APPENDIX I - REVISED AERONAUTICAL IMPACT ASSESSMENT

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Aeronautical Impact Assessment

Future Land Use at 275 Adams Road Luddenham, NSW

Client

Coombes Property Group
EMM Consulting

LB00403

Final V4

18 December 2020

Version No.	Basis of issue	Author	Date
Draft v001	Draft report for submission to Client	PWW	26 May 2020
Draft v002	Updated report with client amendments	PWW	4 June 2020
Draft v003	Updated following meeting with WSACo	PWW	15 June 2020
Draft v004	Update to address DPIE feedback	PWW	6 July 2020
Final V1	Final Report	PWW	15 July 2020
Final V2	Final report updated following WSA feedback	PWW	16 December 2020
Final V3	Final report following liaison with AsA	PWW	17 December 2020
Final V4	Final report addressing client feedback	PWW	18 December 2020

Contents

1 Executive Summary

CFT No 13 Pty Ltd, a member of Coombes Property Group (CPG), has recently acquired the property at 275 Adams Road, Luddenham NSW (Lot 3 in DP 623799. "the site") within the Liverpool City Council municipality. The site is host to an existing shale/clay quarry.

CPG owns, develops and manages a national portfolio of office, retail, entertainment, land and other assets. The company's business model is to retain long-term ownership and control of all its assets. CPG has the following staged vision to the long-term development of the site:

- **Stage 1 Quarry Reactivation: Solving a problem:**
  - CPG intends to responsibly avoid the sterilisation of the remaining natural resource by completing the extraction of shale which is important to the local construction industry as raw material used by brick manufacturers in Western Sydney. Following the completion of approved extraction activities at the end of 2024, the void will be prepared for rehabilitation.
- **Stage 2 Advanced Resource Recovery Centre (ARRC) and Quarry Rehabilitation: A smart way to fill the void:**
  - CPG in partnership with KLF Holdings Pty Ltd (KLF) and in collaboration between the circular economy industry and the material science research sector, intends to establish a technology-led approach to resource recovery, management, and reuse of Western Sydney's construction waste, and repurposing those materials that cannot be recovered to rehabilitate the void. This will provide a sustainable and economically viable method of rehabilitating the void for development.
- **Stage 3 High Value Employment Generating Development: Transform the land to deliver high value agribusiness jobs:**
  - CPG intends to develop the rehabilitated site into a sustainable and high-tech agribusiness hub supporting food production, processing, freight transport, warehousing, and distribution, whilst continuing to invest in the resource recovery R&D initiatives. This will deliver the vision of a technology-led agribusiness precinct as part of the Aerotropolis that balances its valuable assets including proximity to the future Western Sydney Airport (WSA) and the Outer Sydney Orbital.

This aeronautical impact assessment relates to the establishment of the ARRC in Stage 2 described above.

The proposed ARRC, with buildings to a likely height of approximately 16 metres AGL m (80 m AHD) and temporary construction crane activity to approximately 90 to 100 m AHD:

- will not infringe the OLS surface of approximately 110 m to 125.5 m AHD above the site;
- will not infringe the Basic ILS PANS OPS surfaces of approximately 84 m AHD at the south east edge of the quarry and 138 m at the south east corner of the ARRC;
- is located outside of the PANS OPS surface for the Standard Instrument Departures (SIDS);
- will not infringe the likely PANS OPS surface for Instrument Flight Rules (IFR) Circling Procedures if they are implemented;
- will not infringe any Building Restricted Areas (BRA) for navigation aids associated with the ILS;
- will not infringe any BRA for the Ground Based Augmentation System (GBAS) during WSA Stage 1 airport development, but is likely to infringe the BRA for the GBAS if the GBAS is located at the northern site indicated at WSA Stage 2 airport development diagrams;
- will not impact upon Air Traffic Control (ATC) Surveillance or Communication systems;
- is located in an area where ANEC noise contours permit development of Light Industrial or Other Industrial;
- will not produce an exhaust plume that will require assessment by the Civil Aviation Safety Authority (CASA) due to proposed activity at the ARRC and likely planning controls;
- is located within Zone C and Zone D of the airport lighting zones that surround the airport, requiring lighting visible above the horizontal to be less than 150 Cd and 450 Cd respectively;
- is unlikely to cause any additional hazard from sunlight reflections due to reflectivity values of other objects in the area;
- is located outside of the likely Public Safety Area (PSA) templates;
- is likely to reduce the potential for wildlife collisions with aircraft because the development's activities at the ARRC are likely to reduce the amount of natural habitat available to the existing number of birds in the area and activities will not be conducive to attracting extra wildlife to the area;
- the ARRC operator would be a willing participant on an airport safety committee, if established;

- will not cause any adverse wind shear effects as the development site is located outside of the assessment area for wind shear impacts; and
- is unlikely to create any significant dust hazards that would reduce flight visibility below the recommended distance of 5000 m.

Construction of the ARRC will commence immediately upon receipt of Development Approval and will be complete prior to the first runway being constructed and therefore before any aircraft operations at WSA.

Airservices Australia, as the navigation aid authority in Australia, will need to conduct their own analysis of the development site's impact on navigation aids.

Plans are provided in Appendix B of the environmental impact assessment. Updated plans will be provided as part of the response to submissions report. If the ARRC is approved, the ARRC will need to be constructed in accordance with these plans.

2 Introduction

2.1 Overview

CPG in partnership with KLF Holdings Pty Ltd (KLF) are seeking development consent for the construction and operation of an advanced resource recovery centre (ARRC) on 275 Adams Road, Luddenham, NSW (Lot 3, DP 623799) The overall property shares its southern and eastern boundaries with the Western Sydney Airport (WSA) development site, with the ARRC approximately 250 north of the airport boundary.

CPG also proposes to reactivate quarrying operations to complete extraction activities, through a modification of existing consent SSD DA 317-7-2003. Extraction activities will cease at the end of 2024.

The ARRC will enable landfilling of unrecyclable building materials into the quarry. This will ultimately fill the quarry, allowing for the complete rehabilitation of the quarry area and a future use consistent with the vision of the Draft Western Sydney Aerotropolis Plan (Western Sydney Planning Partnership 2019).

The nearest point of the overall site is located approximately 1100 m north of the WSA Aerodrome Reference Point and approximately 250 m north west of the centreline of Runway 05L/23R, immediately adjacent to the perimeter of the airport as per **Figure 1**.

The ARRC component of the overall site is approximately 480 m from the centreline of RWY 05L/23R.

Both WSA runways are proposed to be 60 m wide and be provided with Runway Strips (RWS) 140 m either side of the centreline of the runway. The boundary of the quarry site is located outside of the RWS.

The ARRC will be completely enclosed by a building with a proposed maximum height of 16 m AGL. Excavation of the ARRC site to provide a level slab for the building base at 64 m AHD will therefore provide a maximum building elevation of 80 m AHD, at the top of the roof ridge.

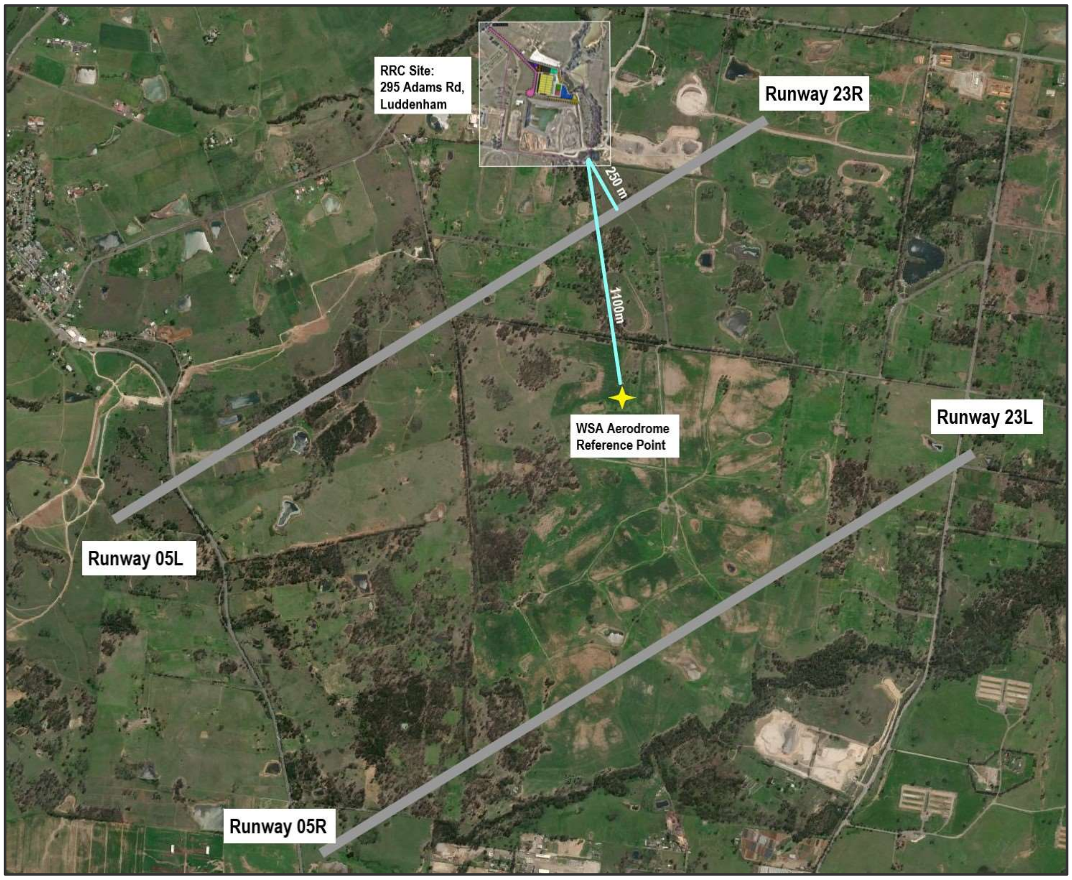


Figure 1: Site location in relation to proposed runway layout.

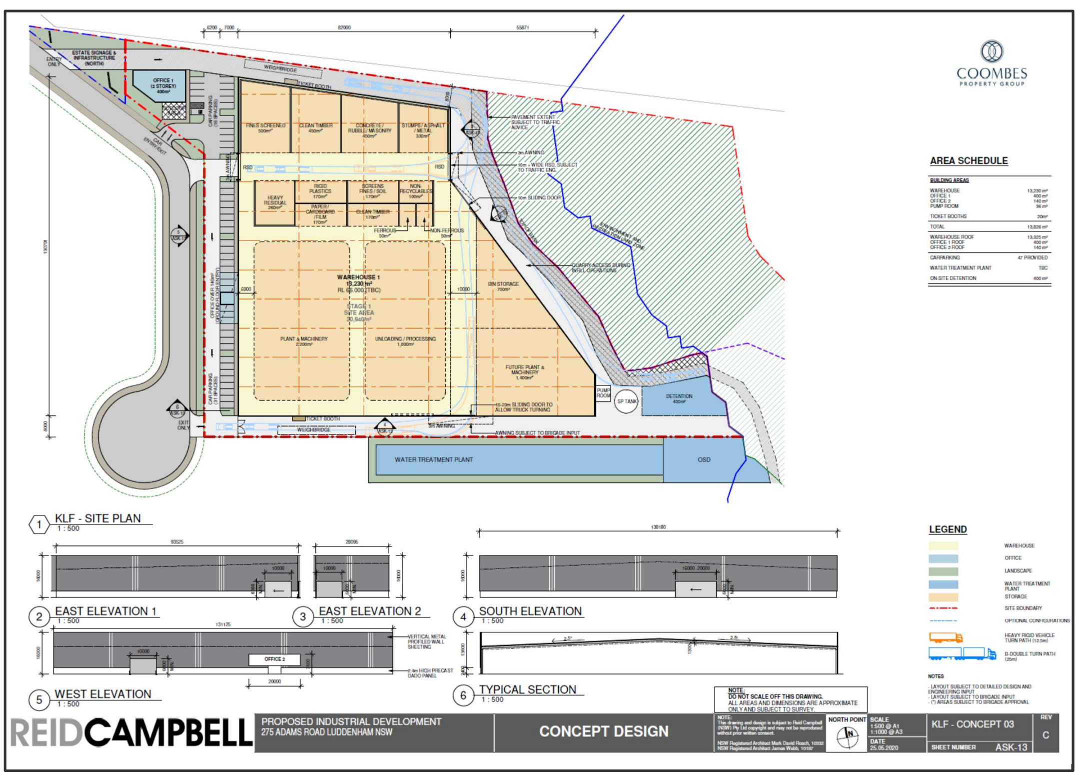


Figure 2: Advanced Resource Recycling Centre Site Layout (CPG)

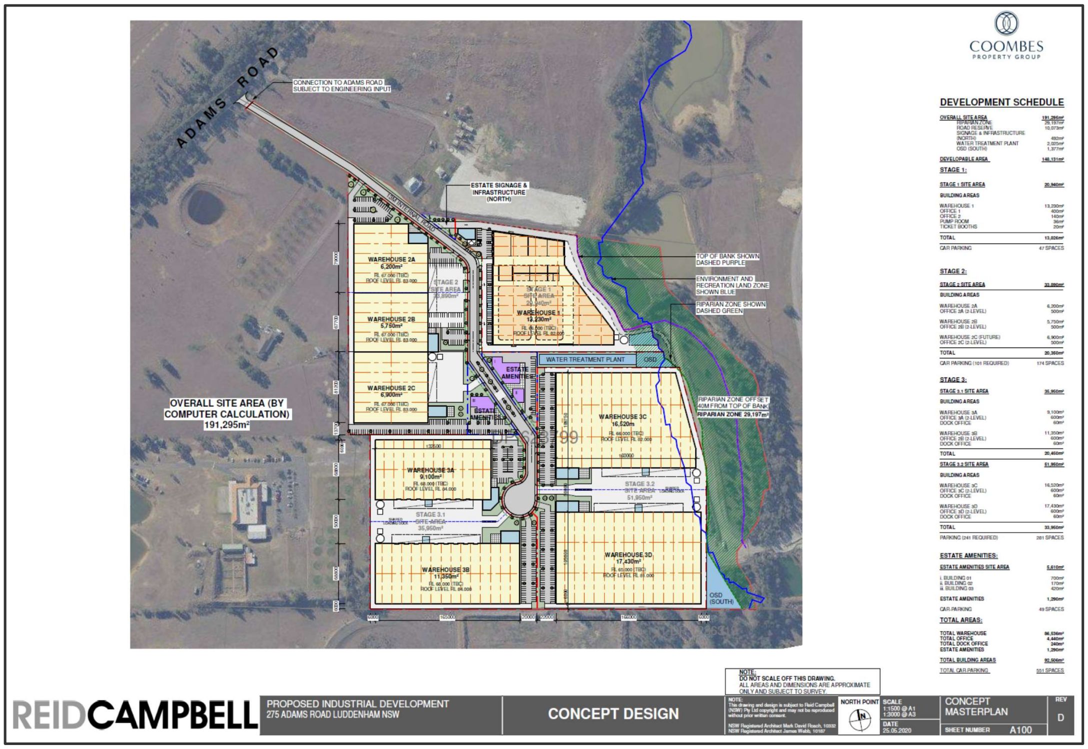


Figure 3: Future Development of Rehabilitated Quarry Site (CPG)

2.2 AIA Overview

CPG has tasked Landrum & Brown Worldwide (Australia) Pty Ltd to prepare an Aeronautical Impact Assessment (AIA) to address the proposed future land uses at 275 Adams Road, Luddenham, NSW.

These include:

- Development of the Advanced Resource Recycling Centre (ARRC);
- Restart and continue quarry operations until the end of 2024 as currently approved;
- Filling the quarry after the cessation of quarrying operations;
- Rehabilitation of the quarry areas to provide final landform;
- Commercial and Industrial development of the quarry site that would complement WSA operations.

The AIA involves the assessment of the aviation environment around the development to determine any likely impact of any buildings, quarry operations, construction crane activity and wildlife attractors, within the proposed ARRC and quarry site in relation to any of the following:

- Protection of Prescribed Airspace (Airports Act 1996);
  - Draft Obstacle Limitation Surfaces for Western Sydney Airport existing over the development site;
  - Draft Procedures for Air Navigation Services – Aircraft Operations (PANS OPS) surfaces for that exist over the development site;
  - Vertical emissions causing air turbulence;
  - Dust and smoke emissions from quarrying operations that could be capable of affecting the ability of an aircraft to operate in Prescribed Airspace in accordance with the Visual Flight Rules;
- Wind shear assessment requirements in accordance with National Airspace Safeguarding Framework (NASF) Guideline B;
- Wildlife strike assessment in accordance with NASF Guideline C;
- Lighting in the Vicinity of Airport in accordance with NASF Guideline E;
- Glint and Glare assessment requirements;
- Possible impact on air traffic control (ATC) communications facilities, navigational aids and radar coverage in accordance with NASF Guideline G;
- SEARS requirements under the EIS.

In preparing aeronautical impact assessments associated with airport safeguarding and protection, it is necessary to observe the requirements of the relevant aviation authorities including:

- The Department of Infrastructure, Transport, Regional Development and Cities (DITRDC);
- The Civil Aviation Safety Authority of Australia (CASA);
- Airservices Australia (ASA); and
- Western Sydney Airport Corporation.

Relevant Acts and Regulations applicable to developments near airports and air traffic routes were referenced during this assessment.

The major relevant documents include:

- Airports Act 1996, Part 12 – Protection of Airspace around Airports;
- Civil Aviation Safety Regulation (CASR) Part 139 Manual of Standards – Aerodromes;
- Aeronautical Information Publication (AIP);
- Airservices Australia's Airways Engineering Instruction – Navigation Aid Building Restricted Areas and Siting Guidance (BRA);
- International Civil Aviation Organisation (ICAO) DOC 8168 Procedures for Air Navigation – Aircraft Operations (PANS OPS);
- Issued Planning Secretary's Environmental Assessment Requirements (SEARS);
- Western Sydney Airport – Airport Plan 2016;
- Western Sydney Aerotropolis Plan - Draft for Public Comment – December 2019;
- Airservices Australia – Western Sydney Airport Preliminary Airspace Management Analysis – 10 April 2015.

A Glossary of Aeronautical Terms and Abbreviations is shown at Appendix D.

3 Western Sydney Airport Prescribed Airspace

Although the WSA Runway locations have been planned, Obstacle Limitation Surfaces have been declared and provisional Instrument Landing System (Basic ILS) PANS OPS surfaces have been shown in an Airservices Australia document, there is still the possibility that they may change slightly as the construction program progresses and consequently, the airport's Prescribed Airspace may also change slightly.

WSA data used to determine the probable Prescribed Airspace above the propose development site was determined from information published on WSA's website - https://westernsydney.com.au/

Major reports referenced are:

- Western Sydney Airport – Airport Plan 2016;
- Western Sydney Aerotropolis Plan - Draft for Public Comment – December 2019;
- Airservices Australia – Western Sydney Airport Preliminary Airspace Management Analysis – 10 April 2015.

Regular discussions and consultation with WSACo and Airservices Australia will continue as the airport layout and systems are defined. This is a standard process that is ongoing, using in the form of an airport safety committee, for the life of all projects to ensure that aviation safety standards are maintained to the required level.

3.1 Airspace Overview

The Airports (Protection of Airspace Regulations) 1996 specifies volumes of Prescribed Airspace related to Federally leased airports and the under-development Western Sydney Airport, that protect them from uncontrolled obstacle growth that may have an adverse impact upon flight safety or the regularity of flight operations at those airports.

Prescribed Airspace for an airport is the airspace above any part of the:

- Obstacle Limitation Surfaces (OLS);
- PANS OPS (Procedures for Air Navigation Services – Aircraft Operations) surfaces; and
- Other airspace declared under Regulation 5 (Protection of Airspace Regulations 1996).

Flight operations at an airport are protected from uncontrolled obstacle intrusion by Obstacle Limitation Surfaces (OLS) and the PANS OPS (Procedures for Air Navigation Services – Aircraft Operations) surfaces which are published in Airport Master Planning Documents for the use of local planning authorities to show areas where building activity requires consideration of aviation requirements and in Aeronautical Publications for the use of pilots during pre-flight planning processes and in-flight operations to ensure that the airport is capable of supporting their planned operation.

The OLS are conceptual surfaces associated with runways that are designed to protect aircraft operations from unrestricted obstacle growth. Intrusions into some areas of the OLS can be approved subject to an aeronautical study that shows that the obstacle does not have an adverse impact upon flight safety or the regularity of operations at the airport.

The PANS OPS surfaces are designed above terrain and obstacles that provide instrument approach and departure flight paths with a prescribed minimum obstacle clearance above the obstacles or terrain to enable safe and efficient aircraft operations in Instrument Meteorological Conditions (IMC) during which flight crews cannot necessarily see the ground or obstacles and they must rely upon aircraft instrumentation to determine their position in relation to navigation aids and runways.

Permanent infringements of PANS OPS protection surfaces are not supported by the aviation authorities, however, temporary activities such as construction cranes may be able to be approved subject to support from the airport, Airservices Australia and CASA for limited periods of time.

Construction of the ARRC is planned to commence immediately after Development Approval is obtained and will be completed prior to the finished construction of the first runway and prior to any aircraft operations at WSA.

3.2 Obstacle Limitation Surfaces

The OLS at Western Sydney Airport comprises:

- conical surface;
- inner horizontal surface (IHS);
- approach surface for each runway;
- inner approach surface for each runway;
- transitional surface for each runway;
- inner transitional surface;
- baulked landing surface; and
- take-off climb surface for each runway.

The Luddenham ARRC is located within the lateral limits of the Inner Horizontal Surface (IHS) of the OLS prescribed for WSA,

The south eastern corner of the developments site is located beneath the TS with a lowest elevation of 110 m AHD increasing in a north westerly direction to 125.5 m at the intersection of the TS with the IHS. The IHS then covers the ARRC site at 125.5 m AHD.

Figure 4: Site Location in relation to OLS contours

Ground elevation over the development site varies from approximately 62 m AHD at the south eastern corner of the quarry to approximately 68 m at the north western corner of the proposed ARRC.

The ARRC will be completely enclosed by a building with a proposed maximum height of 16 m AGL. Excavation of the ARRC site to provide a level slab at 64 m AHD will therefore provide a maximum building elevation of 80 m AHD, at the top of the roof ridge.

Assessment: the proposed ARRC will not infringe the OLS surface of 125.5 m AHD.

3.3 PANS OPS Surfaces

Draft PANS OPS surfaces related to the Basic ILS surfaces and the Standard Instrument Departures (SID) for each runway have been presented by Airservices Australia for the preliminary phase of the construction and operation of the airport in their "Western Sydney Airport Preliminary Airspace Management Analysis – Final Report" dated 10 April 2015.

Noise contours provided within NSW DPIE document: Western Sydney Aerotropolis Plan – Draft for Public Comment dated December 2019 (ANEC Contours Page 44) indicate that straight in approaches to each runway are being provided.

The Basic ILS surfaces are identical to the GBAS Basic surfaces.

