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LIVERPOOL HEALTH AND ACADEMIC PRECINCT

MAIN WORKS SUBMISSION

AVIATION FLIGHT PATH REPORT

18 Jan 20	**Flight Path Review**
Prepared for	NSW Health Infrastructure

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Job title: Liverpool LHAP Aviation Report

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			Prepared by	**Checked by**	**Approved by**
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This Report is prepared for NSW Health Infrastructure for the LHAP SSD Submission by Resolution Response Pty. Ltd. ABN: 94 154 052 883, trading as ‘AviPro’.

The Report relates to the aviation aspects associated with the establishment and site design of the proposed hospital rooftop helicopter landing site to inform Design and the other Submissions.

Contents

1. BACKGROUND

1.1. Establishment

Johnstaff has been engaged by Health Infrastructure NSW as the business responsible for the Planning of the Liverpool Hospital Redevelopment.

The hospital is a teaching hospital and provides inpatient services including coronary and intensive care, orthopaedic, general medical, surgical, obstetric, mental health, paediatric and emergency services.

Outpatient services include allied heath (physiotherapy, occupational therapy and social work) as well as community health, dental and podiatry clinics, child, adolescent and family health, drug and alcohol, health promotion and rehabilitation and aged care.

It is a major health complex in south west Sydney serving local communities as well as communities to the west and south of the Sydney Basin.

The redevelopment will result in the construction of buildings to the west and north west of the existing rooftop emergency services helicopter landing site (HLS). The HLS is used by the NSW Ambulance Helicopter Retrieval Service and is in regular use. Helicopter Emergency Medical Services (HEMS) under contract to NSW Ambulance will continue utilise the HLS with helicopters primarily from NSW Ambulance HEMS bases in Sydney, Orange and potentially Wollongong.

AviPro has been engaged to provide advice to NSW Health Infrastructure via Johnstaff, regarding aviation specific requirements relative to the existing HLS flight paths and also any flight paths associated with the new Western Sydney Airport at Badgerys Creek.

1.2. HLS Terms of Reference and Applicability

Currently within Australia, there are no set rules or regulations applicable to the design, construction or placement of HLSs. There may however be local council planning, location and movement Approvals required.

The appropriate legislation at present for the use of HLSs is Civil Aviation Regulation (CAR) 92 which places the onus on the helicopter pilot to determine the suitability of a landing site. The Civil Aviation Safety Authority as the regulator of aviation in Australia divested itself of direct responsibility in the early 1990s and currently provides only basic operating guidelines via Civil Aviation Advisory Publication (CAAP) 92-2 (2) Guidelines for the Establishment and Operation of Onshore Helicopter Landing Sites. CASA does not provide design, structural information or advice beyond that provided in the CAAP.

CASA, as a component of a Regulatory Reform Program, does propose to prepare rules for helicopter landing sites and currently has a panel established for this purpose. The new rules will form CASR Part 139R, however it is not expected that they will be completed any time soon. If and when they are introduced, there will be an implementation phase and "grandfather" clauses. Standards set by NSW Ambulance were established to meet or exceed those requirements.

Considerable work internationally has been undertaken over many years in this area, particularly through the International Civil Aviation Organisation (ICAO) and the US Federal Aviation Administration (FAA). The resulting documents on the subject provide excellent advisory material, guidelines and best practice standards.

ICAO sets out international Standards and Recommended Practices (SARPS) for the safe conduct of civil aviation activities in the Annexes to the Convention on International Civil Aviation (Chicago, 1944), with the following Annexes applicable to helicopter operations:

- Annex 6: Operation of Aircraft - Part III: International
- Operations - Helicopters 6th Edition July 2004
- Annex 14: Aerodromes - Volume II: Heliports 4th Edition 2013

ICAO Annex 14 Volume II provides SARPS for the planning, design, operation and maintenance of HLS facilities for use by the providers of these facilities, CAAP 92-2(2) provides only limited guidance material on the minimum physical parameters required to assist helicopter pilots and operators in meeting their obligations under CAR 92.

The Supplement (Second Edition, Amendment No.1, 18 February 1999) to Annex 14 Volume II, lists seven CASA Australia recommended differences to the ICAO SARPS relating to heliports. This document is now out-of-date and the differences remain. Subject to differences, CASA supported the adoption of Annex 14, SARPS for heliports.

CASA has for some years been undertaking a Regulatory Reform Program in the rotary wing area and it is assumed that the ICAO SARPS with some of the differences removed, will form the basis of the proposed Civil Aviation Safety Regulations. Proposed new CASRs include:

- Part 133 pertaining to Commercial Air Transport Operations;
- Part 138 pertaining to Aerial Work operations; and
- Part 139R pertaining to helicopter landing sites.

Although CASA has not historically been active in the HLS field, many countries have, and in particular the US. Many years of experience operating large numbers of helicopters in a range of roles, have resulted in the production of comprehensive helicopter landing site and heliport design and operating procedures. The US Federal Aviation Administration (FAA) has produced an Advisory Circular, the content of which is actually required in the US, detailing the necessary standards. Within the AC is a comprehensive section devoted to hospital based "helicopter landing sites", and where more than one HLS is co-located, "heliports".

The resulting documents on the subject provide excellent advisory material, guidelines and best practice standards. Key current documents are as follows:

- ICAO Annex 14, Vol II, Heliports.
- ICAO Heliport Manual Doc 9261-AN/903.
- US FAA Advisory Circular AC 150/5390-2C, Heliport Design, (covers both operational and design criteria, particularly for hospital-based HLSs in Chapter 4, Hospital Heliports).
- Australian Civil Aviation Safety Authority (CASA) Civil Aviation Advisory Publication (CAAP) 92-2 (2) Guidelines for the Establishment and Operation of Onshore Helicopter Landing Sites. (covers essentially operational specifications only and is produced around European commercial helicopter airport- based operations).
- NSW Health GL2018_010 Guidelines for Hospital Helicopter Landing Sites in NSW.

NSW Health GL2018_010 Guidelines for Hospital Helicopter Landing Sites in NSW were prepared primarily around the ICAO and FAA guidelines and standards, utilising the most appropriate recommendations and practical HEMS operating procedures.

The NSW Health GL2018_010 Guidelines for Hospital Helicopter Landing Sites in NSW are the standards used in this report.

In addition, the Australian National Airports Safeguarding Framework Guideline H: Protecting Strategically Important HLS, is a key document that is currently progressing towards legislation.

1.3. Background Material

Reference material in support of the report included:

- Liverpool Health and Academic Precinct Concept Design Report.
- NSW Health GL2018_010 Guidelines for Hospital Helicopter Landing Sites in NSW.
- Australian National Airports Safeguarding Framework Guideline H.

1.4. Methodology

A desktop assessment of the current background material provided by the Project Team was completed. Criteria from all relevant references were assessed, with the NSW Health GL2018_010 Guidelines for Hospital Helicopter Landing Sites in NSW used as the primary tool.

1.5. Explanation of Terms

Aircraft. Refers to both aeroplanes (fixed wing) and helicopters (rotorcraft).

Approach**/Departure Path (VFR).** The flight track helicopters follow when landing at or departing from the FATO of an HLS. Updated standards to align with ICAO recommendations now has the VFR approach/Departure path extending outwards from the edge of the FATO with an obstacle free gradient of 2.5º or 4.5% or 1:22 vertical to horizontal, measured from the edge of the forward edge of the FATO, to a height initially of 500 feet above the FATO at a distance of ~3,500 m. The flight path commences at the forward edge of the FATO at a width of 25 m., and increases in width uniformly to 150 m. at a distance of 3,500 m. The path may be curved left or right to avoid obstacles or to take advantage of a better approach or departure path. Changes in direction by day below 300 feet should be avoided and there should be no changes in direction below 500 feet at night.

