Helicopter Downwash Assessment for the Proposed Helipad Development at Trinity Point

22 May 2019

Prepared by JJ Ryan Consulting Pty Ltd
for Sparke Helmore Lawyers Pty Ltd
on behalf of Johnson Property Group
www.jjryan.com.au
ABN: 69 145 797 726

JJR-2190111B

Contents

1 INTRODUCTION....................1

1.1 Purpose....................1
1.2 Background....................1
1.3 Report Scope....................2
1.4 Downwash Assessment Methodology....................3
1.5 Report Structure....................3

2 PROJECT CONTEXT & ASSESSMENT METHODOLOGY....................4

2.1 Concept Approval Modifications....................4
2.2 Proposed Helicopter Operational Measures....................5

3 HELICOPTER OPERATIONS....................7

3.1 Helicopter Take-Off Procedures....................7
3.2 Helicopter Approach Procedures....................12
3.3 Helicopter Take-Off and Approach Surfaces....................13
3.4 CASA Helicopter Performance Class....................14
3.5 Helipad Flight Paths....................16

4 WIND ANALYSIS....................18

4.1 Operational Impacts of Wind....................18
4.2 Previous Wind Analysis (by Others)....................18
4.3 Helipad Usability for Approach & Departure Movements....................20
4.4 Beaufort Wind Force Scale....................23
4.5 Wind Impact on Downwash Analysis....................24

5 HELICOPTER DOWNWASH....................26

5.1 Concept of Helicopter Downwash....................26
5.2 Theoretical Calculations....................28
5.3 Proposed Helicopter Model Data....................29
5.4 Downwash Assessment....................31
5.5 Naval Impact of Downwash....................37
5.6 Watercraft Movements in the Vicinity of the Helipad....................38

6 RISK ASSESSMENT....................41

6.1 Risk Criteria....................41
6.2 Helicopter Safety Data....................43
6.3 Risk Assessment....................43
6.4 Other Mitigating Factors....................44

7 STAKEHOLDER CONSULTATION....................45

7.1 Similar Helicopter Operations....................45
7.2 Stakeholder Summary....................45

8 CONCLUSION & RECOMMENDATIONS....................46

APPENDICES....................48

Appendix A – Revised Helipad Plans....................49
Appendix B – Flight Paths at Trinity Point under Maximum Performance Take-off Operations....................50
Appendix C – Historical Wind Speed Data....................51
Appendix D – BoM Wind Data and Wind Analysis Calculations....................52
Appendix E – Downwash Risk Assessment....................53

Appendix F – Memorandum Summarising Similar Helicopter Operations 54

Tables

Table 2.1 Concept Approval modifications 4
Table 2.2 Typical helicopters likely to utilise the helipad 5
Table 3.1 Recommended dimensions and slopes of obstacle limitation surfaces for HLS 14
Table 3.2 CASA helicopter performance classes 15
Table 3.3 Helicopter model types 15
Table 4.1 Prevailing wind direction data (Norah Head Lighthouse) 19
Table 4.2 Prevailing wind direction and max average wind speed data (Norah Head Lighthouse) 19
Table 4.3 Helicopter approach and departure wind directions 21
Table 4.4 Wind condition related to helicopter approach availability (AM + PM) 21
Table 4.5 Wind condition related to helicopter departure availability (AM + PM) 21
Table 4.6 Wind condition related to helicopter approach availability (AM only) 22
Table 4.7 Wind condition related to helicopter approach availability (PM only) 22
Table 4.8 Wind condition related to helicopter departure availability (AM only) 22
Table 4.9 Wind condition related to helicopter departure availability (PM only) 22
Table 4.10 Beaufort Wind Force Scale 23
Table 4.11 Overall wind impacts (average of AM + PM) 25
Table 5.1 Summary of potential downwash risks to people, buildings, aircraft and helicopters 26
Table 5.2 Recommended maximum wind velocities 27
Table 5.3 Types of water craft (MPASC) 27
Table 5.4 Proposed helicopter data 29
Table 5.5 Helicopter rotor hub distances 30
Table 5.6 Wave height impacts 37
Table 6.1 Risk likelihood ratings 41
Table 6.2 Risk consequence ratings 41
Table 6.3 Inherent risk rating 42
Table 6.4 Risk level descriptions and tolerance 42
Table 6.5 Effectiveness of Controls 42
Table 6.6 Residual Likelihood based on control effectiveness 42
Table 6.7 Residual Consequence based on control effectiveness 43
Table 6.8 Rate of helicopter accidents by operation 43

Figures

Figure 1.1 Locality plan showing the proposed helipad ... 2
Figure 1.2 Proposed helipad layout ... 2
Figure 3.1 Helicopter profile during a normal take-off from hover ... 7
Figure 3.2 Height vs velocity chart for aircraft below 3,856kg (US FAA, Helicopter Flying Handbook, 2012) ... 8
Figure 3.3 Helicopter profile during a maximum performance take-off ... 9
Figure 3.4 Helicopter take-off profile for Trinity Point test flight paths ... 10
Figure 3.5 Helicopter take-off profile for Orange helipad ... 11
Figure 3.6 Typical profile for a normal approach to hover ... 12
Figure 3.7 Typical profile for a steep approach to hover ... 12
Figure 3.8 Take-off climb/approach surface width (ICAO Annex 14 Volume II) ... 13
Figure 3.9 Approach and take-off climb surfaces "A" slope profile (ICAO Annex 14 Volume II) ... 13
Figure 3.10 Revised take-off and landing area and exclusion zone ... 17
Figure 4.1 Impact of wind direction on helicopter downwash ... 24
Figure 5.1 Downwash velocity vs probe height ... 28
Figure 5.2 Helicopter downwash velocity at different rotor heights ... 31
Figure 5.3 Helipad downwash area on take-off and landing ... 32
Figure 5.4 Helipad downwash extent including prevailing wind conditions (Airbus 135) ... 32
Figure 5.5 Helipad downwash extent including prevailing wind conditions (Airbus 135) ... 33
Figure 5.6 Helipad downwash extent including prevailing wind conditions (Bell 206L) ... 34
Figure 5.7 MPASC Lake Macquarie sailing area ... 35
Figure 5.8 Watercraft in the vicinity of Trinity Point ... 38
Figure 5.9 Vessels in Lake Macquarie near Trinity Point (31/03/2015) ... 39
Figure 5.10 Vessels in Lake Macquarie near Trinity Point (04/09/2016) ... 39
Figure 5.11 Vessels in Lake Macquarie near Trinity Point (24/10/2017) ... 40
Figure 5.12 Vessels in Lake Macquarie near Trinity Point (01/08/2018) ... 40

1 Introduction

1.1 Purpose

The purpose of this report is to provide an overview of a helicopter downwash assessment conducted by JJ Ryan Consulting (JJR) associated with the proposed helipad development at Trinity Point for Sparke Helmore Lawyers ('Sparke') on behalf of Johnson Property Group Pty Ltd (JPG).

1.2 Background

Trinity Point is a luxury residential, tourist and marina destination project located on the shores of Australia's largest salt water lake, Lake Macquarie, and is approximately 1 hour drive from Newcastle.

The Minister for Planning approved Concept Plan 06_309 on 5 September 2009 which included facilities outlined above.

JPG submitted an application for MOD3 to the Concept Plan on 1 October 2013 to include a helipad off the marina and insert appropriate conditions that outline how the helipad is to be assessed for future Part 4 approvals. This modification is currently the subject of ongoing court proceedings.

The modifications to the Concept Approval sought in the Application included the following:

- Add 'helipad' as a permitted use and update the relevant development descriptions and related terms of approval to incorporate the proposed helipad use;
- Incorporate the revised drawings identified in Appendix L of the Environmental Assessment Report (EAR), dated 10 November 2016, into the Concept Approval; and
- Amend the Concept Approval to incorporate a new principle to manage the future construction and use of the proposed helipad in the approved Urban Design Guidelines.

The subject site is located in Bardens Bay with an overview of the proposed helipad location shown in Figure 1.1 with the proposed helipad layout is shown in Figure 1.2.

Amendments are proposed to the original application that:

- Extend a managed safety area around the helipad from 30m from the edge of the helipad to 66.5m from the centre of the helipad;
- Increasing the helipad size from 20mx20m to 25mx25m;
- Establishing an exclusion are and a designated take-off and landing area (as shown in Figure 2); and
- Replacing (in the list of helicopters nominated to use the helipad) the Airbus135 with the AS355F.

The revised helipad layout plans are provided in Appendix A.

Figure 1.1 Locality plan showing the proposed helipad

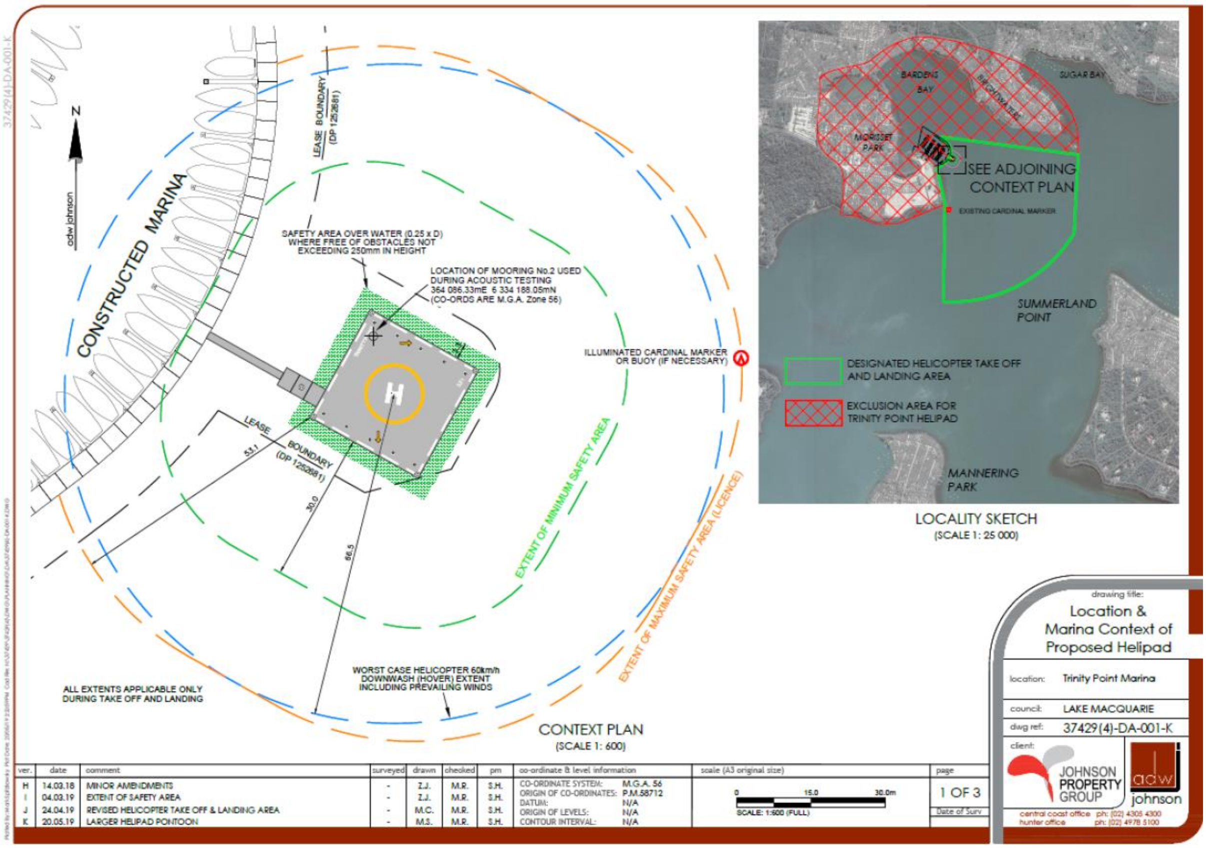


Figure 1.2 Proposed helipad layout

1.3 Report Scope

The scope of this report is to assess the helicopter downwash associated with the proposed helipad and an amended take-off and landing area to determine if these significantly impact surrounding relevant stakeholders including the following:

- Operations of the marina;
- Mannering Park Amateur Sailing Club (MPASC); and
- General lake users of the Lake Macquarie waterbody.

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

- Assessment of helicopter noise impacts; and
- Design of helipad pontoon structure.

1.4 Downwash Assessment Methodology

The methodology adopted to review the downwash impacts associated with the proposed development are as follows:

- Review the proposed arrangement of the helipad;
- Identify the helicopters proposed to operate from the helipad;
- Review the proposed operating parameters for each of the typical helicopters;
- Review the meteorological conditions at the proposed helipad;
- Prepare a downwash models for each helicopter model and determine the theoretical worst-case downwash scenario at the helipad;
- Prepare a sketch (drawing) showing the likely extents of the 60km/h and 80km/h downwash envelopes in both calm (i.e. no wind) and windy conditions near the helipad;
- Review helicopter performance charts for the critical helicopter (assumed generally to be the Airbus 135 because it has the highest rotor disc loading of the proposed helicopters to utilise the helipad), however due to the distribution of downwash, the greatest disc loading may not result in the critical downwash for different wind velocity thresholds;
- Calculate the rotor downwash for both “normal performance” and “maximum performance” take-offs; and
- Determine whether the rotor downwash is acceptable in the context of the proposed helicopter operations and the surrounding marina and waterbody environment.

1.5 Report Structure

The Helicopter Downwash Assessment is structured over the following sections:

- **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 helipad site including usability for helicopter operations;
- **Section 5** provides information on the helicopter downwash assessment including consideration of the wind and naval impacts;
- **Section 6** provides an overview of the risk assessment undertaken on the proposed helipad and associated helicopter operations including the risk methodology and appetite; and
- **Section 7** provides a summary of the stakeholder consultation outcomes; and
- **Section 8** provides an overall conclusion and recommendations for future actions.

2 Project Context & Assessment Methodology

2.1 Concept Approval Modifications

The Application to modify the Concept Approval is supported by conceptual development plans, water quality controls and operational controls for the helipad. The Application does not specifically seek approval to incorporate these details into the Concept Approval, although they do include the items outlined in Table 2.1.

Table 2.1 Concept Approval modifications

Criteria	Description
Conceptual Helipad Design	A 25m x 25m pontoon with four corner telescopic piles up to 600mm diameter. The proposed pontoon would sit 700mm above the water level with a 600mm draught below water level. The proposed pontoon would be constructed of concrete to match the design of the marina breakwater structure.
	A 1.5m wide by 17m long gangway and three 3m x 4m pontoons with one pile connecting the proposed helipad pontoon to the marina. The gangway would be a hinged aluminium gangway.
	The provision of two 9kg fire extinguishers in red cabinets on the marina breakwater and a wind indicator attached to a marina pole as required.
	The installation of a bollard and chain on the marina gangway to restrict access to the proposed helipad, and two bollards at the marina gangway either side of the proposed managed safety zone to restrict access to the marina breakwater during helicopter take-off and landing movements. Two flashing lights are also proposed on the marina pillars for use when helicopter landings and take-off occur.
	Installation of a cardinal marker or buoy (if necessary) 53m east of the proposed helipad pontoon.
Water Quality Controls	Bunding of the helipad to prevent runoff into Lake Macquarie.
	Use of oil/fuel spill kits and a containment boom.
	First flush treatments for the deck of the pontoon structure.
Operational Controls	A maximum of six (6) helicopter movements (3 landings and 3 departures) per day, and a maximum of 38 helicopter movements per week (19 landings and 19 departures) in accordance with the proposed take-off and landing area.
	Proposed operational hours of 8am to sunset (with time seasonally variable) Mondays to Fridays and 9am to sunset on Sundays and public holidays (with time seasonally variable).
	Use of a proposed minimum 30m (and maximum 66.5m) wide managed safety zone, measured from the centre of the helipad for use during helicopter landing and take-off movements.
	Implementation of a proposed Helipad Operations Manual and prior permissions protocol for helicopter landings and take-offs.

2.2 Proposed Helicopter Operational Measures

The key concept operational details for the proposed helipad are as follows:

- A minimum 30m (and maximum 66.5m) wide managed safety zone (during helicopter landing and take-off only) measured from the centre of the helipad will be implemented during take-off and landing movements;
- The safety zone will be managed by appropriately qualified marina staff in accordance with an operations manual, including:
    - Access control on the marina breakwater structure (via use of bollards and chains).
    - Exclusion of persons and craft from within the waters that form part of the safety zone.

The safety zone will not apply during times when no helicopters are arriving at or departing the site. The helipad will however remain off limits to the general public at all times and this will be controlled by a bollard and chain on the marina breakwater where it connects with the gangway access to the helipad.

A 'prior permission' protocol is intended. This will enable information to be communicated and agreed to by users of the helipad, including type of helicopter that can land, fly neighbourly procedures and avoid areas, exclusion zones, take-off and landing areas, operating hours, and can be used as part of registering and demonstrating compliance with maximum daily and weekly movements.

The typical helicopter type was identified to be a general turbine helicopter accommodating 2-5 passengers (or less passengers if includes luggage) plus the pilot. It is expected that helicopters utilising the helipad will commonly be small turbine engine helicopters, with the ability to fly from/to Sydney without the need to refuel, with the occasional medium sized helicopter utilising the helipad.

It is understood that it was agreed from the outset that no joy flights (e.g. up and down local scenic flights across 15 to 30 minute timeframes) should occur, and that Robinson R22/R44 helicopters would be excluded from having permission to utilise the helipad to encourage use of HLS by experienced pilots.

The typical helicopters likely to use the Trinity Point HLS (or type equivalents including any derivatives of the stated models) will primarily be small turbine engine helicopters with occasional medium sized helicopters. The sample of relevant helicopter manufacturers and models, and the associated number of helicopters registered with CASA are outlined in Table 2.2 including the distance from the centre of the helipad to the edge of the 60km/h and 80km/h downwash velocity envelopes.

Table 2.2 Typical helicopters likely to utilise the helipad

Helicopter Manufacturer & Model	Helicopters Registered in Australia	Percentage of Typical Helicopter Types	No Wind		Max Wind	
			80km/hr Contour (m)	60km/hr Contour (m)	80km/hr Contour (m)	60km/hr Contour (m)
Bell 206B	163	31.9%	10.5	23.3	29.8	52.2
Airbus H125 (AS 350)	147	28.8%	22.1	28.1	43.4	57.0
Bell 206L	80	15.7%	19.8	25.3	39.0	51.2
Airbus 130	30	5.9%	23.9	28.0	37.1	56.4
Agusta AW109	26	5.1%	27.0	36.9	36.6	61.7
Airbus 120	25	4.9%	20.6	26.3	40.6	53.3
AS355F	17	3.3%	24.1	28.2	37.4	56.8
Airbus 135	15	2.9%	29.1	39.7	39.3	66.4
Bell 407	8	1.6%	23.4	27.3	36.3	55.1
MD500E	0	0.0%	22.7	28.9	44.6	58.6

It should be noted that the helicopters registered in Australia is not limited to New South Wales (i.e. incorporates all of Australia) and there may be variation between states and territories. The intention is to demonstrate the most available models of helicopter on the assumption that this is proportional to the likely use of the helipad.

The proposal does not limit use of the helipad only to single engine helicopters, however it does limit use by larger/greater capacity helicopters by the design size of the pontoon based on a maximum length and maximum weight. Two twin engine helicopters have been identified to potentially use the HLS, being Airbus 135 (twin engine, max passengers 5 + pilot, maximum weight of 2,835kg) and Agusta Westland AW109 (twin engine, max passengers 6 + pilot, maximum weight of 2,850kg). The physical pontoon design has been based on the AW109, which is physically the largest of the helicopters identified in the likely-use category.

After commencement of JJR's work on this report, the proposal has been revised to remove the Airbus 135 from the list of helicopters likely to use the helipad and to add the AS355F into that list. As work had already commenced and given the Airbus 135 has the higher maximum rotor disc loading of the typical aircraft (including the AS355F), JJR has continued the assessment using the Airbus 135 as generally the critical helicopter.

Throughout this report, data for both the AS355F and the Airbus 135 are provided. While the Airbus 135 may not be one of the helicopter types actually using the helipad, the use of that helicopter for the purposes of the down wash assessment represents a conservative approach, because the other helicopter types will generally have less overall impact than the Airbus 135.

3 Helicopter 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 3.2.
- 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

The flight path profile for helicopters with a gross weight of 3,855kg (8,500lb) and below based on normal take-off procedures is provided in Figure 3.2. The two shaded areas shown should be avoided during normal helicopter operations. This requires pilots to limit their altitude whilst developing sufficient ground speed prior to selecting maximum continuous power which will occur at approximately 55kt (102km/h).

The normal take-off procedure has been assessed based on the United States Federal Aviation Administration (FAA) Helicopter Flying Handbook for the maximum helicopter height above ground without entering the shaded areas shown in Figure 3.2.

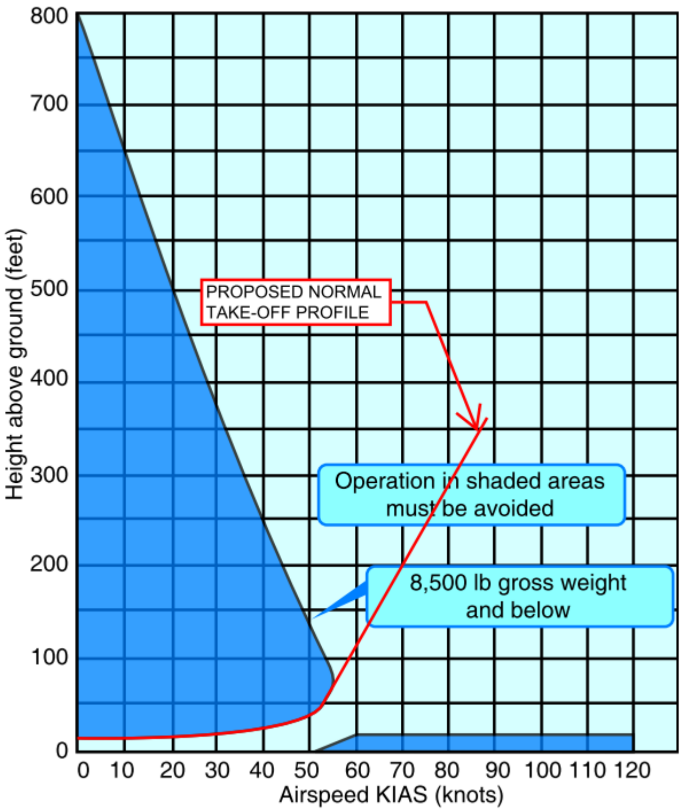


Figure 3.2 Height vs velocity chart for aircraft below 3,856kg (US FAA, Helicopter Flying Handbook, 2012)

It should be noted that the typical safe take-off profile involves initiation of forward flight from a 2–3 feet landing gear height, only gaining altitude as the helicopter accelerates through translational lift and airspeed approaches a safe autorotative speed. At this point, some of the increased thrust available may be used to attain safe climb airspeed and will keep the helicopter out of the shaded or hatched areas of the H/V diagram.

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.

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 3.3:

- 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.

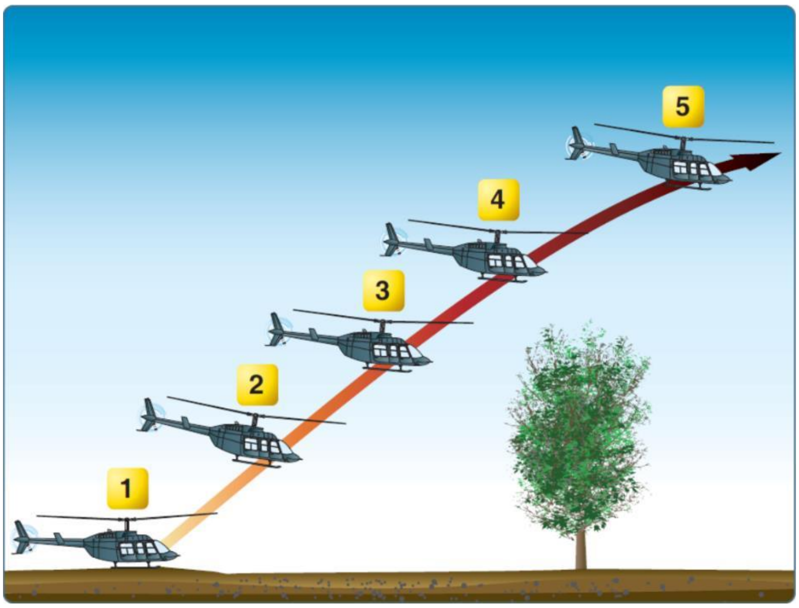


Figure 3.3 Helicopter profile during a maximum performance take-off

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 on the bay and surrounding boat users.

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 (H/V) chart for the specific helicopter conducting the maximum power take-off should be fully considered before performing this manoeuvre. An engine failure at low altitude and airspeed could place the helicopter in a dangerous position, requiring a high degree of skill in making a safe autorotative landing.

It may be necessary to operate in the shaded area of the H/V diagram during the beginning of this manoeuvre when operating in light or no-wind conditions. The angle of climb and resulting airspeed will be dictated by the proximity and height of the obstacles to be cleared. The pilot must be aware of the calculated risk involved when operating in the shaded area of the H/V diagram.

While at the discretion of the pilot, it is recommended that an operational procedure is incorporated into the helipad manual to state:

When a maximum performance take-off is performed pilots are recommended to:

- *Lift off the pad and hover to test the wind conditions;*
- *Touch back down on the helipad; and*
- *Perform a maximum power take-off.*

Trinity Point Take-off Operations

Helicopter flight path data for twenty (20) potential flight paths at Trinity Point was recorded on 24 March 2016. An overview of these test flight paths undertaken are provided in Figure 3.4. The full helicopter take-off and approach profiles for Trinity Point flight paths are provided in Appendix B.

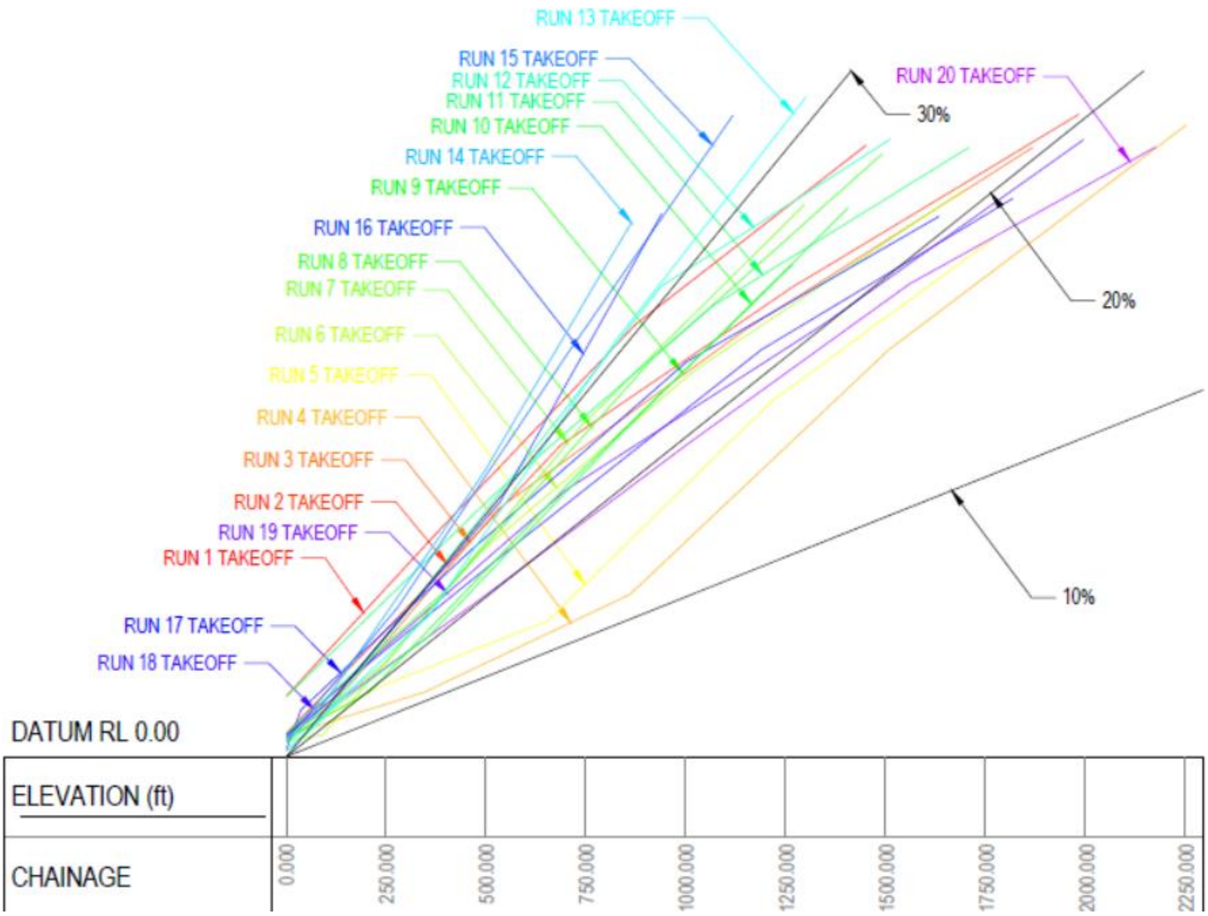


Figure 3.4 Helicopter take-off profile for Trinity Point test flight paths

The Trinity Point flight data indicates a typical take-off profile of between 20% and 30%.

Orange Helipad Take-off Operations

A helipad operator in Orange provided Spidertrack data for their helicopter flight paths under maximum performance take-off conditions, to allow a comparative assessment against the flight paths for Trinity Point. The take-off profiles for twenty (20) runs is provided in Figure 3.5.

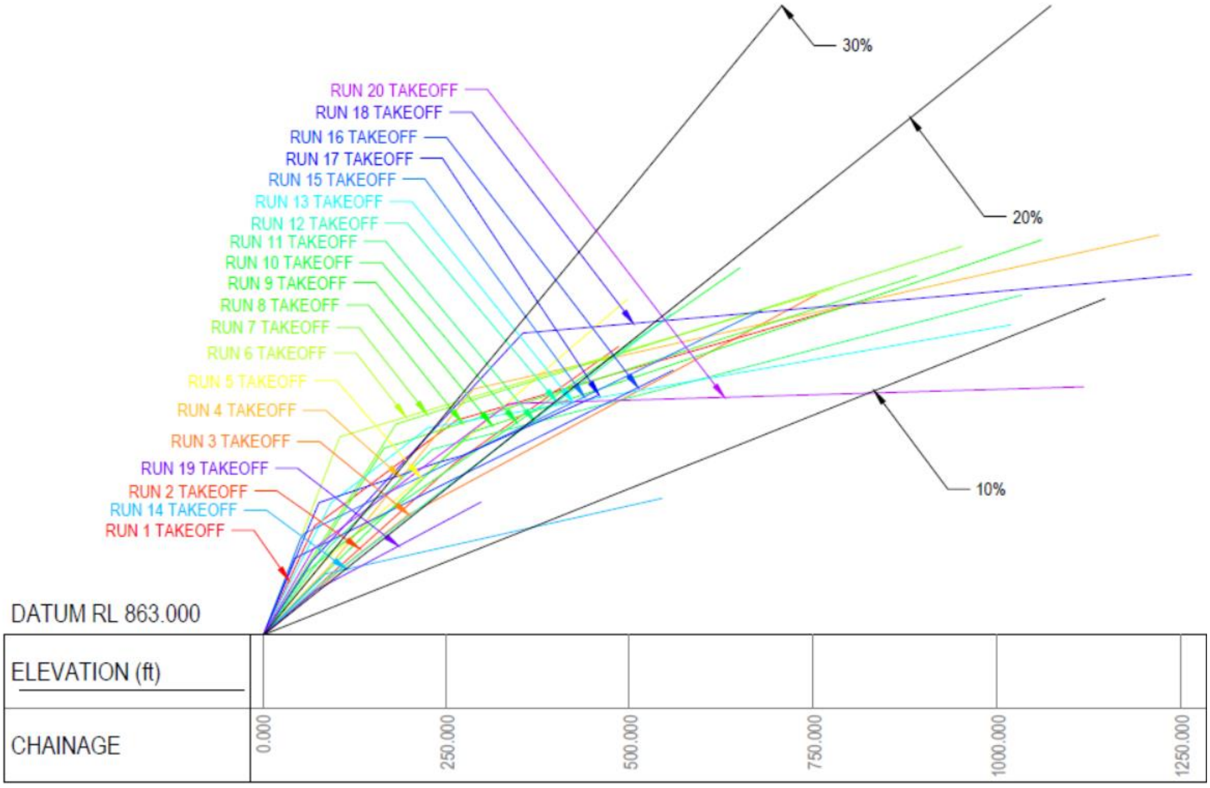


Figure 3.5 Helicopter take-off profile for Orange helipad

The take-off flight data indicates a typical take-off profile of between 20% and 30% which is similar to the Trinity Point flight data outlined in Section 0.

Adopted Maximum Performance Take-off

The Trinity Point flight data has been relied on for the purposes of the downwash assessment for maximum performance take-off scenarios as the flight data indicates safe, realistic and achievable take-off grades that are consistent with other helipad operators within Australia (based on the Orange helipad flight data).

While the maximum performance data provided from GPS for Trinity Point and Spidertracks for Orange indicate take-off generally being between 20% to 30%, a conservative 10% take-off slope has been utilised for downwash modelling.

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 Trinity Point helipad (note that 10 degrees is equal to a 17.6% gradient).

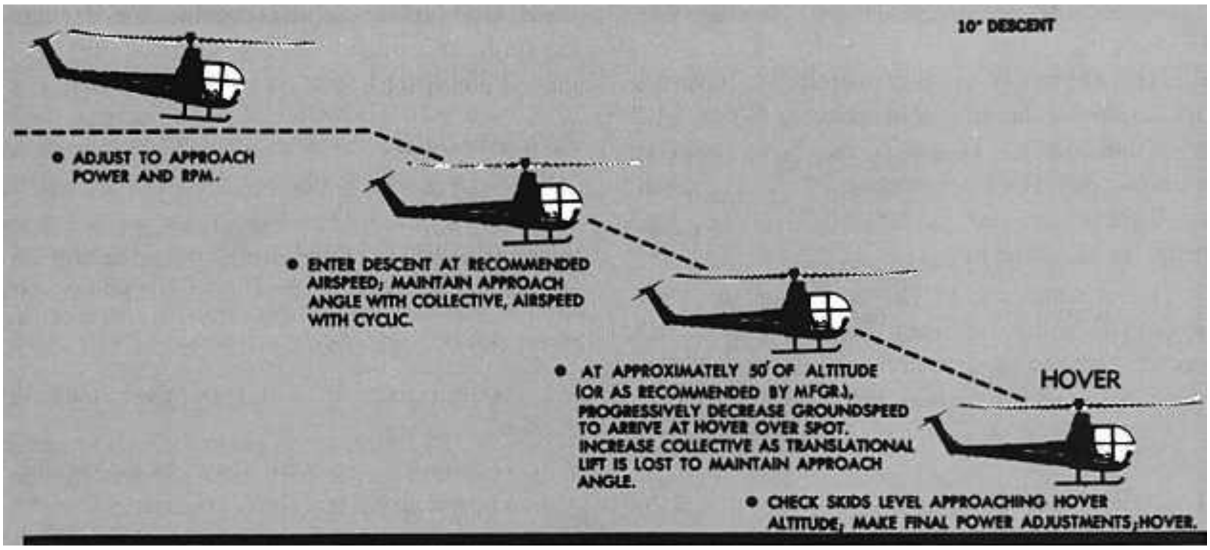


Figure 3.6 Typical profile for a normal approach to hover

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).

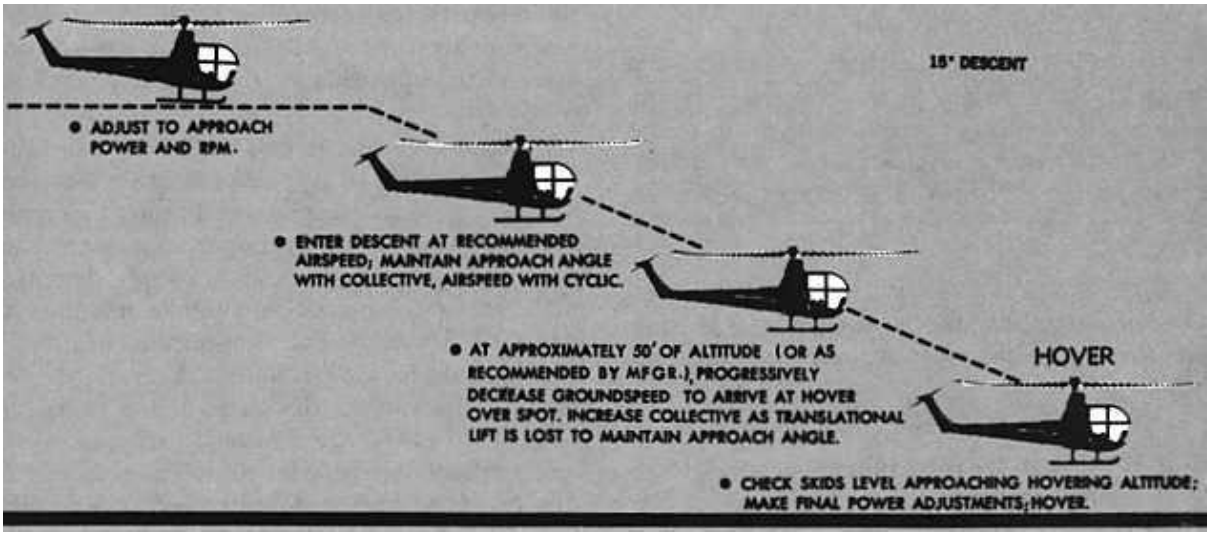


Figure 3.7 Typical profile for a steep approach to hover

3.3 Helicopter Take-Off and Approach Surfaces

It is acknowledged that the helicopters will land at a helipad rather than a heliport, however 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 3.8. The take-off climb and approach surface ends and starts at a height of 152m above the FATO respectively.

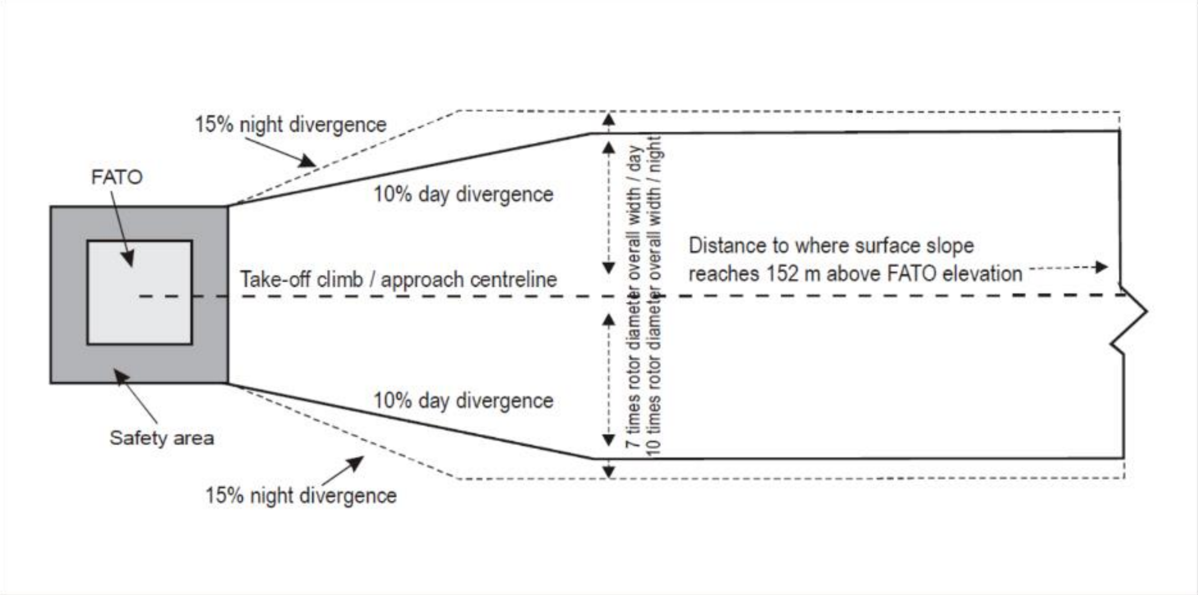


Figure 3.8 Take-off climb/approach surface width (ICAO Annex 14 Volume II)

The approach and take-off climb surface is also provided in Figure 3.9 which is based on an “A” slope profile with a 4.5% design slope.