3.3.1 Basic ILS

The Basic ILS surfaces are very conservative and may be infringed if an assessment of the Obstacle Assessment Surfaces (OAS) or application of the Collision Risk Model determines a safe result for the overall obstacle environment surrounding the airport.

The lowest Basic ILS surfaces above the ARRC is related to the Runway 23R ILS and is at a height of 138 m AHD at the nearest edge of the ARRC site.

The development site is located within, but at the outer edges of the Basic ILS surfaces for Runway 05R/23L and are in the order of 300 m above the runway. They are not affected.

Table 1 shows the lowest Basic ILS surfaces above the listed points within the development site.

Basic ILS Procedure	Location within Site	Surface Height (m AHD)
Runway 05L	SE Edge of ARRC	144
Runway 05L	Warehouse 1	155
Runway 05L	SE Corner of Quarry	144
Runway 05L	SW Corner of Quarry	143
Runway 23R	**SE Edge of ARRC**	**138**
Runway 23R	Warehouse 1	138
Runway 23R	SE Corner of Quarry	84
Runway 23R	SW Corner of Quarry	124

Table1: BASIC ILS PANS OPS Surface Heights

Assessment: the proposed ARRC will not infringe the Basic ILS and GBAS PANS OPS surfaces of approximately 84 m AHD at the south east edge of the quarry and 138 m at the south east corner of the ARRC.

3.4 SIDS

The SID procedures have PANS OPS surface determined by the Procedure Design Gradient (PDG) that is the minimum climb gradient that aircraft are required to perform to in order to ensure obstacle clearance during the initial climb after take-off.

The development site is in an area that does not have any affect upon the SID procedures. **Figure 5** shows the site location outside of the PANS OPS surfaces for the SID procedures.

Assessment: the proposed ARRC is located outside of the PANS OPS surface for the SIDS.

3.5 Other Instrument Approach Procedures

Other instrument approach procedures will be promulgated for WSA once construction of the first runway, Runway 05L/23R, nears completion. RNAV (GNSS) and RNP-AR (see Appendix C) approaches are likely to be implemented for both runways. Obstacle clearance in the area over the proposed development site is likely to be in the order of 75 m above any part of the highest structure within the entire airport and surrounding infrastructure, providing adequate clearance to not impact on the efficiency of future approach procedures.

Assessment: the proposed ARRC will not infringe the OLS or PANS OPS surfaces.

3.6 IFR Circling

If IFR Circling procedures are enabled at WSA then minimum heights over the development site will be at least 90 m above the highest obstacle in the relevant area.

If the ATC Tower is the highest obstacle (assume 60 m AGL- 144 m AHD) then the IFR procedure minimum altitude is likely to be 234 m AHD.

Assessment: the proposed ARRC at a proposed maximum height of 16 m AGL will not infringe the likely PANS OPS surface for IFR Circling Procedures if they are implemented.

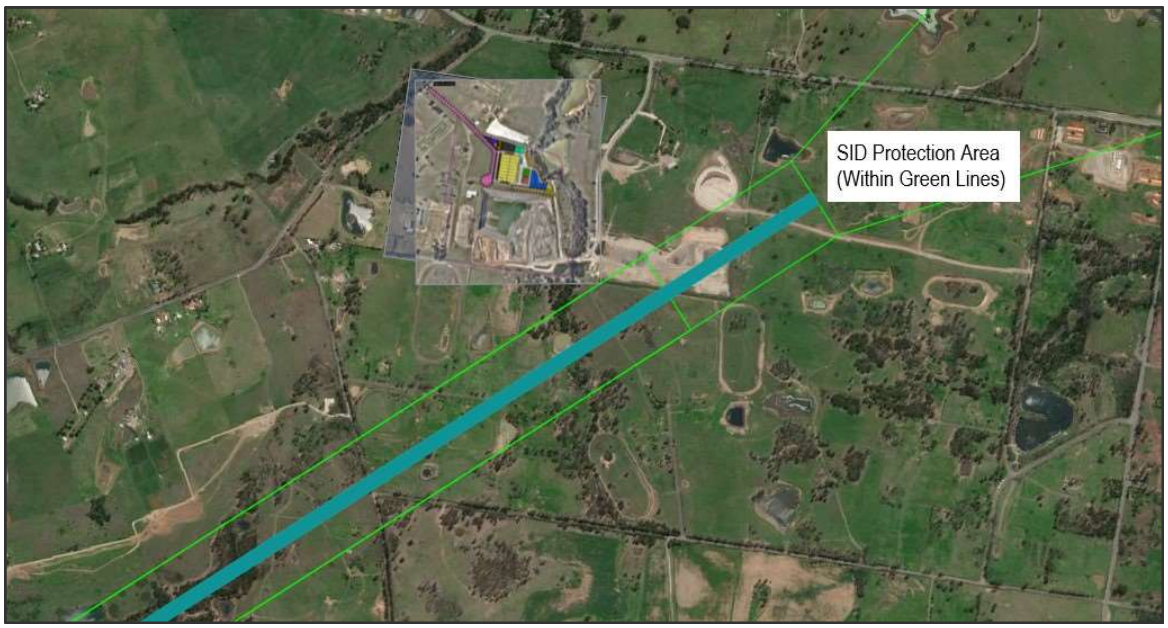


Figure 5: PANSOPS Surfaces for SID Procedures

4 ATC Surveillance System Performance

ATC Surveillance equipment (Terminal Area Radar - TAR) is located at Cecil Park, approximately 10.8 km to the south east of the development site.

Surveillance System	Distance from development	Antenna Elevation (AHD)	Clearance Plane Elevation at development site Distance x Tan 0.5° + TAR elevation
Cecil Park TAR	10,800 m	200.5 m	294 m

Table 2: Surveillance System Clearance Plane

It is likely that Aerodrome Surface Movement Surveillance system will be installed at WSA in order to ensure the safe movement of aircraft and vehicles on the airport during conditions of poor visibility when the ATC's cannot physically see the entire surface of the airport.

Current surface movement surveillance systems use RADAR but it is likely that with technology advances, including the use of Automatic Dependent Surveillance – Broadcast (ADS-B) which is in operation by Airservices throughout Australia today, may negate the use for conventional RADAR.

Any surface movement RADAR will only need to “see” objects on the airport and any signal blockage off the airport are irrelevant. Although reflections from building may need to be considered by Airservices Australia, as the appropriate authority for such equipment. Software filters within the radar are likely to eliminate any reflections irrelevant to ATC requirements.

Should a RADAR based surface movement guidance system be installed, Airservices Australia would need to consider a suitable site that is free from interference from all facilities on and off WSA.

It is unlikely that current RADAR technology will be installed at WSA.

Assessment: All buildings and cranes do not infringe the radar clearance planes and are therefore unlikely to have an adverse impact on ATC Surveillance systems.

5 Navigation Aid Performance

Instrument Landing System (ILS), Distance Measuring Equipment (DME) and Ground Based Augmentation System (GBAS) are planned at Western Sydney Airport. It is unlikely that any other ground-based navigation system will be installed at the airport due to advances in modern navigation aid technology and the use of space-based GPS type navigation procedures. Future advances may also eliminate the need for GBAS and ILS, except in contingency operations.

Airservices Australia operates these navigation systems and protects their signal integrity by applying Building Restricted Area (BRA) criteria to the critical areas around the navigation aid antenna.

5.1 ILS Critical Areas

The ILS is comprised of two components:

- A Localiser antenna situated at the far end of the landing runway, that transmits signals that allows ILS equipment in an aircraft to determine the centreline of the runway accurately;
- A Localiser Far Field Monitor for CAT II/III sites; and
- A Glide Path antenna located near the side of runway adjacent to the touchdown zone, that transmits signals that allows ILS equipment in an aircraft to determine the published flight path descent angle.

Each component has a separate BRA that ensures that aircraft using the ILS can receive uninterrupted accurate signals that are not impacted by signal reflections from buildings that infringe the BRA.

Airservices Australia is the technical authority responsible for the assessment of possible impacts upon the ILS signals.

All buildings within 1000 meters either side of the runway centreline which have a vertical wall facing the runway that exceeds 2000 square meters in area and a height more than 20 metres above the Localiser antenna ground level, such as hangars and office blocks, are to be assessed by the ILS Technical Authority – Airservices Australia. These structures may cause the Localizer to be out of tolerance within the clearance sector ie beyond the front course sector but within ±35° of the extended runway centreline.

The Building Restricted Areas for the Localiser and Glide Path are defined as an area in which static structures such as airport hangars, large buildings, perimeter fences, trees etc, may affect the ILS signal-in-space and is required to be assessed by an ILS Technical Authority.

The ILS installed for Runway 05L/23R is considered to be the most limiting system due to the proximity of the development site to both the Localiser and the Glide Path antennas.

5.1.1 Localiser

The Localizer antenna is located on the extended runway centreline typically between 200m to 500m from the far end of the runway.

An informal analysis of BRA for the Localiser component of the ILS for Runway 05L, the closest and most critical ILS, conducted by L&B is shown in **Table 3**.

The parameters used by L&B are:

- base of the Localiser antenna at 73.2 m AHD; and
- Localiser located at 200m from the end of Runway 05L.

Site Location	BRA Height above Localiser Antenna Base (m)	BRA Height (m AHD)
Closest point of ARRC to RWY 05L	13.3	86.5

Table 3: Localiser Results

Ground heights at the ARRC site are approximately 62 to 68 m AHD. The building, based on a slab at 64 m AHD, and with a maximum height of 16 m AGL, will be 80 m AHD.

The BRA for the Localiser component of the ILS Runway 23R extends along the Runway centreline for a maximum distance of 1500 m from the antenna. The ARRC will not have an impact upon the Localiser antenna as it is located further than 1500 m from the antenna.

Once the ILS installation site and elevations are confirmed, following construction heights of the runway being fixed, Airservices Australia will be able to conduct the formal analysis of the proposed buildings on the site.

Assessment: The ARRC will not infringe the BRA for the Runway 05L Localiser antenna at the indicated location.

5.1.2 Glide Path

The Glide Path antenna is usually situated on the non-taxiway side of the runway, set back approximately 300m from the threshold and between 120m to 175m from the runway centreline.

The Glide Path antenna for Runway 05L is located approximately 300m along the runway from the threshold of the runway and points up the approach path. It does not overlay the development site.

The Glide Path antenna for Runway 23R is located approximately 300m along the runway from the threshold of the runway and points up the approach path. It does not overlay the development site.

Both areas are shown on **Figure 6**, taken from the WSA Airport Plan, Pages 17 and 21.

Assessment: The ARRC will not infringe the BRA for the Runway 05L and 23R Glide Path antenna.

5.1.3 Far Field Monitor

The Far Field Monitor (FFM) is typically a non-executive monitor for the Localizer situated in the far field between 75 to 450 m from the threshold of Runway 05L. No

Generally, the centre of the Localizer FFM antenna should be at least 4.0m above the ground level and should have unobstructed line of sight to the Localizer antenna array.

All development proposals within an area bounded by a 5m radius from the Localizer FFM antenna, with a splay of 10° either side of the Localizer FFM longitudinal centreline continuing to the associated runway threshold and an area bounded by a 5m radius from the Localizer FFM in side elevation, with horizontal lines continuing on to the same runway threshold, require assessment by an ILS Technical Authority.

The ARRC is located outside of the 10° splay. The Quarry site is located within the 10° splay, therefore requiring Airservices Australia to conduct an assessment to ensure signal integrity.

Assessment: the proposed ARRC will not infringe any BRA for navigation aids associated with the ILS.

5.2 GBAS Critical Areas

The GBAS facility comprises two components which are subject to this assessment: the VHF Data Broadcast (VDB) antenna and typically four Remote Satellite Measurement Unit (RSMU) antennas. The components perform specific functions and are located separately. Different siting requirements and restrictions apply to each component.

We understand that the Stage II northern GBAS site (near the ARRC site), as shown in Figure 6, is one option under consideration. We also understand that a GBAS in this area would need be raised to allow signal propagation to be clear of proposed terminal buildings, the fuel farm (adjacent to the ARRC), other airport infrastructure and potentially development within the Aerotropolis Agribusiness Zone (to the west) and Enterprise Zone (to the north). There are other suitable GBAS sites within the airport site.

The terrain around the site increases in height to the north east of the ARRC, already providing any GBAS installation to the north east of the ARRC with an elevated position that is likely to be above the maximum height of the proposed ARRC.

All development proposals within 200m of the VDB antenna, and development proposals between 200m and 3000m from the VDB antenna that exceed an angle of elevation of 0.9° measured from ground level at the base of the VDB antenna, need to be assessed by Airservices Australia.

Other airport infrastructure, including the proposed fuel farm are likely to have an impact on the preliminary indicated GBAS location.

The ARRC is located approximately 300 m from the indicated northern GBAS site. The elevation of this site is not known as yet. Confirmation of the selection of this site and the elevation data related to it are required in order to assess any likely impact upon GBAS operations. The ILS Glide Path antenna and the physical structures within the proposed fuel farm would also need to be assessed prior to confirmation that this proposed GBAS site is suitable.

Confirmation will be required from both WSACo and Airservices Australia at the appropriate time.

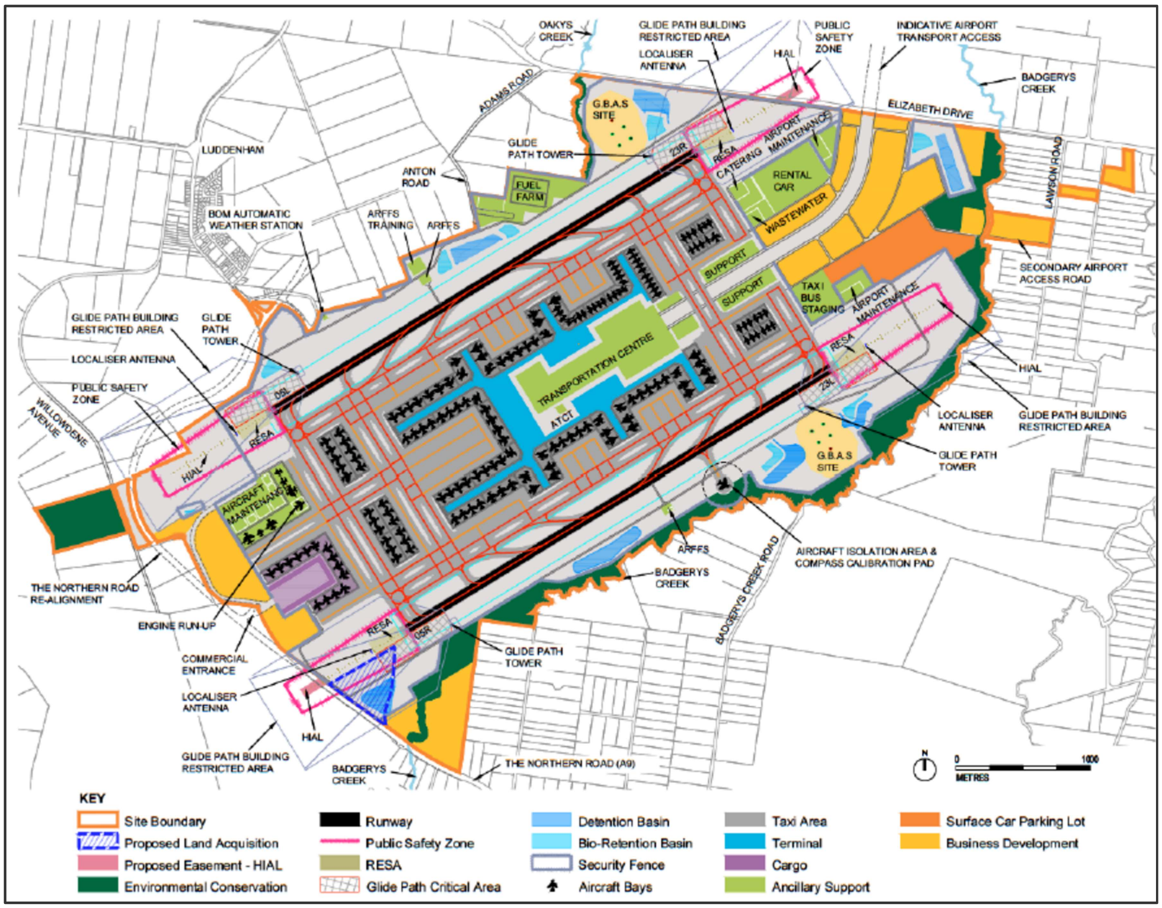


Figure 6: WSA Stage 2 Indicative Layout (WSA - Airport Plan Dec 2016))

5.3 DME

DME siting has not been provided as yet and may not be installed due to likely advances in GPS capabilities in relation to distance readouts for pilots.

Should a DME be installed then the BRA would extend to 1500 m from the facility with a 2° sloping plane above horizontal starting at 4 m below the antenna, which is usually at least 6 m above the ground.

DMEs that may be located with the Localiser component of the ILS require clear signals along the flight path to that runway. The development site is not located between any potential ILS DME and aircraft on approach to any runway.

6 ATC Communications

Reliable ATC communications require a clear line-of-sight path between the base station and aircraft and vehicles using the facilities.

ATC communication systems are generally located atop the ATC Tower located in position that allows Aerodrome Controllers to have site of all runways, taxiways and final approach and take off paths, usually in the middle of the airport.

The Area of Interest for the ATC Communication facilities includes any proposed development between 100 m and 600 m from the centre of the antenna that would exceed an angle of elevation of 1.1° extending out to a distance of 2000m from the centre of the antenna.

The proposed location of the ATC Tower is approximately 1750 m from the boundary of the development site.

Assuming the ATC Tower is at least 60 m AGL (144 m AHD) then the height of the area of interest would be 33 m above the antenna (177 m AHD) at the nearest edge of the development site.

Assessment: the proposed ARRC will not impact upon ATC Surveillance or Communication systems.

7 Roof Top Exhaust Plumes

Exhaust plumes in excess of 4.3 m/s which exist in either OLS or PANS OPS surfaces can create sufficient turbulence to upset the stability of aircraft during take-off and landing operations.

These high velocity exhaust plumes can result from high output air-conditioning units, gas efflux from chimneys and gas turbine power station peak output units.

Part 139 of the Civil Aviation Safety Regulations 1988 (CASR 1988) provides that CASA may determine that a gaseous efflux having a velocity in excess of 4.3 m/s is, or will be, a hazard to aircraft operations because of the velocity of the efflux.

In this case, any exhaust plume with a velocity in excess of 4.3 m/s from any vent on top of the building is likely to reach the height of the lowest PANS OPS or OLS to be referred to CASA.

The applicant has committed to ensuring that all ventilation systems are designed such that the exhaust velocity is less than 4 m/s. It would be appropriate for this to be reflected in an approval condition.

Assessment: There are no planned systems that would produce a hazardous plume.

8 The Planning Secretary's Environmental Assessment Requirements (SEARS)

The Planning Secretary's Environmental Assessment Requirements issued for 275 Adams Road, Luddenham requires:

- an aviation impact assessment addressing the National Airports Safeguarding Framework containing a risk assessment of the proposed development on airport operations and addressing related matters in the Draft Western Sydney Aerotropolis Plan, the Discussion Paper on the proposed Western Sydney Aerotropolis State Environmental Planning Policy and the Draft Western Sydney Aerotropolis Development Control Plan Phase 1; and
- a wildlife attraction risk assessment addressing the waste types to be received, nearby wildlife attractors and the risk of birds transiting through airspace.

This report has assessed the probable impacts caused by the proposed ARRC and quarry operations upon the operation of Western Sydney Airport, associated flight paths and Prescribed Airspace.

Factor Addressed	Outcome	AIA Reference
Building intrusion into Prescribed Airspace	Nil Intrusions	Section 3
ATC Surveillance System Interference	Impact unlikely due to distance from sensors	Section 4
Navigation System Performance	GBAS location remains undefined. Ongoing discussions with WSACo and Airservices Australia. Rest have no impact.	Section 5.
ATC Communication Systems	No impact	Section 6
Roof Top Exhaust Plumes	Impact unlikely due to height of Prescribed Airspace above site	Section 7
Aircraft Noise (ANEF)	ARRC is located is within the noise contours that permit development	Section 9
Lighting and Reflectivity	Unlikely due to reflectivity values of other objects in the area	Section 10
Public Safety Areas	Site located outside of relevant PSA	Section 11
Wildlife Strikes	Refer to EMM Study at Attachment B	Section 12 & Attachment B
Dust	Modelling indicates no cumulative exceedances above criteria	Section13
Wind Shear	Site located outside of wind shear assessment area	Section 14

Table 4: SEARS Assessment Conclusion

9 Australian Noise Exposure Forecast (ANEF) Contours

Australian Standard AS 2021:2015 – Acoustics – Aircraft Noise Intrusion – Building Siting and Construction provides guidance on the siting and construction of buildings in the vicinity of airports to minimise aircraft noise intrusion. It describes the process that should be followed in producing ANEF charts for use in applying this standard,

The projected ANEF contours for Western Sydney Airport are described in the Western Sydney Airport Plan section 2.3.3 and Figures 14 and 15.

DITRDC provides a Noise Modelling Tool on its Western Sydney Airport website. **Table 5** and the associated figures shows the ANEC contour levels for each particular stage of development of the airport and the particular runway in use. The highest ANEC contour is 25 < 30 which allows a “Light Industrial” or “Other Industrial” building type to be “Acceptable” shown in **Table 6** from AA 2021-2015.

Assessment: the proposed ARRC is located in an area where ANEC noise contours permit development of Light Industrial or Other Industrial.

Runway -Year	ANEC Contour
Runway 05 – Stage 1, 2030	20 < 25 and 25 < 30
Runway 23 – Stage 1, 2030	20 < 25 and 25 < 30
Runway 05 - 2050	25 < 30 and 30 < 35
Runway 23 - 2050	25 < 30 and 30 < 35
Runway 05 - 2063	20 < 25 and 30 < 35
Runway 23 - 2063	25 < 30 and 30 < 35

Table 5: ANEC Contours

Building type	ANEF zone site		
	Acceptable	Conditional	Unacceptable
House, home unit, flat, caravan park	Less than 20 ANEF (Note 1)	20 to 25 ANEF (Note 2)	Greater than 25 ANEF
Hotel, motel, hostel	Less than 25 ANEF	25 to 30 ANEF	Greater than 30 ANEF
Hostel, school, university	Less than 20 ANEF (Note 1)	20 to 25 ANEF (Note 2)	Greater than 25 ANEF
Hospital, nursing home	Less than 20 ANEF (Note 1)	20 to 25 ANEF	Greater than 25 ANEF
Public building	Less than 20 ANEF (Note 1)	20 to 30 ANEF	Greater than 30 ANEF
Commercial building	Less than 25 ANEF	25 to 35 ANEF	Greater than 35 ANEF
Light industrial	Less than 30 ANEF	30 to 40 ANEF	Greater than 40 ANEF
Other industrial	Acceptable in all ANEF zones		

Table 6: Building Type Acceptability Table (AS2021-2015)

An assessment of the ANEF and ANEC noise contours, in the following figures shows that the projected noise levels above the development site do not inhibit the development of the estate in relation to "Light Industrial" and "Other Industrial" building types.