Design Helicopter. The Agusta AW139 contracted to the NSW Ambulance. The type reflects the new generation Performance Class 1 capable helicopters used in HEMS and reflects the maximum weight and maximum contact load/minimum contact area. The overall length and rotor diameter are similar to the former and older Bell 412 models.

Elevated Helicopter Landing Site. An HLS located on a roof top or some other elevated structure where the Ground Effect Area/Touchdown and Lift-off Area (TLOF) is at least 2.5 m. above ground level.

Final Approach. The reduction of height and airspeed to arrive over a predetermined point above the FATO of an HLS.

Final Approach and Takeoff Area (FATO). A defined area over which the final phase of the approach to a hover, or a landing is completed and from which the takeoff is initiated. For the purposes of these guidelines, the specification of 1.5 x Length Overall of the Design Helicopter is used and equates to 25 m. diameter. Area to be load bearing.

Ground Taxi. The surface movement of a wheeled helicopter under its own power with wheels touching the ground.

Hazard to Air Navigation. Any object having a substantial adverse effect upon the safe and efficient use of the navigable airspace by aircraft, upon the operation of air navigation facilities, or upon existing or planned airport/heliport capacity.

Helicopter Landing Site (HLS). One or more may also be known as a **Heliport**. The area of land, water or a structure used or intended to be used for the landing and takeoff of helicopters, together with appurtenant buildings and facilities.

Helicopter Landing Site Elevation. At an HLS without a precision approach, the HLS elevation is the highest point of the FATO expressed as the distance above mean sea level.

Helicopter Landing Site PC1 Survey Reference Point. A position at eye height (1.5 m.) above the forward edge of the FATO in the centre of the flight path, from which the PC1 survey at 2.5º (4.5%) is initiated.

Helicopter Landing Site Reference Point (HRP). The geographic position of the HLS expressed as the latitude and longitude at the centre of the FATO.

Hospital Helicopter Landing Site. HLS limited to serving helicopters engaged in air ambulance, or other hospital related functions.

> ***Note:***
>
> *A designated HLS located at a hospital or medical facility is an emergency services HLS and **not** a medical emergency site.*

Heliport. Two or more co-existing helicopter landing sites (HLS).

Hover Taxi. The movement of a wheeled or skid-equipped helicopter above the surface, generally at a wheel/skid height of approximately one metre. For facility design purposes, a skid-equipped helicopter is assumed to hover-taxi.

Length (Overall) (L). The distance from the tip of the main rotor tip plane path to the tip of the tail rotor tip plane path or the fin if further aft, of the Design Helicopter.

Landing and Lift Off Area (LLA). A load-bearing, nominally paved area, normally located in the centre of the TLOF, on which helicopters land and lift off. Minimum dimensions are based upon a 1 x metre clearance around the undercarriage contact points of the Design Helicopter.

Lift Off. To raise the helicopter into the air.

Movement. A landing or a lift off of a helicopter.

Obstruction to Air Navigation. Any fixed or mobile object, including a parked helicopter, which impinges the approach/departure surface or the transitional surfaces.

Parking Pad. The paved centre portion of a parking position, normally adjacent to an HLS.

Performance Class 1 (PC1). Similar to Category A requirements. For a rotorcraft, means the class of rotorcraft operations where, in the event of failure of the critical power unit, performance is available to enable the rotorcraft to land within the rejected take-off distance available, or safely continue the flight to an appropriate landing area, depending on when the failure occurs. For an elevated HLS, the reject area is that area within the FATO (25 m. diameter) and therefore this area is to be load bearing. PC1 also requires CASA approved flight path surveys to/from the HLS.

Performance Class 2 (PC2). For a rotorcraft, means the class of rotorcraft operations where, in the event of failure of the critical power unit, performance is available to enable the rotorcraft to safety continue the flight, except when the failure occurs early during the take-off manoeuvres, in which case a forced landing may be required. PC2 also requires CASA approved flight path surveys to/from the HLS.

Pilot Activated Lighting (PAL). A PAL system utilises a hospital-based VHF radio and timed switching device, activated by the pilot via a VHF radio transmission on a pre-set frequency, to turn on the HLS and associated lighting.

Note:

The HLS owner and the HEMS operator are to ensure that all pilots are thoroughly knowledgeable with the HLS (including such features as approach/departure path characteristics, preferred heading, facility limitations, lighting, obstacles in the area, size of the facility, etc).

Rotor Downwash. The volume of air moved downward by the action of the rotating main rotor blades. When this air strikes the ground or some other surface, it causes a turbulent outflow of air from beneath the helicopter.

Safety Area. A defined area on an HLS surrounding the FATO intended to reduce the risk of damage to helicopters accidentally diverging from the FATO (0.3 x RD of the Design Helicopter). This area should be free of objects, other than those frangible mounted objects required for air navigation purposes. The Safety Area for the Design Helicopter extends 4 m. beyond the FATO circumference forming a 33m. diameter.

Safety Net. Surrounds the outer edge of a rooftop HLS. Is to be a minimum of 1.5 m. wide and have a load carrying capacity of not less than 122 kg/m^2. The outer edge is not to project above the HLS deck, and slope back and down to the deck edge at approximately 10 degrees. Both the inside and outside edges of the safety net are to be secured to a solid structure.

Shielded Obstruction. A proposed or existing obstruction that does **not** need to be marked or lit due to its close proximity to another obstruction whose highest point is at the same or higher elevation.

Standard HLS. A place that may be used as an aerodrome for helicopter operations by day and night.

Take off. To accelerate and commence climb at the relevant climb speed.

Take off Position. A load bearing, generally paved area, normally located on the centreline and at the edge of the TLOF, from which the helicopter takes off. Typically, there are two such positions at the edge of the TLOF, one for each of two takeoff or arrival directions.

Touchdown and Lift-off Area (TLOF). A load bearing, generally paved area, normally centred in the FATO, on which the helicopter lands or takes off, and that provides ground effect for a helicopter rotor system. Size is based on 1 x main rotor diameter of Design Helicopter, and is 14 m. diameter.

Transitional Surfaces. Starts from the edges of the FATO parallel to the flight path centre line, and extends outwards (to the sides) at a slope of 2:1 (two-units horizontal in one-unit vertical or 26.6°) from the outer edges of approach/departure surface. The outer sides are 75 m. from the centreline, i.e. the outer edges are 150 m. wide. The transitional surfaces start at the forward edge of the FATO, overlaid over the approach/departure path (surfaces) and extend to the end of the approach/departure surface at 3,500 m.

Unshielded Obstruction. A proposed or existing obstruction that may need to be marked or lit since it is **not** in close proximity to another marked and lit obstruction whose highest point is at the same or higher elevation.

1.6. Applicable Abbreviations

Abbreviation/Acronym	Meaning
AC	US FAA Advisory Circular
ACC	Aeromedical Control Centre (HQ Eveleigh). Responsible for control and tasking of HEMS
CAAP	Civil Aviation Advisory Publication (Australia)
CASA	Civil Aviation Safety Authority (Australia)
ASB	Acute Services Building
CAOs	Civil Aviation Orders (Australia)
CARs	Civil Aviation Regulations (1988) Australia
CASRs	Civil Aviation Safety Regulations (1998) Australia
CTAF	Common Traffic Advisory Frequency (5 nm. Radius, ground level to 3,000’)
FAA	Federal Aviation Administration, USA
FATO	Final approach and Take-Off Area (1.5 x helicopter length)
FARA	Final Approach Reference Area
FMS	Flight Manual Supplement
GPS	Global Positioning System
HAPI-PLASI	Pulse Light Approach Slope Indicator (see VGI)
HEMS	Helicopter Emergency Medical Service
HLS	Helicopter Landing Site
HLSRO	Helicopter Landing Site Reporting Officer (Airservices requirement)
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions - requiring flight under IFR
ISB	Integrated Services Building
L	Length (also referred to as Overall Length), in relation to a helicopter, the total distance between the main rotor and tail rotor tip plane paths when rotating
LDP	Landing Decision Point (Category A/Performance Class 1 operations)
LLA	Landing and Lift Off Area. Solid surface meeting dynamic loading requirements, with undercarriage contact points + I metre in all directions
MoH	Ministry of Health NSW
MRI	Magnetic Resonance Imagers
MTOW	Maximum Take Off Weight