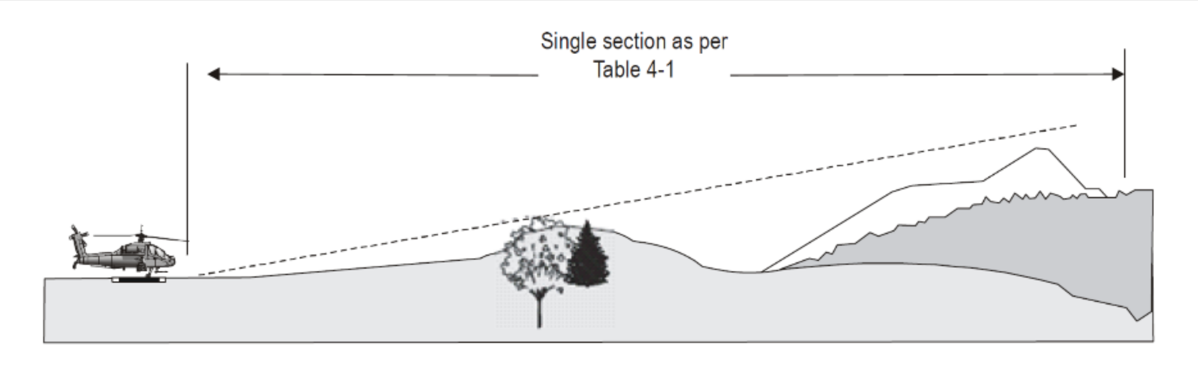


Figure 3.9 Approach and take-off climb surfaces "A" slope profile (ICAO Annex 14 Volume II)

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.

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*	3,3886m	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 will be four (4) performance classes that have been considered in this downwash assessment as outlined in Table 3.2.

The typical helicopters likely to use the Trinity Point HLS that were identified in Section 2.2 have been summarised in Table 3.3 including the performance class and associated obstacle surface slope profile. The rate of climb is the maximum rate of climb for the maximum gross operating weight of the helicopter.

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. 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.

Table 3.3 Helicopter model types

Model	Gross Weight (kg)	Rotor Height (m)	Rate of Climb* (m/s & ft/min)
Bell 206B	1,451kg	2.83m	6.6m/s (1,300ft/min)
Airbus H125	2,250kg	3.14m	9.9m/s (1,950ft/min)
Bell 206L	2,018kg	2.83m	6.6m/s (1,300ft/min)
Airbus 130	2,500kg	3.34m	8.1m/s (1,600ft/min)
Agusta AW109	2,850kg	3.50m	10.5m/s (2,075ft/min)
Airbus 120	1,715kg	3.40m	5.8m/s (1,150ft/min)
AS355F	2,540kg	3.14m	6.8m/s (1,338ft/min)
Airbus 135	2,835kg	3.51m	8.1m/s (1,600ft/min)
Bell 407	2,381kg	3.56m	10.2m/s (2,000ft/min)
MD500E	1,361kg	2.48m	9.0m/s (1,770ft/min)

3.5 Helipad Flight Paths

The flight manual for the AS350B3 (now known as the Airbus H125) as well as helicopter take-off and approach procedures set out earlier in this section have been utilised as the basis for typical helicopter take-off and landing scenarios. Note that the Airbus H125 operating procedures have been provided as a reference example for standard helicopter operating procedures only.

A summary of the relevant operating procedures for the Airbus H125 is provided below:

- **Take-off:** Gradually increase the collective pitch and maintain hover and head into wind at a height of approximately 1.5m (5ft);
- **Transition to hover:** Increase speed without increasing the power demand (power required for hover in ground effect) and without climbing until the Indicated Airspeed (IAS) is 74km/h (40kt);
- **Climb:** Maintain power and climb while avoiding entering the height / airspeed diagram;
- **Climb:** Above 30m (100ft) select maximum continuous power and optimum climbing speed of (v_y) IAS = 65kt (120km/hr – 1 kt/1000ft);
- **Approach:** Final approach should be made into the wind at a low sink rate and recommended airspeed of 120km/h (65kt); and
- **Landing:** From hover, reduce collective pitch gradually until initial touch-down is made, then cancel collective pitch completely.

The amended proposal now introduces an exclusion zone for helicopter operations to the north and west of the helipad.

Figure 3.10 show the proposed exclusion zone as well as the take-off and landing area.

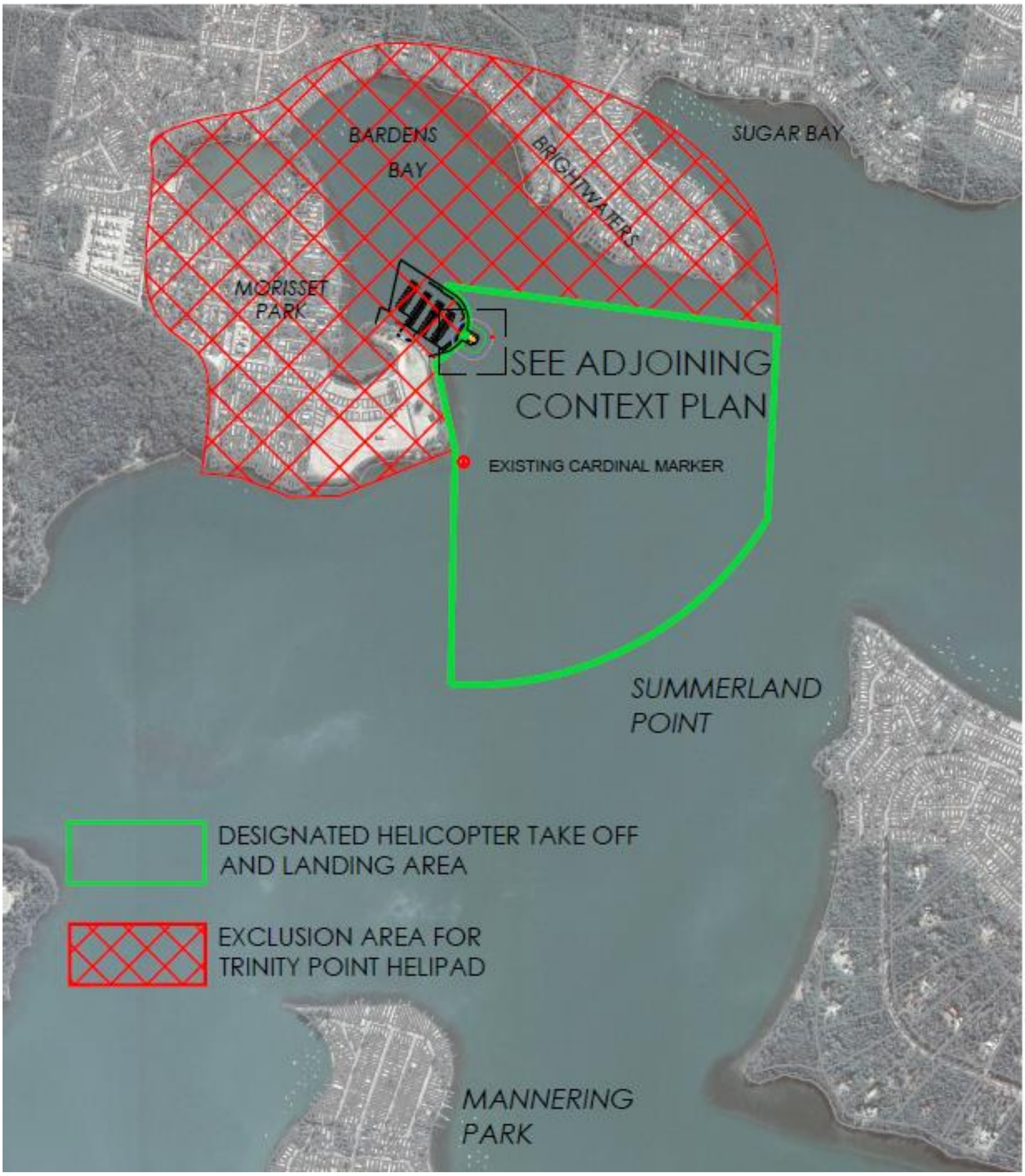


Figure 3.10 Revised take-off and landing area and exclusion zone

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 helipad.

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 Previous Wind Analysis (by Others)

Previous wind analysis completed by others has utilised wind data from the following two locations:

- Norah Head Lighthouse (utilised by AviPro); and
- RAAF Williamtown (utilised by Royal Haskoning DHV).

The mesoscale effects (particularly for winds at and below 1000ft) experienced inland and on Lake Macquarie at Trinity Point will be significantly different to the wind conditions experienced at the Norah Head Lighthouse. The Lighthouse is located approximately 17km south east of Trinity Point and is exposed to more severe offshore wind conditions that are not anticipated to be an accurate representation of wind conditions at Trinity Point.

The wind data obtained from the Bureau of Meteorology (BoM) weather station at RAAF Williamtown has been considered in other studies as a more representative data set of the wind conditions likely to be experienced on the Lake Macquarie foreshores.

Seasonal wind direction percentages and velocity information for the Lake Macquarie area was provided in the Helicopter Landing Site Report Appendix A. This wind information was obtained from the BoM data at the Norah Head Lighthouse with samples taken from July 1969 to October 2004.

The average wind speed for each prevailing wind direction for each season has been summarised into the maximum average wind speed predicted during AM and PM periods in Table 4.1 and the highest average wind speed provided in Table 4.2.

Table 4.1 Prevailing wind direction data (Norah Head Lighthouse)

Prevailing Wind Direction	AM	Average Wind Speed (km/h)	PM	Average Wind Speed (km/h)
North	14%	30	7%	31
North East	8%	31	21.5%	42
East	3%	31	11.5%	31
South East	6.5%	41	14%	41
South	17%	43	25.5%	46
South West	18.5%	31	7.5%	41
West	17%	22	6%	30
North West	16%	31	7%	30

Table 4.2 Prevailing wind direction and max average wind speed data (Norah Head Lighthouse)

Prevailing Wind Direction	AM	Max Average Wind Speed (km/h)	PM	Max Average Wind Speed (km/h)
North	14%	37	7%	41
North East	8%	37	21.5%	42
East	3%	35	11.5%	37
South East	6.5%	41	14%	41
South	17%	43	25.5%	45
South West	18.5%	40	7.5%	41
West	17%	38	6%	35
North West	16%	37	7%	40

Based on the wind analysis undertaken by others, JJR have incorporated a 46km/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/hr (with wind being less than 40km/hr 96.1% of the time). A less-conservative assessment would consider a 40km/hr maximum wind velocity since it is likely to occur only 3.9% of the time.

The previous wind analysis, including the “maximum average speed” calculated by others, is provided in Appendix C for reference.

4.3 Helipad Usability for Approach & Departure Movements

JJR have assessed the remaining helipad usability based on removal of flight paths to the north as requested by the NSW Department of Planning and Environment. The wind analysis is based on assumptions about helicopters landing and taking off in certain wind conditions.

It does not mean that the helipad operator should restrict helicopters landing or taking off in those wind conditions, because it will depend on the experience and expertise of each pilot as to whether they deem it safe to land / take-off within the designated landing and take-off area. Notwithstanding that, part of the prior permission protocol and the operations set out in the manual should include a requirement to check weather and wind conditions prior to landing.

The assessment for helicopter approaches and departures in different wind conditions based on the required exclusion zone has been based on the following parameters:

- Helicopters can only approach and depart in the quadrant clockwise from East through to South, as limited to the mapped take-off and landing area;
- Helicopters can approach and depart into headwinds at any wind speed;
- Helicopters can approach and depart in calm wind conditions (≤ 10km/h with no specified wind direction);
- Helicopters can approach and depart in wind from any direction at ≤ 10 kt (assumed 20km/h); and
- Helicopters can approach and depart in a crosswind of up to 30km/h.

While relatively negligible, an additional allowance has been included for when the wind direction occurs between the 81 degrees through to 90 degrees and 180 degrees through to 188 degrees (due to the assumption of helicopters being able to take off in these directions). An overview of the relevant cardinal wind directions that helicopters can approach and depart in is provided in Table 4.3.

The wind analysis has been based on BoM site number 061078 (RAAF Williamtown), with readings from 1942 – 2016. The analysis has indicated that average wind conditions are acceptable for helicopter approaches and departures as follows:

- Approaches are acceptable on average 77.80% of the day (i.e. unavailable on average 22.20% of the day); and
- Departures are acceptable 80.35% of the day (i.e. unavailable on average 19.65% of the day).

An overview of the overall wind impacts on helicopter approach and departure movements is provided in Table 4.4 and Table 4.5 respectively. Additional information on the wind analysis is provided in Appendix D.

The approach and departure availabilities for the AM and PM are summarised in Table 4.6 to Table 4.9, where it is noted that:

- Wind conditions that are suitable for helicopter approaches occur approximately 89.80% of the time in the morning and 65.80% of the time in the afternoon; and
- Wind conditions that are suitable for helicopter departures occur approximately 81.50% of the time in the morning and 79.20% of the time in the afternoon.

Table 4.3 Helicopter approach and departure wind directions

Wind Direction	Approach	Departure
Northern wind	Headwind	Tailwind
North-eastern wind	Crosswind	
Eastern wind	Tailwind	Headwind
South-eastern wind	Tailwind	Headwind
Southern wind	Tailwind	Headwind
South-western wind	Crosswind	
Western wind	Headwind	Tailwind
North-western wind	Headwind	Tailwind

Table 4.4 Wind condition related to helicopter approach availability (AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	29.55%	0.00%
10 - 20km/h	32.65%	0.00%
20 - 30km/h	8.85%	17.55%
30 - 40km/h	3.85%	3.70%
> 40km/h	2.90%	0.95%
Total	**77.80%**	**22.20%**

Table 4.5 Wind condition related to helicopter departure availability (AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	29.55%	0.00%
10 - 20km/h	32.65%	0.00%
20 - 30km/h	14.30%	12.10%
30 - 40km/h	3.05%	4.50%
> 40km/h	0.80%	3.05%
Total	**80.35%**	**19.65%**

Table 4.6 Wind condition related to helicopter approach availability (AM only)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	41.70%	0.00%
10 - 20km/h	32.40%	0.00%
20 - 30km/h	10.20%	8.10%
30 - 40km/h	3.40%	1.50%
> 40km/h	2.10%	0.60%
Total	**89.80%**	**10.20%**

Table 4.7 Wind condition related to helicopter approach availability (PM only)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	17.40%	0.00%
10 - 20km/h	32.90%	0.00%
20 - 30km/h	7.50%	27.00%
30 - 40km/h	4.30%	5.90%
> 40km/h	3.70%	1.30%
Total	**65.80%**	**34.20%**

Table 4.8 Wind condition related to helicopter departure availability (AM only)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	41.70%	0.00%
10 - 20km/h	32.40%	0.00%
20 - 30km/h	5.70%	12.60%
30 - 40km/h	1.20%	3.70%
> 40km/h	0.50%	2.20%
Total	**81.50%**	**18.50%**

Table 4.9 Wind condition related to helicopter departure availability (PM only)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	17.40%	0.00%
10 - 20km/h	32.90%	0.00%
20 - 30km/h	22.90%	11.60%
30 - 40km/h	4.90%	5.30%
> 40km/h	1.10%	3.90%
Total	**79.20%**	**20.80%**

4.4 Beaufort Wind Force Scale

The Beaufort Wind Force Scale is a system for estimating wind strengths without the use of instruments, based on the effects wind has on the physical environment. The behaviour of smoke, waves, trees, etc., is rated on a 13 point scale of 0 (calm) to 12 (hurricane), as shown in Table 4.10.

The Beaufort Scale is a system utilised for estimating wind strengths without instrument testing based on the wind effect on the physical environment and has been utilised to assess the potential impacts on sailing during helicopter movements in Section 5.4.

Table 4.10 Beaufort Wind Force Scale

Beaufort Scale Force	Wind Speed (kt)	Wind Speed (km/h)	Description
Force 0	0 - 1	0 - 1	Calm, height 0.0m, at sea no waves – glassy like appearance of sea
Force 1	1 - 3	2 - 6	Light airs, height 0m, at sea wind makes glassy ripples on water
Force 2	4 - 6	7 - 11	Light breeze, height 0.1m, at sea smooth wavelets
Force 3	7 - 10	13 - 19	Gentle breeze, height 0.4m slight, at sea slight waves no white horses
Force 4	11 - 16	20 - 30	Moderate breeze, height 1m – slight to moderate, at sea waves described as with occasional white horses On land raises dust and loose paper; small branches are moved
Force 5	17 - 21	31 - 39	Fresh breeze, height 2m, moderate, at sea consistent white horses
Force 6	22 - 27	40 - 50	Strong breeze, height 3m, rough, at sea large waves start to form, more extensive white foam crests, some blown spray
Force 7	28 - 33	51 - 61	Moderate (near) gale, height 4m, rough to very rough, at sea waves begin to heap up and streaks begin to appear down the waves On land whole trees in motion; inconvenience in walking against wind
Force 8	34 - 40	62 - 74	Fresh gale, height 5.5m, very rough to high, at sea waves get longer – crests break into spindrift and the streaks become more pronounced
Force 9	41 - 47	75 - 88	Strong or severe gale, height 7m, high, at sea high waves and dense streaks of foam may begin to affect visibility On land slight structural damage occurs; chimney pots and slates removed
Force 10	48 - 55	89 - 102	Whole gale or storm, height 9m, very high, at sea very high waves with overhanging crests, lots of spray makes the sea almost white, visibility seriously affected
Force 11	56 - 63	103 - 117	Violent storm, height 11m, very high, at sea exceptionally high waves and a complete coverage of long white foam patches. All crests blown into froth
Force 12	64+	118+	Hurricane, height 14m, plus phenomenal, at sea the air is completely filled with driving spray, visibility extremely difficult. On land devastation occurs

4.5 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 pontoon and surrounding marina:

- 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. An overview of the impact of different wind directions on the helipad pontoon and surrounding marina is shown in sectors (where green is positive, yellow is neutral, and red is negative) in Figure 4.1.

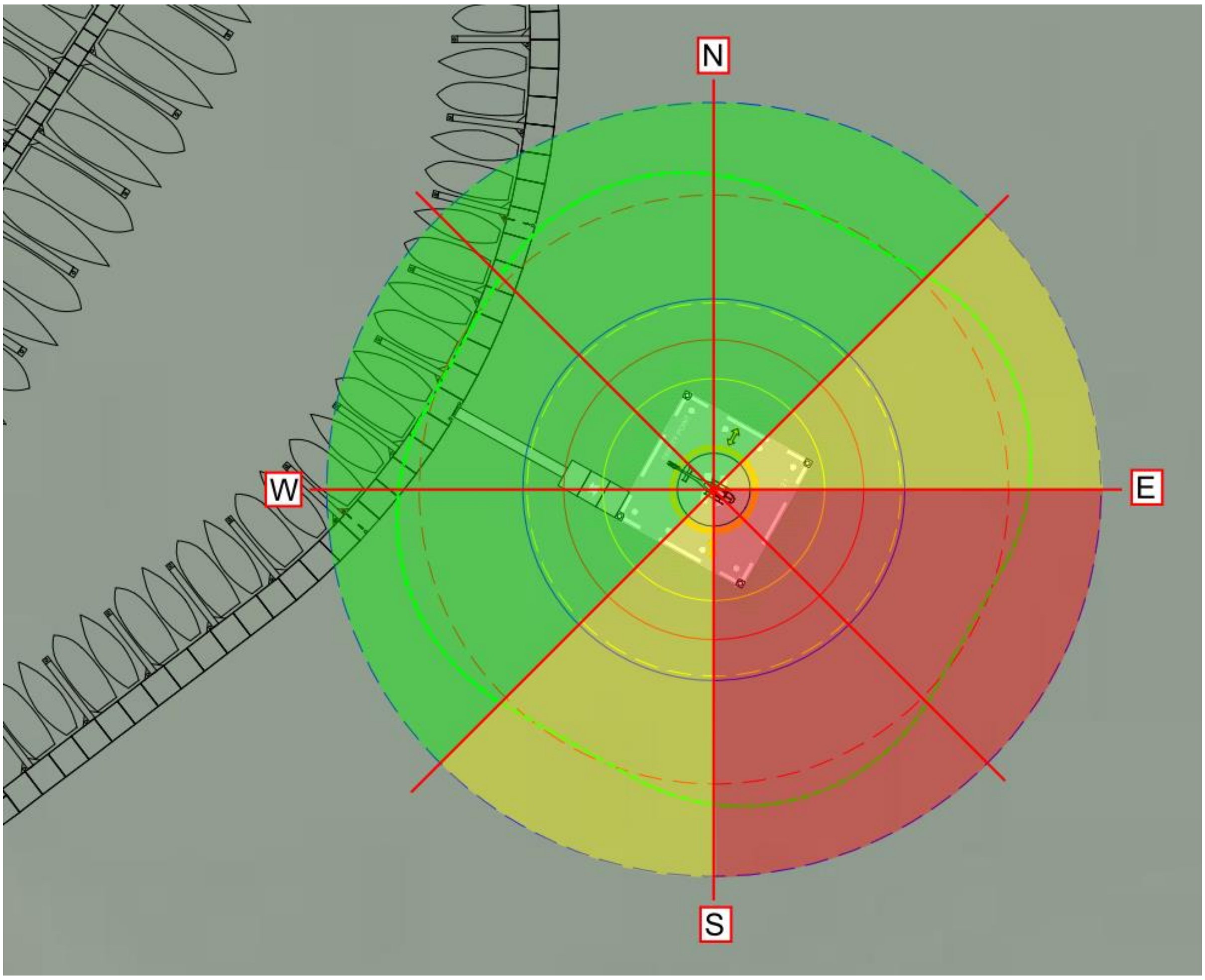


Figure 4.1 Impact of wind direction on helicopter downwash

An overview of the overall wind impacts is provided in Table 4.11 with further detail provided in Appendix D.

Table 4.11 Overall wind impacts (average of AM + PM)

Wind Speed Ranges	Positive Impact	Neutral Impact	Negative Impact
< 10km/h	11.35%	12.95%	5.25%
10 - 20km/h	13.20%	5.25%	14.20%
20 - 30km/h	8.85%	3.25%	14.30%
30 - 40km/h	3.85%	0.65%	3.05%
> 40km/h	2.90%	0.15%	0.80%
Total	**40.15%**	**22.25%**	**37.60%**

The overall wind analysis indicates that for 62.40% of the day helicopter downwash would not be exacerbated by prevailing wind conditions (i.e. 37.60% of the day the wind has a negative impact on helicopter movements).

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
Watercraft	Yachts, boats or other marine vessels being impacted by rotor downwash or helicopters unable to approach or depart the helipad due to obstruction.	Experienced pilots only will be allowed to utilise the helipad on a prior permission basis. Pilots will avoid marine craft utilising fly neighbourly principles, and avoid impact vessels with rotor downwash.
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. It is assumed that dust/sand will not be present on the deck and this should not be an issue. Any maintenance equipment including spanners and hand tools will not become FOD in the 60-80km/hr downwash velocity zone.

JJR have prepared a list of relevant water craft based on information provided by MPASC which is summarised in Table 5.3. This includes various water craft types and wind speed limits for racing and amateur sailing to identify the potential for downwash to impact any sailing operations during helicopter movements. The wind speed limits for racing and amateur sailing have been estimated based on the expert opinion of JJR staff with extensive sailing experience. The wind speed limits have been utilised to quantify reasonable thresholds for downwash impacts on MPASC sailing operations.

Table 5.2 Recommended maximum wind velocities

Wind Velocity Exposure Type	Recommended Maximum Wind Velocity (km/h)
Water craft activity	Refer to Table 5.3 **
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
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, except for water craft*

Table 5.3 Types of water craft (MPASC)

Craft Type	Class	Mast Height (m)	Wind Speed Limit for Racing (kt / km/h)	Wind Speed Limit for Amateur Sailing (kt / km/h)	Wind Speed Limit for Beginner (kt / km/h)
Junior monohull	International Optimist Dinghy	2.26m (excluding sprit)	25kt / 46km/h	10-15 kt / 19-28km/h	10kt / 19km/h
Monohull	Pacer	5.8m	25kt / 46km/h	10-20 kt / 19-37km/h	10kt / 19km/h
Catamaran	Hobie 16	8.1m	20-25 kt / 37-46km/h	N/A (not a boat typically used for learning to sail)	
Yacht	Jeanneau 379	16.8m	30-40kt / 56-74km/h	N/A (not a boat typically used for learning to sail)	

It is noted that additional watercraft such as small fishing boats, jet skis and kayaks may occupy the lake during helicopter operations. These additional watercraft types are not specifically discussed in Table 5.3 because they are less sensitive to helicopter downwash than sailing boats.

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.

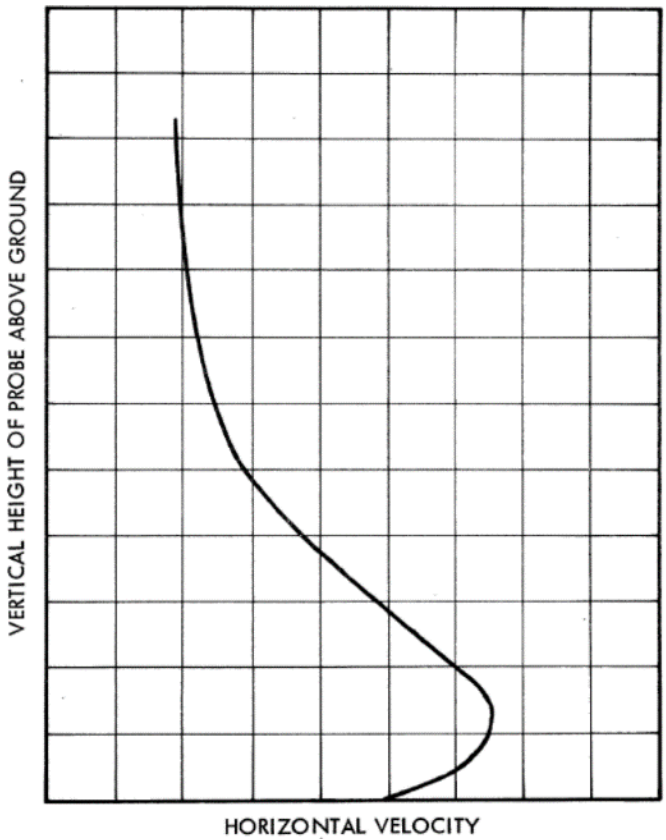


Figure 5.1 Downwash velocity vs probe height

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. JJR were provided with wind speed data in the absence of wind rosettes that have been utilised to inform site specific downwash velocity calculations and the subsequent rotor downwash assessment.

5.3 Proposed Helicopter Model Data

The helicopters proposed to likely utilise the helicopter landing site at Trinity Point 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 5.4 Proposed helicopter data

Model	Rotor Diameter (m)	Disc Area (m^2)	Max Mass (kg)	Max Downwash Velocity (km/h)	
				Theoretical	Empirical
Bell 407	10.67	89.42	2,381	111.52	116.23
Bell 206B	10.16	81.07	1,451	91.43	87.87
Bell 206L	11.28	99.93	2,018	97.11	95.44
Airbus H125	10.70	89.92	2,250	108.10	106.24
Airbus 120	10.00	78.54	1,715	100.99	99.25
Airbus 130	10.69	89.75	2,500	114.06	118.88
MD500E	8.10	51.53	1,361	111.06	109.15
AS355F	10.69	89.75	2,540	114.97	119.83
Airbus 135	10.20	81.71	2,835	127.29	135.24
Agusta AW109	11.00	95.03	2,850	118.35	125.74

Four (4) 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;
- Main public areas where the public are expected to congregate should not be located within areas where downwash velocities are predicted to exceed 60km/h; and
- Watercraft where maritime / sailing etc. activity may be undertaken within the vicinity of the helipad should not be occur in areas where the downwash is expected to exceed 20km/hr.

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 marina.

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 5.5.

Table 5.5 Helicopter rotor hub distances

Model	Maximum Downwash Velocity Radii (m)		
	100km/h	**80km/h**	**60km/h**
Bell 407	16.35	23.38	27.33
Bell 206B	-*	10.49	23.31
Bell 206L	14.66	19.83	25.27
Airbus H125	16.31	22.08	28.13
Airbus 120	15.24	20.62	26.28
Airbus 130	16.72	23.91	27.95
MD500E	16.76	22.68	28.90
AS355F	16.85	24.11	28.18
Airbus 135	26.94	29.09	39.70
Agusta AW109	25.05	27.04	36.91

**Note: "-" indicates the downwash velocity does not exceed 100km/h*

The impacts of helicopter downwash on sailing operations or watercraft more generally during take-off and approach are assessed utilising additional data which provides helicopter rotor side-wash for a variety of configurations of rotor diameter and helicopter mass including helicopter ground speed and rotor height above ground, as well as accounting for greater helicopter ground speeds.

The two helicopters with the greatest rotor disc loading are the Airbus 135 and the Agusta AW109 which have rotor diameters of 10.2m and 11.0m respectively and a maximum weight of 2,835kg and 2,850kg respectively.

An overview of the helicopter downwash velocities with a mass between 2,000kg and 3,000kg with a rotor span between 10m and 11m is provided in Figure 5.2.

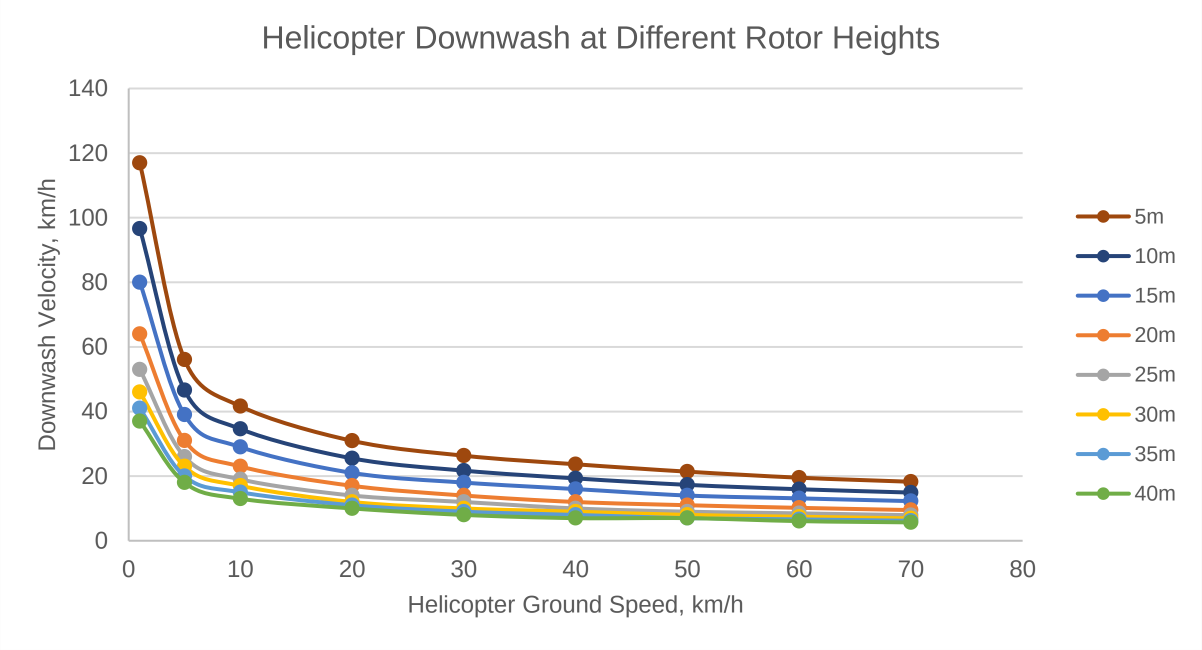


Figure 5.2 Helicopter downwash velocity at different rotor heights

5.4 Downwash Assessment

5.4.1 Helipad Touchdown, Lift-off & Hover (Close Vicinity)

The impact of helicopter downwash was first assessed at the location of the proposed helipad pontoon during hover conditions.

The helicopter take-off manoeuvres have been based on the Airbus 135 (formerly known as the Eurocopter 135) as this helicopter has the highest maximum rotor disc loading of the typical aircraft and is therefore a conservative method of modelling the various helicopter models. It should be noted that this helicopter has been replaced by the AS355F. The Airbus 135 has been utilised to develop a conservative (worst-case) helicopter downwash model, noting that the next most-critical aircraft based on rotor disk loading is the Agusta AW109 helicopter.

A minimum safety area of radius 30m from the edge of the helipad has been developed for calm conditions with a maximum safety area of radius of 66.5m for worst-case wind conditions as shown in Figure 5.3.

It is noted that the concept design details a bollard and chain with flashing light which are located at the edge of the minimum safety area. The bollard and chain ensure personnel on the marina walkway are not exposed to a downwash velocity greater than 60km/h in calm wind conditions and not exposed to combined downwash and wind velocity greater than 80km/h in worst-case wind conditions (noting that it is unlikely that the general public would be in this area during high wind conditions).

The impact of a potential 41km/h south-westerly wind has been considered to identify the extent of downwash impacts during the worst-case prevailing wind conditions. The extent of the 60km/h downwash envelope for the Airbus 135 considering the prevailing wind condition is provided in Figure 5.4.

This indicates that in the worst-case scenario the 60km/h downwash envelope would potentially affect approximately 15-16 marina berths. Therefore, people should not be above deck on those boats during wind conditions and for the worst-case helicopter type. This restriction would not be required during wind conditions that decrease downwash within the marina, nor in calm conditions.

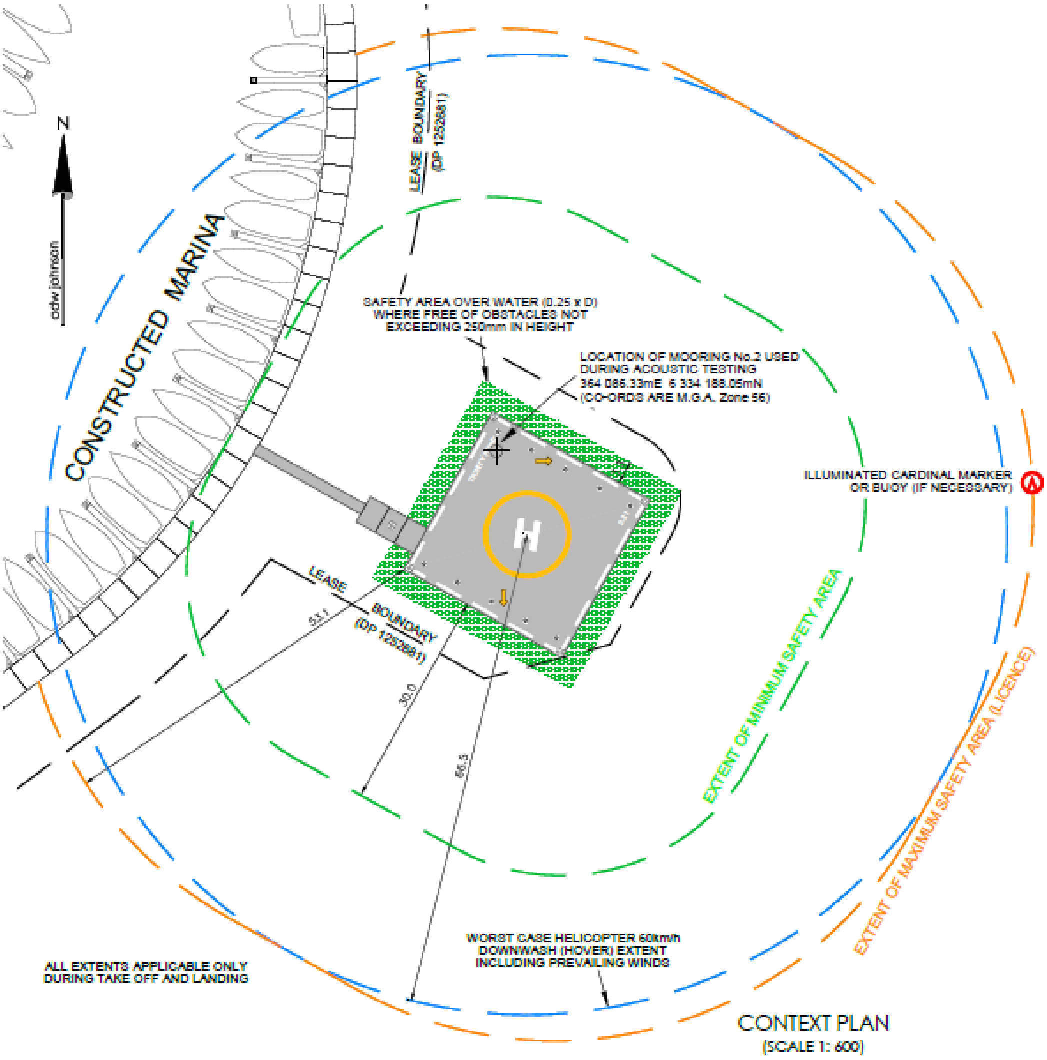


Figure 5.3 Helipad downwash area on take-off and landing

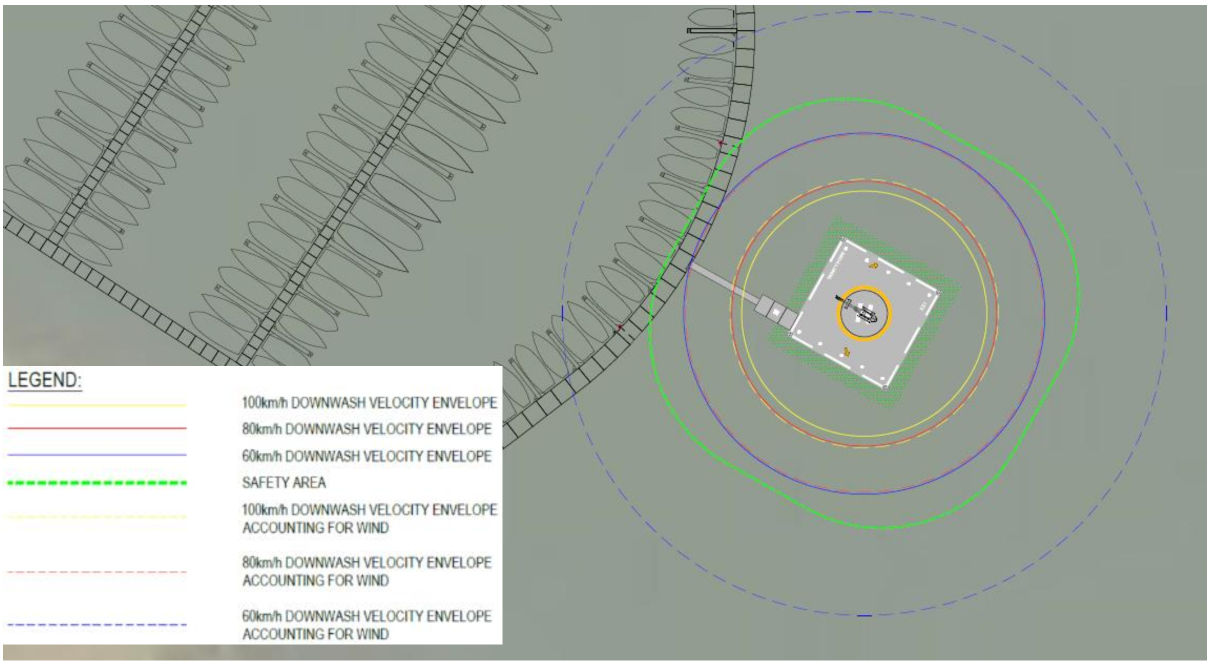


Figure 5.4 Helipad downwash extent including prevailing wind conditions (Airbus 135)

The 80km/h downwash envelope covers approximately the same extent as the 60km/h downwash envelope excluding wind, noting that the 80km/h wind speed is still considered safe for personnel working near an aeroplane or helicopter in this instance. The 80km/hr downwash envelopes (with and without wind) are clear of the marina berths and therefore and therefore additional FOD management is not required for vessels moored within the marina.