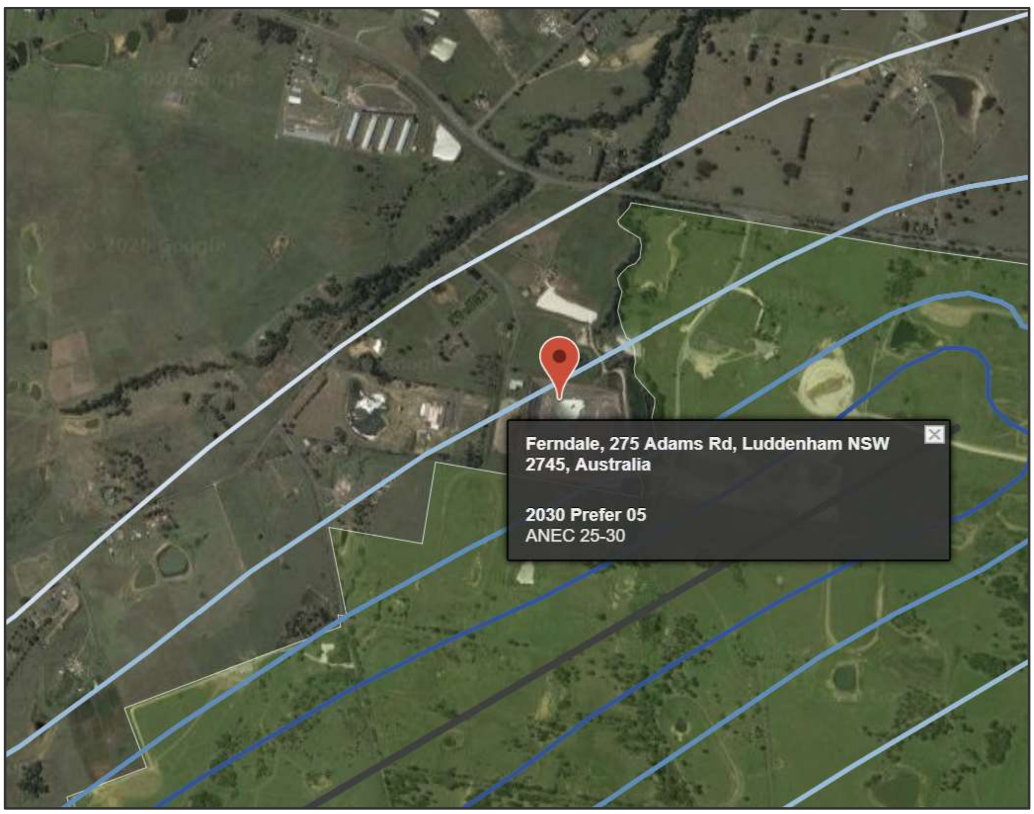


Figure 7: Runway 05 – 2030 Contours

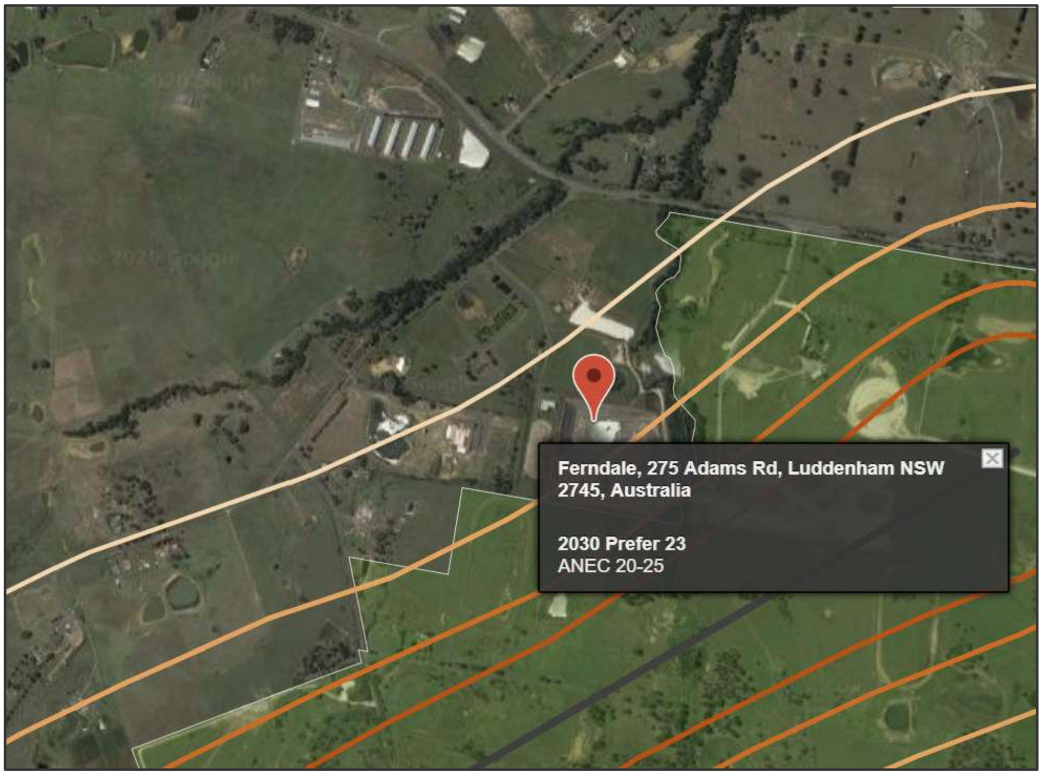


Figure 8: Runway 23 – 2030 Contours

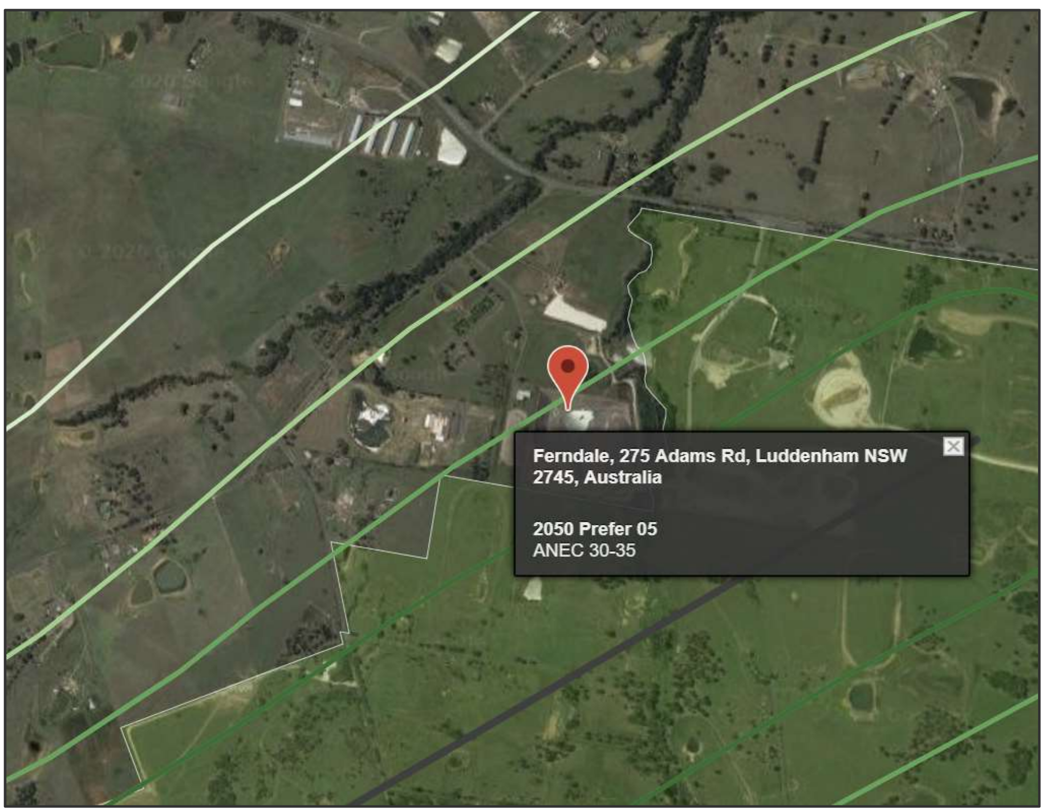


Figure 9: Runway 05 – 2050 Contours

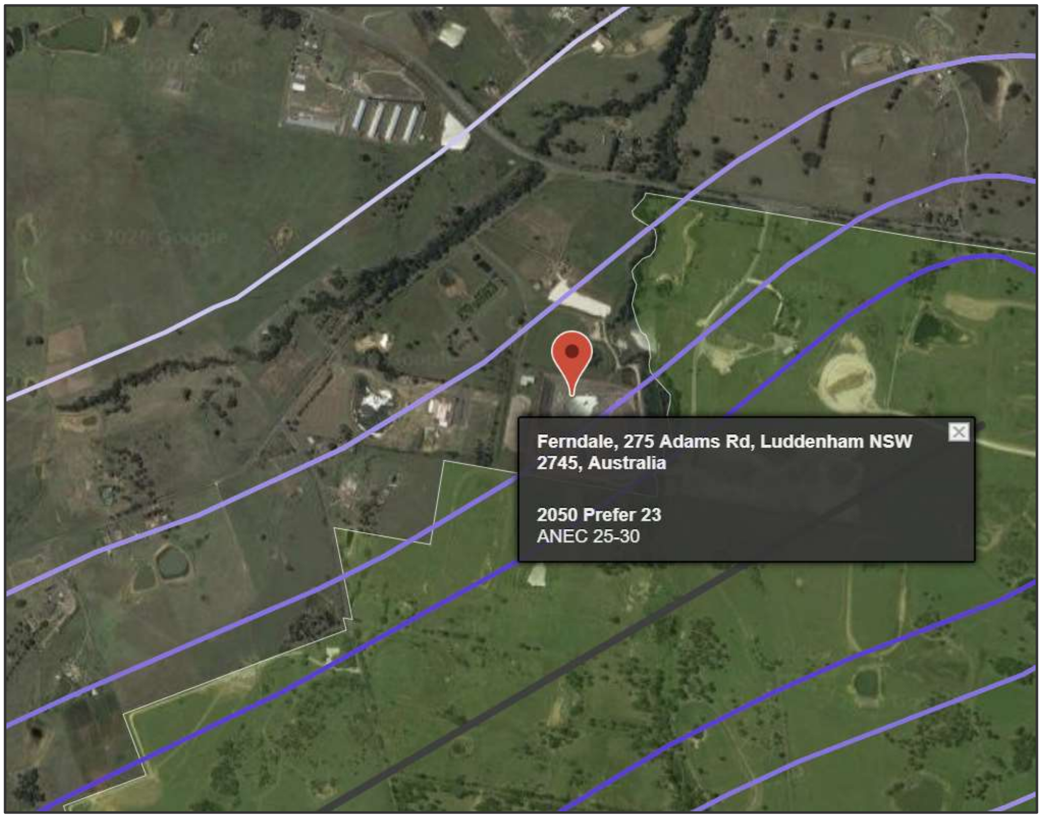


Figure 10: Runway 23 -2050 Contours

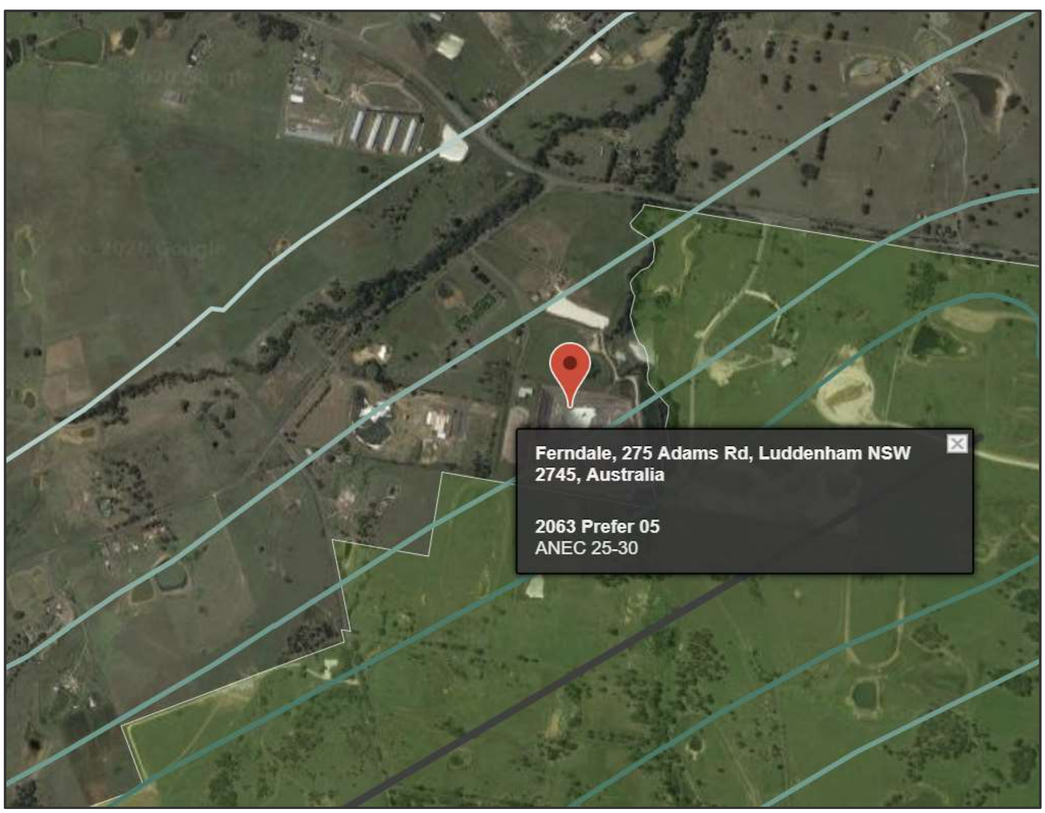


Figure 11: Runway 05 – 2063 Contours

Figure 12: Runway 23 – 2063 Contours

10 Lighting and Reflectivity

10.1 Lighting

NASF Guideline E – Managing the Risk of Distraction to Pilots from Lighting in the Vicinity of Airports, provides guidance to address the risk of distractions to pilots from lighting and light fixtures near airports.

The guideline relates to lighting intensity within four light control zones all of which are within 6 kilometers of the centre of each runway.

Pilots are reliant on the specific patterns of aeronautical ground lights during inclement weather and outside daylight hours. These aeronautical ground lights, such as runway lights and approach lights, play a vital role in enabling pilots to align their aircraft with the runway in use. They also enable the pilot to land the aircraft at the appropriate part of the runway.

Figure 13, from NASF Guideline E, nominates the intensity of light emission above which interference is likely. The maximum intensity of light source shown are measured at 3° above the horizontal. Lighting projects within this area should be closely examined to ensure that they do not exceed the limits shown.

Light fittings that exceed the iso-candela ratings can be fitted with screens to limit the light emission to zero above the horizontal.

The proposed ARRC is located within Zone C and Zone D, limiting lighting intensities to no higher than 150 Cd in Zone C and 450 Cd in Zone D.

Selection of appropriate external light fittings within the site will need to consider:

- The required amount of lighting for the activity in the area;
- Provide energy efficiency; and
- Not allow any light exceeding the stated Candela rating above the required plane.

Different types of lighting produce different luminous intensities. For example, a 100 watt incandescent bulb produces 150 Cd, an automobile headlight (high beam) produces 100,000 Cd.

Coloured lights are likely to cause conflict irrespective of their intensity as coloured lights are used to identify different aerodrome facilities. Proposals for coloured lights should be referred to CASA for detailed guidance.

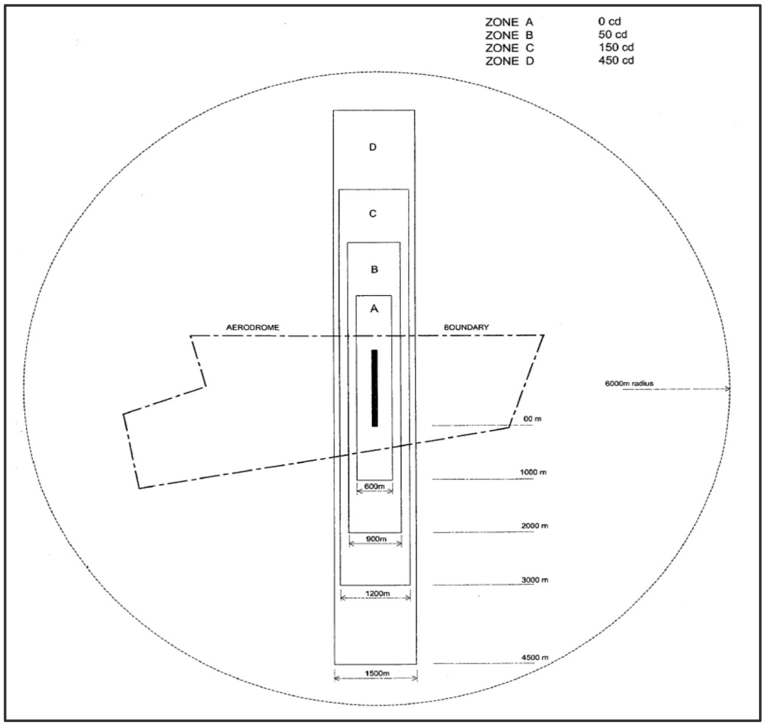


Figure 13: Lighting Zone Guideline (NASF Guideline E)

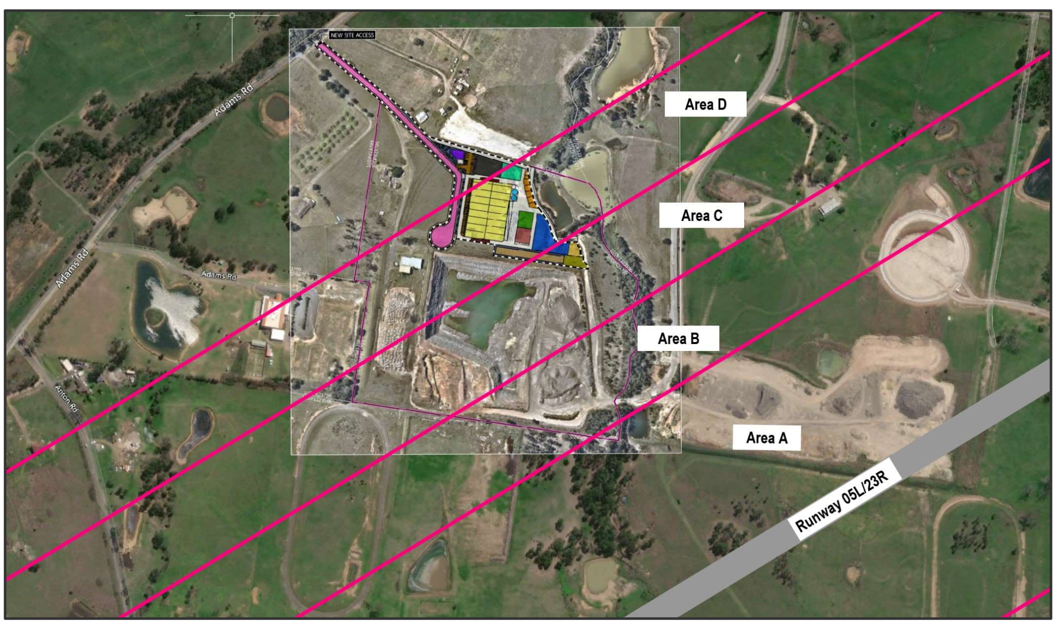


Figure 14: Lighting Zones in Relation to the ARRC.

10.2 Reflectivity

The potential for glare caused by reflected sunlight from structures such as buildings has been raised in some quarters as a potential source of distraction to pilots. However, CASA has advised that glare from buildings tend to be momentary and therefore unlikely to be a source of risk.

The potential for risk from building glare is further attenuated by the use of sunglasses which pilots normally wear in bright daylight.

The movement of the sun causes reflections from many surfaces including roads, lakes, cars, aircraft and even wet grass paddocks.

CASA often requires airports operators to assess solar farm installations for glint and glare impacts to pilots using a USA Federal Aviation Administration approved software tool.

Pilots, airline operators and airline manufacturers are well aware of glare both within the atmosphere when the sun is low or reflecting off clouds or mist and from ground-based man-made and natural objects.

There are many potential sources of sun reflections in the area surrounding the proposed development site including large sheds and dams.

Assessment: the proposed ARRC is unlikely to cause any hazard from sunlight reflections due to reflectivity values of other objects in the area.

11 Public Safety Areas

NASF Guideline I – Managing the Risk in Public Safety Areas (PSA) at the Ends of Runway provides guidance on the assessment and treatment of potential increases in risk to public safety which could result from an aircraft accident near the ends of runways.

This guideline does not prescribe any detail about the extent of any PSA and leaves it up to local planning authorities to determine suitable dimensions relating to each individual airport operations.

Queensland has a state planning policy that includes guidelines addressing public safety risks. It includes a Public Safety Area that extends for 1000 m from the end of the runway, commencing at 350 m wide at the runway end and reducing to 250 m wide at 1000 m from the runway end.

WSA Airport Pan nominally identified 1,000 m trapezoid-shaped clearance areas, extending off the ends of each proposed runway to cover the areas of highest anticipated safety risk, consistent with the Queensland Government PSA template approach. (NASF Guideline I page 16)

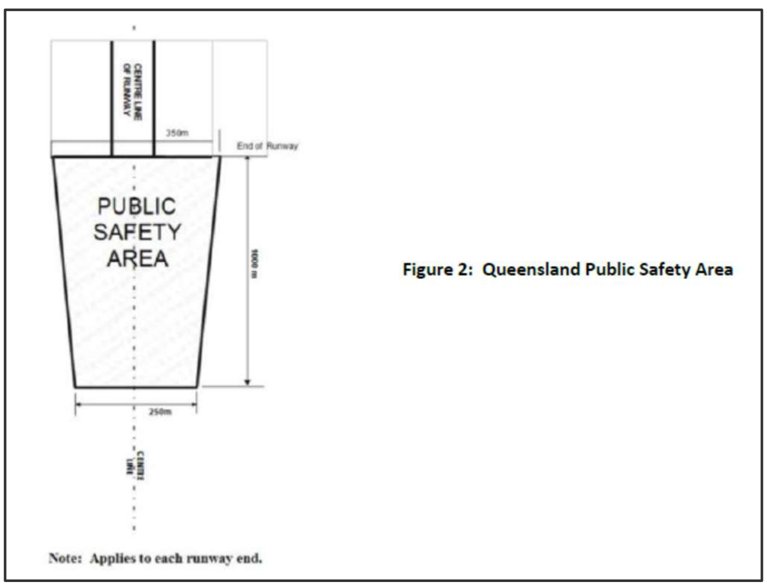


Figure 15: Queensland Public Safety Area (NASF Guideline I)

However, the Western Sydney Aerotropolis Plan 2019 Draft states the PSAs will be based on UK Public Safety Area model, which models anticipated aviation activity at the airport. (Page 48)

The UK model is under development, has a standardised shape which will capture 90-95% of accidents that are likely outside the aerodrome boundary. Figure 16 shows the concept shape.

