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Forestrack Helicopter Downwash

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1 Introduction

1.1 Purpose

The purpose of this report is to provide an overview of downwash impact assessment of helicopter operations on buildings and helistand adjacent to the proposed Helicopter Landing Site (HLS) conducted by JJ Ryan Consulting (JJR) associated with the proposed development of an Emergency Services Facility at Hume, Canberra.

1.2 Background

The proposed acquisition of Block 45 Section 3 Hume is required by Forestrack to establish a new headquarters and operations base for TRG Bushfire Response and Training in the ACT. The proposed operations base will provide for the Forestrack operations including storage of secure equipment associated with tactical, security and police operations as well as a scalable areas and facilities required for the mobilisation of assets and resources to support larger emergency operations. The proposed development will include:

- Three buildings to accommodate offices, maintenance and training facilities (total size approx. 4,400m^2);
- Three helicopter landing pads;
- Storage facilities;
- Hardstand areas for vehicle access/manoeuvring; and
- Car/truck/heavy machinery parking.

Figure 1.1 below shows the proposed development of Emergency Services Facility located in Hume as provided by AMC Architecture in the Masterplan.

Figure 1.1 Proposed operations base development

Forestrack are seeking on to understand the possible impacts of helicopter operations on adjacent buildings and helistands to the HLS. Operations such as hover, taxi and take-off will produce downwash from the helicopter which may affect the structural integrity of the proposed buildings and helistands.

1.3 Report Scope

The scope of this report is to assess the helicopter downwash associated with the proposed HLS and an amended take-off and landing area to determine if these significantly impact on adjacent buildings and helistands to the HLS at the proposed operations base.

The following items have been excluded from the scope of this report:

- Assessment of helicopter noise impacts;
- Development of departure and approach procedures for helicopter operations; and
- Design of the helipad.

1.4 Report Structure

The Helicopter Downwash Report is structured as follows:

- **Section 1** has provided an overview of the Helicopter Downwash Assessment purpose, as well as an overview of the project site and the scope of the project;
- **Section 2** provides an overview of the project context and downwash assessment methodology;
- **Section 3** provides background on the proposed helicopter operations associated with the helipad including regulatory requirements;
- **Section 4** provides an overview of the wind analysis of the helicopter landing site including usability for helicopter operations;
- **Section 5** provides information on the helicopter downwash assessment including consideration of the wind; and
- **Section 6** provides an overall conclusion and recommendations for future actions.

2 Downwash Assessment Context and Methodology

2.1 Forestrack Operations

The proposed application for the development for an emergency services facility in Hume will provide support for emergency services, forestry and related services, educational institution and as well as ancillary uses supporting these functions.

Currently only one helicopter (Bell 206L4 Longranger) has been proposed for the emergency services facility. Specifically, the services (air and ground) to be provided from the new headquarters will mainly consist of the following activities:

- Emergency search and rescue operations;
- Strategic and tactical operational support (Police);
- Airborne surveillance and airborne operations management support;
- Firefighting and tactical support relating to this activity;
- Community education;
- Helicopter maintenance and engineering services; and
- Forestry Site Preparation Services to Government and Private Forest Owners.

Flight operations in an out of the site for the foreseeable future will primarily be to fly machines in and out for maintenance and refurbishment. Flight operations is expected to be at a maximum of 30-35 flights per month or an average 2 in-and-out flights per day on average. Flight directions into and out of the site will generally be to/from a north westerly and easterly direction (prevailing wind being considered).

2.2 Design Helicopter

The design helicopter has been identified as a single Bell 206L4 Longranger helicopter.

Bell 206L4 is a multipurpose single-engine helicopter that will assist TRG Bushfire Response and Training (TRG) with general day-to-day operations.

A summary of Bell 206L4 Longranger specifications including are provided by in Table 2.1.

Table 2.1 Bell 206L4 specifications

Description	Parameter
Helicopter Type	Bell 206L4
No. of Rotors	1
Rotor Diameter (m)	11.28
Disc Area (m2)	99.93
Disc Max Load (kg/m2)	20.19
Empty Weight (kg)	1,057
Max Weight (kg)	2,018
Calculated Downwash Velocity at rotor (m/s)	17.98
Calculated Downwash Velocity (km/h)	64.74
Max Downwash Velocity (km/h)	97.11
Max Speed (km/h)	232
Rate of Climb (m/s & ft/min)	6.71m/s (1,320 ft/min)

2.3 Helicopter Landing Site

Helicopters are assumed to takeoff directly from the proposed HLS at the proposed operational base.

There is one (1) 27.0m by 24.5m HLS at the proposed development.

It has been assumed that helicopters will conduct operations such as hover, taxi and take-off directly from the proposed HLS.

3 Bell 206L4 Operations

3.1 Helicopter Take-Off Procedures

A helicopter's performance is dependent on the power output of the engine and the lift produced by the rotor(s) which varies between helicopter models and types.

3.1.1 Normal Take-Off from Hover

The normal take-off from hover manoeuvre is the typical procedure for a helicopter to take-off from a hover to a normal climb. This take-off procedure provides an orderly transition to forward flight and is executed to increase altitude safely and expeditiously. The technique to complete a normal take-off from hover is provided below with reference to the position points shown in Figure 3.1:

- Position 1:
  - Bring helicopter to hover and make a performance check including power, balance and flight controls.
  - Visually clear the surrounding area.
- Position 2:
  - Start the helicopter moving by smoothly and slowly easing forward.
  - As the helicopter starts to move forward, increase the collective as necessary to prevent the helicopter from sinking and adjust the throttle to maintain rpm.
  - The increase in power requires an increase in proper antitorque pedal to maintain heading.
  - Maintain a straight take-off path through the take-off.
- Position 3:
  - Adjust collective to obtain normal climb power and apply enough forward cyclic to overcome tendency for nose to rise as the helicopter begins to climb.
- Position 4:
  - Hold an altitude that allows a smooth acceleration toward climbing airspeed and a commensurate gain in altitude to ensure the take-off profile does not take the helicopter through any of the shaded areas in the height-velocity diagram shown in Figure 3.3.
- Position 5:
  - As airspeed increases, place the aircraft in trim and allow a crab to take place to maintain ground track and a more favourable climb configuration.
  - As the helicopter continues to climb and accelerate to best rate of climb, apply aft cyclic pressure to raise the nose smoothly to the normal climb altitude.

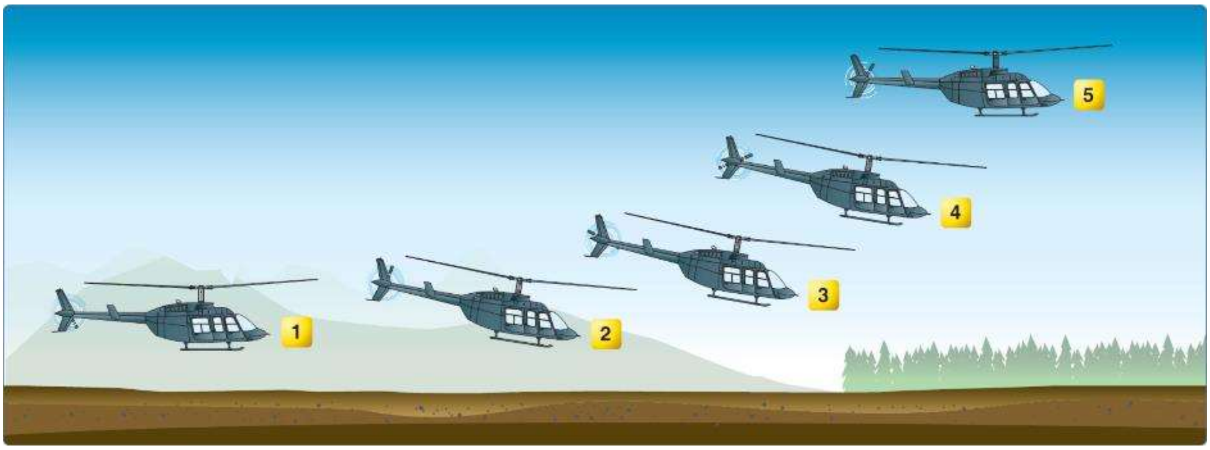


Figure 3.1 Helicopter profile during a normal take-off from hover

3.1.2 Maximum Performance Take-off

The purpose of a maximum performance take-offs is to transition from the helipad surface to a maximum performance climb to clear barriers in the flightpath. To accomplish a maximum performance take-off safely there must be enough power to hover out of ground effect to prevent the helicopter from descending back to the surface after becoming airborne.