Abbreviation/Acronym	Meaning
NDB	Non-Directional Beacon providing a radio signal to an aircraft
NOTAM	Notice to Airmen. Issued by Airservices in relation to airspace and navigation warnings
NVG	Night Vision Goggles
PC1	Performance Class 1
PC2	Performance Class 2
RD	Main Rotor Diameter
SARPS	Standards and Recommended Practices developed by ICAO and promulgated in the Annexes to the Convention of International Civil Aviation
TDP	Takeoff Decision Point (Category A/Performance Class 1 operations)
TLOF	Touch Down and Lift Off Area. Load bearing min. 1 x main rotor diameter.
VFR	Visual Flight Rules
VHF	Very High Frequency radio
VGI	Visual glideslope indicator
VMC	Visual Meteorological Conditions - allowing flight under VFR
VOR	VHF Omni-directional Radio - a ground radio transmitter for aircraft navigation purposes
V_{TOSS}	Take off Safety Speed

1.7. List of Figures

2. EXECUTIVE SUMMARY

The scope of work required AviPro to review the impact of the Liverpool Health and Academic Precinct (LHAP) development on existing and future helicopter operations, any issues relating to the site pertaining to aviation matters, considerations relative to HEMS operations during the construction and following the completion the development, and advice on future campus developments as they may affect HEMS.

During construction, the proposed development will have an appreciable effect on the western flight path into the Liverpool HLS. Whilst it is early to detail exact crane locations, the location of the development to the west and north west of the existing HLS will need planning to ensure continued helicopter operations.

The contracted helicopter operators will be advised of the proposed work, with details of the dates the cranes will be erected on, RL and location. It will be necessary to establish safety protocols through a Helicopter Management Plan to ensure that information pertaining to crane activity is provided to NSW Ambulance/HEMS crews prior to all arrivals and departures.

During the construction phase care must also be taken to ensure that no loose material remains in the vicinity of the HLS flight paths. This information should also be incorporated within the construction company's Helicopter Management Plan protocols.

The development is well below the OLS and PANS OPS level for airport operations (Sydney (Mascot) Western Sydney Aerotropolis and Bankstown). The new Western Sydney Airport who act on behalf of the Department of Infrastructure and Transport, and Bankstown airport should be informed of crane activity and levels as a courtesy. NSW Ambulance helicopters will be informed once dates and locations of the obstructions are known.

The cranes used for the construction will impact the approach/departure paths to the Primary HLS flight path impact. The final structures Stage 1 and Stage 2, will not impact flight operations however care must be exercised with any equipment or obstructions that may be placed on the roof space. A formal helicopter operations management plan will be needed that will address the interactions of helicopters and cranes to maximise access into the site for emergency helicopters.

Once completed, the Stage 2 elevation will be 2.39m higher than the Primary HLS. will not impact the

The Civil Aviation Safety Authority (CASA) is currently reviewing its standards for HLS to enhance safety and is expected to include the certification of HLS into the Regulation. This will require flight paths of certified HLS to be protected to secure their ongoing operations, for example, where associated with emergency medical services. It is also anticipated that new elevated HLS located within populated areas and HLS subject to instrument flight procedures will require certification by CASA.

3. AVIATION REQUIREMENTS AND CONSIDERATIONS

This section provides applicable information that relates to the requirements of helicopter flight paths and the impact of obstructions around flight paths and HLS. It includes details on:

a. The Design Helicopter
b. Object Identification Surface
c. VFR Approach/Departure Path Airspace
d. VFR Approach/Departure Path and Transitional Surfaces
e. Obstructions in close proximity but Outside and Below the Approach/Departure Path
f. Turbulence
g. Exhaust Gas Ingestion
h. Noise and Vibration
i. Main Rotor Downwash

3.1. Design Helicopter

The predominant helicopter type to use the proposed HLS is the Agusta Westland (Leonardo) AW139. The AW139 is the largest/heaviest of the types employed by NSW Ambulance and is the "Design Helicopter" for planning purposes. It has a normal Maximum Take Off Weight (MTOW) of 6,800 kg. See Figures 1 and 2.

Figure 1: NSW Ambulance AW139 "Design Helicopter"

The external dimensions of the AW139 are seen at Figure 2.

Figure 2: AW139 Dimensions

3.2. Object Identification Surfaces (OIS)

The object identification surfaces as specified in the Guidelines are to be met. The object identification surfaces can be described as:

- In all directions from the Safety Area, except under the approach /departure paths, the object identification surface starts at the Safety Area perimeter and extends out horizontally for a distance of ~30 m.
- Under the approach/departure surface, the object identification surface starts from the outside edge of the FATO and extends horizontally out for a distance of ~700 m. From this point, the object identification surface extends out for an additional distance ~2,800 m. while rising on a 2.5º or 22:1 slope (22 units horizontal in 1 unit vertical). From the point ~700 m.

from the FATO perimeter, the object identification surface is ~30 m. beneath the approach/departure surface.

- The width of the safety surface increases as a function of distance from the Safety Area. From the Safety Area perimeter, the object identification surface extends laterally to a point ~30 m. outside the Safety Area perimeter. At the upper end of the surface, the object identification surface extends laterally ~60 m. on either side of the approach/departure path. See Figure 3.