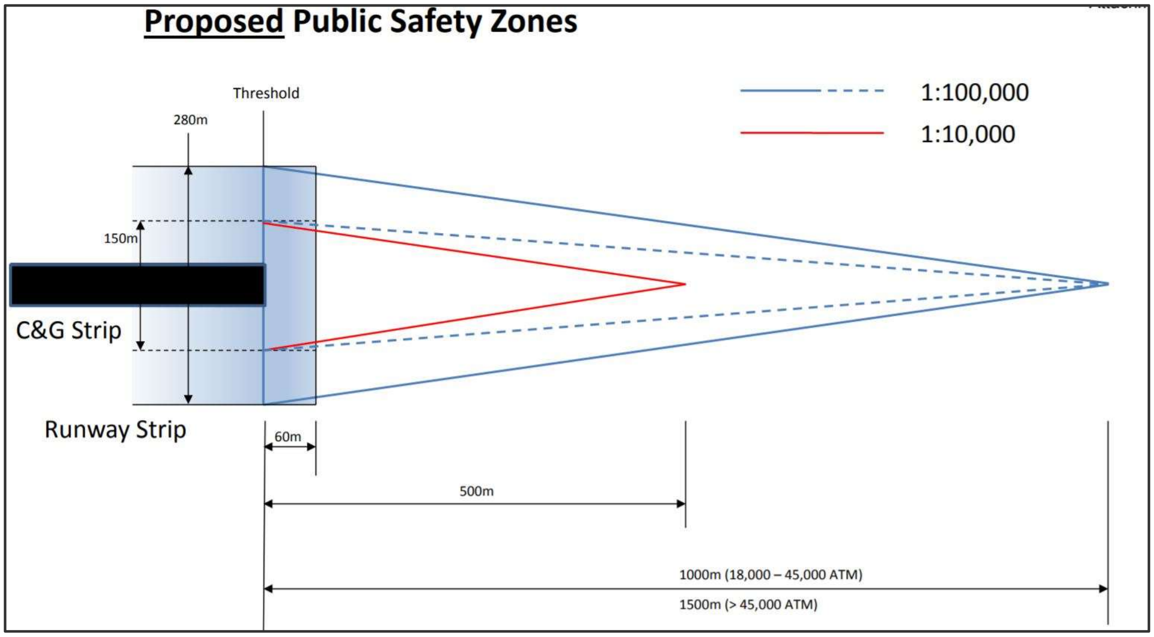


Figure 16: UK Public Safety Area Model

The PSA commences at the runway threshold and the edge of the runway strip and converges towards two points, one at 500 m (red) from the threshold and the other at 1000 m or 1500 m (blue) depending on the number of air transport movements at the airport.

The closest portion of the ARRC is located 250 m from the runway centreline and is located outside of the runway strip (140 m from the runway centreline) and therefore the ARRC is at least 90 m outside the proposed modelled UK PSA that WSA are considering implementing.

Assessment: the proposed ARRC is not located within either PSA template.

12 Wildlife Strikes

NASF Guideline C – Managing the Risks of Wildlife Strikes in the Vicinity of Airports provides guidelines to manage the risk of collisions between wildlife and aircraft at or near airports where that risk may be increased by the presence of wildlife-attracting land uses.

The rural area surrounding Western Sydney Airport is considered to have an abundance of wildlife species already established in the habitat. The many farm dams in the area have been identified as the major attractant for birds that creates the highest risk for wildlife strikes. Roosting prevention methods within the site can be arranged in consultation with a local wildlife committee can be implemented to further reduce any likely attractants.

There are appropriate mitigations and wildlife management strategies to reduce the risk of a wildlife strike from moderate to low, for the ARRC and quarry operation and rehabilitation.

EMM Consulting engaged an environmental specialist to consider the wildlife environment surrounding WSA and upon WSA property, to determine the risk of a wildlife or bird strike resulting from the ARRC.

The study found that:

"The subject property at 275 Adams Road, Luddenham New South Wales poses an extremely low wildlife and bird-strike risk to the new Western Sydney Airport. The proposed development of the property is likely to further reduce this risk by reducing access to standing water on the site, developing a grass paddock into the ARRC and operating, and rehabilitating the quarry. Based on the work completed as part of airport planning, the surrounding area of open paddocks and dams is of far more concern to the airport at this stage. To ensure the proposed development absolutely minimises its risks, a number of additional management and mitigation measures are recommended."

The applicants will implement the recommended management measures.

The development of a wildlife management committee that includes all airport stakeholders, off-airport landowners and wildlife strike specialists would enable an effective Wildlife Management Plan to reduce the airport's wildlife strike risk.

The EMM study forms Attachment B of this report.

13 Dust

NASF Guideline F – Managing the Risk of Intrusions into Protected Operational Airspace of Airports provides guidance to State/Territory and local government decision makers as well as airport operators to jointly address the issue of intrusions into the operational airspace of airports by tall structures, such as buildings and cranes, as well as trees in the vicinity of airports.

The guidelines are also designed to address the following risks:

- activities that could cause air turbulence, where the turbulence could affect the normal flight of aircraft operating in the prescribed airspace; and
- activities that could cause the emission of steam, other gas, smoke, dust or other particulate matter, where the smoke, dust or particulate matter could affect the ability of aircraft to operate in the prescribed airspace in accordance with Visual Flight Rules (VFR).

Meteorological mechanisms govern the generation, dispersion, transformation and eventual removal of pollutants from the atmosphere. To adequately characterise the dispersion meteorology of a region, information is needed on the prevailing wind regime, ambient temperature, rainfall, relative humidity, mixing depth and atmospheric stability.

EMM Consulting prepared an Air Quality Impact Assessment in April 2020 for the Luddenham Quarry Modification 5.

Dust management controls will be formally documented in an air quality management plan agreed with WSA. These will include but are not limited to:

- use of water on internal unsealed roads and crushing plant;
- minimizing drop heights when unloading trucks; and
- sheltering factor applied for wind erosion within the established pit;
- limiting vehicle speeds;
- consideration of meteorological conditions to predict when dust emissions may be high to allow preparatory measures to be implemented to reduce the dust emissions; and
- cessation of certain pit activities.

An Air Quality Monitoring Programme was developed in 2009 for the operation of the quarry (Golder 2009) and this will be reviewed and augmented following approval for the reactivation of the quarry.

Dust levels that could affect the ability of aircraft to operate in the prescribed airspace in accordance with the Visual Flight Rules (VFR) as specified in the NASF Guideline F, occur during large dust storm.

Quarry rehabilitation operations may cause localized dust to be visible but would not cause the general flight visibility to reduce below 5000 m, the minimum VFR visibility distance prescribed below ten thousand feet in Civil Aviation Safety Regulations.

The EMM Consulting Report - Luddenham Quarry – Modification 5 – Air Quality Impact Assessment (April 2020) has been prepared to assess the air quality impacts of the MOD5 proposal on existing sensitive assessment locations in the area and the conclusion states:

"The modelling indicates that there are no cumulative exceedances of the impact assessment criteria at any assessment location for annual average PM10 concentrations, annual average PM2.5 concentrations, annual average TSP concentrations and annual average dust deposition levels. It is noted that the predicted annual average PM2.5 concentration at R3 is equal to impact assessment criterion of 8 μg/m³."

EMM Consulting have also provided a memorandum dated 15 December 2020 (see Appendix C) that provides *"a summary of revised modelling results prepared in response to submissions from NSW EPA and Western Sydney Airport (WSA) on the Air Quality Impact Assessment (AQIA) prepared for the Advanced Resource Recovery Centre (ARRC) development application.*

The memo presents revised modelling results for a cumulative scenario which includes quarry infilling and provides refinements to the emission estimates for the ARRC”.

The memorandum also reports that the annual average TSP and dust deposition do not exceed *“the impact assessment criterion for annual average TSP for the either scenario.”*

“The modelling results … show:

- *there would be no exceedances of the annual average impact assessment criteria for PM10 and PM2.5 at the airport terminal, runway or infrastructure areas;*
- *exceedances of the annual average impact assessment criteria for PM2.5 are limited to the fuel farm area;*
- *exceedances of the 24-hour average impact assessment criteria for PM10 and PM2.5 are limited to the fuel farm area (2–4 additional days over the impact assessment criteria); and*
- *there would be no exceedances of the annual average impact assessment criteria for PM10 and PM2.5 at the airport terminal, runway, infrastructure or fuel farm areas.*

It is noted that the health-based air quality criteria for particulate matter are designed to offer protection for periods of exposure ranging from 24-hours to annual averages. It is expected that exposure risk at the Fuel Farm area would be minimal as employees would not spend significant periods of time within this area.”[1]

The maximum 24-hour PM10 and PM2.5 concentrations within the airport site (at the adjacent fuel farm) are predicted to be 55.4 ug/m3 and 25.5 ug/m3 respectively. This is in the range considered to be 'fair air quality' (Figure 17).

The resulting categories, from Good to Extremely Poor, are labelled and colour-coded for easy interpretation.

			Air quality categories (AQC)				
Air pollutant	Averaging period	Units	GOOD	FAIR	POOR	VERY POOR	EXTREMELY POOR
Ozone O_3	1-hour	pphm	<6.7	6.7–10.0	10.0–15.0	15.0–20.0	20.0 and above
	4-hour rolling	pphm	<5.4	5.4–8.0	8.0–12.0	12.0–16.0	16.0 and above
Nitrogen dioxide NO_2	1-hour	pphm	<8	8–12	12–18	18–24	24 and above
Visibility Neph	1-hour	bsp	<1.5	1.5–3.0	3.0–6.0	6.0–18.0	18.0 and above
Carbon monoxide CO	8-hour rolling	ppm	<6.0	6.0–9.0	9.0–13.5	13.5–18.0	18.0 and above
Sulfur dioxide SO_2	1-hour	pphm	<13.3	13.3–20.0	20.0–30.0	30.0–40.0	40.0 and above
Particulate matter < 10 µm PM_{10}	1-hour	µg/m^3	<50	50–100	100–200	200–600	600 and above
Particulate matter < 2.5 µm $PM_{2.5}$	1-hour	µg/m^3	<25	25–50	50–100	100–300	300 and above

Figure 17: NSW EPA Air Quality Conditions Table

Assessment: the proposed ARRC is unlikely to create any significant dust hazards that would reduce flight visibility below the recommended level of 5000 m. The NSW EPA data indicate good to fair air quality during quarry infill operations.

[1] EMM Memorandum: Luddenham Advanced Resource Recovery Centre – additional air quality modelling for response to submissions. 15 December 2020.

14 Wind Shear

NASF Guideline B – Managing the Risk of Building Generated Wind shear and Turbulence at Airports, provides guidance to Commonwealth, state/territory and local government decision makers and airport operators to manage the risk of building generated wind shear (i.e. changes in wind speed and/or direction between two points) and building generated turbulence (i.e. rapid irregular changes in wind speed and/or direction at a fixed point) at airports.

The building generated winds shear/turbulence issue becomes safety critical when a significant obstacle, such as a building, is located in the path of a crosswind to an operational runway. The wind flow will be diverted around and over the buildings causing the crosswind speed to vary along the runway.

The wind shear assessment trigger areas are design to protect aircraft during the late stages of an approach to land and the touch down zone, an area in which a critical phase of flight occurs.

Buildings that could pose a safety risk are those located within a rectangular ‘assessment trigger area around the runway ends (see **Figure 17**, below):

- 1200m or closer perpendicular from the runway centreline, or extended runway centreline;
- 900m or closer in front of runway threshold (towards the landside of the airport); and
- 500m or closer from the runway threshold along the runway.

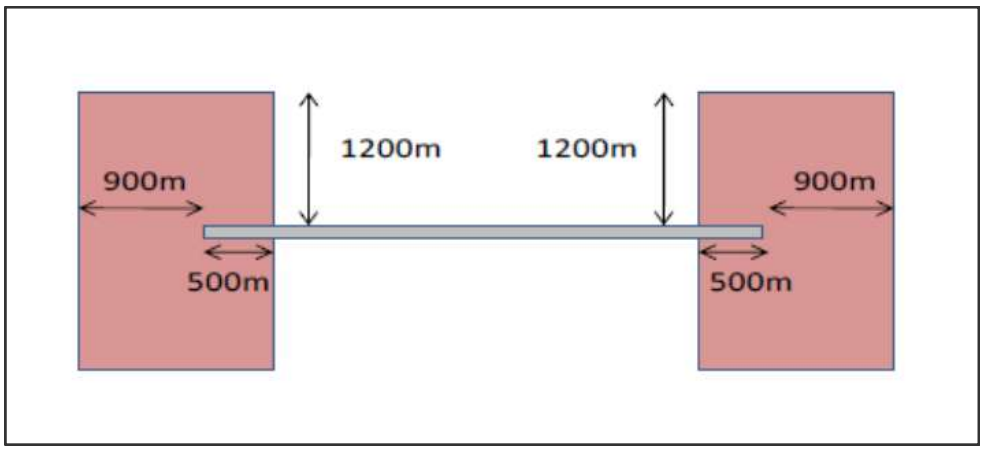


Figure 17: Wind Shear Assessment Trigger Area Around Runway Ends (NASF Guideline B)

Figure 18 clearly shows the ARCC and the quarry site outside of the wind shear assessment trigger area.

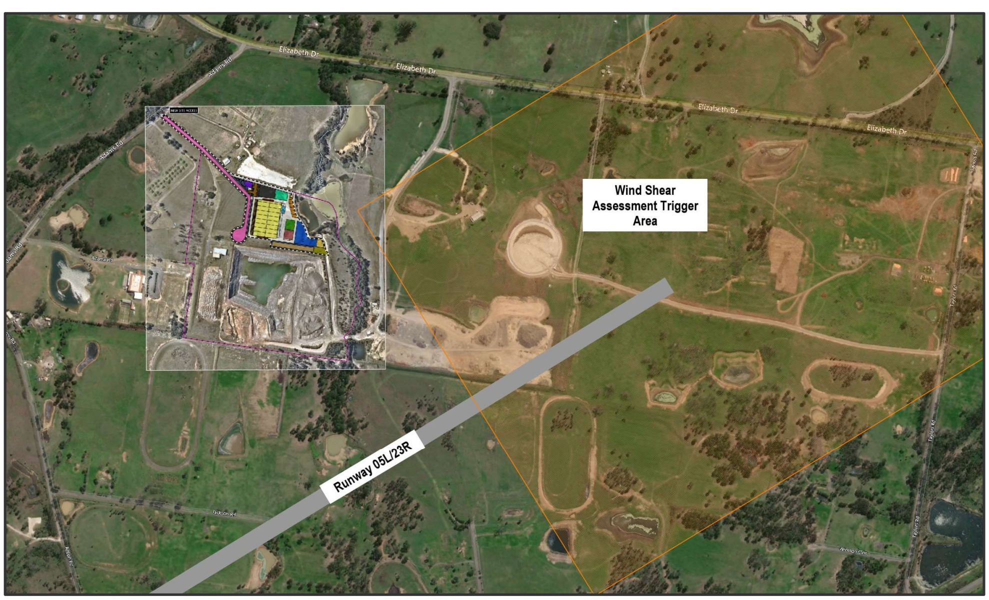


Figure 18: Wind Shear Assessment Trigger Area

As the development site is located outside of the assessment trigger area, any buildings on the development site would be considered to not create a wind shear or turbulence over the critical part of the runway.

Assessment: the proposed ARRC will not cause any adverse wind shear effects as the development site is located outside of the assessment area for wind shear impacts.

15 Conclusion

The proposed ARRC, with buildings to a likely height of approximately 16 metres AGL m (80 m AHD) and temporary construction crane activity to approximately 90 to 100 m AHD:

- will not infringe the OLS of approximately 110m to 125.5 m AHD above the site;
- will not infringe the Basic ILS PANS OPS surfaces of approximately 84 m AHD at the south east edge of the quarry and 138 m at the south east corner of the ARRC;
- is located outside of the PANS OPS surface for the Standard Instrument Departures (SIDS);
- will not infringe the likely PANS OPS surface for Instrument Flight Rules (IFR) Circling Procedures if they are implemented;
- will not infringe any Building Restricted Areas (BRA) for navigation aids associated with the ILS;
- will not infringe any BRA for the Ground Based Augmentation System (GBAS) during WSA Stage 1 airport development, but is likely to infringe the BRA for the GBAS if the GBAS is located at the northern site indicated at WSA Stage 2 airport development diagrams;
- will not impact upon Air Traffic Control (ATC) Surveillance or Communication systems;
- is located in an area where ANEC noise contours permit development of Light Industrial or Other Industrial;
- will not produce an exhaust plume that will require assessment by the Civil Aviation Safety Authority (CASA) due to proposed activity at the ARRC;
- is located within Zone C and Zone D of the airport lighting zones that surround the airport, requiring lighting visible above the horizontal to be less than 150 Cd and 450 Cd respectively;
- is unlikely to cause any additional hazard from sunlight reflections due to reflectivity values of other objects in the area;
- is located outside of the likely Public Safety Area (PSA) templates;
- is likely to reduce the potential for wildlife collisions with aircraft because the area around and including the airport site is already considered a natural habitat for birdlife. The covering of the quarry and the activities at the ARRC will reduce the amount of natural habitat available to the existing number of birds in the area;
- participation by the ARRC operator on an airport safety committee will help ensure that aviation safety standards are maintained at the required level;
- will not cause any adverse wind shear effects as the development site is located outside of the assessment area for wind shear impacts; and
- is unlikely to create any significant dust hazards that would reduce flight visibility below the recommended level of 5000 m.

Construction of the ARRC will commence immediately upon receipt of Development Approval and will be complete prior to the first runway being constructed and therefore before any aircraft operations at WSA.

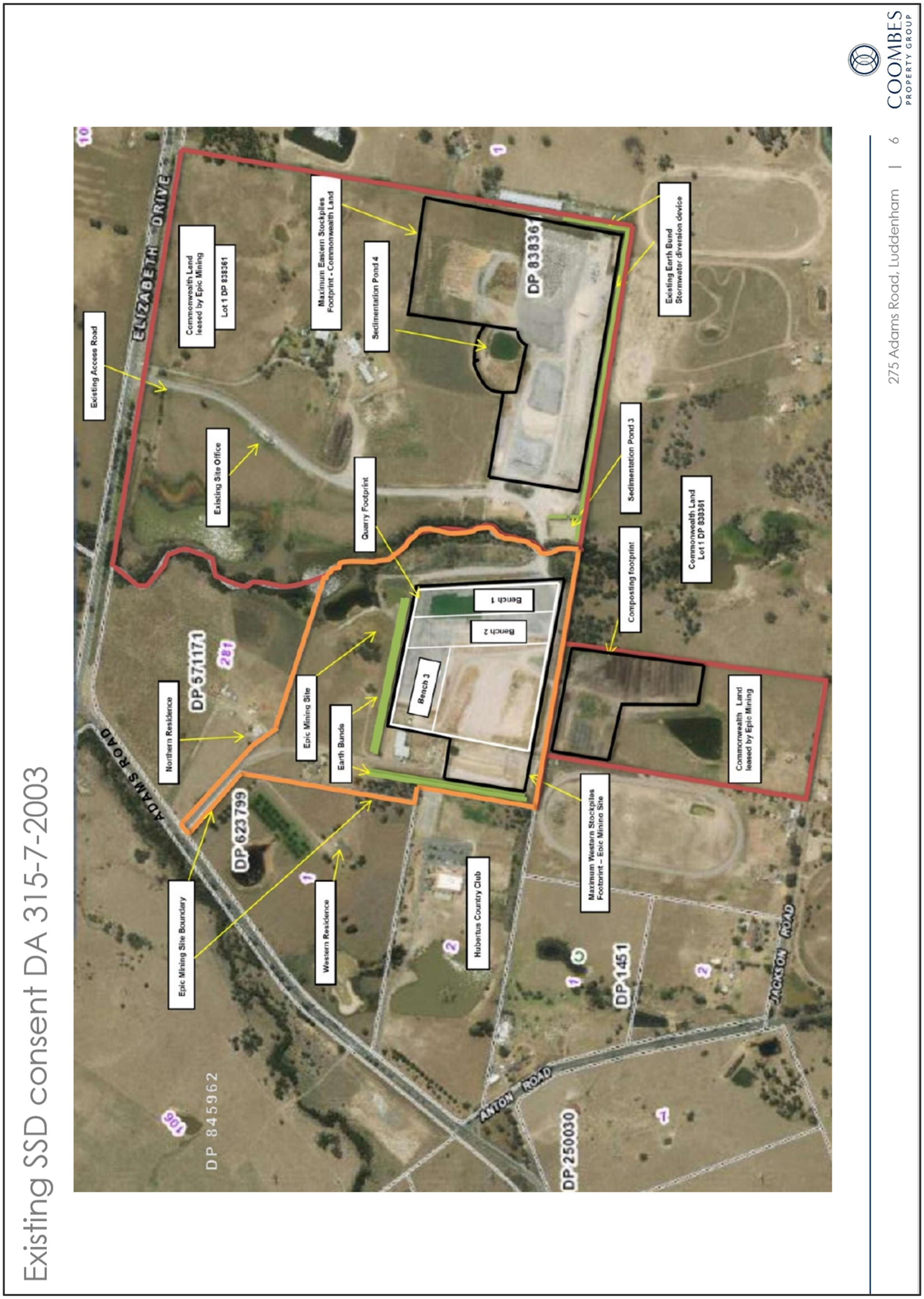
Airservices Australia, as the navigation aid authority in Australia, will conduct their own analysis of the development site’s impact on navigation aids. The provision of detailed plans, once available, will need to be supplied to them.

Ongoing consultation with WSACo, Airservices Australia and CASA will ensure that all parties understand each other’s requirements to achieve agreed outcomes.