Experienced pilots must know the capabilities and limitations of the helicopter and take into consideration the wind velocity, temperature, altitude, density altitude, gross weight, centre-of-gravity location, and other factors affecting the technique and the performance of the helicopter.

To safely accomplish this type of take-off, sufficient power to hover must be available to prevent the helicopter from sinking back to the surface after becoming airborne. This manoeuvre will result in a steep climb, affording maximum altitude gain in a minimum distance forward.

The technique to complete a maximum performance take-off from hover is provided below with reference to the position points shown in Figure 3.2:

- Position 1:
  - Begin take-off by getting the helicopter light on the skids.
  - Pause and neutralise all aircraft movement.
  - Slowly increase the collective and position the cyclic to lift off in a 40kt altitude.
  - Continue to increase the collective slowly until the maximum power available is reached (take-off power is normally 10% above power required for hover).
- Position 2:
  - The large collective movement in Position 1 requires a substantial increase in pedal pressure to maintain heading.
  - Use the cyclic as necessary to control movement toward the desired flightpath.
- Position 3:
  - Continue using cyclic to maintain desired climb angle.
  - Maintain rotor rpm at its maximum and do not allow it to decrease.
- Position 4:
  - Maintain these inputs until the helicopter clears the obstacle or until reaching 50ft.
- Position 5:
  - Establish a normal climb altitude and power setting.

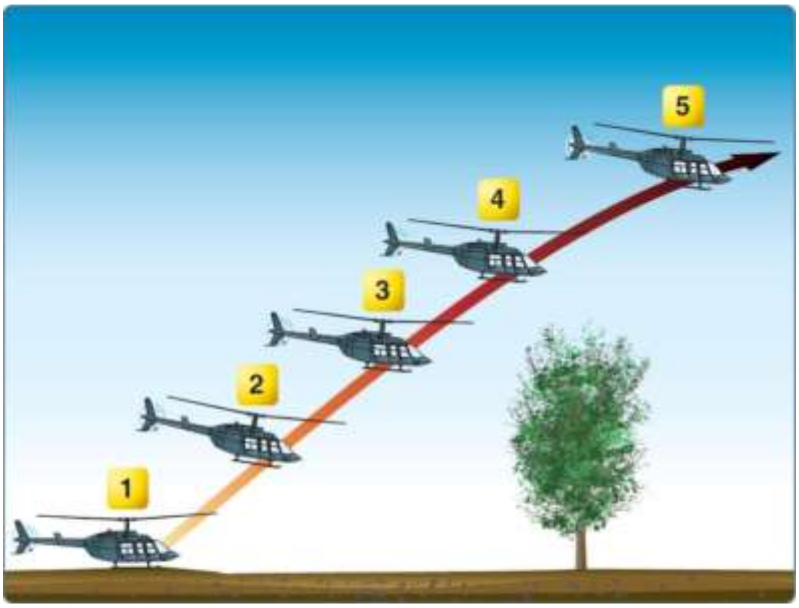


Figure 3.2 Helicopter profile during a maximum performance take-off

There is a variation to the maximum performance take-off manoeuvre is to complete a vertical take-off. This technique allows the pilot to descend vertically back into the confined area if the helicopter does not have the performance to clear the surrounding obstacles. During this manoeuvre, the helicopter must climb vertically and not be allowed to accelerate forward until the surrounding obstacles have been cleared. This manoeuvre has not been investigated in this downwash assessment, although could be considered to further reduce any downwash impacts.

The angle of climb for a maximum performance take-off will depend on existing conditions. The more critical the conditions (e.g. calm winds, etc.) - the shallower the angle of climb should be. If the airspeed is allowed to get too low, the helicopter may settle back to the surface.

The height velocity diagram has been provided in Figure 3.3 which indicates the combinations of altitude and velocity that should be avoided during normal helicopter operations shown in the shaded area. This requires pilots to limit their altitude whilst developing sufficient ground speed prior to selecting maximum continuous power which will occur at approximately 65kt (120.4km/h).

Although helicopters are not restricted from conducting manoeuvres that will place them in the shaded area of the H/V chart, it is important for pilots to understand that operation in those shaded areas exposes pilot, aircraft, and passengers to a certain hazard should the engine or driveline malfunction.

The pilot should always evaluate the risk of the manoeuvre versus the operational value.

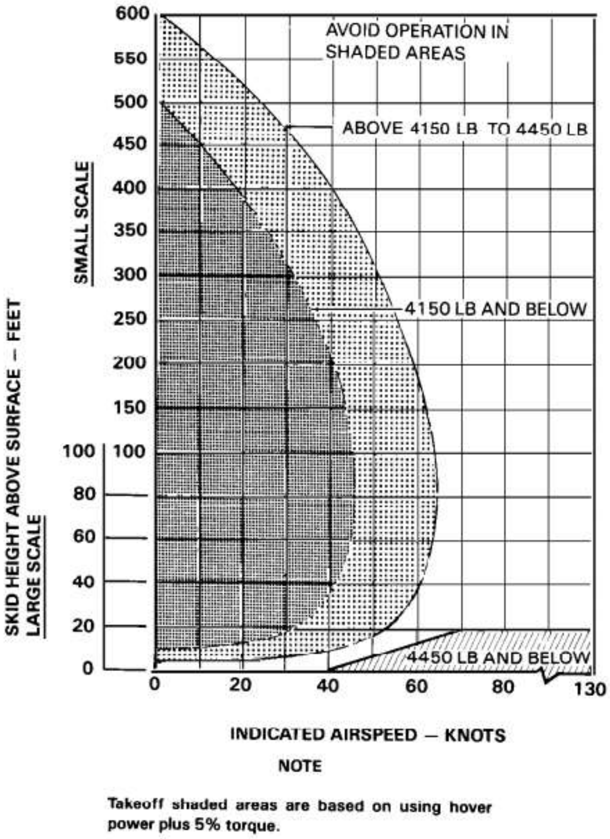


Figure 3.3 Bell 206L4 height – velocity diagram

3.2 Helicopter Approach Procedures

3.2.1 Normal Approach to a Hover

A normal approach to a hover is basically a power glide made at an angle of descent of approximately 10°. This type of approach is used in the majority of cases and is the likely profile for use at the proposed Hume HLS. (note that 10 degrees is equal to a 17.6% gradient).

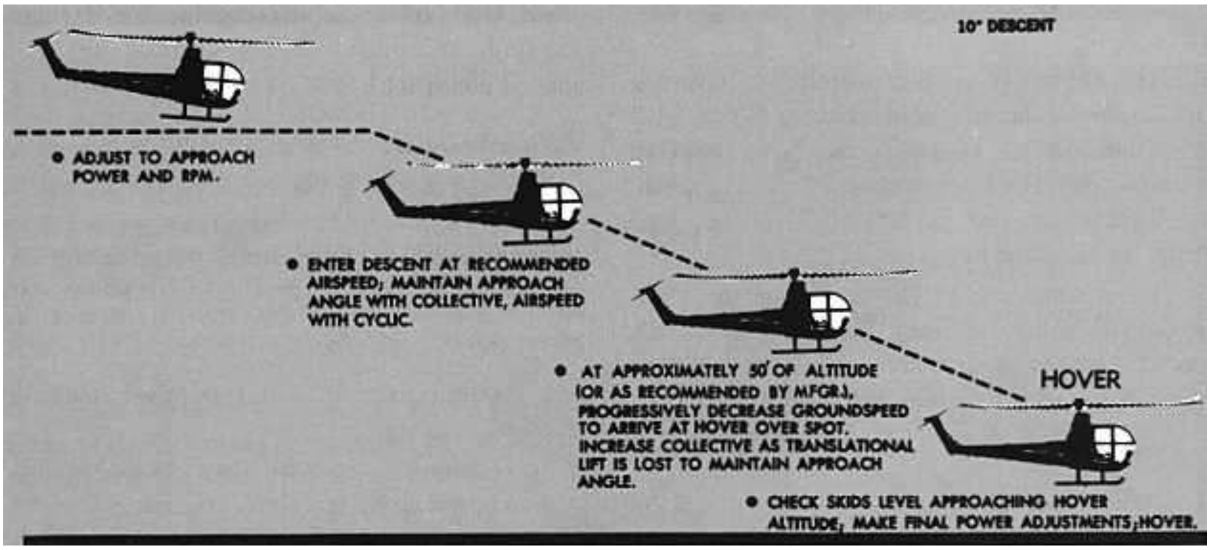


Figure 3.4 Typical profile for a normal approach to hover

Based on the rate of descent/angle of approach for the normal approach to hover, this movement is not considered critical for assessment of the downwash.