To ensure that personnel walking along the gangway whilst a helicopter is operating on the helipad are not exposed to excessive downwash, and so that moored vessels are protected, it is recommended that:

- The 60-80km/hr zone (between dashed blue and dashed red circumference) is clear of general public during helicopter departure and approach procedures;
- There are no restrictions outside of the 60km/hr zones (i.e. outside of the dash blue circumference);
- The area of “no access for public” should conservatively be moved to the edge of the 60km/hr contour (dashed blue circumference);
- Operational procedures are put in place to ensure that people are not exposed to the downwash on their yachts while helicopter approach/departures occur; and
- The area with downwash greater than 80km/hr is kept free of potential foreign object debris (FOD).

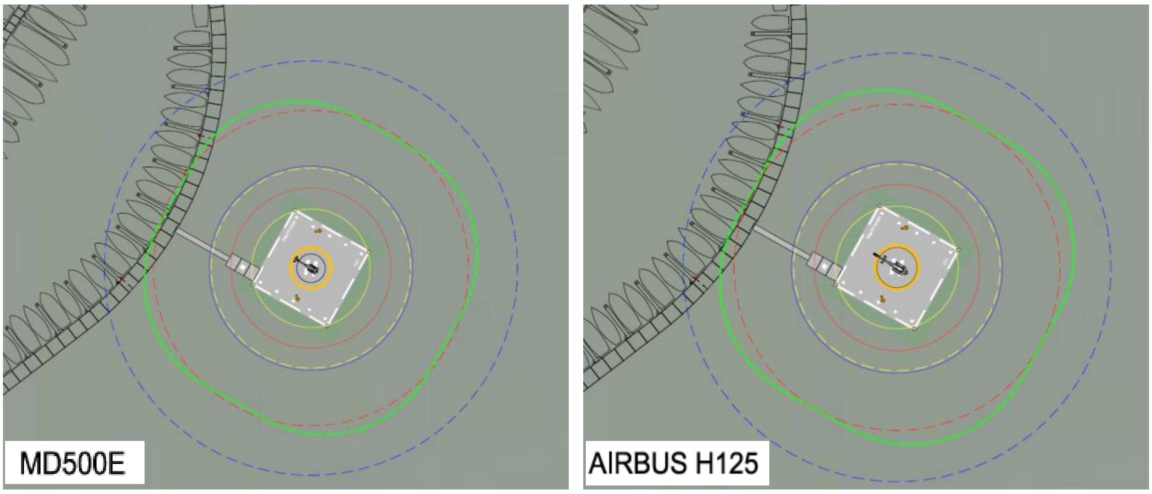


Figure 5.5 Helipad downwash extent including prevailing wind conditions (Airbus 135)

Note that this area could be further reduced by changing the design helicopter (the current modelling is conservatively based on the Airbus 135). For example, based on the modelled helicopters, the Bell 206L has the least impact (refer to the contours in Figure 5.6, which impacts only 7-9 marina berths).

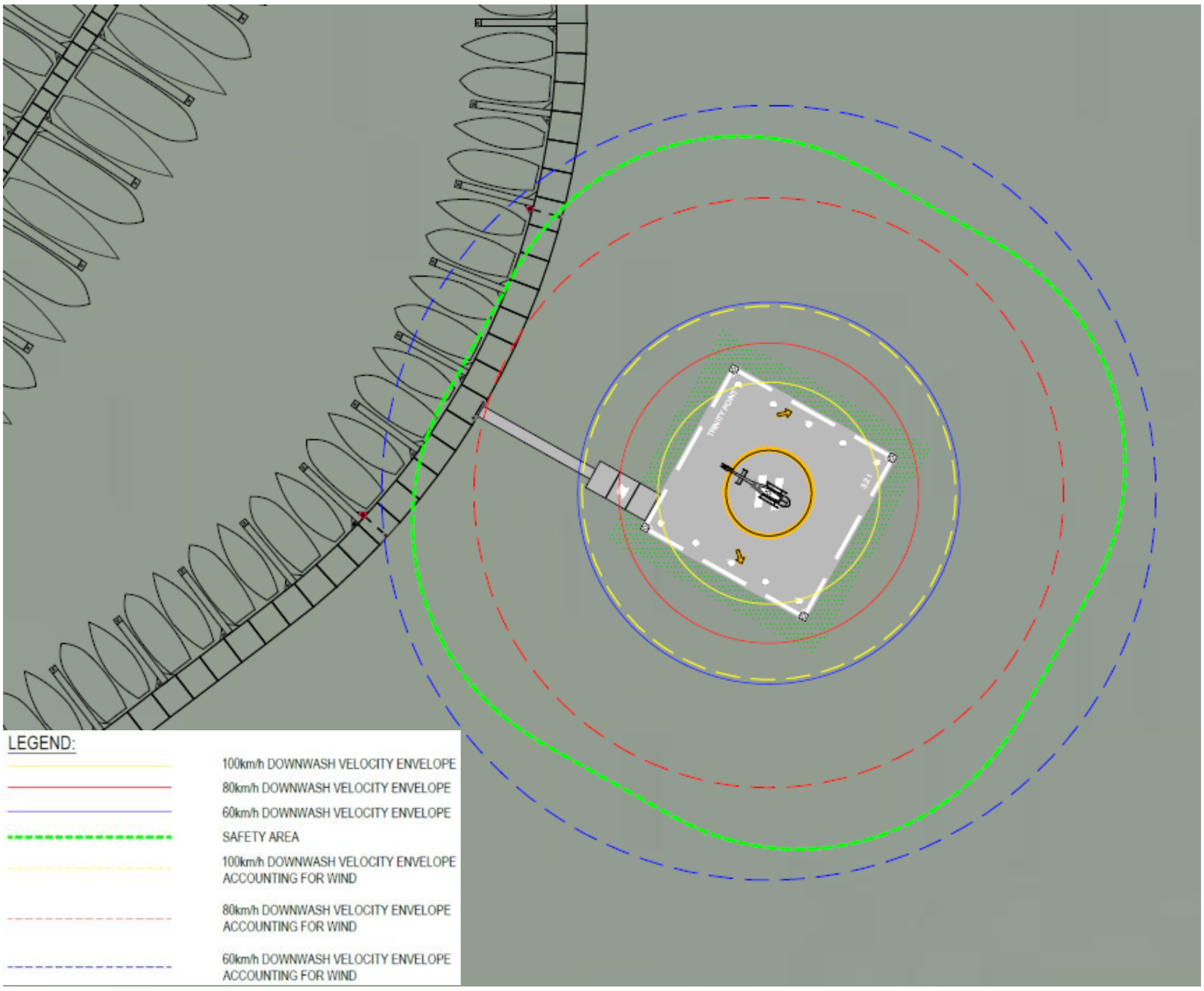


Figure 5.6 Helipad downwash extent including prevailing wind conditions (Bell 206L)

It should be noted that other prevailing wind directions, especially any northerly winds, may reduce the helicopter downwash velocity impacts on the marina.

The contours incorporate a 46km/hr windspeed (based on the wind speed data previously assessed by others based on the Norah Head Lighthouse station), which could potentially be reduced to less than 40km/hr based on a 99th percentile windspeed based on RAAF Williamtown station data analysis.

The extent of helicopter downwash shown in Figure 5.4 is based on the Airbus 135 (previously considered the most-critical helicopter), although it should be noted that helicopters with lower downwash velocities will be more commonly used and will therefore result in a lower downwash impact on the marina. Downwash envelope drawings for each helicopter type are provided in Appendix B.

5.4.2 Take-off & Landing (Wider Vicinity)

The distance of the extent of the 80km/h, 60km/h and 20km/h downwash wind velocities from the helipad were calculated from the above chart based on the downwash velocity data for different rotor heights and ground speeds provided in Figure 5.2.

The downwash velocity reduces below 80km/h for ground speeds above 2.5km/h at a height of 3.96m (i.e. 13ft) above ground. This indicates that the helicopter flight path is safe for operating in minor public areas where people are not expected to congregate provided the helicopter has a ground speed of more than 2.5km/h.

The downwash velocity reduces below 60km/h for ground speeds of at least 5km/h with a height of 3.96m (i.e. 13ft) above ground. This indicates that the helicopter flight path is safe for operating near passengers and main public areas where passengers have to walk and are expected to congregate provided the helicopter has a ground speed of at least 5km/h.

The distance of the extent of the 80km/h and 60km/h downwash wind velocities from the helipad therefore occur at the edge of the helipad almost instantaneously as soon as the helicopter generates a ground speed of 2.5km/h and 5km/h respectively.

The downwash velocity reduces below 20km/h for ground speeds of at least 65km/h with a height of 6.7m (i.e. 22ft) above ground. This indicates that the helicopter flight path is safe for operating near watercraft where the helicopter is 37.6m from the helipad.

It should be noted that the maximum downwash velocity generated at a distance of 75m from the helipad is 16.8km/h.

5.4.3 General Sailing Area

MPASC has raised concerns over the proposed helipad pontoon development at Trinity Point. It is understood that MPASC's primary concern is the height of the helicopters on their approach or departure path across Lake Macquarie and the associated downwash velocity that may affect small sailing craft. MPASC host several sailing regattas throughout the season (including over consecutive days) with fleets of up to 50 boats. A typical sailing season would host up to seven (7) regattas at various times of the season.

The helicopter heights above ground at the edge of the sailing area for the example helicopter flight paths are based on a conservative 10% slope. This slope has been assessed against the approximate sailing area outlined by MPASC which is shown in Figure 5.7 (extent of sailing area shown in yellow).

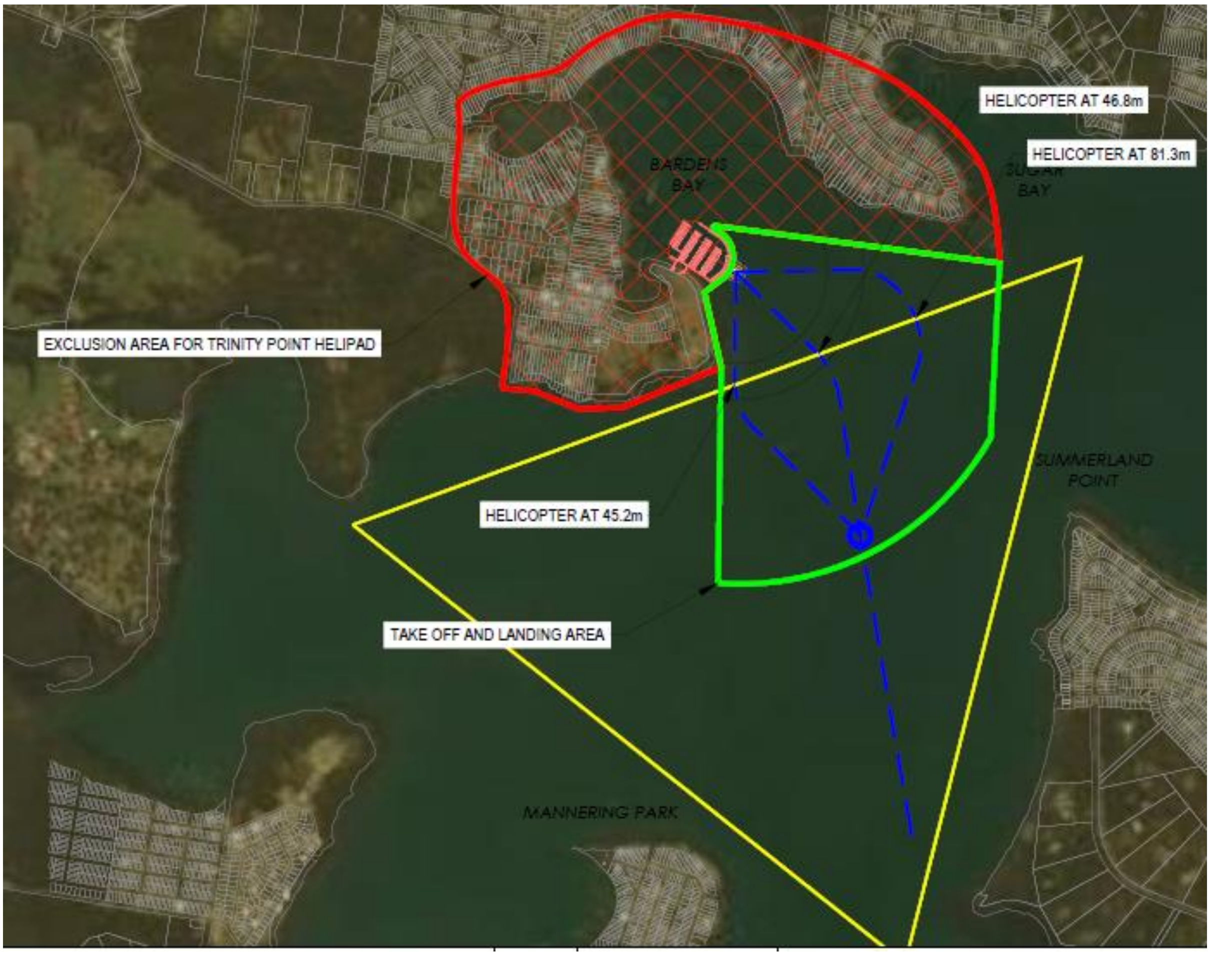


Figure 5.7 MPASC Lake Macquarie sailing area

The sailing area commences approximately 366m south of the centre of the helipad pontoon. The following height information has been utilised to calculate the approximate helicopter rotor height at the edge of the sailing area:

- Pontoon has a freeboard height of 0.7m (i.e. 0.7m above water level);
- The Airbus 135 (generally the critical helicopter) has a rotor height of 3.35m above ground (or pontoon/surface); and
- Helicopters shall hover to a height of 1.5m above ground (or pontoon) prior to departure.

Therefore, the most critical example flight path results in a helicopter rotor disc height above the water of approximately 45.2m at the edge of MPASC's sailing area. The equivalent ground speed of the helicopter would be 74km/h (40kt) based on the helicopter operations manual provided, which indicates the worst-case downwash velocity at the edge of the MPASC sailing area is approximately 6km/h. This downwash velocity would occur approximately 0.1m to 0.5m above the water level.

A downwash velocity of 6km/h is classified by the Beaufort Scale (provided in Table 4.10) as a Force 1 wind resulting in light airs with no wave generation except for glassy ripples on the water surface. This indicates that the impacts of helicopter downwash are not anticipated to significantly impact sailing operations.

It should be noted that the downwash velocity of 6km/h is not significant compared to the expected wind speed sailing limits outlined above as well as any prevailing wind conditions that may reach up to 45km/h.

The flight paths involved maximum performance take-offs, which have an overall flight slope grade of between 10% and 35%. A conservative assessment based on an assumed 10% slope has been undertaken, as well as for an assumed performance slope of 30%.

The outcomes of the maximum performance take-off downwash assessment are provided below:

- Similar to a normal take-off procedure, the downwash wind velocities drop below 80km/h and 60km/h almost instantaneously as soon as the helicopter generates groundspeed for the 10% and 30% flight path slope;
- For the assumed 10% take-off slope: The downwash velocity reduces below 20km/h for ground speeds of at least 60km/h with a height of 5m (i.e. 16ft) above ground. This indicates that the helicopter flight path is safe for operating near watercraft where the helicopter is 50m from the helipad; and
- For the assumed 30% take-off slope: The downwash velocity reduces below 20km/h for ground speeds of at least 45km/h with a height of 9m (i.e. 30ft) above ground. This indicates that the helicopter flight path is safe for operating near watercraft where the helicopter is 30m from the helipad.

5.4.4 Additional Take-off Manoeuvre Considerations

The assessment of the impact of helicopter downwash based on the normal and maximum performance take-offs were developed assuming the helicopter is overflying a watercraft. In reality, helicopter pilots will seek to avoid overflying watercraft during take-off (and approach) to further minimise any potential downwash impacts.

Operational measures could be implemented to ensure that pilots visually assess the locations and routes for boat users and complete all helicopter movements clear of boats and other objects.

5.5 Naval Impact of Downwash

Wind is a major factor affecting the design of small craft harbours as it generates waves and loading (pressure) on the berthed craft and associated structures.

PIANC is the World Association for Waterborne Transport Infrastructure and provides recommendations for acceptable wave criteria for small craft and pleasure boats in RecCom WG Report No. 149 – Guidelines for Marina Design which has been reproduced in Table 5.6.

These recommendations are based on providing safe berthing conditions as well as comfortable mooring with minimal vessel motions.

The JPG concept helipad plans indicate the moorings cater for water craft of approximately 12m in length and have subsequently been in Table 5.6.

Table 5.6 Wave height impacts

Vessel Length (m)	Beam / Quartering Seas		Head Seas	
	Period (s)	Height, H_s (m)	Period (s)	Height, H_s (m)
4-10	< 2.0	0.20	< 2.5	0.20
	2.0 - 4.0	0.10	2.5 - 4.0	0.15
	> 4.0	0.15	> 4.0	0.20
10-16	**< 3.0**	**0.25**	**< 3.5**	**0.30**
	3.0 - 5.0	**0.15**	**3.5 - 5.5**	**0.20**
	> 5.0	**0.20**	**> 5.5**	**0.30**
> 16	< 4.0	0.30	< 4.5	0.30
	4.0 - 6.0	0.15	4.5 - 7.0	0.25
	> 6.0	0.25	> 7.0	0.30

The generation of waves in bodies of water due to wind is dependent on four (4) criteria as follows:

- Wind speed;
- Fetch (length of water over which a wind event blows);
- Water depth; and
- Duration of wind event.

The resultant wave height from helicopter downwash cannot be accurately modelled due to the following:

- Existing models have been developed for assessing effects of meteorological events on wave generation (not generation of waves due to mechanical sources such as helicopters);
- The fetch is significantly lower (i.e. less than 100m) for helicopter downwash than is typically modelled (i.e. several kilometres); and
- Duration of wind is also significantly shorter than typical meteorological events that wave generation models are dependent on (i.e. the water surface is only exposed to the downwash for a short duration).

However, review of charts and equations relating wind speed, fetch and duration indicate that the helicopter downwash would not result in the generation of waves of more than 0.2m in height.

The helicopter downwash velocity is not expected to generate significant wave height to impact the surrounding marina. The downwash wind fetch is insignificant and would not allow for the generation of a wave height that would exceed the indicative acceptable wave heights outlined above.

5.6 Watercraft Movements in the Vicinity of the Helipad

A Recreational Boating Study on Lake Macquarie was undertaken on 19 April 2014 to assess boat ramps, maritime mooring areas and vessel movements and locations throughout the southern end of Lake Macquarie. The Study examined and assessed the impact on the waterway from water users including identification of usage patterns in the study area, any significant incidents and the volume of vessel traffic during the boating season (October to April).

Nearmap data was utilised to determine the number of watercraft in the vicinity of the proposed development at Trinity Point between 20 March 2010 and 3 June 2014. The data indicated that there is on average only one (1) watercraft in the vicinity of Trinity Point. An overview of the watercraft recorded in Bardens Bay is provided in Figure 5.8.

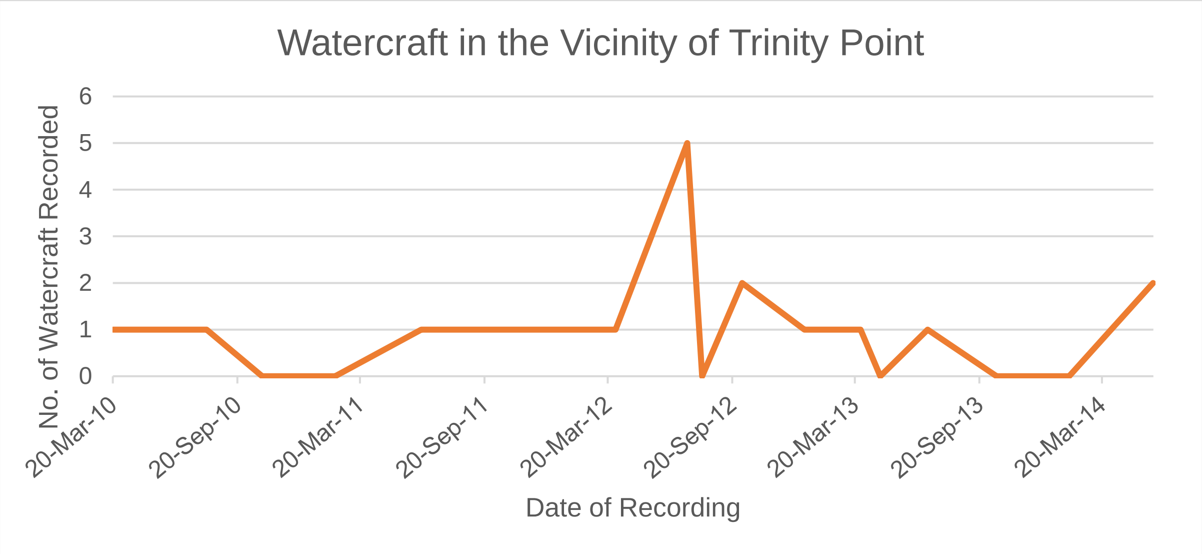


Figure 5.8 Watercraft in the vicinity of Trinity Point

The Trinity Point Marina Recreational Boating Study identified that the southern area of Lake Macquarie is not significantly utilised and there have been no significant environmental or vessel incidents. NSW Maritime Offices noted throughout the boating seasons that the waterway was not congested, was lightly used and to their knowledge there have been no significant incidents or pollution issues.

JJR have supplemented the Recreational Boating Study with additional Google Earth screenshots that show the number and distribution of vessels in the vicinity of the helipad. The historical imagery is consistent with the previous Nearmap information as minimal watercraft users were identified in Bardens Bay. There are several vessels moored north of the marina, although typically no vessels appear to be in the vicinity of the Trinity Point marina.

The Google Earth screenshots of Bardens Bay are provided in chronological order in Figure 5.9 to Figure 5.12.

The demonstrated vessel usage of Southern Lake Macquarie does not show any significant usage pattern or vessel numbers which would restrict the community from accessing or utilising the waterway. This indicates that the minimal helicopter movements proposed (maximum of 6 movements per day) should be able to navigate within the proposed flight area without overflying any boat users and therefore further limiting any downwash impacts.

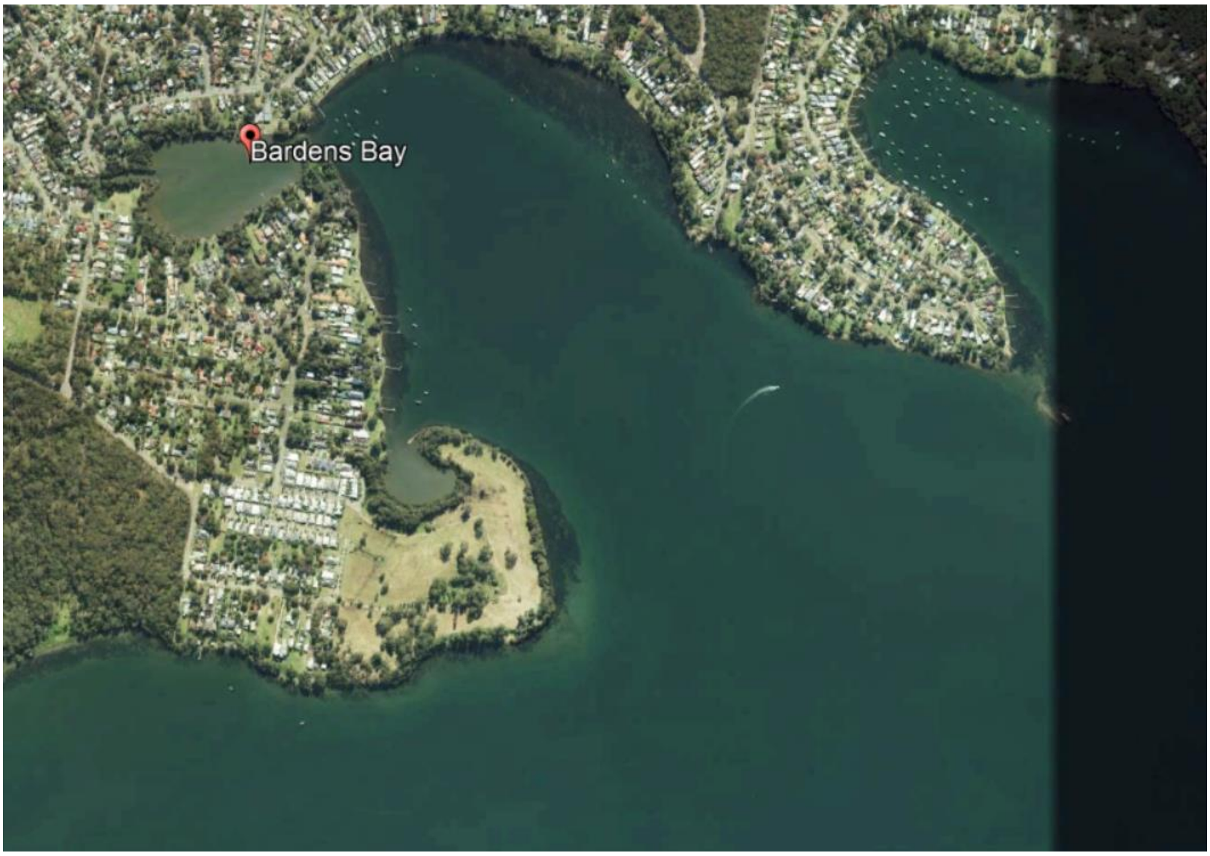


Figure 5.9 Vessels in Lake Macquarie near Trinity Point (31/03/2015)

Figure 5.10 Vessels in Lake Macquarie near Trinity Point (04/09/2016)

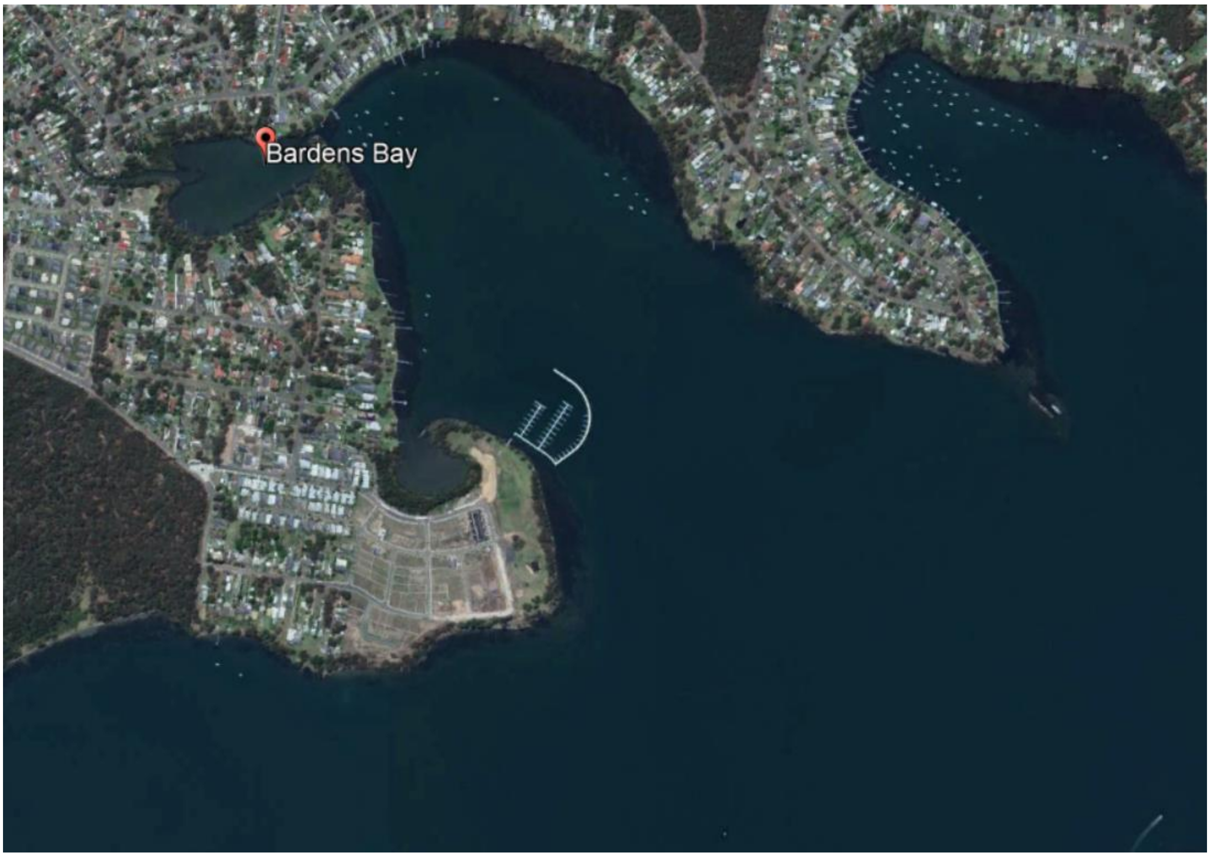


Figure 5.11 Vessels in Lake Macquarie near Trinity Point (24/10/2017)

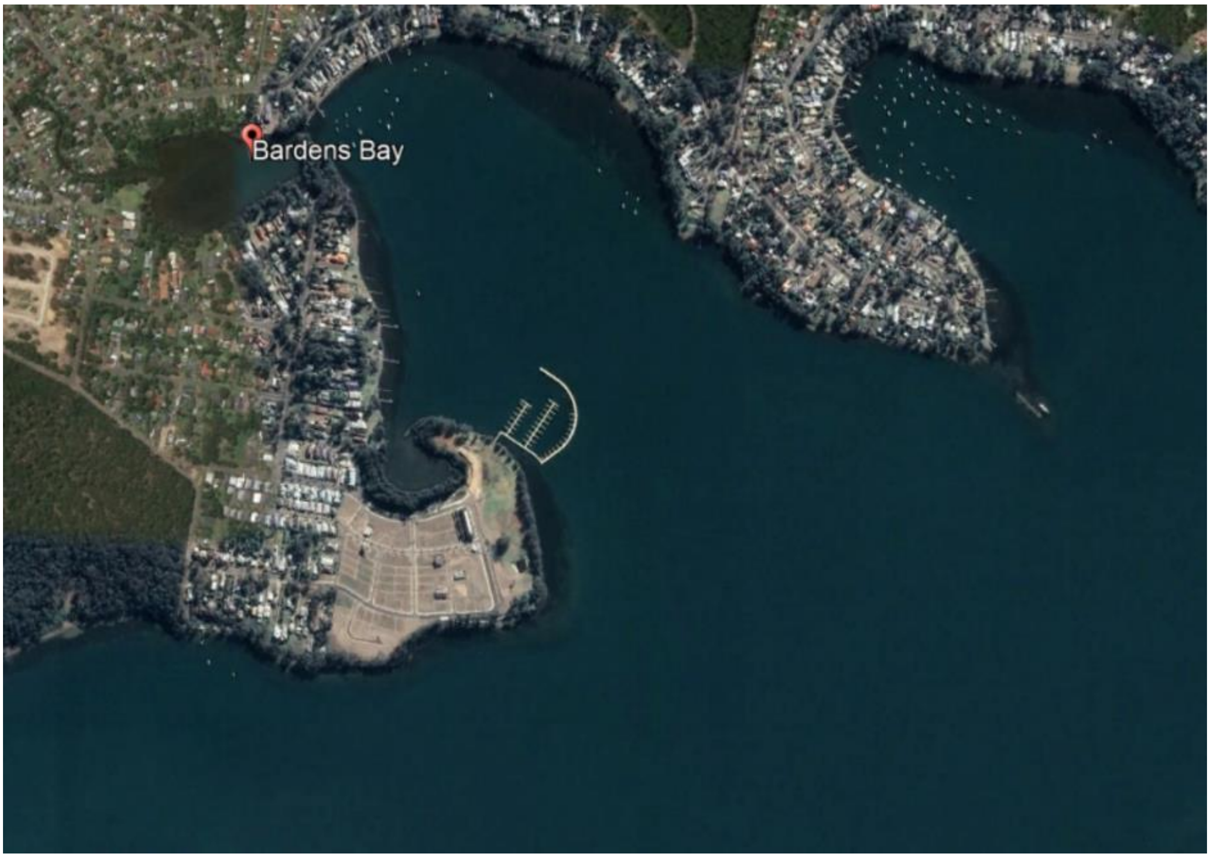


Figure 5.12 Vessels in Lake Macquarie near Trinity Point (01/08/2018)

6 Risk Assessment

CAAP 92-2(2) states that because of the developmental and 'basic' nature of a Helicopter Landing Site (HLS), CASA recommends that helicopter operators carry out thorough risk and hazard assessments for the proposed operation and apply appropriate controls to any hazards identified during this process. A detailed risk assessment on operational hazards including helicopter downwash has been undertaken to determine hazards that require further controls to mitigate risk.

6.1 Risk Criteria

The framework adopted for the risk assessment has been based on AS/NZS ISO 31000:2009 to ensure that information about risk derived from risk management processes are adequately reported and used as a basis for decision making and accountability. Risks that have been identified have been assessed utilising the following risk categories which are based on the Australian Transport Safety Bureau (ATSB) occurrence type taxonomy:

- Airspace;
- Consequential events;
- Environment;
- Infrastructure;
- Operational;
- Technical; and
- Other.

The risks were then assessed for the following, as outlined in Table 6.1 to Table 6.7:

- Risk likelihood ratings;
- Risk consequence ratings;
- Inherent risk rating;
- Risk level descriptions and tolerance;
- Effectiveness of Controls;
- Residual Likelihood based on control effectiveness; and
- Residual Consequence based on control effectiveness.

Table 6.1 Risk likelihood ratings

Likelihood of Risk Materialising	Probability	Definition
Almost Certain	**> 80%**	Expected to occur in most circumstances or occurs regularly
Likely	**40% - 80%**	Will probably occur
Possible	**10% - 40%**	May occur at some time
Unlikely	**2.5% - 10%**	Could occur at some time
Rare	**< 2.5%**	Will only occur in exceptional circumstances

Table 6.2 Risk consequence ratings

Consequence	Impact ($)	Definition
Catastrophic	**> $2.5M**	Equipment or system destroyed, wilful violation of safety regulations that results in serious injury or death
Major	**$500k - $2.5M**	Major equipment or system damaged
Moderate	**$250k - $500k**	Accident or incident with minor injury and/or minor aircraft damage
Minor	**$50k - $250k**	Minor incident resulting in slight to no damage to equipment or aircraft
Negligible	**< $50k**	Little consequence on operational safety

Table 6.3 Inherent risk rating

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	Medium	High	High	Extreme	Extreme
Likely	Low	Medium	High	Extreme	Extreme
Possible	Low	Medium	Medium	High	Extreme
Unlikely	Low	Low	Medium	High	High
Rare	Low	Low	Low	Medium	High

Table 6.4 Risk level descriptions and tolerance

Risk Level	Description
Extreme	Requires immediate action where a fatality, major environment event or major loss of plant may occur. Detailed research, risk identification and control measures to be investigated with a detailed action plan to mitigate risk.
High	Significant risks require timely attention so appropriate controls can be implemented.
Medium	Monitor response procedures.
Low	Manage by routine procedures.

Table 6.5 Effectiveness of Controls

Control Effectiveness	Description	Reduction Value
Damaging	Control(s) in place actually increase the risk	-10%
None	No controls in place	0%
Deficient	Controls applied are not adequate for the job	10%
Marginal	Controls applied go part of the way to reduce the risk or impact	30%
Qualified	Controls applied go a reasonable way to reduce the risk or impact	50%
Effective	Controls applied reduce the risk of impact sufficiently or significantly	70%
Excessive	Controls applied are more than necessary to reduce the risk or impact. Potentially over controlled	90%

Table 6.6 Residual Likelihood based on control effectiveness

Effectiveness of Preventive Controls	Inherent Likelihood Rating				
	Almost Certain	Likely	Possible	Unlikely	Rare
Damaging	Almost Certain	Likely	Possible	Unlikely	Rare
None	Almost Certain	Likely	Possible	Unlikely	Rare
Deficient	Almost Certain	Likely	Possible	Unlikely	Rare
Marginal	Likely	Possible	Unlikely	Unlikely	Rare
Qualified	Possible	Unlikely	Unlikely	Rare	Rare
Effective	Unlikely	Unlikely	Rare	Rare	Rare
Excessive	Rare	Rare	Rare	Rare	Rare

Table 6.7 Residual Consequence based on control effectiveness

Effectiveness of Corrective Controls	Inherent Consequence Rating				
	Negligible	**Minor**	**Moderate**	**Major**	**Catastrophic**
Damaging	Negligible	Minor	Moderate	Major	Catastrophic
None	Negligible	Minor	Moderate	Major	Catastrophic
Deficient	Negligible	Minor	Moderate	Major	Catastrophic
Marginal	Negligible	Minor	Moderate	Major	Catastrophic
Qualified	Negligible	Negligible	Minor	Moderate	Major
Effective	Negligible	Negligible	Minor	Moderate	Major
Excessive	Negligible	Negligible	Minor	Moderate	Major

The risk criteria are also provided in Appendix E along with the helicopter downwash risk register.

6.2 Helicopter Safety Data

Aviation safety data on helicopter operations has been analysed and incorporated into the risk assessment to provide a quantitative analysis into the likelihood of helicopter related incidents at the Trinity Point helipad pontoon.

The accident rate and fatal accident rate from the Australian Transport Safety Bureau (ATSB) per million hours flown between 2008 and 2017 for different categories of helicopter operations are summarised in Table 6.8.

Table 6.8 Rate of helicopter accidents by operation

Operation	Accident Rate (per million hours flown)	Fatal Accident Rate (per million hours flown)
Charter	34.4	2.5
Aerial Work	64.2	9.7
Flying Training	97.1	5.9
Private Business	208.4	30.4
Total	**404.1**	**48.5**

The Trinity Point helipad is proposed to be used predominantly by charter operators which have the lowest accident rate and fatal accident rate of any helicopter operations based on the ATSB accident data.

