WSROC

Review of Western Sydney Airport Draft Environmental Impact Statement

26 November 2015

PARSONS BRINCKERHOFF

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Glossary

ALC	Airport Lessee Company
ANECs	Australian Noise Exposure Concept
ANEF	Australian Noise Exposure Forecast
APU	Auxiliary Power Units
ATM	Annual Traffic Movements
DoE	Department of Environment (Commonwealth)
EIS	Environmental Impact Statement
EPA	NSW Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Act 1999* (Commonwealth)
GBMA	Greater Blue Mountains Area
GBMWHA	Greater Blue Mountains World Heritage Area
GHG	Greenhouse Gas
HIA	Health Impact Assessment
HRA	Health Risk Assessment
INM	Integrated Noise Model
KSA	Kingsford Smith Airport
LGA	Local Government Area
MACROC	Macarthur Regional Organisation of Councils
MAP	Million Annual Passengers
MDP	Major Development Plan
PPB	Parts Per Billion
SWRLe	South West Rail Link extension
TSC Act	*Threatened Species Conservation Act 1995* (NSW)
WSROC	Western Sydney Regional Organisations of Councils
Western Sydney Airport	Western Sydney Airport

Executive summary

The Western Sydney Airport Project

The proposed Western Sydney Airport project will be one of the largest and most complex infrastructure projects in Australia. The project is proposed on Commonwealth land known as Badgerys Creek in the Liverpool Local Government Area.

The project as proposed in the draft Environmental Impact Statement (EIS) is intended as a staged development. The draft EIS and its associated 'Airport Plan' considers an initial single-runway development capable of handling up to 185,000 aircraft movements (37 million passengers per annum) nominally by around 2050, following which a dual runway is proposed with a total theoretical maximum capacity of 370,000 aircraft movements per year (82 million passengers) assumed to be reached in 2063.

Stage 1 works include a single 3.7 kilometre runway in the north of the site, capable of handling a full range of international and domestic passenger and freight aircraft, a business park, parking and cargo facilities in addition to areas of environmental conservation. The stage 1 draft EIS includes operation of the airport until 2030 when it is anticipated that approximately 10 million passengers and 63,00 aircraft would use the airport annually.

The draft EIS provides a broad assessment of the eventual two-runway development, but acknowledges that given the long time horizon to full development, more detailed assessment will be required to fully understand the impacts of the project at that time. Instead the draft EIS focuses on the assessment of Stage 1.

The draft EIS also recognises that there is currently no operator (or Airport Lessee Company – ALC) nominated for the construction and operation of the airport, and as such the Airport Plan is considered to be a transitional document until an operator is on board and a detailed masterplanning and project development process can commence. Sydney Airports currently has a first right of refusal to be the operator of the airport under an agreement reached as part of the privatisation of Kingsford Smith Airport. This creates significant uncertainties for the draft EIS, which acknowledges that key aspects of the draft EIS are effectively indicative only.

Statutory approvals context

Stage 1 of the Western Sydney Airport project is being assessed under the *Environment Protection and Biodiversity Act 1999* (EPBC Act) through an Environmental Impact Statement, as all works are proposed on Commonwealth land (EPBC 2014/7391). The draft EIS was released on public exhibition on Monday 19 October and exhibition will close on Friday 18 December 2015.

The draft EIS contains an 'Airport Plan' which defines the proposed layout and land uses for Stage 1 and an associated 'Airspace Architecture and Operation', which defines operation and flight paths associated with the airport. The Airport Plan must be approved by the Infrastructure Minister under the Commonwealth *Airports Act 1996* (Airports Act) prior to the commencement of development. The approval of the Minister for the Environment is a prerequisite of any consent under the Airports Act, and the Minister for the Environment in deciding to approve the EIS would issue conditions of consent to be imposed through the Airports Act consent on the project. Further detail is provided in Section 1.6.1 of the EIS.

This process is untested in Australia, as to date the Airports Act has only ever been used to manage assessment and approvals relating to the expansion of existing federally leased airports. New legislation has been granted (the *Airports Amendment Act 2015*) specifically to deal with the Western Sydney Airport, to accommodate the special circumstances of a greenfield airport with no lease in place.

Future expansion and approval of the airport beyond 2030 would be subject to further planning and assessment under the Airports Act.

The draft EIS peer review

WSP | Parsons Brinckerhoff were engaged by Western Sydney Regional Organisation of Councils (WSROC) and Macarthur Regional Organisation of Councils (MACROC) to project manage the Peer Review of the Western Sydney Airport draft EIS.

In this capacity WSP | Parsons Brinckerhoff was required to run a competitive tendering process to engage specialists in key areas of interest to the councils. WSP | Parsons Brinckerhoff reported to WSROC under the direction of a Steering Committee (of officers of the participating councils) to confirm which specialists should be engaged, the Steering Committee provided direction throughout the review process and reviewed draft inputs.

The key issues nominated for peer review (and the specialists engaged) were:

- Aviation planning (Arup)
- Overflight noise (Marshall Day)
- Ground based noise and vibration (WSP | Parsons Brinckerhoff)
- Traffic and transport (Arup)
- Air quality and greenhouse gas (Katestone)
- Human health impacts (CHETRE)
- Social and economic (Hill PDA)
- Biodiversity (EMM)
- Surface water and Groundwater (Cardno)
- Impact on Blue Mountains (WSP | Parsons Brinckerhoff)

In its role of project manager, WSP | Parsons Brinckerhoff undertook an overall review of the draft EIS to cover off issues not addressed by the specialists and developed the overarching findings of the peer review.

Key findings

General adequacy

The draft EIS was prepared on a very accelerated program, and it is apparent from media coverage to date that there has been significant Federal political pressure to progress the project rapidly. The draft EIS was prepared over a period of approximately 8 months from engagement of EIS consultants to provision of an initial draft for Commonwealth Department of Environment review. By way of comparison the previous EIS for the project prepared in the late 1990s was undertaken over well over two years. We are aware that the period whereby the Department of Environment reviews the adequacy of the draft EIS prior to approving it for public exhibition was similarly compressed. From our review it is apparent that this has resulted in a number of omissions and limitations, which are discussed throughout this report.

Airport Layout

The draft EIS nominates a preferred airport layout for both the Stage 1 and long term developments, noting that the layouts are indicative only and would be confirmed once an ALC has been appointed. Alternative layouts are presented for both the Stage 1 and long term layouts, however these are all based on a 50/230 degree runway orientation, in other words there has been no consideration of alternative runway orientations – a key determining factor of flight paths. This contrasts with the EIS undertaken in the late 1990s which examines multiple layouts and runway alignments, and gives little visibility of whether the chosen layout, and in particular the runway alignments, achieve the best environmental outcome. Given the time that has lapsed since the previous EIS we would have expected to see a thorough current option-evaluation process to explore alternatives.

Airspace architecture (flight paths)

Chapter 7 of the draft EIS describes the ‘Airspace Architecture and Operation’ of the proposed airport which includes the flight paths for the Stage 1 Scenario (2030), prepared by Air Services Australia on behalf of the Department of Infrastructure. Only one set of flight paths is provided for 2030 in the draft EIS, featuring a ‘merge point’ (a point at which all incoming flights converge) over Blaxland. The concept of merge points is relatively new, and is considered good practice as it allows for incoming flights to minimise thrust and so reduce noise.

The brief of Air Services Australia as outlined in the draft EIS was to develop a set of flight paths that avoids impacts on existing operations at Kingsford Smith at 2030 (although it was acknowledged that this would be impossible in the long term) and to ensure safety of operations. We have a number of concerns in regard to the flight paths presented in the draft EIS:

- The draft EIS makes clear that they have not been designed to minimise environmental (and in particular noise) impacts on communities.
- They have taken no account of the smaller airports (Camden, Richmond, Bankstown), other than to note that these would be impacted in the long term.
- There is no visibility in the draft EIS of how these contours were arrived at, and how they compare to alternatives considered.
- The contours are ‘proof of concept’ – in other words they are indicative only, and could be revised by a future ALC without recourse to the EPBC Act. As such there is considerable uncertainty over what actual impacts may eventuate.

We have the following recommendations in this regard:

- Greater consideration of alternative options is required, with an additional objective of minimising environmental impacts.
- A holistic review of flight paths taking account of all airports in the Sydney metropolitan area should be undertaken. As part of this, options that allow for flight paths at Kingsford Smith to be modified should be considered.
- In recognition that a future ALC may modify the flight paths from those presented in the EIS, sensitivity testing should have been presented to demonstrate the changes of noise impacts that would result if flight paths are modified.
- The case for a merge point should be further explored, and consideration of alternative merge points should be examined.

Our peer review was limited to an evaluation of the information presented, and did not extend to development of alternative flight paths by our peer review team. As such we cannot comment on whether the flight paths nominated may in fact be the best outcome. In other words the key issue is lack of transparency around the nominated flight paths.

Draft EIS places no explicit limits on key impacts

In a number of areas the EIS does not provide assurances that acceptable environmental thresholds will not be breached, and does not set hard limits on environmental impacts. In the case of aircraft noise this is a reflection of the nature in which aircraft noise is managed in Australia, and this is explored further in Section 4.1.1. However the same is also largely true of other aspects of the draft EIS – the mitigation measures are generally not prescriptive, and there is little in the way of hard limits on impacts. This is no doubt in part due to the fact that the ALC has not yet been appointed, and that the Department of Infrastructure is seeking flexibility over management and mitigation. However this creates uncertainty over the likely future impacts.

Uncertainties over the way the approvals process will operate

As noted above, the project is subject to assessment under the EPBC Act, and the Environment Minister's agreement (and conditions) are a prerequisite of any subsequent approval under the Airports Act. The draft EIS notes that the future development and expansion of the airport will be subject to further assessment and approval under the Airports Act, and that the preparation of a masterplan will be required within five years of the commencement of the project. This would superseded the current Airport Plan, which is described in the draft EIS as a transitional document. In effect it is implied that once the airport is leased, all future approvals would be under the Airports Act.

What is less clear is:

- What the potential triggers would be for further referrals and potentially approvals under the EPBC Act.
- What further assessment and approval would be required for the construction and operation of Stage 1 (beyond the current EIS and associated Airport Plan approval) once an ALC is appointed and more is known about the actual airport layout and operations.
- What limitations any EPBC Act approval will place on the airport
- What level of community and stakeholder engagement will be accommodated in the process going forward.

We would like to have seen greater clarity in this regard.

Key issues raised by specialists

Table ES.1 identified the key issues raised by the specialists for each environmental issue reviewed.

Table ES.1 Summary of key issues raised

Environmental issue	Key issues raised
Noise (aircraft overflight)	▪ Assessment based on 2030 scenario which reflects early stage of airport operation only ▪ Uncertainty around actual flight paths ▪ Proposed mitigation measures are generic due to uncertainty of flight paths ▪ Outline of mitigation process is not performance driven.
Noise (airport ground-based noise and vibration)	▪ Type and magnitude of impact, pre and post mitigation has not been included ▪ A single rating background level has been assumed for all receptors, this generalisation has

Environmental issue	Key issues raised
	underestimated the magnitude of noise impacts at receptors close to the airport. ▪ Luddenham sensitive receptors were not included in background noise monitoring. ▪ No cumulative noise impact assessment has been considered ▪ The M12 motorway and the realignment of the Northern Rd has been excluded from the assessment regarding operational road traffic noise in Stage 1.
Local air quality and greenhouse gas (GHG)	▪ Local air quality assessment has several long term exceedances NO_2, formaldehyde, $PM_{2.5}$ and PM_{10} ▪ Effectiveness of proposed mitigation measures to achieve compliance was not quantified. ▪ GHG emissions relatively small
Regional air quality	▪ Stage 1 assessment is acceptable ▪ Ozone concentration significantly above allowable increment for longer term development
Community Health	
Aviation planning	▪ No real visibility in draft EIS of how flight paths were determined ▪ No presentation of alternatives ▪ No certainty over final outcome ▪ No consideration of point merge – impacts on Blaxland
Surface transport and access	▪ STM3 model has not been effectively calibrated and validated as the model is still in development with TfNSW ▪ No traffic intersection modelling undertaken ▪ Did not consider assessment of rail ▪ Traffic estimate is based on 2011 which may be an underestimate as it does not include recent land use developments ▪ Traffic generation (outside of air cargo) is unknown and no consideration made for passengers transferring within the airport.
Human health	▪ Reviewed air quality, noise and water impacts however no discussion on implications of the distribution of effects for inequality and equality have been discussed. ▪ No rational or justification given on why a Health Risk Assessment (HRA) has been undertaken rather than a Health Impact Assessment (HIA) ▪ Perceived health issues not considered ▪ Social determinants of health have not been considered ▪ Long term cumulative impacts were not considered.
Biodiversity and offset strategy	▪ Offset package has not been prepared and residual ecological risks have not been discussed ▪ Mitigation measures are limited ▪ Difficult to assess the biodiversity value of the site for the long term development.

Environmental issue	Key issues raised
Surface water and groundwater	▪ Duncan Creek and its tributaries have not been modelled to allow definition of baseline and hydraulic impacts ▪ Draft EIS appears to dismiss any relevance of increased pollutant loads on the receiving environment ▪ Groundwater assessment lacks qualification of data, no baseline time-series data collected ▪ Two residual risks for groundwater were identified; soil and subsurface contamination from spill/release of chemical or contaminants and impact on groundwater dependant ecosystems from reduced water supply.
Social impact	▪ Balance of discussion on impacts – strong focus on economic benefits rather than a balanced discussion ▪ Strong focus on regional benefits not local impacts ▪ Many potential issues are stated with little assessment of their implications or level of significance or duration ▪ No discussion on how mitigation measures will be co-ordinated or resourced or who the key accountability falls with ▪ Claims being made by Commonwealth about economic generation and job creation have not been explicitly tested in the draft EIS ▪ The draft EIS does not describe the economic or social impacts of any transfer of activity from other areas in Sydney or Australia.
Greater Blue Mountains	▪ A detailed assessment of significance under the Biodiversity Assessment for the Blue Mountains World Heritage Area has been deferred until a 'multidisciplinary workshop' is held to identify and assess potential impacts. ▪ Limited assessment of wilderness value and high sensitivity ▪ Noise levels predicted to be relatively low (below 50-55dB LAmax) however for a natural landscape is prediction is not justified and many impact the amenity values.

1. Introduction

WSP | Parsons Brinckerhoff were engaged by Western Sydney Regional Organisation of Councils (WSROC) and Macarthur Regional Organisation of Councils (MACROC and to project manage the Peer Review of the Western Sydney Airport draft Environmental Impact Statement (EIS) (Commonwealth of Australia, 2015a). A list of councils forming this engagement is provided in section 2.1.1.

This report provides:

- an overview of the draft EIS
- a summary of the peer review results against each of the key technical areas included in the draft EIS
- an overview of the key issues of overall concern in relation to the draft EIS.

Detailed peer reviews of each of the assessed key technical areas have been appended to this report.

1.1 Background

The proposed Western Sydney Airport project will be one of the largest and most complex infrastructure projects in Australia. The EIS prepared in 1997–1999 for the project by WSP | Parsons Brinckerhoff faced substantial community opposition associated primarily with aircraft noise, and the EIS was subject to intensive scrutiny. The Government at that time decided in 1999 not to pursue the project any further.

The political landscape has changed in the intervening years, and media coverage since the remobilisation of the project in 2014 suggests there is growing support mainly as a result of the project's potential for local job creation. However, the project has some significant environmental and social impacts, with aircraft noise still being potentially the single biggest issue from the community's perspective.

This review of the draft EIS has focused on a number of key issues, including aircraft and ground noise, airspace planning, air quality, social, traffic and transport and human health.

The Western Sydney Airport project is being assessed under the *Environment Protection and Biodiversity Act 1999* (EPBC Act) as the proposal is being constructed solely on Commonwealth land (EPBC 2014/7391). The Commonwealth Department of Environment (DoE) issued *guidelines for the content of a draft environmental impact statement for the Western Sydney Airport* (EIS Guidelines) on the 22 of January 2015.

The draft EIS was released on public exhibition on Monday 19 October and will close on Friday 18 December 2015. Figure 1.1 illustrates the current status of the project in relation to the overall approval process.

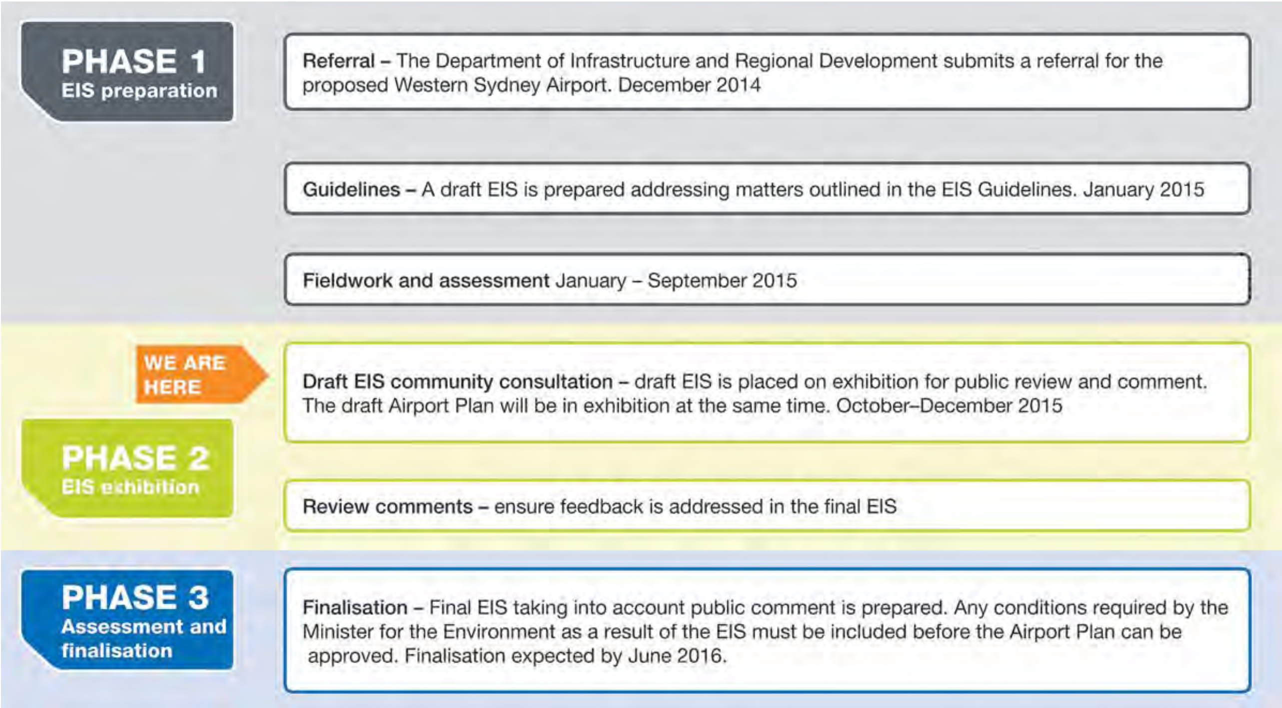


Figure 1.1 Program of assessment

2. Approach to peer review

2.1 Governance arrangements

WSP | Parsons Brinckerhoff was engaged by WSROC and MACROC to undertake the peer review, and worked throughout the duration of the peer review process under the direction of a Steering Committee. A brief summary of the roles and arrangements for the governance of the peer review project is provided below.

2.1.1 Role of WSROC

The peer review has been managed by WSROC, acting on behalf of 11 councils from the WSROC and MACROC region. The participating councils, who have provided funding and guidance throughout the peer review, are as follows:

- WSROC
  - Auburn City Council
  - Blacktown City Council
  - Blue Mountains City Council
  - Fairfield City Council
  - Holroyd City Council
  - Liverpool City Council
  - Parramatta City Council
  - Penrith City Council
- MACROC:
  - Camden Council
  - Campbelltown City Council
  - Wollondilly Shire Council.

WSROC's primary role is the overall management of the peer review on behalf of the councils, including managing the financial contributions from the participating councils, and the engagement and management of the peer review consultant (WSP | Parsons Brinckerhoff).

A dedicated WSROC project manager was engaged to undertake the following functions in relation to the project:

- To manage the procurement process leading to the engagement of WSP | Parsons Brinckerhoff as the EIS Peer Review project managers.
- To manage the financial contributions of the participating authorities in order to fund the consultant's fees associated with the peer review.
- To manage all ongoing contractual matters between WSP | Parsons Brinckerhoff and WSROC (including invoicing, scope management and project program).

- To manage and facilitate the Steering Committee established for the EIS peer review (refer section 2.1.2 below) including convening Steering Committee meetings, and communication with the Steering Committee on relevant issues.

2.1.2 Role of the Steering Committee

The project has been managed under the direction of a Steering Committee comprising officer representation from each of the participating councils within WSROC/MACROC. The functions of the Steering Committee have been to:

- Review and endorse the proposed scopes for technical specialists as part of a tendering process run by Parsons Brinckerhoff for the engagement of technical specialists.
- Review and endorse the recommendations of WSP | Parsons Brinckerhoff in the selection of technical specialists (following receipt of submissions).
- Discuss and agree any scope changes to the peer review following the appointment of WSP | Parsons Brinckerhoff
- Review and provide feedback on the draft peer review report.

The Steering Committee met regularly during the peer review process.

2.2 Methodology

The methodology adopted for this peer review of the draft EIS has been determined through a collaborative process between WSROC/MACROC and WSP | Parsons Brinckerhoff, under the general direction of the Steering Committee.

2.2.1 Project inception and early tasks

At the inception of the peer review, WSP | Parsons Brinckerhoff undertook a review the EPBC Referral, EIS Guidelines and previous EIS to identify topics for peer review (incorporating those topics identified by the brief).

These findings were presented to the WSROC Steering Committee in July 2015, which outlined the proposed program, proposed approach to scoping of peer reviews, proposed studies to be undertaken and appreciation of issues.

2.2.2 Preparation of the consultant briefs and nomination of potential specialists

WSP | Parsons Brinckerhoff prepared consultant briefs for a number of technical issues which were reviewed by the by the Steering Committee. These documents were written to ensure that submitted tenders were comparable with each other and are consistent in terms of general approach, terminology and language within the provided documentation.

Evaluation criteria were developed to allow a robust and transparent evaluation to occur.

In parallel with this, three suitable consultants for each topic were identified where possible by WSP | Parsons Brinckerhoff to bid for the review role. Consultants were identified based on their track record of similar projects with a particular focus on local experience where possible), their ability to deliver to challenging timeframes and their experience in peer review roles.

2.2.3 Evaluation and engagement of specialist proposals

Following Steering Committee endorsement of proposed scopes and shortlisted consultants, briefs were finalised and issued. The draft recommendations report was issued to the Steering Committee in August 2015 for review and the specialists listed in Table 2.1 were engaged to undertake their review:

2.2.4 Scope of the specialist peer reviews

The peer reviews were desk-based with no fieldwork, and no direct communication between the study authors and peer reviewers to ensure independence. The peer reviews for each technical issue evaluated whether the:

- study meet the requirements of the EIS Guidelines and relevant other guidelines and methodologies;
- conclusions reached in the studies are valid in accordance with published standards and guidelines, and whether the conclusions of the assessment are a realistic reflection of the actual impacts;
- underlying assumptions are plausible;
- mitigation and management measures proposed are adequate or have limitations in mitigating the impact;
- level of uncertainty over impacts and the environmental risks; and
- approach to the assessment of the long term development was appropriate.

The peer reviews provided a 'plain English' summary of the key impacts and opportunities associated with the project in relation to each specialist topic, so that the key findings could be readily understood by a broad audience.

Each of the draft peer reviews were reviewed by WSP | Parsons Brinckerhoff, before issuing these to the Steering Committee for review and discussion. Following the Steering Committee meeting to review the peer reviews, the draft peer reviews were finalised by the specialists.

2.2.5 Preparation of overarching review report

The focus of this review is on key environmental issues supported by specialist peer review reports which are included in Volume 4 of the draft EIS. To supplement and draw together the findings of the specialist peer reviews, his overarching review report has been prepared to:

- Review the broader draft EIS including undertaking a gap analysis to identify aspects of the EIS that were not addressed by the specialist peer reviews – generally this includes the early chapters of the EIS that describe matters such as the project background, need and objectives, options considered, stakeholder consultation and project description and management frameworks.
- To prepare an overarching review report that draws together the findings of the individual specialist reviews (including a summary of the most significant issues identified), incorporates the findings of the review of other aspects of the EIS (as described above) and provides an overview commentary on the results of the process.

2.3 Draft EIS review team

Table 2.1 below identifies the peer review team chosen to review the draft EIS for the Western Sydney Airport.

Table 2.1 EIS review team

Environmental issue	Peer reviewer	Primary EIS Section for Review
Noise (aircraft overflight)	Marshall Day	Volume 4 – E1
Noise (airport ground-based noise and vibration)	WSP | Parsons Brinckerhoff	Volume 4 – E2
Local air quality and greenhouse gas	Katestone	Volume 4 – F1
Regional air quality	Katestone	Volume 4 – F2
Community Health	CHETRE	Volume 4 - G
Aviation planning	Arup, supported by The Airport Planning Group	Volume 4 – H Volume 4 – I
Surface transport and access	Arup	Volume 4 – J
Biodiversity	EMM	Volume 4 – K1
Offset strategy	EMM	Volume 4 – K2
Surface water hydrology and geomorphology	Cardno	Volume 4 – L1
Surface water quality	Cardno	Volume 4 – L2
Groundwater	Cardno	Volume 4 – L3
Social impact	Hill PDA	Volume 4 – P1
Property values	Hill PDA	Volume 4 – P2
Greater Blue Mountains	WSP | Parsons Brinckerhoff	Volume 2, Chapter 26

The qualifications of each reviewer is provided in the relevant peer review provided in Appendix A–I of this report.

2.4 Limitations

Due to the limited exhibition period of the draft EIS (which required specialists to prepare their draft peer review reports within three weeks of the start of exhibition), and the agreed approach to the peer review (Chapter 2 – Approach to peer review) several limitations were identified in undertaking the review including:

- The peer review included a desktop assessment only. No site inspections were undertaken as part of the review by WSP | Parsons Brinckerhoff or the peer reviewers.
- No consultation has been undertaken between the peer reviewers and the project team involved in preparing the draft EIS.
- The results of several of the specialist reports (noise, air quality, transport) relied on results generated from a project specific model. These models where not made publically available, despite a direct request from WSROC to the Department of Infrastructure and Regional Development, and therefore a detailed review was not possible.
- No additional modelling was undertaken to verify the results of any of the technical reports.

- A detailed review of the draft airport plan was not undertaken, however, it was referred to ensure consistency with the draft EIS.

2.4.1 Technical reports excluded from review

Not all of the technical reports presented in the draft EIS were reviewed. This was generally because certain issues, while locally important, were not considered to be key issues for the broader region covered by the WSROC and MACROC LGAs, and so did not represent value for money for the project. It was also understood that individual member authorities could choose to undertake additional review work outside the scope of this project. As a result the following technical reports have been excluded from this peer review:

- Aboriginal cultural heritage
- European and other heritage
- Landscape character and visual
- Other ‘non-key’ issues such as contamination, resources and waste and topography, geology and soils (Separate review on waste will be prepared by WSROC and MACROC).

3. Review of the overall draft EIS

WSP | Parsons Brinckerhoff undertook at preliminary review of the broader EIS and its compliance with the *Guidelines for the content of a draft environmental impact assessment, Western Sydney Airport*. Table 3.1 below provides a summary of the compliance of the draft EIS.

Table 3.1 Summary of compliance with EIS guidelines

	Comments
General content	Volume 1, Section 8 described an EIS summary report which was to have been prepared to assist the general public to understand the key issues of the draft EIS without having to read. The draft EIS seeks approval only for the construction and operation of the Western Sydney Airport until 2030. The draft EIS doesn't fully consider all the impacts on the environment during this period as it uses indicative flight paths. The long term environmental impacts (beyond 2030) are also unclear.
Format and style	The draft EIS is generally compliant with the format and style required. It would be useful to have an overall table of contents at the start of each volume. The draft EIS only has a table of contents for each Volume which makes it difficult to find specific information across the four volumes.
General information	This section is generally compliant however, more discussion could be made around how the action relates to other actions in the region, including significant state road and rail projects and urban development projects and their associated impacts.
Description of the action	This section is generally compliant. The inclusion and description of development beyond 2030 is at times confusing for the reader as not all impacts are known and it does not form part of the works to be assessed under Stage 1 of the draft EIS or the draft airport plan.
Feasible alternatives	More details could be provided about the feasible alternatives, especially in relation to airspace planning and the short, medium and long term advantages and disadvantages of the options.
Description of the environment	The description of the environment is generally compliant however, it is noted that not all sensitive receivers have been considered.
Relevant impacts	A key concern of the draft EIS is the description of impacts and residual impacts. As the airspace planning is based on indicative flight paths a detailed assessment of the nature and extent of likely short-term and long-term relevant impacts is not able to be undertaken with any certainty. It is recommended that prior to the determination of the EIS and airport plan more certainty is provided around airspace planning so a more robust assessment of impacts such as noise, air quality and health can be undertaken.
Avoidance and mitigation measures	A consolidated list of mitigation measures has been provided in section 28.4 of the draft EIS however a detailed description of the expected or predicted effectiveness has not been included. Refer to section 3.3 of this report for more detail.
Residual impacts and offsets	The residual impacts and offsets are not clearly defined or summarised in the draft EIS and are scattered throughout Volume 2. This does not give the community any certainty as to the predicted short and long term impacts.

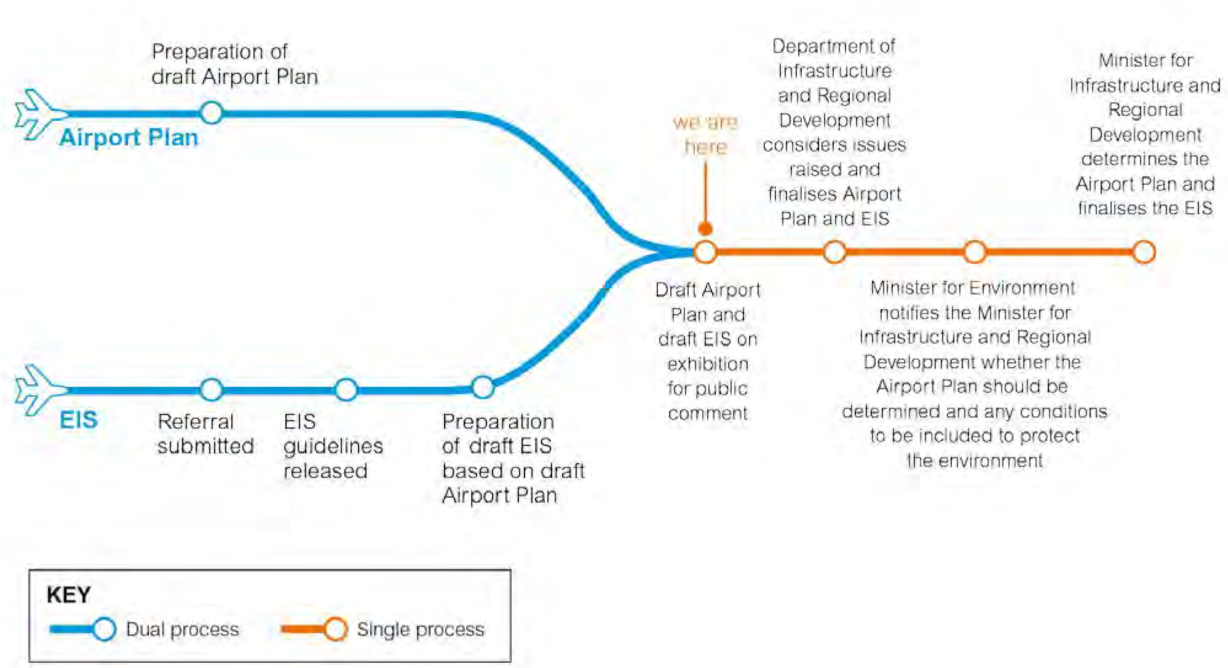
	Comments
	As described in section 4.9 and Appendix I of this report, a Biodiversity Offset package has not been formalised.
Environmental record of person(s) proposing to take the action	The draft EIS has adequately addressed this component.
Other approvals and conditions	The draft EIS has adequately addressed this component.
Economic and social matters	Refer to Section 4.6 below
Information sources provided in the EIS	The draft EIS has adequately addressed this component.
Conclusion	This section of the draft EIS generally complies however given the uncertainty surrounding the airspace planning and indicative flight paths a more precautionary approach is recommended in section 29.5 – Consideration of the principles of ecologically sustainable development.

3.1 Planning and land use statutory approvals context

The Western Sydney Airport will be subject to Commonwealth environment and development approvals framework as the project occurs solely within Commonwealth land.

Development at existing federally leased airports require approval under the *Airports Act 1996* (Airports Act). As the Western Sydney Airport site is a greenfields site and there is no current airport lease, the Airports Act was amended in June 2015 to allow planning, environment and development approval for the Stage 1 development of the proposed airport. The Airports Amendment Act (July 2015) allowed for the preparation of an Airport Plan as a transitional planning instrument to describe the initial development of the site and be supported by an EIS to assess the first stage of the airport development. Prior to the determination of the final Airport Plan the Minister for the Environment is required to give notice stating if the draft Airport Plan should be determined or not and under what conditions , considering the outcomes of the final EIS.

A draft EIS has now been prepared to support the draft Airport Plan which is also currently on exhibition as part of the overall EIS package of documents (http://westernsydneyairport.gov.au/airport_plan/index.aspx). Following the exhibition period both these documents will be finalised and considered by the Minister for Environment and the Minister for Infrastructure and Regional Development for determination (refer to Figure 3.1).



Source: Commonwealth of Australia 2015a

Figure 3.1 Approval process

As the proposed Western Sydney Airport is to be located solely on Commonwealth land, the Airports Act and the EPBC Act authorises development and excludes the operation of any New South Wales (NSW) state law. A range of NSW and local government planning documents have been considered in the preparation of the draft EIS and draft Airport Plan.

3.1.1 Draft Airport Plan

The draft Airport Plan primarily describes the proposed Stage 1 works for the construction and initial operations of a single 3,700 metre runway located in the north-western portion of the site and a range of aviation support facilities including passenger terminals, cargo and maintenance areas, car parks and navigational aids is the subject of this draft EIS. Part 3 of the draft Airport Plan describes the construction works and operational needs to cater for the predicted demand for the first five years of operation to around 2030 of approximately 10 million passengers per year as well as freight traffic. Site preparation activities are proposed to commence in mid-2016.

Development beyond Stage 1, will be undertaken under the existing planning framework in Part 5 of the Airports Act, including the preparation of a major development plan for any significant development at the airport. Significant future works, such as a second runway, which may have an impact on matters of National Environmental Significance may require a Referral under the EPBC Act. Table 3.2 provides a summary of the activity forecast for Stage 1 and beyond.

Section 3.2.3 of this report provides further detail on the approval process for the longer term development of the airport.

Table 3.2 Summary of activity forecasts

	Stage 1 (c. 2030)	First runway at capacity (c.2050)	Long-term (c.2063)
Annual passengers (arrivals and departures)	10 Million Annual Passengers (MAP)	37 MAP	82 MAP
Busy hour passengers (international and domestic)	3,300	9,500,	18,700
Total annual aircraft traffic movements (ATM) (passenger and freight)	63,000	185,000	370,000
Total busy hour ATM	21	49	85

Source: Commonwealth of Australia (2015) Draft Airport Plan

3.2 General observations

WSP | Parsons Brinckerhoff broad review of the draft EIS, in consultation with the WSROC and MADROC Steering Committee has identified several key areas of concern, the most significant being the lack of detail and certainty around airspace planning (or ‘airspace architecture’). Other key concerns relate to the decision to define Phase 1 (i.e. the scenario for which the EIS seeks approval) as the level of operational activity at 2030. This results in an assessment of a level of airport activity well below the theoretical maximum that the initial single runway development could accommodate (63,000 air movements annually, compared to an theoretical maximum of 185,000) Other concerns relate to the high level traffic assessment, adequacy of the health impact assessment and the uncertainty over the longer term development of the airport.

3.2.1 Airspace planning (Airspace architecture)

A key concern of the draft EIS relates to the approach to determining the flight paths (or airspace architecture) and the indicative nature of the flight paths. This section provides a brief overview of the key issues relating to airspace planning, a detailed review is provided in section 4.5 and Appendix C of this report.

Key technical reports which support the draft EIS including aircraft noise and air quality assess impacts of the project over a wide area have undertaken their assessment based on indicative flight paths. The draft EIS notes that it is expected that these flight paths would be ‘*progressively refined during a detailed design process which would provide the opportunity to optimise safety, efficiency, noise and environmental impacts before operations begin at the proposed airport*’. The draft EIS is not clear on the process for these reviews and assessments to occur except to say that they ‘*may require further environmental assessment processes to assist decision making and may be the subject of a future referral under the EPBC Act following detailed design’.* It is not clear if a future EPBC referral would be required for a change in flight paths, the Airports Act notes that this can be assessed under a major development plan (MDP) which would not need approval from the Minister for the Environment, only that the Minister for Infrastructure needs to obtain and consider advice from the Minister for the Environment.

The EIS additionally makes clear that the flight paths presented in the EIS were determined based solely on operational and aviation safety considerations, and that minimising noise impacts was not a consideration in establishing the flight paths presented (other than the fact that the proposed flight paths were then subject to noise impact assessment).

As the flight paths relate directly to the Stage 1 assessment, the uncertainty associated with the flight paths that might ultimately eventuate would ideally need to occur prior to determination of this current assessment to ensure the environmental impacts and risks are properly assessed and the local community informed. We are well aware that in the absence of a future airport operator, the Commonwealth will be reluctant to give more certainty in relation to flight paths.

Specific issues associated with the uncertainties around flight paths, and which are considered further in section 4.5, include:

- Location of the merge point at Blaxland is also indicative until the flight paths are finalised. Currently Blue Mountains City Council and Penrith City Council are very affected by aircraft noise associated with this merge point, however, this is also only indicative.
- Lack of consideration of alternative flight paths including greater consideration of Kingsford Smith, Camden, Richmond and Bankstown airports. In particular it is thought that the impacts on Bankstown airport have not been fully addressed.
- The draft EIS lacks sufficient detail in airspace architecture including a detailed description as what the underlying principles were, how was it developed and any alternatives which were considered.
- The draft EIS did not look at any scenarios beyond the normal/scheduled operation of the airport such as queuing in the event of unscheduled interruption.
- Further analysis of the proposed fleet mix is required. It is not considered suitable to adopt the fleet mix used from Kingsford Smith Airport (KSA) and that further analysis of the preferred fleet mix at the Western Sydney Airport should be undertaken.
- A detailed discussion to determine whether a curfew is required. We recognise that this is a substantial political issue, we sought to investigate the level of night time impacts that might provide a clear basis for the need or otherwise for a curfew. Based on current information, there is not enough information to determine if a curfew is required (from the perspective of compliance with noise standards for sleep disturbance) or not.

3.2.2 Short term assessment within the draft Airport Plan

Whist the draft EIS and associated technical reports provide some detail and assessment on the longer term development of the Western Sydney Airport, the draft EIS is seeking approval only for the construction and operation of Stage 1 until approximately 2030.

The draft EIS notes that by 2050 the single runway will have reached capacity (refer to Figure 3.2 of this report) and a second runway will be required. A general recommendation is that the draft EIS should consider the operation of the airport at 2045 (approaching full capacity of the single runway infrastructure) so the community and stakeholders have a greater understanding of the impacts of a single runway airport.

3.2.3 High level traffic and transport assessment

The traffic and transport assessment assessed in the EIS for Stage 1 works provides a high level assessment of traffic directly relating to the construction and operation of the Stage 1 works until 2030. Whilst it appears that by using the data discussed, the assessment undertaken is largely correct however it is considered that all the impacts are not able to be validated as the following information is not provided or considered:

- freight traffic generation within the Airport precinct (outside of air cargo)
- private vehicle traffic generation from land uses within the Airport precinct (outside of air passengers)
- vehicle travel time comparison (as predicted by strategic modelling)
- intersection performance (as predicted by intersection modelling)
- intersection layout requirements (as predicted by intersection modelling).

It is noted that the proposed Western Sydney Airport is supported by the Western Sydney Infrastructure Plan (WSIP) which is a 10 year project investing in major road infrastructure upgrades in Western Sydney. As the Western Sydney Airport is not going through the NSW state approvals there are no mechanisms to ensure the upgrades proposed in the WSIP occur, or occur in the timeframe required for the Western Sydney Airport project. Also, as described about and in section 4.3 of this report, the draft EIS did not undertake any assessments of intersections to determine if the proposed upgrades are adequate (refer to section 4.3 for more detail).

3.2.4 Uncertainty over longer term development and cumulative impact

The draft EIS provides a discussion on the long term development of the airport. This discussion generally focuses on the development of a second runway and the associated impacts, however at this stage all the impacts are indicative and will not form part of the Stage 1 approval process.

The long term development discussion presented in the draft EIS does not provide a comprehensive evaluation of impacts. We consider that it is reasonable not to attempt a full and detailed assessment of the airport at 2030, as there will be too many variables that are not known at that stage (such as aircraft types, the conditions of the receiving environment, and the pattern of urban development in Western Sydney).

However, we consider that the draft EIS could have been bolder in its assumptions about the long term development of Sydney. The draft EIS is largely limited to identifying known development plans, such as the urban development associated with the growth centres and Western Sydney Employment Area. More discussion on the long term strategic planning initiatives within the region and the impact these future land uses may have on the airport would be beneficial.

3.2.5 Lack of State integration

The proposed Western Sydney Airport occurs solely within Commonwealth land and therefore does not require approval from the New South Wales (NSW) government (i.e. it is exempt from state planning laws). Despite this, there are several significant infrastructure projects such as the WSIP and South West Rail Link Extension which the Western Sydney Airport rely on to be able to operate effectively and reduce the impact on the local community and stakeholders. In addition to these infrastructure projects, the long term strategic planning and future land uses of the greater South Western Sydney region needs to be considered.

Ordinarily, for a major project being assessed under the NSW planning approvals regime, the various other state agencies, including the infrastructure delivery agencies (such as Councils, Roads and Maritime Services and Transport for NSW) would be an integral part of the assessment process (generally led by the NSW Department of Planning and Environment and Minister for Planning). In this capacity they would be actively involved in the development of planning conditions governing a range of matters including, for example, the management of road capacity for major traffic generating developments. Planning contribution mechanisms (requiring financial contributions to upgrade infrastructure associated with the project) would also be established through state legislation.

We are aware that Federal funding has been agreed for a substantial package of road upgrades in the vicinity of the project (the Western Sydney Infrastructure Plan - WSIP). However, as discussed above and in more detail in Chapter 4 of this report, there is no mechanism discussed to ensure that these projects are approved and completed in a timeframe complimentary to the development of the Western Sydney Airport. There is also no certainty around the mechanisms for infrastructure funding beyond the provisions of the WSIP.

3.3 Management and mitigation measures

Once an airport lease has been granted, the Airports Act and the Airports (Environment Protection Regulations 1997) determine the management of activities at airports that have the potential to cause environmental harm. As no airport lease has been granted, the management and mitigation measures for Stage 1 of the proposed Western Sydney Airport have been described in the draft EIS and it is assumed that they would be implemented as proposed.

The draft EIS provides a range of management and mitigation measures for Stage 1 of the Western Sydney Airport for each of the key impacts. A general concern amongst all specialist reviews was that the mitigation measures are generic in nature, primarily due to the uncertainty of the impacts assessed. The effectiveness of achieving compliance through the mitigation measures is also generally not quantified. The type and magnitude pre and post mitigation is often not described.

No specific social management and mitigation measures have been adopted, rather referencing any measures referred to in the technical reports were relevant. A key management and mitigation approach for aircraft noise includes insulation of existing dwellings however there are no details on what this would entail.

Generally, the management and mitigation measures beyond 2030 are not known. The management of the airport beyond 2030 will be described in the Environment Strategy prepared by the lessee in accordance with the Airports Act and the Airports Regulations. The Environment Strategy is not likely to require the same level of scrutiny or approval by Minister for the Environment as does the works described under Stage 1 of the draft EIS. It is again recommended that the works proposed under Stage 1 EIS is extended to include works to allow the full capacity of the single runway so management and mitigation measures can be developed more long term and greater certainty given to the community and key stakeholders.

3.4 Consultation activities

DoE's guidelines for the draft EIS do not specially state any requirements for consultation except that the proponent is required to make the draft EIS available for public exhibition. Community and stakeholder engagement undertaken during the preparation of the draft EIS is discussed in Part C, Volume 1 of the draft EIS and generally appears to be adequate for the level of consultation expected for a major project.

The following items have been raised in regards to the consultation section:

- The Community and Engagement Strategy for the Project addressed the needs of the target audience based on initial community research and stakeholder consultation which included 11 focus groups and an online survey. The online survey was undertaken for residents within a 20 kilometre radius around Badgerys Creek, which excludes most of the Lower Blue Mountains which may be impacted by aircraft noise and amenity of low flying planes. There is also some confusion in the number of residents which were surveyed, Section 8.2.2 – Community and Engagement Strategy refers to 2,041 however Table 8-1 in Section 8.3 – Phase 1 – draft EIS and draft Airport Plan preparation mention 3,041.
- Table 8-7 of Section 8.4.1 – Stakeholder and community engagement programme refers to a plain English EIS summary being developed for the stakeholders and community which would be available at community events, online and at static display locations. The Western Sydney Airport website does not contain this summary paper so it is unclear whether it has been prepared.
- Section 8.5 – assessment and determination refers to an online mapping tool which is not discussed anywhere else in the document. Further discussion on what this tool does would be beneficial.

4. Review of technical reports

4.1 Noise

4.1.1 Aircraft overflight noise

4.1.1.1 Approach

The peer review has been primarily based on information presented in the noise chapters for the Stage 1 proposal and long term developments, in conjunction with the technical noise report presented in Appendix E1 of the draft EIS.

Consideration has also been given to other related sections of the draft EIS to review the broader assessment of noise impacts. The review of these additional sections has been concerned solely with matters related to the aircraft noise assessment. Reference should be made to the separate peer reviews commissioned by WSP Parsons Brinckerhoff for the review of specialist matters directly concerning aviation, fauna, health, planning and social issues.

This peer review addresses the following key elements of the aircraft noise assessment:

- The noise prediction methodology and the associated inputs and assumptions;
- The type of noise level information that has been produced;
- The operational scenarios that have been considered in the noise predictions;
- The noise sensitive receptors that have been identified and considered in the assessment;
- The methods used to assess the impact of the predicted noise levels;
- The proposed noise mitigation and management measures; and
- The level of uncertainty concerning the predicted noise impacts and environmental risks.

In reviewing these aspects of the draft EIS, consideration has been given to the document *Guidelines for the content of a draft Environmental Impact Statement – Western Sydney Airport* (Reference: EPBC 2014/7391 and subsequently referred to as the *EIS guidelines*).

4.1.1.2 Review findings – Stage 1 Development

The noise modelling is considered to generally provide a reasonable representation of the extent of noise impacts for the specific flight tracks and operating scenarios that have been proposed. Specifically, predicted noise levels have been determined for a range of operating scenarios. Aircraft noise information has also been produced in a range of formats that are generally consistent with current federal government guidelines for identifying areas potentially affected by aircraft noise.

All noise predictions have been determined using the latest version of the US Federal Aviation Authority's Integrated Noise Model (INM). This software is used widely in Australia and internationally for aircraft noise predictions and is the appropriate choice for this application. However, the use of this software to calculate short noise levels, which is the main form of noise data used in the draft EIS to identify the extent of affected areas, requires careful consideration. Specifically, the INM supporting documentation notes:

> *INM is not designed for single-event noise prediction, but rather for estimating long-term average noise levels using average input data. Comparisons between measured data and INM calculations must be considered in this context.*

Accordingly, while the use of the INM is reasonable, information has not been provided as part the draft EIS to verify the reliability of the short term noise level data (presented as maximum noise levels and Number Above ratings). This is particularly important for this proposed airport, because of the increased uncertainty associated with the predictions at the lower noise thresholds used in the draft EIS for the assessment of night-time operations and impacts in quiet areas such as the Greater Blue Mountains World Heritage Area.

Notwithstanding the general suitability of the noise modelling data, there are however a number of limitations to the assessment. These relate to the uncertainty surrounding the airspace management design, and the limited assessment of the noise modelling outcomes. These matters are summarised as follows:

Low Stage 1 movement numbers

The total aircraft movement numbers for the Stage 1 development are relatively low when compared to other international airports in Australia. The low movement numbers cast doubt over the suitability of the 5 year time horizon as the primary assessment scenario for the purpose of obtaining approval for a major international airport. In this context, it is unclear how the incremental and periodic approvals that would need to occur as part of the ongoing expansion of the airport provide a sufficient basis for considering the initial 5 years of operation as the primary period for the assessment of noise impacts.

These comments are provided primarily in relation to the plausibility of the movement numbers represented in the noise modelling, based on comparisons with movement numbers documented in the noise modelling for other Australian international airports and similar time horizons. Aircraft traffic forecasts are however outside of our area of expertise and therefore the suitability of the specific movement numbers provided for the noise assessment are considered in further detail in separate aviation peer review commissioned by WSP | Parsons Brinckerhoff.

Airspace management strategy uncertainties

The draft EIS states that the airspace management strategy used as the basis for noise modelling is a proof-of concept design, and that further work is required to determine the actual flight paths which would be flown in practice. Information about the extent of potential change in flight paths is limited. The uncertainty surrounding the final airspace management design that would be implemented represents a significant source of uncertainty in the noise assessment. The potential significance of this source of uncertainty has not been quantified and, with exception of alternative merge points for Stage 1, there has not been any sensitivity analysis carried out to assess the implications of potential flight path changes.

Assessment of community annoyance

The draft EIS includes exposed population statistics which provide a useful indication of the potential scale of the community who may be affected by aircraft noise to varying degrees. However, in isolation, this data does not provide an indication of the scale or significance of potential community reaction to aircraft noise levels as a result of annoyance. The Health Risk Assessment in the draft EIS provides the most discussion of community annoyance, including references to research concerning the relationship between noise exposure and community annoyance. However, the Health Risk Assessment ultimately states that no quantitative assessment of annoyance was conducted as part of the study.

Dose-response relationships of the types referenced in the Health Risk Assessment can be used with noise levels and population data to provide a quantitative measure of the potential reaction. The use of these established relationships to represent the reaction of a separate community exposed to aircraft noise must be used with caution. In particular, due consideration must be given to the increased reaction that may be expected from a newly exposed community. However, this type of analysis provides an objective basis for comparing the impacts of alternative operating strategies and, more broadly, establishing the risk of community noise impacts relative to other established international airports in Australia.

While the assessment of the risk of community annoyance is complex, the scale of the proposed airport and the number of people potentially affected warrant further evaluation of the subject. The introduction of a new 24-hour international airport at a greenfield development site introduces a risk of widespread and prolonged community annoyance. A quantitative analysis of this potential risk would be prudent to inform the environmental impact assessment process and the extent to which operational noise mitigation should be prioritised relative to other non-safety related airspace management considerations. Updated social surveys of the type originally carried out as part of the development of the Australian Noise Exposure metric used in Australia also warrant some consideration, given the significant nature of the proposed development and the availability of detailed aircraft noise information for other existing Australian airports.

Land use impacts

The draft EIS includes calculated Australian Noise Exposure Concept (ANEC) contours for the Stage 1 operating scenarios. ANECs are often presented as an indication of the extent of a potential future Australian Noise Exposure Forecast (ANEF) contour which would be used to guide land use planning for noise-sensitive developments in the vicinity of airports.

However, the ANEC contours presented for the Stage 1 proposal provide limited guidance for the purpose of land use planning. The reason for this is that the ANEF is normally derived from ANECs calculated for long term operations or ultimate capacity scenarios, rather than short term ANECs related to an initial phase of operation. Evaluation of land use planning impacts must therefore be primarily based on the ANEC contours presented for the long term development of the airport, rather than initial Stage 1 development contours.

Greater Blue Mountains World Heritage Area

The draft EIS presents information to evaluate the potential impacts of aircraft operations on the acoustic amenity of the Greater Blue Mountains World Heritage Area (GBMWHA). The assessment indicates the potential for a large number of audible aircraft events within the GBMWHA.

The preservation of quiet areas and tranquil landscapes has been a topical subject of research and policy consideration in Europe and the US. For example, US publication (Transportation Research Board, Airport Cooperative Research Program, Mestre 2008) on the effects of aircraft noise includes a chapter which discusses research and US legislation (National Parks Overflight Act of 1987) concerning the effects of aviation noise on parks, open space and wilderness areas. These publications do not provide definitive guidance on assessment techniques, but highlight the complexity and importance of assessing aircraft overflight noise in sensitive wilderness areas.

While the noise levels in the draft EIS are predicted to be relatively low (below 50–55 dB L_{Amax}), aircraft over flights would be expected to be audible and represent a significant and widespread impact for a World Heritage Area where natural soundscapes are likely to be a valued feature of the areas amenity. The complexities and sensitivities of this area warrant further consideration in the draft EIS. Specifically, the assertion within the draft EIS chapter concerning the GBMWHA that noise levels below 50 and 55 dB L_{Amax} are ‘not significant’ is not considered to have been sufficiently justified, and the assessment may therefore not adequately reflect the potential impact to the values of tranquillity within the World Heritage Area.

Mitigation measures and residual noise impacts

The draft EIS noise modelling is based on an indicative proof-of concept air traffic management design which does not present a comprehensive airspace and final air route design. Given the uncertainties concerning the final form of the airspace design, the final form of noise mitigation measures to be implemented is not yet known. Accordingly, the mitigation measures that have been referred to in the aircraft noise assessment are generic in nature.

This is a particularly important point for an airport development as, unlike other forms of infrastructure development, the policies used to manage aircraft overflight noise do not generally stipulate noise limits that airport operations must adhere to at surrounding noise-sensitive locations.

Accordingly, without a defined airspace design, a defined noise mitigation strategy or defined noise criteria to adhere to in practice, the residual impacts and the location of these impacts is subject to considerable uncertainty. Further, without defined noise criteria, it is unclear how noise considerations would be prioritised among other non-safety related airspace management and operational considerations associated with the proposed airport site. These uncertainties may therefore warrant consideration of performance criteria as part of the approval process for the proposed airport.

In addition to the generic operational measures for the mitigation of noise, the draft EIS also refers to mitigation related to dwelling acquisition or dwelling insulation upgrades. There is however no detail provided in terms of the circumstances in which these measures would be implemented, other than a general reference to the guidance of AS 2021. It is unclear if this is intended to infer that such measures would only be considered within certain Australian Noise Exposure areas, or if such measures would be considered at all locations where internal levels may be expected to exceed AS 2021 internal design criteria as a result of the proposed aircraft operations.

4.1.1.3 Review Findings – Long Term Development

A number of the considerations identified from the peer review of the Stage 1 development are directly relevant to the assessment of the long term development scenarios. For example, matters related to the noise prediction methodology are identical for the Stage 1 and long term development scenarios.

In terms of assumptions about operational capacity, the movement numbers for the 2050 single runway scenario and 2063 dual runway scenario are comparable to the range of movement numbers documented for other similar Australian international airports. On this basis, the values appear to be plausible for noise assessment purposes. Aircraft traffic forecasts are however outside of our area of expertise and therefore the suitability of the specific movement numbers provided for the noise assessment are considered in further detail in separate aviation peer review commissioned by WSP | Parsons Brinckerhoff.

The following limitations are however noted for the long term assessment scenarios.

Land Use Impacts

The draft EIS presents ANECs for a range of operating scenarios in 2050 and 2063 as part of a discussion of the potential land use impacts which may result from a future ANEF for the proposed airport.

However, the latest Australian Standard (AS 2021) which defines how Australian Noise Exposure data should be used to inform land use planning, includes guidance on how ANECs for multiple operating scenarios may be combined to define an overall area where planning controls should apply. The draft EIS does not refer to this guidance and it is therefore unclear how the various ANECs should be interpreted when assessing land use impacts.

Further, while the draft EIS provides population counts for the various ANEC bands, no assessment is provided of the extent to which land use controls may change as a result of a future ANEF prepared as part of the detailed airspace design for the project. Specifically, the draft EIS does not quantify the potential extent of changes to land use controls relative to the measures which have been in place since the original EIS was undertaken in 1985. Furthermore, the discussion of land use planning impacts in the draft EIS notes that the National Airports Safeguarding Framework would '*be instrumental in managing potential future operational noise impacts for future land use planning and development around the airport'*. The Framework could potentially translate to the creation of land use planning controls which extend over significantly greater areas than either the current land use planning controls (based on the 1985 EIS) or the 2063 ANEC contours provided in the draft EIS. This has however not been discussed or assessed in the draft EIS.

Cumulative Impacts

The draft EIS notes that the parallel runway scenario (2063) would introduce a number of issues which would need to be addressed in the final airspace design. In particular, the chapter concerning airspace architecture notes the following issues that would need to be addressed:

- Changes to Sydney Airport flight paths;
- Changes to flight paths serving Bankstown Airport; and
- Resolution of a potential constraint associated with the restricted airspace over Defence Establishment Orchard Hills.

The EIS guidelines establish a requirement to '*identify and address cumulative impacts, where potential project impacts are in addition to existing impacts of other activities'.*

The above issues concerning the airspace architecture are considered to represent potential cumulative impacts which have not been quantified in the draft EIS. Further information concerning this issue is therefore considered necessary to address the requirements of the EIS guidelines.

4.1.1.4 Key Impacts and Opportunities

The findings of the peer review indicate that noise level information of the form required by the EIS guidelines has generally been provided in the draft EIS. However, the peer review has also identified a number of limitations concerning the content of the draft EIS, and therefore further information and assessments are considered necessary to address the general and noise-specific requirements of the EIS guidelines.

Based on the review of the draft EIS, the key noise impacts associated with the proposed airport are:

- Community annoyance, and related impacts such as speech interference and changes to the way individuals use outdoor spaces.
- Sleep disturbance associated with night-time operations, and related impacts such as the potential need for some residents to sleep with windows closed to achieve a suitable internal amenity.
- Degradation of the acoustic amenity of the World Heritage Area within the Greater Blue Mountains area.

In terms of land use impacts, the existing planning instruments that have been used to control development around the proposed airport site would generally be expected to limit the extent of the potential impacts. However, the draft EIS reference to the National Airports Safeguarding Framework as an instrumental tool for guiding future land planning around the proposed airport site introduces the potential for significantly enlarged development controls. This could translate to land use impacts also being a key impact associated with the proposed development.

Other noise related impacts cornering matters such as health, property values and social impacts are addressed in separate peer reviews commissioned by WSP | Parsons Brinckerhoff.

Aircraft noise impacts are ultimately an unavoidable consequence of aircraft operations in urban environments. The creation of a new international airport therefore requires a balance to be achieved between the protection of amenity for neighbouring sensitive land uses and the development of infrastructure to respond to the growing demands of a major city.

Determining whether this balance has been achieved is ultimately a matter for regulatory authorities. While this peer review has identified a number of limitations to the present assessment, this is not intended to infer that the proposed development and development site are unsuitable. Rather, in light of the residual uncertainties in the assessment, further information and assessments are considered necessary before stakeholders can reach an informed view on the potential scale and significance of aircraft overflight noise impacts associated with the proposed airport site.

Conducting these further assessments as part of the environmental impact assessment process represents an opportunity to:

- provide clarity to affected communities and stakeholders about the nature of the noise impacts;
- provide clarity to regulators about the form of noise controls which will be needed in the project approval to ensure that noise is appropriately managed; and
- reduce the potential for unforeseen impacts and the associated risk of reactionary noise management procedures which could subsequently jeopardise the operational flexibility of the proposed airport.

4.1.2 Ground based noise and vibration

4.1.2.1 Approach

This review identified uncertainties and unknowns within the ground noise assessment, provided in the EIS and identified what further assessment would be required to provide an indication of impacts. The limitations of this review are as follows:

- Noise modelling or review of noise modelling files has not been completed as part of this review. Therefore, it was not possible to verify the noise contour plots from ground-based activities presented in the draft EIS. However, comment has been included based on a visual inspection of the plots.
- The review relies on the source noise data that has been included in the ground noise assessment. The review is a desktop exercise and therefore, independent source noise measurements have not been conducted to confirm the noise levels used for taxiing and engine ground running as presented in the EIS.

The components of the review are follows:

- The review comments on the draft EIS chapters relevant to ground noise in addition to Appendix E2 – Airport ground-based noise and vibration. This appendix is the technical basis for all other ground noise related documents, including the relevant draft EIS chapters.
- A document review is contained within Appendix A of Appendix B this report, and provides references and comment on specific sections of the draft EIS.

4.1.2.2 1st stage airport

A summary of the findings for the 1st stage airport is as follows:

- The assessment does not fulfil the requirements of the Guidelines for the Content of a Draft Environmental Impact Statement – Western Sydney Airport 2015 (EIS Guidelines). These guidelines state that the type and magnitude of impact, both pre-mitigation and post-mitigation should be presented. The ground noise assessment should be updated to include this assessment.
- There is insufficient detail to satisfy the EIS Guidelines on the source of the noise data and assumptions used in noise predictions. As these assumptions form the basis for the noise assessment, changes to the source noise data could potentially lead to a significantly different outcome.

- The assessment does not provide sufficient justification to support the assessment being performed based on the year 2030 (5 years after opening) and not 2050 when the airport is expected to be approaching capacity for the single runway configuration with potentially increased noise impacts.
- The report does not provide sufficient detail in the assessment of the ground-based power supply to aircraft when they are parked. The assessment excludes the use of Auxiliary Power Units (APU), however it does not provide sufficient detail of alternative ground-based power supplies. As an alternative power supply method is not presented, there is potential for additional noise sources being introduced that have not been considered.
- Background noise monitoring was conducted at 10 locations in the region, however a single background level has been assumed for all receptors, rather than several location-specific values. This generalisation has underestimated the assessment noise criteria and therefore the magnitude of noise impacts at receptors close to the airport that are currently exposed to low levels of environmental noise.
- The nearest noise sensitive receptors in Luddenham were not included in the background noise monitoring and therefore, there is uncertainty if noise impacts have been adequately assessed at this location.
- No consideration has been given to the cumulative noise impact from all ground noise sources at the nearest noise sensitive receptors both with and without mitigation measures as required by the EIS Guidelines. Additional assessment should also be undertaken for other ground noise sources, such as the compass calibration pad.
- It is recommended that the mitigation measures identified in the assessment, including the restriction of APUs and the limitation of engine ground run-ups during the night, are formalised as part of the project approval.
- The assessment does not provide sufficient evidence that all reasonable and feasible mitigation measures have been considered to reduce noise impacts from taxiing and ground run-ups.
- Semi-enclosed pens and bunded areas to reduce noise impacts from engine ground run-up noise are considered in the assessment. It is recommended that these measures are considered further as part of the approvals and subsequent design stages.
- No comment has been made on the potential cumulative noise impact from the new M12 Motorway and realignment of The Northern Road that are being developed to accommodate the airport.
- The EIS contains misleading statements relating to operational road traffic noise which do not acknowledge the limitations of the assessment. The development of the M12 Motorway and realignment of The Northern Road have been excluded from the assessment and statements regarding operational road traffic noise should include these limitations.

4.1.2.3 Long term development review findings

- The assessment is considered to contain an appropriate level of detail for the long term development as the potential noise impacts are predicted for a considerable time in the future (into 2063). It is acknowledged that the noise environment may change over time.
- The comments raised in this review for the 1st stage airport assessment should be addressed and applied to the long term development assessment. Where this occurs, the current framework for further assessment of the long term development is considered appropriate.
- The EIS does not include ground-based noise in the summary or conclusion for the long term development. It is recommended that the outcomes of the revised long-term development ground-based noise assessment are included in these sections so that all impacts are clearly presented.

4.1.2.4 Key impacts and opportunities

It is considered that the ground-based noise assessment does not provide an appropriate level of detail on a number of key aspects including:

- the derivation and allocation of assessment criteria
- noise impacts at the nearest sensitive receptors in Luddenham
- noise source levels and modelling assumptions
- the type and magnitude of impacts with and without mitigation
- evidence that all reasonable and feasible mitigation has been considered
- cumulative noise impacts from operational activities and road traffic projects.

As a result, without further clarification or justification, it is uncertain that the draft EIS has adequately presented and addressed the noise impacts associated with the proposed development.

It is recommended that these items are addressed to reduce the level of uncertainty, increase the accuracy of the assessment and to satisfy the requirements of the EIS Guidelines.

4.2 Air quality and greenhouse gas

Katestone Environmental Pty Ltd (Katestone) was commissioned to undertake a peer review on the air quality and greenhouse gas assessment of the Western Sydney Airport draft EIS. This section provides a summary of their review whilst Appendix C of this report Their review did not include a health risk assessment which was undertaken separately and presented in section 4.4 Human Health.

To assist with its review, access to all relevant input and output files that were integral to the air quality assessment studies was requested as this information was not contained in the EIS. The provision of such information is a routine expectation and is a minimum requirement of the NSW Environment Protection Authority (EPA) for such studies. For a peer review the data is integral to demonstrating the integrity of the assessment. However, this information was not made available and consequently, Katestone has relied only upon the information contained in the relevant chapters of the EIS to complete its review.

Where apparent errors and inconsistencies were found within and between documents, Katestone has noted these, but in most cases has not been able to discern the full significance of these on the assessment outcomes.

4.2.1 Overall comments on air quality study

The air quality study is contained in Volume 2 Chapter 12, Volume 3 Chapter 32 and Volume 4 Appendix F1 of the Western Sydney Airport EIS. It is noted that these documents contain many typographical errors and inconsistencies that undermine the credibility of the air quality assessment. These sections require a thorough technical and editorial review by its authors to address the issues outlined in this review to improve transparency and credibility of the air quality assessment. To enable confidence in the assessment, all information and data used in the emission estimation, model inputs and outputs should be made available to any interested party.

The air quality study did not adequately address the sensitive receptors as it:

- Failed to identify all sensitive receptors;
- Failed to identify a representative subset of sensitive receptors - whilst a small subset of sensitive receptors was identified, the subset does not appear to be representative of potential air quality impacts at all existing locations of sensitive receptors;
- Did not identify future sensitive receptors; and
- Incorrectly classified community receptors separately and as having a lesser importance than residential receptors. Community receptors included various land-uses such as schools, parks, childcare facilities, churches and shopping centres.

4.2.2 Stage 1 development

4.2.2.1 Local Air Quality

The assessment results are taken as presented in Tables F1 to F8 and Table G1 to G5 (Volume 4, Appendix F1) of the draft EIS, they indicate the following:

- The maximum 1-hour average concentration of NO2 was predicted to exceed the EPA's impact assessment criterion of 246 µg/m^3 at one receptor. Three other receptors have maximum 1-hour average concentrations of NO_2 that are 92% to 98% of the EPA's impact assessment criterion.
- The annual average concentrations of PM2.5 were rounded to one significant figure. A number of receptors were predicted to have an annual concentration of PM2.5 of 8 µg/m^3 – equal to the Air NEPM Advisory Reporting Standard. These results are potentially indicative of minor exceedances (<0.4 µg/m^3) of the Advisory Reporting Standard.
- The 99.9th percentile 1-hour average concentration of formaldehyde was predicted to exceed the EPA's impact assessment criterion at two receptors.
- The predicted concentrations of all other air pollutants were below their respective assessment criteria.
- The major contributor to elevated levels of air pollutants is aircraft emissions. However, for receptors close to existing or new roads, the major contributor is external roadways.
- Mitigation measures were recommended. However, the effectiveness of the measures in achieving compliance was not quantified.

4.2.2.2 Regional air quality

The methods used to assess the regional air quality are acceptable. The assessment of regional air quality showed that only marginal increases in ozone concentrations would result from Stage 1 Development.

4.2.2.3 Greenhouse gases

The methods used to estimate greenhouse gas (GHG) emissions are acceptable. The estimates of greenhouse gas emissions are reliable and the contribution of greenhouse gas emissions from the project will be relatively small with Stage 1 Development emissions approximately 0.11% of Australia's projected 2030 transport-related GHG inventory.

4.2.2.4 Overall comments

The Stage 1 Development assessment was based on the annual throughput of the airport would be 63,302 ATM in 2030. The stated maximum capacity of the airport following completion of Stage 1 is three times higher at 185,000 ATM in 2050. The local air quality assessment, regional air quality and greenhouse gas assessment all use this assumption in the generation of the emissions and resultant impacts. Consequently, the assessment has underestimated the potential impact of the Stage 1 Development by a considerable margin.

4.2.3 Longer term development

4.2.3.1 Local Air Quality

The assessment results are taken as presented in Tables F9 to F11 (Volume 4, Appendix F1) of the EIS, they indicate the air quality assessment of the Longer Term Development shows:

- The maximum 1-hour average concentration of NO_2 was predicted to exceed the EPA's impact assessment criterion of 246 µg/m^3 at 41 of the 96 receptors.
- The maximum 24-hour average PM_{10} concentrations was predicted to exceed the EPA's impact assessment criterion at three receptors.
- The maximum 24-hour average concentrations of $PM_{2.5}$ were predicted to exceed the NEPM Advisory Reporting Standard at three receptors.
- The annual average concentrations of $PM_{2.5}$ were rounded to one significant figure. The annual average concentrations of $PM_{2.5}$ were predicted to exceed the Air NEPM Advisory Reporting Standard at 13 receptors (concentrations are reported as 9 µg/m^3 or higher). A number of receptors were predicted to have an annual concentration of $PM_{2.5}$ of 8 µg/m^3 – equal to the Air NEPM Advisory Reporting Standard.
- These results are potentially indicative of minor exceedances (<0.4 µg/m^3) of the Advisory Reporting Standard.
- Whilst a number of mitigation and management measures were listed within the Western Sydney Airport EIS, the effectiveness of the measures was not quantified and therefore the air quality assessment failed to demonstrate that compliance with the relevant air quality criteria could be achieved.

4.2.3.2 Regional air quality

The assessment of regional air quality showed:

- The change in daily maximum 1-hour ozone concentration from the addition of the airport was 4.5 ppb which is significantly above the maximum allowable increment of 1 ppb defined in the NSW EPA's tiered approach.
- The change in daily 4-hour average ozone concentration from the addition of the airport was 3.7 ppb which is significantly above the maximum allowable increment of 1 ppb defined in the NSW EPA's tiered approach.

However, the regional air quality assessment for the Longer Term Development is hypothetical as:

- the impacts had to be assessed in context of the 2030 base case emissions as a base case inventory has not been projected for 2063;
- changes in emissions to other existing sources had not been accounted for; and
- assumes that the rail network exists.

4.2.3.3 Greenhouse gases

The methods used to estimate greenhouse gas emissions are acceptable.

4.2.3.4 Overall comments

The Longer Term Development contained in the Western Sydney Airport draft EIS includes a second runway, which relies upon the existence of rail services to be feasible. The Western Sydney Airport draft EIS states 'As it is not possible for the longer term development to achieve the project passenger numbers without the rail network the traffic scenario that does not include the rail network was disregarded'.

Air quality associated with Stage 1 is critically dependent on the traffic volumes generated by the airport. Consequently, the impact on air quality due to the Longer Term Development is critically dependent on the existence of the assumed rail services to the airport. The Western Sydney Airport EIS is not seeking approval for the rail infrastructure that is necessary for its feasibility and the EIS does not contain a detailed proposal for the rail infrastructure. As a consequence, the air quality assessment of the Longer Term Development is speculative at best and does not provide a sufficiently robust basis to support approval of the Longer Term Development at this stage.

4.3 Traffic, transport and access

4.3.1 Approach

Arup has undertaken the peer review of the Traffic and Transport sections within the draft EIS. The peer review has been intended to assess the merits of the proposal as presented in the draft EIS – it has not been intended that the peer review will develop recommendations for alternative designs for the project.

In relation to Arup's comments regarding any short comings of this assessment, it should be noted that Arup has not been privy to any specific requirements above and beyond those described in the Guidelines for the Content of a Draft Environmental Impact Assessment Statement, Western Sydney Airport, *Environment Protection and Biodiversity Conservation Act, 1999*. It is understood traffic and transport is likely one of the key environmental issues associated with the Airport. Arup has provided independent traffic and transport reviews relating to the adequacy of the documentation provided and the appropriateness of the mitigation measures proposed in:

- 'Western Sydney Airport draft EIS 19 Volume 2 Chapter 15'
- 'Western Sydney Airport draft EIS 39 Volume 3 Chapter 33'
- 'Western Sydney Airport draft EIS Volume 4 Appendix J Surface transport and access'.

4.3.2 Stage 1 development

Issues identified in terms of predicted traffic impacts as a result of the Stage 1 airport include:

- limitation of the strategic traffic model's (STM3) ability to capture traffic impacts at a detailed level
- detailed intersection traffic modelling not undertaken
- intersection operations and performance not assessed
- future land take impacts as a result of intersection operations
- freight traffic generation and associated impacts (outside of specific air cargo) not assessed

- traffic generation and associated impacts caused by the zoned lands within the Airport precinct not assessed
- impact to public transportation operations (bus network) not assessed.

The above issues and limitations are considered significant. Further information would need to be provided to enable Arup to reach a firm opinion as to whether the conclusions reached in the study are valid. Until these comments are addressed or further information supplied, Arup is unable to comment on the validity of the traffic impact conclusions reached in this draft EIS.

4.3.3 Long term Airport development

The predicted traffic impacts of the long term development of the Western Sydney Airport largely followed the Stage 1 assessment. A number of the issues identified for Stage 1 are also apparent in the longer term development including:

- limitation of the strategic traffic model's (STM3) ability to capture traffic impacts at a detailed level
- detailed intersection traffic modelling not undertaken
- intersection operations and performance not assessed
- future land take impacts as a result of intersection operations
- freight traffic generation and associated impacts (outside of specific air cargo) not assessed
- traffic generation and associated impacts caused by the zoned lands within the Airport precinct not assessed
- impact to public transportation operations (bus network) not assessed.

Additionally, a number of issues identified in the longer term development (above and beyond Stage 1) include:

- The local road network adjacent to the Airport reaches capacity by 2063. No road planning mitigation measures were provided.
- Airport Access Drive (from M12) reaches capacity by 2050, 13 years before long term development year of 2063. Capacity is predicted to be reached for approximately 15 hours a day.
- Insufficient information was provided to determine how air passenger demands would access and egress the Airport beyond 2050 (when the Airport Access Road reaches capacity).
- No assessment was included to understand what impact the air passenger demands using the South West Rail Link extension (SWRLe) would have on the wider Sydney Rail Network.

Prior to the long term development of the airport being constructed, a major development plan (managed in accordance with the Commonwealth *Airports Act 1996*) will be required with final approval provided by the Minister for Infrastructure and Regional Development.

As such, Arup believes the above issues and limitations should be viewed in conjunction with this additional assessment being undertaken.

4.3.4 Key impacts and opportunities

The traffic impacts caused by Stage 1 of the Airport is predicted to be relatively low. With consideration to the methodology used, the draft EIS states the future road network is able to accommodate the predicted Airport traffic demand.

Nonetheless, it was difficult for Arup to confirm the validity of these impacts with confidence. Arup has identified further information that could be provided to quantify the potential impacts, including:

- freight traffic generation within the Airport precinct (outside of air cargo)
- private vehicle traffic generation from land uses within the Airport precinct (outside of air passengers)
- vehicle travel time comparison (as predicted by strategic modelling)
- intersection performance (as predicted by intersection modelling)
- intersection layout requirements (as predicted by intersection modelling).

The following describes the predicted traffic impacts caused by the long term development of the Airport as described in the draft EIS:

- The traffic impacts caused by the Airport is predicted to be significant. The airport Access Drive from the M12 is predicted to fail in 2050. This is approximately 13 years before the ultimate long term airport development year (2063).
- The traffic impacts also affect the wider road network with significant congestion predicted on key road links in 2063. The assessment acknowledges this is a result of significant background growth in conjunction with unknown road infrastructure commitments past 2041.
- The Airport also impacts wider transport modes. The assessment suggests additional rail link capacity (above and beyond the SWRLe) would be required to accommodate both the Airport trips and background growth trips by 2063.

With consideration to the above potential impacts, it is recommended that detailed transport network planning including road and rail network planning be undertaken.

4.4 Human health

A peer review of the human health sections of the Western Sydney Airport draft Environmental Impact Statement (EIS) was undertaken by a team of international reviewers, led by the Centre for Health Equity Training, Research and Evaluation (CHETRE) at the University of New South Wales (UNSW).

4.4.1 Approach

The review team developed a peer review framework based upon existing best practice review guidelines for evaluating health impact assessment (HIA). The framework incorporated key elements, processes, and requirements that should be included in the health assessment of an EIS. Additionally, the review team reviewed existing HIAs of airport developments to establish the range of health effects that are relevant to airport health assessments. This framework allowed the review team to assess the quality of the health assessment that was included in the draft EIS, and also determine important health effects that were not included.

4.4.2 Limitations

The review team were only able to conduct a review of the health impacts included in the health chapters (Human Health Chapter and Community Health Appendix). These were limited to noise, air quality, and water impacts, therefore the review team were not able to further review the assessment of other potential significant health impacts associated with airport development, such as changes to employment, transportation, amenity, and housing.

Although the review team assessed the methods used we were not able to assess the validity of the calculations used in predicting health outcomes. Validity of the findings in the health risk assessment (HRA) were based upon what was included in the health appendix, which did not include all necessary methods and formulas to test the findings. It is assumed that the calculations were carried out correctly.

As there was not a comprehensive HIA included in the draft EIS, the review team were limited in the range of recommendations we could make.

4.4.3 Components of draft EIS Reviewed

- Primary:
  - Part D – Human Health Chapter
  - Appendix G – Community Health
- Secondary:
  - Volume 1:
    - Executive Summary
    - Part A – Project Background
    - Part B – Airport Plan
  - Volume 2
    - Chapter 9 – Approach to Impact Assessment
    - Chapter 27 – Cumulative Impact Assessment
    - Part E – Environmental Management
    - Part F – Conclusions
  - Volume 3
    - Chapter 39, Section 8 – Human Health
    - Part H – Conclusion and recommendations
  - Volume 4
    - Appendix E – Noise
    - Appendix F – Air quality
    - Appendix P1 – Social impact
    - Appendix P3 – Economic analysis.

4.4.4 1st Stage Airport findings

Compliance with EIS Guidance:

- Overall, the Health Chapters of the draft EIS comply with most of the EPBC Guidelines.
- The impacts that are considered in the Health Chapters are those associated with changes in air quality, water quality and noise. Generally, these are assessed in detail in terms of nature and extent of short and long-term impacts.
- Some of the information is presented in a way that makes it difficult for interested stakeholders to fully understand the scope and scale of the potential health impacts. The information provided is not always, clear, succinct and supported by maps or other accessible materials. Technical jargon is generally avoided without losing technical precision or the validity of the statements made. Cross-referencing is used however summaries of the findings of other chapters often do not fully explain key issues. Not all sensitive population sub-groups or receptors have been considered in the areas assessed.
- The rational and justification for why a HRA has been undertaken rather than an HIA are not discussed. There is national and state level guidance on HIA that should have been consulted in the development of the scope and methodology of the health assessment of the draft EIS. Key guidance documents include Health Impact Assessment Guidelines (enHealth, 2001), and Health Impact Assessment: A practical guide (UNSW and NSWHealth, 2007). Ideally the health assessment would have used an HIA framework incorporating an HRA approach.
- Ecologically sustainable development in relation to health is not considered. EPBC guidance states that ecologically sustainable development should ensure that the *health*, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.
- Considering the most significant health impacts/effects/risks considered in the draft EIS are those related to changes in air quality, noise and water quality, the level of analysis and detail presented in the Health Chapters is reflective of the potential significance of these descriptors. However, the potential inequality/inequity impacts have not been sufficiently assessed or discussed. This is a significant gap.

Recommendations for the Health Chapters of the draft EIS to better comply with EPBC guidelines are provided:

- The Health Chapters of the draft EIS should assess the health impacts/effects of changes in the full range of environmental and social determinants of health and the potential inequalities/equity issues due to the proposed development. The level of analysis and detail should be reflective of their likely significance. Examples are changes to road traffic movements and their potential health consequences (community severance, risk of road traffic accident and injury), changes in qualities and characteristics of the surrounding areas (including land values and other economic impacts) and changes in recreational use, amenity of natural areas and access to greenspace and nature and their associated health and wellbeing impacts through, for example, changes to levels of physical activity; effects on services and amenities.
- Findings should be presented in a way that helps to communicate the scale of the population affected, by determinant of health, and also what the synergistic (combined) impacts are likely to be to various communities from exposure to the combined hazards.
- Not all unknown variables, assumptions, and limitations are included in the assessment. A specific comment relates to certain health impacts (e.g. air quality-related health impacts on children, other chronic effects such as incidence of chronic bronchitis in adults) known to occur from exposure to air pollution but for which the level (extent/magnitude) of the health impact associated with a certain level of pollution exposure is uncertain or unknown. These additional health impacts, for which quantification is uncertain or unknown, are not discussed. The Health Chapters should consider and discuss health impacts where quantification is not currently recommended by national guidance (e.g. Australian Government *Guidelines for Health Risk Assessment*) such as air quality impacts on children, other

chronic effects, and other additional morbidity effects of short-term exposure but for which there is a widely acceptable evidence base supporting their likely occurrence.

Assessment of Air Quality:

- The assessment of air quality-related health impacts follows a health risk assessment approach, focussing on quantification of health endpoints from exposure to a range of air pollutants. The methodology used is adequate. The range of air pollutants addressed is adequate. The range of health endpoints considered is also adequate and follows Australian evidence and guidance.
- However, the range of health endpoints addressed could be expanded to include others for which solid exposure-response coefficients exist, for example, group A coefficients provided in the WHO HRAPIE Project report[1].
- It is also not clear what baseline incidence rates were used (Sydney average or Liverpool/suburb rates). If Sydney rates are used, this may have resulted in a small underestimation of risks.
- Risks are estimated for 2030 and 2063 snapshots and separately for each pollutant. An overview of the expected scale of impacts resulting from the combined effect of all pollutants should be provided to provide a picture of the total risk to the exposed communities. It would also have been useful to include stage 1 predictions at full capacity (2050).
- Risks could also have been provided for the entire assessment period e.g. 30 years and not just for the snapshots. Discussion of the uncertainty around estimates could be enhanced, for example through the use of the upper and lower 95% confidence interval values of the exposure-response coefficients used. This would provide a better understanding of the likely range of actual impacts (for the worst-case unmitigated scenario).
- A general level of acceptability for estimated risks is used, stated to be accepted by regulatory agencies. This is for a risk between 1×10^{-6} (1 in a million) and 1×10^{-5} (1 in 100,000). The regulatory agencies should be named and references for this statement should be provided. Consideration should also be given to stakeholder perceptions of acceptability of risk.
- There is no discussion of the implication of the distribution of effects for inequality and equity although baseline information on sensitive/vulnerable groups is provided.
- Community feedback and any potential perceptions or concerns of local residents are not discussed. Community feedback on health concerns should be described and how this feedback was considered and addressed in the assessment should be discussed. Where community comments have not been incorporated or addressed an explanation justifying this should be presented. If there were no specific comments or concerns about health impacts/effects or some determinants of health then this should also be stated explicitly. There should also be a discussion of how communities were consulted.
- Perception effects are different from biological or epidemiological risks, can cause stress and anxiety, and should be considered separately from mortality and morbidity effects.
- Mitigation measures are not discussed, readers are cross-referred to the air quality chapter. An outline of proposed measures (i.e. an air quality management framework or plan) should be provided in the health chapter and an explanation provided for how and to what extent these measures will mitigate the identified health impacts.

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1 Table 1. CRFs recommended by the HRAPIE project, p5–11

Assessment of Noise:

- The assessment of noise-related health impacts follows a health risk assessment approach, focussing on quantification of health endpoints from exposure to a range of noise. The quantitative methodology used is adequate. The range of noise metrics used is adequate. The range of health endpoints considered is also adequate and follows Australian and international evidence and guidance, namely the enHealth Guidance *Health Effects of Environmental Noise other than Hearing Loss* (enHealth, 2004). Risks are estimated for 2030, 2050 and 2063 periods for three different operation phase scenarios.
- A qualitative analysis and discussion of impacts/risks/effects on vulnerable/sensitive groups and on health inequality/equity issues has not been undertaken.
- There is no discussion of the implication of the distribution of effects for inequality and equity.
- Community feedback and any potential perceptions or concerns of local residents are not discussed. Community feedback on health concerns should be described and how this feedback was considered and addressed in the assessment should be discussed. Where community comments have not been incorporated or addressed an explanation justifying this should be presented. If there were no specific comments or concerns about health impacts/effects or some determinants of health then this should also be stated explicitly. There should also be a discussion of how communities were consulted.
- Perception effects are different from biological or epidemiological risks, can cause stress and anxiety and should be considered separately from mortality and morbidity effects.
- Mitigation measures are only discussed in passing and readers are cross-referred to the noise chapter. An outline of proposed measures (i.e. a noise management framework or plan) should be presented in the Health Chapters and an explanation provided for how and to what extent these measures will mitigate the identified health impacts.

Assessment of Water Quality:

A complete health risk assessment is not provided for water quality due to the limitations in water quality sampling (i.e. only 1997 data was available; no new data was collected for this EIS). A more complete assessment is required that includes a clear list of assumptions, a description of population affected, and an assessment of impacts on vulnerable receptor population groups.

Review of Overall Report:

The description of the context and requirements for the HRA are generally sufficient. It would have been advantageous to understand why only an HRA was undertaken and not a full HIA, considering that the Health Chapters recognize the significance of the social determinants of health. The population health profile was very limited in scope and is missing clarification for why only certain information is provided. Consideration of vulnerable populations is based around SEIFA scores only and again, it should be explained why only these scores, and not additional indicators of disadvantage are included. Any further information that is included in other chapters in the draft EIS should be referenced within the Health chapters.

Coverage of Health Topics:

The health risks described in the Health Chapter (air quality, noise and water) shows that some key determinants of health have been considered in reasonable detail. However, the potential inequality/inequity impacts have not been sufficiently assessed or discussed. This is a significant gap.

Some key determinants either do not seem to have been considered anywhere in the draft EIS or have not been considered and discussed in relation to health impacts in the Human Health Chapter and appendix. The approach taken to considering health impacts in the Health Chapters is narrow and does not take into account the findings of other health-relevant assessments, such as in the social impact assessment (SIA).

This has resulted in key environmental and social determinants of health not being considered. The scoping process whereby the decision to focus on air quality, noise and water is unclear so it is not possible to assess whether the narrow focus is justified. However given the current level of evidence on the effects of airports on health as well as the more general evidence base around the social determinants of health, it is likely that relevant health impacts are missing from the Health Chapters. The 'non health' sections of the draft EIS do however contain information about a number of significant impacts on the determinants of health (e.g. housing affordability, visual amenity). The majority of these relevant health determinants are covered within the SIA. These have not been identified as health impacts and the range and magnitude of potential health outcomes resulting from these impacts have not been assessed.

4.4.5 Long term development findings

The long-term development section (Chapter 39, Section 8) provides a summary of the long term health impacts that are discussed in more detail in the appendix. While the report does, at times, make reference back to the appendix, there is a lot of pertinent detail that is missing that should be referenced to the appendix. This section also lacks core components for clarity – such as discussing the methods used or mitigation measures - that would make this section acceptable as a standalone piece of work without having first read the appendix. This section also misses any discussion of long term cumulative impacts. Cumulative impacts are considered elsewhere in the report however this report does not make clear if the cumulative impact assessments were used in this assessment. It would be particularly relevant to include discussion of cumulative impacts here as there is no mention of health impacts in the cumulative impacts chapter. This section should also provide better characterisation of health impacts or otherwise provide a reference to where it is located in the appendix.

4.4.6 Key impacts and opportunities

The Health Chapter contains predictions of the attributable health outcomes from air and noise exposures in communities near the airport. The majority of outcomes for air quality were below accepted thresholds, however there were some exceedances for Particulate Matter 10, Particulate Matter 2.5, and Nitrogen Dioxide. Impacts from noise were also mostly below standards, however, impacts varied widely for different communities, with Luddenham likely to experience the most impacts associated with noise. Sufficient data was not available to conduct a complete HRA for ground water and surface water, therefore there are no predicted health impacts.

The Health Chapter and appendix utilises a Health Risk Assessment approach. This is a quantitative methodology that takes changes to these environmental determinants and estimates their risk to health (i.e. the chances or risk of a disease or fatality occurring). This narrow approach does not address the full range of determinants of health and makes no use of the large evidence base on the association between health determinants, particularly social, and health outcomes.

There are two major weaknesses in relation to the assessment of health impacts that the review team strongly recommend be addressed in order to ensure that health effects are not overlooked or not taken into account when mitigation/enhancement is being considered. These are: the reporting of the identified health impacts; and the scope of the impacts included in the health chapter.

4.5 Aviation planning

4.5.1 Approach

The approach to aviation planning has been to review the four volumes of the draft EIS as well as the draft Airport Plan provided on the Western Sydney Airport website (www.westernsydneyairport.gov.au).

This review is based on a desktop study and a literature review of the four volumes of the draft EIS and the draft Airport Plan, comparison of these against the EIS guidelines, identification of potential opportunities or inconsistencies and a comparison against available benchmarks.

4.5.2 Stage 1 development

Issues identified in terms of aviation planning for the Stage 1 airport include:

Airport planning

- No vocation or aviation purpose is described for Western Sydney Airport.
- There is a degree of variability in the forecasts and demand information used in the draft EIS and draft Airport Plan. In addition, the forecast passenger loads per aircraft for Western Sydney Airport as presented in the draft EIS appear to be high.
- It is unclear what benchmarks or planning decisions sit behind the 1900m runway separation shown for Western Sydney and it is noted that other airports in Australasia are proposing wider runway separation.
- Benchmarking indicates that passenger throughput per aircraft stand is potentially high for Western Sydney Airport. This would imply that the number of aircraft stands shown is less than one might typically expect.

Airspace and flight tracks

- The proposed airspace model is noted as a “proof of concept” and not the subject of exhaustive analysis. This indicative airspace design was not developed with consideration to potential noise or other environmental impacts.
- A single airspace model is presented for Stage 1 development. The basis of the model is that operations at Sydney Kingsford Smith Airport are unaffected. Other than minor flight path displacement, feasible alternatives are not presented or evaluated. However, presenting alternatives is a requirement of the EIS guidelines provided by the Department of Infrastructure and Regional Development.
- Departures track to 'exit gates', concentrating aircraft on several defined routes. This is a common tool used to improve air traffic flow. The impact of concentration and location of turn points has not been tested for environmental impact.
- Modes of operation (flight paths based on runways in use) are mentioned, but not how they affect surrounding areas.
- Noise abatement procedures, commonly implemented at other major airports, have not been developed.

Bird and bat strike

- The bird and bat strike assessment concludes that the overall risk for the airport is low. However the assessment is preliminary.

Fuel dumping

- Fuel dumping is concluded to be low risk and it is considered that the information presented in the draft EIS is appropriate.

4.5.3 Long term development

A number of the issues identified for Stage 1 are also apparent in the longer term planning of Western Sydney Airport.

- The lack of vocation or purpose for Western Sydney Airport and its relationship to the ongoing operation at Sydney Kingsford Smith Airport and, in particular, that potential long-term growth forecasts are very high.
- The variability in the number of stands and the apparent lack of consistency in terms of a base set of planning parameters used in developing the airport.
- Narrow runway separation to achieve all the proposed aviation uses.
- Lack of a full and thorough assessment of the interaction of aircraft traffic in the Sydney Basin which requires an airspace and flight path review not considered as part of Stage 1. The Stage 1 flight paths proposed in the draft EIS are not considered appropriate for the long term plan.

4.5.4 Key impacts and opportunities

Key impacts and opportunities from an airport planning perspective for the above issues are as follows:

- Vocation or purpose of Western Sydney Airport – One might expect that, certainly in its early stages of development, the Western Sydney Airport would potentially be a predominantly domestic, low-cost carrier airport with a significant cargo operation, reflecting lower charges and the lack of noise curfew. Premium international flights would continue to use Sydney Kingsford Smith as the primary airport in New South Wales and the one which provides proximity to the tourist and business centre of Sydney CBD. This vocational aspect is important in influencing how the future airport will operate, peak periods of activity and the type of traffic that will use the airport.
- Forecasts – There is potential that the forecasts understate the number of aircraft movements required, which has knock-on impacts on dependent analysis such as noise modelling. This is a potential area for further assessment or clarification to confirm that findings in the draft EIS and draft Airport Plan based on these forecasts are robust.
- Runway separation – Any wider runway spacing would increase land take, with downstream environmental impacts on biodiversity, surface water and groundwater, landscape and visual amenity. In addition, wider spacing for the future two runway airport will impact on flight tracks and noise given changes to runway thresholds.
- Aircraft stand provision – The number of aircraft stands shown is potentially less than one might typically expect, which has implications for land take and therefore related environmental impacts, though it is noted that the Land Use plan for Stage 1 shows a large area available for development.
- Airspace, OLS and PANS-OPS – In terms of requirements, the evaluation of protection volumes for flight paths and airspace containment is in accordance with normal methods mentioned in the Airports (Protection of Airspace) Regulations and under the Airports Act 1996. Whilst analysis of Obstacle Limitation Surfaces (OLS) and Instrument Flight Procedure protection volumes (known as PANS-OPS surfaces) indicates that, operationally, the Western Sydney airport can operate unrestricted from terrain and artificial obstacles.

However, the following impacts are identified which are either unresolved or which require further clarification:

1. The proposed airspace architecture is 'indicative' and has not been rigorously tested. The draft EIS proposes that another airspace model is tested closer to commencement of operations.
2. Flight paths appear to fly over water storages such as Warragamba Dam and Prospect Reservoir. The environmental impact is unclear.
3. The requirement under the Guidelines, produced by the Department of Infrastructure and Regional Development (DIRD), for feasible alternatives to be included has not been met. This is particularly important in consideration of concentration of approaching traffic over the township of Blaxland for the Stage 1 development and departure tracks.
4. There is no consideration of community sentiment regarding changes to flight paths, proposed in the draft EIS, when the Airport operates with two runways.
5. An alternative Stage 1 airspace model, based on the long term proposal but operating with a single runway, is not tested.
6. Except for Sydney Kingsford Smith, flight paths for aerodromes, affected by the Western Sydney Airport are not evaluated.
7. The draft EIS suggests that Western Sydney Airport will detrimentally affect the operations at Bankstown and Camden, and affect Richmond (military). The environmental impact is not quantified.
8. Relocation of light aircraft traffic to other airports, the definition of new training airspace and consequent environmental impact, is not assessed.

Given the above, it is considered that the information on airspace presented in the draft EIS does not meet requirements.

- Bird and bat strike – the bird and bat strike assessment is preliminary and therefore further works in the airport site and study area are required to confirm the level of bird and bat strike risk and to refine the mitigation strategies, in parallel with design development.
- Fuel dumping – It is considered that the information presented in the draft EIS is appropriate.

4.6 Social and Economic

4.6.1 Approach

In undertaking this review we have had particular regard to the requirements established by Section 10 of the Guidelines for the Content of the Draft EIS – Western Sydney Airport issued in January 2015 by the DoE.

We have also considered the implications of both the Stage 1 Airport and longer term development with regards to:

- Potential gaps in the preparation of the Social and Economic Specialist Studies;
- Any concerns regarding the validity of assumptions and conclusions; and
- Suggestions to improve the effectiveness of the proposed mitigation measures.

4.6.2 Components of the draft EIS reviewed

The following components of the draft EIS have been reviewed in relation to Social and Economic impacts:

- Relevant sections of the Executive Summary
- Volume 2—Stage 1 development – Chapters 23 and 24 – Social and economic
- Volume 3—Long term development – Chapter 37
- Volume 4—Specialist studies in appendix P1, P2 and P3.

The social and economic review support the draft EIS's summation that the main benefits of the Western Sydney Airport relate to the generation of jobs in Western Sydney and associated economic activity. The importance of this contribution to Sydney represents an important policy shift since the preparation of the earlier EIS's for a second airport on the site as Western Sydney has become a greater focus for economic growth and activity.

In drawing this conclusion however we maintain the need for a balanced assessment across positive and negative social and economic impacts, both at a local and regional level, over the short and longer term. To this effect six overarching issues have been identified in relation to the current draft EIS and its assessment of impacts during Stage 1 of the Airport and a further four regarding its assessment over the longer term as discussed on the following pages of this Executive Summary.

4.6.3 Stage 1 development

4.6.3.1 Balance of discussion – Impacts

We identify a strong focus in the EIS on the economic benefits of Stage 1 of the Western Sydney Airport as distinct from a balanced discussion of economic and social costs and benefits. For example the economic Chapter (24) in Vol. 2 focuses entirely on the regional (Western Sydney) and broader (Sydney, NSW and Australian) employment and economic benefits of the Western Sydney Airport with only one general reference to potential adverse economic impacts as follows.

> *'However there would be some negative impacts in the immediate vicinity of the airport site due to combination of the airport development and the changing land uses' Vol. 2, Chapter 23, Pg. 504*

A more balanced discussion of costs and benefits is therefore encouraged. For example in relation to matters such as impacts to local business activity during construction or the potential impacts of a new business park (with retail as a permissible use) to existing and proposed centres in the South West (i.e. Leppington, Edmondson Park and Liverpool).

4.6.3.2 Balance of discussion – Geography

Our comments regarding the balance of discussion also relate to the EIS's strong focus on the regional and Australian economic benefits of the Western Sydney Airport as distinct from any prospective local impacts. For example the economic benefits and costs to centres within close proximity to the Western Sydney Airport (i.e. Luddenham or within the South West Growth Centre) are little, if at all discussed. Whilst the impacts may be positive or minimal, it is appropriate that they are considered and where possible quantified.

4.6.3.3 Translation of issues within the EIS

The Specialist Social Impact Study in Appendix P identifies a number of likely adverse impacts to the local communities. Despite the significance of these impacts and their potential to raise notable social concerns, many are given relatively minor reference in the relevant Chapter (23) with no reference in the Executive Summary.

This results in an ill-informed view of social issues for readers of the EIS who may not progress to read Chapter 23 or Appendix P in detail.

4.6.3.4 Statements without assessment

In the Stage 1 social and economic chapters (23 and 24) many of the potential issues are stated with little assessment of their implications to communities, their degree of significance or duration and alternative approaches that may be applied to alleviate them. For example the provision of alternative open spaces to communities during the construction process, the severity of noise impacts to recreational areas, the degree of noise disturbance for different locations over the short and longer terms.

This approach weakens the appreciation of the issues and the means to mitigate them. It could also result in greater angst by the community as to the likely degree, duration and severity of impacts.

4.6.3.5 Direct response to Stakeholder Engagement

The initial stakeholder engagement programme for the Western Sydney Airport identified a range of social and economic concerns (Vol.1, Chapter 8). A number of these concerns are listed by the specialist studies yet are not specifically addressed by Vol. 2 or 3 of the EIS. Furthermore the consultation chapter (Vol 1, Chapter 8) refers to an EIS summary paper being prepared however it is understood that this paper was not made available.

It is recommended that a summary consultation paper is prepared and made publically available and that each issue raised by stakeholders is considered and responded to by the specialist studies. In turn the body of the EIS should identify the most appropriate mitigation measures and minimise community concerns.

4.6.3.6 Transfer and redistribution effects

Much of the draf EIS's discussion regarding the economic value add as a consequence of the Western Sydney Airport recognises its '….role in attracting economic activity to the Region' at the expense of others i.e. 'There is a reduction in value-add in the Rest of Australia' (Pg. 139) and 'The model assumed the future regional employment growth would be redistributed across Sydney…' (Pg. 141).

Whilst the generation of jobs in Western Sydney is a strong positive of the Western Sydney Airport, the draft EIS does not discuss the economic or social implications of this transfer of activity from the other areas in Sydney or 'the rest of Australia'. Whilst any such impact might be negligible or acceptable, the potential impact should be recognised and considered in the assessment.

4.6.4 Long term development

The longer term assessment of impacts by the EIS is generally an extension of those identified upon operation for Stage 1. Our review finds that if left unmitigated, these impacts would generally be exacerbated on account of the significant increase in flights and passengers owing to the introduction of the second runway.

Key issues relate to:

9. How potential social and economic impacts could be managed and mitigated with such a significant and relatively quick increase in the number of passengers and associated on site employment (+120%) over the 13 year period between 2050 and 2063;

10. The potential impact of additional flight paths and operations to regional amenity and the impacts to the longer term development potential of affected areas in Western Sydney and more specifically in the South West Growth Centre i.e. height and noise restrictions to increasing residential density;
11. The degree to which the Western Sydney Airport could '…lead to the reduction in social amenity and impacts on the existing lifestyle of people living and working….' (Pg. 138) identified by the EIS; and
12. The economic costs or implications of the Western Sydney Airport's '….role in attracting economic activity to the Region' at the expense of others i.e. 'There is a reduction in value-add in the Rest of Australia' (Pg. 139).

4.6.4.1 Mitigation of Longer Term impacts

A review of the discussion concerning mitigation measures over the longer term focuses heavily on planning mechanisms (i.e. zoning of land to exclude residential uses) together with local and State Government investment to address broader traffic, transport and infrastructure issues.

There is no discussion, however, of how this would be co-ordinated or resourced to address specific impacts resonating from the Western Sydney Airport. Further there is no discussion as to who the key accountability would fall with.

This results in a potential risk that some mitigation measures and impacts would be missed or forgotten over time.

4.6.4.2 Setting a framework for further assessment

To improve the longer term assessment and give some comfort to its approach, we suggest:

- Further assessment of the potential social and business impacts and the information gaps with some parameters or ranges of assessment; and
- The identification of the main body responsible for managing and mitigating these impacts and risks over time or how the mitigation framework will be managed.

4.6.5 Key impacts and opportunities

A review of the EIS has identified the following potential impacts and opportunities during Stage 1 and over the long term development.

Table 4.1 Summary of impacts and opportunities

	Stage 1	Longer term
Impacts	**Social** ▪ Improved employment opportunities ▪ Reduced travel time to work opportunities ▪ Increases in average wages ▪ Improved retail and business service choice and price competition ▪ Changes to semi-rural lifestyle ▪ Changed access to spaces and community facilities on the Western Sydney Airport site ▪ Impacts to community cohesion ▪ Impacts to social service provision	**Social** ▪ Improved employment opportunities ▪ Reduced travel time to work opportunities ▪ Increases in average wages ▪ Improved retail and business service choice and price competition ▪ Impacts to social service provision ▪ Amenity and health impacts (noise, visual and air quality) owing to airport operation

	Stage 1	Longer term
	■ Perceived impacts and associated social anxiety ■ Amenity impacts during construction (dust, noise, road closures) ■ Amenity and health impacts (noise, visual and air quality) upon operation ■ Housing affordability	
	Economic ■ Construction jobs ■ Multiplier benefits of operational job generation ■ Economic value add for the economy ■ Increased customer base and business activity ■ Redistribution of jobs to Western Sydney ■ Local business impacts during construction and operation ■ Land value changes ■ Impact to retail and center viability ■ Changes in traffic congestion ■ Congestion impacts to WSEA and local and regional roads ■ Decline in agriculture industries	**Economic** ■ Multiplier benefits of job generation ■ Agglomeration benefits for Western Sydney businesses ■ Economic value add for the Western Sydney economy ■ Redistribution of jobs to Western Sydney ■ Improved appeal of investing and operating airport related businesses in Western Sydney ■ Land value changes ■ Impact to retail viability and opportunities
Opportunities	■ Greater population growth and diversity (age and socio-economic) owing to employment opportunities ■ Improved live/work connections ■ Potential increase in tourism in the Blue Mountains ■ Greater appeal of Western Sydney to business and investment	■ Continued population growth and improvements in social diversity ■ Improved balance of economic outcomes across Sydney ■ Improved balance of social and community outcomes ■ Enhanced local, Sydney and Australian economies

Key: Positive impacts, negative impacts/opportunities, neutral or positive impacts/opportunities dependant on stakeholder

4.7 Surface water and groundwater

4.7.1 Approach

Cardno have undertaken a desktop review of the draft EIS documents and have assessed the draft EIS with respect to the following items:

- An evaluation of whether the ground and surface water studies meets the requirements of the EIS Guidelines and relevant other guidelines and methodologies;
- An evaluation of whether the conclusions reached in the studies are valid;
- An evaluation of whether the underlying assumptions used to inform the assessment are plausible and credible;
- A review of the mitigation and management measures proposed and advice provided on their likely adequacy in mitigating impacts;

- An evaluation of the level of uncertainty over impacts and the environmental risks that will arise as a result of the project; and
- A summary of the key impacts and opportunities associated with the project in relation to the Surface water and groundwater studies.

Descriptions of methodologies and impacts have been cross-referenced across chapters and the technical reports and figures checked for whether they aid understanding. Limited spot checks on values presented in tables have been undertaken together with applying sanity checks to data and model results with expected outcomes.

Surface water and groundwater have been reviewed by separate specialists, except where there is an inter-connection between the two, such as with water quality.

Prior to release of the draft EIS, Cardno initially reviewed available background documents to gain an understanding of site settings and project history including EPBC documentation and the 1997–1999 draft EIS by PPK.

4.7.2 Limitations

The following limitations apply to the review of the surface water and groundwater:

- No site visit has been undertaken;
- No numerical models were available and hence no review of models or inputs has been undertaken other than what has been reported, nor have any models been run as part of the review;
- No data is available for review and assessment is limited to commentary on the data provided, however, data gaps have been identified;
- Cardno assumed the data used for the impact assessment had gone through a quality control process before use and therefore can be relied upon; and
- Similarly Cardno did not review the interpretation of the data, for example the attribution of a bore to a specific aquifer.

4.7.3 Components of the EIS reviewed

The following components of the draft EIS have been reviewed in relation to surface water and groundwater:

- Volume 1—Project Background:
  - Executive Summary
  - Part A— Project background
  - Part B— Airport Plan
- Volume 2—Stage 1 Development:
  - Part D — Environmental Impact Assessment:
    - Chapter 9: Approach to impact assessment
    - Chapter 17: Topography, geology and soils
    - Chapter 18: Surface water and groundwater
    - Chapter 27: Cumulative impact assessment
  - Part E— Environmental Management

  - Part F —Conclusions
- Volume 3—Long Term Development:
  - Part G — Assessment of Long Term Development
    - Chapter 30: Approach to impact assessment
    - Chapter 34: Surface water and groundwater
    - Chapter 39: Other environmental matters
  - Part H — Conclusion and recommendations
- Volume 4—EIS Technical Reports
  - Appendix C: Western Sydney Airport EIS Guidelines
  - Appendix L:
    - L1 Surface water hydrology and geomorphology
    - L2 Surface water quality
    - L3 Groundwater.

4.7.4 Stage 1 airport

A summary of the assessment of compliance of the draft EIS with the EIS guidelines is provided in Table 2-1. In general the elements of the EIS Guidelines have been addressed, however, some gaps have been identified in the assessments.

Primarily, comment on how the reliability of the information was tested and what uncertainties (if any) are in the information is not presented. Further, figures and maps are provided, however, many figures and maps are not clear and could be improved to aid understanding. Mitigation and management measures are identified, however, are generally broad and do not necessarily target specific residual impacts or propose specific measures or targets.

The review has also identified some technically incorrect statements made in the EIS, however, Cardno has assessed that consequences for the outcomes of the impact assessment are limited.

4.7.4.1 Surface water

The overall outcome of the impact assessment is that there are minimal impacts to surface water, geomorphology and water quality as a result of the Stage 1 development including appropriate mitigation measures. Some specific residual impacts are noted in relation to changes to water level and geomorphology at Oaky Creek and on a tributary of Badgerys Creek.

The identified gaps in the assessment relate to:

- Flooding – Residual impacts in Cosgroves, Oaky and Badgerys Creek are identified. Cardno agree that the impacts may be relatively minor if the results as presented are correct. However, it is difficult to confirm whether the statements and conclusions are valid as there is a lack of supporting information and presentation of inputs and results are not clear and concise. Further, these impacts still require management to mitigate them to negligible levels.
- Duncans Creek and its tributaries have not been modelled to allow definition of baseline and relative hydraulic impacts in these locations. Such impacts have been assessed by the changes in the hydrology for these catchments. As such, all summary impacts do not fully consider impacts to the Duncans Creek downstream areas. Investigation of a basin at this location is proposed as a mitigation/management measure.

- Many of the figures/maps provided in both the main chapters of the EIS and in the technical reports are either not easy to understand or omit relevant information to aid ease of understanding.
- Cumulative impacts have been discussed, however, no assessment has been undertaken to quantify the potential impacts other than for climate change scenarios.
- Water quality has not been presented in terms of achieved pollutant load reduction or assessment against guideline pollutant reduction targets. The EIS seems to dismiss any relevance of increased pollutant loads on the receiving environment and instead determines that impacts are acceptable because there are general improvements in pollutant concentrations due to increased flow volumes.
- The EIS discusses the tributary of Badgerys Creek that joins Badgerys Creek approximately 300 metres downstream of Elizabeth Drive under existing conditions. It acknowledges that threatened ecological communities have not been mapped outside the site as part of the biodiversity assessment, but there is evidence of some remnant native vegetation along this reach of creek, which would be reliant on occasional flooding and would be impacted under the current proposals. Such impacts need to be assessed to ensure there are no impacts and any mitigation and management measures identified.

Surface water impact management is required to address the following residual risks to surface water:

- Outstanding localised increases to flood depths in Cosgroves, Oaky and Badgerys Creeks.
- Risks to erosion and geomorphological changes to the downstream creeks due to increases in bed shear stress at various locations.
- Undefined impacts and mitigation for runoff to Duncans Creek.
- Implications of increases in pollutant loads, particularly for cumulative impacts are not addressed.
- Ecological impacts in receiving waters are not clearly addressed.
- Impacts of potential use of stormwater to provide water supply for site preparation works has not been considered.

4.7.4.2 Groundwater

The overall outcome of the impact assessment is that there would be no impact to groundwater systems and associated values due to the presence of tight clay soils and limited groundwater presence directly below the site. Cardno does not concur fully with the assessment, this difference results from a key assumption made in the EIS by characterising the uppermost aquifer.

The identified gaps in the assessment relate to:

- Groundwater values are identified, however the groundwater dependent ecosystem lacks characterisation and conceptualisation with respect to water source.
- Sufficiently complete characterisation of the weathered rock (regolith) aquifer is not provided. For example, the aquifer composition, nature and thickness distribution is unknown (this could have been collated through a review of all drilling logs performed on site overtime), and the level of saturation of the aquifer is also unknown. This is a limitation in understanding the connectivity of the weathered rock (regolith) aquifer to the alluvium aquifer supporting groundwater dependent ecosystem.
- Similarly, no baseline time-series data has been collected. This is especially a limitation when it comes to characterisation of the weathered rock (regolith) aquifer and the contribution of this aquifer to the alluvium formations along the creek lines where groundwater dependent ecosystems are primarily located.
- The impacts are reasonably well identified, however some of the impact assessment is missing a clear outcome statement.

- Impact management and mitigation measures are only discussed generally with potential mitigation measures to be considered and monitoring to be implemented. Groundwater impact arising from contamination is suitably addressed. Groundwater impact arising from the development of the site is, in view of the lack of information on the uppermost aquifer, inappropriate especially when addressing impacts on groundwater dependent ecosystems.
- Consideration of groundwater recharge is discussed at length for the Bringelly Shale and overlying aquifer, however, the discussion does not extend to the alluvium aquifer.

Groundwater management is required to address the two residual risks to groundwater values:

- Risk of soil and subsurface contamination from spill/release of chemicals or contaminants. A discussion is suitably provided to this effect in the EIS documents. Cardno agrees that the details of the management program cannot be defined at this stage and should be incorporated in a site environmental management plan.
- Risk of impact on groundwater dependent ecosystems from reduced water supply to the creek alluvium system. In Cardno's view, the EIS documents do not provide a robust impact assessment of the risk to the Cumberland Plain Woodland along Badgerys Creek. Cardno suggest that the following management and mitigation approach could be considered to address the EIS guidelines requirements:
  - implementation of baseline data acquisition with an aim to document the contribution of recharge to the creek alluvial system from the weathered rock (regolith) aquifer, the Bringelly Shale and streamflow;
  - a review of the risk to the ground water dependent ecosystem; and
  - based on the outcome of the previous item, the management and mitigation will vary with the level of risk. A risk propagation based monitoring strategy and response plan may be suitable. In this case, a response plan would propose a suitable early warning indication of impact propagation and provide the management and mitigation measures if necessary to prevent adverse impact. If the risk is identified to be more significant, engineered solutions may need to be considered in the site design. Another management and mitigation solution could involve inputs into site design to prevent impact on streamflow and indirectly aquifer recharge or mitigate the loss of recharge.

4.7.5 Long term development

4.7.5.1 Surface water

For the long term development, the impact assessment builds on the assessment for Stage 1. The hydrologic, hydraulic and water quality models used in the assessment include representations of the drainage system incorporated into the concept design of the indicative long term development.

The concept design of the long term development includes expanding the drainage system to control the flow of surface water. An extension of the Stage 1 detention basins is proposed together with provision of an additional detention basin in the longer term.

The following risks to surface water for the long term development and their implications have been identified:

- Outstanding localised increases to flood depths in Cosgroves, Oaky and Badgerys Creeks.
- Risks to erosion and geomorphological changes to the downstream creeks due to increases in bed shear stress at various locations.
- Undefined impacts and mitigation for runoff to Duncans Creek.
- Implications of increases in pollutant loads, particularly for cumulative impacts are not addressed.