3.2.2 Steep Approach to a Hover

A steep approach is used primarily when there are obstacles in the approach path that are too high to allow a normal approach. A steep approach will permit entry into most confined areas and is sometimes used to avoid areas of turbulence around a pinnacle. An approach angle of approximately 15° is normally used for steep approaches (note that 15 degrees is equal to a 26.8% gradient).

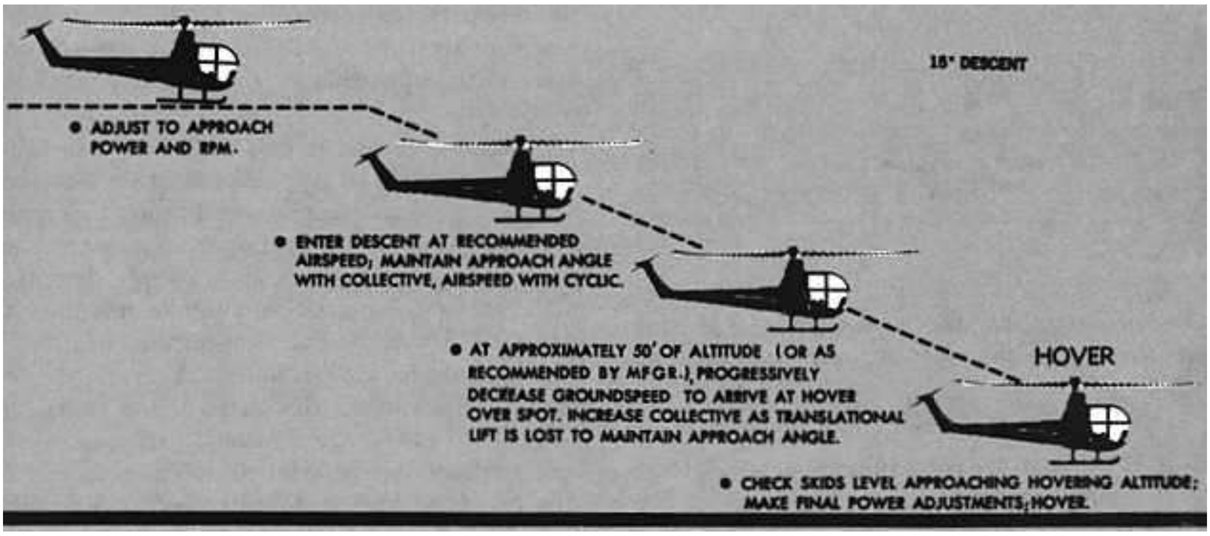


Figure 3.5 Typical profile for a steep approach to hover

3.3 Helicopter Take-Off and Approach Surfaces

The helicopter downwash assessment during flight is based on the International Civil Aviation Organisation (ICAO) Annex 14 Volume II Heliports which includes parameters on heliport design to permit intended helicopter operations to be conducted safely. This ensures that the downwash assessment is conservative based on adopting international standards for heliport operations.

An overview of the take-off climb and approach surface width for helicopter operations is provided in Figure 3.6. The take-off climb and approach surface ends and starts at a height of 152m above the FATO respectively.

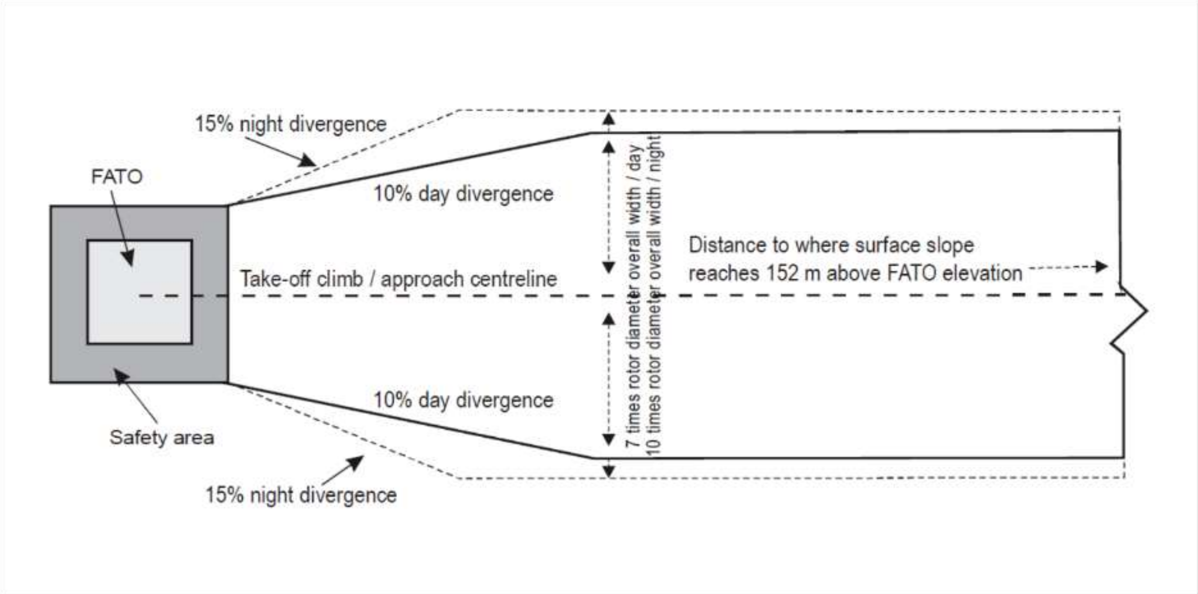


Figure 3.6 Take-off climb/approach surface width (ICAO Annex 14 Volume II)

The approach and take-off climb surface is also provided in Figure 3.7 which is based on an “A” slope profile with a 4.5% design slope.

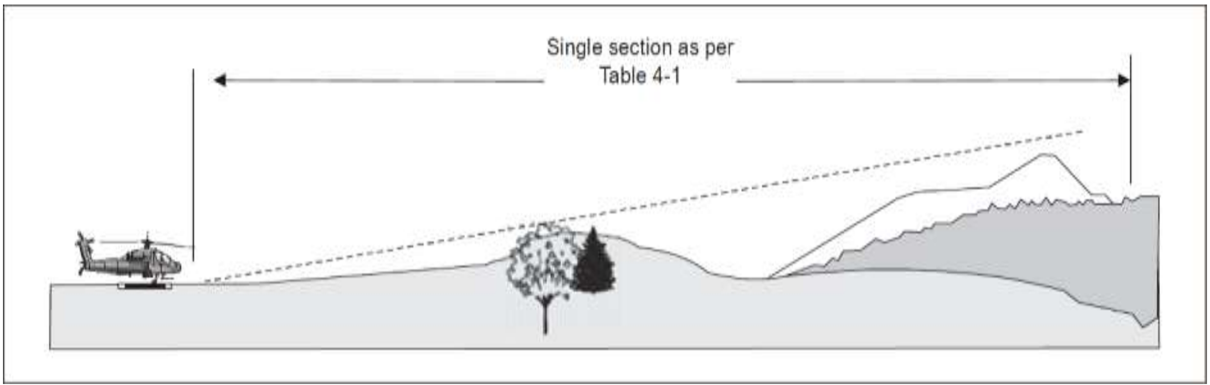


Figure 3.7 Approach and take-off climb surfaces "A" slope profile (ICAO Annex 14 Volume II)

CAAP 92-2(2) Guidelines for the establishment and operation of onshore Helicopter Landing Sites provides the slope design categories for different helicopter performance classes which have been summarised in Table 3.1.