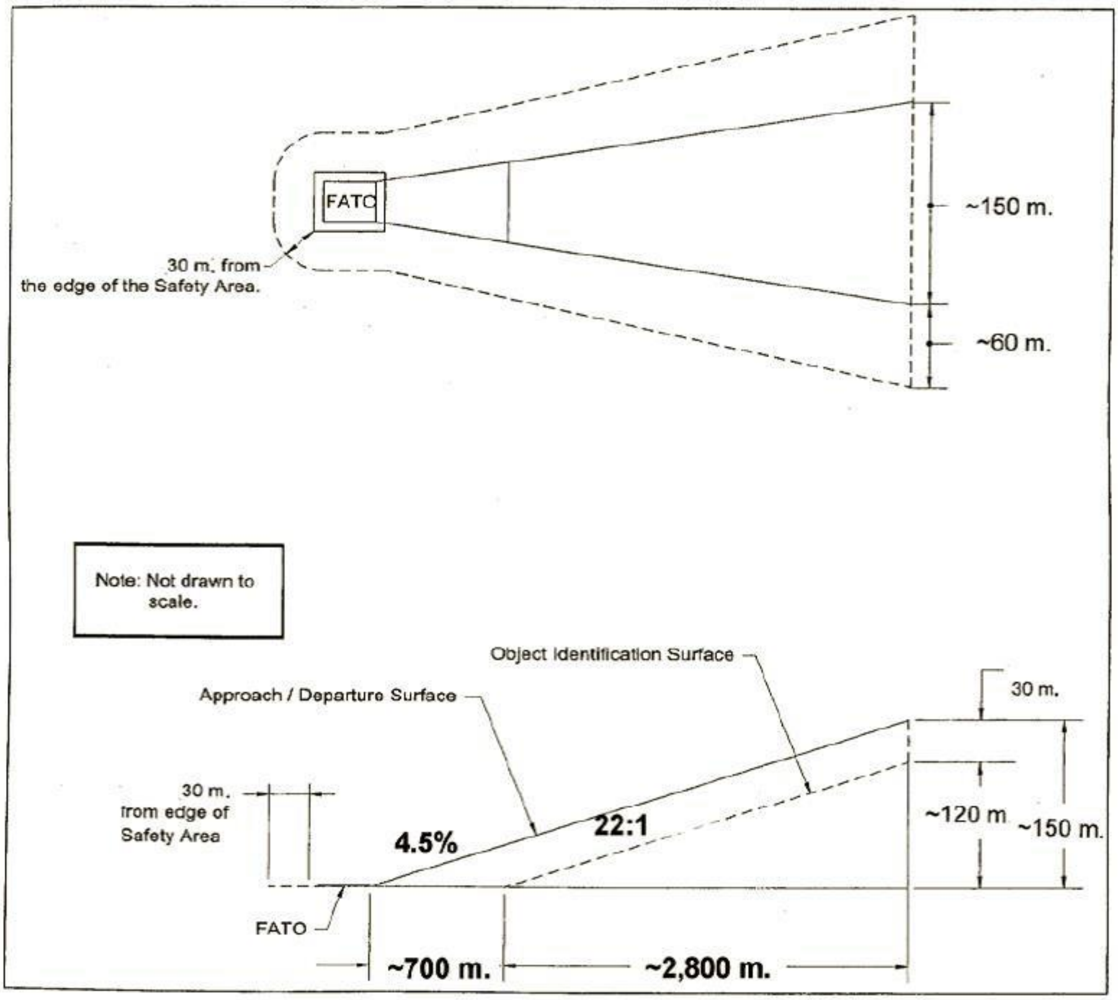

Figure 3: Object Identification Surface

The OIS is used for the purpose of the Design Development Overlay (DDO) and sits below each VFR approach and departure path to provide flight path protection. The OIS below a VFR approach and departure path is the limit for the penetration of obstructions below the flight path. That is, there should be no future development penetrating the OIS. The OIS extends out to 3.5 km. from the forward edge of the FATO.

3.3. VFR Approach/Departure Paths Airspace

The purpose of approach/departure flight path airspace is to provide sufficient airspace clear of hazards to allow safe approaches to and departures from landing sites.

VFR approach/departure paths should be such that there are no downwind operations and crosswind operations are kept to a minimum. To accomplish this, an HLS must have more than one approach/departure path which provides an additional safety margin and operational flexibility.

The preferred flight approach/departure path should where possible, be aligned with the predominate wind when taking account of potential obstacles. Other approach/ departure paths should also be based on an assessment of the prevailing winds and potential obstacles. The separation between such flight paths should not be less than 150 degrees, and preferably180 degrees.

3.4. VFR Approach/Departure and Transitional Surfaces

An Approach/departure surface is centred on each approach/ departure path. Under the Guidelines, the Approach/departure path starts at the forward edge of the FATO and slopes upward at 2.5°/4.5%/22:1 (22 units horizontal in 1 unit vertical) for a distance of ~3,500 m. The approach /departure path commences at the FATO width of 25 m. and expands uniformly to a width of 150 m. at a distance of 3,500 m., where the height is 500 feet above the elevation of FATO surface. For PC1 survey purposes, the survey commences from the forward edge of the FATO in the flight path direction, from a datum point 1.5 m. above the FATO edge. The VFR Approach /departure paths are to be obstacle free. It is important to achieve 2.5° obstacle free to account for the performance requirements of one engine inoperative (OEI) flight following an emergency.

The transitional surface starts from the edges of the FATO parallel to the flight path centre line, and extends outwards (to the sides) at a slope of 2:1 (2 units horizontal in 1 unit vertical or 26.6°) from the outer edges of Approach/departure surface. The outer sides are 75 m. from the centreline, i.e. the outer edges are 150 m. wide. The transitional surfaces start at the forward edge of the FATO, overlaid over the Approach/departure path (surfaces) and extend to the end of the Approach/departure surface at 3,500 m. See Figure 4.

Note:

The transitional surface is not applied on the FATO edge opposite the Approach departure surface.

The Approach/departure surface is to be free of penetrations. Any penetration of the transitional surface is to be considered a hazard.

Figure 4 illustrates the VFR Approach/departure and transitional surfaces.

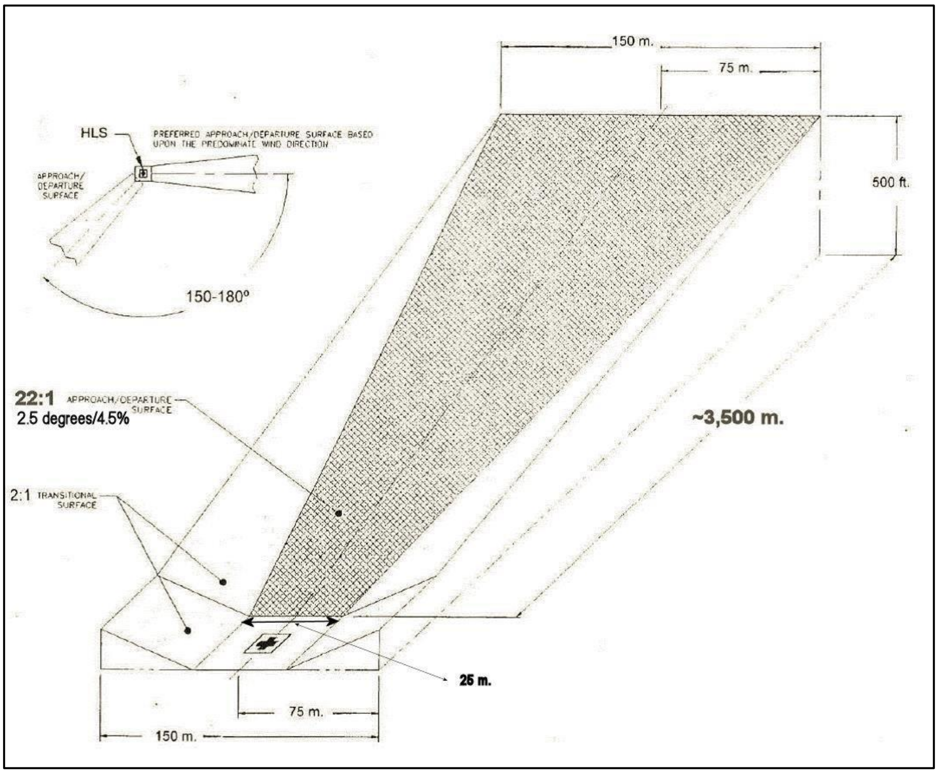

Figure 4: HLS VFR Approach/Departure and Transitional Surfaces

3.5. Obstructions in close Proximity but Outside and Below the Approach/Departure Surface

Unmarked wires, antennas, poles, cell towers, and similar objects are often difficult to see even in the best daylight weather, and in time for a pilot to successfully take evasive action. While pilots can avoid such objects during enroute operations by flying well above them. Approaches and departures require operations near the ground where obstacles may be in close proximity.

Where possible obstructions are to be moved, however if this is impractical, markings and/or obstruction lighting is to be placed.

3.6. Turbulence

Air flowing around and over buildings, stands of trees, terrain irregularities, etc. can create turbulence that may affect helicopter operations. Rotor downwash coming up against a close wall can also produce considerable turbulence and recirculation.

Turbulence from wind effect is usually more pronounced on a rooftop HLS, when compared with an HLS which is elevated on pylons 1.8 m. or more above the level of the rooftop. The reason is that the turbulent effect of air flowing over the roof edge is minimised if the HLS is elevated with an “air gap” above a rooftop.

Strong winds can cause considerable updrafting on the windward side of a building supporting a rooftop HLS due to the vertical slab sides. Turbulence on the leeward side of the deck is normally much reduced.

Reference to a Qualitative Turbulence and Air Quality Study of the area may be relevant.

Normally, the placing of an elevated HLS deck on pylons over a roof top will reduce the effect of updrafting turbulence. Examples of such a process are the RNSH HLS in St. Leonards and Lismore Base Hospital HLS.