- Ecological impacts in receiving waters are not clearly addressed.
- Impacts of potential use of stormwater to provide water supply for site preparation works has not been considered.

It is believed that most of the above issues can be addressed through refinement of the drainage strategy to manage flows, velocities and water quality. There are some outstanding impact assessments which have not been considered and should be addressed such as ecological impacts, use of stormwater for construction and impacts on Duncans Creek.

A reasonably robust assessment of the long term development has been undertaken. There is no formal framework for further assessment established as part of the EIS. The EIS for the Long Term Development simply lists considerations for future development as part of future design stages to address the impacts to be minimised. While this list identifies some of the key items to be addressed, in does not recommend any specific measures or processes that must be adhered to so as to tie those activities back to this EIS and associated approvals.

4.7.5.2 Groundwater

The following risks to groundwater for the long term development and their implications have been identified:

- Risk associated with change of land use and decrease of groundwater recharge. The implication is possibly, a lack of groundwater supply to the groundwater dependent ecosystems (EPBC listed). If the studies highlighted in the data gap analysis confirm that there is a risk, an artificial groundwater supply scheme to the alluvial aquifer or designed streamflow release upstream of the ecosystem will possibly be required to support aquifer recharge. If the studies identify that there is no risk of impact to the groundwater dependent ecosystem water supply, then no further work will be required.
- Risk associated with the possible use of chemicals over irrigated areas. The level of risk will depend largely on locations and practices. The implication is possibly an impact to the health of groundwater dependent ecosystem through runoff and infiltration in the alluvial aquifer. Management of this risk implies best practices be followed for the use of fertilizer and pesticides, additionally, targeted analytes could be included in groundwater monitoring.
- Risk associated with the use of groundwater as a supply. A groundwater assessment will be required to establish whether the extraction of the required volume is feasible and the impact on nearby groundwater users. It should be noted that the target aquifer will be the deeper Hawkesbury Sandstone. The implications in terms of work required will depend on the volume required. At most, the studies for a groundwater assessment are likely to require the drilling of a few wells (at least one observation and one pumping well), pump testing and analysis and some groundwater modelling.

The EIS identifies some of the required assessments and activities especially in relation to water quality management. The EIS also identifies that additional assessments will be required would the project require to use groundwater as a water supply. However, the EIS did not identify the state and federal regulatory processes likely to be required for the management of the site groundwater values (liaison, review and approvals, licences for example), nor did it clearly identify the management plans and response plans required to be in place. The EIS did not identify assessment remaining to be performed to collect baseline data and confirm the hydrogeological conceptual model.

4.7.6 Key impacts and opportunities

Key project impacts and opportunities are as follows:

- Localised increases in flood depths are indicated at a number of locations.

- Impacts in Duncans Creek are not fully considered and additional modelling would be required to determine residual impacts and any proposed management measures.
- Potential erosion and geomorphology changes with increased flow volumes and isolated increases in be shear stress.
- Increased pollutant loads for total suspended solids and nutrients, although pollutant concentration are equal or reduced compared to existing.
- Impacts on the groundwater dependent ecosystem associated with Badgerys Creek are not fully identified due to a lack of characterisation of the alluvium aquifer and in particular of:
  - The relationship between the alluvial aquifer and the weathered rock (regolith) aquifer; and
  - The characterisation of the recharge of the alluvium aquifer.
- These groundwater dependent ecosystems are declared a Matter of National and Environmental Significance under the EPBC Act. A review of the groundwater conceptual model would be required to enable characterisation of impacts on the Badgerys Creek groundwater dependent ecosystem.

There is an opportunity to improve the outcomes of the EIS to manage the residual impacts through refinement of the drainage strategy and management plans during future detailed design stages. It is recommended that the residual impacts are clearly defined in the EIS and appropriate specific management measures and targets be proposed or specified to ensure that these issues are addressed.

Given the complete redevelopment and earthworks taking place on site, there is opportunity to introduce even higher levels of stormwater management and water quality treatment to further minimise the impacts of the project and potentially improve the outcomes. This would assist in minimising cumulative impacts on the environment that may occur in combination with the surrounding South West Growth Centre and Western Sydney Employment Area development impacts.

With respect to groundwater impacts, there is an opportunity before site activities to acquire suitable baseline data and review the level of risk to the groundwater dependent ecosystem along the creeks. There is also an opportunity to define site design requirements to ensure recharge of the alluvium aquifer and, consequently, preservation of Badgerys Creek groundwater dependent ecosystem.

4.8 Greater Blue Mountains

4.8.1 Approach

This section of the draft EIS review focuses on the potential impacts of the proposed airport on the Greater Blue Mountains Area (GBMA). The Greater Blue Mountains are listed as a National Heritage place and as a declared World Heritage property. As such, this review takes into account the following matters of national environmental significance outlined in the EIS guidelines:

- the heritage values of a National Heritage place
- the world heritage values of a declared World Heritage property.

4.8.2 Components of draft EIS reviewed

The potential impacts of the proposed airport on the Greater Blue Mountains are addressed in Chapters 26 and 38 of the draft EIS. Technical reports for noise, social, biodiversity and air quality consider the Greater Blue Mountains as a sensitive receiver in the detailed assessments.

4.8.3 Findings

4.8.3.1 First stage airport

Chapter 26 of the Western Sydney Airport EIS draws on information from the environmental and social assessments undertaken for the first stage airport on the World Heritage and National Heritage values and other values of the Greater Blue Mountains World Heritage Area (GBMWHA).

The methodology applied to the assessment World Heritage, National Heritage values and other values included:

- identification of the property's World Heritage and National Heritage values, including attributes recognised in the Statement of Outstanding Universal Value;
- identification of key examples or attributes of other values that complement the property's World Heritage and National Heritage values;
- collation of relevant baseline information on environmental factors and existing impacts including baseline noise levels and flight paths associated with Sydney Airport;
- assessment of significance of impacts on World Heritage values and the integrity of the world heritage property and the National Heritage values based on the Significant Impact Guidelines 1.1 (DoE 2013a) and the property's Statement of Outstanding Universal Value; and
- assessment of the National Heritage area having regard to all environmental matters.

The draft EIS assessment of the potential impacts was limited to noise, air emissions and amenity impacts from overflight of aircraft, lighting and traffic.

The GBMA comprises eight protected areas. The GBMWHA Strategic Plan (DECC, 2009) provides a framework for the integrated management, protection, interpretation and monitoring of these areas. Each park has a Plan of Management prepared by the NSW National Parks and Wildlife Services which provides the detailed management prescriptions for each reserve which have not been included in the draft EIS.

4.8.3.2 Compliance of the report with the (EPBC Act) EIS Guidelines

As the GBMA is listed as a National Heritage place and a declared World Heritage property, this review assesses compliance with the sections of the EIS Guidelines that relate to the requirements of controlling provisions (5(a), (d), 6(a), 6(b), 6(c)(ii), 7(a)) or MNES (5(c)) or make specific reference to the GBMWHA (4(b), 5(g) and 6(b)(e)).

Table 4.2 Compliance of draft EIS with EPBC Act Guidelines

EIS Guideline		EIS Section	Comment
4	Description of the environment		
	▪ Description of the GBMWHA world heritage values.	26.3.2	Description of the world heritage values adequately reflect the UNESCO 2015 information.
	▪ Description of the GBMWHA national values.	26.3.3	The area and values of the GBMA are the same as the World Heritage Area so the EIS uses one assessment to address both sets of values. Peer review of the EIS confirms the Greater Blue Mountains Area meets the official values of criterion a, b, c and d due to meeting world heritage criterion ix and x and therefore one assessment is considered adequate.

EIS Guideline		EIS Section	Comment
	▪ Reference to World Heritage criterion. ▪ Reference to the integrity of the property.	26.3.2.1 26.3.2.2	Reference to World Heritage criterion ix and x in Chapter 26. Reference to the integrity of the GBMA discussed in Chapter 26 and reflects the world heritage listing.
5	Relevant impacts: ▪ construction, operation and decommissioning phases ▪ facilitated impacts on MNES ▪ justification for no impact.	26.4 26.5 & 38.3	Construction impacts mentioned but none identified that would affect the values of the GBMA due to distance and lack of direct connectivity this is a valid justification. Direct and indirect operational impacts discussed. Indirect impacts associated with noise, air quality and amenity. Facilitated impacts from increased tourism and associated economic development. Decommissioning impacts have not been discussed assessed, given that the likelihood of the airport being decommissioned is low this project phase is not considered relevant.
6	Avoidance and mitigation measures Take into account relevant agreements and plans that cover impacts or known threats.	26.6 & 38.4	Influence on existing threats (26.5.5 & 38.3.5). GBMWHA Strategic Plan forms the basis of the other values and existing threats. It is noted that there are other management plans that cover the individual parks in the GMBA that have not been included in this assessment.
7	Residual impacts and offsets	-	Residual impacts have not been discussed for impacts on the GBMWHA.

Noise

The technical noise report provides an assessment of noise levels in the Greater Blue Mountains World Heritage Area (GBMWHA). To provide a basis for assessing impacts to the GBMWHA, the technical noise report presents information in the form of track density plots. While this form of data provides a useful and established form of information, the reason for reverting to overflight numbers in lieu of predicted noise levels is not stated. As per the discussion in section 2.3.2, this may be related to increased uncertainty in the predictions when considering low predicted noise levels. However, flight track density plots in isolation do not illustrate the full extent of potentially intrusive noise levels at locations to the side of the flight track.

The report notes aircraft are typically at an altitude of approximately 5000 ft, which corresponds to a noise level on the ground of approximately 55 dB L_{Amax}, consistent with INM predictions for the Airbus A320 or Boeing 737-800. Measurements at other airports have however demonstrated that aircraft at that altitude are generally higher than those predicted using the INM, and accordingly noise levels in practise could be higher.

The assessment of noise impacts in tranquil areas is complex and guidance on the subject is limited. As per the technical noise report, levels below 55 dB L_{Amax} could be considered intrusive by recreational visitors and other users. The natural soundscape in terms of sound press levels and sound characteristics are important attributes of high value wilderness areas. While levels below 55 dB L_{Amax} are likely to be comparable to typical levels associated with ambient noise sources in the GBMWHA, it is not considered appropriate to assess aircraft noise intrusion by comparing sound pressure levels; the characteristics of aircraft noise and natural sound sources is very different, and are interpreted in very different ways.

The potential for a large number of audible events below 50–55 dB L_{Amax} is therefore considered to potentially represent a significant and widespread impact within the GBMWHA. On this point, we note that the separate assessment of impacts to the GBMWHA presented in Volume 2 of the draft EIS indicates noise levels below 50 and 55 dB L_{Amax} are 'not significant'. Given the above, the assertion within draft EIS chapter that noise levels below 50 and 55 dB L_{Amax} are 'not significant' is not considered to have been sufficiently justified, and the assessment may therefore not adequately reflect the potential impact to the values of tranquillity within the World Heritage Area.

Given the status of the Blue Mountains as a World Heritage Area, and the potential for intrusive impacts, further assessment of this sensitive receiver location is considered to be warranted. In particular, further information should be provided to demonstrate the relative merits of alternative aircraft arrival management procedures which do not involve a concentration of aircraft movements over the GBMWHA. This should include a discussion of the trade-offs between protection of amenity in residential areas and the protection of the GBMWHA. Consideration should also be given to different areas within the GBMWHA noting any areas of increased recreational use or areas where tranquillity and natural soundscapes may be more valuable.

In addition, the technical noise report considers the number of people potentially affected for alternative merge points in general terms. For the two alternative merge points considered, the technical noise reports notes that the flight densities over Blaxland are reduced, and the people affected are aligned to less populated rural residential areas outside the GBMWHA. Track densities and number of aircraft overflights over Blue Mountains' communities are still predicted to be high, while impacts on some areas within the GBMWHA are increased for the two alternative merge points.

It is therefore unclear why preference has been given to the merge point that affects a greater population, i.e. over Blaxland, in lieu of reducing number of potential affected residences. This is perhaps due to conservation of the world heritage area, though should be confirmed.

Air quality

The air quality impacts relevant to the GBMA have been divided into three elements; regional air quality, climate change and emissions from fuel dumping.

A review of the regional air quality assessment found that the assessment adopted the NSW EPA's tiered assessment approach which was considered appropriate for this project. All the relevant information regarding how the regional air quality assessment was undertaken, with the exception of detailing how the airport sources were parameterised within the model.

Whilst the change in the daily maximum 1-hour ozone concentration was marginally higher that the 1 ppb defined in the EPA's tiered approach, the base concentration at the location of the incremental change was approximately 50 ppb (well below the EPA's impact assessment criterion of 100 ppb). The maximum 1-hour concentrations within the region were not predicted to increase as a result of the Stage 1 Development. Mitigation measures that had a focus on reducing NOx emissions were also recommended for consideration.

The EIS recognises that a challenge identified in world heritage listing (UNESCO, 2015) is the impact of human-enhanced climate change on the GBMA due to the potential for increased temperatures and alteration to the frequency and intensity of fires. A review of the GHG assessment by Katestone Environmental found that despite not specifying the emission factors used to quantify emissions, the greenhouse gas assessment appears to provide reliable estimates of greenhouse gas emissions with the proposed airport representing approximately 0.10% of Australia's project 2030 transport related GHG emissions inventory.

A review by Katestone Environmental identified that the potential impacts from fuel dumping have not been quantified.

Biodiversity

A review of the biodiversity assessment undertaken for the project found that it generally complied with the EIS guidelines. A partial compliance was identified in relation to a detailed assessment of significance on the Greater Blue Mountains Heritage Area which notes that it will be included in the final draft of the report following a multidisciplinary workshop to assess potential impacts.

Social

The GBMWHA has been included in the social impact assessment as an area that provides a range of recreational pursuits that may be impacted by the proposed airport increasing the number of audible overflights to over 70/day in 2030. A review of this technical report has identified that there is a strong focus on the economic benefits at the regional and national levels however lacks the assessment of economic and social impacts at the local level.

4.8.3.3 Commentary on validity of assumptions

Identification of the sensitive receivers

Sensitive tourism and recreation areas used in the assessment were based on the identification of key attractions and associated viewing locations within the GBMA. The assessment considered the remoteness, accessibility and accommodation options as an indication of the type of tourism and recreational experiences available at each location.

Sensitive areas identified for amenity assessment in the EIS stage 1 were:

- Jamison Valley south of Echo Point lookout and the Scenic Cableway at Katoomba and Wentworth Falls lookout;
- Grose Valley east of Evans lookout and Govetts Leap lookout;
- Wilderness area between Deanes lookout and Crawfords lookout within Wollemi National Park;
- Nattai wilderness area;
- Kanangra Walls and wilderness area east of Kanagra-Boyd lookout; and
- Baal Bone Gap within Gardens of Stone National Park.

Other sensitive receivers not included in the assessment that add to the value of the area include towns located in the lower Blue Mountains e.g. Springwood and Leura, walking tours (Aboriginal Blue Mountains Walkabout tour near Faulcon Bridge), sporting events (six foot track marathon, ultra-trail) canoe/kayak trails along Nepean River, Grose River and further north along the Colo River. Viewing locations that are outside the GBMA, but provide views of the area, for example Burragonang lookout near Oakdale could be impacted by the proposed airport. These areas should have been included in the assessments. It is suggested that further consultation with the Blue Mountains City Council or Tourism Board to understand the full range of users of the area.

World Heritage and National Heritage values

The EIS states that the values identified for the Greater Blue Mountains National Heritage Area and World Heritage Area are the same. A review of the National Heritage criteria for the purposes of this item and the *Environment Protection and Biodiversity Conservation Act 1999*, found that each world heritage value that the World Heritage Committee has identified for the property triggers the place to meet a National Heritage criterion.

In this regard the EIS has taken the heritage assessment to cover both the national and world heritage values of GBMA, which is considered a suitable approach.

4.8.3.4 Whether the conclusions reached in the studies are valid

The draft EIS concludes:

- *No direct impacts are expected World Heritage or National Heritage values from the construction or operation of the proposed Western Sydney Airport;*
- *Potential indirect impacts of airport operation would not result in an attribute of the property being lost, degraded or damaged, or notably altered, modified, obscured or diminished.*

It is noted that the detailed assessment of significance on the GBMHA has not been completed and will be included in the biodiversity technical report following a multidisciplinary workshop to assess the potential impacts.

4.8.3.5 Review the mitigation and management measures proposed

Mitigation measures referred to in the aircraft noise assessment are generic in nature due to the airspace design not being finalised. Design of airspace arrangements and flight paths for the proposed airport would take into account the potential impact on sensitive areas including GBMA.

The development of a detailed Environmental Management Plan for the project would take into consideration management plans already in place for GBMA; including the Strategic Plan.

4.8.3.6 The level of uncertainty over impacts and the environmental risks

Given the uncertainties concerning the final form of the airspace design, the final form of noise mitigation measures to be implemented is not yet known. Consequently, the mitigation measures that have been referred to in the aircraft noise assessment are generic in nature.

4.8.4 Long term development

4.8.4.1 Overview of approach to assessment to long term development taken by the EIS

Chapter 38 of the Western Sydney Airport EIS builds on the potential impacts considered for the proposed Stage 1 development (Chapter 26) and takes information from the environmental and social assessments completed for the proposal.

Seven sensitive tourism and recreation areas were identified in relation to the potential impacts from long term development of the airport in relation to noise, air quality and amenity.

- Jamison Valley south of Echo Point lookout and the Scenic Cableway at Katoomba and Wentworth Falls lookout;
- Grose Valley east of Evans lookout and Govetts Leap lookout;
- The wilderness area between Deanes lookout and Crawfords lookout within Wollemi National Park;
- The wilderness area between Mt Yengo lookout and Finchley lookout within Wollemi National Park;
- Nattai wilderness area;
- Kanagra Walls and wilderness area east of Kanangra-Boyd lookout; and
- Baal Bone Gap within Gardens of Stone National Park.

The Strategic Plan was used as the basis to form the additional values and existing threats on the GBMA national heritage listing and the outstanding universal value criterion used as to identify the values of the GBMWHA world heritage listing which is considered valid approach for this project.

Assessment of significance for the potential impact on the world heritage values of the GBMWHA was based on the requirements of the EPBC Act Significant Impact Guidelines 1.1. As noted in above in section 3.1.1, this assessment will be finalised following a multidisciplinary workshop.

Mitigation and management of potential noise impacts will be achieved through planning and implementation of flight paths, airspace design and airport operating procedures to support long term airport operations. The uncertainty of the final airspace design means that mitigation and management measures are generic and not accurately reflect the true noise impacts on the area.

4.8.4.2 Commentary on ‘gaps’ relative to a comprehensive/conventional assessment

Any decommissioning impacts have not been discussed assessed however given that the likelihood of the airport being decommissioned is low this project phase is not considered relevant.

Residual impacts have not identified in the EIS and therefore the effectiveness of the proposed management measures will be difficult to monitor.

4.8.4.3 Key impacts and opportunities

The key impacts on the GBMWHA considered during the review relate to the potential indirect impacts from noise and air quality.

The social impact assessment identifies an opportunity for increased tourism to the GBMWHA due to the closer proximity to an airport and the associated transport network. This opportunity has been assigned a high significance rating.

4.9 Biodiversity

The adequacy of the above documents was reviewed against the *Western Sydney Airport EIS guidelines* (the EIS guidelines), biodiversity survey and assessment guidelines and background data, where appropriate. The review criteria comprised:

- evaluate if the biodiversity study meets the requirements of the EIS guidelines and other relevant guidelines and methods;
- evaluate the validity of the data relied upon to inform the Biodiversity Assessment (draft EIS Appendix K1);
- evaluate the validity of the underlying assumptions of the Biodiversity Assessment (draft EIS Appendix K1);
- evaluate the validity of the conclusions reached in the Biodiversity Assessment (draft EIS Appendix K1);
- review the mitigation and management measures proposed and advise of the adequacy in mitigating impacts; and
- evaluate the level of uncertainty of biodiversity impacts and provide advice on the resulting environmental risks.

A summary of the key impacts and opportunities associated with the project has also been provided.

4.9.1 Stage 1 development review findings

The reports were found to be generally compliant with the EIS guidelines. However, a number of partial and non-compliances were identified. The assumptions and conclusions of the assessment were considered valid, with the exception of three criteria which were deemed 'partially compliant'. The proposed mitigation and management measures were deemed suitable for this stage of the project, with further information required prior to construction with respect to biodiversity and environmental management.

Data gaps were identified with respect to land access restrictions, threatened species locations, the assessment of threatened species, and a large deficit in the proposed offsets. The Biodiversity Assessment (draft EIS Appendix K1) does not clearly define the extent of land access restrictions. A key risk associated with insufficient access (if this is the case) is that biodiversity values and offsetting requirements may have been underestimated.

Assessments of significance were not completed for the Green and Golden Bell Frog, Australasian Bittern, Australian Painted Snipe and a number of migratory species listed under the EPBC Act. Key risks associated with the omission of these assessments are that the level of impact and the offsets required may have been underestimated. The large credit deficit, particularly for Cumberland Plain Woodland in the Sydney Basin Bioregion, listed as a critically endangered ecological community under the *Threatened Species Conservation Act 1995* (TSC Act) and *Environment Protection and Biodiversity Conservation Act 1999* is a key risk as it is not currently known if the quantum of offsets required is available.

4.9.2 Long-term development review findings

The Biodiversity Assessment (draft EIS Appendix K1) provides a general assessment of adverse the long-term development impacts of the project. However, it does not consider the potential impact of successful implementation of biodiversity management measures from the Stage 1 development, which may result in increased biodiversity values and therefore underestimate the longer-term development impacts. In addition, the Offsets Strategy (draft EIS Appendix K2) does not state how offsets will be identified and secured for the long-term development.

4.9.3 Key impacts and opportunities

Key impacts of the project comprise:

- the loss of 90 ha of Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest critically endangered ecological community; and
- the loss of 120 ha of habitat critical to the survival of the Grey-headed Flying-fox, a vulnerable species.

Key opportunities of the project comprise:

- location of the airport site on predominantly cleared land;
- identification of potentially suitable offset sites on private property that may have otherwise degraded, and been subject to key threatening processes; and
- in addition to the offsets, the creation of an on-site environmental conservation zone, containing native vegetation representative of the vegetation types to be cleared.

5. Conclusions

WSP | Parsons Brinckerhoff were engaged by WSROC and MACROC to project manage the peer review of the Western Sydney Airport draft EIS.

In this capacity WSP | Parsons Brinckerhoff ran a competitive tendering process to engage specialists in key areas of interest to the councils. WSP | Parsons Brinckerhoff reported to WSROC under the direction of a Steering Committee (of officers of the participating councils) to confirm which specialists should be engaged, the Steering Committee provided direction throughout the review process and reviewed draft inputs.

5.1 Key findings

The peer review of the draft EIS outlined five key findings as discussed below. A summary of each specialist reviews is provided in Chapter 4 whilst the detailed specialist peer reviews have been included as Appendix A - I and of this report.

General adequacy

The draft EIS was prepared over a period of approximately 8 months from engagement of draft EIS consultants to provision of an initial draft for Commonwealth Department of Environment review. By way of contrast the previous EIS for the project prepared in the late 1990s was undertaken over well over two years. From our review it is apparent that this has resulted in a number of omissions and limitations, which are discussed through Chapter 3 – Review of the overall draft EIS and Chapter 4 – Review of technical report of this report.

Airport Layout

The draft EIS nominates a preferred airport layout for both the Stage 1 and long term developments, noting that the layouts are indicative only and would be confirmed once an Airport Lease Company (ALC) has been appointed. Alternative layouts are presented for both the Stage 1 and the long term development however no consideration of alternative runway orientations has been undertaken. This contrasts with the EIS undertaken in the late 1990s which examines multiple layouts and runway alignments, and gives little visibility of whether the chosen layout, and in particular the runway alignments, achieve the best environmental outcome. Given the time that has lapsed since the previous EIS it would have been expected to see a thorough current option-evaluation process to explore alternatives.

Airspace architecture (flight paths)

Chapter 7 of the draft EIS describes the ‘Airspace Architecture and Operation’ of the proposed airport which includes the flight paths for the Stage 1 Scenario (2030), prepared by Air Services Australia on behalf of the Department of Infrastructure. Only one set of flight paths are provided in the draft EIS, featuring a ‘merge point’ (a point at which all incoming flights converge) over Blaxland. The concept of merge points is relatively new, and is considered good practice as it allows for incoming flights to minimise thrust and so reduce noise.

The brief of Air Services Australia as outlined in the draft EIS was to develop a set of flight paths that avoids impacts on existing operations at Kingsford Smith at 2030 (although it was acknowledged that this would be impossible in the long term) and to ensure safety of operations. We have a number of concerns in regard to the flight paths presented in the draft EIS specifically around the uncertainty of those described.

To reduce some of this uncertainty, we recommend the following:

- Greater consideration of alternative options is required, with an additional objective of minimising environmental impacts.
- A holistic review of flight paths taking account of all airports should be undertaken. As a minimum an option that allows for flight paths at Kingsford Smith to be modified should be considered.
- In recognition that a future ALC may modify the flight paths, sensitivity testing should have been presented to demonstrate the changes of noise impacts that would result if flight paths are modified.
- The case for a merge point should be further explored, and consideration of alternative merge points should be examined.

Draft EIS places no explicit limits on key impacts

In a number of areas the draft EIS does not provide assurances that acceptable environmental thresholds will not be breached, and does not set hard limits on environmental impacts. In the case of aircraft noise this is a reflection of the nature in which aircraft noise is managed in Australia. However the same is also largely true of other aspects of the draft EIS – the mitigation measures are generally not prescriptive, and there is little in the way of hard limits on impacts. This is largely a reflection of the fact that the ALC has not yet been appointed, and that the Department of Infrastructure is seeking flexibility over management and mitigation. However this creates uncertainty over the likely future impacts.

Uncertainties over the way the approvals process will operate

The project is subject to assessment under the EPBC Act, and that the Minister for the Environment's consent (and conditions) are a prerequisite of any subsequent approval under the Airports Act. The draft EIS notes that the future development and expansion of the airport will be subject to further assessment and approval under the Airports Act, and that the preparation of a masterplan will be required within five years of the commencement of the project. This would superseded the current Airport Plan, which is described in the draft EIS as a transitional document, in effect it is implied that once the airport is leased, all future approvals would be under the Airports Act.

What is less clear is:

- What the potential triggers would be for the need for further referrals and potentially approvals under the EPBC Act.
- What further assessment and approval would be required (beyond the current EIS and associated Airport Plan approval) once an ALC is appointed and more is known about the actual airport layout and operations.
- What limitations any EPBC Act approval will place on the airport.
- What level of community engagement will be provided in the process going forward.

6. References

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Appendix A

Aircraft overflight noise (Marshall Day Acoustics)

MARSHALL DAY Acoustics

WESTERN SYDNEY SECOND AIRPORT DRAFT EIS
OVERFLIGHT NOISE PEER REVIEW

Rp 001 R01 2015417ML | 27 November 2015

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Report No.:	**Rp 001 R01 2015417ML**

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EXECUTIVE SUMMARY

Introduction

Marshall Day Acoustics Pty Ltd (MDA) has carried out a peer review of the aircraft overflight noise assessment presented in the draft Environmental Impact Statement (draft EIS) for the proposed Western Sydney Airport (the proposed airport).

The peer review specifically relates to the draft EIS noise assessment of airborne aircraft operations associated with the proposed airport, and the associated ground movements for takeoff and landing. A separate report by WSP Parsons Brinckerhoff documents a peer review of noise impacts associated with construction and aircraft ground operations (including taxiing and engine run-up testing) for the proposed airport.

The objective of this peer review was to assess the reliability and technical accuracy of the aircraft overflight noise assessment.

The peer review considers the following proposed stages of development:

- Stage 1 development comprising a single 3,700 m runway with 63,000 aircraft movements per year which are projected to occur by 2030;
- Longer term development of the single runway to facilitate 164,000 aircraft movements per year which are projected to occur by 2050; and
- Longer term development with an additional parallel runway to enable additional capacity increases to 370,000 aircraft movements per year which are projected to occur by 2063.

Approach

The peer review has been primarily based on information presented in the noise chapters for the Stage 1 proposal and long term developments, in conjunction with the technical noise report presented in Appendix E1 of the draft EIS.

Consideration has also been given to other related sections of the draft EIS to review the broader assessment of noise impacts. The review of these additional sections has been concerned solely with matters related to the aircraft noise assessment. Reference should be made to the separate peer reviews commissioned by WSP Parsons Brinckerhoff for the review of specialist matters directly concerning aviation, fauna, health, planning and social issues.

This peer review addresses the following key elements of the aircraft noise assessment:

- The noise prediction methodology and the associated inputs and assumptions;
- The type of noise level information that has been produced;
- The operational scenarios that have been considered in the noise predictions;
- The noise sensitive receptors that have been identified and considered in the assessment;
- The methods used to assess the impact of the predicted noise levels;
- The proposed noise mitigation and management measures; and
- The level of uncertainty concerning the predicted noise impacts and environmental risks.

In reviewing these aspects of the draft EIS, consideration has been given to the document *Guidelines for the content of a draft Environmental Impact Statement – Western Sydney Airport* (Reference: EPBC 2014/7391 and subsequently referred to as the *EIS guidelines*).

Tasks not conducted as part of this peer review include:

- Consultations with any members of the project team involved in preparing the draft EIS;
- Site studies;
- Review of noise modelling files; or
- Noise modelling for the purpose of validating any of the results presented in the draft EIS

Review Findings – Stage 1 Development

The noise modelling is considered to generally provide a reasonable representation of the extent of noise impacts for the specific flight tracks and operating scenarios that have been proposed. Specifically, predicted noise levels have been determined for a range of operating scenarios. Aircraft noise information has also been produced in a range of formats that are generally consistent with current federal government guidelines for identifying areas potentially affected by aircraft noise.

All noise predictions have been determined using the latest version of the US Federal Aviation Authority's Integrated Noise Model (INM). This software is used widely in Australia and internationally for aircraft noise predictions and is the appropriate choice for this application. However, the use of this software to calculate short term noise levels, which is the main form of noise data used in the draft EIS to identify the extent of affected areas, requires careful consideration. Specifically, the INM supporting documentation notes:

> *INM is not designed for single-event noise prediction, but rather for estimating long-term average noise levels using average input data. Comparisons between measured data and INM calculations must be considered in this context.*

Accordingly, while the use of the INM is reasonable, information has not been provided as part the draft EIS to verify the reliability of the short term noise level data (presented as maximum noise levels and Number Above ratings). This is particularly important for this proposed airport, because of the increased uncertainty associated with the predictions at the lower noise thresholds used in the draft EIS for the assessment of night-time operations and impacts in quiet areas such as the Greater Blue Mountains World Heritage Area.

Notwithstanding the general suitability of the noise modelling data, there are however a number of limitations to the assessment. These relate to the uncertainty surrounding the airspace management design, and the limited assessment of the noise modelling outcomes. These matters are summarised as follows.

Low Stage 1 movement numbers

The total aircraft movement numbers for the Stage 1 development are relatively low when compared to other international airports in Australia. The low movement numbers cast doubt over the suitability of the 5 year time horizon as the primary assessment scenario for the purpose of obtaining approval for a major international airport. In this context, it is unclear how the incremental and periodic approvals that would need to occur as part of the ongoing expansion of the airport provide a sufficient basis for considering the initial 5 years of operation as the primary period for the assessment of noise impacts.

These comments are provided primarily in relation to the plausibility of the movement numbers represented in the noise modelling, based on comparisons with movement numbers documented in the noise modelling for other Australian international airports and similar time horizons. Aircraft traffic forecasts are however outside of our area of expertise and therefore the suitability of the specific movement numbers provided for the noise assessment are considered in further detail in a separate aviation peer review commissioned by WSP Parsons Brinckerhoff.

Airspace management strategy uncertainties

The draft EIS states that the airspace management strategy used as the basis for noise modelling is a proof-of concept design, and that further work is required to determine the actual flight paths which would be flown in practice. Information about the extent of potential flight path changes is limited. The uncertainty surrounding the final airspace management design that would be implemented represents a significant source of uncertainty in the noise assessment. The potential significance of this source of uncertainty has not been quantified and, with exception of alternative merge points for Stage 1, there has not been any sensitivity analysis carried out to assess the implications of potential flight path changes.

Assessment of community annoyance

The draft EIS includes exposed population statistics which provide a useful indication of the number of people who may be affected by aircraft noise to varying degrees. However, in isolation, this data does not provide an indication of the scale or significance of potential community reaction to aircraft noise levels as a result of annoyance. The Health Risk Assessment in the draft EIS provides the most discussion of community annoyance, including references to research concerning the relationship between noise exposure and community annoyance. However, the Health Risk Assessment ultimately states that no quantitative assessment of annoyance was conducted as part of the study.

Dose-response relationships of the types referenced in the Health Risk Assessment can be used with noise levels and population data to provide a quantitative measure of the potential reaction. The use of these established relationships to represent the reaction of a separate community exposed to aircraft noise must be used with caution. In particular, due consideration must be given to the increased reaction that may be expected from a newly exposed community. However, this type of analysis provides an objective basis for comparing the impacts of alternative operating strategies and, more broadly, establishing the risk of community noise impacts relative to other established international airports in Australia.

While the assessment of the risk of community annoyance is complex, the scale of the proposed airport, and the number of people potentially affected, are sufficiently large to warrant further evaluation of the subject. The introduction of a new 24-hour international airport at a greenfield development site introduces a risk of widespread and prolonged community annoyance. A quantitative analysis of this potential risk would be prudent to inform the environmental impact assessment process and the extent to which operational noise mitigation should be prioritised relative to other non-safety related airspace management considerations. Updated social surveys of the type originally carried out as part of the development of the Australian Noise Exposure metric used in Australia also warrant some consideration, given the significant nature of the proposed development and the availability of detailed aircraft noise information for other existing Australian airports.

Land use impacts

The draft EIS includes calculated Australian Noise Exposure Concept (ANEC) contours for the Stage 1 operating scenarios. ANECs are often presented as an indication of the extent of a potential future Australian Noise Exposure Forecast (ANEF) contour which would be used to guide land use planning for noise-sensitive developments in the vicinity of airports.

However, as acknowledged in the draft EIS, the ANEC contours presented for the Stage 1 proposal provide limited guidance for the purpose of land use planning. The reason for this is that the ANEF is normally derived from ANECs calculated for long term operations or ultimate capacity scenarios, rather than short term ANECs related to an initial phase of operation. Evaluation of land use planning impacts must therefore be primarily based on the ANEC contours presented for the long term development of the airport, rather than initial Stage 1 development contours.

Greater Blue Mountains World Heritage Area

The draft EIS presents information to evaluate the potential impacts of aircraft operations on the acoustic amenity of the Greater Blue Mountains World Heritage Area (GBMWHA). The assessment indicates the potential for a large number of audible aircraft events within the GBMWHA.

The preservation of quiet areas and tranquil landscapes has been a topical subject of research and policy consideration in Europe and the US. For example, the US Transportation Research Board publication on the effects of aircraft noise (Mestre, 2008) includes a chapter which discusses research and US legislation (National Parks Overflight Act of 1987) concerning the effects of aviation noise on parks, open space and wilderness areas. These publications do not provide definitive guidance on assessment techniques, but highlight the complexity and importance of assessing aircraft overflight noise in sensitive wilderness areas.

While the noise levels in the draft EIS are predicted to be relatively low (below 50 – 55 dB L_{Amax}), aircraft over flights would be expected to be audible and represent a significant and widespread impact for a World Heritage Area where natural soundscapes are likely to be a valued feature of the areas amenity. The complexities and sensitivities of this area warrant further consideration in the draft EIS. Specifically, the assertion within the draft EIS chapter concerning the GBMWHA that noise levels below 50 and 55 dB L_{Amax} are 'not significant' is not considered to have been sufficiently justified, and the assessment may therefore not adequately reflect the potential impact to the values of tranquillity within the World Heritage Area.

Mitigation measures and residual noise impacts

The draft EIS noise modelling is based on an indicative proof-of concept air traffic management design which does not present a comprehensive airspace and final air route design. Given the uncertainties concerning the final form of the airspace design, the final form of noise mitigation measures to be implemented is not yet known. Accordingly, the mitigation measures that have been referred to in the aircraft noise assessment are generic in nature.

This is a particularly important point for an airport development as, unlike other forms of infrastructure development, the policies used to manage aircraft overflight noise do not generally stipulate noise limits that airport operations must adhere to at surrounding noise-sensitive locations.

Accordingly, without a defined airspace design, a defined noise mitigation strategy or defined noise criteria to adhere to in practice, the residual impacts and the location of these impacts is subject to considerable uncertainty. Further, without defined noise criteria, it is unclear how noise considerations would be prioritised among other non-safety related airspace management and operational considerations associated with the proposed airport site. These uncertainties may therefore warrant consideration of performance criteria as part of the approval process for the proposed airport.

In addition to the generic operational measures for the mitigation of noise, the draft EIS also refers to mitigation related to dwelling acquisition or dwelling insulation upgrades. There is however no detail provided in terms of the circumstances in which these measures would be implemented, other than a general reference to the guidance of AS 2021. It is unclear if this is intended to infer that such measures would only be considered within certain Australian Noise Exposure areas, or if such measures would be considered at all locations where internal levels may be expected to exceed AS 2021 internal design criteria as a result of the proposed aircraft operations.

Review Findings – Long Term Development

A number of the considerations identified from the peer review of the Stage 1 development are directly relevant to the assessment of the long term development scenarios. For example, matters related to the noise prediction methodology are identical for the Stage 1 and long term development scenarios.

In terms of assumptions about operational capacity, the movement numbers for the 2050 single runway scenario and 2063 dual runway scenario are comparable to the range of movement numbers documented for other similar Australian international airports. On this basis, the values appear to be plausible for noise assessment purposes. Aircraft traffic forecasts are however outside of our area of expertise and therefore the suitability of the specific movement numbers provided for the noise assessment are considered in further detail in separate aviation peer review commissioned by WSP Parsons Brinckerhoff.

The following limitations are however noted for the long term assessment scenarios.

Land Use Impacts

The draft EIS presents ANECs for a range of operating scenarios in 2050 and 2063 as part of the discussion of potential land use impacts which may result from a future ANEF for the proposed airport.

However, the latest Australian Standard (AS 2021) which defines how Australian Noise Exposure data should be used to inform land use planning includes guidance on how ANECs for multiple operating scenarios may be combined to define an overall area where planning controls should apply. The draft EIS does not refer to this guidance and it is therefore unclear how the various ANECs should be interpreted when assessing land use impacts.

Further, while the draft EIS provides population counts for the various ANEC bands, no assessment is provided of the extent to which land use controls may change as a result of a future ANEF prepared as part of the detailed airspace design for the project. Specifically, the draft EIS does not quantify the potential extent of changes to land use controls relative to the measures which have been in place since the original EIS was undertaken in 1985.

Furthermore, the discussion of land use planning impacts in the draft EIS notes that the National Airports Safeguarding Framework would '*be instrumental in managing potential future operational noise impacts for future land use planning and development around the airport'*. The Framework could potentially translate to the creation of land use planning controls which extend over significantly greater areas than either the current land use planning controls (based on the 1985 EIS) or the 2063 ANEC contours provided in the draft EIS. This has however not been discussed or assessed in the draft EIS.

Cumulative Impacts

The draft EIS notes that the parallel runway scenario (2063) would introduce a number of issues which would need to be addressed in the final airspace design. In particular, the chapter concerning airspace architecture notes the following issues that would need to be addressed:

- Changes to Sydney Airport flight paths ;
- Changes to flight paths serving Bankstown Airport; and
- Resolution of a potential constraint associated with the restricted airspace over Defence Establishment Orchard Hills.

The EIS guidelines establish a requirement to '*identify and address cumulative impacts, where potential project impacts are in addition to existing impacts of other activities'.*

The above issues concerning the airspace architecture are considered to represent potential cumulative impacts which have not been quantified in the draft EIS. Further information concerning this issue is therefore considered necessary to address the requirements of the EIS guidelines.

Key Impacts and Opportunities

The findings of the peer review indicate that noise level information of the form required by the EIS guidelines has generally been provided in the draft EIS. However, the peer review has also identified a number of limitations concerning the content of the draft EIS, and therefore further information and assessments are considered necessary to address the general and noise-specific requirements of the EIS guidelines.

Based on the review of the draft EIS, the key noise impacts associated with the proposed airport are:

- Community annoyance, and related impacts such as speech interference and changes to the way individuals use outdoor spaces;
- Sleep disturbance associated with night-time operations, and related impacts such as the potential need for some residents to sleep with windows closed to achieve a suitable internal amenity; and
- Degradation of the acoustic amenity of the World Heritage Area within the Greater Blue Mountains area

In terms of land use impacts, the existing planning instruments that have been used to control development around the proposed airport site would generally be expected to limit the extent of the potential impacts. However, the draft EIS reference to the National Airports Safeguarding Framework as an instrumental tool for guiding future land planning around the proposed airport site introduces the potential for significantly enlarged development controls. This could translate to land use impacts also being a key impact associated with the proposed development.

Other noise related impacts cornering matters such as health, property values and social impacts are addressed in separate peer reviews commissioned by WSP Parsons Brinckerhoff.

Aircraft noise impacts are an unavoidable consequence of aircraft operations in urban environments. The creation of a new international airport therefore requires a balance to be achieved between the protection of amenity for neighbouring sensitive land uses and the development of infrastructure to respond to the growing demands of a major city.

Determining whether this balance has been achieved is ultimately a matter for regulatory authorities. While this peer review has identified a number of limitations to the present assessment, this is not intended to infer that the proposed development and development site are unsuitable. Rather, in light of the residual uncertainties in the assessment, further information and assessments are considered necessary before stakeholders can reach an informed view on the potential scale and significance of aircraft overflight noise impacts associated with the proposed airport site.

Conducting these further assessments as part of the environmental impact assessment process represents an opportunity to:

- Provide clarity to affected communities and stakeholders about the nature of the noise impacts;
- Provide clarity to regulators about the form of noise controls which will be needed in the project approval to ensure that noise is appropriately managed; and
- Reduce the potential for unforeseen impacts and the associated risk of reactionary noise management procedures which could subsequently jeopardise the operational flexibility of the proposed airport.

MARSHALL DAY Acoustics

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1.0 INTRODUCTION

This document presents the findings of Marshall Day Acoustics' peer review of the aircraft overflight noise assessment presented in the draft Environmental Impact Statement (*draft EIS*) for the proposed Western Sydney Airport (the *proposed airport*), released on 19 October 2015.

The peer review specifically relates to the draft EIS noise assessment of airborne aircraft operations associated with the proposed airport, and the associated ground movements for takeoff and landing (subsequently referred to as the *aircraft noise assessment* within this document). A separate report by WSP Parsons Brinckerhoff documents a peer review of noise impacts associated with construction and aircraft ground operations (including taxiing and engine run-up testing) for the proposed airport.

The peer review considers the following proposed stages of development:

- Stage 1: development of a single 3,700 m runway at the northern end of the candidate site referred to as Badgerys Creek, with 63,000 aircraft movements per year projected to occur by 2030;
- Longer term development of single runway capacity: incremental development of aviation infrastructure and support services to facilitate 164,000 aircraft movements per year which are projected to occur by 2050; and
- Longer term development with an additional parallel runway to the south: an additional runway is proposed for long term operations, enabling additional capacity increases to 370,000 aircraft movements per year which are projected to occur by 2063.

The peer review was commissioned by WSP Parsons Brinckerhoff on behalf of the following organisations:

- Western Sydney Regional Organisation of Councils (WSROC); and
- Macarthur Regional Organisation of Councils (MACROC).

The above organisations are collectively referred to as the Councils within this document.

The objective of the peer review was to assess the reliability and technical accuracy of the aircraft noise assessment in the draft EIS, in turn assisting the Councils to reach an informed view on potential aircraft noise impacts within their respective shires.

The scope of the peer review was defined by the following requested tasks:

- Evaluate whether the noise and vibration study meet the requirements of the EIS Guidelines and relevant other guidelines and methodologies with respect to aircraft noise;
- Evaluate whether the underlying assumptions used to inform the assessment (including any construction or operational assumptions, and modelling assumptions where appropriate) are plausible;
- Evaluate whether the conclusions reached in the studies are valid i.e. an independent evaluation of whether the predicted impacts are in accordance with published standards and guidelines, and whether the conclusions of the assessment are a realistic reflection of the actual impacts;
- Review the mitigation and management measures proposed and advise on their adequacy in mitigating impacts;
- Evaluate the level of uncertainty over impacts and the environmental risks that will arise as a result; and
- Provide a summary of the key impacts and opportunities associated with the project in relation to aircraft noise as part of the noise and vibration study.

The primary documents that have been reviewed in detail are set out in Table 1.

Table 1: Primary draft EIS sections considered in peer reviewing the aircraft noise assessment

Draft EIS Section	Title
Volume 2 – Stage 1 Development	Chapter 10 – Noise (aircraft) referred to herein as the *Stage 1 noise chapter*
Volume 3 – Long Term Development	Chapter 31 – Noise (aircraft) referred to herein as the *long term development noise chapter*
Volume 4 – EIS Technical Reports	Appendix E1 – Aircraft overflight noise referred to herein as the *technical noise report*

The peer review has also considered additional sections of the draft EIS for contextual information, and to provide informative commentary of the broader assessment of noise impacts which has been presented in other related sections of the draft EIS. The review of these additional sections has been concerned solely with matters related to the aircraft noise assessment. In particular, the review of specialist sections such as airspace architecture, human health and social impacts was limited to technical matters concerning noise modelling scenarios, noise level information and noise mitigation measures. Reference should be made to the separate peer reviews commissioned by WSP Parsons Brinckerhoff for the review of specialist matters directly concerning aviation, fauna, health, planning and social issues. All instances in which the commentary within this peer review relates to a section of the draft EIS other than the primary reference documents listed in Table 1 are identified by a reference to the section of the draft EIS in question.

This peer review has been conducted solely on the basis of the published documentation in the draft EIS. Tasks not conducted as part of this peer review include:

- Consultations with any members of the project team involved in preparing the draft EIS;
- Review of noise modelling files; or
- Noise modelling for the purpose of validating any of the results presented in the draft EIS.

A glossary of terminology used in this report is provided in Appendix A.

2.0 REVIEW FINDINGS – STAGE 1 DEVELOPMENT

This section presents a review of the aircraft noise assessment for the Stage 1 Development, having regard to:

- The noise prediction methodology and the associated inputs and assumptions;
- The type of noise level information that has been produced;
- The operational scenarios that have been considered in the noise predictions;
- The noise sensitive receptors that have been identified and considered in the assessment;
- The methods used to assess the impact of the predicted noise levels;
- The proposed noise mitigation and management measures; and
- The level of uncertainty concerning the predicted noise impacts and environmental risks.

2.1 EPBC Act and EIS Guidelines

In conducting this peer review, reference has been made to the document *Guidelines for the content of a draft Environmental Impact Statement – Western Sydney Airport* (Reference: EPBC 2014/7391 and subsequently referred to as the *EIS guidelines*).

The EIS guidelines establish general content requirements relating to matters including:

- Detailed descriptions of the proposed actions;
- Description of baseline conditions;
- Description of mitigation measures; and
- Description of residual impacts following the implementation of mitigation measures.

In addition, the EIS guidelines note the following requirements directly related to noise:

> *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*

The subsequent sections of this document review the draft EIS against the general and noise-specific requirements of the EIS guidelines.

The findings of the peer review indicate that information of the form required by the EIS guidelines has generally been provided in the draft EIS. However, the peer review has also identified a number of limitations concerning the content of the draft EIS, and therefore further information and assessments are considered necessary to address the general and noise-specific requirements of the EIS guidelines.

In particular, these matters relate to:

- The uncertainty surrounding the airspace management design for the proposed airport, and the corresponding uncertainty this introduces into the noise modelling;
- As a result of the further work required to develop the airspace management design, the proposed mitigation measures have not been developed in detail. As a result, the residual impacts of the proposed airport are not defined; and
- The absence of assessments to evaluate the significance of the predicted noise impacts in terms of community annoyance and land use impacts.

Further discussion of each of these points is provided in the following sections.

2.2 Noise Prediction Methodology

This section provides a review of the input data, assumptions, calculation procedures and calculation settings associated with the noise predictions.

2.2.1 Runway

The technical noise report documents a runway position and configuration which appears to be consistent with the description provided in Volume 1 Chapter 1 *Introduction*. However, the following specific observations are noted:

- The project description in the Stage 1 noise chapter, the technical noise report and Volume 1 Chapter 7 *Airspace architecture and operation* do not define specific location details in terms of an aerodrome reference point, runway end coordinates or elevation details.
- The runway orientation adopted in the noise assessment is consistent with the general description of the Stage 1 proposal and assumes a single southwest / northeast runway designated as runway 23 and 05 respectively. However, the precise orientation of the runway does not appear to have been defined in the project description in the technical noise report or the discussion of airspace architecture presented in Volume 1 Chapter 7, nor is it clear whether the proposed orientation of the runway has been finalised. It is noted that the discussion in Volume 1 Chapter 7 documents the review work conducted by the Australian Bureau of Meteorology to verify the proposed runways 05 and 23. However, the convention of defining runway directions in 10 degree increments means that runways 05 and 23 may relate to direction ranges of 45 to 54 degrees and 225 to 234 degrees respectively. If the runway orientation has not been finalised, this could translate to a significant source of uncertainty in the final location of noise contours.

2.2.2 Terrain Data

The technical noise report specifies the use of terrain data in 10 m height intervals.

The origin of this data has not been specified, however the stated resolution of the terrain data that has been used is considered appropriate for noise modelling purposes.

2.2.3 Flight Paths

The technical noise report specifies that the noise modelling has been prepared on the basis of indicative flight paths prepared by Airservices Australia, noting the following:

> *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 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.*

Section 7.6 also notes

> *The conceptual airspace design presented in this draft EIS has not been developed to a level of detail necessary for implementation…*

The indicative flight paths therefore do not represent the final flight paths which would be flown if the project proceeds; this is to be expected given the current stage of the proposal. However, the description of airspace architecture in Volume 1 Chapter 7 does not provide any indication of the manner or extent to which the final airspace design may vary from the proof-of concept design, nor is this matter addressed in the technical noise report. This represents a significant source of uncertainty in the predicted noise levels.

The following additional items are noted:

- The flight tracks depicted in Figure A1 of Appendix A of the technical noise report indicate that all departures from runway 05 turn left approximately 3 km from the runway end and head due north for 25 km before branching out in a number of directions. This route still passes over populated areas but avoids direct overflight of the relatively densely populated areas to the northeast, such as Blacktown, thus potentially offering benefits in relation to noise. However, while the discussion in Section 7.6.1 of Volume 1 Chapter 7 (airspace architecture) outlines the considerations (including noise) that were factored into the indicative arrival procedures, there is no specific mention of the basis for this departure route. Given that subsequent sections of the technical noise report identify movements on runway 05 result in the greatest total population numbers within the forecast noise contours, it would be prudent to establish the role of noise considerations in the development of this departure track, and the potential extent to which this track may vary in the development of a final airspace management plan.
- The proposed airspace configuration includes a single nominated merge point system applicable for arrivals on each runway. From the description provided in Volume 1 Chapter 7 (airspace architecture), it is understood this system is not presently in use in Australia, and is noted to have been selected for a range of operational reasons. One of these reasons is noted to be noise benefits, presumably on the basis of the reduced noise of continuous descent arrival procedures. However, the noise assessment subsequently identifies that the merge point introduces a number of noise considerations related to the areas beneath the merge point and beneath the arrival paths from the merge point. Accordingly, further discussion of the reasons and justification for proposing a merge point system, with reference to the noise impacts of alternative arrival management options, would be prudent.

- The discussions of airspace architecture in Volume 1 Chapter 7 and in the technical noise report note that the arrival flight paths do not include any dispersion, other than the inclusion of visual approach paths to the merge point which introduce a form of dispersion. The reason is noted to be the tight control available with instrument/satellite assisted arrival procedures. The absence of dispersion has the effect of concentrating noise levels under the flight path, while conversely limiting the spread of noise into other surrounding areas. This is quite an important consideration for the areas located beneath the arrival paths. Further information to support that arrival movements in practice would not significantly deviate from the designated flight paths would be helpful.

2.2.4 Flight Profiles

Arrivals

The technical noise report notes at Section 2.6.1 that the noise modelling assumes that all arrival profiles will be flown using a procedure known as continuous descent approach (CDA).

CDA involves the aircraft approaching the airport at a nominated location (referred to as the merge point), before descending at a constant angle prior to landing. In contrast, standard arrival procedures involve the aircraft stepping down and flying at constant altitude prior to the final descent and landing. As such, the CDA offers potential benefits for reducing ground noise levels as well as allowing aircraft to save significant fuel amounts and hence reduce other emissions, such as carbon dioxide.

It is however noted that around busy airports, or locations where airspace is congested, as is anticipated to be the case with the proposed airport and the existing Sydney Airport and other smaller airports, that CDA can be difficult to achieve for all arrival operations(Airservices Australia, 2012). Airspace management and other factors, including bad weather, could prohibit the use of CDA for all arrival operations. Furthermore, information provided in Volume 1 Chapter 7 *Airspace architecture* notes the following in Section 7.6:

> *If the point merge system is adopted for the proposed airport, the location of the merge point would be a key component of this further development.*

As the assessment assumes 100 % of arrivals adopt CDA, hence reducing the extent of predicted noise contours, it would be prudent for the assessment consider a percentage of arrival operations that would adopt a standard approach flight profile. Conversely, consideration of a conservative situation whereby standard approach flight profiles are assumed to account for expected variation in airspace management requirements for a new airport, with progressively increased CDA usage when feasible.

Departures

The technical noise report notes at Section 2.9 that the noise modelling assumes standard aircraft departure profiles for all aircraft operations. However, the International Civil Aviation Organization (ICAO) defines noise abatement departure procedures (NADP) which can be used by civilian jet operations to reduce noise levels at varying distances from an airport. Data for NADP movements is contained in the Integrated Noise Model (INM) software and can be used to calculate the potential effectiveness of NADP operations for a given airport.

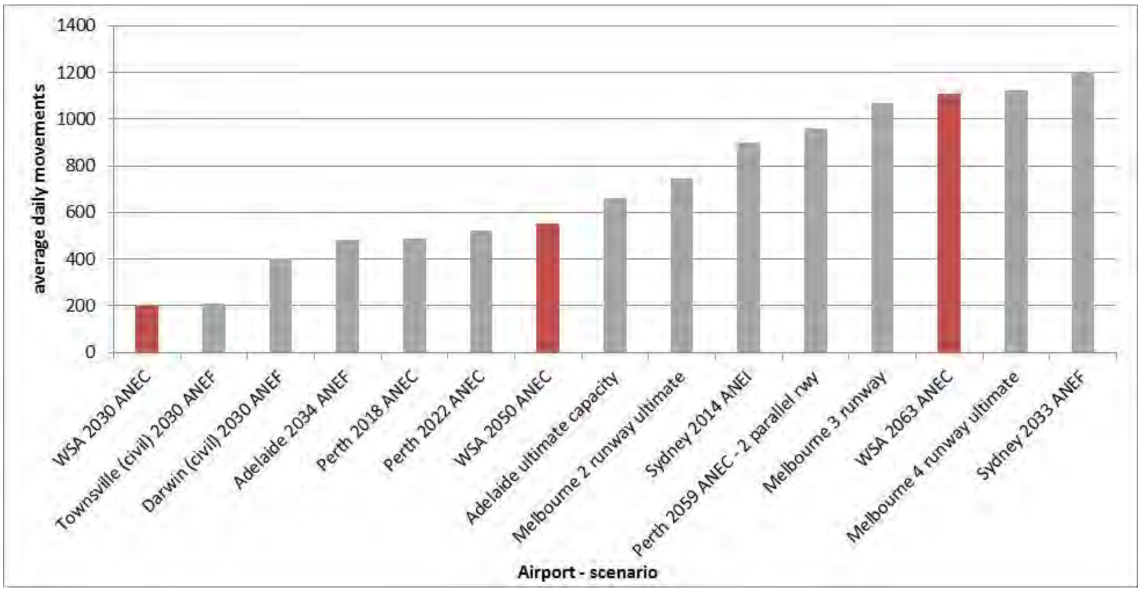
The technical report notes that final design of airspace management arrangements for the airport, including flight paths and procedures, would need to be optimised for noise management purposes as part of the work that Airservices Australia would undertake before the proposed airport becomes operational.

However, in contrast to arrival procedures, there is no mention of the potential use of NADP in the Stage 1 noise chapter or technical noise report. It is unclear if these types of procedures would be considered as part of the final design of airspace management arrangements, and if so, under what circumstances they would be proposed.

2.2.5 Movement Numbers

A general review of the movement numbers associated with Stage 1 development has been carried out by comparing the values with current and future movements at other Australian international airports. Figure 1 shows the proposed daily movement numbers for the Stage 1 development appear relatively low compared with other Australian international airports. This may be reasonable given the relatively short time period of 5 years between the commencement of operations and the assessment year. However, this directly translates to a relatively low numbers of aircraft events exceeding relevant noise thresholds when compared to the longer term development plans for the site. Given the objective of the proposal is to develop a major international airport, the relatively low movement numbers raises the question of the suitability of the 5 year time horizon as the appropriate primary assessment scenario for the purpose of obtaining approval for the development, irrespective of the incremental and periodic approvals (under the Airports Act) that would need to occur as part of the ongoing expansion of the airport.

Figure 1: Comparison of average daily airport movement numbers with other existing Australian International airports



It is noted that the draft EIS refers to ongoing development of airside infrastructure to facilitate the continued growth of the airport. However, it is unclear whether the initial primary infrastructure is to be developed to accommodate a greater number of movements than is projected to occur in Stage 1. Further, it is unclear whether an approval for Stage 1 would specifically restrict the movements to the forecast values presented in the draft EIS. Given these considerations, further information concerning the implications of greater than expected demand under Stage 1 would assist in understanding whether the movement numbers, and therefore the predicted noise levels, could be higher than the forecasts presented in the draft EIS.

These comments are provided primarily in relation to the plausibility of the movement numbers represented in the noise modelling, based on comparisons with the movement numbers documented in the noise modelling for other Australian international airports and similar time horizons. Aircraft traffic forecasts are however outside of our area of expertise and therefore the suitability of the specific movement numbers adopted for the stage 1 noise assessment are considered in further detail in a separate aviation peer review commissioned by WSP Parsons Brinckerhoff.

2.2.6 Aircraft Fleet Mix

The aircraft noise modelling has been based on a range of different aircraft types to represent the overall mix of aircraft that is expected to operate from the proposed Stage 1 development.

The selected aircraft types that have been included in the modelling are considered appropriate. Further, the noise modelling has opted for a conservative approach by assuming that all future aircraft operations are characterised by the noise emissions of existing aircraft. Given that aircraft are generally expected to produce lower noise emissions in future, this choice is considered to be reasonable and conservative.

Further, the choice for particular aircraft types and single event noise contours is considered conservative. For example, the freight Boeing 747-400 which is being phased out and replaced by the newer Boeing 747-800.

These comments are provided solely on the basis of the mix of INM aircraft assignments that have been adopted to represent the proposed fleet mix. Forecast aircraft fleet mix are outside of our area of expertise and are considered in further detail in the separate aviation peer review commissioned by WSP Parsons Brinckerhoff.

2.2.7 Calculation Procedure

The Integrated Noise Model (INM) version 7.0d developed by the United States Federal Aviation Authority (FAA) has been used to calculate noise levels associated with the proposed airport operations.

The technical noise report acknowledges that INM has been superseded by the Aviation Environmental Design Tool (AEDT) Version 2b, released in May 2015. The technical report then goes on to note that the core procedures for calculating of noise levels are equivalent between the INM and AEDT programs. This is reasonable and it is not expected that the calculation outputs of the two programs would differ significantly. The use of the latest version of INM is therefore considered appropriate. However, its use for the calculation of a range of different noise exposure metrics warrants further consideration.

The INM was primarily designed for the calculation of long term energy-based exposure metrics such as the Australian Noise Exposure (ANE), equivalent noise level (L_{Aeq}), and day night noise level (L_{dn}). In this respect, the user guide for the software notes:

> *INM is designed to estimate long-term average effects using average annual input conditions. Because INM is not a detailed acoustics model, differences between predicted and measured values can and do sometimes occur because important local acoustical variables are not averaged, or because complicated physical phenomena are not explicitly modelled.*

The program also enables the calculation of short term event levels such as the maximum level, and it is widely used for this purpose. However, in relation to the use of INM for short term maximum noise levels, the user guide notes:

> *INM is not designed for single-event noise prediction, but rather for estimating long-term average noise levels using average input data. Comparisons between measured data and INM calculations must be considered in this context.*

This is an important point as the Number Above contours which are used in the draft EIS to demonstrate the potential extent of noise impacts associated with the proposed airport are based on maximum noise levels calculated using the INM. Accordingly, while the use of the INM for calculating the maximum (L_{Amax}) noise levels is considered reasonable, consideration should be given to factors that can affect the INM's calculation of maximum noise levels. This is discussed in the next section and the subsequent discussion of overall prediction uncertainties.

2.2.8 Meteorological Conditions

The meteorological conditions used in the assessment were sourced from the Bureau of Meteorology (BoM) website, based on the previous 5 years. The data has been used largely for determining the airport operational modes and the number of aircraft movements on each runway and flight path.

In addition to the above, local atmospheric conditions can also affect the calculated noise levels in two ways:

- by varying the aircraft position (altitude influenced by air density); and
- by varying the rate of absorption as sound propagates through the atmosphere.

Of these two, the change in the rate of atmospheric absorption generally has the largest effect on the noise levels, particularly when considering the calculation of short term noise metrics such as maximum noise levels. In this respect, it is important to note that seemingly minor changes in calculated noise levels can translate to relatively large changes in the size of noise contours, owing to the distances associated with aircraft noise contours.

The INM enables atmospheric absorption to be factored in one of the two following ways:

- adopting default atmospheric absorption values: these default values do not correspond to any specific temperature or humidity. Instead, the default values are an average of varied absorption conditions relating to noise certification testing throughout Europe and the US; or
- adopting user defined atmospheric values: a single set of average temperature and humidity values are entered by the user for each modelled scenario and INM applies the corresponding atmospheric absorption values.

The noise modelling description in the technical noise report does not explicitly comment on whether default or user defined atmospheric conditions have been accounted for in this aspect of the calculation. However, the stated meteorological conditions do not reference the humidity values that are needed to set user defined atmospheric absorption values. Accordingly, it appears that the default INM atmospheric absorption values have been used which result in lower predicted noise levels.

Previous discussions with Airservices Australia have suggested it is appropriate to adopt user defined atmospheric values where the appropriate environmental parameters are available. They did however note that this was as a conservative approach, which they considered appropriate. Furthermore, the FAA note that the user defined atmospheric values should be used to account for study specific weather conditions, especially when considering specific time periods as opposed to the annual average day.

Accordingly, to account for the variability of short term noise events, and the fact INM is not specifically intended for predicting short term noise events, the adoption of user defined site-specific atmospheric absorption values is generally preferable to default conditions.

2.2.9 Uncertainties

The combined uncertainty of the noise modelling data relates to the net effect of the various calculation settings and choices adopted for the study. Specific values of calculated uncertainty are not provided in the technical noise report. Instead, uncertainty has been addressed through the selection of conservative model input choices in most instances. This is considered a reasonable approach.

However, the following points are noted:

- Information should be provided to support the reliability of the overall prediction methodology and choices for predicting maximum noise levels. This should ideally include details of measurement and prediction comparisons that have been used to validate the INM for predicting maximum noise levels. For example, comparison of available noise information from the Sydney Airport Noise Flight Path and Monitoring System or bespoke surveys. Further detail should also be provided concerning the manner in which atmospheric conditions have been accounted for in the noise predictions.
- The largest source of uncertainty is the indicative flight paths which do not represent the final flight paths which would be flown if the project proceeds. A more detailed analysis on the extent of uncertainty in predicted noise levels due to flight path variation should be provided, either by way of a sensitivity analysis or predicted noise levels for a selection of key flight paths that could change as part of the detailed airspace design.

2.3 Noise Prediction Data

2.3.1 Airport operating modes

Noise prediction information for the Stage 1 development has been provided for a number of operating modes, primarily driven by the prevailing wind direction at the time.

Matters relating to the suitability of the operating modes are considered in a separate peer review of the airport operations described in Volume 1 Chapter 7 airspace architecture.

The operating strategies that have been modelled are generally considered appropriate. However, the following observations are noted:

- Each of the preferred operating strategies includes the use of both runway modes i.e. mode 05 and mode 23. It is expected that the component of movements associated with each mode has been determined on the basis of a statistical analysis of 5 year Bureau of Meteorology data that is referred to in the technical noise report. However, the technical noise report does not specify the component of movements associated with mode of each preferred operating strategy, nor does the report specify how the components were derived.
- The technical report does not present information about how frequently each of the operating strategies would be used, nor is there any information presented to demonstrate whether or not certain times of day would be more or less likely to favour particular operating strategies.
- The modelling assumes the use of a head to head operating strategy comprising arrivals on runway 05 and departures on runway 23 would be viable. However, Volume 1 Chapter 7 *Airspace architecture* indicates the viability of head to head operations is yet to be confirmed, noting the following at Section 7.5:

  > *A third operating mode, 'head to head' may be feasible following further detailed assessment prior to the commencement of operations. This would involve all landings and take off movements occurring in opposing directions, either to or from the south west; or to or from the north east.*

2.3.2 Calculation Metrics and Scenarios

The Stage 1 noise chapter and technical noise report present aircraft noise information in a range of alternative formats, consistent with established government guidance.

The choice of metrics and scenarios are generally appropriate for defining the extent of areas which would potentially be affected by the noise of the assumed Stage 1 operating scenario. In all cases, noise contours do not represent the absolute extent of audible noise which an individual may find unsatisfactory, however this is not a practical objective for a noise assessment.

The following provides a discussion of the key forms of information that have been provided in the technical noise report for the assessment of noise impacts. Further information on the applicability of these metrics is provided in Section 2.4.1 of this review.

Number Above (NA) Ratings

NA ratings represent the number of times that aircraft events are predicted to exceed specified noise levels in a specified time period. The specified noise levels used in the technical noise report are 70 dB L_{Amax} and 60 dB L_{Amax}, resulting in calculated N70 and N60 values for different time periods on a typical busy day.

These values are generally appropriate. The draft EIS also usefully introduces the 90th percentile Number Above ratings as a way of representing the upper N60s and N70s that would be expected to occur in practice.

However, the following observations are noted:

- The 60 dB L_{Amax} lower threshold is generally suitable for assessing noise in urban areas. However, for the assessment of amenity impacts in quiet locations where natural soundscapes are valued, such as the Blue Mountains, lower predicted noise levels would be informative. It is acknowledged that the uncertainties associated with the prediction method increase with distance, meaning the lower values of predicted noise levels are subject to a greater degree of uncertainty. However, the alternative form of information relating to track density plots is not without compromises and is potentially more difficult to properly interpret – particularly given that the noise contours at the low levels extend considerably further than the width of the flight paths used to portray flight density tracks.
- The information concerning the number of events exceeding key thresholds of 60 dB L_{Amax} and 70 dB L_{Amax} is generally only provided as 24-hour average or night-time values, with additional periods selected for assessing recreation areas. While this information is useful, further data to address the number of events expected to occur during specific time periods could provide a useful indication of impacts during sensitive times.

Single event combined maximum noise level contours

Single event maximum noise levels are provided for the loudest and most common aircraft, being the Boeing 747-400 and Airbus A320 aircraft, respectively.

It is noted that the ‘combined’ contour refers to the worst case scenario of a single noise event occurring on each of the tracks used by the aircraft i.e. where a departure track splits into 2, the maximum noise level considers noise on both tracks, thus providing an overestimate of the maximum level from a true single event. This generally provides a conservative representation of the extent of areas that could experience maximum noise levels of a given value, however the approach also introduces artefacts into the contours which are evident as a ‘comb’ effect on the contour lobes, artificially suggesting lower noise levels at some positions at the extent of the contours.

Australian Noise Exposure Concept (ANEC)

An ANEC is provided for each operating mode. The ANE metric is an exposure based noise metric, used solely for land use planning in Australia. The ANEC contours presented for Stage 1 provide limited information in regards to land use planning, as these would typically consider longer term, ultimate capacity scenarios. However, the ANEC can be useful in understanding noise exposure around an airport. A number of studies, including the study upon which the ANE was based, have determined a relationship between noise exposure around an airport and community annoyance. This type of information is not provided in the technical noise report, and further discussion is provided in Section 2.4.3 of this review.

Summer/winter variations

The potential changes in noise contour extents between summer and winter are considered in the appendices of the technical noise report. The analysis generally shows minor change in predicted noise levels. However, as per the discussion in Section 2.2.8, it is unclear if the predictions include an account of varied atmospheric conditions for different times of year.

2.4 Impact Assessment Methodology

Environmental noise may result in a number of different direct and indirect impacts. The draft EIS addresses the range of impacts as follows:

- Assessment of the extent of the potential aircraft noise impacts within the Stage 1 noise chapter and technical noise report on the basis of a range of modelling scenarios and metrics used to present aircraft noise information; and
- Assessment of the effect and significance of these impacts in other sections of the draft EIS related to:
  - Health
  - Land use
  - Social
  - Property values

The separation of assessments in this way is not an uncommon approach, particularly given the assessment of the effect and significance of noise impacts often requires specialist knowledge beyond the areas of expertise of acoustic consultants. However, a complete appreciation of noise related impacts therefore requires reference to a range of distributed sections throughout the draft EIS.

Accordingly, while the noise chapters (Stage 1 and long term development) and technical noise report provide the primary basis for the comments in this section of the peer review, additional comment is provided in the following sections in relation to technical noise matters as they are presented in the assessment of noise effects in other chapters and specialist reports.

2.4.1 Methodology Overview

The Stage 1 noise chapter and technical report present predicted noise levels in the form of noise contours and population counts to demonstrate the potential extent of areas that may be affected around the proposed airport. The noise contours are supplemented by additional information such as flight track density maps which illustrate the patterns of overflights beyond the extent of the predicted noise contours.

The predicted noise level information presented in the draft EIS is consistent with the types of aircraft noise information recommended in a number of Federal government publications. Further, the contours generally extend down to relatively low noise levels and event numbers to demonstrate the extent of potential effects well beyond ANEC contours. This approach is considered appropriate.

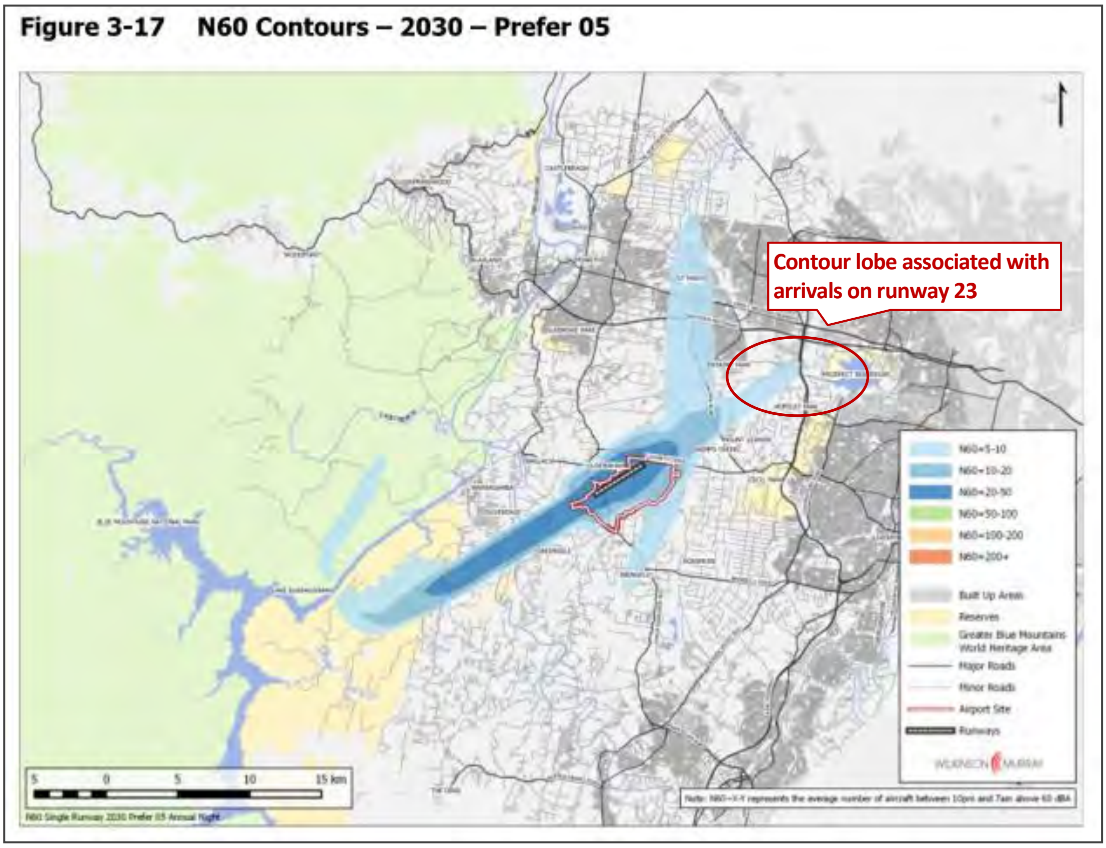
However, the following key observations are noted:

- The illustrated extent of the noise contours is generally considered to be an accurate representation for the assumed Stage 1 operations. However, the uncertainties relating to these assumed Stage 1 operations appear to be significant. The extent to which the Stage 1 airspace design may change is not prescriptively defined in the draft EIS; accordingly, the potential change to the extent of the predicted noise contours has not been defined. An indication of the potential changes to the extent of the contours is partly evident from the various operating modes that have been included in the prediction scenarios. It is however unclear if these represent the maximum extent of the noise contours which could be expected for the final airspace design. The example noted earlier in Section 2.2.3 regarding the departure track from runway 05 illustrates how the final airspace design may significantly alter the areas affected.
- The aircraft movement numbers in the assumed Stage 1 operating conditions are linked to a specific point in time related to the definition of the initial stage of development. The duration of this initial stage of development is linked to one of the incremental milestones in the longer term periodic approval and management framework for the proposed airport. In this respect, the movement numbers do not relate to a specific point in time at which movement numbers are stable or do not change significantly. Accordingly, the contours represent a snapshot of the extent of affected areas at that particular point in time, while the actual extent of areas affected will continually change and expand over time.
- The predicted N60 and N70 noise data are important metrics used to demonstrate a broader extent of impact than exposure metrics such as the ANEC. These values are specifically referenced for:
  - Indoor noise assessment: quantifying the number of external events which would give rise to internal noise levels inside a home with partially open windows which could potentially interfere with conversation or exceed thresholds commonly used for the assessment of sleep disturbance; and
  - Outdoor noise assessment: quantifying the number of events which could interfere with conversational voice levels or require a raised voice for conversation to be understood. This is however specifically only noted in relation to recreation areas (see section 3.7 of the technical noise report), rather than as a general consideration for the external amenity of residential settings.

  The above considerations mean that the extent of impacts illustrated by the N60 and N70 contours is primarily focussed on matters of indoor amenity or external speech interference. As per the discussion of the Greater Blue Mountains area in Section 7 of the technical noise report, noise impacts in quiet outdoor areas where natural soundscapes are valued (whether these are public or private outdoor areas) will occur at levels below 60 dB L_{Amax}. The impacts to these types of locations therefore extend beyond the N60 and N70 contours and reference must be made to alternative forms of supplementary information such as the track density maps presented for the Greater Blue Mountains.

- Noise contour information is presented in terms of ANEC data and NA values for alternative operating configurations including preferred operating strategies such as Prefer 05 (runway strategy favouring movements directed from the southwest and toward the northeast) and Prefer 23 (runway strategy favouring movements directed from the northeast and toward the southwest). It is evident from the noise contours that the Prefer 05 and Prefer 23 scenarios include movements occurring in both directions. For example, this is most evident on figures for scenario Prefer 05. These figures illustrate contour lobes extending to the northeast along the runway centre line, beyond the extent of the departure track, thus indicating the influence of an arrival movement on runway 23 (see example extract in Figure 2 below). Technically this is consistent with the definitions provided for Prefer 05 and Prefer 23. However, these contours may be prone to misinterpretation as single mode contours which illustrate the noise associated with movements occurring in single directions (and would extend further than the illustrated Prefer 05 and Prefer 23 strategy noise contours).

Figure 2: Extract from section 3 of the technical report illustrating the influence of mode 23 movements in the Prefer 05 operating scenario



2.4.2 Sensitive Receivers and Noise Exposure Data

Section 2.10 of the technical noise report notes that the noise sensitive receptors around the proposed airport site include residences, education facilities and health facilities.

The technical noise report subsequently provides noise data and assessments relating to residential receptors, in addition to data concerning sensitive uses in recreation areas and the Greater Blue Mountains World Heritage Area.

However, education facilities and health facilities are not directly referenced or assessed in the Stage 1 noise chapter or technical noise report. Instead, reference is made to alternative noise metrics which were calculated and subsequently assessed in the health report contained in the draft EIS. The predicted noise levels for these locations should be available in the Stage 1 noise chapter and technical noise report, in the same way that they have been provided for other types of noise-sensitive receiver locations such as recreational areas (i.e. including the predicted N60 and N70 values).

Section 2.10 of the technical noise report also describes information sources and methodologies which were used to calculate the number of residential receiver locations experiencing a given level of noise exposure. The data sources and methods used to develop these population statistics are considered appropriate for the application, and include an appropriate account of projected population increases in the areas surrounding the proposed airport. As noted previously however, these are based on a snapshot at the particular assessment point in time, while the actual extent of impacts and people affected will continually change and expand over time.

2.4.3 Community Annoyance Assessment

The Stage 1 noise chapter and technical noise report primarily quantify the extent of areas which may be affected by aircraft noise. The subject of potential community annoyance is separately discussed in the draft EIS chapters and technical reports concerning potential social impacts and health risk assessments.

The population statistics discussed in the preceding section provide a useful indication of the number of people who may be affected by aircraft noise to varying degrees. However, in isolation, this data does not provide an indication of the likelihood or significance of potential community reaction to aircraft noise levels as a result of annoyance.

The Health Risk Assessment presented in Volume 4 Appendix G provides the most discussion of potential annoyance, noting that annoyance is most prevalent community response in a population exposed to environmental noise. The Health Risk Assessment includes a discussion of a range of research studies concerning dose-response relationships between total noise exposure levels and the percentage of a community likely to be annoyed or highly annoyed. However, the Health Risk Assessment concludes the discussion of annoyance by stating that no quantitative assessment of annoyance was conducted as part of the study.

The assessment of potential community annoyance is ultimately a complex task for a development of this scale. Dose-response relationships of the types referenced in the Health Risk Assessment can be used with noise levels and population data to provide a quantitative measure of the potential reaction. The use of these established relationships to represent the reaction of a separate community exposed to aircraft noise must be used with caution. In particular, consideration must be given to the uncertainties associated with using community reactions observed at other airports to predict the reaction of a separate community, exposed to a new source of aircraft noise. This type of analysis does however provides an objective basis for comparing the impacts of alternative operating strategies and, more broadly, establishing the risk of community noise annoyance relative to other established international airports in Australia.

Accordingly, while the assessment of the risk of community annoyance is complex, the scale of the proposed airport, and the number of people potentially affected, are considered sufficiently large to warrant further evaluation of the subject. In particular, the introduction of a new 24-hour international airport at a greenfield development site ultimately represents a significant risk of wide spread and prolonged community annoyance.

A quantitative analysis of community annoyance is therefore considered appropriate to assess the significance of the impact. This analysis would also assist with determining the extent to which operational noise mitigation should be prioritised relative to other non-safety related airspace management considerations. Further consideration should therefore be given to quantitative analysis based on established response relationships. The scale of the project may also warrant consideration of further social surveys which could be used to establish a new dose response relationship which may be more relevant to the long term impacts on potentially affected communities around the proposed airport site. Other types of quantitative analysis could comprise population statistics and complaint trends for existing Australian airports which could provide contextual information about the sensitivity, or otherwise, of the proposed airport site relative to other established international airports in Australia.

Importantly, without a meaningful appraisal of the risks of significant community disturbance, there is the potential for unforeseen impacts and the associated risk of a requirement for reactionary noise management procedures. As well as the impacts to neighbouring communities, this could subsequently jeopardise the operational flexibility of the proposed airport.

2.4.4 Sleep Disturbance Assessment

The technical noise report provides information concerning sleep disturbance in terms of the number of events exceeding 60 dB L_{Amax} for each operating mode during the night-time period 10 pm to 7 am. A level of 60 dB L_{Amax} is cited as the external level which would approximately correspond to an internal level of 50 dB L_{Amax}; an internal level that is commonly used as a design criterion for protection against sleep disturbance.

The selected assessment thresholds in the technical noise report are consistent with common industry practice for assessing sleep disturbance. In particular, the values are generally consistent with the advice contained in the World Health Organisation guidelines (Bergland et al, 2009) which also refers to an external level of 60 dB L_{Amax} for the avoidance of sleep disturbance. The values are also similar to values referenced in NSW policies concerning road traffic. While the technical report does not specifically state the number of events exceeding 60 dB L_{Amax} which are sufficient to represent an increased risk of sleep disturbance, the information is provided for a relatively low number of events (i.e. down to 5 – 10 events). For context, the WHO guidelines suggest that external noise levels exceeding these values should ideally not occur more than 10 to 15 times per night when assessing dwellings with partially open windows.

The technical noise report provides future population counts for this data indicating that between approximately 4,000 and 48,000 people could experience more than 5 events per night exceeding 60 dB L_{Amax}, depending on operating strategy. In terms of areas experiencing a greater number of events, the technical noise report identifies between approximately 600 to 1,200 people experiencing 20 to 15 events per night above 60 dB L_{Amax}, depending on operating strategy.

The key points from these figures are that:

- A large number of people are predicted to experience external maximum noise levels which are sufficient to result in internal noise levels corresponding to sleep disturbance thresholds. In turn, this indicates a large number of people may need to sleep with windows closed to maintain an acceptable internal amenity. The extent of this potential impact would depend on the prevalence of existing ambient noise sources which could prompt an individual to sleep with closed windows, irrespective of the proposed airport.

- As referred to in the technical noise report, the Prefer 05 strategy results in the greatest number of people experiencing more than 5 events per night over 60 dB LAmax , but the least number of people experiencing more than 20 events per night over . In the absence of established guidelines, or proposals in the draft EIS, to indicate whether priority should be given to reducing the number of people to a small number of events or reducing the number of people exposed to the highest number of events, it is unclear how these findings would inform the selection of noise mitigation measures or a preferred operating strategy.
- The information is primarily directed at understanding noise impacts experienced by people in dwellings with partially open windows. The information does not indicate if there are dwellings which would experience night-time events that are sufficiently high in level to result in noise levels above the 50 dB L_{Amax} internal criterion, even if the windows are closed. This type of information would provide an indication of the number of dwelling locations which could potentially require upgraded insulation to maintain an acceptable internal amenity.

In addition to the technical noise report, it is noted that Section 6.3.1 of Volume 4 Appendix G *Community Health* provides an assessment of sleep disturbance. The peer review of this document is being separately carried out be specialists in the field of health assessment and is therefore not reviewed in detail in this peer review document. It is however noted that while the Community Health report makes reference to the maximum noise level data contained in the technical noise report, the Community Health report primarily assesses impact on the basis of equivalent noise levels. Given that the 2030 assessment year involves a relatively low number of movements from the proposed airport (refer to earlier discussion of movement numbers in Section 2.2.5), some discussion of the rationale for focussing on equivalent noise levels instead of maximum noise levels would be prudent; particularly given that the Health Report acknowledges that the dose-response curves have been derived from European studies and may underestimate the impact in the area surrounding the Western Sydney airport site.

2.4.5 Land Use Impacts

The technical noise report presents Australian Noise Exposure Concept (ANEC) contours in section 3.6 titled *Land Use Planning Impacts*.

ANEC contours are not used for land use planning, but are normally presented as an indication of the potential extent of Australian Noise Exposure Forecast (ANEF) contours which are used for land use planning; the ANEF being an endorsed ANEC or combination of ANECs.

However, as acknowledged in the draft EIS, the ANEC contours presented for the Stage 1 proposal provides limited guidance in this instance, as the ANEF is normally derived from ANECs calculated for long term operations or ultimate capacity scenarios, rather than short term ANECs related to the initial phase of operation. Evaluation of land use planning impacts must therefore be based on the long term ANEC contours presented in subsequent sections of the technical noise report. These long term ANEC contours are discussed subsequently in Section 3.1.3 and Section 3.2.5 of this peer review report.

2.4.6 Dwelling Insulation

The Stage 1 noise chapter and technical noise report do not refer to requirements for, or proposals for, insulation of dwellings for the protection of internal amenity.

The potential for dwelling insulation is however mentioned in Volume 2 Chapter 28 *Environmental Framework* which notes the following:

> *the possible insulation or acquisition of buildings exposed to the highest noise levels having regard to Australian Standard 2021, including mechanisms for funding potential noise amelioration works and property acquisitions;*

There is however no detail provided in the draft EIS in terms of quantifying the extent to which such measures would be implemented, or how the process of insulating or acquiring dwellings would occur 'with regard to Australian Standard 2021'. The reference to AS 2021 for this application requires further clarification to understand the extent of areas that may be insulated or acquired. For example, it is unclear if dwelling insulation would only be considered within certain Australian Noise Exposure areas, or if such measures would be considered at all locations where internal levels may be expected to exceed AS 2021 internal design criteria as a result of the proposed airport operations.

2.4.7 General Recreation Areas

Section 3.7 of the technical noise report provides information relating to recreation areas. Separate information concerning the Blue Mountains is provided in section 7 of the technical noise report.

The assessment for these locations is primarily based on the number of events predicted to exceed 60 dB L_{Amax} and 70 dB L_{Amax}. The information and assessment procedures for these locations is considered appropriate, subject to the points noted in the technical noise report concerning the impact on acoustic amenity. Specifically, that the noise would be noticeable in areas used for passive recreation and the noise could be considered intrusive on the acoustic amenity.

2.4.8 Greater Blue Mountains World Heritage Area

The technical noise report provides an assessment of noise levels in the Greater Blue Mountains World Heritage Area (GBMWHA).

To provide a basis for assessing impacts to the GBMWHA, the technical noise report presents information in the form of track density plots. While this form of data provides a useful and established form of information, the reason for reverting to overflight numbers in lieu of predicted noise levels is not stated. As per the discussion in Section 2.3.2 of this peer review, this may be related to increased uncertainty in the predictions when considering low predicted noise levels. However, flight track density plots in isolation do not illustrate the full extent of potentially intrusive noise levels at locations to the side of the flight track.

The report notes that aircraft are typically at an altitude of approximately 5000 ft, which corresponds to a noise level on the ground of approximately 55 dB L_{Amax}, consistent with INM predictions for the Airbus A320 or Boeing 737-800. Measurements at other airports have however demonstrated that aircraft at that altitude are generally higher than those predicted using the INM, and accordingly noise levels in practise could be higher.

As per the technical noise report, levels below 55 dB L_{Amax} could be considered intrusive by recreational visitors and other users, as the natural soundscape is an important attribute of high value wilderness areas. While levels below 55 dB L_{Amax} are likely to be comparable to typical levels associated with ambient noise sources in the GBMWHA, it is generally not considered appropriate to assess aircraft noise intrusion by comparing sound pressure levels; the characteristics of aircraft noise and natural sounds and very different, and are interpreted in very different ways.

The preservation of quiet areas and tranquil landscapes has been a topical subject of research and policy consideration in Europe and the US. For example, the US Transportation Research Board publication on the effects of aircraft noise (Mestre, 2008) includes a chapter which discusses research and US legislation (National Parks Overflight Act of 1987) concerning the effects of aviation noise on parks, open space and wilderness areas. These publications do not provide definitive guidance on assessment techniques, but highlight the complexity and importance of assessing aircraft overflight noise in sensitive wilderness areas.

The potential for a large number of audible events below 50 – 55 dB L_{Amax} is therefore considered to represent a potentially significant and widespread impact within the GBMWHA. On this point, we note that the separate assessment of impacts to the GBMWHA presented in Volume 2 of the draft EIS indicates noise levels below 50 and 55 dB L_{Amax} are 'not significant'. Given the above, the assertion within draft EIS GBMWHA chapter that noise levels below 50 and 55 dB L_{Amax} are 'not significant' is not considered to have been sufficiently justified, and the assessment may therefore not adequately reflect the potential impact to the values of tranquillity within the World Heritage Area.

Given the status of the Blue Mountains as a World Heritage Area, and the potential for intrusive impacts, further assessment of this sensitive receiver location is considered to be warranted. In particular, further information should be provided to demonstrate the relative merits of alternative aircraft arrival management procedures which do not involve a concentration of aircraft movements over the GBMWHA. This should include a discussion of the tradeoffs between protection of amenity in residential areas and the protection of the GBMWHA. Consideration should also be given to different areas within the GBMWHA noting any areas of increased recreational use or areas where tranquillity and natural soundscapes may be more valuable.

2.5 Alternatives

The EIS guidelines establish a requirement to investigate feasible alternatives for the proposal, including:

a) *If relevant, the alternative of taking no action;*

b) *A comparative description of the impacts of each alternative on the matters of national environmental significance and other matters protected by controlling provisions of Part 3 of the EPBC Act for the action; and*

c) *Sufficient detail to make clear why any alternative is preferred to another.*

The technical noise report considers the number of people potentially affected for alternative merge points in general terms. For the two alternative merge points considered, the technical noise reports notes that the flight densities over Blaxland are reduced, and the people affected are aligned to less populated rural residential areas outside the GBMWHA. Track densities and number of aircraft overflights over Blue Mountains' communities are still predicted to be high, while impacts on some areas within the GBMWHA are increased for the two alternative merge points.

It is therefore unclear why preference has been given to the merge point that affects a greater population, i.e. over Blaxland, in lieu of reducing the number of potential affected residences. This is perhaps due to conservation of the world heritage area, however this should be confirmed.

Further, while the merge point system appears to offer some noise benefits related to the use of constant descent approaches, the merge point conversely results in concentrated impacts directly beneath the merge point. The considerations warrant an assessment of the noise of additional alternatives, in terms of alterative merge point configurations (e.g. multiple merge points as per the 2063 airpsace design in lieu of a single merge point), and in terms of alternatives arrival management procedures to the merge point system.

In broader terms, with the exception of the merge points noted above, no assessment of alternative flight tracks or noise mitigation procedures has been presented in the noise chapter or technical noise report. This is presumably related to the limited extent to which the airspace management design has been progressed, however this source of uncertainty is a key reason to consider the impacts of potential alternative procedures.

2.6 Proposed Mitigation Measures

The noise modelling presented in the Stage 1 noise chapter and technical noise report provides information concerning the following mitigation measures:

- The use of continuous descent approaches for all arrival procedures; and
- Relocation of the merge point associated with the Stage 1 proof of concept airspace design.

As discussed in Section 2.2.3 of this peer review report, the noise modelling is based on an indicative proof-of concept air traffic management design which 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.

Given the uncertainties concerning the final form of the airspace design, the final form of noise mitigation measures to be implemented is not yet known. Accordingly, the mitigation measures that have been referred to in the aircraft noise assessment are generic in nature. The residual noise impacts associated with the proposed airport's operations following the implementation of such mitigation measures is therefore presently unknown.

To provide context, feasibility noise assessments and generic mitigation measures are not uncommon for other forms of infrastructure project for which there are well defined policies that limit the allowable noise that may occur in practice. In contrast, aircraft noise policies and regulations in Australia do not specify limits which apply to aircraft over overflight noise at surrounding sensitive receptor locations. Accordingly, without a defined airspace design or defined noise criteria to adhere to in practice, a defined noise mitigation strategy and the residual impacts and the location of these impacts is subject to considerable uncertainty. Further, without a defined noise limit, it is unclear how noise considerations would be prioritised among other non-safety related airspace management and operational considerations associated with the proposed airport site.

Based on the above considerations, further information about the likely airspace management plan, mitigation strategies or proposed control mechanisms (with reference to performance criteria) is considered essential. The discussion of mitigation measures should include:

- Clarification of preferred operating strategies to manage environmental noise impacts, including reference to mitigation priorities and the manner in which alternative mitigation measures would be evaluated, e.g. is priority given to limiting the number of people experiencing the greatest noise effects or limiting the total number of people within the overall extent of the contours, and how will considerations related to residential and non-residential noise-sensitive receiver locations be balanced;
- Clarification of how the flight paths and hence predicted noise levels may vary during the detailed design of the airspace management procedures;
- Clarification of whether Noise Abatement Departure Procedures (NADP) as defined by ICAO would be considered in the noise management plan, and if so, under what circumstances or operating scenario. For example, would NADP be considered for all operations, operations on a given runway, or operations occurring at night;
- Clarification of the proposal to implement a merge point arrival system;
- Clarification of the proposal to implement head to head operations during night-time hours;

- Clarification of the extent to which dwelling insulation or property acquisition measures would be implemented, or how the process of insulating or acquiring dwellings would occur 'with regard to Australian Standard 2021'. For example, would such measures be limited to locations within the ANEC/ANEF 20 contour, or would dwelling insulation potentially extend to locations outside of the ANEC/ANEF contours to address internal noise levels at locations where noise levels above the design criteria in AS 2021 are not expected to be achieved. Consideration should be given to circumstances where a resident must close windows to protect internal amenity, or in instances where the noise levels are above the design criteria even with windows closed; and
- Consideration of the potential merits of mitigation strategies tailored to the initial phase of operations when communities may be particularly sensitive to the presence of a new major noise source in the area. For example, this could include deliberate and staged incremental movement number increases to avoid 'sudden' noise exposure which has led to significant community reaction at some new airports, particularly in terms of night operations.

3.0 REVIEW FINDINGS – LONG TERM DEVELOPMENT

The following section discusses the noise impacts associated with the longer term development of the proposed airport, accounting for:

- Longer term development of single runway capacity: incremental development of aviation infrastructure and support services to facilitate 164,000 aircraft movements per year which are projected to occur by 2050; and
- Longer term development with an additional parallel runway to the south: an additional runway is proposed for long term operations, enabling additional capacity increases to 370,000 aircraft movements per year which are projected to occur by 2063.

A number of the considerations identified from the peer review of the Stage 1 development are directly relevant to the assessment of the long term development scenarios. For example, matters related to the noise prediction methodology are identical for the Stage 1 and long term development scenarios. Accordingly, this section details any variation to those assessed in the long term development scenarios.

3.1 2050 – Additional capacity single runway

3.1.1 Flight paths

The flight paths are as per the stage 1 development and accordingly the same findings apply. Specifically, they do not represent the final flight paths which would be flown if the project proceeds and the reports do not provide any indication of the manner or extent to which the final airspace design may vary from the proof-of concept design. This represents a significant source of uncertainty in the predicted noise levels.

The 2050 scenario also includes Boeing 747-400 stage 9 departures (i.e. a higher takeoff weight due to longer trip length). However, the proposed runway length of 3,700 m is noted to be less than the required runway length specified in Volume 1 Chapter 5 Airside Precinct (see Table 5-4) for a maximum weight Boeing 747-400 take off. This may be plausible if weight restrictions are applied to Boeing 747-400 departure operations. Irrespective, from a noise perspective, this suggests that the Boeing 747-400's inclusion in the noise modelling may be conservative.

3.1.2 Movement numbers

The movement numbers for the 2050 scenario are consistent with forecasts for similar single runway Australian International airports (Perth, Adelaide), refer Figure 1. Accordingly, the predicted noise levels for this scenario would appear more suitable as the appropriate primary assessment scenario for the purpose of obtaining approval for the development.

These comments are provided primarily in relation to the plausibility of the movement numbers represented in the noise modelling, based on comparisons with the movement numbers documented in the noise modelling for other Australian international airports and similar time horizons. Aircraft traffic forecasts are however outside of our area of expertise and therefore the suitability of the specific movement numbers adopted for the 2050 noise assessment are considered in further detail in a separate aviation peer review commissioned by WSP Parsons Brinckerhoff.

3.1.3 Land use impacts

We note a difference in the population counts within ANEC bands for the 2050 scenario between the technical noise report and the long term development noise chapter. The source of this discrepancy is unclear. For reference, a sample of the differing values is presented in Table 2.

Table 2: Estimated population within ANEC contours (2050) for Prefer 23 with head-to-head

ANEC	Data from Table 31-2 of Volume 3	Data from Table 4-3 of the technical noise report
20-25	1,293	1,672
25-30	302	379
30-35	72	77
>35	4	4
Total	1,672	2,132

3.2 2063 – Parallel runway

3.2.1 Runway position

The proposed second parallel runway would be located to the south of the proposed stage 1 development runway, with a separation distance of approximately 1,900 m according to Volume 2 (Section 30.2).

The specific location is not defined with reference to an aerodrome reference point, runway end coordinates or elevation details. The parallel runway orientation is assumed to be consistent with the Stage 1 proposal runway, i.e. a single southwest / northeast runway designated as runway 05R and 23L respectively. However, as per the discussion earlier in this peer review report in Section 2.2.1, it is unclear if the exact orientation of the runway has been finalised.

3.2.2 Departure tracks

The flight tracks depicted in Figure B1 of Appendix B of the technical noise report show that departures on runway 05R (parallel) turn left approximately 3 km from the runway end and head due north for 25 km before branching out to a number of directions. This flight path is similar to the track depicted for the initial runway of the Stage 1 development.

However, an additional departure track to the northeast is included in this scenario, and involves direct overflight of the relatively densely populated areas to the northeast, such as Blacktown. Further discussion of noise mitigation measures relating to this flight path would be prudent.

3.2.3 Cumulative impacts

Airspace architecture chapter of Volume 1 (Section 7.4.1) notes that under a parallel runway scenario at the proposed airport, a number of issues would need to be addressed as part of the future airspace design process, including:

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

Section 5B of the EIS Guidelines requires the EIS to:

> *identify and address cumulative impacts, where potential project impacts are in addition to existing impacts of other activities (including known potential future expansions or developments by the proponent and other proponents in the region and vicinity)*

The draft EIS has not considered implications on flight paths at other airports and the associated noise impacts on other communities closer to Sydney, Bankstown and Defence establishments having regard to the potential variation in the final flight paths. The issues concerning the airspace architecture are considered to represent potential cumulative impacts which have not been quantified in the draft EIS.

Further information concerning this issue is therefore considered necessary to address the requirements of the EIS guidelines.

3.2.4 Operating modes

The assessment considers two operating modes only, 'prefer 05' and 'prefer 23'. The technical noise report notes that the use of alternative night time operating modes, such as 'head to head' as per the Stage 1 development could likely reduce night time impacts. This is not quantified and conclusions on the potential reduction in noise levels can therefore not be established.

Further, the discussions presented in Volume 1 Chapter 7 *Airspace architecture* indicate that the feasibility of head to head operations is yet to be confirmed.

3.2.5 Land use impacts and dwelling insulation

As per the assessment of the stage 1 development, the land use planning impacts in the technical noise report considers only the number of potential people within each ANEC band for each of the operating modes.

The ANECs prepared in the technical noise report for the long term development may be considered indicative of the extent of an ANEF for the proposed airport. The technical noise report does however note that an ANEF chart based on further formal flight path design would need to be produced and endorsed by Airservices Australia prior to the commencement of airport operations and to inform land use planning around the proposed airport.

The 1985 EIS prepared an indicative ANEC for the Western Sydney Airport. It is understood this ANEC formed the basis for zoning land uses around a future airport, as detailed in local environmental plans having regard to future aircraft noise. As such, there are current planning mechanisms in place to ensure future dwellings incorporate appropriate treatment in anticipation of the proposed airport.

The draft EIS has not fully undertaken an assessment of land use impacts. Specifically, an assessment of the location of current dwellings within 'zones affected by aircraft noise' documented in the local environmental plans (based on 1985 EIS ANEC contours) and their relative location based on the ANECs prepared as part of this EIS. Details on the change in the ANEC rating for individual dwellings would ideally be undertaken to determine the extent of further mitigation measures. Such measures may include potential dwelling insulation to dwellings where a significant change in ANEC has occurred.

Noting the ANECs prepared for this EIS are not final, consideration should still be given to the potential extent of a single ANEF to be adopted for future land use planning. Australian Standard *AS2021:2015 Acoustics - Aircraft Noise Intrusion – Building Siting and Construction*, details procedures for the preparation of an ANEF. Specifically, where future runways are proposed, a composite chart of a number of ANECs should be produced to cover areas the single runway at ultimate capacity ANEC are not covered by adopting the ANEC incorporating the 2 runways.

A complete assessment should therefore be undertaken with the above considerations, to enable a complete understanding of the potential land use impacts associated with the airport operations.

In addition to the above, the technical noise report does not discuss the potential land use planning impacts related to the National Airports Safeguarding Framework (the *Framework*) which was developed by the National Airports Safeguarding Advisory Group in 2012. This Framework is however noted in the noise chapter, which subsequently refers readers to Chapter 21 *Planning and land use* for further information.

The Framework provides guidance on planning requirements for development that affects aviation operations. As part of the guidance, the Framework proposes the use of new noise metrics for land use planning, subject to the outcomes of a review of Australian Standard AS 2021. The review of AS 2021 was completed and the revised version of AS 2021 published in May 2015. While the revised standard did not include the additional land use buffers that were requested by the National Airports Safeguarding Advisory Group (i.e. the updated version of AS 2021 continues to refer to solely to the ANEF parameter rather than Number Above metrics), it is noted that an amendment to Victorian Planning Provisions (see VC128) was scheduled by the Victorian government on 8 October 2015 to include the National Airports Safeguarding Framework as a policy guideline. This policy only applies in Victoria and it is unclear how this new guidance will affect land use planning around Victorian airports. However, the introduction of the Framework into a state policy provides a precedent for the potential use of noise contours extending well beyond ANEC contours to inform land use planning.

Further, while the Framework is not directly referenced in the noise chapter or technical noise report, the Framework is introduced in Volume 2 Chapter 21 *Planning and land use*. The peer review of this document is being separately carried out by specialists in land use planning and is therefore not reviewed in detail in this peer review document. It is however noted that 21.7.2.2 focuses on the implications of a future ANEF for land use planning, but concludes with the following statement:

> *The implementation of Guideline A: Measures for Managing Impacts of Aircraft Noise under the NASF would be instrumental in managing potential future operational noise impacts for future land use planning and development around the airport.*

This would appear to imply the potential for land use planning instruments extending well outside of the future ANEF contours, despite land use impacts outside of the ANEC/ANEF contours not being specifically cited in the discussion. This is reinforced by content in Volume 2 Chapter 27 *Cumulative Impact Assessment* which states:

> *The draft EIS provides ANEC contours and identified other potential noise impact areas which can be used to guide appropriate future land use planning and compatible development.*

The imposition of the Framework for land use planning around the proposed airport could therefore result in land use impacts extending well beyond the existing land use controls or a future ANEF developed during the detailed design phase of the airport. The potential for these extended impacts should be clarified and clearly disclosed.

4.0 SUMMARY

A peer review of the aircraft overflight noise assessment contained within the draft Environmental Impact Statement (draft EIS) for the proposed Western Sydney Airport has been carried out.

The noise modelling is considered to generally provide an accurate representation of the extent of noise impacts for the development description and operating scenarios that have been proposed. However, the peer review has identified a number of limitations which relate to both the extent to which the airspace management's design has been progressed, and the assessment of the noise modelling outcomes. These matters are summarised as follows:

Low Stage 1 movement numbers

The total aircraft movement numbers for the Stage 1 development are relatively low when compared to other international airports in Australia. Given the objective of the proposal is to develop a major international airport, the low movement numbers raises the question of the suitability of the 5 year time horizon as the appropriate primary assessment scenario for the purpose of obtaining approval for the development. Further, it is unclear how the incremental and periodic approvals that would need to occur as part of the ongoing expansion of the airport provides a sufficient basis for considering the initial 5 years of operation as the primary period for the assessment of noise impacts.

These comments are provided primarily in relation to the plausibility of the movement numbers represented in the noise modelling, based on comparisons with movement numbers documented in the noise modelling for other Australian international airports and similar time horizons. Aircraft traffic forecasts are however outside of our area of expertise and therefore the suitability of the specific movement numbers provided for the noise assessment are considered in further detail in separate aviation peer review commissioned by WSP Parsons Brinckerhoff.

Airspace management strategy uncertainties

the draft EIS clearly indicates that the airspace management strategy used as the basis for noise modelling is a proof-of concept design, and further work is required to determine the actual flight paths which would be flown in practice. Information about the extent of potential changes is limited. The uncertainty surrounding the final airspace management design that would be implemented represents a potentially significant source of uncertainty in the noise assessment. The potential significance of this source of uncertainty has not been quantified and, with exception of alternative merge point points for Stage 1, there has not been any sensitivity analysis carried out to assess the implications of potential flight path changes.

Assessment of community annoyance

The draft EIS includes exposed population statistics which provide a useful indication of the number of people who may be affected by aircraft noise to varying degrees. However, in isolation, this data does not provide an indication of the scale or severity of potential community reaction to aircraft noise levels as a result of annoyance.

The Health Risk Assessment provides the most discussion of community annoyance, including references to research concerning the relationship between noise exposure and community annoyance, but ultimately states that no quantitative assessment of annoyance was conducted as part of the study.

Dose-response relationships of the types referenced in the Health Risk Assessment can be used with noise levels and population data to provide a quantitative measure of the potential reaction. The use of these established relationships to represent the reaction of a separate community exposed to aircraft noise must be used with caution. In particular, consideration must be given to the uncertainties associated with using community reactions observed at other airports to predict the reaction of a separate community to a new source of aircraft noise. However, this type of analysis provides an objective basis for comparing the impacts of alternative operating strategies and, more broadly, establishing the risk of community noise impacts relative to other established international airports in Australia.

Accordingly, while the assessment of the risk of community annoyance is complex, the scale of the proposed airport, and the number of people potentially affected, are considered sufficiently large to warrant further evaluation of the subject. In particular, the introduction of a new 24-hour international airport at a greenfield development site ultimately represents a significant risk of wide spread and prolonged community annoyance.

A quantitative analysis of community annoyance is therefore considered appropriate to assess the significance of the impact. This analysis would also assist with determining the extent to which operational noise mitigation should be prioritised relative to other non-safety related airspace management considerations. Further consideration should therefore be given to quantitative analysis based on established response relationships. The scale of the project may also warrant consideration of further social surveys which could be used to establish a new dose response relationship and may be more relevant to the long term impacts to potentially affected communities around the proposed airport site.

Land use impacts

The draft EIS includes calculated Australian Noise Exposure Concept (ANEC) contours for the Stage 1 and long term development operating scenarios. ANECs are often presented as an indication of the extent of a potential future Australian Noise Exposure Forecast (ANEF) contour which would be used to guide land use planning for noise-sensitive developments in the vicinity of airports.

However, while the draft EIS provides population counts for the various ANEC bands, no assessment is provided of the extent to which land use controls may change as a result of a future ANEF prepared as part of the detailed airspace design for the project. Specifically, the draft EIS does not quantify the potential extent of changes to land use controls relative to the measures which have been in place since the original EIS was undertaken in 1985.

Furthermore, the discussion of land use planning impacts in the draft EIS notes that the National Airports Safeguarding Framework (the Framework) would *'be instrumental in managing potential future operational noise impacts for future land use planning and development around the airport'*. The Framework could potentially translate to the creation of land use planning controls which extend over significantly greater areas than either the current land use planning controls (based on the 1985 EIS) or the 2063 ANEC contours provided in the draft EIS. This has however has not been discussed or assessed in the draft EIS.

Greater Blue Mountains World Heritage Area (GBMWHA)

The draft EIS presents information to evaluate the potential impacts of aircraft operations on the acoustic amenity of the GBMWHA. The assessment indicates the potential for a large number of audible aircraft events within the GMWHA. While the levels are predicted to be relatively low (below 50 – 55 dB L_{Amax}), aircraft over flights would be expected to be audible and represent a significant and widespread impact for a World Heritage Area where natural soundscapes are a likely to be a valued feature of the areas amenity. Accordingly, the assertion within draft EIS chapter that noise levels below 50 and 55 dB L_{Amax} are 'not significant' is not considered to have been sufficiently justified, and the assessment may therefore not adequately reflect the potential impact to the values of tranquillity within the World Heritage Area.

Mitigation measures and residual noise impacts

The draft EIS noise modelling is based on an indicative proof-of concept air traffic management design which does not present a comprehensive airspace and air route design. Given the uncertainties concerning the final form of the airspace design, the final form of noise mitigation measures to be implemented is not yet known. Accordingly, the mitigation measures that have been referred to in the aircraft noise assessment are generic in nature. This is a particularly important point for an airport development as, unlike other forms of infrastructure development, the policies used to manage aircraft overflight noise do not generally stipulate noise limits that airport operations must adhere to at surrounding noise-sensitive locations. Accordingly, without a defined airspace design, a defined noise mitigation strategy or defined noise criteria to adhere to in practice, the residual impacts and the location of these impacts is subject to considerable uncertainty. Further, it is unclear how noise considerations would be prioritised among other non-safety related airspace management and operational considerations associated with the proposed airport site.

Based on the above considerations, further information and assessment are considered necessary before stakeholders can reach an informed view on the potential scale and significance of aircraft overflight noise impacts associated with the proposed airport site.

Conclusion

Aircraft noise impacts are an unavoidable consequence of aircraft operations in urban environments. The creation of a new international airport therefore requires a balance to be achieved between the protection of amenity for neighbouring sensitive land uses and the development of infrastructure to respond to the growing demands of a major city.

Determining whether this balance has been achieved is ultimately a matter for regulatory authorities. While this peer review has identified a number of limitations to the present assessment, this is not intended to infer that the proposed development and development site are unsuitable. Rather, in light of the residual uncertainties in the assessment, further information and assessments are considered necessary before stakeholders can reach an informed view on the potential scale and significance of aircraft overflight noise impacts associated with the proposed airport site.

Conducting these further assessments as part of the environmental impact assessment process represents an opportunity to:

- Provide clarity to affected communities and stakeholders about the nature of the noise impacts;
- Provide clarity to regulators about the form of noise controls which will be needed in the project approval to ensure that noise is appropriately managed; and
- Reduce the potential for unforeseen impacts and the associated risk of reactionary noise management procedures which could subsequently jeopardise the operational flexibility of the proposed airport.

5.0 MDA PEER REVIEW PERSONNEL

The following personnel from Marshall Day Acoustics have conducted this peer review on behalf of WSP Parsons Brinckerhoff.

Engineer and role	Qualifications and key relevant experience
Justin Adcock, Lead Peer Reviewer	*Bachelor of Engineering (Mech), University of Adelaide, South Australia* Department of Defence, New Air Combat Capability: Contract and technical manager for the environmental noise modelling and impact assessment of Joint Strike Fighter operations - lead author of the noise impact assessment. Dubai International Airport and Jebel Ali International airport: Noise modelling, model validation works and impact assessment– lead report
Alex Morabito, Peer Reviewer	*Bachelor of Engineering (Mech), University of Adelaide, South Australia* *Bachelor of Finance, University of Adelaide, South Australia* Department of Defence, New Air Combat Capability: environmental noise modelling and impact assessment of Joint Strike Fighter operations Adelaide Airport Noise Insulation Program: Compliance testing to verify acoustic design of churches eligible for program
Steve Peakall Peer Reviewer	*Bachelor of Science (Environmental Engineering), University of the West of England, Bristol, UK* Institute of Acoustics, Diploma in Acoustics and Noise Control Sydney Airport, Peer review of the INM inputs for ANEF contours presented in the 2009 and 2013 Sydney Airport Master Plans.

In addition to the above main peer review personnel, review of key issues has also been provided by the following Marshall Day Acoustics.

Engineer and role	Qualifications and key relevant experience
Christopher Day	*Bachelor of Engineering (Mech), Monash University, Melbourne* Christchurch International Airport: Ongoing involvement since 1992 including, initial modelling and update of noise contours, presentation of expert evidence, member of the International Expert Panel, review of noise monitoring strategy and engine testing noise assessments. Auckland International Airport: Extensive involvement for more than 23 years involving the preparation of noise contours, assessment of aircraft noise effects, noise management and land use planning and development of a sound insulation programme.

APPENDIX A GLOSSARY OF TERMINOLOGY

Ambient	The ambient noise level is the noise level measured in the absence of the intrusive noise or the noise requiring control. Ambient noise levels are frequently measured to determine the situation prior to the addition of a new noise source.
ANEC	A contour map showing forecast of aircraft noise exposure around an aerodrome for a future year. It is based on a forecast of aircraft movement numbers, operating times, types, destinations and flight paths
ANEF	A reviewed and endorsed ANEC by Airservices Australia or Department of Defence. It is the only contour map with status in land use planning decisions for aircraft noise exposure
ANEI	A contour map based on historical data from a previous year, where the numbers and types of aircraft which used the aerodrome are known. The map provides the average daily aircraft noise exposure around the aerodrome for that year. ANEI are typically used as benchmarks or an indicator of change in aircraft noise exposure
A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.
dB	Decibel. The unit of sound level.
Feet (ft)	Unit length 0.3048 m
Frequency	The number of pressure fluctuation cycles per second of a sound wave. Measured in units of Hertz (Hz).
Integrated Noise Model (INM)	A computer program used to model the impact of aircraft noise developed by the US Federal Aviation Administration
L_{Aeq}	The A-weighted equivalent continuous sound level. This is commonly referred to as the average noise level and is measured in dB.
L_{Amax}	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.