The slope design categories represent the recommended minimum design slope angles and not the actual departure and approach procedure slopes (i.e. the approach and take-off climb surfaces are obstacle limitation surfaces only and are not actual paths of flight). The obstacle limitation surfaces are recommended to ensure obstacle clearance and protect airspace.

It is further noted that the dimensions and slopes of the obstacle limitation surfaces are recommendations only, however, are summarised below for completeness:

- Slope category "A" generally corresponds with helicopters operated in performance class 1;
- Slope category "B" generally corresponds with helicopters operated in performance class 3; and
- Slope category "C" generally corresponds with helicopters operated in performance class 2.

Bell 206L4 has been classified as a category A helicopter.

Table 3.1 Recommended dimensions and slopes of obstacle limitation surfaces for HLS

	Slope Design Categories		
	A	**B**	**C**
First Section			
Length	3,386m	245m	1,220m
Slope	4.5%	8%	12.5%
Second Section			
Length	N/A	830m	N/A
Slope	N/A	16%	N/A
Total Length*	3,886m	1,075m	1,220m

**Note: Total length brings the helicopter to 152m above FATO elevation*

3.4 CASA Helicopter Performance Class

ICAO Annex 6 Part III Chapter 3 Paragraph 3.1.1 requires the State of the operator to develop a "code of performance" for the operation of rotorcraft that reflects "for the conduct of operations, both various phases of flight and the operational environment". CASA does not currently have a performance standard for helicopters which was investigated in Project OS 11/24 – Incorporation of Performance Class concepts into Australian helicopter operations.

CASR Part 133 and Part 138 are in the development with the objective of having a performance code embedded within their respective provisions. There is a total of four (4) performance classes as outlined in Table 3.2.

The Bell 206L4 is identified to be a Performance Class 1 (PC1) rotorcraft.

Table 3.2 CASA helicopter performance classes

Performance Class	Description
Performance Class 1 (PC1)	For a rotorcraft means the class of operations where, in the event of failure of an engine, 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.
Performance Class 2 (PC2)	For a rotorcraft means the class of operations where, in the event of failure of an engine, performance is available to enable the rotorcraft to safely continue the flight except when the failure occurs early during the take-off manoeuvre or late in the landing manoeuvre, in which case a forced landing may be required.
Performance Class 2 with exposure (PC2E)	PC2 operations can be designed to operate with a permitted exposure time for the periods where safe continuation of flight or landing is not assured, or alternatively at all times with a safe forced landing capability. The policy recommendations for PC2 operations include the maximum permitted exposure time concept - see definitions below.

Performance Class	Description
	The maximum permitted exposure time is a period, determined on the basis of the engine failure rate recorded for the helicopter's engine type, during which the probability of an engine failure can be discounted. CASA may publish maximum permitted exposure times for various specialised in-flight purposes and aerial work operations.
Performance Class 3 (PC3)	For a rotorcraft means the class of operations where, in the event of failure of an engine at any time during the flight, a forced landing: 1. in the case of a multi-engine rotorcraft - may be required; or 2. in the case of a single-engine rotorcraft - will be required.

4 Wind Analysis

4.1 Operational Impacts of Wind

A quantitative analysis of the project site wind conditions was determined to be required to accurately define the impact of helicopter downwash considering prevailing wind conditions and assess the usability of the HLS.

The performance of a helicopter is dependent on the power output and lift generated and thus any factor that affects the engine and rotor efficiency affect the performance. The three (3) major factors in helicopter performance are as follows:

- Density altitude;
- Weight; and
- Wind.

Wind direction and velocity affects the hovering, take-off and climb performance of a helicopter. The existence of wind generates translational lift due to the relative airflow of the wind over the helicopter rotor disk. Increasing the wind speed increases the translational life and thus less power is required for the helicopter to hover which improves take-off and landing performance.

The wind direction is important because this can govern helicopter flight paths. Headwinds are the most desirable scenario as they provide the most significant increase to helicopter performance. The occurrence of a crosswind or tailwind may require more tail rotor thrust to maintain directional control which absorbs power from the engine. This results in less power available for the main rotor to generate lift.

Undertaking helicopter take-offs into a headwind results in a lower groundspeed on lift-off which makes it easier to enter into a hover should it be necessary to reject the take-off. Climbing into a headwind also provides the steepest angle of ascent after take-off which increases obstacle clearance. Due to the higher groundspeeds and decreased angle-of-climb, helicopter departures in a tailwind should be avoided where possible.

Helicopter landings into a headwind ensures a lower groundspeed which provides pilots with more time to navigate their approach manoeuvre. The additional airflow through the rotor disc allows for more engine power to be available for unexpected scenarios including strong alternative gusts.

4.2 Wind Analysis (BoM)

Wind analysis was undertaken utilising wind data from the Tuggeranong AWS, located approximately 7.6km south-east from the proposed site, from the Bureau of Meteorology (BoM) which is attached in Appendix B.

The average wind speed for each prevailing wind direction for each season has been summarised into the maximum average wind speed predicted during 9am and 3pm periods in Table 4.1.

Table 4.1 Prevailing wind direction data (BoM)

Prevailing Wind Direction	AM (%)	Average Wind Speed (km/h)	PM (%)	Average Wind Speed (km/h)
North	12.5	9.8	21.0	13.5
North East	7.4	6.9	8.2	13.2
East	6.5	7.0	6.8	12.9
South East	5.7	11.8	5.1	15.0

South	14.0	14.0	6.7	16.3
South West	6.6	6.1	3.8	10.8
West	10.4	8.5	15.5	18.1
North West	18.2	11.8	32.2	17.6
Calm	18.7	-	0.7	-
Overall	**-**	**8.5**		**15.8**

Based on the wind analysis, JJR have incorporated a 40km/hr wind component to the baseline downwash calculations, in all directions.

It is noted that the BoM data analysed by JJR is limited to 40km/h (with wind being less than 40km/hr accounting to 100% of the time as according to BoM) in 10km/h intervals. As the proportion of wind with a velocity higher than 40km/hr were determined not to be present by BoM, wind speeds above 40km/h were not considered.

4.3 Wind Impact on Downwash Analysis

The wind data was assessed and classified in the following three (3) categories based on the impact of the helicopter downwash on the helipad:

- Positive impact (i.e. reduces the downwash velocity of a helicopter);
- Neutral impact (i.e. marginal impact on the downwash velocity of a helicopter); and
- Negative Impact (i.e. increases the downwash velocity of a helicopter).

The sectors have been divided into eight cardinal wind directions, with the sectors divided into the cardinal direction clockwise as a reference point. It was assumed that the helicopter would undertake takeoff in north westerly direction. An overview of the impact of different wind directions on the helipad and surrounding areas is shown in sectors (where green is positive, yellow is neutral, and red is negative) in Figure 4.1 and summarised in Table 4.11.

