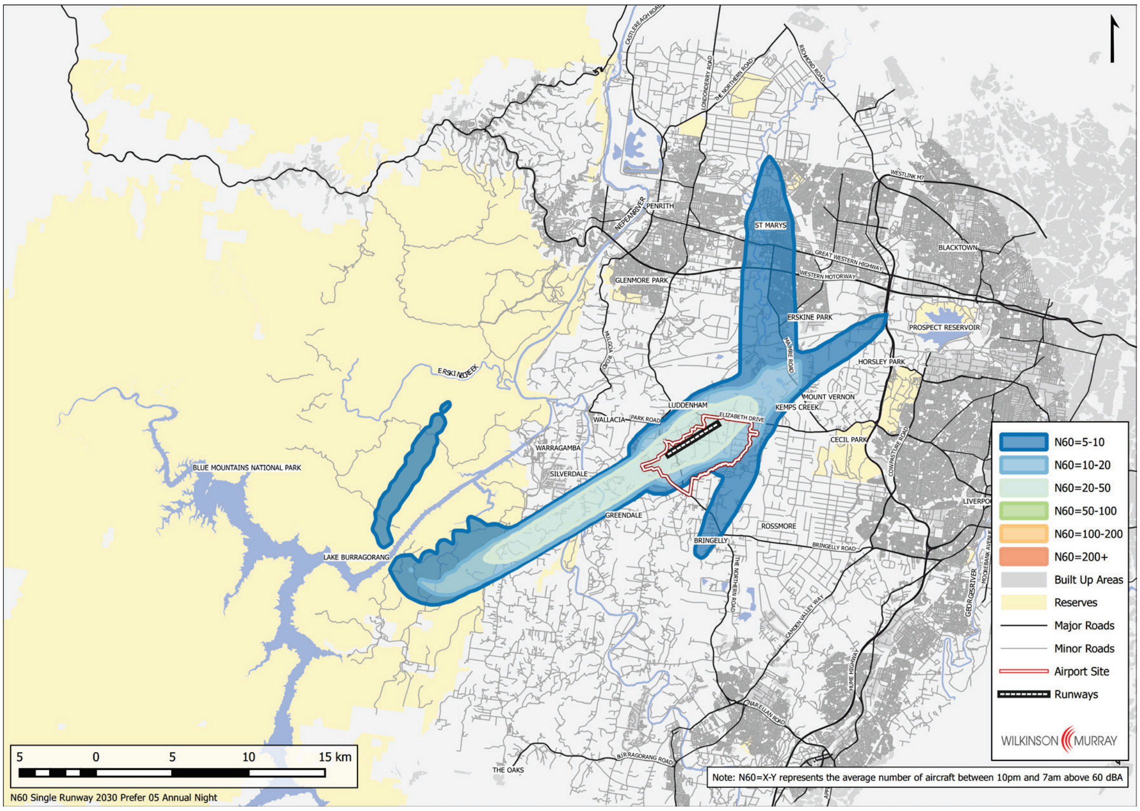
Figure C-5 N60 Contours – Stage 1 – Prefer 05 – Winter



Note: N60=X-Y represents the average number of aircraft between 10pm and 7am above 60 dBA

N60 Single Runway 2030 Prefer 05 Winter Night

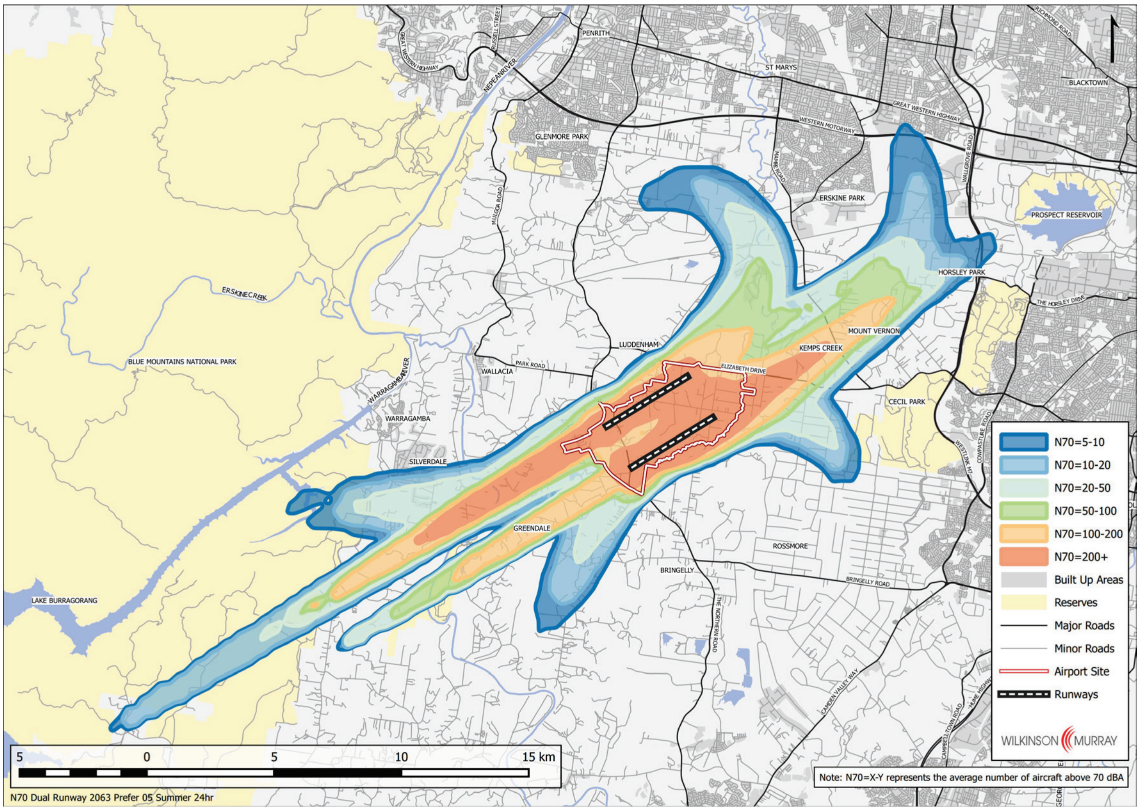
Figure C-6 N60 Contours – Stage 1 – Prefer 05 – Annual