APPENDIX B REFERENCES

Airservices Australia, 2012. Continuous Descent Approaches. [ONLINE] Available at: http://www.airservicesaustralia.com/environment/continuous-descent-approaches/

Society of Automotive Engineers, 1986, Committee A-21, *Procedure for the Computation of Airplane Noise in the Vicinity of Airports*, SAE-AIR-1845

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Mestre, V, 2008, *Synthesis 9 - Effects of Aircraft Noise: Research on Selected Topics*, Washington, D.C: Airport Cooperative Research Program by the US Transportation Research Board

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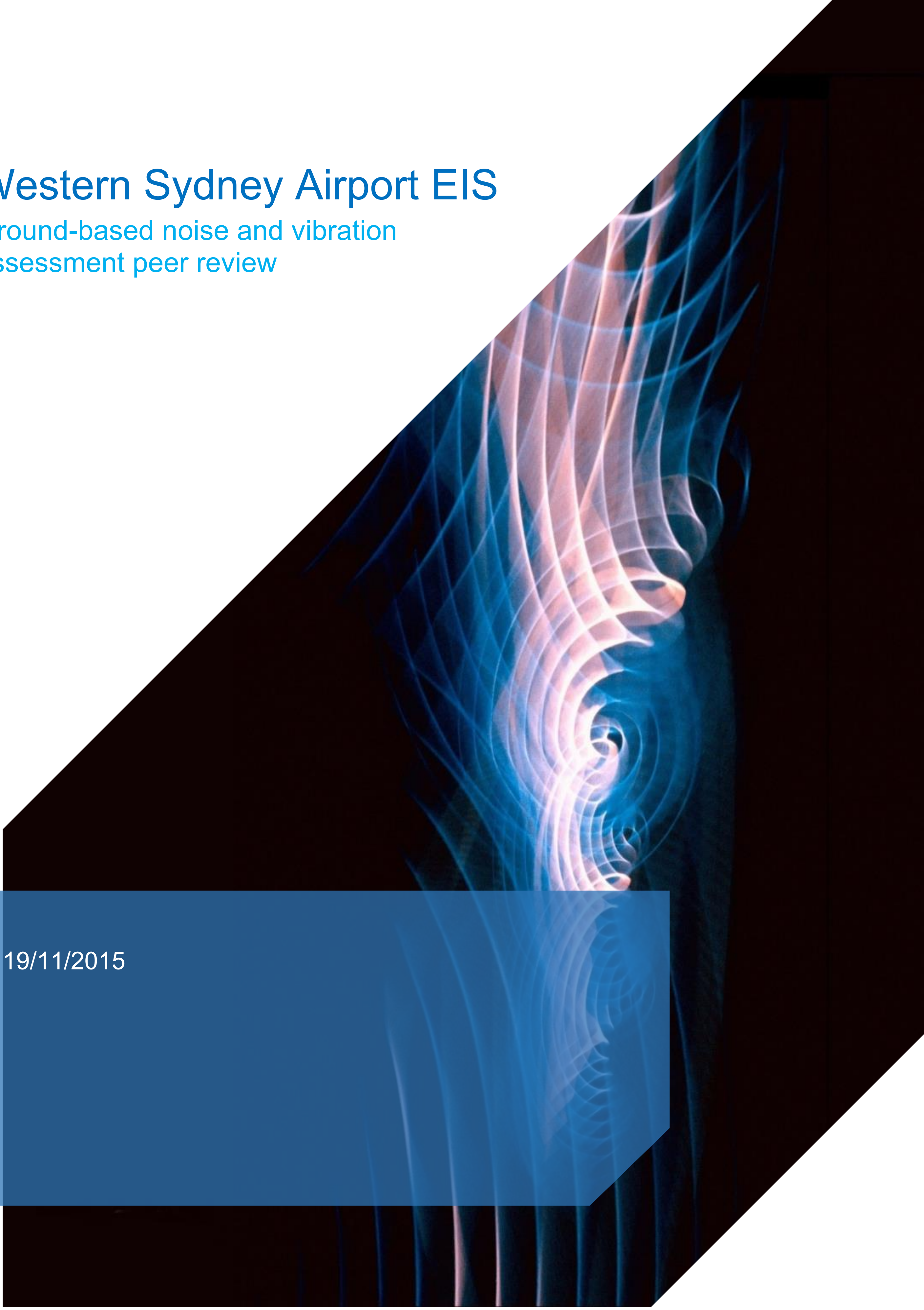
Appendix B

Ground-based noise and vibration (WSP | Parsons Brinckerhoff)

Western Sydney Airport EIS

Ground-based noise and vibration assessment peer review



19/11/2015

Western Sydney Airport EIS

Ground-based noise and vibration assessment peer review

Project no: ACG1517900
Date: 19/11/2015

Prepared for: WSROC

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Table of Contents

Executive summary

Introduction

The Western Sydney Airport draft Environmental Impact Statement (EIS) was prepared to provide an assessment of environmental impacts associated with the development of a new international airport near Badgerys Creek in Western Sydney, NSW. The draft EIS contains an assessment of noise impacts in two components; noise impacts from air-based activities such as aircraft in flight, landing and take-off; and from ground-based activities such as aircraft taxiing and ground based engine run-up. This review is concerned with ground-based activities only.

Scope of review

This scope of this report is to provide an unbiased peer review of all work presented as part of the Western Sydney Airport draft EIS in relation to ground-based noise.

Approach

This review identified uncertainties and unknowns within the ground noise the assessment, provided in the EIS and identified what further assessment would be required to provide an indication of impacts. The limitations of this review are as follows:

- Noise modelling or review of noise modelling files has not been completed as part of this review. Therefore it was not possible to verify the noise contour plots from ground-based activities presented in the EIS. However, comment has been included based on a visual inspection of the plots.
- The review relies on the source noise data that has been included in the ground noise assessment. The review is a desktop exercise and therefore independent source noise measurements have not been conducted to confirm the noise levels used for taxiing and engine ground running as presented in the EIS.

The components of the review are follows:

- The review comments on the EIS chapters relevant to ground noise in addition to *Appendix E2 – Airport ground-based noise and vibration.* This appendix is the technical basis for all other ground noise related documents, including the relevant EIS chapters.
- A document review is contained within Appendix A of this report, and provides references and comment on specific sections of the EIS. The documents reviewed are identified in Section 1.3 of this report.

1st stage airport review findings

A summary of the findings for the 1st stage airport is as follows:

- The assessment does not fulfil the requirements of the Guidelines for the Content of a Draft Environmental Impact Statement – Western Sydney Airport 2015 (EIS Guidelines). These guidelines state that the type and magnitude of impact, both pre-mitigation and post-mitigation should be presented. The ground noise assessment should be updated to include this assessment.
- There is insufficient detail to satisfy the EIS Guidelines on the source of the noise data and assumptions used in noise predictions. As these assumptions form the basis for the noise assessment, changes to the source noise data could potentially lead to a significantly different outcome.
- The assessment does not provide sufficient justification to support the assessment being performed based on the year 2030 (five years after opening) and not 2050 when the airport is expected to be approaching capacity for the single runway configuration with potentially increased noise impacts.
- The report does not provide sufficient detail in the assessment of the ground-based power supply to aircraft when they are parked. The assessment excludes the use of Auxiliary Power Units (APU), however it does not provide sufficient detail of alternative ground-based power supplies. As an alternative power supply method is not presented, there is potential for additional noise sources being introduced that have not been considered.
- Background noise monitoring was conducted at 10 locations in the region, however a single background level has been assumed for all receptors, rather than several location-specific values. This generalisation

has underestimated the assessment noise criteria and therefore the magnitude of noise impacts at receptors close to the airport that are currently exposed to low levels of environmental noise.

- The nearest noise sensitive receptors in Luddenham were not included in the background noise monitoring and therefore there it is uncertain if noise impacts have been adequately assessed at this location.
- No consideration has been given to the cumulative noise impact from all ground noise sources at the nearest noise sensitive receptors both with and without mitigation measures as required by the EIS Guidelines. Additional assessment should also be undertaken for other ground noise sources, such as the compass calibration pad.
- It is recommended that the mitigation measures identified in the assessment, including the restriction of APUs and the limitation of engine ground run-ups during the night, are formalised as part of the project approval.
- The assessment does not provide sufficient evidence that all reasonable and feasible mitigation measures have been considered to reduce noise impacts from taxiing and ground run-ups.
- Semi-enclosed pens and bunded areas to reduce noise impacts from engine ground run-up noise are considered in the assessment. It is recommended that these measures are considered further as part of the approvals and subsequent design stages.
- No comment has been made on the potential cumulative noise impact from the new M12 motorway and realignment of The Northern Road that are being developed to accommodate the airport.
- The EIS contains misleading statements relating to operational road traffic noise which do not acknowledge the limitations of the assessment. The development of the M12 motorway and realignment of The Northern Road have been excluded from the assessment and statements regarding operational road traffic noise should include these limitations.

Long term development review findings

- The assessment is considered to contain an appropriate level of detail for the long term development as the potential noise impacts are predicted for a considerable time in the future (into 2063). It is acknowledged that the noise environment may change over time.
- The comments raised in this review for the 1st stage airport assessment should be addressed and applied to the long term development assessment. Where this occurs, the current framework for further assessment of the long term development is considered appropriate.
- The EIS does not include ground-based noise in the summary or conclusion for the long term development. It is recommended that the outcomes of the revised long-term development ground-based noise assessment are included in these sections so that all impacts are clearly presented.

Key impacts and opportunities

It is considered that the ground-based noise assessment does not provide an appropriate level of detail on a number of key aspects including:

- The derivation and allocation of assessment criteria
- Noise impacts at the nearest sensitive receptors in Luddenham
- Noise source levels and modelling assumptions
- The type and magnitude of impacts with and without mitigation
- Evidence that all reasonable and feasible mitigation has been considered
- Cumulative noise impacts from operational activities and road traffic projects.

As a result, without further clarification or justification, it is uncertain that the draft EIS has adequately presented and addressed the noise impacts associated with the proposed development.

It is recommended that these items are addressed to reduce the level of uncertainty, increase the accuracy of the assessment and to satisfy the requirements of the EIS Guidelines.

1 Scope

1.1 Summary of approach

This scope of this report is to provide an unbiased peer review of all work presented as part of the draft Western Sydney Airport Environmental Impact Statement (EIS) in relation to ground-based noise.

The draft Western Sydney Airport EIS was prepared to provide an assessment of environmental impacts associated with the development of an international airport near Badgerys Creek in Western Sydney, NSW. The EIS contains an assessment of noise impacts in two components; noise impacts from air-based activities such as aircraft in flight, landing and take-off; and from ground-based activities such as aircraft taxiing and ground based engine run-up. This review is concerned with ground-based activities only.

The Guidelines for the Content of a Draft Environmental Impact Statement – Western Sydney Airport (EIS Guidelines) (Commonwealth Government, 2015) were released to provide a framework for the preparation of the EIS.

The current status of the approvals process for the airport is presented in Figure 1-1. It is recommended that the findings of this review are considered and incorporated into the final EIS prepared in the next phase of the approvals process.

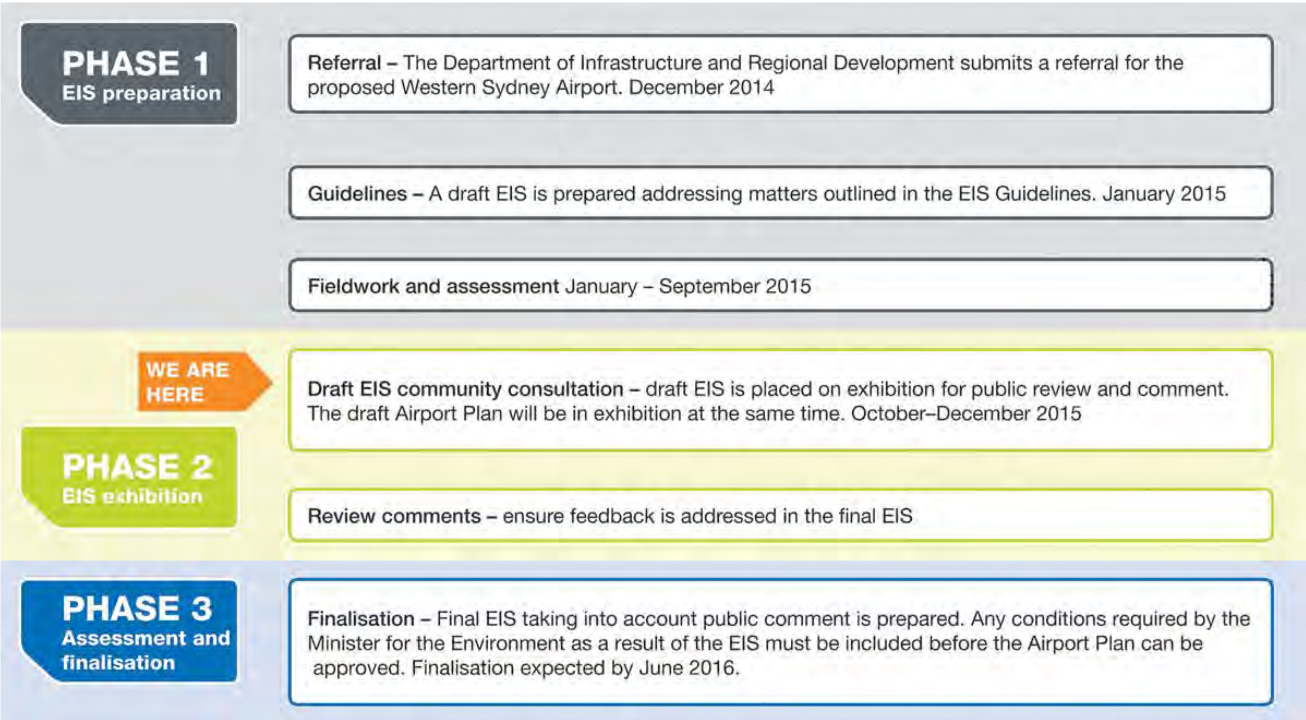

Figure 1-1 - Development approval process

This review has identified areas of uncertainty in the assessment provided in the EIS and has identified what further assessments or detail is reasonably considered to be required to reduce these uncertainties and satisfy the requirements of the EIS Guidelines.

Specifically this review:

- Evaluates whether the study meet the requirements of the EIS Guidelines
- Evaluates whether the conclusions reached in the studies are valid

- Evaluates whether the underlying assumptions are plausible
- Reviews the mitigation and management measures proposed
- Evaluates the level of uncertainty over impacts and the environmental risks
- Provides a summary of the key impacts and opportunities associated with the project in relation to aircraft noise as part of the noise and vibration study
- Discusses the approach to assessment of long term development.

A document review is provided in Appendix A of this report which provides comment and recommendations for specific areas items in the EIS.

In order to identify the scale of significance for items identified as part of the review, the significance ratings in Table 1-1 have been adopted.

Table 1-1 - Significance scale

Significance	Consequence
High	Likely to result in significantly different outcomes
Medium	Potential to change outcomes significantly
Low	Unlikely to result in significantly different outcomes
Noted for information	Unlikely to change outcomes, noted for information

1.2 Limitations

Noise modelling has not been conducted as part of this review as modelling files were not available for review. Therefore it is not possible to verify the validity of noise contour plots presented in the EIS. However, the review was conducted based on a visual inspection of the plots.

The review also relies on the source noise data included in the EIS. As the review is a desktop exercise it was not possible to undertake independent source noise measurements to verify the noise levels stated in the EIS for taxiing and engine ground running.

1.3 Components of the EIS reviewed

The EIS is divided into four volumes. For each volume the sections relevant to this review have been identified in Table 1-2.

Table 1-2 – EIS sections relevant to ground-based noise

EIS PART	Section Title	Page reference
Volume 1 — Project Background		
N/A	Executive Summary	p30 – 33, p49 - 52
Part B	Airport Plan	p125 - 256
Volume 2 — Stage 1 Development — EIS for Stage 1 development (single runway facility in 2030)		
Part D	9. Approach to impact assessment	p3 - 18
Part D	11. Noise (ground operations, construction, road and rail)	p75 - 100

EIS PART	Section Title	Page reference
	27. Cumulative impact assessment	p561 - 574
Part E	28. Environmental management framework	p577 - 620
Part F	29. Conclusion	p623 – 634
Volume 3 — Long Term Development **—** Strategic assessment of the long-term development (dual runway facility by 2063)		
Part G	Approach to impact assessment	p3 - 10
	Assessment of Long Term Impact - Noise	p11 - 72
Part H	Conclusion and recommendations	p193 – 200
Volume 4 — EIS Technical Reports		
Appendix E	E2 Airport ground-based noise and vibration	Separate report

1.4 Policy and guidance

The following documents, standards and guidance have been used to inform the EIS review process:

- Airports (Environment Protection) Regulations 1997 (to be ceased by 1 April 2019)
- Airports Act 1996
- AS 2021: 2015 Acoustics – Aircraft Noise Intrusion – Building Siting and Construction
- Assessing vibration: a technical guideline (Department of Environment and Conservation, 2006)
- Australian Government Department of Sustainability, Environment, Water, Population and Communities – Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies – Significant impact guidelines 1.2 – Environment Protection and Biodiversity Conservation Act 1999
- EIS Guidelines – Australian Government Department of the Environment (Commonwealth Government, 2015)
- German Standard DIN 4150-3 Structural Vibration: Effects of Vibration on Structures.
- NSW Industrial Noise Policy (Environmental Protection Authority, 2000)
- NSW Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009)
- NSW Road Noise Policy (Department of Environment, Climate Change and Water, 2013)

2 Detailed findings - 1st stage airport

2.1 Summary

2.1.1 EIS Guidelines

A number of aspects were identified that did not satisfy the requirements of the EIS Guidelines.

- The assessment did not present sufficient evidence to support the noise levels used in the predictions. Changes to the noise source levels could potentially lead to significantly different outcomes.
- The identification of the type and magnitude of impact, both pre-mitigation and post-mitigation was not presented in the assessment.
- The effectiveness of identified noise mitigation measures is not able to be identified.
- The cumulative assessment does not consider the potential for noise impacts from the simultaneous operation of activities on the ground at the airport including ground based run ups and taxiing.
- The cumulative assessment does not include consideration of the operation of the M12 motorway and The Northern Road realignment which provide access to the airport and are likely to introduce an additional significant noise sources into the area.

2.1.2 Assumptions

- It has been assumed that Auxiliary Power Units (APU) would not be used at the airport. However, the type of ground power to be employed instead is not clearly defined. Ground power units (GPU) have the potential to cause additional noise impacts and the inclusion of either APU or GPU usage at the airport could adversely affect the outcome of the assessment.
- There is insufficient information regarding assumed noise source levels used in the assessment, particularly in relation to noise from taxiing aircraft.
- A single rating background level has been assumed for all receptors, rather than several location-specific values. This generalisation has underestimated the magnitude of noise impacts at receptors close to the airport that are currently exposed to low levels of environmental noise.
- The assumption that construction traffic will primarily travel on Elizabeth Drive does not include an assessment of roads that connect to Elizabeth Drive being used by construction vehicles.

2.1.3 Conclusions

- No consideration has been given to the cumulative noise impact from all ground noise sources at the nearest noise sensitive receptors both with and without mitigation measures. Additional assessment should also be undertaken for other ground noise sources, such as the compass calibration pad.
- The conclusions reported in the body of the EIS regarding operational traffic noise are misleading as they do not state that development of a new motorway or substantial realignment of an arterial road to accommodate the airport were excluded from the assessment.

2.1.4 Mitigation and management measures proposed

- It is recommended that the mitigation measures identified in the assessment, including the restriction of APUs and the limitation of engine ground run-ups during the night, should be formalised as part of the project approval.
- The assessment does not provide sufficient evidence that all reasonable and feasible mitigation measures have been considered to reduce noise impacts from taxiing and ground run-ups.

- Semi-enclosed pens and bunded areas to reduce noise impacts from engine ground run-up noise are considered in the assessment. It is recommended that these measures are considered further as part of the approvals and subsequent design stages.

2.1.5 Uncertainty of impacts and environmental risks

- There are noise sensitive receptors closer to the airport than those selected for noise monitoring, leaving uncertainty over the current noise environment for the potentially most affected noise sensitive receptors.
- The level of impact at the nearest sensitive receivers in Luddenham is not appropriately defined in the EIS and represents a potential risk to the validity of the assessments.

2.2 Detailed findings

2.2.1 Introduction

Appendix E2 – Airport ground-based noise and vibration is the primary document under review, as this appendix forms the technical basis for all other ground noise related documents, including the EIS chapters.

2.2.2 Scope

The scope of the ground noise assessment is limited to aircraft taxiing noise, engine ground run-ups, development generated road traffic noise and construction phase noise and vibration.

The noise impact of auxiliary power units (APUs) has been excluded, on the assumption that ground power and preconditioned air will be provided at all gates, negating the need to use APUs. The use of APUs is not discussed in the Airport Plan. Therefore there is a potential risk that APUs could be used in future, which could change the result of the noise assessment.

An assessment of the noise impact of APU usage should be undertaken, if they could potentially be routinely used.

There is a reference within the ground noise assessment to the use of reverse thrust at night-time, however it is assumed that reverse thrust has been included in the aircraft noise assessment.

2.2.3 Baseline noise survey

From a review of available aerial mapping, there are closer noise sensitive receptors in the area than those selected for noise monitoring, leaving uncertainty over the noise impacts on the most affected noise sensitive receptors, particularly for properties in Luddenham to the north west of the Site. Figure 2-1 shows the adopted noise monitoring locations that are closest to the Site boundary. Figure 2-2 shows that there are many noise sensitive receptors much nearer to the Site boundary (marked in grey). Further consideration should therefore be given to quantifying the existing noise environment for properties closest to the airport.

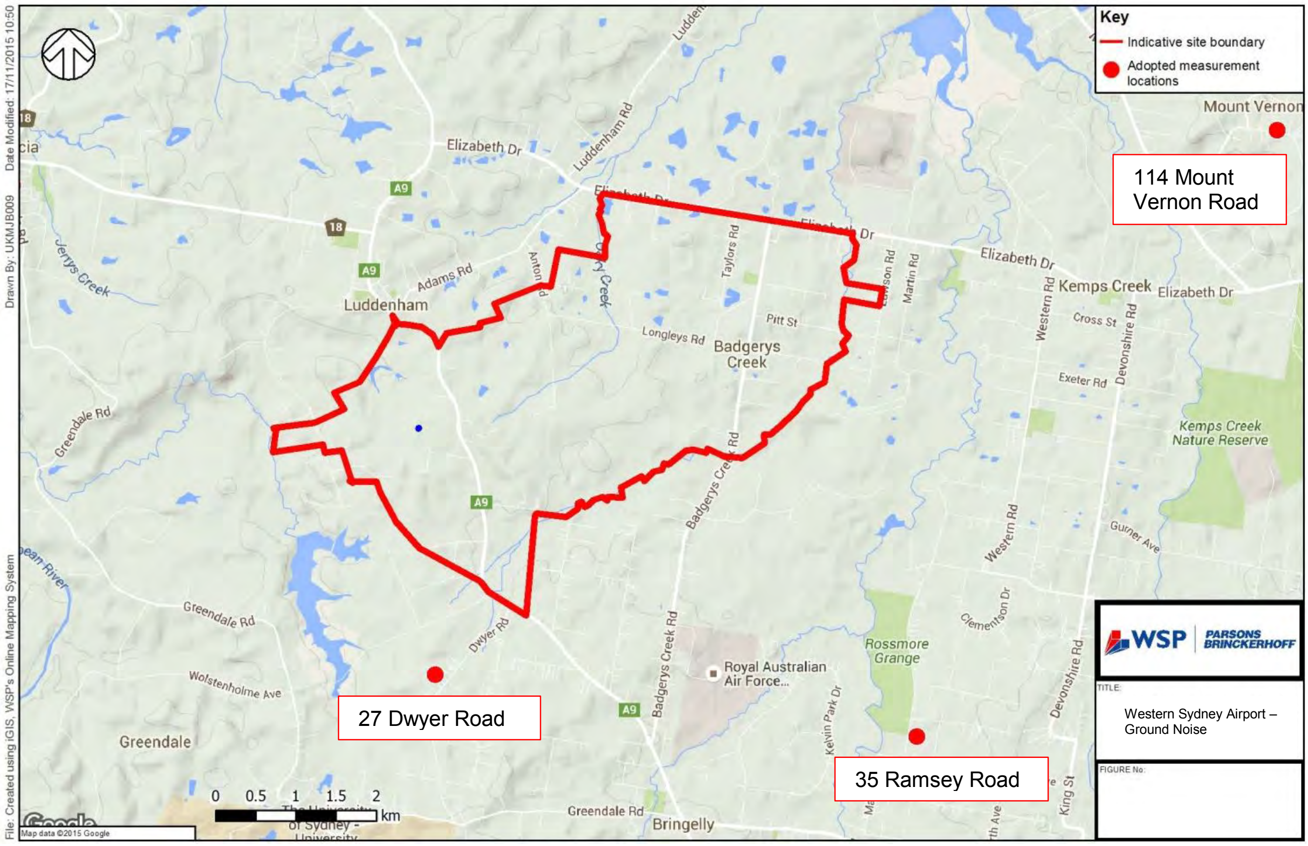

Figure 2-1 – Noise monitoring locations which are closest to the Site boundary

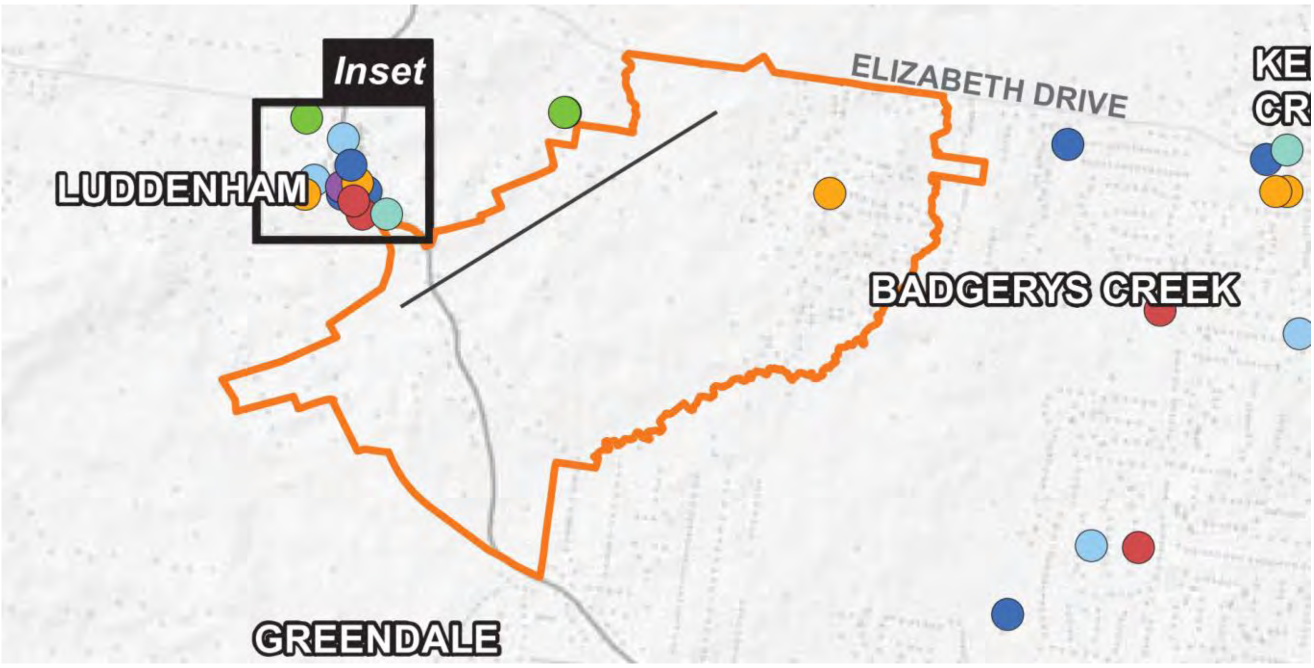

Figure 2-2 – Nearest noise sensitive residential receptors to the Site boundary (marked as light grey points)

There is insufficient detail provided to accurately determine the specific noise monitoring locations, whether noise measurements were taken in free-field conditions, or at what height above ground microphones were positioned at. It is not possible to determine whether microphones had direct line of sight to dominant noise sources such as main roads, or whether they were placed in backyards. There is a risk that existing noise levels have been overestimated if they have not been placed on quietest facades of residential receptors. The existing noise levels have been used to determine assessment criteria, so this information could potentially affect the conclusions of the assessment. Therefore the precise measurement locations should be defined.

Figure 11-2 (reproduced below in Figure 2-3) depicts the noise sensitive receptors surrounding the airport site. It identifies the location of nearby non-residential noise sensitive receptors in the area clearly, however the location of residential receptors is indicated by very small points in light grey, which are difficult to observe and could be considered misleading. It is recommended that Figure 11-2 is updated to show more clearly the location of residential receptors.

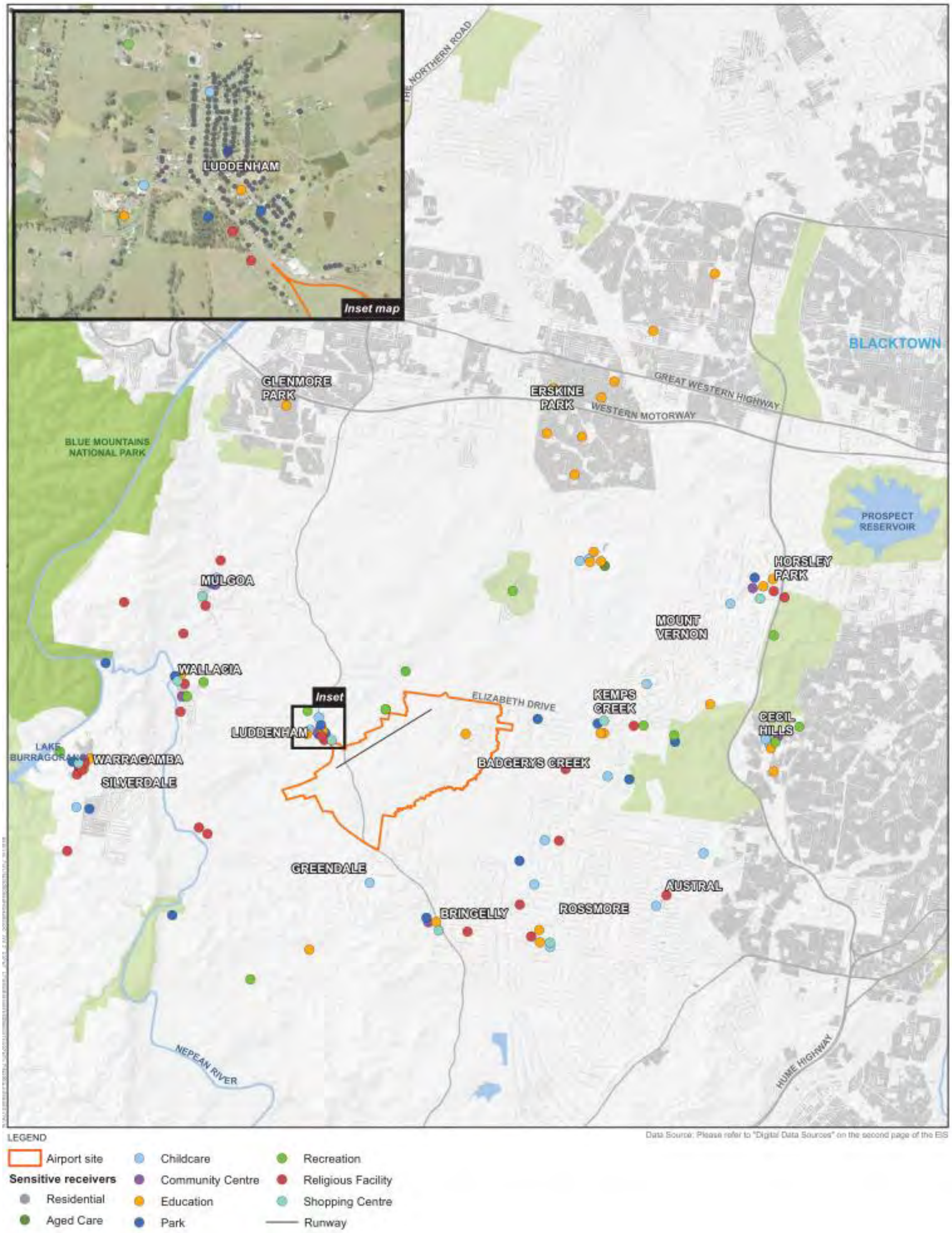

Figure 2-3 - Sensitive receivers surrounding the airport site (reproduced from Western Sydney Airport draft EIS)

2.2.4 Criteria

Ground based operations noise

There is insufficient evidence that the intrusiveness criterion is more stringent than the amenity criterion for all assessed locations. Based on the rural nature of the surrounding area, Table 2.1 of the NSW Industrial Noise Policy 2000 (INP) (presented in Table 2-1 of this report) recommends a noise level of 40 dB L_{Aeq} at night as "acceptable". This is lower than some tabulated night-time values in Table 3-1 of Appendix E2 (albeit they are $L_{Aeq,15min}$, corrected). The incorrect criterion selection could potentially underestimate the extent of the noise impacts, therefore further evidence should be provided to demonstrate that the intrusiveness criterion is the more stringent at all locations.

Furthermore, the contribution from existing industrial noise sources was not quantified in the assessment, therefore there is insufficient evidence presented in the report

The approach of selecting one noise criterion undermines the results of the noise monitoring at multiple locations. Noise criteria at five of the ten locations are lower than 40 dBA, and as low as 35 dBA, which is 5 dB lower than the adopted criterion. As a result, noise impacts at some locations are considered to have been incorrectly identified, and should be reassessed for each measurement location using the criterion specific to that assessment location.

Table 3-2 of Appendix E2 sets out noise criteria for non-residential receivers based on recommended maximum L_{Aeq} levels. However Section 2.2 of the INP states that, in all cases, it is expected that all feasible and reasonable mitigation measures would be applied before the recommended maximum noise levels are referenced. Therefore the "acceptable" noise levels stated in Table 2.1 of the INP should be used in the first instance, rather than "Recommended Maximum". The criteria adopted would therefore be 5 dB lower than that used in the assessment, which could potentially alter the assessment outcome.

No assessment of low frequency noise or other modifying factors as defined in Section 4 of the INP has been conducted. The assessment should be revised to include consideration of these aspects.

Table 2-1 – INP Amenity criteria (reproduced from Table 2.1 of the INP)

Recommended L_{Aeq} noise levels from industrial noise sources

Type of Receiver	**Indicative Noise Amenity Area**	**Time of Day**	**Recommended L_{Aeq} Noise Level, dB(A)** *(see Note 8 in Section 2.2.1)*	
(see Notes in Section 2.2.1)			**Acceptable** *(See Note 11)*	**Recommended Maximum** *(See Note 11)*
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
	Urban	Day	60	65
		Evening	50	55
		Night	45	50
	Urban/Industrial Interface – for existing situations only	Day	65	70
		Evening	55	60
		Night	50	55
School classroom—internal	All	Noisiest 1-hour period when in use	35 *(See Note 10)*	40
Hospital ward —internal —external	 All All	 Noisiest 1-hour period Noisiest 1-hour period	 35 50	 40 55
Place of worship—internal	All	When in use	40	45
Area specifically reserved for passive recreation (e.g. National Park)	All	When in use	50	55
Active recreation area (e.g. school playground, golf course)	All	When in use	55	60
Commercial premises	All	When in use	65	70
Industrial premises	All	When in use	70	75

Construction noise and vibration

It is unclear whether the adopted construction noise criteria are based on the NSW Interim Construction Noise Guideline (ICNG) or the Airports (Environment Protection) Regulations 1997. Usual hours of construction are proposed from 6.00 am, which is classed as night-time. Therefore, it is important that the appropriate criterion is used for night-time work, which will be included in standard hours of construction. It is recommended that clarification is provided for the appropriate criteria set to be used for the assessment during daytime and night-time periods.

Table 2 of the ICNG states that strong justification would typically be required for works outside of the recommended standard hours. No justification has been provided in the assessment.

The construction noise assessment identifies that, for some receptors, the noise management level (NML) should be 39 dBA, however 45 dBA (weekday) and 40 dBA (weekend and early morning works) have been adopted as the criteria set. This potentially underestimates the noise impacts from construction by up to 6 dB. Construction noise should be reassessed based on the different measurement locations adopted in the assessment, in order to more accurately quantify the potential noise impacts.

Road traffic noise

The Road Noise Policy (RNP) and RNP application notes provide specific criteria for the assessment of land uses affected by traffic generating developments on existing roads. Whilst the report does provide an assessment of impacts consistent with the RNP, the appropriate section of the RNP and RNP application notes should be referenced in the report.

2.2.5 Noise modelling

Assumptions

It has been assumed that there will only be one high power run up, which would occur for less than 5 minutes in any night. INP Section 4.2 states that the acceptable noise level may be increased by 5 dB to account for unusual and one-off events, but does not apply to regular high-noise levels that occur more frequently than once per day. Should there be more than one high power run-up in one night, it would be inappropriate to apply this correction. Clarification is required to determine the likelihood of high power ground run-ups in a given night-time period.

The assumed location for ground run-ups is defined in Figure 3-1 of Appendix E2 (presented in Figure 2-4 below), however the indicative building location near the location is not finalised nor is fixed within the application. Figure 3-2 of Appendix E2 (presented in Figure 2-5 below) shows that communities to the west and north west of the Site benefit from the screening afforded by this building. Noise impacts could significantly change if the buildings or run-up area change location. It is therefore considered appropriate to assess a scenario where the building does not provide any acoustic benefit, to take into account that final locations are not fixed and may change.

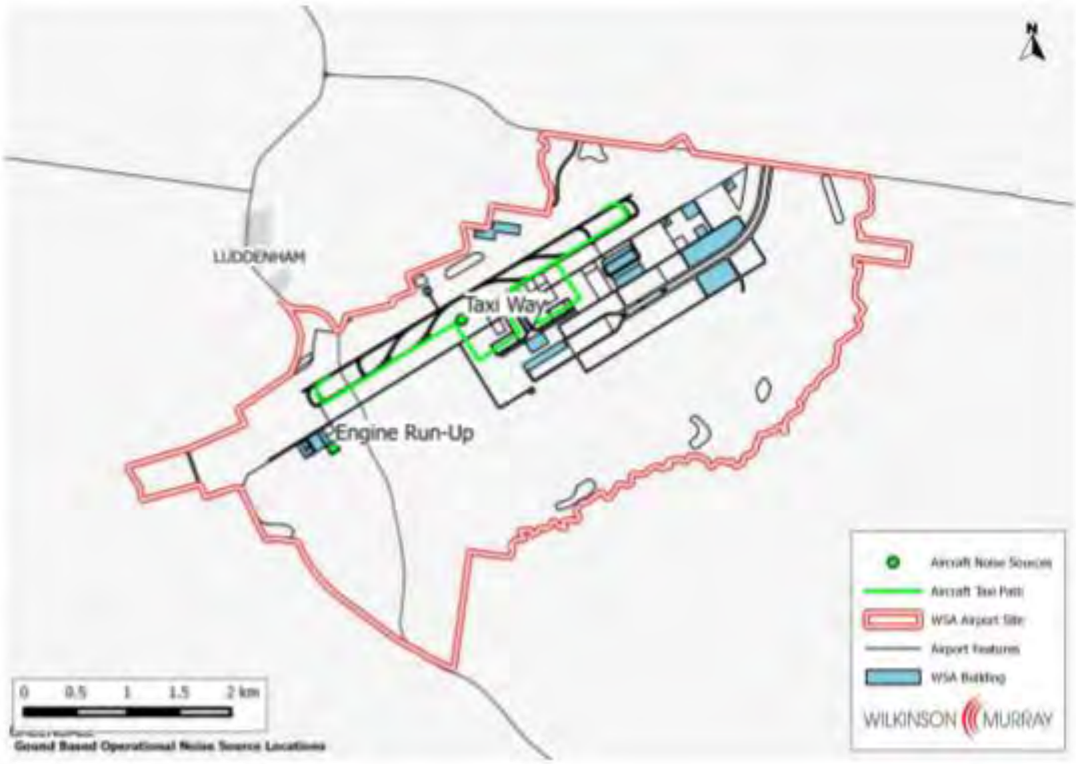

Figure 2-4 - Ground based operational noise source locations, 2030 (reproduced from EIS Appendix E2 Figure 3-1)

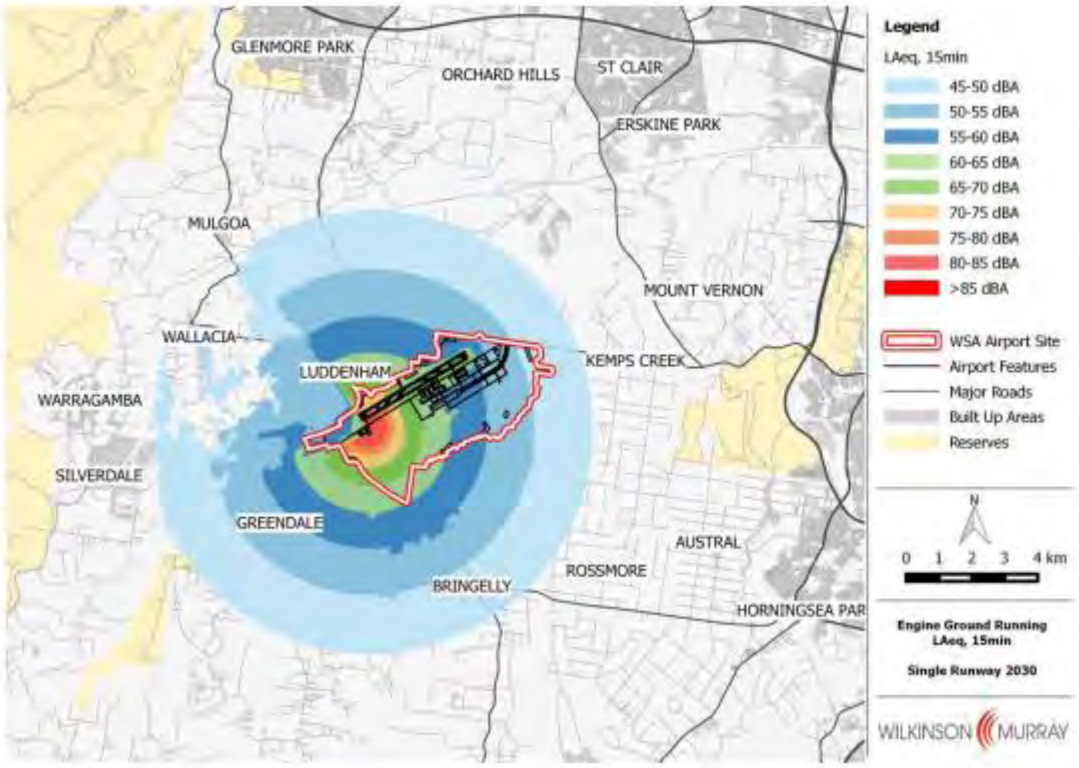

Figure 2-5 - Worst case $L_{Aeq,15min}$ engine ground running noise contours, 2030 (reproduced from EIS Appendix E2 Figure 3-2)

Source noise data

Chapter 9 Table 9-2 of the EIS presents EIS Guideline requirements and indicates where in the EIS they are addressed. In Table 9-2 Section 11 – Information sources it states that for information given in the EIS, the EIS must state (amongst other points) the source of the information, how recent the information is, and how reliable the information is. This requirement has not be fulfilled in the EIS as this information is not presented for the noise source levels in the ground based noise assessment.

A sound power level of 151 dBA has been assumed for aircraft engine ground running, based on measurements of aircraft taking off. There is no indication of which aircraft this refers to, or the range of typical levels that might be expected. It is assumed that this level is an A weighted Sound Power Level (L_{WA}), however it is not explicitly stated. More information should be provided regarding the adopted source noise level and the range of values expected from engine run-ups, given the anticipated fleet of aircraft for the airport.

A sound power level of 138 dBA has been assumed for taxiing aircraft. This is stated as the highest level measured, based on measurements of a B777, B747, B737, B717 and A330 aircraft. It is assumed that the 747 taxi noise has been used for the purposes of the noise modelling exercise. In addition, the directionality of the source has not been stated. As aircraft engines are directional sources, there is potential for an underestimation of impacts from a directional source with the same sound power level as an omni-directional source. As a result, it is unclear how this sound power level has been calculated.

Taxiing aircraft is in essence a moving point source. Depending on how the source has been modelled, this may not be the appropriate sound power level to use (e.g. series of point sources, line source with a total sound power, line source with a sound power per unit length). It is unclear whether taxiing was under two engine conditions, one engine conditions or engine off taxiing (EOT). Clarification is required on the method used to determine the sound power level for the line source, and the measurements that were undertaken in support of this.

2.2.6 Assessment

General

The requirements of Section 5 “Relevant Impacts” and Section 7 “Residual impacts and offsets” in Table 9-2 have not been met within Chapter 11, and this chapter should be updated to include clear statements on whether impacts are short term, long term, direct, indirect, unknown, predictable or irreversible, and a clear indication of the significance of the impacts, pre and post mitigation. This should include the reasons why avoidance or mitigation of impacts may not reasonably be achieved, where necessary.

A magnitude scale for impact significance should be set out at the beginning of the chapter and used for pre-mitigation and post mitigation assessments so that it can be seen what the residual noise impacts are predicted to be.

Ground based operations noise

The assessment year for Stage 1 is 2030, which is only five years after anticipated opening. Given that passengers and air movements are expected to steadily increase to 2050, when the single runway will be at full capacity, it could be considered more appropriate to take 2050 (i.e. 25 years after opening) as the assessment year so that realistic longer term impacts can be taken into account. Given that there is more certainty over this than a two runway scenario, it is important that the single runway noise impacts are fully explored.

Table 3-4 of Appendix E2 (reproduced in Table 2-2) shows the population affected above the adopted criteria for engine ground running and taxiing. The table may be subject to change when the issues identified in this review are addressed. It is recommended that it is stated how many receptors will be exposed to 5 dB above criterion, 10 dB above criterion etc. as there is currently no indication of the magnitude of exceedance that will be experienced by individual receptors. At this stage, it is likely that the population numbers will increase.

Table 2-2 - Predicted residential noise impact of ground-based operational noise under worst-case conditions (reproduced from appendix E2 Table 3-4)

Noise Type	Noise Criterion	Population Affected above Criterion
Engine Ground Running	45 dBA	7,258
Taxiing	40 dBA	3,117

Note: Population exposures are esitmates only

Similarly, Table 3-5 of Appendix E2 (shown in Table 2-3) shows other receivers and land uses affected above the adopted criteria for engine ground noise and taxiing. There may also be implications to this table as a result of the above issues. It is recommended that the actual noise levels anticipated at these buildings/areas are presented so that the magnitude of the exceedance can be understood.

Table 2-3 - Predicted noise impact of ground-based operational noise on other receiver types under worst-case conditions (reproduced from Appendix E2 Table 3-5)

Noise Type	Other Buildings and Land Uses Affected Above Criterion		
	Building or Land Use Type	Criterion	Number
Engine Ground Running	Educational Institutions	55 dBA	5
	Hospitals	60 dBA	0
	Place of Worship	60 dBA	2
	Passive Recreation	60 dBA	2
	Active Recreation	65 dBA	0
Taxiing	Educational Institutions	50 dBA	1
	Hospitals	55 dBA	0
	Place of Worship	55 dBA	0
	Passive Recreation	55 dBA	0
	Active Recreation	60 dBA	0

Note: Building numbers are based on information obtained in 2015, however datasets may be older. No verficiation of building types or uses has been undetaken.

Road traffic noise

The construction road traffic noise assessment only includes an assessment of impacts from vehicles accessing the site on Elizabeth Drive. No assessment or comment is provided for other stages of construction where there are additional entrances to the site, nor for roads which connect to Elizabeth Drive, which may carry construction traffic.

The road traffic noise assessment for the operational airport does not include the assessment of the planned M12 motorway or The Northern Road realignment which are being developed to accommodate the airport. The impacts of these projects has been excluded from the assessment as these are to be developed and approved by other authorities and proponents. However, the EIS does not state the limitations of the assessment, which does not include these major road projects, as presented in Appendix E2.

The assessment of road traffic noise only includes assessment of one year (2030). It does not provide sufficient justification for the omission of other operating years for example up to 2050. It is considered likely that traffic on the assessed roads would increase as a result of the second stage of development and no comment has been made on this.

2.2.7 Mitigation

General

Section 6 of the EIS Guidelines, “Avoidance and mitigation measures”, states that the EIS must include an assessment of the expected or predicted effectiveness of mitigation measures. The draft EIS does present analysis to satisfy this requirement and it is recommended that an assessment of the expected or predicted effectiveness of each mitigation measure identified is provided.

Ground based operations noise

The restriction on the amount of high power running at night time is stated to substantially reduce the impact of ground running noise. As this assumption has been included the noise predictions, night-time engine ground run-up should be conditioned appropriately as part of the project approval.

Engine run-up noise mitigation measures are identified, including the construction of buildings, mounds or barriers near the run-up area to provide greater acoustic screening, and the possibility of relocating the run up area further to the south-east to reduce the noise impact on Luddenham. The quantifiable benefits to the closest noise sensitive receptors from the adoption of such measures should be defined, in terms of resultant noise levels and the residual exceedance of the criteria. The use of such measures should be included in the project approval for appropriate periods.

The assessment states that there is *“little that could be done to reduce noise levels emanating from the airport as a result of taxiing”*. However, there are a number of potential mitigation measures that could be considered, including single engine taxiing, engine off taxiing (EOT) and the installation of acoustic barriers at effective locations. It is therefore recommended that consideration should be given to these mitigation measures in a revised assessment. In addition, the unmitigated noise impact from taxiing and the residual noise impact following potential mitigation measures should be presented. The measures identified to be reasonable and feasible should be included in the project approval.

The assessment has assumed that APUs will not be used, and that instead ground power and pre-conditioned air will be available at all gates. However, ground power could be supplied either by fixed electrical ground power (FEGP), or by Ground Power Units (GPUs). GPUs could have the potential to cause noise impacts and should be assessed accordingly. An approval condition should be included that restricts the use of APUs, and the type of ground power to be employed on site.

The use of ground power and pre-conditioned air are not included in Table 11-13 of Chapter 11, which sets out the mitigation and management measures, nor is any mention of the restriction over APU usage.

Construction noise and vibration

The report identifies the need for a Construction Noise & Vibration Management Plan. This should be conditioned appropriately as part of a project approval.

2.2.8 Cumulative assessment

Cumulative noise impact from engine run-ups and taxiing have not been considered, and no assessment has been included for airside service vehicles, sirens, noise from fixed plant associated with the airport buildings or use of the compass calibration pad. As a minimum, consideration should be given to the cumulative noise impact from all ground noise sources at nearest noise sensitive receptors with and without mitigation measures.

The cumulative noise assessment is not consistent with the requirements of the EIS Guidelines as it does not include an assessment of cumulative noise impacts associated with the operation of the M12 motorway or realignment of The Northern Road, which are being developed to accommodate the airport. These planned road projects have the potential to significantly increase noise levels in the area surrounding the airport and should therefore be considered as part of a cumulative assessment.

2.2.9 Conclusions

Chapter 21 Table 29-1 provides a summary of the key environmental impacts. The “Noise – ground operations, construction and road traffic” section of the table does not provide an indication of the magnitude of significance of the noise sources stated, and whether mitigation measures are included. There is also no evaluation of the acceptability of the noise impacts. The table should be updated to include this detail.

The conclusions of the draft EIS that there are no significant operational traffic noise impacts is misleading, as it does not acknowledge the limitations of the assessment, which excludes the development of the M12 motorway and substantial realignment of The Northern Road to accommodate the airport. The statements relating to operational traffic noise should be updated to acknowledge the limitations of the road traffic noise assessment.

3 Detailed findings - long term development

3.1 Summary

The assessment is considered to contain an appropriate level of detail for the long term development as the potential noise impacts are predicted for a considerable time in the future (into 2063). It is acknowledged that the noise environment may change over time. The identified issues are summarised as follows:

- The comments raised in this review for the 1st stage airport assessment should be addressed and applied to the long term development assessment. Where this occurs, the current framework for further assessment of the long term development is considered appropriate.
- The draft EIS does not include ground-based noise in the summary or conclusion for the long term development. It is recommended that the outcomes of the revised long-term development ground-based noise assessment are included in these sections so that all impacts are clearly presented.
- The assessment does provide comment on the potential noise impacts from the long-term development of the airport. The trip generation of the fully developed airport is predicted to be over 300,000 vehicles per day and no comment has been made on potential noise impacts on the surrounding existing road network, including the M7 and The Northern Road.

3.2 Detailed findings

3.2.1 Modelling

Engine ground run-up noise in 2063 has been modelled at the location indicated in Figure 3-4 of Appendix E2, shown below in Figure 3-1. Figure 3-5 of Appendix E2 shows the noise propagation from this source but does not have the same level of acoustic screening afforded by nearby buildings as that shown in Figure 3-2 of Appendix E2, which is the corresponding noise contour plot for the single runway scenario. These two figures are compared in Figure 3-2 below). There is therefore uncertainty regarding the level of screening from buildings.

Clarification is also required regarding the assumption that, in the event of a two runway airport, there would continue to only be one ground run-up area.

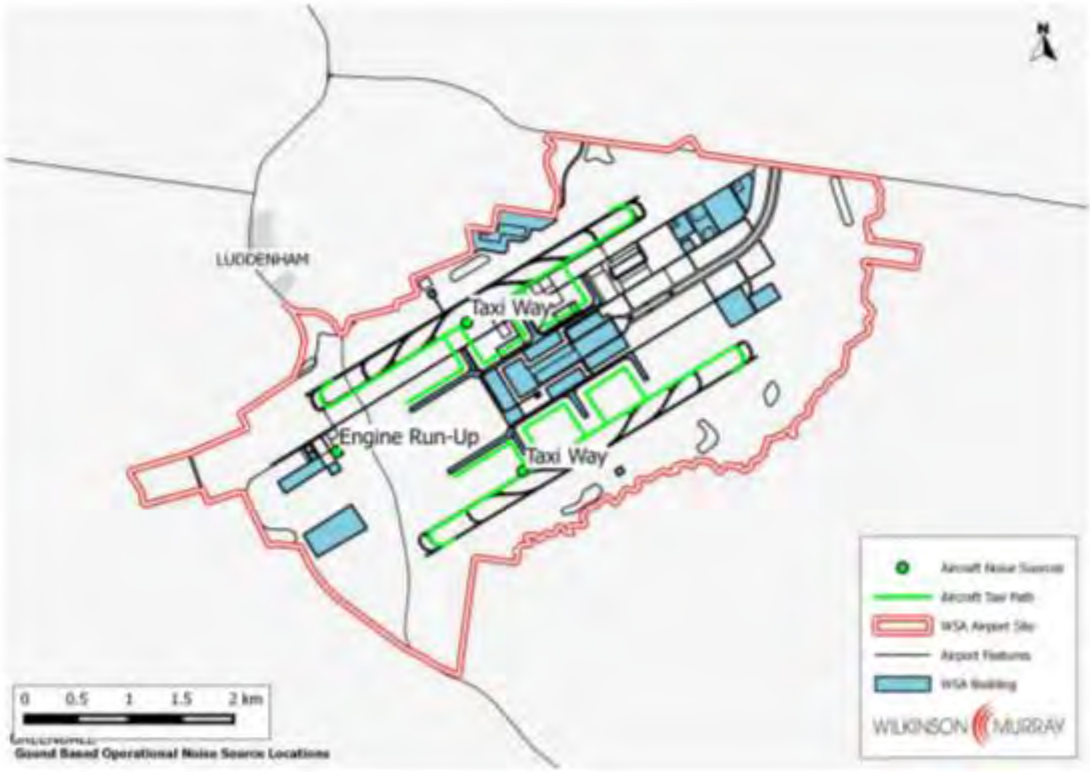

Figure 3-1 - Ground-based operational noise source locations, 2063 (reproduced from Appendix E2 Figure 3-4)

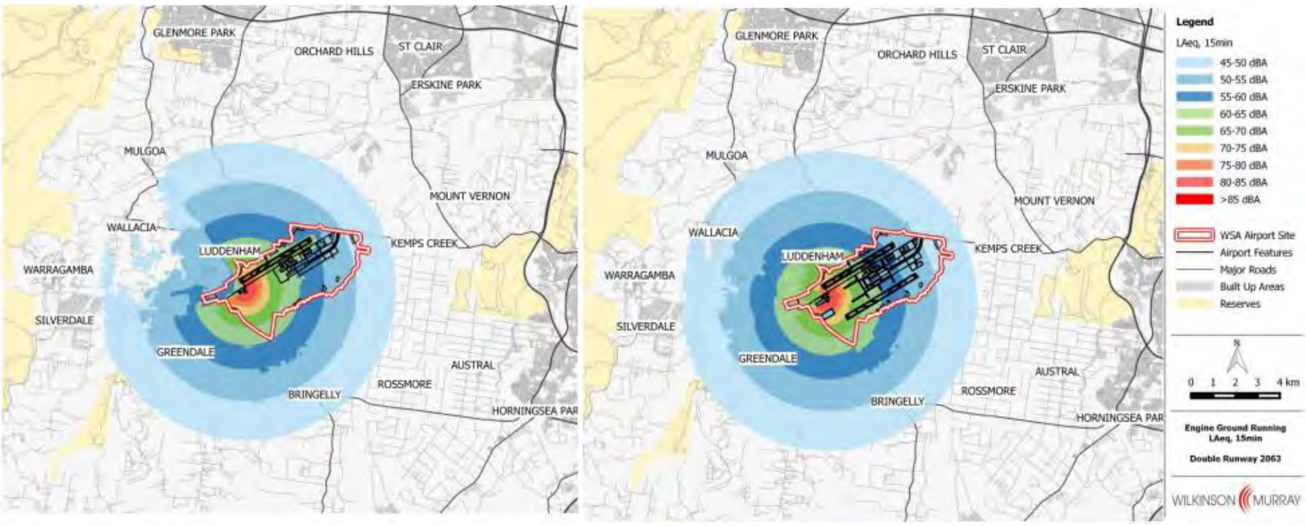

Figure 3-2 - Comparison between worst-case $L_{Aeq,15min}$ engine ground running noise contours for 2030 (single runway, left) and 2063 (two runway, right)

Figure 3-4 of Appendix E2 does not accurately represent Figure 5-3 of the draft EIS Volume 1 (p143) document which shows the indicative airport site layout – long term development. The two figures are compared in Figure 3-3 below. In particular, there are additional areas within that layout where aircraft would be taxiing that have not been included in the noise model. The model only accounts for the usage of 63 out of 95 aircraft gates. It is recommended that the model is updated to include the additional areas where aircraft will be taxiing. It is anticipated that there will be an increase of approximately 1 dB in including these additional areas.

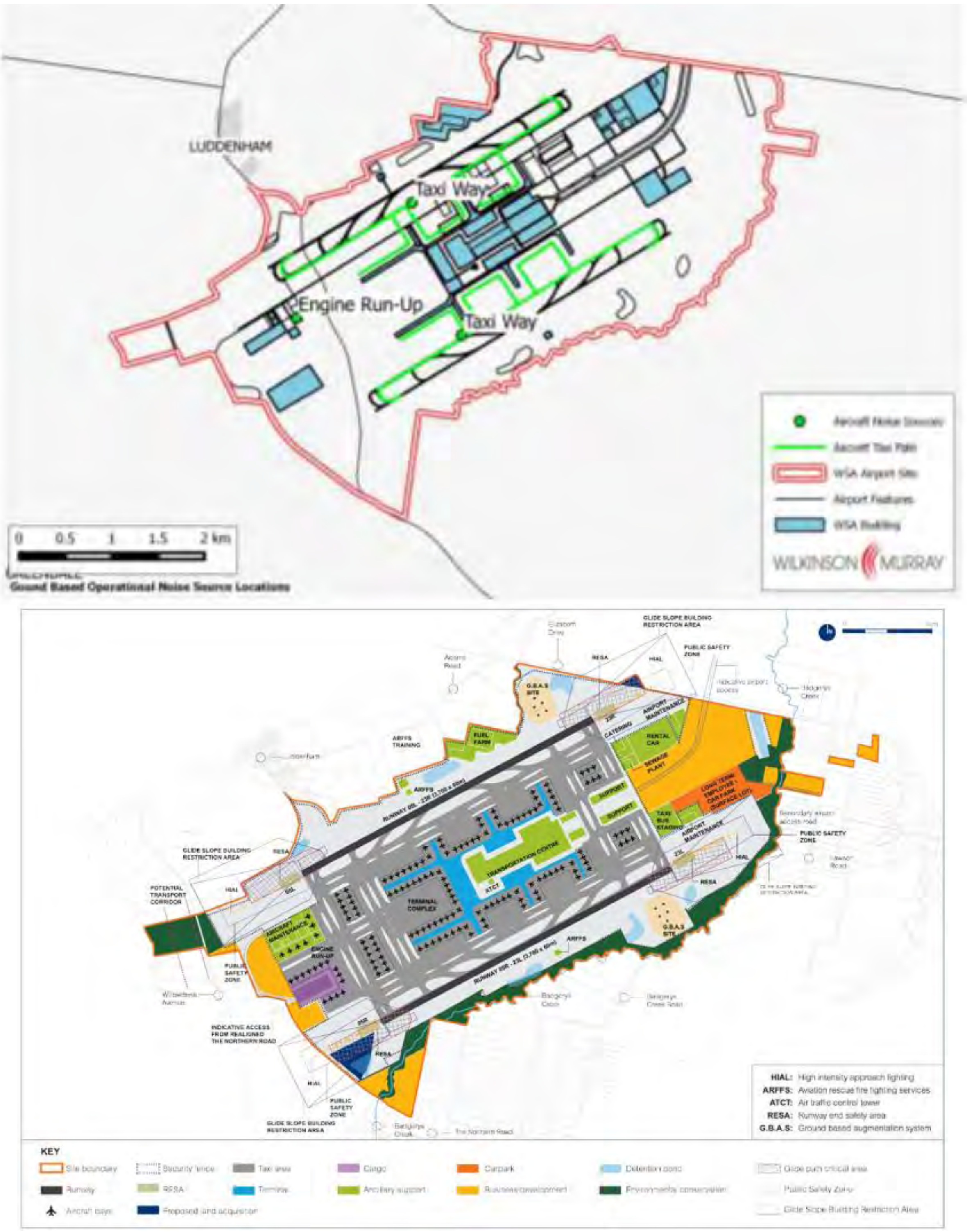

Figure 3-3 - Comparison between modelled noise sources in 2063 (Appendix E2 Figure 3-4, top image) and indicative airport site layout in 2063 (Volume 1 Chapter 5 Figure 5-3, bottom image)

3.2.2 Assessment

The 2063 aircraft taxiing noise contours shown in Volume 3 Chapter 31 Figure 31-39 show the increased number of aircraft movements and extend further south as a result of the commissioning of the second runway. The aircraft noise section (Volume 3 Chapter 31, Sections 31.2 to 31.4, Tables 31-7 to 31-9) has identified the population numbers affected by aircraft noise, however this information is not presented for ground noise.

There is no indication of the level of exceedance for nearest noise sensitive receptors in order to determine the magnitude of the impact. It is recommended that population number affected by ground noise is included, in 5 dB bands, in order to determine the magnitude of the potential noise impact.

The assessment does not comment on the potential road traffic noise impacts as a result of the long term development. The traffic and transport assessment (draft EIS Appendix J) includes predictions that indicate more than 300,000 additional trips would be generated by the development of the airport by 2063. This volume of traffic is more than the typical volumes currently carried by some motorways in Sydney. As a result it is recommended that comment is made to identify the potentially affected roads and noise impacts as a result of such traffic generation.

3.2.3 Conclusions

There is no reference to ground noise in the summary of findings or the Conclusion and Recommendation chapter (Chapter 40) of Volume 3. Ground noise impacts may therefore not be considered by decision makers. A summary of the ground noise impact assessment should be included in this chapter.

4 Key impacts and opportunities

Below is a summary of the key impacts and opportunities that have been identified as a result of the review.

- There is insufficient detail surrounding the selection of source noise data. Changes to the source noise data could potentially lead to a significantly different outcome.
- The draft EIS does not satisfy the EIS Guideline requirements to identify the type and magnitude of impact, both pre-mitigation and post-mitigation.
- The exclusion of Auxiliary Power Unit (APU) usage at the airport and uncertainty surrounding the method of alternative ground power could potentially adversely affect the outcome of the assessment.
- A single noise level has been used for existing noise levels at all receptors, rather than several location-specific values. This generalisation has underestimated the magnitude of noise impacts at receptors close to the airport that are currently exposed to low levels of environmental noise.
- No consideration has been given to the cumulative noise impact from all ground noise sources at nearest noise sensitive receptors with and without mitigation measures. Further consideration should also be given to noise from other ground noise sources, such as the compass calibration pad.
- Several mitigation measures have been put forward, including the restriction of APUs and the limitation of engine ground run-ups during the night. These measures should be included as part of any approval conditions.
- Sufficient analysis of feasible and reasonable mitigation measures to reduce taxiing noise has not been included. Several mitigation options exists which are not discussed in the assessment. It is recommended that further analysis is conducted for these measures.
- Semi-enclosed pens and bunded areas to reduce noise impacts from engine ground run-up noise are considered in the assessment. It is recommended that these measures are considered further as part of the approvals and subsequent design stages.
- Nearest noise sensitive receptors such as residences in Luddenham have not been included in the baseline noise monitoring. It is recommended further noise monitoring is undertaken in this area.
- The findings of the long term development ground noise impact assessment are not included in the draft EIS chapter summary or the conclusion chapter. A summary of the ground noise impact assessment should be included in these areas.
- The potential cumulative impact of the M12 motorway and realignment of the Northern Road which are being developed to accommodate the airport should be considered in the assessment.
- No comment is made on the long term developments potential noise impacts from significant traffic generation from the airport. It is recommended that this is included in the assessment.

The above issues currently indicate a high level of uncertainty over the accuracy and extent of the noise impact from ground noise currently. In particular, from ground noise related operations at the airport. It is recommended that each point above be considered and addressed in subsequent assessment of ground noise for the airport.

5 Qualifications of the study team

5.1 Project manager

Alex Campbell, Asia-Pacific Acoustics Manager

MEng, MAAS, MIOA, C.Eng

12 Years' Experience

Alex leads the WSP | Parsons Brinckerhoff acoustics team in the Asia-Pacific region. He has over 12 years industry experience, the last 9 years of which have been with WSP Acoustics - who are one of the world's largest globally connected acoustic specialist teams employing 150 engineers worldwide.

He has seen the successful completion of projects in a wide range of sectors, and has managed and been technically involved with projects including Review of Environmental Factors (REF) and Environmental Impact Statement (EIS) Noise & Vibration assessments throughout Australia. In addition to this, Alex has significant experience in delivering major international projects on-time and on-budget for both government and private sector clients.

5.2 Supporting technical team

Mike Barrett, Principal Acoustic Consultant

BSc(hons), MIOA

10 Years' Experience

Mike has worked on projects associated with many of the UK's largest airports, including Heathrow, Gatwick, Stansted, Manchester, London City and Luton Airports – many of which have been in the capacity of peer reviewer.

Mike is a Principal Acoustic Consultant for WSP | Parsons Brinckerhoff, and has 10 years' experience in the modelling, monitoring and assessment of noise and vibration. He has been involved with a wide range of environmental, architectural and building services projects, and regularly provides specialist advice to developers, architects, industry and local authorities.

During his time in consultancy experience has been gained across a number of different sectors including aviation, surface transport, residential, industrial, commercial, leisure and retail, and he presently sits on the Institute of Acoustics UK North West Branch Committee.

Adrian White, Associate Acoustic Consultant

BSc, MAAS

8 Years' Experience

Adrian has worked on major EIS projects throughout Australia. He has over eight years of experience working as a professional and acoustic consultant in Australia with internationally recognised noise and vibration consultancies. Adrian specialises in acoustics with niche expertise in a variety of areas such as environmental and industrial acoustics, architectural acoustics and transportation noise and vibration.

Chris Marsh, Senior Acoustic Consultant

MEng, MAAS, AMIMechE

5 Years' Experience

Chris is a senior acoustics engineer at WSP | Parsons Brinckerhoff experienced in environmental acoustics and monitoring projects. He has over five years' experience in the assessment, monitoring and management of environmental noise and has been involved in a number of major projects across transportation, industrial and resource sectors.

Appendix A Document review

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
Appendix E2 – Airport ground-based noise and vibration				
1.3 / p5 para 1	"*The use of auxiliary power units (APUs) on aircraft has not been assessed because it is assumed that power and pre-conditioned air would generally be supplied to aircraft at the terminal gates.*"	There is no mention of the use of APUs in the Airport Plan. The potential effect of using APUs has not been covered, nor has it been expressly stated that they would not be used.	Clarification should be sought as to whether APUs will be used. Assessment of the noise impact of APU usage, should such usage be an option.	Medium
2 / p6	A description of the baseline noise survey that has informed the setting of noise limits	There is insufficient detail contained within the section to determine the specific noise monitoring locations. For example, it is unclear as to whether noise measurements were taken in free-field conditions, and what height above ground the microphone was positioned at. Crucially, it does not include a description of the exact measurement location to be able to determine whether microphones had direct line of sight to dominant noise sources such as main roads, or whether they were placed in rear gardens. There is a risk that existing noise levels have been overestimated if they have not been placed on quietest facades of residential receptors.	Clarification on exact noise measurement locations.	Low
2 / p6 para 2	"*The locations were also chosen to represent potentially-affected development in the surrounding area.*"	From a review of available aerial mapping, it is evident that there are closer noise sensitive receptors in the area than those selected for noise monitoring. There is a concern that the potential impacts on the most affected noise sensitive receptors have not been accurately quantified. Properties in Luddenham to the north west of the Site are particularly close yet there has been no noise monitoring undertaken in this area	Further consideration should be given to quantifying the existing noise environment for properties closest to the airport, particularly Luddenham.	Low

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
3.1 / p9, para 5, Table 3-1	"*In the area surrounding the airport, the intrusiveness criterion is the more stringent at all locations.*"	There is no evidence base for the conclusion that is drawn regarding the appropriate criteria set to be used. This could potentially underplay the extent of the noise impacts. Based on the rural nature of the surrounding area, Table 2.1 of the INP recommends a noise level of 40 dB L_{Aeq} at night as "acceptable". It is clear that this is lower than some tabulated night-time values in Table 3-1, albeit they are $L_{Aeq,15min}$ (corrected).	Evidence to demonstrate that the intrusiveness criterion is the more stringent at all locations.	Low
3.1 / p10, para 2, Table 3-1	*"So that the noise contours included below in this report can be readily interpreted, it is preferable to adopt one criterion for all residences an overall noise criterion of 40 dBA can be taken as generally appropriate for residential locations at night."*	The approach of selecting one criterion undermines the results of the noise monitoring at multiple locations. It is clear that noise criteria at five of the ten locations are lower than 40 dBA, and are as low as 35 dBA, which is 5 dB lower than the adopted criterion. Noise impacts at certain locations have been incorrectly identified.	Request reassessment for each measurement location using the appropriate criterion for that receptor, as set out in Table 3-1	Medium
3.1 / p10, para 2	*"By the time the proposed airport becomes operational, background noise levels in the general area are expected to have increased as a result of increased road traffic and associated development in the surrounding area. This would particularly be so for the lower background noise levels and would in turn raise the value of the appropriate noise criteria for the assessment of airport operational noise."*	The argument made in the paragraph is in reference to selecting an overall noise criterion of 40 dBA, which would be up to 5 dB higher than the locations-specific criteria set out in Table 3-1. However, an increase of 5 dB would be, in simple terms, equivalent to more than three times the amount of sound energy incident at the measurement location. Therefore, for road traffic to have this impact, there would need to be more than three times the amount of traffic that is currently on the road network, assuming no changes to the current road network.	None, comment for information only.	Noted for information

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
3.1 / **p11, Table 3-2**	Table setting out "*noise criteria for other receiver types*", referring to those other than residential receivers. Values contained within the table are recommended maximum L_{Aeq} Noise Criteria.	Section 2.2 of the INP states the following: *"To limit continuing increases in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.1. Meeting the acceptable noise levels in Table 2.1will protect against noise impacts such as speech interference, community annoyance and, to some extent, sleep disturbance. These levels represent current best practice for assessing industrial noise sources, based on research and a review of assessment practices used overseas and within Australia.* *Table 2.1 also includes recommended maximum noise levels for different land uses. These recommended maximum values provide guidance on an upper limit to the level of noise from industry.* ***In all cases it is expected that all feasible and reasonable mitigation measures would be applied before the recommended maximum noise levels are referenced****."*	The "Acceptable" noise levels stated in Table 2.1 of the INP should be used in the first instance, rather than "Recommended Maximum", which would in turn mean the criteria adopted would be 5 dB lower than used in the assessment.	Medium
3.2 / **p11, para 3**	*"For modelling purposes it has been assumed that high power run up would occur for less than 5 minutes in any night. Therefore, the night time residential criterion for this activity has been set using the industrial noise criterion as 5 dB over the general INP night time criterion for residential receivers; that is 45 dBA, in accordance with the INP duration adjustment."*	INP Section 4.2 states that the acceptable noise level may be increased by the adjustment shown in Table 4.2 of the INP, and that the adjustment is designed to account for unusual and one-off events, and does not apply to regular high-noise levels that occur more frequently than once per day. Should there be more than one high power run-up in one night, it would be inappropriate to apply this correction, and given that this is a realistic scenario, there is a concern that the criterion set is inappropriate.	Evidence to show the likelihood of high power ground run-ups in a given night-time period. Reassessment, where appropriate, of impact of high power ground running.	High
3.2 / **p11, para 4**	*"Like other major airports in Australia, the proposed airport is expected to have restrictions in place on engine ground runs, including limitations on night time run up activity."*	Assumption on future controls.	None, comment for information only. Consideration to condition.	Noted for information

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
3.5.1 / **p13, para 2, Figure 3-1, Figure 3-2**	*"It has been assumed that aircraft ground runs would occur at the location shown in Figure 3-1."*	It is acknowledged that the assumed location for run-ups is defined in Figure 3-1, however there is a concern that, at this stage, the indicative building location near the position is not finalised nor is fixed within the planning application. It is evident from Figure 3-2 that communities to the west and north west of the Site benefit from the screening afforded by this building. Should the building or run-up area move, it is likely that it could significantly affect the resulting noise impact from the Site.	Given the indicative layout, and the level of assumed acoustic benefit provided, it is considered appropriate to assess a scenario where the building does not provide any acoustic benefit, to take into account that final locations are not fixed and may change.	High
3.5.1 / **p13, para 2,**	On the subject of source noise levels for aircraft engine ground running *"… a level of 151 dBA has been assumed, based on measurements of aircraft taking off."*	There is no indication of which aircraft this refers to, or the range of typical levels that might be expected. It is assumed that this level is an effective A weighted Sound Power Level (L_{WA}), however it is not explicitly stated. It would be expected that, given the potentially critical nature of the noise impact in the progression of the scheme, it would be appropriate to provide more information regarding the adopted source noise level.	More information is required regarding the range of values expected from engine run-ups given the anticipated fleet of aircraft for the airport, and more information regarding which aircraft the 151 dBA refers to.	Medium
3.5.2 / **p13, para 5**	*"A sound power level (noise level at source) for each aircraft of 138 dBA has been assumed. This is the highest level measured for aircraft taxiing, based on measurements of a B777, B747, B737, B717 and A330 aircraft."*	Typically, turboprops emit higher noise levels than jet aircraft whilst taxiing. It is anticipated that there will be a very low number of turboprops in service at the airport. It is unclear how this sound power level has been calculated. Taxiing is in essence a moving point source. Depending on how the source has been modelled, this may not be the appropriate sound power level to use. It is also unclear whether measured taxiing was under two engine conditions, one engine conditions or engine off taxiing (EOT).	Confirmation of the method used to determine the sound power level for the line source that has been used, and confirmation that measurements were undertaken to determine this. It would be useful to have the data presented in a table within the report.	Medium

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
3.6 / p15, Table 3-4	Table 3-4 shows population affected above criterion.	There may be implications to this table as a result of the above issues. It would also be helpful to understand how many receptors will be exposed to 5 dB above criterion, 10 dB above criterion etc.	Update table based on the outcome of the above recommendations. It is likely that the population numbers will increase. Provide number of people exposed to 5 dB above criterion, 10 dB above criterion etc.	Noted for information
3.6 / p16, Table 3-5	Table 3-5 shows other buildings and land uses affected above criterion.	There may be implications to this table as a result of the above issues. It would be helpful if the actual noise levels anticipated at these buildings/areas are presented, given the small number of them, so that the magnitude of the exceedance can be understood.	Update table based on the outcome of the above recommendations. It is likely that the population numbers will increase. Provide noise levels anticipated at each receptor.	Noted for information
3.6 / p16, para 2	The text refers to the use of reverse thrust at night.	It is assumed that reverse thrust at night has been included in the aircraft noise assessment.	Consider removing reference	Noted for information
3.7 / p17, para 2, Figure 3-4, Figure 3-5	*"Ground-based noise levels have been predicted for the longer term airport development using the same methods as for the initial airport development. The noise source locations are shown in Figure 3-4 and the resulting contours are shown in Figure 3-5 and Figure 3-6."*	The text infers that, even with two runways and a significant increase in aircraft movements as a result, there would still be only one engine run-up for less than 5 minutes in any 15 minute period. This single point source of noise has been modelled as indicated in Figure 3-4, however Figure 3-5 (which shows the noise propagation) does not appear to have the same level of acoustic screening from nearby buildings as the similar situation in Figure 3-2, which suggests that either Figure 3-2 overestimates the level of acoustic screened afforded by buildings, or Figure 3-5 underestimates this.	Clarification that, in the event of a two runway airport, there would continue to only be one ground run-up area. Confirmation that the acoustic screening from buildings has been correctly accounted for in both Figure 3-2 and Figure 3-5	Medium
3.7 / Figure 3-4	The figure shows ground-based operational noise source locations in 2063	The figure does not accurately represent Figure 5-3 of the EIS Volume 1 (p143) document which shows the indicative airport site layout – long term development. In particular, there are additional areas within that layout where aircraft would be taxiing that have not been included in the noise model. The model roughly only accounts for the usage of 63 out of 95 aircraft gates.	It is recommended that the model be updated to include the additional areas where aircraft will be taxiing.	Low

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
3.8 / p19, para 3	*"High power running at night time should be restricted to special circumstances where high power testing is required after maintenance activity prior to an aircraft taking off […] Restricting the amount of high power running at night time would substantially reduce the impact of ground running noise."*	The paragraph refers to mitigation measures, however this has already been factored in to the original noise assessment. It is therefore important that this mitigation measure is carried through to operation.	Condition night-time engine ground run-up appropriately.	Noted for information
3.8 / p19, para 3	*"It may also be practical to construct buildings, mounds or barriers near the run-up area to provide greater noise shielding, particularly on the northern side to shield the closest area of Luddenham. It is possible that reductions of around 10 dBA could be achieved with mounds or buildings at least 10 m high, but moderate residual impacts would still occur under worst-case meteorological conditions. There may also be a benefit in relocating the run up area further to the south-east to reduce the noise impact on Luddenham, but practical operational issues would need to be considered for this."*	It is unclear within the report what the quantifiable benefits to the closest noise sensitive receptors would be from moving the run-up area and installing run-up pens or barriers, in terms of resultant noise levels and the residual exceedance of the established criteria. It is unclear as to whether the impact during the day would be acceptable.	Given that moderate residual impacts are predicted with run-up pens, it is recommended that consideration be given to a more thorough assessment of the acoustic benefits of including such an area, and that its use should be conditioned during appropriate periods. Confirmation of the level of impact during the day.	Noted for information
3.8 / p19, para 4	*"Aircraft taxiing noise would be relatively low in comparison to other noise associated with operation of the airport. There would be little that could be done to reduce noise levels emanating from the airport as a result of taxiing."*	The statements made do not appear to be accurate. On inspection of the noise contours, particularly for the long term scenario, noise from taxiing is on a similar scale to noise from engine run-ups. There are a number of potential mitigation measures that could be considered, including single engine taxiing, engine off taxiing (EOT), the installation of acoustic barriers at effective locations	Consideration to the unmitigated noise impact from taxiing and the residual noise impact following possible mitigation measures, which could be conditioned.	High
3.8 / p20, para 2	*"The proposed use of ground power and pre-conditioned air for aircraft at the gates avoids the use of aircraft auxiliary power units and the associated noise."*	The assessment has assumed no use of auxiliary power units (APUs). The report assumes that ground power and pre-conditioned air will be available at all gates. However, ground power could be supplied either by fixed electrical ground power (FEGP), or by Ground Power Units (GPUs). Should the latter be used, it would be expected that they could have the potential to cause a noise impact and should be assessed accordingly.	Recommend that a condition is included that restricts the use of APUs. Clarify the type of ground power to be used. If GPUs are to be used, assess their noise impact.	Medium

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
3 / General	There is no consideration given to the cumulative noise impact from engine run-ups and taxiing, and no assessment has been included for airside service vehicles, sirens, noise from fixed plant associated with the airport buildings or use of the compass calibration pad.	As a minimum, it would be expected that some consideration would be given to the cumulative noise impact from all ground noise sources at nearest noise sensitive receptors with and without mitigation measures.	Recommend a cumulative ground noise assessment is included, and further consideration be given to noise from other ground noise sources.	Medium
4.1.1 / P21, para 4	Various construction noise criteria are discussed.	It is unclear as to whether the criteria is based on the NSW Interim Construction Noise Guideline (ICNG) or the Airports (Environment Protection) Regulations 1997. Usual hours of construction are proposed from 6.00 am, which is classed as night-time. Therefore, it is particularly important that the appropriate criterion is used for night-time work as this will be the norm. In addition where the ICNG is used, the guidelines states that strong justification should be provided for works that occur outside of standard hours.	Clarification of the appropriate criteria set to be used for this assessment for daytime and night-time.	Medium
4.1.1 / P21, para 5	*"Based on the daytime background noise levels shown in Table 2-1, the daytime residential NML would be between 39 dBA and 49 dBA for standard hours. For assessment of construction noise, a NML of 45 dBA may reasonably be adopted for all residential receivers, for week-day construction. Equally, for weekend works and early morning works, an NML of 40 dBA may be adopted."*	The report identifies that, for some receptors, the NML should be 39 dBA, however 45 dBA (weekday) and 40 dBA (weekend and early morning works) have been adopted as the criteria set. This potentially underplays the noise impacts from construction by up to 6 dB.	Reassess based on the different measurement locations adopted in the assessment in order to more accurately quantify the potential noise impacts.	Low
4.4 / P29, para 4	*"It is proposed that these strategies be applied to areas of exceedance identified in the preceding section. The contractors responsible for the construction works should implement a Construction Noise & Vibration Management Plan. The Plan should provide for ongoing communication with potentially-affected residents and establish a complaint management and response system."*	The report identifies the need for a Construction Noise & Vibration Management Plan.	Recommend that this be included as a planning condition.	Noted for information

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
4.6 / P31, para 1	*"All construction traffic is expected to travel to the site via Elizabeth Drive."*	No assessment has been made for construction vehicles on roads accessing Elizabeth Drive for example The Northern Road, Luddenham Road, Mamre Road etc. No justification for excluding these roads is provided. In addition, Section 6.2.4 of the EIS indicates that for site establishment works, additional site accesses would be utilised on roads other than Elizabeth Drive.	Additional assessment of construction vehicles accessing Elizabeth Drive and other site accesses should be included.	Medium
4.6 / Table 4-7	Results table presents predicted increases in noise level for three sections of Elizabeth Drive.	The construction traffic assessment only considers three sections of Elizabeth Drive, whereas the Operational traffic assessment considers five sections which include additional sections: West of Badgerys Creek and West of Luddenham Road. No assessment has been provided for these sections in the construction traffic assessment	Justification should be provided for why there are inconsistencies between the operational and construction traffic assessment.	Medium
4.6 / p31, para 3	*Using the traffic noise criterion discussed in Section 5.2 below, it is concluded that this level of noise change resulting from the proposed construction works would not represent a perceptible noise increase.*	As calculation details are not available for review, the results are not able to be verified. However, for the results presented in the report, this conclusion is considered acceptable.	None	For information only
5 / P32	-	The assessment acknowledges the future development of the M12 motorway, however does not specifically mention the planned realignment of The Northern Road to accommodate the airport.	The Northern Road realignment is acknowledged and considered in the report.	For information only
5 / P32	*"Future road works would be the subject of separate approval processes by the relevant authorities undertaking these actions and the assessment of these is not covered in this document. However, a preliminary assessment of the general impact of the expected change in road traffic associated with operation of the proposed airport has been undertaken."*	Whilst it is understood that details may not be available for the M12 or Northern Road realignment projects and they are subject to a separate approvals process, the report does not provide "a preliminary assessment of the general impact" as it subsequently excludes the potential impacts from these roads.	A statement in the report should be included to acknowledge the limitations of the assessment that only considers existing roads and acknowledges that whilst it does not consider impacts from new motorways or realigned arterial roads, additional impacts as a result of the airport may occur from these roads.	Major

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
5.1 / **p32, para 1 and 2**	*Reference has been made to the NSW Road Noise Policy (RNP) to assess the effect of the proposed airport on road traffic noise in the area. The RNP recommends noise assessment criteria for residential and non-residential land uses affected by traffic generating developments. These criteria are more relevant to the assessment of new road infrastructure works, and they do not assist greatly in determining the impact of road traffic noise increases on existing roads due to the proposed airport and associated development.* *In Section 3.4, the RNP document indicates that …. "an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person". It is this statement which is useful in assessing the significance of traffic noise level increases due to the proposed airport development.*	The RNP provides specific guidance for land uses affected by additional traffic on existing roads generated by land use developments in Step 4 of Section 3.4.1. The guidance was clarified in the RNP Application Notes (EPA, 2013) as follows: *"The second paragraph in Step 4 should therefore be read to mean: 'After taking Steps 1 to 3, for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dB above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion."*	The report should be amended to include the appropriate RNP assessment criteria.	For information only
5.2 / **p32, para 1**	*"Road traffic projections for major roads in the vicinity of the airport have been provided by traffic planners for the year 2030 (GHD 2015a (R9)) with and without the airport."*	The suggested approach in Section 2.5.3 of the RNP is to assess a project at the year of opening and a design year, typically ten years after opening. The intention of the design year is provide an indication of road traffic noise impacts in the longer term when the project is established. The project opening year for the airport is stated to be around 2025 in the EIS.	The road traffic assessment should consider the project's impacts at the opening year and at a design to assess potential long term impacts, or else provide justification for an alternative approach.	Medium
5.2 / **p32, para 1**	*Noise levels at typical distances from these roads have been calculated using the CoRTN (R7) procedure which has allowed the increase in road traffic noise due to the proposed airport development to be forecast.*	The typical offset distance is not stated.	The typical offset distances for each road should be stated	For information only
5.2 / **P 33 Table 5-1**	*"The highest noise level increase expected is less than 2 dB and accordingly, it is concluded that there would not likely be a perceptible noise increase resulting from road traffic as a result of the proposed airport development."*	The traffic volumes used to generate these results are not presented in the report and therefore the results are not able to be verified. However, for the results presented in the report, this conclusion is considered acceptable.	None	For information only

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
6 / P34	Conclusions section	This section may require updating based on the resolution of the previously stated issues.	Update where appropriate based on the outcome of the considerations above	Noted for information
6 / p35, para 9	*"Although heavy and light vehicles would need to access the proposed airport during the construction stage, the resulting increase in traffic noise would not be significant."*	Insufficient evidence presented in the assessment to support this conclusion, as vehicles accessing Elizabeth Drive on surrounding roads were not included in the assessment.	Additional assessment of roads that link to Elizabeth Drive	Medium
6 / p35, para 10	*"During operation of the proposed airport, road traffic noise level increases in the surrounding area are predicted to be insignificant. This is without considering the impact of the newly proposed M12 motorway and any road realignments which would be subject to separate applications and approvals by the relevant authorities."*	This statement acknowledges the limitations of the assessment. The main body of the EIS does not includes the same statement of limitations.	The limitations of the assessment should be reflected in statements throughout the EIS.	High
6 / p35, para 10	*"During operation of the proposed airport, road traffic noise level increases in the surrounding area are predicted to be insignificant. This is without considering the impact of the newly proposed M12 motorway and any road realignments which would be subject to separate applications and approvals by the relevant authorities."*	Section 5(b) of the EIS Guidelines state: *"The EIS should identify and address cumulative impacts, where potential project impacts are in addition to existing impacts of other activities (including known potential future expansions or developments by the proponent and other proponents in the region and vicinity)."*	Impacts of the associated new motorway and road redevelopments/realignments should be considered as part of a cumulative impact assessment in accordance with 5(b) of the EIS Guidelines.	High
Volume 2 – Chapter 9. Approach to impact assessment				

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
9.3.2, p6, Table 9-2	Table presents EIS Guideline requirements and indicates where in the EIS they are addressed. Under "Section 5 – Relevant Impacts" it states the following requirements:- *"a detailed assessment of the nature and extent of the likely short-term and long-term relevant impacts (detailing direct and indirect impacts);* *a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible;* *analysis of the significance of the relevant impacts; and* *any technical data and other information used or needed to make a detailed assessment of the relevant impacts."*	These guidelines have not been followed adequately within Chapter 11.	Update Chapter 11 to include clear statements on whether impacts are short term, long term, direct, indirect, unknown, predictable or irreversible, and the significance of the impacts.	Noted for information
9.3.2, p11, Table 9-2	Table presents EIS Guideline requirements and indicates where in the EIS they are addressed. Under "Section 6 – Avoidance and mitigation measures" it states that the EIS must include an assessment of the expected or predicted effectiveness of mitigation measures.	These guidelines have not been followed clearly within Chapter 11.	Update Chapter 11 to provide a clearer assessment of the expected / predicted effectiveness of mitigation measures.	Noted for information
9.3.2, p11, Table 9-2	Table presents EIS Guideline requirements and indicates where in the EIS they are addressed. Under "Section 7 – Residual impacts and offsets" it states that the EIS must include the reasons why avoidance or mitigation of impacts may not reasonably be achieved, and quantification of the extent and scope of significant residual impacts.	These guidelines have not been followed adequately within Chapter 11.	Update Chapter 11 to include clear statements on whether residual impacts are short term, long term, direct, indirect, unknown, predictable or irreversible, and the significance of the residual impacts. Include the reasons why avoidance or mitigation of impacts may not reasonably be achieved, where necessary.	Noted for information

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
9.3.2, p13, Table 9-2	Table presents EIS Guideline requirements and indicates where in the EIS they are addressed. Under "Section 11 – Information sources" it states that, for information given in the EIS, the EIS must state (amongst other points) the source of the information, how recent the information is, and how reliable the information is.	These guidelines have not been followed adequately within Chapter 11.	Update Chapter 11 to include this information – specifically regarding the source noise data used as a basis for the engine ground running noise assessment and the aircraft taxiing noise assessment.	Noted for information
Volume 2 – Chapter 11. Noise (ground operations, construction, road and rail)				
Summary, p75	*"Under worst case meteorological conditions, noise associated with engine run-up has the potential to affect Luddenham, Badgerys Creek, Bringelly and Greendale."*	Appendix E2 states that this noise also has the potential to affect Wallacia. This location has not been brought through from the technical appendix.	Update summary to include Wallacia	Noted for information
Summary, p75	*"During operation of the proposed airport, increased noise levels due to airport generated road traffic in the surrounding area are not expected to be significant."*	This statement is misleading as it implies that development of the airport will not result in increases in road traffic noise in the project area. However, a new motorway (M12) is being built to service the airport. Whilst the assessment of the new road would be assessed and approved under a different approvals process, the impact of a new motorway would likely increase noise levels in the surrounding area as a direct result of airport generated traffic. The summary also does not include the limitations stated in Appendix E2 which acknowledges that the M12 and other road realignments have not been considered in the assessment.	Revision of statements for operational road traffic noise to include limitations and acknowledging that operation of the M12 and realignment of The Northern Road are not included in the impact assessment.	High
11.2.2, p76-77	*"A sound power level for each aircraft of 138 dBA has been assumed, being the highest level measured for aircraft taxiing (B777, B747, B737, B717 and A330) […]* *[…] the Boeing 747 is the loudest aircraft anticipated to operate at the proposed airport"*	It is assumed that the 747 taxi noise has been used for the purposes of the noise modelling exercise.	Clarify that the source noise level for the 747 aircraft has been used as a basis for the taxi noise assessment	Noted for information
11.2.3 **P 78, para 1**	*"The traffic projections were used to calculate noise levels at typical distances from roads near the airport site using the 'Calculation of road traffic noise' procedure (CoRTN)"*	No predicted traffic noise levels are presented in the EIS or Appendix E2. Noise levels presented are the change in noise level.	Amend statement to reflect that traffic noise levels are not presented in the report, only predicted increase.	For information only

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
11.3, Figure 11-2, p79	A figure depicting noise sensitive receptors surrounding the airport site	It is difficult to see the location of nearest residential receptors, as their location appears to be indicated by very small points in light grey – whereas the other types of receptor are more clearly marked. It is also difficult to see this in the inset image displaying Luddenham. The initial impression that the figure currently gives is that there are little, if any.	Recommend that the figure is updated to show more clearly the location of residential receptors, particularly in Luddenham.	Noted for information.
11.7, p97, Table 11-13	The table details the mitigation/management measures to be put forward.	It is important that these proposals are brought forward and conditioned appropriately. The use of ground power and pre-conditioned air are not included in the table, nor is any mention of the restriction over APU usage.	Given the anticipated impact of noise from engine ground running, consideration should be given to the inclusion of a condition relating to the installation and use of a ground run-up pen or other such structure to provide effective acoustic screening. Given that the assessment has been based on no APU usage, a condition should be imposed on APU usage. Recommend that the mitigation measures be conditioned and adopted.	Noted for information
11	**General**	**A number of points/issues from Appendix E2 have been carried through to this document.**	**Update based on the outcome of the Appendix E2 updates.**	**High**
11	General	Magnitude of significance of ground noise impacts, the extent of their impacts, and whether they are temporary or permanent have not been identified. This is a fundamental flaw in the EIS chapter.	Recommend that a magnitude scale for impact significance is used for pre-mitigation and post mitigation assessments so that it can clearly be seen what the residual noise impact is predicted to be.	Noted for information
Volume 2 Chapter 27. Cumulative impact assessment				

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
27.3.1	*"There is also anticipated to be a general increase in background noise levels associated with the ongoing urbanisation and development of Western Sydney. For example, certain proposed road projects, such as the proposed relocation and upgrade of The Northern Road, would contribute to changed background noise levels in the vicinity of the airport site. An increase in background noise would effectively limit the incremental increase associated with noise generated by the airport operations."*	There are two major road projects being developed due to the airport is being built: the M12 motorway and The Northern Road realignment. The cumulative assessment does not mention the operation of the M12 motorway and does not indicate the degree of impact from The Northern Road realignment. The omission of these items is not consistent with Section 5(b) of the EIS Guidelines. Whilst it is recognised that the mitigation and management of these road projects may not be the responsibility of the proponent, the EIS guidelines require that cumulative impacts from known potential future projects are considered.	Further cumulative assessment should be provided to indicate the potential impact of the operation of the M12 and The Northern Road realignment.	High
Volume 2 Chapter 28. Environmental Management Framework				
28.4.2, Table 28-5	The table provides a list of mitigation and management measures applicable to Stage 1 operation	It is important that these proposals are brought forward and conditioned appropriately. The use of ground power and pre-conditioned air are not included in the table, nor is any mention of the restriction over APU usage.	Given the anticipated impact of noise from engine ground running, consideration should be given to specific item relating to the installation and use of a ground run-up pen or other such structure to provide effective acoustic screening. Given that the assessment has been based on no APU usage, a specific item should be imposed on APU usage. Recommend that the mitigation measures be conditioned.	Noted for information
Volume 2 Chapter 29. Conclusion				
29.3, p625, Table 29-1	The tables provides a summary of the key environmental impacts	The "Noise – ground operations, construction and road traffic" section of the table does not provide an indication of the magnitude of significance of the noise sources stated, and whether this is with or without mitigation measures in place	Recommend that the magnitude of the noise impacts is included to assist in the decision making process.	Noted for information
Volume 3 Chapter 31. Noise				

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
31.5.1, p66, para 2	*"It is not anticipated that taxiing and engine run-up noise levels would increase, but these types of noise may become more frequent in the 2050 scenario."*	It is assumed that the text refers to the effective source noise associated with a single taxiing movement or engine run-up would not increase, rather than the resultant noise impact associated with the number and intensity of operational noise.	None. For information only.	Noted for information
31.5.2, p67, para 4	*"The 2063 aircraft taxiing noise contours reflect the increased number of aircraft movements and would extend further south as a result of the commissioning of the second runway."*	The increased impact is not adequately quantified. The aircraft noise section has identified the population numbers affected, however this information in absent for ground noise. There is no indication of the level of exceedance for nearest noise sensitive receptors in order to determine the magnitude of the impact.	Recommend that population number affected by ground noise is included. Recommend that population number affected is in 5 dB bands in order to understand the magnitude of the potential noise impact.	Noted for information
31.5.2, p67, para 4	*"Ground run-up noise would also likely occur more frequently in the long term, although the noise contours are not predicted to change based on the modelling assumptions adopted for this assessment."*	On comparison of the ground run-up noise contours for 2030 and 2063, the shape of the contour changes, therefore the statement is incorrect.	Revise the statement	Noted for information
31.5.2, p68 - 69, Figure 31-38, Figure 31-39	Figure 31-38 and Figure 31-39 show predicted noise levels for engine ground running and taxiing, respectively.	The figures are incorrectly labelled "maximum noise levels". They should be labelled "$L_{Aeq,15min}$ noise levels".	Correct the labelling of the figures	Noted for information
31.7, p70-72	These pages contain a summary of the findings from the chapter.	The summary of findings does not make any reference to ground noise.	Include a summary of the ground noise impact assessment	Noted for information
Volume 3 Chapter 40. Conclusion and recommendations				
40	The Chapter provides a summary of the key environmental impacts	The summary of findings does not make any reference to ground noise.	Include a summary of the ground noise impact assessment	Noted for information

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Appendix C

Air quality and greenhouse gas (Katestone Environmental)

Western Sydney Airport: Peer Review of Air Quality and Greenhouse Gas Assessment

Prepared for:

WSP | Parsons Brinckerhoff

November 2015

Final

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Contents

Tables

Glossary

Term	Definition
$\mu g/m^3$	micrograms per cubic metre
Nomenclature	
CO	carbon monoxide
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalents
NO	nitric oxide
NO_2	nitrogen dioxide
NO_x	oxides of nitrogen
PM_{10}	particulate matter with a diameter less than 10 micrometres
$PM_{2.5}$	particulate matter with a diameter less than 2.5 micrometres
SO_2	sulfur dioxide
TSP	total suspended particulates
VOC	volatile organic compounds
Abbreviations	
AEPR	Airport Environment Protection Regulation 1997
AERMOD	US EPA approved dispersion model
Air NEPM	National Environment Protection (Ambient Air Quality) Measure
Approved Methods	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW
DEC	Department of Environment and Conservation (NSW)
EDMS	Emissions and Dispersion Modelling System
EIS	Environmental Impact Statement
EPA	Environmental Protection Authority
GHG	Greenhouse gases
NPI	National Pollutant Inventory database
MACROC	Macarthur Regional Organisation of Councils
OEH	New South Wales Office of Environment and Heritage
US EPA	United States Environmental Protection Agency
WSROC	Western Sydney Regional Organisation of Councils

EXECUTIVE SUMMARY

Katestone Environmental Pty Ltd (Katestone) was commissioned by WSP | Parsons Brinckerhoff on behalf of the Western Sydney Regional Organisation of Councils (WSROC) and Macarthur Regional Organisation of Councils (MACROC) to complete a peer review of the local and regional air quality studies completed as part of the Environmental Impact Statement (EIS) for the Western Sydney Airport.

Limitations of peer review

Katestone's peer review has considered the air quality and greenhouse gas assessments presented in the EIS. A separate health risk assessment was also conducted and presented in the EIS. Katestone's peer review has not considered the separate health risk assessment. The separate health risk assessment has been the subject of a separate peer review by another party.

To assist with its review, Katestone requested access to all relevant input and output files that were integral to the air quality assessment studies as this information was not contained in the EIS. The provision of such information is a routine expectation and is a minimum requirement of the EPA for such studies. For a peer review the data is integral to demonstrating the integrity of the assessment. However, this information was not made available to Katestone for its review. Consequently, Katestone has relied only upon the information contained in the relevant chapters of the EIS to complete its review. Where apparent errors and inconsistencies were found within and between documents, Katestone has noted these, but in most cases has not been able to discern the full significance of these on the assessment outcomes.

Overall Comments on air quality study

The air quality study is contained in Volume 2 Chapter 12, Volume 3 Chapter 32 and Volume 4 Appendix F1 of the Western Sydney Airport EIS. Katestone has noted that these documents contain many typographical errors and inconsistencies that undermine the credibility of the air quality assessment. These sections require a thorough technical and editorial review by its authors to address the issues outlined in this review to improve transparency and credibility of the air quality assessment. To enable confidence in the assessment, all information and data used in the emission estimation, model inputs and outputs should be made available to any interested party.

The air quality study did not adequately address the sensitive receptors as it:

- Failed to identify all sensitive receptors
- Failed to identify a representative subset of sensitive receptors - whilst a small subset of sensitive receptors was identified, the subset does not appear to be representative of potential air quality impacts at all existing locations of sensitive receptors
- Did not identify future sensitive receptors
- Incorrectly classified community receptors separately and as having a lesser importance than residential receptors. Community receptors included various land-uses such as schools, parks, childcare facilities, churches and shopping centres.

Stage 1 Development

<u>Local Air Quality</u>

Setting aside the issues identified above, if the assessment results are taken as presented in Tables F1 to F8 and Table G1 to G5 (Volume 4, Appendix F1) of the EIS, they indicate the following:

- The maximum 1-hour average concentration of NO_2 was predicted to **exceed** the EPA's impact assessment criterion of 246 µg/m^3 at one receptor. Three other receptors have maximum 1-hour average concentrations of NO_2 that are 92% to 98% of the EPA's impact assessment criterion.

- The annual average concentrations of $PM_{2.5}$ were rounded to one significant figure. A number of receptors were predicted to have an annual concentration of $PM_{2.5}$ of 8 µg/m^3 – equal to the Air NEPM Advisory Reporting Standard. These results are potentially indicative of minor exceedances (<0.4 µg/m³) of the Advisory Reporting Standard.
- The 99.9th percentile 1-hour average concentration of formaldehyde was predicted to **exceed** the EPA's impact assessment criterion at two receptors.
- The predicted concentrations of all other air pollutants were below their respective assessment criteria.
- The major contributor to elevated levels of air pollutants is aircraft emissions. However, for receptors close to existing or new roads, the major contributor is external roadways.
- Mitigation measures were recommended. However, the effectiveness of the measures in achieving compliance was not quantified.

Regional air quality

The methods used to assess the regional air quality are acceptable. The assessment of regional air quality showed that only marginal increases in ozone concentrations would result from Stage 1 Development.

Greenhouse gases

The methods used to estimate greenhouse gas emissions are acceptable. The estimates of greenhouse gas emissions are reliable and the contribution of greenhouse gas emissions from the project will be relatively small with Stage 1 Development emissions approximately 0.11% of Australia's projected 2030 transport-related GHG inventory.

Overall comments

The Stage 1 Development assessment was based on the annual throughput of the airport would be 63,302 ATM in 2030. The stated maximum capacity of the airport following completion of Stage 1 is three times higher at 185,000 ATM in 2050. The local air quality assessment, regional air quality and greenhouse gas assessment all use this assumption in the generation of the emissions and resultant impacts. Consequently, the assessment has underestimated the potential impact of the Stage 1 Development by a considerable margin.

Longer Term Development

Local Air Quality

The assessment results are taken as presented in Tables F9 to F11 (Volume 4, Appendix F1) of the EIS, they indicate the air quality assessment of the Longer Term Development shows:

- The maximum 1-hour average concentration of NO_2 was predicted to exceed the EPA's impact assessment criterion of 246 µg/m^3 at 41 of the 96 receptors.
- The maximum 24-hour average PM_{10} concentrations was predicted to exceed the EPA's impact assessment criterion at three receptors.
- The maximum 24-hour average concentrations of $PM_{2.5}$ were predicted to exceed the NEPM Advisory Reporting Standard at three receptors.
- The annual average concentrations of $PM_{2.5}$ were rounded to one significant figure. The annual average concentrations of $PM_{2.5}$ were predicted to exceed the Air NEPM Advisory Reporting Standard at 13 receptors (concentrations are reported as 9 µg/m^3 or higher). A number of receptors were predicted to

have an annual concentration of $PM_{2.5}$ of 8 µg/m^3 – equal to the Air NEPM Advisory Reporting Standard. These results are potentially indicative of minor exceedances (<0.4 µg/m^3) of the Advisory Reporting Standard.

- Whilst a number of mitigation and management measures were listed within the Western Sydney Airport EIS, the effectiveness of the measures was not quantified and therefore the air quality assessment failed to demonstrate that compliance with the relevant air quality criteria could be achieved.

Regional air quality

The assessment of regional air quality showed:

- The change in daily maximum 1-hour ozone concentration from the addition of the airport was 4.5 ppb which is significantly above the maximum allowable increment of 1 ppb defined in the NSW EPA's tiered approach
- The change in daily 4-hour average ozone concentration from the addition of the airport was 3.7 ppb which is significantly above the maximum allowable increment of 1 ppb defined in the NSW EPA's tiered approach.

However, the regional air quality assessment for the Longer Term Development is hypothetical as:

- The impacts had to be assessed in context of the 2030 base case emissions as a base case inventory has not been projected for 2063
- Changes in emissions to other existing sources had not been accounted for
- Assumes that the rail network exists

Greenhouse gases

The methods used to estimate greenhouse gas emissions are acceptable.

Overall comments

The Longer Term Development contained in the Western Sydney Airport EIS includes a second runway, which relies upon the existence of rail services to be feasible. The Western Sydney Airport EIS states "*As it is not possible for the longer term development to achieve the project passenger numbers without the rail network the traffic scenario that does not include the rail network was disregarded.*"

Air quality associated with Stage 1 is critically dependent on the traffic volumes generated by the airport. Consequently, the impact on air quality due to the Longer Term Development is critically dependent on the existence of the assumed rail services to the airport. The Western Sydney Airport EIS is not seeking approval for the rail infrastructure that is necessary for its feasibility and the EIS does not contain a detailed proposal for the rail infrastructure. As a consequence, the air quality assessment of the Longer Term Development is speculative at best and does not provide a sufficiently robust basis to support approval of the Longer Term Development at this stage.

1. INTRODUCTION

Katestone Environmental Pty Ltd (Katestone) was commissioned by WSP | Parsons Brinckerhoff acting on behalf of the Western Sydney Regional Organisation of Councils (WSROC) and Macarthur Regional Organisation of Councils (MACROC) to complete a peer review of the local and regional air quality studies completed as part of the Environmental Impact Statement (EIS) for the Western Sydney Airport.

1.1 Approach

WSP | Parsons Brinckerhoff requested a peer review that:

- *Evaluates whether the local and regional air quality studies meet the requirements of the EIS Guidelines and relevant other guidelines and methodologies.*
- *Evaluates whether the conclusions reached in the studies are valid – i.e. an independent evaluation of whether the predicted impacts are in accordance with published standards and guidelines, and whether the conclusions of the assessment are a realistic reflection of the actual impacts.*
- *Evaluates whether the underlying assumptions used to inform the assessment (including any construction or operational assumptions, and modelling assumptions where appropriate) are plausible.*
- *Review the mitigation and management measures proposed and advises on their adequacy in mitigating impacts.*
- *Evaluates the level of uncertainty over impacts and the environmental risks that will arise as a result.*
- *Provides a summary of the key impacts and opportunities associated with the project in relation to the local and regional air quality studies*.

WSP | Parsons Brinckerhoff also requested that the following be considered:

- *...a key part of the peer review role to identify any gaps in information, errors or shortcomings.*
- *The purpose of this review is to present factual unbiased information about the technical rigour of the studies and both the positive and negative aspects of the proposal. All views expressed within the peer review should be substantiated with reference to information in the EIS or published elsewhere.*
- *The peer review is intended to assess the merits of the proposal as presented in the EIS – it is not at this stage intended that the peer review will develop recommendations for alternative designs for the project.*

1.2 Limitations

Katestone's peer review has considered the air quality and greenhouse gas assessments presented in the EIS. A separate health risk assessment was also conducted and presented in the EIS. Katestone's peer review has not considered the separate health risk assessment. The separate health risk assessment has been the subject of a separate peer review by another party.

To assist with its review, Katestone requested access to all relevant input and output files that were integral to the air quality assessment studies as this information was not contained in the EIS. The provision of such information is a routine expectation, is a minimum requirement of the EPA for such studies and is integral to demonstrating the integrity of the assessment.

The EPA's requirements an air quality assessments are detailed in its *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DEC, 2005) (Approved Methods). The Approved Methods specifies the minimum requirements for the information to be contained within impact assessment reports. In relation to air pollutant emissions, the following is expected to be included in the report:

> *Detailed calculations of pollutant emission rates for each source*

In relation to dispersion modelling, the following is expected to be included in the report:

> *All input, output and meteorological files used in the dispersion modelling supplied in a Microsoft Windows-compatible format*

However, this information was not made available to Katestone for its review. Consequently, Katestone has relied only upon the information contained in the relevant chapters of the EIS to complete its review. Where apparent errors and inconsistencies were found within and between documents, Katestone has noted these, but in most cases has not been able to discern the full significance of these on the assessment outcomes.

As a minimum, the following information should be provided within the technical air quality reports for review:

- Local air quality
    - Construction
        - Assumptions used in the emission estimation such as tonnages of material moved, equipment numbers and control measures
        - Spreadsheet of emissions information for input into AERMOD model
        - AERMOD input files and output files, including post processing information.
    - Operation
        - Assumptions used in the emission estimation such as engine type assumed for each aircraft, taxiing length
        - Spreadsheet for emissions information from EDMS
        - AERMOD input and output files, including post processing information.

1.3 Components of the EIS Considered in Peer Review

This report presents the outcomes of Katestone's independent peer review of the following components of the EIS:

- Local air quality
- Regional air quality
- Greenhouse gases.

In conducting its peer review of the Western Sydney Airport EIS, Katestone has had specific regard to the following information and relevant documents:

- Western Sydney Airport EIS Volume 2 Chapter 12 Air Quality and Greenhouse Gases
- Western Sydney Airport EIS Volume 3 Chapter 32 Air Quality
- Western Sydney Airport EIS Volume 4 Appendix C Airport EIS Guidelines
- Western Sydney Airport EIS Volume 4 Appendix F1 – Local Air Quality and Greenhouse Gas Assessment
- Western Sydney Airport EIS Volume 4 Appendix F2 – Regional Air Quality

- *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005) (*Approved Methods*).
- *National Environment Protection (Ambient Air Quality) Measure 1998*.

2. EIS GUIDELINES

The EIS Guidelines that relate to air quality and greenhouse gas emissions are as follows:

"2 DESCRIPTION OF THE ACTION

All construction, operational and (if relevant) decommissioning components of the action should be described in detail. This should include the precise location (including coordinates) of all works to be undertaken, structures to be built or elements of the action that may have impacts on matters of National Environmental Significance. The description of the action must also include details on how the works are to be undertaken (including stages of development and their timing) and design parameters for those aspects of the structures or elements of the action that may have relevant impacts.

5 RELEVENT IMPACTS

…

(g) Impacts to the environment (as defined in section 528) should include but not be limited to the following:

…

- *Changes to air quality during construction and operation (associated with both passenger movements and workers)*
- *Potential fuel dump impacts*
- *…*

Quantification and assessment of impacts should:

- *Be against appropriate background/baseline levels*
- *Be prepared according to best practice guidelines and compared to best practice standards*
- *Consider seasonal and temporal variations where appropriate (including temporal changes in the sensitivity of the receptor)*
- *Be supported by maps, graphs and diagrams as appropriate to ensure information is readily understandable*

Guidelines and standards used to quantify baselines and impacts should be explained and justified.

6 AVOIDANCE AND MITIGATION MEASUES

(a) The EIS must provide information on proposed avoidance and mitigation measures to manage the relevant impact of the action on a matter protected by a controlling provision (as listed in the preamble of this document).

...

(c) The EIS must include specific and detailed descriptions of the proposed avoidance and mitigation measures based on best available practices..."

The air quality and greenhouse gas assessments appear to satisfy the EIS guidelines because they refer to the correct legislation and technical guidance. However, it has been very difficult to verify this independently via an analysis of the EIS due to the many typographical errors and inconsistencies (refer to Section 3, Section 4 and Appendix A) and because critical information was not made available (Section 1.2).

3. REVIEW FINDINGS –STAGE 1 DEVELOPMENT

3.1 Local air quality

3.1.1 Methodology

The EIS Guidelines require the assessment of impacts to be prepared according to best practice guidelines and compared to best practice standards. The key documents that contain best practice assessment guidelines and standards are:

- The Environment Protection Authority's *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DEC, 2005) (Approved Methods)
- *National Environment Protection (Ambient Air Quality) Measure 1998*.