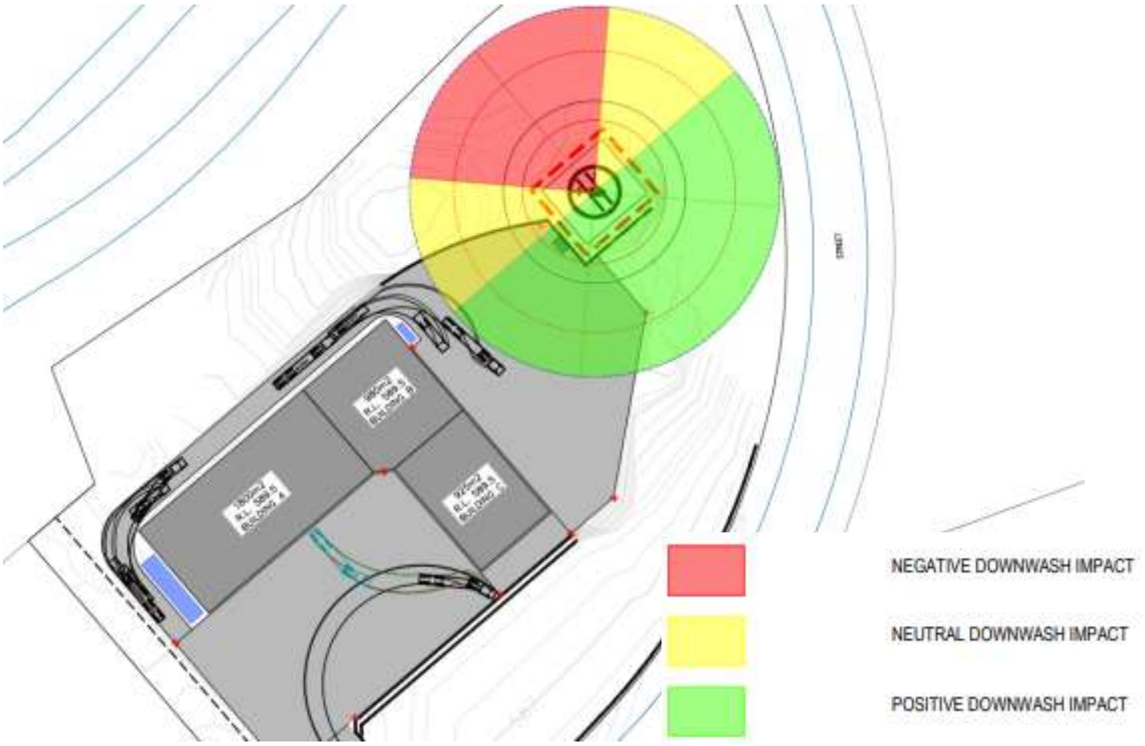


Figure 4.1 Impact of wind direction on helicopter downwash

Table 4.2 Overall wind impacts (average of AM + PM)

Wind Speed Ranges	Positive Impact	Neutral Impact	Negative Impact
< 10km/h	12.65%	10.05%	12.95%
10 - 20km/h	12.05%	8.15%	16.50%
20 - 30km/h	3.95%	2.90%	9.80%
30 - 40km/h	0.25%	0.25%	0.80%
> 40km/h	0.00%	0.00%	0.00%
Calm	-	9.70%	-
Total	28.90%	31.05%	40.05%

The overall wind analysis indicates that for 59.95% of the day helicopter downwash would not be exacerbated by prevailing wind conditions.

It is noted that the downwash assessment includes downwash that is exacerbated by worst-case prevailing wind conditions (conservatively applied to all directions).

5 Helicopter Downwash

5.1 Concept of Helicopter Downwash

Rotor downwash is a commonly overlooked phenomenon that occurs during helicopter hover in close proximity to a ground surface (including water etc.). It has the potential to cause significant damage to nearby vehicles and objects, as well as people. There are a variety of risks associated with helicopter rotor downwash that are summarised in Table 5.1.

Table 5.1 Summary of potential downwash risks to people, buildings, aircraft and helicopters

Risk Element	Risk Description	Risk Mitigation
People	Secondary effects of Foreign Object Debris (FOD) such as dust and sand or other objects becoming airborne causing injury	Ensuring that the helicopter movement areas have an appropriate surface and have sufficient clearance to areas where people may be located (i.e. paths, congregation areas etc.)
Buildings	Operational effects on hangars and other building structures resulting in damage to cladding or other structure elements exceeding wind design loads	Designing the helicopter movement areas away from buildings or ensuring buildings are designed to withstand additional load
Light Aircraft	Impact on light (recreational or general aviation) aircraft while taxiing or in aircraft parking zones	Ensuring sufficient separation between helicopters taxiing or in aircraft parking zones
Helicopters	Brownouts or water spray during landing procedures causing loss of spatial awareness and resulting in a hard landing or helicopter crash	Ensuring effects of the zone of influence related to downwash is understood to allow an appropriate landing surface to be constructed

The Civil Aviation Safety Authority (CASA) Manual of Standards (MOS) Part 139 – Aerodromes Section 6.6 outlines the jet blast and propeller wash protection area requirements. The recommended maximum wind velocities which people, objects and buildings in the vicinity of an aircraft may be subjected to should not be more than those provided in Table 5.2.

The main impacts on person are dust and sand particles (i.e. FOD) becoming airborne over 15-30 knots. Any maintenance equipment including spanners and hand tools will not become FOD in the 60-80km/hr downwash velocity zone.

Table 5.2 Recommended maximum wind velocities

Wind Velocity Exposure Type	Recommended Maximum Wind Velocity (km/h)
Passengers and main public areas, where passengers have to walk and are expected to congregate	60km/h
Minor public areas, where people are not expected to congregate	80km/h
Public roads where the vehicular speed may be 80km/h or more	50km/h
Public roads where the vehicular speed is expected to be below 80km/h	60km/h
Personnel working near an aeroplane	80km/h
Apron equipment	Generally not in excess of 80km/h

Wind Velocity Exposure Type	Recommended Maximum Wind Velocity (km/h)
Light aeroplane parking areas	Desirably 60km/h and not greater than 80km/h
Buildings and other structures	Not exceeding 100km/h

*** All values are from MOS Part 139 recommendations*

The United States Army Aeromedical Research Unit (USAARU) report titled 'Effects of Downwash Upon Man' provides the following general characteristics of helicopter downwash that are applicable to this assessment:

- Downwash does not produce significant vertical components to the resultant wind when a helicopter is within ground effect. The resultant winds are horizontal at all levels;
- The magnitude of resultant wind is directly related to the gross weight of the helicopter, and to some extent the disc loading. The initial downwash velocity at the rotor disc is directly proportional to the square root of the disc loading;
- The magnitude of resultant downwash at ground level is inversely proportional to the height above the ground of the thrust generator when the helicopter is within ground effect;
- The magnitude of resultant wind is not uniform vertically above a point on the ground as shown in Figure 5.1. The maximum downwash velocity generally occurs between 0.1m and 0.5m above the ground;
- The height above the ground of maximum downwash velocity is directly proportional to the effective disc diameter of the thrust generator and to the height of the thrust generator above ground; and
- Maximum wind velocities generally occur within in a radius of 1 to 1.5 times the rotor disc diameter from the rotor hub.

The general findings of the United States Department of Agriculture (USDA) Forest Service research were consistent with the findings above, as well as noting that helicopter downwash increases as the ground speed of the helicopter decreases.

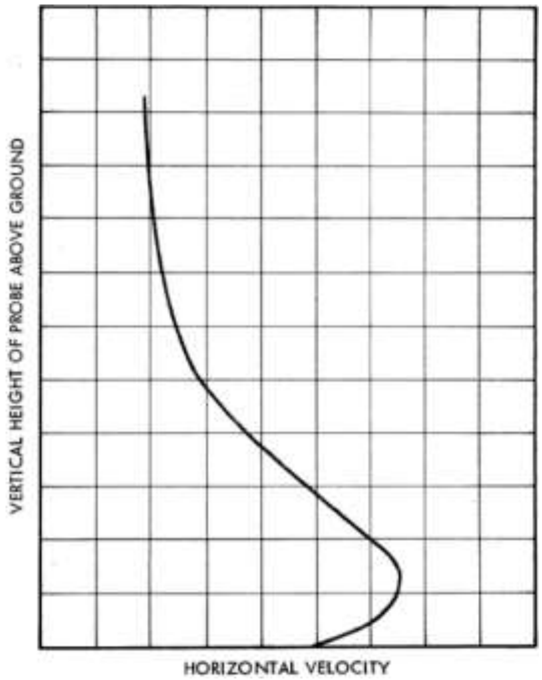


Figure 5.1 Downwash velocity vs probe height

5.2 Theoretical Calculations

The helicopter downwash velocities have been calculated based on a report entitled 'Helicopter Downwash Data' (Grady W. Leese, 1974). The report summarised the outcomes of measurements of rotor downwash horizontal velocities along and up to 6ft above the ground surface generated by various US Army helicopters during take-off, hover and fly-by movements. The tests were conducted at Fort Rucker, Alaska with the CH-54 helicopter testing conducted at Apelachicola, Florida.

The helicopters used in physical testing had different mass and rotor characteristics to most current helicopters utilised in Australia, however helicopter specifications have been utilised to determine equivalent downwash velocities based on engineering principles.

