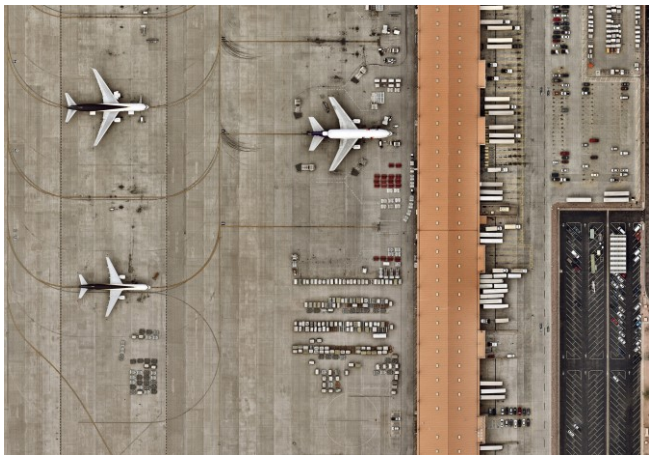

WESTERN SYDNEY INTERNATIONAL AIRPORT REVIEW OF THE HEALTH COMPONENT OF THE AIRSPACE AND FLIGHT PATH DESIGN DRAFT EIS

ABSTRACT

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Introduction

The Western Sydney International (Nancy-Bird Walton) Airport – Airspace and flight path design, Draft Environmental Impact Statement was released for public exhibition on 24 October 2023. [1]

The Western Sydney Regional Organisation of Councils (WSROC) approached the Centre for Health Equity Training, Research and Evaluation, UNSW to independently review the health component of the EIS to guide their submission and the potential submissions of member councils.

Environmental Impact Statements are usually huge documents and this one is no exception. The size and detail create enormous challenges for members of the public, officers in councils and community organisations to grapple with the sheer volume of material, technical detail, and its interpretation. The rationale for this document is to make the job of interpretation of the EIS (at least the health parts) easier.

Our objective

Our overall objective is to review the appropriateness of the discussion of health effects of aircraft noise in the draft EIS, the measures of exposure (noise measures) chosen and their relevance for health effects, the thresholds for health concern, and proposed control and mitigation.

Our approach

We independently reviewed the literature on the health effects of aircraft noise taking as a starting point the enHealth guideline *The health effects of environmental noise*. [2] We did this because we were familiar with this document, so it was a convenient starting point. We used this to review the appropriateness of health risk assessment which is part of the EIS and is contained in *Technical Paper 12: Human health*. We then go on to comment on the noise metrics and their relevance for health, thresholds for health concern and control and mitigation to protect health.

Scope and Limitations

Our review is of the draft EIS and our consideration is limited to human health effects. The only potential risk considered is overflight aircraft noise. We do not attempt to review any other risk such as changes in air quality which are also discussed at length in the human health risk assessment. We acknowledge the special amenity considerations of overflights of bush and wilderness in the Blue Mountains, but they are not considered here. The documents assessed are limited to *Technical paper 12: Human health* and *Chapter 11: Aircraft noise* and not the entirety of EIS. There is a reliance on the information contained in the EIS and (apart from our review of the literature) no independent capacity to review or estimate new contours, additional populations, additional residences, sensitive locations other than those described in the EIS.

Independent review of evidence for health effects

enHealth review

We took as our starting point the enHealth review *Heath effects of environmental noise* [2] and updated literature searches with a specific focus on health effects of aircraft noise. The enHealth review was published in 2018 and used a series of systematic reviews to assess the strength of evidence for the relationship between environmental noise (from road traffic, rail noise, aircraft noise) and health outcomes. It was conducted at approximately the same time as a more extensive WHO Europe review. There were three health effects considered for which there was an evidence base: sleep disturbance, cardiovascular outcomes and cognitive outcomes. There was extensive literature for each. The kinds of studies that are used to examine health effects from environmental noise are almost always observational studies (i.e. studies comparing people with different levels of exposure to noise and their health effects) with the exception of some laboratory studies (sleep). The body of evidence supporting an association between

environmental noise and sleep disturbance was assessed as National Health and Medical Research Council (NHMRC) Grade C (the body of evidence has limitations and care should be taken in interpretation of findings). The body of evidence supporting an association between noise and cardiovascular outcomes was assessed as NHMRC Grade C (the body of evidence has limitations and care should be taken in interpretation of findings). For the relationship between environmental noise and cognition the body of the evidence was assessed as NHMRC Grade D (the body of evidence is weak and findings cannot be trusted). Overall, summary statements in the enHealth review concluded that there was a likely causal relationship between environmental noise and sleep disturbance and environmental noise and cardiovascular outcomes and suggested thresholds of 55 dB Lnight,outside for sleep disturbance and 60 dB LAeq day, 16h for cardiovascular outcomes.