The air quality assessment of the Western Sydney Airport is stated to have been conducted in accordance with the Approved Methods. There is insufficient information contained within the EIS documentation to allow our review to determine if this is a true statement. As detailed in Section 1.2, critical information was not made available to Katestone for its review, which makes it very difficult to verify independently whether the assessment has been conducted in accordance with the Approved Methods.

The table below summarises the elements of the assessment and whether the method used was acceptable. Sections 3.1.2, 3.1.3 and 3.1.4 elaborate further on these issues. A detailed description of each element is provided in Appendix A.

Table 1 Methodology overview

Chapter of Approved Methods	Section of Approved Methods	Comments
3. Emissions inventory	3.1 Identify all sources of air pollution and potential emissions	Construction - acceptable.
		Operations - acceptable.
	3.2 Determine source release parameters	Construction - cannot verify - No details provided.
		Operation – cannot verify - some parameters acceptable but not all parameters were provided.
	3.3 Estimate emission rates	Construction – cannot verify - Insufficient information to fully verify.
		Operations – cannot verify - EDMS used, which is acceptable. However, insufficient information to fully verify.
	3.6 Presentation of emissions inventory	Construction – cannot verify - errors in presentation of emissions inventory.
		Operations – cannot verify - inconsistencies and errors in presentation of emissions inventory.
4. Meteorological data	4.1 Minimum data requirements	Acceptable.
	4.2 Siting and operating meteorological monitoring equipment	Acceptable.
	4.4 Preparation of Level 2 meteorological data	Acceptable.

Chapter of Approved Methods	Section of Approved Methods	Comments
5. Background air quality, terrain, sensitive receptors and building wake effects	5.1 Background air quality data	Acceptable.
	5.2 Terrain and sensitive receptors	Terrain – cannot verify - no information on terrain provided. Sensitive receptors – not acceptable – all sensitive receptors have not been identified. A small subset of sensitive receptors was included; however, the reason for selecting certain sensitive receptors and not others is unclear. Justification and appropriateness needs to be provided. As a minimum, the subset of sensitive receptors should be representative of potential air quality impacts at all existing and possible future locations of sensitive receptors.
6. Dispersion modelling	6.1 Dispersion models	Acceptable. Has used AERMOD.
7. Interpretation of dispersion modelling results	7.1.1 Impact assessment criteria	All acceptable except for NO_2. The EIS refers to an NO_2 criterion of 320 µg/m³, which is incorrect. The correct criterion for 1-hour average concentrations of NO_2 is 246 µg/m³ as specified in the Approved Methods.
	7.1.2 Application of impact assessment criteria	Construction – cannot verify odour – insufficient information has been provided to determine whether odour assessment criteria have been applied correctly. Other air pollutants - acceptable. Operations – cannot verify odour – insufficient information has been provided to determine whether odour assessment criteria have been applied correctly. Incorrect 1-hour average NO_2 criterion applied in places. Other air pollutants – acceptable.
	Summary of impacts	Construction – cannot verify - Inconsistencies with presentation of results and reporting of results. Operations – cannot verify - Inconsistencies with presentation of results and reporting of results.
8. Modelling pollutant transformations	8.1 NO_2 assessment	Acceptable.
	8.2 Detailed assessment of ozone and NO_2	Approach based on tiered assessment approach. Acceptable.
9. Impact assessment report	9.1 - 9.6	Not acceptable – the report includes many typographical errors and inconsistencies. The report requires a thorough editorial and technical review. Dispersion modelling inputs and outputs were not supplied.

3.1.2 Key assumptions

The air quality and greenhouse gas assessment for the Stage 1 Development was based on the key assumption that Stage 1 Development represented 10 million passengers and 63,302 Aircraft transport movements (ATM) for 2030. The Western Sydney EIS states that the capacity of the single runway is 37 million passengers and 185,000 ATM. Whilst it is stated that the capacity of the Stage 1 Development won't be reached until 2050, the ATMs are three times higher than those assessed for the Stage 1 Development. Therefore, the ATM assumption for Stage 1 is critical to the outcome of the assessments for local air quality, regional air quality and greenhouse gas.

- Other assumptions that will affect the emission rates of air pollutants are: specific aircraft fleet breakdown as detailed in Appendix C of Volume 4, Appendix F1, engine type and taxiing time. Details were not provided regarding the engine type(s) and taxiing time assumed in the assessment, therefore, the appropriateness of the assumptions could not be verified.

3.1.3 Construction

The review of the local air quality assessment for construction found the following:

- The emission rates associated with bulk earthworks, concrete batching and asphalt batching appeared reasonable; however, the emission rates were not able to be verified due to insufficient information provided in Volume 4 Appendix F1 of the EIS regarding construction activities and mitigation measures assumed.
- The emission rates associated with aviation infrastructure (Table 3-6 (Volume 4, Appendix F1) have been reported incorrectly as the total $PM_{2.5}$ emissions associated with aviation infrastructure are higher than those reported for PM_{10}. $PM_{2.5}$ is a subset of PM_{10} and therefore it is not possible for $PM_{2.5}$ emission rates to be higher than PM_{10} emission rates. It was not possible to verify whether the correct emission rates were used in the modelling as the modelling files were not available for review.
- The dispersion modelling results (shown in Tables 12-19 to 12-22 (Volume 2, Chapter 12) and Tables 7-1 to 7-4 and G1 to G4 (Volume 4, Appendix F1)) showed that construction of the aviation infrastructure will result in higher concentrations of PM_{10} and $PM_{2.5}$ than the bulk earthworks. This is inconsistent with the emissions inventories (shown in Table 3-6 (Volume 4, Appendix F1), that indicates that emissions of TSP and PM_{10} for the bulk earthworks are at least twice those for construction of the aviation infrastructure.
- The dust deposition results appear to be very low when compared to PM_{10} concentrations. The dust deposition rates appear to be 1000 times lower than what would be expected considering the PM_{10} concentrations.
- Inconsistencies in the air pollutant concentrations at sensitive receptors that are presented in tables (Table G1 to Table G5 (Volume 4, Appendix F1)) compared with the concentration that may be inferred by considering the relevant contour plots (Figure G1 to Figure G5 (Volume 4, Appendix F1)).
- The odour concentration is described in Table 12-23 (Volume 2 Chapter 12) and Table 7-5 and G5 (Volume 4, Appendix F1) as a 1-hour average concentration. The Approved Methods specifies impact assessment criteria for odour as "nose-response time" averages not 1-hour averages. Consequently, it is possible that odour levels have not been correctly assessed and may be much higher than presented.

3.1.4 Operations

The review of the local air quality for operations found:

- The emission rates due to operations were not able to be verified due to insufficient information provided in Volume 4 Appendix F1 of the EIS regarding assumptions relating to taxiing time, aircraft type and engines.
- The air quality assessment defined three types of receptors: residential receptors, on-site receptors and community receptors. Community receptors included various land-uses such as schools, parks, childcare facilities, churches and shopping centres. Whilst the technical air quality report (Volume 4 Appendix F1) presented air pollutant concentrations at each of the three receptor types, the Volume 2 air quality chapter focused on residential receptors and on-site receptors. The delineation between residential and community receptors is not supported by the Approved Methods, which defines a sensitive receptor as:

  > *A location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area. An air quality impact assessment should also consider the location of known or likely future sensitive receptors.*

  Community receptors are therefore sensitive receptors, and as such should be assessed on the same basis as residential receptors. Therefore the Volume 2 air quality chapters should also present predicted concentrations at these community receptors. Concentrations at some of these community receptors were predicted to be higher than concentrations at residential receptors.
- The EIS refers variously to two impact assessment criteria for 1-hour concentrations of NO_2, namely: the *Airport Environment Protection Regulation 1997* criterion of 320 $\mu g/m^3$; and the Approved Methods' impact assessment criterion of 246 $\mu g/m^3$. Volume 2 Chapter 12 states that where there are multiple criteria the most stringent criterion has been used. However, it appears that the less stringent criterion of 320 $\mu g/m^3$ has been used. If the stricter impact assessment criterion were used, there would have been one exceedance of the impact assessment criterion instead of none.
- The odour concentration relating to aircraft exhaust is described in Table 12-35 (Volume 2, Chapter 12) and Tables 5-13 and F-8 (Volume 4, Appendix F1) as a 1-hour average concentration. The Approved Methods specifies impact assessment criteria for odour as "nose-response time" averages not 1-hour averages. Consequently, it is possible that odour levels have not been correctly assessed and may be much higher than presented.
- A number of errors within the report were identified. Examples of errors are provided in Table A1 and Table A2. A summary of errors are as follows:
  - Inconsistencies in emissions inventories presented in Volume 2 Chapter 12 and Volume 4 Appendix F1.
  - Inconsistencies in the air pollutant concentrations at sensitive receptors that are presented in tables compared with the concentration that may be inferred by considering the relevant contour plots (Volume 4, Appendix F1 (refer to Appendix A of this review report for details)).
  - Errors in the total emission rates due to airport and roadways presented in all tables.
  - A number of typographical errors in relation to presentation of results where incorrect pollutants or averaging periods were reported.
  - Incorrect units stated for result tables, resulting in concentrations being reported as 1000 times lower than actual.
  - Contour lines on the figures do not cover all identified receptors, indicating that some receptors may not have been included in the modelling.

Whilst many of these "errors" may be typographical, insufficient information was provided in the reports and, consequently, Katestone could not conduct cross-checking to determine their importance. For example, the dispersion model input files were not available for review and therefore it was not possible to verify the emissions, modelling or results.

3.1.5 Fuel dumping

The potential impacts due to fuel dumping were not quantified. The EIS stated "*fuel dumping is not considered likely to have a significant immediate or future impact on air quality*" due to "*the inability of many aircraft to perform dumps, the rapid vaporistation and wind dispersion of jettisoned fuel, the strict guidelines on fuel dumping altitudes and locations, and the anticipated reduction in fuel dumping events and volumes in the future*."

3.1.6 Mitigation and management measures

Recommended mitigation and management measures in the Western Sydney EIS included, but were not limited to:

- Construction
  - Development and implementation of stakeholder communications plan
  - Development and implementation of a dust management plan
  - Specific dust management, demolition, earthworks, construction and track out mitigation measures
- Operation
  - Development and implementation of an operational air quality and odour management plan as part of the operational plan for the proposed airport
  - Installation of an air quality monitoring station at the airport site to monitor NOx, NO, NO_2, CO, O_3, PM_{10}, $PM_{2.5}$ and VOCs
  - Consider best available techniques to reduce emissions of ozone precursors.

Whilst these mitigation and management measures should be part of conditions of approval for the project, the effectiveness of these measures to mitigate exceedances was not quantified.

3.2 Regional air quality

The regional air quality assessment (Volume 4, Appendix F2) methodology was based on the NSW EPA's Tiered Procedure for Estimating Ground-level Ozone Impacts from Stationary Sources (Environ, 2011). The EIS acknowledges that "*Stationary sources are defined as scheduled activities listed in Schedule 1 of the Protection of the Environment Operations (POEO) Act (1997) (NSW). The most significant sources at the proposed airport (e.g. aircraft in flight) would not be designated as scheduled activity under the POEO Act and, as such, the tiered procedure for ozone assessment is only applicable for minor emission sources such as boilers. Notwithstanding, the tiered procedure provides guidance on how ozone assessment should be conducted in NSW and there are aspects of the guidance that are relevant and applicable*."

Details of the method for the regional air quality assessment are summarised in Appendix A. Adoption of the NSW EPA's tiered assessment approach is appropriate for this project. The regional air quality technical report (Volume 4, Appendix F2) was well written and edited. It provided all the relevant information regarding how the regional air quality assessment was undertaken, with the exception of detailing how the airport sources were parameterised within the model.

The assessment showed:

- The change in daily maximum 1-hour ozone concentration from the addition of the airport was 1.1 ppb, which is marginally above the maximum allowable increment of 1 ppb defined in the NSW EPA's tiered approach
- The change in daily 4-hour average ozone concentration from the addition of the airport was 0.9 ppb, which is below the maximum allowable increment of 1 ppb defined in the NSW EPA's tiered approach.

Mitigation measures that had a focus on reducing NOx emissions were also recommended for consideration.

Whilst the change in the daily maximum 1-hour ozone concentration was marginally higher that the 1 ppb defined in the EPA's tiered approach, the base concentration at the location of the incremental change was approximately 50 ppb (well below the EPA's impact assessment criterion of 100 ppb). The maximum 1-hour concentrations within the region were not predicted to increase as a result of the Stage 1 Development.

3.3 Greenhouse gas

Greenhouse gas emissions were quantified due to construction and operations. The report did not specify the emission factors that were used to quantify emissions; however, Katestone was able to produce similar emission estimates using the emission factors in the National Greenhouse and Energy Reporting Determinations with the exception of emissions associated with waste water treatment. It is possible that assumptions not documented have been included in the calculations emissions associated with waste water treatment. Overall, waste water treatment emissions were found to be a relatively small proportion of total greenhouse gas emissions.

Notwithstanding the above, the greenhouse gas assessment appears to have provided reliable estimates of greenhouse gas emissions from the Stage 1 development, as follows:

- *Direct (scope 1) and indirect (scope 2) GHG emissions from Stage 1 Development of the airport have been estimated to comprise 0.13 Mt CO2-e/annum, with the majority of emissions associated with purchased electricity. The Stage 1 Development Scope 1 and Scope 2 emission estimates represent approximately 0.11% of Australia's projected 2030 transport related GHG emission inventory. From this it can be concluded the GHG emission from the airport will not be material in terms of a national inventory, however a number of mitigation measures have been suggested.*

Measures to reduce or offset direct and indirect GHG emission from airport and aviation activities were listed. It is recommended that these be included in the conditions of approval.

3.4 Review of the conclusions of the Western Sydney Airport EIS

In relation to air quality and greenhouse gases the Western Sydney Airport EIS concluded:

- Air quality – local
    - *"Predicted dust impacts during construction would be below the air quality assessment criteria at all sensitive residential receptors. Odour from the asphalt plant is also predicted to be below the relevant criteria at all sensitive residential receptors*
    - *Operation of the proposed Stage 1 Development would result in an increase in emissions of NO_2, particulate matter (PM_{10} and $PM_{2.5}$), CO, SO_2 and air toxics. There would also be odour emissions from exhaust and from the on-site waste water treatment plant.*
    - *There were almost no predicted exceedances of the air quality assessment criteria at any of the sensitive residential receptors investigated as part of the assessment of the Stage 1 Development. The exception was the maximum (99.9^{th} percentile) 1-hour concentration of formaldehyde with an exceedance shown at on-site receptor.*

- *Predicted off-site odour concentrations were expected to be below odour detection limits for both aircraft exhaust emissions and odour from the on-site waste water treatment plant."*

- Air quality – regional
  - *"Only marginal ozone impacts would result from the operation of the Stage 1 development. These emissions would be managed using best available techniques and/or offsets."*

- Greenhouse gas
  - "*It can be concluded that the greenhouse gas emissions from the proposed airport would not be material in terms of a national inventory."*

3.5 Overall comments

The EIS conclusions presented for the greenhouse gas and regional air quality assessments are acceptable assuming that the emissions scenario of 63,302 ATM is appropriate.

The air quality study is contained in Volume 2 Chapter 12, Volume 3 Chapter 32 and Volume 4 Appendix F1 of the Western Sydney Airport EIS. Katestone has noted that these documents contain many typographical errors and inconsistencies that undermine the credibility of the air quality assessment. These sections require a thorough technical and editorial review by its authors to address the issues outlined in this review to improve transparency and credibility of the air quality assessment. To enable confidence in the assessment, all information and data used in the emission estimation, model inputs and outputs should be made available to any interested party. Based on these issues and those identified in Section 3.1 it is not possible to verify the conclusions of the EIS in relation to local air quality.

Setting aside the issues identified above, if the assessment results are taken as presented in Tables F1 to F8 and Table G1 to G5 (Volume 4, Appendix F1), they indicate the:

- Maximum 1-hour average concentration of NO_2 is predicted to exceed the EPA's impact assessment criterion of 246 µg/m^3 criterion at one sensitive receptor (Table F1, Volume 4 Appendix F1, Appendix F)
- Three other sensitive receptors have maximum 1-hour average concentrations of NO_2 that are predicted to be 92% to 98% of the EPA's impact assessment criterion.
- The annual average concentrations of $PM_{2.5}$ were rounded to one significant figure. A number of receptors were predicted to have an annual concentration of $PM_{2.5}$ of 8 µg/m^3 – equal to the Air NEPM Advisory Reporting Standard. These results are potentially indicative of minor exceedances (<0.4 µg/m^3) of the Advisory Reporting Standard.
- The 99.9th percentile 1-hour average concentration of formaldehyde was predicted to **exceed** the EPA's impact assessment criterion at two receptors.
- The predicted concentrations of all other air pollutants were below their respective assessment criteria.
- The major contributor to elevated levels of air pollutants is aircraft emissions. However, for receptors close to existing or new roads, the major contributor is external roadways.
- Mitigation measures were recommended. However, the effectiveness of the measures in achieving compliance was not quantified.

  With regards to the key assumption of the Stage 1 Development assessment, if the ATMs for Stage 1 Development are higher than 63,302 ATM there is a high probability that the assessment will result in additional exceedances of the EPA's impact assessment criterion for NO_2.

4. REVIEW FINDINGS – LONGER TERM DEVELOPMENT

4.1 Local air quality

4.1.1 Methodology

The methodology used for the Longer Term Development was the same as used for the Stage 1 assessment. It is relatively unusual for an air quality assessment to project potential impacts almost 50 years into the future. The assessment of major road projects is an area where similar projections are attempted, albeit over shorter time horizons of 20 or 30 years. In such instances, future projections are normally conducted by quantifying the change induced by the project over time and assuming the status quo or a reasonable foreseeable change for other key features. For example, it might be assumed that background air quality and impact assessment criteria would remain unchanged but that improvements in motor vehicle emissions would occur. There is no strict framework or guideline for assessing future impacts decades into the future.

The Longer Term Development has adopted an equivalent assessment framework to the Stage 1 assessment. No attempt has been made to project key variables except the increase in flights.

The comments presented in Section 3.1.1 regarding methodology are also relevant to peer review of the Longer Term Development.

4.1.2 Key assumptions

The air quality and greenhouse gas assessment for the Longer Term Development was based on the following key assumptions:

- Longer Term Development is based on 82 million passengers and 365,000 ATM
- There is no improvement in aircraft emissions
- A specific aircraft fleet breakdown as detailed in Appendix C of Volume 4, Appendix F1
- The air quality assessment criteria is unchanged
- Background air quality is unchanged from that derived from recent measurements; hence, there would be no change in the sources of air pollutants in the broader region nor their spatial distribution
- Projected increases in flights at the airport and traffic volumes on external major roads associated with the airport contribute to increased emissions
- No account was taken of the locations of possible future sensitive receptors
- A rail network that is yet to be planned or approved would be implemented to transport a significant proportion of airport passengers.

4.1.3 Construction

Construction emissions were not quantified for the Longer Term Development. The EIS stated that the activities will need to be well managed to satisfy airport safety requirements; however, the EIS did not demonstrate that impacts would be below the relevant air quality criteria.

4.1.4 Operations

The review of the local air quality for Longer Term Development operations found:

- The emission rates due to operations were not able to be verified due to insufficient information provided in Volume 4 Appendix F1 of the EIS regarding assumptions relating to taxiing time and aircraft type and engines.
- As with the Stage 1 Development, the air quality assessment defined three types of receptors: residential receptors, on-site receptors and community receptors. Community receptors included various land-uses such as schools, parks, childcare facilities, churches and shopping centres. Whilst the technical air quality report (Volume 4 Appendix F1) presented air pollutant concentrations at each of the three receptor types, the Volume 3 air quality chapter focused on residential receptors and on-site receptors. The delineation between residential and community receptors is not supported by the Approved Methods, as detailed above. Community receptors are also sensitive receptors under the Approved Methods and, as such, should be assessed on the same basis as residential receptors. Therefore the 3 air quality chapters should also present predicted concentrations at these community receptors. Concentrations at some of these community receptors were predicted to be higher than concentrations at residential receptors.
- The air pollutant levels predicted for the Longer Term Development are fundamentally reliant upon the development of a rail network to transport airport passengers to and from the airport. The rail network is not yet at the planning stage and there is no guarantee that the rail network will go ahead and, as a consequence, there is no guarantee that the predicted levels of air pollutants that are associated with traffic will be achieved in practice..
- A number of errors within the report were identified. Examples of errors are provided in Table A1 and Table A2. A summary of errors are as follows:
    - Inconsistencies in emissions inventories presented in Volume 3 Chapter 32 and Volume 4 Appendix F1. Inconsistencies in concentrations presented in tables compared with figures for various receptors.
    - Errors in the total emissions due to airport and roadways presented in all tables.
    - Contour lines on the figures illustrating predicted concentrations did not cover all receptors assessed, indicating that all receptors may not have been modelled.

Whilst many of these “errors” may be typographical, insufficient information was provided in the reports and, consequently, Katestone could not conduct cross-checking to determine their importance. For example, the dispersion model input files were not available for review and therefore it was not possible to verify the emissions, modelling or results.

4.1.5 Mitigation and management measures

A number of mitigation and management measures that could be considered in the future as the number of passengers using the airport increases were listed within the Western Sydney Airport EIS based on a literature review of emission mitigation measures adopted at various international airports. It was also acknowledged that some of the measures listed were up to the individual airline and out of control of the airport operator.

Notwithstanding the list of mitigation and management measures, the effectiveness of the measures was not quantified and therefore the air quality assessment failed to demonstrate that compliance with the relevant air quality criteria could be achieved.

4.2 Regional air quality

The regional air quality assessment for the Longer Term Development used the same methodology as for the Stage 1 Development.

The assessment showed:

- The change in daily maximum 1-hour ozone concentration from the addition of the airport was 4.5 ppb, which is significantly above the maximum allowable increment of 1 ppb defined in the EPA's Tiered approach
- The change in daily 4-hour average ozone concentration from the addition of the airport was 3.7 ppb, which is significantly above the maximum allowable increment of 1 ppb defined in the EPA's Tiered approach.

Mitigation measures that had a focus on reducing NOx emissions were recommended for consideration.

However, the regional air quality assessment for the Longer Term Development is hypothetical as:

- The potential impacts had to be assessed in context of the 2030 base case emissions as a base case inventory has not been projected for 2063
- Changes in emissions to other existing sources had not been accounted for
- Assumes that the rail network exists.

4.3 Review of the conclusions of the Western Sydney Airport EIS

In relation to air quality, the Western Sydney Airport EIS concluded:

- Air quality – local
    - *The results indicate that exceedances of the 1-hour average NO_2 criterion of 246 µg/m^3 maybe experienced at 11 residential receptors. These exceedances are predicted to occur for between one and four hours per year.*
    - *Under conservative assumptions there may be exceedances of the 1-hour AEPR objective of 320 µg/m^3 at up to seven residential receptors. These exceedances are predicted to occur for between one and two hours per year.*
    - *Predicted (cumulative) PM_{10} concentrations are anticipated to be above the NSW EPA impact assessment criterion of 50 µg/m^3 on occasion at one on-site receptor.*
    - *Predicted (cumulative) $PM_{2.5}$ concentrations are anticipated to be above NEPM advisory reporting goals at a number of receptors.*
- Air quality – regional
    - *The change in daily maximum 1-hour ozone concentration from the addition of the airport was 4.5 ppb which is significantly above the maximum allowable increment of 1 ppb defined in the NSW EPA's tiered approach*
    - *The change in daily 4-hour average ozone concentration from the addition of the airport was 3.7 ppb which is significantly above the maximum allowable increment of 1 ppb defined in the NSW EPA's tiered approach.*

4.4 Overall comments

If the assessment results are taken as presented in Tables F9 to F11 (Volume 4, Appendix F1), the air quality assessment of the Longer Term Development shows:

- The maximum 1-hour average concentration of NO_2 was predicted to exceed the EPA's impact assessment criterion of 246 μg/m^3 at 41 of the 96 receptors (Table F9, Volume 4 Appendix F1, Appendix F)
- The maximum 24-hour average PM_{10} concentration was predicted to exceed the EPA's impact assessment criterion at three receptors.
- The maximum 24-hour average concentrations of $PM_{2.5}$ were predicted to exceed the NEPM Advisory Reporting Standard at three receptors (Table F11, Volume 4 Appendix F1, Appendix F).
- The annual average concentrations of $PM_{2.5}$ were rounded to one significant figure. The annual average concentrations of $PM_{2.5}$ are exceeded at 13 receptors (concentrations are reported as 9 μg/m^3 or higher). A number of receptors were predicted to have an annual concentration of $PM_{2.5}$ of 8 μg/m^3 – equal to the Air NEPM Advisory Reporting Standard. These results are potentially indicative of minor exceedances (<0.4 μg/m^3) of the Advisory Reporting Standard.

The Longer Term Development adopted the same air quality assessment framework as the Stage 1 Development. In particular, the assessment considered the existing air quality assessment criteria, background air quality derived from recent measurements and with no account taken of possible changes in the sources of air pollutants nor their spatial distribution over time. The assessment of the Longer Term Development indicates that concentrations will exceed the current air quality assessment criteria at existing sensitive receptors.

The most important issue with regards to the Longer Term Development is the assumption regarding the development of a new rail network. The Western Sydney Airport EIS states "*As it is not possible for the longer term development to achieve the project passenger numbers without the rail network the traffic scenario that does not include the rail network was disregarded.*"

Air quality associated with Stage 1 is critically dependent on the traffic volumes generated by the airport. Consequently, the impact on air quality due to the Longer Term Development is critically dependent on the existence of the assumed rail services to the airport. The Western Sydney Airport EIS is not seeking approval for the rail infrastructure that is necessary for its feasibility and the EIS does not contain a detailed proposal for the rail infrastructure. As a consequence, the air quality assessment of the Longer Term Development is speculative at best and does not provide a sufficiently robust basis to support approval of the Longer Term Development at this stage.

5. QUALIFICATIONS

This review has been undertaken by Simon Welchman, Natalie Shaw and Michael Burchill.

Simon is a Director at Katestone has a background of proven success over 20 years working as an environmental engineer in the private sector and for the environmental regulator. His expertise includes: air quality impact assessment of major industrial, infrastructure and mining projects; licensing, approvals and regulations; peer review and advice on air quality planning matters; odour impact assessment; greenhouse and air pollution control and management. Simon also provides expert witness services for matters relating to air quality and odour assessment in the Planning and Environment Court in Queensland and the Land and Environment Court in New South Wales. Most recently Katestone completed the air quality and greenhouse gas impact assessment for the Sunshine Coast Airport Expansion Project, for which Simon was the project director.

A summary of qualifications and role of each team member in project is provided in Table 2.

Table 2 Key personnel and project team

Name	Qualifications	Role on Project	Skills
Simon Welchman *Director*	BEng (Environmental) (Hons) 20+ years experience	Project Director	• Project direction and management • Expert advice on emissions regulation • Emissions benchmarking and assessment of best available control technologies • Air quality impact assessment studies of major industrial and infrastructure projects • Developing government policy for air quality and odour impact assessment • Developing environmental regulation • Air pollution emissions monitoring and ambient air quality monitoring
Natalie Shaw *Principal Air Quality Consultant*	BAppSc (Chemistry), MAppSc 15 years experience	Project Team	• Project management • Air quality modelling including TAPM, CALMET, CALPUFF, Ausplume, ISC3, CAL3QHCR, AERMOD • Photochemical modelling using TAPM-CTM • Air quality impact assessments for major industrial and infrastructure projects • Air pollution emission estimation • Assessment of site meteorology for industries including site specific meteorological data for inclusion in dispersion modelling • Air pollution emissions monitoring and ambient air quality monitoring
Dr Michael Burchill *Air Quality Consultant*	BAppSc (Physics)(Hons), PhD 4 years experience	Project Team	• Air quality modelling including TAPM, CALMET, CALPUFF, Ausplume, CAL3QHCR, AERMOD • Air quality impact assessments for major industrial and infrastructure projects • Air pollution emission estimation • Assessment of site meteorology for industries including site specific meteorological data for inclusion in dispersion modelling

APPENDIX A – DETAILED REVIEW

Table A1 Review of air quality assessment against Approved Methods

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	**Section of Approved Methods**		
3. Emissions inventory	3.1 Identify all sources of air pollution and potential emissions	Volume 2, Chapter 12 - Section 12.3.2 Volume 4, Appendix F1 - Section 3.6	**Construction - acceptable** • Construction impacts were quantified for Stage 1 Development. Construction impacts were not quantified for the Longer Term Development. • The following sources were included: ○ Bulk earthworks including dozers, scrapers, loading and unloading material, hauling on paved and unpaved roads, wind erosion and grading ○ Aviation infrastructure including working crew, asphalt plant and concrete batching plant • Potential emissions identified as TSP, PM_{10}, $PM_{2.5}$ and odour
		Volume 2, Chapter 12 - Section 12.6.1 Volume 4, Appendix F1 - Section 3.1.2.3 - Appendix C	**Operation – Stage 1 Development - acceptable** • The following sources were included: ○ Aircraft main engines, including approach mode, taxi/idle, take-off and climb-out mode ○ Auxiliary power units (APUs) ○ Ground support equipment (GSE) including but not limited to aircraft push back, mobile generators, tractors, powered passenger stairs, tractors, catering trucks, etc ○ Parking facilities ○ Stationary sources including boilers, engine tests, fuel tanks, generators, paints and solvents ○ Training fires ○ Terminal traffic ○ Road traffic ○ Waste water treatment plant • Potential emissions identified as NOx, SO_2, CO, VOCs, lead, PM_{10}, $PM_{2.5}$ and odour
		Volume 4, Appendix F1 - Section 3.1.2.3 - Appendix C	**Operation – Longer Term Development - acceptable** • The following sources were included: ○ Aircraft main engines, including approach mode, taxi/idle, take-off and climb-out mode ○ Auxiliary power units (APUs) ○ Ground support equipment (GSE) including but not limited to aircraft push back, mobile

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	Section of Approved Methods		
			generators, tractors, powered passenger stairs, tractors, catering trucks, etc ◦ Parking facilities ◦ Stationary sources including boilers, engine tests, fuel tanks, generators ◦ Training fires ◦ Terminal traffic ◦ Road traffic • Potential emissions identified as NOx, SO_2, CO, VOCs, lead, PM_{10}, $PM_{2.5}$ and odour
	3.2 Determine source release parameters	Not provided.	**Construction – cannot verify** • No detail was provided in the report • Modelling files were not available for review
		Volume 4, Appendix F1 - Appendix C	**Operation – Stage 1 Development – cannot fully verify – some parameters acceptable but not all parameters provided** • Source characteristics were provided for parking facilities, boilers, generators, fuel tanks, surface coating/painting and training fires • There was no information on source release parameters for the aircraft main engines, auxiliary power units, terminal traffic or road traffic in the report • Emission concentrations limits for the boilers and generators were not specified. • Modelling files were not available for review
		Not provided.	**Operation – Longer Term Development – cannot verify** • No specific information was provided for the Longer Term Development scenario
	3.3 Estimate emission rates	Volume 4, Appendix F1 - Section 3.6	**Construction – cannot fully verify due to insufficient information** • Emission factors were stated to be based on local and US EPA factors which is acceptable, if the correct factors are used. However the specific references were not provided. • Emissions were estimated for construction in relation to the Stage 1 Development only. • There was no information on construction information used to calculate emission rates. For example quantity of material moved, stockpile areas, number of trucks etc • There was no information on control measures incorporated in the emission rate calculation. • The correct pollutants were included in the assessment (TSP, PM_{10}, $PM_{2.5}$ and odour)

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	**Section of Approved Methods**		

		Volume 4, Appendix F1 - Appendix C	**Operation – Stage 1 Development – cannot fully verify due to insufficient information**
			• Emissions were estimated using the Emissions and Dispersion modelling system (EDMS (v5.1.4)) for the airport related activities. EDMS is appropriate for this use.
			• Emissions were based on 10 million passengers and 63,302 aircraft movements
			• The correct pollutants were assessed (NOx, CO, PM_{10}, $PM_{2.5}$, SO_2, VOCs and odour)
			• Lead was deemed to not require assessment due to only 5% of planes having a pistol engine. However, it is recommended that the emission rates of lead be quantified and compared to the emissions for other pollutants.
			• There were a number of assumptions made regarding:
			  ○ Taxiing (a 50 / 50 split was assumed in each direction) The report states "It is acknowledged that in reality the runway combinations are a function of the prevailing weather conditions" and therefore operations may occur in a single combination for an extended period of time. Averaging operations may underestimate impacts under these circumstances, in particular for the shorter term averaging periods.
			  ○ Duration of taxiing was estimated; however, assumption was not specified
			  ○ Engine type; however, assumption was not specified
			• There was no detail provided as to the sensitivity to emissions based on the above assumptions

		Volume 4, Appendix F1 - Appendix C	• **Operation – Longer Term Development – cannot fully verify due to insufficient information**
			• Emissions were estimated using the Emissions and Dispersion modelling system (EDMS) for the airport related activities. EDMS is appropriate for this use.
			• Emissions were based on 82 million passengers and 369,952 aircraft movements
			• NOx, CO, PM_{10}, $PM_{2.5}$, SO_2 and, VOCs were correctly included in the assessment, as above lead should also have been considered.
			• .
			• There were a number of assumptions made regarding:
			  ○ Taxiing (a 50 / 50 split was assumed in each direction) The report states "It is acknowledged that in reality the runway combinations are a function of the prevailing weather conditions" and therefore operations may occur in a single combination for an extended period of time. Averaging operations may underestimate impacts under these circumstances, in particular for the shorter term averaging periods.
			  ○ Duration of taxiing was estimated; however, assumption was not specified
			  ○ Engine type; however, assumption was not specified

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	**Section of Approved Methods**		
			• There was no detail provided as to the sensitivity to emissions based on the above assumptions
	3.6 Presentation of emissions inventory	Volume 4, Appendix F1 - Section 3.6.2 - Section 3.6.3 - Section 3.6.4	**Construction – cannot fully verify – errors in presentation of emissions inventory** • Emission inventories for TSP, PM_{10} and $PM_{2.5}$ have been presented for: o Bulk earthworks (Table 3-6) o Aviation infrastructure works (Table 3-6) o Concrete batching plant (Table 3-7) o Asphalt batching plant (Table 3-8) • As there was insufficient information provided in the Volume 4, Appendix F1 the emissions were for bulk earthworks, aviation infrastructure works, concrete batching and asphalt batching were not able to be reproduced. Notwithstanding this: o The emission inventory for bulk earthworks appears reasonable o The emissions inventory for concrete batching plant appears reasonable o The emissions inventory for asphalt batching plant appears reasonable o As presented in Volume 4, Appendix F1, the emissions due to the construction of aviation infrastructure does not appear to be correct as the total emissions of $PM_{2.5}$ are higher than that for PM_{10}. As $PM_{2.5}$ is a subset of PM_{10} this is not correct. As the emissions spreadsheets and model inputs were not available for review it was not possible to determine whether this was a typographical error or an error in the assessment.
		Volume 2, Chapter 12 - Section 12.6.1 Volume 4, Appendix F1 - Section 5.1.1	**Operation – Stage 1 Development – cannot verify – inconsistencies and errors in presentation of inventory** • Emissions inventories for NOx, CO, PM_{10}, $PM_{2.5}$, SO_2 and VOCs are presented in both Volume 2, Chapter 12 and Volume 4, Appendix F1 • The emission inventory (Table 12-24 in Volume 2 Chapter 12 and Table 5-1 in Volume 4 Appendix F1) appears to include typographical errors. o The total including external roadways is different in the two tables; however, the tables are supposed to represent the same emissions o Emissions from stationary sources should consist of the individual emissions from boilers, engine tests, fuel tanks, generators and paint solvents. However, in providing the total emissions from the airport, these stationary sources have been double counted in both tables. The percentage contribution of all of the individual sources is therefore also incorrect. o The total (tonnes per year) for the airport is incorrect for all pollutants in both tables • Figures 12-6 and 12-7 (Volume 2 Chapter 12) and Figures 5-1 and Figure 5-2 (Volume 4 Appendix

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	Section of Approved Methods		
			F1) which reflect the emissions and percentages presented in the emission inventories are incorrect and should be updated. • The inventory (Table 5-1 Volume 4, Appendix F1) has a $PM_{2.5}/PM_{10}$ ratio of 0.43 for external roads. From the NSW Greater Metropolitan Region Inventory the $PM_{2.5}/PM_{10}$ ratio was 0.74. • As there was insufficient information provided in the Volume 4, Appendix F1 the emissions for Stage 1 Development were unable to be reproduced exactly. Whilst some pollutants for some sources were able to be replicated this could not be done for all pollutants and all sources.
		Volume 3, Chapter 32 - Section 32.4.1 Volume 4, Appendix F1 - Section 5.1.2	**Operation – Longer Term Development – cannot verify – inconsistencies and errors in presentation of emissions inventory** • Emissions inventories for NOx, CO, PM_{10}, $PM_{2.5}$, SO_2 and VOCs are presented in Table 32-1 in Volume 3 Chapter 32 and Table 5-3 in Volume 4 Appendix F) • These tables appear to include typographical errors. o Emissions from stationary sources should consist of the individual emissions from boilers, engine tests, fuel tanks, generators and paint solvents. However, in providing the total emissions from the airport, these stationary sources have been double counted in both tables. The percentage contribution of all of the individual sources is therefore also incorrect. o The total (tonnes per year) for the airport is incorrect for all pollutants in both tables • Figures 32-1 and 32-2 (Volume 3 Chapter 32) and Figures 5-4 and Figure 5-5 (Volume 4 Appendix F1) which reflect the emissions and percentages presented in the emission inventories do not match the data in the tables • As there was insufficient information provided in the Volume 4, Appendix F1 the emissions for Longer Term Development were unable to be reproduced exactly. Whilst some pollutants for some sources were able to be replicated this could not be done for all pollutants and all sources.
4. Meteorological data	4.1 Minimum data requirements	Volume 4, Appendix F1 - Section 4.1	**Acceptable** • Data from Bureau of Meteorology (BoM) Badgerys Creek site and Camden Airport site was used. • At least one year of data – this has been addressed adequately • At least 90% complete – this has been addressed adequately • Correlated against a longer-duration site-representative meteorological database of at least five *years* – this has been addressed adequately
	4.2 Siting and	Volume 4, Appendix F1	**Acceptable**

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	**Section of Approved Methods**		
	operating meteorological monitoring equipment	- Section 4.1	• It is stated in Section 4.1 that the Badgerys Creek site is compliant with the Australian Standards AS 2923-1987 Guide for Measurement of Horizontal Wind for Air Quality Applications.
	4.4 Preparation of Level 2 meteorological data	Volume 4, Appendix F1 - Appendix D Section D.1 .2	**Acceptable** • A meteorological file suitable for use in the dispersion model AERMOD was generated using USEPA approved meteorological pre-processor AIRMET to process the Badgerys Creek and Camden Airport data into suitable format for AERMOD.
5. Background air quality, terrain, sensitive receptors and building wake effects	5.1 Background air quality data	Volume 4, Appendix F1 - Section 4.2	**Acceptable** • Ambient monitoring data from the NSW Office of Environment (OEH) sites at Bringelly, Liverpool and Richmond has been used in the assessment. Data was used from the year 2014 to coincide with the meteorological year used in the assessments. It is noted that based on the ambient monitoring summary pollutant concentrations in particular NO_2, appear to be lower than other years. No commentary was provided for the decrease in NO_2 concentrations. This should be provided to provide some comfort that selection of another year would not result in exceedances for the 1-hour NO_2 concentrations. • Specific requirements of the Approved Methods are: ○ Obtain ambient monitoring data that includes at least one year of continuous measurements and is contemporaneous with the meteorological data used in the dispersion modelling – this has been adequately addressed. ○ At each receptor, add each individual dispersion model prediction to the corresponding measured background concentration (e.g. add the first hourly average dispersion model prediction to the first hourly average background concentration) to obtain hourly predictions of total impact - this has been adequately addressed. ○ At each receptor, determine the 100th percentile total impact for the relevant averaging - this has been adequately addressed.
	5.2 Terrain and sensitive receptors	Volume 4, Appendix F1 - Appendix E	**Terrain – cannot verify - no information on terrain provided.** • Sensitive receptors – not acceptable – all sensitive receptors have not been identified. A small subset of sensitive receptors was included; however, the reason for selecting certain sensitive receptors and not others is unclear. Justification and appropriateness needs to be provided. As a minimum, the subset of sensitive receptors should be representative of potential air quality impacts at all existing and possible future locations of sensitive receptors.
	5.3 Building wakes		• Building wakes have been stated to be included in the modelling. However, as no modelling files

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	**Section of Approved Methods**		
			were available for review these could not be verified.
6. Dispersion modelling	6.1 Dispersion models	Volume 2 Chapter 12 -Section 12.3 Volume 4 Appendix F1 - Appendix D	• The US EPA approved dispersion model AERMOD was used. Whilst the model is not specified within the Approved Methods, it is been accepted for use in Australia.

7. Interpretation of dispersion modelling results	7.1.1 Impact assessment criteria	Volume 2 Chapter 12
		
		Volume 4 Appendix F1
		- Section 2.2
		- Section 2.3
			• The following impact assessment criteria were used:
			  ○ Approved Methods
			  ○ *Airports (Environment Protection) Regulations 1997*
			  ○ *National Environment Protection (Air Toxics) Measure*
			• It is relevant to note that, in places, the EIS refers to an NO_2 criterion of 320 µg/m³, which is incorrect. The correct criterion for 1-hour average concentrations of NO_2 is 246 µg/m³ as specified in the Approved Methods.

	7.1.2 Application of impact assessment criteria	Volume 2 Chapter 12 - Section 12.5 -Section 12.6 Volume 3 Chapter 32 - Section 32.4.2 Volume 4 Appendix F1 - Section 5 - Section 7 - Appendix F - Appendix G	• Construction – cannot verify for odour – insufficient information has been provided to determine whether odour assessment criteria have been applied correctly. Other air pollutants - acceptable. • Operations – cannot verify for odour – insufficient information has been provided to determine whether odour assessment criteria have been applied correctly. Incorrect 1-hour average NO_2 criterion applied in places. Other air pollutants – acceptable.
	Summary of impacts	See below	• See results for Construction, Stage 1 Development and Longer Term Development below.

	Construction results	Volume 2 Chapter 12
		- Section 12. 5
		
		Volume 4 Appendix F1
		- Section 7
			• For bulk earthworks (as reported in EIS)
			  ○ Maximum 24-hour and annual concentrations of PM_{10} and $PM_{2.5}$ are well below the relevant air quality criteria
			  ○ Annual dust deposition rates are well below the criterion
			• For aviation infrastructure (as reported in EIS)

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	Section of Approved Methods		
		- Appendix G	○ Maximum 24-hour and annual concentrations of PM_{10} and $PM_{2.5}$ are well below the relevant air quality criteria ○ Annual dust deposition rates are well below the criterion • The results indicate that construction of the aviation infrastructure is likely to result in higher concentrations of particulate than the bulk earthworks associated with construction. This does not agree with the emissions inventory presented for both which indicates that emissions of TSP and PM_{10} for the bulk earthworks are at least twice those for aviation infrastructure. • The dust deposition results appear to be very low when compared to PM_{10} concentrations. The dust deposition rates appear to be 1000 times lower than what would be expected. • For asphalt batching plant (as reported in the EIS) ○ The odour concentration is below relevant odour criterion. • The odour concentration is presented as 99th 1-hour concentration. The Approved Methods specifies impact assessment criteria for odour as “nose-response time” averages not 1-hour averages. • Both the concrete batching plant and asphalt plant emit dust. It is not clear whether the emissions of dust from these facilities are included in the bulk earthworks or aviation infrastructure results.
	Stage 1 Development	Volume 2 Chapter 12 - Section 12. 6 Volume 4 Appendix F1 - Section 5 - Appendix F	• For the Stage 1 development (as reported in the EIS) local air quality is as follows: ○ Maximum 1-hour and annual average concentrations of NO_2 are below the air quality assessment criteria at all residential receptors, with maximum 1-hour NO_2 predicted to be 60% and 70% of the AEPR criterion of 320 µg/m^3. (The EIS did not compare against the EPA criterion of 246 µg/m^3.) ○ Maximum 24-hour average and annual average concentrations of PM_{10} and $PM_{2.5}$ are below the assessment criteria at all residential receptors ○ Maximum 10-minute, 1-hour, 24-hour and annual average concentrations of SO_2 are well below the assessment criteria at all residential receptors ○ Concentrations of air toxics at residential receptors are well below the air quality assessment criteria for the 99.9th percentile ○ The 99.9th percentile 1-hour average concentration of formaldehyde is predicted to exceed the on-site receptor R24. ○ The predicted 99th percentile odour concentration for aircraft exhaust is well below the criterion at all residential receptors. ○ The predicted 99th percentile odour concentration for waste water treatment is well below the criterion at all residential receptors. • The summary of local air quality in Volume 2 Chapter 12 focused on the residential receptors.

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	Section of Approved Methods		
			However, there are 75 community receptors identified in Volume 4 Appendix F1. Taking into consideration these receptors and the most stringent air quality criteria, the review found the following: ○ Maximum 1-hour average concentration of NO_2 is above the EPA criterion of 246 µg/m^3 at one receptor (Table F1, Volume 4 Appendix F1, Appendix F) ○ Three other receptors have maximum 1-hour average concentrations of NO_2 that are 92% to 98% of the EPA criterion. ○ The annual average concentrations of $PM_{2.5}$ were rounded to one significant figure. A number of receptors were predicted to have an annual concentration of $PM_{2.5}$ of 8 µg/m^3 – equal to the Air NEPM Advisory Reporting Standard. These results are potentially indicative of minor exceedances (<0.4 µg/m^3) of the Advisory Reporting Standard. ○ The 99.9th percentile 1-hour average concentration of formaldehyde is predicted to exceed at two receptors ○ The predicted concentrations of all other air pollutants were below their respective assessment criteria.

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	**Section of Approved Methods**		
	Longer Term Development	Volume 3 Chapter 32 - Section 32.4 Volume 4 Appendix F1 - Section 5 - Appendix F	• For the Longer term development (as reported in the EIS) ○ Annual average concentrations of NO_2 are below the air quality assessment criteria at all residential receptors ○ Maximum 1-hour concentrations of NO_2 are predicted to exceed the AEPR criterion of 320 µg/m^3 at seven of the 20 receptors. (The EIS did not compare against the EPA criterion of 246 µg/m^3.) ○ Annual average concentrations of PM_{10} are below the assessment criteria at all residential receptors ○ Maximum 24-hour average concentrations of PM_{10} are below the criterion at all receptors with the exception of R24 (on-site receptor) ○ Maximum 24-hour and annual average concentrations of $PM_{2.5}$ will be above the relevant criteria for a number of receptors (one receptor for 24-hour average and four receptors for annual average). • The summary of local air quality in Volume 3 Chapter 32 focused on the residential receptors. However, there are over 100 community receptors identified in Volume 4 Appendix F1. Taking into consideration these receptors and the most stringent air quality criteria, the review found the following: ○ Maximum 1-hour average concentration of NO_2 is above the EPA criterion of 246 µg/m^3 at 41 of the 96 receptors (Table F9, Volume 4 Appendix F1, Appendix F) ○ The NO_2 criterion contour has not been added to Figure F55. This should be added to demonstrate the extent of the exceedance. ○ The maximum 24-hour average PM_{10} concentrations exceed the criterion at three receptors. ○ The PM_{10} criterion contour has not been added to Figure F61. This should be added to demonstrate the extent of the exceedance. ○ The maximum 24-hour average concentrations of $PM_{2.5}$ are exceeded at 3 receptors (Table F11, Volume 4 Appendix F1, Appendix F). ○ The annual average concentrations of $PM_{2.5}$ were rounded to one significant figure. The annual average concentrations of $PM_{2.5}$ are exceeded at 13 receptors (concentrations are reported as 9 µg/m^3 or higher). A number of receptors were predicted to have an annual concentration of $PM_{2.5}$ of 8 µg/m^3 – equal to the Air NEPM Advisory Reporting Standard. These results are potentially indicative of minor exceedances (<0.4 µg/m^3) of the Advisory Reporting Standard. (Table F11, Volume 4 Appendix F1, Appendix F).

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	Section of Approved Methods		
8. Modelling pollutant transformations	8.1 NO_2 assessment	Volume 4 Appendix F1	Acceptable.
	8.2 Detailed assessment of ozone and NO_2	Volume 4 Appendix F2	Approach based on tiered assessment approach. Acceptable.
9. Impact Assessment Report	9.1 – 9.6	Volume 4 Appendix F1	Not acceptable - the report includes many typographical errors and inconsistencies. The report requires a thorough editorial and technical review. Dispersion modelling inputs and outputs were not supplied.

Table A2 General comments relating to air quality sections of EIS

Section of EIS	Comment
Volume 2 Chapter 12	• Table 12-29 – Incorrect units presented for CO concentrations. Concentrations should read "mg/m^3" not "µg/m^3" • Table 12-34 – Incorrect pollutant names in header row of table. The columns should read Benzene, Toluene, Xylene not Toluene, Xylene and Formaldehyde
Volume 4 Appendix F1 - Section 3.1.2.3 - Appendix F1 Section C.4 - Appendix F1 Section C.5	• It is not clear what emission factors were used to determine emissions for parking facilities and road traffic ○ Section 3.1.2.3 states that "…roadways and parking emissions have been based on the Australian traffic emissions data developed by PIARC". ○ Appendix F Section C.4 states "Emissions from a given car park were calculated in EDMS for vehicles moving and idling" ○ Appendix F Section C.5 states "emissions from road traffic were calculated using the emission factors developed by the EPA for the latest emissions inventory for the Greater Metropolitan Region (GMR)."

<table>
<tr><th>Section of EIS</th><th>Comment</th></tr>
<tr><td>Volume 4 Appendix F1

- Section 5.2</td><td>
Table 5-7 – Incorrect units presented for CO concentrations. Concentrations should read “mg/m^3” not “µg/m^3”
Table 5-10 – Table heading indicates the 99th percentile 1-hour average concentrations are presented. Should read 99.9th percentile.
Table 5-12 – Incorrect pollutant names in header row of table. The columns should read Benzene, Toluene, Xylene not Toluene, Xylene and Formaldehyde
Table 5-13 – Averaging period for odour is stated as 1-hour 99.9th. This should be 1-s nose-response-time average. Not clear whether typographical error or incorrect averaging period for concentrations.
</td></tr>
<tr><td>Volume 4 Appendix F1

- Section F1 Stage 1 Development</td><td>
Table F1 – Predicted NO_2 concentrations due to the airport in isolation are higher than predicted NO_2 concentrations due to cumulative assessment. Affected receptors are R59, R99, R124, R126, R127 and R138
Table F1 and Figure F1 – Inconsistencies between reported 1-hour concentration in the Table F1 and Figure F1. Examples are provided below.
<table>
<tr><th rowspan="2">Receptor</th><th colspan="2">Cumulative 1-hour NO_2 (µg/m^3)</th></tr>
<tr><th>Table F1</th><th>Figure F1</th></tr>
<tr><td>R104</td><td>305</td><td>100</td></tr>
<tr><td>R118</td><td>241</td><td>Between 100 and 120</td></tr>
</table>
Figures F2 – F6, F8 – F12, F14 – F60, F62 – F66 and F68 have contours that do not cover the entire domain. This has resulted in lines disappearing. For some receptors it is difficult to compare concentrations presented in the Figures with the corresponding concentrations presented in the Tables. There are also inconsistencies between the concentrations in the tables and figures.
Table F4 and Figure 14 – Inconsistencies in predicted 1-hour CO concentration at R24 due to airport in isolation
Table F5-b and Figure F26 - Inconsistencies in predicted 1-hour SO_2 concentrations at some receptors due to cumulative impact. Examples are provided below.
<table>
<tr><th rowspan="2">Receptor</th><th colspan="2">Cumulative 1-hour SO_2 (µg/m^3)</th></tr>
<tr><th>Table F5-b</th><th>Figure F26</th></tr>
<tr><td>R4</td><td>50</td><td>80</td></tr>
</table>
</td></tr>
</table>

Section of EIS	Comment
	(continued table below)

R6	115	Between 60 and 80
R17	122	Between 60 and 80
R117	141	Between 100 and 120

- Table F7-a – Incorrect pollutant names and NEPM-AAQ Investigation level in header row of table.
- Table F7b – Incorrect NEPM-AAQ Investigation level in header row of table.

Section of EIS	Comment
Volume 4 Appendix F1 - Appendix F	• Table F9 – incorrect averaging period in table header. Should read “1-hour” not "24-hour” • Figure F56 and Table F9 – Inconsistencies in 1-hour NO_2 concentrations in the table and figure • Figure F56 – Contour line displaying criterion is not presented on figure. This should be included as it would indicate areas where exceedance of the criterion is predicted for NO_2. • Figure F57 and Table F10 – Inconsistencies in 24-hour PM_{10} concentrations in the table and figure • Figure F61 - Contour line displaying criterion is not presented on figure. This should be included as it would indicate areas where exceedance of the criterion is predicted for PM_{10}.
Volume 4 Appendix F1 - Section G.1.2	• Table G2 – Typographical error regarding table description. Should read “Predicted cumulative results during bulk earth works” not “Predicted cumulative results during site preparation works” • Table G3 – Typographical error regarding averaging period in header row of table. Sixth column across should read “Annual” not “24-hour hour” for the pollutant $PM_{2.5}$. • Table G4 – Typographical error regarding averaging period in header row of table. Sixth column across should read “Annual” not “24-hour” for the pollutant $PM_{2.5}$. • Table G5 and Figure G17 - Inconsistencies in odour concentrations in the table and figure. Examples are provided below.

Receptor	99^{th} percentile Odour (ou)	
	Table G5	Figure G17
R14	1.7	Between 0.02 and 0.04
R17	0.4	Between 0.02 and 0.04
R18	0.5	0.04

Section of EIS	Comment
	• Table G5 – Averaging period referred to as “1-hour”. The odour criterion is a "nose-response” average. It is not clear whether the 1-hour concentrations have been converted to a “nose-response” average using the peak to mean ratios in the Approved Methods.

Table A3 Review of regional air quality assessment against NSW EPA’s tiered assessment approach

Documentation required for NSW EPA’s Tiered Ozone Assessments		Comment
Photochemical model used		• Comprehensive Air Quality Model with extensions (CAMx) used. This is acceptable
Chemical mechanism used		• CB05. This is acceptable.
Source of input data	• Emissions	• Acceptable • Scenarios – 2008/2009 base case, 2030 future base case, 2030 Airport case, 2063, Airport case • Base emissions used 2030 projected inventory for Greater Metropolitan Region (with the exception of biogenics • Biogenics derived using Model of Emissions of Gases and Aerosols from Nature (MEGAN) • Airport emissions for 2030 • Road emissions due to airport only (excluded existing as incorporated in base emissions)
	• Meteorology	• Acceptable • TAPM derived meteorology using OEH and BoM data for data assimilation. • TAPM configuration in accordance with recommendations in TAPM manual. Justification provided for deviation in nesting of grids ratio

Documentation required for NSW EPA's Tiered Ozone Assessments		Comment
		• Used November 2008 to February 2009
Source of input data	• Boundary conditions	• Acceptable • Obtained using global model MOZART
	• Modelling periods	• Acceptable • November 2008 to February 2009 for model validation • 12 case days for impact assessment
Procedures for evaluating base case model performance		• Acceptable
Sources of ambient data		• Acceptable • OEH data
Statistical evaluation methods		• Acceptable
Graphical evaluation methods		• Acceptable
Characteristics of new source	• Location	• Not provided
	• Stack parameters	•
	• Emissions rates	• Acceptable
	• VOC speciation	• Acceptable
Procedures for selecting days to evaluate ozone impacts		• Acceptable

Documentation required for NSW EPA's Tiered Ozone Assessments		Comment
Ozone increases from new source emission on evaluation days	• Results for 1-hour and 4-hour ozone	• Acceptable
	• Maximum ozone increases	• Acceptable
	• Base case ozone at location of maximum increase	• Not provided in tables; however, can see in figures provided.
Significance assessment of new source ozone increases against 1-hour and 4-hour average incremental ozone criterion		• Acceptable. • As the project is in a nonattainment area assessed against maximum increment of 1ppb
Ozone impact (increase plus background) due to new source emissions on evaluation day		• Acceptable
Significance assessment of new source ozone impact against 1-hour and 4-hour average Air NEPM ozone standards		• Acceptable

Appendix D

Traffic and Transport (ARUP)

WSROC and MACROC Councils

Western Sydney Airport EIS Peer Review

Peer Review: Traffic and Transport sections within the Western Sydney Airport EIS

Final | 20 November 2015

Job number 24624100

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Document Verification

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			Prepared by	Checked by	Approved by
		Name	Sam Gray	Peter Dunn	Andrew Hulse
		Signature			
Draft 2	11 Nov 2015	**Filename**	Peer Review WSA EIS.docx		
		Description	Final		
			Prepared by	Checked by	Approved by
		Name	Sam Gray	Peter Dunn	Andrew Hulse
		Signature			
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			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ✓

Contents

1 Executive Summary

Background and Scope

Arup has been commission by WSP | Parsons Brinckerhoff on behalf of the Western Sydney Regional Organisation of Councils (WSROC) and Macarthur Regional Organisation of Councils (MACROC) to provide Peer Review Services of the traffic and transport sections of the draft environmental impact statement (EIS) for Western Sydney Airport.

The purpose this review was to inform these member authorities regarding the technical adequacy and completeness of this traffic and transport impact assessment. As such this peer review purpose is to present factual, unbiased information about the technical rigour of the study (both the positive and negative aspects contained within). All views expressed within the peer review will be substantiated with reference to information in the draft EIS or published elsewhere.

The peer review has been intended to assess the merits of the proposal as presented in the draft EIS – it has not been intended that the peer review will develop recommendations for alternative designs for the project.

The results of the peer review will be provided to the member authorities of WSROC and MACROC to assist them in making their submissions to the draft EIS.

In relation to Arup's comments regarding any short comings of this assessment, it should be noted that Arup has not been privy to any specific requirements above and beyond those described in the *Guidelines for the Content of a Draft Environmental Impact Assessment Statement, Western Sydney Airport, Environment Protection and Biodiversity Conservation Act, 1999.*

It is understood traffic and transport is likely one of the key environmental issues associated with the Airport. Arup has provided independent traffic and transport reviews relating to the adequacy of the documentation provided in and the appropriateness of the mitigation measures proposed in:

- *"WSA EIS 19 volume 2 chapter 15"*
- *"WSA EIS 39 volume 3 chapter 33"*
- *"WSA EIS GHD volume 4 appendix j surface transport and access"*

Stage 1 Airport

Issues identified in terms of predicted traffic impacts as a result of the Stage 1 airport include:

- Limitation of the strategic traffic model's (STM3) ability to capture traffic impacts at a detailed level
- Detailed intersection traffic modelling not undertaken

- Intersection operations and performance not assessed
- Future land take impacts as a result of intersection operations
- Freight traffic generation and associated impacts (outside of specific air cargo) not assessed
- Traffic generation and associated impacts caused by the zoned lands within the Airport precinct not assessed
- Impact to public transportation operations (bus network) not assessed

The above issues and limitations are considered significant. Further information would need to be provided to enable Arup to reach a firm opinion as to whether the conclusions reached in the study are valid. Until these comments are addressed or further information supplied, Arup is unable to comment on the validity of the traffic impact conclusions reached in this draft EIS.

Long Term Airport Development

The predicted traffic impacts of the long term development of the Western Sydney Airport largely followed the Stage 1 assessment. A number of the issues identified for Stage 1 are also apparent in the longer term development including:

- Limitation of the strategic traffic model's (STM3) ability to capture traffic impacts at a detailed level
- Detailed intersection traffic modelling not undertaken
- Intersection operations and performance not assessed
- Future land take impacts as a result of intersection operations
- Freight traffic generation and associated impacts (outside of specific air cargo) not assessed
- Traffic generation and associated impacts caused by the zoned lands within the Airport precinct not assessed
- Impact to public transportation operations (bus network) not assessed

Additionally, a number of issues identified in the longer term development (above and beyond Stage 1) include:

- The local road network adjacent to the Airport reaches capacity by 2063. No road planning mitigation measures were provided
- Airport Access Drive (from M12) reaches capacity by 2050, 13 years before long term development year of 2063. Capacity is predicted to be reached for approximately 15 hours a day.
- Insufficient information was provided to determine how air passenger demands would access and egress the Airport beyond 2050 (when the Airport Access Road reaches capacity)

- No assessment was included to understand what impact the air passenger demands using the SWRLe would have on the wider Sydney Rail Network.

Prior to the long term development of the airport being constructed, a major development plan (managed in accordance with the Commonwealth Airports Act 1996) will be required with final approval provided by the Minister of Infrastructure and Regional Development.

As such, Arup believes the above issues and limitations should be viewed in conjunction with this context

Key Impacts and Opportunities

The traffic impacts caused by Stage 1 of the Airport is predicted to be relatively low. With consideration to the methodology used, the draft EIS states the future road network is able to accommodate the predicted Airport traffic demand.

Nonetheless, it was difficult for Arup to confirm the validity of these impacts with confidence. Arup has identified further information that could be provided to quantify the potential impacts, including:

- Freight traffic generation within the Airport precinct (outside of air cargo)
- Private vehicle traffic generation from land uses within the Airport precinct (outside of air passengers)
- Vehicle travel time comparison (as predicted by strategic modelling)
- Intersection performance (as predicted by intersection modelling)
- Intersection layout requirements (as predicted by intersection modelling)

The following describes the predicted traffic impacts caused by the long term development of the Airport as described in the draft EIS:

- The traffic impacts caused by the Airport is predicted to be significant. The Airport Access Drive from the M12 is predicted to fail in 2050. This is approximately 13 years before the ultimate long term airport development year (2063).
- The traffic impacts also effect the wider road network with significant congestion predicted on key road links in 2063. The assessment acknowledges this is a result of significant background growth in conjunction with unknown road infrastructure commitments past 2041.
- The Airport also impacts wider transport modes. The assessment suggests additional rail link capacity (above and beyond the SWRLe) would be required to accommodate both the Airport trips and background growth trips by 2063.

With consideration to the above potential impacts, it is recommended that detailed transport network planning including road and rail network planning be undertaken.

2 Peer Review Methodology

2.1 Approach

Arup reviewed the traffic and transport assessment of the draft EIS of the proposed Western Sydney Airport with respect to its technical adequacy and completeness. The review considered relevant guidelines, requirements and legislation.

Specifically, Arup undertook the following tasks:

- Consider whether the traffic and transport study meet the requirements of the EPBC EIS Guidelines and relevant other guidelines and methodologies.
- Reviewed the validity of the draft EIS conclusions – i.e. an independent evaluation of whether the predicted impacts are in accordance with published standards and guidelines, and whether the conclusions of the assessment are likely to be a realistic reflection of the actual impacts.
- Evaluated the appropriateness of the underlying assumptions used to inform the assessment (including any construction or operational assumptions and modelling assumptions) are plausible.
- Reviewed the mitigation and management measures proposed and advised on their adequacy in mitigating impacts.
- Assessed the level of uncertainty over impacts and the environmental risks identified in the draft EIS.
- Reviewed the transport modelling and analysis presented in the report of the construction scenario and the Stage 1 and long term development scenarios for the Airport and assessed each models fitness to draw conclusions of the Airports impacts
- Provided a summary of the key impacts and opportunities associated with the projects traffic and transport impact assessment based on the information provided.

2.2 Limitations

The following details the limitations within Arup's peer review assessment:

- The peer reviews was based on the draft EIS reports provided, with no fieldwork undertaken or any direct communication with the specialists preparing the report, or regulators.
- No detailed model auditing was undertaken, Arup only provided comment on the modelling methodology and results presented in the draft EIS documentation
- Arup did not undertake any additional modelling or analysis to assess the adequacy of the modelling results provided

2.3 Draft EIS Sections Reviewed

Arup reviewed the following specific sections of the Environmental Impact Statement (EIS) for the proposed Western Sydney Airport, including:

- *“WSA EIS 19 volume 2 chapter 15”*
- *“WSA EIS 39 volume 3 chapter 33”*
- *“WSA EIS GHD volume 4 appendix j surface transport and access”*

3 Detailed Findings: Construction & Stage 1

The following details Arup's peer review of the construction and operational traffic impacts caused by Stage 1 of the proposed Western Sydney Airport.

3.1 Compliance of the report with the (EPBC Act) EIS Guidelines

The following describes Arup's consideration of the key Traffic and Transport sections of the Western Sydney Airport draft EIS compared to the requirements set out in the EPBC Guidelines.

a. The *EPBC guidelines*, *Section 5 Relevant Impacts* suggests that the EIS should assess *changes in traffic movements during construction and operation (associated with both passenger movements and workers)* where this assessment should *be prepared according to best practice guidelines and compared to best practice standards.*

The Sydney Strategic Travel Model (STM3) model has been used to forecast and assess the changes in traffic movements as a result of construction and operational traffic generated by the Airport. STM3 is the accepted travel demand forecasting tool for Greater Sydney Metropolitan Area (GMA) that is operated and maintained by the Bureau of Transport Statistics within Transport for New South Wales. STM's features include:

- Examining the effects of significant land use changes and significant transport initiatives which may include packages of road, rail and travel demand management measures
- Travel demand forecasts for the Greater Sydney Metropolitan Area by travel zone by mode choice and distribution.
- Private vehicle assignment on the strategic road network based on link based delay functions
- Transport mode choice and distribution for trips to/from the Airport. It therefore has additional rigour when conducting its vehicle assignment.
- When calibrated and validated, the STM3 is best suited to forecasting changes in demand or growth rather than absolute forecasts on a corridor.

With consideration of the above, the STM3 is likely to be a well suited model that is able to capture the effects of the Airport at a strategic level.

However, Arup also appreciates the strategic nature of the STM3 and the limitations inherent within the model, namely:

- The STM3 is a large area travel demand model that includes complex functions and interactions that approximate travel behavioural characteristics based on relatively large input dataset. The model therefore approximates travel patterns experienced in the real world.

- The STM3 contains road link geometry that is relatively simplified, using only link lengths and number of lanes as inputs. For example, turning bays at intersections are not specifically modelled.
- The STM3 models vehicle operations on the road links in a relatively simplified manner. Predicted traffic delays and congestion follow only basic ‘volume to speed’ relationships.
- Vehicle operations at intersections are not specifically modelled. For example, traffic delays and congestion caused by inefficient intersection geometry and/or inefficient signal phasing is not captured.

Furthermore, as disclosed in the draft EIS assessment, there is a risk that the STM3 is not effectively calibrated and validated for the purposes of this draft EIS. The assessment states “*STM3 models were provided by Transport for NSW for this task. The models are currently in development by Transport for NSW. However, due to the time constraints for the Western Sydney Airport EIS, GHD has used the latest available versions as the basis for the analysis in this study. GHD has not reviewed or corroborated the models provided beyond consistency checks of outputs*” (WSA EIS GHD volume 4 appendix j surface transport and access). This is a limitation of the draft EIS methodology and is considered a risk.

With consideration to both the STM’s features and limitations listed above, Arup further acknowledges the industry standards that suggest strategic models like the STM3 be only applied for strategic purposes. It is generally accepted that strategic models can form strong baselines for transport impact assessments, but are not considered the best tool for detailed assessments. *(BTS Technical Documentation, February 2011)*

The BTS describes that “*For specific projects, the STM outputs should be used as a starting point to produce estimates of overall demand in response to alternative land use and/or transport supply scenarios. However, the STM, due to its limitations as a strategic modelling tool, may need to be supplemented with more detailed analyses for project evaluation purposes” (BTS InfoSheet, December 2013)*

Hence the STM analysis undertaken for the draft EIS would have captured the effects of changing traffic movements as a result of the Airport at a strategic rather than detailed level. STM, as a strategic travel demand model, does not include representation of intersections and would not provide confidence in traffic forecasts at a corridor level. This is why a model hierarchy exists in Sydney with STM providing strategic travel forecasts, and more detailed traffic and public transport patronage assessments being undertaken in the Roads and Maritime’s traffic model and the BTS’s PTPM model respectively. Furthermore, various project specific models can be developed on a project by project basis for detailed traffic analysis.

b. Section 5 of the *EPBC guidelines* , *Section 5 Relevant Impacts* suggests that the EIS should assess *changes in traffic movements during construction and operation (associated with both passenger movements and workers)* where this assessment should *be prepared according to best practice guidelines and compared to best practice standards.*

The draft EIS did not include intersection modelling to assess the Airports potential traffic impacts. This is a key limitation of the assessments methodology and is considered a significant risk.

Traffic intersection modelling could supplement the broad strategic baseline set by strategic traffic models, and further capture impacts on road networks at a detailed level. For example, unlike strategic traffic models, intersection traffic models can capture the relationship between intersection capacity and intersection lane geometry. Namely, they can be used to assess if additional land take would be required to widen intersections to allow for acceptable traffic operations. Hence, unlike strategic models, they can be used to capture the direct effects of traffic impacts on land acquisition. In relation to adhering to the EPBC requirements for 'best practice', Arup acknowledges the use of both strategic traffic modelling and intersection traffic modelling in other EIS submissions. The following large scale infrastructure projects in Sydney used detailed intersection traffic modelling coupled with strategic traffic modelling to capture future traffic impacts:

- Sydney Metro Northwest (North West Rail Link): Intersection modelling of construction and operational impacts
- WestConnex Stage 1a: Intersection modelling of construction and operational impacts
- WestConnex Stage 1b: Intersection modelling of construction and operational impacts
- NorthConnex (M1-M2 Link): Intersection modelling of construction and operational impacts

c. The *EPBC guidelines*, *Section 5 Relevant Impacts* suggests that the EIS should assess *changes in traffic movements during construction and operation (associated with both passenger movements and workers)* where the assessments should *be supported by maps, graphs and diagrams as appropriate to ensure information is readily understandable,* and where this assessment should *be prepared according to best practice guidelines and compared to best practice standards*.

The following tables and diagrams are contained within the assessment (but not limited to):

- Mid-block Volume/Capacity Diagrams (existing)
- Mid-block Level of Service Diagrams (existing)
- Mid-block Level of Service Tables (existing)
- Mid-block Volume/Capacity Diagrams (future)
- Mid-block Level of Service Diagrams (future)
- Mid-block Level of Service Tables (future)
- Mid-block Volume Difference Diagrams (future)

When considering Level of Service, Arup acknowledges that the worst Level of Sevice reported is F and also acknowledges that comparative distinctions can be made when Level of Service changes within the A to F spectrum. For example, '*as a result of the future traffic generated by the shopping centre, the existing road deteriorates in performance from Level of Service C to E*'.

However, when roads links already operate at Level of Service F the addition of traffic and associated impacts can be hidden within Level of Service results. For example *Level of Service F to F*. For this reason, a table of midblock volume to capacity values should be provided to gauge and quantify any potential traffic impacts caused above and beyond Level of Service F.

The draft EIS provided mid-block volume to capacity diagrams, but did not provide tables with explicit volume to capacity values. When comparing to other large scale infrastructure EIS assessment, Arup notes the provision of these values is generally accepted as industry best practice.

Vehicle travel time comparisons were not provided in this draft EIS assessment. These are important metrics that identify future congestion levels and accessibility to the airport. This is a limitation of the assessments methodology and is considered a risk. Arup notes that strategic modelled travel time comparison metrics were used in the WestConnex, NorthConnex and NWRL EIS assessments.

The STM3 could be used to predict vehicle travel times along road links 'with' and 'without the Airport' to further quantify the traffic impacts.

d. The *EPBC guidelines*, *Section 3 Feasible Alternatives* suggests the EIS should consider feasible alternatives, provide comparative analysis and commentary of the alternative, and also make clear which alternative is preferred.

Importantly, one such alternative could be the 'do nothing' alternative (i.e do not build the Airport). Arup acknowledges that the traffic and transport sections of this assessment did provide analysis and commentary pertaining to the 'do nothing' alternative. Through the use of the STM3 strategic model, this assessment provided commentary on performance of the road network 'with Airport' and 'without Airport (do nothing).

However, Arup also understands that the potential use of Wilton or the RAAF Base Richmond were also considered alternatives. The Traffic and Transport sections of this draft EIS did not provide analysis and commentary pertaining to either of these alternatives.

e. The *EPBC guidelines*, *Section 5 Relevant Impacts* suggests the EIS should identify and address the cumulative impacts of the project in addition to existing impacts of other activities. Critically, the impacts should include future developments from other proponents in the region or vicinity.

This assessment provided analysis and commentary pertaining to the existing impacts of other activities (including future developments) in the region or vicinity. As described, these future regional impacts will arise from key land use developments from the South West Growth Centre (SWGC), the Broader Western Sydney Employment Area (BWSEA) and the Greater Macarthur Land Release Area. The STM3 strategic model captured the combined effects of traffic generation from the proposed Airport land uses and also traffic generation of these future land uses in the in the region. Hence, through the use of the STM3, this assessment made commentary on the cumulative impacts of the Airport land uses above and beyond future non-airport land uses.

However, no commentary pertaining to future land use assumptions were provided. This assessment makes the following comment in relation to the traffic impacts of the Airport in 2031 "*the substantial package of road improvements proposed as part of the WSIP, in addition to those identified in the BWSEA and SWGC, would have sufficient capacity to cater for the expected airport passenger and employee traffic demand in 2031*". As land use is one of the key underlying drivers of traffic generation, the explicit future land uses in the region should be provided. This would hence cater for improved comparisons between future land use traffic generation and future roadway capacity. To support this claim Section 5 of the EPBC guidelines suggests that the EIS should assess *changes in traffic movements during construction and operation (associated with both passenger movements and workers)* where *standards and guidelines used to quantify baselines and impacts should be explained or justified*. Arup believes the disclosure of the explicit land use assumptions of future land uses in the area is justified by the EPBC Act.

f. The *EPBC guidelines*, *Section 5 Relevant Impacts* suggests that the EIS should assess *changes in traffic movements during construction and operation (associated with both passenger movements and workers)* where this assessment should *be against appropriate background/baseline levels.*

As described in point (e) above, the draft EIS has captured effects of traffic generation from the future non-airport related land uses in the in the region and has therefore established and 'appropriate background/baseline level'. Nonetheless, this should be viewed in conjunction with lack of information provided on the specifics of these land use assumptions.

3.2 Commentary on validity of assumptions

The following describes Arup's consideration on the validity of the assumptions used in the Traffic and Transport sections of the Western Sydney Airport draft EIS.

3.2.1 Traffic Generation Assumptions

a. Non Direct Airport Related Traffic – As described in the methodology section of the Traffic and Transport assessment, trips originating in and destined for the Airport site were defined as

- Construction traffic
- Air passenger arrival and departing vehicle traffic
- Airport related employee traffic (only those who work directly for the Airport)
- Freight traffic (only those vehicles required to service the predicted tonnage of air cargo)

From above, the traffic impact assessment of Stage 1 only considered traffic generation from these 'direct airport-related trips'. Any traffic generation caused by other land uses (either by staff, businesses or general public) within the Airport site has not been presented in the draft EIS. As in, the assessment has not considered the impacts from non-directly related airport traffic, but traffic that would otherwise not be in existence without the Airport being constructed.

As described in section 2.3 of *Draft Airport Plan – Western Sydney Airport (October 2015),* 229 hectares and 167 hectares would be zoned for 'Terminal and Support Services' and 'Business Development' respectively.

Section 2.4.2.2 states that 'Terminal and Support Services' would include "*Developments to facilitate the provision of goods and services necessary to meet the quality and standards that international, domestic and regional travellers have come to reasonably expect*" including, but not limited to the following uses:

- Business premises
- Markets
- Kiosks
- Freight handling and transport facility
- Hotel or motel accommodation
- Office premises

Section 2.4.2.5 states that 'Business Development' would "enable a mix of business, retail and industrial uses in locations that are close to and that support the functioning of the Airport" including, but not limited to the following uses:

- Business premises
- Retail premises
- Recreational facility
- Hotel or motel accommodation
- Freight handling and transport facility
- Warehouse and distribution centres
- Light Industry
- Office premises

The scale and function of the above land use developments could generate a significant cumulative amount of traffic. This draft EIS did not make any assumptions to account for this potential traffic and associated potential impacts.

Adjustments to the land use assumptions that inform STM and the use of traffic generation first principles or empirical benchmarking data (of other airports) could have been used to capture and assess this potential traffic impact.

b. Flight Related Traffic – Commentary on the validity of the assumptions used in the draft EIS are found in Section 2.2.2 Aviation Demand and Activity of the Arup document entitled "Western Sydney Airport EIS Peer Review - Aviation Planning and dated 6 November 2015":

With respect to passenger transfer reductions and in relation to traffic generation, it is noted the draft EIS did not account for the potential transfer of air passengers between flights. Namely, no assumptions were made pertaining to whether any passengers may arrive by one flight, transfer, and then depart on a subsequent flight. A behaviour sequence like this would result in the passenger not impacting on the landside road network.

This passenger transfer information would likely be available for other airports of similar size and type to the proposed Airport. Hence, Arup believes a benchmarking exercise could be undertaken that would result in an informed assumption of 'transfer of air passengers'. Arup understands that without such an assumption, all arriving airside passengers convert into landside trips. This represents a worst case scenario, but also an unlikely scenario.

c. Airport Related Staff Traffic – Arup acknowledges the level of detail and rigour used to predict the quantity and mode share of trips created by Airport staff. Considering that the Airport is in early stages of planning, Arup believes the assumptions used in these predictions are fit for purpose for the draft EIS assessment.

However, Arup does not agree with the validity of the assumption that states "*For each shift, 50 percent of employees have been assumed to arrive in the hour before their shifts starts…"* Arup believes it is unlikely that many staff members (if any) would arrive more than a full hour prior to their shift start. Nonetheless, Arup does not believe this assumption would significantly affect the outcomes of this assessment.

d. Air Freight Cargo Traffic – For commentary on the validity of the assumptions used to predict peak hour air freight cargo for the Airport are found in Section 2.2.2 Aviation Demand and Activity of the Arup document entitled "Western Sydney Airport EIS Peer Review - Aviation Planning and dated 6 November 2015".

Regarding the predicted vehicle trips generated by the air freight cargo only, Arup notes a discrepancy between the freight trips tabulated in Table 6-10 and the freight trips described in section 7.4 of *WSA EIS GHD volume 4 appendix j surface transport and access.* Table 6-10 indicates a total of 9 and 13 freight trips to/from the Airport in the 2 hours AM and PM peaks respectively. While section 7.4 describes a total of 3,966 freight trips to the Airport in the 2 hour AM peak and a total of 1,905 freight trips from the Airport in the 2 hour PM peak. It is unknown where this discrepancy has come from. It should be noted the 3,966 and 1,905 trip volumes seem to relate to the total traffic trips to/from the Airport shown in Table 6-10.

e. Public Transport Trip Generation –

Air Passenger Public Transportation Use

As described in Table 6-3 of '*WSA EIS GHD volume 4 appendix j surface transport and access'*, public transportation use (for air passenger trips) originating in and destined for the Airport in 2031 were assumed as:

- 5% Shuttle
- 5-10% Bus
- 0% Train

The draft EIS indicates the Sydney Airport Land Transport Model (SALTM) was used to predict the proportions of each transport mode used by air passengers to and from the Airport (no rail trips) in 2031. It appears that adjustments were made to these mode proportions to respond to the predicted capacity constraint of the Airport Access Drive. The approach in determining these adjustments is unclear.

However, the results shown in Figure 7-6 and 7-7 of '*WSA EIS GHD volume 4 appendix j surface transport and access'*, contradicts the suggestion that the Airport Access Drive forms a constraint in 2031. The figures show the Airport Access Drive is not coloured pink or red, and therefore operates below capacity in 2031.

It is hence unclear why road link capacity was used to adjust transport mode proportions.

The NSW Government is currently planning the SWRLe. At the time of the draft EIS publication, no commitment to its construction had been made. As a result, this draft EIS assumed no rail link would service the Airport by 2031. This lack of rail service is likely to generate higher dependency on private vehicle usage and possibly higher dependency on buses and shuttles. The draft EIS did not specifically assess any predicted impacts of future Airport bus servicing on the local bus network.

There is insufficient supporting information in the Draft EIS for Arup to comment on the methodology used to assess air passenger public transport use in 2031. Further modelling and benchmarking the public transportation use of the proposed Airport against other airports of comparative size and function should be considered.

Airport Employees Public Transportation Use

The draft EIS indicates the 2031 airport employee transport mode splits were determined using journey to work (JTW) data for the existing Kingsford Smith Airport.

As it was assumed that the airport in 2031 will not be serviced by rail, the rail trips found in the JTW were apportioned to the other modes. The draft EIS then compared these apportioned mode splits with JTW data for other employees in adjacent areas to the proposed Airport site (Liverpool, Penrith, Camden, Fairfield, Campbelltown, Blacktown and Holroyd).

The comparison suggested the JTW splits for the proposed Airport contained higher private vehicle usage than the JTW splits for the adjacent areas. Hence its use is considered conservative for the assessment of employee traffic impacts of the proposed airport in 2031.

3.2.2 Strategic Modelling Assumptions

To assess the changes in traffic movements as a result of construction and operational traffic of the proposed Airport, this assessment used the STM3 transport model. Arup believes the STM3 is likely to contain the most up to date assumptions and hence be well suited to capture the effects of the Airport at a *strategic level*.

However, the following lists those assumptions that may be considered invalid or lack supportive information:

a. Road Link Calibration and Validation – As stated in Appendix J of this draft EIS, at the time of the assessment, the STM3 models were currently in development by BTS. This assessment used the latest available version as the basis for the draft EIS assessment. No model calibration or validation statistics have been provided in this assessment, in particular for the existing major road links in the vicinity of the Airport site. Arup appreciates the calibration challenges of previous versions of the STM (STM and STM2). Poor calibration of existing road links in base models can generate large errors in the forecast performance of these road links in the future. Alternatively the previously calibrated STM2 could have been used as the strategic model for this assessment.

b. Model Road Toll Choice – The STM3 does not contain sophisticated toll choice functionality. Arup notes that other large scale infrastructure EIS assessments used a separate toll choice model to capture these effects with greater confidence. Westconnex 1a and 1b used "*…a toll choice model for assigning road traffic to toll routes through the application of a toll choice diversion model, known as a distributed value of time (VOT) multi-class equilibrium assignment model*" (Westconnex Stage 1B EIS). As stated in Appendix J of this draft EIS, the use of a two-stage process to assign vehicles to road links was used for the base year and future year road networks. The second stage used a toll-choice assignment to reflect those vehicle drivers who are willing to pay for tolls and those who are not. The methodology used to model toll choice was not disclosed in the draft EIS. This is a potent a risk as several major toll roads would provide access to the airport in the future including:

   - M4
   - WestConnex
   - M7

c. Base year selection – This draft EIS indicated that 2011 was modelled as the base year to represent existing conditions. Observed traffic data from 2011 was used to validate the model.

As stated in the assessment, the use of 2011 data does not include recent land use developments in the region. This includes vehicles trips that are generated by the BWSEA and SWGC today in 2015. As described in the assessment, some of the road links in the region have grown by up to 2.8% per year between 2008 and 2014.

Future years modelled in this assessment include the construction year (2021), Stage 1 operation (2031) and longer term airport development year (2063) are all forecast based on the 2011 base year calibration. There were no calibration and validation results provided in the draft EIS. Furthermore, as described by BTS "*there may be some variation between (existing) modelled results and on the ground results for the base year. For this reason the BTS recommends using STM growth factors applied to known base year numbers, rather than the directly predicted STM volumes*" *(*BTS Technical Documentation, February 2011*).* This suggests the importance of using correct 'known' base year data for all future forecast modelling.

d. Future year selection – The draft EIS identified that 2031 was selected as the year to represent Stage 1 Airport conditions.

As stated in the *Draft Airport Plan – Western Sydney Airport (October 2015),* the Plan's primary concern relates to '*the Stage 1 Development… (which) would cater for the predicted demand for the first five years of operation to around 2030'.*

It also identifies that any airport development beyond this time (including a rail link) will be '*staged in line with demand'* and that *'Developments after Stage 1 will be undertaken under the existing planning framework in Part 5 of the Act (Airports Act 1996*)*'.*

Arup understands the above to mean that prior to any long term development of the airport being constructed, a major development plan (managed in accordance with the Airports Act 1996) will be required with final approval provided by the Minister of Infrastructure and Regional Development.

Hence, the use of 2031 as the year that represents Stage 1 of the Airport is considered appropriate for this draft EIS.

e. Freight Traffic – The draft EIS considered future freight vehicle trips as a result of the Airport. However, Arup notes these generated vehicle trips are only related to the predicted tonnage of air cargo in 2031. It was identified this would equate to approximately 9 and 13 heavy vehicle trips to/from the Airport in the 2 hour AM and PM peaks respectively.

This heavy vehicle freight traffic is the only freight traffic predicted in this draft EIS assessment. No allowance, assumption or testing of any other freight traffic has been made in the assessment. Arup understands the proposed Airport is predicted to serve freight operations (24 hours per day) that would generate vast economic benefits to the region. The freight operations are predicted to unlock economic benefits of Western Sydney's growing population (SWGC) and growing economy (BWSEA). Considering this strategic objective, and also that this draft EIS assessment noted "*the analysis excludes the traffic to and from the proposed Airport generated by associated commercial development or freight traffic for consumables*", there may be insufficient assumptions being made regarding the likely freight traffic generation caused by the Airport.

Without a detailed terminal plan, it would be difficult to determine the heavy vehicle traffic required to service the Airport with full confidence. However, as stated in section 2.3 of the *Draft Airport Plan – Western Sydney Airport (October*

2015), provision for specific types and quantity of zoned areas within the Airport precinct is made. It also provides the potential uses within these zones. Hence, the lack assumption regarding wider freight traffic generation and subsequent lack of inclusion of such in this draft EIS is considered a risk.

It is not clear what assumptions were made regarding future freight movements in the strategic modelling undertaken as part of the draft EIS. The Freight Movement Model (FMM) has been used in other transport planning assessments. Like the (STM3), the FMM is government owned and operated (by BTS). It predicts freight movements by professional drivers that are not found explicitly in the STM.

It should be noted, the FMM contains the Kingsford Smith Airport (both domestic and international terminals) modelled and calibrated as a 'special generator'. *TDC Heavy Vehicle Forecasts - February 2010 Release.*

3.3 Discussion whether the conclusions reached in the studies are valid

With consideration to Arup's comments described in sections 3.1 and 3.2, Arup notes some limitations within the Traffic and Transport sections of this assessment, namely:

- Potential gaps in and/or potential lack of supportive information for:
    - Explicit future land use assumptions in the region of the Airport
    - Potential land use within the Airport precinct that has not been accounted for
    - Airport related freight generation (above and beyond air cargo tonnage)
- Methodologies that measure traffic impacts that may not be considered industry best practice, including:
    - Intersection modelling not undertaken
- Sections of analysis and commentary that may not be considered industry best practice, including:
    - Quantifiable values of road capacity (volume to capacity)
    - Vehicle travel time comparisons on major road links, 'with' and 'without' the Airport not provided
    - Intersection performance values, 'with' and 'without' the Airport, are not provided (intersection modelling not undertaken)
    - Intersection layouts (and subsequent potential land acquisition impacts) required to accommodate future Airport traffic are not provided or not described.

Based on our review, these limitations could be considered significant. Further information would need to be provided to enable Arup to reach a firm opinion as to whether the conclusions reached in the study are valid. Until these comments are addressed or further information supplied, Arup is unable to comment on the validity of the conclusions reached in this draft EIS.

3.4 Review of proposed mitigation and management measures

Regarding the traffic impacts caused by construction activities, industry standards and best practice allow EIS documents to refer to the requirement of a Construction Traffic Management Plan (CTMP) as part of a Construction Environment Management Plan (CEMP) to capture and mitigate specific construction disruptions to the community. This assessment nominates these requirements. Arup believes this approach is fit for purpose.

Regarding the traffic impacts caused by the operation of Stage 1 of the Airport, this assessment concluded that the Western Sydney Infrastructure Plan will provide sufficient road capacity that will accommodate airport related traffic. Nonetheless, this assessment also mentions that mitigation and management measures that will reduce any other impacts will be delivered via a Ground Transport Plan (as part of detailed design). Subject to the comments raised by Arup in the rest of this peer review, this approach could be considered in accordance with industry standards.

3.5 The level of uncertainty over impacts and the environmental risks

The following matrix tabulates what Arup believes to be the level of uncertainty to the traffic and transport impacts caused by the Airport.

Issue	Level of Uncertainty: Low	Medium	High	Unknown
Assumption gaps + Lack of supportive information				
Explicit future land use in region and subsequent traffic generation	X			
Potential land use within the Airport precinct subsequent traffic generation		X		
Freight generation (outside of air cargo)				X
Assessment Methodology				
Intersection performance				X
Analysis and Commentary				
Explicit volume to capacity ratios of midblock road links	X			
Vehicle travel time comparisons				X
Public transport operations				X
Intersection layout descriptions				X

4 Detailed Findings: Long Term development

Arup understands that the assessment of the long term development of the Western Sydney Airport should be viewed as ‘preliminary consideration’. Prior to the long term development of the airport being constructed, a major development plan (managed in accordance with the Commonwealth Airports Act 1996) will be required with final approval provided by the Minister of Infrastructure and Regional Development.

4.1 Approach of Airport long term development assessment

The predicted traffic impacts of the long term development of the Western Sydney Airport largely followed the Stage 1 assessment, including:

- Similar Airport vehicle traffic generation
    - Air Passengers (private vehicles, taxis and buses)
    - Airport Employees (private vehicles, taxis and buses)
    - Air Cargo Tonnage (freight vehicles)
- Similar road network modelling assessment (traffic impacts)
    - Midblock capacity assessment (STM3)
- Similar presentation of analysis, results and commentary

However, the key difference between the Stage 1 and long term development assessment are:

- Road network configuration
    - Introduction of Castlereagh Highway connection to the M7
- Introduction of passenger rail link
    - South West Rail Link Extension (SWRLe)
    - North and south connection of the SWRLe to St Marys and Narellan respectively

4.2 Potential ‘gaps’ of long term development assessment relative to a conventional EIS assessment

When identifying the potential gaps in the long term airport development impact assessment, Arup broadly considered the following:

- Arup’s comments regarding the limitations of the Stage 1 assessment described in sections 3.1 to 3.4,

- The long term development impact assessment largely follows the Stage 1 assessment
- Prior to the long term development of the airport being constructed, a major development plan (managed in accordance with the Commonwealth Airports Act 1996) will be required with final approval provided by the Minister of Infrastructure and Regional Development.

The following are specific gaps or areas of concern that Arup believes are related to the long term development impact assessment:

- The draft EIS states that the Airport Access Drive (from M12) is predicted to fail in 2050
    - Failure of the Airport Access Drive has been defined as when the midblock reaches LoS of D. This corresponds to a midblock capacity of 1,700 vehicles per hour per lane.
    - When considering the environment of an airport access road (multi decision points, merging and weaving effects, passenger drop offs effects), Arup notes the 1,700 vehicles per hour per lane capacity is likely to be overestimated. Nonetheless without a detailed layout plan of the internal road network, it is difficult to comment on the appropriateness or the likely effects of this capacity assumption.
    - Arup inferred (via the graphical results provided) the inbound or outbound vehicle movements on the Airport Access Road will be over capacity for 15 hours out of 24 hours per day
    - The road link capacity is reached approximately 13 years before the long term airport development impact assessment scenario year (2063)
- The Northern Road, M7, Elizabeth Drive, Mamre Road, Luddenham Drive reach capacity with the Airport in 2063. The assessment has not provided any strategic measures to mitigate these constraints.
- Passenger Rail Link Provision (SWRLe)
    - Insufficient information has been provided to determine how air passenger demand would access and egress the Airport beyond 2050 (when the Airport Access Road reaches capacity). The *WSA EIS GHD volume 4 appendix j surface transport and access* does identify:
        - "*…… that this forecast level (access road failure) is predicted to be achieved in based on current airport passenger volumes 2050 and investment in rail infrastructure would be required beyond this point… to enable the Airport to reach the desired 82 MAP*"
        - "*the modelling undertaken for the concept plan requires the capacity of the proposed access road network to be a*

constraint, the mode split proportions are required to be an input….(and) are shown in Table 9.3"

    - "*the mode split for car modes was modified down based on the capacity of a potential staff car park when the access road reaches its nominal capacity*"

- Arup has hence inferred (from above) that a large proportion of air passenger and airport staff trips will be required to shift from vehicles to rail beyond 2050. However:
    - The STM3 does not account for rail capacity constraints Passengers are therefore not deterred from catching trains even if they are crowded
    - The graphs contained within the long term airport development assessment suggest train arrival and departure demands of approximately 2,000 trips per hour for many hours of the day. No information has been provided as to assess what impact this would have on the Sydney Rail Network.
    - STM3 modelling only considered the morning peak public transportation network only.

Arup understands the long term airport development assessment to be in a 'preliminary consideration' phase and may not require the level of detail of an EIS assessment. Hence the issues or 'gaps' noted above should be viewed in this context.

Arup recommends a future airport long term development assessment could be undertaken with additional rigour which could explicitly address the issues relating to detailed passenger rail planning and detailed road network planning.

4.3 Key risks and implications as a result of the gaps

As Arup understands the long term airport development assessment to be in a 'preliminary consideration' phase it may not require the level of detail of an EIS assessment. As a result, the implications of the aforementioned gaps are less severe. This is subject to a commencement of further investigations.

4.4 Effectiveness of the assessment in setting a framework for further assessment.

The assessment of the long term airport development impact has mentioned limitations within the methodology and/or limitations in available information required for the assessment. These are:

- Committed road network beyond 2041 (to 2063)
- Commitments to the nature of the SWRLe.

Arup hence believes the assessment has eluded to further studies that may be required to assess the long term airport development and hence has effectively provided some of the framework required for further assessment.

5 Summary of key impacts and opportunities

5.1 Construction

The following describes the predicted construction traffic impacts caused by the Airport as described in the draft EIS:

- The traffic impacts of construction of the Airport on the local road network is predicted to be relatively low. The proponent predicts the local road performance and operations 'with' and 'without' construction traffic to remain relatively stable.

With regard to above, it is difficult for Arup to confirm the validity of these impacts with confidence. Arup has identified further information that could be provided to quantify the potential impacts, including:

- Vehicle travel time comparison (as predicted by strategic modelling)
- Intersection performance (as predicted by intersection modelling)
- Intersection layout requirements (as predicted by intersection modelling)

5.2 Stage 1

The following describes the predicted traffic impacts caused by Stage 1 of the Airport as described in the draft EIS:

- The traffic impacts caused by Stage 1 of the Airport is predicted to be relatively low. The draft EIS states "*the substantial package of road improvements proposed as part of the WSIP, in addition to those identified in the BWSEA and SWGC, would have sufficient capacity to cater for the expected airport passenger and employee traffic demand in 2031*" (WSA EIS GHD volume 4 appendix j surface transport and access*)*. With consideration to the methodology used, the draft EIS states the future road network is able to accommodate the predicted Airport traffic demand.

With regard to above, it is difficult for Arup to confirm the validity of these impacts with confidence. Arup has identified further information that could be provided to quantify the potential impacts, including:

- Freight traffic generation within the Airport precinct (outside of air cargo)
- Private vehicle traffic generation from land uses within the Airport precinct (outside of air passengers)
- Vehicle travel time comparison (as predicted by strategic modelling)
- Intersection performance (as predicted by intersection modelling)
- Intersection layout requirements (as predicted by intersection modelling)

5.3 Long term Airport development

The following describes the predicted traffic impacts caused by the long term development of the Airport as described in the draft EIS:

- The traffic impacts caused by the Airport is predicted to be significant. The Airport Access Drive from the M12 is predicted to fail in 2050. This is approximately 13 years before the ultimate long term airport development year (2063).
- The traffic impacts also effect the wider road network with significant congestion predicted on key road links in 2063. The assessment acknowledges this is a result of significant background growth in conjunction with unknown road infrastructure commitments past 2041.
- The Airport also impacts wider transport modes. The assessment suggests additional rail link capacity (above and beyond the SWRLe) would be required to accommodate both the Airport trips and background growth trips by 2063.

For the purposes of the Peer Review, Arup was not privy to the specific requirements of the draft EIS. Arup recommends detailed transport network planning including road and rail network planning.

6 Peer Reviewers Qualifications

Sam Gray

Sam is a Senior Traffic Engineer based in Sydney with extensive experience in the development, design and management of transport planning and road design projects. Sam is a specialist in planning and operational assessments of road networks, motorways and public transportation.

Specifically, Sam has vast experience in the application of land used changes on motorway and surface road networks. His has expertise working with forecasting demands and operational flows to suitably assess road and motorway projects. His strategic and operational assessments include road construction staging, interim network staging and ultimate layouts. He completes design options analysis, traffic impacts and environmental impacts to validate a wide variety of projects.

Sam also understands the strategic elements of road planning and the relationship between modal shifts which is evidenced by his involvement on related projects that incorporate wider transportation solutions. His qualities and experience allow him to identify project hurdles early and he has shown that he can overcome these project hurdles by relaying the critical information pieces above and below first hand. This practise allows for quality decisions making across the project, manages expectations of possible project changes, and ultimately allows for timely delivery of quality project outcomes.

Project Experience

NorthConnex (M1-M2) EIS Approvals, Sydney

Mona Vale Road REF Traffic and Transport Study, Sydney

North West Rail Link EIS Approvals, Sydney

WestConnex Stage 3 Road Operations Assessment, Sydney

WestConnex Full Scheme Business Case, Sydney

WestConnex Alignment and Interchange Assessment, Sydney

Northern Beaches Hospital Road Network Assessment, Sydney

Old Wallgrove Road Upgrade Design Construction Staging, Sydney

Camden Valley Way Road Upgrade Design, Sydney

Edmondson Park Road Network Assessment, Sydney

Inner Newcastle Road Network Study and Concept Designs, Newcastle

Peter Dunn

Peter is a transport planner specialising in strategic transport planning, economic evaluation, demand forecasting, and design of transport infrastructure. He has extensive international experience in major transportation projects. As an Associate Principal, Peter is responsible for the project management of transport related work undertaken in Australia and New Zealand. Peter has a firm understanding of transport issues as they relate to the needs of different cities, through being responsible for significant transport planning studies in Australia, New Zealand, England, Ireland and Hong Kong. He is experienced in the application of analytical techniques to assess and provide solutions to complex transport issues. His design experience includes numerous road planning and intersection design studies.

Project Experience

Public Transport Project Model Audit, Sydney

NSW Long Term Transport Master Plan: Transport for New South Wales

Auckland Public Transport Model: Review of mode specific constant

Wellington Strategic Transport Model Peer Review, New Zealand.

AMETI Model Peer Review, Auckland New Zealand

Wellington Public Transport Model Review

Sydney Metro Demand Analysis Advisor, New South Wales

Sydenham to Bankstown Corridor Study

Central to Eveleigh Transport Study

Canberra Light Rail Master Plan

Andrew Hulse

Andrew is an Associate Principal in the Transport Planning division of Arup, Sydney. He provides transport planning advice and design input on a range of major development projects. Andrew has worked with Arup for 30 years in a number of the Arup Australian offices, in London for a two year secondment and Hong Kong and Singapore on specific projects.

He has particular skills in the areas of traffic management, bicycle planning, traffic calming, hospital parking demand and town centre traffic and parking design. Many of these projects have involved public consultation and Andrew has acted as an expert witness on a range of project types.

Andrew provides transport advice on multi-disciplinary projects working closely with planners and architects on projects such as CBD office developments, land rezoning studies and site master planning. He provides patronage assessment, interchange design and route assessment for public transport infrastructure projects, and undertakes traffic assessment for major road projects.

Project Experience

Melbourne Airport Southern Precinct Project

Brisbane Domestic Terminal (Precinct) Expansion Projects, QLD, Australia

Sydney Airport International Terminal, Ground Access Project

Newcastle Airport Car Park

Canberra Airport Master Plan

FIFA World Cup Transport Strategy

Sydney International Convention and Exhibition Centre Peer Review

Barangaroo Development

TfNSW Transport Access Program

Appendix E

Human Health (Centre for Health Equity Training Research and Evaluation)

Centre for Health Equity Training Research and Evaluation
UNSW Australia

Human Health Impacts Peer Review of the Western Sydney Airport Environmental Impact Statement

Commissioned by WSP/PARSONS BRINCKERHOFF

19 November 2015

Table of Contents

List of Abbreviations

CHETRE	Centre for Health Equity Training, Research and Evaluation
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EPBC	Environment Protection and Biodiversity Conservation Act
HIA	Health Impact Assessment
HRA	Health Risk Assessment
HRAPIE	Health Risks of Air Pollution in Europe
MACROC	Macarthur Regional Organisation of Councils
REVIHAPP	Review of Evidence on Health Aspects of Air Pollution
SES	Socio-Economic Status
SIA	Social Impact Assessment
UNSW	University of New South Wales
WHO	World Health Organisation
WSA	Western Sydney Airport
WSROC	Western Sydney Regional Organisation of Councils

Executive Summary

A peer review of the human health sections of the Western Sydney Airport (WSA) draft Environmental Impact Statement (EIS) was undertaken by a team of international reviewers, led by the Centre for Health Equity Training, Research and Evaluation (CHETRE) at the University of New South Wales (UNSW). This work was commissioned by WSP/Parsons Brinckerhoff on behalf of the Western Sydney Regional Organisation of Councils (WSROC) and the Macarthur Regional Organisation of Councils (MACROC).

Methods

The review team developed a peer review framework based upon existing best practice review guidelines for evaluating health impact assessment (HIA). The framework incorporated key elements, processes, and requirements that should be included in the health assessment of an EIS. Additionally, the review team reviewed existing HIAs of airport developments to establish the range of health effects that are relevant to airport health assessments. This framework allowed the review team to assess the quality of the health assessment that was included in the draft EIS, and also determine important health effects that were not included.

Limitations

The review team were only able to conduct a review of the health impacts included in the health chapters (Human Health Chapter and Community Health Appendix). These were limited to noise, air quality, and water impacts, therefore the review team were not able to further review the assessment of other potential significant health impacts associated with airport development, such as changes to employment, transportation, amenity, and housing.

Although the review team assessed the methods used we were not able to assess the validity of the calculations used in predicting health outcomes. Validity of the findings in the health risk assessment (HRA) were based upon what was included in the health appendix, which did not include all necessary methods and formulas to test the findings. It is assumed that the calculations were carried out correctly.

As there was not a comprehensive HIA included in the draft EIS, the review team were limited in the range of recommendations we could make.

Components of Draft EIS Reviewed

Primary:

- Part D – Human Health Chapter
- Appendix G - Community Health

Secondary:

- Volume 1
    - Executive Summary
    - Part A - Project Background
    - Part B - Airport Plan
- Volume 2
    - Chapter 9 - Approach to Impact Assessment

- Chapter 27 - Cumulative Impact Assessment
  - Part E - Environmental Management
  - Part F - Conclusions
- Volume 3
  - Chapter 39, Section 8 – Human Health
  - Part H - Conclusion and recommendations
- Volume 4
  - Appendix E - Noise
  - Appendix F – Air quality
  - Appendix P1 – Social impact
  - Appendix P3 – Economic analysis

1st Stage Airport Findings

Compliance with EIS Guidance:

- Overall, the Health Chapters of the draft EIS comply with most of the Environment Protection and Biodiversity Conservation (EPBC) Guidelines.
- The impacts that are considered in the Health Chapters are those associated with changes in air quality, water quality and noise. Generally, these are assessed in detail in terms of nature and extent of short and long-term impacts.
- Some of the information is presented in a way that makes it difficult for interested stakeholders to fully understand the scope and scale of the potential health impacts. The information provided is not always, clear, succinct and supported by maps or other accessible materials. Technical jargon is generally avoided without losing technical precision or the validity of the statements made. Cross-referencing is used however summaries of the findings of other chapters often do not fully explain key issues. Not all relevant sensitive population sub-groups or receptors have been considered in the areas assessed.
- The rational and justification for why a HRA has been undertaken rather than an HIA are not discussed. There is national and state level guidance on HIA that should have been consulted in the development of the scope and methodology of the health assessment of the draft EIS. Key guidance documents include Health Impact Assessment Guidelines (enHealth, 2001), and Health Impact Assessment: A practical guide (UNSW and NSWHealth, 2007). Ideally the health assessment would have used an HIA framework incorporating an HRA approach.
- Ecologically sustainable development in relation to health is not considered. EPBC guidance states that ecologically sustainable development should ensure that the *health*, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.
- Considering the most significant health impacts/effects/risks considered in the draft EIS are those related to changes in air quality, noise and water quality, the level of analysis and detail presented in the Health Chapters is reflective of the potential significance of these descriptors. However, the potential inequality/inequity impacts have not been sufficiently assessed or discussed. This is a significant gap.

Recommendations for the Health Chapters of the draft EIS to better comply with EPBC guidelines are provided:

- The Health Chapters of the draft EIS should assess the health impacts/effects of changes in the full range of environmental and social determinants of health and the potential inequalities/equity issues due to the proposed development. The level of analysis and detail should be reflective of their likely significance. Examples are changes to road traffic movements and their potential health consequences (community severance, risk of road traffic accident and injury), changes in qualities and characteristics of the surrounding areas (including land values and other economic impacts) and changes in recreational use, amenity of natural areas and access to greenspace and nature and their associated health and wellbeing impacts through, for example, changes to levels of physical activity; effects on services and amenities.
- Findings should be presented in a way that helps to communicate the scale of the population affected, by determinant of health, and also what the synergistic (combined) impacts are likely to be to various communities from exposure to the combined hazards.
- Not all unknown variables, assumptions, and limitations are included in the assessment. A specific comment relates to certain health impacts (e.g. air quality-related health impacts on children, other chronic effects such as incidence of chronic bronchitis in adults) known to occur from exposure to air pollution but for which the level (extent/magnitude) of the health impact associated with a certain level of pollution exposure is uncertain or unknown. These additional health impacts, for which quantification is uncertain or unknown, are not discussed. The Health Chapters should consider and discuss health impacts where quantification is not currently recommended by national guidance (e.g. Australian Government *Guidelines for Health Risk Assessment*) such as air quality impacts on children, other chronic effects, and other additional morbidity effects of short-term exposure but for which there is a widely acceptable evidence base supporting their likely occurrence.

Assessment of Air Quality:

- The assessment of air quality-related health impacts follows a health risk assessment approach, focussing on quantification of health endpoints from exposure to a range of air pollutants. The methodology used is adequate. The range of air pollutants addressed is adequate. The range of health endpoints considered is also adequate and follows Australian evidence and guidance.
- However, the range of health endpoints addressed could be expanded to include others for which solid exposure-response coefficients exist, for example, group A coefficients provided in the WHO HRAPIE Project report[1].
- It is also not clear what baseline incidence rates were used (Sydney average or Liverpool/suburb rates). If Sydney rates are used, this may have resulted in a small underestimation of risks.
- Risks are estimated for 2030 and 2063 snapshots and separately for each pollutant. An overview of the expected scale of impacts resulting from the combined effect of all pollutants should be provided to provide a picture of the total risk to the exposed

[1] Table 1. CRFs recommended by the HRAPIE project, p5-11

communities. It would also have been useful to include stage 1 predictions at full capacity (2050).

- Risks could also have been provided for the entire assessment period e.g. 30 years and not just for the snapshots. Discussion of the uncertainty around estimates could be enhanced, for example through the use of the upper and lower 95% confidence interval values of the exposure-response coefficients used. This would provide a better understanding of the likely range of actual impacts (for the worst-case unmitigated scenario).
- A general level of acceptability for estimated risks is used, stated to be accepted by regulatory agencies. This is for a risk between 1×10^{-6} (1 in a million) and $1\text{x}10^{-5}$ (1 in 100,000). The regulatory agencies should be named and references for this statement should be provided. Consideration should also be given to stakeholder perceptions of acceptability of risk.
- There is no discussion of the implication of the distribution of effects for inequality and equity although baseline information on sensitive/vulnerable groups is provided.
- Community feedback and any potential perceptions or concerns of local residents are not discussed. Community feedback on health concerns should be described and how this feedback was considered and addressed in the assessment should be described. Where community comments have not been incorporated or addressed an explanation justifying this should be presented. If there were no specific comments or concerns about health impacts/effects or some determinants of health then this should also be stated explicitly. There should also be a discussion of how communities were consulted in regards to potential impacts on health.
- Perception effects are different from biological or epidemiological risks, can cause stress and anxiety, and should be considered separately from mortality and morbidity effects.
- Mitigation measures are not discussed; readers are cross-referred to the air quality chapter. An outline of proposed measures (i.e. an air quality management framework or plan) should be provided in the health chapter and an explanation provided for how and to what extent these measures will mitigate the identified health impacts.

Assessment of Noise:

- The assessment of noise-related health impacts follows a health risk assessment approach, focussing on quantification of health endpoints from exposure to a range of noise. The quantitative methodology used is adequate. The range of noise metrics used is adequate. The range of health endpoints considered is also adequate and follows Australian and international evidence and guidance, namely the enHealth Guidance *Health Effects of Environmental Noise other than Hearing Loss* (enHealth, 2004). Risks are estimated for 2030, 2050 and 2063 periods for three different operation phase scenarios.
- A qualitative analysis and discussion of impacts/risks/effects on vulnerable/sensitive groups and on health inequality/equity issues has not been undertaken.
- There is no discussion of the implication of the distribution of effects for inequality and equity.
- Community feedback and any potential perceptions or concerns of local residents are not discussed. Community feedback on health concerns should be described and how this feedback was considered and addressed in the assessment should be discussed. Where

community comments have not been incorporated or addressed an explanation justifying this should be presented. If there were no specific comments or concerns about health impacts/effects or some determinants of health then this should also be stated explicitly. There should also be a discussion of how communities were consulted.

- Perception effects are different from biological or epidemiological risks, can cause stress and anxiety and should be considered separately from mortality and morbidity effects.
- Mitigation measures are only discussed in passing and readers are cross-referred to the noise chapter. An outline of proposed measures (i.e. a noise management framework or plan) should be presented in the Health Chapters and an explanation provided for how and to what extent these measures will mitigate the identified health impacts.

Assessment of Water Quality:

A complete health risk assessment is not provided for water quality due to the limitations in water quality sampling (i.e. only 1997 data was available; no new data was collected for this EIS). A more complete assessment is required that includes a clear list of assumptions, a description of population affected, and an assessment of impacts on vulnerable receptor population groups.

Review of Overall Report:

The description of the context and requirements for the HRA are generally sufficient. It would have been advantageous to understand why only an HRA was undertaken and not a full HIA, considering that the Health Chapters recognize the significance of the social determinants of health. The population health profile was very limited in scope and is missing clarification for why only certain information is provided. Consideration of vulnerable populations is based around SEIFA scores only and again, it should be explained why only these scores, and not additional indicators of disadvantage are included. Any further information that is included in other chapters in the draft EIS should be referenced within the Health Chapters.

Coverage of Health Topics:

The health risks described in the Health Chapter (air quality, noise and water) shows that some key determinants of health have been considered in reasonable detail. However, the potential inequality/inequity impacts have not been sufficiently assessed or discussed. This is a significant gap.

Some key determinants either do not seem to have been considered anywhere in the draft EIS or have not been considered and discussed in relation to health impacts in the Human Health Chapter and appendix. The approach taken to considering health impacts in the Health Chapters is narrow and does not take into account the findings of other health-relevant assessments, such as in the social impact assessment (SIA). This has resulted in key environmental and social determinants of health not being considered. The scoping process whereby the decision to focus on air quality, noise and water is unclear so it is not possible to assess whether the narrow focus is justified. However given the current level of evidence on the effects of airports on health as well as the more general evidence base around the social determinants of health, it is likely that relevant health impacts are missing from the Health Chapters. The 'non health' sections of the draft EIS do however contain information about a number of significant impacts on the determinants of health (e.g. housing affordability, visual amenity). The majority of these relevant health determinants are covered within the SIA. These have not been identified as health impacts and the range and magnitude of potential health outcomes resulting from these impacts have not been assessed.

Long Term Development Findings

The long-term development section (Chapter 39, Section 8) provides a summary of the long term health impacts that are discussed in more detail in the appendix. While the report does, at times, make reference back to the appendix, there is a lot of pertinent detail that is missing that should be referenced to the appendix. This section also lacks core components for clarity – such as discussing the methods used or mitigation measures - that would make this section acceptable as a standalone piece of work without having first read the appendix. This section also misses any discussion of long term cumulative impacts. Cumulative impacts are considered elsewhere in the report however this report does not make clear if the cumulative impact assessments were used in this assessment. It would be particularly relevant to include discussion of cumulative impacts here as there is no mention of health impacts in the cumulative impacts chapter. This section should also provide better characterisation of health impacts or otherwise provide a reference to where it is located in the appendix.

Key Impacts and Opportunities

The Health Chapter contains predictions of the attributable health outcomes from air and noise exposures in communities near the airport. The majority of outcomes for air quality were below accepted thresholds, however there were some exceedances for Particulate Matter 10, Particulate Matter 2.5, and Nitrogen Dioxide. Impacts from noise were also mostly below standards, however, impacts varied widely for different communities, with Luddenham likely to experience the most impacts associated with noise. Sufficient data was not available to conduct a complete HRA for ground water and surface water, therefore there are no predicted health impacts.

The Health Chapter and appendix utilises a Health Risk Assessment approach. This is a quantitative methodology that takes changes to these environmental determinants and estimates their risk to health (i.e. the chances or risk of a disease or fatality occurring). This narrow approach does not address the full range of determinants of health and makes no use of the large evidence base on the association between health determinants, particularly social, and health outcomes.