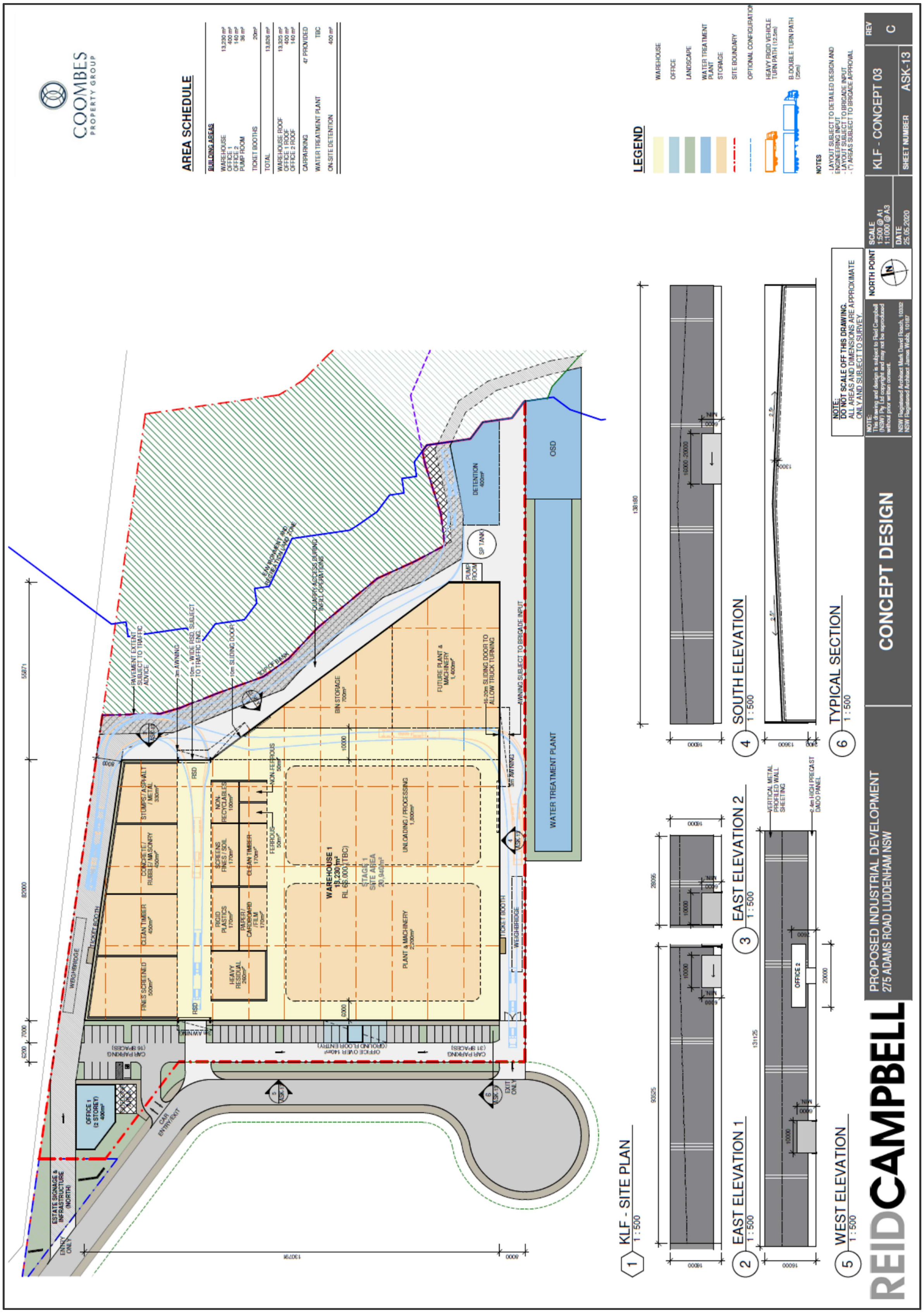
The Commonwealth Department of Infrastructure, Transport, Regional Development and Communications (DITRDC) will be provided with comprehensive information including the content of this report, as they make their determination related to this proposed ARRC.

Appendix A –Site Layout Diagrams

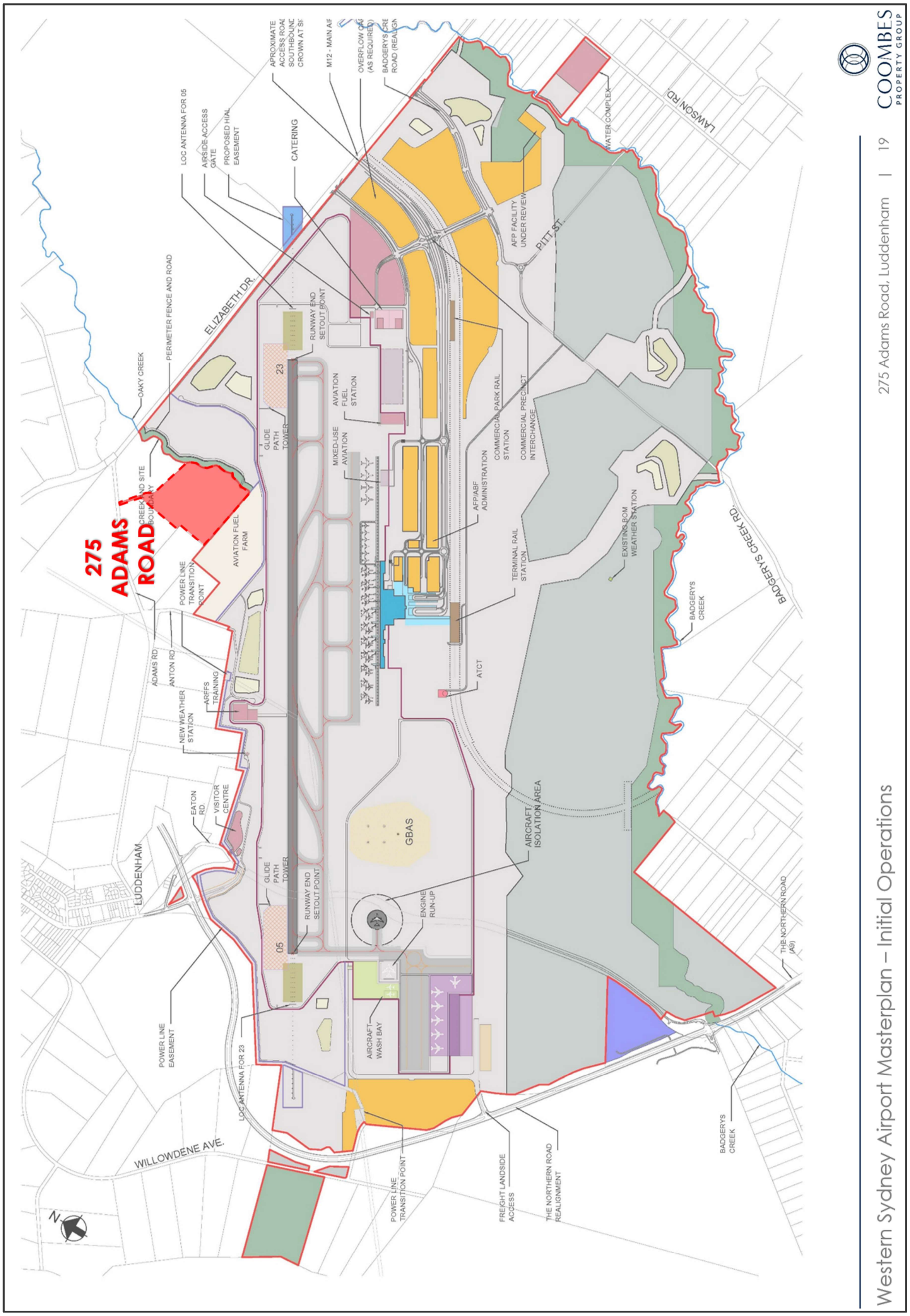
Site Layout (CPG)



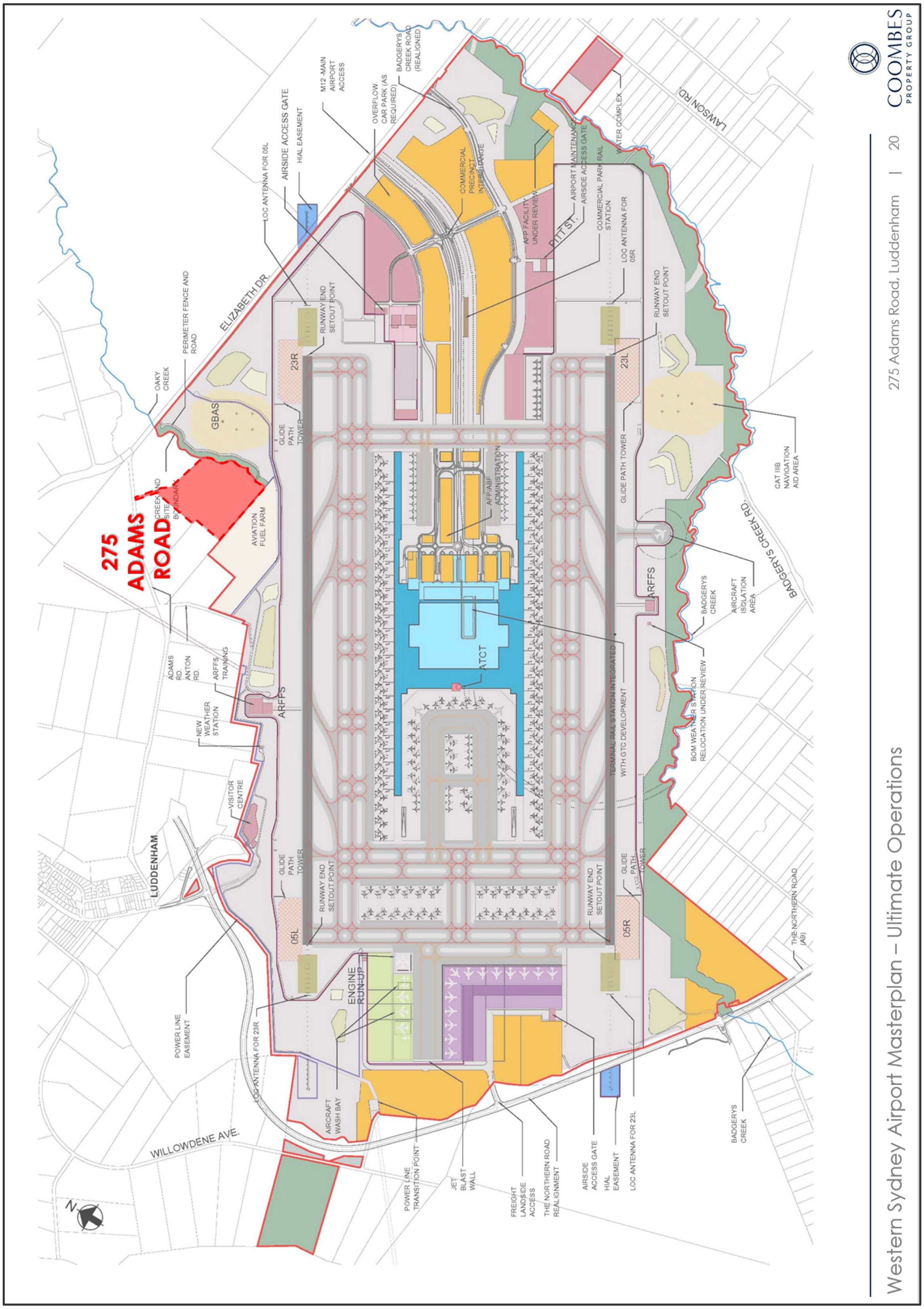
Existing Consents (CPG)



Preliminary Future Development (CPG)



Stage 1 Airport Layout (CPG)



Stage 2 Proposed Airport Layout (CPG)

Appendix B – EMM Wildlife Strike Risk Assessment

15 June 2020

Level 1, 87 Wickham Terrace
Spring Hill QLD 4000

T 07 3648 1200
E info@emmconsulting.com.au

www.emmconsulting.com.au

Michael Coombes
Director
Coombes Property Group
sent by email

Re: Luddenham Quarry - Wildlife strike and Birdstrike Risk Review

Dear Sirs,

1 Background

CFT No 13 Pty Ltd, a member of Coombes Property Group (CPG), has recently acquired the property at 275 Adams Road, Luddenham New South Wales (NSW) (Lot 3 in DP 623799, 'the subject property') within the Liverpool City Council municipality. The subject property is host to an existing shale/clay quarry (the quarry site). CPG has the following staged vision for the long-term development of the subject property:

- Stage 1 Quarry Reactivation: Solving a problem. CPG intends to responsibly avoid the sterilisation of the remaining natural resource by completing the extraction of shale which is important to the local construction industry as raw material used by brick manufacturers in Western Sydney. Following the completion of approved extraction activities, the void will be prepared for rehabilitation.

- Stage 2 Advanced Resource Recovery Centre (ARRC) and Quarry Rehabilitation: A smart way to fill the void: CPG in partnership with KLF Holdings Pty Ltd (KLF) and in collaboration with the circular economy industry and the material science research sector, intends to establish a technology-led approach to resource recovery, management, and reuse of Western Sydney's construction waste, and repurposing those materials that cannot be recovered for use to rehabilitate (ie fill) the quarry void. This will provide a sustainable and economically viable method of rehabilitating the void for development.

- Stage 3 High Value Employment Generating Development: Transform the land to deliver high value agribusiness jobs. CPG intends to develop the rehabilitated quarry site into a sustainable and high-tech agribusiness hub supporting food production, processing, freight transport, warehousing, and distribution, whilst continuing to invest in the resource recovery research and development (R&D) initiatives. This will deliver the vision of a technology-led agribusiness precinct as part of the Aerotropolis that balances its valuable assets including proximity to the future Western Sydney Airport (WSA) and Outer Sydney Orbital.

This Wildlife Strike and Birdstrike Risk Review informs the Aeronautical Impact Assessment relating to the establishment of the ARRC in Stage 2 described above.

KLF is an Australian-owned and operated waste management company that operates two strategically located resource recovery and recycling facilities in Sydney; one at Camellia and another at Asquith. KLF has 20 years' experience in the waste recycling and resource recovery industry. KLF facilities are licensed by the NSW Environment Protection Authority (EPA) and have full International Organisation for Standardisation (ISO) accreditation.

2 Purpose and context of this letter

To operate safely, airports require expansive, flat, open space within the airport's operational area (airside) and in the surrounding areas for at least 20 km. The surrounding land can provide habitats (such as ponds and grasslands) which provide habitat for, or can attract, wildlife. Wildlife which can fly, particularly birds, but also bats, can pose a significant risk to aircrafts, especially during their take-off and landing at airports. All significant civilian and military airports actively manage their land to reduce its attractiveness to key species of bird and other key risks such as flying fox camps. However, many airports face birdstrike hazards from land uses outside of their direct ownership or control. Key habitats or land uses of concern around airports include (Australian Airports Association,2016):

- municipal waste sites (taking food and other putrescible waste);
- wetlands, dams, and reservoirs;
- natural coastal habitats mudflats;
- sewage treatment works;
- abandoned sand, gravel, and clay pits (containing water); and
- agricultural areas such as fruit trees, grape crops, etc.

Since 1912, 120 aircraft have been destroyed due to birdstrike[1] incidents with 60 of these leading to fatalities (297 people in total). Approximately USD $1.2 billion is spent repairing aircraft engines and frames on an annual basis.

This letter reviews the potential wildlife strike and birdstrike risks posed by the approved and proposed future operations on the subject property (stage 1 and 2 set out above) to the new Western Sydney Airport (WSA). Construction of the airport is underway and on track to begin operations in 2026. The subject site is situated immediately adjacent to the north-west corner of the airport's boundary next to the Hubertus Country Club.

3 Study approach

The following information and data were used in this desktop assessment:

- *Aeronautical Impact Assessment Future Land Use at 275 Adams Road Luddenham*, prepared for NSW Coombes Property Group by Landrum & Brown Worldwide (Aust) Pty Ltd (2020);
- *Western Sydney Airport Environmental Impact Statement - Preliminary Bird and Bat Strike Risk Assessment* prepared for GHD by Avisure (2015);
- AC 139-26(0) JULY 2011 - Wildlife Hazard Management at Aerodromes;
- Australian Airports Association (2016)) – *Wildlife Management at Airports Airport Practice Note 9*; and
- Australian Transport Safety Bureau (ATSB) information (www.atsb.gov.au and https://www.atsb.gov.au/media/news-items/2019/latest-birdstrike-stats-released/).

1 References to 'birdstrike' in this letter include of bat strike.

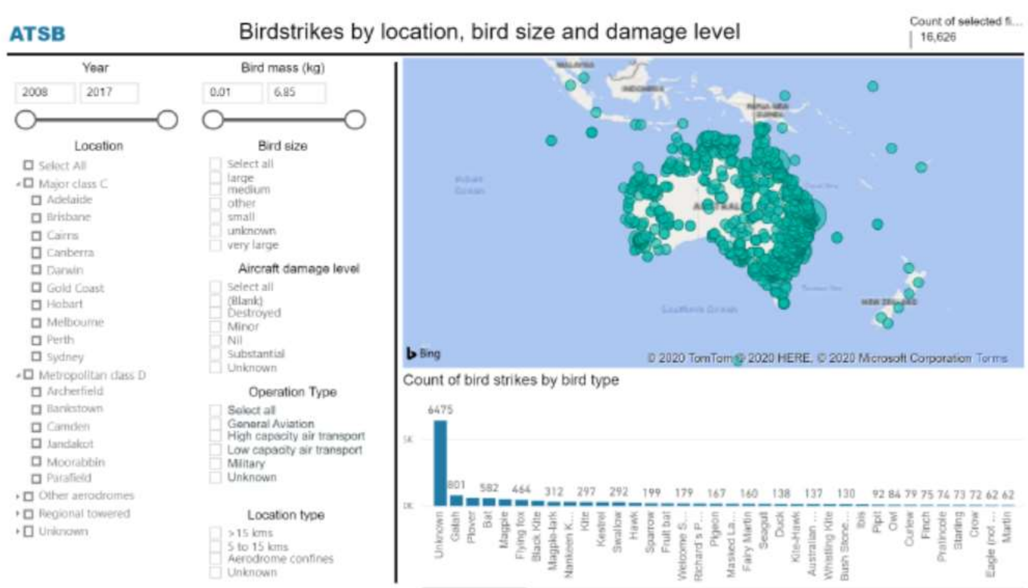
4 The current assessed risk at the Western Sydney Airport

4.1 National context

The ATSB collects and publishes birdstrikes data on its website. In 2019, the ATSB stated:

> Between 2008 and 2017, there were 16,626 confirmed birdstrikes reported to the ATSB. The number of reported birdstrikes has increased in recent years, with 2017 having the highest on record with 1,921. Despite being a high frequency occurrence, birdstrikes rarely result in aircraft damage or injuries. Of the 16,626 birdstrikes in this reporting period, 99.8 per cent were classified as incidents, while 19 (~0.1 per cent) were classified as accidents and another five (~0.03 per cent) as serious incidents. Nine birdstrikes, or approximately 0.05 per cent of the birdstrikes in the ten years, resulted in minor injuries to pilots or passengers. There were no reported serious injuries or fatalities associated with a birdstrike occurrence in the ten-year period.
>
> Domestic high capacity aircraft were those most often involved in birdstrikes, and the birdstrike rate per aircraft movement for these aircraft was significantly higher than all other categories. Both the number and rate of birdstrikes per 10,000 movements in high capacity operations have increased in the past two years 2016 – 2017. In contrast, the number of birdstrikes in low capacity operations and general aviation has remained relatively consistent in the most recent two years.
>
> The number of birdstrikes involving a bird ingested into an engine in high capacity air transport operations has risen in recent years with about one in ten birdstrikes for turbofan aircraft involving a bird ingested into an engine. Additionally, over the ten-year reporting period, there have been 11 occurrences involving one or more birds ingested into two engines of turbofan-powered aircraft.
>
> The five most commonly struck flying animals in the 2016 to 2017 period were flying foxes, galahs, magpies, and 'bats' (many of which were likely to be flying foxes) and plovers.

This data is visually represented below from their website in Figure 4.1. It should be noted that 6,475 (about 39%) of strikes we not found or not identifiable after the collision.

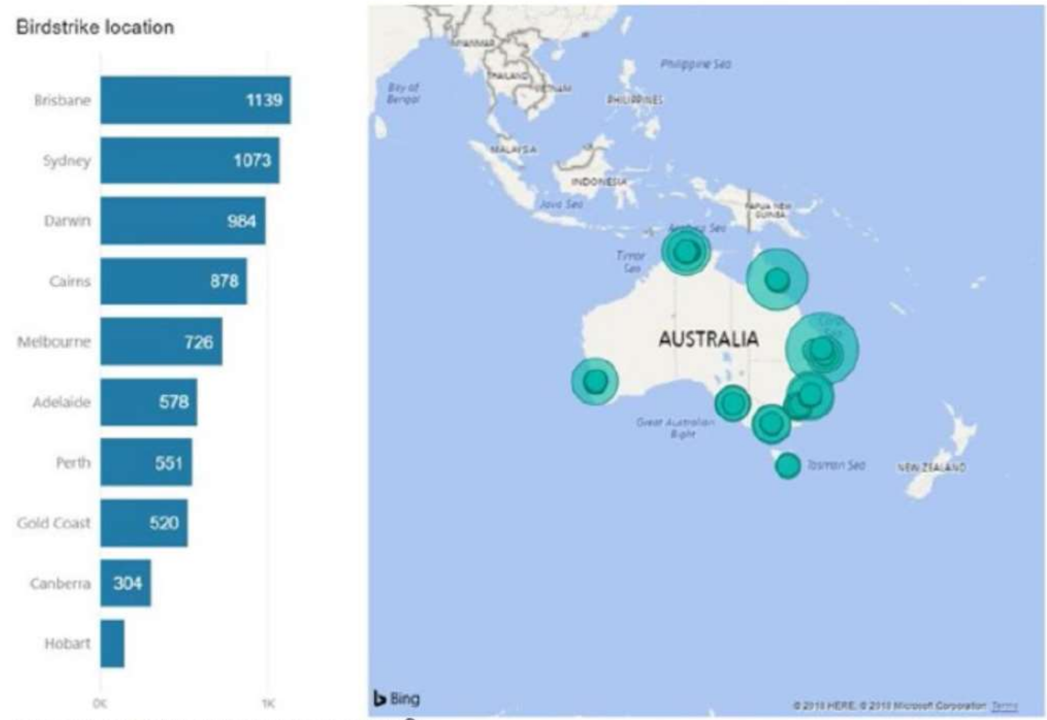


Source: ATSB

Figure 4.1 Birdstrikes by species across Australia (2008–2017)

4.2 Birdstrikes by location across Australia

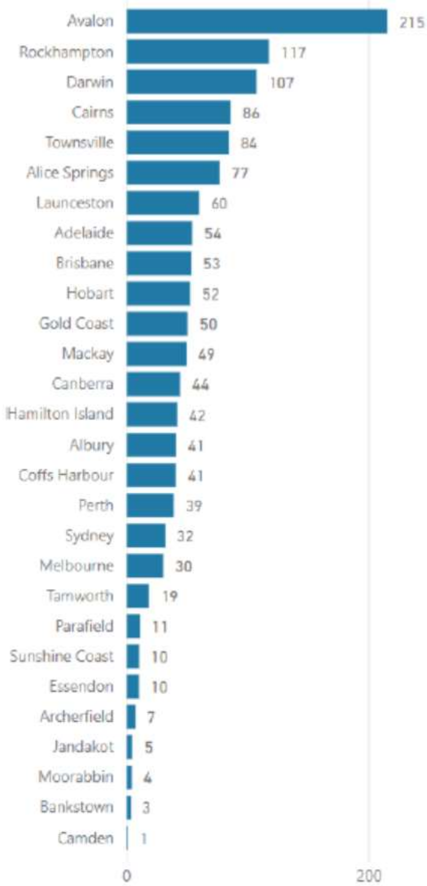
The ATSB examines data by location and by the frequency of strikes per 10,000 flights. As expected, the busiest airports have higher numbers of birdstrikes. In total numbers in the period from 2008-2017 Brisbane Airport had the highest number of birdstrikes (1139) followed by Sydney (1073) (see Figure 4.2).