Note: N60=X-Y represents the average number of aircraft between 10pm and 7am above 60 dBA

N60 Single Runway 2030 Prefer 05 Annual Night

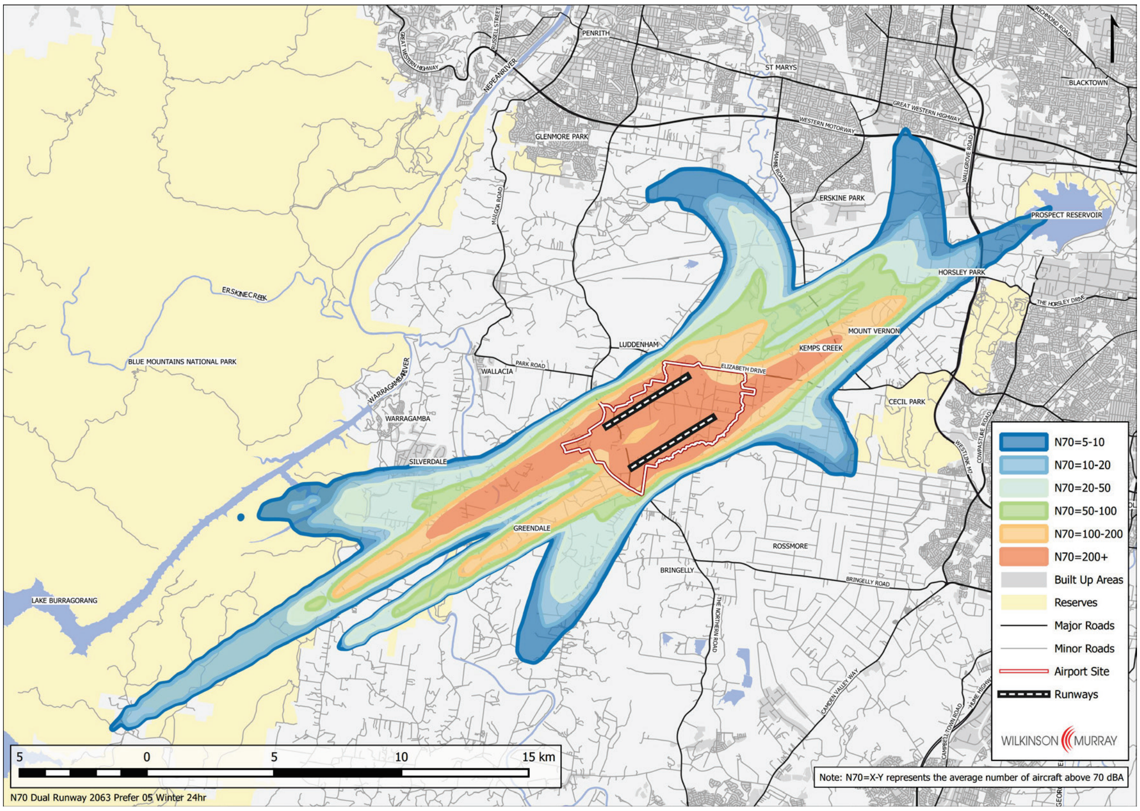
Figure C-7 N70 Contours – Long Term – Prefer 05 – Summer



Note: N70=X-Y represents the average number of aircraft above 70 dBA

N70 Dual Runway 2063 Prefer 05 Summer 24hr

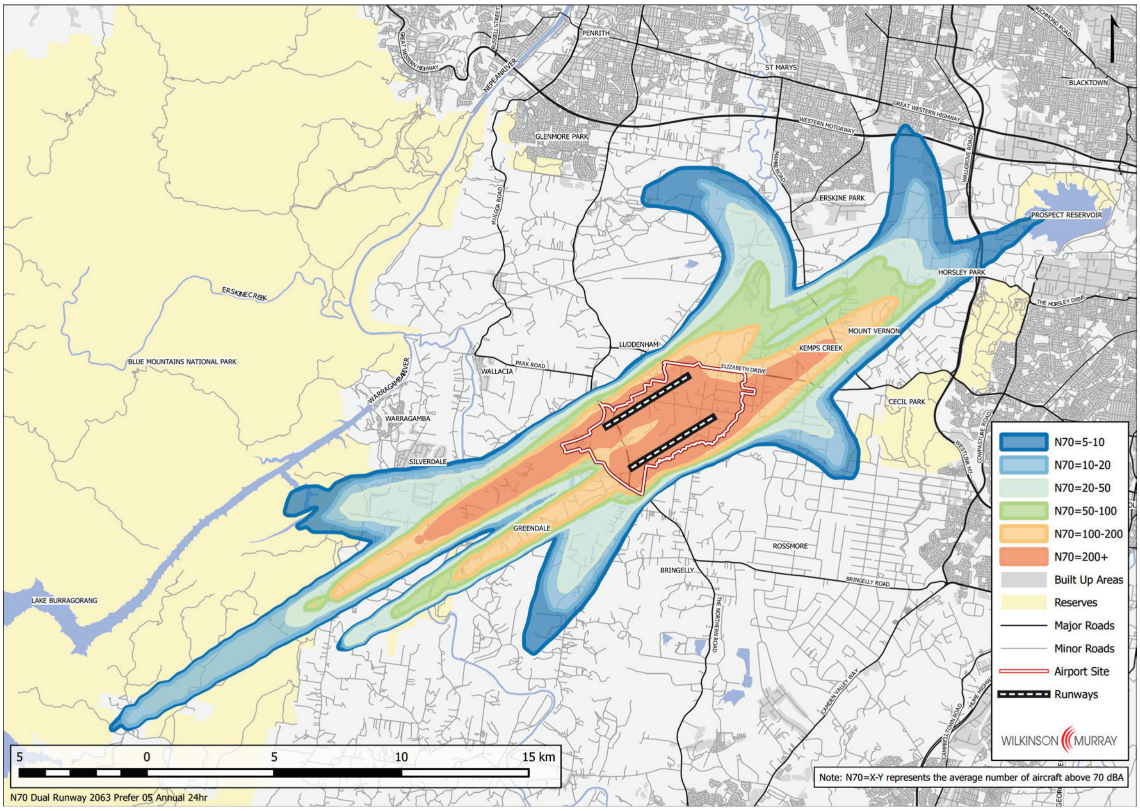
Figure C-8 N70 Contours – Long Term – Prefer 05 – Winter