The equation for theoretical downwash velocity is provided in Equation 5.1.

$$Downwash\ velocity\ v_1 = 2 \times \sqrt{\frac{Gross\ Weight \times g}{2 \times Air\ Density \times Rotor\ Surface\ Area}};\ Where\ g = 9.807 m/s^2$$

Equation 5.1 Theoretical downwash velocity

It should be noted that this equation calculates the theoretical downwash velocity at the rotor disk. The wind velocity increases further below the rotor disk due to the air flowing through the rotor blades being compressed. This compression represents additional energy that is transferred to the air and as the compressed air is not contained, it decompresses below the rotor blades and expands.

This expansion can occur in a horizontal or downward stream but cannot expand upwards due to the column of higher pressure compressed air above it. When the expansion occurs in a downward direction, this increases the downward speed of the stream of air and subsequently the downwash velocity.

The empirical data utilised indicates that the maximum observed downwash velocity is approximately 1.5 times the theoretical downwash velocity at the rotor disk calculated in Equation 5.1. This maximum downwash velocity typically occurs one rotor diameter below the rotor disk.

Wind rosettes (diagrams that demonstrate wind speed and direction as well as frequency for a particular station) from the Bureau of Meteorology (BoM) should be taken into consideration for more detailed modelling.

5.3 Proposed Helicopter Model Data

Bell 206L4 data utilised for the analysis are summarised in Table 5.1, including technical specification data relevant to the downwash calculations as well as the theoretical and empirical maximum downwash velocities predicted.

Table 5.3 Proposed helicopter data

Model	Rotor Diameter (m)	Disc Area (m^2)	Max Mass (kg)	Max Downwash Velocity (km/h)	
				Theoretical	Empirical
Bell 206L4	11.28	99.93	1,057	97.11	95.44

Three (3) critical wind velocity thresholds have been identified to determine a safe distance from operating helicopters for various elements as follows:

- Buildings and structures should not be located within areas where downwash velocities are predicted to exceed 100km/h;
- Minor public areas or areas where maintenance personnel are working should not be located within areas where downwash velocities are predicted to exceed 80km/h; and

- Public areas where access is available to the public should not be located within areas where downwash velocities are predicted to exceed 60km/h.

The maximum radius from the helicopter rotor hub to the three downwash velocity thresholds identified have been utilised to ensure the proposed helipad does not result in unsafe wind speeds during helicopter hover movements in proximity to the external awning.

An overview of the radius from the rotor hub to each downwash velocity threshold for the helicopter models identified to potentially use the helipad are provided in Table 5.4.

Table 5.4 Helicopter downwash velocity radii

Model	Maximum Downwash Velocity Radii (m)		
	100km/h	**80km/h**	**60km/h**
Bell 206L4	14.66	19.83	25.27
	Maximum Downwash Velocity Radii Accounting for Wind (m)		
	100km/h	**80km/h**	**60km/h**
Bell 206L4	24.71	39.00	51.22

5.4 Downwash Assessment

The impact of helicopter downwash was assessed at the proposed HLS site, northeast of the proposed buildings for the operations base.

The helicopter take-off manoeuvres have been based on the Bell 206L4 typical profiles as it has been designated as the design helicopter.

The proposed buildings for the operations base lies outside of the 60km/h downwash velocity envelope accounting for wind.

The proposed helistand lies within approximately the 80km/h downwash velocity envelope accounting for wind. It should be noted that the proposed helistand are located southwest of the HLS, where wind would have a positive impact on the downwash, which would generally reduce the downwash velocity of a helicopter.

Sheppard St which is located east of the proposed HLS at the closest point is located outside of the 60km/h downwash velocity envelope accounting for wind.

Figure 5.2 below shows the modelled downwash extents for Bell 206L4 on the HLS at the proposed development and is attached in Appendix A.