Data source: ATSB. Link to interactive tool

Figure 4.2 Primary birdstrike locations across Australia 2008–2017

However, of more relevance is the frequency of incidents per 10,000 flights. Avalon Airport has the highest frequency at 215 incidents per 10,000 flights. Avalon is followed by four airports in the tropics which are all on or near the coast: Rockhampton (117), Darwin (107), Cairns (86) and Townsville (84). Brisbane Airport has the 9th highest with 53 and Sydney sits at 18th with only 32 incidents per 10,000 flights (Figure 4.3). Avalon and Brisbane Airports are coastal and surrounded by wetlands, which explains their higher rates per 10,000 movements. Whilst Sydney Airport is coastal, the surrounding land uses are less conducive to attracting birds (open coast water and with surrounding urban and industrial land uses).

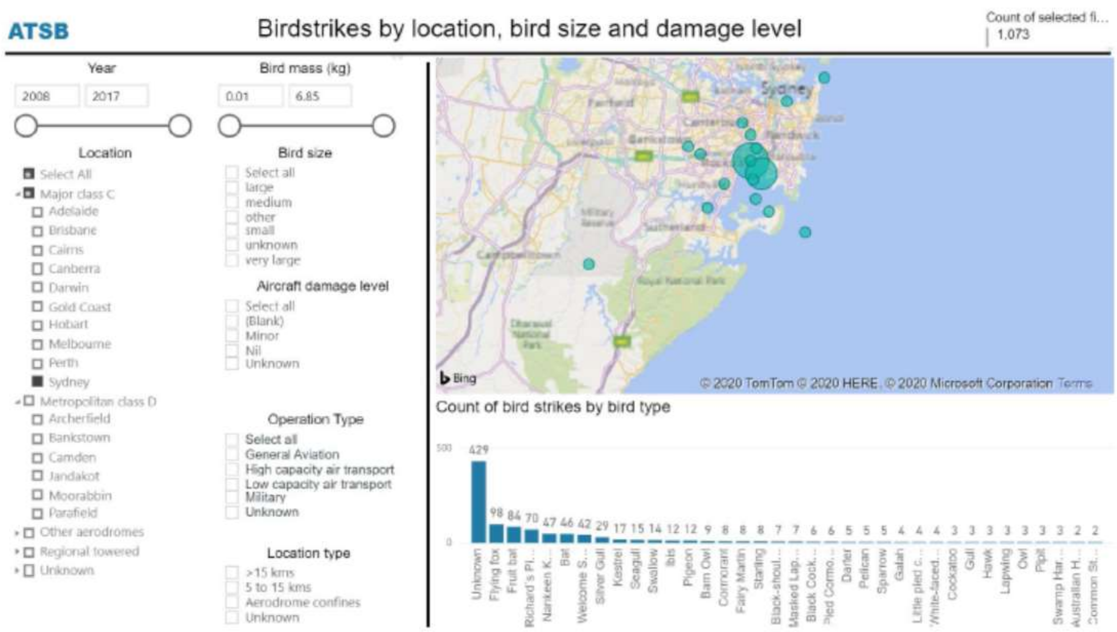


Source: ATSB

Figure 4.3 Rates if birdstrike per 10,000 movements

4.3 Sydney Airport

The current Sydney Airport has significant existing birdstrike data, and is the closest airport to the new Western Sydney Airport. Whilst its geographical context is different, it still gives come indication of potential species which may be of concern. Of the top five species encountered in incidents at Sydney Airport three are 'bats' of some description (flying fox, fruit bat, and bat). It is clear that flying foxes are a significant issue at Sydney Airport. Nationally, they are the 3rd most commonly struck species. Other species of concern at Sydney are Richard's Pipit (now scientifically Australasian Pipit), Nankeen Kestrel, Welcome Swallow, and Silver Gull. Of these birds, Silver Gull is likely the most concerning due to its size and prevalence of flocking. Further species details for Sydney Airport are given in Figure 4.4.



Source: ATSB

Figure 4.4 Birdstrike species data from Sydney Airport 2008-2017

4.4 Western Sydney Airport site

4.4.1 Overview

As part of the Western Sydney Airport Environmental Impact Statement, Avisure undertook a *Preliminary Bird and Bat Strike Risk Assessment* (2015). A summary of the preliminary assessment is provided below:

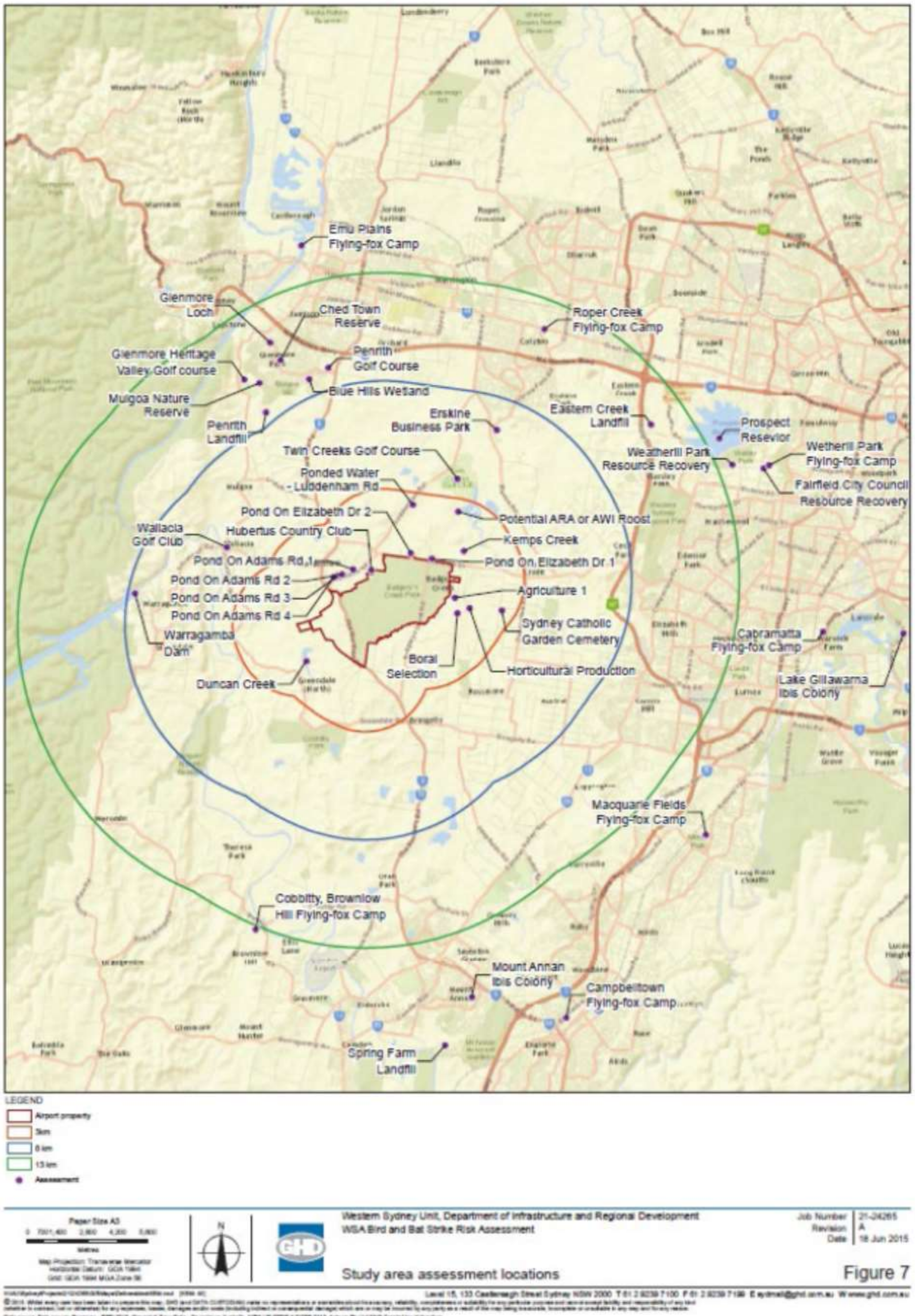
> The assessment was based on a desktop review of relevant literature and a three-day site visit conducted in March 2015. The visit included investigations within the airport site and study area. The study area included the area within a 25 km radius of the airport site centre point. The justification for the distance is based on international standards (ICAO and World Birdstrike Association) and national guidelines (National Airports Safeguarding Framework) and recommended identifying, and where necessary managing potential wildlife attractions within 13 km of runways.
>
> The assessment found that there would be a bird and bat strike risk at the proposed airport due to species presence and abundance, habitat available on the airport site and within the study area, projected aircraft movements and stage construction. The presence of farm dams presents the greatest risk for birdstrike at the proposed airport. Despite the complexity involved in managing an abundant and highly distributed habitat type outside the airport site, it is important to consider this risk relative to other possible features which could present significant bird and bat strike risk for an airport. For example the proposed site does not have a large estuary in close proximity, is not within a major bird migratory route, does not have flying-fox roosts or ibis colonies in closed proximity, and is likely to have reduced available habitat as the airport surrounds urbanise.
>
> Each potential contributor to bird and bat strike risk at the proposed Western Sydney Airport can be managed to an acceptable risk level so the preliminary assessment of overall bird and bat strike risk for the airport is low. Risk management would require the airport operator to implement a suite of mitigation measures and develop an integrated management program designed for ongoing implementation. The mitigation measures detailed in this report are specific to Stage 1 of the proposed airport site development. Similar strategies will apply to the longer term development with additional risk of bird and bat strike risk due to the operation of one runway during construction of a second. Further review of appropriate mitigation strategies will be required during the detailed design, construction and operation

stages of longer term development. In addition, the airport operator would need to comply with the International Civil Aviation Organisation, the Civil Aviation Safety Authority and the National Airport Safeguarding Framework regulations and standards and guidelines.

The mitigation strategies listed in this report are based on our preliminary assessment and need to be refined as more information about the detail design and construction of the proposed airport becomes available. Key considerations include: that the design does not create bird and bat attractive features; that bird and bat populations are monitored to assess strike risk; and, that a plan to implement mitigation actions where hazards are identified is developed.

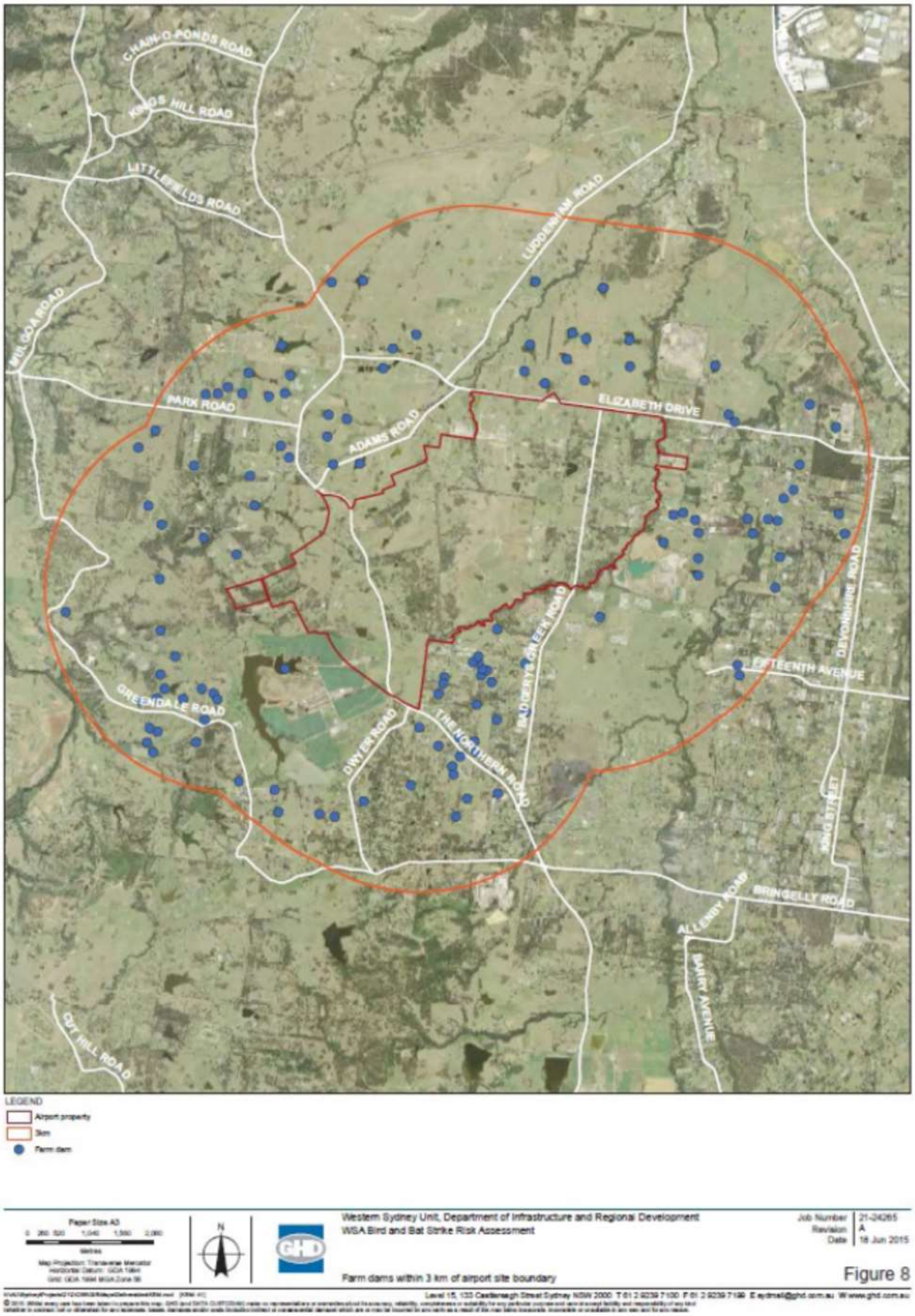
The Avisure survey area is shown in Figure 4.5. This figure also shows the study area assessment locations. The study area's dams considered to be of concern are shown in Figure 4.6. As stated above, the presence of farm dams scattered across this area presents the greatest risk for birdstrike at the proposed airport.

The subject property at Adams Road was not identified as an area of concern in the *Preliminary Bird and Bat Strike Risk Assessment*.



Source: *Preliminary Bird and Bat Strike Risk Assessment* (Avisure 2015)

Figure 4.5 The Preliminary Birdstrike Assessment (Avisure 2015) survey area



Source: Preliminary Bird and Bat Strike Risk Assessment (Avisure 2015)

Figure 4.6 Farm dams within 3 km of the Western Sydney Airport boundary

4.4.2 Species found around Western Sydney Airport

The species mix found around the Western Sydney Airport is typical of an inland semi-rural environment. Avisure (2015) stated the following:

> Of the aforementioned species, Avisure recorded Masked Lapwing, Galah, Australian Magpie, and every duck species in the airport site surveys. Of particular note was the number of Galahs recorded, with an average of 9.33% per survey and four ducks species (Pacific Black Duck, Grey Teal, Australian Wood Duck, and Hardhead) with greater than 10 per survey. In addition the presence of Straw-necked Ibis in high numbers presents a risk as they are a flocking species of significant mass (1.3 kg) and are relatively difficult to manage on an operating airport

Futher details are provided in Figure 4.7.

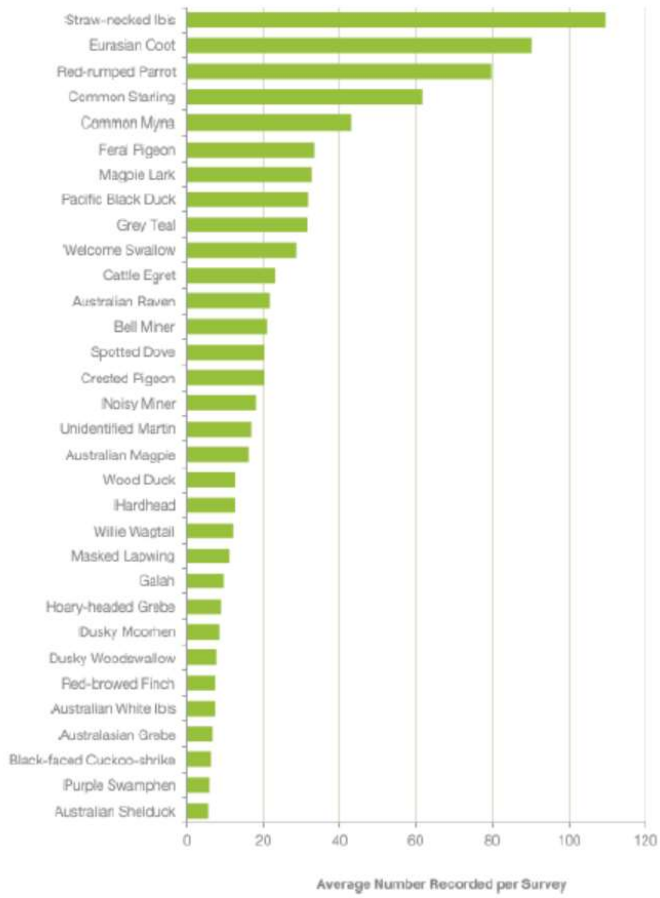


Figure 4. Species and average numbers observed per survey, site for the Western Sydney Airport, March 2015. Note: includes only species with an average number of individuals per survey greater than 5. An additional twenty-eight species were recorded, but had an average less than 5 per survey.

Source: Preliminary Bird and Bat Strike Risk Assessment (Avisure 2015)

Figure 4.7 Bird species and average numbers observed around Western Sydney Airport boundary (2015)

5 Subject site's past (theoretical) and current birdstrike risk profile (to the Western Sydney Airport)

The following assessment of the subject property's risk to cause wildlife and birdstrike risk to the Western Sydney Airport is based on the species recorded around the site, and those which are known to cause risk at Sydney Airport and nationally.

5.1 Birdstrike risks in 2015

In 2015, when the Preliminary Bird and Bat Strike Risk Assessment was undertaken, the subject property was an active shale/clay quarry. It was not identified as an area of concern by the Avisure (2015) assessment.

Source: Nearmap

Figure 5.1 The subject site and surrounds in March 2015

The very disturbed, actively worked environment across the subject property would not have acted as an attractant to any of the birds or bats (flying-foxes) in question. Most of these species are attracted to grasslands, agricultural areas and vegetated wetlands. For example, the subject site would not provide food, safe roosting areas or attractive habitats, particularly in the context of the surrounding rural landscape and number of relatively undisturbed farm dams around it. The site is shown in Figure 5.1 below).

Overall, it is considered that the subject property would not have contributed to birdstrike risk should the airport been operational in 2015.

5.2 Birdstrike risk in 2020

As of 2020, the quarry has been inactive for about two years .The primary change to the site (from 2015) is that water has accumulated in the floor of the quarry (red circle in Figure 5.2). Whilst this could potentially attract water birds, the environment is still relatively sterile and unlikely to provide foraging.

Source: Nearmap

Figure 5.2 The subject site and surrounds in April 2020

The very disturbed site would still not act as an attractant to any of the birds or bats (flying-foxes) in question, particularly in the context of the surrounding rural landscape and number of relatively undisturbed farm dams around it. Whilst the risk profile would be very slightly elevated by the water ponding on site in the quarry, overall, it is considered that the subject property would not contribute to birdstrike risk, should the airport be currently operational.

6 Future birdstrike risk should the proposed development proceed

6.1 Overview of the proposed development

In summary, the proposed development activity at the subject property considered by this assessment includes:

- re-opening and operating the clay/shale quarry;
- upgrading and using the access road to the Adams Road;
- developing a fully enclosed ARRC which has been designed to meet the requirements of the EPA and Western Sydney Airport to ensure that onsite activities will not impact airport operations;
- an onsite water detention basin adjacent to the ARRC;
- the ongoing use of the existing water management dam; and
- future infilling of the quarry void with inert waste allowing rehabilitation for future land uses in accordance with the Aerotropolis State Environmental Planning Policy.

The ARRC will process inert, non-putrescible construction and demolition waste. No food or putrescible waste will be processed or disposed of on the site.

6.2 Changes to birdstrike risk

As outlined above in Section 5, the subject property currently poses minimal birdstrike risk to the airport, compared to the surrounding environment. The proposed development set out above will cause the following changes to the site:

- the site will become active with human disturbance and vehicles using the area of the quarry and the ARRC;
- the quarry will become active including water being drained from the quarry floor, quarrying taking place and future infilling occurring to rehabilitate the site;
- the ARRC will cover most of the paddock north of the existing quarry;
- an onsite water detention basin will be constructed adjacent to the ARRC; and
- the existing water management dam will be used.

Taking the points above in order, the following assessment is provided regarding how they may contribute (or otherwise) to wildlife strike and birdstrike risk at the WSA:

- increased use and activity on the site is likely to reduce the site's attractiveness to wildlife and birds;
- removing water from the quarry floor, active quarrying, and future infilling of the void with inert waste is also likely to reduce the site's attractiveness for wildlife and birds;
- the removal of the grassland paddock for the development of the covered ARRC north of the quarry will remove habitat that could attract grassland birds and birds which use grasslands to feed upon – such as Straw-necked Ibis. This will reduce the site's attractiveness for wildlife and birds; and
- with suitable management, the risks associated with the onsite water detention basins and dams could be reduced, even though these would be minor risks to begin with due to their small size.

The current site poses very low birdstrike risk to the airport's operation. It is largely disturbed and sterile and is less attractive to key wildlife and bird species than surrounding agricultural areas, paddocks, and farm dams. Given the type and scale of the proposed development, the site will be even less attractive to wildlife and birds with the removal of open water from the quarry, removal of the paddock, and the general activity that will occur on site. The development of this site will reduce the likelihood of wildlife and birdstrikes occurring at the airport, albeit by a very small fraction given the site's scale and surrounding environment. The small risk posed by the subject site would be further reduced by the implementation of the mitigation and management measures described in Section 7.

7 Recommended mitigation/management measures

Despite being considered a very low risk site from the perspective of increasing birdlife strikes at the airport, there are additional mitigation/management measures which can be implemented to further reduce the site's attractiveness for wildlife. The following measures are recommended:

- No new planting (eg for landscaping) should occur on the subject property that produces fruit or flowers that are likely to attract birds and wildlife.

- Any new water features (such as the onsite water detention basin) should either be netted or have lines across it with moving flags on them to deter birds using it.

- The existing water management dam should be netted or have lines for flags across it to deter birds from utilising it.

- The building designs, including on fences and lighting, should ensure that they minimise areas for wildlife, especially birds, to use for breeding, roosting, or perching. This could include:

  - having no eaves or ensuring there is no access to the roof through the eaves; and

  - using 'bird-spikes' on roof edges, fences and lighting.

- Waste management on site must include careful management of any food waste from employees, for example by providing waste bins which are inaccessible to birds and vermin.

- Documenting the above measures in a management plan as part of the site's overall environmental management plan to define roles, responsibilities, and actions to ensure the above are implemented, managed, and maintained.

- Should birds or other wildlife start using the site, particularly in numbers of concern, the operator of the ARRC and/or quarry should engage specialists to survey/monitor the species utilising the site to remedy the situation.