Note: N70=X-Y represents the average number of aircraft above 70 dBA

N70 Dual Runway 2063 Prefer 05 Winter 24hr

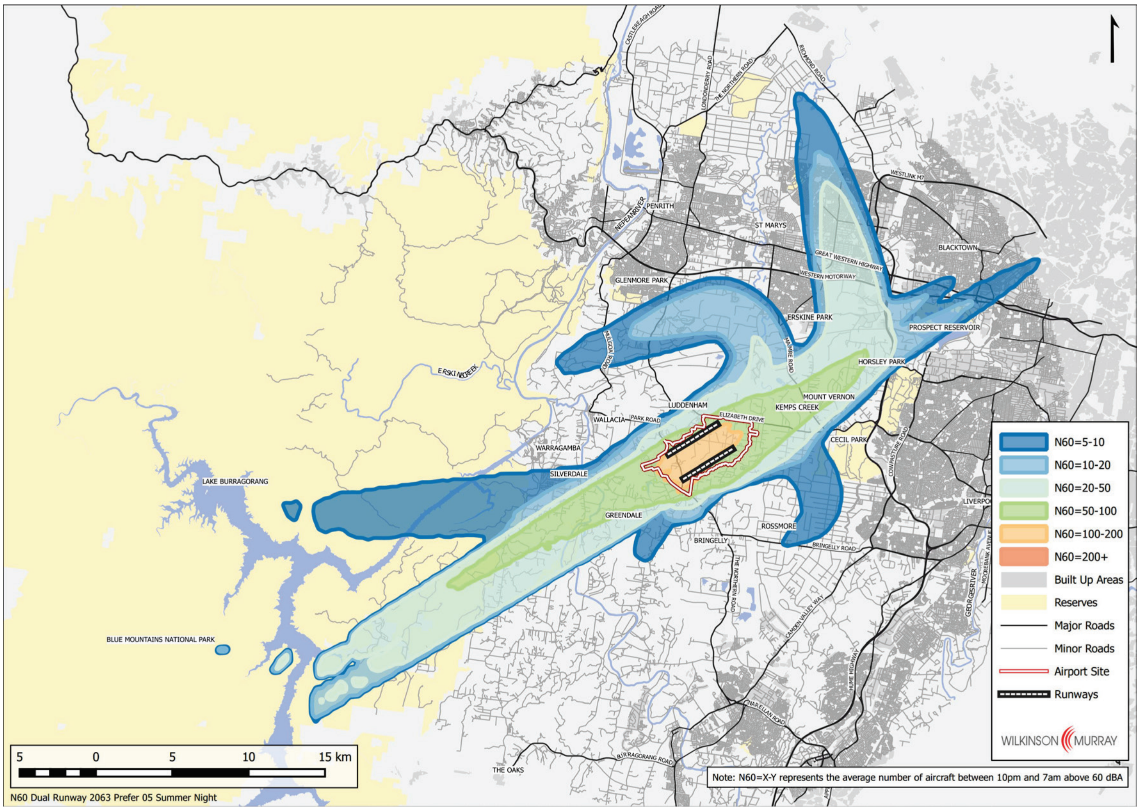
Figure C-9 N70 Contours – Long Term – Prefer 05 – Annual



Note: N70=X-Y represents the average number of aircraft above 70 dBA

N70 Dual Runway 2063 Prefer 05 Annual 24hr

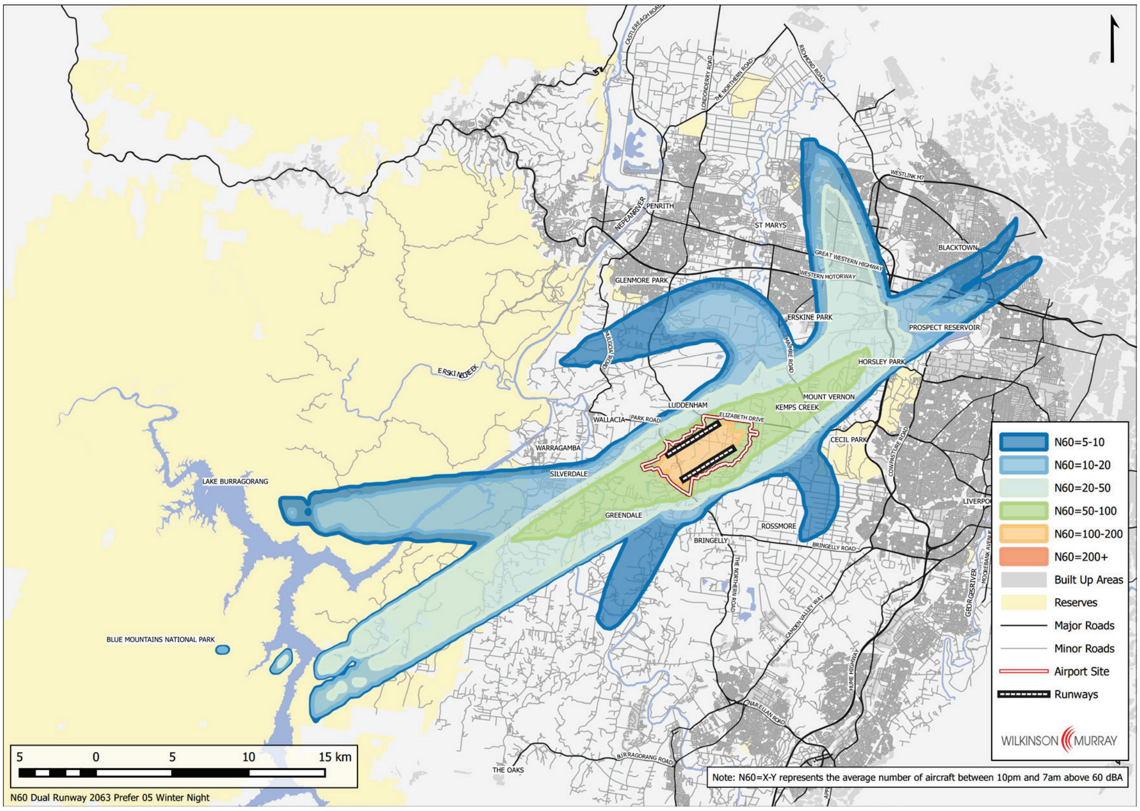
Figure C-10 N60 Contours – Long Term – Prefer 05 – Summer