Box: What are all these noise measures?

Each type of noise measure attempts to capture some aspect of our human experience of sound or noise (unwanted sound). Nearly all measure A-weighted sound which is a weighting that reflects human sensitivity to sound, they measure across very short or long (average) time periods over different times of the day and night.

Examples

Lnight is the equivalent continuous A-weighted sound level measured in decibels (dB) at the outside of a house or a building over a specified period during the night, e.g. eight-hour period between 11 pm and 7 am (averaged over a year).

LAeq day, 16 hour is the equivalent continuous A-weighted sound level measured over a 16-hour period, typically 7 am to 11 pm.

Lden is an A-weighted average measure over a 24 hour period with a 12 hour day, a 4 hour evening, and an 8 hour night incorporating a 5 dB penalty for noise in the evening and a 10db penalty for noise at night.

LAmax -a maximum sound pressure level

Updated review of the literature

We supervised a literature review that updated the 2018 enHealth document (which during its development had commissioned systematic literature reviews completed in 2014). This report is included in Appendix 1, and covers literature between 2014 and 2023 across: sleep, CVD, annoyance, cognitive, other health concerns, and control and mitigation. There were 80 new studies included in this new review. The most relevant updates to the literature are narratively summarised here:

Sleep disturbance

Shubert, et al [3]use the LIFE-Adult cohort study in Leipzig Germany to generate relationships between Lnight (aircraft noise) and the proportion who report high sleep disturbance. The study found a much stronger relationship than WHO guidelines. At 45dB 32% of the Leipzig cohort are reporting high sleep disturbance compared to 15% for WHO. This looks to be a high-quality study and it is interesting that it is reporting a much stronger relationship between aircraft noise at night and self-reported sleep disturbance.

Smith et al update the WHO meta-analysis and similarly find a stronger relationship for the relationship between aircraft noise and sleep disturbance than previously reported. [4]

Cardiovascular outcomes

A study by Saucy et al [5] examined night-time noise exposure in the two hours preceding death for 24,886 cardiovascular deaths in Zurich and found associations between aircraft noise and mortality for Ischemic Heart Disease (IHD), Myocardial Infarction (MI), heart failure and arrythmia. This supports the biological plausibility of a relationship between aircraft noise and IHD.

Cognitive outcomes

A very thorough systematic review by Thompson, et al looks at studies in both adults and children. [6] As per the enHealth review it finds weaknesses in the literature but does find moderate support for a relationship between increasing classroom noise and reduced reading comprehension. It also finds support for a relationship between environmental noise and adult cognition.

The EIS health risk assessment of the health evidence

We look briefly below at the health effects as examined in the EIS.

Table 1: Summary of main health effects linked to aircraft noise and their treatment in the draft EIS

Health effect	*Treatment in the draft EIS*	*Quantitative exposure-response function*
Annoyance	As per 6.3.2 discusses annoyance as a reliable and accepted measure. Noise annoyance is derived from standardized surveys. There is a well-accepted relationship between increasing aircraft noise and survey reports of annoyance. By convention the proportion 'highly annoyed' in surveys is reported and a threshold for important effects is often taken to be 10% highly annoyed.	Uses the exposure response function developed by WHO review in 2018 which links Lden (a measure of noise or sound that averages across the day and evening and night) with the proportion of people who are 'highly annoyed'.
Sleep disturbance	Section 6.3.3 accepts the biological plausibility of noise induced sleep disturbance. It argues that the relationship between Lnight and %highly sleep disturbed is best for 'determining actions and outcomes'. % highly sleep disturbed is derived from surveys asking about sleep disturbance.	Uses the relationship between Lnight and the proportion reporting their sleep to be highly disturbed as per WHO 2018.
Cardiovascular outcomes	In section 6.3.4 the health risk assessment selects hospitalisations with ischaemic heart disease as the best measure available.	Uses the WHO 2018 reported relationship between noise (Lden) and hospitalisations with ischaemic heart diseases – a 9% increase for each 10 dB increase in noise (Lden)

Cognitive outcomes	The traditional concern and most of the literature is around various measures of learning in children usually derived from studies in schools. In section 6.3.5 the health risk assessment selects delay in reading and oral comprehension as the most appropriate measure.	Uses the WHO 2018 identified 1-2 month delay in reading and oral comprehension for an increase in noise of 5dB (Lden). There must be some concern around whether this is a robust relationship, but it gives readers an indication of possible health effects.