There are two major weaknesses in relation to the assessment of health impacts that the review team strongly recommend be addressed in order to ensure that health effects are not overlooked or not taken into account when mitigation/enhancement is being considered. These are: the reporting of the identified health impacts; and the scope of the impacts included in the health chapter.

1. Introduction

This report details the findings of a peer review conducted on the Western Sydney Airport (WSA) draft Environmental Impact Statement (EIS). The peer review was commissioned by WSP/Parsons Brinckerhoff to examine the quality of the health and human impacts considered within the draft EIS. The review was conducted by a team of international experts in health impact assessment (HIA) and was led by researchers from the Centre for Health Equity Training, Research and Evaluation (CHETRE) at the University of New South Wales (UNSW). The review was conducted rapidly over 2 weeks in order to fit within the public comment period for the draft EIS. The findings of this review may be used by the consultant to inform the Western Sydney Regional Organisation of Councils (WSROC) and Macarthur Region of Councils (MACROC) in their comments on the draft EIS.

2. Approach

Health Impacts of Airports

Human health is a broad concept that encompasses more than the absence of disease. “Health is a state of complete physical, social and mental wellbeing and not simply the absence of disease or infirmity,”[2] it is a “resource for everyday life, not the objective of living; it is a positive concept, emphasizing social and personal resources, as well as physical capacities.”[3] This understanding recognises that though illness and disease (mortality and morbidity) are useful ways of measuring health, they need to be fitted within a broader understanding of health and wellbeing.

It is important to note that health is influenced by a very broad range of factors – the determinants of health (see figure 1[4]). These can be categorized as inherent factors, lifestyles and behaviours, socio-economic and environmental conditions, and access to services. These determinants are affected by development proposals (policies, plans, programmes and projects) from all sectors of society. Therefore, health is influenced by actions from all sectors and not just the health sector. Infrastructure projects, and airport development in particular, can have a wide range of impacts including on several determinants of health, therefore directly, indirectly, in-combination (synergistically) and cumulatively impacting on health.

Anything which alters a determinant of health, such as those listed in Table 1, may as a consequence, have an impact on health. Impacts on health determinants can be thought of as leading to changes in health outcomes such as communicable diseases, non-communicable diseases, physical injury, mental health and wellbeing, and nutrition-related disorders.

[2] WHO, 1948. Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19-22 June, 1946; Official Records of the World Health Organization, no. 2, p. 100.

[3] WHO Regional Office for Europe, 1984. Health Promotion. Summary report of the Working Group on Concept and Principles of Health Promotion, Copenhagen, 9-13 July 1984

[4] Barton, H. and Grant, M., 2006. A health map for the local human habitat. Journal of the Royal Society for the Promotion of Public Health, 126 (6) pp252-261.

Table 1 Examples of Key Determinants of Health

Fixed	Social and Economic	Lifestyles & Behaviours	Access to Services	Environmental
• Genes • Sex • Ageing	• Poverty • Employment • Social exclusion • Community structure and infrastructure	• Diet • Physical activity • Smoking • Alcohol • Sexual behaviour • Drugs • Coping skills	• Education • Health services • Social services • Transport • Leisure	• Safe water and clean air • Healthy workspaces • Safe housing

Source: enHealth 2001[5], Adapted from UK DOH[6] Inset 1A

Impact assessment, an important decision-support tool, providing information to decision makers on the impacts of proposed action and their management, needs to cover health impacts adequately to be fit-for-purpose. Historically, health impacts within environmental impact assessment (EIA) have been addressed narrowly, assessing only changes to traditional environmental determinants such as air quality, noise or water quality. Health Risk Assessment (HRA) is a quantitative methodology that takes changes to these environmental determinants and estimates their risk to health (i.e. the chances or risk of a disease or fatality occurring). This narrow approach does not address the full range of determinants of health and makes no use of the large evidence base on the association between health determinants, particularly social, and health outcomes. The narrow approach has over the years been found to be of limited use to policy and decision-makers and a fuller, more comprehensive qualitative and quantitative assessment of health impacts is often called for. This has

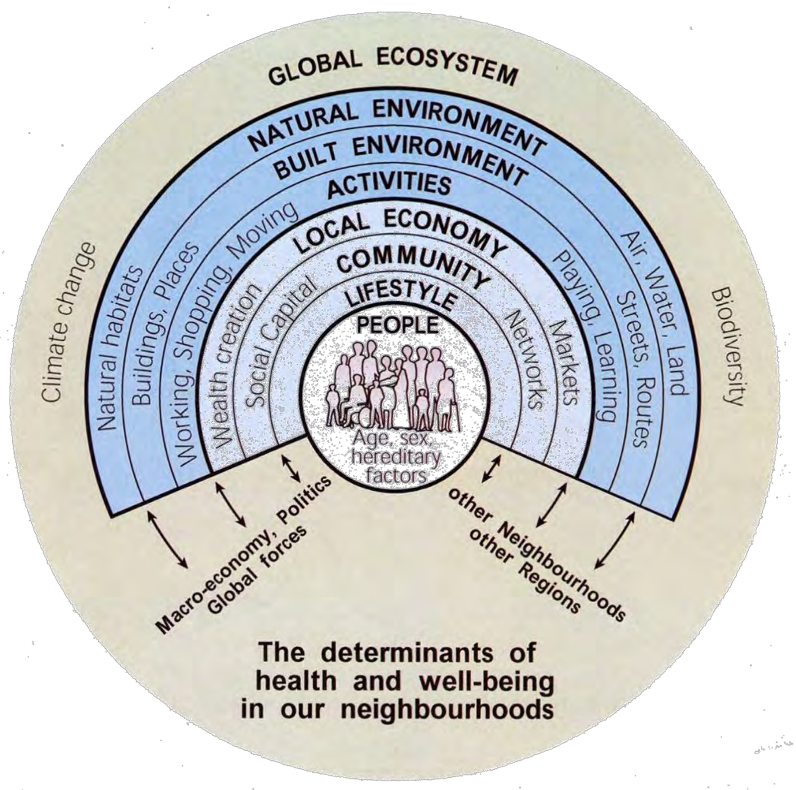

Figure 1 Determinants of Health (Barton and Grant, 2006)

[6] Department of Health, UK, 2000. A resource for Health Impact Assessment. http://www.doh.gov.uk/london/healthia.htm

occurred internationally as well as in Australia, with guidelines and practical guides published on how to undertake a comprehensive assessment of health impacts[7] [8].

What is Health Impact Assessment?

The international Gothenburg Consensus definition of HIA is:

"A combination of procedures, methods and tools by which a policy, program or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population."[9]

The more recent International Association for Impact Assessment's definition of HIA, which updates the earlier Gothenburg Consensus definition, is that HIA is:

"A combination of procedures, methods and tools that systematically judges the potential, and sometimes unintended, effects of a policy, plan, programme or project on the health of a population and the distribution of those effects within the population. HIA identifies appropriate actions to manage those effects."[10]

The aim of HIA is to inform and add value to the decision-making process by providing a systematic analysis of the potential impacts as well as recommending options, where appropriate, for enhancing the positive effects, mitigating the negative ones and reducing health inequities/inequalities. It uses a psycho-social definition of health and considers the full range of environmental and social determinants of health. To do this HIA uses a range of structured and evaluated sources of qualitative and quantitative evidence that includes public and other stakeholders' perceptions and experiences as well as public health, epidemiological, toxicological and medical knowledge. It is the preferred methodology to ensure development proposals are undertaken in a way that safeguards the health and wellbeing of affected communities, promotes health opportunities, reduces health inequalities and promotes health equity. HIA is therefore particularly concerned with the distribution of effects within a population, as different groups are likely to be affected in different ways, and therefore looks at how health and social inequities/inequalities might be reduced or widened by a proposed plan or project.

The World Health Organization (WHO) describes health equity as:

"…the absence of avoidable or remediable differences among groups of people, whether those groups are defined socially, economically, demographically, or geographically. Health inequities therefore involve more than inequality with respect to health determinants and access to the resources needed to improve and maintain

[7] enHealth, 2001. Health Impact Assessment Guidelines. Australia
[8] Harris, P., Harris-Roxas, B., Harris, E., & Kemp, L., 2007. Health Impact Assessment: A Practical Guide, Sydney: Centre for Health Equity Training, Research and Evaluation (CHETRE). Part of the UNSW Research Centre for Primary Health Care and Equity, UNSW.
[9] European Centre for Health Policy, WHO Regional Office for Europe, 1999. Gothenburg Consensus Paper on Health Impact Assessment. Main Concepts and Suggested Approach
[10] Quigley, R., L. den Broeder, P. Furu, A. Bond, B. Cave and R. Bos 2006. Health Impact Assessment International Best Practice Principles. Special Publication Series No. 5. Fargo, USA: International Association for Impact Assessment.

health or health outcomes. They also entail a failure to avoid or overcome inequalities that infringe on fairness and human rights norms.

Reducing health inequities is important because health is a fundamental human right and its progressive realisation will eliminate inequalities that result from differences in health status (such as disease or disability) in the opportunity to enjoy life and pursue one's life plans.

A characteristic common to groups that experience health inequities—such as poor or marginalized persons, racial and ethnic minorities, and women—is lack of political, social or economic power. Thus, to be effective and sustainable, interventions that aim to redress inequities must typically go beyond remedying a particular health inequality and also help empower the group in question through systemic changes, such as law reform or changes in economic or social relationships." [11]

Internationally the WHO Commission on the Social Determinants of Health in "Closing the Gap in a Generation" (2008) and the Marmot Review in the UK in "Fair Society, Healthy Lives" (2010) demonstrated and advocated for the importance of considering health inequities and inequalities when assessing the health and wellbeing impacts of policies and projects.[12] [13]

Relevant Determinants of Health for Airport Development

An airport is a large infrastructure project. Like any large infrastructure, a considerable construction phase is anticipated, followed by a very long operation phase. Decommissioning is not always clear and may never occur. As with other infrastructures with a large requirement for land/space, an airport has the potential to affect the full range of health determinants and not just those related to air transport. For example, communities may need to be relocated, greenspace may be lost, employment may be generated and lost, economic development may be fostered or changed, opportunities for learning ad education may be provided or disrupted, pollutants may be emitted to the air, water and soil, activities may generate noise, physical barriers may be erected, and traffic patterns may be altered to name just a few. Consequently, a wide range of health impacts can potentially occur. These need to be systematically identified, scoped, analysed and managed as part of comprehensive impact assessment process.

3. Methods

A review framework was developed based on existing guidelines for reviewing assessments and reporting of human health and wellbeing impacts. *A Review Package for Health Impact Assessment Reports of Development Projects* formed the core review framework. This framework has been used

[11] World Health Organization (WHO). (2015). Equity. Health systems. Available at http://www.who.int/healthsystems/topics/equity/en/

[12] World Health Organization (WHO). (2008). Closing the gap on a generation: Health equity through action on the social determinants of health. Commission on Social Determinants of Health. Available at: http://www.instituteofhealthequity.org/projects/commission-on-social-determinants-of-health

[13] The Marmot Review. (2010). Fair Society, Healthy Lives: Strategic Review of Health Inequalities in England post-2010.

extensively over the last six years,[14] including by the Wales Health Impact Assessment Support Unit, South Cambridgeshire District Council[15] and Bristol City Council in the UK.[16] The Review Package was also used to review an HIA on proposals for expansion at London City Airport for the London Borough of Newham. It has also been used to assess 55 HIAs in both Australia and New Zealand.[17]

A Guide for the Evaluation of Health Impact Assessments Carried Out Within the EIA Process,[18] published this year, was also analysed and incorporated into the review package to enhance the peer review framework and methodology described in *A Review Package for Health Impact Assessment Reports of Development Projects*. This Australian guidance was developed at the WHO Collaborating Centre for Environmental Health Impact Assessment.

Lastly, specifications for the draft EIS, the Environment Protection and Biodiversity Conservation Act (EPBC) guidelines, were also taken into account in developing the review framework (See Table 2 for details).

The final review framework considers both the possible and likely health and wellbeing effects as well as the distribution of those impacts and health equity issues, and the fulfilment of draft EIS guidance.

Components of the Draft EIS Considered in the Review

In accordance with the commissioned work, a comprehensive review was conducted on the Community Health Appendix (G) and the Human Health Chapter (Volume 2, Part D) (Health Chapters). In order to complete the review frameworks, the following parts of the EIS were considered although not fully reviewed in detail:

- Volume 1
    - Executive Summary
    - Part A - Project Background
    - Part B - Airport Plan
- Volume 2
    - Chapter 9 - Approach to Impact Assessment
    - Chapter 27 - Cumulative Impact Assessment
    - Part E - Environmental Management
    - Part F - Conclusions
- Volume 3
    - Chapter 39, Section 8 – Human Health
    - Part H - Conclusion and recommendations
- Volume 4

[14] Winge Fredsgaard M, Cave B and Bond A. A review package for Health Impact Assessment reports of development projects. Leeds, UK: Ben Cave Associates Ltd. (2009).
[15] https://www.scambs.gov.uk/content/health-impact-assessment-spd
[16] Bristol City Council. Planning a healthier Bristol: Assessing the health impacts of develoment. 2013. Bristol City Council. Planning a healthier Bristol: Assessing the health impacts of develoment. 2013.
[17] Haigh F, et al. "The effectiveness of health impact assessment in influencing decision-making in Australia and New Zealand 2005–2009." BMC public health 13.1 (2013): 1188.
[18] Spickett J and Katscherian D, A Guide for the Evaluation of Health Impact Assessments Carried Out Within the EIA Process, WHO Collaborating Centre for Environmental Health Impact Assessment, Curtin University.

- Appendix E - Noise
- Appendix F – Air quality
- Appendix P1 – Social impact
- Appendix P3 – Economic analysis

Review of Past Airport HIAs

Prior to beginning the peer review, the review team carried out a review of past airport HIAs in order to identify the existing evidence on the likely and potential health and wellbeing impacts of airports in settings similar to the proposed Western Sydney Airport (WSA).

Criteria for inclusion in the review were:

- Comparability to WSA
- Availability of report
- Recent (<5 years)
- Fulfilled basic quality criteria in terms of reporting (in particular adequate descriptions of methods used and findings)

Exclusion criteria were:

- Health Risk Assessments that only considered a narrow range of impacts (e.g. noise, air quality)

The review team identified 13 Airport HIAs. Three of which satisfied the inclusion criteria:

1. HIA of proposed expansion to Billy Bishop Toronto City Airport
2. HIA of London Luton Airport
3. The Stanstead Generation 2 Project HIA[19]

Impacts were categorised according to type of health impact (e.g. environmental, economic, socio-cultural), activity (e.g. air traffic movements, traffic, construction), and the potential health outcome (e.g. respiratory effects, mental health).

An initial review of the Health Chapters was carried out to identify health topics covered. These health impacts were subject to peer review using the peer review framework. This peer review was commissioned to focus on the Health Chapters, however, it became apparent that significant areas of potential health impact were missing from the health chapter and technical report. The review team carried out an additional search of the technical documents within the appendix to identify whether there were relevant health impacts included within the draft EIS that had not been included in relevant health sections. A discussion of the impacts located in sections of the draft EIS outside the Health Chapters is in Section 5 of this report.

Limitations

The framework developed for this peer review enables a comprehensive assessment of the draft EIS Health Chapters, however there are limitations to our review. Primarily, the review team were limited to conducting a review of the health impacts included in the health chapters. Given that

[19] This HIA was outside of the time criteria but is considered an early example of a comprehensive HIA submitted as part of a planning application and alongside an EIS

these were limited to only noise, air quality, and water impacts, the review team were not able to further discuss the potential significant impacts associated with airport development, such as changes to employment, transportation, amenity, and housing. Also, given the significant time restraints of the review, the review team were not able to assess the validity of the calculations used in predicting health outcomes. Validity of the findings in the HRA were based upon what was included in the health appendix, which did not include all necessary methods and formulas to test the findings. The review team were limited to discussing the assumptions used in the methods, any limitations with the methods used, and the presentation of the findings. Furthermore, without a comprehensive health impact assessment included in the draft EIS, the review team were limited in the types of recommendations we could make.

4. Detailed Findings – 1st Stage Airport

This section details the findings of the peer review conducted on the Health Chapters for 1st Stage Airport development. The findings are presented according to different components of the review: compliance of the Health Chapter with draft EIS guidance (Table 2); assessment of health pathways included in the draft EIS – air quality (Table 3), noise (Table 4), water quality (Table 5); and components of the overall report such as the context and baseline health profile (Table 6).

Table 2 Compliance of the Report with Draft EIS Guidelines (EPBC Act)

Requirement	Comment	Recommendation
1.1. Reporting		
1.1.1. The draft EIS [health chapters] should enable interested stakeholders and the Minister to understand the environmental consequences of the proposed development. (1 General Content)	The Health Chapters of the draft EIS identify, describe and discuss the health consequences of changes to noise, air quality and the water environment from the proposed development. Some of this information is presented in a way that makes it difficult for interested stakeholders to fully understand the scope and scale of the potential health impacts. Health consequences associated with potential changes in other environmental and social determinants of health are not addressed in the Health Chapters. An example is risk of road traffic accidents and injuries associated with project-induced traffic.	The Health Chapters of the draft EIS should assess the health impacts/effects of changes in the full range of environmental and social determinants of health due to the proposed development. Key additional health consequences and or determinants of health to consider are (not an exhaustive list): effects on services and amenities; traffic and transport, in particular road traffic accidents and injuries; employment (see Table 8 about the main health determinants influenced by airports and airport-related developments). Findings should be presented in a way that helps the reader to understand the scale of

Requirement	Comment	Recommendation
	Equally importantly, the potential unequal and inequitable impacts/effects to affected communities and vulnerable/sensitive sub-groups are not analysed or discussed.	the population affected, by determinant of health, and also what the synergistic impacts are likely to be to various communities from exposure to the combined hazards.
1.1.2. Information provided in the draft EIS [health chapters] should be objective, clear, and succinct and, where appropriate, be supported by maps, plans, diagrams or other descriptive detail. (1 General Content)	Health Chapters mostly fulfil this requirement. See 1.1.3.	None at this time.
1.1.3. The body of the draft EIS [health chapters] is to be written in a clear and concise style that is easily understood by the general reader. Technical jargon should be avoided wherever possible. Cross-referencing should be used to avoid unnecessary duplication of text. (1 General Content)	Health chapters mostly fulfil this requirement. One subsection where technical jargon is used without a subsequent description of what it entails is the final paragraph of section 13.8.3: "The health risk assessment predicts an increase in cancer risk attributable to diesel particles ranging from 1.3 x 10^{-6} to 8.4 x 10^{-6} per 1µg/m^3. Accordingly, the resultant cancer risk estimates are demonstrated to fall within levels for risk generally considered acceptable to regulators (by two orders of magnitude)."	Make this paragraph more clear and understandable. HRA should use consistent measurements of risk, and detail risk according to the community impacted, in terms of geographic areas and/or by vulnerable/sensitive sub-groups, to allow the audience a quicker and more accessible understanding of the information.

Requirement	Comment	Recommendation
	It may be difficult for the general public to understand the magnitude of the risk involved i.e. a low risk.	
1.1.4. The level of analysis and detail in the draft EIS [health chapters] should reflect the level of significance of the expected impacts on the environment. (1 General Content)	Assuming that the most significant health risks are those related to changes in air quality, noise and the water environment, the level of analysis and detail presented in the Health Chapters of the draft EIS is reflective of the potential significance of these determinants of health. However, what has not been considered is the full range of environmental and social determinants of health, related potential health impacts/effects/risks and inequality/equity issues. This is an omission.	The Health Chapters of the draft EIS should address the full range of environmental and social determinants of health, related potential health impacts/effects/risks and inequality/equity issues with a level of analysis and detail reflective of their likely significance.
1.1.5. Any and all unknown variables or assumptions made in the assessment must be clearly stated and discussed. The extent to which the limitations, if any, of available information may influence the conclusions of the environmental assessment should be discussed. (1 General	Not all unknown variables, assumptions, and limitations are included in the assessment. For example, using region level baseline statistics in the HRA calculations introduces errors that affect the precision of the predications stated (e.g. 6 death over 100 years), in that using the central value for the exposure response coefficients is the best "guess" but there is a 95% confidence interval (CI) that should be stated. The predictions should be understood	There should be qualitative discussion and analysis of health impacts/effects where quantification is not currently recommended by national guidance (e.g. Australian Government *Guidelines for Health Risk Assessment*). Uncertainties should be more clearly discussed including by presenting and discussing confidence intervals.

Requirement	Comment	Recommendation
Content)	as a best estimate, recognising there is some variance around the estimate but that the true value (for a worst case unmitigated scenario) is likely to lie within that order of magnitude. The scientific literature shows that the range of health impacts/effects associated with exposure to air pollutants is broader than the range of health impacts/effects for which internationally accepted exposure-response coefficients exists (i.e. where good quality research has identified exposure-response coefficients and there is international scientific consensus). This means that there are health impacts known to occur from exposure to air pollution (e.g. some air quality-related health impacts on children, some chronic effects such as incidence of chronic bronchitis in adults) but the level of health impacts/effects associated with a certain level of pollution exposure is uncertain or unknown. These health impacts/effects and the uncertainty around their extent/magnitude are not considered or discussed.	

Requirement	Comment	Recommendation
	The implications of future population growth are also not addressed.	
1.2. Principles of Ecologically Sustainable Development		
Requirement	Comment	Recommendation
The Proponent should ensure that the draft EIS [health chapters] assesses compliance of the action with the principles of Ecologically Sustainable Development:		
1.2.1. Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations. (1 General Content)	While vulnerable populations are identified e.g. those with high levels of deprivation, health impacts/effects are not assessed for their potentially disproportionate distribution (inequalities/inequity). Health impacts/effects are quantified for 'snapshots' in time and not over the whole life of the project. Synergistic or in-combination impacts/effects are not considered and discussed.	The human health chapter of the draft EIS should assess distribution of potential health impacts and consider assessing health impacts for the entire assessment period, e.g. 60 years, both quantitatively (e.g. report attributable cases for this period) and qualitatively. There should also be discussion of the synergistic or in-combination impacts/effects.
1.2.2. If there are threats of serious or irreversible (health relevant) environmental damage, lack of full scientific certainty should	None at this time.	None at this time.

Requirement		Comment	Recommendation
	not be used as a reason for postponing measures to prevent environmental degradation. (Attachment 1 3A(b))		
1.2.3.	The principle of inter-generational equity – that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations –should be addressed. (Attachment 1 3A(b))	The Health Chapters do not take into consideration inequality, equity, or intergenerational impacts/effects.	There should be discussion of inequality, equity, or intergenerational impacts/effects.
1.3. Assessment			
Requirement		Comment	Recommendation
1.3.1.	A detailed assessment of the nature and extent of the likely short-term and long-term relevant impacts (detailing direct and indirect impacts) is provided. (Relevant Impacts 5(a))	The health impacts that are addressed in the Health Chapters of the draft EIS are described in terms of their characteristics, specific health endpoints (range of mortality and morbidity endpoints) for both the construction and operation phases; and their magnitude/extent. However, as described in 1.1.1 the health impacts/effects associated with potential	The health implications of impacts on social determinants of health currently included in other draft EIS chapters should be addressed and included in the Health Chapters.

Requirement	Comment	Recommendation
	changes in environmental (other than noise, air quality and water quality) and social determinants of health are not addressed.	
1.3.2. A statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible is provided. (Relevant Impacts 5(a))	For the impacts discussed, all are considered to be likely for a scenario where mitigation measures are not in place. It is considered that with mitigation in place, impacts are likely to be lower. Unknown, unpredictable or irreversible impacts are not discussed (e.g. relocation of local residents). There is also no discussion of residual impacts/effects after mitigation is in place.	See 1.3.1 The significance and implications of the residual impacts/effects should also be addressed.
1.3.3. An analysis of the significance of the relevant impacts is provided. (Relevant Impacts 5(a))	Impacts and effects are discussed in terms of their significance to national and international guidance, standards and thresholds. Significance is assumed to be defined in terms of national and international guidance, standards and thresholds. There is no discussion of the significance of impacts/effects to affected communities i.e. community perception of risks.	Consider including a broader discussion of the significance of the health impacts/effects for affected communities (e.g. community perception of risks).
1.3.4. Any technical data and other information used or needed to make a detailed assessment of	Most underlying technical data regarding the environmental exposures to noise, air or water pollutants is not presented in the	See Air Quality and Noise Review Tables. The actual worked out health impact

Requirement	Comment	Recommendation
the relevant impacts are discussed. (Relevant Impacts 5(a))	Health Chapters. There are cross-references to the respective Noise, Air Quality and Water Quality chapters. No exposure-response coefficients for the quantification of health impacts/effects/risks are provided nor are the actual worked out calculations presented. Some key references are also missing from the methods. For example the sources of the exposure response functions for pm10 and pm2.5 (EPHC, 2011; HEI, 2009) are not included in the reference section.	calculations and exposure-response coefficients used should be presented and discussed. All references to enable a review of the methods should be provided.
1.3.5. The draft EIS [health chapters] should identify and address cumulative impacts, where potential project impacts are in addition to existing impacts of other activities (including known potential future expansions or developments by the proponent and other proponents in the region and vicinity). (Relevant Impacts 5(b))	Cumulative impacts from potential future expansions or developments by the proponent and other proponents in the region and vicinity are not discussed. There is a cumulative impact chapter (volume 2 chapter 27) but this does not have a specific section on the implication for health of the cumulative impacts of other projects occurring around the proposed development.	The health impacts/effects/risks of potential cumulative impacts should be discussed in the cumulative impact chapter and the health chapter should reference this and the air quality, noise and other health relevant sections in the cumulative impact chapter.
1.3.6. Aircraft noise and vibration impacts on everyday activities and on sensitive environmental	Vibration and its potential health and wellbeing impacts/effects/risks (e.g. disturbing sleep patterns, annoyance and	There should be discussion and assessment of the health impacts/effects/risks to other sensitive receptors and population sub-

Requirement	Comment	Recommendation
receptors (all sensitive receptors within the community and natural environment) are discussed. (Relevant Impacts 5(g))	wellbeing effects) are not discussed. Noise impacts are discussed for learning impairment and interference with sleep (as well as other morbidity endpoints). Noise impacts on schools (sensitive receptors) are discussed. However, sensitive receptors are narrowly scoped to only looking at schools. There is no discussion of other sensitive receptors e.g. hospitals, nursing homes.	groups. There should also be discussion of the health impacts/effects/risks of vibration.
1.3.7. The draft EIS should consider: • noise and vibration from construction activities and machinery • changes in traffic movements during construction and operation (associated with both passenger movements and workers) • changes to air quality during construction and operation (including consideration of seasonal and meteorological variations that influence local air quality)	Noise from construction activities is considered. Vibration from construction activities and their potential health and wellbeing impacts/effects/risks (e.g. disturbing sleep patterns, annoyance and wellbeing effects) are not discussed. Changes to road traffic movements and their potential health consequences (severance, risk of road traffic accidents and injuries) are not considered except for their noise and air quality implications. Changes to air quality and their health effects	The potential health impacts/effects/risks from road traffic changes e.g. severance and road traffic accidents and injuries (this not an exhaustive list) should be assessed and discussed. The potential health impacts/effects/risks on local communities from changes in the qualities and characteristics of the surrounding areas (including land values and other economic impacts) should also be assessed and discussed. The potential health impacts/effects/risks (e.g. associated with levels of physical activity, access to greenspace and nature) from

Requirement	Comment	Recommendation
• potential fuel dumping impacts • lighting impacts on everyday activities and on sensitive environmental receptors (all sensitive receptors within the community and natural environment) • change in qualities and characteristics of the surrounding areas and associated impacts to local communities (including land values and other economic impacts) • Creation of any risks or hazards to people or property that may be associated with any component of the action. • changes in recreational use and amenity of natural areas (Relevant Impacts 5(g))	are considered. Potential fuel dumping is considered. The potential health impacts/effects/risks on local communities from changes in the qualities and characteristics of the surrounding areas (including land values and other economic impacts) have not been discussed. The potential health impacts/effects/risks from changes in recreational use and amenity of natural areas have not been discussed. Some health-relevant issues (e.g. traffic, local amenity, visual impacts) are discussed in the social chapter (Volume 2, Chapter 23), but they are not discussed or referenced in the health chapter.	changes in recreational use and amenity of natural areas should also be assessed and discussed. See 1.3.1
1.3.8. Quantification and assessment of impacts should: • be against appropriate background/baseline levels	Quantification of health impacts/effects/risks is in relation to existing rates of disease and existing burden of ill health attributable to air pollution.	The assessment should consider and develop a broader health and wellbeing baseline (taking into account of the full range of environmental and social determinants of

Requirement	Comment	Recommendation
• be prepared according to best practice guidelines and compared to best practice standards • consider seasonal and temporal variations where appropriate (including temporal changes in the sensitivity of the receptor) • be supported by maps, graphs and diagrams as appropriate to ensure information is readily understandable • Guidelines and standards used to quantify baselines and impacts should be explained and justified. (Relevant Impacts 5(g))	However, the baseline health conditions are narrowly defined both in terms of scope (a narrow range of health impact/effects/risks and no consideration of wellbeing) and geography (only Liverpool LGA). The assessment also does not adequately take into account future population growth. Impacts are assessed according to national guidance, namely the Australian Government *Guidelines for Health Risk Assessment* (enHealth 2012) and the National Health and Medical Research Council *Approach to Hazard Assessment for Air Quality* (NHMRC 2006). However, for future assessments, it is worth noting that the above guidance is based on outdated international (state-of-the-art) knowledge and guidance on quantification of health impacts from air pollution. The current state-of-the art is described in the World Health Organization HRAPIE and REVIHAPP reports. Impacts are assessed against national and international noise and air quality guidance, standards, and thresholds.	health), a geography that includes all affected populations, and the implications of future population growth. See 1.3.1

Requirement	Comment	Recommendation
1.3.9. For information given in the draft EIS, the EIS must state: (a) the source of the information (b) how recent the information is (c) how the reliability of the information was tested (d) what uncertainties (if any) are in the information (e) what guidelines, plans and/or policies have been considered during preparation of the draft EIS. (Information Sources Provided in the EIS, 11)	Sources of health baseline data are presented. Dates for the information are provided. Policy guidelines are discussed in relation to air quality and noise however, there is no discussion of the public health policy context. Recent information is used for noise and air quality but not for water – the limitations of this are stated in the report. Uncertainties are not presented in terms of using confidence intervals.	The public health policy context should have been reviewed, summarised in the draft EIS and used to inform the scope and approach of the assessment. For example, there is no discussion or justification of why a health risk assessment approach was used instead of a health impact assessment approach. See 1.1.5.
1.4. Conclusion		
Requirement	Comment	Recommendation
An overall conclusion as to the environmental acceptability of the proposal on protected matters must be provided, which includes:		

Requirement	Comment	Recommendation
(Conclusion 12)		
1.4.1. a discussion on how consideration has been given to the objects of the EPBC Act, the principles of ecologically sustainable development, and the precautionary principle	A discussion on how consideration has been given to the objects of the EPBC Act is provided. Principles of ecologically sustainable development, and the precautionary principle are not explicitly discussed.	See 1.2.3
1.4.2. justification for undertaking the proposal in the manner proposed, including the acceptability of the avoidance and mitigation measures	Mitigation is not described in the Chapters but there is cross-referencing to air quality, water quality and noise chapters. There is no explanation of why the assessment only considers and assesses the health impacts/effects/risks of noise, air quality and water.	An outline of the mitigation framework/plan should be provided in the Health Chapters alongside cross-referencing to the air quality, noise and water quality chapters.
1.4.3. If relevant, a discussion of residual impacts and any offsets and compensatory measures proposed or required for significant residual impacts on protected matters, and the relative degree of compensation and acceptability.	There is also no discussion of residual impacts/effects after mitigation is in place. See 1.3.2 There is no discussion of the acceptability of mitigation measures.	The significance and implications of the residual impacts/effects should be discussed. See 1.3.2 There should also be a consideration and discussion of the acceptability to the community of proposed mitigation and compensation measures.

Requirement	Comment	Recommendation

EPBC Compliance Comments:

Overall, the Health Chapters of the draft EIS (draft EIS volume 2, chapter 13, volume 4, appendix G) comply with most of the EPBC Guidelines.

The impacts that are considered in the human health chapters are those associated to changes in air quality, water quality and noise. Generally, these are assessed in detail in terms of nature and extent of short- and long-term impacts.

Some of the information is presented in a way that makes it difficult for interested stakeholders to fully understand the scope and scale of the potential health impacts. The information provided is not always, clear, succinct and supported by maps or other accessible materials. Technical jargon is generally avoided without losing technical precision or the validity of the statements made. Cross-referencing is used however summaries of the findings of other chapters often do not fully explain key issues. Not all sensitive population sub-groups or receptors have been considered.

The rational and justification for why a health risk assessment has been undertaken rather than a health impact assessment (HIA) are not discussed. There is existing national and state level guidance on the value of using HIA that should have been consulted in the development of the scope and methodology of the health assessment of the draft EIS. The key guidance documents are Health Impact Assessment Guidelines (enHealth, 2001), and Health Impact Assessment: A practical guide (UNSW and NSWHealth, 2007).

Ecologically sustainable development in relation to health is not considered.

Considering the most significant health impacts/effects/risks considered in the draft EIS are those related to changes in air quality, noise and water quality, the level of analysis and detail presented in the Health Chapters is reflective of the potential significance of these descriptors.

Recommendations for the Health Chapters of the draft EIS to better comply with EPBC guidelines are provided below:

- The Health Chapters of the draft EIS should assess the health impacts/effects of changes in the full range of environmental and social determinants of health and the potential inequalities/equity issues due to the proposed development. The level of analysis and detail

Requirement	Comment	Recommendation
should be reflective of their likely significance. Examples are changes to road traffic movements and their potential health consequences (community severance, risk of road traffic accident and injury), changes in qualities and characteristics of the surrounding areas (including land values and other economic impacts) and changes in recreational use, amenity of natural areas and access to greenspace and nature and their associated health and wellbeing impacts through, for example, changes to levels of physical activity; effects on services and amenities. • Findings should be presented in a way that helps to communicate the scale of the population affected, by determinant of health, and also what the synergistic impacts are likely to be to various communities from exposure to the combined hazards. • Not all unknown variables, assumptions, and limitations are included in the assessment. A specific comment relates to certain health impacts (e.g. air quality-related health impacts on children, other chronic effects such as incidence of chronic bronchitis in adults) known to occur from exposure to air pollution but for which the level (extent/magnitude) of the health impact associated with a certain level of pollution exposure is uncertain or unknown. These additional health impacts, for which quantification is uncertain or unknown, are not discussed. The Health Chapters should have considered and discussed health impacts where quantification is not currently recommended by national guidance (e.g. Australian Government *Guidelines for Health Risk Assessment*) such as air quality impacts on children, other chronic effects, other additional morbidity effects of short-term exposure but for which there is a widely acceptable evidence base supporting their likely occurrence (e.g. WHO REVIHAPP report).		

Table 3 Health Pathways Included in the Draft EIS - Air Quality

Assessment	Comment	Recommendation
1.1 Description of health effects		
1.1.1 The potential health impacts/effects of the project, both beneficial and adverse, should be identified and presented in a systematic way.[20]	Health impacts/effects i.e. mortality and morbidity endpoints are presented systematically for short-term and long-term health effects in association with changes in both short-term and long-term exposure to air pollutants; health impacts are described for both the construction and operation (start of operation 2030 and full operation 2063) phases. Health impacts/effects are presented inconsistently and in a manner that makes it difficult to understand the potential scale of the impacts/effects across all the affected communities. Health impacts resulting from perceived risk and community concern have not been considered.	Develop summary tables that provide consistent presentation of potential health impacts. For example: "For health impact/effect A an X increase in PM2.5 would lead to an additional Y events per 100,000 population. In M town with a population of N this would mean an extra Z cases in the next ten years."
1.1.2 Has the exposure pathway been identified?	The exposure pathway for air quality is described from likely emission sources (during both construction and operation phases) to exposure of populations living within the vicinity of the airport.	None at this time.

[20] *Does the identification of impacts consider short-term, long-term (and are these timescales defined?), direct and indirect impacts on health and well-being? Does the identification of health impacts distinguish between the construction phase, the operational phase and where relevant the decommissioning phase?*

Assessment		Comment	Recommendation
1.1.3	Has an appropriate time period been considered for health and wellbeing impacts/effects?	Health and wellbeing impacts have been described for 'snapshot' years: 2030 and 2063.	Consider presenting impacts for the entire assessment period e.g. 33 years (from 2030-2063).
1.1.4	Has an appropriate range of possible future (health relevant) scenarios been considered?	A worst case scenario was considered. This is appropriate and in line with common practice.	None at this time.
1.1.5	What is the predicted exposure level or condition? How does this compare with the exposure standard (for environmental impacts/risks) or acceptable condition (for social, community or psychological impacts/risks)?	Exposure levels are described in figures and the highest exposure level is discussed in the text in relation to the national air quality standard.	None at this time.
1.1.6	What level of risk has been designated for this impact?	Risks have been considered to be low with the highest risk being for all-cause mortality from long-term exposures of 6 additional deaths per 10 years predicted for 2063.	None at this time.

Assessment		Comment	Recommendation
1.1.7	What justification has been provided for this risk level?	Ranking risks as low has been based on what is considered acceptable levels of risk ("It is generally accepted by regulatory agencies that an increase in risk between 1 x 10-6 (1 in a million) and 1x10-5 (1 in 100,000) is considered to be a low risk and within acceptable criteria") and against current deaths in Sydney ("According to Health Statistics NSW in 2012-13 there were 10,127 deaths in the Western Sydney Local Health District due to all causes. This is in a population of 904,886 people. "). The human health chapter (volume 2 part D) discusses the widely accepted scientific consensus that there is no known safe level of exposure to key air pollutants below which there is no adverse health effect. However, this is only discussed under sub-section 13.10.3 on nitrogen dioxide when this is also true for the other air pollutants. In contrast in the health appendix (Appendix G) this is stated in the general introductory paragraphs to the air quality section.	The health chapter should discuss the no safe threshold in the general introductory paragraphs on air quality rather than in the nitrogen dioxide section so that it is clear that this issue is for all the key air pollutants discussed in the air quality section and not just nitrogen dioxide.

Assessment	Comment	Recommendation
1.1.8 Has the weighting/significance of health impacts/effects/risks been described and is it appropriate? [21] ➢ Direction: Whether the potential change would be beneficial or adverse ➢ Severity: More severe effects include those that are disabling, life-threatening, and permanent ➢ Magnitude: How widely the effects would be spread within a population or across a geographical area ➢ Likelihood: How likely it is that a given exposure or effect will occur. ➢ Certainty: level of certainty or uncertainty attached to the predictions of health effects.	Impacts are described as adverse; severity is implicit as impacts are for mortality (death) or a range of morbidity effects (hospital admissions for cardiovascular or respiratory effects or emergency visits for asthma). Magnitude is described in terms of risk and attributable cases; likelihood is described in terms of risk i.e. probability of occurrence, and described in the context of an unmitigated worst case scenario. Certainty and uncertainty issues are implicit as the evidence base supports a strong association/causation between exposure to air pollution and occurrence of health impacts. Exposure response coefficients used are the central values. The uncertainty over the actual coefficients (captured by the 95% confidence intervals, CI) is not discussed.	There should be a clearer discussion of certainty or uncertainty, how levels of uncertainty are taken, or not taken into account, and assumptions used in the modelling and the calculation of predicted/forecasted health effects/impacts/risks. Clarify whether population growth, and the increase in people, affected by changes in air pollution, is taken into account in the estimation of magnitude.

[21] Does the assessment consider the severity of impact/exposure (intensity, reversibility and impact on vulnerable population groups), the impact magnitude (number of people affected and duration of impact/exposure) and the importance (political and ethical)? Have the health impacts of each alternative been assessed? Sometimes the health impacts are ranked and prioritized before making recommendations, if so; have the criteria for prioritizing and ranking health impacts been given?

Assessment		Comment	Recommendation
1.1.9	Does it take into account stakeholder and community concerns?	Stakeholder and community concerns are not discussed.	Community feedback on air quality and health (as well as other concerns) should be described and how this feedback was considered and addressed in the assessment should be discussed. Where community comments have not been incorporated or addressed an explanation justifying this should be presented. If there were no specific comments or concerns about noise and health then this should also be stated explicitly.
1.1.10	What mitigation measures have been proposed?	Mitigation measures for the operation are not described or discussed in this chapter. There is cross-referencing to the air quality chapter where the main mitigation is described and discussed. The reviewers have not reviewed the air quality chapter as this was not in the terms of reference for this review.	Provide in the Health Chapters a brief summary of the mitigation framework/plan and measures discussed in the air quality chapter.

Assessment		Comment	Recommendation
1.1.11	Has a residual health risk level been determined and mitigated where practicable?	There is no discussion of residual impacts/effects after mitigation. However, the risks assessed for worst case and unmitigated scenarios are estimated to be low and therefore implicitly the likely residual risks after mitigation would be even lower. The report seems to assume that mitigation measures will attenuate most risk without discussing what the remaining risk will be and how they could be further minimised through ongoing monitoring and evaluation of the effectiveness of the proposed main mitigation measures.	Even though the residual risks are likely to be low/very low there should be a discussion/explicit statement about the level and significance of the residual risks from air quality changes after mitigation strategies are taken into account.
1.1.12	Have community concerns been identified and adequately addressed?	Same as 1.1.9	Same as 1.1.9
1.1.13	The causal pathway leading to health effects should be outlined along with an explanation of the underpinning evidence.[22]	Causal pathways are described and evidence underpinning the pathway is detailed except for statements on the “international levels of acceptability” (discussed below in 1.2.2)	See 1.2.2

[22] *The potential health effects may be presented in diagrams, which show the causal pathways and changes in intermediate factors by which the project may affect population health, or may be descriptive.*

Assessment		Comment	Recommendation
1.2 Risk assessment			
1.2.1	Have assumptions been made explicit and uncertainties considered and taken into account?	A range of assumptions underpinning the evidence base and the health impact/risk/effect calculation methods are discussed. Exposure response coefficients used are the central values. The uncertainty over the actual coefficients (captured by the 95% confidence intervals, CI) is not discussed.	Provide estimates for the health impacts/effects estimated as a central value and a range to provide a sense of what the possible magnitude/extent of the impacts/effects may be.
1.2.2	The report should identify and justify the use of any standards and thresholds used to assess the significance of health impacts.	Standards and thresholds used are identified: - NEPM air quality standards - "It is generally accepted by regulatory agencies that an increase in risk between 1 x 10^{-6} (1 in a million) and 1x10^{-5} (1 in 100,000) is considered to be a low risk and within acceptable criteria." – reference for this is not provided. While valid for cancer risk, the reviewer is unaware of its application or validity for mortality and morbidity effects from exposure to PM or NO_2.	It should be stated what regulatory agencies consider an increase in risk between 1 x 10^{-6} (1 in a million) and 1x10^{-5} (1 in 100,000) to be low and "within acceptable criteria" and references should be provided for this statement. In addition, the phrase "acceptable criteria" needs to be explained in terms of what is acceptable and to whom and again referenced.

Assessment		Comment	Recommendation
1.2.3	Have the methods used to calculate impacts been adequately described (e.g. replicability, transparency, sources of information identified)	Yes, the health Risk Assessment (HRA) method is described. The formulas/equations used are described in the chapter. However, the quantification of health impacts/effects makes use of "baseline health incidence rate/100,000 population" figures taken from "baseline health statistics for Sydney". It is unclear whether these figures are for the Sydney average or the relevant suburbs within 5 km of the airport site boundary. These figures are not presented in the human health chapter or the health appendix (appendix G) nor is a reference to their source provided.	It should be stated what "baseline health incidence rate/ 100,000 population" figures are used i.e. the Sydney average, suburb values or other area. A reference to the source of the information should be provided, and the actual rates should be presented as a table to enable the reader to understand the calculations made (enables replicability and transparency).
1.3 Analysis of distribution of effects		Comment	Recommendation
1.3.1	The affected populations should be explicitly identified.	Affected populations are described geographically i.e. the suburbs within 5 km of the airport site boundary.	See also 1.1.8 in relation to population growth.

Assessment		Comment	Recommendation
1.3.2	Inequalities in the distribution of predicted health impacts should be investigated and the effects of these inequalities should be stated. [23]	Inequality and equity, as important concepts that should be considered as part of the health assessment, are not discussed in the report. Potential impacts/effects/risks in terms of health inequalities or equity are not assessed or discussed. There is some allusion to potential impacts on inequality as the affected suburbs are rated in terms of relative deprivation but there is no discussion of whether the most deprived suburbs, or suburbs with higher proportions of vulnerable or sensitive group (e.g. children) are more affected than other suburbs.	There should be a discussion of how the distribution of health impacts/risks/effects between and within the suburbs/affected populations narrow or widen existing inequalities and whether these may be inequitable. There should also be a discussion of mitigation measures that could/are likely to reduce any identified health inequalities.

[23] How does the report define inequalities? Inequalities are found between social groups and can be measured in different ways e.g. by geography, social class or social position, population (ethnicity, gender, sexuality etc.).

Assessment		Comment	Recommendation
1.3.3	Have populations more vulnerable to impacts/risk/effects been identified and discussed; and have mitigations been proposed?	Populations more vulnerable to air quality impacts have been identified, specifically elderly, people with existing cardiovascular and respiratory disease, people with asthma, low socio-economic groups/socially deprived, and children as groups likely to be more affected by exposure to air pollution and the reasons for this are discussed. However, differential impacts from exposure to the airport-related air pollution have not been discussed qualitatively or quantitatively except for $PM_{2.5}$ and ozone and emergency department attendance in 1-14 year olds. Mitigation measures aimed at these groups are not discussed in the health chapter or health appendix. There is cross-referencing to the air quality chapter however the reviewers has not reviewed the air quality chapter, as this was not in the terms of reference for this review, and therefore cannot give a judgment on the appropriateness of the proposed mitigation in terms of sensitive groups.	Same as 1.3.2 Develop a more detailed qualitative discussion of the health impacts/risks/effects of changes in air pollution on vulnerable groups described in Appendix G, and children specifically.

Assessment		Comment	Recommendation
1.3.4	Impacts/risks/effects on health should be examined based on the population profile.[24]	The health impacts/effects have been calculated based on existing levels of mortality and morbidity. It appears that population projections have not been taken into account. Where results are presented as expected numbers of cases this is likely to be an underestimation given the expected increases in population. This is not identified clearly as a limitation.	Population projections should be included in the calculations or, at a minimum, if excluded this should be clearly identified as a limitation. See also 1.1.8 and 1.3.1

[24] It should be possible to determine whether effects are more prevalent in certain demographic or vulnerable groups.

Assessment	Comment	Recommendation
Air Quality Assessment Comments:		
• The assessment of air quality-related health impacts follows a health risk assessment approach, focussing on quantification of health endpoints from exposure to a range of air pollutants. The methodology used is adequate. The range of air pollutants addressed is adequate. The range of health endpoints considered is also adequate and follows Australian evidence and guidance. • However, the range of health endpoints addressed could be expanded to include others for which solid exposure-response coefficients exist, for example, group A coefficients provided in the WHO HRAPIE Project report[25]. • It is also not clear what baseline incidence rates were used (Sydney average or Liverpool/suburb rates). If Sydney rates are used, this may have resulted in a small underestimation of risks. For example, the Liverpool standardized mortality ratio is 107.3 (compared to New South Wales). • Risks are estimated for 2030 and 2063 snapshots and separately for each pollutant. As risks from exposure to different pollutants have similar effects (are synergistic) e.g. mortality and hospital admissions, these could have been added across pollutants to provide a picture of the total risk to the exposed communities. • Risks could also have been provided for the entire assessment period e.g. 30 years and not just for the snapshots. Discussion of the uncertainty around estimates could be enhanced, for example through the use of the upper and lower 95% confidence interval values of the exposure-response coefficients used. This would provide a better understanding of the likely range of actual impacts (for the worst-case unmitigated scenario). • A general level of acceptability for estimated risks is used, stated to be accepted by regulatory agencies. This is for a risk between 1×10^{-6} (1 in a million) and $1x10^{-5}$ (1 in 100,000). The regulatory agencies should be named and references for this statement should be provided. Consideration should also be given to stakeholder perceptions of acceptability of risk. • There is no discussion of the implication of the distribution of effects for inequality and equity although baseline information on sensitive/vulnerable groups is provided. • Community feedback and any potential perceptions or concerns of local residents are not discussed. • Perception effects are different from biological or epidemiological risks, can cause stress and anxiety and should be considered separately from mortality and morbidity effects. • Mitigation measures are not discussed, readers are just cross-referred to the air quality chapter. An outline of proposed measures (i.e. an air quality management framework or plan) should be provided in the health chapter and an explanation provided for how and to what extent these measures will mitigate the identified health impacts.		

[25] Table 1. CRFs recommended by the HRAPIE project, p5-11

Table 4 Health Pathways Included in the Draft EIS - Noise

Assessment		Comment	Recommendation
2.1 Description of health effects			
2.1.1	The potential health impacts/effects of the project, both beneficial and adverse, should be identified and presented in a systematic way.[26]	Health effects and attributable cases associated with exposure to daytime and night time noise are presented systematically; health impacts/effects are described for both the construction and operation phases.	None at this time.
2.1.2	Has the Exposure Pathway been identified?	Yes, exposure pathways linking noise to health effects are discussed in detail in Appendix G, Community Health, 6.1 Literature on Health Effects related to Noise.	None at this time.
2.1.3	Has an appropriate time period been considered for health and wellbeing impacts/effects?	Health and wellbeing impacts/effects have been described for 'snapshot years': 2030, 2050 and 2063 during the operation phase. There is a general discussion of the potential health effects during the construction phase.	None at this time.
2.1.4	Has an appropriate range of possible future (health relevant) scenarios been considered?	Yes. Potential health impacts/effects of noise are considered for the "Prefer 05", "Prefer 23" and "head-to-head" operation phase scenarios. There is a general discussion on construction phase noise, though specific scenarios for the construction phase are not discussed.	None at this time.

[26] *Does the identification of impacts consider short-term, long-term (and are these timescales defined?), direct and indirect impacts on health and well-being? Does the identification of health impacts distinguish between the construction phase, the operational phase and where relevant the decommissioning phase?*

Assessment		Comment	Recommendation
2.1.5	What is the predicted exposure level or condition? How does this compare with the exposure standard (for environmental impact/risks) or acceptable condition (for social, community or psychological impacts/risks)?	Tables detailing a range of daytime and night time exposure levels for different periods and scenarios are provided and compared to World Health Organisation (WHO) guidelines.	None at this time.
2.1.6	What level of risk has been designated for this impact?	The level of risks is generally considered to be low. Some risks for some locations (Luddenham) are considered higher than low (not ranked but actual risk is described e.g. "In 2063, the increase is predicted to be about 10%").	Health risks should be presented for the different communities in a more accessible manner than what is currently presented in the tables. This should also be presented in a way so that multiple impacts (myocardial infarction, sleep disturbance, learning, etc.) and from multiple causes (daytime ground operations, night-time operations, over flights etc.) can be understood by a interested stakeholders.
2.1.7	What justification has been provided for this risk level?	Levels of risk have been compared, or benchmarked, against World Health Organization (WHO) or other similar guideline values (e.g. EEA identify that 33 dB Lnight, outside appears to be a threshold value for awakenings related to aircraft noise and below this, sleep disturbance is unlikely to occur), as well as described in the context of existing baseline levels of risk.	Explain why certain standards are used for different aspects of the assessment (i.e. the European Environment Agency - EEA - guidance/evidence is used at times and then WHO guidance/evidence is used at others)

Assessment	Comment	Recommendation
2.1.8 Has the weighting/significance of health impacts/effects/risks been described and is it appropriate? [27] ➢ Direction: Whether the potential change would be beneficial or adverse ➢ Severity: More severe effects include those that are disabling, life-threatening, and permanent ➢ Magnitude: How widely the effects would be spread within a population or across a geographical area ➢ Likelihood: How likely it is that a given exposure or effect will occur. ➢ Certainty: level of certainty or uncertainty attached to the predictions of health effects.	Impacts are described as adverse; severity, in terms of morbidity, is implicit for some impacts e.g. cardiovascular disease. Severity for cognitive impairment in children or annoyance is not clearly defined, though this is a difficult area to consider. Magnitude is described in terms of risk and attributable cases (or events); it is not clear how population growth was considered/factored into the calculation of future attributable cases (magnitude). Likelihood is described in terms of risk, i.e. probability of occurrence, and described in the context of an unmitigated range of scenarios. Certainty and uncertainty attached to the predictions is not explicitly discussed. However, there is implicit discussion of the likelihood or certainty of key health effects occurring in the evidence base section. This discusses the scientific consensus that there is good/strong evidence of the link between exposure to noise and occurrence of some health impacts/effects.	There should be a clearer discussion of certainty or uncertainty, how levels of uncertainty are taken, or not taken into account, and assumptions used in the modelling and the calculation of predicted/forecasted health effects/impacts/risks. Consider a clearer discussion of the uncertainty in relation to the severity of the health effects of cognitive impairment and annoyance. Clarify whether population growth, and the increase in people, affected by changes in noise is taken into account in the estimation of magnitude.

[27] Does the assessment consider the severity of impact/exposure (intensity, reversibility and impact on vulnerable population groups), the impact magnitude (number of people affected and duration of impact/exposure) and the importance (political and ethical)? Have the health impacts of each alternative been assessed? Sometimes the health impacts are ranked and prioritized before making recommendations, if so; have the criteria for prioritizing and ranking health impacts been given?

Assessment		Comment	Recommendation
2.1.9	Does it take into account stakeholder and community concerns?	Stakeholder and community concerns are not discussed.	Community feedback on noise and health (as well as other health concerns) should be described and how this feedback was considered and addressed in the assessment should be discussed. Where community comments have not been incorporated or addressed an explanation justifying this should be presented. If there were no specific comments or concerns about noise and health then this should also be stated explicitly.
2.1.10	What mitigation measures have been proposed?	Mitigation measures for the operation are not described or discussed in this chapter. There is cross-referencing to the noise chapter where the main mitigation is described and discussed. The reviewers have not reviewed the noise chapter as this was not in the terms of reference for this review. A short description on some specific temporary measures is provided for the construction phase.	Provide in the human health chapter a brief summary of the mitigation framework/plan and measures discussed in the noise chapter. Some specific temporary mitigation measures that are mentioned for the construction phase, e.g. temporary noise barriers and exclusions buffers, should become recommendations rather than “could be considered” measures.
2.1.11	Has a residual health risk level been determined and mitigated where practicable?	There is no discussion of residual impacts/effects after mitigation. The report seems to assume that mitigation measures will attenuate most risk without discussing what the remaining risk will be and how they could be further minimised through ongoing monitoring and evaluation of the effectiveness of the proposed main mitigation measures.	Residual impacts/risks/effects should be discussed given that it is stated that these could still be significant. There should be a discussion of the significance of the residual or unmitigated impacts/risks/effects given the discussion that some mitigation measures may not be feasible or effective.

Assessment		Comment	Recommendation
2.1.12	Have community concerns been identified and adequately addressed?	See 1.1.9	See 1.1.9
2.1.13	The causal pathway leading to health effects should be outlined along with an explanation of the underpinning evidence.[28]	Causal pathways are described and the evidence underpinning the pathway is discussed.	None at this time.
2.2 Risk assessment			
2.2.1	Have assumptions been made explicit and uncertainties considered and taken into account?	A range of assumptions underpinning the evidence base and the health impact/risk/effect calculation methods are discussed. Assumptions relate to the assessment methodology and analysis of impacts/risks/effects. However, there are some assumptions mentioned in the HRA without a clear explanation in the health chapter and appendix of why they are used. For example, it is not clear in Appendix G why the "Head to Head" operation model is only used for the night-time operations. These types of assumptions should be clearly explained.	Include a clearer explanation/discussion of all the assumptions made.
2.2.2	The report should identify and justify the use of any standards and thresholds used to assess the significance of health impacts.	Standards and thresholds used are identified, namely WHO daytime and night time noise guideline values and EEA 33dB$L_{night, outside}$ threshold value for awakenings.	See 1.1.7

[28] *The potential health effects may be presented in diagrams, which show the causal pathways and changes in intermediate factors by which the project may affect population health, or may be descriptive.*

Assessment		Comment	Recommendation
2.2.3	Have the methods used to calculate impacts/risks/effects been adequately described (e.g. replicability, transparency, sources of information identified)	The HRA method is described. The methods used to calculate impacts/risks/effects are adequately described and cross-referenced to literature. Unclear what sensitivity analysis has been carried out. The calculations are not always clear and incorporate many assumptions that are not well described. For example, it is not clear how population estimates and growth are considered in the calculation of health impacts/risks/effects.	Methods used should be presented in a manner that is clear and easily understood to a lay audience (to the extent possible). Indicate possible range of estimates by including results from sensitivity analysis (using range of parameters such as possible change in population upper and lower 95% CIs of risk estimates used in calculations and different exposure scenarios)
2.3 Analysis of distribution of effects			
2.3.1	The affected populations should be explicitly identified.	Affected populations are described geographically i.e. the suburbs and schools in the vicinity of the airport site boundary. However, how the growth in affected populations has been considered in the calculation of impacts/risks/effects is not clear.	See also 1.1.8 in relation to population growth.

Assessment		Comment	Recommendation
2.3.2	Inequalities in the distribution of predicted health impacts should be investigated and the effects of these inequalities should be stated.[29]	Inequality and equity, as important concepts that should be considered as part of the health assessment, are not discussed in the report. Potential impacts/effects/risks in terms of health inequalities or equity are not assessed or discussed. There is no discussion of whether the most deprived suburbs, or suburbs with higher proportions of vulnerable or sensitive groups (e.g. children) are more affected than other suburbs.	There should be a discussion of how the distribution of health impacts/risks/effects between and within the suburbs/affected populations narrow or widen existing inequalities and whether these may be inequitable. There should also be a discussion of mitigation measures that could/are likely to reduce any identified health inequalities.
2.3.3	Have populations more vulnerable to impacts/ effects/risks been identified and discussed; and have mitigations been proposed?	Populations more vulnerable/sensitive to noise impacts have been identified but only the impacts/risks/effects on children are discussed (hazard quotient for learning and cognitive development). Mitigation measures aimed at these groups are not discussed in the health chapter or health appendix. There is cross-referencing to the noise chapter however the reviewers have not reviewed the noise chapter, as this was not in the terms of reference for this review, and therefore cannot give a judgment on the appropriateness of the proposed mitigation in terms of sensitive groups.	Develop a more detailed qualitative discussion of the long term health impacts/risks/effects of noise on vulnerable groups described in Appendix G, and children specifically.

[29] How does the report define inequalities? Inequalities are found between social groups and can be measured in different ways e.g. by geography, social class or social position, population (ethnicity, gender, sexuality etc.).

Assessment		Comment	Recommendation
2.3.4	Impacts/effects/risks on health should be examined based on the population profile.[30]	Impacts/risks/effects have been assessed against the existing health status of affected populations.	None at this time.

Noise Assessment Comments:

- The assessment of noise-related health impacts follows a health risk assessment approach, focussing on quantification of health endpoints from exposure to a range of noise. The quantitative methodology used is adequate. The range of noise metrics used is adequate. The range of health endpoints considered is also adequate and follows Australian and international evidence and guidance, namely the enHealth Guidance *Health Effects of Environmental Noise other than Hearing Loss* (enHealth, 2004). Risks are estimated for 2030, 2050 and 2063 periods for three different operation phase scenarios.
- A qualitative analysis and discussion of impacts/risks/effects on vulnerable/sensitive groups and on health inequality/equity issues has not been undertaken.
- There is no discussion of the implication of the distribution of effects for inequality and equity.
- Community feedback and any potential perceptions or concerns of local residents are not discussed.
- Perception effects are different from biological or epidemiological risks, can cause stress and anxiety and should be considered separately from mortality and morbidity effects.
- Mitigation measures are only discussed in passing and readers are cross-referred to the noise chapter. An outline of proposed measures (i.e. a noise management framework or plan) should be presented in the health chapter and an explanation provided for how and to what extent these measures will mitigate the identified health impacts.

[30] It should be possible to determine whether effects are more prevalent in certain demographic or vulnerable groups.

Table 5 Health Pathways Included in the Draft EIS – Water Quality

Assessment	Comment	Recommendation
3.1 Description of health effects		
3.1.1 The potential health effects of the project, both beneficial and adverse, should be identified and presented in a systematic way.[31]	A systematic assessment has not been conducted. The risk identification is generally adequate, but the characterisation and assessment of these risks is not provided. There is inadequate detail of how mitigation measures will address potential health impacts.	A detailed quantitative assessment of water impacts is required. Further information on baseline conditions, exposure pathways, population affects and potential health outcomes is required.
3.1.2 Has the Exposure Pathway been identified?	No - The potentially contaminating activities, contaminants of potential concern and exposure pathway linkages are identified. However these are not fully assessed to determine potential health outcomes.	A full assessment to determine health risks and potentially affected populations see be conducted
3.1.3 Has an appropriate time period been considered for health and wellbeing impacts?	No – there is no description of latency of health impacts included.	Identify latency of health impacts in full assessment.
3.1.4 Has an appropriate range of possible future (health relevant) scenarios been considered?	There is no discussion of the various stages of operation (i.e. long term operations). It only lists potential risks associated with construction and operation.	Include assessment of long term operations.

[31] *Does the identification of impacts consider short-term, long-term (and are these timescales defined?), direct and indirect impacts on health and well-being? Does the identification of health impacts distinguish between the construction phase, the operational phase and where relevant the decommissioning phase?*

Assessment		Comment	Recommendation
3.1.5	What is the predicted exposure level or conditions? How does this compare with the exposure standard (for environmental risks) or acceptable condition (for social, community or psychological risks)?	Standards are identified, but the exposure levels are not clearly articulated. The risks are not clearly and transparently assessed. The ground water and surface water risk assessment relies on data that is too limited and does not include specific exposure assessments or detailed quantitative risk characterisations.	See 1.1.2
3.1.6	What level of risk has been designated for this impact?	No clear risk has been stated, though the draft EIS notes: "the implementation of mitigation measures described in the related technical reports (surface water, water quality and groundwater), the potential risks would be minimised. " These mitigation measures are not described within this section, and the mechanisms by which they will reduce risks remains unclear.	Provide further detail on mitigation measures and how they will contribute to the reduction of specific risks.
3.1.7	What justification has been provided for this risk level?	There is an argument presented on potential risk though this is based on limited evidence.	See 1.1.2

Assessment	Comment	Recommendation
3.1.8 Has the weighting/significance of health impacts been described and is it appropriate? [32] ➢ Direction: Whether the potential change would be beneficial or adverse ➢ Severity: More severe effects include those that are disabling, life-threatening, and permanent ➢ Magnitude: How widely the effects would be spread within a population or across a geographical area ➢ Likelihood: How likely it is that a given exposure or effect will occur. ➢ Certainty: level of certainty or uncertainty attached to the predictions of health effects.	No weighting has been made for severity, magnitude, likelihood or certainty.	A description of the severity, magnitude, likelihood and certainty of health impacts should be provided as part of a complete assessment.
3.1.9 Does it take into account stakeholder and community concerns?	This is not detailed in this section. Although the report does mention that there were community concerns raised about the potential impacts from aircraft emissions to tank water (p137), it is not clear how these were considered in the assessment.	Community feedback on water quality and health (as well as other health concerns) should be described and how this feedback was considered and addressed in the assessment should be discussed. Where community comments have not been incorporated or addressed an explanation justifying this should be presented. If there were no specific comments or concerns about noise and health then this should also be stated explicitly.

[32] Does the assessment consider the severity of impact/exposure (intensity, reversibility and impact on vulnerable population groups), the impact magnitude (number of people affected and duration of impact/exposure) and the importance (political and ethical)? Have the health impacts of each alternative been assessed? Sometimes the health impacts are ranked and prioritized before making recommendations, if so; have the criteria for prioritizing and ranking health impacts been given?

Assessment		Comment	Recommendation
3.1.10	What mitigation measures have been proposed?	Several are mitigation strategies are outlined: - Dust control - Surface water discharge control and monitoring - Monitoring of water quality in Warragamba Dam, Prospect Reservoir and local water tanks	Further detail on mitigation measures and monitoring requirements is needed. Or make explicit where else these are listed in the draft EIS.
3.1.11	Has a residual health risk level been determined and mitigated where practicable?	There is no discussion of residual risks after mitigation strategies have been implemented.	Include discussion of residual risk.
3.1.12	Have community concerns been identified and adequately addressed?	Not addressed in section.	See 1.1.9
3.1.13	The causal pathway leading to health effects should be outlined along with an explanation of the underpinning evidence.[33]	The pathway beyond risk identification is not described.	Assessment should clearly outline impacts to health, including a literature review.
3.2 Risk assessment		Comment	Recommendation
3.2.1	Have assumptions been made explicit and uncertainties are considered and taken into account?	A number of assumptions have been alluded to in the section on "potential health risks associated with construction and operation". These are used to argue against the significance of certain health risks but have not been clearly stated earlier in the section.	A clear list of assumptions underpinning the assessment of Groundwater and Surface Water impacts should be included.
3.2.2	The report should identify and justify the use of any standards and thresholds used to assess the significance of health impacts.	Standards are identified but their use and application is not described.	Include further justification for the inclusion and use of standards.

[33] *The potential health effects may be presented in diagrams, which show the causal pathways and changes in intermediate factors by which the project may affect population health, or may be descriptive.*

Assessment		Comment	Recommendation
3.2.3	Have the methods used to calculate impacts been adequately described (e.g. replicability, transparency, sources of information identified)	The processes for exposure assessment and risk characterisation have not been clearly described.	See 1.1.2
3.3 Analysis of distribution of effects		**Comment**	**Recommendation**
3.3.1	The affected populations should be explicitly identified.	A population profile is provided earlier in the appendix but this section does not described which populations will be affected.	Include an analysis of potential impacts to populations including vulnerable receptors (vulnerable groups) in the full assessment.
3.3.2	Inequalities in the distribution of predicted health impacts should be investigated and the effects of these inequalities should be stated. [34]	No differential impacts have been described.	Include discussion of the distribution of impacts with consideration for vulnerable populations as part of the full assessment.
3.3.3	Have populations more vulnerable to this impact been identified, discussed and mitigations proposed?	Vulnerable populations have not been described or assessed.	See 1.3.2
3.3.4	Effects on health should be examined based on the population profile. [35]	The impacts have not been assessed relative to the existing population profile.	Include assessment of impacts relative to the existing population profile as part of the full assessment.
Water Quality Assessment Comments:			
A more complete assessment is required that includes a clear list of assumptions, a description of population affected, and an assessment of impacts on vulnerable receptor population groups.			

[34] How does the report define inequalities? Inequalities are found between social groups and can be measured in different ways e.g. by geography, social class or social position, population (ethnicity, gender, sexuality etc.).

[35] It should be possible to determine whether effects are more prevalent in certain demographic or vulnerable groups.

Table 6 Review of Overall Report

Assessment		Comment	Recommendation
4.1 Site description and policy framework			
4.1.1	The report should describe the physical characteristics[36] of the project[37] site and the surrounding area.	A brief description and map of the project site is located in the appendix. A more comprehensive description is in vol.1 introduction p. 59-61	Sufficient description for the appendix and health chapter.
4.1.2	Is there an adequate description and location of the communities likely to be affected by the proposed development?	Only includes a description of communities within close proximity to the airport site. It is not clear, given the proximity of other LGAs, and the reach of some health impacts (noise, AQ) why other communities were not considered.	Either include better justification of only assessing impacts to close proximity communities, Or also consider impacts to other affected communities.
4.1.3	The report should describe the way in which the project site and the surrounding area are currently used.[38]	Given that most of the land has been obtained and cleared by the Government for this project, there was not much description provided of the existing use of the land. There is no discussion of how development of the project may change use/demand on existing infrastructure and services.	A description of the land use of the area surrounding the airport (not just the airport itself) should be included. This would help to understand the community character not just the physical land use.

[36] *The physical characteristics may include the location, design, size and an outline of the area of land take during the construction and operation phase. Presentation or reference to diagrams, plans or maps will be beneficial for this purpose. Graphical material should be easy to understand without having any knowledge about planning and design.*

[37] *The review package uses the term project to mean the execution of construction works or of other installations or schemes; or other interventions in the natural surroundings and landscape including those involving the extraction of mineral resources (30;46).*

[38] *Does the site description indicate whether the site and the surrounding area are used, either formally or informally, and if so who by? What are the demands of the project on local infrastructure and services?*

Assessment		Comment	Recommendation
4.1.4	The report should describe the policy context and state whether the project accords with significant policies[39] that protect and promote wellbeing and public health and reduce health inequalities.	The only policies referenced are the EPBC Act and Airports Act. It is stated in the health appendix that a health risk assessment is not required under the EPBC but that one has been undertaken because of the known effects of airports on human health. It states that the HRA has been conducted in accordance with Australian HRA guidelines and other practice guidelines (NHMRC, NEPC). No reference is made to relevant Health Impact Assessment Guidelines (e.g. enHealth HIA Guidelines, WHO guidelines:- A Guide for the Evaluation of Health Impact Assessments carried out within the EIA process) The context for the inclusion of an assessment on health is described but it is unclear why a health risk assessment rather than a health impact assessment was commissioned.	It is not clear why, if there is recognition of the impacts of airports on human health, that only an HRA was undertaken. Further clarification should be provided for only doing an HRA and not an HIA. Given the EPBC requirements to consider principles of inter-generational equity – "that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations," there should be a clear justification for not considering the full range of health impacts and health equity impacts. It should be noted that it appears the consultants who produced the Health Chapter were commissioned to carry out a health risk assessment of air quality, noise and water. So the issues relating to the failure to adequately assess a broader range of health impacts appears to have appeared at an earlier stage of planning the draft EIS.

[39] The policies may be local, regional, national or international policies or they may be sector-specific.

4.2 Description of project		Comment	Recommendation
4.2.1	The aims and objectives of the project should be stated and the final operational characteristics of the project should be described.[40]	The objectives of the airport are described briefly in the appendix and are described in detail elsewhere in the draft EIS. The previous EIS considered site alternatives so none were explored in this draft EIS. There is also considerable detail provided around the governance structure of approval of both the EIS and the airport master plan. The objectives of the EIS are also clearly stated.	None.
4.2.2	The estimated duration of the construction phase, operational phase and, where appropriate, decommissioning phase should be given.	The multi-stage development (construction, stage 1, long term) are not described in the appendix or health chapter but are described in detail elsewhere in the report (vol. 1, introduction).	It would be helpful to have a summary of the various activities that will take place at the different stages within the health chapters, although activities are described within the assessment of each health pathway.
4.2.3	The relationship of the project with other proposals should be stated.	There is ample description of the justification of the airport and its relationship to other planning processes elsewhere in the report (Volume 1, chapter 2). Further description is not necessary for the health appendix or chapter.	None.

[40] Has a do-nothing option and other alternatives to the project been described? Does the report also describe the primary advantages and disadvantages to health of the proposal and alternatives? It should be noted if no alternatives are being assessed.

4.3 Public health profile		Comment	Recommendation
4.3.1	The public health profile should establish an information base from which requirements for health protection, health improvement and health services can be assessed.	General health information is provided for Liverpool LGA. Data is presented as real estimates and as a proportion of the NSW average. They also give childhood asthma prevalence for Liverpool, but nowhere else. It is not clear why the baseline data is only provided for Liverpool LGA when some of the communities that they are assessing are located in Penrith LGA. There is no rationale provided for why only Liverpool LGA is profiled. Page 24 of the Health Chapter states that "It should be noted that the airport site will occupy significant parts of Badgerys Creek and Luddenham and a number of current residents will be relocated. Therefore the future populations in these areas is likely to be much lower than that recorded in 2011." This is misleading in that it does not acknowledge the future expected increases in population in the profile area.	The baseline indicators are appropriate for assessing predicted health impacts related to air quality. Given the impacts of noise on sleep disturbance and learning ability, it would have been useful to include baseline rates of depression (or overall mental health) and any cognitive learning indicators (if available). If these were not available then they should have been more clear about why they included the health indicators that they did. They should also either make explicit why they only provided baseline data for Liverpool LGA or should include the same data for Penrith LGA and any other relevant LGAs. The demographic profile should provide information about expected population changes.

Assessment		Comment	Recommendation
4.3.2	The profile should identify vulnerable population groups. The profile should describe, where possible, inequalities in health between population groups and should include the wider determinants of health[41].	They acknowledge that people of disadvantage are more at risk to airport impacts (i.e. air/noise pollution) and therefore provide indicators of socio economic disadvantage through the SEIFA index. They do point out that certain communities appear to be more disadvantaged than the Australian average but it is hard to discern to what extent they are disadvantaged based merely on the SEIFA score (e.g. how much more disadvantaged is someone with a SIEFA score of 881 vs. 914?) They do recognize that as a whole, due to their low SEIFA scores, certain communities will be more vulnerable to effects than others.	While the SEIFA index does help to show overall disadvantage, it is not a very useful tool in comparing communities or for the lay person to understand what a particular SEIFA score means. If possible, would be more useful to use SEIFA quintiles for a clearer comparison. Likewise, it is difficult to understand the overall burden of disease when it is compared to the NSW average. It would be more helpful to see the health indicators expressed as proportions of the local population rather than a comparison to state averages (or could do both). If data is available, it would also be helpful to understand the health status of the communities that have been identified as having vulnerability based on their SEIFA scores (i.e. do they also have higher rates of asthma or heart disease) if this data is available.
4.3.3	information provided should include characteristics of the populations such as:		
	Population size, age and gender profile	Population Size – yes Age – Not in actual numbers but expressed as percentage less than 15, and over 65 years of age, but no further breakdown Gender - no	What is provided is generally sufficient

[41] People's health is influenced by the conditions in which they live. Health determinants are the personal, social, cultural, economic and environmental factors that influence the health status of individuals or populations. These include, but are not limited to, factors such as income, employment, education, social support and housing.

Assessment	Comment	Recommendation
Population density and distribution	No	Include if possible, or reference to where it is located in other part of the draft EIS
Ethnicity	no	Include if possible, or reference to where it is located in other part of the draft EIS
Socioeconomic status	Yes – SEIFA score	Included
Vulnerable groups/locations such as schools, aged care facilities, hospitals	No	Should include
Health status from clinics and other authorities	Health status is expressed for Liverpool LGA level	It would be helpful to have more specific health data if available but the LGA may be all there is available
Sources of and types of employment	No	Include if possible, or reference to where it is located in other part of the draft EIS
Health behaviour indicators such as physical activities, smoking drug use	Rates of prevalence of the behaviour are not included but the disease burden (death and hospitalisations) attributable to smoking, high BMI and alcohol is included.	Include if possible
Environmental conditions such as air, water, soil quality	This is not included in the health appendix but it is available in the draft EIS (Air quality appendix, water appendix). Some current air quality, hydrogeology and water conditions are mentioned and/or described in the health chapter but a full baseline assessment is not included in the health chapters.	Include only as needed to further clarify information in the assessment or reference to where they are located in other parts of the draft EIS.

Assessment		Comment	Recommendation
	Roads and other infrastructure such as power, water, transport – rail, road, air, and so on	No	Include if possible, or reference to where it is located in other part of the draft EIS
	Housing types and quality	No	Include if possible, or reference to where it is located in other part of the draft EIS
	Health services such as hospitals, clinics	No	Include if possible, or reference to where it is located in other part of the draft EIS
	Community services such as police, ambulance, fire and other emergency services, recreation, etc.	No	Include if possible, or reference to where it is located in other part of the draft EIS
4.3.4	The information in the profile should be specific about the timescale, the geographic location and the population group being described and links should be made with the proposed project.[42]	Information is provided about the anticipated population growth of the Liverpool LGA. It is also mentioned that there will be a population decline in certain areas that inhabit the airport site. There is no further mention of whether anticipated population growth incorporates growth due to the airport, or whether there will be growth in those same areas in close proximity to the airport site.	Further clarification on population growth estimates and assumptions around population size of communities in close proximity to the airport in the future should be included.

[42] Does the profile include consideration of the future profile of the population?

Overall Report Comments:
The description of the context and requirements for the HRA are generally sufficient. It would have been helpful to understand why only an HRA was undertaken and not a full HIA, particularly considering that recognition of the significance of the social determinants of health and their impacts on health. The population health profile was very limited in scope and is missing clarification for why only certain information is provided. Consideration of vulnerable populations is based around SEIFA scores only and again, it should be explained why only these scores, and not additional indicators of disadvantage are include. Any further information that is included in other chapters in the draft EIS should be referenced within the health chapters.

5. Coverage of Health Topics

The review team have identified the extent to which potential health impacts have been identified in the health chapter and associated appendix. The approach taken to considering health impacts in the health chapter is narrow and does not take into account the findings of other health-relevant assessments, such as in the SIA. This has resulted in key environmental and social determinants of health not being considered. The scoping process whereby the decision to focus on air quality, noise and water is unclear so it is not possible to assess whether the narrow focus is justified. However given the current level of evidence on the effects of airports on health as well as the more general evidence base around the social determinants of health it is likely that relevant health impacts are missing from the health chapter.

The review team have carried out a scoping review of the technical reports other than the health appendix to identify the extent to which health topics have been included within the entire draft EIS. It is outside the scope of this peer review to carry out a comprehensive review of the health topics covered in the non-health documentation or to assess/assess in more detail any health impacts.

The 'non health' sections of the draft EIS contain information about a number of significant impacts on the determinants of health (e.g. housing affordability, visual amenity). The majority of these relevant health determinants are covered within the SIA. These have not been identified as health impacts and the range and magnitude of potential health outcomes resulting from these impacts have not been assessed. For example, significant impacts on amenity have been identified but the link between amenity and health outcomes such as mental health has not been made. This means that the impacts on health resulting from these changes are unknown. As these are not currently included within the health chapter they risk being overlooked by stakeholders concerned with understanding how WSA potentially impacts on human health. Health effects may be overlooked and not taken into account when mitigation/enhancement is being considered. In addition, the inter-related nature of the health and wellbeing impacts identified in the draft EIS has not been fully considered and therefore combined effects from, for example, changes to air pollution, noise, water quality, flood risk, community, place and local economy have not been considered.

Table 7 shows potential health effects arising from the project that are covered in the health chapter and associated appendix. They are arranged by health determinant. For each determinant Table 7 shows project activity and the sub-activities by stage (e.g. construction and operation). The potential health outcomes arising from these activities are shown as are the likely affected communities. Communities are defined by geography and by shared characteristics. The potential effect on vulnerable populations is noted. The final two columns note where this information is located in the draft EIS and any mitigation measures provided. Table 7 shows that some key determinants of health have been considered in reasonable detail. However, the potential inequality/inequity impacts have not been sufficiently assessed or discussed. This is a significant gap.

Table 8 shows that some key determinants either do not seem to have been considered anywhere in the draft EIS or have not been considered and discussed in relation to health impacts in the Human Health Chapter and Community Health Appendix. The determinants that do not seem to have been covered anywhere in the draft EIS are those in table listed under the heading of socio-cultural:

Healthcare, Other public and community services, Recreation, Social capital and community cohesion and Housing. The determinants that have been covered elsewhere in the draft EIS but where specific health impacts or a discussion of the implications for community health have not been addressed in the Human Health Chapter and associated appendix are: Traffic and transportation, Economic (Employment/income), Visual intrusion, Odour and Climate change.

These determinants and why they should have been assessed or assessed in more detail is discussed in the next section.

Table 7 Health Topics Covered in Health Chapter

<table>
<tr><th>Health determinant</th><th>Activity</th><th>Sub activity</th><th>Potential health outcome/effect</th><th>Likely affected communities</th><th>Vulnerable populations</th><th>Where addressed in the draft EIS</th><th>Mitigation measures in draft EIS</th></tr>
<tr><td rowspan="8">Air quality</td><td rowspan="2">Construction activities</td><td>Bulk earthworks and aviation infrastructure works (emissions and dust deposition)</td><td rowspan="8">Long-term: All-cause mortality in adults; cardiopulmonary, ischemic heart disease, lung cancer mortality in adults (subset of all-cause mortality)

Short-term: all-cause mortality in all ages; Cardiovascular disease mortality; hospital admissions for respiratory, cardiac, cardiovascular, ischemic heart disease COPD and pneumonia/bronchitis in 65+; hospital admissions for respiratory disease in 15-64; ED visits for asthma in 1-14 year olds;</td><td rowspan="8">Geographically: communities/suburbs within 5 km from the airport boundary have been considered – Bringelly, Luddenham, Greendale, Kemps Creek, Mulgoa, Wallacia, Badgerys Creek, Rossmore and Mount Vernon

Vulnerable/sensitive groups considered: elderly, people with existing cardiovascular and respiratory disease, people with asthma, low socio-economic groups/socially deprived and children</td><td rowspan="8">Impacts on inequality/equity not explicitly discussed but implicitly as impacts are described by areas for which information on existing levels of elderly, children and proportion of deprived residents is presented.</td><td rowspan="8">Human health chapter (chapter 13) and Health Risk Assessment appendix (appendix G)</td><td rowspan="8">Not presented in the human health chapter or appendix but cross-referred to the air quality and greenhouse gases chapter (chapter 12).</td></tr>
<tr><td>Construction traffic (emissions)</td></tr>
<tr><td rowspan="6">Operation-related activities</td><td>Passenger vehicle movements</td></tr>
<tr><td>Staff vehicle movements</td></tr>
<tr><td>Internal airport vehicle movements</td></tr>
<tr><td>Air traffic movements</td></tr>
<tr><td>Airport-related energy production and waste management including power plant/s</td></tr>
<tr><td>Aircraft Auxiliary Power Units (APUs) and Ground Support Equipment (GSE)</td></tr>
<tr><td>Noise</td><td>Construction activities</td><td>Construction traffic</td><td>Wellbeing (annoyance and sleep disturbance)
Learning
Cardiovascular</td><td>Geographically: Bringelly, Kemps Creek, Erskine Park, Kemps Creek 2, St Marys, Greendale,</td><td>Sensitive receptors such as schools mentioned.</td><td>Human health chapter (chapter 13) and Health Risk Assessment appendix (appendix</td><td>Not presented in the human health chapter or appendix but cross-referred to the noise chapter.</td></tr>
</table>

Health determinant	Activity	Sub activity	Potential health outcome/effect	Likely affected communities	Vulnerable populations	Where addressed in the draft EIS	Mitigation measures in draft EIS
			effects	Silverdale, Rossmore, Horsley Park, Rooty Hill, Prospect; Additionally, a range of locations for educational facilities have been considered given their sensitive nature;		G)	
Water quality	Chemical and fuel storage Equipment Operation Equipment maintenance Fire fighting	Potential leaking of underground storage tanks and pipes; fuel spillage or leakage during ground handling of aircraft; washing of aircraft and vehicles and fire-training for which flame-retardant chemicals may be used; fuel jettisoning Surface water discharge	Acute or chronic exposure to range of health hazards leading to range of health effects	No analysis of differential impacts in relation to water quality, including likely affected communities	None discussed	Pages 141-143	Monitoring proposed for surface water discharge but not detailed in this section. Spill management and containment protocols Fuel discharge is characterised as a rare occurrence.
	Dust emissions during construction	Impact on potable water supply at Warragamba Dam	Impact on water quality	No analysis of differential impacts in relation to water quality, including likely affected communities		Pages 142-143 Assessed risk to water quality through PM 10 modelling as being low	Dust controls through water spray

Error! Not a valid bookmark self-reference. shows potential health effects arising from the project that are not covered in the health chapter and associated appendix. They are arranged by health determinant. For each determinant Table 8 shows project activity and the sub-activities by stage (e.g. construction and operation). The potential health outcomes arising from these activities are shown.

Table 8 Health Topics Not Covered in Health Chapter

Health determinant	Activity	Sub activity	Potential health outcome/effect
Environmental			
Traffic and transportation	Construction-related traffic		RTAs related injuries and fatalities Severance (see social capital and community cohesion)
	Operation-related traffic (passengers, staff and freight HGVs e.g. fuel, retail, other)		
	Aircraft accidents		Aircraft accident related injuries and fatalities
	Fly parking and speeding		Wellbeing (annoyance/ frustration)
	Congestion and travel times		Wellbeing (annoyance/ frustration)
	National and international connectivity		Wellbeing (improved for those using)
Odour	Odour associated with aircraft		Wellbeing (annoyance)
Climate change	Construction	Primary and linked secondary greenhouse gas emissions	No direct health effects but potential for contributing to increase extreme weather events globally that have health effects (e.g. drought, flooding, forest fires, etc.)
	Operation	Primary and linked secondary greenhouse gas emissions	
Economic			
Employment/income	Job opportunities at airport and associated facilities (skills, training and additional income)		Physical and mental health and wellbeing (improved)
	Property Values		
Socio-cultural			
Healthcare	Increased demand on local level health care because of the		Mental health and wellbeing Physical health

Health determinant	Activity	Sub activity	Potential health outcome/effect
	presence of the workforce		
Other public and community services	Disruption to utilities	Construction Land take	Mental health and wellbeing Physical health
Recreation	Loss of public and green space		Mental health and wellbeing Physical health
Social capital and community cohesion	Land take for proposed runway	Displacement of People Loss of housing and sense of community	Mental health and wellbeing (e.g. psychosocial distress) Physical health
	Community disruption due to noise of air traffic and noise and severance of construction and operation related road traffic		
	Migration of workers and presence of non-local workers		
	Community concerns/ perceptions and beliefs about the airport		
Housing	Additional Housing		Mental health and wellbeing (improved) Physical health (improved)
	Creation of new facilities		
Visual intrusion	Land take for proposed runway	Loss of green space Loss of farming space	Mental health and wellbeing Physical health
	Construction		
	Visual effect of additional vehicles		

Important health implications of the determinants of health that have not been fully assessed in the draft EIS

Below potential health implications of the determinants of health that have not been fully assessed in the draft EIS, based on current public health evidence are described.

Environmental impacts

Traffic and transport

Higher levels of traffic in residential areas are associated with poor health and lower levels of social cohesion. This particularly affects older people and children. Time spent commuting can impact on family life and mental wellbeing. Increases in traffic can lead to increases in traffic related accidents. The social impact assessment identifies opportunity for “comprehensive planning, improvements to the road network in conjunction with new public transport infrastructure would create connected communities, reducing commute times and providing opportunities for an active lifestyle” (pg. 97). In addition, increased local job opportunities were predicted to reduce travel times and improve quality of life. Risk due to aircraft accidents is discussed but road traffic accidents due to increased traffic density has not been assessed.

Odour

Odour can cause annoyance and avoidance behaviour (for example, changes in use of outside areas). Odour from exhaust emissions and the on-site waste water treatment plant is assessed within the Air Quality Assessment. These were assessed to be below detectable levels off site for Stage 1. Odour was not assessed for the longer term scenario.

Climate Change

Climate change has significant impacts on human health ranging from changes to food production to increases in extreme weather events. Climate change is addressed in the draft EIS in the Biodiversity assessment. Climate change is identified as being exacerbated by WSA. Potential impacts on health from climate change have not been identified.

Economic impacts

Employment

Evidence shows that higher levels of employment lead to better population health. Participating in employment has been shown to have strong positive effects on mental and physical wellbeing. In general being in work is better for health than having no job; however there are exceptions. Workers in jobs that are poor quality, low paid and precarious (insecure) have similar health scores to the unemployed. Low paid, low skill, insecure jobs with few opportunities for training, development and progression are less healthy than higher paid, higher skill, secure jobs with good opportunities for training, development and progression. Previous HIAs of airports have shown that airports tend to generate a relatively high proportion of lower paid, low skill level jobs.

Employment and economic impacts are discussed in depth in the Social Impact Assessment technical report. It is estimated that during stage 1 construction there will be approximately 758 FTE jobs created. In addition, there is an estimated 7,500 FTE airport related employment by the end of stage

1 (2030) and a further 4,400 FTE jobs in the business parks associated with the airport. Longer term it is estimated that approximately 61,500 FTE jobs would be required for airport operations (2063). Although employment opportunities are expected to increase there are some expected negative impacts on agricultural and manufacturing industry due to competition for land. This could also result in potential loss of agricultural land. The potential health impacts related to the existing local economy and those employed in that economy are not described in the SIA.

The SIA identified a potential reduction in commuting times for Western Sydney residents by being able to access jobs closer to where they live. This could have positive benefits for community and family life.

Socio-cultural impacts

Community facilities

Healthcare

Changes on population, both residential and workforce, can lead to increased demand on health services. There are also potential effects on health services through risks associated with airport development. People within healthcare facilities also tend to be disproportionately vulnerable to impacts such as noise and air quality. The SIA identifies insignificant impacts on healthcare demand for Stage 1 and potential additional demand in the longer term scenario. Health care facilities are also identified as 'sensitive social infrastructure' more likely to be affected by impacts such as noise, social amenity, etc. but the specific health impact on these sensitive settings is not assessed.

Other public and community services

The SIA identifies sensitive social structures that may be particularly vulnerable to potential negative impacts (child care, schools, hospitals, recreational spaces and places of worship) but the specific health impact on these sensitive structures is not assessed.

New facilities

The SIA identifies that it is likely that new facilities will be developed as part of the growth associated with the airport.

Recreation resources

Access to good quality green space is associated with improved mental and physical health outcomes. This may happen through ameliorating stress, increased physical activity and there is also evidence of exposure to nature reducing blood pressure. The mental health benefits of activities in a natural environment have been identified as:

- Social, emotional, creative and cognitive development of children and young people
- Quality of life and relaxation
- Recovery from stress
- Relief of symptoms
- Therapeutic and healing; spiritual
- Physical activity; sport; adventure; challenge
- Learning; intellectual and creative development
- Sense of meaning/purpose/perspective
- Social contact; cohesion; belonging; identity
- Volunteering; conservation; "giving something back"

The SIA identifies loss of amenity for recreational areas from visual and noise impacts. Noise is expected to negatively impact on the amenity of Bents Basin Recreational Area in Greendale, Rossmore Grange, Twins Creek Golf and Country Club, Whalan Reserve at St Marys, Burragorang State Conservation Area and a small part of the Western Sydney Parklands and Prospect Nature Reserve). The Blue Mountains World Heritage Area is going to be negatively impacted on by noise and visual impact from planes. The impacts on recreational facilities and greenspace on health have not been considered.

Social capital and community cohesion

Research has demonstrated a link between social capital and health, in particular mental wellbeing. Communities with high social capital have higher levels of trust, reciprocity and participation. At an individual level social participation and support are associated with lower levels of metal health problems and higher levels of self-reported health. Further discussion on how social capital and community cohesion is addressed in the points below.

Land take for Airport

Loss of housing and forced relocation of residents and businesses have been shown to have significant negative health impacts on individuals as well as community level impacts due to loss of or disruption to social capital and community cohesion. The SIA excludes the impacts of forced relocation on health and wellbeing because the relocations have already taken place.

The SIA identifies that there will be a loss of agricultural land. Food security is an important public health issue and has not been assessed within the draft EIS.

Community disruption due to noise of air traffic and noise and severance of construction and operation related road traffic

The health chapter includes an assessment of noise related impacts in terms of awakenings, cardiovascular events, learning and cognitive development in children. Air quality is assessed in terms of impacts on physical health (e.g. cancer risk, increased mortality and morbidity). Community disruption, and impacts on social capital and community wellbeing are not assessed in the health chapters. Stress and anxiety related impacts are also not assessed. Within the SIA loss of amenity due to air and road traffic noise is identified as a potential negative impact. The implications of this for public health and wellbeing are not identified. The draft EIS has not assessed the potential increase in road traffic accidents as a result of airport related traffic.

Migration of workers and presence of non-local workers

Migration of workers and the presence of non-local workers in communities can cause community disruption and impacts on local facilities and resources. The SIA identifies that the majority of the workforce is expected to be local but also some moving into the area permanently and also people commuting in from other parts of Sydney. The expectation for a mostly local workforce appears to be based on the availability of working-age people in the South Western Sydney area. It was beyond the scope of this peer review to assess the validity of assumptions around employment opportunities. It is not clear whether the expected increase in employment opportunities will benefit young residents, unemployed residents and residents experiencing deprivation in the surrounding area. These residents are also likely to be most negatively affected by existing and future environmental, social and health impacts from airport activities.

Community concerns/ perceptions and beliefs about the airport
Evidence of health impacts, as laid out in the draft EIS, may not be the same as the community's perception of health risks. The perception of changes to noise, air quality, and home prices can influence the behaviour of local community members and in turn affect their health. This has been evidenced by other HIAs on airport developments. The extent to which individuals and communities have control over their lives has a significant influence on mental health and overall health. Lack of control and lack of influence (believing you cannot influence the decisions that affect your life) are independent risk factors for stress. Heightened risk perceptions, low control and low involvement in decision-making are associated with negative physical and mental health impacts**.** The SIA acknowledges uncertainty over the airport plans (e.g. flight path location) that could cause anxiety among local community but the potential impacts on health and wellbeing are not drawn out. This is a potentially significant area of health impact that has not been assessed.

Housing
The SIA reports that most stakeholders noted housing affordability during consultation as a key issue. The SIA identified no significant impacts on values for large blocks of land that are currently common around the airport. The population forecast carried out for the draft EIS predicts significant population growth in Southwest Sydney. Areas close to the airport have been identified as both employment and housing growth areas. The SIA identifies that potential longer term housing unaffordability due to growth may negatively impact on already disadvantaged groups.

In addition, housing prices may be relatively more affordable in areas exposed to higher levels of noise. This means that already vulnerable population groups are more likely to live closer to environmental risks. Communities close to the airport may have already experienced disruption and corresponding loss of identity, social capital and social cohesion due to relocation of housing and community facilities, changes in employment opportunities, and other environmental impacts due to the airport development. Although longer-term housing unaffordability is identified as a potential problem in the SIA, the implications of this for health and health equity are not drawn out.

Visual intrusion
The airport itself and associated development, construction and additional traffic will negatively impact on visual amenity. The SIA identifies the loss of agricultural land; this will impact on the visual amenity of the area as it is replaced by other more built up industries. As mentioned previously, recreational areas including the Blue Mountains will suffer loss of visual amenity due to the presence of planes overhead and for some areas changes to the landscape. Some residential areas will also have views of the airport.

The potential negative permanent impacts from the loss of amenity and green space on health are not identified in the SIA. These impacts would affect future generations. The potential health impacts on communities that will experience multiple amenity impacts (e.g. noise and visual) has not been considered. These impacts can lead to a significant loss of community and sense of place (with or without any additional increase in aircraft noise) making the area less desirable to live in and affecting community identity and cohesion.

6. Detailed Findings – Long Term Development

This section details the findings of the peer review conducted on the Health Chapters for long-term development. The peer review took into consideration long-term impacts described in the Health Appendix (G) and any health considerations included in Volume 3.

Table 9 Long Term Health Impacts Considered in the Draft EIS

Requirement		Comment	Recommendation
4.4 Description of health effects			
4.4.1	The potential health effects of the project, both beneficial and adverse, should be identified and presented in a systematic way.[43]	The assessment focuses only on the risks (adverse effects) to human health. This section only considers the effects from the long-term development scenario (other timescales are considered in the health appendix). Impacts are limited to direct risks via noise, air quality and water exposure.	Consider broader range of health pathways and indirect impacts, as well as considering positive impacts/effects.
4.4.2	Has the Exposure Pathway been identified?	Exposure pathways for air, noise and water are clearly explained. They include exposure from aircraft overflights, ground activity, and traffic, which seem to include all the major pathways for these health determinants.	None.

[43] *Does the identification of impacts consider short-term, long-term (and are these timescales defined?), direct and indirect impacts on health and well-being? Does the identification of health impacts distinguish between the construction phase, the operational phase and where relevant the decommissioning phase?*

Requirement		Comment	Recommendation
4.4.3	Has an appropriate time period been considered for health and wellbeing impacts?	Without considering the appropriateness of the assumptions used in the air, noise and water assessments it is not possible to determine whether the assumptions used for the health assessment are appropriate. The HRA assesses for increased risk from exposure with an assumption for continued exposure (non-mitigated) in which case this would seem appropriate.	Given the long-term stage of this assessment, the time period for the health impacts seem appropriate.
4.4.4	Has an appropriate range of possible future (health relevant) scenarios been considered?	The health outcomes are very narrowly considered (all-cause mortality; cardiopulmonary mortality; respiratory mortality; ED visits for asthma in children; EEG awakenings; learning and cognitive development; myocardial infarction). These do not take into consideration any assumption about future health scenarios which may be appropriate given the uncertainties about the assumptions for the air and noise modelling for this future stage of development. However, the assessment does not taken into account future population growth scenarios.	Consider population growth scenarios in the assessment of long term impacts.

Requirement		Comment	Recommendation
4.4.5	What is the predicted exposure level or conditions? How does this compare with the exposure standard (for environmental risks) or acceptable condition (for social, community or psychological risks)?	The Human health Chapter authors note that all exposure levels are below accepted standards. However this does not take into consideration the potential health outcomes of synergistic impacts (of the combined exposures). Likewise, the authors note that for NO2, even though it falls below the NEPM standards, there is no safety threshold for NO2. This is also true for PM 2.5, although this is not stated in the report. There is also no mention of the acceptability of these risks by communities or health professionals.	In addition to comparing risks to NEPM standards, they should also consider synergistic impacts and the acceptability of risks for the communities, particularly those that will be most impacted.
4.4.6	What level of risk has been designated for this impact?	The authors don't include specific findings for all pathways in this section, they only summarize the health impacts (i.e. they don't say what the actual dB will be just that it will result in 10 EEG awakenings). This information is in the Appendix (volume 4 appendix G). Only the "highest risk" for health effects are reported in this section.	This report should either provide better clarification on the level of risk or otherwise provide a reference to where it is located in the appendix.
4.4.7	What justification has been provided for this risk level?	Level of risk is only presented as a comparison (i.e. "highest" not "high, medium, low"). No further discussion of the justification of risk is provided.	Further characterisation of risk should be provided. See 1.1.8

Requirement	Comment	Recommendation
4.4.8 Has the weighting/significance of health impacts been described and is it appropriate? [44] ➢ Direction: Whether the potential change would be beneficial or adverse ➢ Severity: More severe effects include those that are disabling, life-threatening, and permanent ➢ Magnitude: How widely the effects would be spread within a population or across a geographical area ➢ Likelihood: How likely it is that a given exposure or effect will occur. ➢ Certainty: level of certainty or uncertainty attached to the predictions of health effects.	Health effects are characterized according to level of risk and community with highest risk.	As most risks look at mortality or hospitalization for AQ there's no need to define severity in this case. However, it would help to define severity for noise, such as EEG awakenings. There is a greater discussion in the literature review of awakenings in the appendix but some discussion or definition of the severity of awakenings and cognitive development should be included. Magnitude of impacts should also be considered. The authors include which communities will be most affected for PM2.5, PM10 and noise but not for NO2 or Ozone. They should be clearer about which communities will be impacted for all pathways, and discuss the magnitude of the impact in those communities including consideration for the most vulnerable. Consideration of likelihood and certainty should also be included.

[44] Does the assessment consider the severity of impact/exposure (intensity, reversibility and impact on vulnerable population groups), the impact magnitude (number of people affected and duration of impact/exposure) and the importance (political and ethical)? Have the health impacts of each alternative been assessed? Sometimes the health impacts are ranked and prioritized before making recommendations, if so; have the criteria for prioritizing and ranking health impacts been given?

Requirement		Comment	Recommendation
4.4.9	Does it take into account stakeholder and community concerns?	There is no discussion of stakeholder or community concerns. The assessment only makes mention of community concerns within the discussion of surface water.	Community feedback on health concerns should be described and how this feedback was considered and addressed in the assessment should be discussed. Where community comments have not been incorporated or addressed an explanation justifying this should be presented. If there were no specific comments or concerns about health impacts/effects or some determinants of health then this should also be stated explicitly. There should also be a discussion of how communities were consulted.
4.4.10	What mitigation measures have been proposed?	Within the three pathways assessed, mitigation strategies are only referenced within the noise pathway, and are in reference to chapter 31 (volume 3). No other reference to mitigation strategies is provided although they are discussed elsewhere in the report.	Mitigation measures should be discussed for each pathway or at least referenced to where they are discussed elsewhere in the draft EIS. Provide a brief summary of the mitigation framework/plan and measures discussed for each pathway.
4.4.11	Has a residual health risk level been determined and mitigated where practicable?	There is no discussion of residual health risk.	As part of the discussion of mitigation measures, residual health risk should also be determined.
4.4.12	The causal pathway leading to health effects should be outlined along with an explanation of the underpinning evidence.[45]	The casual pathway between health risks and outcomes is not discussed nor does it reference where this information is in the report. The relationship is presented in the literature reviews for each pathway in the appendix.	Reference the appendix to show relationship between health determinants, health risks and health outcomes (exposure pathways).

[45] *The potential health effects may be presented in diagrams, which show the causal pathways and changes in intermediate factors by which the project may affect population health, or may be descriptive.*

Requirement		Comment	Recommendation
4.5 Risk assessment			
4.5.1	Have assumptions been made explicit and uncertainties are considered and taken into account?	The assumptions and limitations provided are in reference to the limitations and assumptions in the technical reports used to do the assessment (air/noise/water assessments). Other assumptions used for the HRA are not described.	Make explicit any assumptions or limitations in conducting the HRA or reference where these are located in the appendix.
4.5.2	The report should identify and justify the use of any standards and thresholds used to assess the significance of health impacts.	The report does not justify the use of standards or thresholds.	Provide better explanation of the use of thresholds and standards in the assessment (particularly when the report also discusses the lack of a safety threshold such as in the case for NO_2). If it is not included in this section then it should at least be referenced to in the full assessment appendix.
4.5.3	Have the methods used to calculate impacts been adequately described (e.g. replicability, transparency, sources of information identified)	The HRA process is briefly described but the assessment calculations are not. These are provided in the health appendix but this section does not make reference to them.	This report should reference the detailed methods in the appendix when they are not provided in the report.
4.6 Analysis of distribution of effects			
4.6.1	The affected populations should be explicitly identified.	There is no discussion of the potentially affected populations aside from identifying which communities will be most affected from noise and air quality impacts.	Report should provide a description of the populations potentially affected or reference where that information is located in the appendix.

Requirement		Comment	Recommendation
4.6.2	Inequalities in the distribution of predicted health impacts should be investigated and the effects of these inequalities should be stated. [46]	There is no discussion of the equity distribution of impacts.	Report should provide a discussion of the equity impacts or reference where that information is provided in the appendix.
4.6.3	Have populations more vulnerable to this impact been identified, discussed and mitigations proposed?	There is no discussion of vulnerable populations.	Report should provide a discussion of vulnerable population or reference where information is provided in the appendix.
4.6.4	Effects on health should be examined based on the population profile. [47]	The report makes mention of comparing impacts to a baseline assessment from health statistics for Sydney. However, there is no reference to where this information is available in the report.	Report should reference where the full baseline health profile and health statistics are available in the appendix.
Long Term Impacts Assessment Comments:			
This section is presented as a summary of the impacts that are discussed in more detail in the assessment. While the report does, at times, make reference back to the appendix, there is a lot of pertinent detail that is missing that should be referenced to the appendix. This section also lacks core components for clarity – such as discussing the methods used or mitigation measures - that would make this section acceptable as a standalone piece of work without having first read the appendix. This section also misses any discussion of long term cumulative impacts. It appears that cumulative impacts are considered elsewhere in the report (Volume 2. Chapter 27) however this report does not make clear if those cumulative impact assessments were used in this assessment. It would be particularly relevant to include discussion of cumulative impacts here as there is no mention of health impacts in the cumulative impacts chapter (Volume 2 chapter 27). This section should also provide better characterisation of health impacts or otherwise provide a reference to where it is located in the appendix.			

[46] How does the report define inequalities? Inequalities are found between social groups and can be measured in different ways e.g. by geography, social class or social position, population (ethnicity, gender, sexuality etc.).

[47] It should be possible to determine whether effects are more prevalent in certain demographic or vulnerable groups.

7. Summary of Key Findings

The Health Risk Assessment (HRA) predicted the attributable health outcomes from air and noise exposures in communities near the airport. The summary of key findings from the review team's interpretation of the data is provided below. Sufficient data was not available to conduct a complete a health risk assessment for ground water and surface water, therefore the health impacts from changes in ground and surface water are not presented below..

Air Quality

The HRA primarily considered the health outcomes of exposure to particulate matter 10, particulate matter 2.5, nitrogen dioxide, sulfur dioxide, and carbon monoxide from exposure associated with airport construction, stage 1 operations, and long term operations. The communities assessed were Badgerys Creek, Bringelly, Greendale, Luddenham, Kemps Creek, Mulgoa, Wallacia, Rossmore and Mount Vernon. The primary health outcomes considered were mortality, cardiovascular disease, respiratory disease, and emergency department visits related to asthma for 0-14 year olds. It should be noted that airport constructions is scheduled to occur over 10 years. Therefore, any impacts from construction that occur beyond 10 years are less likely to be realised.

Particulate Matter 10 (PM_{10})

Stage 1 Operations

The communities with the highest predicted attributable cases across all health outcomes were Bringelly, Kemps Creek, Wallacia and Rossmore. Kemps Creek had the highest number of annual mortality cases (over 30 year olds) with 0.1 deaths per year, or 1 death every 10 years attributable to PM_{10}.

Long Term Operations

Bringelly, Kemps Creek, and Rossmore had the highest predicted attributable cases across all health outcomes. Rossmore had the highest number of annual mortality cases (over 30 year olds, long-term) with 0.4 deaths per year, or 4 deaths every 10 years attributable to PM_{10}.

Construction Bulk Earthworks

Luddenham will be most impacted with the most predicted attributable cases across all health outcomes and with the highest number of annual mortality cases (over 30 year olds) with .01 deaths per year, or 1 death every 100 years attributable to PM_{10}.

Construction Aviation Infrastructure

Kemps Creek had the highest predicted attributable cases across all health outcomes. Kemps Creek, Bringelly, Luddenham and Badgerys Creek all had the highest number of annual mortality cases (over 30 year olds) with .01 deaths per year, or 1 death every 100 years attributable to PM_{10} in each community.

Particulate Matter 2.5 ($PM_{2.5}$)

Stage 1 Operations

Bringelly, Kemps Creek and Rossmore had the highest predicted attributable cases across all health outcomes. The highest predicted risk is for all-cause mortality and cardiopulmonary mortality from long-term exposure. Rossmore and Kemps Creek had the highest number of annual mortality cases (over 30 year olds) with .06 deaths per year, or 6 deaths every 100 years, in both communities. Rossmore and Kemps Creek also had the highest number of cardiopulmonary mortality cases (over 30 years old) with .06 deaths per year, or 6 deaths every 100 years, in both communities, attributable to $PM_{2.5}$.

Long Term Operations

The communities with the highest predicted attributable cases across all health outcomes were Bringelly, Kemps Creek, and Rossmore. Rossmore had the highest number of annual mortality cases (over 30 year olds, long-term) with 0.3 deaths per year, or 3 deaths every 10 years attributable to $PM_{2.5}$.

Construction Bulk Earthworks

Kemps Creek had the highest predicted attributable cases across all health outcomes. Bringelly and Luddenham had the highest number of annual mortality cases (over 30 year olds, long-term) with 0.004 deaths per year, or 4 deaths every 1000 years attributable to $PM_{2.5}$ in each community.

Construction Aviation Infrastructure

Luddenham had the highest predicted attributable cases across all health outcomes. Bringelly and Luddenham had the highest number of annual mortality cases (over 30 year olds, long-term) with .02 deaths per year, or 2 deaths every 100 years attributable to $PM_{2.5}$ in each community.

Nitrogen Dioxide (NO_2)

Stage 1 Operations (including traffic)

The communities with the highest predicted attributable cases across all health outcomes were Bringelly, Kemps Creek, Mulgoa and Rossmore. Kemps Creek had the highest number of annual mortality cases (over 30 year olds, long-term), with .6 deaths per year, or 6 deaths every 10 years attributable to $NO_{2.}$

Long Term Operations (including traffic)

Kemps Creek had the highest predicted attributable cases across all health outcomes. Kemps Creek, Bringelly and Rossmore had the highest number of annual mortality cases (over 30 year olds, long-term), with .6 deaths per year, or 6 deaths every 10 years attributable to $NO_{2.}$

Sulfur Dioxide (SO_2)

Stage 1 Operations

Modelling for health impacts from SO_2 was only conducted for stage 1 operations. The highest predicted attributable cases were related to respiratory disease hospital admissions (over 65 year olds) and emergency department visits for asthma (1-14 year olds). Kemps Creek had the highest number of respiratory disease hospital admissions with .004 admissions per year, or 4 admissions every 1000 years attributable to SO_2. Bringelly had the highest number of emergency department visits for asthma with .007 visits per year, or 7 visits per 1000 years attributable to SO_2.

Carbon Monoxide (CO)

Stage 1 Operations

The primary health outcome considered in the HRA for CO was cardiovascular disease hospital admissions (over 65 year olds). Kemps Creek had the highest number of cases with .005 admissions per year or 5 admissions per 1000 years attributable to CO.

Noise

The HRA considered the health outcomes associated with noise from aircraft over flights and ground based operations. The primary health outcomes considered were impacts on sleep disturbance, cognitive development and learning, and annoyance. The WHO has calculated the health effects from exposure to varying levels of noise (WHO, 2009). Noise exposure in a school environment over 35 dB may lead to interruptions in learning and cognitive development. Exposure over 40 dB inside at night may lead to sleep disruptions in the form of EEG awakenings (partial awakenings detected by electroencephalogram, EEG, readings) and full awakenings. Noise exposure above 55 dB may lead to annoyance, and increased risk for cardiovascular disease. The HRA considered impacts to Bringelly, Kemps Creek, Erskine Park, Kemps Creek 2 (secondary monitoring station), St Marys, Greendale, Silverdale, Rossmore, Horsley Park, Rooty Hill and Prospect. It also used data from monitoring stations at various schools: Warragamba Preschool; Emmaus Catholic College Kemps Creek; Horsley Park Public School; Luddenham Public School; Bringelly Public School; Mount Druitt Public School; St Marys South Public School; Bennett Road Public School; Colyton High School; St Clair High School; Banks Public School; Blackwell Public School; and Plumpton High School. It is assumed in the HRA that the noise levels at schools may be representative of the noise levels of the surrounding communities.

Aircraft Noise

Daytime

Annoyance

No community site exceeded the 55dB threshold for daytime noise exposure. No school site exceeded the 55dB threshold either.

Learning and Cognitive Development

Luddenham Public School and Horsley Park Public School exceeded the 35dB threshold for daytime noise exposure inside for certain operation stages and flight scenarios. The highest noise exposures would occur in Luddenham in 2063 operations with 39bB for flight scenario ‘Prefer 05’ and 41dB for flight scenario ‘Prefer 23.’

Night Time

EEG Awakenings

Luddenham Public School had the most predicted additional EEG awakenings across all operation stages and flight scenarios. The most additional EEG awakenings would occur at Luddenham Public School in 2050 and 2063 with the most occurring in the 2063 operation stage with flight scenario 'Prefer 23' with 110 additional EEG awakenings per person per year, or .3 EEG awakenings per person per night. It is important to note that the average person will experience 24 EEG awakenings per night during 8 hours of undisturbed sleep.

Full Awakenings

Luddenham Public School had the most predicted additional full awakenings across all operation stages and flight patterns. The most additional full awakenings would occur at Luddenham Public School for 2050 operations with 10 additional full awakenings per person per year, in all flight scenarios.

Ground Operations Noise

Daytime

Annoyance

Only Luddenham Public School exceeded the daytime threshold of 55dB from ground operations noise. The highest level is for 2063 operations, with a noise level of 58dB.

Learning and Cognitive Development

Bringelly Public School and Luddenham Public School exceeded the 35dB daytime noise exposure inside. Luddenham Public School exceeded 35dB for all operation scenarios, with 44dB inside in 2030, 45dB inside in 2050, and 48dB inside in 2063. Bringelly Public School only exceeded the guideline in 2063 with 36dB inside.

Night Time

EEG Awakenings

Luddenham Public School had the most predicted additional EEG awakenings across all operation stages. The most additional EEG awakenings would occur at Luddenham Public School in 2063 with the most occurring in the 2063 operation with 400 additional EEG awakenings per person per year, or 1 additional EEG awakening per person per night from ground operations noise. It is important to note that the average person will experience 24 EEG awakenings per night during 8 hours of undisturbed sleep.

Full Awakenings

The most full awakenings per person per year would occur in Luddenham Public School with 10 additional awakenings in 2030, 12 additional awakenings in 2050, and 15 additional awakenings in 2063 operations stage from ground operations noise.

8. Opportunities in relation to assessment of health effects

The health chapter and associated technical reports considered health impacts resulting from changes in air quality, noise and water. The methods of assessment used for assessing the resulting predicted impacts are appropriate and largely in accordance with published standards and guidelines. The Review Team's detailed comments and recommendations are contained within the relevant sections in the review tables. It should be noted that where weaknesses in the assessment method have been identified this does not necessary mean that if these were addressed the findings would be significantly different. However given the scale of this development, the potential for significant permanent impacts and this being the only environmental impact assessment currently planned for the WSA, it is recommended that these identified weaknesses be addressed.

The Health Chapter and appendix utilise a Health Risk Assessment approach. This is a quantitative methodology that takes changes to these environmental determinants and estimates their risk to health (i.e. the chances or risk of a disease or fatality occurring). This narrow approach does not address the full range of determinants of health and makes no use of the large evidence base on the association between health determinants, particularly social, and health outcomes. The narrow approach has over the years been found to be of limited use to policy and decision-makers and a fuller, more comprehensive qualitative and quantitative assessment of health impacts is often called for. This has occurred internationally as well as in Australia, with guidelines and practical guides published on how to undertake a comprehensive assessment of health impacts (enHealth 2001; NSW Health 2007).