Note: N60=X-Y represents the average number of aircraft between 10pm and 7am above 60 dBA

N60 Dual Runway 2063 Prefer 05 Summer Night

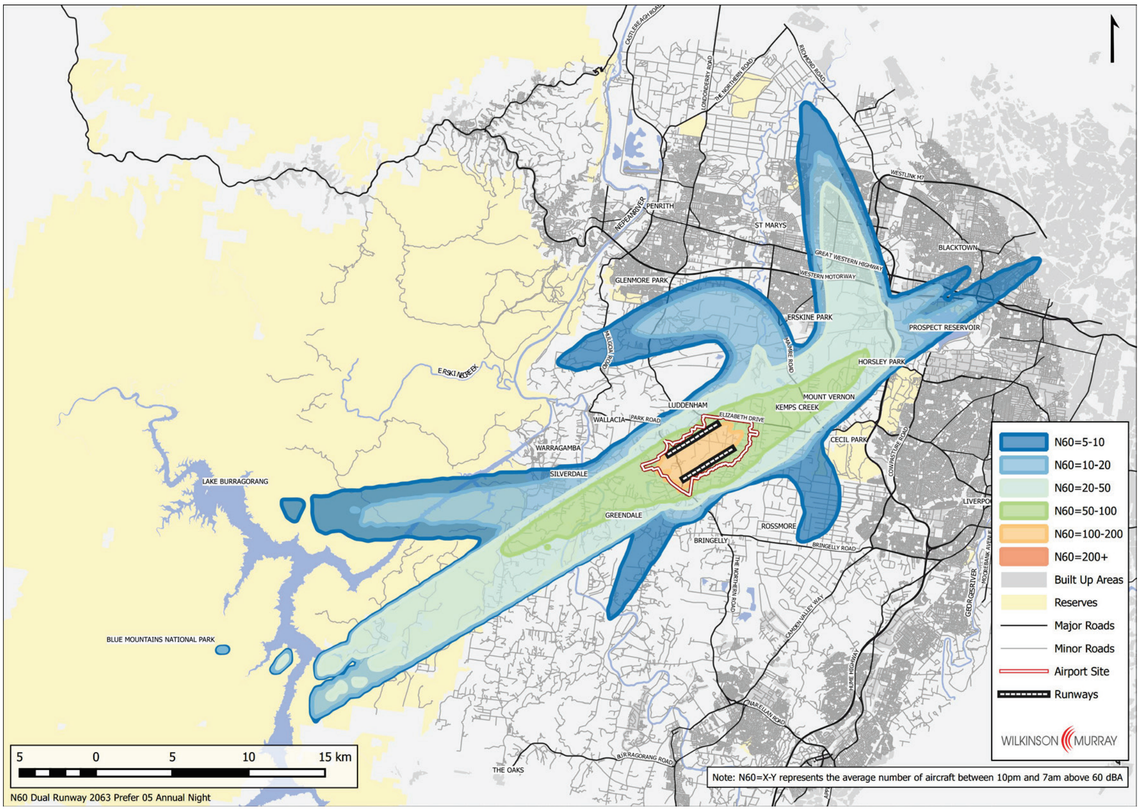
Figure C-11 N60 Contours – Long Term – Prefer 05 – Winter



Note: N60=X-Y represents the average number of aircraft between 10pm and 7am above 60 dBA

N60 Dual Runway 2063 Prefer 05 Winter Night

Figure C-12 N60 Contours – Long Term – Prefer 05 – Annual



Note: N60=X-Y represents the average number of aircraft between 10pm and 7am above 60 dBA