Does the EIS get the health risks right?

In general, we find the health risk assessment to be sound in that it identifies the hazard, adequately reviews the main health effects, and identifies and measures quantitative health risk using accepted relationships. The authors of the risk assessment nearly always follow the WHO guidance. The health outcomes or endpoints assessed are usefully summarised in Table 6.2 p. 100 of Technical paper 12.

Extent of harm and thresholds for unacceptable health outcomes

There are no explicit statements in the EIS that a particular noise predicted to cause a health effect at a particular level is unacceptable. The task is left to the reader to work this out. However, there are some identified threshold levels that could be argued to be thresholds for unacceptable harm.

Daytime noise

The main measures of relevance are annoyance and cognition. Concentrating on cognition, the EIS uses (as outlined above) an exposure-response function relating aircraft noise to delay in reading and oral comprehension. The body of evidence does suffer from inconsistency, and it is unclear whether there are any truly persistent effects on children's learning. However, it is certainly plausible that cumulative classroom noise may interfere with leaning. A threshold is set so that only daytime average noise above 55dB is predicted to result in any delay to reading and oral comprehension (following WHO a 1-month delay is considered negligible). This relatively high bar (55dB) seems to strike the right balance. Consequently, for almost all schools there is expected to be no reading comprehension delay even out to 2055 aircraft movements. The exceptions are University of Sydney Farms, Greendale, Mamre Anglican School, and Luddenham Public School (see appendix G of Technical paper 12: Human health). Consequently, we would expect that it is only these schools that would merit any mitigation.

Night-time noise

Western Sydney International Airport is a 7 day a week 24-hour operation and the possible harm to health from this continuous operation is one of the chief reasons for focusing carefully on night-time noise. Sleep is important for restoration, productivity and quality of life and disturbance of sleep is linked to more serious health outcomes. Sleep disturbance we consider to be the biggest threat to health.

Technical paper 12 uses as its main measure of sleep disturbance the proportion of people who are 'highly sleep disturbed' (%HSD). This is a measure derived from surveys asking questions about difficulty falling asleep, awakenings during the night and sleep disturbance. These responses are linked to exposure to aircraft noise using the annual cumulative average measure L_{night} . This is measured or calculated at the *façade of a building* from 11 pm to 7 am or 10 pm to 6 am and is a measure widely used internationally.

The other class of measures are event based. They are derived from sleep studies and measure the maximum sound pressure of the aircraft noise at the person's ear. So, these are indoor maximum noise levels of single events and the health effects measured are physiological such as awakenings, sleep stage changes, and movements during sleep.

You would hope that there is an easy and direct translation between these complementary measures, i.e. noise events that result in physiological disturbance and average or cumulative noise measures across the night. However, it is not that easy and straight-forward particularly since the physiological response are indoor measures.

Note that noise thresholds for both kinds of sleep disturbance occur at low levels. A few percent of the population report being highly sleep disturbed at noise levels that are fairly quiet and, similarly, physiological measures of sleep disturbance start to occur at low noise levels. So this is a reason to be cautious in setting any thresholds for noise goals and this is what WHO Europe did in their night noise guidelines when they set 40 db Lnight as the 'night noise guideline values recommended for the protection of public health from night noise'.

Table 2: Thresholds for sleep disturbance

Measure of sleep disturbance	*Threshold for any effect (lowest observable effect)*	*Accepted threshold / guideline level (WHO Europe)*
% highly sleep disturbed (survey report)	35 dBA Lnight	40 dB Lnight (equivalent to 11% highly sleep disturbed)
Sleep change (physiologically measured awakening or sleep stage change)	33-38 dBA Lamax [7]	LAmax 52 dBA (WHO 2009) equivalent to 3.6% probability of awakening [7]

It is important and worthwhile to consider event-based noise at night because it is potentially measuring something different. If there is a very quiet background, there may be multiple clearly audible and disturbing overflight events and yet it is possible that average noise may not exceed an average noise threshold. In addition, even in areas with high background noise (from traffic for example) noise events from ,aircraft can be distinguished. [8] It would be highly useful if an event-based metric like N60, widely used in the EIS, could be used as a threshold and we think it is logical and makes sense that a high number of overflights is likely to cause disturbance to sleep structure. Choosing a threshold for number of events needs some considered work but we would think that more than 10 events above N60 in the 11pm to 5.30 am night period may be a level we need to minimize to protect health.

Who is especially vulnerable to noise?