6.3 Risk Assessment

JJR's risk assessment was based on an analysis of helicopter downwash only to identify the impacts on watercraft and nearby personnel. Twenty-three (23) risks were identified related to helicopter downwash with the following two (2) risks determined to have a medium residual level of risk after considering proposed controls:

- Ground operations: Persons struck by tail / main rotor blades of helicopter; and
- Power plant / propulsion: Engine failure during a maximum performance take-off results in an aircraft crash.

These risks are considered to be acceptable with the proposed mitigation controls in place.

6.4 Other Mitigating Factors

The draft Manual sets out information for pilots and helicopter operators that:

- That the HLS can only be used under a ‘prior permission’ process;
- That the HLS is committed to Fly Neighbourly procedures and Fly Neighbourly Avoid areas (and now the exclusion area);
- That the HLS has preferred approach and departure paths (and now the take-off and landing area);
- That the HLS is available only during daylight hours with certain operating hours, and has no refuelling facilities;
- That the HLS is designed for a maximum weight and helicopter size; and
- That the pilot will need to ensure their flight-path is clear of potential objects, small craft, masts and public, in conjunction with the duty HLS officer.

The draft Manual sets out additional information (in addition to above) for the marina operator, including:

- Staff Training;
- Prior Permission procedure;
- Daily inspection requirements;
- Pre-arrival inspection requirements;
- Duties to ensure persons and craft are clear of, and objects secure, within the safety area for landing and take-off;
- Helicopter Reception/Dispatch procedures; and
- Provision of emergency procedures integrated into marina emergency procedures.

7 Stakeholder Consultation

7.1 Similar Helicopter Operations

JJR held preliminary discussions with the following operators that manage similar helipads across Australia to the proposed helipad pontoon at Trinity Point:

- Sea World Helicopters;
- Microflite; and
- Helipad operator at Orange.

A summary of the key recommendations from these similar helipad operators are provided below:

- Helicopter pilots should conduct visual line of sight checks for nearby boats prior to take-off and landing to minimise downwash impacts on boat users;
- Helicopter pilots should give-way to boat users to minimise or eliminate the impact of helicopter downwash;
- Radio contact with regular boat users could be considered to provide a communication channel;
- A Fly Neighbourly agreement should be developed to ensure pilots fly with consideration of nearby residents and boat users;
- Helicopter pilots should climb as quickly as possible to minimise impacts on the public and other water users;
- The helipad operations should be managed by an operator who manages all helicopter movements and operations, including wind and weather checks, prior permission and management of the safety zone; and
- There are several other water-based helipad operators across Australia that operate in a similar manner to the helipad and operations proposed at the Trinity Point helipad.

An overview of the full discussions with the similar helipad operators is provided in Appendix F.

7.2 Stakeholder Summary

A summary of the outcomes of the discussions with stakeholders are provided below:

- JPG have redesigned the proposed helicopter flight paths in accordance with the exclusion area based on discussions with the Department of Planning and Environment;
- There are several water-based helipad across Australia that facilitate safe aircraft operations with minimal impact on watercraft or neighbours; and
- The recommendations from similar helipad operators should be implemented to maximise operational safety and minimise impact of watercraft and lake users.

8 Conclusion & Recommendations

The helicopter downwash assessment demonstrates that the proposed helipad and associated helicopter operations at Trinity Point do not significantly impact on existing water users in the surrounding area.

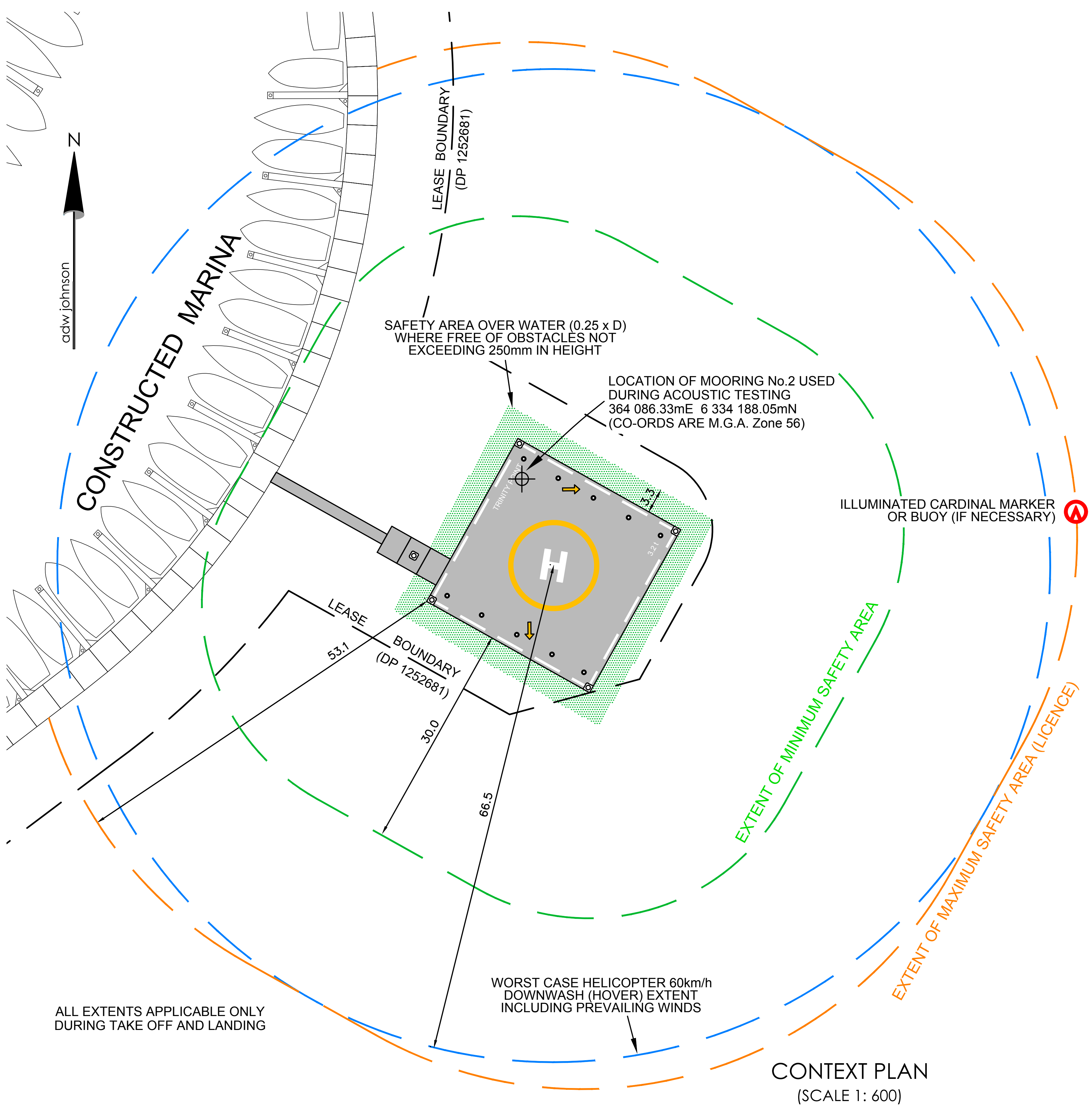
A summary of JJR's findings based on an assessment of helicopter downwash associated with the proposed helipad development are provided below:

- The downwash assessment has been completed based on the Airbus 135 which has the highest disc loading of any proposed helicopters, noting that this has been replaced with the AS355F (which has a lower downwash impact), however the next most-critical helicopter is the Agusta AW109;
- Headwinds are the most desirable scenario as they provide the most significant increase to helicopter performance for approach or departure;
- Wind conditions suitable for helicopter approaches occur on average 77.80% of the day (i.e. unavailable on average 22.20% of the day);
- Wind conditions suitable for helicopter departures occur on average 80.35% of the day (i.e. unavailable on average 19.65% of the day);
- Wind conditions suitable for helicopter approaches occur on average 89.80% of morning times and 65.80% of afternoon times;
- Wind conditions suitable for helicopter departures occur on average 81.50% of morning times and 79.20% of afternoon times.
- Southerly to easterly winds increase the impact of helicopter downwash on the marina and occur 37.60% of the day;
- The currently proposed location of the helipad pontoon does not generate significant downwash impacts beyond the minimum safety area in zero wind conditions;
- The currently proposed location of the helipad pontoon does not generate significant downwash impacts beyond the maximum safety area in worst-case wind conditions;
- The walkway located within the 60km/h safety area is currently designed with gates that will restrict public access along the walkway during helicopter take-off and landing;
- The 60km/h downwash velocity envelope may impact on up to 15 marina berths (based on the Airbus 135) during worst-case prevailing wind conditions from a south-westerly wind;
- The current location of the helipad pontoon does not generate significant downwash impact on nearby water craft;
- The proposed helicopter flight paths may generate downwash at water level of up to 10.3km/h within the MPASC sailing area which are deemed to not significantly impact sailing operations based on the downwash classified as a Force 2 wind in accordance with the Beaufort Scale;
- The theoretical normal take-off procedure will produce a downwash velocity of less than 20km/h at a distance of 37.6m from the helipad at a ground speed of at least 65km/h and a height of 6.7m above ground;
- The maximum performance take-off procedure (assuming 10% take-off slope) will produce a downwash velocity of less than 20km/h at a distance of 50m from the helipad at a ground speed of at least 60km/h and a height of 5m above ground;
- The maximum performance take-off procedure (assuming 30% take-off slope) will produce a downwash velocity of less than 20km/h at a distance of 30m from the helipad at a ground speed of at least 45km/h and a height of 9m above ground;
- The resultant wave height from helicopter downwash cannot be accurately modelled to determine any impacts on the marina primarily due to the short fetch, although a review of relevant charts and equations indicates the helicopter downwash would not generate waves of more than 0.2m in height;

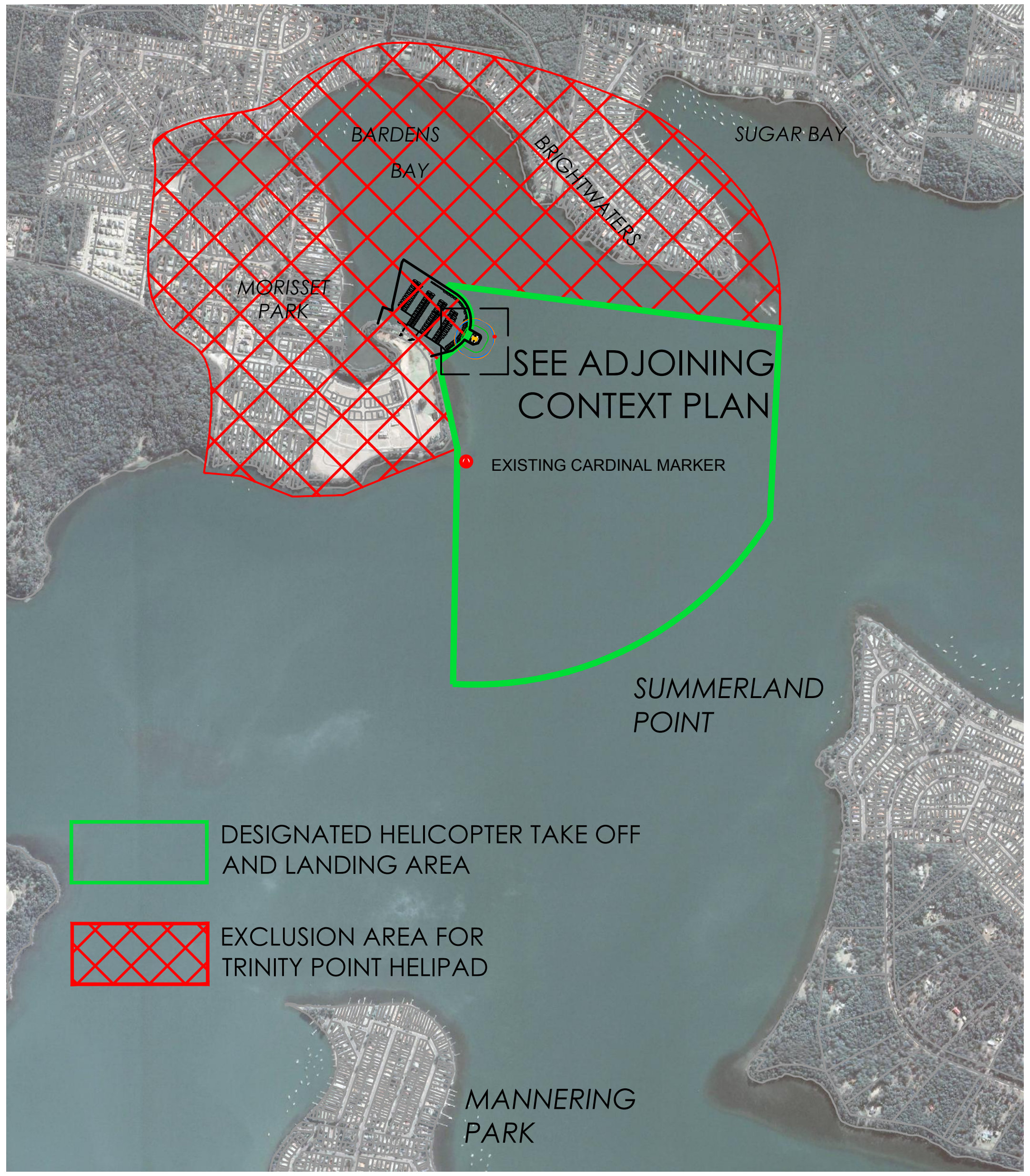
- There is typically minimal watercraft in the vicinity of the Trinity Point marina and helicopter pilots should be able to navigate during take-off and approach without overflying lake users;
- The Trinity Point helipad is proposed for use predominantly by charter operators which have the lowest accident rate and fatal accident rate of any helicopter operations;
- Helicopter pilots should conduct visual line of sight checks for nearby boats and liaise with the helipad landing officer prior to take-off and landing to minimise downwash impacts on boat users;
- Helicopter pilots should give-way to boat users to minimise or eliminate the impact of helicopter downwash;
- Radio contact with regular boat users could be considered to provide a communication channel;
- A Fly Neighbourly agreement should be developed to ensure pilots fly with consideration of nearby residents and boat users;
- Helicopter pilots should climb as quickly as possible to minimise impacts on the public and other water users;
- The helipad operations should be managed by an operator who manages all helicopter movements and operations, including wind and weather checks, prior permission and management of the safety zone; and
- There are several other water-based helipad operators across Australia that operate in a similar manner to the helipad and operations proposed at the Trinity Point helipad.

Appendices

Appendix A – Revised Helipad Plans



CONTEXT PLAN
(SCALE 1: 600)



LOCALITY SKETCH
(SCALE 1: 25 000)

drawing title:
Location & Marina Context of Proposed Helipad

location: Trinity Point Marina

council: LAKE MACQUARIE

dwg ref: 37429(4)-DA-001-K

client: JOHNSON PROPERTY GROUP

adw johnson

central coast office ph: (02) 4305 4300
hunter office ph: (02) 4978 5100

ver.	date	comment	surveyed	drawn	checked	pm
H	14.03.18	MINOR AMENDMENTS	-	Z.J.	M.R.	S.H.
I	04.03.19	EXTENT OF SAFETY AREA	-	Z.J.	M.R.	S.H.
J	24.04.19	REVISED HELICOPTER TAKE OFF & LANDING AREA	-	M.C.	M.R.	S.H.
K	20.05.19	LARGER HELIPAD PONTOON	-	M.S.	M.R.	S.H.

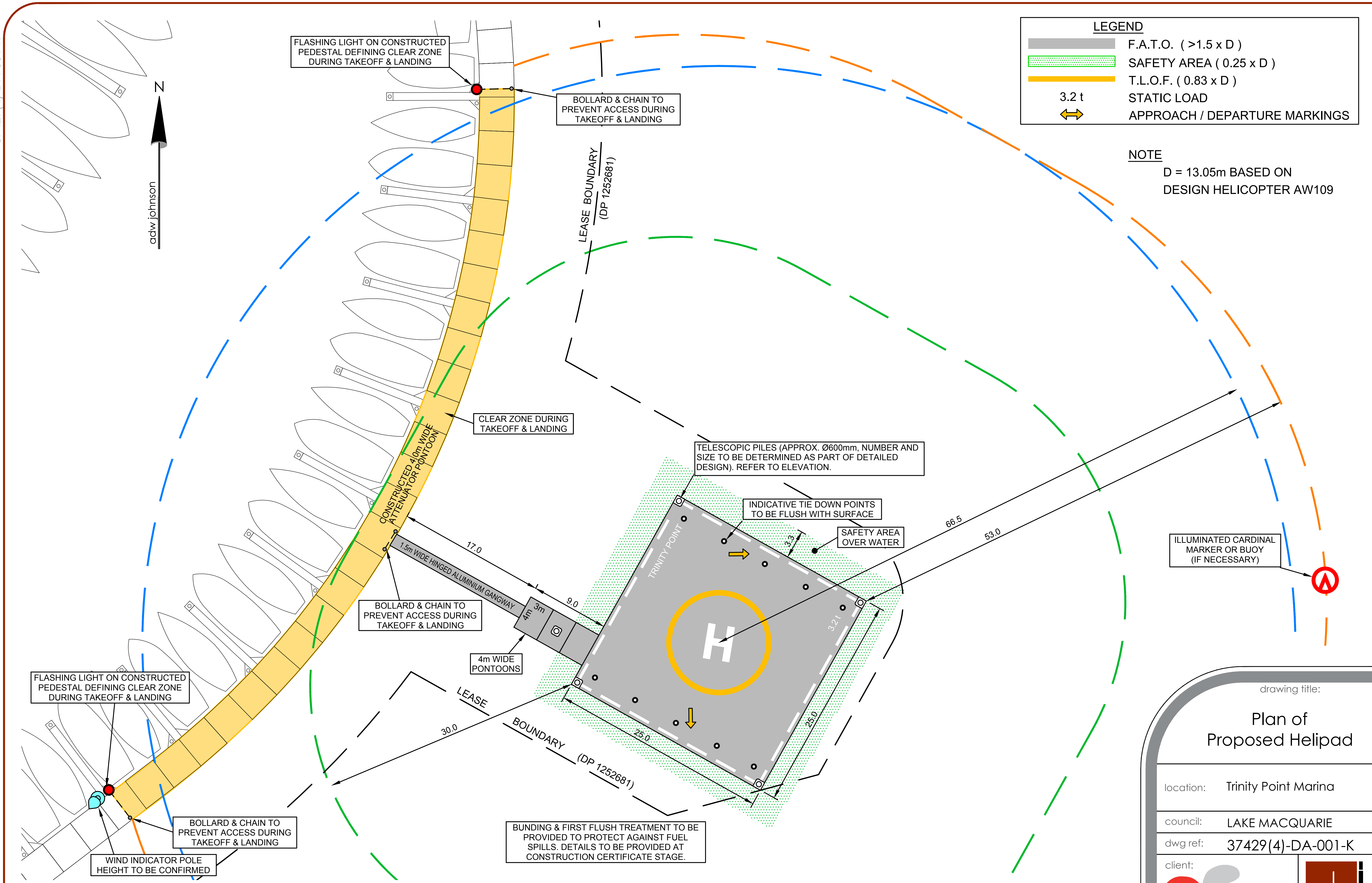
co-ordinate & level information
CO-ORDINATE SYSTEM: M.G.A. 56
ORIGIN OF CO-ORDINATES: P.M.58712
DATUM: N/A
ORIGIN OF LEVELS: N/A
CONTOUR INTERVAL: N/A

scale (A3 original size)
0 15.0 30.0m
SCALE: 1:600 (FULL)

page
1 OF 3
Date of Surv

37429(4)-DA-001-K

Plotted By: Mark Spitzkowsky Plot Date: 20/05/19 2:20:59PM Cad File: N:\37429\37429(4)\DWG\PLANNING\DA\37429(4)-DA-001-K.DWG



37429(4)-DA-001-K

drawing title:

Plan of Proposed Helipad

location: Trinity Point Marina

council: LAKE MACQUARIE

dwg ref: 37429(4)-DA-001-K

client: JOHNSON PROPERTY GROUP

adw johnson

central coast office ph: (02) 4305 4300
hunter office ph: (02) 4978 5100

ver.	date	comment	surveyed	drawn	checked	pm
H	14.03.18	MINOR AMENDMENTS	-	Z.J.	M.R.	S.H.
I	04.03.19	EXTENT OF SAFETY AREA	-	Z.J.	M.R.	S.H.
J	24.04.19	REVISED HELICOPTER TAKE OFF & LANDING AREA	-	M.C.	M.R.	S.H.
K	20.05.19	LARGER HELIPAD PONTOON	-	M.S.	M.R.	S.H.

co-ordinate & level information

CO-ORDINATE SYSTEM:	M.G.A. 56
ORIGIN OF CO-ORDINATES:	P.M.58712
DATUM:	N/A
ORIGIN OF LEVELS:	N/A
CONTOUR INTERVAL:	N/A

scale (A3 original size)

0 10.0 20.0m

SCALE: 1:400 (FULL)

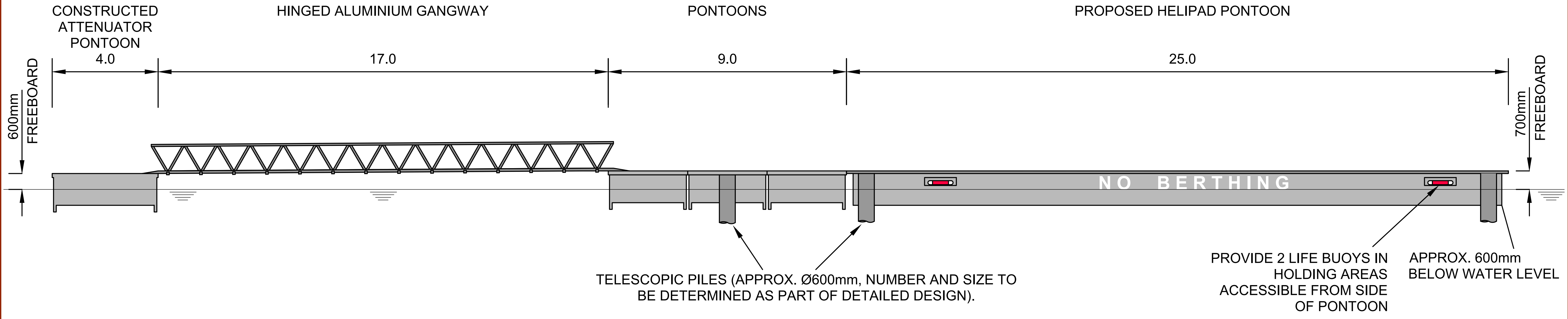
page

2 OF 3

Date of Surv

Plotted By: Mark Spitzkowsky Plot Date: 20/05/19 2:20:59PM Cad File: N:\37429\37429(4)\DWG\PLANNING\DA\37429(4)-DA-001-K.DWG

37429(4)-DA-001-K



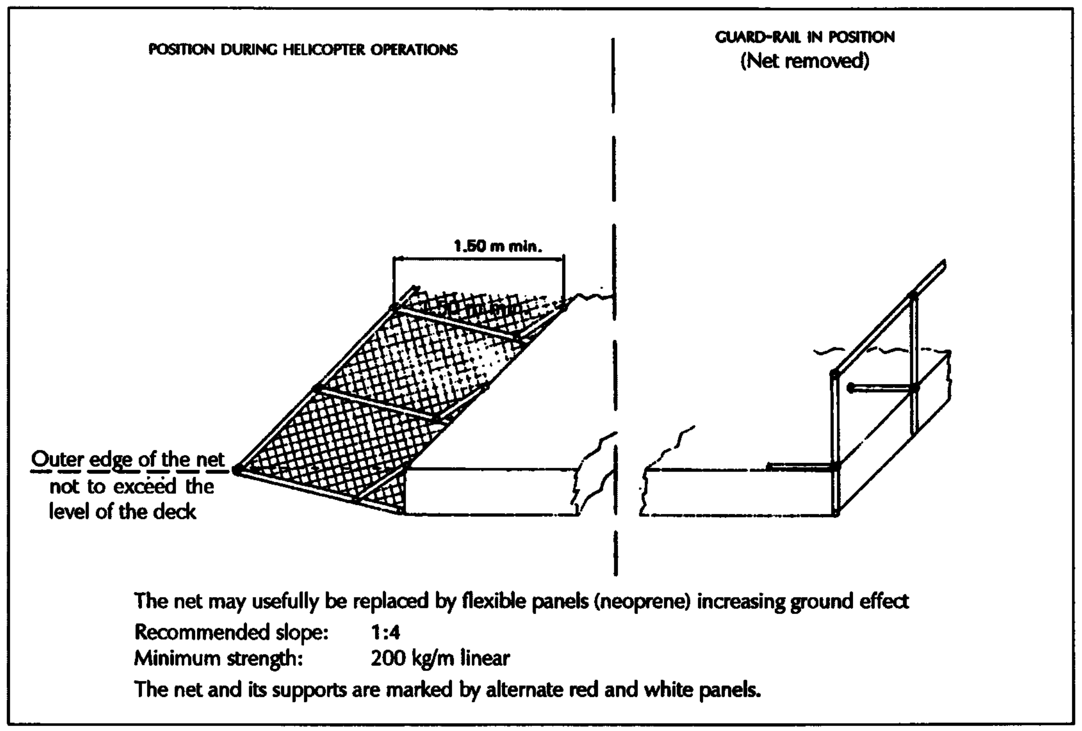


Figure 3-1. Collapsible guard-rail with movable safety net

Detailed design to include a safety net on the perimeter of the floating pontoon, consistent with Section 3.2.8 & 3.2.9 of CAANZ Advisory Circular 139-8, if required.

ver.	date	comment	surveyed	drawn	checked	pm
H	14.03.18	MINOR AMENDMENTS	-	Z.J.	M.R.	S.H.
I	04.03.19	EXTENT OF SAFETY AREA	-	Z.J.	M.R.	S.H.
J	24.04.19	REVISED HELICOPTER TAKE OFF & LANDING AREA	-	M.C.	M.R.	S.H.
K	20.05.19	LARGER HELIPAD PONTOON	-	M.S.	M.R.	S.H.

co-ordinate & level information

CO-ORDINATE SYSTEM:	M.G.A. 56
ORIGIN OF CO-ORDINATES:	P.M.58712
DATUM:	N/A
ORIGIN OF LEVELS:	N/A
CONTOUR INTERVAL:	N/A

scale (A3 original size)

0 5.0 10.0m

SCALE: 1:200 (FULL)

page

3 OF 3

Date of Surv

drawing title:

Typical Elevation of Proposed Helipad

location: Trinity Point Marina

council: LAKE MACQUARIE

dwg ref: 37429(4)-DA-001-K

client: JOHNSON PROPERTY GROUP

adw johnson

central coast office ph: (02) 4305 4300
hunter office ph: (02) 4978 5100

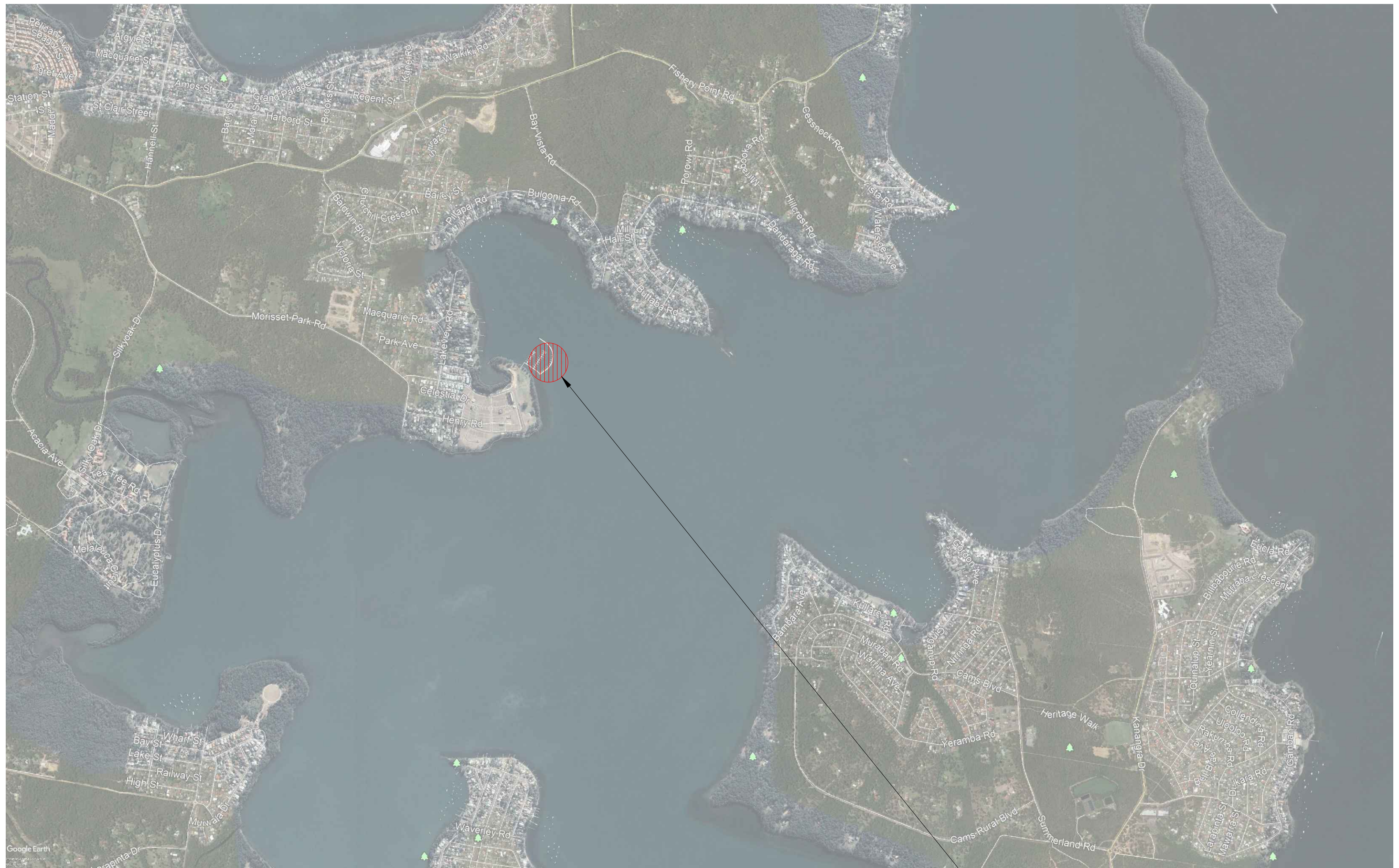
Plotted By: Mark Spitzkowsky Plot Date: 20/05/19 2:21:00PM Cad File: N:\37429\37429(4)\DWG\PLANNING\DA\37429(4)-DA-001-K.DWG

Appendix B – Flight Paths at Trinity Point under Maximum Performance Take-off Operations

JOHNSON PROPERTY GROUP

FOR INFORMATION

HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
ROTOR DOWNWASH AT HELIPAD PONTOON



SITE LOCATION

DRAWING INDEX

DRAWING NAME	DRAWING TITLE
2190111B-SK000	DRAWING INDEX & LOCALITY PLAN
2190111B-SK001	BELL 407
2190111B-SK002	BELL 206B
2190111B-SK003	BELL 206L
2190111B-SK004	AIRBUS H125
2190111B-SK005	AIRBUS 120
2190111B-SK006	AIRBUS 130
2190111B-SK007	MD500E
2190111B-SK008	AIRBUS 135
2190111B-SK009	AGUSTA AW109
2190111B-SK010	FLIGHT PATH LONG SECTIONS SHEET 1 OF 10
2190111B-SK011	FLIGHT PATH LONG SECTIONS SHEET 2 OF 10
2190111B-SK012	FLIGHT PATH LONG SECTIONS SHEET 3 OF 10
2190111B-SK013	FLIGHT PATH LONG SECTIONS SHEET 4 OF 10
2190111B-SK014	FLIGHT PATH LONG SECTIONS SHEET 5 OF 10
2190111B-SK015	FLIGHT PATH LONG SECTIONS SHEET 6 OF 10
2190111B-SK016	FLIGHT PATH LONG SECTIONS SHEET 7 OF 10
2190111B-SK017	FLIGHT PATH LONG SECTIONS SHEET 8 OF 10
2190111B-SK018	FLIGHT PATH LONG SECTIONS SHEET 9 OF 10
2190111B-SK019	FLIGHT PATH LONG SECTIONS SHEET 10 OF 10
2190111B-SK020	COMBINED FLIGHT PATH PROFILES SHEET 1 OF 1
2190111B-SK021	COMBINED FLIGHT PATHS
2190111B-SK022	TAKE OFF, LANDING AND EXCLUSION AREAS

DRAWING FILE LOCATION / NAME
C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK000.dwg

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

A3 ORIGINAL — 100 mm ON ORIGINAL

EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
	A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR

DESIGN LOT CODE: TS
PLOT DATE: 05 March 2019
TIME: 15:47:29
DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

PRINCIPAL: JOHNSON PROPERTY GROUP
DESIGNER: JJ RYAN CONSULTING PTY LTD
SCALES AT A3 SIZE DRAWING
CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: A.H.D.

JOHNSON PROPERTY GROUP
HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
ROTOR DOWNWASH AT HELIPAD PONTOON
DRAWING INDEX & LOCALITY PLAN

CLIENT PROJECT / DRAWING No:
ISSUE STATUS: FOR INFORMATION
JJR PROJECT / DRAWING No: 2190111B-SK000
ISSUE: A

LEGEND:

- 100km/h DOWNWASH VELOCITY ENVELOPE
- 80km/h DOWNWASH VELOCITY ENVELOPE
- 60km/h DOWNWASH VELOCITY ENVELOPE
- SAFETY AREA
- 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 ADW JOHNSON. 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.

DRAWING FILE LOCATION / NAME
C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK001.dwg

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

A3 ORIGINAL 100 mm ON ORIGINAL

DESIGN LOT CODE: TS

PLOT DATE: 22 May 2019 TIME: 09:16:04

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

EXTERNAL REFERENCE FILES: x_jjr_title_block_a3, x_legend

REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR
B	22.05.2019	REVISED HELIPAD DESIGN	N/A	JR

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

PRINCIPAL: JOHNSON PROPERTY GROUP

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 56

HEIGHT DATUM: A.H.D.

JOHNSON PROPERTY GROUP

HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
ROTOR DOWNWASH AT HELIPAD PONTOON
BELL 407

CLIENT PROJECT / DRAWING No

ISSUE STATUS: FOR INFORMATION

JJR PROJECT / DRAWING No: 2190111B-SK001

ISSUE: B

LEGEND:

- 100km/h DOWNWASH VELOCITY ENVELOPE
- 80km/h DOWNWASH VELOCITY ENVELOPE
- 60km/h DOWNWASH VELOCITY ENVELOPE
- SAFETY AREA
- 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 ADW JOHNSON. 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.

DRAWING FILE LOCATION | NAME
C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK002.dwg

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

A3 ORIGINAL — 100 mm ON ORIGINAL

DESIGN LOT CODE: TS | PLOT DATE: 22 May 2019 | TIME: 09:15:46

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

EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
	A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR
	B	22.05.2019	REVISED HELIPAD DESIGN	N/A	JR

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

PRINCIPAL: JOHNSON PROPERTY GROUP

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 56 | HEIGHT DATUM: A.H.D.

JOHNSON PROPERTY GROUP

HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
ROTOR DOWNWASH AT HELIPAD PONTOON
BELL 206B

CLIENT PROJECT / DRAWING No	ISSUE STATUS	JJR PROJECT / DRAWING No	ISSUE
	FOR INFORMATION	2190111B-SK002	B

LEGEND:

- 100km/h DOWNWASH VELOCITY ENVELOPE
- 80km/h DOWNWASH VELOCITY ENVELOPE
- 60km/h DOWNWASH VELOCITY ENVELOPE
- SAFETY AREA
- 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 ADW JOHNSON. 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.

DRAWING FILE LOCATION / NAME
C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK003.dwg

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

A3 ORIGINAL 100 mm ON ORIGINAL

REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR
B	22.05.2019	REVISED HELIPAD DESIGN	N/A	JR

EXTERNAL REFERENCE FILES

DESIGN LOT CODE: TS
PLOT DATE: 22 May 2019
TIME: 09:15:29
DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

PRINCIPAL: JOHNSON PROPERTY GROUP

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 56
HEIGHT DATUM: A.H.D.

JOHNSON PROPERTY GROUP

HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
ROTOR DOWNWASH AT HELIPAD PONTOON
BELL 206L

CLIENT PROJECT / DRAWING No

ISSUE STATUS: FOR INFORMATION

JJR PROJECT / DRAWING No: 2190111B-SK003

ISSUE: B

LEGEND:

- 100km/h DOWNWASH VELOCITY ENVELOPE
- 80km/h DOWNWASH VELOCITY ENVELOPE
- 60km/h DOWNWASH VELOCITY ENVELOPE
- SAFETY AREA
- 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 ADW JOHNSON. 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.

DRAWING FILE LOCATION / NAME
C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK004.dwg

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

A3 ORIGINAL 100 mm ON ORIGINAL

DESIGN LOT CODE: TS | PLOT DATE: 22 May 2019 | TIME: 09:15:10

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

EXTERNAL REFERENCE FILES

REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR
B	22.05.2019	REVISED HELIPAD DESIGN	N/A	JR

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

PRINCIPAL: JOHNSON PROPERTY GROUP

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 56 | HEIGHT DATUM: A.H.D.

JOHNSON PROPERTY GROUP

HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
ROTOR DOWNWASH AT HELIPAD PONTOON
AIRBUS H125

CLIENT PROJECT / DRAWING No	ISSUE STATUS	JJR PROJECT / DRAWING No	ISSUE
	FOR INFORMATION	2190111B-SK004	B

LEGEND:

- 100km/h DOWNWASH VELOCITY ENVELOPE
- 80km/h DOWNWASH VELOCITY ENVELOPE
- 60km/h DOWNWASH VELOCITY ENVELOPE
- SAFETY AREA
- 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 ADW JOHNSON. 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.

DRAWING FILE LOCATION / NAME
C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK005.dwg

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

A3 ORIGINAL 100 mm ON ORIGINAL

EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
x_jjr_title_block_a3 x_legend	A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR
	B	22.05.2019	REVISED HELIPAD DESIGN	N/A	JR

DESIGN LOT CODE: TS
PLOT DATE: 22 May 2019
TIME: 09:16:43
DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

PRINCIPAL: JOHNSON PROPERTY GROUP

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 56
HEIGHT DATUM: A.H.D.

JOHNSON PROPERTY GROUP

HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
ROTOR DOWNWASH AT HELIPAD PONTOON
AIRBUS 120

CLIENT PROJECT / DRAWING No
ISSUE STATUS: FOR INFORMATION
JJR PROJECT / DRAWING No: 2190111B-SK005
ISSUE: B

LEGEND:

- 100km/h DOWNWASH VELOCITY ENVELOPE
- 80km/h DOWNWASH VELOCITY ENVELOPE
- 60km/h DOWNWASH VELOCITY ENVELOPE
- SAFETY AREA
- 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 ADW JOHNSON. 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.

DRAWING FILE LOCATION / NAME
C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK006.dwg

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

A3 ORIGINAL 100 mm ON ORIGINAL

DESIGN LOT CODE: TS | PLOT DATE: 22 May 2019 | TIME: 09:17:32

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

EXTERNAL REFERENCE FILES: x_jjr_title_block_a3, x_legend

REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR
B	22.05.2019	REVISED HELIPAD DESIGN	N/A	JR

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

PRINCIPAL: JOHNSON PROPERTY GROUP

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 56

HEIGHT DATUM: A.H.D.