There are two major weaknesses in relation to the assessment of health impacts that the review team strongly recommend be addressed in order to ensure that health effects are not overlooked or not taken into account when mitigation/enhancement is being considered. These are: the reporting of the identified health impacts; and the scope of the impacts included in the health chapter.

Reporting of the identified health impacts

Currently the results of the health risk assessment are presented in a way that it is difficult for readers of the report to identify the scale of the health impacts identified.

The review team recommend:

1. Presenting total number of people potentially affected by health outcomes (i.e. not just presented for individual communities).
2. Presenting information for all affected geographic areas not just worst affected area.
3. Presenting information in formats from which people can easily extract key information (i.e. clearly identifying significant impacts within tables, providing all necessary information within tables, clearly labelling tables).
4. Using consistent measurements of risk (e.g. number of cases per year) and detailing risk according to the community impacted, in terms of geographic areas and where appropriate by vulnerable/sensitive sub-groups.
5. Where numbers are presented, identify levels of certainty and assumptions used. For example, indicate possible range of estimates by including results from sensitivity analysis; where predictions of health outcomes are made for future scenarios (2030, 2060) state clearly if population growth predictions have not been taken into account and if the numbers presented are likely to be an underestimation.
6. Describing (qualitatively) the synergistic (combined) health impacts on communities close to the

airport.

7. Disaggregating the assessment to identify the potential differential health impacts on:
    a. population groups (e.g. younger people, older people, low socio-economic people); and
    b. 'sensitive social infrastructure,' such as education and health care facilities.

Scope of impacts included in the health chapter

Currently the 'non health' sections of the draft EIS contain information about a number of potentially significant impacts on the determinants of health (e.g. housing affordability, amenity, and employment). These impacts have not been identified as health impacts and the range and magnitude of potential health outcomes resulting from these impacts have not been assessed. This means that the potential health impacts resulting from these changes are currently unknown. This is likely the result of a Health Risk Assessment rather than a Health Impact Assessment being carried out. It is unclear why a health risk assessment rather than a health impact assessment, which would have incorporated the full range of health impacts, was not carried out. The review team recommends that the health implications of changes in determinants of health identified in 'non health' chapters be reported in the health chapter. This would enable interested stakeholders to identify the range and scale of potential health impacts.

The review team recommend:

8. The full range of potential significant impacts on health should be assessed and appropriate mitigation measures developed. Consideration should be given to including:
    - 8.1. Assessment of the public and community health impacts of the loss of agricultural land, green, open and recreation space.
    - 8.2. Potential impacts on health caused by perceived risk, stress and anxiety about the airport development.
    - 8.3. Loss of greenspace and loss of amenity of greenspace and the impact of this on health and wellbeing of current and future generations.
    - 8.4. Detailed information on the likely mix of part-time and full-time, low vs. high skill and low vs. high paid jobs generated by the airport and the likelihood of jobs being taken up by local communities and unemployed people to assess the quality and uptake of the employment likely to be generated and corresponding health benefits.
    - 8.5. The permanent loss of agricultural land should be considered from a food security, sustainability and public health perspective.
    - 8.6. The potential impacts on housing affordability on health, in particular the impacts on health inequalities resulting from increased housing prices and potential exposure of lower SES populations to residential areas with higher noise levels.
    - 8.7. Impacts on communities (e.g. social capital, community severance, social cohesion, community identity) due to noise and increases in traffic.
    - 8.8. Perception effects from noise and air quality – different from biological or epidemiological risks and can cause stress and anxiety - should be considered separately from mortality and morbidity effects.
    - 8.9. The potential for an increase in road traffic incidents, accidents and congestion including impacts on physical health and communities.
    - 8.10. The residual impact on communities resulting from compulsory relocations.

Mitigation Measures

Mitigation measures are only discussed in passing and readers are cross-referred to other sections of the draft EIS (e.g. noise chapter, air quality chapter). Mitigation measures to manage impacts identified in the draft EIS are described for noise, air quality and water issues. Mitigation measures specifically addressing health issues are not detailed as the health issues that have been considered are all associated with changes to air, water and noise hence managing these is considered sufficient in the environmental management framework. Mitigation measures aimed at vulnerable groups are not discussed in the health chapter or health appendix. There is no discussion of residual impacts (effects after mitigation). The report seems to assume that mitigation measures will attenuate most risk.

Where there is cross-referencing to the water/noise/air quality chapter the reviewers have not reviewed these chapters, as this was not in the terms of reference for this review, and therefore cannot give a judgment on the appropriateness of the proposed mitigation in terms of health impacts. The Part E Environmental Management Chapter does not include health specific mitigation measures.

The range of mitigation measures proposed for noise during Stage 1 design and construction is appropriate and likely to effectively manage the associated health impacts, provided the community aviation consultation forum and the community feedback provided by it is satisfactorily incorporated into the final specific mitigation measures and on an on going basis.

The range of mitigation measures proposed for air quality and greenhouse gases during Stage 1 design and construction is appropriate and likely to lower the likely health and wellbeing impacts associated with exposure to air pollutants.

The range of mitigation measures proposed for noise during Stage 1 operation is appropriate and likely to reduce some of the associated health impacts, provided health issues are given specific attention through involvement of NWS Health and/or other relevant health authorities and local communities are effectively engaged and their feedback satisfactorily incorporated into the noise management plan on an on going basis.

The range of mitigation measures proposed for air quality and greenhouse gases during Stage 1 operation is likely to lower the health and wellbeing impacts associated with exposure to air pollutants provided best available technologies and techniques are employed to reduce emissions. As this is uncertain, effective pre-operation air quality monitoring (to establish baseline conditions) and monitoring during operation is key to manage and address potential emerging health risks.

Stakeholder and community engagement will be managed through the use of a Community and Stakeholder Engagement Plan to guide activities, keep the community informed, address enquiries and complaints, and help manage potential impacts during construction of the proposed airport. Coordination with relevant government agencies should ensure NSW Health is included as a primary stakeholder.

The review team recommend:

9. An outline of proposed measures (i.e. a noise/air quality/water management framework or plan) should be presented in the health chapter and an explanation provided for how and to what

extent these measures will mitigate the identified health impacts.

10. In line with our previous recommendations to broaden the scope of the health chapter to include all relevant health impacts, the review team also recommend that corresponding health specific mitigation measures be provided.
11. This should include targeted mitigation measures for addressing impacts on vulnerable groups and sensitive social infrastructure.
12. Mitigation measures that take into account the synergistic (combined) nature of the impacts on communities close to the airport should be developed. This would include consideration of impacts due to: noise, air quality, traffic, loss of amenity, changes in populations, perceived risk, and community identity.

Part E Environmental Management Chapter currently proposes the development of specific management plans. There is no proposed management plan for health impacts.

The review team recommend:

13. A health specific management plan should be developed for both construction and operation phases.
14. In line with our previous recommendations this should include mitigation measures addressing:
    - 14.1. All relevant health impacts (i.e. not just limited to noise, air quality and water)
    - 14.2. Impacts on vulnerable groups and sensitive social infrastructure
    - 14.3. Synergistic nature of the impacts on areas close to the airport.
    - 14.4. Any health inequalities that may be widened (or health equity that is reduced).
15. Include identification of residual risks.
16. Identification of health opportunities where community health can be promoted and improved, health inequalities narrowed and health equity enhanced.

9. Qualifications of the Reviewers

Fiona Haigh
Project Manager

Fiona is an experienced Health Impact Assessment practitioner, researcher and educator. She has spent the last twelve years working in the field of HIA in Germany, United Kingdom and Australia. Fiona has had extensive experience of conducting HIAs using a range of methods. This includes, for example, modelling impacts of noise on health outcomes, literature reviews, collecting and analysing qualitative date from, surveys, focus groups, workshops and interviews. Fiona has routinely project managed large and small HIA projects and as well as providing expert support. Fiona has collaborated in the development of methods for HIAs, including 'EPHIA' – the European Policy Health Impact Assessment Guide, 'URHIA' - Urban HIA methodology, Health Equity Impact Assessment, Migrant Health Impact Assessment and Human Rights Health Impact Assessment. In addition Fiona was the lead project officer on a large study evaluating the effectiveness of HIA in Australia and New Zealand. This involved reviewing the quality of 55 HIA reports.

Fiona has led and been involved in a wide variety of HIAs including: airport runway extension, intermodal terminal, energy from waste facility, sports stadium and retail development, employment strategies, health service redevelopment, housing regeneration, and new housing developments.

Katie Hirono
Review Coordinator and Main Reviewer

Katie is an experienced trainer and practitioner of health impact assessment. Katie came to Australia from the leading HIA organisation in the U.S. - the Health Impact Project, a collaboration of the Pew Charitable Trusts and the Robert Wood Johnson Foundation. With over US $10 million in funding to support the growth of HIA, the Health Impact Project provided grants, hosted national events, and developed legislative support for HIAs. As part of this Katie provided grant management, advisory support, and technical assistance to over 15 organisations conducting HIA. She also participated in national capacity developing events, including advisory sessions with the US Environmental Protection Agency to discuss integration of HIA in EIA. At the Centre for Health Equity Training, Research and Evaluation her research has focused on health impact assessment, health equity, and the social determinants of health. Katie was the lead project officer on the Trans Pacific Partnership Agreement HIA and conducted an evaluation of the HIA learning by doing training program. She has also helped to conduct two equity focused HIAs on health programs in Victoria.

Katie has been involved in HIAs on topics including: biomass fuel; intermodal terminals; public housing redevelopment; casino development; solar energy; water and plumbing development; clean water; concession bus fares; public transportation extension; waterway clean-up; and free trade agreements.

Salim Vohra
International HIA Expert Reviewer (Health Impact Evidence Review and Assessment Methods)

Salim has extensive experience of undertaking and researching Health Impact Assessment (HIA) in the UK and internationally (15 years) on economic, energy, health services, housing, transport, regeneration and waste at project and policy levels. These were either stand-alone HIAs or ones that were part of environmental, social and health impact assessments (ESHIAs) and strategic environmental assessments/ sustainability appraisals.

He has undertaken a Strategic Health Equity-Focused Policy Review for the London Borough of Hillingdon, that critically reviewed the appropriateness and comprehensiveness of the health-relevant assessments undertaken as part of the Airports Commission, led by Sir Howard Davies, on where a new runway should be built in the South of England. He also has experience of HIAs of Nationally Significant Infrastructure Projects in the UK such as Thames Tideway Tunnel, High Speed 2 and Transport for London Tube Extensions.

He has worked with a range of international organisations such as the World Health Organization and the International Council on Mining and Metals as well as environmental consultancies and multinational commissioners of HIA and ESHIAs.

He is a specialist in public health with 23 years of experience in public health medicine in various settings. Apart from HIA he has extensive experience of public health research and epidemiology (13 years), management of community perceptions of environmental and health risks (10 years), stakeholder engagement (23 years), health systems management (6 years), reviewing public health and medical research ethics (6 years), community development work (5 years) and public health teaching and training (13 years ad hoc). He has over 20 years of project management experience gained in a variety of settings – university and voluntary, public and private sectors. He has worked with public, private and voluntary sector organisations throughout my career.

His educational background is in medicine (MBChB), environmental epidemiology (MSc) and public health policy (PhD).

He is a Lecturer in Health Promotion and Public Health at the University of West London. He is also an Honorary Fellow of Staffordshire University and Conjoint Lecturer at the University of South Wales for his expertise in HIA.

He is a Fellow of the Royal Society for Public Health; Associate Member of the Faculty of Public Health; Member and Webmaster for the Transport and Health Study Group; Affiliate Member of the Institute of Environmental Management and Assessment; Member of the Town and Country Planning Association and Member, and ex Co-Chair of the Health Section, of the International Association for Impact Assessment. He is also an Editorial Board member for Environmental Impact Assessment Review.

Ben Harris-Roxas
International HIA Expert Reviewer (Social Determinants, Equity)

Ben has over 14 years' experience working in public health and program evaluation, both in Australia and overseas. He has worked in consulting and research for private sector companies, several universities, government agencies and NGOs.

Ben has project managed several large multi-year evaluation projects for Commonwealth and state government departments. Ben has conducted projects for the Commonwealth Department of Health, the NSW Ministry of Health, the Health Education and Training Institute, the Agency for Clinical Innovation, Queensland Health, NSW Treasury, the National Heart Foundation, private sector clients and several Australian local governments. These projects have involved developing logic models, evaluation frameworks, in-depth interviewing and stakeholder consultations, statistical analysis of routinely collected quantitative service data, data linkage, qualitative research, and program and service evaluation.

Ben is also Conjoint Lecturer in the Faculty of Medicine at the University of NSW. He has also guest lectured and tutored at Macquarie University, the University of Newcastle and the University of Western Sydney.

Ben's PhD research was on the use of health impact assessment in health service planning. Ben has published 23 peer reviewed journal articles and seven book chapters and editorials. He is an Associate Editor for BMC Public Health and is on the Editorial Committee for Environmental Impact Assessment Review.

Ben is Convenor of the International Union for Health Promotion and Education's Global Working Group on Health Impact Assessment. He is on the NSW Committee of the Australasian Evaluation Society and was Health Section Co-Chair of the International Association for Impact Assessment from 2011-2015. He recently participated in expert consultations for the WHO Centre for Health Development in Kobe on multisectoral action for health and health indicators for urban development. Ben is also a member of the International Association for Public Participation (IAP2).

Ben Cave
International HIA Expert Reviewer (Airport Health Impacts, Peer Review Methods and Methodologies)

Ben has specialised in health and social impact assessment for the last 16 years. He has worked across the UK, in mainland Europe and further afield with policy makers, public health academics, environmental scientists and spatial planners. He has provided public health and policy advice at a senior level in local, regional, national and international arenas.

Ben conducts Strategic Environmental Assessments and advises the World Health Organization on requirements and methodologies for SEA. He also integrates health into environmental assessment at the project level: He has led Health Impact Assessments (HIAs) in conjunction with environmental assessments and focused on providing high quality HIAs that are robust and defensible. He has lead HIAs in a wide range of sectors: for example infrastructure for energy, mining, road and rail. Ben has also worked on health in environmental assessments at the following UK airports: Stansted; Heathrow; London-Luton; Bristol and London City.

He is committed to improving standards and quality in the field of impact assessment: he is an active member of, and has held leadership positions in, the International Association for Impact Assessment (IAIA). In 2009 he led research for, and development of, a review package for HIA reports with input from an expert panel of reviewers. He convened a seminar on quality in impact assessment at the 2015 annual meeting of the IAIA. His work contributes to national and international developments.

His awards include: 2015 Honorary Member of the Faculty of Public Health; 2011 International Association for Impact Assessment (IAIA) "Individual Award" for major achievement and advancement in the theory and/or practice over a period of time at an international level.

His professional associations include: Chair of Section Coordinating Committee of the IAIA (2011-2014) and co-chair of the Health Section of the IAIA (2005-2011); Associate member of the Institute for Environmental Management and Assessment. Ben is a member of the International Union of

Health Promotion and Education Global Working Group on HIA (2010-present); and sole European member of National Research Council/Institute Of Medicine committee for a study on Health Impact Assessment in the USA (2009-2011).

Filipe Silva

International HIA Expert Reviewer (Health Impact Evidence Review and Assessment Methods)

Filipe has 6 years of experience in public health medicine in various settings – undertaking health impact assessment and health assessment components of environmental and social assessments (3 years), public health research and epidemiology (3 years), epidemiological surveillance (1 year), health systems management (2 years), community development and health promotion work in both high income and low to middle income countries, mostly in the UK but also across Europe, Africa, South East Asia and South America, within public, private and voluntary sector organisations.

Filipe has participated in more than fifteen impact assessments including stand-alone health impact assessments and the health assessment component of EIAs and SEAs on policies, plans and projects in the transport, urban and spatial planning, and extractive sectors. He has a strong focus on the quantitative assessment of health effects, particularly in relation to air pollution. Filipe was part of the team that undertook a Strategic Health Equity-Focused Policy Review for the London Borough of Hillingdon, critically reviewing the appropriateness and comprehensiveness of the health-relevant assessments undertaken as part of the Airports Commission, led by Sir Howard Davies, on where a new runway should be built in the South of England. He also has experience of HIAs of Nationally Significant Infrastructure Projects in the UK such as High Speed 2 and Transport for London Tube Extensions. He has worked with a range of international organisations such as the World Health Organization and the Asian Development Bank as well as environmental consultancies and multinational commissioners of HIA and ESHIAs.

Filipe has a Bachelor and Masters in Medicine from the University of Oporto, Portugal, a Master's in Public Health by the London School of Hygiene and Tropical Medicine (2013) with a focus on health in EIA and SEA, environmental health and environmental epidemiology. He has undertaken additional specific training in geographical information systems applied to public health research and practice, health impact assessment (IMPACT, University of Liverpool, 2013), strategic environmental assessment and environmental impact assessment principles and practice.

Appendix F

Aviation planning (ARUP and The Airport Group)

WSP PB

Western Sydney Airport - Draft EIS Peer Review

Aviation Planning

001

FINAL | 20 November 2015

Job number 246163

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ARUP

Contents

Executive Summary

Scope of Review

Our approach has been to review the four volumes of the draft EIS as well as the draft Airport Plan provided on the website (www.westernsydneyairport.gov.au).

This document is based on a desktop study and a literature review of the four volumes of the draft EIS and the draft Airport Plan, comparison of these against the EIS guidelines, identification of potential opportunities or inconsistencies and a comparison against available benchmarks.

Stage 1 airport

Issues identified in terms of aviation planning for the Stage 1 airport include:

Airport planning

- No vocation or aviation purpose is described for Western Sydney Airport.
- There is a degree of variability in the forecasts and demand information used in the draft EIS and draft Airport Plan. In addition, the forecast passenger loads per aircraft for Western Sydney Airport as presented in the draft EIS appear to be high.
- It is unclear what benchmarks or planning decisions sit behind the 1900m runway separation shown for Western Sydney and it is noted that other airports in Australasia are proposing wider runway separation.
- Benchmarking indicates that passenger throughput per aircraft stand is potentially high for Western Sydney Airport. This would imply that the number of aircraft stands shown is less than one might typically expect.

Airspace and flight tracks

- The proposed airspace model is noted as a “proof of concept” and not the subject of exhaustive analysis. The indicative airspace design was not developed with consideration to potential noise or other environmental impacts.
- A single airspace model is presented for Stage 1 development. The basis of the model is that operations at Sydney Kingsford Smith Airport are unaffected. Other than minor flight path displacement, feasible alternatives are not presented or evaluated. However, presenting alternatives is a requirement of the EIS guidelines provided by the Department of Infrastructure and Regional Development.
- Departures track to 'exit gates', concentrating aircraft on several defined routes. This is a common tool used to improve air traffic flow. The impact of concentration and location of turn points has not been tested for environmental impact.

- Modes of operation (flight paths based on runways in use) are mentioned, but not how they affect surrounding areas.
- Noise abatement procedures, commonly implemented at other major airports, have not been developed.

Bird and bat strike

- The bird and bat strike assessment concludes that the overall risk for the airport is low. However the assessment is preliminary.

Fuel dumping

- Fuel dumping is concluded to be low risk and it is considered that the information presented in the draft EIS is appropriate.

Long term development

A number of the issues identified for Stage 1 are also apparent in the longer term planning of Western Sydney Airport.

- The lack of vocation or purpose for Western Sydney Airport and its relationship to the ongoing operation at Sydney Kingsford Smith Airport and, in particular, that potential long-term growth forecasts are very high.
- The variability in the number of stands and the apparent lack of consistency in terms of a base set of planning parameters used in developing the airport.
- Narrow runway separation to achieve all the proposed aviation uses.
- Lack of a full and thorough assessment of the interaction of aircraft traffic in the Sydney Basin which requires an airspace and flight path review not considered as part of Stage 1. The Stage 1 flight paths proposed in the Draft EIS are not considered appropriate for the long term plan.

Key impacts and opportunities

Key impacts and opportunities from an airport planning perspective for the above issues are as follows:

- Vocation or purpose of Western Sydney Airport – One might expect that, certainly in its early stages of development, the Western Sydney Airport would potentially be a domestic, low-cost carrier airport with a significant cargo operation, reflecting lower charges and the lack of noise curfew. Premium international flights would continue to use Sydney Kingsford Smith as the primary airport in New South Wales and the one which provides proximity to the tourist and business centre of Sydney CBD. This vocational aspect is important in influencing how the future airport will operate, peak periods of activity and the type of traffic that will use the airport.

- Forecasts – There is potential that the forecasts understate the number of aircraft movements required, which has knock-on impacts on dependent analysis such as noise modelling. This is a potential area for further assessment or clarification to confirm that findings in the draft EIS and draft Airport Plan based on these forecasts are robust.
- Runway separation – Any wider runway spacing would increase land take, with downstream environmental impacts on biodiversity, surface water and groundwater, landscape and visual amenity. In addition, wider spacing for the future two runway airport will impact on flight tracks and noise, given changes to runway thresholds.
- Aircraft stand provision – The number of aircraft stands shown is potentially less than one might typically expect, which has implications for land take and therefore related environmental impacts, though it is noted that the Land Use plan for Stage 1 shows a large area available for development.
- Airspace, OLS and PANS-OPS – In terms of requirements, the evaluation of protection volumes for flight paths and airspace containment is in accordance with normal methods mentioned in the Airports (Protection of Airspace) Regulations and under the Airports Act 1996. Analysis of Obstacle Limitation Surfaces (OLS) and Instrument Flight Procedure protection volumes (known as PANS-OPS surfaces) indicates that, operationally, the Western Sydney airport can operate unrestricted from terrain and artificial obstacles.

  However, the following impacts are identified which are either unresolved or which require further clarification:

  1. The proposed airspace architecture is 'indicative' and has not been rigorously tested. The draft EIS proposes that another airspace model is tested closer to commencement of operations.
  2. The modelling indicates several flight paths over water storages, such as Warragamba Dam and Prospect Reservoir. Other flight paths traverse the Blue Mountains National Park. The environmental impact is unclear.
  3. The requirement under the Guidelines, produced by the Department of Infrastructure and Regional Development (DIRD), for feasible alternatives to be included has not been met. This is particularly important in consideration of concentration of approaching traffic over the township of Blaxland for the Stage 1 development and departure tracks.
  4. There is no consideration of community sentiment regarding changes to flight paths, proposed in the draft EIS, when the Airport operates with two runways.
  5. An alternative Stage 1 airspace model, based on the long term proposal but operating with a single runway, is not tested.

6. Except for Sydney Kingsford Smith, flight paths for aerodromes, affected by the Western Sydney Airport are not evaluated.
7. The draft EIS suggests that Western Sydney Airport will detrimentally affect the operations at Bankstown and Camden, and affect Richmond (military). The environmental impact is not quantified.
8. Relocation of light aircraft traffic to other airports, the definition of new training airspace and consequent environmental impact, is not assessed.

Given the above, it is considered that the information on airspace presented in the draft EIS does not meet requirements.

- Bird and bat strike – the bird and bat strike assessment is preliminary and therefore further works in the airport site and study area are required to confirm the level of bird and bat strike risk and to refine the mitigation strategies.
- Fuel dumping – It is considered that the information presented in the draft EIS is appropriate though more detail could be provided to give certainty for local government and communities.

1 Scope

The following document provides a peer review of airport planning aspects of the draft Environmental Impact Statement (EIS) for Western Sydney Airport released by the Federal Government for public exhibition on 19th October 2015. Airspace and flight tracks have been reviewed by The Airport Group (TAG) and salient points and key findings are also captured in this document. For the full discussion on airspace and flight tracks, the TAG report entitled "Peer Review - Western Sydney Airport EIS" and dated 17th November 2015 is also included in its entirety as Appendix A.

Given that Western Sydney Airport is a new facility, amendments to the Airports Act 1996 have been passed which provide for the preparation of an "Airport Plan" to guide the development of the airport and a draft of this Plan has been provided along with the draft EIS.

The draft EIS and draft Airport Plan have been put forward to obtain "planning, environment and development approval for Stage 1 of the proposed [Western Sydney] airport".[1] In addition, indicative information is also provided for a longer term planning horizon out to 2063 to enable stakeholders and the public to understand and consider potential longer term environmental impacts of the new airport, including noise.

The document states that the "draft EIS has been prepared in accordance with the requirements of the EPBC Act and the EIS guidelines, including the requirement for public consultation. In determining the Airport Plan, the Minister for Infrastructure and Regional Development must accept any environmental conditions proposed by the Minister for the Environment, taking into account the finalised EIS".[2]

Longer term development beyond Stage 1 would be subject to the requirements of the Airports Act including provision of additional Master Plan and MDP studies, and potentially additional EIS requirements, as appropriate.

1.1 Approach

Our approach has been to review the four volumes of the draft EIS as well as the draft Airport Plan provided on the website (www.westernsydneyairport.gov.au).

The four volumes of the draft EIS are Volume 1 – Project Background, Volume 2 – Stage 1 Development, Volume 3 – Long Term Development and Volume 4 – Technical Appendices.

[1] p.9, Regulatory framework, Department of Infrastructure and Regional Development, Western Sydney Airport – Environmental Impact Statement – Volume 1, October 2015
[2] p.10, Regulatory framework, Department of Infrastructure and Regional Development, Western Sydney Airport – Environmental Impact Statement – Volume 1, October 2015

1.2 Limitations

This document is based on a desktop study and a literature review of the four volumes of the draft EIS and the draft Airport Plan, comparison of these against the EIS guidelines[3], identification of potential opportunities or inconsistencies and a comparison against available benchmarks.

No analysis or modelling has been undertaken and indeed modelling files have not been made available.

The document provides guidance to WSROC in terms of the work undertaken and where further clarification may be required on key issues.

1.3 Components of the draft EIS Reviewed

The following sections have been reviewed for this aviation planning peer review:

- **Draft Airport Plan**
  Part 1: Airport Plan for Western Sydney Airport
  Part 2: Concept Design
  Part 3: Specific Developments

- **Draft EIS Volume 1 – Project Background**, including
  Part A – Project background and rationale
  1. Introduction
  2. The need for Western Sydney Airport
  3. Approvals framework

  Part B – Airport plan
  4. Land use plan
  5. Stage 1 Western Sydney Airport
  7. Airspace architecture and operation

- **Draft EIS Volume 2 – Stage 1 Development**, including
  Part D – Environmental impact assessment
  9. Approach to impact assessment
  10. Noise (aircraft)
  12. Air quality and greenhouse gases
  14. Hazard and risk
  21. Planning and Land Use
  26. Greater Blue Mountains
  27. Cumulative Impact

  Part E – Environmental Management
  28. Environmental management framework

- **Draft EIS Volume 3 – Long Term Development**, including
  Part G – Assessment of long term development
  30. Introduction

[3] These guidelines are provided in EIS Volume 4 Appendix C.

32. Air quality and greenhouse gases
39. Other environmental matters

- **Draft EIS Volume 4 – Appendices**, including:
  Appendix E1 Aircraft overflight noise
  Appendix F1 Local Air Quality and Greenhouse Gas
  Appendix I Bird and Bat Strike

- Western Sydney Airport, Preliminary Airspace Management Analysis, Airservices Australia, 2015

2 Detailed Findings – Stage 1 Airport

2.1 Compliance with the EIS Guidelines

In general, most requirements of the EIS guidelines have been addressed in relation to aviation planning aspects.[4] However, it is considered that the information on airspace presented in the draft EIS does not meet requirements.

From an aviation planning perspective, the EIS requirements are as described below:

- In accordance with Section 5(a) of the EIS guidelines, all operational components of the action, in this case the proposed development of a Western Sydney Airport, driven by aviation demand and planning of appropriate infrastructure, need to be presented. The draft Airport Plan which accompanies the draft EIS is provided to guide the development of the physical characteristics of airport, including runway, taxiways, aprons, terminal and landside facilities.
- The assessment needs to consider the Stage 1 operation, which is the action for which approval is sought, but also to foreshadow longer term development. This is in accordance with Section 5(a) of the EIS guidelines.
- The EIS Guidelines, Section 5(g) require a description of all of the relevant impacts of the action to the environment including:
    1. Consideration of potential flight paths and varying aircraft operating procedures (with respect to noise etc).
        - Airspace is discussed in Sections 7, 14, 21, 27 and 30 of the EIS, Volume 4 Appendix E1 Aircraft Overflight & Operational Noise and in the documents entitled Western Sydney Airport, Preliminary Airspace Management Analysis, Airservices Australia, 2015.
    2. Bird or bat airstrike - EIS Guidelines, Section 5(g) require the consideration of impacts arising from bird or bat airstrike, and the creation of any risks or hazards to people or property that may be associated with any component of the action.
        - Bird or bat airstrike is discussed in Section 14.4, 16.5 and 16.6 of the EIS and Volume 4 Appendix I.
    3. Aviation fuel dumping - EIS Guidelines, Section 5(g) require the consideration of air quality and environmental impacts arising from potential fuel dumping impacts.

[4] The guidelines are entitled Guidelines for the Content of a draft Environmental Impact Statement Western Sydney Airport Environment Protection and Biodiversity Conservation Act 1999 (Reference: EPBC 2014/7391) and dated 22nd January 2015. They are provided in Appendix C of Volume 4 of the draft EIS.

  - Fuel dumping is discussed in Section 7.8, 12.6 and 32.4 of the EIS and Volume 4 Appendix F1.

- In addition, under EIS Guidelines Section 3. Feasible Alternatives, the draft EIS is supposed to assess "feasible alternatives" to the action and then "undertak[ing] a comparative description of the impacts of each alternative on the matters of national environmental significance".[5]

The following sections of this document describe the outcomes of the Arup and TAG peer review, with respect to the above guidelines and with commentary on assumptions and findings.

2.2 Assumptions

2.2.1 General

The draft Airport Plan and much of the draft EIS is focussed on the Stage 1 scenario, for which approval is sought. This is equivalent to an airport with a mixture of domestic and international traffic with a maximum throughput of 10 million annual passengers.

No rationale is provided for the 10 million passenger per annum threshold other than it provides for predicted demand in 2030, 5 years after the proposed opening of the airport in 2025. One might typically expect the approach to have been to look at the maximum capacity of single runway airport and to identify logical capacity stages to get to that point. The maximum capacity of the single runway as set out in the draft EIS is 37 million annual passengers by 2050, equivalent to the current throughput of Sydney Kingsford Smith Airport.

The approach taken leads to an incremental planning solution when moving to the long-term capacity scenario, with full build-out of terminal and apron capacity between two parallel runways, stated to be by 2063.

No vocation or aviation purpose is described for Western Sydney Airport. One might expect that, certainly in its early stages of development, the airport would potentially be a domestic, low-cost carrier airport with a significant cargo operation, reflecting lower charges and the lack of noise curfew.[6] Premium international flights would continue to use Sydney Kingsford Smith as the primary airport in New South Wales and the one which provides proximity to the tourist and business centre of Sydney CBD.

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[5] p.4 Section 3, Feasible Alternatives, Appendix C, Guidelines for a draft Environmental Impact Statement for Western Sydney Airport, Australian Government, Department of Infrastructure and Regional Development, Western Sydney Airport – Environmental Impact Statement, October 2015

[6] It is assumed that the need or otherwise for a noise curfew at Western Sydney is discussed in the review undertaken by the noise consultant. From an operational standpoint, it is preferable that an airport operates unrestricted by curfews, however it is imperative that principles of "Fly Neighbourly" are introduced to minimise the environmental impact of noise.

This vocational aspect is important in influencing how the airport will operate, peak periods of activity and the type of traffic that will use the airport. A number of these aspects are alluded to in the draft EIS without ever being fully explained.[7]

2.2.2 Aviation Demand and Activity

Estimating future aviation activity and demand is fundamental component of airport masterplanning, impacting not only on sizing of the airport and its associated infrastructure requirements but also being an important element in predicting aircraft noise as well as understanding landside transport impacts.

Future demand estimates to 2063

Demand estimates in the main volumes of the draft EIS broadly align and are summarised in Table 1 of this report. It is noted that growth between 2050 and 2063 is extremely high – 45 million annual passengers in 13 years, which is unprecedented. It is assumed that the 2063 time horizon is therefore indicative though this is not explained in the draft EIS.

Table 1: Western Sydney Airport - Aviation Demand

	2030	2050	2063
Annual passengers (arrivals and departures)	10,000,000	37,000,000	82,000,000
Peak hour passengers (international and domestic)	3,400	9,500	18,700
Total annual air traffic movements (passenger and freight)	63,000	185,000	370,000
Total peak hour air traffic movements	21	49	85

Source: p.16 Table ES 1 and p.106 Table 2-6, Department of Infrastructure and Regional Development, Western Sydney Airport – Environmental Impact Statement – Volume 1, October 2015

Whilst Tables ES 1 and 2-6 in the draft EIS reference 85 peak hour aircraft movements, elsewhere draft EIS volume 1 states "with parallel runways, the proposed airport could potentially achieve aircraft movement rates of around 100 movements per hour (one landing or one arrival constitutes an aircraft movement)".[8] This has potential implications for noise modelling.

Moreover, when considering the data provided, it would seem that peak hour demand in terms of passengers per movement is comparable to and potentially even less than the annual average – as shown in blue in Table 2.

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[7] p.150, Activity Forecasts, Department of Infrastructure and Regional Development, Western Sydney Airport – Environmental Impact Statement – Volume 1, October 2015

[8] p.19, Department of Infrastructure and Regional Development, Western Sydney Airport – Environmental Impact Statement – Volume 1, October 2015

Table 2: Western Sydney Airport - Passengers per Aircraft Movement

	2030	2050	2063
Annual passengers (arrivals and departures)	10,000,000	37,000,000	82,000,000
Peak hour passengers (international and domestic)	3,400	9,500	18,700
Total annual air traffic movements (passenger and freight)	63,000	185,000	370,000
Passengers per movement (annual)	159	200	222
Total peak hour air traffic movements	21	49	85
Passengers per movement (peak)	162	194	220

Source: Arup analysis using the data provided in Table ES1 and Table 2-6 of draft EIS Volume 1

This is counter-intuitive and does not reflect trends at other airports. One would typically expect a 15% to 20% difference between peak hour and annual loads.

The passenger load per aircraft and its impact on ATMs is important as variations in this will affect the number of aircraft flying in an hour, across a day or across the year, which in turn impacts on other considerations, including noise modelling.

It is noted that the above data includes both annual and peak hour air freight traffic movements (which are broken out for Stage 1 only in the draft Airport Plan, as described in the section below). However, assuming consistent patterns of growth between peak hour and annual freight, the findings still seem atypical.

In addition, when considering other Australian Airports and load factors in their most recently approved Master Plans, passenger loads estimated for Western Sydney Airport seem high.

Current passenger loads through Sydney, Melbourne and Brisbane are as follows:

- Sydney Airport – 36.9 million passengers on 292,800 passenger movements in 2012, at an average load per movement of 126 passengers.
- Melbourne Airport – 30.17 million passengers on 210,350 passenger movements in 2013, at an average load per movement of 143 passengers.
- Brisbane Airport – 21.3 million passengers on 194,000 passenger movements in 2012/13, at an average load per movement of 110 passengers.

All of these airports are mature, with well-defined markets, and reasonable share of international traffic. It therefore seems optimistic for Western Sydney Airport to expect higher average passenger loads per aircraft movement than these three airports in the 5 years after it opens.

Assuming higher passenger loads has the potential to understate the number of aircraft movements required, which has knock-on impacts on dependent analysis such as noise modelling. This is a potential area for further assessment or clarification.

Demand estimates for Stage 1 Airport

Table 3 provides information from Table 1 of the draft Airport Plan in terms of the mix of international and domestic passengers and air traffic movements (ATMs) and this data differentiates between passenger and freight ATMs.

When considering the data in the draft Airport Plan, peak hour arriving and departing passengers are shown as 4,000 passengers over 19 peak hour passenger ATMs (2,000 departing and 2,000 arriving passengers). This gives an average passenger load per aircraft of 211 which is higher than the annual average of 179 passengers.

This is intuitive as peak hour demand is generally higher than daily or annual averages, though it is noted that an average passenger load per ATM of 211 is very high when considering a predominantly domestic airport using Code C aircraft at 2030 – which is how the Stage 1 airport is described.[9] The capacity of typical Code Cs flown in Australia are as follows - Qantas 737-800s at 168 seats, Jetstar A320s at 180 seats and Virgin Australia A320s at 168 seats.

Table 3: Stage 1 Aviation Demand

Annual Traffic	International	Domestic	Stage 1 Total
Annual passengers	2,200,000	7,800,000	10,000,000
Annual passengers ATM	7,700	48,300	56,000
Passengers per ATM	286	161	179
Annual freight throughput (tonnes)	167,000	52,000	220,000
Annual freight ATM	3,900	3,100	7,000
Design busy hour passengers			
Departing (passengers per hour)	550	1,600	2,000
Arriving (passengers per hour)	600	1,600	2,000
Design busy hour ATM			
Passenger (movements per hour)	4	17	19
Passengers per ATM	288	188	211
Freight (movements per hour)	3	4	6
Peak movements per hour	4	19	21

Source: p.73, Table 11, Draft Airport Plan, Australian Government, Department of Infrastructure and Regional Development, Draft Airport Plan – Western Sydney Airport, October 2015

From the draft Airport Plan, it is not clear if the 2,000 arriving and 2,000 departing passengers occur at the same time (i.e. if this is a two-way peak, or if these are peak passenger numbers for a specific arrivals peak hour and departures peak hour at different times of the day) and indeed elsewhere in the draft EIS, the combined peak hour of international and domestic passengers is quoted as 3,400 over 19 movements, which would be 179 passengers per aircraft, or in line with the annual average.

[9] "In 2030, Code C aircraft are expected to account for the majority of domestic operations at the Airport, representing approximately 90 per cent of the domestic fleet mix. In the long-term, Code C aircraft could represent 80 per cent of the domestic fleet mix". p.26, Aircraft Fleet Mix, Draft Airport Plan, Australian Government, Department of Infrastructure and Regional Development, Draft Airport Plan – Western Sydney Airport, October 2015

Landside Transport Analysis

It is noted that a separate analysis has been undertaken of surface transport impacts as documented in draft EIS Volume 4, Appendix J Surface transport and access. This analysis uses the following assumptions:[10]

- For each domestic aircraft, an assumed average capacity of 180 passengers with an average flight occupancy of 90 per cent has been assumed.
- For each international aircraft, an assumed average capacity of 420 passengers with an average flight occupancy of 90 per cent has been assumed.

It is unclear how these assumptions relate to the demand presented for the Stage 1 airport as repeated in Table 3 of this report. For example, assuming 4 international aircraft movements as per Table 3, this would equate to 4 aircraft at 420 x 90% = 378 passengers for a total of 1,512 passengers. This is much higher than the combined international departing and arriving passenger numbers shown in the table (550 + 600 = 1,150 passengers) both in the draft Airport Plan and elsewhere in the draft EIS.

Summary

Given the importance of demand forecasts both for sizing the airport and it infrastructure but also for informing other dependent analysis such as noise modelling and planning of landside infrastructure, the variation in some of this data requires clarification to confirm that findings in the draft EIS and draft Airport Plan based on the aircraft forecasts are robust.

2.2.3 Airport Master Plan

The draft Airport Plan states that the Land Use Plan presented for Stage 1 "will apply from the grant of an airport lease until approval of the first master plan".[11] Indeed, the draft Airport Plan clarifies further by stating that "some components of the Airport, such as the location of the runway and the required spacing of airfield infrastructure elements are fixed, while others such as the location and shape of the terminal and cargo areas may change provided they comply with the Land Use Plan and the development objectives for the airport".[12]

[10] p.58, GHD,| Report for Western Sydney Unit - Western Sydney Airport EIS, 21/24265, which forms draft EIS Volume 4 Appendix J, Australian Government, Department of Infrastructure and Regional Development, Draft Airport Plan – Western Sydney Airport, October 2015

[11] p.59 Land Use Plan, Draft Airport Plan, Australian Government, Department of Infrastructure and Regional Development, Western Sydney Airport – Environmental Impact Statement, October 2015

[12] p.17, Stage 1 Development – construction and initial operations (approximately 2016−2030), Draft Airport Plan, Australian Government, Department of Infrastructure and Regional Development, Western Sydney Airport – Environmental Impact Statement, October 2015

Figure 1: Western Sydney Airport - Stage 1 Airport Land Use Plan

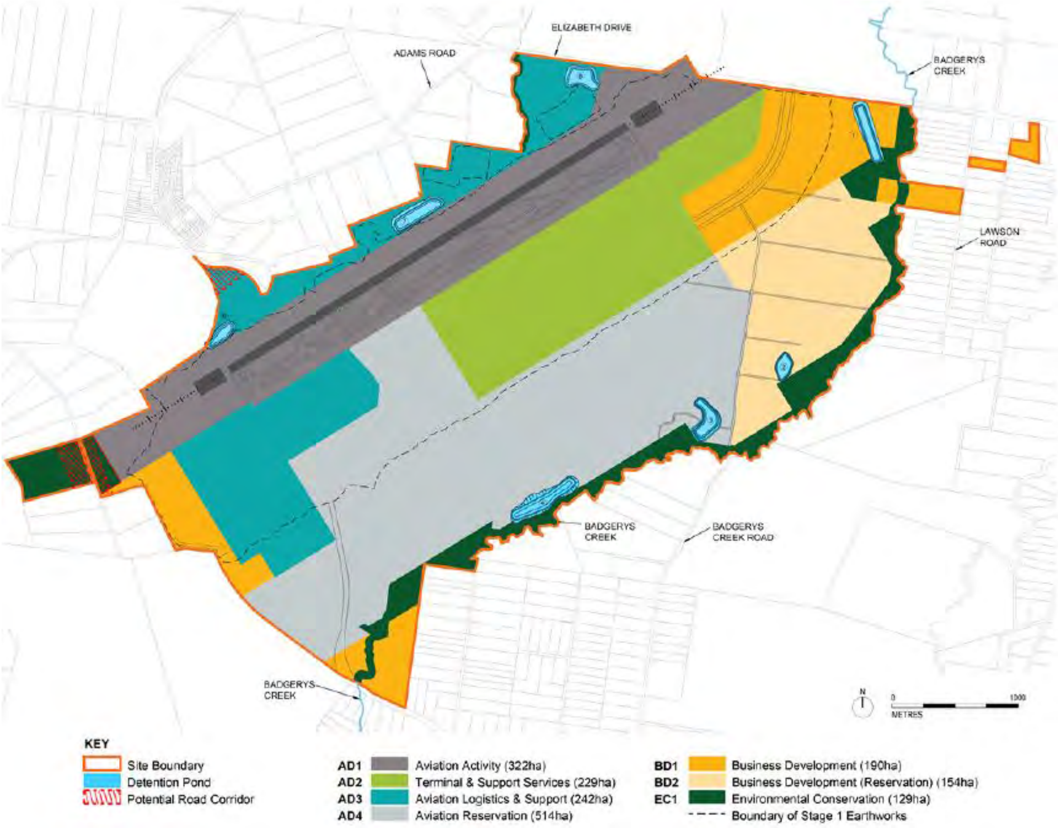
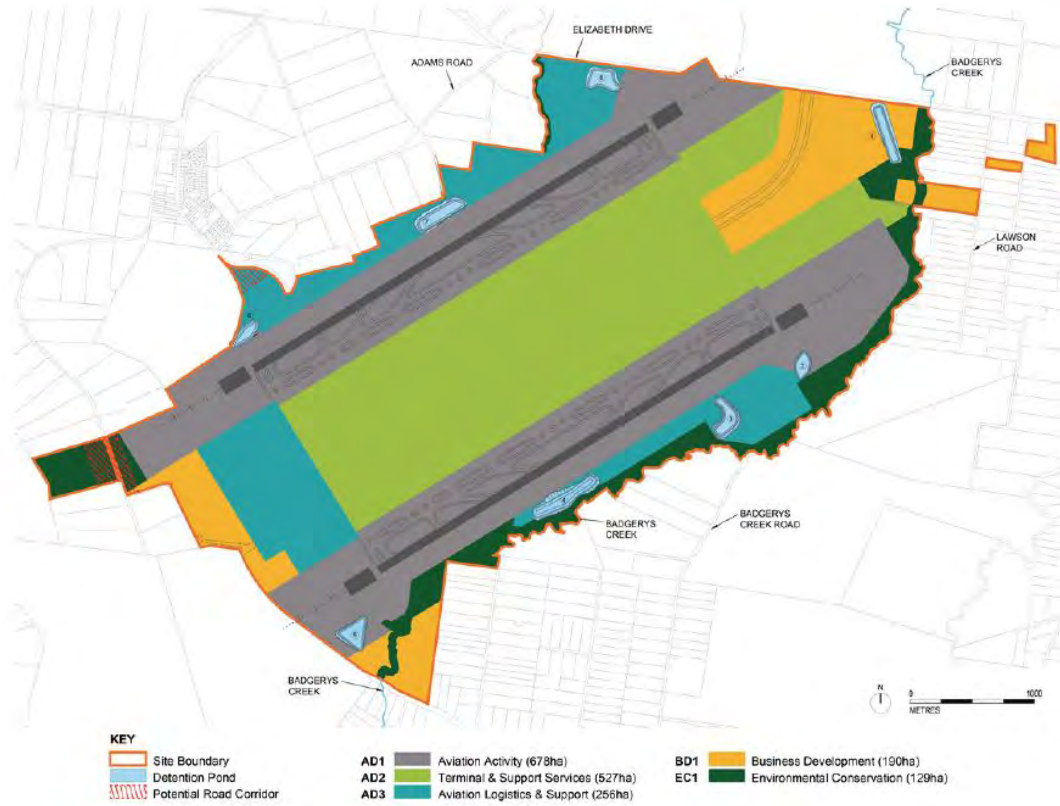


Figure 2: Indicative Western Sydney Airport - Long-Term Airport Land Use Plan



Runway Characteristics

The aircraft mix used in assessing runway length requirements, in planning the airport is provided in Table 5-4 of Volume 1 of the draft EIS and is shown in Figure 3.

Figure 3: Fleet Mix used in Stage 1 Airport Planning

Table 5-4 – Maximum take-off weights for critical aircraft expected to use the proposed airport

Aircraft	Code	Maximum take-off weight (kg)	Runway length requirements (m)
B737-500	C	60,550	2,960
B747-400	E	396,894	3,790
B747-800	F	447,696	3,670
B767-300ER	D	186880	3,790
B777-200	E	286,900	3,320
B777-300ER	E	351,535	3,640
A321-200	C	93,500	3,000
A330-300	E	242,000	3,650
A340-600	E	380,000	3,400
A380-800	F	575,000	2,900

Source: Aircraft Manufacturer's Manuals

The runway length shown for Stage 1 is 3,700m which is appropriate for all but the 747-400 and 767-300ER at Maximum Take-Off Weight (MTOW). As the draft EIS notes these two aircraft "are currently being phased out of the Boeing fleet"[13] and accordingly a 3,700m accommodates the other main aircraft types.

The runway will be 60m wide to accommodate up to Code F aircraft.

Whilst the runway length and width are described, other characteristics which one might expect to see in an EIS are not included such as runway longitudinal and transverse slopes, runway surface, runway shoulder and strip longitudinal and transverse slopes etc. One would expect these to be included as they impact upon water run-off and drainage which is usually an important consideration in an EIS.

In terms of operation, the draft Airport Plan identifies that the airport will operate with a single runway to around 2050 at 37 million annual passengers on 185,000 movements, equivalent to 49 busy hour ATMs. At this point a second parallel runway of 3,700 metres is expected to be required.

It should be noted that 49 movements per hour off a single runway is close to the current maximum at Gatwick, which is the world's busiest single runway airport at 39.7 million passengers[14] and which achieves up 55 movements per hour. However, Gatwick is an exception globally and is currently engaged in discussion with the UK Government in relation to building a second runway. The next

[13] p.154, Runway length requirements, Western Sydney Airport – Environmental Impact Statement – Volume 1, October 2015

[14] Gatwick Airport website, http://mediacentre.gatwickairport.com/press-releases/2015/15-10-09-london-gatwick-september-traffic-figures.aspx

busiest single runway airport in the world is San Diego Airport at 18.8 million annual passengers.

These benchmarks would indicate that a potential second runway may be sought earlier than 2050 and this would require its own Master Plan and MDP process, potentially with additional EIS requirements as appropriate.

Runway Separation

In general, the principles behind the Land Use plans appear sensible.

The plans for Western Sydney Airport allow 1900m between the two runways which provides for development area for terminal, aviation and logistics support land uses when considering long-term growth. This aligns with the distance between the main runways for the original Beijing Airport and for the recently opened Kunming Airports and is greater than the runway separation for new Beijing T3 and Hong Kong Chek-Lap-Kok which are both at approximately 1500m.

However, recent development of independent parallel runways with main terminal complexes between them are typically wider between 2000m and 2500m (Auckland, Kuala Lumpur, New Istanbul and New Dubai). This is also reflected by other Australian and New Zealand Airports which are allowing for 2000m to 2100m including:

- 2000m at Brisbane, Melbourne and Perth Airports; and
- 2072m at Auckland Airport;

This is to provide greater flexibility for the central terminal area development.

It is unclear what benchmarks or planning decisions sit behind the 1900m runway separation shown and any wider spacing would increase land take, with downstream environmental impacts on areas such as in turn impacts on biodiversity, surface water and groundwater, landscape and visual amenity. In addition, wider spacing for the future two runway airport will impact on flight tracks and noise given changes to runway thresholds.

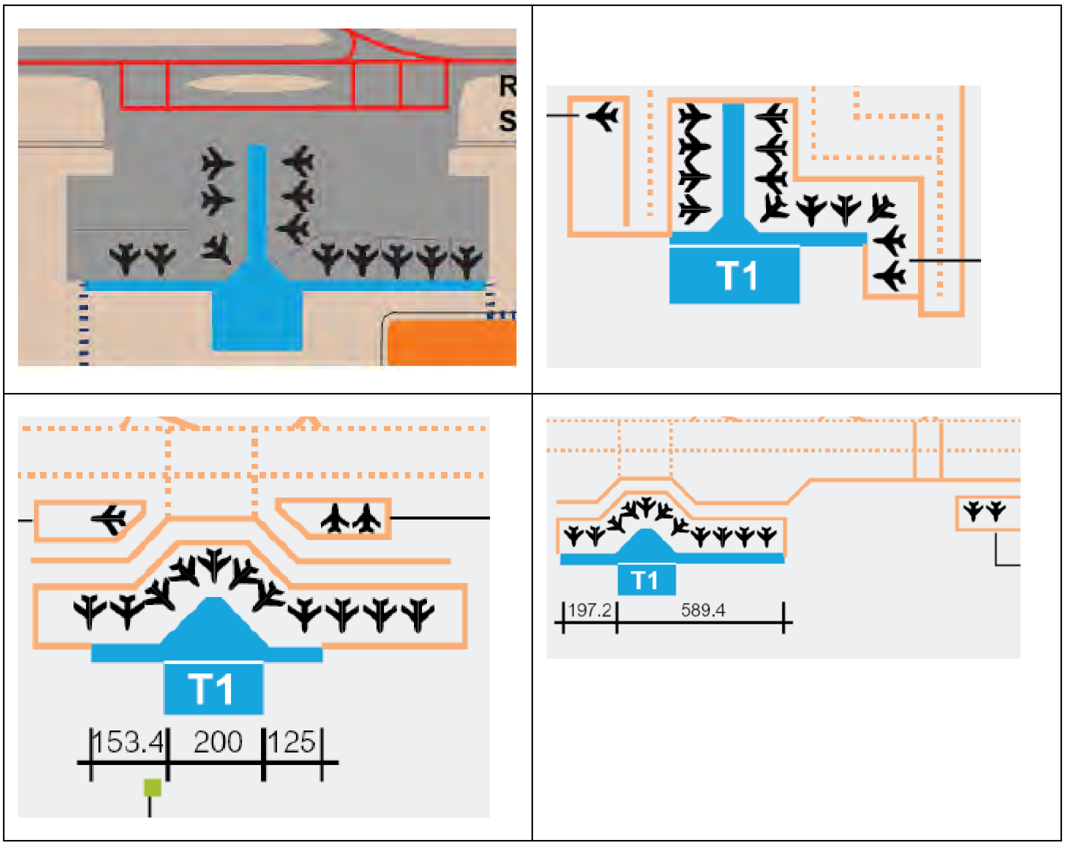
This closer runway separation will also likely provide for less room to manage the proposed incremental development of the site, in particular when considering construction, construction access, site compounds etc.

It is recommended that clarification is sought on the issue of runway separation and whether the proposed 1900m is appropriate.

Aircraft Stands

There are a number of inconsistencies in terminal sizing and provision of stands when considering the Stage 1 Master Plan, as shown in Figure 4.

Figure 4: Indicative Stage 1 Terminal Arrangements



Whilst the draft Airport Plan identifies that multiple terminal and stand configurations exist, one would expect the fundamental elements to remain the same. However, the total number of widebody (Code E or F) aircraft stands shown ranges from 13 to 14 and the location of these stands connected to the terminal (also known as contact stands) and those that are remote for aircraft parking ranges from all contact to up 3 widebody aircraft on remote stands.

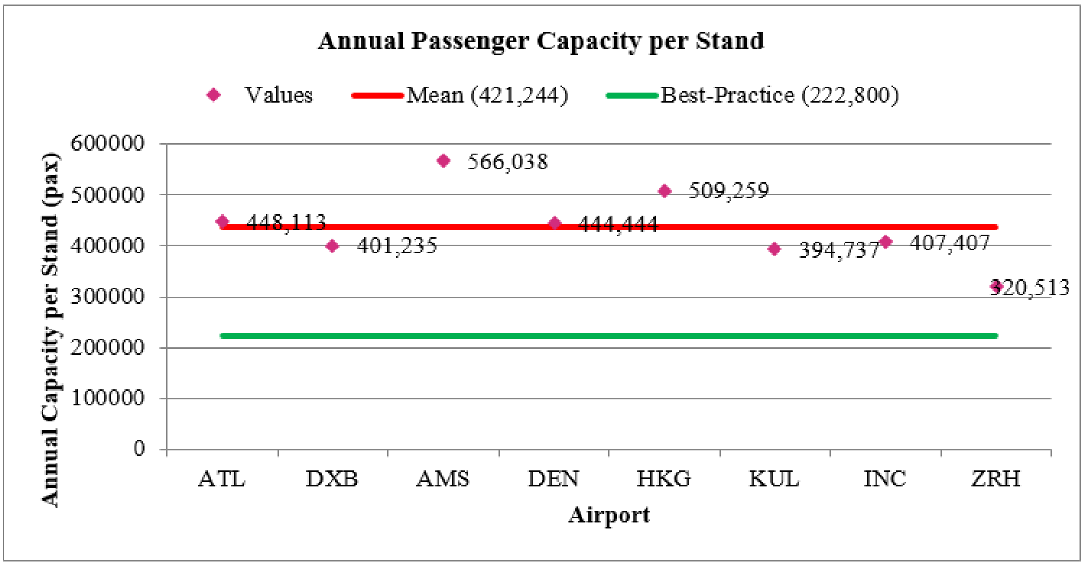
Indeed, the draft Airport Plan describes "the expectation that approximately 21 passenger aircraft stands (Code C, Code D and Code F) and four freight aircraft stands will be required to provide the Stage 1 Capacity. MARS and swing gates may be used to meet the Stage 1 Capacity and reduce the overall stand requirement to approximately 19".[15] This is different set of numbers again, although the Master Plan options shown in Figure 4 would provide enough space for this mix.

Whilst not considered critical issue at this stage, it does raise the question of consistency in terms of the base set of planning parameters used in developing the airport. Moreover, when considering 10 million annual passengers on 21 stands,

[15] p.75, 3.2.3 Apron, Draft Airport Plan, Australian Government, Department of Infrastructure and Regional Development, Draft Airport Plan – Western Sydney Airport, October 2015

this gives a passenger throughput of 467,190 passengers per stand. This is a very high throughput and benchmarks with major airports such as Atlanta, Dubai, Amsterdam, Denver and Hong Kong. However, these are major hubs with much higher throughputs and 6 or 7 waves of arrivals or departures and high levels of transfer. One would not expect this level of demand per stand through a 10 million passenger per annum airport but a lower throughput. This implies that the Western Sydney Airport will actually require more aircraft stands than those shown on the plans.

Figure 5: Benchmarking – Annual Capacity per Stand



Source: Graph extracted from Arup benchmarking study using 2008 data

This is reaffirmed through benchmarking against current Australian airports. For example, when considering the current Sydney Airport, the published Aeronautical Information Package (AIP) indicates a total of 106 stands. Current throughput at Sydney is 36.9million passengers, which over 106 stands is equivalent to 348,113 passengers per stand.

It is unlikely that new airport in the same region would perform more efficiently than an existing airport with a mature route network and more extensive international reach, in particular in its early years of operation.

As per the passenger load per aircraft data described earlier in this section, this benchmarking would imply that the number of aircraft stands shown is less than one might typically expect, which has potential implications for land take and therefore related environmental impacts, though it is noted that the Land Use plan for Stage 1 shows a large area available for development.

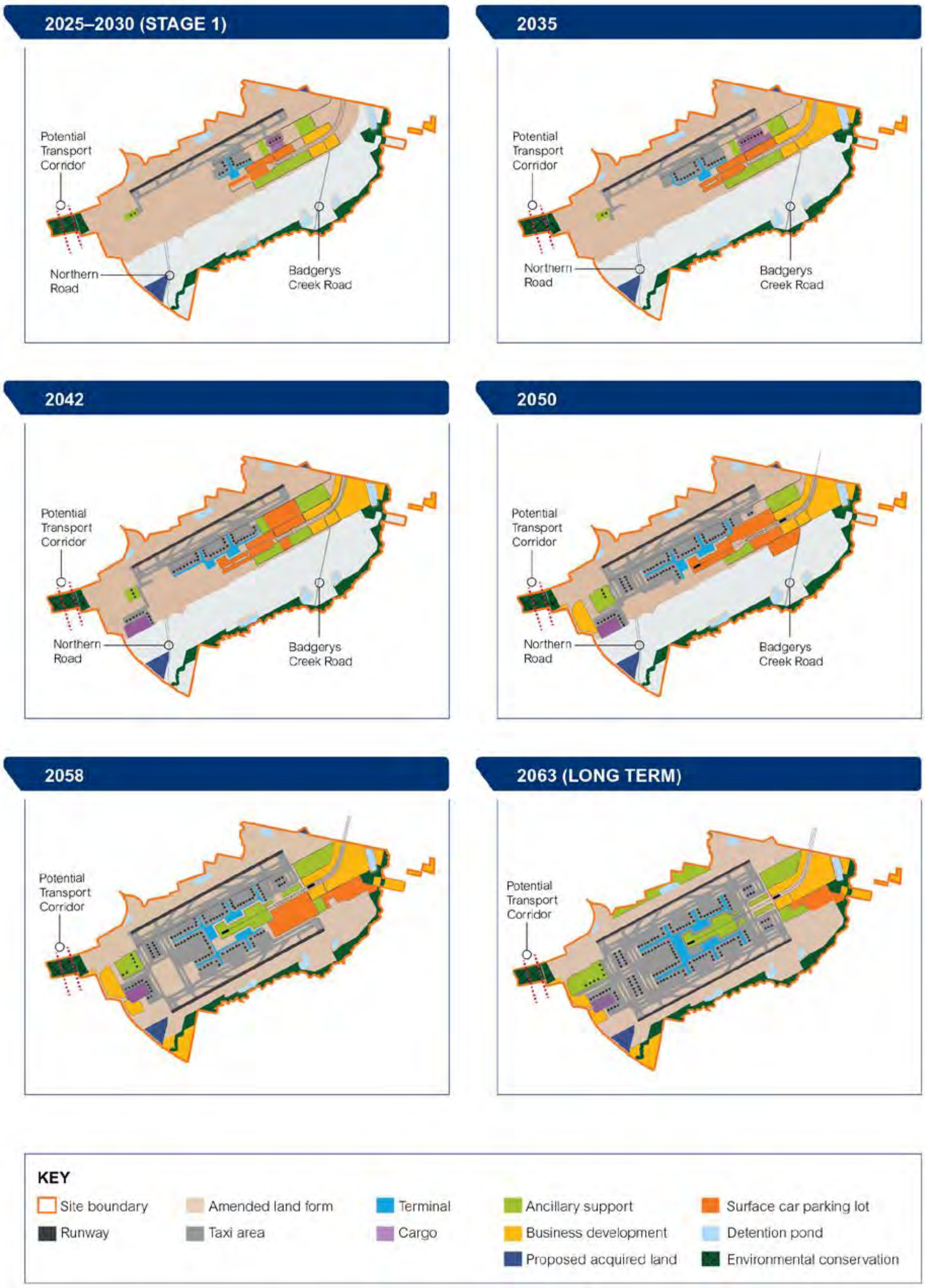
Phasing

Overall the Master Plan appears to be largely influenced by the initial stage of development at 10mppa with incremental expansion out to 2063. This would imply that Western Sydney airport is not seen as a true competitor or even replacement airport to Sydney Kingsford Smith but more of a complementary airport to the existing one. Therefore, the planning appears to have been developed on the basis of decanting traffic in as similar way to past development priorities at London Stansted or Montreal Mirabel.

As can be seen from Figure 6, the expansion plan is extremely incremental using multiple terminal processors and pier extensions all linked to each other. This raises questions with regard to the vision and purpose of Western Sydney Airport in relation to the current Sydney Airport.

In addition, the amount of capacity being added every 7 to 8 years is sometimes equivalent to 12 widebody Code E or F aircraft or 24 narrowbody Code C aircraft which is significant and implies the airport will be a continuous building site which raises questions of construction and buildability.

Figure 6: Indicative Staging of Expansion



2.2.4 Noise from Aircraft

Another consultant is reviewing the noise modelling presented in the draft EIS.

The aircraft mix used in the noise modelling is provided in Table 10-3 of Volume 3 of the draft EIS and is shown in Figure 7 below.

Figure 7: Fleet Mix used in Stage 1 Airport Planning

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

It is noted that planning to 2030 for Stage 1 of the airport includes aircraft that may not be operational at that time such as the B747-400 and B767-300 which as the draft EIS notes "are currently being phased out of the Boeing fleet".[16] By including for these in noise modelling, it is likely that this aspect of the modelling has been conservative as older aircraft are typically noisier than the more current generation. However, as noted earlier in this section, it is not clear whether the number of aircraft movements is correct or whether these numbers have been understated owing to high load factors.

2.2.5 Airspace and flight tracks

Airspace and flight tracks have been reviewed by The Airport Group (TAG) and salient points and key findings are also captured in this document. For the full discussion on airspace and flight tracks, the TAG report entitled "Peer Review - Western Sydney Airport EIS" and dated 17th November 2015 is also included in its entirety as Appendix A.

In summary, the airspace modelling presented in the draft EIS is repeatedly referenced as being "indicative" with further statements on the high-level nature

[16] p.154, Runway length requirements, Western Sydney Airport – Environmental Impact Statement – Volume 1, October 2015

of the work such as being a "preliminary assessment undertaken by Airservices Australia … limited to a conceptual level airspace management design".[17]

The draft EIS goes on to explain that the "indicative airspace design did not consider potential noise or other environmental considerations".[18] In essence, the development of flight tracks has not been undertaken to respond to environmental considerations.

Moreover the work undertaken by Airservices Australia and which underpins the draft EIS is described as being "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".[19]

Both statements, above, indicate that the airspace components presented in this draft EIS do not meet the requirements of the EIS guidelines.

In addition, draft EIS does not explore alternatives to the flight paths shown. For Stage 1, other than minor flight path displacement, "feasible" alternatives are not presented or evaluated, as required in the Guidelines provided by the Department of Infrastructure and Regional Development. This is evidenced by a single flight path "Point Merge" being located over Blaxland township for the Stage 1 development, as shown in Figure 8 overleaf.

The draft EIS implies that this single Point Merge for the short term plan can accommodate both runways and describes movement of the point by up to 3 nautical miles. However, no other options are considered for Stage 1, despite the long term plan having a different set of four Point Merges for the two runway system. This is at odds with the EIS guidelines provided in Appendix C and needs further investigation. A single untested airspace model based on traffic considerations is unlikely to provide a satisfactory outcome, as no comparative scenario is offered.

Based on the above, this draft EIS does not therefore meet the requirement of the EIS guidelines to demonstrate feasible alternatives. A refined method, considering a several alternative models, is required to meet the guidelines and also to remove uncertainty of flight paths and the consequent impact on the community from environmental considerations, such as noise, pollution, building restriction, etc.

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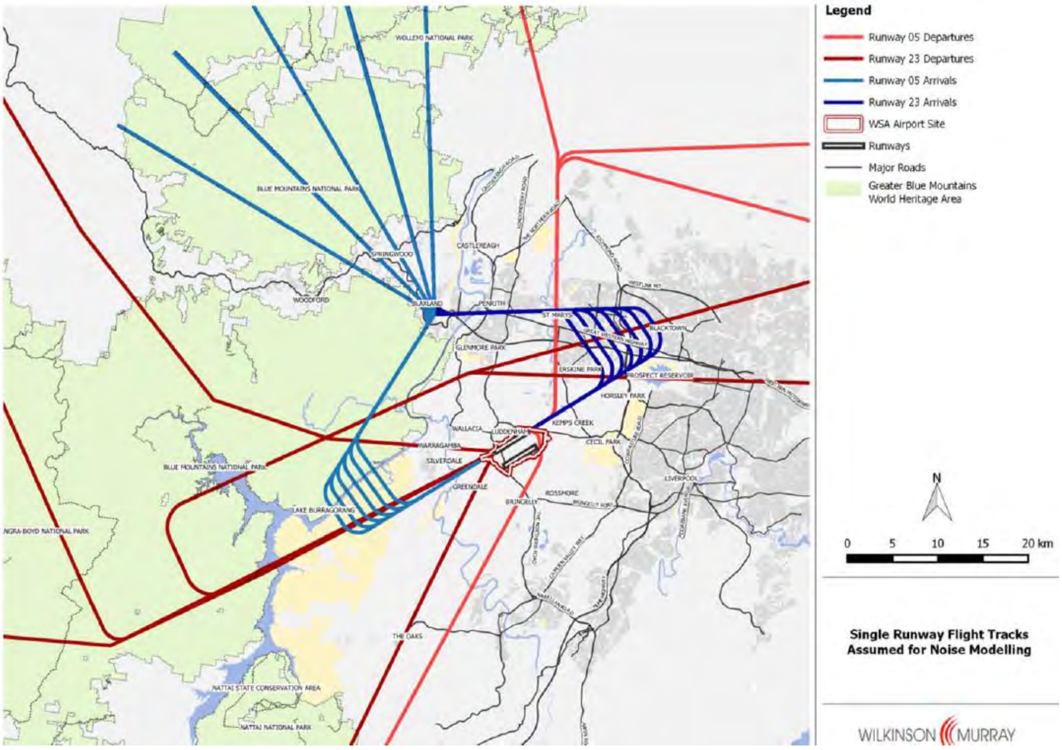
[17] p.18, Department of Infrastructure and Regional Development, Western Sydney Airport – Environmental Impact Statement – Volume 1, October 2015

[18] p.197, Section 14.4.1 Flight Tracks, Western Sydney Airport – Environmental Impact Statement – Volume 2, October 2015

[19] p.25, Section 2.6 Flight Tracks, Western Sydney Airport – Environmental Impact Statement – Volume 4, Appendix E1 Aircraft Overflight Noise

Figure 8: Flight Tracks Modelled for Initial Development (Single Runway – All Operating Modes Combined)



2.2.6 Bird and bat strike

The draft EIS references relevant standards and guidelines for the assessment and management of bird and bat strike risk, in accordance with Section 5(g) of the EIS guidelines.

However, the fieldwork described is limited to one set of surveys therefore seasonal/temporal changes cannot be identified. In addition, some sites within the study area were not assessed due to access limitations. Monitoring of seasonal variability is required by Section 5(g) of the EIS guidelines.

Volume 4 Appendix I states that study area for the assessment is 25km radius from the airport site centre point. This is based on international and national guidelines for identifying and managing wildlife attractants within 13km of runways. This is potentially misleading as Figure 7 shows the Study Area Assessment Locations and these extend to approximately 15km from the airport site. This requires clarification.

2.2.7 Aviation fuel dumping

No analysis is presented on fuel dumping in the draft EIS.

The draft EIS benchmarks current instances of “emergency fuel jettisoning occurring in approximately 0.001 per cent of all aircraft movements”[20] and

[20] p.247, 7.9.4 Emergency fuel jettison (fuel dumping),Western Sydney Airport – Environmental Impact Statement – Volume 1, October 2015

concludes that “given the rarity of fuel jettisoning globally, the known low occurrence in Australian airspace, the standards set out in the Aeronautical Information Package (AIP), and the high evaporation rates known to occur at high altitude, authorised fuel jettisoning associated with the operation of the proposed airport, is unlikely to cause significant environmental or social impacts”.[21]

If fuel dumping occurs as part of an emergency, the AIP as specified by Airservices Australia states that fuel jettison must occur “where possible, … in clear air at an altitude of above 6,000 feet (approximately 1.8 kilometres) and in an area nominated by air traffic control” to limit local impacts to allow the fuel to evaporate. However, if fuel dumping were to occur below 6,000 feet, there is potential that this could occur over Blacktown or Wetherill Park when considering the flight tracks related to Rwy 23 or over Camden and Blacktown when considering the flight tracks related to Rwy 05. In order to reassure local government and communities, the draft EIS could discuss local measures which would prevent fuel dumping over these areas.

2.3 Validity of Conclusions

In general, the approach and findings appear valid. However, it is recommended that further explanation is ought on the following matters:

- Vocation or purpose of Western Sydney Airport – No vocation or aviation purpose is described for Western Sydney Airport. One might expect that, certainly in its early stages of development, the airport would potentially be a predominantly domestic, low-cost carrier airport with a significant cargo operation, reflecting lower charges and a lack of noise curfew.[22] Premium international flights would continue to use Sydney Kingsford Smith as the primary airport in New South Wales and the one which provides proximity to the tourist and business centre of Sydney CBD. This vocational aspect is important in influencing how the airport will operate, peak periods of activity and the type of traffic that will use the airport.

- Forecasts – There is a degree of variability in the forecasts and demand information used in the draft EIS and draft Airport Plan. In addition, the forecast passenger loads per aircraft for Western Sydney Airport as presented in the draft EIS appear to be high. Assuming higher passenger loads has the potential to understate the number of aircraft movements required, which has knock-on impacts on dependent analysis such as noise modelling. This is a potential area for further assessment or clarification to confirm that findings in the draft EIS and draft Airport Plan based on these forecasts are robust.

- Runway separation – It is unclear what benchmarks or planning decisions sit behind the 1900m runway separation shown for Western Sydney and it

[21] p.247, Section 7.9.4 Emergency fuel jettison (fuel dumping), Western Sydney Airport – Environmental Impact Statement – Volume 1, October 2015

[22] It is assumed that the need or otherwise for a noise curfew at Western Sydney is discussed in the review undertaken by the noise consultant. From an operational standpoint, it is preferable that an airport operates unrestricted by curfews, however it is imperative that principles of “Fly Neighbourly” are introduced to minimise the environmental impact of noise.

is noted that other airports in Australasia are proposing wider runway separation. Any wider spacing would increase land take, with downstream environmental impacts on areas such as in turn impacts on biodiversity, surface water and groundwater, landscape and visual amenity. In addition, wider spacing for the future two runway airport will impact on flight tracks and noise given changes to runway thresholds.

- Aircraft stand provision – benchmarking indicates that passenger throughput per aircraft stand is potentially high for Western Sydney Airport. This would imply that the number of aircraft stands shown is less than one might typically expect, which has potential implications for land take and therefore related environmental impacts, though it is noted that the Land Use plan for Stage 1 shows a large area available for development.
- Airspace and flight tracks – In terms of airspace and flight tracks, conclusions drawn from the draft EIS with respect to Stage 1 flight paths and airspace (Air Traffic Management) include:

    1. There are no known physical impediments to the operation of an airport at Western Sydney;
    2. An indicative “proof of concept” airspace plan exists which facilitates the management of aircraft traffic, which conforms to current standards.
    3. Based on the airspace “concept”, noise modelling is indicative of the effect of aircraft on those flight paths.
    4. Maintaining aircraft at higher altitudes will reduce the noise impact on the community.

  The conclusions are valid for the cases presented and they follow current “best practice” guidelines for flight path design and protection of airspace.

  Items which are not considered include:

    1. Any alternative airspace model and flight paths. It is considered that alternative scenarios should be developed to determine an acceptable overall model for airspace.
    2. Environmental impact on selection of flight paths needs to be included to minimise impacts on the community.
    3. There is no consideration of community acceptance of change to aircraft flight path and altitudes. The effect of noise is not restricted solely to loudness, but also to perception, and this has not been tested. Metrics of noise evaluation should be considered for the proposed paths.
    4. Height restrictions on buildings not located in the immediate vicinity of the airport. Locations, such as the Blue Mountains Council region, Camden, Penrith, Parramatta etc, are potentially affected by the airport at Western Sydney and should be evaluated.

5. Noise abatement procedures are promulgated for major airports around Australia. They define modes of operation at certain times to reduce the effect on surrounding population centres. No consideration has been given to operational management to minimise public impact.

- Bird and bat strike – the bird and bat strike assessment in draft EIS, Volume 4, Appendix I concludes that the overall bird and bat strike risk for the airport is low. However the assessment is preliminary and therefore further works in the airport site and study area are required to confirm the level of bird and bat strike risk and to refine the mitigation strategies, in parallel with design development. Indeed, Appendix I provides recommendations for further work in Section 6, including monthly bird and bat surveys for one year to account for seasonal changes.
- Fuel dumping – It is considered that the information presented in the draft EIS is appropriate though discussion of local effects would provide reassurance to local governments and communities. The advice presented in the draft EIS accords with policy for both the US Federal Aviation Authority (FAA) and UK Civil Aviation Authority.

2.4 Mitigation and Management Measures

2.4.1 Airport planning

No mention is made of measures to reduce environmental impact on airport e.g. reducing the impact of water run-off by minimising areas of pavement for aircraft parking.

No mention is made of terminal building design which is currently moving towards low energy consumption and sustainable or ‘green’ solutions including the harvesting of rain water for grey water reuse, reduced use of artificial light through the use of skylights, and so on.

Whilst this may be a level of detail too far for a Master Plan, this is something one might expect in an EIS.

2.4.2 Airspace and flight tracks

The primary methods of mitigation against flight path environmental impacts is to create a Point Merge System to reduce the emissions and noise generated on approach and to have tracking of departures over less sensitive areas. The former maximises the altitude of aircraft whilst reducing the thrust required, thereby minimising adverse environmental effects. The latter seeks to separate the emissions and noise events from sensitive areas.

Both strategies are commonplace, are considered ‘best practice’ and are presented in the draft EIS.

2.4.3 Bird and bat strike

Section 5 of Appendix I identifies mitigation measures for detailed design, construction and operation, in accordance with Section 6 of the EIS guidelines. The strike risk mitigation strategies described in Section 5 of Appendix I apply to Stage 1 of the development only.

Section 16.6.2.3 of the draft EIS describes the significance of the potential impacts to the EPBC listed Grey-Headed Flying Fox, and includes consideration of aircraft strike as a potential impact. The assessment concludes that the project is likely to have a significant impact to the Grey-Headed Flying Fox but that aircraft strike is unlikely to substantially impact the population as a whole.

Section 7 of the draft EIS guidelines require that details are provided of likely residual impacts upon a matter protected by a controlling provision, after the proposed avoidance and mitigation measures have been taken into account. This includes quantification of the extent and scope of significant residual impacts. The assessment does not specifically link the mitigation measures to a reduction in the level of impact, and residual impacts are not detailed for bird and bat strike, specifically for the Grey-Headed Flying Fox.

2.4.4 Fuel dumping

No mitigation measures proposed. Approach taken for Western Sydney aligns with the approach taken for other major Australian Airports though the majority of these are existing.

2.5 Uncertainty over Impacts and Environmental Risks

The issues presented around forecasts have implications for:

- Economics and social impact;
- Noise, which in turn impacts on Human Health;
- Air quality and greenhouse gases;
- Hazard and risk; and
- Traffic.

Wider runway separation and more aircraft stands have a potential impact on:

- Land take which in turn impacts on:
    1. Biodiversity;
    2. Surface water and groundwater;
    3. Landscape and visual amenity; and
    4. Airport construction and staging.

Changes to airspace and flight tracks will have potential impacts on:

- Noise and air quality;
- Hazard and Risk;
- Greater Blue Mountains; as well as
- The cumulative impact assessment when considering other airports.

Bird and bat strike have a potential impact in terms of:

- Hazard and risk.
- Impacts on birds and bats also relate to:
    1. Biodiversity.

3 Detailed Findings – Long term Development

3.1 Approach

As for Stage 1, our approach has been to review the four volumes of the draft EIS as well as the draft Airport Plan provided on the website (www.westernsydneyairport.gov.au).

The four volumes of the draft EIS are Volume 1 – Project Background, Volume 2 – Stage 1 Development, Volume 3 – Long Term Development and Volume 4 – Technical Appendices.

3.2 Gap analysis

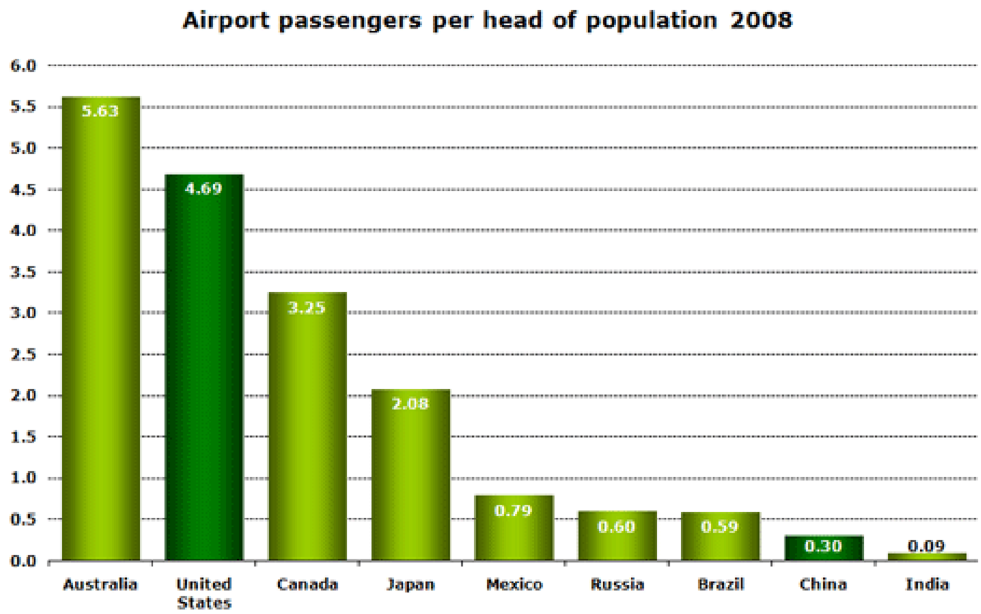
A number of the issues identified for Stage 1 are also apparent in the longer term planning of Western Sydney Airport. Additional longer-term considerations are provided in the following sections.

3.2.1 Aviation demand and activity

In addition to the variations in demand identified in Section 2, the relationship between Western Sydney and Sydney Airport is not fully explored long-term.

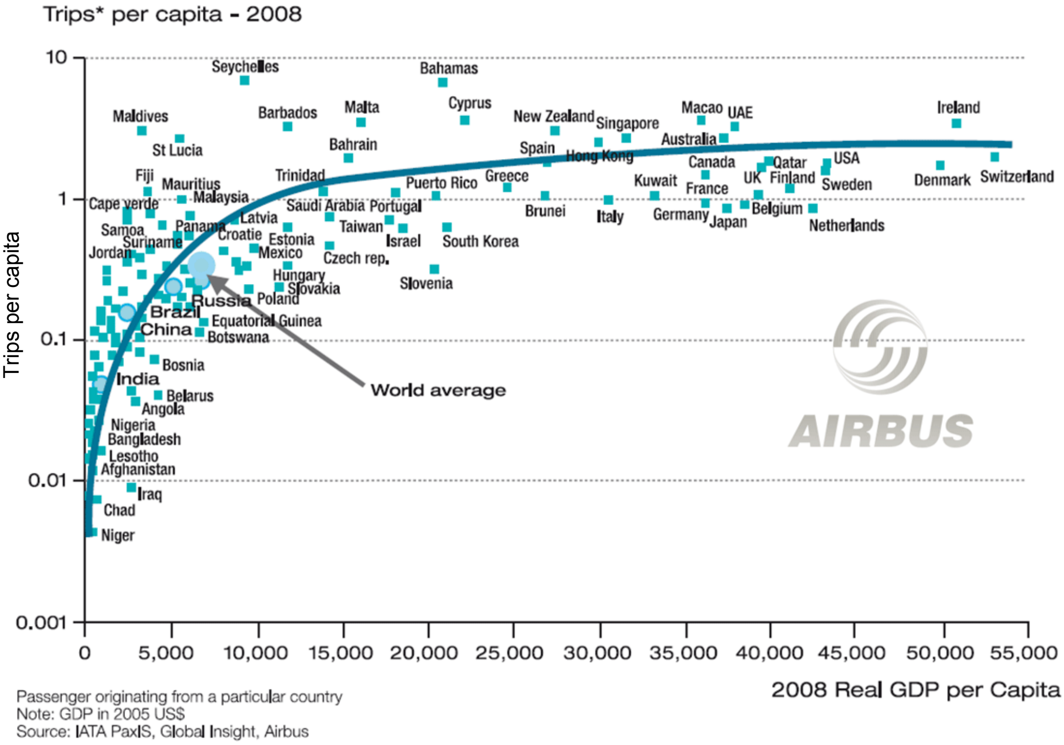
Current throughput at Sydney is 40mppa as compared to a NSW population of 7.7 million. This is equivalent to ~5.2 trips per capita of population which aligns with analysis undertaken for Australia by anna.aero and Airbus, and as presented in the figures below.

Figure 9: Airport Passengers per head of Population for non-European Countries



Source: http://www.anna.aero/2009/10/23/us-propensity-for-air-travel-is-15-times-greater-than-in-china-cyprus-tops-european-rankings/

Figure 10: Airbus- Trips per Capita by Country



The draft EIS reflects the Government's Joint Study on Aviation Capacity in the Sydney Region which projects potential demand to be 165 million passengers by 2060.[23] This would imply Sydney Airport operating at over 80 mppa. In addition, across the state, this would imply trips per capita more than doubling by 2060 at 13 trips per capita of population[24] which is significantly higher than current maximums for countries of the size and characteristics of Australia (as per Figure 9 and Figure 10).

The relationship between the two Sydney Airports is not explored in the draft EIS, although planning of the Airport and indeed flight tracks and airspace have been allocated assuming maximum growth at each airport without any exploration of the vocation of each airport or how traffic might be split between the two. This could affect the type of aircraft and carriers (e.g. low-cost, cargo etc) using each airport, which in turn will influence the environmental impacts of each airport.

3.2.2 Master Plan

As described in 2.2.3 for the Stage 1 Airport, total stands provision for the ultimate long-term airport development varies from 150 widebody stands to 165 widebody stands and significant variation in the amount of contact and remote capacity.

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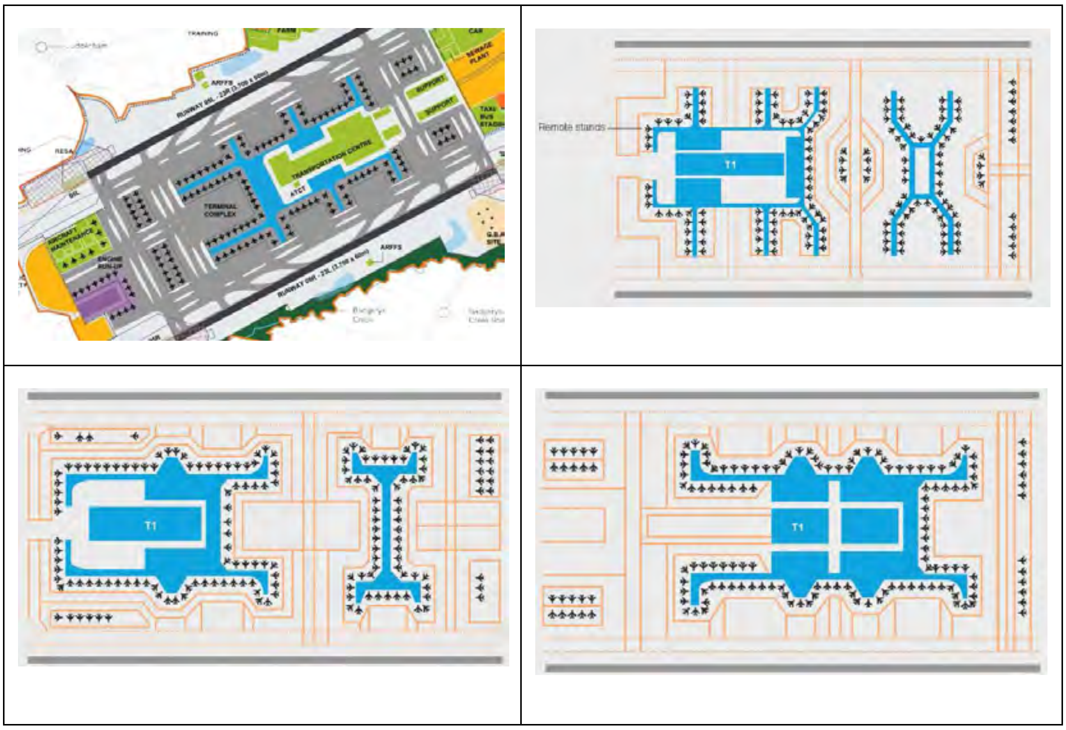
[23] Note that Joint Study on Aviation Capacity in the Sydney Region indicates even higher demand in the Sydney region at 165 million passengers by 2060. p.84, Capacity Constraints – The Joint Study, Western Sydney Airport – Environmental Impact Statement – Volume 1, October 2015

[24] Based on the Australian Bureau of Statistics projection of a NSW population of 12.6 million. http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/3222.0main+features72012%20(base)%20to%202101

Figure 11: Indicative Long-Term Terminal Arrangements



The variability in the number of stands again raises the question of consistency in terms of the base set of planning parameters used in developing the airport.

In terms of runway separation, the terminal and transport centre are all contained within the 1900m separation between the runways and the space looks narrow for all of the functions that will be required here. In addition, when building the airport, it will be difficult to construct everything within this envelope whilst not disrupting airport operations.

3.2.3 Airspace and flight tracks

Most issues identified for Stage 1 are also apparent in the longer term planning of Western Sydney Airport. Additional longer-term considerations are provided in the following sections.

Flight path development

Due to the requirements for separation of aircraft on parallel runways, the modelling is much more complex for the longer term scenario than for that on a single runway. Aircraft must be separated vertically, longitudinally (time between aircraft crossing a point) or laterally. Flight paths created facilitate the separation with little, if any, external involvement by Air Traffic Control.

The draft EIS proposal contains a single model for flight paths, developed for parallel runway operations. Similarly, to Stage 1, there is no consideration of more than one scenario included in the modelling. The draft EIS includes statements that this is solely due to the extended timeframe and that there is uncertainty about the service available at implementation. Further, it is intimated that amount of work required was not justified and would be required prior to commissioning in about 2050. This does not align with the DIRD guidelines.

Interaction with other airports

The model considers broad interaction with Sydney Kingsford Smith and notes that there will significant effects on the operation of other airports in the Sydney basin. The specific interactions, restrictions and changes to airspace is encapsulated in Section 7.4.1 in Volume 1 of the draft EIS entitled Airspace architecture, and potential impacts on air traffic movement. This states that "CASA recently identified a number of important Sydney basin airspace matters that should be considered in in future airspace design process".[25]

The implication is that the current modelling may not have, or be able to have, future CASA determinations included for the draft EIS. However, it is clear that the ultimate mode of operation of Western Sydney Airport will result in operational incompatibility with the operations at smaller airports like Bankstown and Camden, potentially forcing closure or relocation. Neither eventuality is investigated.

Modelling

The draft EIS is based on assumptions for fleet operations and performance, and "indicative" and "proof of concept" flight paths and airspace definitions. As with Stage 1, no consideration of feasible alternatives is made. The location of Point Merge and Departure tracks and did not consider potential noise or other environmental considerations. Therefore, there has been no testing of alternate solutions.

Within the model, there are several modes of operation, and each is evaluated. The analysis associated with the above follows standard procedure and the results are consistent. It indicates that the modelling conducted will allow the operation of both Western Sydney Airport and Sydney Kingsford Smith independently and as high capacity aerodromes.

3.3 Key risks and implications

These are as for Stage 1 and as described in Section 4 below.

In terms of aircraft noise (which is being reviewed by another consultant), other than modes of runway operation, it is unclear whether the evaluation considers noise abatement. From an operational standpoint, it is preferable that an airport operates unrestricted by curfews, however it is imperative that principles of "Fly Neighbourly" are introduced to minimise the environmental impact of noise.

In terms of airspace, for the certainty of local government management and processes, it is expected that the draft EIS would develop some clarity regarding matters such as impacts on water quality, building restrictions, noise abatement

[25] p.229, 7.4 Interactions with Sydney Airport and the broader Sydney region airspace, Western Sydney Airport – Environmental Impact Statement – Volume 1, October 2015

and continuity of airspace flight paths. As with Stage 1, it is unclear whether any evaluation was undertaken with respect to building development restriction within local government areas surrounding the airport, with the exception of areas immediately at the runway ends. One would expect that this would be considered as part of the draft EIS.

For the long term development of the airport there is a potential risk to long term operation if the airspace and flight paths change. Revision to Stage 1 flight paths and airspace may meet with resistance from stakeholders, such as property owners and local authorities. As such, it would be expected that flight paths and airspace developed for Stage 1 can also be staged for the long term operation.

3.4 Effectiveness

The plan presented for longer term development are indicative. Whist these highlight similar issues to those raised for the Stage 1 airport, it is noted that longer term development beyond Stage 1 would be subject to the requirements of the Airports Act including provision of additional Master Plan and MDP studies as appropriate.

In terms of airspace, it appears that the draft EIS is orientated to the current conditions and has not explored in sufficient depth the conditions expected for Stage 1, nor long term development at Western Sydney Airport.

4 Key Impacts and Opportunities

The following section summarises key impacts and opportunities from an airport planning perspective as identified in Sections 2 and 3.

- Vocation or purpose of Western Sydney Airport – No vocation or aviation purpose is described for Western Sydney Airport. One might expect that, certainly in its early stages of development, the airport would potentially be a predominantly domestic, low-cost carrier airport with a significant cargo operation, reflecting lower charges and the lack of noise curfew. Premium international flights would continue to use Sydney Kingsford Smith as the primary airport in New South Wales and the one which provides proximity to the tourist and business centre of Sydney CBD. This vocational aspect is important in influencing how the airport will operate, peak periods of activity and the type of traffic that will use the airport.

- Forecasts – There is a degree of variability in the forecasts and demand information used in the draft EIS and draft Airport Plan. In addition, the forecast passenger loads per aircraft for Western Sydney Airport as presented in the draft EIS appear to be high. Assuming higher passenger loads has the potential to understate the number of aircraft movements required, which has knock-on impacts on dependent analysis such as noise modelling. This is a potential area for further assessment or clarification to confirm that findings in the draft EIS and draft Airport Plan based on these forecasts are robust.

- Runway separation – It is unclear what benchmarks or planning decisions sit behind the 1900m runway separation shown for Western Sydney ad it is noted that other airports in Australasia are proposing wider runway separation. Any wider spacing would increase land take, with downstream environmental impacts on areas such as in turn impacts on biodiversity, surface water and groundwater, landscape and visual amenity. In addition, wider spacing for the future two runway airport will impact on flight tracks and noise given changes to runway thresholds.

- Aircraft stand provision – benchmarking indicates that passenger throughput per aircraft stand is high for potentially high for Western Sydney Airport. This would imply that the number of aircraft stands shown is less than one might typically expect, which has potential implications for land take and therefore related environmental impacts, though it is noted that the Land Use plan for Stage 1 shows a large area available for development.

- Airspace, OLS and PANS-OPS – In terms of requirements, the evaluation of protection volumes for flight paths and airspace containment is in accordance with normal methods mentioned in the Airports (Protection of Airspace) Regulations and under the Airports Act 1996. Analysis of Obstacle Limitation Surfaces (OLS) and Instrument Flight Procedure protection volumes (known as PANS-OPS surfaces) indicates that, operationally, the Western Sydney airport can operate unrestricted from terrain and artificial obstacles.

However, the following impacts are identified which are either unresolved or which require further clarification:

1. The proposed airspace architecture is 'indicative' and has not been rigorously tested. The draft EIS proposes that another airspace model is tested closer to commencement of operations.
2. The modelling indicates several flight paths over water storages, such as Warragamba Dam and Prospect Reservoir. Other flight paths traverse the Blue Mountains National Park. The environmental impact is unclear.
3. The requirement under the Guidelines, produced by the Department of Infrastructure and Regional Development (DIRD), for feasible alternatives to be included has not been met. This is particularly important in consideration of concentration of approaching traffic over the township of Blaxland for the Stage 1 development and departure tracks.
4. There is no consideration of community sentiment regarding changes to flight paths, proposed in the draft EIS, when the Airport operates with two runways.
5. An alternative Stage 1 airspace model, based on the long term proposal but operating with a single runway, is not tested.
6. Except for Sydney Kingsford Smith, flight paths for aerodromes, affected by the Western Sydney Airport are not evaluated.
7. The draft EIS suggests that Western Sydney Airport will detrimentally affect the operations at Bankstown and Camden, and affect Richmond (military). The environmental impact is not quantified.
8. Relocation of light aircraft traffic to other airports, the definition of new training airspace and consequent environmental impact, is not assessed.

Given the above, it is considered that the information on airspace presented in the draft EIS does not meet requirements.

- Bird and bat strike – the bird and bat strike assessment in draft EIS, Volume 4, Appendix I concludes that the overall bird and bat strike risk for the airport is low. However the assessment is preliminary and therefore further works in the airport site and study area are required to confirm the level of bird and bat strike risk and to refine the mitigation strategies. Indeed, Appendix I provides recommendations for further work in Section 6, including monthly bird and bat surveys for one year to account for seasonal changes.

- Fuel dumping – It is considered that the information presented in the draft EIS is appropriate though more detail could be provided to give certainty for local government and communities. The advice presented in the draft EIS accords with statements made by both the US Federal Aviation Authority (FAA) and UK Civil Aviation Authority which forbids fuel dumping unless in an emergency.

5 Review Team

Jim Peacock

Jim Peacock is an Associate with over 15 years of experience at Arup. Since joining Arup, he has attained particular experience in airport masterplanning and in airport terminal design.

Jim is currently Arup's Project Manager for provision of transport planning services to Gatwick Airport, including Gatwick's response to the UK Airports Commission for a second runway. Jim was Arup's Project Manager for the Auckland Airport Master Plan (2012-2013) and Arup's lead airport planner for the Terminal 1expansion project at Perth Airport working with Woods Bagot. Jim also has terminal planning and masterplanning experience at Brisbane Airport, Hobart Airport and for a number of regional aerodromes in Victoria.

Kay Casson

Kay is a Senior Environmental Consultant in the Arup Brisbane office with 10 years' experience. Kay has been involved in a broad range of projects including environmental impact assessments and constraints studies for major infrastructure projects for government and private clients.

Kay has a strong background in airport projects, including Major Development Plans for Brisbane Airport, Gold Coast Airport and the environmental components of the Hobart Airport Master Plan, and the environmental referral documents for the Sunshine Coast Airport Expansion Project.

For airspace and flight tracks, the review team from TAG is as follows:

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Location	Brisbane
Designation	Chief Designer and Airspace Specialist
Role	QA of product in accordance with CASA Parts 139 and 173
Qualifications	Bachelor of Engineering (Honours, Civil, UQ) Diploma in Instrument Flight Procedure Design (with Distinction, Singapore Aviation Academy)
Relevant Experience	Over 20 years' experience in airspace and instrument flight procedure design. Former Chief Designer, Airservices Australia (2007-2012). Instrument Flight Procedure Designer (1999-). Airways Data Officer (1996-1999). Commercial Pilot (1990-). Trainer of PANS-OPS instrument Flight Procedure Design.

Name	Mark Fineran
Location	Brisbane
Designation	Senior Procedure Designer
Role	Instrument Flight Procedure Design, Air Traffic Management
Qualifications	Diplomas in Aviation (Air Traffic Services) and Transport and Distribution (Air Traffic Control). Airservices Training College (2003) Diploma in Instrument Flight Procedure Design (Singapore Aviation Academy)
Relevant Experience	Over 10 years' experience in aviation. Specialising in Instrument Flight Procedure Design and Air Traffic Control liaison.

Appendix A

TAG Report - Peer Review, Western Sydney Airport EIS, Airspace and Flight Tracks

The Airport Group

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Peer Review

Western Sydney Airport EIS

Prepared for ARUP

November 2015

The Airport Group – Australian Airports Association
Winner 2013
Corporate Project Of The Year

DOCUMENT SUMMARY

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2.0	Draft Peer Review	Incorporation of comments	RRR	17 Nov 2015

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

1.1. Scope of Review

This review is based on a desktop study and a literature review of the four volumes of the draft EIS and the draft Airport Plan with respect to flight paths. A comparison is made against the EIS guidelines, specifically for flight paths, to identify any potential inconsistencies with legislation and common practice.

1.2. Stage 1 Airport

Issues identified in the Draft EIS regarding Airspace and Flight Paths for the development of the Stage 1 Airport include:

- Airspace and flight paths are derived from 'WESTERN SYDNEY AIRPORT, Preliminary Airspace Management Analysis', produced by Airservices Australia 2015.
- Due to assumptions regarding traffic numbers, fleets, staged airport development and primarily long timeframes, the proposed airspace model is noted as a 'proof of concept' and not the subject of exhaustive analysis.
- The indicative airspace design did not consider potential noise or other environmental considerations in flight path development.
- A single airspace model is presented for Stage 1 development. The basis of the model is that operations at Sydney Kingsford Smith Airport are unaffected.
- Other than minor flight path displacement, 'feasible' alternatives are not presented or evaluated, as required in the Guidelines provided by the Department of Infrastructure and Regional Development. This is evidenced by a single flight path 'Point Merge' being located over Blaxland township for the Stage 1 development.
- Mitigation for environmental issues relies on the proposed airspace being based on adopted International Civil Aviation Organization (ICAO) methodologies. These methods have been implemented at several locations worldwide with positive results.
- Flight paths based on the ICAO methodology facilitate aircraft operations which minimise pollutants and noise generation on approach when compared to existing methods.
- Departures track to 'exit gates', concentrating aircraft on several defined routes. This is a common tool used to improve traffic flow. The impact of concentration and location of turn points is not tested for environmental purposes.

- Modes of operation (flight paths based on runways in use) are mentioned, but not how they affect surrounding areas.
- Noise abatement procedures, commonly implemented at other major airports, are not developed.

1.3. Long Term Development

There are several issues regarding airspace and flight paths for the long term development of a Western Sydney Airport.

- For safety of flight, the introduction of a second runway operating in parallel requires rules for separation of parallel traffic. Flight paths for separation of traffic at Western Sydney Airport will affect those at Sydney Kingsford Smith Airport and other airports in the Sydney Basin.
- Interaction of aircraft traffic in the Sydney Basin requires an airspace and flight path review not considered as part of Stage 1.
- The Stage 1 flight paths proposed in the Draft EIS are considered not appropriate for the long term plan.
- Except for Sydney KSA, the effects on other airports in the Sydney region are not quantified, other than in general terms.

1.4. Key Impacts and Opportunities

Key impacts and opportunities from the perspective of airspace and flight paths are as follows:

- The evaluation of protection volumes for flight paths and airspace containment is in accordance with normal methods mentioned in the Airports (Protection of Airspace) Regulations, and under the Airports Act, 1996.
- Analysis of Obstacle Limitation Surfaces (OLS) and Instrument Flight Procedure protection volumes (known as PANS-OPS surfaces) indicates that, operationally, the Western Sydney airport can operate unrestricted from terrain and artificial obstacles.
- The proposed airspace architecture is ‘indicative’ and has not been rigorously tested. The draft EIS proposes that another airspace model is tested closer to commencement of operations.
- Flight paths appear to fly over water storages such as Warragamba Dam and Prospect Reservoir. The environmental impact is unclear.

- The requirement under the Guidelines, produced by the Department of Infrastructure and Regional Development (DIRD), for ‘feasible alternatives’ to be included has not been met. This is particularly important in consideration of concentration of approaching traffic over the township of Blaxland for the Stage 1 development and departure tracks.
- There is no consideration of community sentiment regarding changes to flight paths, proposed in the draft EIS, when the Airport operates with two runways.
- An alternative Stage 1 airspace model, based on the long term proposal but operating with a single runway, is not tested.
- Except for KSA, flight paths for aerodromes, affected by the Western Sydney Airport, are not evaluated
- The draft EIS suggests that Western Sydney Airport will detrimentally affect the operations at Bankstown and Camden, and affect Richmond (military). The environmental impact is not quantified.
- Relocation of light aircraft traffic to other airports, the definition of new training airspace and consequent environmental impact, is not assessed.

2. SCOPE

The scope of this assessment is a Peer Review conducted with respect to Airspace and Flight Path matters discussed within the draft EIS for Western Sydney Airport released by the Federal Government for public exhibition on 19th October 2015.

2.1. Approach

The approach to this EIS peer review includes relevant matters in the four volumes of the draft EIS as well as the draft Airport Plan provided at the website www.westernsydneyairport.gov.au.
The methodology is to assess proposed flight paths and their containment volumes against the requirements of the Act and common practice. This entails correlating the proposed flight paths in relation to the sensitive areas for environmental significance and noise concentrations and population.

2.2. Limitations

This document is based on a desktop study and a literature review of the four volumes of the EIS and the draft Airport Plan, comparison of these against the EIS guidelines, identification of potential opportunities or inconsistencies and a comparison against available benchmarks.

No analysis or modelling has been undertaken.

The document provides guidance to WSROC in terms of considerations included in the draft EIS and where further clarification may be required on key issues,

2.3. EIS Components Reviewed

Airspace assessments contained in the following have been reviewed:

Volume 1 – Project Background

Part A – Project background and rationale

Chapter 1 Introduction,

Chapter 2 Need for Western Sydney Airport,

Chapter 3 Approvals Framework,

Part B – Airport plan

Chapter 7 Airspace architecture and operation,

Volume 2 – Stage 1 Development

Part D – Environmental impact assessment

Chapter 10 Noise,

Chapter 14 Hazard and Risk,
Chapter 21 Planning and Land Use,
Chapter 26 Greater Blue Mountains,
Chapter 27 Cumulative impact assessment.

Volume 3 – Long Term Development

Part G – Assessment of long term development

Chapter 30 Introduction

Volume 4 – Appendices

Appendix E1 Aircraft overflight noise

and, specifically,

'*WESTERN SYDNEY AIRPORT, Preliminary Airspace Management Analysis'*, produced by Airservices Australia 2015.

3. DETAILED FINDINGS - Stage 1 Airport

3.1. Compliance with EIS Guidelines

3.1.1. General Content

The level of analysis and detail in the EIS does reflect the level of significance of the expected impacts on the environment.

Unknown variables and assumptions made in the assessment, such as future aircraft types, proposed staged runway development, technology implementation, assumed traffic and fleet projections, are stated and discussed.

Items which are not discussed include:

- Potential restriction of building heights in local government areas not directly in line with the runway complex;
- Environmental impacts of placing flight paths directly overhead water storage locations such as Warragamba Dam and Prospect Reservoir; and
- Noise Abatement Procedures.

3.1.2. Feasible Alternatives

Section 3 of the DIRD guidelines refers to *feasible alternatives*, and suggests that **any** feasible alternatives should be discussed and the rationale for the preferred option is presented. It also suggests that short, medium and long-term advantages and disadvantages of each should be considered.

The assessment concludes that a 'proof of concept', rather than an exhaustive analysis, is appropriate due to length of time before the operation of an airport at Western Sydney (reference § 7.3 Preliminary assessment of airspace). This concept is at odds with the guidelines and needs further investigation. Furthermore, as the proposed paths are the basis for all subsequent environmental considerations, the single, untested airspace model based on traffic considerations is unlikely to provide a satisfactory outcome, as no comparative scenario is offered.

3.1.3. Modelling

The airspace plan and flight paths are based on work done by Airservices Australia. The following are annotated excerpts from the draft EIS.

Note that the **proof of concept** "indicative airspace design did not consider potential noise or other environmental considerations". (reference §14.4.1)

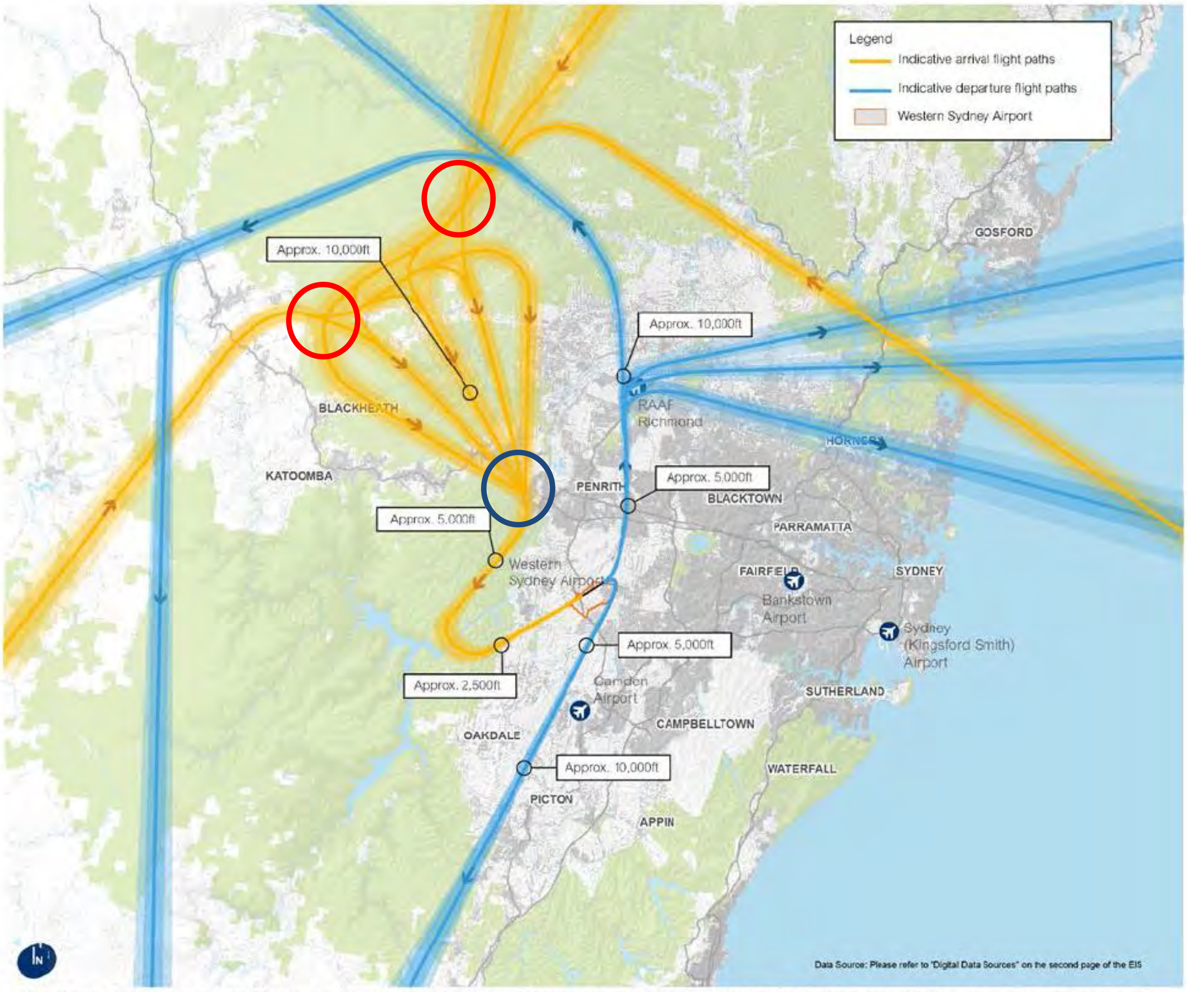
“The design and analysis presented in this report is intended to meet a narrow scope focussed on demonstrating a proof of concept. It does not present a comprehensive airspace and air route design and does not consider all essential components that would be necessary to implement an air traffic management 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”. (reference Volume 4 Appendix E1).

Both statements, above, indicate that the airspace components do not meet the requirements of the EIS guidelines. A refined method, considering a several alternative models, is required to meet the guidelines and also to remove uncertainty of flight paths and the consequent impact on the community from environmental considerations, such as noise, pollution, building restriction, etc.

In both the short term and long term, only one airspace and air route design is offered, and the long term plan does not expand on that proposed for the Stage 1.

This is due to the Stage 1 plan being based on leaving operations at Sydney KSA unaffected by the implementation of a new airport in Western Sydney. The long term plan considers that requirements for safe operation of parallel runways are inconsistent with current operations at Sydney KSA and thus a more comprehensive air traffic management plan for the Sydney basin is required. This is reasonable; however, it raises the question of why the long term alternative wasn’t considered as an extension of Stage 1, especially given the concentration of traffic over Blaxland township for the short term plan.

3.1.4. Flight path design



Note: Indicative flight paths are based on Airservices Australia's Western Sydney Airport: Preliminary Airspace Management Analysis. It does not present a comprehensive airspace and air route design and does not consider many essential components that would be necessary to implement an air traffic management plan for the Sydney basin. The formal flight path design for the Airport will be undertaken much closer to the commencement of operations.

The proposed plans make use of 'Point Merge System' for approach, highlighted in yellow in the attached diagram. The concept is to offer several 'entry gates' (circled in red) and then use longer or shorter paths to increase or reduce flight times, such that aircraft arrive at the Point Merge (circled in blue) in a sequence to provide separation and minimise delays.

The International Civil Aviation Organization (ICAO) sets worldwide standards for aviation. Future improvements and standardisation of aircraft operations are set out in blocks called Aviation System Block Upgrade (ASBU). The Point Merge System is part of the next ABSU to be introduced, and will facilitate Continuous Descent Operations (CDO). CDO is recognised as the best method of reducing and mitigating the environmental footprint of aviation, by requiring aircraft to remain at high altitudes (where they are most efficient) for as long as possible, and then descend through altitudes where they operate inefficiently using just minimum engine thrust and gravity.

The Point Merge has been shown to minimise aviation environmental effects in both emissions and noise, have cost benefits for operators and reduce traffic delays and congestion.

The draft EIS suggests that there is a single Point Merge for the short term plan, which is located over Blaxland township and accommodates both runways. The report entertains movement of the point by up to 3 nautical miles, but considers no other options, despite the long term plan having a different set of 4 Point Merges (one for each runway). This is not in keeping with the guidelines, where 'all feasible' alternatives should be considered.

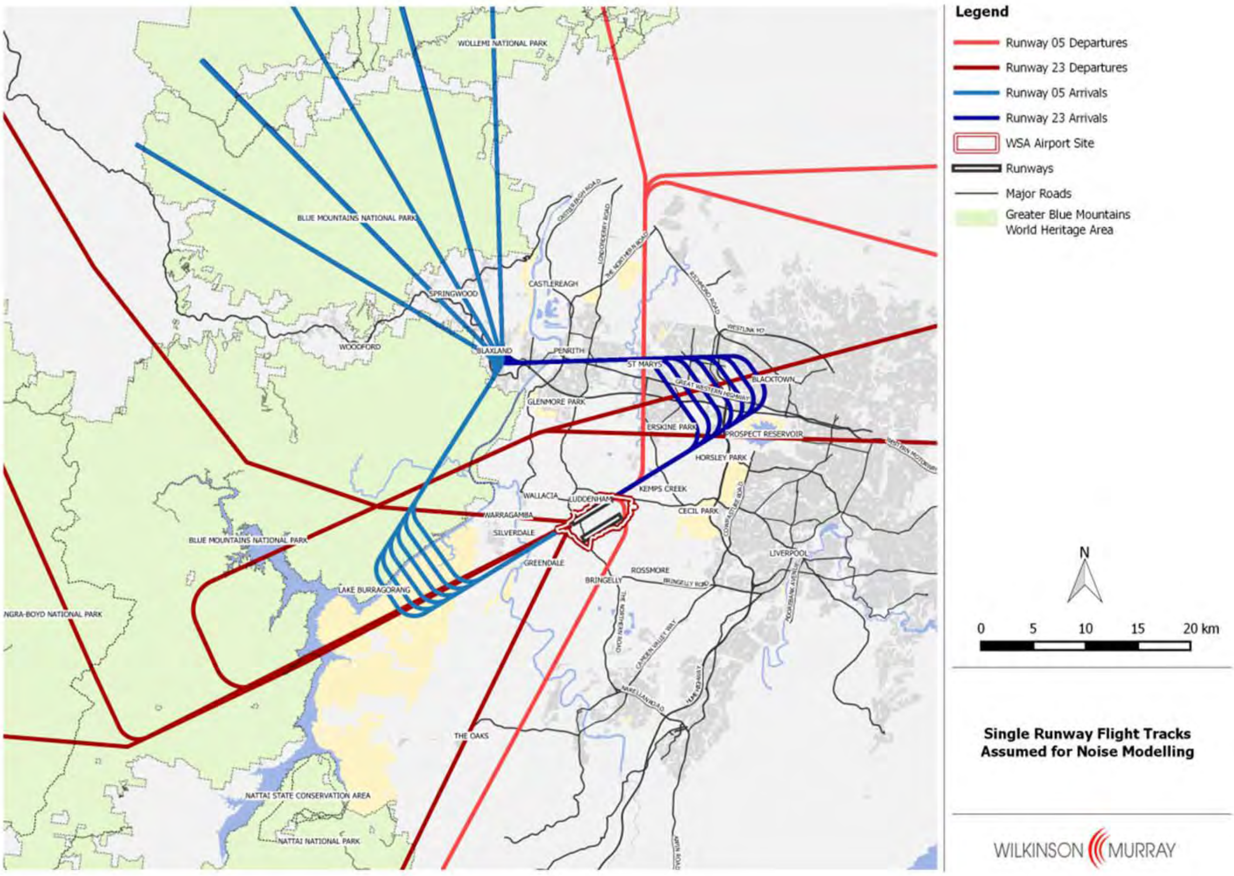


Figure 1 - Appendix A-1 (Preliminary Indicative Flight Tracks – Initial Development) to Appendix E of the EIS.