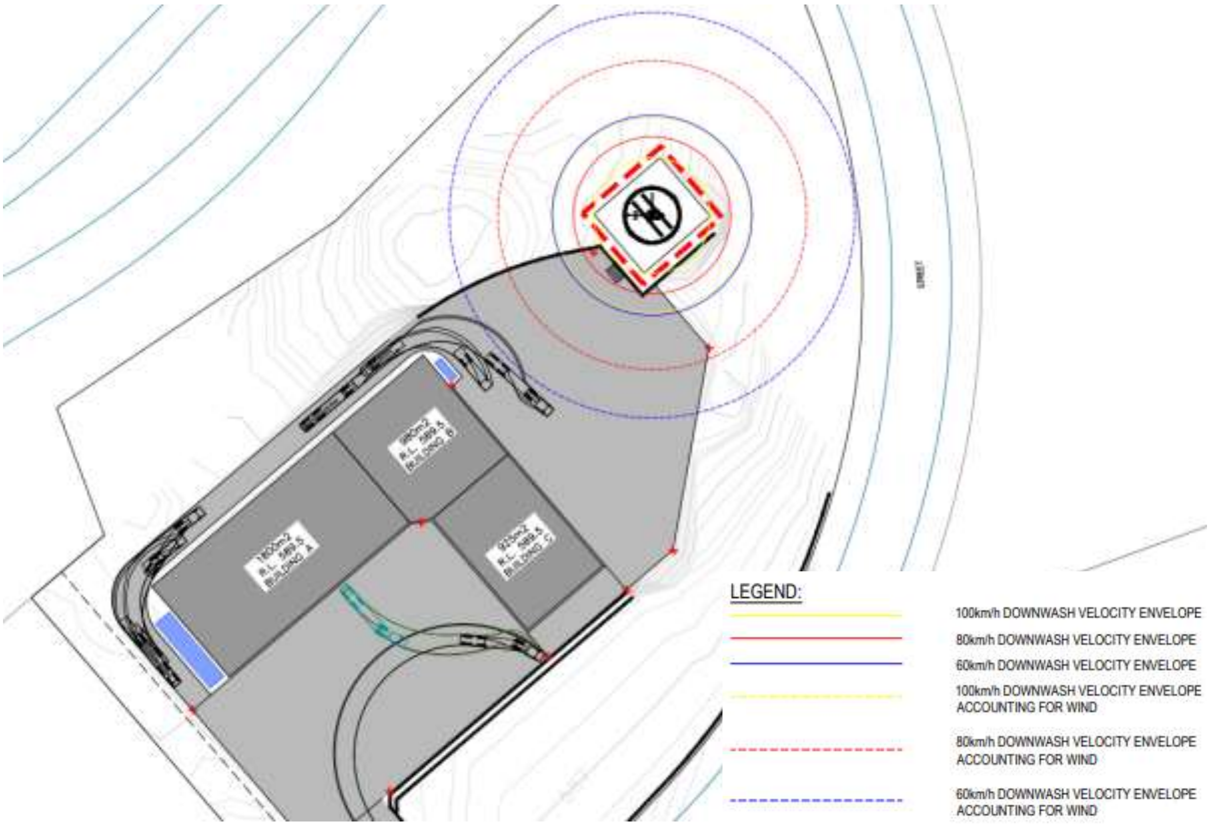


Figure 5.2 Bell 206L4 downwash extent

6 Conclusion & Recommendations

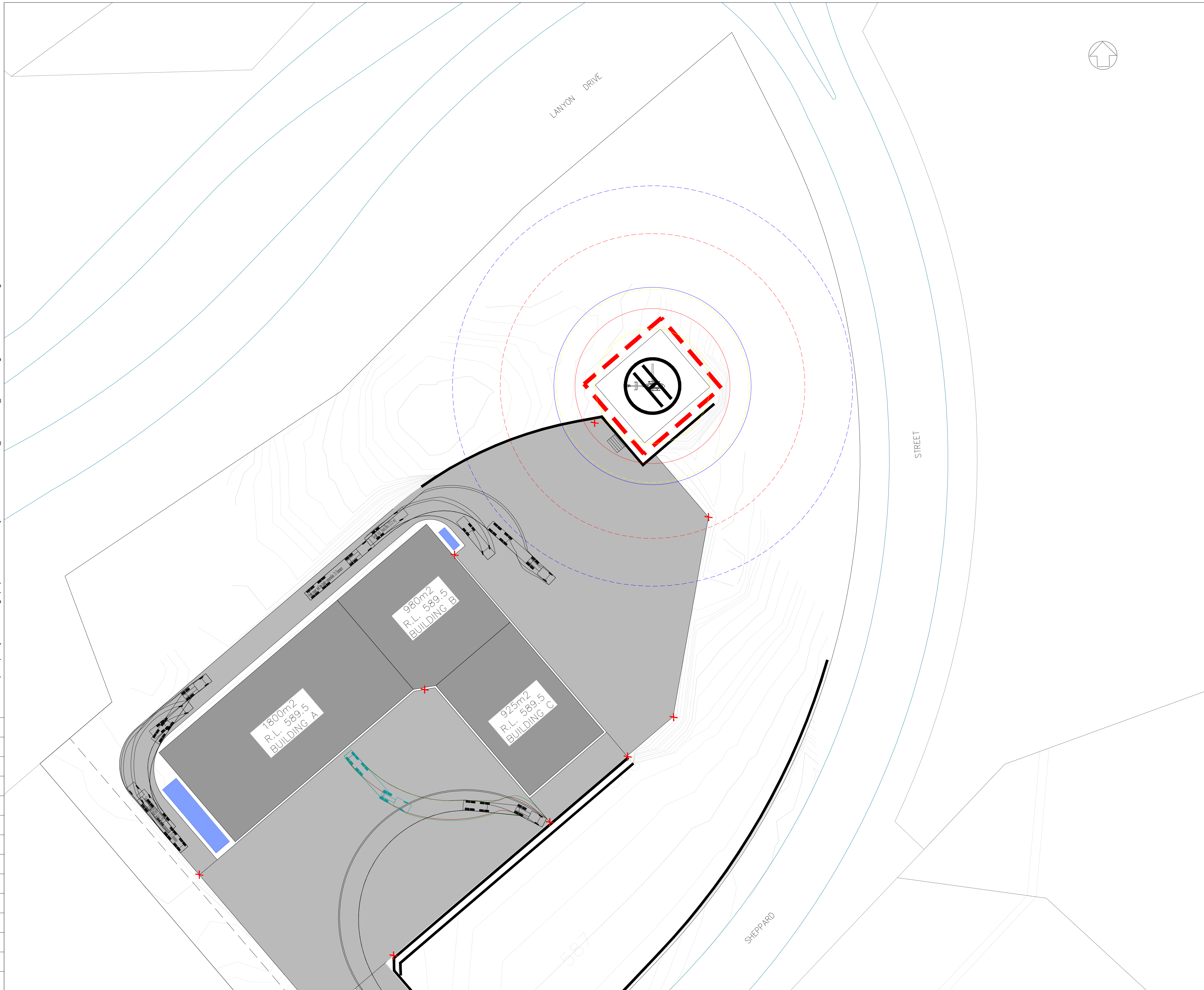
The helicopter downwash assessment demonstrates that the proposed HLS located to the northeast of the proposed operations base area are within CASA's recommended maximum wind velocity and will not have an impact on the proposed buildings and helistands.

Both the proposed buildings and Sheppard St are outside of the 60km/h downwash velocity envelope accounting for wind.

The proposed helistand lies approximately within the 80km/h downwash velocity envelope accounting for wind, which is still in accordance with CASA's recommendation. It should be noted that the proposed helistand are located where wind would have a positive impact on the downwash, which would generally reduce the downwash velocity of a helicopter, thus would have a downwash velocity lower than 80km/h.

Appendices

Appendix A – Downwash Velocity Contours



LEGEND:

- 100km/h DOWNWASH VELOCITY ENVELOPE
- 80km/h DOWNWASH VELOCITY ENVELOPE
- 60km/h DOWNWASH VELOCITY ENVELOPE
- 100km/h DOWNWASH VELOCITY ENVELOPE ACCOUNTING FOR WIND
- 80km/h DOWNWASH VELOCITY ENVELOPE ACCOUNTING FOR WIND
- 60km/h DOWNWASH VELOCITY ENVELOPE ACCOUNTING FOR WIND

NOTES:

1. CONCEPT PLAN LAYOUT PROVIDED BY FORESTRACK. JJR TAKES NO RESPONSIBILITY FOR THE ACCURACY OF THE PROVIDED FILES.
2. THE HELICOPTER ROTOR DOWNWASH CONTOURS HAVE BEEN DEVELOPED BY JJR BY UTILISING A PROPRIETARY CALCULATION SYSTEM BASED ON EMPIRICAL HELICOPTER ROTOR DOWNWASH RESEARCH. JJR'S MODELLING SYSTEM AND CONSEQUENT HELICOPTER DOWNWASH VELOCITY CONTOURS MAY BE SUBJECT TO CHANGE AND REFINEMENT BASED ON NEW INFORMATION FROM TIME TO TIME.

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PLOT DATE: 08 March 2021 TIME: 12:07:41

TITLE	NAME
DRAFTER	D.BRUGMAN
DRAFTING CHECK	T.BAXTER
DESIGNER	D.BRUGMAN
DESIGN CHECK	T.BAXTER
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING

PRINCIPAL: FORESTRACK

DESIGNER: JJ RYAN CONSULTING PTY LTD

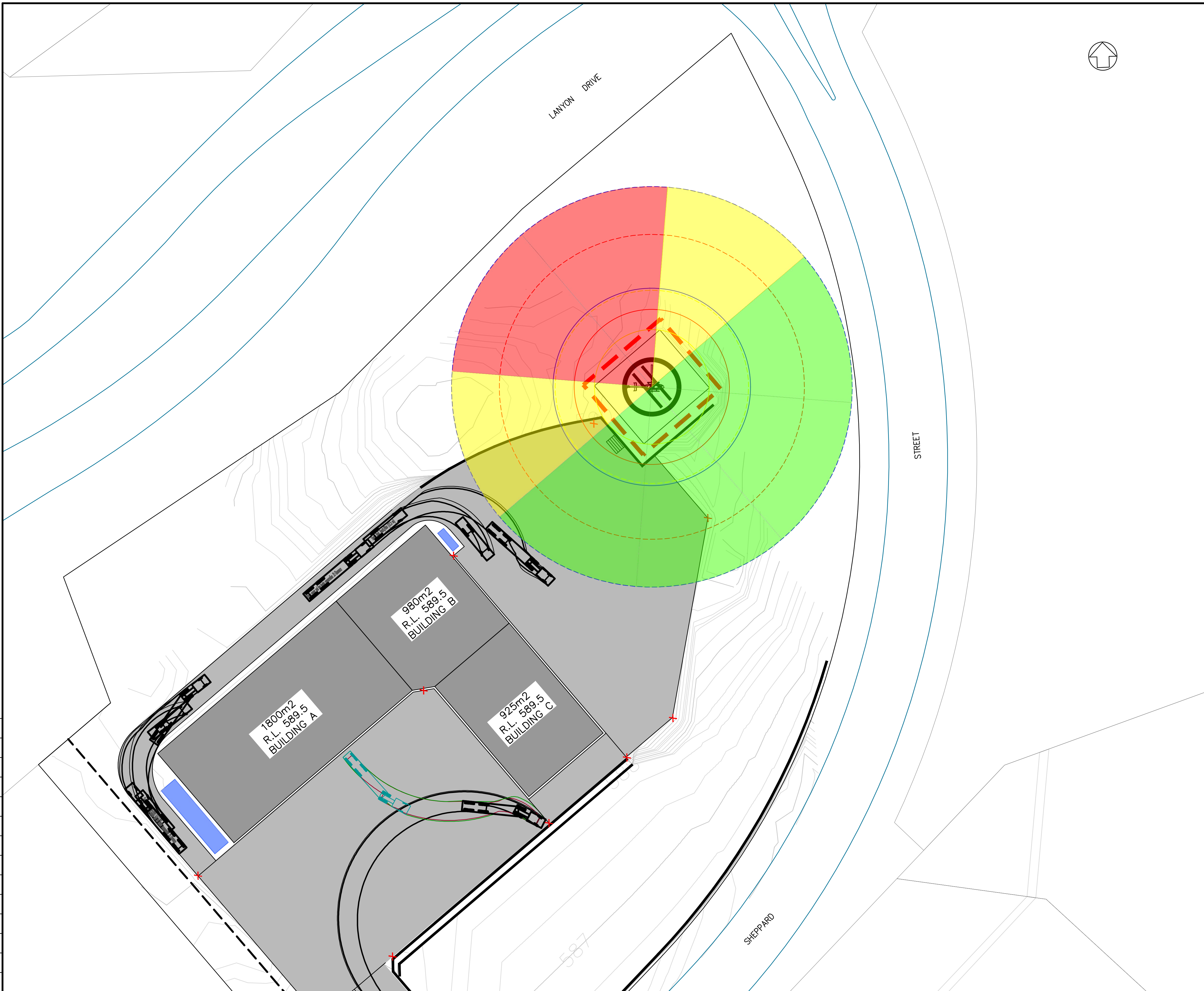
SCALES AT A3 SIZE DRAWING: SCALE 1:1000 (5 0 5 10 15 20 25m)