JOHNSON PROPERTY GROUP

HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
ROTOR DOWNWASH AT HELIPAD PONTOON
AIRBUS 130

CLIENT PROJECT / DRAWING No

ISSUE STATUS: FOR INFORMATION

JJR PROJECT / DRAWING No: 2190111B-SK006

ISSUE: B

LEGEND:

- 100km/h DOWNWASH VELOCITY ENVELOPE
- 80km/h DOWNWASH VELOCITY ENVELOPE
- 60km/h DOWNWASH VELOCITY ENVELOPE
- SAFETY AREA
- 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 ADW JOHNSON. 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.

DRAWING FILE LOCATION / NAME
C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK007.dwg

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

A3 ORIGINAL 100 mm ON ORIGINAL

DESIGN LOT CODE: TS
PLOT DATE: 22 May 2019
TIME: 09:18:17
DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING

EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
	A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR
	B	22.05.2019	REVISED HELIPAD DESIGN	N/A	JR

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

PRINCIPAL: JOHNSON PROPERTY GROUP

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 56

HEIGHT DATUM: A.H.D.

JOHNSON PROPERTY GROUP

HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
ROTOR DOWNWASH AT HELIPAD PONTOON
MD500E

CLIENT PROJECT / DRAWING No:

ISSUE STATUS: FOR INFORMATION

JJR PROJECT / DRAWING No: 2190111B-SK007

ISSUE: B

LEGEND:

- 100km/h DOWNWASH VELOCITY ENVELOPE
- 80km/h DOWNWASH VELOCITY ENVELOPE
- 60km/h DOWNWASH VELOCITY ENVELOPE
- SAFETY AREA
- 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 ADW JOHNSON. 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.

DRAWING FILE LOCATION / NAME
C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK008.dwg

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

100 mm ON ORIGINAL

A3 ORIGINAL

x_jjr_title_block_a3
x_legend

EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
	A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR
	B	22.05.2019	REVISED HELIPAD DESIGN	N/A	JR

DESIGN LOT CODE: TS
PLOT DATE: 22 May 2019
TIME: 09:19:13

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

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

PRINCIPAL: JOHNSON PROPERTY GROUP

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 56
HEIGHT DATUM: A.H.D.

JOHNSON PROPERTY GROUP

HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
ROTOR DOWNWASH AT HELIPAD PONTOON
AIRBUS 135

CLIENT PROJECT / DRAWING No

ISSUE STATUS: FOR INFORMATION
JJR PROJECT / DRAWING No: 2190111B-SK008
ISSUE: B

LEGEND:

- 100km/h DOWNWASH VELOCITY ENVELOPE
- 80km/h DOWNWASH VELOCITY ENVELOPE
- 60km/h DOWNWASH VELOCITY ENVELOPE
- SAFETY AREA
- 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 ADW JOHNSON. 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.

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

DRAWING FILE LOCATION | NAME
C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK009.dwg

A3 ORIGINAL — 100 mm ON ORIGINAL

DESIGN LOT CODE: TS
PLOT DATE: 22 May 2019
TIME: 09:20:12
DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING

EXTERNAL REFERENCE FILES: x_jjr_title_block_a3, x_legend

REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR
B	22.05.2019	REVISED HELIPAD DESIGN	N/A	JR

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

PRINCIPAL: JOHNSON PROPERTY GROUP

DESIGNER: JJ RYAN CONSULTING PTY LTD

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

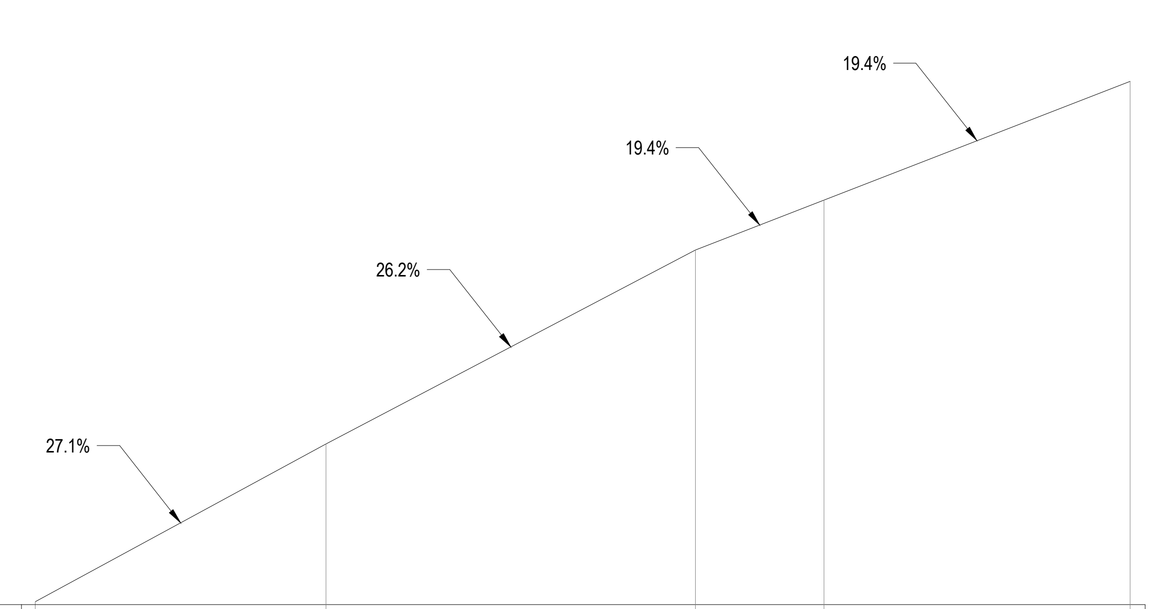
CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: A.H.D.

JOHNSON PROPERTY GROUP

HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
ROTOR DOWNWASH AT HELIPAD PONTOON
AGUSTA AW109

CLIENT PROJECT / DRAWING No:
ISSUE STATUS: FOR INFORMATION
JJR PROJECT / DRAWING No: 2190111B-SK009
ISSUE: B

DRAWING FILE LOCATION / NAME
C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK014.dwg

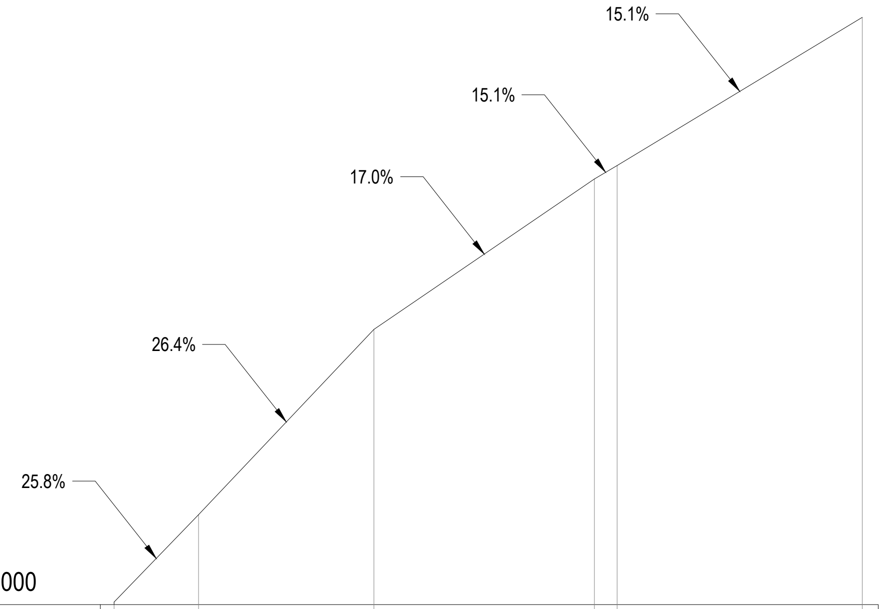


DATUM RL 36.000

ELEVATION (ft)	37.800	142.200	270.500	303.480	382.100
CHAINAGE	0.000	385.000	874.000	1044.000	1449.000

RUN 1 - TAKEOFF

SCALE - VERT 1:5000 HORZ 1:10000

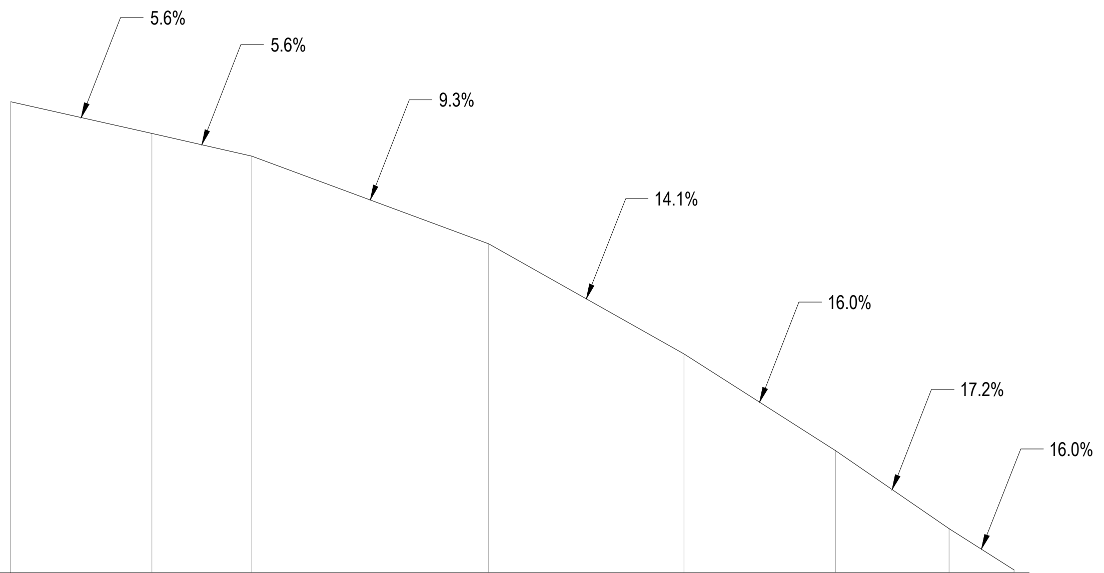


DATUM RL 13.000

ELEVATION (ft)	14.600	72.500	195.100	294.500	303.480	401.400
CHAINAGE	0.000	224.000	688.000	1271.000	1331.000	1980.000

RUN 2 - TAKEOFF

SCALE - VERT 1:5000 HORZ 1:20000

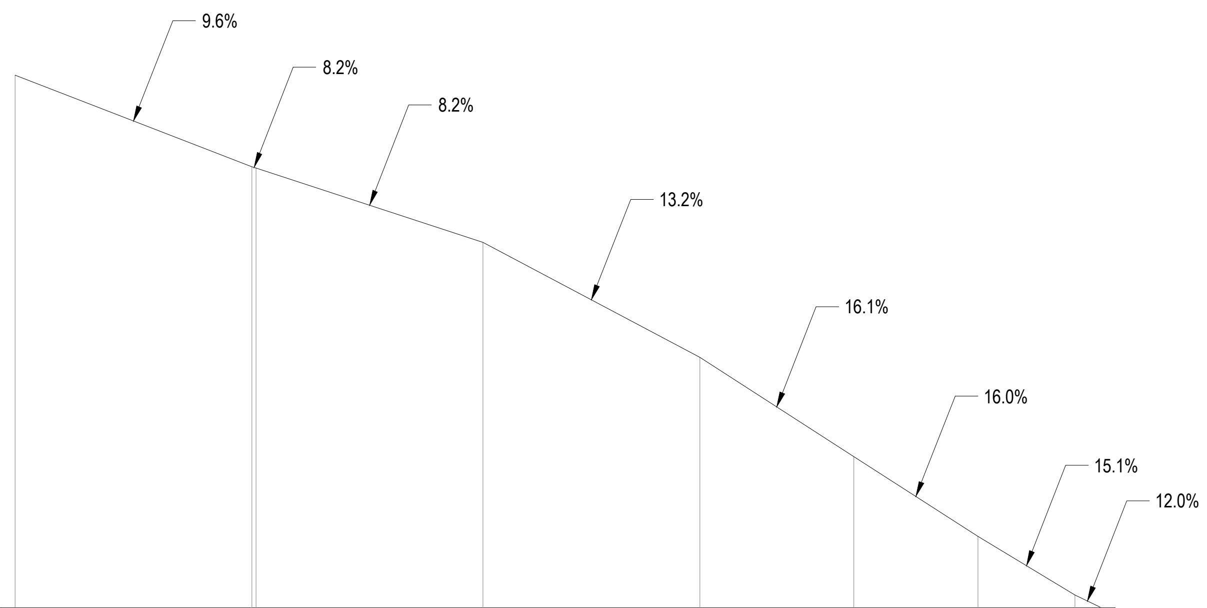


DATUM RL 13.000

ELEVATION (ft)	324.500	303.480	288.600	230.500	157.700	93.700	42.200	14.800
CHAINAGE	0.000	373.000	637.000	1264.000	1780.000	2181.000	2481.000	2653.000

RUN 1 - LANDING

SCALE - VERT 1:5000 HORZ 1:20000



DATUM RL 13.000

ELEVATION (ft)	364.800	304.400	303.480	254.500	178.500	112.900	60.100	21.500	13.400
CHAINAGE	0.000	627.000	638.000	1238.000	1812.000	2219.000	2548.000	2804.000	2871.000

RUN 2 - LANDING

SCALE - VERT 1:5000 HORZ 1:20000

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

A3 ORIGINAL — 100 mm ON ORIGINAL

EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
	A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR

DESIGN LOT CODE: TS
PLOT DATE: 05 March 2019 TIME: 15:18:57
DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

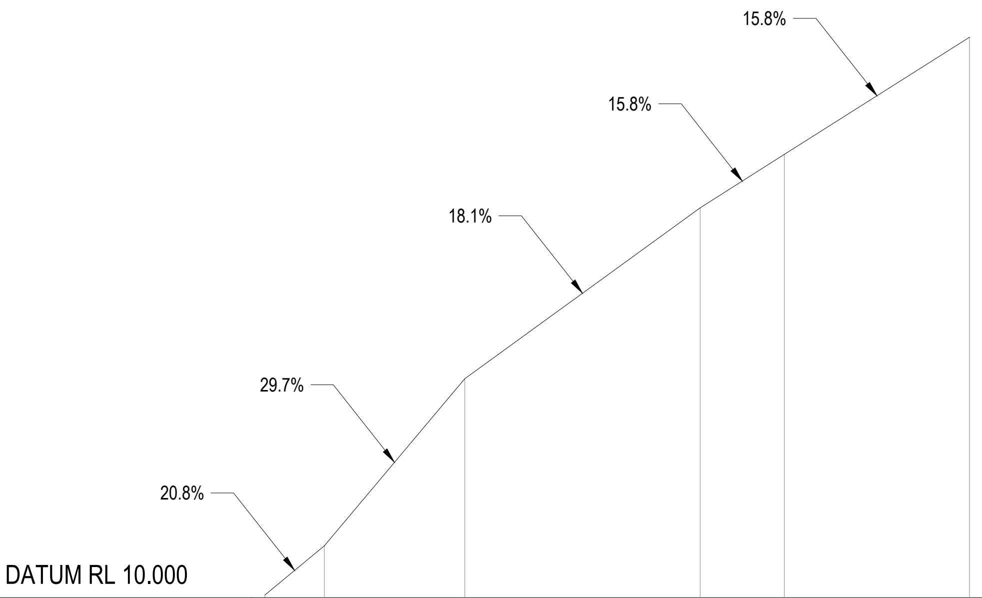
PRINCIPAL: JOHNSON PROPERTY GROUP
DESIGNER: JJ RYAN CONSULTING PTY LTD

SCALES AT A3 SIZE DRAWING: SCALE 1:10000 — 50 0 50 100 150 200 250m

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: A.H.D.

JOHNSON PROPERTY GROUP
HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
HELICOPTER FLIGHT PATH LONG SECTIONS
SHEET 1 OF 10

CLIENT PROJECT / DRAWING No	ISSUE STATUS	JJR PROJECT / DRAWING No	ISSUE
	FOR INFORMATION	2190111B-SK010	A

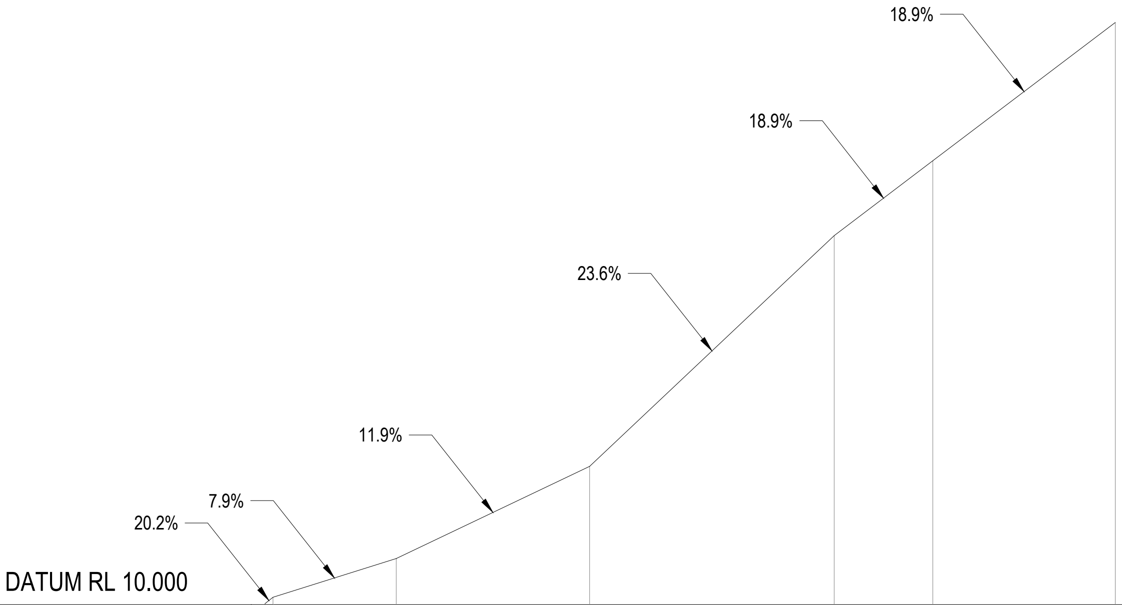


DATUM RL 10.000

ELEVATION (ft)	12.000	44.700	155.100	268.100	303.480	381.100
CHAINAGE	0.000	157.000	529.000	1152.000	1375.000	1865.000

RUN 3 - TAKEOFF

SCALE - VERT 1:5000 HORZ 1:20000

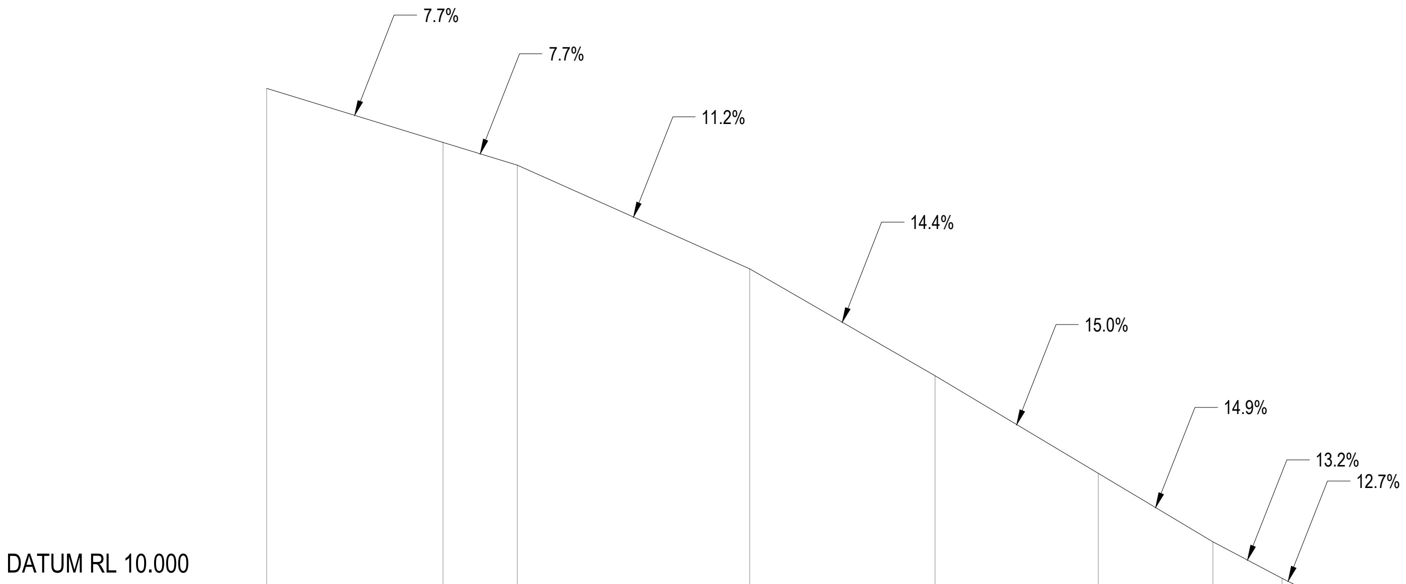


DATUM RL 10.000

ELEVATION (ft)	10.600	14.800	40.400	101.400	254.100	303.480	394.900
CHAINAGE	0.000	21.000	347.000	859.000	1505.000	1766.000	2249.000

RUN 4 - TAKEOFF

SCALE - VERT 1:5000 HORZ 1:20000

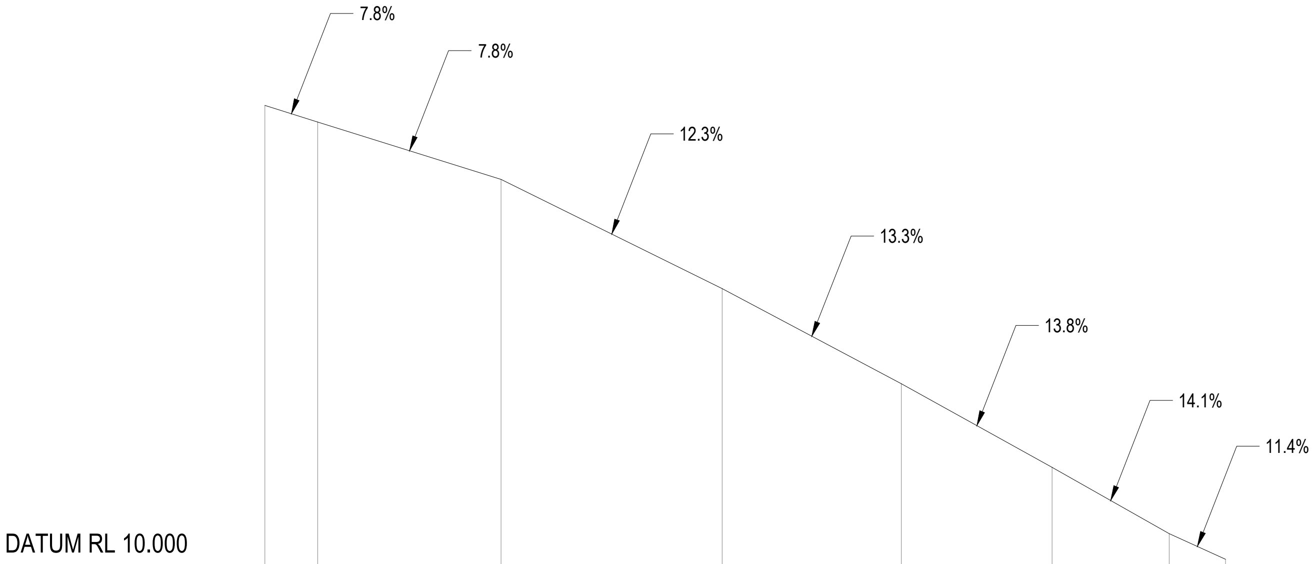


DATUM RL 10.000

ELEVATION (ft)	339.300	303.480	288.400	219.800	149.100	84.600	39.400	15.300	11.200
CHAINAGE	0.000	467.000	663.000	1278.000	1768.000	2200.000	2503.000	2686.000	2718.000

RUN 3 - LANDING

SCALE - VERT 1:5000 HORZ 1:20000



DATUM RL 10.000

ELEVATION (ft)	314.400	303.480	265.600	193.400	130.500	75.300	31.500	14.500
CHAINAGE	0.000	140.000	625.000	1210.000	1684.000	2083.000	2393.000	2542.000

RUN 4 - LANDING

SCALE - VERT 1:5000 HORZ 1:20000

DRAWING FILE LOCATION / NAME
C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK015.dwg

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

A3 ORIGINAL 100 mm ON ORIGINAL

EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
	A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR

DESIGN LOT CODE: TS

PLOT DATE: 05 March 2019 TIME: 15:25:18

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

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

PRINCIPAL: JOHNSON PROPERTY GROUP

DESIGNER: JJ RYAN CONSULTING PTY LTD

SCALES AT A3 SIZE DRAWING: SCALE 1:10000 — 50 0 50 100 150 200 250m

CO-ORDINATE SYSTEM: MGA ZONE 56 HEIGHT DATUM: A.H.D.

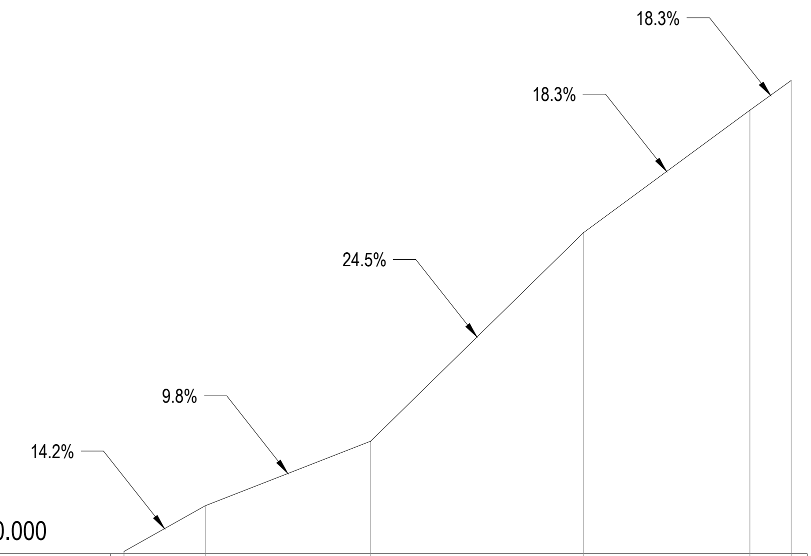
JOHNSON PROPERTY GROUP

HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
HELICOPTER FLIGHT PATH LONG SECTIONS
SHEET 2 OF 10

CLIENT PROJECT / DRAWING No	ISSUE STATUS	JJR PROJECT / DRAWING No	ISSUE
	FOR INFORMATION	2190111B-SK011	A

C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK016.dwg

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

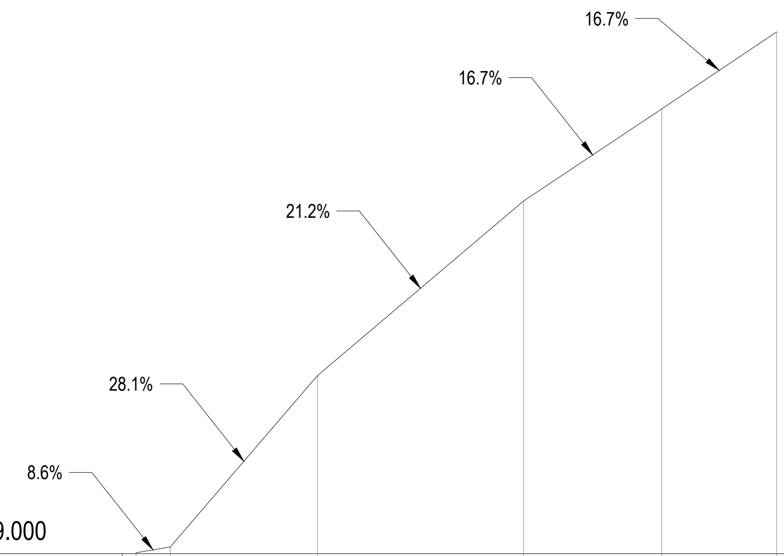


DATUM RL 10.000

ELEVATION (ft)	11.400	41.800	84.600	222.500	303.480	323.300
CHAINAGE	0.000	215.000	652.000	1215.000	1656.000	1765.000

RUN 5 - TAKEOFF

SCALE - VERT 1:5000 HORZ 1:20000

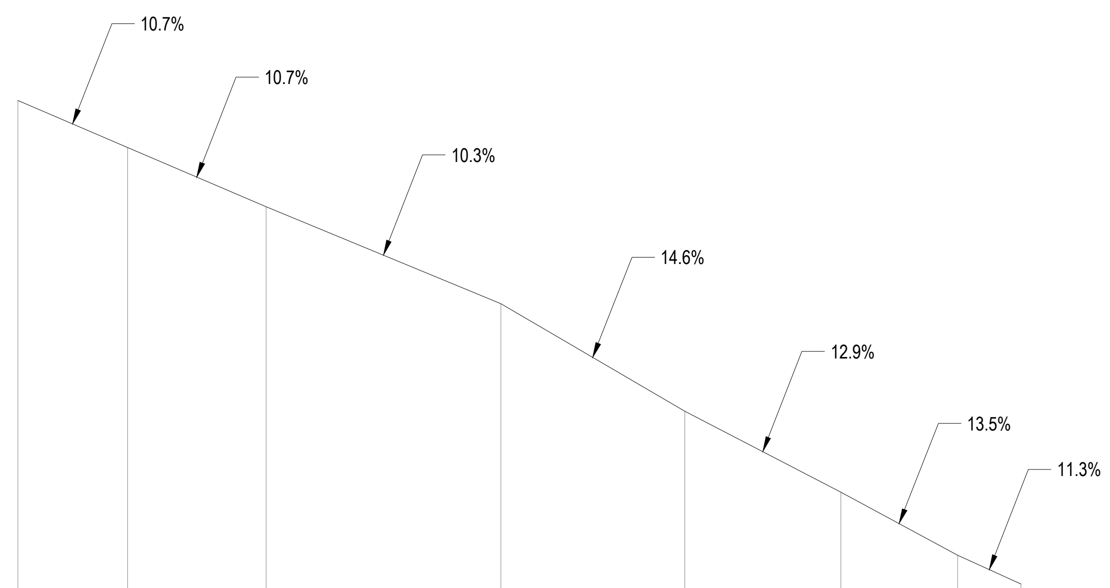


DATUM RL 9.000

ELEVATION (ft)	9.700	17.500	126.800	242.400	303.480	354.400
CHAINAGE	0.000	91.000	480.000	1026.000	1391.000	1695.000

RUN 6 - TAKEOFF

SCALE - VERT 1:5000 HORZ 1:20000

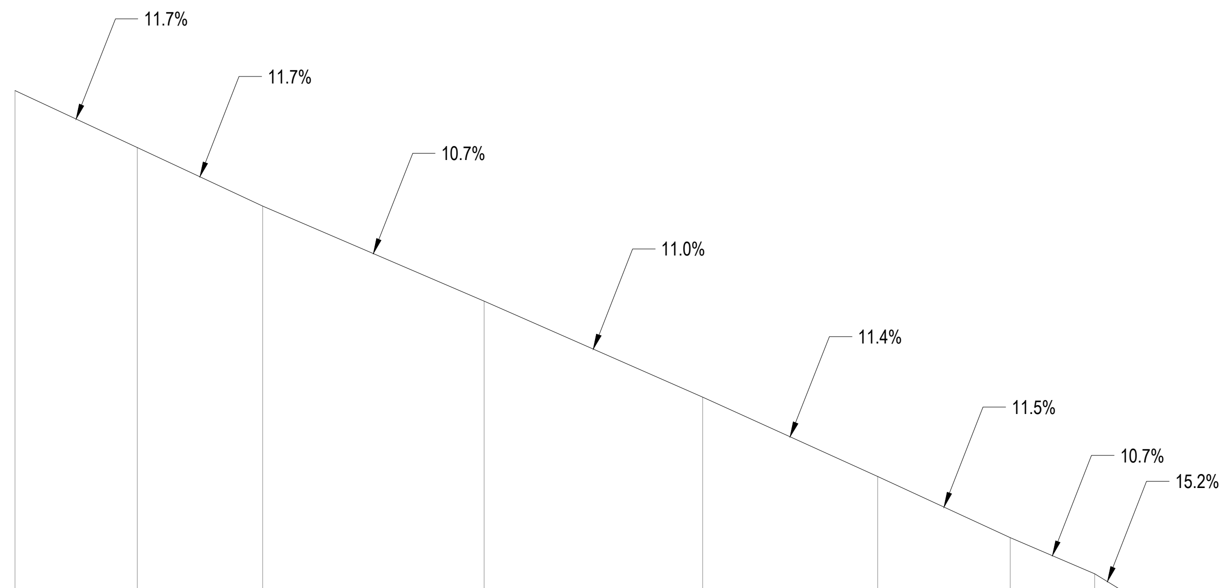


DATUM RL 10.000

ELEVATION (ft)	334.700	303.480	264.300	200.300	129.100	75.600	33.800	14.800
CHAINAGE	0.000	292.000	659.000	1280.000	1767.000	2180.000	2489.000	2657.000

RUN 5 - LANDING

SCALE - VERT 1:5000 HORZ 1:20000



DATUM RL 10.000

ELEVATION (ft)	341.200	303.480	264.800	202.000	138.500	85.900	45.500	21.600	11.300
CHAINAGE	0.000	323.000	655.000	1241.000	1819.000	2282.000	2633.000	2856.000	2924.000

RUN 6 - LANDING

SCALE - VERT 1:5000 HORZ 1:20000

EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
	A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR

DESIGN LOT CODE: TS
PLOT DATE: 05 March 2019 TIME: 15:25:56
DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

PRINCIPAL: JOHNSON PROPERTY GROUP

DESIGNER: JJ RYAN CONSULTING PTY LTD

SCALES AT A3 SIZE DRAWING: SCALE 1:10000 (50 0 50 100 150 200 250m)

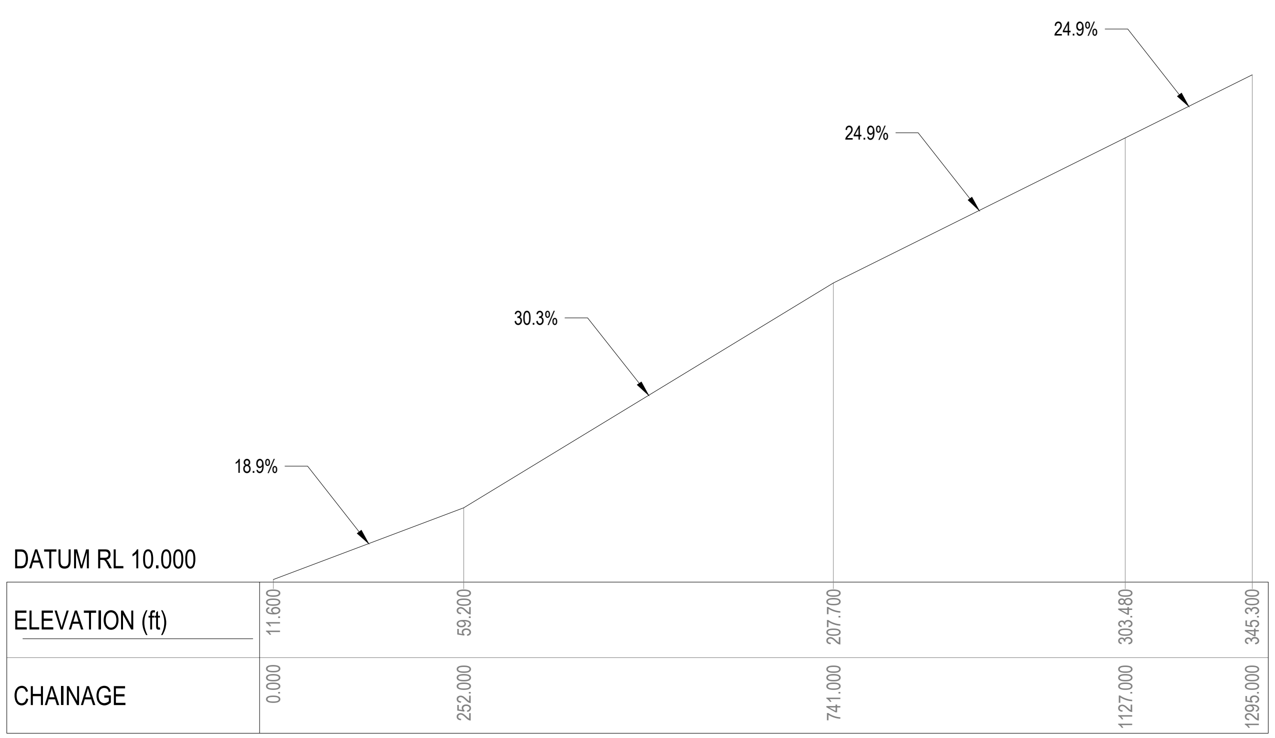
CO-ORDINATE SYSTEM: MGA ZONE 56 | HEIGHT DATUM: A.H.D.