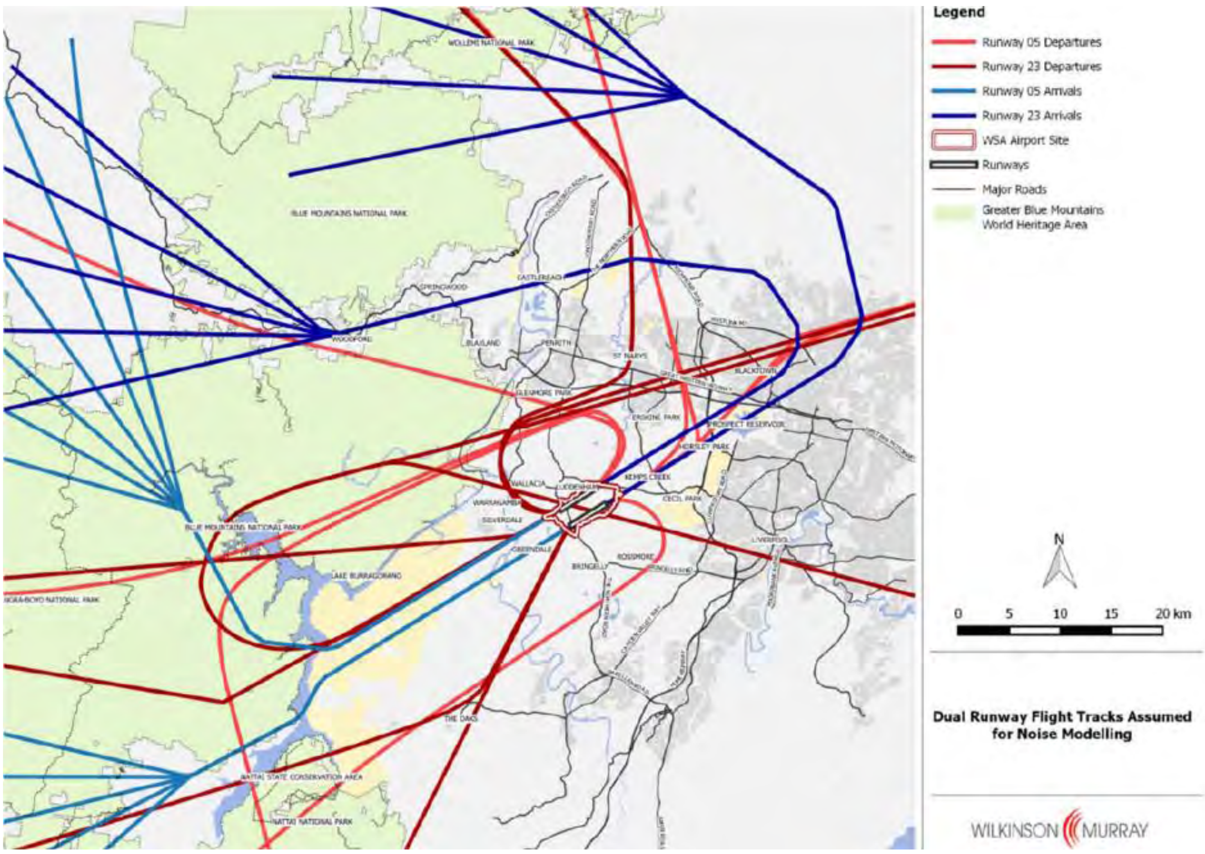


Figure 2 - Appendix B (Preliminary Indicative Flight Tracks – Longer Term Development) to Appendix E of the EIS.

Departures are to be implemented by conventional methods, and that aircraft will assigned flight paths along a corridor to a point from which routes to destination will commence. This is common practice and provides aircraft separation from both approaching and departing aircraft. However, indicative flight paths require refinement and evaluation of alternatives which are not provided in the draft EIS.

3.2. Validity of Assumptions

In dealing with flight paths and the containing airspace, the draft EIS indicates that it is a 'proof of concept'. This means that it is recognised that further work is required prior to implementation. Although the work presented is indicative of the final outcome, and thus suitable for an evaluation, it does not compare any alternative scenarios as required by the DIRD guidelines.

The assumptions made for flight paths are based on known performance and operating characteristics of current aircraft fleets. Using this data is conservative with respect to emissions and noise effects.

The assumption regarding the orientation and length of runways at Western Sydney Airport is based on information derived from the Bureau of Meteorology and on the land holdings set aside for the airport. Both are reliable data sets and form valid assumptions.

Traffic utilisation of the airport is based on current fleets, and this is considered conservative. The operation of aircraft, and specifically the flight paths, are in accordance with current 'best practice'. The protection of airspace via Obstacle Limitation Surfaces and 'PANS-OPS' surfaces does meet the requirements of current regulations. However, a rigorous evaluation will be required at the construction phase.

The assumption that the Stage 1 development of airport flight paths can exist isolated from other airports is questionable, especially where long term parallel operations will require a comprehensive review of procedures in the Sydney basin. Although it is indicated that a system does exist to allow an isolated mode of operation, it delays the inevitable review and may potentially affect the ultimate airport development. The latter assertion is based on increasing population near the airport, as a centre for employment, and a resistance by community to changes in the environment and flight paths.

3.3. Validity of Conclusions

Conclusions drawn from the draft EIS with respect to Stage 1 flight paths and airspace (Air Traffic Management) include:

- There are no known physical impediments to the operation of an airport at Western Sydney;
- A 'concept' airspace plan exists which facilitates the management of aircraft traffic, which conforms to current standards.
- Based on the 'concept', noise modelling is indicative of the effect of aircraft on those flight paths.
- Maintaining aircraft at higher altitudes will reduce the noise impact on the community.

The conclusions are valid for the cases presented and they follow current 'best practice' guidelines for flight path design and protection of airspace.

Items which are not considered include:

- Any alternative airspace model and flight paths. It is considered that scenarios should be developed to determine an acceptable model for airspace.
- Environmental impact on selection of flight paths needs to be included to minimise impacts on the community.
- There is no consideration of community acceptance of change to aircraft flight path and altitudes. The effect of noise is not restricted solely to loudness, but also to perception, and this has not been tested. Metrics of noise evaluation should be considered for the proposed paths.
- Height restrictions on buildings not located in the immediate vicinity of the airport. Locations, such as the Blue Mountains Council region, Camden, Penrith, Parramatta etc, are potentially affected by the airport at Western Sydney and should be evaluated.
- Noise abatement procedures are promulgated for major airports around Australia. They define modes of operation at certain times to reduce the effect on surrounding population centres. No consideration has been given to operational management to minimise public impact.

3.4. Mitigations and Management Measures

The primary methods of mitigation against flight path environmental impacts is to create a Point Merge System to reduce the emissions and noise generated on approach and to have tracking of departures over less sensitive areas. The former maximises the altitude of aircraft whilst reducing the thrust required, thereby minimising adverse environmental effects. The latter seeks to separate the emissions and noise events from sensitive areas.

Both strategies are commonplace and are considered ‘best practice’.

3.5. Impacts and Risks

The air traffic management methods and proposed flight paths work to minimise distribution of adverse effects.

Part of the strategy is to concentrate aircraft on specific, repeatable flight paths. Provided that those paths are separated from sensitive areas, the methodology is simple, predictable and repeatable, offering economies in fuel, efficiency and standardisation of procedure and the risks are moderated.

However, repeatable flight paths leads to the concentration of noise events and emissions and may involve risk when those paths cross populated areas.

The draft EIS adopts the above methodology for flight paths; however it does not evaluate alternatives to the presented modelling.

4. DETAILED FINDINGS – Long Term Development

4.1. Overview

As for Stage 1, the approach to this EIS peer review includes relevant matters in the four volumes of the draft EIS as well as the draft Airport Plan provided at the website www.westernsydneyairport.gov.au.

4.2. Differences to Assessment based on Stage 1

Most issues identified for Stage 1 are also apparent in the longer term planning of Western Sydney Airport. Additional longer-term considerations are provided in the following sections.

4.2.1. Flight path development

Due to the requirements for separation of aircraft on parallel runways, the modelling is much more complex than for that on a single runway. Aircraft must be separated vertically, longitudinally (time between aircraft crossing a point) or laterally. Flight paths created facilitate the separation with little, if any, external involvement by Air Traffic Control.

The principles for the development of airspace remain the same; however, the proximity of another flight path has implications for spacing. The proposed runway layout and spacing will allow the runways to operate independently, meaning that each operation on a runway is not required to wait (time separation) for an operation on the other runway. This minimises delays and maximises the utilisation of the airport.

With widely spaced runways it is also possible to operate in a mode called Simultaneous Opposite Direction Parallel Runway Operations (SODPROPS). SODPROPS allows aircraft to land in one direction and take-off in the other from different runways. The benefit of SODPROPS is that all airport operations can be to one end of the airport when weather conditions allow, thereby confining environmental impacts to the end where it has lesser impact. Weather conditions play a major role and may preclude SODPROPS.

The draft EIS proposal contains a single model for flight paths, developed for parallel runway operations. Similarly, to Stage 1, there is no consideration of more than one scenario included in the modelling. The draft EIS includes statements that this is solely due to the extended timeframe and that there is uncertainty about the service available at implementation. Further, it is intimated that amount of work required was not justified and would be required prior to commissioning in about 2050. This is at odds with the DIRD guidelines.

4.2.2.Interaction with other airports

The model considers broad interaction with Sydney KSA and notes that there will significant effects on the operation of other airports in the Sydney basin. The specific interactions, restrictions and changes to airspace is encapsulated in § 7.4.1 *Airspace architecture and potential impacts on air traffic movement*. This states that 'CASA has identified matters that should be considered in future airspace design'. The implication is that the current modelling may not have, or be able to have, future CASA determinations included for the draft EIS. However, it is clear that the ultimate mode of operation of Western Sydney Airport will result in operational incompatibility with the operations at smaller airports like Bankstown and Camden, potentially forcing closure or relocation. Neither eventuality is investigated.

4.2.3.Modelling

The draft EIS is based on assumptions for fleet operations and performance, and 'proof of concept' flight paths and airspace definitions. As with Stage 1, no consideration of feasible alternatives is made. The location of Point Merge and Departure tracks and "indicative airspace design did not consider potential noise or other environmental considerations". (reference §14.4.1) Therefore, there has been no testing of alternate solutions.

Within the model, there are several modes of operation, and each is evaluated. The analysis associated with the above follows standard procedure and the results are consistent. It indicates that the modelling conducted will allow the operation of both Western Sydney Airport and Sydney KSA independently and as high capacity aerodromes.

4.3. Risks and Implications

For the certainty of local government management and processes, it is expected that the draft EIS would develop some clarity regarding matters such as impacts on water quality, building restrictions, noise abatement and continuity of airspace flight paths.

The modelling indicates several flight paths over water storages, such as Warragamba Dam and Prospect Reservoir. Other flight paths traverse the Blue Mountains National Park. The environmental impact was not considered in selection of the flight paths.

As with Stage 1, it is unclear whether any evaluation was undertaken with respect to building development restriction within local government areas surrounding the airport, with the exception of areas immediately at the runway ends. One would expect that this would be considered as part of the draft EIS.

Other than modes of operation, it is unclear whether evaluation considers Noise Abatement. From an operational standpoint, it is preferable that an airport operates unrestricted by curfews, however it is imperative that principles of 'Fly Neighbourly' are introduced to minimise the environmental impact of noise.

For the long term development of the airport there is a potential risk to long term operation if the airspace and flight paths change. Revision to 'established' Stage 1 flight paths and airspace may meet with resistance from stakeholders, such as property owners and local authorities. As such, it would be expected that flight paths and airspace developed for Stage 1 can also be staged for the long term operation.

4.4. Further Assessment

As noted in the draft EIS, a revised assessment will be required closer to implementation. However, the work included will form the basis of a review. It would be expected that the EIS would form a solid base from which to commence that evaluation. It appears that the draft EIS is orientated to the current conditions and has not explored in sufficient depth the conditions expected for Stage 1, nor long term development at Western Sydney Airport.

4.5. Key Impacts and Opportunities

Key impacts and opportunities from the perspective of airspace and flight paths are summarised as follows:

- The evaluation of protection volumes for flight paths and airspace containment is in accordance with normal methods mentioned in the Airports (Protection of Airspace) Regulations, and under the Airports Act, 1996.
- An Obstacle Limitation Surface (OLS) and Instrument Flight Procedure protection volume (PANS-OPS) analysis indicates that, operationally, the Western Sydney Airport can operate unrestricted from terrain and artificial obstacles.
- The proposed airspace architecture is noted as 'indicative' and has not been rigorously tested. The draft EIS proposes that another airspace model is tested

closer to commencement of operations. This would indicate that the draft EIS is non-compliant with the requirements of the Department of Infrastructure and Regional Development (DIRD) Guidelines.

- Flight paths appear to fly over water storages such as Warragamba Dam and Prospect Reservoir. The environmental impact is unclear.
- The requirement under the Guidelines for 'feasible alternatives' to be included has not been met.
- There is no consideration of community sentiment regarding changes to flight paths, proposed in the draft EIS, when the Airport operates with two runways.
- Except for KSA, flight paths for airports, affected by the Western Sydney Airport, are not evaluated.
- The draft EIS suggests that Western Sydney Airport will detrimentally affect the operations at Bankstown and Camden, and affect Richmond (military). The environmental impact is not quantified.
- Relocation of light aircraft traffic to other airports, the definition of new training airspace and consequent environmental impact, is not assessed.

5. Review Team

Name	Ray Romano
Location	Brisbane
Designation	Chief Designer and Airspace Specialist
Role	QA of product in accordance with CASA Parts 139 and 173
Qualifications	Bachelor of Engineering (Honours, Civil, UQ) Diploma in Instrument Flight Procedure Design (with Distinction, Singapore Aviation Academy)
Relevant Experience	Over 20 years' experience in airspace and instrument flight procedure design. Former Chief Designer, Airservices Australia (2007-2012). Instrument Flight Procedure Designer (1999-). Airways Data Officer (1996-1999). Commercial Pilot (1990-). Trainer of PANS-OPS instrument Flight Procedure Design.

Name	Mark Fineran
Location	Brisbane
Designation	Senior Procedure Designer
Role	Instrument Flight Procedure Design, Air Traffic Management
Qualifications	Diplomas in Aviation (Air Traffic Services) and Transport and Distribution (Air Traffic Control). Airservices Training College (2003) Diploma in Instrument Flight Procedure Design (Singapore Aviation Academy)
Relevant Experience	Over 10 years' experience in aviation. Specialising in Instrument Flight Procedure Design and Air Traffic Control liaison.

Appendix G

Social and economic (Hill PDA Consulting)

Independent Review of the Western Sydney Airport Environmental Impact Statement

Social and Economic Issues

Prepared for:

Western Sydney Regional Organisation of Councils (WSROC) and Macarthur Regional Organisation of Councils (MACROC)

November 2015

HillPDA
CONSULTING

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Limitations

This assessment is a desktop based review of the relevant documentation submitted with the EIS within a three week period. It does not therefore encompass any independent modeling, research or testing of assumptions.

EXECUTIVE SUMMARY

Report Purpose

The following Report has been commissioned as an independent review of the Social and Economic components of the Environmental Impact Statement (EIS) prepared for the Western Sydney Airport (WSA).

This Report contributes to a broader review being undertaken by multiple specialists to provide independent advice to the Western Sydney Regional Organisation of Councils (WRSROC) together with the Macarthur Regional Organistion of Councils (MACROC).

Report Approach

In undertaking this review we have had particular regard to the requirements established by Section 10 of the Guidelines for the *Content of the Draft EIS – Western Sydney Airport* issued in January 2015 by the Department of the Environment.

We have also considered the implications of both the Stage 1 Airport and longer term development with regards to:

- Potential gaps in the preparation of the Social and Economic Specialist Studies;
- Any concerns regarding the validity of assumptions and conclusions; and
- Suggestions to improve the effectiveness of the proposed mitigation measures.

Components of the EIS Reviewed

This Report has reviewed the following EIS components:

- Relevant sections of the Executive Summary
- Volume 2—Stage 1 development – Chapters 23 and 24 – social and economic
- Volume 3—Long term development – Chapter 37
- Volume 4 – Specialist studies in appendix P1, P2 and P3

To discuss the key issues, this Report is structured into three parts:

Part A – Stage 1 – Social and Economic Impacts

Part B – Long Term Development – Social & Economic Impacts

Part C – Assessment against the draft EIS Guidelines

Key Finding

Our Review support's the EIS's summation that the main benefits of the WSA relate to the generation of jobs in Western Sydney and associated economic activity.

The importance of this contribution to Sydney represents an important policy shift since the preparation of the earlier EIS's for a second airport on the site as Western Sydney has become a greater focus for economic growth and activity.

In drawing this conclusion however we maintain the need for a balanced assessment across positive and negative social and economic impacts, both at a local and regional level, over the short and longer term. To this effect we identify six overarching issues in relation to the current EIS and its assessment of impacts during Stage 1 of the Airport and a further four regarding its assessment over the longer term as discussed on the following pages of this Executive Summary.

EXECUTIVE SUMMARY CONT.

1 STAGE AIRPORT REVIEW FINDINGS

1. Balance of Discussion - Impacts

We identify a strong focus in the EIS on the economic benefits of Stage 1 of the WSA as distinct from a balanced discussion of economic and social costs and benefits.

For example the economic Chapter (24) in Vol. 2 focuses entirely on the regional (Western Sydney) and broader (Sydney, NSW and Australian) employment and economic benefits of the WSA with only one general reference to potential adverse economic impacts as follows.

"However there would be some negative impacts in the immediate vicinity of the airport site due to combination of the airport development and the changing land uses"
Vol. 2, Chapter 23, Pg. 504

A more balanced discussion of costs and benefits is therefore encouraged. For example in relation to matters such as impacts to local business activity during construction or the potential impacts of a new business park (with retail as a permissible use) to existing and proposed centres in the South West (i.e. Leppington, Edmondson Park and Liverpool).

2. Balance of Discussion – Geography

Our comments regarding the balance of discussion also relate to the EIS's strong focus on the regional and Australian economic benefits of the WSA as distinct from any prospective local impacts.

For example the economic benefits and costs to centres within close proximity to the WSA (i.e. Luddenham or within the South West Growth Centre) are little, if at all discussed. Whilst the impacts may be positive or minimal, it is appropriate that they are considered and where possible quantified.

3. Translation of Issues within the EIS

The Specialist Social Impact Study in Appendix P identifies a number of likely adverse impacts to the local communities. Despite the significance of these impacts and their potential to raise notable social concerns, many are given relatively minor reference in the relevant Chapter (23) with no reference in the Executive Summary.

This results in an ill informed view of social issues for readers of the EIS who may not progress to read Chapter 23 or Appendix P in detail.

4. Statements without Assessment

In the Stage 1 social and economic chapters (23 and 24) many of the potential issues are stated with little assessment of their implications to communities, their degree of significance or duration and alternative approaches that may be applied to alleviate them. For example the provision of alternative open spaces to communities during the construction process, the severity of noise impacts to recreational areas, the degree of noise disturbance for different locations over the short and longer terms.

This approach weakens the appreciation of the issues and the means to mitigate them. It could also result in greater angst by the community as to the likely degree, duration and severity of impacts.

EXECUTIVE SUMMARY CONT..

STAGE 1 AIRPORT REVIEW FINDINGS

5. Direct Response to Stakeholder Engagement

The initial stakeholder engagement programme for the WSA identified a range of social and economic concerns (Vol.1, Chapter 8).

A number of these concerns are listed by the specialist studies yet are not specifically addressed by Vol. 2 or 3 of the EIS. Furthermore the consultation chapter (Vol 1, Chapter 8) refers to an EIS summary paper being prepared however it is understood that this paper was not made available.

It is recommended that a summary consultation paper is prepared and made publically available and that each issue raised by stakeholders is considered and responded to by the specialist studies . In turn the body of the EIS should identify the most appropriate mitigation measures and minimise community concerns.

6. Transfer and Redistribution Effects

Much of the EIS's discussion regarding the economic value add as a consequence of the WSA recognises its *"….role in attracting economic activity to the Region"* at the expense of others i.e. *"There is a reduction in value-add in the Rest of Australia"* (Pg. 139) and *"The model assumed the future regional employment growth would be redistributed across Sydney…"* (Pg. 141).

Whilst the generation of jobs in Western Sydney is a strong positive of the WSA, the EIS does not discuss the economic or social implications of this transfer of activity from the other areas in Sydney or *"the rest of Australia"*. Whilst any such impact might be negligible or acceptable, the potential impact should be recognised and considered in the assessment.

LONGER TERM DEVELOPMENT REVIEW FINDINGS

The longer term assessment of impacts by the EIS is generally an extension of those identified upon operation for Stage 1. Our review finds that if left unmitigated, these impacts would generally be exacerbated on account of the significant increase in flights and passengers owing to the introduction of the second runway.

Key issues relate to:

1. How potential social and economic impacts could be managed and mitigated with such a significant and relatively quick increase in the number of passengers and associated on site employment (+120%) over the 13 year period between 2050 and 2063;
2. The potential impact of additional flight paths and operations to regional amenity and the impacts to the longer term development potential of affected areas in Western Sydney and more specifically in the South West Growth Centre i.e. height and noise restrictions to increasing residential density;
3. The degree to which the WSA could *"…lead to the reduction in social amenity and impacts on the existing lifestyle of people living and working…."* (Pg. 138) identified by the EIS; and
4. The economic costs or implications of the WSA's *"….role in attracting economic activity to the Region"* at the expense of others i.e. *"There is a reduction in value-add in the Rest of Australia"* (Pg. 139).

EXECUTIVE SUMMARY

LONG TERM DEVELOPMENT REVIEW FINDINGS

Mitigation of Longer Term Impacts

A review of the discussion concerning mitigation measures over the longer term focuses heavily on planning mechanisms (i.e. zoning of land to exclude residential uses) together with local and State Government investment to address broader traffic, transport and infrastructure issues.

There is no discussion however of how this would be co-ordinated or resourced to address specific impacts resonating from the WSA. Further there is no discussion as to who the key accountability would fall with.

This results in a potential risk that some mitigation measures and impacts would be missed or forgotten over time.

Setting a Framework for Further Assessment

To improve the longer term assessment and give some comfort to its approach, we suggest:

- Further assessment of the potential social and business impacts and the information gaps with some parameters or ranges of assessment; and
- The identification of the main body responsible for managing and mitigating these impacts and risks over time or how the mitigation framework will be managed.

EXECUTIVE SUMMARY

POTENTIAL IMPACTS AND OPPORTUNITIES

A review of the EIS has identified the following potential impacts and opportunities during Stage 1 and over the longer term.

Legend:
Positive impacts
Negative impacts / opportunities
Neutral or positive or negative impacts / opportunities dependant on stakeholder

Impacts

STAGE 1

Social
- Improved employment opportunities
- Reduced travel time to work opportunities
- Increases in average wages
- Improved retail and business service choice and price competition
- Changes to semi-rural lifestyle
- Changed access to spaces and community facilities on the WSA site
- Impacts to community cohesion
- Impacts to social service provision
- Perceived impacts and associated social anxiety
- Amenity impacts during construction (dust, noise, road closures)
- Amenity and health impacts (noise, visual and air quality) upon operation
- Housing affordability

Economic
- Construction jobs
- Multiplier benefits of operational job generation
- Economic value add for the economy
- Increased customer base and business activity
- Redistribution of jobs to Western Sydney
- Local business impacts during construction and operation
- Land value changes
- Impact to retail and centre viability
- Changes in traffic congestion
- Congestion impacts to WSEA and local and regional roads
- Decline in agriculture industries

LONGER TERM

Social
- Improved employment opportunities
- Reduced travel time to work opportunities
- Increases in average wages
- Improved retail and business service choice and price competition
- Impacts to social service provision
- Amenity and health impacts (noise, visual and air quality) owing to airport operation

Economic
- Multiplier benefits of job generation
- Agglomeration benefits for Western Sydney businesses
- Economic value add for the Western Sydney economy
- Redistribution of jobs to Western Sydney
- Improved appeal of investing and operating airport related businesses in Western Sydney
- Land value changes
- Impact to retail viability and opportunities

Opportunities

Stage 1:
- Greater population growth and diversity (age and socio-economic) owing to employment opportunities
- Improved live / work connections
- Potential increase in tourism in the Blue Mountains
- Greater appeal of Western Sydney to business and investment

Longer term:
- Continued population growth and improvements in social diversity
- Improved balance of economic outcomes across Sydney
- Improved balance of social and community outcomes
- Enhanced local, Sydney and Australian economies

Part A

Stage 1 Economic and Social Impacts

The following Part reviews the Stage 1 Social and Economic assessments provided in the EIS having particular regard to:

- Information and assessment gaps
- Assumptions and conclusions
- Proposed mitigation measures

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STAGE 1 AIRPORT – SOCIAL

ASSESSMENT GAPS

The Stage 1 social impacts are assessed within:

- Vol 2. Chapter 23
- Appendix P1 – Report for Western Sydney Unit, WSA EIS (GHD, 2015)
- Appendix P1 – Socio – Economic Impact Assessment, Western Sydney Population and Demographic Analysis (SGS, 2015)

There are varying references in the GHD Specialist Study as to whether it is a Social Impact Assessment (SIA) or Socio-economic Assessment. In any case it draws together the findings of the specialist studies in Appendix P1 prepared by SGS, Appendix P2 prepared by JLL and Appendix P3 prepared by EY suggesting that it is in fact a Social and Economic Assessment of the WSA. It is on this basis that the Specialist Study is considered and the subsequent translation of issues into the body of the EIS.

Local Community - Perceived and Actual Impacts

As identified by the GHD specialist study *"perceived impacts are as important as actual (measurable) impacts as people may modify their behaviours or experience discomfort simply because of a perceived impact"*(Page 12).

Despite this recognition, we highlight a number of potential or perceived social impacts to the local communities that do not appear to been adequately identified or assessed by the Specialist Study including:

- Consideration of the physical and perceived impacts of a new airport (and resulting restrictions to access across the locality) to social cohesion and any associated community and cultural connections;
- Consideration of the potential social concerns relating to the perceived or actual impacts of the WSA to the local communities health (i.e. noise disturbance, fuel jettisoning etc.);
- Consideration of the potential social concerns relating to airport related risks and hazards (i.e. terrorism, aircraft crashes etc.) identified during initial stakeholder engagement (Vol. 1, Chapter 8);
- Consideration of the social implications of the locality changing from a rural and low density residential area to a more urbanised one. Whilst the GHD Specialist Study (Appendix P1) makes the assumption that this transition would be a positive one (i.e. provide additional jobs and improved access to work Page 485) we highlight that different communities may value varying levels of urbanisation differently. Therefore a change to a denser built form may be considered undesirable and stressful for some established and retired community members;
- Consideration of the degree and duration of the impacts to existing residents located in Luddenham, Badgerys Creek, Bringelly, Greendale and Wallacia during construction and operation i.e. construction noise, access and traffic congestion.

STAGE 1 – AIRPORT- SOCIAL

ASSESSMENT GAPS CONT…

- Further consideration of the implications of increased pressure on social services as well as impacts to housing availability and affordability owing to worker relocation (as identified by the SIA);
- Consideration of the implications of the identified impacts of the WSA to the range of existing facilities likely to be adversely affected by the WSA including:
  - Five schools;
  - A child care centre;
  - Three parks and recreational facilities;
  - Three places of worship in Luddenham and Mulgoa; and
  - Thirteen recreational areas.

Source: Fig 8-5, Volume 1 of Draft EIS

Relocations from the WSA Site

- Further gaps in assessment have been identified in relation to the relocation of existing residents, business and community uses from the WSA site.
- The need to relocate from the WSA site was identified as a concern by stakeholders in the Benchmark surveys referenced in the Vol. 1, Chapter 8 of the EIS. Whilst the uses affected have been listed in the GHD Specialist Study (Appendix P1) and subsequently in Chapter 23, they are not discussed or assessed to any degree as the majority (yet not all) had been relocated a few months prior to the GHD Specialist Study's finalisation.
- Whilst the relocations have been actively managed by the Commonwealth in conjunction with the NSW Government, including the appointment of a Place Manager, the assessment would benefit from reference to this and the approach employed to mitigate:
  - The impacts to the 139 residential tenancies relocated or extinguished from the WSA site having particular regard to the elderly, disabled and / or longer term tenants;
  - The impacts of lost or restricted community access to existing uses and facilities on the WSA site i.e. Badgery's Creek Park, the Scout Hall, cemeteries etc.; and
  - The loss or relocation of jobs generated by businesses on the WSA site i.e. the 16 agricultural tenancies and eight commercial tenancies (quarry, vineyard and Christmas tree farm).

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STAGE 1 AIRPORT- ECONOMIC
ASSESSMENT GAPS

The Stage 1 economic impacts are assessed within:

- Vol 2. Chapter 24
- Appendix P1 – Socio – Economic Impact Assessment, Western Sydney Population and Demographic Analysis (SGS, 2015)
- Appendix P2 – Potential Impacts on Property Prices (JLL, 2015)
- Appendix P3 – Draft Economic Analysis (EY, 2015)

The relevant sections of the EIS have a strong focus on job generation and economic value add. As described in Vol.2 Chp 24 an SCGE model was prepared to *"identify the potential economic impacts"* of the WSA and assist *"….in the translation of the benefits and costs into real economic impacts accrued through time…"*.

The model has a number of inputs including improvements to value add, gross business profits, gross household labour incomes, enhanced productivity per worker and net imports.

Each of these elements have a positive focus resulting in a strong narrative regarding the economic and employment benefits of the WSA to Western Sydney and Sydney more generally.

There is no discussion however with respect to the modeling or otherwise assessment of the potential costs of the WSA.

Whilst on balance the benefits of the WSA might outweigh the costs for Sydney, a more detailed discussion of costs, and who would be affected is recommended i.e. costs with respect to increased traffic generation and congestion, health impacts, the loss of agricultural land, local business impacts etc.

Chapter 24 and the specialist studies provided in Appendix P1, P2 and P3 also identify that the WSA would result in employment and population growth being redirected from Sydney to Western Sydney.

For example it is stated that the *"…WSA is a city-shaping investment that will contribute to a more balanced and sustainable growth for Sydney."*

In doing this however the same report states that *"A project such as the WSA has the potential to impact jobs and population growth in Sydney. In particular the WSA would be expected to redistribute population and employment towards Western Sydney, away from other parts of Sydney"* (EY, Page 29).

Whilst this is a welcome redistribution with regards to Government Policy objectives, the redistribution does come at an opportunity cost from other areas that are 'loosing' prospective employment and growth. The effects of this redistribution and any associated opportunity costs to areas such as the City of Sydney, Botany Bay, Rockdale, North Sydney and Randwick are not however assessed.

This effect should also be considered in the context of Kingsford Smith Airports capacity challenges and the impact of no WSA to actual job growth across Sydney more generally.

STAGE 1 AIRPORT- ECONOMIC

ASSESSMENT GAPS CONT…

- The costs and / or benefits of redistributing growth from inner city, urban infill areas of Sydney to greenfield areas is also not discussed with respect to infrastructure provision.
- In this regard it is unclear what the 'standing' of any cost benefit analysis is for the assessment – that is what is the area being assessed. If the standing is Western Sydney as a whole, there would be a net benefit gained by the WSA to the area of assessment. If the standing is Greater Sydney, the Specialist Studies infer that there would be no net increase with regards to job growth or value add over the short term as result of the WSA.

Local Business Impacts

- The risk assessment profiled in Vol. 2 Chp 9 states that a risk to be assessed by the Social and Economic Chapters relates to the:

  "Significant reduction in business activity and services caused by general access and land use changes associated with construction" (Vol.2 Pg 17).

- Despite this identified risk, impacts to local businesses during construction and operational phases are not discussed in Chapters 24 (Stage 1) or 37 (longer term) nor by all four specialist studies.
- Whilst it is recognised that the area immediately surrounding the WSA site is not a dense business area, a number of businesses do operate within the locality. The EIS should provide details about the local business context to better understand the potential Impacts to existing businesses (i.e. access constraints, additional traffic congestion, noise effects and customer implications) together with potential benefits and costs to businesses operating within surrounding centres such as Luddenham.
- We also identify the need to balance the discussion regarding job generation with the impacts of relocating the existing businesses on the site and any implications this might have to local business activity and job provision.
- The EIS also recognises that the WSA would increase congestion on parts of the M4, M5 and M7 Motorways together with the M31 Hume Highway. The potential impacts to businesses reliant on these access routes for servicing and delivery should also be considered.
- As a final consideration, there is no assessment of the potential impacts of the WSA (positive or negative) to the future operation of businesses within the Western Sydney Employment Lands (i.e. in relation to noise or congestions impacts, access improvements and land value increases – perceived or otherwise).

STAGE 1 AIRPORT- ECONOMIC

ASSESSMENT GAPS CONT….

Local and Regional Centre Impacts

A number of minor references are made within the EIS to the designation of land on the WSA site as a business park. More specifically 167ha of land is proposed in Stage 1 with the potential for a further 148ha over the longer term.

Of particular note, the proposed permissible uses within this zone include commercial, business and retail. On this basis, the EY 2015 report provides the most detail regarding the business park calculating:

- In Stage 1 it could provide over 158,000sqm of bulky goods floorspace increasing to a significant 561,000sqm by 2063;
- Over the longer term a new regional shopping centre of 200,000sqm – equating to the size of a new Liverpool or Leppington centre;
- 15,000sqm of petrol station and food outlets increasing to 40,000sqm by 2063;
- 10,000sqm to 100,000sqm of office space; and
- 350,000sqm to 845,000sqm of industrial space.

Importantly these calculations are estimates and do not necessarily mean that this type of development and the associated jobs would transpire.

By the same token, there is potential for additional floorspace (i.e. retail and bulky goods) to be provided within the proposed business park zone and at an earlier date i.e. during Stage 1.

Despite the significant quantum of new retail, commercial and industrial floorspace proposed , the EIS does not:

- Assess the potential economic impacts of the retail floorspace to the economic viability of existing centres in the South West (i.e. Luddenham or Liverpool) or the timely delivery of proposed centres in the South West Growth Centre (i.e. Leppington and Edmondson Park);
- Assess the demand for, or impacts as a result of, a new business park in this part of the South West and the potential implications to other centres such as Campbelltown and Leppington that both aspire to provide a regionally significant business park;
- Asesss the demand for, and implications of a potential 845,000sqm of additional industrial floorspace to the Western Sydney Employment Lands;
- Assess the level of demand for, and impact to social infrastructure in the locality as a result of these uses and their employees (+4,400 to +27,000 people); and
- Assess the potential benefits of a business park and how these jobs would align with the characteristics and skills of the new population in the South West.

STAGE 1 AIRPORT- ECONOMIC

VALIDITY OF ASSUMPTIONS AND CONCLUSIONS

Property Prices

The potential impact of the WSA to property prices as a consequence of noise impacts was identified as a key concern by stakeholders during the WSA's initial stakeholder engagement (Vol.1, Chapter 8). To this effect, whilst property prices are discussed within the Social impacts Chapter (23), we believe they are also an important economic consideration.

A specific specialist study was commissioned to consider the effects of the WSA to property prices (Jll,2015). The JLL Study identified that the noise impacts associated with the WSA would be likely to adversely affect the sale value of land zoned for non-residential uses. Owing however to the complexities of quantifying this impact the assessment was restricted to residential properties having particular regard to large lot residential.

Impacts to Residential Property Prices

- The JLL 2015 Study's multiple regression analysis of property sales data for Brisbane and Adelaide found a strong correlation (most significantly in Adelaide owing to the wealth of available sales data) between airport noise and land values.
- A similar correlation was not however found for land affected by Sydney and Melbourne airports.
- The JLL Study poses a number of reasons for this result including the fact that property values in Central Sydney may be more significantly and positively influenced by factors other than noise including proximity to Sydney CBD. We support this suggestion and caution any conclusions that seek to draw the same correlation as central Sydney between property prices and airport noise for the WSA. Despite this, Chapter 24 concludes:

  "Overall there would be no discernable negative impact expected on property values, as the anticipated value uplift from land use changes will outweigh any consequence or concern about noise impacts" Pg. 489

- Rather we caution that the characteristics of land and properties surrounding the WSA could be more akin to the localities surrounding Adelaide or Brisbane airports (i.e. land that is not located within a few kilometres of a Global CBD) resulting in a different correlation between noise and land values to the Kingsford Smith Airport analysis.
- We also draw attention to the conclusion made by the JLL Study that the growth rates for properties affected by Sydney airport were on par with other non affected areas in Sydney. Whilst this may certainly be the case with respect to growth rates, there is likely to be very different actual sale value starting points i.e. lower land values in noise affected areas than non affected areas consistent with the findings of other literature cited by the Study.

STAGE 1 AIRPORT- ECONOMIC

VALIDITY OF ASSUMPTIONS & CONCLUSIONS CONT..

Impacts to Large Lot Residential

We also caution against the JLL Study's inability to find a discernible effect between airport noise and the value of large lot housing. This result was drawn from the Study's assessment of land value impacts within a 5km radius of the WSA site following the announcement of the WSA. In this regard we highlight:

- Not all land within a 5km radius of the WSA site would be noise affected. Therefore the sale values sample has a mix of noise and non noise affected land skewing results and contributing to the conclusion of no discernible effect;
- The recent increase in property prices in the locality may be a short term speculative response to the announcement of the investment stimulus and once again incorporates a notable proportion of land that would not be noise affected; and
- Unlike the other case studies referenced, the WSA is not yet operational and therefore the degree or significance of potential noise is not yet apparent to the market.

Employment Calculations

- The EY Report 2015 estimates that the proposed business park would generate 4,439 jobs by Stage 1 increasing to 27,148 by 2063.
- A review of the employee occupancy rates used to calculate these figures (Table 10, Page 24) indicates they are likely to be overly ambitious. For example 1 employee per 10sqm of commercial floorspace equates to rates achieved in new Sydney CBD stock and not greenfield business parks. Further 1 employee per 50sqm of industrial floorspace is also considered high, particularly if the uses are more orientated to freight and logistics.
- Conversely we believe that the employee occupancy figures calculated for the regional shopping centre (1 job per 90sqm) are too low and should be re-adjusted to 55-65sqm GFA per worker.
- Applying our revised rates, we calculate that the Stage 1 workforce would be 3,800 workers by 2031 increasing up to 20,000 in 2063, lower than the EY Report estimates.
- To improve the accuracy of these estimates, we suggest a similar approach is taken to benchmarking employment related to airports in other parts of the EIS. That is the benchmarking of rates achieved by business parks connected with airports internationally.

STAGE 1 AIRPORT – SOCIAL & ECONOMIC IMPACTS

MITIGATION AND MANAGEMENT MEASURES PROPOSED

A review of the proposed mitigation measures for both the social and economic impacts finds the following.

- No mitigation measures have been identified by the economic Chapter 24 or Specialist Studies as very few adverse impacts were identified.
- A fairly standard approach to mitigation measures has been taken to address the social impacts. That is the GHD Specialist Study cross references identified risks to appropriate measures. Further the the majority of key issues are addressed through a series of plans with the detail yet to be determined i.e. stakeholder engagement plans, construction and environmental management plans etc.
- This general approach is considered appropriate given the timescale associated with the development of the WSA. The approach does however rely on the quality of approach detail provided within the subsequent plans regarding how best to manage the implementation of the measures set out in the plans.
- Chapter 23 Social summarises these measures down to two – the development of an Australian Industry Participation Plan and Stakeholder Engagement. Both of these measures are supported however we would add the need for an engagement plan that provides timely and regular information updates to allay any concerns and fears by stakeholders during construction and a point of contact during operation.
- We also highlight the strong reliance on mitigation measures being addressed and implemented by local and State Government with little discussion as to how this would work in practice nor how any ongoing mitigation measures would be resourced or co-ordinated / who would be accountable for their implementation and any associated ongoing monitoring.
- This becomes a particular issue over the longer term when construction management plans are no longer applicable and it is unclear who the responsible party is to mitigate impacts i.e. the airport operators vs. local and State Governments.

STAGE 1 AIRPORT

UNCERTAINTY OVER IMPACTS AND ENVIRONMENTAL RISKS

On the basis of our independent review, we summarise some of the key uncertainties and risks of the WSA to be:

- The potential economic costs i.e. health services, reduced travel times by road, viability impacts to existing and proposed centres;
- The degree of economic impact to the viability and desirability of existing and proposed centres and business parks in the South West as a result of a significant supply of new retail, bulky goods and commercial floorspace on the WSA site;
- Potential impacts during construction and operation to existing local businesses together with prospective future businesses in the Western Sydney Employment Area;
- Implications as a consequence of the transfer of population and job growth to Sydney's greenfields as opposed to infill locations;
- Potential impacts to non-residential land values;
- Potential implications to existing residents, businesses and community services of being relocated from the WSA site;
- The degree of potential impacts, consequences and alternatives to local residents, businesses and community facilities during construction and operation;
- The potential for social concerns regarding community dislocation, airport related risks and hazards (i.e. terrorism, aircraft crashes etc.) and the potential impacts of this to business investment and land values; and
- The degree of impact to housing supply and affordability.

Part B
Longer Term Impacts

The following Part reviews the Longer Term Social and Economic assessments provided in the EIS having particular regards to:

- Information and assessment gaps
- Assumptions and conclusions
- Proposed mitigation measures

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LONG TERM DEVELOPMENT – SOCIAL & ECONOMIC IMPACTS

INFORMATION GAPS

The longer term social and economic impacts associated with the WSA are assessed within:

- Vol 3. Chapter 37
- Appendix P1 – Report for Western Sydney Unit, WSA EIS (GHD, 2015) and Socio – Economic Impact Assessment, Western Sydney Population and Demographic Analysis (SGS, 2015)
- Appendix P2 – Potential Impacts on Property Prices (JLL, 2015)
- Appendix P3 – Draft Economic Analysis (EY, 2015)

The longer term assessment of impacts by the EIS is generally an extension of those identified upon operation for Stage 1. These impacts are generally recognised as being exacerbated however on account of the significant increase in flights and passengers owing to the introduction of the second runway. Those longer term impacts that could be quantified relate to:

- Significant employment growth associated with both the airport and expanded business park (4,400 employees to over 27,000);
- The value add as a result of the additional airport activity.

Other impacts that could not be quantified relate to:

- The changing nature of the locality and the impacts this would have to communities.
- The reduction in social amenity and impacts on existing lifestyles in the locality as a result of noise, air quality, traffic and social infrastructure impacts (medical facilities, schools, dentists, pharmacies and child care) together with 13 identified recreational areas.

Information Gaps

The first 3 of the 9 pages of the longer term impact assessment provided by Chapter 37 reiterates the same methodological approach applied for the assessment of the Stage 1 impacts.

A further 2 pages identifies general social impacts related to amenity impacts. The remaining 4 pages reiterate the employment benefits, population projections and conclusion.

It therefore follows that many of the information gaps identified in Part A of this Report hold true for the longer terms impacts. We highlight however some additional matters that we believe should be considered including:

- How potential social and economic impacts would be managed and mitigated with such a significant and relatively quick increase in the number of passengers and associated on site employment (+120%) over the 13 year period between 2050 and 2063;

LONG TERM DEVELOPMENT – SOCIAL & ECONOMIC IMPACTS

RISKS AND GAPS

- What impact the additional flight paths, operations and associated amenity impacts would have to the longer term development potential of affected areas in Western Sydney, and specifically in the South West Growth Centre i.e. height and noise restrictions to increasing residential density;
- The degree to which the airport could *"…lead to the reduction in social amenity and impacts on the existing lifestyle of people living and working…."* (Pg. 138) identified by the EIS; and
- The economic costs or implications of the WSA's *"….role in attracting economic activity to the Region"* at the expense of others i.e. *"There is a reduction in value-add in the Rest of Australia"* (Pg. 139).

Key Risks and their Implications

As discussed above, the EIS identified the potential for additional amenity impacts to the local communities as a consequence of the WSA. Means to mitigate these impacts are not identified other than general references to the need for local and State Government planning (i.e. appropriate land use zoning) and service provision (i.e. new community facilities etc.).

Whilst it is difficult to be definitive with respect to mitigation measures over such a period of time, this predicament, combined with the significant scale of the development, creates a significant risk over the longer term. This risk is on account of uncertainties as to how these additional facilities would be funded and who would be responsible for their provision, operation and maintenance to a level that adequately addressed the impacts.

This reliance on other parties to manage the WSA's impacts has the potential to result in missed mitigation measures and governance overlaps or gaps.

Setting a Framework for Further Assessment

To improve the longer term assessment and give some comfort to its approach, we suggest:

- Further assessment of the potential social and business impacts and the information gaps with some parameters or ranges of assessment; and
- The identification of the main body responsible for managing and mitigating these impacts and risks over time or how the mitigation framework will be managed.

Part C

Compliance with Section 10 of the Draft EIS Guidelines for the WSA

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COMPLIANCE WITH EIS GUIDELINES

Based on the assessment discussed in Parts A and B of this Report, we provide the following comments (in blue font) in relation to the matters established under Section 10 of the Department of the Environment's guidelines (black font).

a) The economic and social impacts of the action, both positive and negative, must be analysed.

The EIS has a strong focus on the economic benefits of the WSA. Concerns are raised by this Report however regarding the balance of the assessment having particular regard to the assessment of potential economic costs as well as the translation of social costs to matters summarised in the Executive Summary.

Source: Volume 1, Chapter 8 of Draft EIS

Matters of interest may include:

i. details of any public consultation activities undertaken, and their outcomes

The GHD Specialist Study profiles the stakeholders consulted during its preparation (Appendix P1, Pg. 12).

The Specialist Study does not however profile the issues raised by these stakeholders (as set out in Part in Vol.1 Chapter 8), nor whether they have been addressed by the assessment and where.

As discussed in this Report, some of the Stakeholder issues identified within Vol. 1 of the EIS (shown in the adjacent image) have not been discussed or assessed in detail including:

- property access for site investigations;
- integration with other major infrastructure projects; and
- ensuring local economic benefits are realised.

ii. details of any consultation with Indigenous stakeholders

Whilst discussed in other sections of the EIS, matters raised by these stakeholders and responses to them are not clear from a reading of Chapter 23 or the GHD Specialist Study.

COMPLIANCE WITH EIS GUIDELINES CONT…

iii. projected economic costs and benefits of the project, including the basis for their estimation through cost/benefit analysis or similar studies

The SGS and EY Specialist Studies (Appendix P1 and P3) identify many of the economic benefits of the WSA however they do not constitute a cost benefit analysis prepared in accordance with Australian Treasury Guidelines. We note that there is some reference to broader cost benefit analysis in Vol.1 Chapter 2 with respect to site choice, however there is no assessment of the costs and benefits of the WSA compared to the base case – i.e. no airport or alternative staging and development scenarios.

iv. employment opportunities expected to be generated by the project (including construction and operational phases).

The number of potential jobs generated by the WSA are quantified by the SGS and EY Specialist Studies (Appendix P1 and P3). Our independent assessment suggests that there may be a modest over-estimation of jobs generated by the proposed business park based on benchmark employee occupancy ratios.

b) The economic and social impacts must include impacts at the local, regional and national level.

The EIS has a strong focus on the economic benefits of the WSA at the regional (Western Sydney and Sydney wide) and national level. Our review identifies a gap however with respect to the assessment of economic and social impacts at the local level.

c) Details of the relevant cost and benefits of alternative options to the proposed action, as identified in Section 3, should also be included.

In response to this requirement, the EIS (Vol.2 Chapter 2) discusses the findings of a rapid cost benefit analysis of potential airport locations across NSW.

The details of the analysis have not however been provided nor any cost benefit analysis of alternative scenarios for the WSA itself i.e. with / without the business park, alternative flight paths etc.

ABOUT THE REVIEWERS

Sarah Hill is a an Adjunct Professor at the University of Technology Sydney in the Faculty of Design, Architecture and Building as well as a Director of Hill PDA, Australia's leading firm of land economists, property valuers and planners. Sarah specialises in providing strategic advice to local and State Government to bridges the divide between land economics and planning.

Previously Sarah worked as a Principal Planner in London where she developed and led the London Borough of Hackney (LBH) Major Projects Development Assessment Team. While working for the LBH Sarah created a new planning authority known as the London Olympic and Paralympic Joint Planning Authority that successfully assessed the planning application for the London 2012 Olympic Games and its Legacy. In turn, Sarah acted as lead consultant for the London Olympic Delivery Authority on planning, design and environmental matters.
Sarah is the immediate past President of the NSW Division of the Planning Institute of Australia and a graduate of the Australian Institute of Company Directors. Sarah is presently appointed as:

- The Land Economics and Planning Advisor to the Parramatta Road Precinct Review Panel for UrbanGrowth NSW (panel to sit from March to April 2015);
- Chair of the UTS Dean's Advisory Board;
- Member of the University of Sydney Planning Research Centre;
- Member of the Planning Institute of Australia NSW Divisional Committee and Executive Committee;
- Director of the NSW Building Professionals Board (BPB); and
- Member of the BPB Accreditation and Judiciary Committees.

Previously Sarah was appointed as:

- The independent chair of the Industry Advisory Panel (Minister appointed role) to assess the market, economic and planning implications of the Redfern Waterloo Built Environment Plan 2;
- A member of the NSW Affordable Housing Taskforce (Minister appointed role);
- A Specialist advisor to the Sydney
- Metropolitan Development Authority (SMDA);
- An advisor to the NSW Department of Planning and Infrastructure (as it was known) on matters relating to NSW planning reform;
- An independent panel member of the DP&E E planning Steering Committee, funding review panel and metropolitan open space grant funding panel;
- The Independent member of the NSW Panel for the grant allocations in relation to the National Rental Affordability Scheme (Housing NSW);
- Member of the PIA NSW Division Code of Conduct and Disciplinary Committee;
- The planning expert on the NSW Minister for Justice's Break and Enter Working Group; and
- A member of the NSW Department of Planning and Infrastructure Culture Change Working Group.

Sarah has been the recipient of numerous awards including the Mayor of London's Award for Planning Excellence (2005), the 2005 Royal Town Planning Institute Award for Planning (2005) and the UDIA NSW and Stockland Women in Development Leadership Award (2012).

SARAH HILL
Adjunct Professor, UTS,
Director, HillPDA

ABOUT THE REVIEWERS

Adrian is a principal of the firm with over 22 years of service at Hill PDA. Prior to Hill PDA he worked 10 years in both local and state government (Department of Housing and Darling Harbour Authority) in strategic planning, statutory planning and project management.

At Hill PDA Adrian has played a leadership role in all consultancy activities of the practice including market research, analysis and forecasting, development feasibility appraisal, economic appraisals (including cost benefit analysis), economic impact assessment, financial modelling, policy research, affordable housing studies and employment lands and commercial centres strategies. This has led to an involvement in diverse array of projects for government bodies, private sector corporations, institutions and other organisations.

Adrian manages the retail economics team in the preparation of both long-term strategies and specific development proposals. He developed and continues to refine numerous models in this field including expenditure forecasts, retail floor space demand, gravity modelling and economic impact assessment.

Regularly he provides expert advice and evidence in the land and environment court in the area of economic impact assessment (in relation to appeals and compulsory acquisition) and in highest and best use assessment (land valuation cases).

Adrian is also on the NSW Planning Institute's Economic Development Chapter. The chapter's role seeks to promote the understanding of economics, property and development in the Planning profession.

Through much of the 1990's and the early part of the following decade he was the principal architect of Estate Master, the industry standard in property development analysis software and he is still responsible for its continued development and refinement. This involved working with industry representatives in refining the the development feasibility model, sensitivity and probability procedures and the funding structuring. Adrian also had a major role in developing the investment analysis and development management models.

ADRIAN HACK

Principal, HillPDA

Relevant Projects Experience

- North West Rail Link Economic Analysis, Urban Growth NSW (2014)
- Meadowbank Railway Station Precinct Master Plan – Stage 1 Market Demand Assessment (2014)
- Bays Precinct Urban Activation Precinct Financial Modelling, UrbanGrowth NSW (2014)
- Economic Impact Study of Pacific Highway Upgrade at Wyong Town Centre (2014)
- Eastern Creek Business Hub, Western Sydney Parklands Trust (2013)
- Liverpool Retail Centres Hierarchy Review, Liverpool City Council (2012)
- Campsie Retail Revitalisation Plan, RailCorp (2012)

ABBREVIATIONS AND DEFINITIONS

EIS – Environmental Impact Statement

GFA – Gross Floor Area

MACROC - Macarthur Regional Organistion of Councils

WSA – Western Sydney Aiprot

WSROC - Western Sydney Regional Organisation of Councils

DOCUMENTS REFERENCES

Western Sydney Airport Environmental Impact Statement Incorporating:

- *Volume 2* —Stage 1 Development – Chapter 37 – Social and Economic
- *Volume 3 —Long Term Development.*
- *Volume 4, Appendix P1 – The Socio – Economic Impact Assessment undertaken by GHD (October 2015) and associated specialist studies including:*
    - *Western Sydney Population and Demographic Analysis (SGS, July 2015)*
    - *Potential Impacts on Property Prices (JLL, September 2015)*
    - *Western Sydney Airport – Draft Economic Analysis (EY, September 2015*

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Appendix H

Surface water and groundwater (Cardno)

Peer Review of Draft EIS - Surface Water and Groundwater

Western Sydney Airport
Environmental Impact Statement

Prepared for
WSROC

23 November 2015

Cardno
Shaping the Future

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A	10/11/2015	Draft for Client Review	D Whyte, F d'Hautefeuille	K Roberts
B	20/11/2015	Final Report including comments	D Whyte, F d'Hautefeuille	K Roberts

Executive Summary

1. Scope of review

Cardno was engaged by WSP Parsons Brinckerhoff on behalf on the Western Sydney Regional Organisation of Councils (WSROC) to undertake a peer review of the Western Sydney Airport Draft Environmental Impact Statement (EIS) and the supporting surface water and groundwater studies including hydrology, hydraulics, stormwater management, groundwater and water quality components.

It is noted that any reference to EIS throughout the document should be taken as referring to the draft EIS.

Approach

Cardno have undertaken a desktop review of the draft EIS documents and have assessed the draft EIS with respect to the following items:

- An evaluation of whether the ground and surface water studies meets the requirements of the EIS Guidelines and relevant other guidelines and methodologies;
- An evaluation of whether the conclusions reached in the studies are valid;
- An evaluation of whether the underlying assumptions used to inform the assessment are plausible and credible;
- A review of the mitigation and management measures proposed and advice provided on their likely adequacy in mitigating impacts;
- An evaluation of the level of uncertainty over impacts and the environmental risks that will arise as a result of the project; and,
- A summary of the key impacts and opportunities associated with the project in relation to the Surface Water and groundwater studies.

Descriptions of methodologies and impacts have been cross-referenced across chapters and the technical reports and figures checked for whether they aid understanding. Limited spot checks on values presented in tables have been undertaken together with applying sanity checks to data and model results with expected outcomes.

Surface water and groundwater have been reviewed by separate specialists, except where there is an inter-connection between the two, such as with water quality.

Prior to release of the draft EIS, Cardno initially reviewed available background documents to gain an understanding of site settings and project history including EPBC documentation and the 1997-99 draft EIS by PPK.

Limitations

The following limitations apply to the review of the surface water and groundwater:

- No site visit has been undertaken;
- No numerical models were available and hence no review of models or inputs has been undertaken other than what has been reported, nor have any models been run as part of the review;
- No data is available for review and assessment is limited to commentary on the data provided, however, data gaps have been identified;
- Cardno assumed the data used for the impact assessment had gone through a quality control process before use and therefore can be relied upon; and,
- Similarly Cardno did not review the interpretation of the data, for example the attribution of a bore to a specific aquifer.

Components of the EIS reviewed

The following components of the draft EIS have been reviewed in relation to surface water and groundwater:

- **Volume 1—Project Background**
  - Executive Summary
  - Part A—Project background
  - Part B—Airport Plan
- **Volume 2—Stage 1 Development**
  - Part D—Environmental Impact Assessment:
    - Chapter 9: Approach to impact assessment
    - Chapter 17: Topography, geology and soils
    - Chapter 18: Surface water and groundwater
    - Chapter 27: Cumulative impact assessment
  - Part E—Environmental Management
  - Part F—Conclusions
- **Volume 3—Long Term Development**
  - Part G—Assessment of Long Term Development
    - Chapter 30: Approach to impact assessment
    - Chapter 34: Surface water and groundwater
    - Chapter 39: Other environmental matters
  - Part H—Conclusion and recommendations
- **Volume 4—EIS Technical Reports**
  - Appendix C: Western Sydney Airport EIS Guidelines
  - Appendix L:
    - L1 Surface water hydrology and geomorphology
    - L2 Surface water quality
    - L3 Groundwater

2. Stage 1 airport

- *Summary of detailed findings including compliance with EIS guidelines*

A summary of the assessment of compliance of the draft EIS with the EIS guidelines is provided in **Table 2-1**. In general the elements of the EIS Guidelines have been addressed, however, some gaps have been identified in the assessments which means that compliance with certain EIS guidelines are incomplete.

Primarily, discussion on how the reliability of the information was tested and what uncertainties (if any) are in the information is not presented. Further, figures and maps are provided, however, many figures and maps are not clear and could be improved to aid understanding.

Mitigation and management measures are identified, however, are generally broad and do not necessarily target specific residual impacts or propose specific measures or targets. The proposed mitigation and management measures are not concise and appear to differ in different sections of the draft EIS.

The review has also identified some technically incorrect statements made in the EIS, however, Cardno has assessed that consequences for the outcomes of the impact assessment are limited.

Surface Water

The overall outcome of the impact assessment is that there are minimal impacts to surface water, geomorphology and water quality as a result of the Stage 1 development incorporating mitigation measures. Some specific residual impacts are noted in relation to changes to water level and geomorphology at Oaky Creek and on a tributary of Badgerys Creek.

The identified gaps in the assessment relate to:

- Flooding – Residual impacts in Cosgroves, Oaky and Badgerys Creek are identified. Cardno agree that the impacts may be relatively minor if the results as presented are correct. However, it is difficult to confirm whether the statements and conclusions are valid as there is a lack of supporting information and presentation of inputs and results are not clear and concise. Further, these impacts still require management to mitigate them to negligible levels.
- Duncans Creek and its tributaries have not been modelled to allow definition of baseline and relative hydraulic impacts in these locations. Such impacts have been assessed by the changes in the hydrology for these catchments. As such, all summary impacts do not fully consider impacts to the Duncans Creek downstream areas. Investigation of a basin at this location is proposed as a mitigation/management measure.
- Many of the figures/maps provided in both the main chapters of the EIS and in the technical reports are either not easy to understand or omit relevant information to aid ease of understanding.
- Cumulative impacts have been discussed, however, no assessment has been undertaken to quantify the potential impacts other than for climate change scenarios.
- Geomorphological changes are documented as being expected to be low, however, have simplified/understated the potential impact. Changes to bed shear stress are determined to be around a 5% change, however, could be as high as 25% (or more in isolated locations). Further, assessment of erosion potential has centred on threshold values for vegetation (100-200 N/m2) rather than consideration of the in-situ sediment critical shear stress which is likely much lower (potentially <5N/m2).
- Water quality has not been presented in terms of achieved pollutant load reduction or assessment against guideline pollutant reduction targets. The EIS seems to dimiss any relevance of increased pollutant loads on the receiving environment and instead determines that impacts are acceptable because there are general improvements in pollutant concentrations due to increased flow volumes.
- There are significant impacts to water quality which are not addressed as part of the currently proposal water quality measures and significant improvements to the design will be required to address water quality to meet any of the identified guidelines.
- The EIS discusses the tributary of Badgerys Creek that joins Badgerys Creek approximately 300 metres downstream of Elizabeth Drive under existing conditions. It acknowledges that threatened ecological communities have not been mapped outside the site as part of the biodiversity assessment, but there is evidence of some remnant native vegetation along this reach of creek which would be reliant on occasional flooding and would be impacted under the current proposals. Such impacts need to be assessed to ensure there are no impacts and any mitigation and management measures identified.
- Management and mitigation measures are not concise and are not clearly identified consistently throughout the document. No costing is provided and there is no specific criteria recommended to address certain residual impacts as part of future mitigation and management measures.

Surface water impact management is required to address the following residual risks to surface water:

- Outstanding localised increases to flood depths in Cosgroves, Oaky and Badgerys Creeks.
- Risks to erosion and geomorphological changes to the downstream creeks due to increases in bed shear stress at various locations
- Undefined impacts and mitigation for runoff to Duncans Creek.
- Implications of increases in pollutant loads, particularly for cumulative impacts are not addressed. Water quality with current management measures does not currently meet any guidelines.
- Ecological impacts in receiving waters are not clearly addressed
- Impacts of potential use of stormwater to provide water supply for site preparation works has not been considered.

Groundwater

The overall outcome of the impact assessment is that there would be no impact to groundwater systems and associated values due to the presence of tight clay soils and limited groundwater presence directly below the site. Cardno does not concur fully with the assessment, this difference results from a key assumption made in the EIS by characterising the uppermost aquifer.

The identified gaps in the assessment relate to:

- Groundwater values are identified, however the groundwater dependent ecosystem lacks characterisation and conceptualisation with respect to water source.
- Sufficiently complete characterisation of the weathered rock (regolith) aquifer is not provided. For example, the aquifer composition, nature and thickness distribution is unknown (this could have been collated through a review of all drilling logs performed on site overtime), and the level of saturation of the aquifer is also unknown. This is a limitation in understanding the connectivity of the weathered rock (regolith) aquifer to the alluvium aquifer supporting groundwater dependent ecosystem.
- Similarly, no baseline time-series data has been collected. This is especially a limitation when it comes to characterisation of the weathered rock (regolith) aquifer and the contribution of this aquifer to the alluvium formations along the creek lines where groundwater dependent ecosystems are primarily located.
- The impacts are reasonably well identified, however some of the impact assessment is missing a clear outcome statement.
- Impact management and mitigation measures are only discussed generally with potential mitigation measures to be considered and monitoring to be implemented. Groundwater impact arising from contamination is suitably addressed. Groundwater impact arising from the development of the site is, in view of the lack of information on the uppermost aquifer, inappropriate especially when addressing impacts on groundwater dependent ecosystems.
- Consideration of groundwater recharge is discussed at length for the Bringelly Shale and overlying aquifer, however, the discussion does not extend to the alluvium aquifer.

Groundwater management is required to address the two residual risks to groundwater values:

- Risk of soil and subsurface contamination from spill/release of chemicals or contaminants. A discussion is suitably provided to this effect in the EIS documents. Cardno agrees that the details of the management program cannot be defined at this stage and should be incorporated in a site environmental management plan. .
- Risk of impact on groundwater dependent ecosystems from reduced water supply to the creek alluvium system. In Cardno's view, the EIS documents do not provide a robust impact assessment of the risk to the Cumberland Plain Woodland along Badgerys Creek. Cardno would suggest that

the following management and mitigation approach could be considered to address the EIS guidelines requirements:

- Implementation of baseline data acquisition with an aim to document the contribution of recharge to the creek alluvial system from the weathered rock (regolith) aquifer, the Bringelly Shale and streamflow;
- A review of the risk to the groundwater dependent ecosystem;
- Based on the outcome of the previous item, the management and mitigation will vary with the level of risk. A risk propagation based monitoring strategy and response plan may be suitable. In this case, a response plan would propose a suitable early warning indication of impact propagation and provide the management and mitigation measures if necessary to prevent adverse impact. If the risk is identified to be more significant, engineered solutions may need to be considered in the site design. Another management and mitigation solution could involve inputs into site design to prevent impact on streamflow and indirectly aquifer recharge or mitigate the loss of recharge.

3. Long term development

- *Summary of detailed findings including key gaps, risks and effectiveness of assessment in setting a framework for further assessment.*

Surface Water

For the long term development, the impact assessment builds on the assessment for Stage 1. The hydrologic, hydraulic and water quality models used in the assessment include representations of the drainage system incorporated into the concept design of the indicative long term development.

The concept design of the long term development includes expanding the drainage system to control the flow of surface water. An extension of the Stage 1 detention basins is proposed together with provision of an additional detention basin in the longer term.

The following risks to surface water for the long term development and their implications have been identified:

- Outstanding localised increases to flood depths in Cosgroves, Oaky and Badgerys Creeks.
- Risks to erosion and geomorphological changes to the downstream creeks due to increases in bed shear stress at various locations
- Undefined impacts and mitigation for runoff to Duncans Creek.
- Implications of increases in pollutant loads, particularly for cumulative impacts are not addressed.
- Ecological impacts in receiving waters are not clearly addressed
- Impacts of potential use of stormwater to provide water supply for site preparation works has not been considered.

It is believed that most of the above issues can be addressed through refinement of the drainage strategy to manage flows, velocities and water quality. There are some outstanding impact assessments which have not been considered and should be addressed such as ecological impacts, use of stormwater for construction and impacts on Duncans Creek.

A reasonably robust assessment of the long term development has been undertaken. There is no formal framework for further assessment established as part of the EIS. The EIS for the Long Term Development simply lists considerations for future development as part of future design stages to address the impacts to be minimised. While this list identifies some of the key items to be addressed, in does not recommend any specific measures or processes that must be adhered to so as to tie those activities back to this EIS and associated approvals.

Groundwater

The following risks to groundwater for the long term development and their implications have been identified:

- Risk associated with change of land use and decrease of groundwater recharge. The implication is possibly, a lack of groundwater supply to the groundwater dependent ecosystems (EPBC listed). If the studies highlighted in the data gap analysis confirm that there is a risk, an artificial groundwater supply scheme to the alluvial aquifer or designed streamflow release upstream of the ecosystem will possibly be required to support aquifer recharge. If the studies identify that there is no risk of impact to the groundwater dependent ecosystem water supply, then no further work will be required.
- Risk associated with the possible use of chemicals over irrigated areas. The level of risk will depend largely on locations and practices. The implication is possibly an impact to the health of groundwater dependent ecosystem through runoff and infiltration in the alluvial aquifer. Management of this risk implies best practices be followed for the use of fertilizer and pesticides, additionally, targeted analytes could be included in groundwater monitoring.
- Risk associated with the use of groundwater as a supply. A groundwater assessment will be required to establish whether the extraction of the required volume is feasible and the impact on nearby groundwater users. It should be noted that the target aquifer will be the deeper Hawkesbury Sandstone. The implications in terms of work required will depend on the volume required. At most, the studies for a groundwater assessment are likely to require the drilling of a few wells (at least one observation and one pumping well), pump testing and analysis and some groundwater modelling.

The EIS identifies some of the required assessments and activities especially in relation to water quality management. The EIS also identifies that additional assessments will be required would the project require to use groundwater as a water supply. However, the EIS did not identify the state and federal regulatory processes likely to be required for the management of the site groundwater values (liaison, review and approvals, licences for example), nor did it clearly identify the management plans and response plans required to be in place. The EIS did not identify assessment remaining to be performed to collect baseline data and confirm the hydrogeological conceptual model.

4. Key impacts and opportunities

Key project impacts and opportunities are as follows:

- Localised increases in flood depths are indicated at a number of locations.
- Impacts in Duncans Creek are not fully considered and additional modelling would be required to detemrine residual impacts and any proposed management measures.
- Potential erosion and geomorphology changes with increased flow volumes and isolated increases in bed shear stress
- Increased pollutant loads for total suspended solids and nutrients, although pollutant concentration are equal or reduced compared to existing.
- Impacts on the groundwater dependent ecosystem associated with Badgerys Creek are not fully identified due to a lack of characterisation of the alluvium aquifer and in particular of:
  - The relationship between the alluvial aquifer and the weathered rock (regolith) aquifer; and
  - The characterisation of the recharge of the alluvium aquifer.
- These groundwater dependent ecosystems are declared a Matter of National and Environmental Significance under the EPBC Act. A review of the groundwater conceptual model would be required to enable characteristion of impacts on the Badgerys Creek groundwater dependent ecosystem.

There is an opportunity to improve the outcomes of the EIS to manage the residual impacts through refinement of the drainage strategy and management plans during future detailed design stages. It is recommended that the residual impacts are clearly defined in the EIS and appropriate specific management measures and targets be proposed or specified to ensure that these issues are addressed.

Given the complete redevelopment and earthworks taking place on site, there is opportunity to introduce even higher levels of stormwater management and water quality treatment to further minimise the impacts of the project and potentially improve the outcomes. This would assist in minimising cumulative impacts on the environment that may occur in combination with the surrounding South West Growth Centre and Western Sydney Employment Area development impacts.

With respect to groundwater impacts, there is an opportunity before site activities to acquire suitable baseline data and review the level of risk to the groundwater dependent ecosystem along the creeks. There is also an opportunity to define site design requirements to ensure recharge of the alluvium aquifer and, consequently, preservation of Badgerys Creek groundwater dependent ecosystem.

Overall there are some key shortcomings of the draft EIS and the assessment and the document could be improved by addressing these:

- The main chapters of the report in relation to surface water and groundwater, particularly Chapter 18, lack much of the key content of the technical reports and passes over some key information, descriptions, residual impacts and management measures.
- Figures and graphs are not well presented, missing some key information, which makes it difficult to understand some of the descriptions and inputs of data.
- There are inconsistencies between different chapters with similar content. E.g. key environmental impacts as well as mitigation and management measures.
- Residual Impacts are not clearly identified and listed in a separate section, but are rather interspersed throughtout the document.
- There are no proposed specific compliance criteria linked to future assessments to address any outstanding items not completed in the current assessment to ensure that residual impacts are addressed to a specific recommended outcome.

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1 Scope of the Review

1.1 Introduction

Cardno was engaged by WSP Parsons Brinckerhoff on behalf on the Western Sydney Regional Organisation of Councils (WSROC) to undertake a peer review of the Western Sydney Airport Draft Environmental Impact Statement (EIS) and the supporting surface water and groundwater studies including hydrology, hydraulics, stormwater management, groundwater and water quality components.

The scope of the review falls under compliance with the "Guidelines for a content for a draft Environmental Impact Assessment", issued by the Department of the Environment (DoE) under the Environment Protection and Biodiversity Conservation Act 1999 (the EPBC Act) in January 2015 for the Western Sydney Airport.

It is noted that any reference to EIS throughout the document should be taken as referring to the draft EIS.

1.2 Approach

Cardno have undertaken a desktop review of the draft EIS documents and have assessed the EIS with respect to the following items:

- An evaluation of whether the ground and surface water studies meets the requirements of the EIS Guidelines and relevant other guidelines and methodologies;
- An evaluation of whether the conclusions reached in the studies are valid;
- An evaluation of whether the underlying assumptions used to inform the assessment are plausible and credible;
- A review of the mitigation and management measures proposed and advice provided on their likely adequacy in mitigating impacts;
- An evaluation of the level of uncertainty over impacts and the environmental risks that will arise as a result of the project; and,
- A summary of the key impacts and opportunities associated with the project in relation to the Surface Water and groundwater studies.

Descriptions of methodologies and impacts have been cross-referenced across chapters and the technical reports and figures checked for whether they aid understanding. Limited spot checks on values presented in tables have been undertaken together with applying sanity checks to data and model results with expected outcomes.

Surface water and groundwater have been reviewed by separate specialists, except where there is an inter-connection between the two, such as with water quality.

Prior to release of the draft EIS, Cardno initially reviewed available background documents to gain an understanding of site settings and project history.

Cardno referred to the following documents:

1. EPBC documentation:

- Guidelines for the content of a draft Environmental Impact statement, Western Sydney Airport, Environment Protection and Biodiversity Conservation Act 1999 (Reference: EPBC 2014/7391), 29 January 2015
- Decision whether action needs approval/approval required, 23 December 2014. This decision confirms that the development requires assessment and approval under the EPBC Act before it can proceed.

- Invitation for Public Comment on Referral, 04 December 2014
  - Western Sydney Airport Referral of proposed action, Dec 2014, Department of Infrastructure and Regional Development*
  - Environmental field survey of Commonwealth land at Badgerys Creek Report prepared for Western Sydney Unit Department of Infrastructure and Regional Development, SMEC, 2014*
  - Biodiversity Report Commonwealth land at Badgerys Creek, Prepared for Western Sydney Unit Department of Infrastructure and Regional Development, SMEC, October 2014*
  - Badgerys Creek Initial Environmental Survey: Historic Heritage, Australian Museum Consulting for SMEC, October 2014
  - Environmental Survey of Commonwealth Land at Badgerys Creek: Aboriginal Heritage, Australian Museum Consulting for SMEC, October 2014

2. 1997-99 EIS and associated technical studies documentation:

- Draft EIS, Summary of the Environmental Impact Statement for the Proposed Second Sydney Airport at Badgerys Creek, PPK, 1997-1999
- Second Sydney Airport Proposal, Technical Paper 7: Geology, Soils and Water, PPK, 1997
- Second Sydney Airport Proposal Technical Paper 10: Hazards and Risks, PPK, 1997

Upon release of the draft EIS, Cardno reviewed:

- general chapters of the draft EIS to obtain an understanding of the proposal, the general approach to the impact assessment, and any community hydrological and hydrogeological concerns;
- the (EPBC Act) EIS Guidelines and any requirements relevant to surface and groundwater; and
- the chapters relevant to surface water and groundwater; and
- surface water and groundwater technical reports of the draft EIS.

1.3 Limitations

The following limitations apply to the review of the surface water and groundwater:

- No site visit has been undertaken
- No numerical models were available and hence no review of models or inputs has been undertaken other than what has been reported, nor have any models been run as part of the review
- Assessment is limited to commentary on the data provided, however, data gaps have been identified
- Cardno assumed the data used for the groundwater impact assessment had gone through a quality control process before use and therefore can be relied upon
- Similarly Cardno did not review the interpretation of the data, for example the attribution of a bore to a specific aquifer.

1.4 Components of the EIS reviewed

The following components of the EIS have been reviewed in relation to surface water and groundwater:

- **Volume 1—Project Background**
  - Executive Summary
  - Part A—Project background
  - Part B—Airport Plan
- **Volume 2—Stage 1 Development**
  - Part D—Environmental Impact Assessment:
    - Chapter 9: Approach to impact assessment
    - Chapter 17: Topography, geology and soils
    - Chapter 18: Surface water and groundwater
    - Chapter 27: Cumulative impact assessment
  - Part E—Environmental Management
  - Part F—Conclusions
- **Volume 3—Long Term Development**
  - Part G—Assessment of Long Term Development
    - Chapter 30: Approach to impact assessment
    - Chapter 34: Surface water and groundwater
    - Chapter 39: Other environmental matters
  - Part H—Conclusion and recommendations
- **Volume 4—EIS Technical Reports**
  - Appendix C: Western Sydney Airport EIS Guidelines
  - Appendix L:
    - L1 Surface water hydrology and geomorphology
    - L2 Surface water quality
    - L3 Groundwater

2 Detailed Findings – 1st Stage Airport

2.1 Compliance with the requirements of the (EPBC Act) EIS Guidelines

2.1.1 Requirements

The draft EIS was assessed for compliance with the requirements of the EIS Guidelines and key requirements for impact assessment from the NSW Office of Water or NSW EPA on groundwater.

The EPBC EIS Guidelines for the Western Sydney Airport requires the EIS is to provide the following with respect to surface water and groundwater:

- A Description of the Environment
  - Information on listed threatened species (including suitable habitat) and ecological communities that are or are likely to be present in all areas of potential impact.
  - A description of the environment in all areas of potential impact, including all components of the environment as defined in Section 528 of the EPBC Act:
    - ecosystems and their constituent parts, including people and communities
    - natural and physical resources
    - the qualities and characteristics of locations, places and areas
    - Heritage values of places
    - the social, economic and cultural aspects of a thing mentioned in preceding dot points.
- Relevant impacts are required to be identified
  - Impacts to the environment (as defined in section 528) should include but not be limited to the following:
    - changes to water quality on site and downstream of the site
    - changes to siltation
    - hydrological changes
    - native flora and fauna habitat removal and degradation (on site and in surrounding areas that may be affected by the action)
    - changes in recreational use and amenity of natural areas
    - creation of any risks or hazards to people or property that may be associated with any component of the action.
  - The guidelines require that Quantification and assessment of impacts should be:
    - against appropriate background/baseline levels
    - be prepared according to best practice guidelines and compared to best practice standards
    - consider seasonal and temporal variations where appropriate (including temporal changes in the sensitivity of the receptor)
    - be supported by maps, graphs and diagrams as appropriate to ensure information is readily understandable
  - Guidelines and standards used to quantify baselines and impacts should be explained and justified.
- The EIS must provide information on proposed avoidance and mitigation measures to manage the relevant impact to a MNES
- The EIS is to provide specifics on the management measures

- The EIS must provide details of the likely residual impacts on MNES and any proposed offset packages to reduce the residual impact
- The EIS must include information on any other requirements for approval or conditions that apply, or that the proponent reasonably believes are likely to apply, to the proposed action i.e. State Government's applicable requirements.
- The EIS must inform on sources of information as follows: the source of the information, how recent the information is, how the reliability of the information was tested, what uncertainties (if any) are in the information
- Reference to the Guidelines, plans and/or policies that have been considered during preparation of the EIS.

2.1.2 Assessment of Compliance

The summary of the assessment of compliance of the draft EIS with the EIS guidelines is provided in **Table 2-1**. Please note that technical validity is discussed in later sections in further detail (Section 2.1.3 to Section 2.5 for the first stage and Section 3 for long term development).

Table 2-1 Compliance with the EIS Guidelines

	Groundwater	Surface Water
Identification of Matters of National Environmental Significance (MNES)	The response of the draft EIS is incomplete. MNES are not clearly identified in the groundwater chapters. A discussion on the presence of high value Groundwater Dependent Ecosystems (GDEs) is given, however, there appears to be conflicting information between maps and text on the Cumberland Plain Woodland and sources, age and reliability of data is not provided.	MNES are not clearly identified in the surface water chapters. However, the relevant MNES is taken as the environment in general.
4. Description of the Environment (a) Information on listed threatened species (including suitable habitat) and ecological communities that are or are likely to be present in all areas of potential impact. (c) A description of the environment in all areas of potential impact • ecosystems and their constituent parts, including people and communities • natural and physical resources • the qualities and characteristics of locations, places and areas • heritage values of places • the social, economic and cultural aspects of a thing mentioned in preceding dot points.	The response of the draft EIS is incomplete. The hydrogeological settings are reasonably well provided albeit for some gaps in the characterisation having significant impact on the ability of characterise impacts to some of the groundwater values. Some technical limitations identified.	The response of the draft EIS only partly addresses the guideline. Ecological communities that are or are likely to be present in all areas of potential impact are not defined outside the airport site in the receiving creeks which are impacted by the project. Description of catchments and watercourses is well presented. There is no discussion of the social, economic and cultural aspects of the natural and physical resources. No linkages to specific ecosystems is provided.
5. Identification of relevant impacts	The guideline is addressed, however, there are gaps in the assessments. Relevant impacts are identified, however the qualification of the level of impact is not fully addressed.	The guideline is addressed however, there are gaps in the assessments. Impacts are identified, however the qualification of the level of impact is not fully addressed and gaps in the assessment exist. For Example, surface water and geomorphological impacts on Duncans Creek have not been defined.
(b) Cumulative Impacts	Long term development scenario is addressed	Impacts of the long-term development scenario have been undertaken (except for Duncans Creek). Cumulative impacts have been considered for Climate Change and future adjacent development,

		however, impacts have only been quantified through modelling for Climate Change.
(g) Changes to water quality on site and downstream of the site	The response of the draft EIS is acceptable. Impacts include change to water quality. Impact to water quality resulting from release of contamination and runoff water management are addressed fully. Technical limitations identified in relation to potential water quality changes to the creek alluvial aquifer from reduced groundwater inter-aquifer flows.	Impacts include changes to surface water quality, however, there are some queries around the assessment and conclusions discussed in more detail in sections of this review.
(g) Changes to siltation	N/A	The response of the draft EIS is acceptable. Changes to siltation are discussed, particularly impacts during construction
(g) Hydrological Changes	The response of the draft EIS is not appropriate. Changes to hydrological behaviour and impact on groundwater recharge are considered but exclude the alluvium aquifer along Badgerys Creek.	The response of the draft EIS is incomplete. Changes to hydrology are considered extensively with regards to impacts. However, there are still gaps and some changes are undefined, particularly for Duncans Creek. Geomorphological conclusions may have technical deficiencies.
(g) Quantifications and assessment of impacts are prepared: • Against baseline levels • Follow best practices • Consider seasonal and temporal variations • be supported by maps, graphs and diagrams for ease of understanding	The draft EIS response is only partly appropriate, it is not appropriate in regards to impacts to groundwater dependent ecosystems. Quantification of impact against baseline levels are not provided. The reviewer agrees with the report that considering the low level of changes and hazards that a qualitative discussion is appropriate. The reviewer notes that a sentence to this effect could be added to the impact assessment section introduction. Follow best practice – the impact assessment could gain by using a clearer risk assessment approach Consider seasonal and temporal variations – not considered however Cardno agrees with the technical report that it is not necessary for the impact assessment at this stage. It is required to be addressed for monitoring and management measures in regards to surface water flows and water levels in the weathered rock (regolith) aquifer. Supporting maps, graphs and diagrams are provided	The EIS guideline is mainly addressed. Quantification of baseline flood behaviour, geomorphology and water quality is presented. Impacts are compared to baseline levels. Assessment generally follows best practice, although impacts for the full range of design rainfall events is not reported. There is consideration of seasonal variability of rainfall when planning construction stage activities when managing soil and water. However, this is not deemed to be as important during operation because major flood events can occur at any time of year. Maps and graphs are provided to support the assessment, however, do not necessarily provide the relevant information to aid ease of understanding. Many figures could include additional information e.g. Appendix L1 Figure 3-5 should include ground contours to assist with demonstrating the catchment delineation.

6. (a) Information on proposed avoidance and mitigation measures to manage the relevant impact to a MNES	The response of the draft EIS is acceptable. Some generic discussion on approach to avoidance and mitigation is provided.	The response of the draft EIS is incomplete. Management and mitigation measures are identified, albeit are fairly general and aren't necessarily targeted to mitigating a specific impact.
6. (c) Specifics of the mitigation measures	The response of the draft EIS is not appropriate. Partly provided, for groundwater monitoring. Technical limitations identified. No response plan provided. Agency responsible not identified.	The response of the draft EIS is partly appropriate. This is noted generally within Chapter 17 and 18, however, more specific measures are identified in the Appendix L1 technical report. No costing has been provided. Agency responsible has not been provided for all measures. Criteria for the success of a mitigation measure has not been provided.
7. Details of the likely residual impacts on MNES	Not discussed	Residual impacts are identified, however, these are not clearly identified in a concise format or dedicated section. Some impacts are omitted from Table 29–1 –summary of key environmental impacts in Chapter 34 – Conclusion.
9. Other requirements for approval or conditions that apply, or likely to apply	Only partly provided	This is provided in reference to development of various management plans and their need to adhere to industry standards and guidelines to ensure effective mitigation of impacts. No proposed conditions for approval are made to ensure specific residual impacts are effectively mitigated or long term development impacts are managed.
11.(a) – (d) Document sources of information including age of data, reliability and uncertainties	The response of the draft EIS is acceptable. Source and age references are provided, reliability and uncertainties of data not provided	The response of the draft EIS is acceptable. Source and age references provided, reliability and uncertainties of rainfall or water quality data is not provided.
11. (e) Reference to guidelines, plans and/or policies considered during preparation of the EIS	The response of the draft EIS is appropriate. Provided.	The response of the draft EIS is appropriate. Provided.

2.1.3 Conclusion of Assessment of Compliance with EIS Guidelines

In general the elements of the EIS Guidelines have been addressed however, some gaps have been identified in the assessments. The review has also identified some technically incorrect statements made in the EIS, however, Cardno has assessed that consequences for the outcomes of the impact assessment are generally limited.

2.1.4 Surface Water

Overall the surface water impact assessment addresses the relevant EIS guidelines including:

- Description of existing environment (catchments and watercourses) is well presented.
- Description of baseline flood conditions are presented
- Impact assessment during construction has been undertaken
- Impact assessment during operation has been undertaken
- Mitigation and management measures are identified
- Reference to guidelines, plans and/or policies considered during preparation of the EIS is provided.

However, full compliance with many of the EIS guidelines fall short due to incomplete or missing assessments or information. The identified gaps in the assessment relate to:

- Flooding – It is difficult to confirm whether the statements and conclusions are valid as there is a lack of supporting information and presentation of inputs to confirm their validity. E.g. Residual impacts in Cosgrove, Oaky and Badgerys Creek are identified. Cardno agree that the impacts in Cosgrove, Oaky and Badgerys Creek may be relatively minor if the results as presented are correct. Further, these residual impacts still require management to mitigate them to negligible levels.
- Duncans Creek and its tributaries have not been modelled to allow definition of baseline and relative hydraulic impacts in these locations. Such impacts have been assessed by the changes in the hydrology for these catchments. As such, all summary impacts do not fully consider impacts to the Duncans Creek downstream areas. Investigation of a basin at this location is proposed as a mitigation/management measure.
- Many of the figures/maps provided in both the main chapters of the EIS and in the technical reports are either not easy to understand or omit relevant information to aid ease of understanding. E.g. Stage 1 design contour information, to identify the proposed ridgeline separating the Stage 1 runway and longer term second runway and the extent of earthworks proposed is not provided on any figures.
- Cumulative impacts have been discussed, however, no assessment has been undertaken to quantify the potential impacts other than for climate change scenarios.
- Water quality has not been presented in terms of achieved pollutant load reduction or assessment against guideline pollutant reduction targets. The EIS seems to dimiss any relevance of increased pollutant loads on the receiving environment and instead determines that impacts are acceptable because there are general improvements in pollutant concentrations due to increased flow volumes.
- The EIS discusses the tributary of Badgerys Creek that joins Badgerys Creek approximately 300 metres downstream of Elizabeth Drive under existing conditions. It acknowledges that threatened ecological communities have not been mapped outside the site as part of the biodiversity assessment, but there is evidence of some remnant native vegetation along this reach of creek which would be reliant on occasional flooding and would be impacted under the current proposals. Such impacts need to be assessed to ensure there are no impacts and any mitigation and management measures identified.
- Management and mitigation measures are not concise and are not clearly identified consistently throughout the document. No costing is provided and there is no specific criteria recommended to address certain residual impacts as part of future mitigation and management measures.

2.1.5 Groundwater

The overall outcome of the impact assessment is that there would be no impact to groundwater systems and associated values due to the presence of tight clay soils and limited groundwater presence directly below the site. Cardno does not concur fully with the assessment, this difference results from a key assumption made in the EIS by characterising the uppermost aquifer.

The identified gaps relate to:

- The lack of qualification of the data (previous data and interpretation of the reliability and uncertainty of outcomes).
- The identification of MNES is not provided in the groundwater studies. The MNES of relevance appears to be the Cumberland Plain Woodland. This ecosystem is also classified as a high priority groundwater dependent ecosystem under the NSW regulatory framework. The text of the EIS does not clearly define the Cumberland Plain Woodland as a MNES. Additionally, the text in the EIS documents locates the Cumberland Plain Woodland along Badgerys Creek, however, the map appears to locate the ecosystem at several places over the site. Due to the nature of the project, vegetation over most of the site is expected to be cleared. As such, impacts to the Cumberland Plain Woodland ecosystem only need to be addressed for the groundwater impact assessment along creek lines. This is provided in the EIS documents.
- Sufficiently complete characterisation of the weathered rock (regolith) aquifer is not provided as no additional data from previous studies was collected.
- Similarly, no baseline time-series data has been collected. This is especially a limitation when it comes to characterisation of the weathered rock (regolith) aquifer and the contribution of this aquifer to the alluvium formations along the creek lines where groundwater dependent ecosystems are primarily located.
- The impacts are reasonably well identified, however some of the impact assessment is missing a clear outcome statement.
- Impact management and mitigation measures are only discussed generally with potential mitigation measures to be considered and monitoring to be implemented. Groundwater impact management is required to address the two residual risks to groundwater values:
    - Risk of soil and subsurface contamination from spill/release of chemicals or contaminants. A discussion is suitably provided to this effect in the EIS documents. Cardno agrees that the details of the management program cannot be defined at this stage and should be incorporated in a site environmental management plan. .
    - Risk of impact on groundwater dependent ecosystems from reduced water supply to the creek alluvium system. In Cardno's view, the EIS documents do not provide a robust impact assessment of the risk to the Cumberland Plain Woodland along Badgerys Creek. Cardno would suggest that the following management and mitigation approach could be considered to address the EIS guidelines requirements:
        - Implementation of baseline data acquisition with an aim to document the contribution of recharge to the creek alluvial system from the weathered rock (regolith) aquifer and the Bringelly Shale;
        - A review of the risk to the groundwater dependent ecosystem;
        - Based on the outcome of the previous item, the management and mitigation will vary with the level of risk. A risk propagation based monitoring strategy and response plan may be suitable. In this case, a response plan would propose a suitable early warning indication of impact propagation and provide the management and mitigation measures if necessary to prevent adverse impact. If the risk is identified to be more significant, engineered solutions may need to be considered in the site design.

2.2 Commentary on Validity of Assumptions

2.2.1 Surface Water

The surface water and water quality impact assessment developed for the Western Sydney Airport makes the following assumptions:

- Hydrology – % Impervious parameters are generally reasonable for the existing scenario except it is reported that 10% imperviousness has been used for "Infrastructure". It is not clear what "Infrastructure" refers to or what it was applied to. This might be a typographical error and is supposed to be 100% for buildings etc.
- Hydraulics - Roughness parameters are generally reasonable, although there could be a wider range of categories to represent more land use or vegetation types.
- Downstream boundary of the hydraulic model is noted as a normal depth boundary. This should be checked against flood levels in South Creek and an appropriate coincident flood chosen for the tailwater condition. For example if the 5 year ARI flood in South Creek is higher than the normal depth within Badgerys Creek for a 100 year ARI, then the South Creek tailwater condition should be adopted. A validation of results with the South Creek flood model appears to indicate an acceptable correlation.
- The EIS assumes that current impacts (increases in stream depths and modelled shear stress values) indicated along sections of Badgerys Creek between Basin 2 and Basin 3 are not expected to eventuate as the design layout used in the hydraulic model has been subsequently superseded. This may be a valid assumption, however, not enough information has been provided about the differences in the concept layout and modelling of the new concept would be required to demonstrate this is correct.
- The Water quality assessment for Stage 1 development notes that there are some discrepancies between the surface water management plans provided and the land use plan for which assumptions had to be made, however, there is no detail on the assumptions and hence no comment on the validity of the assumptions can be made.

Overall, the impact assessment has followed appropriate methodology and used industry standard software. It is difficult to assess the validity of some inputs as the presentation of data to match the descriptions and assumptions is lacking in some instances.

2.2.2 Groundwater

The hydrogeological impact assessment developed for the Western Sydney Airport makes the following assumptions:

- The EIS assumes that existing hydrogeological site conditions have not changed significantly since the previous studies (Coffey, 1991 and PPK, 1999). Previous investigation results have been considered suitable for this EIS. Cardno agrees that since the site activities have remained unchanged, hydrogeological conditions are unchanged and previous data can be used. Cardno would however point out that this EIS is required to address additional elements than was required in the previous EIS, for example impact on groundwater dependent ecosystems, and that data had not necessarily been collected or analysed consistent with the current objectives. As a consequence, the previous assessment dataset or outcomes may not fully address the current EIS guidelines.
- The hydrogeological conceptual model assumes the weathered rock unconfined aquifer to be intermittent. No data is provided to support this assumption. Under this assumption, contribution of groundwater flow to the creek alluvial aquifer is limited to water seeping from the Bringelly Shale. As a consequence, there could be an under estimation of impacts to groundwater dependent ecosystems located along the creek.
- Cardno notes that there appears to be a reasonable spread of groundwater bores over the site so that sufficient, additional stratigraphy data could be available from the geotechnical investigation, provide to better confirm the assumption about the weathered rock (regolith) aquifer.

- The technical report assumes a low aquifer recharge rate from rainfall. The information provided on recharge rates does not confirm this assumption due to the heterogeneity of the results presented and the lack of associated discussion. However, this is of no consequence to the outcome as the soils are defined as being silt and clay overlying residual clays (Section 17.3.3 EIS) which by nature are associated with low rainfall recharge.
- The risk of dewatering of the Bringelly Shale associated with the potential construction of an underground train station and other types of excavation required for buildings has been dismissed based on the low hydraulic conductivity value of the Bringelly Shale at depth and the small seepage volumes expected. It should be noted that no project specifications are developed enough at this stage to document further the risk associated with underground facilities. Cardno generally agrees that underground facilities at depth in the Bringelly Shale are unlikely to cause significant groundwater impacts.
- The risk associated with groundwater impact assessment does not address the impact from groundwater extraction to partially sustain site water supply. Site requirements for groundwater use are unknown at this stage. The EIS documents states that this would be subject to a separate approval. Cardno agrees with this assumption.

2.3 Suitability of Technical Findings/Conclusions

2.3.1 Surface Water – Overall Findings

Cardno has reviewed the description of the hydrological settings and the methodology and inputs to models to ensure validity of the discussions which support the impact assessment. Based on the site information provided, Cardno has checked that all environmental values associated with surface water have been identified and that impact on these values has been assessed in the draft EIS.

Appropriate and industry recognised software has been used for hydrology (XP-RAFTS), hydraulics (MIKE 21) and water quality (MUSIC) modelling.

Identification of environmental values:

The key indicators of changes considered throughout the EIS are:

- changes in discharge from the site;
- changes in watercourse bed shear stress;
- changes in water quality; and
- changes in downstream water level.

It is agreed that these are the main considerations, however, note that additional considerations should be considered including:

- Changes to biodiversity
- Changes to hazards and risks to downstream people and property due to flooding or dam break of proposed detention basins

Outcome of impact assessment

The following conclusions are reached in the EIS for the Stage 1 Development:

- Modelling of stream flows indicates that duration, volume and velocity of surface water flows in watercourses would generally be similar or reduced when compared to existing flow conditions.
- Flood impacts noted are “increases of up to 100 mm in stream depths may occur at Cosgroves Creek and up to 250 mm in limited reaches of its tributary Oaky Creek for the smaller one year ARI and five year ARI events, plus associated increases in flow volume and velocity. No changes to flood levels are expected to occur at dwellings or other infrastructure surrounding the airport site”.
- The EIS concludes that the Stage 1 Development will have a low impact on the morphology of watercourses adjoining and downstream of the airport site.

- The Stage 1 development leads to “general improvements in pollutant concentrations locally and regionally, the improvements would not be sufficient to meet ANZECC guideline objectives, noting the catchment has not met ANZECC guidelines for several years.
- The attenuation of the incoming flows by the basins indicates that a basin strategy can be used to manage the increase in flow peaks and impacts to flood peak timing. Cardno agree with this conclusion.

Cardno make the following comments

- Duncans Creek or its tributaries have not been modelled with a hydraulic model to allow definition of baseline and relative hydraulic impacts in these locations. The EIS notes that “The land use downstream of the site was largely primary industry, with few dwellings identified close to the creek. Following the hydrology assessment, the benefit of developing a detailed hydraulic model of Duncans Creek to inform the impact assessment was considered limited. An impact assessment was carried out but was based on the findings of the hydrology model at the points of discharge from the site for Duncans Creek”. As such, all summary impacts do not fully consider impacts on the Duncans Creek downstream areas.
- No figures presented show the topography or DEM used for the different model scenario runs, so it is difficult to understand the topography used for catchment delineation or hydraulic model setup, particularly for Stage 1 where only half the site will be constructed.
- Figures of Stage 1 flood depth and flood difference results would be enhanced with an overlay of the Stage 1 development to understand the flood extents in relation to the development and potential flood affected dwellings. Further providing the locations of properties with above floor flooding from Appendix L1 Figure 1-1 would allow an easy assessment of flood impacts at those locations.
- Figures showing afflux (change in flood level/depth) for Stage 1 development are only provided for the 1, 5 and 100 year ARI events, so it is not clear what the relative impacts are for other modelled design storm events i.e. 20 year ARI and PMF.
- Conclusions focus on the one year ARI, five year ARI and the 100 year ARI. There is no presentation or discussion of other intermediate design storm events to ascertain whether there are impacts for these events.
- Geomorphological changes are documented as expected to be low, however, have simplified/understated the potential impact. Changes to bed shear stress are determined to be around a 5% change, however, could be as high as 25% (or more in isolated locations). Further, assessment of erosion potential has centred on threshold values for vegetation (100-200 N/m^2) rather than consideration of the in-situ sediment critical shear stress which is likely much lower (potentially $<5N/m^2$).
- The EIS discusses the tributary of Badgerys Creek that joins Badgerys Creek approximately 300 metres downstream of Elizabeth Drive under existing conditions. It acknowledges that threatened ecological communities have not been mapped outside the site as part of the biodiversity assessment, but there is evidence of some remnant native vegetation along this reach of creek which would be reliant on occasional flooding and would be impacted under the current proposals.
- There are significant impacts to water quality which are not addressed as part of the currently proposal water quality measures and significant improvements to the design will be required to address water quality to meet any of the identified guidelines.
- Despite the general decrease in pollutant concentrations, Stage 1 would result in increased loads of phosphorous and nitrogen, largely as a function of the increase in runoff volumes associated with the modified catchment areas and changes to land-use”. The EIS notes that “further resolution of mitigation measures would be provided in the final EIS having regard to identified downstream assets and potential for impacts”. This is a fairly key statement and should have already been addressed given that downstream assets and potential for impacts should have already been identified as part of this draft EIS.

- The adopted reduction pollutant targets are derived from the UPRCT WSUD Guidelines for Western Sydney as being 80% for TSS, 40% for Total Phosphorus and 40% for Total Nitrogen. This document may be considered to be outdated and that adjacent Council DCP requirements may provide a better guidance on targets that should be adopted to align with the overall objectives of the receiving areas being managed by the relevant Councils. These would indicate pollutant reduction targets of 80% for TSS, 60% for Total Phosphorus, 45% for Total Nitrogen and 90% for Gross Pollutants.
- The EIS notes there would be increased pollutant loads due to increased runoff volumes, however, the focus of impacts reporting centres around ANZECC guidelines for pollutant concentrations and do not focus on the achieved reduction targets versus the adopted guidelines. Pollutant load guidelines are not met at the basin outlets and are not met for the overall site.

2.3.2 Groundwater – Overall Findings

Cardno has reviewed the description of the hydrogeological settings and the hydrogeological conceptual model to ensure validity of the discussions which support the impact assessment. Based on the site information provided, Cardno has checked that all environmental values associated with groundwater have been identified and that impact on these values has been assessed in the draft EIS.

Identification of groundwater values

The groundwater values identified throughout the EIS documents are:

- Groundwater dependent ecosystems located within the alluvial formation along Badgerys Creek;
- Groundwater users (private groundwater bores); and
- Water quality (through potential changes to groundwater quality affecting surface water through baseflow and migrating off-site).

Cardno agrees with these findings.

Groundwater Conceptual Model

A groundwater conceptual model is the simplified representation of the groundwater system characteristics (aquifer/aquitards characteristics, groundwater flows, groundwater levels and groundwater quality), its environmental values and the interactions between the characteristics and with surface water. The groundwater conceptual model needs to be well defined for a robust approach to the risk identification and impact assessment.

The EIS describes the aquifer system as including:

- unconfined aquifer in the shallow alluvium of the main watercourses at the airport site;
- intermittent aquifer in weathered clays overlying the Bringelly Shale;
- confined aquifer within the Bringelly Shale; and
- confined aquifer within the Hawkesbury Sandstone.

The following statements in the EIS further define the hydrogeological conceptual model:

- The aquifer extents are interpreted to be limited to the three creeks surrounding the site (Badgerys Creek, Cosgrove Creek and Duncan Creek);
- The Bringelly Shale is considered to have low hydraulic conductivity (EIS Chapter 18) and, the technical groundwater study describes the aquifer systems as having low yield (this statement is expected to exclude the Hawkesbury Sandstone);
- There appears to be a strong downward head gradient (EIS Chapter 18) and the technical groundwater study only relates to a downwards head gradient of the alluvial aquifer and the Bringelly Shale;
- Groundwater recharge is low;
- Groundwater quality is poor (high salinity levels);

- Baseflow to creeks is limited (based on electrical conductivity values). Note that no quantification is provided. The technical report adds that the creeks are intermittent, reinforcing the low reliance of creek flow on baseflow;
- Groundwater levels are found between 1 to 12 m below ground level and a groundwater level map is provided.

Overall, the different elements of the hydrogeological conceptual model are provided and appear thorough, however, Cardno's review has identified a number of technically incorrect conclusions. The significant ones are listed below, the detailed findings section enters further into the technical findings.

- The definition of the different aquifers, more specifically the Bringelly Shale and the weathered rock (regolith) aquifer.
  - Characterisation of the "intermittent aquifer in weathered clays overlying the Bringelly Shale: is necessary, including thickness of the formation, geographical distribution, discussion of material, water levels. This characterisation is required to understand the potential interactions (if any) of the weathered rock (regolith) aquifer with the alluvial aquifer. This has potential implication on the impact assessment and support of groundwater dependent ecosystems. This aquifer is not reflected on the hydrogeological conceptual model drawing.
  - The Bringelly Shale is defined as an aquifer where it should be defined as an aquitard. Apart from being confusing terminology there is no consequence to the impact assessment as the properties of the shale formation are accurately considered.
  - Although the aquifer in weathered clays overlying the Bringelly Shale will be bounded by the creeks as defined in the EIS documents, the Bringelly Shale and Hawkesbury Sandstone extend regionally. The Luddenham Dyke is a flow barrier and a local flow divide in the southern part of the site.
- Based on the data provided in the EIS documents, the nature of the hydraulic connectivity between formations should be qualified as follows:
  - Very small downwards gradient between the alluvial aquifer and the Bringelly Shale. No information is available on seasonal variations, the gradients could possibly be reversed at times;
  - Under natural conditions, the Hawkesbury Sandstone is not hydraulically connected to the upper alluvial aquifer or unconfined weathered rock aquifer simply due to the stratigraphical properties, low hydraulic conductivity and significant thickness (approximately 100 m over the site, as informed in the EIS documents) of the Bringelly Shale.
- The occurrence of baseflow (groundwater flow into the creek) is discussed. Cardno notes that the discussion should also include groundwater recharge of the alluvium aquifer and the contribution made by the surrounding aquifers. This would set the scene for assessing the impact to groundwater ecosystems.
- A groundwater quality summary for each aquifer is not provided. A suitable baseline would be necessary prior to the start of the project (further discussed in Section □).

Overall, Cardno considers that the conceptual model is lacking information about aquifer characterisation and the aquifers geographical distribution and interactions along Badgerys Creek. If the weathered rock formation proves to be thin and effectively only carries interflow, then these gaps are of no consequence to the impact assessment findings. If the aquifer is reasonably thick and has a constant water table, the conclusion of the current impact assessment on impacts to groundwater dependent ecosystems may be different.

Impact Assessment Process

Cardno's review of the groundwater impact assessment process is that it is not supported by a rigorous risk analysis process:

- The impact assessment is based on three categories of consequences of the site activities (i.e. decreased recharge, decreased water levels and change of water quality) rather than approaching the impact assessment from the activities that are the source of the impact. While good practice Cardno considers that this deficiency does not appear to be important for the outcome of the assessment. The impact qualification is not based on a risk matrix approach, this has the potential to make the outcome quite subjective.

- The impact assessment does provide a clear conclusion on the impact to groundwater for each risk. A clear statement could have been provided for each risk. For example, the impact conclusion on water quality changes states that the likelihood of the impact is (low) and the pathway for impact (low hydraulic conductivity) is medium. However, the impact could still rank as high if the risk resulted in a non-reversible impact on high value receptors.

Outcome of impact assessment

The technical study and section 18.5.4 of the EIS come to the following conclusions:

- Reduction of recharge is not expected to affect sensitive ecological receptors and beneficial uses;
- Groundwater drawdown resulting from the re-profiling of the soil would result in minor impacts. The drawdown is not expected to be below creek level and dry the creeks;
- Adverse impact on groundwater quality may potentially emerge. The emergence of groundwater quality impact would be slow (EIS). The technical report discussed the risk to groundwater quality and concludes it is low, with the risk level possibly decreasing upon implementation of control measures.

The conclusion on the impact from reduced recharge is intrinsically linked to the hydrogeological conceptual model. Cardno would comment that the role of the upper weathered rock (regolith) aquifer needs to be confirmed to conclude either way.

Cardno agrees that groundwater drawdown due to excavations is not likely to affect groundwater levels substantially. It may cause local groundwater built up and local groundwater flow changes, but have no impact on environmental values. The technical report states that groundwater drawdown in the upper part of the ground profile associated with cuts is expected to result in seepages (as opposed to flows) and result in minor drawdown impacts.

Groundwater quality impacts will be associated with the accidental release of contaminants. Cardno agrees with the general findings of the study that impact levels are low and that impact can be controlled through management and monitoring measures.

Vulnerability of groundwater values

<u>Groundwater users:</u>

Impact on groundwater users is not clearly addressed in the EIS documents. Cardno's review however concludes that groundwater users are not at risk of impact due to the distance of existing bores from the site and the different aquifer that existing private bores are tapping. Groundwater users tap into the Hawkesbury Sandstone that is located at depth and isolated from surface activities at the project site by the Bringelly Shale. It should be noted here, that no requirement for groundwater supply from the Hawkesbury Sandstone for the project is included in the project definition. If groundwater supply was required, additional review would be required.

<u>Groundwater dependent ecosystems</u>

Vulnerability of the groundwater dependent ecosystems was assessed through impact of reduced recharge and groundwater drawdown. The technical report concludes that drawdown impact in areas of sensitive vegetation are expected to be minor. The report states that construction and development of the airport will reduce recharge and hence reduce groundwater discharge to the surrounding creek systems. The technical report appears to associate contribution to the alluvial aquifer to baseflow discharge and implies that the reliance on groundwater discharge is low and would have minor impacts. Cardno's review is that there is currently not sufficient data to conclude the vulnerability of groundwater dependent ecosystems.

The level of the risk will be linked to the level of groundwater contribution from the unconfined regolith aquifer (undocumented until now) to the alluvial aquifer. If the aquifer is intermittent as stated in the EIS documents, then Cardno agrees the impact will be insignificant.

Groundwater quality

Cardno's review supports the conclusion that there is a risk on groundwater quality. The technical report classified it as low in Section 6.2 and the EIS report does not provide a conclusion on the risk (as discussed earlier). Cardno believes that the risk is likely to rank low to medium if using a risk matrix approach. The risk can be decreased to low by implementing site controls as defined in EIS documents.

2.3.3 Surface Water – Detailed Findings

This section follows a chronological reading of the surface water and geomorphology technical report (Appendix L1) and water quality technical report (Appendix L2) and the various sections of the EIS document related to surface water. The comments below are only presented when providing more detailed technical findings that are presented in the overall findings section.

2.3.3.1 Appendix L1 – Surface Water hydrology and geomorphology

Section 3.2 – Data Collection and Review

Data review and sources are presented. No discussion of quality or accuracy of data is presented.

Section 3.3 – Existing environment modelling and analysis

Hydrology – % Impervious parameters are generally ok for existing except it is reported that 10% imperviousness has been used for Infrastructure. It is not clear what "Infrastructure" refers to or what it was applied to. Might be a typographical error and is supposed to be 100% for buildings etc.

Figure 3-1 shows catchment areas for the existing scenario. This figure would aid understanding if surface contours were also provided to show the topography associated with the catchment delineation. The figure also does not show the Badgerys Creek, Cosgroves Creek and Duncans Creek catchments, which are referenced in Table 3-3. Such broader catchments are shown in Figure 4-2.

Roughness parameters used in hydraulic modelling are generally acceptable, although there could be a wider range of categories to represent more land use types, particularly for creek roughness.

Downstream boundary is noted as a normal depth boundary. This should be checked against flood levels in South Creek and an appropriate coincident flood chosen for the tailwater condition. For example if the 5 year ARI flood in South Creek is higher than the normal depth within Badgerys Creek for a 100 year ARI, then the South Creek tailwater condition should be adopted.

Section 3.4 – Stage 1 and longer term modelling and analysis

Figure 3-5 and Figure 3-6 would be enhanced by providing the Stage 1 design contours and the longer term development design contours, respectively. It is difficult to understand the topography used for catchment delineation or hydraulic model setup, particularly for Stage 1 where only half the site will be constructed.

Section 3.5 Impact Assessment

The assessment considered the impacts of the development on:

- surface flows, including the effectiveness of the proposed basins in mitigating changes to hydrology;
- watercourse geomorphology;
- flooding and flood risk to surrounding developments and people; and
- cumulative aspects.

The assessment did fully consider:

- native flora and fauna habitat removal and degradation (on site and in surrounding areas that may be affected by the action) – e.g. the ecology of sensitive receiving environments
- changes in recreational use and amenity of natural areas
- creation of any risks or hazards to people or property – no consideration of flood hazard (velocity x depth criteria) or any risks posed by dam break of detention basins.

Consideration of climate change is included in the assessment

Sensitivity of model parameters is included in the assessment

A validation of model results against previous studies has been undertaken

Section 4 – Existing Environment

The report notes the following flood affected properties – "There are a number of existing dwellings located within the flood extent or in close proximity to the flood extent clustered on Badgerys Creek upstream of the site. Two dwellings in close proximity to the flood extent were also identified downstream of the airport site on Cosgroves Creek. On the eastern bank of Badgerys Creek are a number of flood affected lots, though the existing dwellings are located beyond the 100 year flood extent".

There is no comparison of the actual increase in flood level at these properties documented as part of impact assessment in later sections of the report.

Section 5 – Construction Impacts

It is noted that due to the long construction period, the likelihood of a major flood event occurring is high. Due to the modifications to the site and impervious area added, the volume of runoff from the site would increase and without mitigation, this would result in increased peak flows from the site and the potential for associated flooding and geomorphological impacts downstream.

Given the high likelihood of flooding, specific management measures should be identified rather than a general statement that it needs to be managed.

Section 6.1 – Operational Impacts Stage 1 Development

Duncans Creek or its tributaries have not been modelled with a hydraulic model to allow definition of baseline and relative hydraulic impacts in these locations. The EIS notes that "The land use downstream of the site was largely primary industry, with few dwellings identified close to the creek. Following the hydrology assessment, the benefit of developing a detailed hydraulic model of Duncans Creek to inform the impact assessment was considered limited. An impact assessment was carried out but was based on the findings of the hydrology model at the points of discharge from the site for Duncans Creek". As such, all summary impacts do not fully consider impacts on the Duncans Creek downstream areas.

Figures 4-6 to 4-9 of Stage 1 development flood depth results would be enhanced with an overlay of the Stage 1 development masterplan to understand the flood extents in relation to the development. Further providing the locations of properties with above floor flooding from Figure 1-1 would allow an easy assessment of flood impacts at those locations.

Figures showing afflux (change in flood level/depth) for Stage 1 development are only provided for the 1, 5 and 100 year ARI events, so it is not clear what the relative impacts are for other modelled design storm events i.e. 20 year ARI and PMF.

Conclusions focus on the one year ARI, five year ARI and the 100 year ARI. There is no presentation or discussion of other intermediate design storm events to ascertain whether there are impacts for these events.

The EIS discusses the tributary of Badgerys Creek that joins Badgerys Creek approximately 300 metres downstream of Elizabeth Drive under existing conditions. It acknowledges that threatened ecological communities have not been mapped outside the site as part of the biodiversity assessment, but there is evidence of some remnant native vegetation along this reach of creek which would be reliant on occasional flooding and would be impacted under the current proposals. Such impacts may be important and should be addressed.

The EIS states that "Where increases in flow discharging from the basins are predicted, no major impacts to flood prone residences are predicted, though some increases in flow depths are indicated".

- There is no quantification of the impact to flood prone residences, so it is unknown what is meant by "no major impacts.

The EIS identifies residual impacts on Oaky Creek and the identified tributary of Badgerys Creek. It states that it is expected that the basin strategy would mitigate the major impacts of changes to surface water from the development, though refinement of the strategy during design development would be required to reduce impacts to negligible levels and address specific more substantial impacts on Oaky Creek and the identified tributary of Badgerys Creek.

- This is a loose statement and merely states that the action would be required. There is no specific criteria set to tie achievement of an appropriate outcome back to the approval.

The EIS does not clearly summarise the residual impacts, rather they are dispersed through the sections.