3.7. Exhaust Gas Ingestion

Hospital air conditioning air intake systems should not be positioned in the vicinity of a rooftop HLS deck. Under particular wind conditions the exhaust gases emitted from the helicopter engines exhausts can travel for some distance. It may be necessary to install a venting system that is closed during helicopter movements. A Qualitative Turbulence and Air Quality Study of the area may be relevant.

Some HLS designs incorporate a vent shut-off valve that is linked to the activation of the HLS lights. Therefore, when a helicopter pilot or hospital staff member activates the lights (radio/switch respectively), the air shut-off valve activates before the helicopter (and fumes) arrives at the HLS for the landing.

3.8. Noise and Vibration

Helicopters generate both noise and vibration. Where possible flights are conducted on a "Fly Neighbourly" basis with overflight of buildings, particularly those occupied, avoided. In the case of the development, the urban area surrounding the hospital makes overflight over occupied housing and buildings along the flight paths inevitable. "Fly Neighbourly" procedures will however be followed at all times.

A combination of helicopter noise and downwash created by the main rotors can cause vibration to existing and new buildings. Local building codes and Australian Standards should be consulted for guidance in this area. There is no guidance information provided within the MoH HLS Guidelines.

Noise effect from the proposed HLS deck RL will be dependent on the wind direction and strength and the frequency of movements.

3.9. Main Rotor Downwash

The effects of main rotor downwash must be considered, particularly during the take-off and landing phases of flight. Downwash behind the helicopter during Category A take-offs involving a rear moving climb, and landings, both when within 50-70 m. of the HLS, can produce strong gusts capable of blowing over people and raising loose objects into the air.

The vertical velocity of the column of air beneath a hovering helicopter depends on several factors including surface wind, main rotor radius and 'disc loading' (the weight of the helicopter divided by the 'swept' area of the rotor disc).

Large helicopters not only have a greater mass, but they generally have a higher 'disc loading' when compared to smaller helicopters. This is because other design influences limit the practical main rotor radius on large helicopters. The AW139 is a larger medium helicopter and this inevitably means greater impact due to rotor downwash in the vicinity of the landing site that needs to be planned for in the design of the building and immediate surrounds.

The following Table provides the final velocity of the down wash for the AW139.

Aircraft	Disc Loading		Air Density at Sea Level		Final Velocity	
	Metric	Imperial	Metric	Imperial	Metric	Imperial
	kg/m^2	lbs/ft^2	kg/m^3	slugs/ft^3	m/sec	ft/sec
AW 139	42.78897861	8.764518314	0.1225	0.002377	26.43095854	85.87454191
S 76C	37.56814994	7.695129654	0.1225	0.002377	24.76605641	80.46525238
B412 EP	34.95960439	7.16081811	0.1225	0.002377	23.89077335	77.62144588
EC 155	38.89652174	7.96722166	0.1225	0.002377	25.20010423	81.8754796

3.10. Performance Class 1 Flight Paths Survey

Under proposed changes to CASA Rules, HEMS operations will fall under Medical Transport, an extension of a new Air Transport category. Operations are proposed to be undertaken to PC1. Both PC1 and PC2 require a Category A certified helicopter meeting the relevant Category A requirements, Approaching and departing a PC1 accredited HLS along VFR Approach and departure paths, which have been surveyed for obstacles. The survey must be "current" and be provided to the operator so that Appropriate Category A procedures may be planned.

To meet PC1 requirements, VFR Approach and departure paths are to have no obstacles penetrating 2.5º/4.5%/22:1. Likewise obstacles should not be penetrating the adjacent transitional surface; however, some penetration may be accepted depending on the amount of penetration and the proximity to the relative flight path.

The survey is to be prepared by a licensed surveyor and involve:

- A survey covering the entire VFR Approach and departure path and transitional surface area for each flight path. The entire area is a rectangle 150 m. x 3,500 m., commencing from the forward edge of the FATO at eye height (1.5 m.) extending out at 2.5° for 3.5 km. At 3.5 km., the flight path is Approximately 500 feet above the HLS elevation. The width of the flight path at the commencement (FATO edge) is 25 m., expanding uniformly to 150 m. at a distance of 3.5 km.
- The transitional surface extends laterally from the outer edges of the flight paths at 2:1.
- A written report. Refer to NSW Ambulance for advice on content.
- A plan drawing out to the limit of any obstruction along the flight path/s accompanied by a statement to the effect that no obstructions exist beyond the relevant distance.
- A side elevation drawing out to the extent of the obstructions along the flight path/s. Drawings are to clearly show the horizontal

distance to obstructions, the height of the obstruction above the HLS elevation and the height of the penetration above 2.5º.

- 3D modelling along the flight paths is a very effective method of showing obstacles and their relative position etc., is to be provided.

Advice on survey providers who have met NSW Ambulance requirements can be provided. A completed survey and Design Development Overlay (DDO) report is required to meet NSW Ambulance HLS acceptance/certification requirements.

This survey should be included in the contractor’s Scope of Work.

3.11. Flight Path Protection – Safeguarding Guidelines

This document provides guidance to State/Territory and local government decision makers as well as the owners/operators of identified strategically important HLS (SHLS) to ensure:

a. the ongoing operation of those SHLS
b. the use of those SHLS are not compromised by any proposed development encroaching into flight paths
c. new development (and associated activities) do not present a hazard to helicopters arriving or departing from those SHLS, and
d. any new SHLS are appropriately located.

4. LIVERPOOL HOSPITAL HLS

4.1. HLS Location

Liverpool has two operational HLS. The Primary HLS is rated to take the static and dynamic landing forces of the Design Helicopter. Figure 5 illustrates the locations of the HLS and they are labelled Primary and Secondary.

Figure 5: Liverpool Hospital HLS locations

4.2. Object Identification Surface

Each HLS have associated approach/departure paths that are surveyed per the detail provided in paragraph 3.2. As stated, the Object Identification Surface is created and provided to local planning authorities.

Figure 6: Liverpool HLS OIS

Figure 6 shows the current OIS for the Primary HLS. The OIS illustrates that there are no objects higher than the HLS (RL42.71) in that direction at the time of the survey. Under the intent of Guideline H of the National Airports Safeguarding Framework, local Councils should ensure developments are not approved that penetrate this height along the HLS approach/departure flight paths.

At Liverpool, Development Approvals already submitted to Council have recently caused a change to the flight path from 270 degrees magnetic to 290 degrees magnetic. Figure 7 illustrates this change which was able to be accommodated only due to the present refurbishment of the HLS surface.

Figure 7: Primary HLS Western approach/departure path direction change (new - green)

The refurbishment will however, include the laying of lights and this is the last opportunity for any adjustment. Figure 8 shows the western approach/departure paths for the Primary and Secondary HLS. The red dashed area represents the general area of the LHAP development.

Figure 8: Liverpool HLS western approach/departure paths

5. LHAP REDEVELOPMENT

5.1. Development Overview

The LHAP development is located to the west and north west of the Liverpool Hospital HLS complex. Liverpool Hospital has two HLS, each capable of operations with the Design helicopter[1].

Figure 9 illustrates the location and proximity of the Liverpool HLS to the LHAP development. This view is looking to the south east

Figure 9: Aerial View proposed LHAP looking south east

Figure 10 illustrates the height and proximity of the HLS to the highest points of the LHAP development.

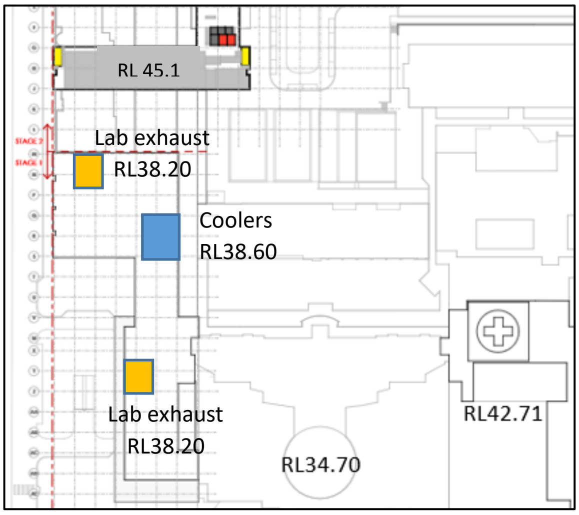

Figure 10: Heights of the HLS and the LHAP tallest structures

[1] The Secondary HLS is presently undergoing upgrading of the structure in order for it to accommodate the Design Helicopter.