JOHNSON PROPERTY GROUP

HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
HELICOPTER FLIGHT PATH LONG SECTIONS
SHEET 3 OF 10

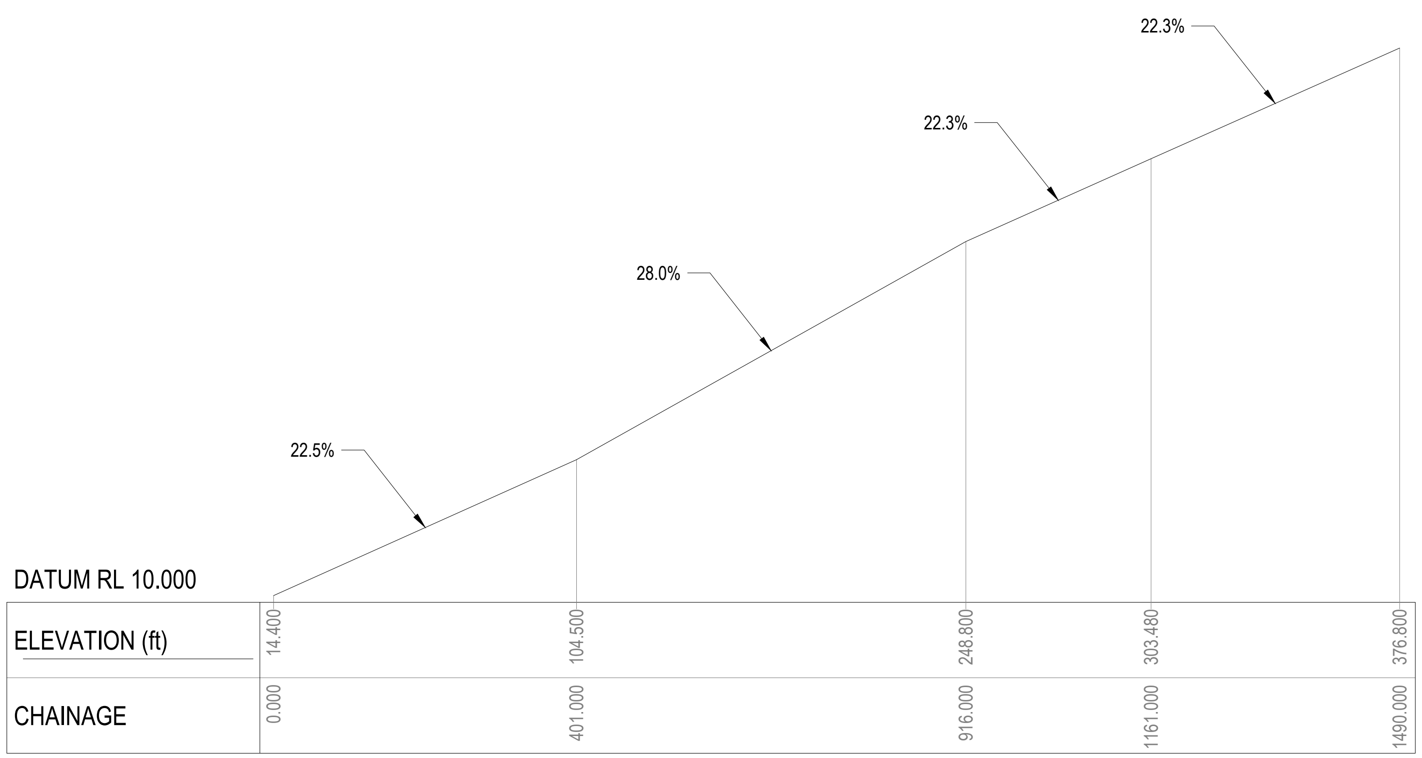
CLIENT PROJECT / DRAWING No | ISSUE STATUS: FOR INFORMATION | JJR PROJECT / DRAWING No: 2190111B-SK012 | ISSUE: A

A3 ORIGINAL 100 mm ON ORIGINAL



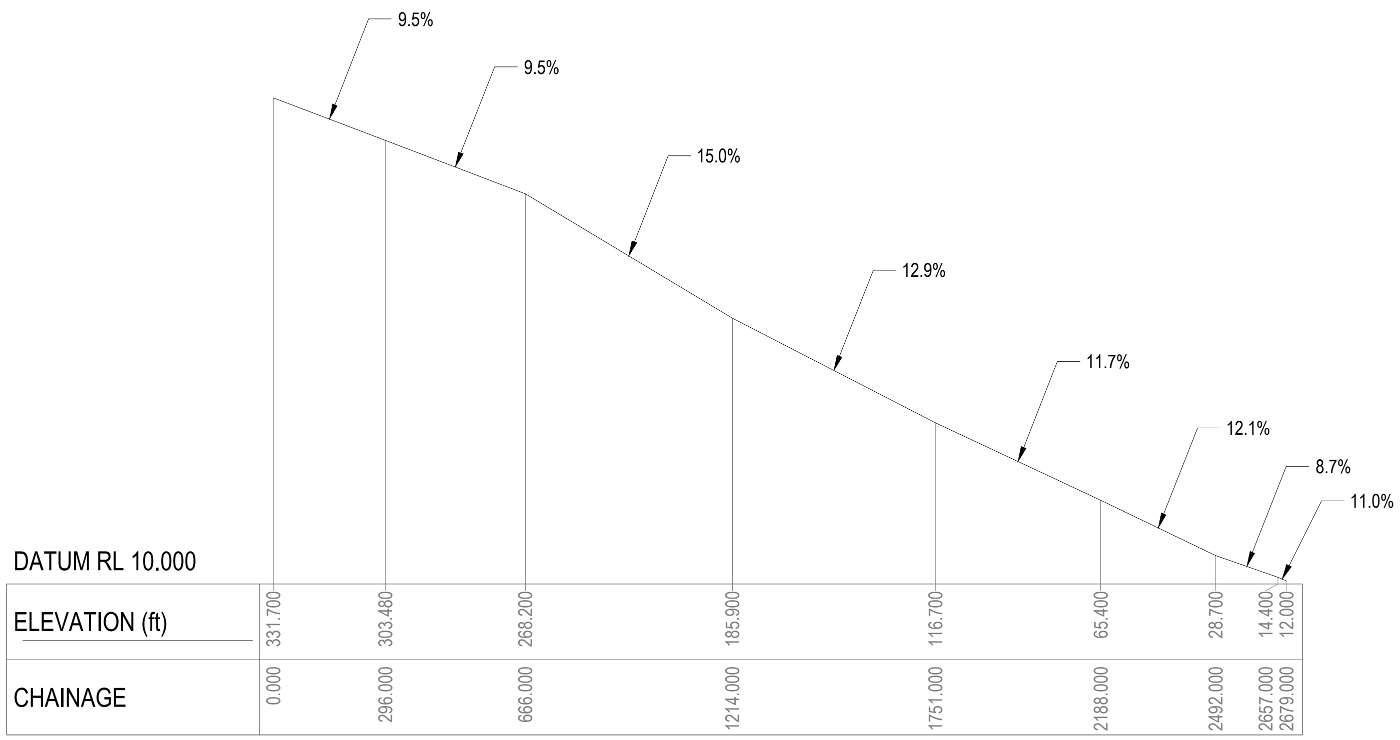
RUN 7 - TAKEOFF

SCALE - VERT 1:5000 HORZ 1:10000



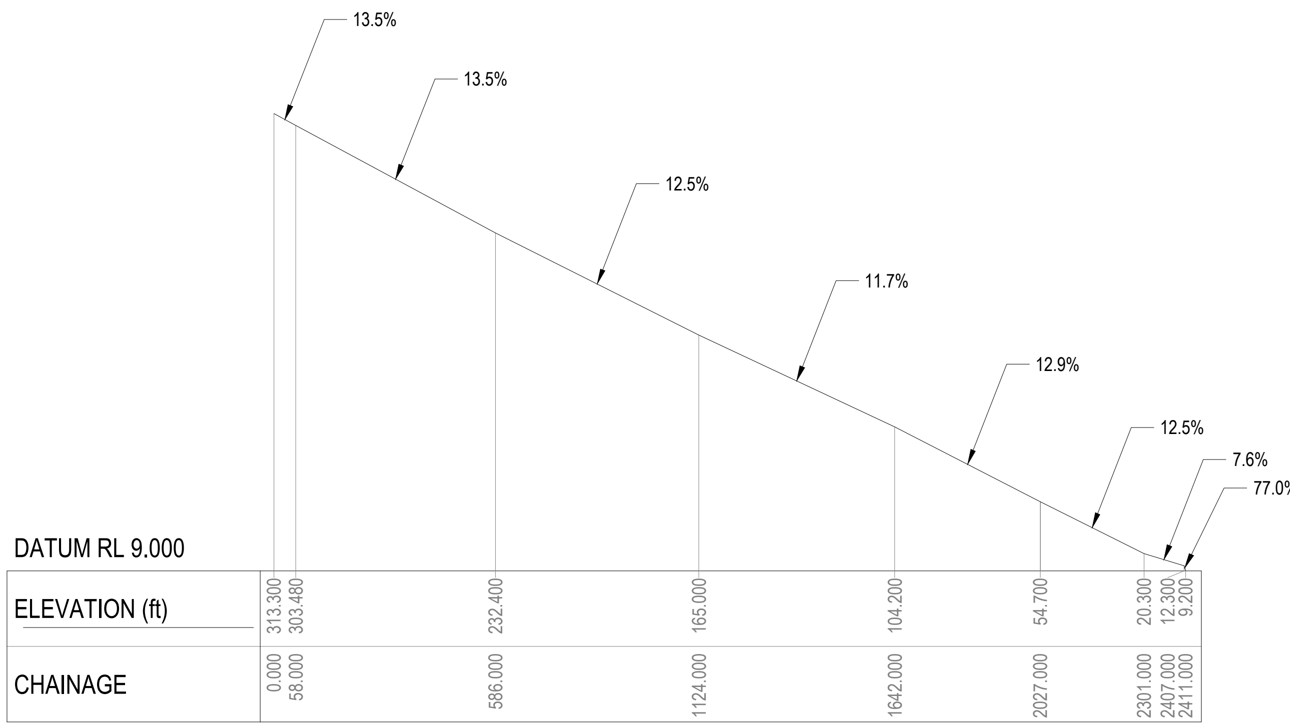
RUN 8 - TAKEOFF

SCALE - VERT 1:5000 HORZ 1:10000



RUN 7 - LANDING

SCALE - VERT 1:5000 HORZ 1:20000



RUN 8 - LANDING

SCALE - VERT 1:5000 HORZ 1:20000

DRAWING FILE LOCATION / NAME
C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK017.dwg

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

A3 ORIGINAL — 100 mm ON ORIGINAL

EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
	A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR

DESIGN LOT CODE: TS
PLOT DATE: 05 March 2019 TIME: 15:26:31

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

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

PRINCIPAL: JOHNSON PROPERTY GROUP

DESIGNER: JJ RYAN CONSULTING PTY LTD

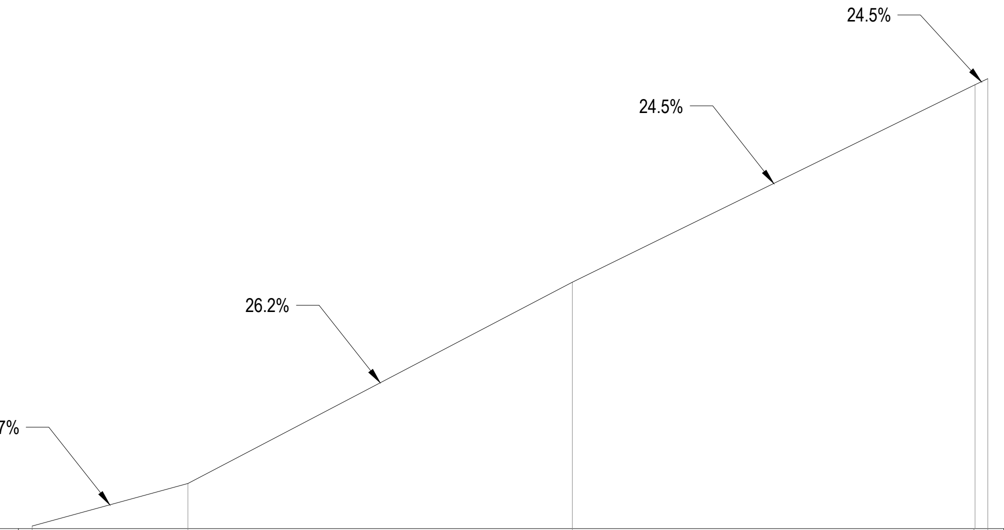
SCALES AT A3 SIZE DRAWING
SCALE 1:10000 — 50 0 50 100 150 200 250m

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: A.H.D.

JOHNSON PROPERTY GROUP
HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
HELICOPTER FLIGHT PATH LONG SECTIONS
SHEET 4 OF 10

CLIENT PROJECT / DRAWING No	ISSUE STATUS	JJR PROJECT / DRAWING No	ISSUE
	FOR INFORMATION	2190111B-SK013	A

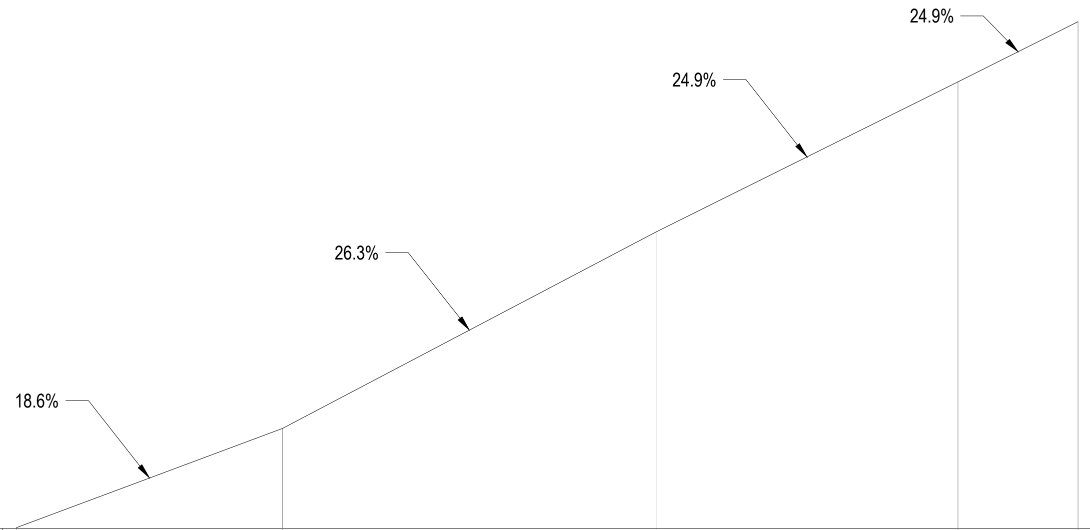
DRAWING FILE LOCATION / NAME
C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK018.dwg



DATUM RL 10.000

ELEVATION (ft)	11.600	39.900	173.000	303.480	307.600
CHAINAGE	0.000	206.000	715.000	1248.000	1265.000

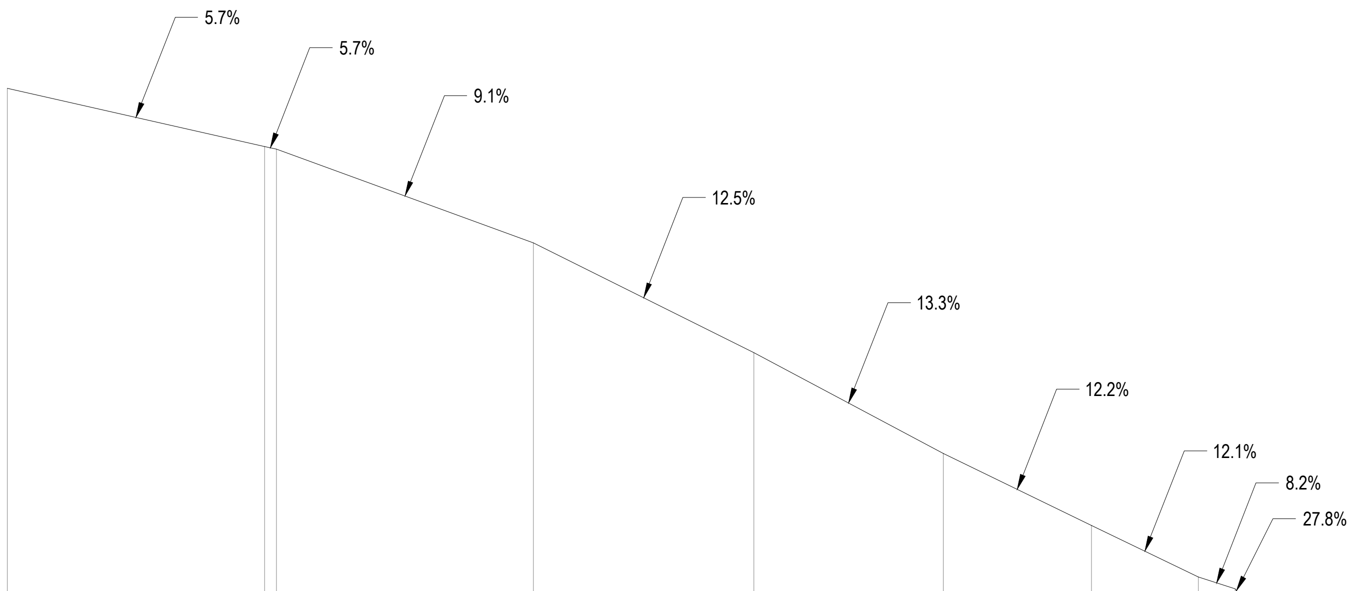
RUN 9 - TAKEOFF
SCALE - VERT 1:5000 HORZ 1:10000



DATUM RL 8.000

ELEVATION (ft)	8.700	74.200	204.100	303.480	343.200
CHAINAGE	0.000	352.000	494.000	1245.000	1404.000

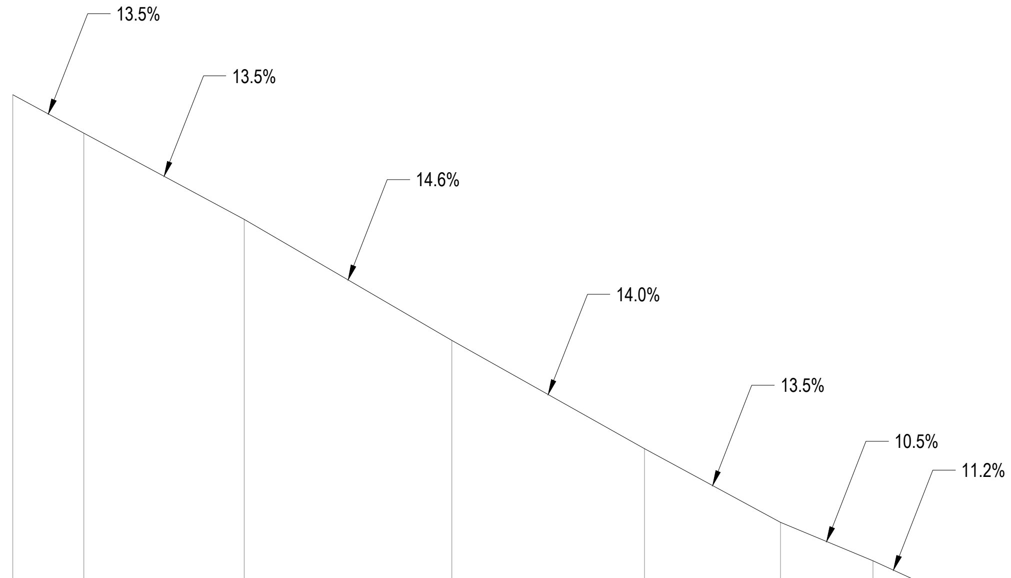
RUN 10 - TAKEOFF
SCALE - VERT 1:5000 HORZ 1:10000



DATUM RL 8.000

ELEVATION (ft)	342.000	303.480	301.700	239.700	167.100	100.500	52.900	18.700	10.800	8.400
CHAINAGE	0.000	680.000	712.000	1392.000	1975.000	2476.000	2868.000	3151.000	3248.000	3256.000

RUN 9 - LANDING
SCALE - VERT 1:5000 HORZ 1:20000



DATUM RL 8.000

ELEVATION (ft)	328.800	303.480	246.400	166.400	94.900	46.300	20.800	8.400
CHAINAGE	0.000	188.000	612.000	1161.000	1671.000	2031.000	2275.000	2385.000

RUN 10 - LANDING
SCALE - VERT 1:5000 HORZ 1:20000

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

A3 ORIGINAL 100 mm ON ORIGINAL

EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
	A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR

DESIGN LOT CODE: TS
PLOT DATE: 05 March 2019 TIME: 15:27:20

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

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

PRINCIPAL: JOHNSON PROPERTY GROUP

DESIGNER: JJ RYAN CONSULTING PTY LTD

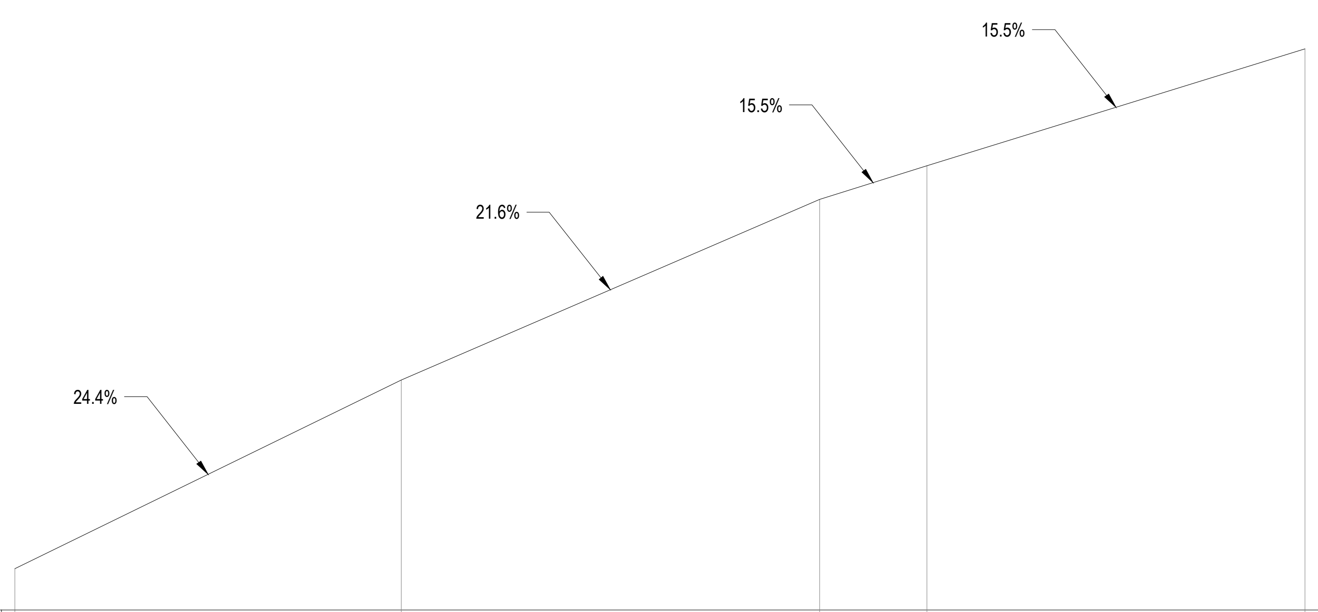
SCALES AT A3 SIZE DRAWING: SCALE 1:10000 — 50 0 50 100 150 200 250m

CO-ORDINATE SYSTEM: MGA ZONE 56 | HEIGHT DATUM: A.H.D.

JOHNSON PROPERTY GROUP
HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
HELICOPTER FLIGHT PATH LONG SECTIONS
SHEET 5 OF 10

CLIENT PROJECT / DRAWING No	ISSUE STATUS	JJR PROJECT / DRAWING No	ISSUE
	FOR INFORMATION	2190111B-SK014	A

C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK019.dwg

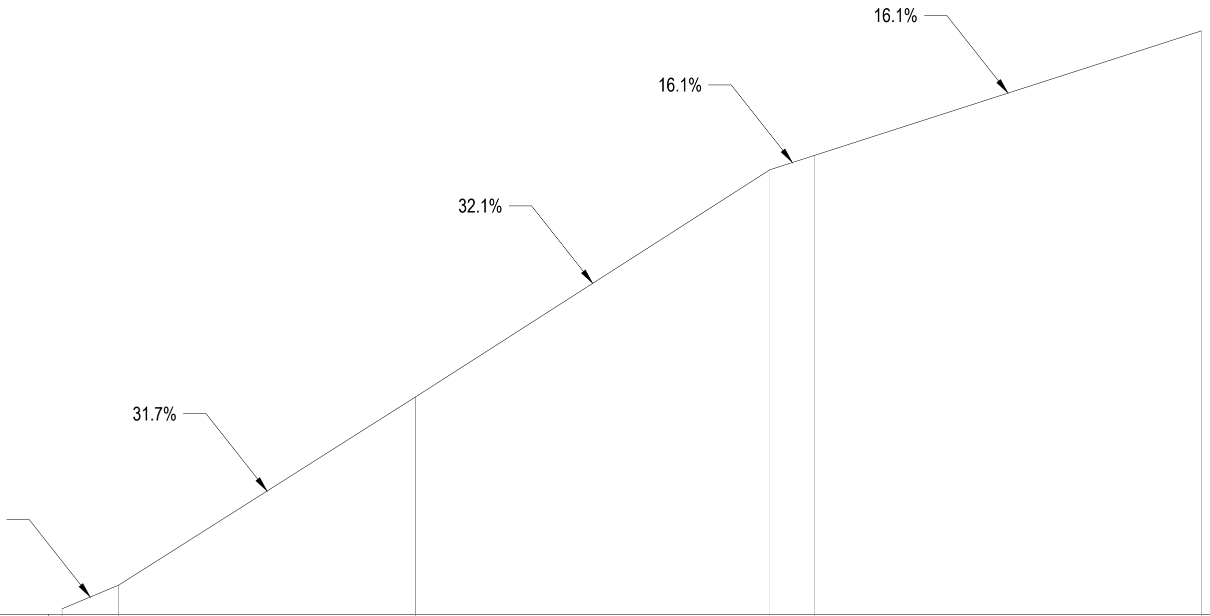


DATUM RL 10.000

ELEVATION (ft)	37.400	161.900	281.400	303.480	380.900
CHAINAGE	0.000	511.000	1064.000	1206.000	1706.000

RUN 11 - TAKEOFF

SCALE - VERT 1:5000 HORZ 1:10000

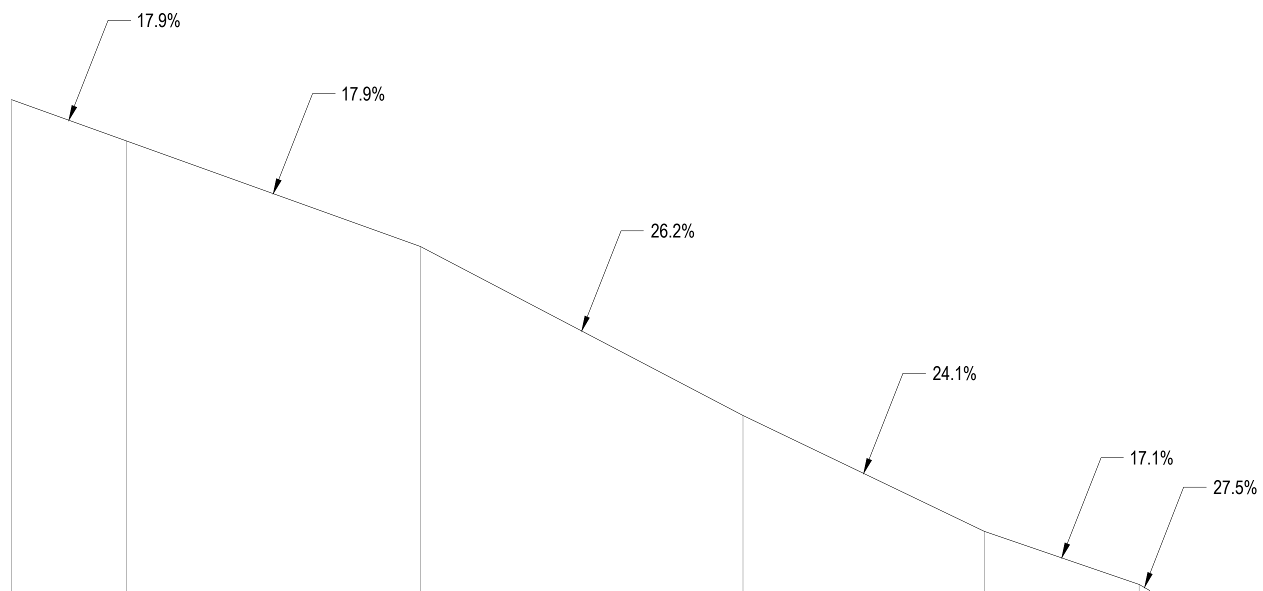


DATUM RL 0.000

ELEVATION (ft)	3.500	19.100	143.600	294.000	303.480	385.800
CHAINAGE	0.000	75.000	468.000	937.000	996.000	1508.000

RUN 12 - TAKEOFF

SCALE - VERT 1:5000 HORZ 1:10000

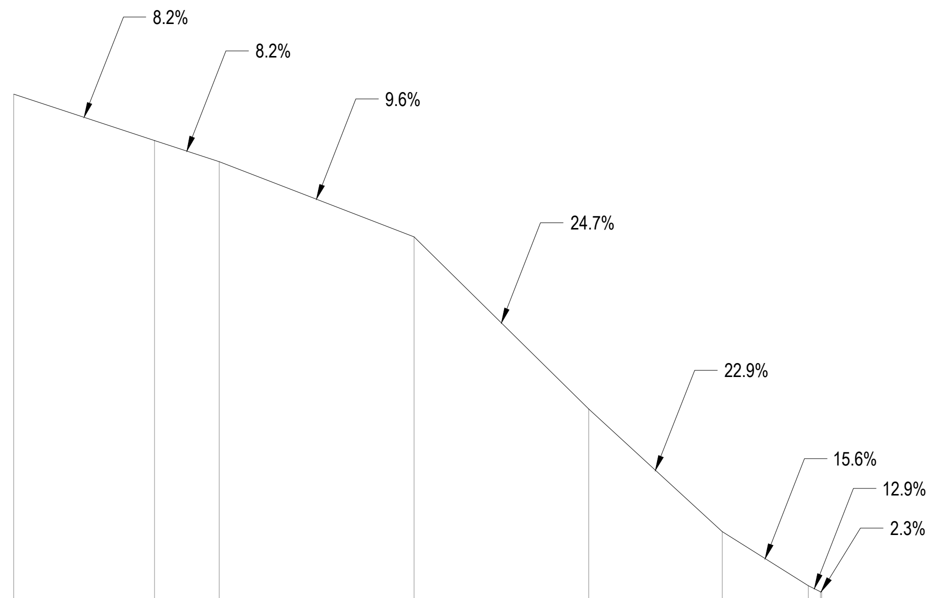


DATUM RL 5.000

ELEVATION (ft)	330.800	303.480	233.800	122.000	45.300	10.200	6.300
CHAINAGE	0.000	152.000	541.000	968.000	1287.000	1492.000	1506.000

RUN 11 - LANDING

SCALE - VERT 1:5000 HORZ 1:10000



DATUM RL 0.000

ELEVATION (ft)	334.100	303.480	289.400	239.800	125.800	44.700	9.100	5.000	4.900
CHAINAGE	0.000	372.000	543.000	1059.000	1521.000	1874.000	2102.000	2134.000	2138.000

RUN 12 - LANDING

SCALE - VERT 1:5000 HORZ 1:20000

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

A3 ORIGINAL — 100 mm ON ORIGINAL

EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
	A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR

DESIGN LOT CODE: TS — PLOT DATE: 05 March 2019 — TIME: 15:32:58

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

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

PRINCIPAL: JOHNSON PROPERTY GROUP

DESIGNER: JJ RYAN CONSULTING PTY LTD

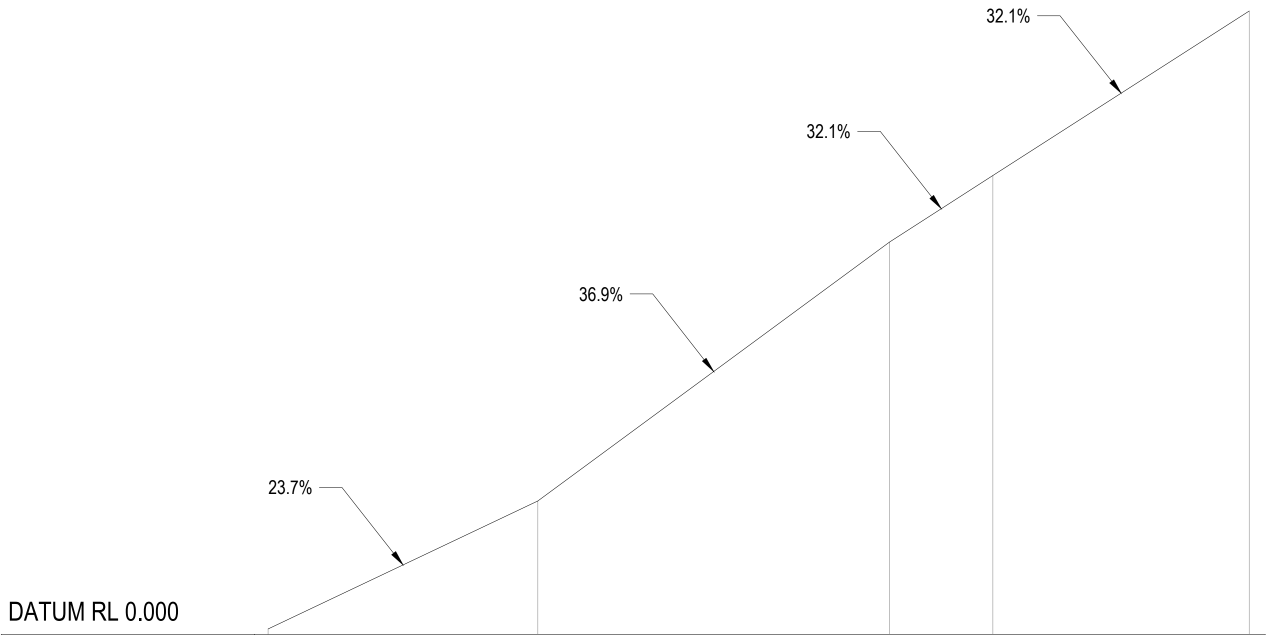
SCALES AT A3 SIZE DRAWING: SCALE 1:10000 — 50 0 50 100 150 200 250m

CO-ORDINATE SYSTEM: MGA ZONE 56 — HEIGHT DATUM: A.H.D.

JOHNSON PROPERTY GROUP

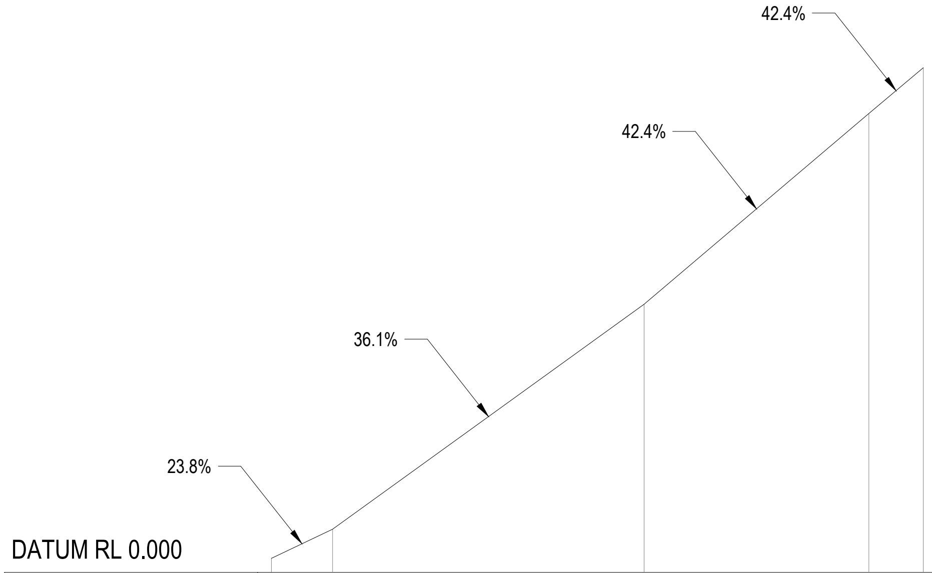
HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
HELICOPTER FLIGHT PATH LONG SECTIONS
SHEET 6 OF 10

CLIENT PROJECT / DRAWING No	ISSUE STATUS	JJR PROJECT / DRAWING No	ISSUE
	FOR INFORMATION	2190111B-SK015	A



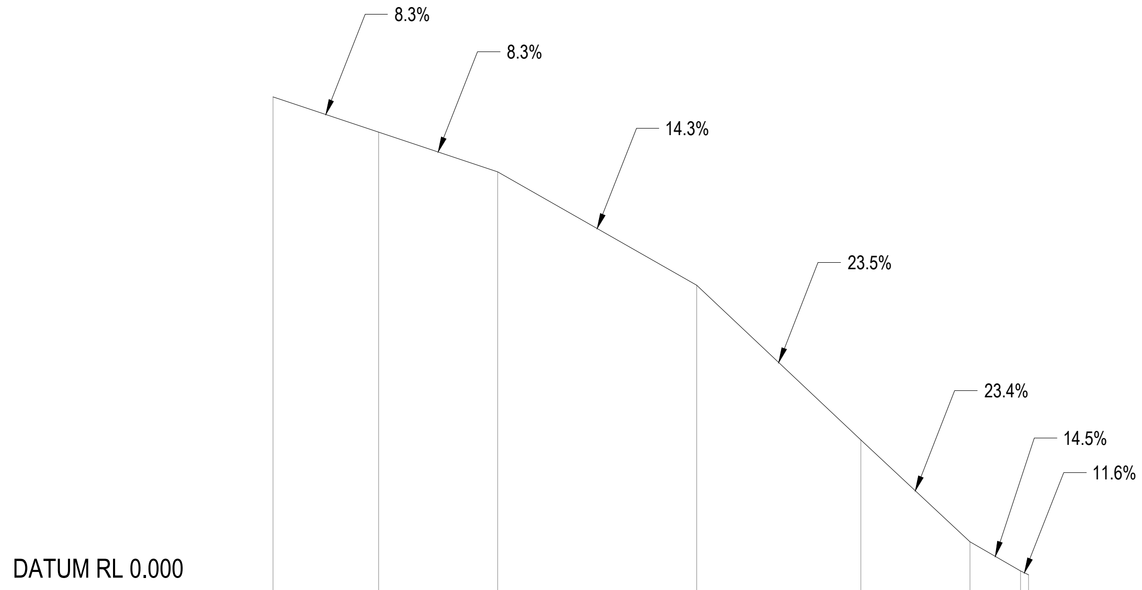
ELEVATION (ft)	3.500	88.200	259.400	303.480	412.300
CHAINAGE	0.000	357.000	822.000	959.000	1298.000

RUN 13 - TAKEOFF
SCALE - VERT 1:5000 HORZ 1:10000



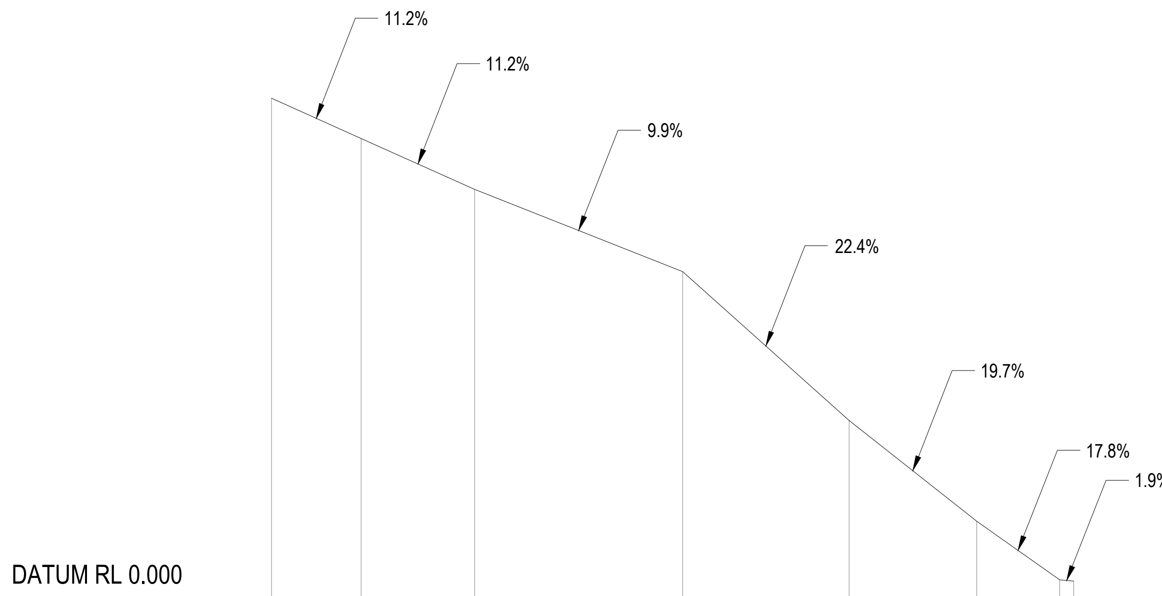
ELEVATION (ft)	9.300	28.600	177.300	303.480	333.700
CHAINAGE	0.000	81.000	493.000	790.000	862.000