N60 Dual Runway 2063 Prefer 05 Annual Night

APPENDIX D

GBMWHA FLIGHT DENSITY PLOTS FOR AIRCRAFT BELOW 5000 FT

Figure D-1 Track Density of Existing 2015 Aircraft Movements below 5000 ft

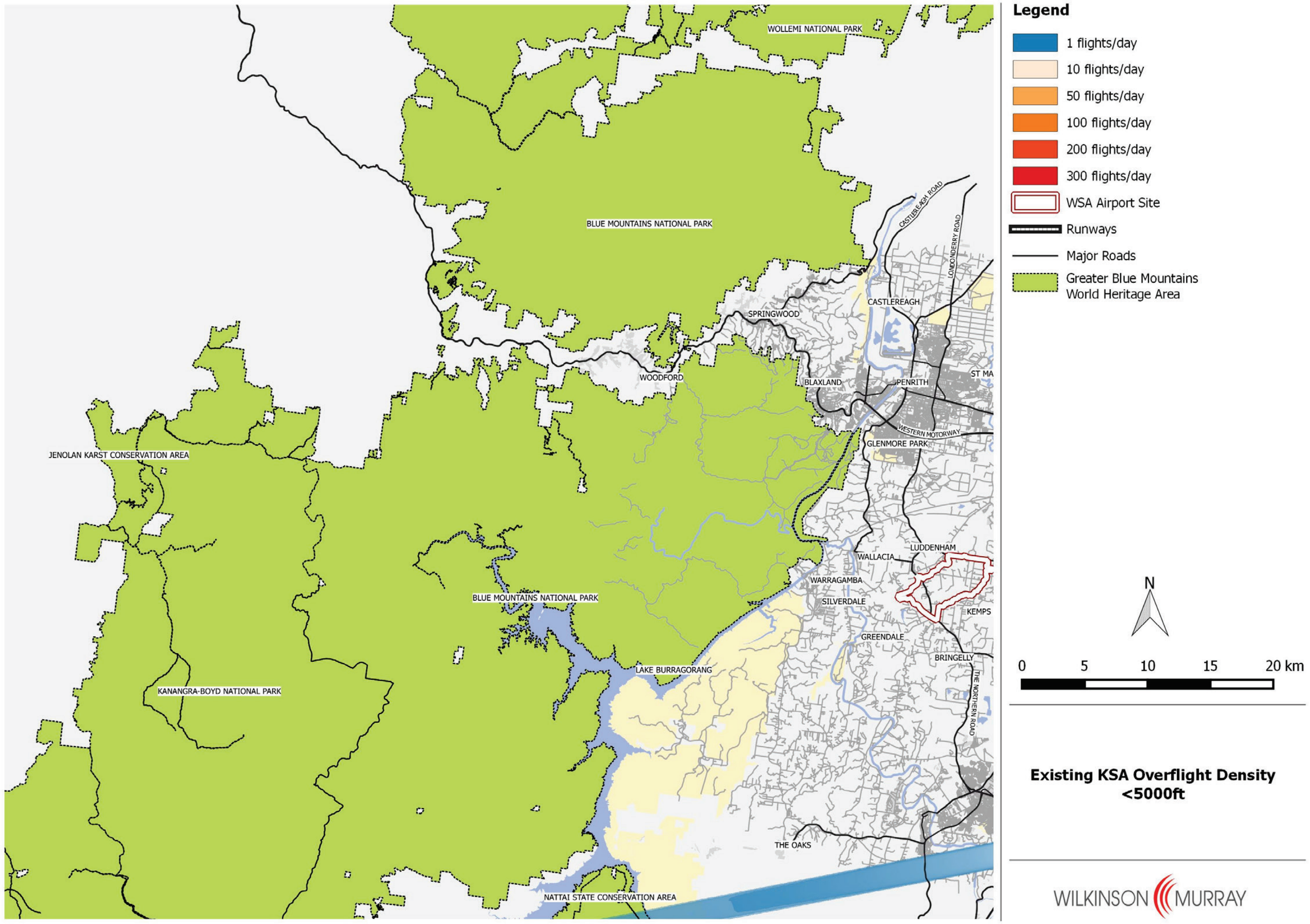


Figure D-2 Track Density – Existing & WSA Stage 1 Aircraft Movements – Prefer 05

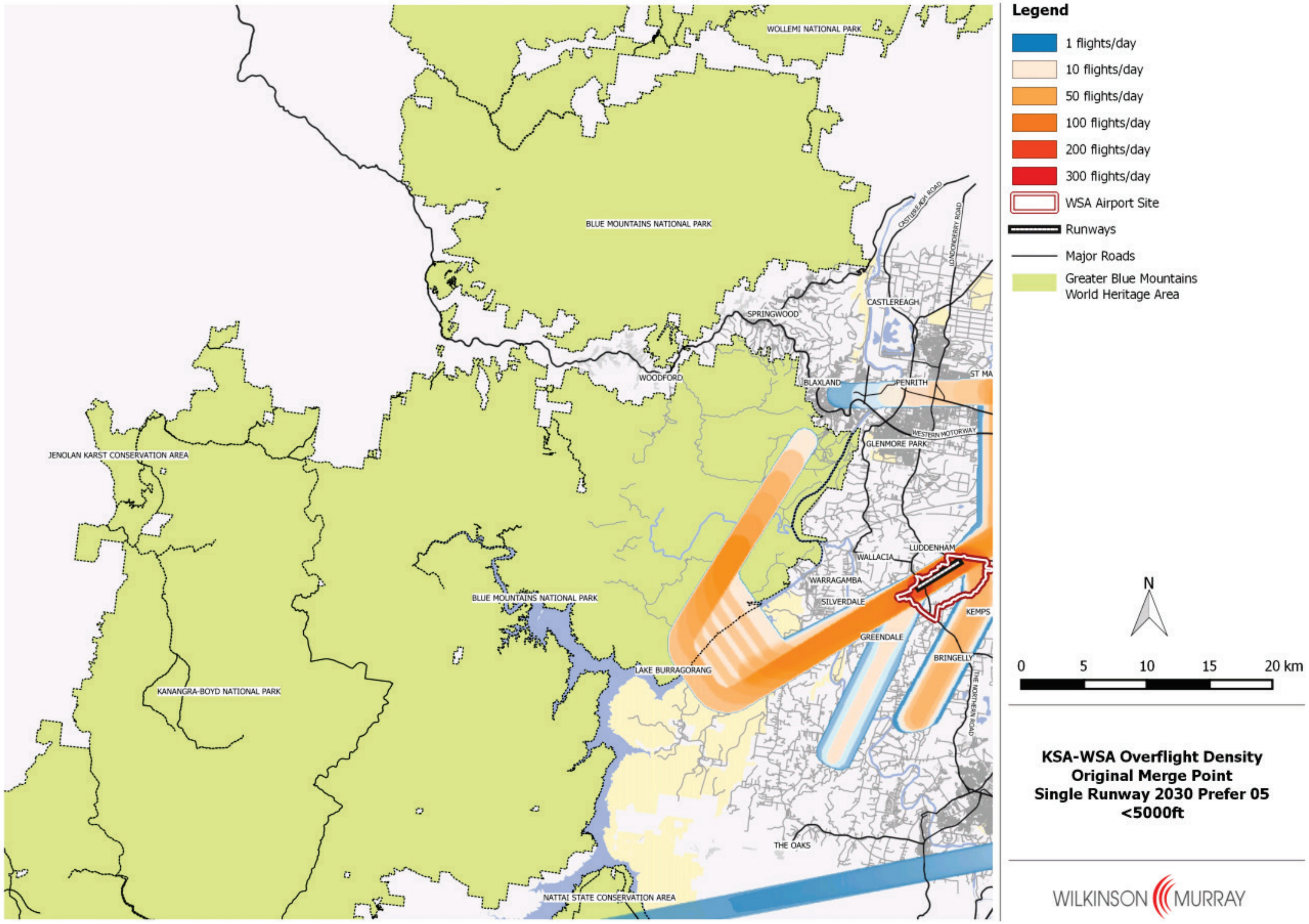


Figure D-3 **Track Density – Existing & WSA Stage 1 Aircraft Movements – Prefer 23**