The Night noise guidelines for Europe discuss this. [8] They comment that children have higher awakening thresholds than adults and are often seen to be less sensitive to night noise. However, their sleep requirement is higher. Elderly people, pregnant women and people with ill health have a more fragmented sleep structure and are more vulnerable to disturbance. Shift workers are at risk because their sleep structure is already stressed.

Suite of noise measures in the EIS and their relevance to health outcomes

These noise measures or metrics are described in Table 11.2 of the EIS and are reproduced below with comments.

Table 3: Noise measures used in the EIS and their relevance for health.

Noise metric	*Description*	*Comment*
ANE	Australian Noise Exposure. A noise metric used in Australia to calculate noise exposure in areas around an	The validation and derivation of the ANE/ANEC/ANEF was based on extensive social surveys as published in the 1970s and early 1980s by Hede

	airport using the concept of an annual average day. Measurement of the aircraft noise expressed using the Effective Perceived Noise Level (EPNdB), which take account of the character (spectral, temporal and spatial) aspects of the noise. Flights between 7pm – 7am, are weighted to account for increased sensitivity of communities during periods of relaxation and sleep.	and Bullen [9] and uses a composite general response outcome and a cut-off. The measure incorporates fear of crashing, negative attitudes to airports and not just noise annoyance. Hede and Bullen considered an equal energy measure sufficient rather than incorporating any Lamax. It is not a health outcome measure and is aligned with annoyance approaches, although its different derivation and validation limits international comparability. An ANEF of 20 is equivalent to 10% of the population 'seriously affected' by aircraft noise.
ANEC	Australian Noise Exposure Concept is a forecast of aircraft noise exposure around an airport, typically to evaluate alternative operating configuration.	
ANEF	Australian Noise Exposure Forecast is an ANEC that has been reviewed and endorsed by Airservices Australia or Defence.	The only contour map with status in land use planning decisions for aircraft noise exposure.
N60	The number of overflight events in a given period at a noise level of 60 dB LAmax at an external building façade.	This is very useful illustrative measure that is relevant for sleep. The generally accepted reduction in noise from the most exposed façade to the bedroom is 20dB with windows closed and 10dB with windows open†. So 60dB outside may be 40dB which will be audible and around or just above the level or threshold where physiological sleep disturbance may occur.
N70	The number of overflight events in a given period at a noise level 70 dB L_{Amax} or above at an external building façade.	A useful illustrative measure because events above 70 dB are loud and interfere with speech, hearing and are relevant for cognitive outcomes.
LAmax	The A-weighted maximum noise level. The highest noise level which occurs from a single overflight or noise event	Useful to know especially if you have an internal bedroom goal to aim for!

Respite	Proportion of days without aircraft overflights	Although achieving respite is one of the operational aims of noise sharing this is still a relatively novel measure and a progressive measure to include. The relevance for 'health' of respite is difficult to determine as there is a limited evidence base. However, we think it is important. What is not well covered in the EIS is the importance of respite at important times such as in the evening, prior to going to sleep, or early morning.

† See Night Noise Guidelines for good discussion of variations around this. There will be considerable variation depending on position of the bedroom in relations to the exposed facade, orientation of windows, etc.

Of interest is that there is not much presentation of internationally used metrics such as Lnight. However, these are output from the models as they are necessary to generate, for example, the proportion highly sleep disturbed.

Population exposure to noise and preferred runway configuration in the EIS

This is really the crux of the EIS. The operational configuration chosen will affect the number of people potentially harmed by aircraft noise. This is well described in the EIS document and can be found in Chapter 11 – Aircraft noise. There are three runway configurations or operations:

- Planes can land from the north-east and take off to the south-west – this is called runway 23 or '23',
- Planes can land from the south-west and take off to the north-east – this is called runway '05',
- Planes can also take-off to and land from the south-west – this is called RRO and is an alternative at night when there are fewer aircraft movements.

The EIS provides in Table 11.4 outlines for seven scenarios with various mixes of the above: no preference, no preference day/RRO night, prefer 05 day/RRO night, prefer 23/RRO night, prefer 05 day and prefer RRO night, prefer 23 day and prefer RRO night, prefer 23 non-peak/no preference peak/RRO night.

In population exposure terms the EIS concludes:

- Prefer runway 23 with RRO at night results in the fewest affected (N70 metric)
- At night both prefer runway 23 and prefer runway 05 with RRO are 'operationally identical' (N60)

The populous areas to the north of the airport in St Clair and Kingswood would be less affected if there were fewer take-offs to the north hence preference for runway 23. In section 11.7.2 it notes that 'the number of night-time noise events in densely populated areas could be reduced by the use of RRO'.