RUN 14 - TAKEOFF
SCALE - VERT 1:5000 HORZ 1:10000



ELEVATION (ft)	326.800	303.480	277.200	202.200	100.100	32.800	13.400	10.900
CHAINAGE	0.000	280.000	595.000	1121.000	1556.000	1844.000	1978.000	1999.000

RUN 13 - LANDING
SCALE - VERT 1:5000 HORZ 1:20000



ELEVATION (ft)	330.000	303.480	269.800	215.400	117.000	50.400	11.500	10.800
CHAINAGE	0.000	237.000	538.000	1088.000	1528.000	1866.000	2085.000	2123.000

RUN 14 - LANDING
SCALE - VERT 1:5000 HORZ 1:20000

DRAWING FILE LOCATION / NAME
C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK020.dwg

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

A3 ORIGINAL — 100 mm ON ORIGINAL

EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
	A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR

DESIGN LOT CODE: TS
PLOT DATE: 05 March 2019 — TIME: 15:33:33

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

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

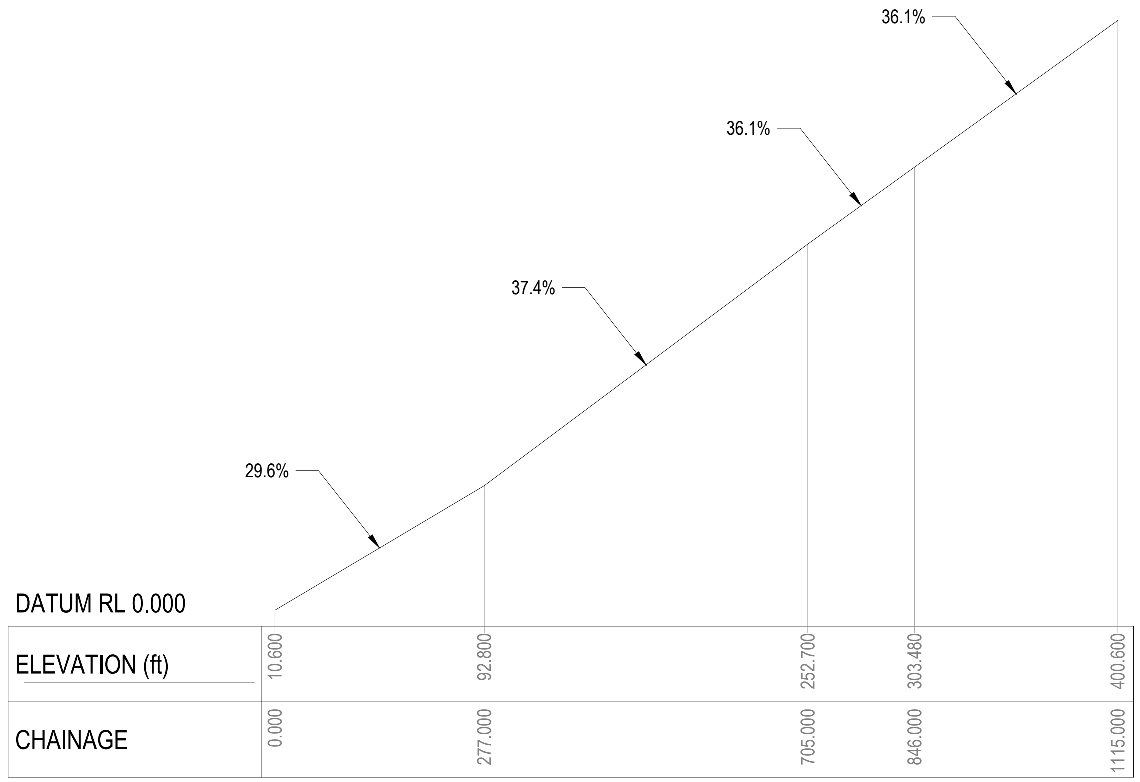
PRINCIPAL: JOHNSON PROPERTY GROUP
DESIGNER: JJ RYAN CONSULTING PTY LTD

SCALES AT A3 SIZE DRAWING
SCALE 1:10000 — 50 0 50 100 150 200 250m

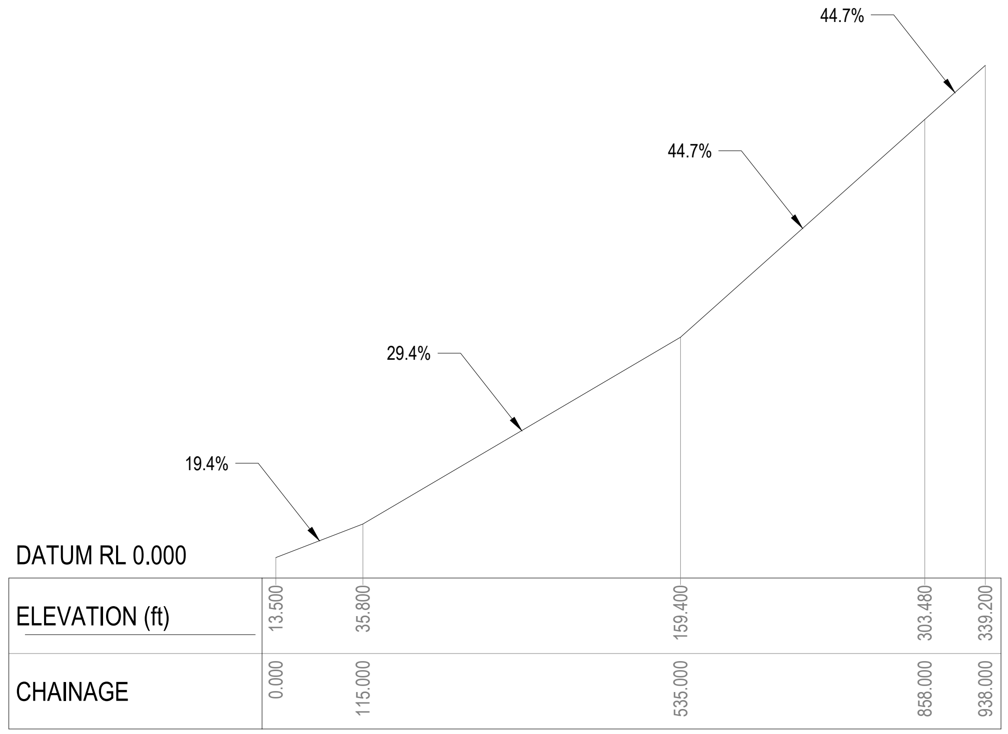
CO-ORDINATE SYSTEM: MGA ZONE 56 — HEIGHT DATUM: A.H.D.

JOHNSON PROPERTY GROUP
HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
HELICOPTER FLIGHT PATH LONG SECTIONS
SHEET 7 OF 10

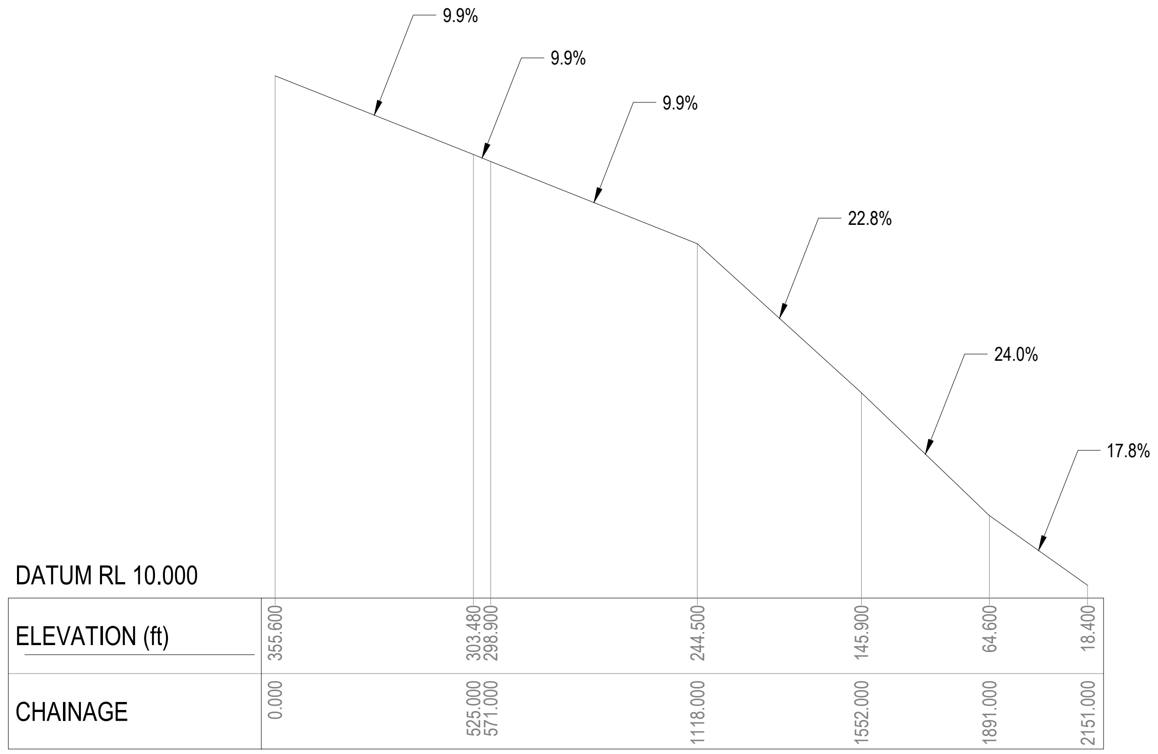
CLIENT PROJECT / DRAWING No
ISSUE STATUS: FOR INFORMATION
JJR PROJECT / DRAWING No: 2190111B-SK016
ISSUE: A



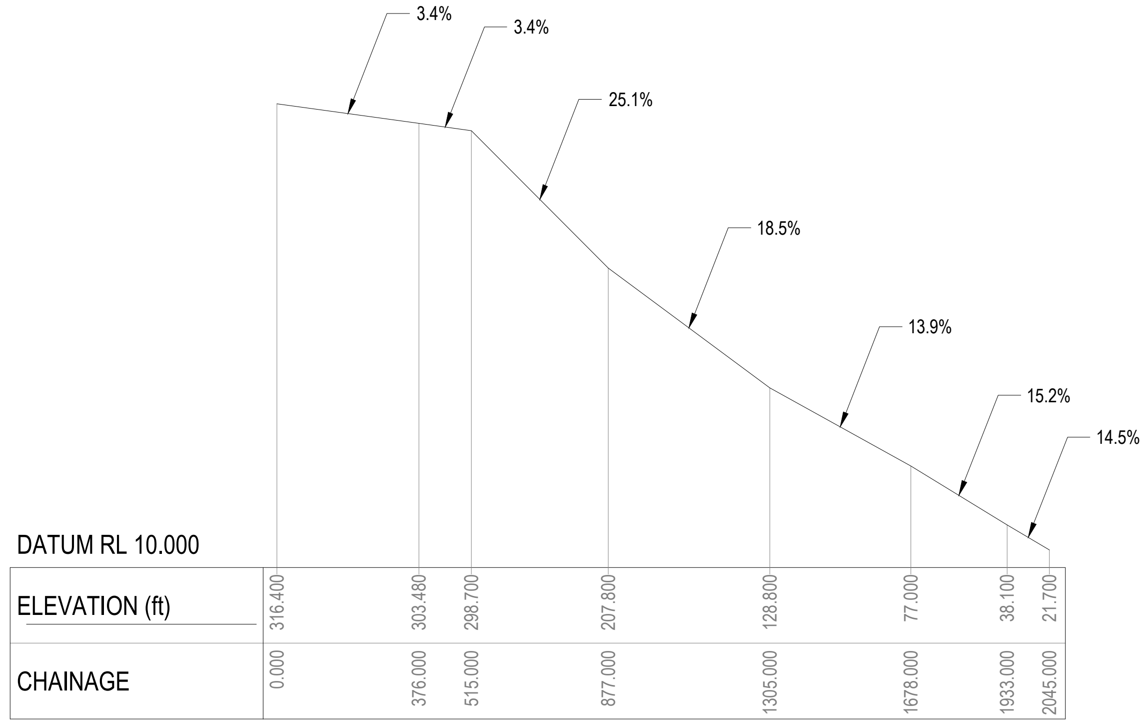
RUN 15 - TAKEOFF
SCALE - VERT 1:5000 HORZ 1:10000



RUN 16 - TAKEOFF
SCALE - VERT 1:5000 HORZ 1:10000



RUN 15 - LANDING
SCALE - VERT 1:5000 HORZ 1:20000



RUN 16 - LANDING
SCALE - VERT 1:5000 HORZ 1:20000

DRAWING FILE LOCATION / NAME
C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK021.dwg

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

A3 ORIGINAL 100 mm ON ORIGINAL

EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
	A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR

DESIGN LOT CODE: TS
PLOT DATE: 05 March 2019
TIME: 15:34:17
DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

PRINCIPAL: JOHNSON PROPERTY GROUP
DESIGNER: JJ RYAN CONSULTING PTY LTD

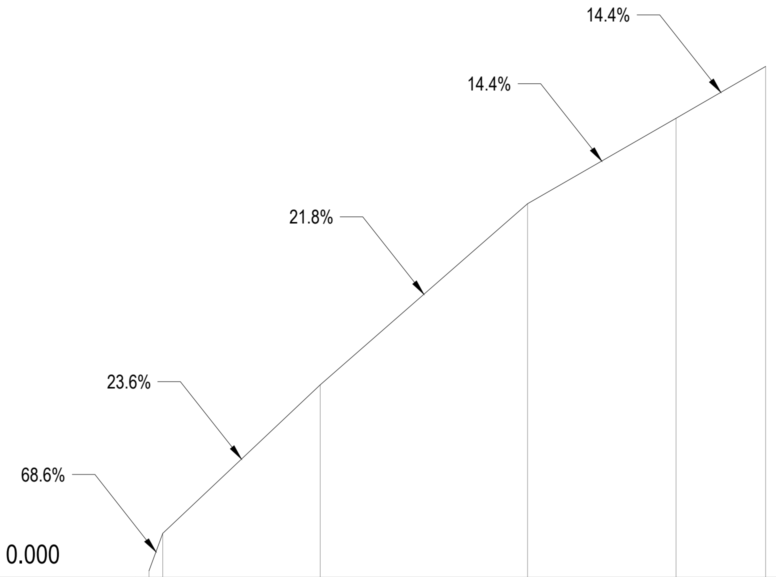
SCALES AT A3 SIZE DRAWING
SCALE 1:10000 — 50 0 50 100 150 200 250m

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: A.H.D.

JOHNSON PROPERTY GROUP
HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
HELICOPTER FLIGHT PATH LONG SECTIONS
SHEET 8 OF 10

CLIENT PROJECT / DRAWING No
ISSUE STATUS: FOR INFORMATION
JJR PROJECT / DRAWING No: 2190111B-SK017
ISSUE: A

C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK022.dwg

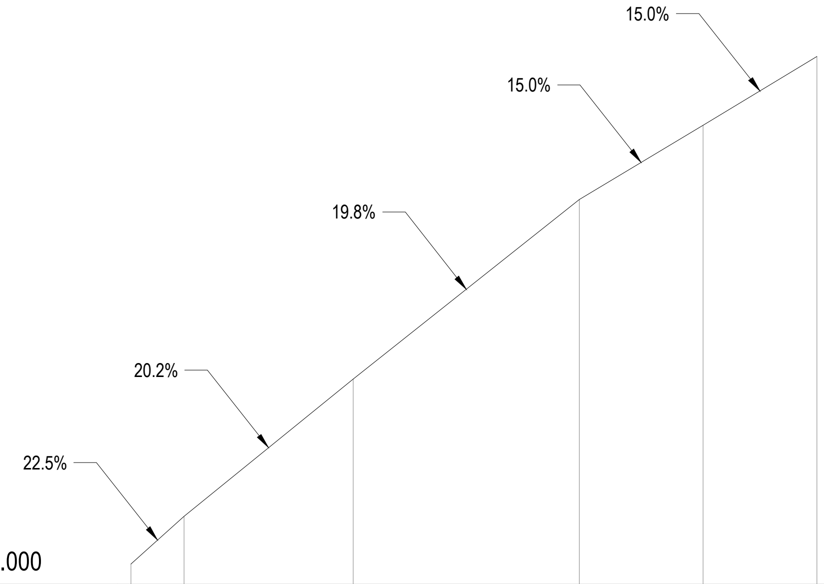


DATUM RL 0.000

ELEVATION (ft)	4.200 / 29.000	127.000	246.900	303.480	337.700	
CHAINAGE	0.000 / 36.000	453.000	1001.000	1394.000	1631.000	

RUN 17 - TAKEOFF

SCALE - VERT 1:5000 HORZ 1:20000

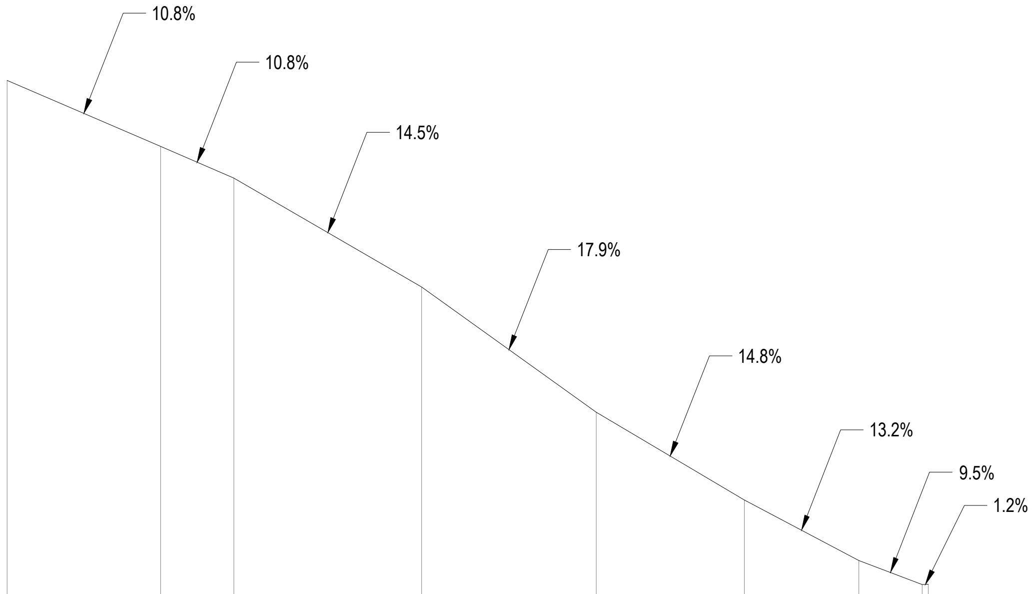


DATUM RL 0.000

ELEVATION (ft)	13.400	44.900	135.600	254.300	303.480	348.900
CHAINAGE	0.000	140.000	588.000	1187.000	1514.000	1816.000

RUN 18 - TAKEOFF

SCALE - VERT 1:5000 HORZ 1:20000

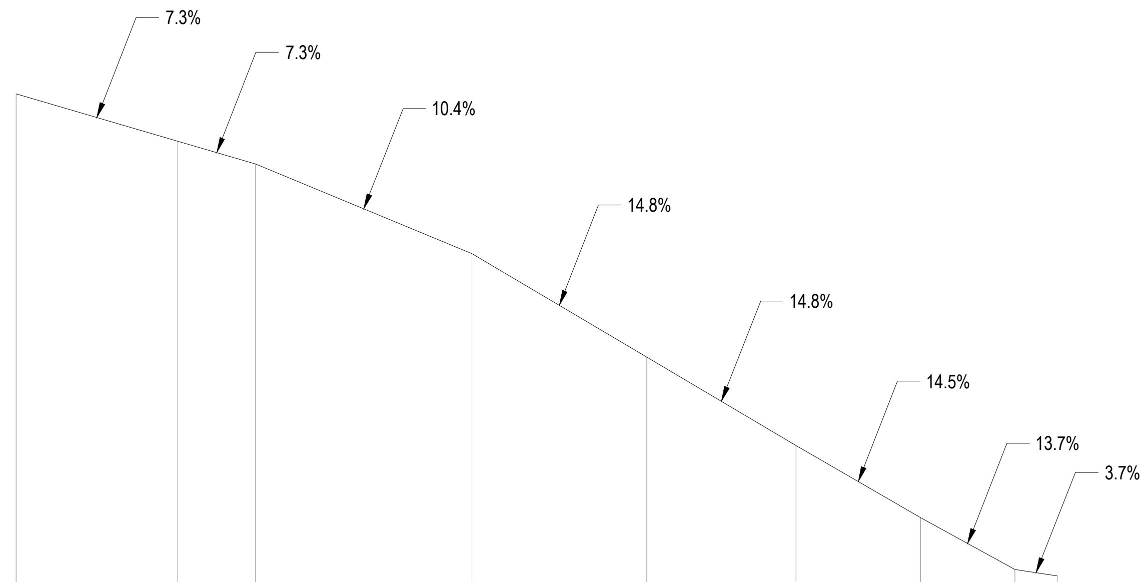


DATUM RL 0.000

ELEVATION (ft)	347.200	303.480	282.600	210.600	127.800	69.900	30.000	14.000	14.200
CHAINAGE	0.000	406.000	600.000	1097.000	1559.000	1951.000	2254.000	2422.000	2438.000

RUN 17 - LANDING

SCALE - VERT 1:5000 HORZ 1:20000



DATUM RL 10.000

ELEVATION (ft)	334.800	303.480	288.400	229.200	160.800	102.400	54.700	20.500	16.300
CHAINAGE	0.000	428.000	634.000	1206.000	1668.000	2063.000	2392.000	2642.000	2754.000

RUN 18 - LANDING

SCALE - VERT 1:5000 HORZ 1:20000

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

A3 ORIGINAL — 100 mm ON ORIGINAL

EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
	A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR

DESIGN LOT CODE: TS
PLOT DATE: 05 March 2019 — TIME: 15:35:08

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

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

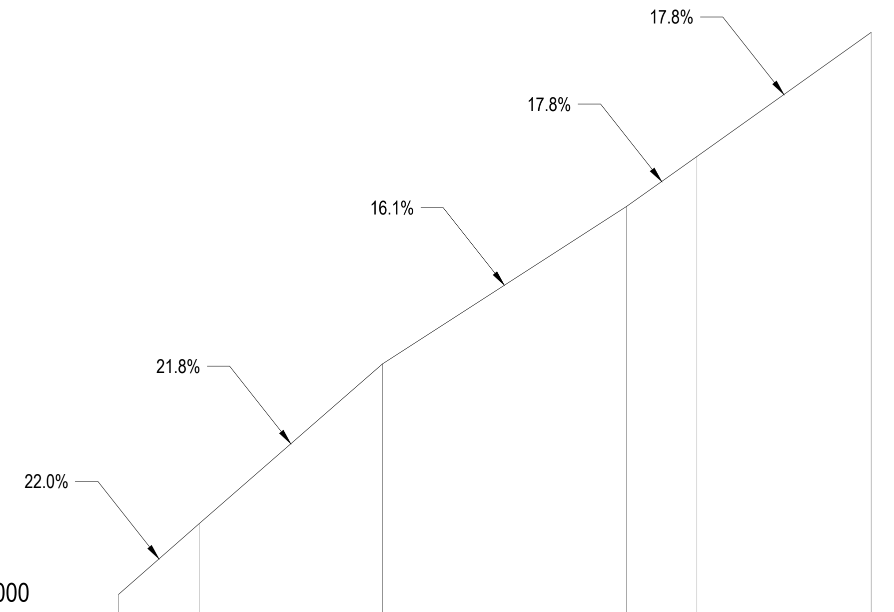
PRINCIPAL: JOHNSON PROPERTY GROUP
DESIGNER: JJ RYAN CONSULTING PTY LTD

SCALES AT A3 SIZE DRAWING: SCALE 1:10000 — 50 0 50 100 150 200 250m

CO-ORDINATE SYSTEM: MGA ZONE 56 — HEIGHT DATUM: A.H.D.

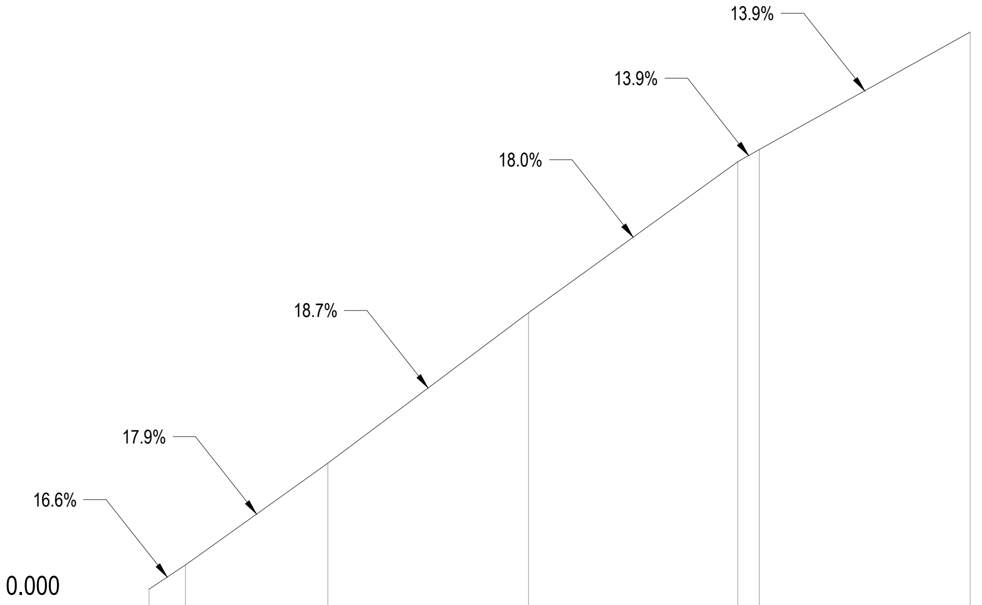
JOHNSON PROPERTY GROUP
HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
HELICOPTER FLIGHT PATH LONG SECTIONS
SHEET 9 OF 10

CLIENT PROJECT / DRAWING No — ISSUE STATUS: FOR INFORMATION — JJR PROJECT / DRAWING No: 2190111B-SK018 — ISSUE: A



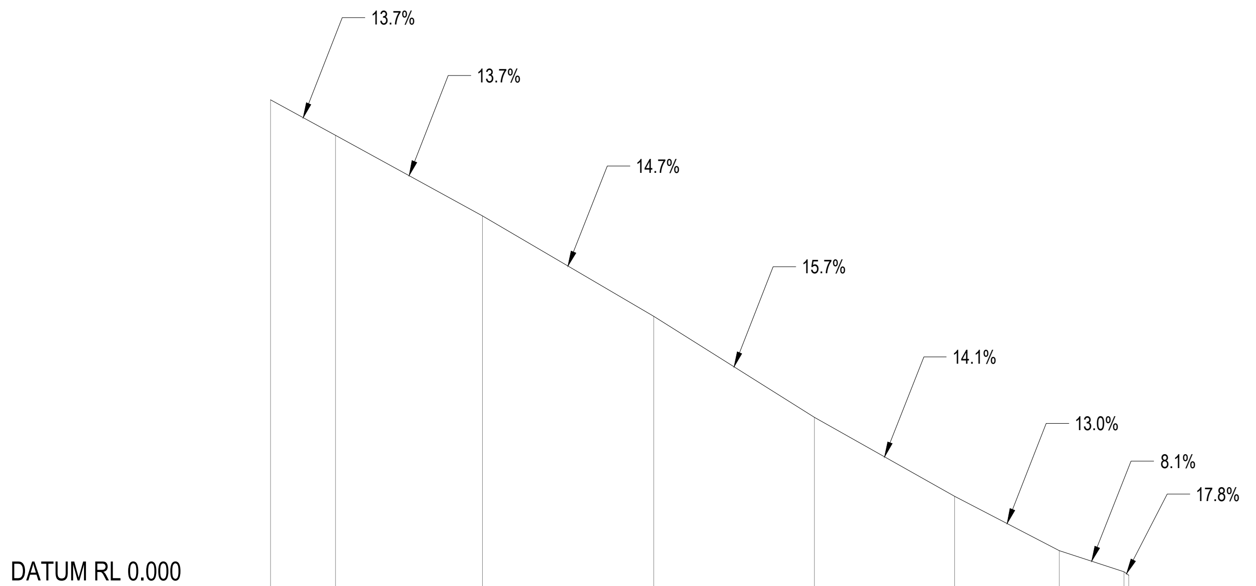
ELEVATION (ft)	13.900	60.800	166.400	270.400	303.480	385.500
CHAINAGE	0.000	213.000	698.000	1344.000	1530.000	1992.000

RUN 19 - TAKEOFF
SCALE - VERT 1:5000 HORZ 1:20000



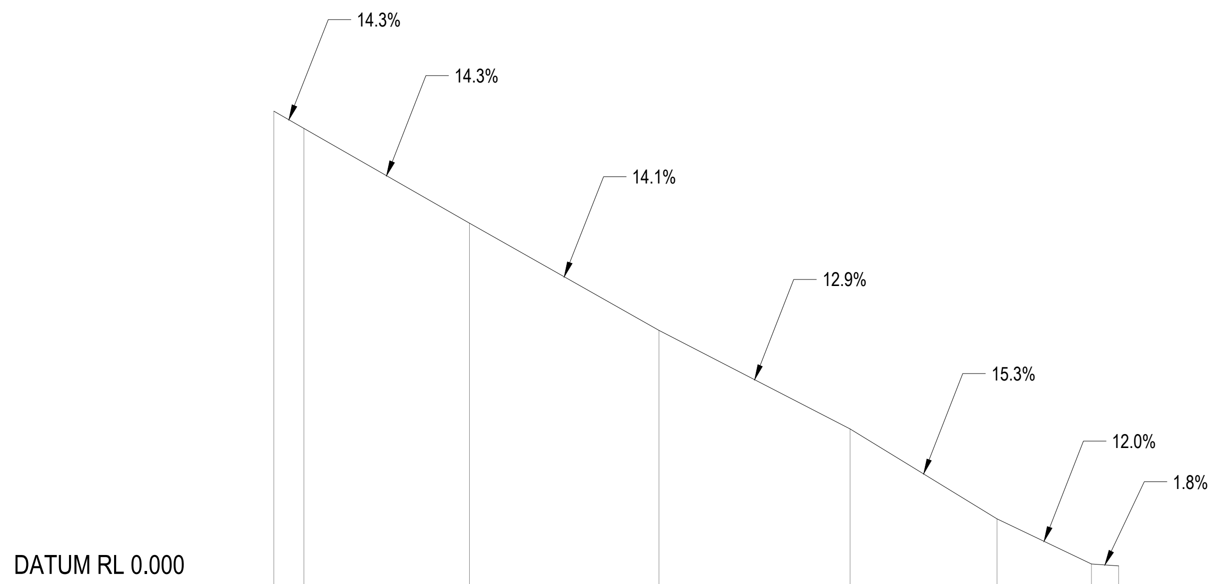
ELEVATION (ft)	12.600	28.700	96.100	195.500	295.500	303.480	381.100
CHAINAGE	0.000	97.000	473.000	1004.000	1558.000	1615.000	2173.000

RUN 20 - TAKEOFF
SCALE - VERT 1:5000 HORZ 1:20000



ELEVATION (ft)	327.000	303.480	250.200	183.800	116.900	64.600	28.600	14.700	12.300
CHAINAGE	0.000	172.000	560.000	1013.000	1438.000	1809.000	2086.000	2257.000	2270.000

RUN 19 - LANDING
SCALE - VERT 1:5000 HORZ 1:20000



ELEVATION (ft)	315.000	303.480	240.900	170.000	104.800	45.400	15.500	14.200
CHAINAGE	0.000	80.000	517.000	1019.000	1524.000	1913.000	2162.000	2234.000

RUN 20 - LANDING
SCALE - VERT 1:5000 HORZ 1:20000

EXTERNAL REFERENCE FILES

REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR

DESIGN LOT CODE: TS
PLOT DATE: 05 March 2019 TIME: 15:35:54

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

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

PRINCIPAL: JOHNSON PROPERTY GROUP

DESIGNER: JJ RYAN CONSULTING PTY LTD

SCALES AT A3 SIZE DRAWING
SCALE 1:10000 — 50 0 50 100 150 200 250m

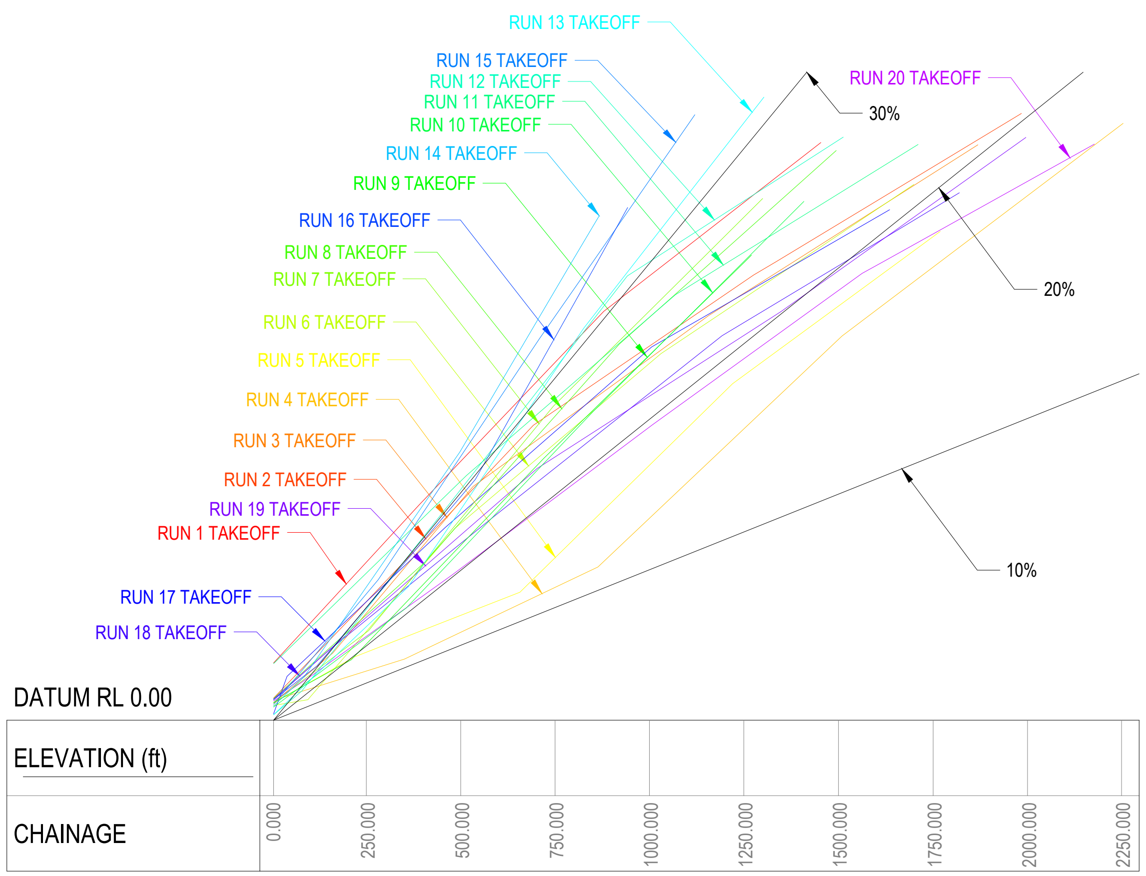
CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: A.H.D.

JOHNSON PROPERTY GROUP
HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
HELICOPTER FLIGHT PATH LONG SECTIONS
SHEET 10 OF 10

CLIENT PROJECT / DRAWING No:
ISSUE STATUS: FOR INFORMATION
JJR PROJECT / DRAWING No: 2190111B-SK019
ISSUE: A

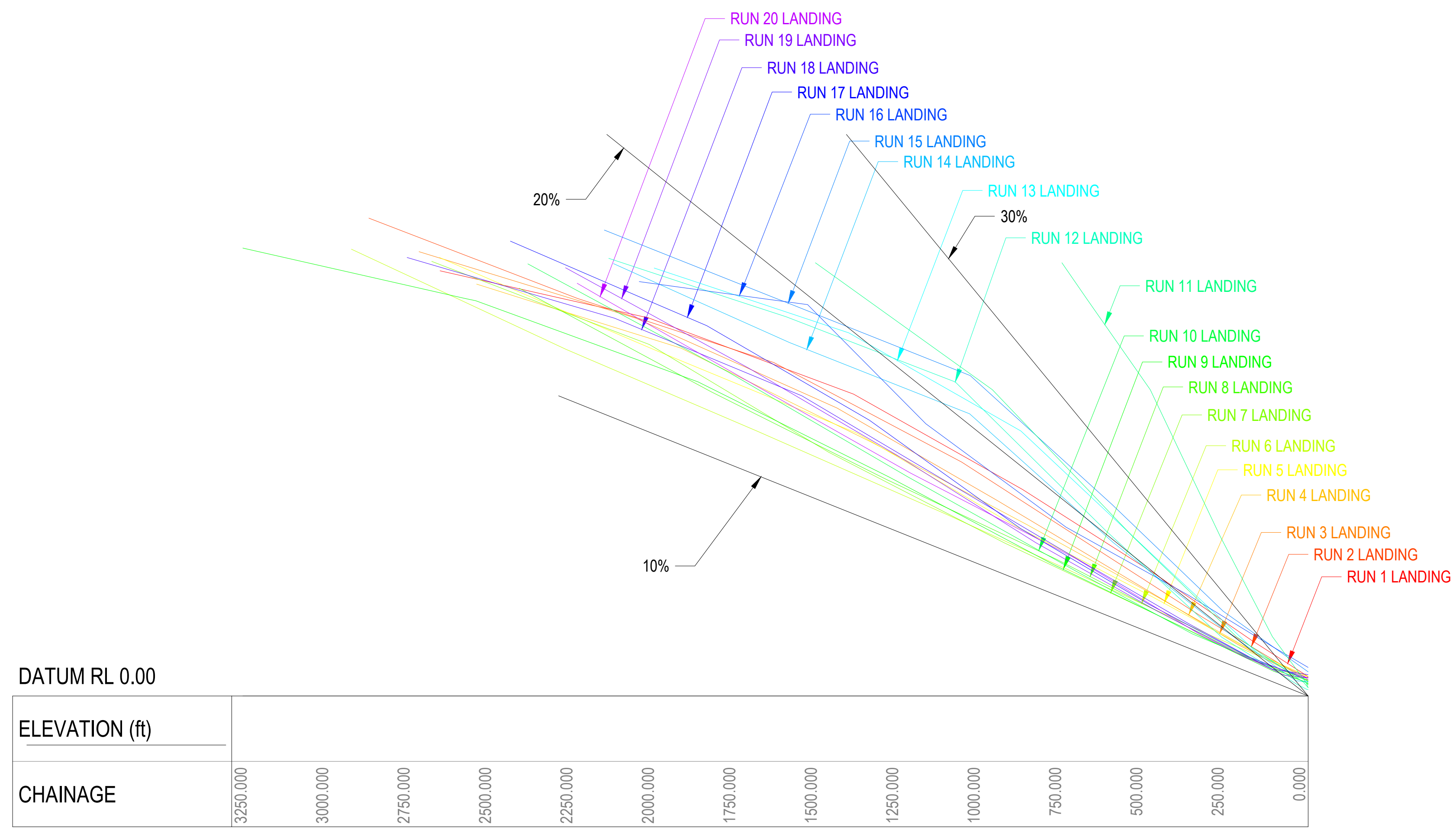
DRAWING FILE LOCATION / NAME
C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK024.dwg

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED



RUN 1 - 20 TAKEOFF

SCALE - VERT 1:5000 HORZ 1:20000



RUN 1 - 20 LANDING

SCALE - VERT 1:5000 HORZ 1:20000

EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
	A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR

DESIGN LOT CODE: TS

PLOT DATE: 05 March 2019 TIME: 15:41:13

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

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

PRINCIPAL: JOHNSON PROPERTY GROUP

DESIGNER: JJ RYAN CONSULTING PTY LTD

SCALES AT A3 SIZE DRAWING

CO-ORDINATE SYSTEM: MGA ZONE 56

HEIGHT DATUM: A.H.D.