The relevant heights are indicated in the following table.

Site	Height (RL)
Primary HLS	42.71
Secondary HLS	34.70
LHAP Stage 2	45.10
LHAP Stage 1 (cooling tower)	38.60
LHAP Stage 1 (lab exhaust)	38.20

Table 1: Relevant structure heights

From the Table 1 it can be seen that only the Stage 2 structure will be above the height of the Primary HLS by 2.39m. This is not a significant issue as the preferred flight path does not go over the Stage 2 building (maximum height of RL45.10) and therefore will not impose a constraint on the HLS.

Figure 11 illustrates the relationship of the Stage 1 structure and the Stage 2 structure to the Secondary HLS.

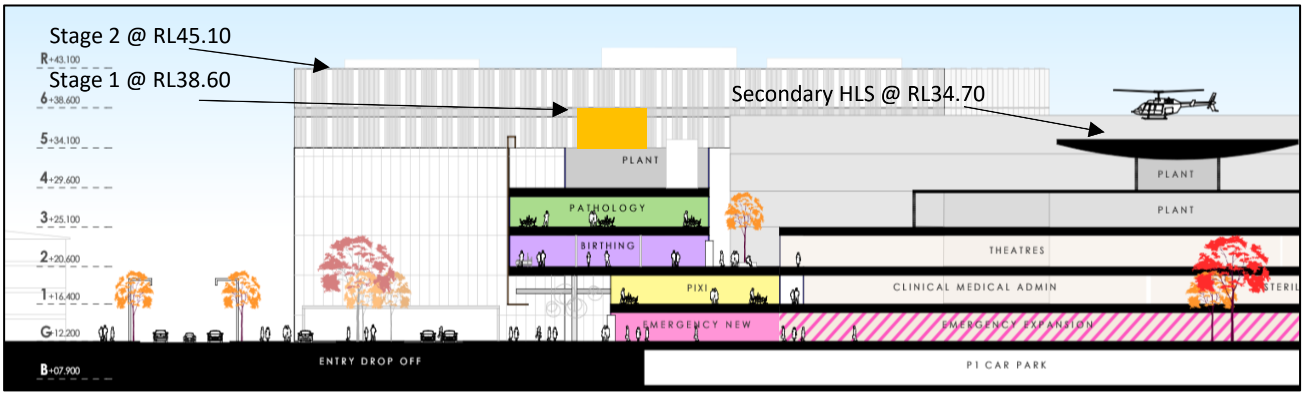

Figure 11: Plan View of the LHAP development looking north with relevant RL

The Stage 1 structure, when completed, will not impact operations to/from the Secondary HLS as the access flight paths will not cross the highest points (laboratory exhaust points at RL 38.20) – see Figure 12. Flight paths to the Primary HLS may be impacted by the proposed cooling towers (RL38.20) and laboratory exhaust (RL 38.60). It will therefore be essential that these obstructions, along with the roof tops, will need to have aviation obstruction lights at the highest points and corners of the buildings.

5.2. Obstructions and VFR Approach/Departure Paths and Transitional Surfaces

The existing VFR Approach and departure paths run essentially east west for the Primary HLS and due to the hospital structure around the Secondary HLS, it has a different approach and departure paths as shown in Figure 12.

The Secondary HLS approach and departure paths are shaped to ensure an obstruction free approach to the HLS. The design of this HLS is a cantilevered deck oriented to the south of the hospital complex. It is currently undergoing an upgrade so the deck can accommodate the Design Helicopter. Whilst the dimensions of this HLS are not ideal, strengthening the structure and adding new lights will make the Secondary HLS more compliant.

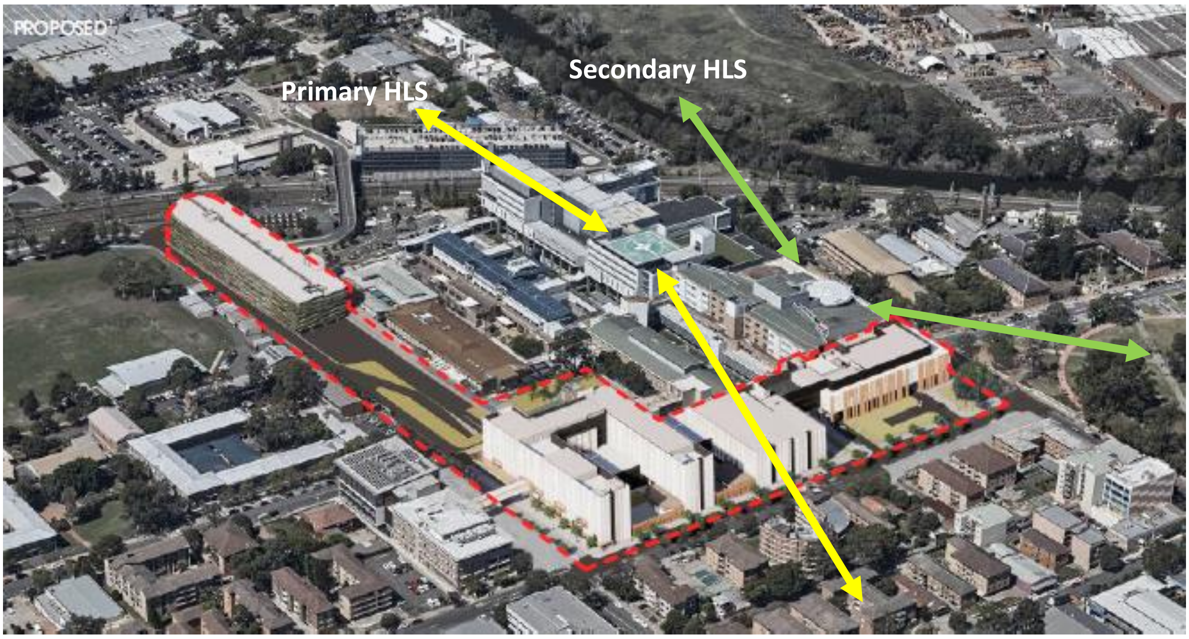

Figure 12: Liverpool Hospital HLS VFR approach and departure paths

The Primary HLS western approach/departure path does fly directly over the Stage 1 and to the immediate south of the Stage 2 buildings. As stated, the LHAP buildings when completed, will not impact operations from either HLS. During construction however, it is expected that there will be impact on continued critical care helicopter operations caused by the construction activity, specifically cranes.

5.3. Prescribed Airspace

The airspace over the site has been reviewed for compliance with obstacle limitation surfaces (OLS) and Procedures for Air Navigation Services – Aircraft Operations (PANS OPS).

Civil Aviation Safety Authority/Airservices Australia approval for this structure is not required as the site structures and cranes WILL NOT penetrate the OLS or the PANS OPS lower limit for Sydney (Mascot), the new Western Sydney (Badgerys Creek) or Bankstown Airports.

Engagement with Airservices Australia for any impact of the cranes supporting the development will be required if the cranes are planned to be higher than RL154.90. It is unlikely that this will be the case, however if it is the following information, as a minimum, needs to be supplied to Air Services Airspace Management team:

- The dates of crane erection and disassembly,
- The location (in MGA94 reference) of the crane base,
- The type of crane

- The RL of the base,
- The RL of the top of the crane,
- The RL of the highest point ASB development

AirServices will require 8-10 weeks to assess the application and this will be submitted through Bankstown Regional Airport Operations.