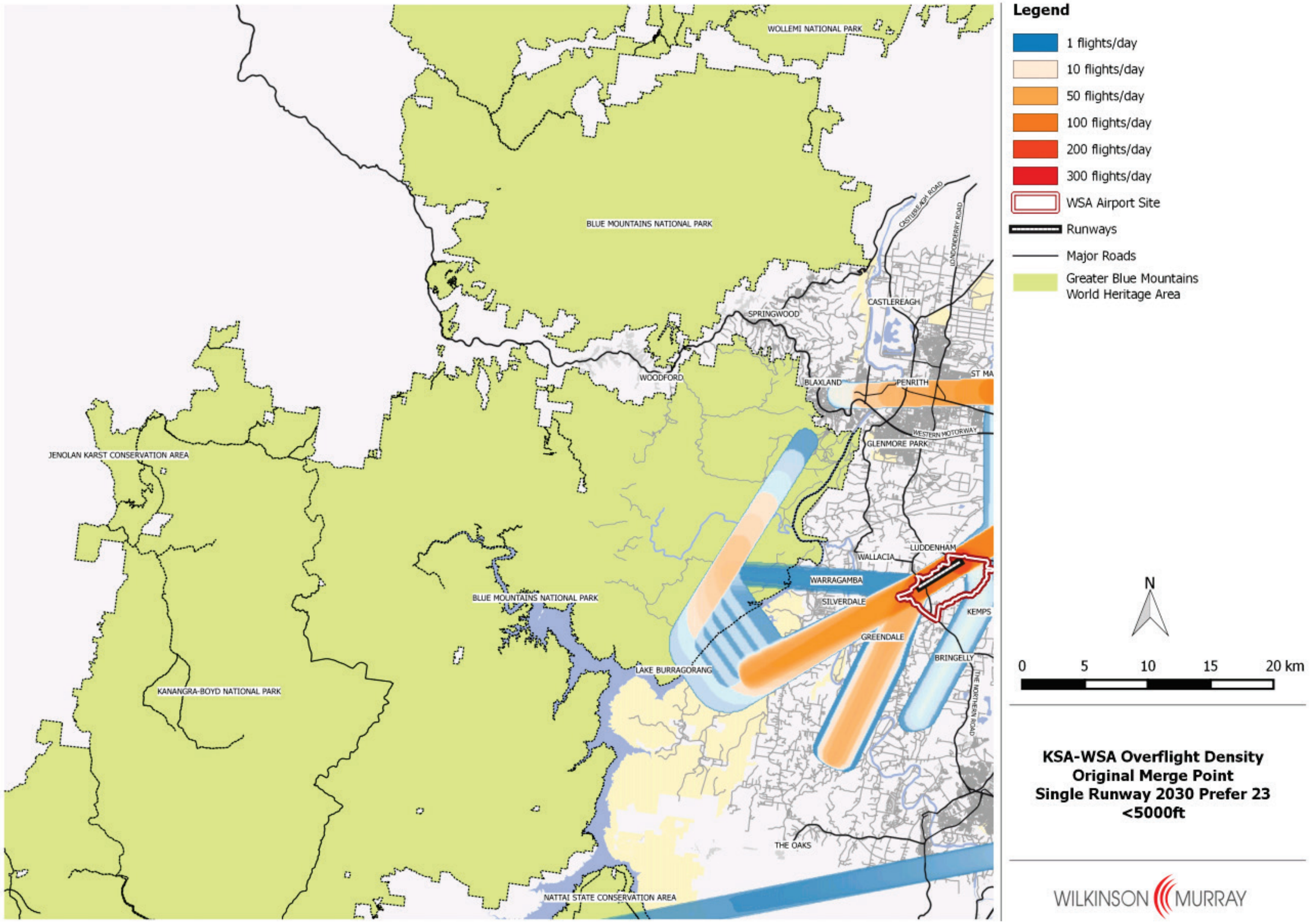


Figure D-4 Track Density – Existing & WSA 2050 Aircraft Movements – Prefer 05

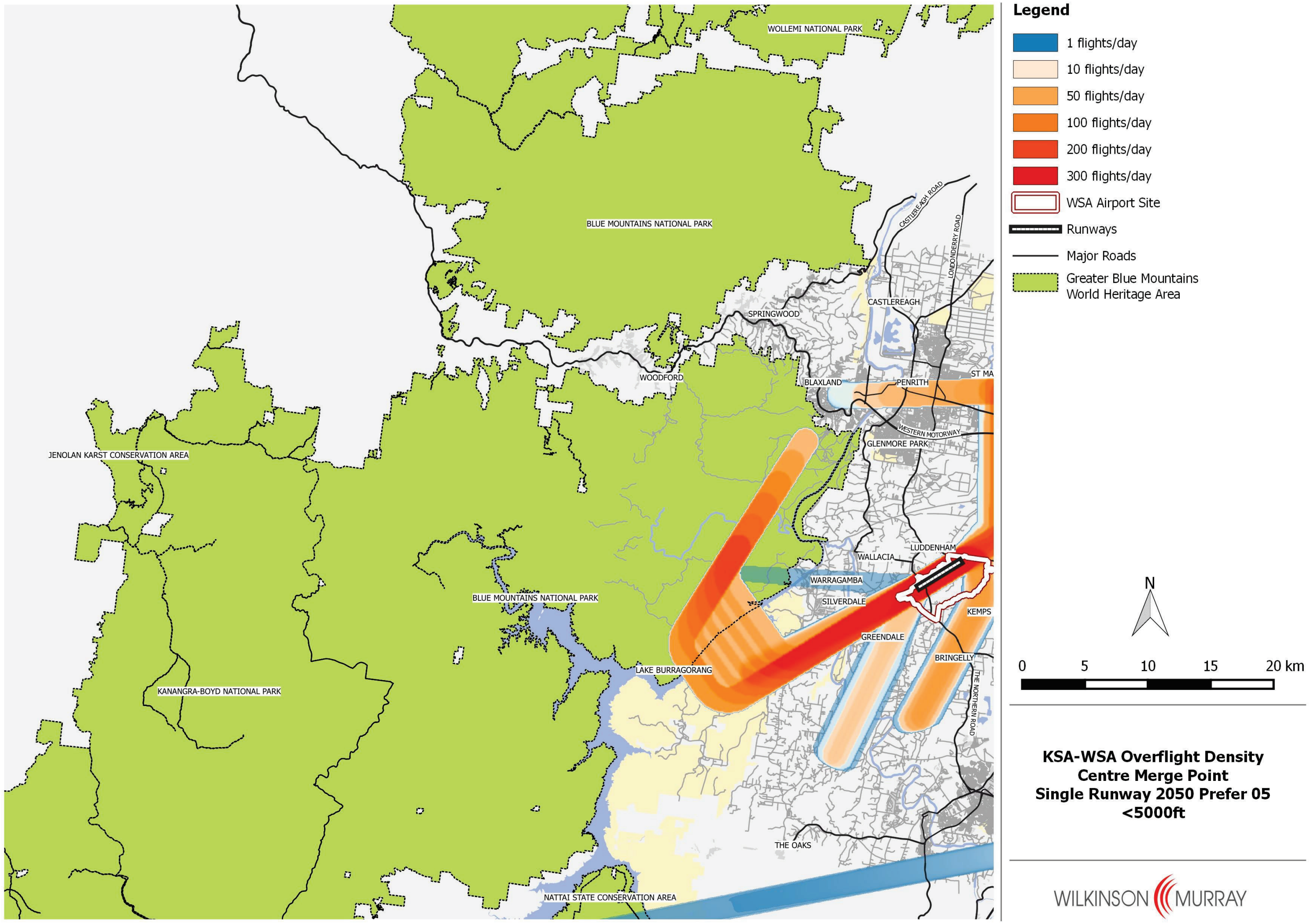
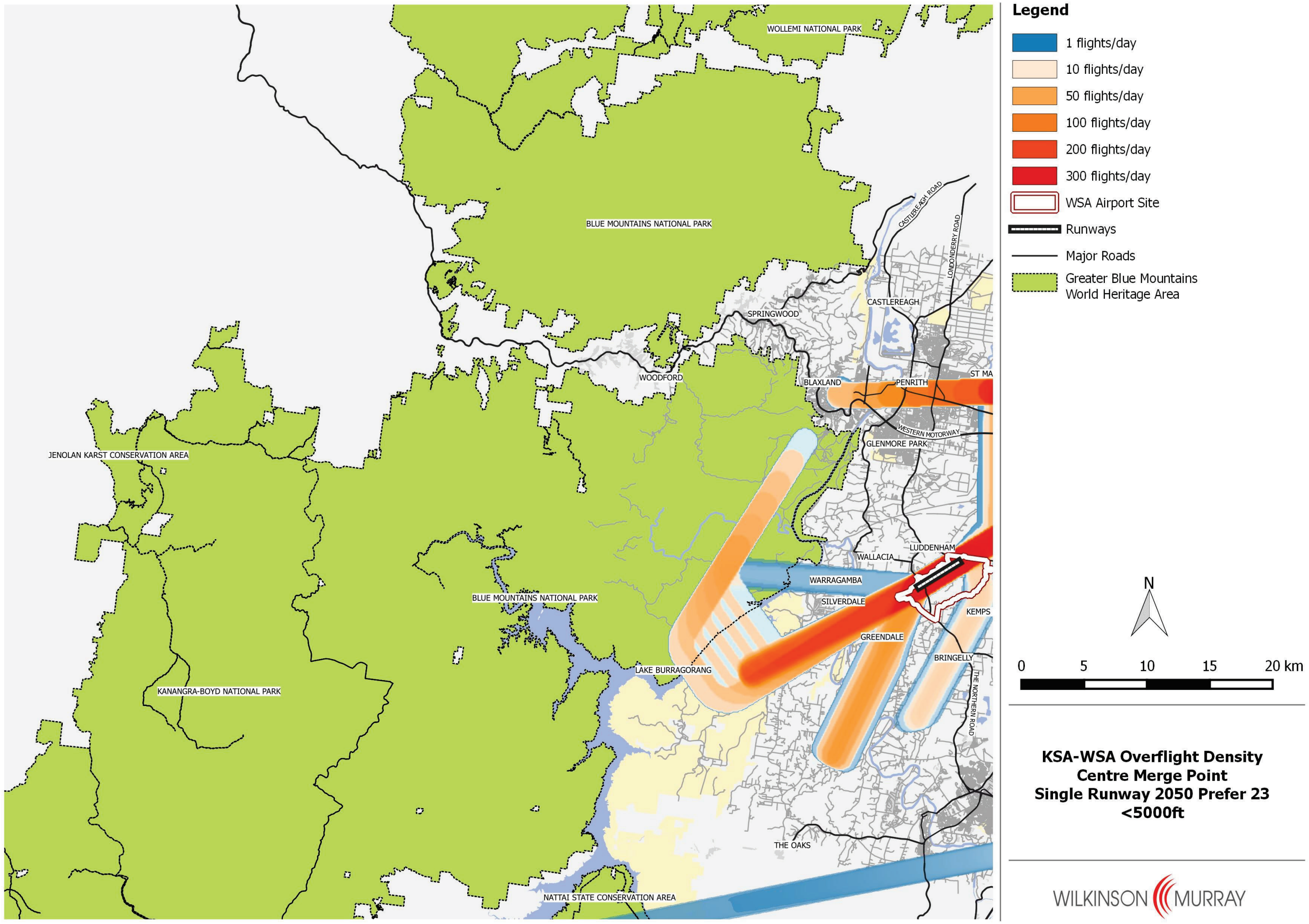


Figure D-5 Track Density – Existing & WSA 2050 Aircraft Movements – Prefer 23



KSA-WSA Overflight Density
Centre Merge Point
Single Runway 2050 Prefer 23
<5000ft

APPENDIX E

GLOSSARY

ACOUSTIC TERMINOLOGY

A-Weighted Noise Level (dBA) – This is a value representing the loudness of a sound at a specific time, allowing for the differential response of the human ear to different sound frequencies.

Maximum Noise Level (L_{Amax}) – L_{Amax} over a sample period is the maximum A-weighted noise level measured during the period. In the context of aircraft overflight noise, L_{Amax} generally means the maximum A-weighted noise level recorded during a specific overflight, measured using "Slow" speed, and can therefore also be written L_{ASmax}. In this report, L_{Amax} denotes the maximum level attained during a single overflight.