Note figures 11.28 and 11.29 show fairly long extensions of N60 10-19 movement contour northwest into the Blue Mountains and south to the west of Camden using both prefer 05 with RRO and prefer 23 with RRO.

The EIS indicates a number of areas 'where the %HSD is considered to be of potential significance' and highlight Luddenham, Greendale, Silverdale, Wallacia and Kemps Creek.

Equity or fairness (about who is impacted) need to be considered. For instance, running RRO every night may be good for most but will seriously disadvantage people to the south-west of the airport such as in the Oaks, Silverdale, and Cobbitty. So balance and respite need to be brought into the equation.

Hierarchy of controls and mitigation in the EIS

Chapter 11 sections 11.3 and 11.8 outlines the approach to mitigation and management. The section outlines the four fundamental options for mitigation of aircraft noise, namely:

- Reduction of noise at source
- Land use management and planning
- Noise abatement operational procedures
- Operational restrictions

Chapter 11 makes it quite clear that the EIS is focused solely on the third dot point -i.e. noise abatement operational procedures. This includes the planning of flight paths, runway preferences, controlled descent, air traffic control procedures and the like. The main noise abatement operational procedure considered is runway use patterns. These patterns are considered throughout Technical paper 12 and other parts of the EIS and are the fundamental point of consultation. Reduction of noise at source refers to aircraft fleet characteristics and won't be in the power of WSI to change and is not considered further. Operational restrictions refer to placing 'restrictions on aircraft types and time of operation'. It is considered 'off the table' because WSI is a 7 day a week 24-hour airport and there will be no 'curfew'. Nonetheless it is important to consider effective mitigation which could and should include some respite including specific respite at night using some sort of designed noise sharing.

Noise insulation and property acquisition policy

This is a special class of mitigation and accepts that some people and properties will be so badly affected that acquisition and/or noise insulation will be the only acceptable option. The policy is based on the interim 2040 scenario and uses ANEC. The summary table is Table 11.11 which is reproduced below.

Eligibility criteria	**Metric**
Treatments for residential	ANEC 20
Acquisition within ANEC contour	ANEC 40 or case by case
Internal noise objective	50 dB LAmax
Noise level to determine level of noise treatment required	LAmax

The rationale for using the 2040 mid scenario is not very clear. It would make more sense to use the 2055 projection when the single runway is anticipated to reach capacity.

How the EIS can be improved to protect health

Take sleep seriously

As we have argued above and is consistent with the conclusions of technical paper 12 on human health the most important health impacting endpoint is sleep disturbance. There is no doubt that whatever way the airport is operated if aircraft take off and land at night-time there are going to be aircraft overflights and there are going to be many people disturbed at night. The EIS clearly and commendably documents disturbance using the measure % highly sleep disturbed. This should be complemented by an event-based threshold like N60 to identify more clearly residential areas that have severe impacts.

Remedy the mismatch between protections afforded by ANEC and health effects

Sleep disturbance is not an outcome that is adequately captured by the ANEC which is a noise exposure metric with a different derivation and purpose. Examining Figure 6.10 in Technical Report 12 there are a number of residences / receptors which lie outside 2055 ANEC composite and are considered to be 'highly sleep disturbed'. Figure 6.11 and 6.12 also illustrate that this is the case for % highly annoyed and reading delay in children.

Flight respite needs to be rethought and presented differently

Flight respite is a very important consideration that will have a real bearing on people's amenity and health. Although it is difficult to find high quality evidence that supports 'respite' as being health protective, there are some studies and we think there is good reason to believe it is important. The EIS provides commendable detail about the proportion of people at any one location with no flight movements. However, respite may be important at different times of the day and night such as in the late evening when people are trying to fall asleep or in the early hours of the morning when people are resting deeply. There is no discussion of this and no data that can be used to determine this.

Length of night is arbitrary and irregular

Defining the nighttime period as from 11 p.m. to 5.30 a.m. is inadequate. 6.5 hours is inadequate for sleep for most adults. The standard international measure is Lnight which is an 8-hour measure usually from 11pm -7am. Defining the night in this way minimizes the count of overflight events at night. Data should be represented for an 8-hour nighttime period.

Precautionary principle

A major challenge facing the airport is the 24-hour operation. We recommend that the precautionary principle be the standard consideration for all decision making (i.e. to adopt the strictest measures even in the absence of evidence). Further, we recommend that the EIS includes a recommendation for ongoing investment in monitoring and evaluation, supported by taking action where this is found to be required, across the life of the airport.

[i]Disclaimer

The views in this document are the authors' opinions and do not represent the views of their organisations.

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Appendix

Updated literature review (attached).

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