8 Conclusions

The subject property at 275 Adams Road, Luddenham New South Wales poses an extremely low wildlife and birdstrike risk to the new Western Sydney Airport. The proposed development of the property is likely to further reduce this risk by reducing access to standing water on the site, developing a grass paddock into the ARRC and operating, and rehabilitating the quarry. Based on the work completed as part of airport planning, the surrounding area of open paddocks and dams is of far more concern to the airport at this stage. To ensure the proposed development absolutely minimises its risks, a number of additional management and mitigation measures are recommended.

Yours sincerely

R.P. Morris

Rob Morris
Associate Director
rmorris@emmconsulting.com.au

Attached:
Curriculum vitae, Robert Morris

Appendix C – EMM Additional Air Quality Modelling Memo 15 December 2020

Memorandum

EMM creating opportunities

Ground floor, 20 Chandos Street
St Leonards NSW 2065
PO Box 21
St Leonards NSW 1590

T 02 9493 9500
E info@emmconsulting.com.au

www.emmconsulting.com.au

15 December 2020

To: Coombes Property Group & KLF Holdings Pty Ltd
From: Ronan Kellaghan
Subject: Luddenham Advanced Resource Recovery Centre - additional air quality modelling for response to submissions

1 Introduction

This memo provides a summary of revised modelling results prepared in response to submissions received from the NSW EPA and Western Sydney Airport (WSA) on the Air Quality Impact Assessment (AQIA) prepared for the Advanced Resource Recovery Centre (ARRC) development application.

The memo presents revised modelling results for a cumulative scenario which includes quarry infilling and provides refinements to the emission estimates for the ARRC.

2 Revised emission estimates

2.1 Changes to the ARRC emission inventory

Since the submission of the EIS, changes have been made to the assumptions for truck movements in and out of the site. The majority of waste (approximately 400,000 tonnes (t)) will be brought in by truck and dog, semi-trailer and B-doubles, with an average load of between 30 to 50 t. The emission inventory was therefore updated to account for this revised split for truck movements, as follows:

- 200,000 tonnes per annum (tpa) bulk waste transfer from other KLF facilities with an average incoming load of 35 t;
- 200,000 tpa of general solid waste/excavated material with an average incoming load of 35 t; and
- 200,000 tpa of waste from construction, industrial and commercial sites with average incoming loads of 5 t (eg skip bins).

The revised assumptions result in a change to the total number of truck movements to site (as the larger incoming loads require less trips) and consequently result in a small decrease to the emission estimates for wheel generated dust from access roads.

The allocation of emissions from truck movements across the day has also been updated to reflect the operations of the site more accurately. The previous modelling presented in the EIS assumed an even split of truck movements across the day and night; however, this does not reflect how facilities would operate, with the majority of truck movements occurring during the day. The revised modelling presented in this memo therefore assumes that 80% of the truck movements occur between the hours of 6 am and 6 pm with the remaining trucks (20%) entering from 6 pm to 6 am.

The emissions estimates for diesel have been revised in response to EPA's submission on reducing emissions from non-road diesel equipment. The proponent has confirmed that most of their existing fleet is US EPA Tier 4 compliant and they have committed to using similar equipment for the ARRC. Emission estimates for diesel are therefore updated using US EPA Tier 4 emission factors.

2.2 Emission inventory for quarry infilling

The cumulative scenario presented in the EIS has been revised to account for quarry infilling. An emission inventory has been developed for quarry infilling based on the following assumptions:

- 300,000 tpa of incoming external waste would travel via the site access road and around the northern and eastern perimeter of the site and enter the quarry pit via the existing ramp;
- An addition 60,000 tpa of internal waste from the ARRC would be transported from the ARRC around the eastern perimeter of the site and enter the quarry pit via the existing ramp;
- external waste would be transported in trucks with an average load of 35 t;
- internal waste would be transported in dump trucks with an average load of 38 t;
- trucks would unload in the pit and waste would be rehandled and spread using a front end loader and compacted using a compactor;
- 3.4 hectares of the pit would be active for wind erosion;
- water carts would operated on the haulage routes and would dampen waste for spreading; and
- diesel consumption would be approximately half that of the operational quarry.

The assumptions are taken from and consistent with the Concept Design and Filling Strategy prepared by InSitu Advisory.

A summary of the estimated emissions for quarry infilling compared with the Luddenham Quarry extraction scenario is presented in Table 2.1. The table also presents emission estimates for the ARRC (as presented in the EIS) and the revised estimates based on the changes described in Section 2.1.

Table 2.1 Calculated emissions for development stages

Development stage	TSP (kg/year)	PM_{10} (kg/year)	$PM_{2.5}$ (kg/year)
Luddenham Quarry	34,666	10,327	1,437
Quarry infilling	19,845	5,898	801
ARRC (as presented in EIS)	7,786	1,573	578
ARRC (revised estimate)	7,655	1,221	314

3 Revised modelling results – residential / commercial

The cumulative scenario presented in the EIS has been revised to account for quarry infilling. Cumulative results are presented as follows:

- Cumulative scenario 1: ARRC increment + quarry extraction + background + construction of WSA; and
- Cumulative scenario 2: ARRC increment + quarry infilling + background + operation of WSA.

3.1 Annual average PM_{10} and $PM_{2.5}$

The predicted ARRC increment and cumulative annual average PM_{10} and $PM_{2.5}$ concentrations are presented in Table 3.1. The highest predicted ARRC increment for annual average PM_{10} is 2.2 μg/m^3 at assessment location R3 (EIS prediction: 3.9 μg/m^3). The next highest predicted ARRC increment (0.6 μg/m^3) occurs at R6 (EIS prediction: 1.1 μg/m^3). There are no exceedances of the impact assessment criterion for annual average PM_{10}.

The highest predicted ARRC increment for annual average $PM_{2.5}$ is 0.8 μg/m^3 also at assessment location R3 (EIS prediction: 1.3 μg/m^3). The next highest predicted ARRC increment (0.2 μg/m^3) occurs at R6 (EIS prediction: 0.4 μg/m^3).

For both cumulative assessment scenarios, there is an exceedance of the impact assessment criterion for annual average $PM_{2.5}$ at R3 (8.6 μg/m^3 for Scenario 1 and 8.5 μg/m^3 for Scenario 2). It is noted that R3 is currently vacant and the land use for the lot has been changed from residential to commercial/industrial as part of the Western Sydney Aerotropolis Land Use Plan.

Table 3.1 Predicted incremental and cumulative annual average PM_{10} and $PM_{2.5}$ concentrations

	PM_{10} (µg/m³)					$PM_{2.5}$ (µg/m³)				
	Increment			Cumulative		Increment			Cumulative	
	ARRC	Quarry	Quarry infill	Scenario 1 (Background + WSA construction + Quarry)	Scenario 2 (Background + WSA operation + quarry infill)	ARRC	Quarry	Quarry infill	Scenario 1 (Background + WSA construction + Quarry)	Scenario 2 (Background + WSA operation + quarry infill)
Goal	25 µg/m³					8 µg/m³				
R1	0.1	0.1	0.1	19.0	18.8	<0.1	<0.1	<0.1	7.5	7.5
R2	0.2	0.2	0.1	19.2	18.9	0.1	0.1	0.0	7.5	7.5
R3	2.2	1.8	0.9	22.9	21.8	0.8	0.4	0.2	**8.6**	**8.5**
R4	0.1	0.3	0.2	19.3	18.9	<0.1	0.1	<0.1	7.6	7.6
R5	0.1	0.2	0.1	19.2	18.9	<0.1	0.1	<0.1	7.6	7.5
R6	0.6	1.3	0.6	20.8	19.9	0.2	0.3	0.1	8.0	7.9
R7	<0.1	0.1	0.1	19.0	18.8	<0.1	<0.1	<0.1	7.5	7.5
R8	0.1	0.1	<0.1	18.9	18.7	<0.1	<0.1	<0.1	7.4	7.4
C1	0.3	1.4	0.6	20.6	19.6	0.1	0.3	0.1	7.9	7.7
AR1	0.2	1.2	0.5	20.3	19.4	0.1	0.3	0.1	7.8	7.7

3.2 24-hour average PM_{10} and $PM_{2.5}$

The predicted ARRC increment and cumulative 24-hour average PM_{10} and $PM_{2.5}$ concentrations are presented in Table 3.2. Exceedances of the impact assessment criteria are shown in bold, and the number of additional days above the criteria are shown in brackets.

The highest predicted ARRC increment for 24-hour average PM_{10} is 6.3 µg/m³, at assessment location R3 (EIS prediction: 9.1 µg/m³). The next highest predicted ARRC increment (3.6 µg/m³) occurs at assessment location R6 (EIS prediction: 5.0 µg/m³).

The highest predicted ARRC increment for 24-hour average $PM_{2.5}$ is 1.9 µg/m³, at assessment location R3 (EIS prediction: 3.2 µg/m³). The next highest predicted ARRC increment (1.0 µg/m³) occurs at R6 (EIS prediction: 2.1 µg/m³).

The cumulative daily-varying 24-hour average results at each receptor are derived as follows:

- Cumulative Scenario 1: The 2017 Bringelly daily monitoring data is combined with the maximum predicted 24-hour average concentration from the construction of WSA, added to every day of the background dataset. The project-only predicted increment for each day is then added to this background plus WSA contribution and then combined with the predicted increment for the Luddenham Quarry on the same day;

- Cumulative Scenario 2: The 2017 Bringelly daily monitoring data is combined with the maximum predicted 24-hour average concentration from the operational phase of WSA, added to every day of the background dataset. The project-only predicted increment for each day is then added to this background plus WSA contribution and then combined with the predicted increment for the quarry infilling on the same day.

There are six existing exceedances of the daily PM_{10} criterion in the 2017 background dataset. With the additional contribution from the construction and operation of the WSA, there are another two exceedances of the daily PM_{10} criterion (total of eight existing exceedances across all receptors assumed for background). Therefore, for PM_{10}, the 9th highest cumulative concentrations are presented. For $PM_{2.5}$, there are two existing exceedances of the daily $PM_{2.5}$ criterion in the 2017 background dataset. With the additional contribution from the construction and operational phase of the WSA, no additional exceedances would occur. Therefore, the third highest cumulative concentrations are presented for 24-hour average $PM_{2.5}$ for both scenarios.

As shown in Table 3.2, for 24-hour PM_{10} concentrations, there are additional days over the impact assessment criterion for Scenario 1 at R3 (three additional days) and no additional days over the impact assessment criteria for Scenario 2 (with quarry infilling). For 24-hour $PM_{2.5}$ concentrations, there are two additional days over the impact assessment criterion for both scenarios at R3.

Table 3.2 Predicted incremental and cumulative 24-hour average PM_{10} and $PM_{2.5}$ concentrations

	PM_{10} (µg/m³) (number of additional days above goal shown in brackets)					$PM_{2.5}$ (µg/m³) (number of additional days above goal shown in brackets)				
	Increment			Cumulative		Increment			Cumulative	
	ARRC	Quarry	Quarry infill	Scenario 1 (ARRC + background + WSA construction + Quarry)	Scenario 2 (ARRC + background + WSA operation + quarry infill)	ARRC	Quarry	Quarry infill	Scenario 1 (Background + WSA construction + Quarry)	Scenario 2 (Background + WSA operation + quarry infill)
Goal	50 µg/m³					25 µg/m³				
R1	0.5	1.0	0.7	47.8	44.9	0.2	0.2	0.1	23.5	23.0
R2	0.8	2.2	1.1	47.9	44.9	0.2	0.5	0.2	23.3	22.9
R3	6.3	10.2	4.2	**50.7 (3)**	48.5	1.9	1.9	1.0	**25.1 (2)**	**25.2 (2)**
R4	0.9	3.2	1.3	47.8	45.9	0.3	0.7	0.3	23.7	23.9
R5	0.4	2.6	0.9	47.8	45.9	0.1	0.7	0.3	23.7	23.8
R6	3.6	5.5	3.0	48.9	46.6	1.0	1.4	0.7	24.1	24.1
R7	0.5	1.4	0.5	47.8	45.8	0.2	0.4	0.2	23.6	23.8
R8	0.5	1.2	0.6	47.7	44.8	0.2	0.3	0.1	23.2	22.8
C1	1.7	8.0	4.7	48.7	46.6	0.5	1.6	0.7	23.9	24.0
AR1	1.1	8.6	4.3	48.5	46.4	0.4	1.6	0.6	23.8	23.9

3.3 Annual average TSP and dust deposition

The predicted ARRC increment and cumulative annual average TSP and dust deposition are presented in Table 3.3. The highest predicted ARRC increment for annual average TSP is 11.6 $\mu g/m^3$ at assessment location R3 (down from the EIS prediction of 16.7 $\mu g/m^3$). There are no exceedances of the impact assessment criterion for annual average TSP for either scenario.

The highest predicted ARRC increment for annual average dust deposition is 0.7 g/m^2/month also at assessment location R3 (down from the EIS prediction of 0.8 g/m^2/month). There are no exceedances of the impact assessment criterion for annual average dust deposition for either scenario.

Table 3.3 Predicted incremental and cumulative annual average TSP and dust deposition

	TSP ($\mu g/m^3$)					Dust deposition ($g/m^2/month$)				
	Increment			Cumulative		Increment			Cumulative	
	ARRC	Quarry	Quarry infill	Scenario 1 (Background + WSA construction + Quarry)	Scenario 2 (Background + WSA operation + quarry infill)	ARRC	Quarry	Quarry infill	Scenario 1 (Background + WSA construction + Quarry)	Scenario 2 (Background + WSA operation + quarry infill)
Goal	90 $\mu g/m^3$					2 $g/m^2/month$			4 $g/m^2/month$	
R1	0.3	1.0	0.2	51.0	50.3	<0.1	0.1	<0.1	1.7	1.6
R2	0.8	2.1	0.4	52.6	50.9	0.1	0.1	<0.1	1.8	1.7
R3	11.6	26.1	3.4	87.4	64.7	0.7	1.5	0.3	3.8	2.6
R4	0.3	0.9	0.4	51.0	50.4	<0.1	<0.1	<0.1	1.7	1.6
R5	0.2	0.7	0.3	50.6	50.2	<0.1	<0.1	<0.1	1.6	1.6
R6	2.9	7.7	1.6	60.2	54.2	0.2	0.4	0.2	2.2	1.9
R7	0.1	0.4	0.1	50.2	50.0	<0.1	<0.1	<0.1	1.6	1.6
R8	0.2	0.6	0.1	50.5	50.0	<0.1	<0.1	<0.1	1.6	1.6
C1	1.2	3.5	1.5	54.4	52.5	0.1	0.2	0.1	1.8	1.8
AR1	0.8	2.2	1.2	52.8	51.8	<0.1	0.1	0.1	1.7	1.8

4 Future airport receptors

Air quality predictions at future receptors associated with the Western Sydney Airport have been modelled. The air quality predictions are presented in Table 4.1, Table 4.2 and Table 4.3 at three discrete receptor points for each of the future terminal area, runway area, fuel farm area and airport infrastructure area (shown in Figure 4.1).

Air quality predictions are presented for Scenario 2 only, which includes the operation of the ARRC, quarry infilling, background plus the operation of WSA. Air quality predictions for Scenario 1 are not presented as quarry extraction would be completed in 2024, prior to the start of airport operations in 2026.

The modelling results presented in in Table 4.1, Table 4.2 and Table 4.3 show:

- there would be no exceedances of the annual average impact assessment criteria for PM_{10} and $PM_{2.5}$ at the airport terminal, runway or infrastructure areas;
- exceedances of the annual average impact assessment criteria for $PM_{2.5}$ are limited to the fuel farm area;
- exceedances of the 24-hour average impact assessment criteria for PM_{10} and $PM_{2.5}$ are limited to the fuel farm area (2–4 additional days over the impact assessment criteria); and
- there would be no exceedances of the annual average impact assessment criteria for PM_{10} and $PM_{2.5}$ at the airport terminal, runway, infrastructure or fuel farm areas.

It is noted that the health-based air quality criteria for particulate matter are designed to offer protection for periods of exposure ranging from 24-hours to annual averages. It is expected that exposure risk at the Fuel Farm area would be minimal as employees would not spend significant periods of time within this area.

Table 4.1 Predicted incremental and cumulative annual average PM_{10} and $PM_{2.5}$ concentrations for airport receptors

	PM_{10} (µg/m³)			$PM_{2.5}$ (µg/m³)		
	Increment		Cumulative	Increment		Cumulative
	ARRC	Quarry infill	Scenario 2 (Background + WSA operation + quarry infill)	ARRC	Quarry infill	Scenario 2 (Background + WSA operation + quarry infill)
Goal		25 µg/m³			8 µg/m³	
Terminal R1	<0.1	0.1	18.8	<0.1	<0.1	7.5
Terminal R2	<0.1	0.1	18.8	<0.1	<0.1	7.5
Terminal R3	<0.1	0.1	18.8	<0.1	<0.1	7.5
Runway R1	<0.1	0.1	18.9	<0.1	<0.1	7.5
Runway R2	0.1	0.3	19.1	<0.1	0.1	7.6
Runway R3	0.1	0.3	19.1	<0.1	0.1	7.6
Fuel farm R1	0.2	2.2	21.2	0.1	0.3	7.9
Fuel farm R2	0.3	3.1	22.1	0.1	0.5	**8.1**
Fuel farm R3	0.2	3.5	22.4	0.1	0.5	**8.1**
Infrastructure R1	<0.1	0.1	18.8	<0.1	<0.1	7.5
Infrastructure R2	<0.1	0.1	18.8	<0.1	<0.1	7.5
Infrastructure R3	<0.1	0.1	18.8	<0.1	<0.1	7.5

Table 4.2 Predicted incremental and cumulative 24-hour average PM_{10} and $PM_{2.5}$ concentrations for airport receptors

	PM_{10} (µg/m³) (number of additional days above goal shown in brackets)			$PM_{2.5}$ (µg/m³) (number of additional days above goal shown in brackets)		
	Increment		Cumulative	Increment		Cumulative
	ARRC	Quarry infill	Scenario 2 (Background + WSA operation + quarry infill)	ARRC	Quarry infill	Scenario 2 (Background + WSA operation + quarry infill)
Goal		50 µg/m³			25 µg/m³	
Terminal R1	0.8	1.6	45.9	0.4	0.4	23.8
Terminal R2	0.7	1.5	45.9	0.3	0.3	23.8
Terminal R3	0.5	1.1	45.9	0.2	0.2	23.8
Runway R1	0.9	2.0	45.9	0.4	0.4	23.8
Runway R2	0.8	5.3	46.2	0.4	0.8	23.8
Runway R3	1.1	4.6	46.0	0.5	0.7	23.8
Fuel farm R1	1.3	10.0	49.0	0.5	1.2	24.4
Fuel farm R2	1.7	16.0	**55.2 (2)**	0.6	2.6	25.0
Fuel farm R3	2.0	23.7	**55.4 (4)**	0.9	3.0	**25.5 (2)**
Infrastructure R1	0.4	1.3	45.9	0.2	0.2	23.8
Infrastructure R2	0.5	1.0	45.9	0.3	0.2	22.1
Infrastructure R3	0.2	1.8	45.9	0.1	0.3	22.1

Table 4.3 Predicted incremental and cumulative annual average TSP and dust deposition for airport receptors

	TSP ($\mu g/m^3$)			Dust deposition ($g/m^2/month$)		
	Increment		Cumulative	Increment		Cumulative
	ARRC	Quarry infill	Scenario 2 (Background + WSA operation + quarry infill)	ARRC	Quarry infill	Scenario 2 (Background + WSA operation + quarry infill)
Goal	90 $\mu g/m^3$			2 $g/m^2/month$		4 $g/m^2/month$
Terminal R1	0.1	0.2	50.0	<0.1	<0.1	1.6
Terminal R2	0.1	0.1	49.9	<0.1	<0.1	1.6
Terminal R3	0.1	0.2	50.1	<0.1	<0.1	1.6
Runway R1	0.2	0.3	50.2	<0.1	<0.1	1.6
Runway R2	0.3	0.7	50.7	<0.1	0.1	1.7
Runway R3	0.3	0.8	50.8	<0.1	0.0	1.7
Fuel farm R1	1.0	6.4	57.1	<0.1	0.6	2.2
Fuel farm R2	1.2	8.7	59.7	0.1	0.7	2.4
Fuel farm R3	0.9	10.1	60.7	<0.1	0.8	2.4
Infrastructure R1	0.1	0.1	49.9	<0.1	<0.1	1.6
Infrastructure R2	0.1	0.2	50.0	<0.1	<0.1	1.6
Infrastructure R3	0.1	0.1	49.9	<0.1	<0.1	1.6

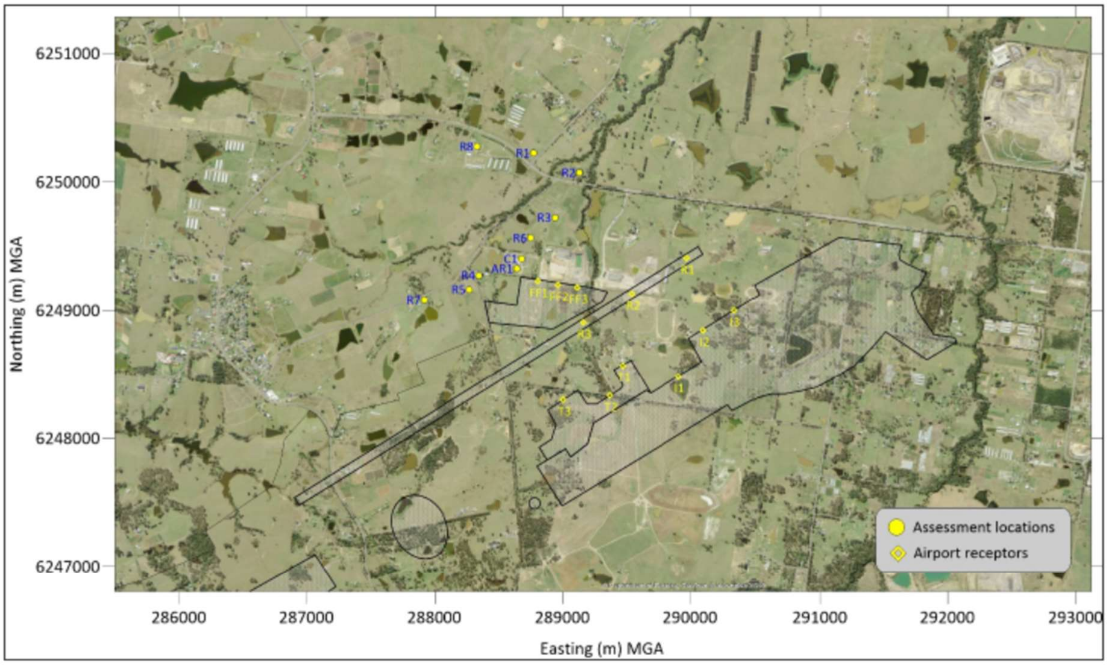


Figure 4.1 EIS modelled sensitive assessment locations and future airport receptors

5 Conclusion

The cumulative scenario presented in the EIS has been revised to account for quarry infilling. Modelling results predict that air quality impacts from the proposed operation of the ARRC would not adversely impact local air quality. Exceedances of the impact assessment criteria are limited to receptor R3, which is currently vacant and the land use for the lot has been changed from residential to commercial/industrial as part of the Western Sydney Aerotropolis Land Use Plan.