6. CRANES AND HELICOPTER OPERATIONS

6.1. LHAP Cranes and Continued Helicopter Operations

The development of the LHAP will include the positioning and operations of tower cranes. While the number and location of the cranes have not yet been planned, these will typically extend to up to 20m above the planned height of the LHAP. The current height of the Stage 2 LHAP building (see Figure 11 and Table 1) is RL45.10 and therefore the expected height of the tower crane will be approximately RL65.00.

Figure 13: Image of the LHAP with tower crane illustration

As can be seen, the crane will be an imposing structure(s) in the precinct and will impact both HLS. Therefore, it will be necessary to manage the potential impact the crane arcs have on the access to the HLS in certain wind conditions. Figure 14 shows a collage of crane arcs and illustrates how the crane arcs would impact the flight path (orange arrow)

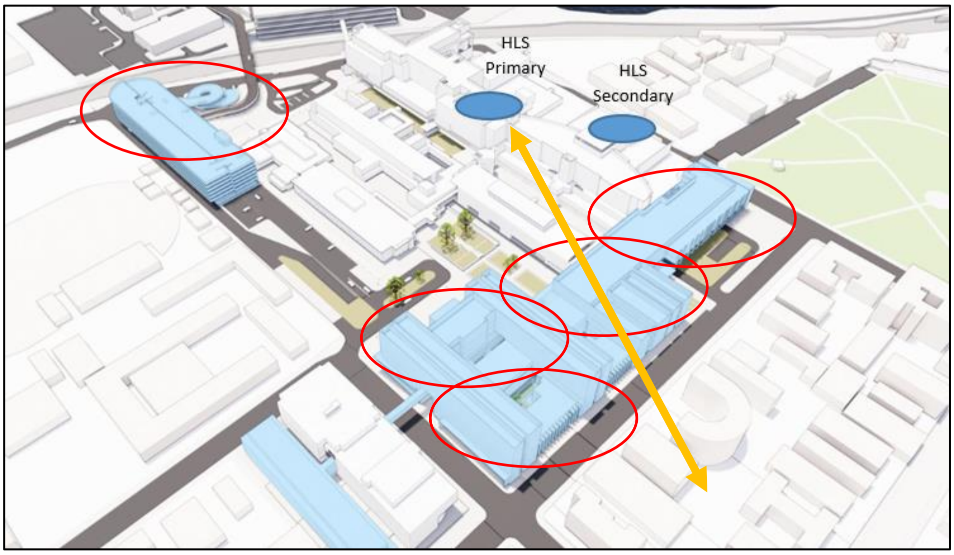

Figure 14: Illustration of potential crane arc impact on HLS flight path

Given the clear impact the cranes will have, it will be necessary to ensure:

- The cranes are illuminated at night.
- Construction staff are aware of the potential for helicopter operations in an east/west direction.

6.2. Crane Illumination

The illumination of cranes adjacent to hospital HLS is a contentious issue as the present regulatory requirement falls well short of operational necessity. The Civil Aviation Safety Authority (CASA) Manual of Standards (MOS Part 139) that addresses obstruction lighting was not designed to consider modern helicopter operations with night vision devices – especially around hospital HLS. As such, the following minimum lighting outline has been developed which provides pilots with situational awareness of the crane jib location and height – especially when the crane is in weather-vane mode.

As a minimum for all tower cranes:

- Top of crane A frame or cabin: medium intensity red obstruction light (night)
- Both ends of Jib: medium intensity red obstruction light (night)
- Along Jib: line of white LED fluro on a PE cell along the full length of the jib
- Tower section: stairway lights or spot lights attached to the top of the tower pointing down and onto the tower (not up into pilot eyes)

As a minimum for all luffing cranes:

- Top of crane A frame or cabin: medium intensity red obstruction light (night) and white by day
- End of Jib: medium intensity red obstruction light (night) and white by day
- Along Jib: line of white LED fluro on a PE cell along the full length of the jib
- Tower section: stairway lights or spot lights attached to the top of the tower pointing down and onto the tower (not up into pilot eyes)

The LED jib Fluro details are:

- Lights used: LED weather proof emergency fluros (minimum 90-minute battery back-up)
- Lights are controlled via a PE Cell

Some recently designed red LED strip lighting can be used as this is visible to pilots using night vision devices.

Figures 15 and 16 illustrate appropriate crane illumination.

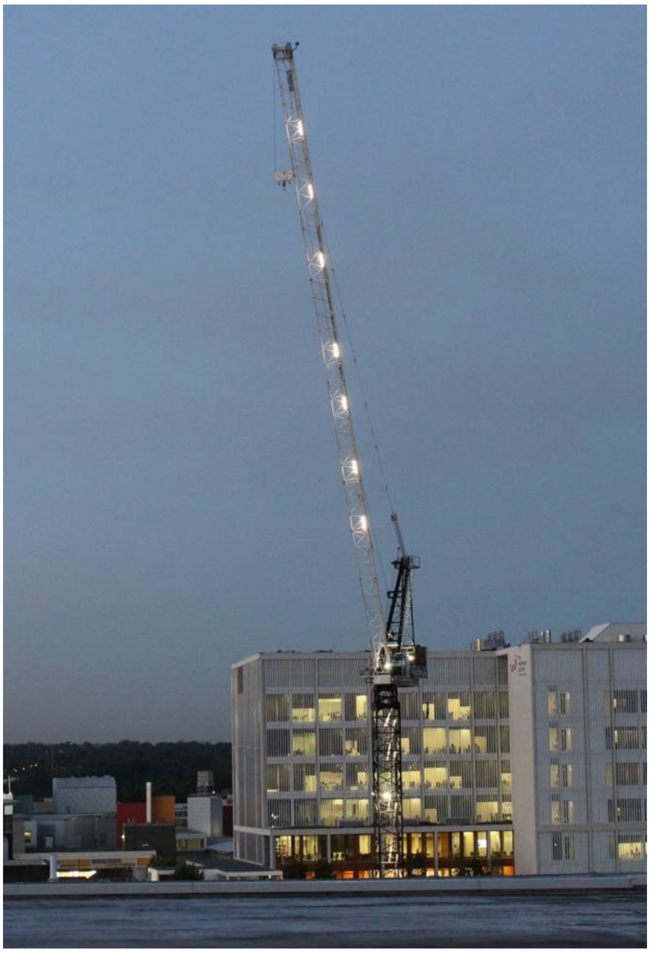

Figure 15: Luffing crane illumination

Figure 16: Tower crane illumination

6.3. Crane Helicopter Interoperability Plan

Developing a crane/helicopter procedure is the preferred way to manage concurrent construction activities and helicopter operations. It would be applicable only during hours of construction and involves the cessation of lifting activities during a helicopter arrival/departure.

The outcome of the procedure means from a practical perspective, the crane jib is manoeuvred away from the flight path to allow the helicopter to access the HLS. It is not necessarily applicable during non-crane operating hours when the crane is in weather-vane mode.

The procedure needs to identify and address any risks to operating helicopters and/or the construction site, and potential disruptions to the helicopter patient transfer activity due to construction activities. It is possible that under certain circumstances, works may need to be temporarily suspended to accommodate a helicopter movement

The procedure is therefore required in order to manage:

- communication protocols for helicopter arrivals and departures, and
- HLS operational and construction considerations in order to ensure the mitigation of the effects of rotorwash and reduce the impact of construction activities on helicopter operations.

7. WESTERN SYDNEY AEROTROPOLIS IMPACT ON OPERATIONS

7.1. Western Sydney Aerotropolis

The development of the Western Sydney Aerotropolis is well advanced. Figure 17 provides an indication of the flight path studies currently being conducted. The runway directions are 050/230 degrees magnetic and oriented in a way that will not impact future operations into/from the LHAP. of the Badgerys Creek site relevant to the LHAP.