Section 6.1.2 – Impacts on watercourse geomorphology

The EIS concludes that as flow durations for the modelled events under the Stage 1 conditions remain similar to existing conditions, and peak discharges typically reduce, the potential for significant impacts to the morphology of watercourses downstream is considered low.

Further, existing bed shear stress levels are noted to be between 20-100 N/m^2 (from Figures C1-C3) and changes in shear stress values as a result of the Stage 1 Development are between – 5 to +5 N/m^2. The EIS uses shear stress thresholds for the disturbance of vegetation and surface erosion in the range of 100 to 200 N/m^2 and concludes that “Given the modelled shear stress changes under the Stage 1 Development are typically at least less than 5% of this threshold range, the Stage 1 Development is unlikely to result in widespread and significant further exceedances of thresholds for the disturbance of vegetation and surface erosion along watercourses adjoining and downstream of the airport site”.

The following comments are made:

- The statements assume vegetation cover for this threshold value to be valid and does not consider the critical shear stress of the in-situ bed sediments which are likely present which have lower threshold shear stress, generally 50-200 for cobbles, 5-50 for gravel and <5 for sands, silts and clays
- the in-situ stream condition may be susceptible to erosion under existing shear stress values and any change may worsen the level of erosion.
- further, if the existing shear stress is actually closer to 20N/m^2, then a 5N/m^2 change is actually a 25% change which could be significant.
- the calculations note increases in bed shear stress which could lead to greater erosion, so it is difficult to conclude that impacts are low without further management or criteria placed on future design.

Section 6.2 - Long Term Development

It is noted that changes to catchments could create a transfer of water from the Water Sharing Plan’s Wallacia Weir Management Zone (in which Duncans Creek is located) to the Upper South Creek Management Zone (in which Badgerys, Oaky and Cosgroves Creeks are located). The implications of this are not discussed.

On Duncans Creek, there is a predicted increase in flow in a 100 year ARI event at Location K, and there is potential for localised increase in flooding and scour at this location under large flood events. No basin is currently proposed at this location although is noted that consideration of a basin at this location is included as a management measure.

The EIS concludes that as flow durations for the modelled events under the longer term development conditions remain similar to existing conditions, and peak discharges typically reduce, the potential for significant impacts to the morphology of watercourses downstream is considered low. Figures 6-14 to 6-21 show that flow durations will actually be longer under the longer term development as would be expected from the behaviour of detention basins.

In addition, Cardno make the same comments as for Stage 1 in that increases in bed shear stress could lead to greater erosion, so it is difficult to conclude that impacts are low without further management or criteria placed on future design.

Section 7 Cumulative Impacts

Changes to flood depth for Climate Change scenarios are presented in Figure 7-1 and Figure 7-2. The scale and information presented does not provide a clear understanding of the impacts. An afflux/difference plot would more clearly show the changes in flood depth expected in these scenarios.

Cumulative impacts of surrounding development is discussed, however, only very briefly and no assessment or quantification of the impacts has been undertaken.

2.3.3.2 Appendix L2 – Surface Water Quality

Section 2 – Methodology

Legislation and guidelines are well documented.

The assessment uses industry accepted software – the Model for Urban Stormwater Improvement Conceptualisation (MUSIC).

Section 2.5 – MUSIC water quality modelling approach

The MUSIC model has used user defined nodes for the model setup and has adjusted parameters to calibrate the model against field data. This may not be appropriate given (as noted in the EIS) that the field data were discrete rather than continuous and little or no correlation to rainfall or flow conditions at the time of the sampling was available. As such, adjusted the model to suit sampling from a discrete time with no correlation and then using this to estimate water quality changes over longer periods may be flawed.

Table 2-7 and Table 2-9 show the Adopted Modelling Parameters for existing conditions and then the Stage 1 and longer term development, respectively. There are changes to parameters such as recharge rate increasing from 30% under existing conditions to 50% under Stage 1 which are not explained/justified and which may influence the results of the water quality modelling.

Section 2.5.4 notes that for the Stage 1 development modelling "The surface water management plans provided were based on an earlier version of the land use plan. As a result, there were minor inconsistencies between the data sources characterising the airport site. Where necessary, assumptions in the assessment were made to manage those discrepancies". However, there is no detail provided about the assumptions.

Section 2.6 – Bio-retention basins sizing and treatment targets

In evaluating the effectiveness of the proposed measures, three treatment targets were assessed, as follows:

- existing or pre-development pollutant loads for total phosphorus, total nitrogen, and suspended solids (Neutral OR Beneficial Effect (NORBE));
- WSUD Guidelines (pollutant load reduction targets); and
- ANZECC Guidelines (pollutant concentration criteria).

The report states that "It is understood that the bio-retention sizes adopted in the Draft Airport Plan have been provided with the aim of satisfying WSUD Guidelines, rather than Neutral or reduced Beneficial Effects (NORBE) or ANZECC Guidelines. Accordingly, it is expected that supplementary design and management measures would be required during detailed design to further improve the water quality prior to downstream discharge."

  - This statement doesn't indicate which criteria/guidelines the detailed design would need to meet. The technical report focusses on meeting ANZECC guidelines and suggest that this cannot be met with the current design. The report doesn't give the impression that there are significant water quality issues other than this statement.

Section 3 – Existing Conditions

The existing environment is well described.

The presentation of meteorological data is complete and includes discussion of seasonal variability.

The assessment and description of existing land uses is well documented.

Section 4 – Assessment of operational impacts of proposal

Table 4-2 notes considerable increases in impervious (paved and roofed areas) for Stage 1 and longer term development scenarios which does not appear to be consistent with impervious area increases documented in Appendix L1 for hydrology. As such, it is not clear whether the water quality and flooding assessments are consistent.

Section 4.3 - Stage 1 development

Section 4.3.1 notes impacts in relation to NORBE guidelines. Key findings are:

- Local Impacts – There are large increases in pollutant loads at basin outlets as a result of the Stage 1 development (-40% to +497% for TSS, +108% to +624% for TP and +42% to +308% for TN). It is concluded that the bio-retention basins proposed for Stage 1 for water quality management are not adequate in satisfying the NORBE or pre-development load targets.
- Regional Impacts – the EIS states that "results indicate that the NORBE targets are not achieved at the downstream regional locations assessed with the bio-retention basins in place. However, it is expected that these regional impacts would progressively decrease at locations further downstream of the airport due to the increasing loads derived from catchments outside the airport at those downstream locations".

Section 4.3.2 documents performance in relation to WSUD Technical Guidelines for pollutant load reduction targets. This shows that reduction targets are met at only a few locations and generally only for one pollutant, never for all three (other than Basin 6 and 7 which come close to meeting the targets).

Section 4.3.3 notes impacts in relation to ANZECC guidelines. Key findings are:

- Local Impacts – There are general improvements in pollutant concentrations discharging from the site except for a few exceptions.
- Regional Impacts – similar to local impacts other than Duncans Creek where the concentrations are estimated to increase for all the three pollutants.
- ANZECC water quality objectives would not be achieved, despite the general improvements in water quality.

Cardno make the following comments:

- There are significant impacts to water quality which are not addressed as part of the currently proposal water quality measures and significant improvements to the design will be required to address water quality to meet any of the identified guidelines.
- Statements around meeting NORBE for regional impacts relies and flows and loads from other rural areas to "dilute" the impacts. This does not consider the cumulative impacts of surrounding developments that would reduce or worsen this effect.
- Not meeting the WSUD Guidelines is explained that this is due to land areas modified for the proposed airport development, or residual areas, that cannot physically discharge into the basins under Stage 1 of the development. Additional land management is required to intercept and treat such flowpaths or over-treatment of other areas which do discharge to basins would be required.

Section 5 – Assessment of Construction Impacts

This section identifies the appropriate impacts expected during construction and identifies then need for management through a Soil and Water Management Plan (SWMP) and a Construction Environmental Management Plan (CEMP). A water quality monitoring plan would also be developed and implemented as part of these plans to monitor any potential impacts during the construction phases of the project.

Section 6 – Mitigation and management measures

This section identifies mitigation and management measures that can be implemented through design and management based measures for Operational Phase along with Construction Phase measures, namely erosion and sediment control. Mitigation measures are identified in a reasonably comprehensive list to address identified risks. However, as required by the EIS guidelines, the measures are not costed or responsibilities identified, nor are there any criteria provided which must be met for specific impacts requiring management.

2.3.3.3 Chapter 14 – Hazard and Risk

Chapter 14 addresses broadly how stormwater will be managed on site and the relevant design criteria.

The following comments are made:

- Section 14.5.3 notes that the airport infrastructure has been designed in accordance with the Stormwater Drainage Design Manual, however, this is not a full reference and it is not clear which Stormwater Drainage Design Manual is being referenced.
- In Section 14.5.3 it is noted that a "detailed surface water management plan would be developed to manage the impacts of on-site flooding during the construction period", however, stormwater management plan to mitigate/manage site flooding is not listed in Table 14–5 – Mitigation measures to be resolved in future design stages.
- The EIS in Chapter 14 focusses on hazards and risks on site such as site flooding (Section 14.5.3), but does not necessarily consider hazards to people or property off-site such as the potential change in flood depth or hazard to adjacent and downstream areas. The EIS guidelines require consideration of the creation of any risks or hazards to people or property that may be associated with any component of the action.

2.3.3.4 Chapter 17 – Topography, geology and soils

Chapter 17 focusses on soil erosion and degradation on site and does not discuss the erosion potential for soils off-site that may be impacted by increased flow. Erosion and geomorphology are, however, discussed in Chapter 18 and Appendix L1.

Stage 1 design contour information, to identify the proposed ridgeline separating the Stage 1 runway and longer term second runway and the extent of earthworks proposed is not provided on any figures. Long term development design contours are not provided in any figures.

Chapter 17 also identifies a reclaimed water irrigation scheme and notes that "the principal risk associated with the operation of a reuse scheme is excess irrigation, leading to additional waterlogging, leaching of nutrients, a rise in water tables and increases in soil salinity or other soil properties."

Section 17.6 identifies suitable management and mitigation measures to address:

- soil erosion and degradation - through a site soil and water management plan and erosion and sediment controls in accordance with relevant guidelines and standards as part of a construction Environmental Management Plan (EMP).
- Reclaimed irrigation scheme – through risk management framework in accordance with relevant guidelines and standards. It is also proposed that soil and groundwater conditions would be monitored to identify and correct trends in soil salinity or other potential effects of irrigation.

Cardno agree that these issues could be addressed through appropriate management plans, though identifying the appropriate standards and guidelines in use today would be a good benchmark, even if changes to standards require these references to be updated in the future.

2.3.3.5 Chapter 18 – Surface Water and Groundwater

Information reported in Chapter 18 is essentially taken from the technical reports Appendix L1 and L2, however, there is some omission of key information with no reference to the relevant information in the technical reports.

Cardno makes the following comments:

Stormwater and Flooding

- A sub-catchment breakdown of impervious areas is not provided and the impervious areas in Table 18-6 do not appear to be high enough given the expected large impervious areas presented by the airport. No figure is provided to show the catchments for Stage 1 in relation to the airport plan to understand the derivation of these values. This figure would also demonstrate the changes to the catchments from existing and how the detention basins are situated with respect to the proposed catchments.

- The only flood impacts noted are "increases of up to 100 mm in stream depths may occur at Cosgroves Creek and up to 250 mm in limited reaches of its tributary Oaky Creek for the smaller one year ARI and five year ARI events, plus associated increases in flow volume and velocity. No changes to flood levels are expected to occur at dwellings or other infrastructure surrounding the airport site". There are no figures in the main EIS Chapter 18 provided to show where and what extents such increases cover. It does not describe what is impacted and does not quantify the impact in terms or areas or duration and any associated economic, social or environmental impacts. Further, it seems to only identify impact to current property and ignores future growth plans for WSEA and SWGC where such increases may affect the development potential of lands or properties that have been built in the interim prior to the airport's construction.
- The EIS notes that stormwater would be used for site preparation works and notes that "to meet water demand during construction it may be necessary to source water from other sources such as groundwater or other sources of surface water. However, consideration of the impacts associated with using these alternative sources would be subject to a separate assessment". – these impacts should be considered as part of this assessment if it is deemed that such sources would be potentially required either during normal weather or due to drought periods. Consideration of the total storage capacity of identified sources or basins with relation to demand should be undertaken to assess the likelihood of this eventuality.
- The nominated mitigation measures of potential impacts are through further refinement of the surface water drainage system to reduce flows as far as reasonably practical. However, this does not nominate whether this is likely to be easily achieved or whether there are limitations to this. Nor does it propose specific measures associated with the residual impacts and does not nominate a target outcome.

Water Quality

- Table 18-8 – there are some unusual results in this table. Phosphorus and suspended solids would normally increase and decrease in correlation with each other as phosphorus is adhered to sediments and is removed through settlement of suspended solids. Some results in this table show opposite trends for the two parameters.
- Section 18.6.3 notes that Stage 1 development leads to "general improvements in pollutant concentrations locally and regionally, the improvements would not be sufficient to meet ANZECC guideline objectives, noting the catchment has not met ANZECC guidelines for several years. Despite the general decrease in pollutant concentrations, Stage 1 would result in increased loads of phosphorous and nitrogen, largely as a function of the increase in runoff volumes associated with the modified catchment areas and changes to land-use".
- The EIS notes that "further resolution of mitigation measures would be provided in the final EIS having regard to identified downstream assets and potential for impacts". This is a fairly key statement and should have already been addressed given that downstream assets and potential for impacts should have already been identified as part of this draft EIS.
- The adopted reduction pollutant targets are derived from the UPRCT WSUD Guidelines for Western Sydney as being 80% for TSS, 40% for Total Phosphorus and 40% for Total Nitrogen. This document may be considered to be outdated and that adjacent Council DCP requirements may provide a better guidance on targets that should be adopted to align with the overall objectives of the receiving areas being managed by the relevant Councils. These would indicate pollutant reduction targets of 80% for TSS, 60% for Total Phosphorus, 45% for Total Nitrogen and 90% for Gross Pollutants.
- The EIS notes there would be increased pollutant loads due to increased runoff volumes, however, these are not reported in terms of the achieved reduction targets versus the adopted guidelines.
- The EIS also notes the potential for accidental spills of fuels and chemicals being released to the environment in the event of a mishap during refuelling, maintenance or general storage and handling. Management and mitigation of such spills is noted as the implementation of Australian

standards for the storage and handling of hazardous materials. This does not identify the appropriate example measures and does not call out the need for the development of a spill and remediation action plan.

2.3.3.6 Chapter 27 – Cumulative impacts

Section 27.3.5. Water Resources only considers cumulative impacts of water quality of receiving waters and indicates that there is an improvement in water quality from the airport site, which is not true for all locations, as documented in Section 18.6.3. Further, this seems to be with respect to general reductions in pollutant concentrations, yet it is noted that there would be increased loads of phosphorous and nitrogen due to increased runoff volume. Such loads are important and would in fact have a bearing on the cumulative impact and the capacity of the receiving environment to cope with such increased nutrient loads, particularly when added to loads from other surrounding developments.

Other potential cumulative impacts such as flood affectation and total runoff volumes have not been addressed in this chapter.

Cumulative Impacts of climate change and urban development are presented in Appendix L1, however, are not discussed in this Chapter of the draft EIS.

2.3.3.7 Chapter 28 – Environmental Management

This chapter discusses mitigation measures identified in earlier chapters. It identifies proposed environmental management plans and timing, however, does not always note what organisation is responsible for undertaking the monitoring/management except during construction and operation. Preparation of a plan to refine the surface water drainage system during detailed design timing is identified as a "pre-construction", however, does not note who would be responsible for developing it.

2.3.3.8 Chapter 29 – Conclusion

Table 29–1 – Provides a summary of key environmental impacts. The following comments are made:

- Under "Water" it states "While there are potential risks to surface and groundwater resources from construction and operation of the airport site, most of these are not specific to airport developments and a range of standard industry design and precautionary measures would be implemented to reduce these risks".
    - It does not appear relevant whether impacts are specific to airport developments. It appears as though it is suggesting that impacts can be managed as per common practice for other major infrastructure developments, however, the specific impacts have not been identified in this summary.
- Under "Surface water and groundwater" it states "Changes to catchment areas within the airport site and the permeability of the ground surface, would alter the duration, volume and velocity of surface water flow".
    - There is no discussion on the implications or actual impacts that altered duration, volume and velocity of surface water flow would have.

2.3.4 Groundwater – Detailed Findings

This section follows a chronological reading of the technical groundwater report (Appendix L3) and the groundwater sections of the EIS document (Section 18). The comments below are only presented when providing more detailed technical findings that are presented in the overall findings section.

2.3.4.1 Groundwater Technical Report – Appendix L3

Table of contents:

Cardno notes that no methodology is included therefore, no qualification of the data is provided in terms of reliability, age and completeness.

Section 2.4.2 Water Sharing Plans on Access to Groundwater

The water sharing plan identifies spare allocation for the Sydney Basin central porous rock aquifer as stated in the report. If the project requires groundwater supply, it will need to be provided from the Hawkesbury Sandstone and will require liaison with the NSW Office of Water.

Section 3.3 Geology:

There is a terminology error in the Bringelly Shale description. The report should read laminite (defined as a sedimentary rock composed of very fine layers) instead of laminate.

The Luddenham Dyke should be named on the geological map. This would provide more understanding about groundwater flow direction if mapped on the groundwater level contour map.

Section 3.4.1 Aquifer Parameters

Aquifer water levels need to be compared together using the same elevation reference system. Water levels cannot be compared as the depth below ground level for bores are located at significant distance from each other. The values should be expressed as an elevation (m AHD). Because of this, the sentence "The standing water elevations relative to well depth in the surrounding registered use bores (presented in Appendix B), suggests there is a strong downward head gradient, which supports the presence of very low vertical hydraulic conductivities" is technically incorrect. If compared correctly the data is likely to still indicate a downwards gradient. The issue however does not affect the outcome of the impact assessment.

Section 3.5 Groundwater Elevation

Cardno's review disagrees with the conclusion that the data presented indicate that there is a limited hydraulic connection between the two aquifer systems. Cardno considers that there is the presence of low vertical hydraulic conductivities in the Bringelly Shale aquifer. The groundwater head difference between the alluvial aquifer and the Bringelly Shale are observed at two location to be 0.4 m and 1.4 m (not 2.4 m as wrongly calculated in the report). Cardno agrees that these values indicate a downward gradient. The gradient may change overtime due to the recharge or discharge of the alluvial aquifer. The formations being adjacent, there is likely to be some level of connectivity at the interface generally with a downwards contribution.

The presence of low vertical hydraulic conductivity in the shale is linked to the nature of the formation, the low value of the hydraulic conductivity acquired through hydraulic testing and the fact that generally vertical conductivity in fractured rock aquifers are a few orders of magnitude lower than the horizontal conductivity.

Section 3.7 Groundwater Recharge

This section is unnecessarily long and provides a list of previously acquired results without discussion and conclusion, the data is not used later in the report. Additionally, Cardno notes that the units are inconsistent preventing comparison of results.

Section 3.10 Groundwater Dependent Ecosystems

There is inconsistency between the map and the statement of the second paragraph as to the location of the vegetation of high groundwater dependence. The source and date of the data mapped is not provided. Ultimately, any remaining vegetation not in the creek corridor is expected to make place for the airport facilities. The groundwater impact assessment focusses on the groundwater dependent ecosystems along Badgerys Creek.

Section 3.11 Conceptual Model

The aquifer extents are wrongly defined if it applies to all aquifers. The current definition will only apply to the unconfined weathered rock aquifer (which is defined as intermittent).

For the unconfined regolith aquifer, the following comments are made:

- the thickness of the aquifer over the site needs to be known to inform on the role of the aquifer within the hydrogeological conceptual model;
- The water levels are unknown and the intermittent status is undocumented. The depth to groundwater is identified as ranging between 2.4 m and 4 m below the measuring point. This statement requires further characterisation on the timing of these measurements, the reliability of the

data and the distribution of the data available. The intermittent nature of the aquifer needs supporting information.

For the Bringelly Shale aquifer, the following comment is made:

- The classification as an aquifer requires some qualification. On a regional scale, the Bringelly Shale is considered as an aquitard (McNally 2009)1, this is the reason why no producing bores are drilled within the Bringelly Shale and is supported by low hydraulic conductivities. Nevertheless, the classification needs to be consistent with the definition of the term aquifer adopted for the EIS. The technical report defines an aquifer as a groundwater bearing formation sufficiently permeable to transmit and yield groundwater. It is noted that the Bringelly Shale may contain some small water bearing zones associated with minor sandstone beds but the storage capacity is expected to be very low. As such the Bringelly Shale is more likely to seep water than yield a useful amount of water.

Figure 6 – Conceptual Hydrogeological Model shows the water pressures in the Bringelly Shale and the alluvial aquifer as the same which contradicts the previous findings. In line with the defined intermittent status of the weathered rock aquifer, no water table is drawn for that aquifer.

The interaction between creek and groundwater is partly explained through the documents. It could however be improved by including discussion on creek perennial or ephemeral characteristics and illustration of surface water-groundwater interactions.

<u>Section 4 Impact assessment</u>

The approach taken in the EIS identified three categories of impact:

- impact from decreased recharge,
- impact from decrease of water levels,
- impact from change of water quality.

This approach ignores any other impacts as for example the potential increase of water levels due to underground constructions. However, this is unlikely to affect the outcome of the assessment. The report would gain in ease of reading by presenting a visual approach such as a table summarising the activity causing the impact (for e.g. change in ground conditions), the potential consequence/risk (for e.g. decrease of groundwater recharge) of the impact and the resulting impact on receptors/ groundwater values.

2.3.4.2 Groundwater Impact EIS Chapter 18

Information reported in Chapter 18 is essentially taken from the technical report, however some rewording has resulted in wrong statements.

Cardno makes the following comments:

- The section on groundwater levels (S 18.4.6) appears to assimilate water levels (expressed in depth to water in a monitoring bore) and the depth of the top of an aquifer. For confined systems, the depth to water level (water pressures) is usually not the depth to the top of the water bearing zone and can be found metres above the top of the geological formation. Access to it, however requires access to the geological formation.
- Paragraph 3 of Section 18.4.6, plural form for the Bringelly Shale suggesting a different groundwater system than previously stated.
- Last paragraph of Section 18.4, the Hawkesbury Sandstone is not preferably targeted for its better water quality than the Bringelly Shale but critically because it is an aquifer able to yield commercial amount of water as opposed to an aquitard.
- Section 18.5, introduction, the use of groundwater as a potential water supply has been commented upon earlier.

[1] Greg McNally, Soil and groundwater salinity in the shales of western Sydney, Proceedings of the International Association of Hydrogeologists, New South Wales Branch Groundwater in the Sydney Basin Symposium, Sydney, NSW, Australia, 4 – 5, August 2009

2.4 Review of Mitigation & Management Measures Proposed

Cardno has reviewed the proposed management strategies for technical soundness, practicality and reliability of the outcomes.

2.4.1 Surface Water

The EIS documents propose the following broad mitigation and management measures for surface water:

- Surface Water Drainage System: Preparation of a plan to refine the surface water drainage system during detailed design to address the following:
  - detailed design of basins and channels to capture the majority of runoff, including during construction;
  - refinement of drainage system design performance standards to optimise capacity and release timing, mimicking natural flows as far as practicable;
  - provision of intermediate sediment retention basins upstream of larger basins to provide additional treatment;
  - provision of separate bio-retention swales and basins to provide additional treatment and separation of these features from the drainage system to protect contained water during floods;
  - provision of pollutant traps to prevent debris and other coarse material entering the drainage system;
  - stabilisation structures at outlets to include rock check dams at regular intervals along channels and energy dissipaters at basin outlets; and
  - capacity for containment of accidental leaks or spills in the drainage system at maintenance areas, fuel farms or other areas where fuels or chemicals are stored or handled in accordance with Australian standards.
- Erosion and Sedimentation: The surface area disturbed at any one time would be minimised as far as possible by construction staging and stabilised with vegetation or appropriate cover.

Appendix L1 provides the following mitigation and management measures for specific surface water impacts:

- Changes to water level at Oaky Creek and on a tributary of Badgerys Creek need to be managed through subsequent design development.
- Need to further develop the basin strategy during design development such that the basins would be effective at mimicking natural flows as closely as possible across a range of storm durations and magnitudes including low and high flows.
- Consideration should be given to the need to introduce a basin or alternative water quantity management measure at one of the site discharge points into a tributary of Duncans Creek.
- Requirement to ensure that any future development in the vicinity of Badgerys Creek where it passes through the site would be appropriate for a third order creek, including protecting and preserving habitat along the riparian corridor and ensuring no worsening of flooding downstream.

The EIS documents provides the following monitoring specifications:

- Baseline and ongoing monitoring of surface water and groundwater would be undertaken to characterise any residual impacts and prompt corrective action where necessary.
- Surface water quality monitoring would be conducted at basin outflows and selected upstream and downstream conditions.

Cardno makes the following comments:

- There are differences between the summary tables for mitigation and management measures (Table 18–9 and Appendix L1 Table 8-1, Table 28–4 and Table 28-5) and mitigation and management measures discussed throughout the various chapters. Alignment of these would provide a clearer outcome and framework for future assessment and mitigation measures.

- It is agreed that many of the residual impacts relating to increase flows, velocities and water levels can be managed through refinement of the drainage system during detailed design.
- It is agreed that residual impacts relating to water quality can be managed through refinement of the drainage system during detailed design. However, the impacts at present are not clearly defined in terms of their ability to meet pollutant reduction loads and hence the likelihood of achieving these through refinement of the drainage treatment system is not clear.
- The EIS also notes the potential for accidental spills of fuels and chemicals being released to the environment in the event of a mishap during refuelling, maintenance or general storage and handling. Management and mitigation of such spills is noted as the implementation of Australian standards for the storage and handling of hazardous materials. This does not identify the appropriate example measures and does not call out the need for the development of a spill and remediation action plan in Chapter 28.

2.4.2 Groundwater

The EIS documents propose the following mitigation and management measures for groundwater:

- The documents discuss possible mitigation measures to mitigate the risk of impact to groundwater dependent ecosystems. The documents recommend a reactive approach based on monitoring be considered.
- Water quality risks are to be managed through a series of measures either as part of the airport design or to be incorporated in the site construction environmental management plan and the operational environmental management plan.

The EIS documents provides the following monitoring specifications:

- Key locations for monitoring: the areas of monitoring proposed in the EIS report target sensitive creeks and groundwater dependent ecosystems. The technical report provides additional locations.
  - areas of subsurface infrastructure and cuttings where seepage could occur to characterise potential groundwater impacts (water level);
  - areas near creeks and areas with groundwater dependent ecosystems (water level, water quality);
  - around and down-gradient of major infrastructure (water quality);
  - surface water down-gradient of key site works (seepage monitoring during dry periods, water quality).
- Monitoring target: Bringelly Shale, alluvial aquifer, possibly targeted fill areas and creeks.
- Frequency: quarterly monitoring for water levels and water quality
- Length: three years or until stabilisation
- Baseline monitoring on a quarterly basis.

Cardno makes the following comments:

- Monitoring location and frequency needs to be defined based on the risk of impact. Generally Cardno agrees with the locations defined in the technical report, however Cardno would recommend that the need for monitoring near infrastructure be assessed on a case by case basis;
- Cardno agrees with the monitoring targets. The unconfined weathered rock aquifer may need to be included in the target (this will depend on the outcome of its characterisation);
- Frequency:
  - The water quality monitoring frequency is suitable for detection of contamination near the infrastructure;

    - The water quality monitoring frequency is suitable for acquisition of baseline in the aquifers near sensitive ecological receptors and upon review of the data, the frequency could then be reduced;
    - The water level frequency is not suitable for baseline acquisition or for ongoing monitoring. Baseline acquisition requires daily water level data (through the use of an automated logger and quarterly manual water level to confirm the logged data). This is even more critical in aquifers which are subject to discharge to creek and to direct rainfall recharge. The data is critical for assessment of water level changes during operation and removal of natural variability which may otherwise trigger an exceedance. The definition of the frequency monitoring for ongoing monitoring should be based on the assessment of the baseline data.
- Length: the length provided in the EIS documents is acceptable. Cardno notes that monitoring of baseline would ideally start before the start of any activities on site, one year is often a minimum recommended time.
- Water quality parameters: the parameters defined in the technical study are suitable for contamination identification. With respect to baseline, some analytes would need to be changed to allow for a full characterisation. Critically major cations and anions should be added. Cardno notes that suspended solids are typically done only in surface water monitoring.

Cardno makes the additional comments on the approach and specifications taken to management and mitigation:

- The management and mitigation measures do not include a response plan. The approach provided in the EIS documents is suitable for the detection of contamination, however not suitable for the identification of impact to groundwater levels affecting groundwater dependent ecosystems. The response plan should take into consideration the level of risk associated with a confirmed exceedance, the time for impact propagation (i.e. the time available for implementing mitigation if required), identify the various steps between identification of an exceedance and mitigation and identify the regulatory and compliance requirements applicable to the situation.
- The use of the ANZECC Guidelines 2000 as a trigger will not necessarily be successful. As identified in the EIS documents, natural concentrations for a number of water parameters currently exceed the ANZECC 20000. It is recommended that triggers be defined specific to the protected environmental value. For contamination to groundwater, the NSW Contaminated Land Management Act 1997 (CLM Act) should be referred to.

2.5 Discussion on Existing Level of Uncertainty over Environmental Risks and Impacts

2.5.1 Surface Water

While the approach, methodology and description of parameters appear to be appropriate, a robust presentation of inputs to the hydrology and hydraulic model setup is lacking. For example, figures showing catchments do not show overlays of topography, airport concept plan layouts or the water management strategy. As such the figures do not allow an assessment of the appropriateness of catchment delineation, stormwater design or assignment of impervious percentages.

While it is noted that a full range of design rainfall events has been modelled (1, 2, 5, 20, 100 year ARI and PMF), not all events are presented in the impacts. It is assumed that intermediate events are unlikely to alter from the trend of results presented, however, they have not been documented and hence some uncertainty remains.

Impacts on Duncans Creek are only assumed at this stage and no hydraulic assessment has been undertaken. Further no mitigation measures are proposed other than consideration of a basin at this location

Limitations with water quality monitoring are noted and this lends to uncertainty over the baseline water quality levels. However, a model has been used for simulating water quality impacts and was calibrated to the monitoring data. As such, the model should provide a reasonable estimate of the relative impacts from the airport construction.

Further, it is noted that a surface water quality monitoring program will be implemented to collect additional background data prior to the commencement of construction to provide additional baseline data to allow further calibration of the modelled results. This will allow a more robust design to be developed to address water quality relative to better data into the future.

2.5.2 Groundwater

The main uncertainties come from the assumption that the unconfined regolith aquifer is intermittent. The assumption is unsubstantiated in the EIS documents. If the assumption is proven to be valid, then the overall risk to groundwater values will be insignificant. If the assumption is not valid, the groundwater dependent ecosystems in Badgerys Creek could be at risk of impact from reduced groundwater flow towards the groundwater dependent ecosystem due to changes to the ground surface and infiltration/recharge.

3 Detailed findings – Long Term Development

3.1 Description of Approach to Impact Assessment Developed in the EIS

3.1.1 Surface Water

The assessment of the Long Term Development builds on the assessment of impacts associated with the Stage 1 development. The assessments focusses on the operational impacts and construction impacts have not been considered due to the unknowns surrounding the final Stage 2 layout and the timing of construction being so far into the future.

The EIS uses the predictive numerical models to consider the impact of the change in landform characteristics on runoff volumes and the subsequent impacts on stream flow, flooding, groundwater recharge and water quality. Potential impacts on the environmental values and beneficial uses of surface and groundwater resources were identified, and options for future management practices were considered as part of the assessment.

The hydrologic, hydraulic and water quality models used in the assessment include representations of the drainage system incorporated into the concept design of the indicative long term development.

The concept design of the long term development includes expanding the drainage system to control the flow of surface water. An extension of the Stage 1 detention basins is proposed together with provision of an additional detention basin in the longer term.

The results of the models were analysed to identify impacts on waterways, people and property and thereby assess the effectiveness of the drainage system. The drainage system has been designed to contain flows up to the 100 year average recurrence interval (ARI) event.

A climate change scenario to determine likely impacts has also been considered.

3.1.2 Groundwater

The EIS's approach is that the risk to groundwater and groundwater values will not change between the first stage and the operational phase, neither will the level of impact (S 34.4.4).

Cardno agrees that the risks to groundwater values are unchanged. However, a new risk, the risk associated with irrigation of reclaimed water needs to be included in the discussion. The risk is discussed in a previous section (S 34.4.3), but the discussion does not consider products such as fertilisers often associated with irrigation which may have an impact on groundwater dependent ecosystem along the creek.

The risk to groundwater dependent ecosystem is the same as during the first stage of development and also needs to be considered for the long term development unless proven insignificant.

Cardno agrees with the EIS on other conclusions regarding long term impacts to groundwater, as follows:

- The modification of groundwater flow are minor and located near underground structures, they would result in minor groundwater seepage which is required to be controlled through infrastructure design.
- There would be no impact to groundwater users, note that this assumes groundwater will not be used as water supply at the site. Impact to groundwater users will required to be assessed separately would the project decide to use groundwater as a supply.
- There is a risk to groundwater quality through chemical contamination release and spills. The risk can be managed efficiently though a number of measures such as implementation of Australian standards and best practices and implementation of an environment management plan.

3.2 Assessment Gap Identification

3.2.1 Surface Water

Gaps in the assessment are largely the same as for Stage 1 development:

- Duncans Creek and its tributaries have not been modelled to allow definition of baseline and relative hydraulic impacts in these locations. As such, all summary impacts do not fully consider impacts to the Duncans Creek downstream areas. Investigation of a basin at this location is proposed as a mitigation/management measure.
- Cumulative impacts have been discussed, however, no assessment has been undertaken to quantify the potential impacts other than for climate change scenarios.
- Various detention basin peak outflow values are higher than existing peak flows, indicating that there is likely to be an impact of stream flood depths downstream, however, such increases are not reported to occur. Further, there are no figures presenting the afflux (changes in flood level/depth) presented in the main report (Chapter 18) to clearly show the modelled impacts at all locations.
- Water quality impacts have not been presented in terms of achieved pollutant load reduction or assessment against guideline pollutant reduction targets. The EIS seems to dimiss any relevance of increased pollutant loads on the receiving environment and instead determines that impacts are acceptable because there are general improvements in pollutant concentrations due to increased flow volumes.
- Threatened ecological communities have not been mapped outside the site as part of the biodiversity assessment. But there is evidence of some remnant native vegetation along the tributary of Badgerys Creek that joins Badgerys Creek approximately 300 metres downstream of Elizabeth Drive under existing conditions. This reach of creek would be reliant on occasional flooding and would be impacted under the current proposals. Such impacts need to be assessed to ensure there are no impacts and any mitigation and management measures identified.

3.2.2 Groundwater

The following gaps have been identified. The data gaps affect both the first stage and the operational phase of the airport project.

- The weathered rock (regolith) aquifer requires further characterisation to establish its role in regards to supply to the alluvial aquifer and as such potential indirect impact from reduced recharge to the groundwater dependent ecosystems. This data gap should ideally be addressed during the first stage of development. The study will be followed by a review of the risk to groundwater dependent ecosystems along Badgerys Creek.
- Similarly, attention should also be brought to the role played by streamflow in the recharge of the alluvial aquifer and the impacts which can result from the design of flow control elements.
- Time series water level data are required to be collected as baseline for the alluvial aquifer, the Bringelly Shale and the weathered rock (regolith) aquifer to allow for the consideration of natural variations when assessing long term compliance data.
- A groundwater management and mitigation plan will need to be developed upon collection of groundwater baseline and groundwater characterisation of the groundwater dependent ecosystem and the weathered rock (regolith) aquifer. The plan should allow for a risk based approach to monitoring and mitigation and the project team should engage early during preparation with the applicable regulatory agencies.
- Handling of chemical and wastes may warrant some operation licences under the NSW POEO Act. The project team should consult with the NSW EPA. The monitoring requirements should be included in the site environmental management plan.
- A separate groundwater assessment and liaison with the NSW Office of Water would be required would the project decides to use groundwater as a water supply option either for construction or ongoing use. Groundwater would be sourced from the Hawkesbury Sandstone.

Upon addressing the data gaps identified above, the risks and associated impacts should be reviewed.

3.3 Resulting Key Risks and Implications

3.3.1 Surface Water

The following risks to surface water for the long term development and their implications have been identified:

- Outstanding localised increases to flood depths in Cosgroves, Oaky and Badgerys Creeks.
- Risks to erosion and geomorphological changes to the downstream creeks due to increases in bed shear stress at various locations
- Undefined impacts and mitigation for flood and geomorphology due to runoff to Duncans Creek.
- Implications of increases in pollutant loads, particularly for cumulative impacts are not addressed.
- Ecological impacts in receiving waters are not clearly addressed
- Impacts of potential use of stormwater to provide water supply for site preparation works has not been considered.

It is believed that most of the above issues can be addressed through refinement of the drainage strategy to manage flows, velocities and water quality. There are some outstanding impact assessments which have not been considered and should be addressed.

3.3.2 Groundwater

The following risks to groundwater for the long term development and their implications have been identified:

- Risk associated with change of land use and decrease of groundwater recharge. The implication is possibly, a lack of groundwater supply to the groundwater dependent ecosystems (EPBC listed). If the studies highlighted in the data gap analysis confirm that there is a risk, an artificial groundwater supply scheme to the alluvial aquifer will possibly be required. If the studies identify that there is no risk of impact to the groundwater dependent ecosystem water supply, then no further work will be required.
- Risk associated with the possible use of chemicals over irrigated areas. The level of risk will depend largely on locations and practices. The implication is possibly an impact to the health of groundwater dependent ecosystem through runoff and infiltration in the alluvial aquifer. Management of this risk implies best practices be followed for the use of fertilizer and pesticides, additionally, targeted analytes could be included in groundwater monitoring.
- Risk associated with the use of groundwater as a supply. A groundwater assessment will be required to establish whether the extraction of the required volume is feasible and the impact on nearby groundwater users. It should be noted that the target aquifer will be the deeper Hawkesbury Sandstone. The implications in terms of work required will depend on the volume required. At most, the studies for a groundwater assessment are likely to require the drilling of a few wells (at least one observation and one pumping well), pump testing and analysis and some groundwater modelling.

3.4 Effectiveness of assessment in setting a framework for further assessment

3.4.1 Surface Water

A reasonably robust assessment of the long term development has been undertaken. There is no formal framework for further assessment established as part of the EIS. The EIS for the Long Term Development simply lists considerations for future development as part of future design stages to address the impacts to be minimised. While this list identifies some of the key items to be addressed, in does not recommend any specific measures or processes that must be adhered to so as to tie those activities back to this EIS and associated approvals.

3.4.2 Groundwater

The EIS identifies some of the required assessments and activities especially in relation to water quality management. The EIS also identifies that additional assessments will be required would the project require to use groundwater as a water supply. However, the EIS did not identify the state and federal regulatory processes likely to be required for the management of the site groundwater values (liaison, review and approvals, licences for example), nor did it clearly identify the management plans and response plans required to be in place. The EIS did not identify assessment remaining to be performed to collect baseline data and confirm the hydrogeological conceptual model.

4 Key Project impacts and opportunities

Key project impacts are as follows:

- Localised increases in flood depths are indicated at a number of locations.
- Impacts in Duncans Creek are not fully considered and additional modelling would be required to detemrine residual impacts and any proposed management measures.
- Potential erosion and geomorphology changes with increased flow volumes and isolated increases in bed shear stress.
- Increased pollutant loads for total suspended solids and nutrients, although pollutant concentration are equal or reduced compared to existing.
- Impacts during construction related to water demand for site preparation works are not fully considered.
- Impacts on the groundwater dependent ecosystem associated with Badgerys Creek are not fully identified due to a lack of characterisation of the alluvium aquifer and in particular of:
  - The relationship between the alluvial aquifer and the weathered rock (regolith) aquifer; and
  - The characterisation of the recharge of the alluvium aquifer.
- These groundwater dependent ecosystems are declared a Matter of National and Environmental Significance under the EPBC Act. A review of the groundwater conceptual model would be required to enable characterisation of the impacts on the Badgerys Creek groundwater dependent ecosystem.

There is an opportunity to improve the outcomes of the EIS to manage the residual impacts through refinement of the drainage strategy and management plans during future detailed design stages. It is recommended that the residual impacts are clearly defined in the EIS and summarised in a separate chapter and appropriate specific management measures and targets be proposed or specified to ensure that these issues are addressed.

Given the complete redevelopment and large earthworks taking place on site, there is opportunity to introduce even higher levels of stormwater management and water quality treatment to further minimise the impacts of the project and potentially improve the outcomes. This would assist in minimising cumulative impacts on the environment that may occur in combination with the surrounding South West Growth Centre and Western Sydney Employment Area development impacts.With respect to groundwater impacts, there is an opportunity before site activities to acquire suitable baseline data and review the level of risk to the groundwater dependent ecosystem along the creeks. There is also an opportunity to define site design requirements to ensure recharge of the alluvium aquifer and consequently preservation of Badgerys Creek groundwater dependent ecosystem.

5 Reviewers' Qualifications

No significant qualifications are noted other than the limited time available for review. The entire document has not been read and reviewed, and only selected components have been reviewed as outlined in Section 1.4.

The general chapters, particularly describing the project and the airport plan have not been read in depth, but rather reviewed in brief to identify relevant background information sufficient to inform this review. The focus has been on reviewing the relevant specialist chapters and technical reports in detail.

While all care has been taken to identify the relevant sections of the EIS, a guarantee cannot be provided that some relevant information pertaining to surface water and groundwater is not contained within other sections of the EIS such as “Biodiversity” and “Planning and Land Use”.

The review is limited to comments on the methodology, processes and outcomes presented. As no data or models have been reviewed, it is difficult to confirm whether the inputs, parameters and model setup is accurate and appropriate, especially for the water quality assessment. As noted throughout the review, figures to support the descriptions of inputs and outcomes are not well presented often lacking vital information to ease understanding.

Appendix I

Biodiversity (EMM)

EMGA Mitchell McLennan

Western Sydney Airport EIS

Biodiversity Assessment Peer Review

Prepared for WSP Parsons Brinckerhoff | 19 November 2015

Planning + Environment + Acoustics

Western Sydney Airport EIS

Biodiversity Assessment Peer Review

Prepared for WSP Parsons Brinckerhoff | 19 November 2015

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Western Sydney Airport EIS

Final

Report J15103RP2 | Prepared for WSP Parsons Brinckerhoff | 19 November 2015

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Executive summary

ES1 Introduction

EMM Consulting Pty Limited was commissioned to conduct a peer review of the Biodiversity Assessment (EIS Appendix K1), Offsets Strategy (EIS Appendix K2) and biodiversity chapter (EIS Chapter 16) of the *Western Sydney Airport Environmental Impact Statement* (GHD 2015a). The purpose of the review is to provide the Western Sydney Regional Organisation of Councils (WSROC) and Macarthur Regional Organisation of Councils (MACROC) with factual, unbiased information regarding the technical rigour of the biodiversity study. The review will provide information to support individual submissions from WSROC and MACROC on the environmental impact statement (EIS) and supporting technical studies.

ES2 Approach

The adequacy of the above documents was reviewed against the *Western Sydney Airport EIS guidelines* (the EIS guidelines), biodiversity survey and assessment guidelines and background data, where appropriate. The review criteria comprised:

- evaluate if the biodiversity study meets the requirements of the EIS guidelines and other relevant guidelines and methods;
- evaluate the validity of the data relied upon to inform the Biodiversity Assessment (EIS Appendix K1);
- evaluate the validity of the underlying assumptions of the Biodiversity Assessment (EIS Appendix K1);
- evaluate the validity of the conclusions reached in the Biodiversity Assessment (EIS Appendix K1);
- review the mitigation and management measures proposed and advise of the adequacy in mitigating impacts; and
- evaluate the level of uncertainty of biodiversity impacts and provide advice on the resulting environmental risks.

A summary of the key impacts and opportunities associated with the project has also been provided.

ES3 Stage 1 development review findings

The reports were found to be generally compliant with the EIS guidelines. However, a number of partial and non-compliances were identified. The assumptions and conclusions of the assessment were considered valid, with the exception of three criteria which were deemed 'partially compliant'. The proposed mitigation and management measures were deemed suitable for this stage of the project, with further information required prior to construction with respect to biodiversity and environmental management.

Data gaps were identified with respect to land access restrictions, threatened species locations, the assessment of threatened species, and a large deficit in the proposed offsets. The Biodiversity Assessment (EIS Appendix K1) does not clearly define the extent of land access restrictions. A key risk associated with insufficient access (if this is the case) is that biodiversity values and offsetting requirements may have been underestimated.

Assessments of significance were not completed for the Green and Golden Bell Frog, Australasian Bittern, Australian Painted Snipe and a number of migratory species listed under the EPBC Act. Key risks associated with the omission of these assessments are that the level of impact and the offsets required may have been underestimated. The large credit deficit, particularly for Cumberland Plain Woodland in the Sydney Basin Bioregion, listed as a critically endangered ecological community under the *Threatened Species Conservation Act 1995* (TSC Act) and *Environment Protection and Biodiversity Conservation Act 1999* is a key risk as it is not currently known if the quantum of offsets required is available.

ES4 Long-term development review findings

The Biodiversity Assessment (EIS Appendix K1) (GHD 2015b) provides a general assessment of adverse the long-term development impacts of the project. However, it does not consider the potential impact of successful implementation of biodiversity management measures from the Stage 1 development, which may result in increased biodiversity values and therefore underestimate the longer-term development impacts. In addition, the Offsets Strategy (EIS Appendix K2) does not state how offsets will be identified and secured for the long-term development.

ES5 Key impacts and opportunities

Key impacts of the project comprise:

- the loss of 90 ha of Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest critically endangered ecological community; and
- the loss of 120 ha of habitat critical to the survival of the Grey-headed Flying-fox, a vulnerable species.

Key opportunities of the project comprise:

- location of the airport site on predominantly cleared land;
- identification of potentially suitable offset sites on private property that may have otherwise degraded, and been subject to key threatening processes;
- in addition to the offsets, the creation of an on-site environmental conservation zone, containing native vegetation representative of the vegetation types to be cleared.

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Appendices

Tables

1 Introduction

1.1 Background

WSP Parsons Brinckerhoff commissioned EMM Consulting Pty Limited (EMM) to complete a technical peer review of the biodiversity components of the Western Sydney Airport Environmental Impact Statement (EIS) (GHD 2015a). These components comprise the EIS chapter 16 Biodiversity (GHD 2015a), Biodiversity Assessment Report (EIS Appendix K1) (GHD 2015b) and Offsets Strategy (EIS Appendix K2) (GHD 2015c).

The purpose of the review is to provide the Western Sydney Regional Organisation of Councils (WSROC) and Macarthur Regional Organisation of Councils (MACROC) with factual, unbiased information regarding the technical rigour of the biodiversity study. The review will provide information to support individual submissions from WSROC and MACROC on the EIS and supporting technical studies.

1.2 Approach

The review method is shown in Table 1.1, which provides details on the guidelines against which the technical rigour of the biodiversity study was assessed, and how each component of the biodiversity study was evaluated.

Table 1.1 Method

Scope item	Guidelines assessed against	How each scope item was evaluated
Prior to exhibition		
Background reading	N/A	• Detailed review of the 1997-1999 EIS. • Desktop review of local vegetation mapping datasets and plant community types for the bioregion. • Database searches on the Atlas of NSW Wildlife, OEH threatened species database and Protected Matters Search Tool to determine relevant threatened species, populations and communities (threatened biodiversity). • Review other publically available local biodiversity studies.
During exhibition		
Evaluate if the biodiversity study meets the requirements of the EIS Guidelines and relevant other guidelines and methods	• *Guidelines for the content of a draft Environmental Impact Statement: Western Sydney Airport (Reference: EPBC 2014/7391)* • *Survey guidelines for Australia's threatened bats* • *Survey guidelines for Australia's threatened birds* • *Survey guidelines for Australia's threatened frogs* • *Survey guidelines for Australia's threatened mammals*	• Detailed review against Section 4(a) of the EIS guidelines to and Commonwealth survey guidelines and referral guidelines for the Koala to determine if the survey effort has been completed satisfactorily. • Identify gaps in survey effort or the threatened biodiversity considered in the Biodiversity Assessment (EIS Appendix K1). • Confirm that potential groundwater dependent ecosystems have been investigated.

Table 1.1 Method

Scope item	Guidelines assessed against	How each scope item was evaluated
	threatened mammals • *Survey guidelines for Australia's threatened reptiles* • *EPBC Act referral guidelines for the vulnerable Koala*	
Evaluate the validity of the information relied upon	• *EPBC Act Policy Statement 1.1 Significant Impact Guidelines for Matters of National Environmental Significance* • *EPBC Act Environmental Offsets Policy*	• Compare local vegetation mapping datasets to those identified in the Biodiversity Assessment (EIS Appendix K1) determine if vegetation types are accurate. • Review of justification for plant community types assigned in accordance with the Vegetation Information System to check accuracy. • Compare database search results to those identified in the Biodiversity Assessment (EIS Appendix K1) to ensure all relevant threatened biodiversity have been identified and considered. • Review preliminary determinations for threatened species, populations and communities to ensure they are considered. • Compare the list of target threatened biodiversity to those identified in the desktop study to ensure all relevant target biodiversity has been identified. • Review of known threats to the threatened biodiversity identified. • Review the likelihood of occurrence for threatened biodiversity, to ensure all relevant species have been considered. • Review the assessments of significance to ensure that the necessary assessments have been completed. • Review calculations and assumptions used in the Commonwealth offset calculator. • Comparison of offset package against the offset principles in the *EPBC Act Environmental Offsets Policy.* • Review the identification of groundwater dependent ecosystems.
Evaluate the validity of the underlying assumptions used to inform the assessment	• N/A	• Assess validity and consistency against EIS Chapter 16, the Biodiversity Assessment (EIS Appendix K1) and Offsets Strategy (EIS Appendix K2).
Evaluate the validity of conclusions reached in the biodiversity study	• *EPBC Act Policy Statement 1.1 Significant Impact Guidelines for Matters of National Environmental Significance*	• Review the project description to determine the intensity, duration, magnitude and geographic extent of impacts. • Review assessments of significance against the Significant Impact Criteria in the *Significant Impact Guidelines for Matters of National Environmental Significance* for each relevant threatened species, population and community to ensure that all relevant direct and indirect impacts have been considered.

Table 1.1 Method

Scope item	Guidelines assessed against	How each scope item was evaluated
		• Review assessment of impacts on potential groundwater dependent ecosystems.
Review the mitigation and management measures proposed and advise of the adequacy in mitigating impacts	N/A	• review management and mitigation measures for the pre-construction, construction and operational stages and assess their suitability for the threatened species, communities and populations to be impacted.
Evaluate the level of uncertainty of biodiversity impacts and provide advice on the resulting environmental risks	• *EPBC Act Policy Statement 1.1 Significant Impact Guidelines for Matters of National Environmental Significance*	• Review conclusions of each assessment of significance and the impact assessment chapter to determine any uncertainty openly identified (ie where the precautionary principle has been applied due to data gaps) by the report author. • Identify areas where data gaps exist and conclusions have been made without sufficient background data. • Identify potential risks resulting from data gaps and changes to the outcome of assessments of significance.
Provide a summary of the key impacts and opportunities associated with the project and the biodiversity study	N/A	• Summarise the key impacts and opportunities identified in the biodiversity report. • Summarise key data gaps and potential risks arising from these.

1.3 Limitations

This report is based on a desktop based assessment, with no field verification. Therefore, this review is reliant on the provision of information that is publically available, to determine the reliability and accuracy of the biodiversity study.

1.4 Components of the EIS reviewed

Three components of the EIS were reviewed, comprising the:

- Biodiversity Assessment (EIS Appendix K1) (GHD 2015b);
- Offsets Strategy (EIS Appendix K2) (GHD 2015c); and
- EIS Chapter 16 Biodiversity (GHD 2015a).

Other relevant background documents reviewed comprise the:

- *Guidelines for the content of a draft Environmental Impact Statement: Western Sydney Airport* (hereafter referred to as the EIS guidelines);
- *Draft Environmental Impact Statement Second Sydney Airport Proposal: Technical Paper 8 Flora and Fauna* (Biosis 1997); and
- Biodiversity Report: *Commonwealth Land at Badgery's Creek (SMEC 2014), hereafter referred to as 'the baseline report'*.

2 Detailed findings - Stage 1 development

2.1 Compliance of the Biodiversity Assessment with the Western Sydney Airport EIS Guidelines

Table 2.1 summarises the EIS guidelines with respect to biodiversity and assesses the compliance of the Biodiversity Assessment (EIS Appendix K1) with these guidelines. The Biodiversity Assessment (EIS Appendix K1)is generally compliant with the EIS guidelines, with a few exceptions. Items that are not compliant have been classified into:

- partially compliant: items that have been completed, however sufficient detail has not been provided; and
- not compliant: items that have not been considered.

These comprise:

- partial compliance:
  - a detailed outline of the monitoring and management has been provided, however the future management plans will detail the outcomes to be achieved and a framework for auditing their effectiveness;
  - the self-assessment of biodiversity survey effort is not quantitative (ie does not compare number of plots, targeted searches and fauna survey effort against the number of sampling points and effort required);
  - assessments of significance have been completed for most species and communities listed under the EPBC Act. However, assessments have not been completed for the Green and Golden Bell Frog (*Litoria aurea*), Australasian Bittern (*Botaurus poiciliioptilus*), Australian Painted Snipe (*Rostratula australis*) and migratory species, which are all considered likely to occur;
  - recovery plans have been considered in the assessments of significance. However, the recovery plans of species where assessments of significance were omitted (as above) have not been considered;
  - the EIS Chapter 16 and the Biodiversity Assessment (EIS Appendix K1) report state that high-probability groundwater dependent ecosystems occur in the project area. However, potential impacts to these groundwater dependent ecosystems as a result of the project have not been discussed;
  - potential traffic impacts to fauna are examined for the operational phase, but not the construction phase of the project; and
  - a detailed assessment of significance on the Greater Blue Mountains Heritage Area will be included in the final draft of the report following a multidisciplinary workshop to assess potential impacts.
- not compliant:

- a statement has not been provided regarding whether the impacts are unknown, unpredictable or irreversible;

- the predicted effectiveness, policy basis and likely cost of mitigation measures has not been assessed/provided;

- an Offsets Strategy (EIS Appendix K2) has been presented for the project, while the EIS guidelines require an offset package (ie finalised offset plan); and

- an analysis of how the Offsets Strategy (EIS Appendix K2) meets the requirements of the EPBC Act Environmental Offset Policy (SEWPaC 2012) has been provided. However, as this has not been finalised into an offset package, an assessment of how it meets the policy cannot be provided.

A detailed assessment of the Biodiversity Assessment's (EIS Appendix K1) compliance against the EIS guidelines is provided in Table 2.1. The adequacy of the Biodiversity Assessment (EIS Appendix K1) is discussed in further detail in the following sections.

Table 2.1 Overview of compliance of EIS Chapter 16 Biodiversity, Biodiversity Assessment (EIS Appendix K1) and Offsets Strategy (EIS Appendix K2) with the EIS guidelines

Relevant part of EIS guideline	Section addressed in the EIS Chapter 16	Section addressed in EIS Appendix K1	Section addressed in EIS Appendix K2	Compliance with EIS guidelines
Section 4 Description of the environment				
The EIS must include a description of the environment, land uses and character of the proposal site and the surrounding areas that may be affected by the action. It is recommended that this include the following information:				
(a) Listed threatened species (including suitable habitat) and ecological communities that are or are likely to be present in all areas of potential impact.	Section 16.3	Chapter 4	Section 2.1	**Compliant**
To satisfy this requirement details must be presented on the scope, timing/effort (survey season/s) and methodology for studies and surveys used to provide information on the relevant listed threatened species/ecological community/habitat (as identified in Attachment 3). This includes details of:	Section 16.2.3 (terrestrial) and 16.2.4 (aquatic)	Section 4.4	N/A	**Compliant**
• how best practice survey guidelines have been applied;	Section 16.2.3 (terrestrial) and 16.2.4 (aquatic)	Section 3.1	N/A	**Compliant**
• how surveys are consistent with (or a justification for divergence from) published Australian Government guidelines and policy statements.	Not detailed	Appendix B provides a general assessment of compliance, but does not quantify how these guidelines have been met.	N/A	**Partially compliant**
Section 5 Relevant impacts				
(a) The EIS must include a description of all of the relevant impacts of the action. Relevant impacts are impacts that the action will have or is likely to have on a matter protected by a controlling provision (as listed in the preamble of this document). Impacts during both the construction, operational and (if relevant) the decommissioning phases of the project should be addressed, and the following information provided:	Section 16.4 and 16.5	Chapter 5 and Chapter 6	N/A	**Compliant**
• a detailed assessment of the nature and extent of the likely short-term and long-term relevant impacts (detailing direct and indirect impacts);	Summary provided in Section 16.4 and 16.5	Section 5.1 and 5.2	N/A	**Compliant**
• a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible; and	Not provided	Not provided	N/A	**Not compliant**
• analysis of the significance of the relevant impacts; and any technical data and other information used or needed to make a detailed assessment of the relevant impacts.	Summary provided in Section 16.6	Summary provided in Chapter 8, Assessments of Significance in accordance with the EPBC Act	N/A	**Partially compliant**

Table 2.1 Overview of compliance of EIS Chapter 16 Biodiversity, Biodiversity Assessment (EIS Appendix K1) and Offsets Strategy (EIS Appendix K2) with the EIS guidelines

Relevant part of EIS guideline	Section addressed in the EIS Chapter 16	Section addressed in EIS Appendix K1	Section addressed in EIS Appendix K2	Compliance with EIS guidelines
		provided in Appendix D. It should be noted that Assessments of Significance were not prepared for the Green and Golden Bell Frog, Australasian Bittern, Australian Painted Snipe and migratory species were not completed because significant impacts were not predicted. Further information is provided in Section 2.2 of this report.		
(b) The EIS should identify and address cumulative impacts, where potential project impacts are in addition to existing impacts of other activities (including known potential future expansions or developments by the proponent and other proponents in the region and vicinity).	Not detailed	Chapter 7	N/A	Compliant
(c) The EIS should address the potential for facilitated impacts upon MNES at the local, regional, state, national and international scale.	Not detailed	Chapter 7	N/A	Compliant
(d) If the conclusion is made that any relevant controlling provision or element of a relevant controlling provision will not be impacted by the proposed action, then justification must be provided for how this conclusion has been reached. This includes any threatened species or ecological communities that are likely to be present on site, heritage items/places likely to be on site and other relevant elements of the environment that may be impacted by the proposed action.	Summary provided in Section 16.6	Summary provided in Chapter 8, assessments of significance in accordance with the EPBC Act provided in Appendix D. It should be noted that Assessments of Significance were not prepared for the Green and Golden Bell Frog, Australasian Bittern, Australian Painted Snipe and migratory species were not completed because significant impacts were not predicted. Further information is provided in Section 2.2 of this report.	N/A	Partially compliant
(g) Impacts to the environment (as defined in section 528) should include but not be limited to the following:				
• changes to water quality on site and downstream of the site;	Section 16.4.1.3	Section 6.1.7	N/A	Compliant

Table 2.1 Overview of compliance of EIS Chapter 16 Biodiversity, Biodiversity Assessment (EIS Appendix K1) and Offsets Strategy (EIS Appendix K2) with the EIS guidelines

Relevant part of EIS guideline	Section addressed in the EIS Chapter 16	Section addressed in EIS Appendix K1	Section addressed in EIS Appendix K2	Compliance with EIS guidelines
• changes to siltation;	Section 16.4.2	Section 6.1.8	N/A	Compliant
• hydrological changes;	Section 16.4.2	Section 4.2.4 states that high probability groundwater dependent ecosystems are present. However, the impacts to these are not assessed.	N/A	Partially compliant
• native flora and fauna habitat removal and degradation (on site and in surrounding areas that may be affected by the action);	Section 16.4.1.1	Section 5.1.2 (Stage 1) and 5.2.1 (Longer-term)	Section 2.2.1	Compliant
• aircraft noise and vibration impacts on everyday activities and on sensitive environmental receptors (all sensitive receptors within the community and natural environment);	Section 16.4.2	Section 5.2.2	N/A	Compliant
• noise and vibration from construction activities and machinery;	Section 16.4.2	Section 5.1.11	N/A	Compliant
• potential fuel dumping impacts;	Section 16.4.2.5	Section 5.2.2	N/A	Compliant
• changes in traffic movements during construction and operation (associated with both passenger movements and workers);	Not provided for construction. Detailed in and 16.5.1.2 (operation)	Not provided for construction. Detailed in Section 6.1.2 (operation)	N/A	Partially compliant
• bird or bat airstrike; and	Section 16.6.2.3 and 16.5.1.1	Section 6.1.1. It should be noted that a separate independent review is being completed to determine the adequacy of the bird and bat airstrike assessment.	N/A	Compliant
• lighting impacts on everyday activities and on sensitive environmental receptors (all sensitive receptors within the community and natural environment).	Summary provided in Section 16.4.2.7 (construction) and 16.5.2.1 (operation)	Section 5.1.11 (construction) and 6.1.4 (operation)	N/A	Compliant
Quantification and assessment of impacts should: • be against appropriate background/baseline levels;	Section 16.2.1 states that the baseline assessment (SMEC 2014) was used to verify results, against	Section 3.1.1 states that the baseline assessment (SMEC 2014) was used to verify results, against which the impact assessment was completed.	N/A	Compliant

Table 2.1 Overview of compliance of EIS Chapter 16 Biodiversity, Biodiversity Assessment (EIS Appendix K1) and Offsets Strategy (EIS Appendix K2) with the EIS guidelines

Relevant part of EIS guideline	Section addressed in the EIS Chapter 16	Section addressed in EIS Appendix K1	Section addressed in EIS Appendix K2	Compliance with EIS guidelines
	which the impact assessment was completed.			
• be prepared according to best practice guidelines and compared to best practice standards; and	Section 16.1 states that the assessment was prepared in accordance with the EIS guidelines.	Appendix B provides a general assessment of compliance, but does not quantify how these guidelines have been met.	N/A	Partially compliant
• be supported by maps, graphs and diagrams as appropriate to ensure information is readily understandable Guidelines and standards used to quantify baselines and impacts should be explained and justified.	Figures 16-1-A to 16-1-D, Figure 16-2-A to 16-2-D	Figure 4A to 4D, Figure 5A to 5D, Figure 6A to 6D	N/A	Compliant
6 Avoidance and mitigation measures				
(a) The EIS must provide information on proposed avoidance and mitigation measures to manage the relevant impact of the action on a matter protected by a controlling provision (as listed in the preamble of this document).	Section 16.7.1 provides a summary of minimisation measures. However, avoidance measures are not discussed.	Avoidance is discussed in Section 9.1 and minimisation measures are discussed in Section 9.2.	N/A	Compliant
(b) The EIS must take into account relevant agreements and plans that cover impacts or known threats to a matter protected by a controlling provision (including but not necessarily limited to:				
(i) any recovery plan and/or conservation advice for the affected species or ecological community	Discussed in Section 16.8.3.2, 16.3.3.4, 16.6.2.1 with respect to threatened species, populations and communities.	Recovery plans are considered in all assessments of significance in Appendix D, with the exception of the assessments of significance that were omitted.	N/A	Partially compliant
(ii) any threat abatement plan for a process that threatens an affected species or ecological community	Not discussed	Addressed in Section 8.1.3	N/A	Compliant
(iii) any wildlife conservation plan for the affected species	Discussed in Section 16.8.3.2, 16.3.3.4, 16.6.2.1 with respect	Recovery plans are considered in all assessments of significance in Appendix D, The Offsets Strategy (EIS	N/A	Partially compliant

Table 2.1 Overview of compliance of EIS Chapter 16 Biodiversity, Biodiversity Assessment (EIS Appendix K1) and Offsets Strategy (EIS Appendix K2) with the EIS guidelines

Relevant part of EIS guideline	Section addressed in the EIS Chapter 16	Section addressed in EIS Appendix K1	Section addressed in EIS Appendix K2	Compliance with EIS guidelines
	to threatened species, populations and communities.	Appendix K2) has not been finalised into an offset package. Therefore, an analysis cannot be provided.		
(iv) any relevant strategic assessment undertaken in accordance with an agreement under Part 10 of the EPBC Act.	Not described	Section 9.3.1 states that the future offset package would consider the North West and South West growth centres strategic assessment.	Section 1.2 states that the future offset package would consider the North West and South West growth centres strategic assessment.	**Compliant**
(v) the Greater Blue Mountains Area World Heritage property, the World Heritage Convention; the Australian World Heritage Management Principles; the Greater Blue Mountains Area World Heritage Area Strategic Plan, and relevant NSW National Parks and Wildlife Service/Office of Environment and Heritage Plans of Management.	Section 16.2.7	Appendix D states that a detailed assessment of significance of impacts on the BMWHA will be included in a Final Draft of this report after a multidisciplinary workshop is held to help identify and assess potential impacts.	N/A	**Partially compliant**
(c) The EIS must include specific and detailed descriptions of the proposed avoidance and mitigation measures based on best available practices. This must include the following elements:	Section 16.7.1 provides a summary of minimisation measures. However, avoidance measures are not discussed.	Avoidance is discussed in Section 9.1 and minimisation measures are discussed in Section 9.2.	N/A	**Compliant**
i. A consolidated list of mitigation measures proposed to be undertaken to prevent, minimise or compensate for the relevant impacts of the action, including:	Section 16.7.1 provides a summary of minimisation measures. However, avoidance measures are not discussed.	Table 70	N/A	**Compliant**
• a detailed description of proposed measures;	Section 16.7.1	Table 70	N/A	**Compliant**

Table 2.1 Overview of compliance of EIS Chapter 16 Biodiversity, Biodiversity Assessment (EIS Appendix K1) and Offsets Strategy (EIS Appendix K2) with the EIS guidelines

Relevant part of EIS guideline	Section addressed in the EIS Chapter 16	Section addressed in EIS Appendix K1	Section addressed in EIS Appendix K2	Compliance with EIS guidelines
	provides a summary of minimisation measures. However, avoidance measures are not discussed.			
• assessment of the expected or predicted effectiveness of the mitigation measures;	Not provided	Not provided	N/A	Not compliant
• any statutory or policy basis for the mitigation measures; and	Not provided	Not provided	N/A	Not compliant
• the likely cost of the mitigation measures.	Not provided	Not provided	N/A	Not compliant
ii. A detailed outline of a plan for the continuing management, mitigation and monitoring of relevant matters protected by a controlling provision, including a description of the outcomes that will be achieved and any provisions for independent environmental auditing.	Not described	Table 70 outlines the management and monitoring plans that will be completed for the project.	N/A	Partially compliant
iii. Where appropriate, each project phase (construction and operation) must be addressed separately. It must state the environmental outcomes, performance criteria, monitoring, reporting, corrective action, contingencies, responsibility and timing for each environmental issue.	Not described	Table 70 outlines the management and monitoring plans that will be completed for the project.	N/A	Partially compliant
iv. The name of the agency responsible for endorsing or approving each mitigation measure or monitoring program.	Not described	Table 70 outlines the management and monitoring plans that will be completed for the project, which would include the responsible agency.	N/A	Partially compliant
7 Residual impacts and offsets				
i) The EIS must provide details of the likely residual impacts upon a matter protected by a controlling provision after the proposed avoidance and mitigation measures have been taken into account. This includes:	Section 16.8.2	Section 9.3.2	Chapter 3	Compliant
• the reasons why avoidance or mitigation of impacts may not be reasonably achieved; and	Section 16.8.2	Section 9.3.2	Chapter 3	Compliant
• quantification of the extent and scope of significant residual impacts.	Section 16.8.2	Section 9.3.2	Chapter 3	Compliant
ii) The EIS must include details of an offset package to be implemented to	Section 16.8.3	Section 9.3.3 outlines the proposed	Chapter 4	Not compliant

Table 2.1 Overview of compliance of EIS Chapter 16 Biodiversity, Biodiversity Assessment (EIS Appendix K1) and Offsets Strategy (EIS Appendix K2) with the EIS guidelines

Relevant part of EIS guideline	Section addressed in the EIS Chapter 16	Section addressed in EIS Appendix K1	Section addressed in EIS Appendix K2	Compliance with EIS guidelines
compensate for residual significant impacts associated with the project, as well as an analysis of how the offset meets the requirements of the Department's Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy October 2012 (SEWPaC 2012).	discusses the proposed offset strategy	offset strategy, and the compliance of the strategy against the EPBC offset policy. This offset strategy has not yet been finalised into an offset package.	outlines the proposed offset strategy. However, no analysis is provided on how the offsets meet the EPBC Act Environmental Offset Policy (SEWPaC 2012).	
b) The offset package can comprise a combination of direct offsets and other compensatory measures, as long as it meets the requirements of the EPBC Act Environmental Offset Policy. Offsets should align with conservation priorities for the impacted protected matter and be tailored specifically to the attribute of the protected matter that is impacted in order to deliver a conservation gain.	Section 16.8.3 discusses the proposed offset strategy, which only includes direct offsets. The offset package has not yet been finalised, however the strategy only references impacts from the Stage 1 development with no consideration of the subsequent long term development.	Section 9.3.3 discusses the proposed offset strategy, which only includes direct offsets. The offset package has not yet been finalised, however the strategy only references impacts from the Stage 1 development with no consideration of the subsequent long term development.	Chapter 4 outlines the proposed offset strategy, which only includes direct offsets. The offset package has not yet been finalised, however the strategy only references impacts from the Stage 1 development with no consideration of the subsequent long term development.	Not compliant
c) Offsets should compensate for an impact for the full duration of the impact.	Section 16.8.3.1	Section 9.3.3 states that offsets will	Section 1.3.2	Compliant

Table 2.1 Overview of compliance of EIS Chapter 16 Biodiversity, Biodiversity Assessment (EIS Appendix K1) and Offsets Strategy (EIS Appendix K2) with the EIS guidelines

Relevant part of EIS guideline	Section addressed in the EIS Chapter 16	Section addressed in EIS Appendix K1	Section addressed in EIS Appendix K2	Compliance with EIS guidelines
	states that offsets will be protected into perpetuity.	be protected into perpetuity.	states that offsets will be protected into perpetuity.	
d) Offsets must directly contribute to the ongoing viability of the protected matter impacted by the project and deliver an overall conservation outcome that maintains or improves the viability of the protected matter, compared to what is likely to have occurred under the 'status quo' (i.e. if the action and associated offset had not taken place).	As the offset strategy and package has not been finalised, this cannot be determined.	As the offset strategy and package has not been finalised, this cannot be determined.	As the offset strategy and package has not been finalised, this cannot be determined.	Partially compliant
e) Note: offsets do not make an unacceptable impact acceptable and do not reduce the likely impacts of a proposed action. Instead, offsets compensate for any residual significant impact.	Section 16.8.2 states that the purpose of offsets is to compensate for residual impacts.	Section 9.3.2 states that the purpose of offsets is to compensate for residual impacts.	Chapter 3 states that the purpose of offsets is to compensate for residual impacts.	Compliant
f) The EIS must provide: i details of the offset package to compensate for significant residual impacts on a protected matter; and	Section 16.8.2 provides details of the offset strategy. The offset package has not been finalised.	Section 9.3.2 provides details of the offset strategy. The offset package has not been finalised.	Chapter 3 provides details of the offset strategy. The offset package has not been finalised.	Not compliant
ii an analysis of how the offset package meets the requirements of the EPBC Act Environmental Offsets Policy (SEWPaC 2012).	The offset package has not been finalised. Therefore, an analysis cannot be provided.	The offset package has not been finalised. Therefore, an analysis cannot be provided.	The offset package has not been finalised. Therefore, an analysis cannot be provided.	Not compliant

2.2 Validity of data relied upon

The validity of the data relied upon in the Biodiversity Assessment (EIS Appendix K1) (GHD 2015b) was tested against 11 criteria, listed in Table 2.2. The data relied upon in the Biodiversity Assessment (EIS Appendix K1)are valid, with the exception of three criteria which are partially valid (ie some information has been omitted). Some threatened and migratory species have not been considered. While they are not expected to occur in the project area, it was required that this was considered and documented accordingly. Assessments of significance were not completed for the Green and Golden Bell Frog, Australasian Bittern, Australian Painted Snipe and migratory species listed under the EPBC Act. A comparison of the Offsets Strategy (EIS Appendix K2) was provided against the EPBC Act Environmental Offset Policy (SEWPaC 2012). However, as the offset strategy has not yet been finalised into an offset package, an effective comparison against the policy cannot be made.

Table 2.2 Validity of data relied upon

Criteria to test validity of data relied upon	Assessment	Validity of data relied upon
Compare local vegetation mapping datasets to those identified in the Biodiversity Assessment (EIS Appendix K1) to determine if vegetation types are accurate.	The vegetation types in the Biodiversity Assessment were compared to the baseline assessment (SMEC 2014) and vegetation mapping for the Cumberland Plain (NPWS 2002). Vegetation types in the Biodiversity Assessment were found to be consistent.	Valid
Review of justification for plant community types assigned in accordance with the Vegetation Information System to check accuracy.	The plant community types assigned in the biodiversity assessment were compared to their descriptions in the Vegetation Information System (OEH 2015a). These were found to be consistent.	Valid
Compare database search results to those identified in the biodiversity assessment to ensure all relevant threatened biodiversity have been identified and considered.	The Biodiversity Assessment (EIS Appendix K1) considered all threatened flora and fauna species listed under the EPBC Act that are predicted to occur in the locality (DoE 2015), with the exception of the Dural Land Snail. Whilst the species distribution is outside the project area, as it was predicted by the Protected Matters Search Tool (DoE 2015), it was required to be considered and documented accordingly in the Biodiversity Assessment (EIS Appendix K1). Irrespective of distribution, it is a DoE requirement to report all species predicted to occur by the Protected Matters Search Tool. It is noted that this species has been recently listed on the EPBC Act. Four migratory species listed under the EPBC Act were also not considered. Whilst they were not expected to occur in the project area (based on the habitat types), they were required to be considered and documented accordingly. These comprise: • Oriental Cuckoo – non-breeding vagrant to Australia, therefore habitat in the project area is not important to the species; • Black-faced Monarch – only occurs in rainforest, which is absent from the project area; • Yellow Wagtail – non breeding vagrant to Australia, therefore habitat in the project area is not important to the species; and • Satin Flycatcher – only occurs in tall wet forest, which is absent from the project area. Whilst not required to consider state environmental and planning legislation due to the Commonwealth *Airports Act 1996*, the EIS stated that it would consider relevant state legislation, which includes the NSW *Threatened Species Conservation Act 1995* (TSC Act).	Partially valid

Table 2.2 Validity of data relied upon

Criteria to test validity of data relied upon	Assessment	Validity of data relied upon
	Further, Section 1.1 of the Offsets Strategy (EIS Appendix K2) states that DoE instructed the proponent to include impacts to species listed under the TSC Act in the offset package. The Biodiversity Assessment (EIS Appendix K1) considered all threatened flora and fauna species and populations listed under the TSC Act that have been previously recorded in the locality (OEH 2015b).	
Review preliminary determinations for threatened species, populations and communities to ensure they are considered.	The Biodiversity Assessment (EIS Appendix K1) has not reviewed preliminary determinations. There are currently nine preliminary determinations, none of which are relevant to the project area.	Valid
Compare the list of target threatened biodiversity to those identified in the baseline study to ensure all relevant target biodiversity has been identified.	The Biodiversity Assessment (EIS Appendix K1) builds upon the results of the baseline study and is consistent with its findings.	Valid
Review of known threats to the threatened biodiversity identified.	Section 8.1 of the Biodiversity Assessment (EIS Appendix K1) identifies relevant key threatening processes.	Valid
Review the likelihood of occurrence for threatened biodiversity, to ensure all relevant species have been considered.	The likelihood of occurrence was reviewed for all species considered. I agree with the assessment. It is worth noting that the White-bellied Sea Eagle was considered as a migratory species under the EPBC Act. This species was delisted shortly after the EIS was exhibited.	Valid
Review the assessments of significance to ensure the necessary assessments have been completed.	Assessments of significance have been completed for most of the relevant species in accordance with the EPBC Act. However, no assessments carried out for the Green and Golden Bell Frog, Australasian Bittern, Australian Painted Snipe or migratory species that were deemed 'possible' to occur in the project area. The EPBC Act Policy Statement 1.1 Matters of National Environmental Significance guidelines (DoE 2013) state that their purpose is to: *'The significant impact criteria, set out on the following pages, for each matter of national environmental significance, are intended to assist you in determining whether the impacts of your proposed action on any matter of national environmental significance are likely to be significant impacts'.* In consideration of the above, assessments of significance should have been completed for the abovementioned species.	Partially valid
Review calculations and assumptions used in the Commonwealth offset calculator.	The calculations and assumptions used in the Commonwealth offset calculator have been reviewed, and are commensurate to the impacts of the project and the value of the offset sites.	Valid
Comparison of offset package against the offset principles in the EPBC Act Environmental Offsets Policy (SEWPaC 2012).	Section 9.3.4 of the Biodiversity Assessment (EIS Appendix K1) has compared the offset strategy against the offset principles in the EPBC Act Environmental Offsets Policy (SEWPaC 2012). However, as the Offsets Strategy (EIS Appendix K2) has not yet been finalised into an offset package, an effective comparison against the policy cannot be made.	Partially valid

2.3 Validity of assumptions

The validity and consistency of the assumptions in Section 1.5 of the Biodiversity Assessment (EIS Appendix K1) was evaluated against the content of EIS Chapter 16, the Biodiversity Assessment (EIS Appendix K1) and the Offsets Strategy (EIS Appendix K2), and the EIS guidelines. One assumption was found to be partially valid, one was not valid, and four assumptions were valid.

Table 2.3 Validity of assumptions

Assumption	Assessment	Validity
No vegetation clearing or other direct impacts would occur outside the airport site to meet the requirements of the proposed airport's Obstacle Limitation Surface (OLS) or for other significant infrastructure.	The *Western Sydney Infrastructure Plan* (DIRD 2015) identifies the need for significant infrastructure, comprising upgrades to the existing Bringelly Road and The Northern Road, and a new motorway connecting the M7 and The Northern Road. These significant infrastructure projects have been assessed separately to the EIS, and therefore only need to be considered with respect to cumulative impacts with the Stage 1 development and long-term development.	**Partially valid**
The environmental conservation zones shown on Figure 2 would be managed as open space. Native vegetation would be retained and would be available as refuge habitat for displaced fauna and translocated snails, frogs, habitat resources etc. as required.	The *Standard instrument - Principal Local Environmental Plan 2015* does not contain an 'open space' zoning. Section 9.2 of the Biodiversity Assessment (EIS Appendix K1) states that the cleared parts of the proposed environmental conservation zone would be revegetated. A more appropriate zoning for this area would be E2 Environmental Conservation, as the zone objectives aim to: • protect, manage and restore areas of high ecological, scientific, cultural or aesthetic values; and • prevent development that could destroy, damage or otherwise have an adverse effect on those values. However, if a Biobanking agreement is established in this area (see Section 2.6.1), rezoning to E2 is not recommended as the land would generate more offset credits if it retained its rural zoning.	**Not valid**
Assessments of significance have been prepared in accordance with the '*Matters of National Environmental Significance Significant Impact Guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999*' (DotE 2013a) for impacts on threatened biota and other MNES and the '*Significant Impact Guidelines 1.2 - Actions on, or impacting upon, Commonwealth land and Actions by Commonwealth Agencies*' (DotE 2013b) for impacts on flora and fauna. Impacts on other aspects of the environment are discussed in the EIS and relevant technical reports.	These are the correct guidelines to assess impacts on matters of national environmental significance.	**Valid**
The biodiversity offset package is for Stage 1 only and includes the preferred approach to offsetting along with the specific detail that was available at the time of publication.	The Offsets Strategy (EIS Appendix K2) does not explicitly state that its purpose is to only compensate for the Stage 1 development's impacts, however the long-term development is not considered. The EIS guidelines require that offsets are calculated for the	**Not valid**

Table 2.3 Validity of assumptions

Assumption	Assessment	Validity
	entire project, which would include both the Stage 1 development and long-term development.	
Offsets on threatened biota listed under the EPBC Act have been calculated with reference to the EPBC Act Environmental Offset Policy.	The EIS guidelines require that offsets for matters of national environmental significance are calculated in accordance with the EPBC Act Environmental Offset Policy.	**Valid**
The suite of biodiversity credits that would be presented to offset impacts on threatened biota listed under the EPBC Act and TSC Act have been calculated using BioBanking.	Section 1.1 of the Offsets Strategy (EIS Appendix K2) states: *'Further consultation with the Commonwealth Department of the Environment (DotE) has revealed that the estimate of offsets for residual impacts on the environment, including threatened biota and their habitats listed under the New South Wales (NSW) Threatened Species Conservation Act 1995 (TSC Act), should be calculated using the NSW Biodiversity Banking and Offsets Scheme (BioBanking) assessment methodology'.* Therefore, credits have also been calculated using BioBanking.	**Valid**

2.4 Validity of conclusions

The validity of the conclusions reached in the Biodiversity Assessment (EIS Appendix K1) was tested against the intensity, duration, magnitude and geographic extent of the project's expected impacts. The impacts have been deemed significant for Cumberland Plain Shale Woodland and Shale-Gravel Transition Forest critically endangered ecological community and the Grey-headed Flying-fox. These conclusions have been deemed valid.

Assessments of significance have not been completed for threatened species, populations and communities listed under the TSC Act, as this is not required for the project. As stated in Section 1.1 of the Offsets Strategy (EIS Appendix K2)(, the impacts to threatened biodiversity listed under the TSC Act will be accounted for by finding and securing suitable offsets in accordance with the NSW Biodiversity Banking and Offsets Scheme (BioBanking) assessment methodology. These conclusions have been deemed valid.

No conclusion has been reached with respect to the impacts on high-priority groundwater dependent ecosystems in the conservation area, or outside the project area. This conclusion is partially valid as the information is incomplete.

2.5 Efficacy of proposed mitigation and management measures

2.5.1 Design

The Biodiversity Assessment (EIS Appendix K1) recommended measures to be implemented at the design stage to address four issues, comprising:

- fauna hazard: development of a wildlife hazard management plan and implementing ways to make the airport less attractive to fauna (and reduce wildlife hazard);
- hydrology: design of surface water systems that are sensitive to downstream environments;

- waterway crossings: in accordance with *Policy and guidelines for fish habitat conservation and management* (DPI 2013); and

- lighting: as far as is practical, reducing light spill.

These proposed measures are considered suitable for implementation at the design stage. However, it may be very difficult to achieve a reduction in light spill from the project, to the extent that nocturnal fauna would still use brightly lit areas adjacent to the project. Increased light is known to be a deterrent to some nocturnal species that will move away from suitable habitat if it is too brightly lit.

2.5.2 Pre-construction

The Biodiversity Assessment (EIS Appendix K1) recommended a number of measures for the pre-construction stage, comprising:

- the preparation of a construction environmental management plan (CEMP) and relevant sub-plans;

- worker inductions;

- sediment and erosion controls;

- deferral of vegetation clearance and habitat loss as long as practical;

- inclusion of disease management (ie *Phytopthora cinnamomi,* Myrtle Rust and Chytrid Fungus) in the CEMP;

- development of threatened fauna management plans;

- development of a threatened flora translocation plan;

- completion of pre-clearance surveys for threatened species;

- development of a habitat clearing and fauna management protocol;

- preparation of a weed management plan;

- development of an unexpected finds protocol;

- development of a dam decommissioning protocol; and

- development of a bushfire management plan.

The measures were compared against the expected impacts identified in Section 5.1 (construction impacts) of the Biodiversity Assessment (EIS Appendix K1). The recommended measures are considered suitable for this stage of the project. Their effectiveness should be determined through the development of review and monitoring protocols within each of the management plans to be developed. Each management plan should also be prepared in consultation with the relevant agencies (ie DoE for the threatened species management plan).

2.5.3 Construction

The Biodiversity Assessment (EIS Appendix K1) has recommended a number of measures to minimise biodiversity impacts during construction. These comprise:

- water quality management in accordance with the ANZECC (2000) guidelines;
- groundwater seepage treatment prior to discharge;
- reduction of lighting spill;
- implementation of erosion and sediment controls in accordance with the CEMP;
- implementation of weed management in accordance with the CEMP;
- fauna management, including the completion of pre-clearance surveys and the use of a fauna spotter/catcher to safely relocate fauna outside the clearing area;
- implementation of threatened species management plans; and
- implementation of dam decommissioning protocol.

The measures have been compared against the expected impacts identified in Section 5.1 (construction impacts) of the Biodiversity Assessment (EIS Appendix K1). The recommended measures are considered suitable for the construction stage of the project. Their effectiveness should be determined through the monitoring and reporting protocols within each of the management plans to be developed and conditions of approval.

2.5.4 Pre-operation and operation

The Biodiversity Assessment (EIS Appendix K1) has recommended a number of pre-operation and operational measures to minimise biodiversity impacts. These comprise:

- active bird and bat strike management;
- the development of operational environmental management plans (OEMPs);
- preparation of a vegetation management plan;
- compliance with the *Quarantine Act 1908*;
- compliance with wildlife strike management practices prescribed by the *Civil Aviation Safety Requirements 1998*;
- implementation of the bushfire management plan;
- implementation of measures to manage contaminants; and
- implementation of stormwater and water quality measures.

The measures were compared against the expected impacts identified in Section 6.1 (operational impacts) of the Biodiversity Assessment (EIS Appendix K1). The recommended measures are considered suitable for the operational stage of the project, with the exception of the Vegetation Management Plan. It is recommended that the Vegetation Management Plan is prepared at the pre-construction stage to adequately manage the clearing operations and salvage of habitat resources for use in the proposed conservation zone and biodiversity offset sites. The effectiveness of these measures should be determined through the monitoring and reporting protocols within each of the operational environmental management plans to be developed and conditions of approval.

2.6 Level of uncertainty regarding impacts and environmental risks

2.6.1 Uncertainty identified by the author

The author of the Biodiversity Assessment (EIS Appendix K1) has stated that there were limitations with respect to weather conditions, access, and targeted surveys for the Green and Golden Bell Frog:

> The targeted Green and Golden Bell Frog surveys were conducted towards the end of the nominated September-March survey period because of property access restrictions. On no occasion did a total of greater than 50 mm of rain fall in the week prior to a given survey as is specified in the EPBC Act significant impact guidelines for the species (DEWHA 2009a). However conditions were warm, humid and still and other frog species were calling and were active and easily detected during surveys at the airport site. Green and Golden Bell Frogs were active (but not calling) at the reference site and were readily observed. Given these considerations it is likely that the targeted Green and Golden Bell Frog surveys would have detected the species if a population was present at the airport site.

However, the author has stated that the following measures should be implemented for the species, prior to construction:

> ...additional targeted searches of the airport site for the Green and Golden Bell Frog in optimal conditions to confirm that they are not present at the site (surveys for the species were conducted at the end of the survey season and were subject to access constraints as discussed in Section 3.4.3). A management plan should be prepared as a sub plan to the CEMP to provide more detail on Green and Golden Bell Frog relocation and habitat management should this species be located during targeted surveys. Frog collection and relocation would need to be conducted by appropriately experienced ecologists.

Given the inclusion of this measure, it appears that there is some uncertainty from the author whether the Green and Golden Bell Frog is present in the project area. As the survey did not access all properties and the conditions were not optimal (although it is acknowledged that they were close to optimal), I agree that this additional targeted survey is completed for the species in the project area when access is granted, during optimal weather conditions.

The author of the Biodiversity Assessment (EIS Appendix K1) states in Section 1.3.1 that an environmental conservation zone would be established, and that it would be managed for the purposes of biodiversity conservation. Section 5.1.2 on native vegetation clearing states that:

> Impacts would be further mitigated by the retention of around 122 hectares of land in the environmental conservation zone, including around 61 hectares of native vegetation and representative areas of each of the vegetation types at the airport site (see Figure 4). All or part of the 61 hectares of land within the conservation zone that does not currently contain native vegetation could be revegetated.

However, the protection mechanism for the environmental conservation zone has not been discussed. Despite containing vegetation communities that would be impacted by the project and the potential to reduce the offset deficit, the environmental conservation zone has not been included in the Offsets

Strategy (EIS Appendix K2). If the environmental conservation zone was protected under a BioBanking agreement it would have protection into perpetuity and ongoing management funding. Its protection under an environmental conservation zone only does not provide protection into perpetuity and ongoing management funding, therefore the continued ability of these areas to mitigate the project's impacts are uncertain.

2.6.2 Data gaps and potential associated risks

- Key data gaps were identified in the Biodiversity Assessment (EIS Appendix K1) and Offsets Strategy (EIS Appendix K2) which relate to:land access restrictions;
- assessments of significance; and
- offset requirements

i Land access restrictions

The Biodiversity Assessment (EIS Appendix K1) states that land access was not possible in all areas and some survey seasons. However, the report does not detail or provide any map to show the extent of land that could not be accessed, and the methods used to assess the biodiversity values in areas of restricted access.

The risk associated with restricted land access is that biodiversity values and offset requirements may have been underestimated in these areas, if suitable methods were not employed to address data gaps, ie assessing aerial imagery, available vegetation mapping datasets and biodiversity databases to infer biodiversity values.

ii Assessments of significance

Assessments of significance were not completed for the following species that have been deemed 'possible' to occur in the project area:

- Australasian Bittern;
- Australian Painted Snipe; and
- migratory species listed under the EPBC Act.

The author stated that the assessments were not completed as impacts to these species were not predicted to be significant. The EPBC Act Policy Statement 1.1 Matters of National Environmental Significance guidelines (DoE 2013) state that their purpose is to:

> The significant impact criteria, set out on the following pages, for each matter of national environmental significance, are intended to assist you in determining whether the impacts of your proposed action on any matter of national environmental significance are likely to be significant impacts.

In consideration of the above, assessments of significance should have been completed for the abovementioned species to adequately consider potential impacts.

In addition, the Green and Golden Bell Frog was considered by the author to have a low probability of occurrence. However, the author has recommended that an additional targeted survey should be completed for the species to verify their presence (or otherwise) despite close to optimal survey conditions. As there is some doubt, the precautionary principle should have been applied in this instance, and an assessment of significance should have been completed.

Where there is risk of serious or irreversible harm, it is necessary to establish whether there is adequate scientific knowledge of the subject to evaluate the perceived threat. Where risk of serious or irreversible harm and lack of scientific knowledge of the nature of environmental harm combine, the precautionary principle applies. Case law has established that if the precautionary principle is triggered the proponent bears the burden of proof for demonstrating that their actions will not cause environmental harm (Preston 2008 in RMS 2014).

The potential risks association with not completing assessments of significance for these species are that the proposed mitigation and offsets may not account for their specific requirements.

iii Offset requirements

Section 7a of the EIS guidelines state that an offset package must be developed for the project. However, the Offsets Strategy (EIS Appendix K2) has not been finalised into an offset package (ie all offsets identified to compensate for project impacts), and only refers to offsets required for the Stage 1 development. In addition, the offset sites identified do not satisfy the requirements of the EPBC Act Offset Policy (SEWPaC 2012).

The author of the Offsets Strategy (EIS Appendix K2) against the EPBC Act Environmental Offset Policy (SEWPaC 2012). The author states:

> The outcome of these preliminary EPBC offset assessment calculations is that:
>
> - the proposed offset areas containing around 180 hectares of EPBC Act Cumberland Plain Woodland would offset 59 per cent of the proposed airport's impacts on the ecological community;
>
> - the proposed offset areas containing around 79 hectares of poorer condition Cumberland Plain Woodland would offset around 15 per cent of the proposed airport's impacts on the ecological community, resulting in a total offset contribution of 74 per cent of the proposed airport's impacts;
>
> - the proposed offset areas containing up to 401 hectares of habitat for the Grey-headed Flying-fox would offset around 136 per cent of the proposed airport's impacts on this vulnerable species.
>
> Based on these preliminary calculations, the proposed offset sites could not meet all of the proposed airport's EPBC Act offsetting requirements as direct offsets. Additional offset sites containing Cumberland Plain Woodland will be identified throughout the environmental assessment and approval process for the proposed airport and will be included in the final offset package.

As the Offsets Strategy (EIS Appendix K2) cannot achieve a 90% direct offset, it does not meet criteria 4 of the EPBC Act Environmental Offset Policy (SEWPaC 2012), in that it is not 'of a size and scale proportionate to the residual impacts on the protected matter'. Therefore, the Offsets Strategy (EIS Appendix K2) currently does not meet the requirements of the EPBC Act Environmental Offset Policy (SEWPaC 2012). The above statetement also says that additional offset sites will be identified during the environmental assessment and approval process. Given the approval pathway for the development, the finalised EIS (which considers the issues raised during the public exhibition of the draft EIS) would need to include a final offset package to satisfy the EPBC Act Environmental Offset Policy (SEWPaC 2012). Following finalisation of the EIS, the DotE notifies the DIRD (as determining authority) of any conditions to be included to protect the environment. The statement within the Offsets Strategy (EIS Appendix K2) is not clear that the offset package will be finalised for the review of DotE..

As referenced in Section 1.1 of the Offsets Strategy (EIS Appendix K2), the proponent was instructed by the Commonwealth to use the NSW Biodiversity Offset and Banking Scheme to estimate offsets for residual impacts on the environment. A review of this information indicates large deficits for offsets calculated using the NSW Biodiversity Offset and Banking Scheme. This comprises a deficit of 5,689 ecosystem credits for HN528 (Cumberland Plain Woodland critically endangered ecological community), 156 credits for HN512 (Shale-Gravel Transition Forest endangered ecological community) and 688 credits for HN630 (Freshwater Artificial Wetlands). If the Biobanking metric used to convert the credits into hectares is used (ie division of credits by 9.3), the credit deficit for Cumberland Plain Woodland translates to approximately 645 ha of the community. This is a large area and it has not yet been determined if sufficient offsets exist in the area that would meet these credit requirements. In addition, a large number of species credits are required, totalling 6,723. The author has completed a preliminary assessment of the proposed offset sites to provide these species credits. The feasibility of the offset sites providing the required species credits therefore has not yet been determined.

3 Detailed findings – long-term development

3.1 Overview of approach to assessment to long-term development taken in the Biodiversity Assessment

The Biodiversity Assessment (EIS Appendix K1) investigated the biodiversity values of the entire project area (ie Stage 1 and long-term) in their method and results. Therefore, their assessment of impacts is based upon the current biodiversity values, and the threatened species, populations and communities that currently occupy the site.

The author provided a general assessment of the direct and indirect long-term development impacts for both the construction and operational stages of the project, separately to the Stage 1 development. Although not explicitly stated as the purpose in the Offsets Strategy (EIS Appendix K2), the author has only provided biodiversity offset calculations for the Stage 1 development, and has not provided calculations for long-term development. In addition, the Offsets Strategy has not identified how and when suitable offsets for the long-term development would be identified.

3.2 Gaps identified relative to a comprehensive/ conventional assessment

The Biodiversity Assessment (EIS Appendix K1) identified the current biodiversity values of the long-term development area, and assesses impacts on this basis. However, the long-term development is forecast to commence in approximately 2050. It is very difficult to predict the biodiversity values of the long-term development area in 35 years time. As the clearing of these areas will be deferred until approximately 2050, their biodiversity values may degrade, and therefore the impact of their removal would be lower than is currently predicted. Conversely, the biodiversity values of these areas may increase through good management (ie higher number of threatened flora and fauna species present), and therefore the impact of their removal may be greater than is currently predicted. For example, the removal of key threatening processes such as 'predation by the Eastern Gambusia' may lead to expansion of the Green and Golden Bell Frog population (if present) or re-colonisation (if not currently present). It is also likely that new species and communities will be listed in the years leading up to 2050, and the current biodiversity planning and assessment legislation may change.

3.3 Key risks and implications as a result of the gaps

The Biodiversity Assessment (EIS Appendix K1) does not acknowledge the effect of the biodiversity management applied for the Stage 1 development, and how its success may influence biodiversity of the area in 35 years time for the longer-term development (ie regeneration of vegetation communities and/or improvement of corridors and habitat connectivity.

Key risks and implications resulting from a potential increase in biodiversity values leading up to 2050 include:

- underestimation of the range of the mitigation and management measures required to account for threatened biodiversity in the long-term development area; and

- no consideration of the successful implementation of biodiversity management measures for the Stage 1 development and its influence on the biodiversity of the area for the long-term development.

3.4 Effectiveness of assessment in setting a framework for further assessment

The Biodiversity Assessment (EIS Appendix K1) has not set a framework for further assessment of the long-term development area. It is acknowledged that it would be very difficult to do so, as an assessment can only be made based on the current biodiversity values of the long-term development area. However, the following measures are recommended for inclusion to ensure that threatened biodiversity impacts of the longer-term development are adequately managed and offset:

- review of current listings of threatened species, populations and communities prior to construction of the longer-term development area;
- consider the successful implementation of biodiversity management measures for the Stage 1 development and its influence on the biodiversity of the area for the longer term development; and
- review the current biodiversity legislation, assessment and offsetting requirements, prior to construction of the long-term development area.

4 Key impacts

4.1 Key project impacts to biodiversity

The Biodiversity Assessment (EIS Appendix K1) has identified the following key impacts relevant to threatened biodiversity listed under the EPBC Act:

- the loss of 90 ha of Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest critically endangered ecological community; and

- the loss of 120 ha of habitat critical to the survival of the Grey-headed Flying-fox, a species listed as vulnerable.

The Biodiversity Assessment (EIS Appendix K1) has determined that the project is likely to result in a significant impact for this community and species, and that offsets are required in accordance with the EPBC Act Environmental Offsets Policy (SEWPaC 2012).

The Biodiversity Assessment (EIS Appendix K1) also identified the following key impacts relevant to threatened biodiversity listed under the TSC Act which were required to be considered in the estimate of residual impacts using the NSW Biodiversity Offset and Banking Scheme:

- removal of the local occurrence of *Pultenaea parviflora,* a vulnerable shrub;

- removal of the local occurrence of *Marsdenia viridiflora* subsp. *viridiflora* endangered population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas;

- the loss of 221.3 ha of Cumberland Plain Woodlands in the Sydney Basin Bioregion critically endangered ecological community, 34.1 ha of River Flat Eucalypt Forest in the Sydney Basin Bioregion endangered ecological community and 2.6 ha of Shale Gravel Transition Forest in the Sydney Basin Bioregion endangered ecological community;

- the removal of 120.6 ha of known habitat of the endangered Cumberland Plain Land Snail; and

- removal of and fragmentation of known habitat for the vulnerable Eastern Freetail Bat (*Mormopterus norfolkensis*) and potential habitat for the Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Greater Broadnosed Bat (*Scoteanax rueppellii*) and Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*).

The Biodiversity Assessment (EIS Appendix K1) has determined that the project is likely to result in significant impacts to these threatened species, populations and ecological communities, and that biodiversity offsets are required in accordance with the NSW Biobanking framework.

4.2 Key opportunities

Key opportunities of the project comprise:

- location of airport site on predominantly cleared land, comprising 784 ha; and
- identification of potentially suitable offset sites on private property that may have otherwise degraded and subjected to key threatening processes listed under the TSC and EPBC Acts, including:
  - the clearing of native vegetation;
  - invasion of native plant communities by African Olive;
  - aggressive exclusion of birds from potential woodland and forest habitat by overabundant Noisy Miners;
  - forest eucalypt dieback associated with overabundant psyllids and Bell Miners;
  - clearing of hollow-bearing trees; and
  - removal of dead wood and dead trees.
- in addition to the offsets, the creation of an on-site environmental conservation zone covering 122 ha. This environmental conservation zone currently contains 61 ha of native vegetation representative of the vegetation types to be cleared. The remainder of the area not currently containing native vegetation (ie 61 ha) would be revegetated.

5 Conclusion

The Biodiversity Assessment (EIS Appendix K1), Offsets Strategy (EIS Appendix K2) and EIS Chapter 16 of the *Western Sydney Airport EIS* have been reviewed. The purpose of the review was to:

- determine the compliance of these reports with the EIS guidelines;
- test the validity of data relied upon, assumptions and conclusions;
- determine the efficacy of proposed mitigation and management measures;
- determine the level of uncertainty regarding impacts and environmental risks;
- examine the efficacy of the assessment approach with respect to longer-term development; and
- identify key project impacts and opportunities.

The review was completed by comparing the methods, results, impact assessment and offsets against the relevant government guidelines, and by comparison with a structured set of criteria.

The Biodiversity Assessment (EIS Appendix K1), Offsets Strategy (EIS Appendix K2) and EIS Chapter 16 were found to be generally compliant with the EIS guidelines. Some items were found to be partially compliant, where further information was required to comply with the guidelines. However, some items were also found to be non-compliant where required items had not been considered.

The underlying assumptions of the Biodiversity Assessment (EIS Appendix K1) were valid, with the exception of three criteria tested. Although their distribution is outside the project area, one threatened and four migratory species listed under the EPBC Act had not been considered. Assessments of significance were not completed for three threatened species and a number of migratory species that may occur in the project area. The Offsets Strategy (EIS Appendix K2) had also been compared against the EPBC Act Environmental Offsets Policy (SEWPaC 2012). However, as the Offsets Strategy (EIS Appendix K2) has not been finalised into an offset package, an effective comparison against the policy cannot be made. These items were deemed as 'partially valid', as additional information is required to achieve compliance with the EIS guidelines.

The proposed mitigation and management measures were deemed effective for the current stage of the project. Further detail is required to be included in the CEMP and specific sub-plans to be developed. The efficacy of these plans can be tested in the future through the development and implementation of monitoring and reporting protocols contained within the plans.

Data gaps and associated risks were identified, relating to:

- land access restrictions: the extent of land access restrictions has not been clearly identified in the Biodiversity Assessment (EIS Appendix K1). Biodiversity values and offset requirements may have been underestimated in these areas if suitable methods were not employed to address data gaps;
- threatened species assessment: assessments of significance were not completed in accordance with the EPBC Act for the Green and Golden Bell Frog, Australasian Bittern, Australian Painted Snipe and a number of migratory species. If these assessments predict that impacts are significant, then the biodiversity has underestimated the level of impact and offsets required; and

- proposed offsets: the offsets do not meet the EPBC Act Environmental Offsets Policy (SEWPaC 2012) of providing a 90% direct offset. In addition, there is a large deficit in the proposed offsets under the BioBanking scheme, particularly for Cumberland Plain Woodland critically endangered ecological community, which equates to approximately 645 ha. It is not currently known if this large area of this critically endangered ecological community is available to secure as biodiversity offsets.

The Biodiversity Assessment (EIS Appendix K1) has provided a general assessment of the adverse direct and indirect long-term development impacts of the project. This assessment is based upon the current biodiversity values of the longer-term project area. It is acknowledged that accurate assessment of the long-term impacts is difficult as they will occur approximately 35 years from now, when the area may have degraded (ie reduced biodiversity value) or improved (ie increased biodiversity value) through successful implementation of biodiversity measures from the Stage 1 development. In addition, new threatened species, populations and/or communities may be listed, and the biodiversity planning and assessment legislation and mechanisms may have changed.

It is recommended that the following measures are implemented to ensure that threatened biodiversity impacts of the long-term development are adequately managed and offset:

- review of current listings of threatened species, populations and communities prior to construction of the longer-term development area;

- consider the successful implementation of biodiversity management measures for the Stage 1 development and its influence on the biodiversity of the area for the long-term development; and

- review of the current biodiversity legislation, assessment and offsetting requirements, prior to construction of the long-term development area.

6 Qualifications and study team

6.1 Lead peer reviewer - Katie Whiting – BSc, MWldMgt (Habitat)

Katie is EMM's Ecology Services Manager and the nominated lead peer reviewer for the project. She has over a decade of experience in ecological and environmental consulting, and has a broad range of experience in infrastructure projects. Katie provides expert ecological advice to her clients and their projects. She has led biodiversity assessments for state significant infrastructure projects, and has a strong background in:

- peer review for biodiversity assessments;
- ecological and environmental impact assessment;
- preparation of Commonwealth referrals;
- threatened biodiversity survey, monitoring and assessment; and
- biodiversity offsets.

Katie has successfully completed the Biobanking Assessor Accreditation Course and is in the process of applying for accreditation through the OEH.

In addition to her strong technical experience, Katie has excellent communication skills and high ethical standards. She communicates with clients in an open and practical manner to achieve best-for-project outcomes. Katie also has great time management skills and has a strong focus on delivering projects on time and within budget.

Katie's CV is provided at Appendix A.

6.2 Strategic direction - Duncan Peake – BSc (Hons)

Duncan is a very experienced Project Director and peer reviewer of complex environmental impact assessments, inclusive of high profile state significant developments in NSW. He has extensive experience working within the framework of the EPBC Act for a range of infrastructure projects, including at airports with the Commonwealth as the proponent. Duncan has the following directly relevant experience for the project:

- has over 15 years experience in the preparation of environmental impact assessments for state significant development within the NSW and Commonwealth planning framework;
- is a nominated pre-qualified EIS peer reviewer for the NSW Department of Planning and Environment;
- has managed environmental assessments for airports and associated infrastructure; and
- obtained approvals for state significant development under the EPBC Act.

Duncan has provided strategic direction to the project and a technical and quality review of the document prior to submission. Duncan's CV is provided at Appendix A.

References

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Appendix A

Qualifications of reviewers

Curriculum vitae


Duncan Peake

Associate Director

Duncan is an Associate Director with over 15 years experience in environmental impact assessment (EIA), environmental compliance auditing, environmental management and community and stakeholder engagement in Australia, Europe and Africa. He has considerable experience in the following sectors: mining, extractive industries, transport, energy industry, agriculture, oil and gas and waste management.

Duncan has specialised in EIA for state significant development and infrastructure under the NSW *Environmental Planning and Assessment Act 1979*.

Duncan has considerable project management and direction experience in the development of approval strategies and the preparation of EIAs for large infrastructure projects.

Qualifications and memberships

- Bachelor of Science (Hons) in Applied Economic Geography, University of New South Wales, 2000
- Member of the Environment and Sustainability Committee for the Urban Development Institute of Australia, NSW branch, 2011–2014

Career

- EMM Consulting, 2009–present
- Associate Environmental Planner, AECOM (formerly HLA-Envirosciences), 2005–2009
- Environmental Planner, Environmental Resources Management, Sydney and Edinburgh, 2000–2005

Representative experience

Key environmental impact assessment and approvals

- Mount Thorley and Warkworth Continuation Projects, Singleton LGA NSW (Rio Tinto Coal Australia)
- Mangoola Coal Mine Modification 6, Muswellbrook LGA NSW (Glencore)
- Warkworth Mine Extension, Singleton LGA (Warkworth Mining)
- Mount Pleasant Project modifications, Mount Pleasant NSW (Rio Tinto Coal Australia)
- Gloucester Gas Project modifications, Gloucester LGA NSW (AGL Energy)
- Integrated oilseed processing and biodiesel plant, Wagga Wagga NSW (ROBE)

Environmental management plans

- Baal Bone Colliery, annual environmental management plan, Wallerawang NSW (Wallerawang Collieries)
- Hunter Gas Project Exploration, Hunter Valley NSW (AGL Energy)
- Gloucester Gas Project Exploration, Gloucester NSW (AGL Energy)
- Mount Pleasant Project, Mount Pleasant NSW (Rio Tinto Coal Australia)
- Camden Gas Projects, Camden NSW (AGL)

Environmental compliance auditing

- Doyles Creek Exploration Program, independent compliance audit, Doyles Creek NSW (Sparke Helmore Lawyers)

Other environmental impact assessment and approvals

- Teven Quarry modifications, Teven NSW (Boral Resources)
- Mount Pleasant, modification to operations, Mount Pleasant NSW (Rio Tinto Coal Australia)
- Camden Gas Project, coal seam methane expansion, Spring Farm and Menangle Park NSW (AGL)
- Attemperation Reservoir, capacity increase, Sydney NSW (Eraring Energy)
- Camden Gas Project Modifications, Camden NSW (AGL Energy)
- Continued operation of Baal Bone Colliery, Lithgow NSW (Xstrata coal)
- Camden Gas Project, northern expansion, Camden NSW (AGL Energy)
- Upgrade and extension of electricity distribution line along Wolgan Road, Wolgan Valley NSW (Emirates)
- Geothermal Energy, various locations in rural NSW (AGL Energy)

Review of environmental factors

- Rookwood Road Substation, Rookwood NSW (TransGrid)
- Hunter Gas Project, Windermere pilot testing, Hunter Valley NSW (AGL Energy)
- Hunter Gas Project, Spring Mountain pilot testing, Hunter Valley NSW (AGL Energy)
- Gloucester Gas Project, corehole exploration, Gloucester NSW (AGL Energy)
- Gloucester Gas Project, 2D seismic exploration, Gloucester NSW (AGL Energy)
- Gloucester Gas Project, Waukivory pilot testing, Waukivory NSW (AGL Energy)
- Gloucester Gas Project, Wards River pilot testing, Wards River NSW (AGL Energy)

Environmental risk assessments

- Coleambally Ethanol Plant, scoping study, Coleambally NSW (AIE)
- Mount Pleasant, environmental gap analysis, Mount Pleasant NSW (Rio Tinto Coal Australia)

Environmental opportunities and constraints analysis for a new coal mine, Hunter Valley NSW (confidential)

Curriculum vitae


Katie Whiting

Ecology Services Manager

Katie is EMM's Ecology Services Manager. She provides expert ecological advice to clients and has led studies with complex technical issues. Katie has a strong focus on achieving best for project outcomes, and works closely with her clients to find balanced solutions.

Katie has extensive experience in ecological and environmental impact assessment, threatened biodiversity survey and providing practical on site biodiversity management assistance to construction teams.

Katie's ecological expertise lies in the survey of microchiropteran bats including harp trapping, ultrasonic detection and the collection of reference calls. Katie is skilled in the identification and analysis of ultrasonic bat call signatures.

Qualifications and memberships

- Bachelor of Science in Ecology, Macquarie University, 2003
- Master of Wildlife Management (Habitat), Macquarie University, 2008
- Australasian Bat Society — extended executive
- Australasian Bat Society – NSW Flying-fox subcommittee

Career

- EMM Consulting, 2011–present
- Senior Ecologist, SMEC Australia, 2007–2011
- Environmental Consultant, SPA Consulting, 2004–2007

Representative Experience

Ecological impact assessments and due diligence

- Sydney Sewer Rehabilitation Program ecological impact assessments, Sydney NSW, Abergeldie Watertech
- Hume Coal Project Terrestrial Ecology Impact Assessment, Southern Highlands NSW (Hume Coal Pty Ltd)
- North West Rail Link Due Diligence Ecological Assessment, Sydney NSW (Lend Lease)
- HVO North Fine Reject Emplacement Modification Ecological Assessment, Singleton NSW (Coal & Allied);
- Cobbora Coal Project, Cobbora NSW (Cobbora Holding Company)
- Moolarben Coal Project Stage 1, optimisation modification, Moorlarben NSW (Moolarben Coal)
- Talbragar Quarry Ecological Assessment, Dubbo NSW (Boral Country)
- Allandale Quarry Expansion ecological assessment, (Quarry Products Newcastle)

Ecological impact statements

- Hume Coal Project, Southern Highlands NSW (Cockatoo Coal)
- Majura Parkway Project, Pialligo ACT (Roads ACT)
- Clarrie Hermes Drive Extension, Nicholls ACT (Roads ACT)
- Kings Highway Upgrade, Kowen district ACT (Roads ACT)

Curriculum vitae


Katie Whiting

Peer review services

- Goonbri Road Biodiversity Assessment Peer Review, Narrabri NSW (Narrabri Shire Council)
- Objection to Moorebank Waste Facility Biodiversity Assessment, Sydney NSW (Investa Property Group)
- Moorebank Intermodal Offset Review (assistance to peer reviewer), Sydney NSW (Moorebank Intermodal Company Ltd)

Expert witness services

- Broken Head Quarry Redevelopment Expert Witness, Ballina NSW (Broken Head Quarries)
- Allandale Quarry (assistance to expert witness), Hunter Valley NSW (Quarry Products Newcastle)

Ecological monitoring and management plans

- Auburn Stabling Project Grey-headed Flying-fox monitoring project, Sydney NSW (Transport for NSW)
- North West Rail Link Project baseline ecological monitoring, Sydney NSW (Lend Lease)
- Tarcutta Bypass, threatened species monitoring, Tarcutta NSW (Tarcutta Hume Alliance)
- Upper Nepean Borefields, baseline ecological monitoring, Sydney NSW (Sydney Catchment Authority)
- Georges River, estuary process study, Sydney NSW (Georges River Combined Council’s Committee)
- Prospect Creek, strategic management plan and rehabilitation plan, Sydney NSW (Fairfield City Council)

Fauna mitigation and on-site ecological management

- HVO South and Mount Thorley Warkworth pre-clearance surveys, Hunter Valley NSW (Rio Tinto Coal Australia)
- Johns River and Seaham Quarry pre-clearance survey and fauna rescue, NSW (Boral)
- North West Rail Link Early Works pre-clearing surveys, fauna rescue and nest box allocation, Sydney NSW (Lend Lease)
- Tarcutta Bypass, fauna rescue and nestbox allocation, Tarcutta NSW (Tarcutta Hume Alliance)
- Holbrook Bypass, fauna rescue and nestbox allocation, Holbrook NSW (Abigroup; RTA)
- Hume Highway, nestbox survey, pre-clearing surveys and fauna rescue, Wagga Wagga NSW (Northern Hume Alliance; RTA)

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