Modelling predictions for a number of future airport receptors indicate that there would be no air quality impact for the operation of the WSA, with exceedances of the impact assessment criteria limited to the fuel farm area where exposure risk would be minimal.

Yours sincerely

Ronan Kellaghan
Associate - Air Quality
rkellaghan@emmconsulting.com.au

Appendix D - Curriculum Vitae

Robert Morris

Associate Director

Curriculum vitae

Robert has over 28 years' experience in environmental consulting, taking on leadership, managerial and technical roles. Robert specialises in environmental and ecological impact assessment and environmental management. Robert has managed many major EIA projects in the minerals extraction, oil and gas, waste management, renewable energy and infrastructure sectors both in Australia and internationally. He has also managed World Bank funded projects and acted as an advisor to major banks on the Equator Principals and due-diligence audits.

Robert has particular knowledge and expertise in understanding the environmental and social impacts of airports and also the potential impacts of the environment on airports. Rob has worked for many years on both airport expansions and new airport developments from an ecological, birdstrike & environmental assessment

Qualifications

- Master of Science, Environmental Assessment and Management, Oxford Brookes University, 1995
- Bachelor of Science (Hons) Ecology (2:1), University of East Anglia, 1990
- Graduate of the Australian Institute of Company Directors
- Various vocational qualifications in People Management, Leadership, Safety Leadership, Financial management, Marketing, and Business Development.

Career

- EMM Consulting, 2017–present
- Group Executive – Energy & Resources, Coffey 2015–2016
- Group Executive – Coffey Environments, 2013–2015
- Principal / General Manager Qld & PNG – Coffey Environments, 2009–2013
- Senior Associate – Coffey Natural Systems, – 2007
- Associate Director, Arup (London), 2006–2007
- Associate Director – Environment, Scott Wilson UK, 2003–2006
- Principal Environmental Specialist, Scott Wilson UK / Hong Kong, 2000–2003
- Senior Environmental Specialist, Scott Wilson Hong Kong, 1997–2000
- Senior Environmental Specialist, Scott Wilson UK and Zimbabwe, 1993–1996
- Environmental Consultant, Scott Wilson (previously (CRC) UK), 1993–1996
- Ecological Consultant, Bioscan (UK), 1992–1993.
- Research Ecologist / Consultant, Oxford University, WildCRU, Zoology Department (Lady Margaret's Hall) / Nature Conservation Bureau UK, 1990–1992

EMM
creating opportunities

Representative experience

- **Williamtown Airport – Expansions** (Defence Australia) PD for the post approvals Ecology issues relating to the EPBC assessment following the project being a controlled action. Liaison with Defence on site and key consultees over operational impacts and proposed monitoring on Bats, migratory waders and Gould's Petrel.
- **Stansted Airport Expansion – SG2** (BAA) Topic manager for economic, employment, community and planning effects. Liaison manager for surface access issues and off-site infrastructure issues.
- **Birmingham International Airport – Master Plan Review** (BIA Ltd) Project Manager for the Environmental work-stream (excluding air and noise work) of the 2030 Masterplan Development. The position included sitting on monthly Board Meetings at BIAL.
- **Dalaman Airport – Environmental Due-diligence Review** (HVB) Environmental review of the terminal expansion of Dalaman Airport based on the Equator Principles for a major German Investment Bank (2005).
- **Birmingham International Airport – Runway Extension EIS;** Carried out and wrote the ecological assessment as part of the EIA for the proposed runway extension (BIAL – 2001).
- **Dublin Airport – Proposed Second Runway** Managed the EIA sub-consultant on behalf of Aer-Rianta, to ensure the EIA is compliant and addresses the issues necessary for the 2nd Runway to receive planning permission (Aer-Rianta, (Secondment 2001-2003)
- **South East Regional Airport Strategy (SERAS)** Provided the ecological and birdstrike risk input to this Strategic Environmental Assessment which is part of a larger study to determine the need for future airport development in the SE of England. (2001)
- **Birmingham Airport Planning and Environmental Review** - Carried out a planning and environmental review of the A45 Tunnel and Diversion Options, associated with the proposed Runway Extension. (BIAL, 2000)
- **Birmingham Airport Environmental Review** of the Revised Master Plan Carried out an environmental review of the revised Master Plan Strategy to be published in 2001. (BIAL, 2000)
- **Brussels International Airport (BIAC) Environmental Review** Environmental Manager for the BIAC Strategic Airport Development Study which aims to set out development options for BIAC for the next 20 years. (BIAC, 2000)
- **UK: London Airport Surface Access Study (LASAS)** Managed a strategic environmental appraisal to ascertain the environmental consequences of several route options for providing surface rail access between Gatwick and Heathrow airports. The study covered all environmental parameters and compared the environmental acceptability of each route option.
- **UK: Birmingham International Airport**. Managed the ecological component of the environmental assessment. The assessment was based upon development proposals including terminal expansion, runway extension, road diversions and other associated infrastructure improvements. Liaison with both English Nature and the local wildlife trust was undertaken.
- **UK: Manchester International Airport** - preparation of the ecology chapter for the final environmental assessment. This involved editing the detailed specialist study to highlight critical points and significant impacts.
- **UK: Bristol Airport,** Avon An ecological assessment of Bristol Airport was coordinated. This included an assessment of the airports ecological value, research into the areas designated sites of ecological importance, research into birdstrike, noise and emission pollution and subsequent mitigation measures.
- **Kooragang Island CO2 Plant and Fairfield Gas distribution centre – Environmental Audit** – desk study, site audit, report and debrief (Air Liquide Australia).
- **Cowal Gold Operations expansion** – PD for the expansion of the gold mine with a new underground mine.
- **Kunioon Coal Mine EIS (Tarong Energy Corp)** – Project Manager for this proposed new coal mine.
- **Meandu Coal Mine Extension - EPBC Referral (Tarong Energy Corp)** Project Manager for this EPBC referral for this proposed new expansion of Meandu Mine.
- **Berrima Cement Works** – Annual Environmental Return. Project manager for a review of the operations' performance against its EPL and associated conditions. Boral Cement.
- **Galilee Basin Railway** – Ecological Team leader for endangered species surveys. Adani
- **San Jorge Nickel Mine** – EIA/EIS – Project Manager and lead ecologist.
- **Contract Manager (Arrow Energy).** Site Selection / due diligence study – Coastal LNG sites (Shell).
- Stanley Power Project, PNG Western Province (Consortium of Banks / PNG Sustainable Energy Ltd.)

www.emmconsulting.com.au

Peter White

Managing Consultant - Airspace Safeguarding

Qualifications

Diploma of Aviation (ATS), RAAF School of Air Traffic Control 1986

PANS OPS Basic, DFS Akademie, Langen, Germany, 2001

Advanced PANS OPS, Singapore Aviation Academy, 2002

Aviation Quality and Safety Systems Lead Auditor, Aviation Quality Services, 2013

Operational Risk Management, AeroSafe, 2013

Safety Management Systems, AeroSafe, 2013

Australian Pilots Licence with Command Instrument Rating

Year Started in Industry

1980

Year Started at L&B

2017

Overview

Peter is a Managing Consultant overseeing L&B's Airspace and Air Traffic Management team.

He has over 39 years' experience in Air Traffic Services as a Flight Service Officer, Military Air Traffic Controller and Civilian Air Traffic Controller, including as an On-the-job-training instructor and more recently as the Civil Aviation Authority of New Zealand's ATC Testing Officer.

Peter is an experienced instrument flight procedure designer (ICAO PANS OPS) designing the entire range of instrument approaches to military and civilian airports and heliports in Australia and overseas, including Saudi Arabia, Fiji, East Timor and the Solomon Islands.

Having worked for the RAAF Aeronautical Information Service as Chief Designer and Airservices Australia as a CASA Qualified Instrument Flight Procedure Designer, he has successfully designed conventional ground-based procedures and GPS based procedures, including SIDS and STARS.

As an Air Safety Regulator with New Zealand's Civil Aviation Authority Peter was responsible for hazard determinations in relation to airport airspace (Part 77), conditions for approval of new aerodromes and heliports, airspace designations and as CAA's ATS Examiner, ensuring senior ATC staff met and complied with Part 172 requirements as ATS training officers and ATS examiners. He was a senior member of New Zealand's New Southern Sky program which transitioned New Zealand airspace into the Performed Based Navigation (PBN) environment.

Peter was New Zealand's member of ICAO's Separation and Airspace Safety Panel (SASP) from 2013 to 2017, working mainly on the implementation of parallel runway approach standards implemented in ICA Doc 4444 in 2018, having his dedicated service formally recognised by ICAO.

Peter provides consultancy services related to the safeguarding of airspace around major and regional airports in relation to infrastructure developments such as high-rise buildings, wind farms and other man-made obstacles and their potential impact upon aviation activity in the area. He also arranges aviation authority approval for these activities.

He is responsible for the operation of the two CA/GRO operations at Ballina/Byron Gateway airport and Ayres Rock airport.

Peter also holds a Command Instrument Rating for fixed wing aircraft and is also a qualified gliding instructor.

Relevant Experience

Survey and design instrument approach procedures for medivac and military aircraft operations, East Timor and the Solomon Islands; 2003/2004

During UN and Australian peacekeeping missions UNMISET and RAMSI, Peter was deployed to East Timor and the Solomon Islands to assist survey teams to identify suitable runways and heliports and then to design RNAV (GNSS) instrument flight procedures to them to support military and civilian contracted medivac flight operations to those locations.

ICAO Instrument Flight Procedure Design Expert, King Abdulaziz International Airport, Jeddah, Kingdom of Saudi Arabia: 2012- 2013

Guide a small team of designers to develop amended departure and approach procedures related to the construction of the proposed (now under construction) Kingdom Tower, Kingdom City, 5 km north east of the airport.

Air Safety Regulator, Civil Aviation Authority of New Zealand, 2013 - 2017

Assess, approve and promulgate airspace amendments, air-route restructures, aerodrome and heliport working plans, Performance Based Navigation (PBN) planning and implementation, separation standards and regulatory oversight and examination of ATC operations, lead safety audits of ATS providers.

New Zealand member on ICAO Separation and Airspace Safety Panel (SASP) developing modern performance-based separation standards to facilitate more efficient use of controlled airspace used worldwide.

Western Australia Route Review, Airservices Australia, 2006 - 2008

Review and redesign the terminal airspace configuration supporting Perth International Airport, RAAF Bases Pearce and Gin Gin, and Jandakot Airport for efficiency and capacity improvements – redesign SIDs and STARs, design new RNAV approaches, integrate ATC procedures, confirm aircraft profiles.

Solar Farm Glare Impact Assessment, Major International Airport, January 2018.

Conduct glare assessment for a proposed large on-airfield solar farm at a major international airport to ensure that reflected glare would not cause retinal damage or after image distraction for pilots on approach paths and ATC Tower staff.

Wind Farm Impact Assessments

Conduct obstacle, radar interference and lighting requirement assessment of wind farms both near and remote from aerodromes. Provide liaison with aviation authorities for approvals of these major infrastructure developments.

High Intensity Radiation Frequency (HIRF) Impact assessment on Air-Routes, Arrival Routes and Approach and Departure Procedures, November 2017 – April 2018 and ongoing.

Assess the likely impact of increased power to communications station signals from a major Deep Space Communication Centre, against existing Departure and Arrival route to determine airspace protection requirements.

Infrastructure Development Airspace Protection Assessments, Nov 2017 – Ongoing.

Provide detailed advice to infrastructure developers such as high rise buildings, wind farms and mobile phone towers, regarding any impact upon local airspace that is likely cause disruption to aviation activity or that may require procedure amendment to accommodate critically required infrastructure.

Future International Airport Siting Assessment, April 2018 - Ongoing.

As part of a small team, investigate the most suitable location for a green-field airport to support large scale local infrastructure development. Local airspace, ATC procedures, terrain and meteorological impacts formed the basis of this assessment.

CA/GRO Management: August 2019 – Present

Manage L&B's Certified Air/Ground Radio operations at Ballina/Byron Gateway and Ayres Rock Airports.

Wind Shear Assessment, Container Terminal Expansion: 2019

Assess the impact of proposed larger container vessels to a large container vessel terminal in very close proximity to a major international airport.

Runway Development Program: 2019

Research previous studies and assess new data in relation to determining the best option for the next runway configuration at a major international airport. Peter's active participation in multi-disciplined workshops enabled the airport to determine the best configuration for the planning and development of the next runway at the airport.

Conduct Operational Risk Assessment for airport apron operations at major international airport: 2018

Organise and conduct Bowtie based operational risk assessment workshops involving all stakeholders to determine hazard management systems for all operations on the aprons of a major international airport. Prepare and present final report for airport management.

Global Aviation Planning and Development

Appendix E – Glossary of Aeronautical Terms and Abbreviations

To facilitate the understanding of aviation terminology used in this report, the following is a glossary of terms and acronyms that are commonly used in aeronautical impact assessments and similar aeronautical studies.

AC (Advisory Circulars) are issued by CASA and are intended to provide recommendations and guidance to illustrate a means, but not necessarily the only means, of complying with the *Regulations*.

Aeronautical study is a tool used to review aerodrome and airspace processes and procedures to ensure that safety criteria are appropriate.

AIPs (Aeronautical Information Publications) are publications promulgated to provide operators with aeronautical information of a lasting character essential to air navigation. They contain details of regulations, procedures and other information pertinent to flying and operation of aircraft. In Australia, AIP is issued by Airservices Australia on behalf of CASA.

Air routes exist between navigation aid equipped aerodromes or waypoints to facilitate the regular and safe flow of aircraft operating under IFR.

Airservices Australia is the Australian government-owned corporation providing safe and environmentally sound air traffic management and related airside services to the aviation industry.

Altitude is the vertical distance of a level, a point or an object, considered as a point, measured from mean sea level.

ATC (Air Traffic Control) service is a service provided for the purpose of:

a. preventing collisions:
   1. between aircraft; and
   2. on the manoeuvring area between aircraft and obstructions; and

b. expediting and maintaining an orderly flow of air traffic.

CASA (Civil Aviation Safety Authority) is the Australian government authority responsible under the *Civil Aviation Act 1988* for developing and promulgating appropriate, clear and concise aviation safety standards. As Australia is a signatory to the ICAO *Chicago Convention,* CASA adopts the standards and recommended practices established by ICAO, except where a difference has been notified.

CASR (Civil Aviation Safety Regulations) are promulgated by CASA and establish the regulatory framework *(Regulations)* within which all service providers must operate.

Civil Aviation Act 1988 (the Act) establishes the CASA with functions relating to civil aviation, in particular the safety of civil aviation and for related purposes.

ICAO (International Civil Aviation Organization) is an agency of the United Nations which codifies the principles and techniques of international air navigation and fosters the planning and development of international air transport to ensure safe and orderly growth. The ICAO Council adopts standards and recommended practices concerning air navigation, its infrastructure, flight inspection, prevention of unlawful interference, and facilitation of border-crossing procedures for international civil aviation. In addition, the ICAO defines the protocols for air accident investigation followed by transport safety authorities in countries signatory to the Convention on International Civil Aviation, commonly known as the *Chicago Convention*. Australia is a signatory to the *Chicago Convention.*

IFR (Instrument Flight Rules) are rules applicable to the conduct of flight under IMC. IFR are established to govern flight under conditions in which flight by outside visual reference is not safe. IFR flight depends upon flying by reference to instruments in the flight deck, and navigation is accomplished by reference to electronic signals. It is also referred to as, “a term used by pilots and controllers to indicate the type of flight plan an aircraft is flying,” such as an IFR or VFR flight plan. Pilots must hold IFR qualifications and aircraft must be suitably equipped with appropriate instruments and navigation aids to enable flight in IMC.

IMC (Instrument Meteorological Conditions) are meteorological conditions expressed in terms of visibility, distance from cloud and ceiling, less than the minimum specified for visual meteorological conditions.

LSALT (Lowest Safe Altitudes) are published for each low level air route segment. Their purpose is to allow pilots of aircraft that suffer a system failure to descend to the LSALT to ensure terrain or obstacle clearance in IMC where the pilot cannot see the terrain or obstacles due to cloud or poor visibility conditions. It is an altitude that is at least 1,000 feet above any obstacle or terrain within a defined safety buffer region around a particular route that a pilot might fly.

MDA (Minimum Descent Altitude) is the lowest altitude that can be used during a non-precision approach in IMC. Flight below the MDA reduces the clearance above obstacles and is not permitted in IMC.

MOS (Manual of Standards) comprises specifications (Standards) prescribed by CASA, of uniform application, determined to be necessary for the safety of air navigation.

NOTAMs (Notices to Airmen) are notices issued by the NOTAM office containing information or instruction concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to persons concerned with flight operations.

Obstacles. All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that are located on an area intended for the surface movement of aircraft or that extend above a defined surface intended to protect aircraft in flight.

OLS (Obstacle Limitation Surfaces) are a series of planes associated with each runway at an aerodrome that defines the desirable limits to which objects may project into the airspace around the aerodrome so that aircraft operations may be conducted safely.

PANS OPS (Procedures for Air Navigation Services – Aircraft Operations) is an Air Traffic Control term denominating rules for designing instrument approach and departure procedures. Such procedures are used to allow aircraft to land and take off under Instrument Meteorological Conditions (IMC) or Instrument Flight Rules (IFR). ICAO document 8168-OPS/611 (volumes 1 and 2) outlines the principles for airspace protection and procedure design which all ICAO signatory states must adhere to. The regulatory material surrounding PANS OPS may vary from country to country.

PANS OPS Surfaces. Similar to an Obstacle Limitation Surface, the PANS OPS protection surfaces are imaginary surfaces in space which guarantee the aircraft a certain minimum obstacle clearance. These surfaces may be used as a tool for local governments in assessing building development. Where buildings may (under certain circumstances) be permitted to infringe the OLS, they cannot be permitted to infringe any PANS OPS surface, because the purpose of these surfaces is to guarantee pilots operating under IMC an obstacle free descent path for a given approach.

Prescribed airspace is an airspace specified in, or ascertained in accordance with, the Regulations, where it is in the interests of the safety, efficiency or regularity of existing or future air transport operations into or out of an airport for the airspace to be protected. The prescribed airspace for an airport is the airspace above any part of either an OLS or a PANS OPS surface for the airport and airspace declared in a declaration relating to the airport.

Radar Terrain Clearance Chart (RTCC) is a chart that provides air traffic controllers with the lowest usable altitude that they can vector an aircraft using prescribed surveillance procedures within controlled airspace. There is a protection surface below this usable altitude which is shown in airport master plans.

Regulations (Civil Aviation Safety Regulations)

VFR (Visual Flight Rules) are rules applicable to the conduct of flight under VMC. VFR allow a pilot to operate an aircraft in weather conditions generally clear enough to allow the pilot to maintain visual contact with the terrain and to see where the aircraft is going. Specifically, the weather must be better than basic VFR weather minima. If the weather is worse than VFR minima, pilots are required to use instrument flight rules. Pilots must be specifically qualified and aircraft specifically equipped to enable flight in IMC,

VMC (Visual Meteorological Conditions) are meteorological conditions expressed in terms of visibility, distance from cloud and ceiling, equal or better than specified minima.

Abbreviations

Abbreviations used in this report, and the meanings assigned to them for the purposes of this report are detailed in the following table.

Abbreviation	Meaning
AC	Advisory Circular (documents that support CAR 1998)
ACFT	Aircraft
AD	Aerodrome
ADS-B	Automatic Dependent Surveillance – Broadcast
AHD	Australian Height Datum
AIP	Aeronautical Information Publication
Airports Act	Airports Act 1996, as amended
AIS	Aeronautical Information Service
ALT	Altitude
AMSL	Above Mean Sea Level
APARs	Airports (Protection of Airspace) Regulations, 1996 as amended
ARP	Aerodrome Reference Point
AsA	Airservices Australia
ATC	Air Traffic Control(ler)
ATM	Air Traffic Management
BARO-VNAV	Barometric Vertical Navigation
BRA	Building Restricted Area
CAO	Civil Aviation Order
CAR	Civil Aviation Regulation
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation
Cat	Category
DAP	Departure and Approach Procedures (charts published by AsA)
DER	Departure End of (the) Runway
DME	Distance Measuring Equipment
Doc nn	ICAO Document Number nn
DITRDC	Department of Infrastructure, Transport, Regional Development and Cities
ELEV	Elevation (above mean sea level)
ENE	East North East
ERSA	Enroute Supplement Australia
FAF	Final Approach Fix
FAP	Final Approach Point
FAS	Final Approach Surface of a BARO-VNAV approach

Abbreviation	Meaning
ft	feet
GBAS	Ground Based Augmentation System (satellite precision landing system)
GNSS	Global Navigation Satellite System
GP	Glide Path
HLS	Helicopter Landing Site
IAS	Indicated Airspeed
ICAO	International Civil Aviation Organisation
IHS	Inner Horizontal Surface, an Obstacle Limitation Surface
ILS	Instrument Landing System
ISA	International Standard Atmosphere
km	kilometres
kt	Knot (one nautical mile per hour)
LAT	Latitude
LOC	Localizer
LONG	Longitude
LNAV	Lateral Navigation criteria
m	metres
MAPt	Missed Approach Point
MDA	Minimum Descent Altitude
MGA94	Map Grid Australia 1994
MOC	Minimum Obstacle Clearance
MOS	Manual of Standards, published by CASA
MSA	Minimum Sector Altitude
MVA	Minimum Vector Altitude
NASAG	National Airports Safeguarding Advisory Group
NDB	Non Directional Beacon
NE	North East
NM	Nautical Mile (= 1.852 km)
nnDME	Distance from the DME (in nautical miles)
NNE	North North East
NOTAM	NOtice to AirMen
OAS	Obstacle Assessment Surface
OCA	Obstacle Clearance Altitude
OCH	Obstacle Clearance Height
OHS	Outer Horizontal Surface
OIS	Obstacle Identification Surface
OLS	Obstacle Limitation Surface

Abbreviation	Meaning
PANS OPS	Procedures for Air Navigation Services – Aircraft Operations, ICAO Doc 8168
PBN	Performance Based Navigation
PRM	Precision Runway Monitor
QNH	An altimeter setting relative to height above mean sea level
REF	Reference
RL	Relative Level
RNAV	aRea NAVigation
RNP	Required Navigation Performance
RPA	Rules and Practices for Aerodromes — replaced by the MOS Part 139 — Aerodromes
RPT	Regular Public Transport
RTCC	Radar Terrain Clearance Chart
RWY	Runway
SFC	Surface
SID	Standard Instrument Departure
SOC	Start Of Climb
STAR	STandard ARrival
SGHAT	Solar Glare Hazard Analysis Tool
TAR	Terminal Approach Radar
TAS	True Air Speed
THR	Threshold (Runway)
TNA	Turn Altitude
TODA	Take-Off Distance Available
VNAV	Vertical Navigation criteria
V_n	aircraft critical Velocity reference
VOR	Very high frequency Omni directional Range
WAC	World Aeronautical Chart