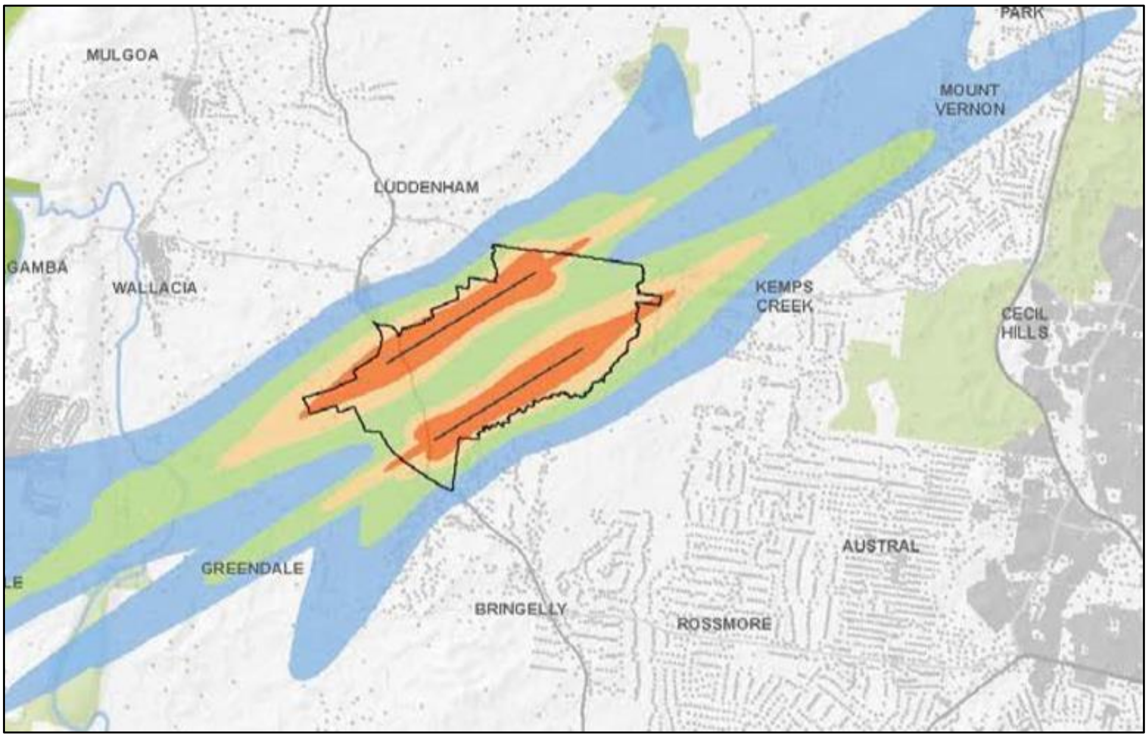

Figure 17: Flight path noise contour results (Western Sydney Airport Plan 2016)

The exact details of this and any associated flight paths are far from being completed. Recent contact with Air Services operations management support the following extract from the Department of Infrastructure, Cities and Regional Development website on the Western Sydney Airport.

The flight paths for Western Sydney Airport are currently being developed.

Airspace design in Australia generally starts with developing proof-of-concept flight paths. This first step was completed for Western Sydney Airport through developing indicative flight paths for the Environmental Impact Statement. These flight paths showed that Western Sydney Airport could operate safely and efficiently in the Sydney basin.

Detailed work to begin planning for the flight paths design started in 2017 and will be finalised in 2024. Before flight paths are finalised, the proposed design will be open for public consultation as part of the environmental assessment. This is expected to take place around 2021.

Figure 18: Flight path status extract from DIRD Sydney Airport site

7.2. Flight Operations Impact

The proximity of the LHAP site to the Aerotropolis for flight operations consideration is best illustrated in Figure 19. When operational, the airspace in and around the LHAP will be tightly controlled by Air Traffic Control.

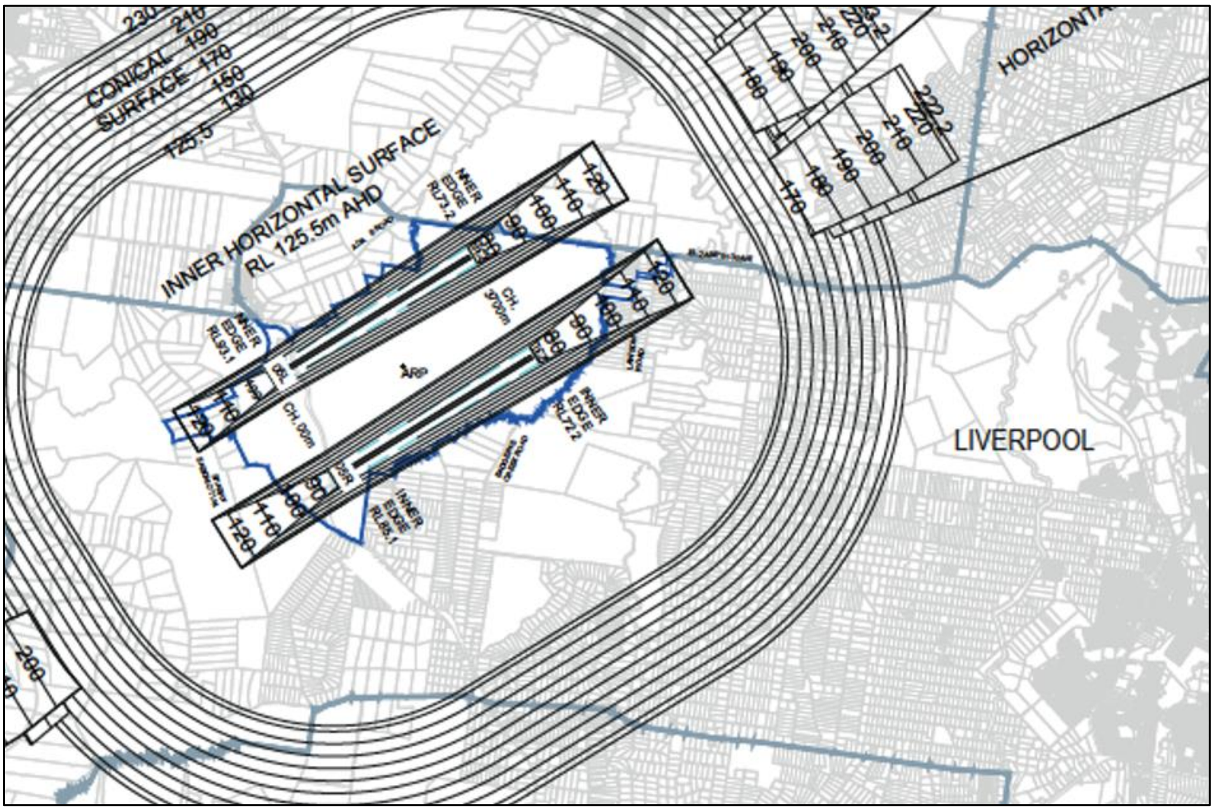

Figure 19: Aerotropolis protected airspace Obstacle Limitation Surface

As stated, flight paths, including instrument approach procedures, are far from complete.

Helicopter operations in and around major airports are normal activities for the NSW Ambulance helicopter contractors. Presently in Sydney, helicopter flights into and from the following hospital sites, are directly controlled by Sydney Tower, Air Traffic Control. The sites are:

a. Prince of Wales, Randwick
b. Royal Prince Alfred, Camperdown
c. St George, Kogarah

Until further detail is presented in the form of any restrictions that the Aerotropolis may have on airspace, it is reasonable to conclude that the highest level of air traffic control, as it exists in and around Sydney Mascot Airport, will apply to the Liverpool site. This I manageable and will not impact the transport of critical patients into the LHAP.