L_{A90} – The L_{A90} level is the A-weighted noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the A-weighted noise level over a sample period, and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is sometimes used to describe aircraft noise, in which case it refers to the noise level that is due to aircraft only, excluding other noise. Variants of this measure have been defined that cover specific time periods, such as $L_{Aeq,9am\text{-}3pm}$ which is used to describe noise affecting school classrooms.

ANEF & ANEC – For land use planning around airports, Australia has adopted the Australian Noise Exposure Forecast (ANEF) system, which describes cumulative aircraft noise for an annual period. The unit of noise measurement is similar to L_{Aeq}, but uses a more complex measure of noise from an individual overflight.

ANEC – An ANEC chart represents a forecast produced for a hypothetical future usage pattern, and is useful for considering the land use planning consequences of alternative strategies. ANEC forecasts are based on indicative data on aircraft types, flight paths, operating modes etc., and are generally used in environmental assessments to depict potential noise exposure for the hypothetical scenarios being considered;

ANEF - An ANEF chart shows contours representing a forecast of future noise exposure around an airport that has been endorsed by Airservices Australia on the basis of approved operational arrangements and official air traffic forecasts. In some cases an ANEF chart may be based on the outer envelope of contours from a number of ANEC charts.

N70 – N70 is a measure of noise exposure that indicates the average number of aircraft overflights per day (or other specified time period) exceeding 70 dBA. The numbers of overflights are graded in contour lines on a map. N70 contours can be calculated for different time periods, indicating the average number of over flights experienced per day in that period.

N60 – N60 is a measure of noise exposure defined exactly as for N70, but representing the average number of aircraft overflights per day exceeding 60 dBA. N60 is generally used to describe night time noise exposure. In this report, unless otherwise noted, N60 values represent the average number of aircraft overflights per day exceeding 60 dBA during the period 10pm-7am.

90th Percentile N70 – This unit has been introduced in the present report to overcome one drawback of N70 values, namely that they represent an average number of events over a large number of days, which can mask variation between days. The 90th Percentile N70 represents the N70 value that is exceeded on only 10% of days, and hence represents the upper range of aircraft numbers likely to be experienced per day at any point.

90th Percentile N60 – This is defined exactly as for 90th Percentile N70, and represents the N60 value that is exceeded on 10% of nights.

OTHER TERMINOLOGY

EIS – environmental impact statement.

Western Sydney Airport (WSA) – The proposed airport at Badgerys Creek as assessed in the Western Sydney Airport Environmental Impact Statement.

Airport Site – The airport site is the total of all properties that may become part of the proposed Western Sydney Airport.

DIRD – the Australian Government Department of Infrastructure and Regional Development tasked with the detailed planning and investigation of the proposed Western Sydney Airport.

Stage 1 Development – The first stage in the development of the proposed Western Sydney Airport, including a single runway and associated infrastructure to handle up to approximately 10 million annual passenger movements, presently anticipated to occur in 2030. Also referred to as the Stage 1 development.

Long Term Development – A long term development at Western Sydney Airport could include dual runways and associated infrastructure to handle approximately 82 million annual passenger movements. The Western Sydney Airport EIS considers this patronage level could be reached around 2063.

GBMWHA – Greater Blue Mountains World Heritage Area.

Aircraft Operation – In the context of this report, this refers to an aircraft arrival or departure.

Flight Track – A flight track is a line in three-dimensional space representing the path travelled by an aircraft, generally as it descends for landing at an airport and ascends after take-off.

Flight Path – A flight path is the two-dimensional projection of a flight track onto the ground – that is, it represents the points on the ground that lie directly beneath an aircraft's flight track.

Instrument Meteorological Conditions (IMC) – An aviation flight category that describes weather conditions requiring pilots to fly primarily by reference to instruments, and therefore under instrument flight rules (IFR), rather than by outside visual references under visual flight rules (VFR). Typically, this means flying in cloud or bad weather.

Visual Meteorological Conditions (VMC) – An aviation flight category in which visual flight rules (VFR) flight is permitted — that is, conditions in which pilots have sufficient visibility to fly the aircraft maintaining visual separation from terrain and other aircraft.

Instrument Landing System (ILS) – An instrument landing system is a ground-based navigational aid that provides precision horizontal and vertical guidance to an aircraft approaching and landing on a runway, using a combination of radio signals and, in many cases, high-intensity lighting to enable a safe landing during IMC, or other adverse meteorological conditions.

Continuous Descent Approach – An approach in which the aircraft's height is reduced continuously from a point at a large distance from the airport until it touches the runway. This results in lower noise emission than alternatives in which the aircraft's height may be held constant for sections of the track.

Point Merge – Point Merge is an airspace management concept referenced by ICAO as a technique to support continuous descent approaches. It involves designing all approach tracks to pass over a specific "merge point" before beginning the final approach. A point merge manages traffic flow in order to space aircraft more efficiently and eliminate the need for vectoring or stacking. If there is runway congestion, this system 'holds' the aircraft at much higher altitudes which consequently decreases fuel burn and reduces the effect on the environment. It was first implemented at Oslo airport in 2011 and since then in a number of other European and Asian airports including Dublin (2012), Seoul (2012), Paris ACC (2013), Kuala Lumpur (2014), Lagos (2014), Canary Islands (2014) and Hannover (2014).

Airport Operating Mode – A way of allocating aircraft operations to runways and runway directions at an airport. For example, one operating mode may require all aircraft to approach and depart using one runway direction, while another mode may require them to approach and depart in the opposite direction. Modes may or may not be available for use at any given time, depending on meteorology, number of aircraft operations per hour, and sometimes other factors. The proposed runway orientation at WSA is 05/23 (that is, 50/230 degrees compass bearing or approximately north-east/south-west). 05 operations involve landing from the south-west and take-off to the north-east whilst 23 operations involve landing from the north-east and take-off to the south-west.

Airport Operating Strategy – A way of determining which airport operating mode will be in use at any time. For example, a strategy may indicate that where several modes are available, one particular mode should be preferred, whereas in an alternative strategy, another mode is preferred.