CO-ORDINATE SYSTEM: MGA ZONE 55 HEIGHT DATUM:

FORESTRACK

PROPOSED HELIPAD DEVELOPMENT FOR BLOCK 45 SECTION 3, HUME
HELICOPTER DOWNWASH ASSESSMENT
BELL 206L-4 HELICOPTER
DOWNWASH VELOCITY CONTOURS

CLIENT PROJECT / DRAWING No:
ISSUE STATUS: FOR INFORMATION
JJR PROJECT / DRAWING No: 3200316A-SK001
ISSUE: A



LEGEND:

- 100km/h DOWNWASH VELOCITY ENVELOPE
- 80km/h DOWNWASH VELOCITY ENVELOPE
- 60km/h DOWNWASH VELOCITY ENVELOPE
- 100km/h DOWNWASH VELOCITY ENVELOPE ACCOUNTING FOR WIND
- 80km/h DOWNWASH VELOCITY ENVELOPE ACCOUNTING FOR WIND
- 60km/h DOWNWASH VELOCITY ENVELOPE ACCOUNTING FOR WIND
- NEGATIVE DOWNWASH IMPACT
- NEUTRAL DOWNWASH IMPACT
- POSITIVE DOWNWASH IMPACT

NOTES:

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TITLE	NAME
DRAFTER	D.BRUGMAN
DRAFTING CHECK	T.BAXTER
DESIGNER	D.BRUGMAN
DESIGN CHECK	T.BAXTER
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

PRINCIPAL: FORESTRACK

DESIGNER: JJ RYAN CONSULTING PTY LTD

SCALES AT A3 SIZE DRAWING: SCALE 1:1000 (5 0 5 10 15 20 25m)

CO-ORDINATE SYSTEM: MGA ZONE 55

HEIGHT DATUM:

FORESTRACK

PROPOSED HELIPAD DEVELOPMENT FOR BLOCK 45 SECTION 3, HUME
HELICOPTER DOWNWASH ASSESSMENT
BELL 206L-4 HELICOPTER
DOWNWASH IMPACT ZONES

CLIENT PROJECT / DRAWING No	ISSUE STATUS	JJR PROJECT / DRAWING No	ISSUE
	FOR INFORMATION	3200316A-SK002	A

Appendix B – Tuggeranong AWS Wind Data (BoM)

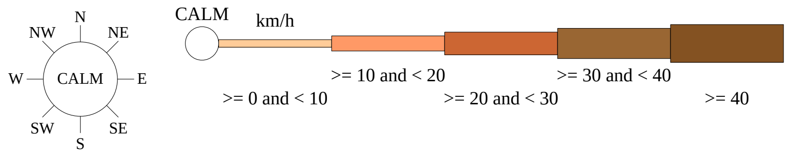
Rose of Wind direction versus Wind speed in km/h (26 May 1996 to 11 Aug 2020)

Custom times selected, refer to attached note for details

TUGGERANONG (ISABELLA PLAINS) AWS

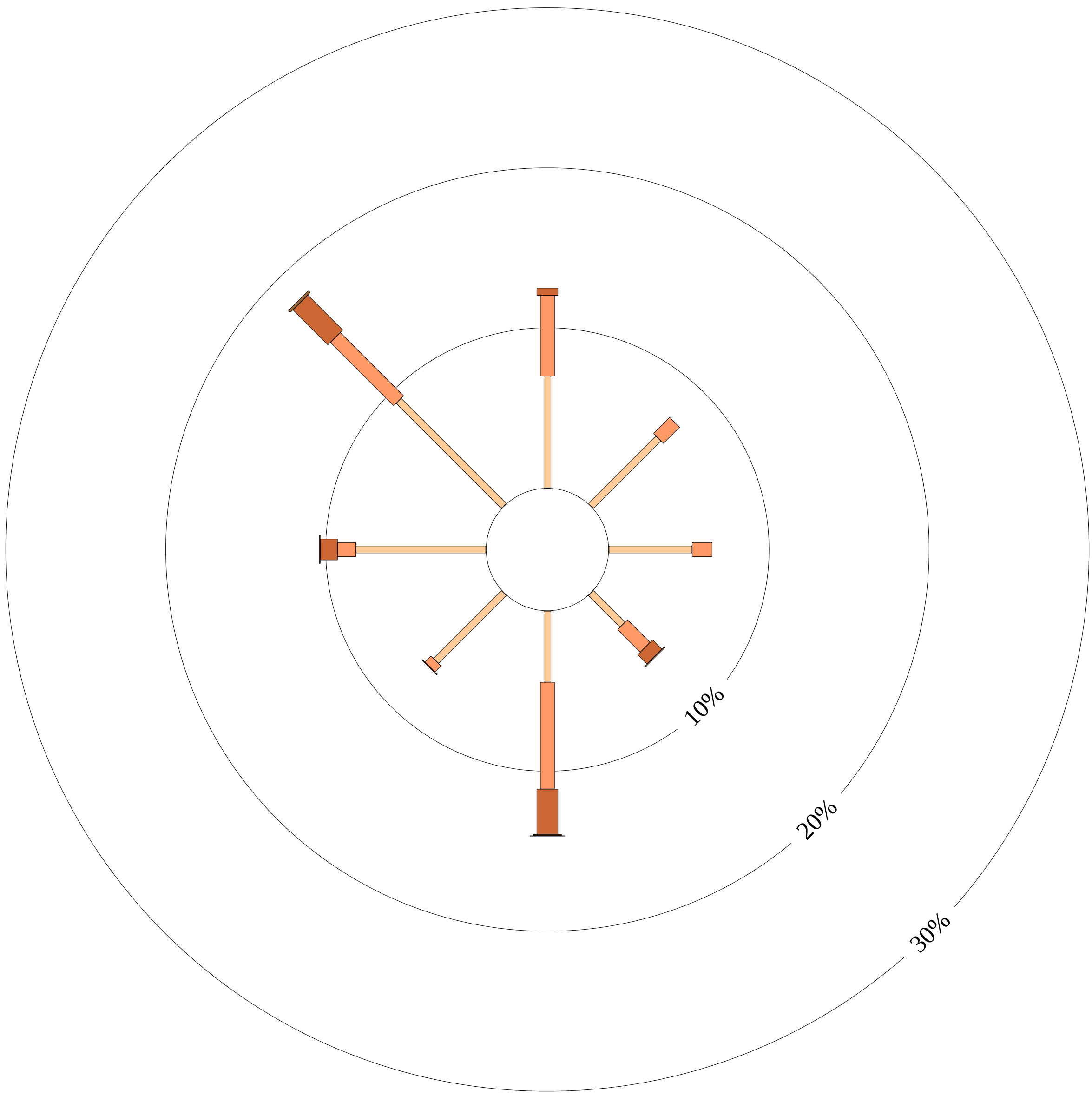
Site No: 070339 • Opened May 1996 • Still Open • Latitude: -35.4184° • Longitude: 149.0937° • Elevation 586.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am
8674 Total Observations

Calm 19%



Rose of Wind direction versus Wind speed in km/h (26 May 1996 to 11 Aug 2020)

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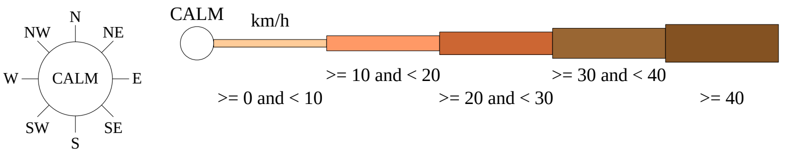

3 pm
8695 Total Observations

Calm 1%