JOHNSON PROPERTY GROUP

HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
COMBINED FLIGHT PATH PROFILES
SHEET 1 OF 1

CLIENT PROJECT / DRAWING No

ISSUE STATUS: FOR INFORMATION

JJR PROJECT / DRAWING No: JJR-2190111B-SK020

ISSUE: A

A3 ORIGINAL 100 mm ON ORIGINAL

LEGEND:

- 100km/h DOWNWASH VELOCITY ENVELOPE
- 80km/h DOWNWASH VELOCITY ENVELOPE
- 60km/h DOWNWASH VELOCITY ENVELOPE
- SAFETY AREA
- 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 ADW JOHNSON. 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.

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

A3 ORIGINAL — 100 mm ON ORIGINAL

DRAWING FILE LOCATION / NAME: C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK025.dwg

DESIGN LOT CODE	PLOT DATE	TIME	DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING
TS	05 March 2019	15:42:16	

EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
x_jjr_title_block_a3 x_legend x_flight paths	A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

PRINCIPAL: JOHNSON PROPERTY GROUP

DESIGNER: JJ RYAN CONSULTING PTY LTD

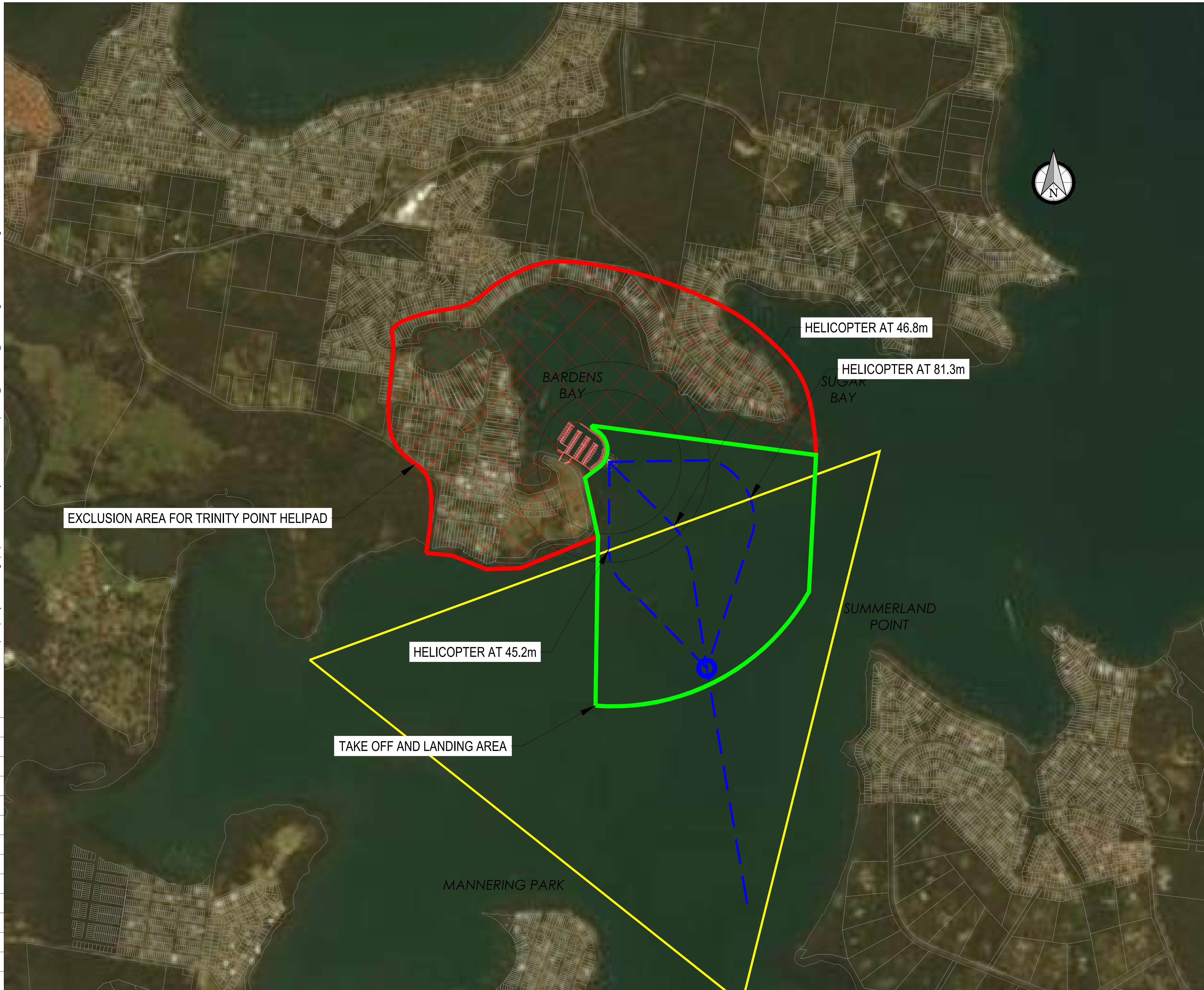
SCALES AT A3 SIZE DRAWING: SCALE 1:5000 (25 0 25 50 75 100 125)

CO-ORDINATE SYSTEM: MGA ZONE 56 — HEIGHT DATUM: A.H.D.

JOHNSON PROPERTY GROUP

HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
COMBINED FLIGHT PATHS

CLIENT PROJECT / DRAWING No	ISSUE STATUS	JJR PROJECT / DRAWING No	ISSUE
	FOR INFORMATION	JJR-2190111B-SK021	A



LEGEND:

- 100km/h DOWNWASH VELOCITY ENVELOPE
- 80km/h DOWNWASH VELOCITY ENVELOPE
- 60km/h DOWNWASH VELOCITY ENVELOPE
- SAFETY AREA
- 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 ADW JOHNSON. 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.

DRAWING FILE LOCATION / NAME
C:\Users\Tom\Dropbox (JJ Ryan Consulting P)\Operations Folder\Projects\JJR-2190111B-Sparke\02_Technical\04_CAD\Drawings\2190111B-SK026.dwg

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

A3 ORIGINAL 100 mm ON ORIGINAL

DESIGN LOT CODE: TS
PLOT DATE: 22 May 2019
TIME: 13:05:39
DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING

EXTERNAL REFERENCE FILES
x_jjr_title_block_a3
x_legend
x_flight paths

REV	DATE	AMENDMENT / REVISION DESCRIPTION	DVF No	APPROVAL
A	05.03.2019	ISSUED FOR INFORMATION	N/A	JR
B	22.05.2019	REVISED TAKE OFF AND LANDING AREA	N/A	JR

TITLE	NAME
DRAFTER	T. BLACK
DRAFTING CHECK	H. ANSTEE
DESIGNER	H. ANSTEE
DESIGN CHECK	S.ECCLES
DESIGN MANAGER	J.RYAN
PROJECT MANAGER	J.RYAN

PRINCIPAL: JOHNSON PROPERTY GROUP

DESIGNER: JJ RYAN CONSULTING PTY LTD

SCALES AT A3 SIZE DRAWING
SCALE 1:5000 (25 0 25 50 75 100 125)

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: A.H.D.

JOHNSON PROPERTY GROUP
HELICOPTER DOWNWASH ASSESSMENT
PROPOSED HELIPAD DEVELOPMENT AT TRINITY POINT
TAKE OFF, LANDING AND EXCLUSION AREAS

CLIENT PROJECT / DRAWING No
ISSUE STATUS: FOR INFORMATION
JJR PROJECT / DRAWING No: JJR-2190111B-SK022
ISSUE: B

Appendix C – Historical Wind Speed Data

APPENDIX A: WIND DATA

TABLE A1: INDICATIVE 'ANNUAL' WIND DIRECTION PERCENTAGES AND VELOCITY – BOM HISTORICAL DATA

Prevailing Wind	AM Arrival	Av. Wind Speed kmph	PM Arrival	Av. Wind Speed kmph
North	14%	30	7%	31
North East	8%	31	21.5%	42
East	3%	31	11.5%	31
South East	6.5%	41	14%	41
South	17%	43	25.5%	46
South West	18.5%	31	7.5%	41
West	17%	22	6%	30
North West	16%	31	7%	30

Notes:

1. This analysis is based on BOM historical data being daily readings at 9.00 AM and 3.00 PM.
2. Pilots will normally always land and take-off into the prevailing wind.
3. The approach to the HLS will be briefed to all pilots through the Trinity Point Operations Procedure.
4. Pilots will always be responsible for the conduct of the flight and the flightpath they use.
5. Safety will always be the overriding factor in flightpath selection.

TABLE A2: INDICATIVE 'SUMMER' WIND DIRECTION PERCENTAGES AND VELOCITY – BOM HISTORICAL DATA

Prevailing Wind	AM Arrival	Av. Wind Speed kmph	PM Arrival	Av. Wind Speed kmph
North	17%	30	4%	37
North East	15%	30	31%	42
East	6%	27	16%	34
South East	9%	41	18%	41
South	25%	43	25%	44
South West	15%	37	3%	41
West	6%	17	1%	13
North West	7%	22	2%	32

Notes:

1. This analysis is based on BOM historical data.
2. Pilots will normally always land and take-off into the prevailing wind.
3. The approach to the HLS will be briefed to all pilots through the Trinity Point Operations Procedure.
4. Pilots will always be responsible for the conduct of the flight and the flightpath they use.
5. Safety will always be the overriding factor in flightpath selection.

TABLE A3: INDICATIVE 'AUTUMN' WIND DIRECTION PERCENTAGES AND VELOCITY – BOM HISTORICAL DATA

Prevailing Wind	AM Arrival	Av. Wind Speed kmph	PM Arrival	Av. Wind Speed kmph
North	11%	25	6%	30
North East	5%	25	20%	40
East	5%	34	12%	37
South East	7%	41	15%	41
South	16%	43	30%	45
South West	22%	35	6%	41
West	18%	18	4%	24
North West	16%	22	6%	23

Notes:

1. This analysis is based on BOM historical data.
2. Pilots will normally always land and take-off into the prevailing wind.
3. The approach to the HLS will be briefed to all pilots through the Trinity Point Operations Procedure.
4. Pilots will always be responsible for the conduct of the flight and the flightpath they use.
5. Safety will always be the overriding factor in flightpath selection.

TABLE A4: INDICATIVE ‘WINTER’ WIND DIRECTION PERCENTAGES AND VELOCITY – BOM HISTORICAL DATA

Prevailing Wind	AM Arrival	Av. Wind Speed kmph	PM Arrival	Av. Wind Speed kmph
North	10%	33	11%	37
North East	1%	23	10%	34
East	1%	30	5%	27
South East	2%	37	8%	40
South	6%	41	26%	42
South West	22%	39	15%	41
West	31%	38	13%	35
North West	27%	32	13%	40

Notes:

1. This analysis is based on BOM historical data.
2. Pilots will normally always land and take-off into the prevailing wind.
3. The approach to the HLS will be briefed to all pilots through the Trinity Point Operations Procedure.
4. Pilots will always be responsible for the conduct of the flight and the flightpath they use.
5. Safety will always be the overriding factor in flightpath selection.

TABLE A5: INDICATIVE ‘SPRING’ WIND DIRECTION PERCENTAGES AND VELOCITY – BOM HISTORICAL DATA

Prevailing Wind	AM Arrival	Av. Wind Speed kmph	PM Arrival	Av. Wind Speed kmph
North	17%	37	7%	41
North East	9%	37	27%	42
East	3%	35	14%	34
South East	6%	41	16%	40
South	21%	43	22%	45
South West	17%	40	4%	41
West	12%	31	4%	34
North West	15%	37	6%	40

Notes:

1. This analysis is based on BOM historical data.
2. Pilots will normally always land and take-off into the prevailing wind.
3. The approach to the HLS will be briefed to all pilots through the Trinity Point Operations Procedure.
4. Pilots will always be responsible for the conduct of the flight and the flightpath they use.
5. Safety will always be the overriding factor in flightpath selection.

TABLE A6: ANNUAL SEASONAL DATA

Month	N	kmph	NE	kmph	E	kmph	SE	kmph	S	kmph	SW	kmph	W	kmph	NW	kmph	%
Dec AM	16%	31	16%	31	6%	30	8%	41	24%	43	15%	40	7%	20	8%	30	100%
Dec PM	5%	40	33%	42	18%	40	15%	41	22%	43	3%	40	2%	40	2%	40	100%
Jan AM	18%	30	18%	30	5%	20	8%	40	27%	42	14%	31	5%	10	5%	15	100%
Jan PM	5%	40	32%	43	15%	31	20%	41	24%	43	3%	40	0%	0	1%	40	100%
Feb AM	16%	30	11%	30	8%	30	12%	41	24%	44	16%	40	5%	20	8%	20	100%
Feb PM	3%	30	28%	41	16%	32	19%	41	29%	45	2%	42	0%	0	3%	15	100%
AM Av	17%	30	15%	30	6%	27	9%	41	25%	43	15%	37	6%	17	7%	22	
PM Av	4%	37	31%	42	16%	34	18%	41	25%	44	3%	41	1%	13	2%	32	
Mar AM	13%	22	9%	30	7%	40	11%	41	21%	43	20%	40	10%	10	9%	15	100%
Mar PM	3%	30	27%	41	16%	40	19%	41	29%	46	2%	41	1%	10	3%	15	100%
Apr AM	11%	22	3%	30	4%	31	7%	41	18%	43	22%	25	18%	22	17%	22	100%
Apr PM	5%	30	21%	40	14%	40	16%	41	29%	45	5%	41	4%	32	6%	22	100%
May AM	9%	31	2%	15	3%	30	4%	41	10%	43	24%	40	26%	22	22%	30	100%
May PM	9%	30	12%	40	7%	30	11%	41	33%	44	11%	42	8%	30	9%	31	100%
AM Av	11%	25	5%	25	5%	34	7%	41	16%	43	22%	35	18%	18	16%	22	
PM Av	6%	30	20%	40	12%	37	15%	41	30%	45	6%	41	4%	24	6%	23	
Jun AM	9%	30	0%	0	1%	10	3%	41	6%	42	26%	40	30%	40	25%	30	100%
Jun PM	10%	31	7%	30	3%	30	6%	40	28%	43	19%	41	14%	32	13%	40	100%
Jul AM	9%	30	1%	40	1%	40	2%	41	5%	40	20%	35	35%	35	27%	35	100%
Jul PM	11%	40	8%	32	3%	20	7%	41	25%	42	18%	41	14%	32	14%	40	100%
Aug AM	12%	40	3%	30	1%	40	2%	30	6%	41	19%	40	29%	40	28%	32	100%
Aug PM	11%	40	14%	40	8%	31	10%	40	25%	42	9%	41	11%	40	12%	41	100%
AM Av	10%	33	1%	23	1%	30	2%	37	6%	41	22%	38	31%	38	27%	32	
PM Av	11%	37	10%	34	5%	27	8%	40	26%	42	15%	41	13%	35	13%	40	
Sep AM	18%	30	4%	30	2%	25	3%	41	12%	42	20%	41	19%	40	22%	40	100%
Sep PM	9%	41	20%	41	12%	30	14%	40	22%	44	5%	40	8%	40	10%	40	100%
Oct AM	16%	40	11%	40	4%	40	7%	40	24%	43	16%	40	10%	22	12%	40	100%
Oct PM	7%	41	30%	43	15%	40	14%	40	22%	44	4%	40	3%	31	5%	40	100%
Nov AM	17%	40	12%	40	4%	40	8%	41	26%	43	15%	40	8%	30	10%	30	100%
Nov PM	5%	40	30%	43	15%	32	19%	41	23%	47	2%	42	2%	30	4%	40	100%
AM Av	17%	37	9%	37	3%	35	6%	41	21%	43	17%	40	12%	31	15%	37	
PM Av	7%	41	27%	42	14%	34	16%	40	22%	45	4%	41	4%	34	6%	40	

Note: Orange filled areas indicate higher percentage of wind from that direction.

37429/4

Sandra Hutton

From: Sandra Hutton
Sent: Friday, 17 June 2016 9:36 AM
To: 'g.wright@avipro.com.au'; 's.graham@avipro.com.au'
Cc: 'Bryan Garland (bryang@johnsonpropertygroup.com.au)'; 'les@marmongpointmarina.com.au'; Craig Marler
Subject: RE: Amended conceptual siting and 30m safety area - Trinity HLS
Attachments: DOC170616.pdf

Further to below, I have attached an extract summary of wind data that was in some technical reports for the marina EIS. It references BoM wind stations nearby. It's out of a technical report that was primarily interested in the water currents and columns and hydrodynamic processes (and hence wind at lake surface level). Might provide a starting point for your consideration of wind conditions and flight paths over water and southerly as discussed.

Regards,

Sandra Hutton
SENIOR TOWN PLANNER

adw johnson

Hunter Office
7/335 Hillsborough Road,
Warners Bay NSW 2282
Email : sandrah@adwjohnson.com.au
Website: www.adwjohnson.com.au
Ph: 02 49785 100
Mobile: 0414 689 098

From: Sandra Hutton
Sent: Thursday, 16 June 2016 5:43 PM
To: g.wright@avipro.com.au; 's.graham@avipro.com.au'
Cc: Bryan Garland (bryang@johnsonpropertygroup.com.au); les@marmongpointmarina.com.au; Craig Marler
Subject: Amended conceptual siting and 30m safety area - Trinity HLS

Hi Graeme and Steve,

Once again, thank you for your time yesterday to meet us all and share your initial thoughts and knowledge with us. Just to confirm who you met and how we all fit into the puzzle:

- Bryan Garland – Johnson Property Group Planning Director (client);
- Les Binkin – Marina advisor and co-ordinator of HLS design with marine company, marina operator currently at Marmong Point Marina and building Koolewong Marina;
- Craig Marler – Planner from AdW Johnson Pty Ltd (strategic input and high level management);
- Sandra Hutton – Planner from AdW Johnson Pty Ltd (day to day detail).

5.3 Water Level Data

Much of Lake Macquarie has a small tidal range and weak tidal circulation. This is particularly true for Bardens Bay. Regardless of this, tidal hydraulics of the lake are included in the current investigation, based on the tidal forcing of the model boundary located at the ocean end of the Swansea Channel Entrance. Tidal planes, to chart datum, for the Swansea Channel Entrance from the *Australian National Tide Tables 2009* [*Department of Defence, 2009*] have been reproduced below;

- Highest Astronomical Tide (HAT) 1.7 mLAT
- Mean High Water Springs (MHWS) 1.3 mLAT
- Mean High Water Neaps (MHWN) 1.1 mLAT
- Mean Sea Level (MSL) 0.8 mLAT
- Mean Low Water Neaps (MLWN) 0.4 mLAT
- Mean Low Water Springs (MLWS) 0.2 mLAT
- Lowest Astronomical Tide (LAT) 0.0 mLAT

Tidal harmonic constituents sourced from the *Australian National Tide Tables [Department of Defence, 2009]* were used to derive predicted tidal water level time series. Tidal predictions were applied at the models ocean boundary. Tidal predictions were based on the Institute of Ocean Science (IOS) method applied using the t_tide package [*Pawlowicz, et al 2002*].

5.4 Wind Data

The quality of the wind data is an important factor for hydrodynamic modelling of the lake. Due to the weak tidal signal within the main body of Lake Macquarie, wind stress at the water surface is the main forcing mechanisms driving circulation. Theoretically, wind conditions over the lake may be different from wind measurements at an onshore station, as wind varies spatially and there is reduced roughness over the lake. Ideally long term wind data measured at the lake would be used. However, no site specific wind data is available for this study. Historical time series data describing wind speed and direction at a number of nearby meteorological data collection sites was obtained from the Bureau of Meteorology (BoM). Table 5-2 gives a summary of the wind sites analysed. A time-series plot of the wind speed at the four locations is shown in Figure 5-1.

Table 5-2: Summary of nearby BoM wind stations

Station Name	Distance to Site (km)	Length Of Record Analysed (years)	Maximum recorded wind speed (10-min average) (m/s)
Williamtown RAAF	45	20	20.6
Nobby Heads (Newcastle)	33	7.4	23.1
Norah Head	18	19.4	24.2
Cooranbong	9	0.5	8.7

Royal HaskoningDHV

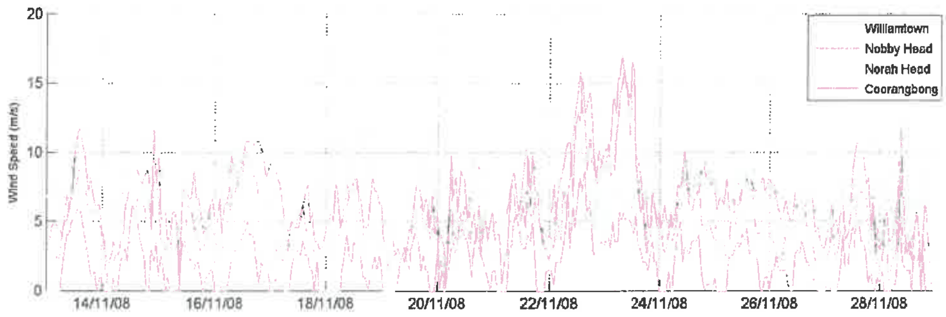


Figure 5-1: Wind speed measurement comparisons at Williamtown (blue), Nobbys Head (red). Norah Head (green) and Cooranbong (magenta)

Williamtown was selected as the most representative of the available wind speed/ direction data sets as it is located a similar distance inland as the site, it also has the longest historical record. The Nobbys Head and Norah Head were rejected, as these sites are located on the coast and show generally higher wind speeds typical of coastal exposed sites. Although closest to the site, wind data collection at the Cooranbong site only commenced in July 2008. The site was rejected as it is located near a hilly area, is further from the coast than the Lake and shows consistently and significantly lower wind speeds than other nearby sites. Comparison of wind data statistics derived from the Williamtown data show good general agreement with published statistics derived from 5 years of wind data collected at Munmorah Power Station [*AWAC, 1994*].

A wind rose for the Williamtown wind data is shown in Figure 5-2 and the associated directional probability of occurrence table is show in Appendix B. It is observed that the most persistent wind is from the west to north-west sector. Figure 5-3 shows the seasonal wind roses for the four seasons based on the long-term Williamtown data. It is observed that summer winds are typically more energetic (highest average wind speeds) with wind directions predominately from the north east to south directions. Winter is generally described as having persistent west to north-west winds. Autumn and spring show a similar spread to the wind directions typical of the annual average. However, autumn has the lowest energy wind regime of the year.

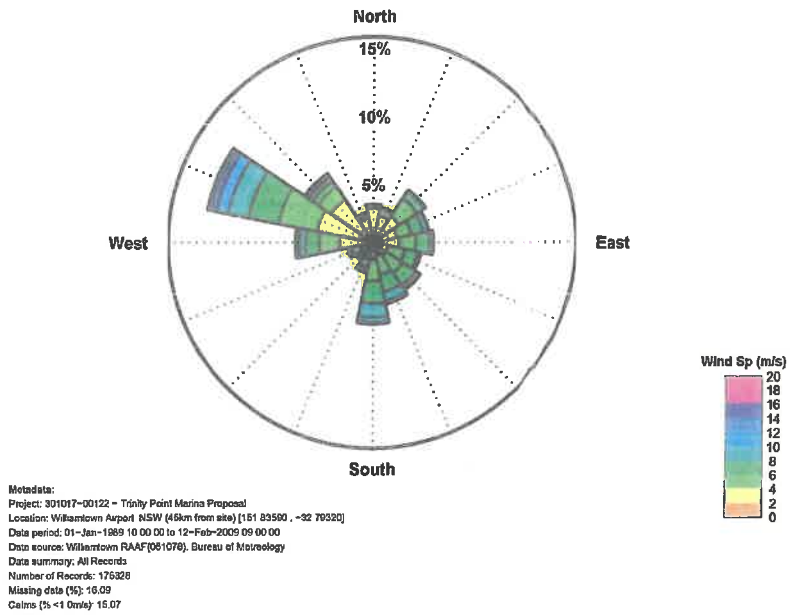


Figure 5-2: Wind rose at Williamtown for the period Jan-1989 to Feb-2009

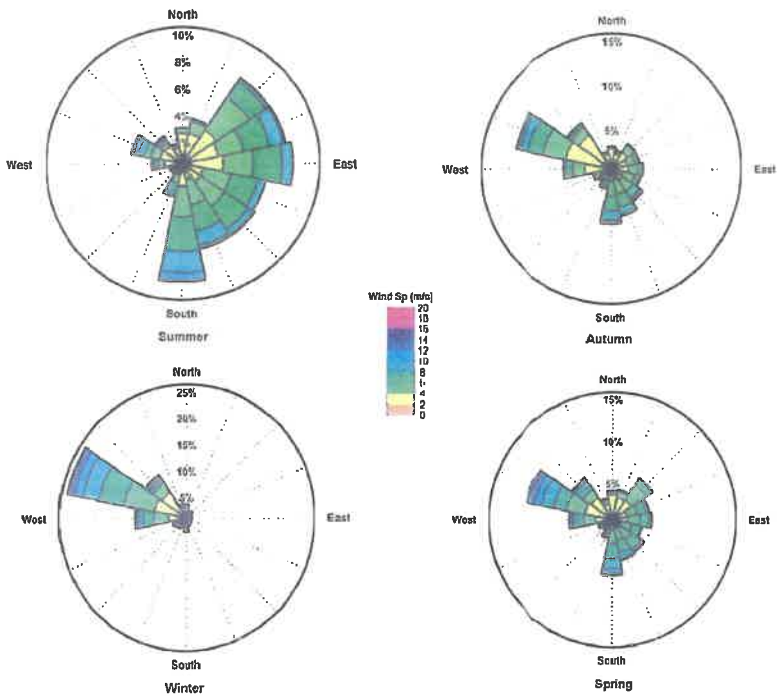


Figure 5-3: Seasonal Wind roses based on long-term Williamtown data

In the previous investigation [*PBP, 2008*], the 10-minute averaged wind speed data from

Williamtown was converted to the 5-hour average equivalent and then statistically analysed to establish directional (at 45 degree increments) wind speed exceedance values. Reproduced here, is the directional 5-hourly winds speeds. Table 5-3 presents the calculated exceedance values. The resulting statistical representation of the wind patterns was used for the numerical modelling of wind driven processes such as waves and wind driven currents.

Table 5-3: Directional 5 hourly average wind speed (m/s) exceedance values

Wind Direction	Williamtown Airport		Munmorah Power Station (AWACS, 1994)
	50th Percentile Wind Speed (m/s)	1st Percentile Wind Speed (m/s)	1st Percentile Wind Speed (m/s)
N	1.3	5.5	6
NE	2.4	7.8	7.6
E	2.8	8.0	7.5
SE	3.3	9.5	7.1
S	4.0	10.5	10.5
SW	2.9	9.9	10.3
W	3.1	11.7	8.5
NW	2.4	11.8	7.6

These 50th percentile winds where adopted for steady state simulations aimed at describing the general circulation pattern under average conditions (as defined by median wind conditions). The median wind condition is the condition that on average would be exceeded tomorrow if it was not today. Under steady state conditions the magnitude of the wind speed does not significantly alter the circulation patterns but only the current strengths within that circulation pattern. It is thus considered that the 50th percentile wind speed adopted during the previous investigation provide an adequate description and have been adopted here.

Appendix D – BoM Wind Data and Wind Analysis Calculations

Bureau of Meteorology Wind Frequency Analysis

```
Site Number: 061078            Location: WILLIAMTOWN RAAF
Latitude: -32.79               Longitude: 151.84              Elevation: 9 metres (above sea
level)
Start year: 1942               End year: 2016
Period: 9am Annual
```

```
Station number,Time period,No. of obs.,Range of wind speed in km/h,% of wind from (N),% of wind
from (NE),% of wind from (E),% of wind from (SE),% of wind from (S),% of wind from (SW),% of wind
from (W),% of wind from (NW),% of Calms,Row totals
061078,9 am                 , 24968, >= 0 and < 10 ,  3.3,  2.4,  1.4,  1.4,  1.7,  1.9,  6.0,
8.4, 15.2, 41.7
061078,9 am                 , 24968,>= 10 and < 20 ,  1.9,  3.1,  2.0,  2.2,  2.8,  2.9,  7.8,
9.7,    0, 32.5
061078,9 am                 , 24968,>= 20 and < 30 ,  0.1,  0.7,  0.8,  1.9,  3.0,  1.7,  6.2,
3.9,    0, 18.2
061078,9 am                 , 24968,>= 30 and < 40 ,  0.0,  0.0,  0.1,  0.4,  0.7,  0.3,  2.1,
1.3,    0,  4.9
061078,9 am                 , 24968,         >= 40 ,  0.0,  0.0,  0.0,  0.2,  0.3,  0.1,  1.1,
1.0,    0,  2.7
061078,9 am                 , 24968,Column Totals  ,  5.4,  6.2,  4.3,  6.1,  8.5,  6.9, 23.2,
24.2, 15.2,  100
```

Notes for wind speed vs direction frequency analysis completed on 06/04/2016

All available wind speed and direction observations for 9am and 3pm local time were included in this analysis

```
Byte Location , Byte Size  , Explanation
----------------------------------------------------------------------------
1-6           ,6           , Bureau of Meteorology station number
8-27          ,20          , Time period for the analysis based on local time
29-34         ,6           , Number of observations used in the analysis
36-50         ,15          , Range for wind speed in km/h
52-56         ,5           , Percentage of wind direction observations in class N
58-62         ,5           , Percentage of wind direction observations in class NE
64-68         ,5           , Percentage of wind direction observations in class E
70-74         ,5           , Percentage of wind direction observations in class SE
76-80         ,5           , Percentage of wind direction observations in class S
82-86         ,5           , Percentage of wind direction observations in class SW
88-92         ,5           , Percentage of wind direction observations in class W
94-98         ,5           , Percentage of wind direction observations in class NW
100-104       ,5           , Percentage of calms
106-110       ,5           , Row totals
```

IMPORTING INTO A SPREADSHEET

---

1) Select the contents of a table (including the first row which describes each column) and copy to the clipboard.
2) Open a text editor and paste the content of the clipboard into a new file and save it as type .csv
3) Open with a spreadsheet software package (For example, Excel)

Optionally, the content of the clipboard can be directly pasted into a spreadsheet and converted from
text to columns (For example, in Excel, select Data tab, click Text to columns then option delimited, then select comma)

WIND DIRECTIONS

Much of the recent wind direction data are now stored in 10s of degrees, so data broken into specfic bins such as 8 or 16 compass points will likely cause some aliasing, with some bins holding more directions as 36 is not divisible by 8 or 16.

INSTRUMENTS AND OBSERVATIONAL PRACTICES

Historically a nearby site (within about 1 mile in earlier days) may have used the same site number. There may have been changes in instrumentation and/or observing practices over the period included in a dataset, which may have an effect on the long-term record.
In recent years many sites have had observers replaced by Automatic Weather Stations, either completely or at certain times of the day.

Wind Analysis Calculations

Approaches, AM & PM	Average Frequency
Acceptable Wind Condition	77.80%
Unsuitable Wind Condition	22.20%

Departures, AM & PM	Average Frequency
Acceptable Wind Condition	80.35%
Unsuitable Wind Condition	19.65%

Approaches, AM Only	Average Frequency
Acceptable Wind Condition	89.80%
Unsuitable Wind Condition	10.20%

Approaches, PM Only	Average Frequency
Acceptable Wind Condition	65.80%
Unsuitable Wind Condition	34.20%

Departures, AM Only	Average Frequency
Acceptable Wind Condition	81.50%
Unsuitable Wind Condition	18.50%

Departures, PM Only	Average Frequency
Acceptable Wind Condition	79.20%
Unsuitable Wind Condition	20.80%

JJ RYAN CONSULTING PTY LTD

AM WIND

Range of wind speed in	% of wind from (N)	% of wind from (NE)	% of wind from (E)	% of wind from (SE)	% of wind from (S)	% of wind from (SW)	% of wind from (W)	% of wind from (NW)	% of Calms	Row Total
>= 0 and < 10	3.3	2.4	1.4	1.4	1.7	1.9	6.0	8.4	15.2	41.7
>= 10 and < 20	1.9	3.1	2.0	2.2	2.8	2.9	7.8	9.7	0.0	32.5
>= 20 and < 30	0.1	0.7	0.8	1.9	3.0	1.7	6.2	3.9	0.0	18.2
>= 30 and < 40	0.0	0.0	0.1	0.4	0.7	0.3	2.1	1.3	0.0	4.9
>= 40	0.0	0.0	0.0	0.2	0.3	0.1	1.1	1.0	0.0	2.7
Column Totals	5.4	6.2	4.3	6.1	8.5	6.9	23.2	24.2	15.2	100

PM WIND

Range of wind speed in	% of wind from (N)	% of wind from (NE)	% of wind from (E)	% of wind from (SE)	% of wind from (S)	% of wind from (SW)	% of wind from (W)	% of wind from (NW)	% of Calms	Row Total
>= 0 and < 10	1.4	1.3	1.7	2.9	1.4	0.7	1.6	2.0	4.4	17.5
>= 10 and < 20	1.1	2.9	6.1	10.2	5.1	1.6	3.1	2.8	0.0	32.8
>= 20 and < 30	0.2	2.5	7.1	9.0	6.8	1.6	3.6	3.7	0.0	34.4
>= 30 and < 40	0.0	0.4	1.2	1.2	2.5	0.6	2.1	2.2	0.0	10.2
>= 40	0.0	0.0	0.1	0.2	0.8	0.2	2.0	1.7	0.0	5.1
Column Totals	2.7	7.2	16.1	23.5	16.7	4.7	12.3	12.4	4.4	100

HELICOPTER APPROACH

NN ANALYSIS	0	315	45	Headwind
		135	225	Crosswind

AM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	3.30%	
10 - 20km/h	1.90%	
20 - 30km/h	0.10%	
30 - 40km/h	0.00%	
> 40km/h	0.00%	
	5.30%	**0.00%**

PM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.40%	
10 - 20km/h	1.10%	
20 - 30km/h	0.20%	
30 - 40km/h	0.00%	
> 40km/h	0.00%	
	2.70%	**0.00%**

OVERALL IMPACTS (AVERAGE OF AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	2.35%	
10 - 20km/h	1.50%	
20 - 30km/h	0.15%	
30 - 40km/h	0.00%	
> 40km/h	0.00%	
	4.00%	**0.00%**

NE ANALYSIS	45	0	90	Headwind
		180	270	Crosswind
		180	180	

AM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	2.40%	
10 - 20km/h	3.10%	
20 - 30km/h		0.70%
30 - 40km/h		0.00%
> 40km/h		0.00%
	5.50%	**0.70%**

PM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.30%	
10 - 20km/h	2.90%	
20 - 30km/h		2.50%
30 - 40km/h		0.40%
> 40km/h		0.00%
	4.20%	**2.90%**

OVERALL IMPACTS (AVERAGE OF AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.85%	
10 - 20km/h	3.00%	
20 - 30km/h		1.60%
30 - 40km/h		0.20%
> 40km/h		0.00%
	4.85%	**1.80%**

JJ RYAN CONSULTING PTY LTD

EE ANALYSIS	90	45	135	Headwind
		225	315	Crosswind
AM IMPACTS		0	0	

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.40%	
10 - 20km/h	2.00%	
20 - 30km/h		0.80%
30 - 40km/h		0.10%
> 40km/h		0.00%
	3.40%	**0.90%**

PM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.70%	
10 - 20km/h	6.10%	
20 - 30km/h		7.10%
30 - 40km/h		1.20%
> 40km/h		0.10%
	7.80%	**8.40%**

OVERALL IMPACTS (AVERAGE OF AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.55%	
10 - 20km/h	4.05%	
20 - 30km/h		3.95%
30 - 40km/h		0.65%
> 40km/h		0.05%
	5.60%	**4.65%**

SE ANALYSIS	135	90	180	Headwind
		270	0	Crosswind
AM IMPACTS		0	0	

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.40%	
10 - 20km/h	2.20%	
20 - 30km/h		1.90%
30 - 40km/h		0.40%
> 40km/h		0.20%
	3.60%	**2.50%**

PM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	2.90%	
10 - 20km/h	10.20%	
20 - 30km/h		9.00%
30 - 40km/h		1.20%
> 40km/h		0.20%
	13.10%	**10.40%**

OVERALL IMPACTS (AVERAGE OF AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	2.15%	
10 - 20km/h	6.20%	
20 - 30km/h		5.45%
30 - 40km/h		0.80%
> 40km/h		0.20%
	8.35%	**6.45%**

JJ RYAN CONSULTING PTY LTD

SS ANALYSIS	180	135	225	Headwind
		315	45	Crosswind
AM IMPACTS		0	0	

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.70%	
10 - 20km/h	2.80%	
20 - 30km/h		3.00%
30 - 40km/h		0.70%
> 40km/h		0.30%
	4.50%	**4.00%**

PM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.40%	
10 - 20km/h	5.10%	
20 - 30km/h		6.80%
30 - 40km/h		2.50%
> 40km/h		0.80%
	6.50%	**10.10%**

OVERALL IMPACTS (AVERAGE OF AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.55%	
10 - 20km/h	3.95%	
20 - 30km/h		4.90%
30 - 40km/h		1.60%
> 40km/h		0.55%
	5.50%	**7.05%**

SW ANALYSIS	225	180	270	Headwind
		0	90	Crosswind
AM IMPACTS		90	90	

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.90%	
10 - 20km/h	2.90%	
20 - 30km/h		1.70%
30 - 40km/h		0.30%
> 40km/h		0.10%
	4.80%	**2.10%**

PM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	0.70%	
10 - 20km/h	1.60%	
20 - 30km/h		1.60%
30 - 40km/h		0.60%
> 40km/h		0.20%
	2.30%	**2.40%**

OVERALL IMPACTS (AVERAGE OF AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.30%	
10 - 20km/h	2.25%	
20 - 30km/h		1.65%
30 - 40km/h		0.45%
> 40km/h		0.15%
	3.55%	**2.25%**

JJ RYAN CONSULTING PTY LTD

WW ANALYSIS	270	225	315	Headwind
		45	135	Crosswind
AM IMPACTS		90	135	

AM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	6.00%	
10 - 20km/h	7.80%	
20 - 30km/h	6.20%	
30 - 40km/h	2.10%	
> 40km/h	1.10%	
	23.20%	**0.00%**

PM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.60%	
10 - 20km/h	3.10%	
20 - 30km/h	3.60%	
30 - 40km/h	2.10%	
> 40km/h	2.00%	
	12.40%	**0.00%**

OVERALL IMPACTS (AVERAGE OF AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	3.80%	
10 - 20km/h	5.45%	
20 - 30km/h	4.90%	
30 - 40km/h	2.10%	
> 40km/h	1.55%	
	17.80%	**0.00%**

NW ANALYSIS	315	270	360	Headwind
		90	180	Crosswind
AM IMPACTS		90	180	

AM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	8.40%	
10 - 20km/h	9.70%	
20 - 30km/h	3.90%	
30 - 40km/h	1.30%	
> 40km/h	1.00%	
	24.30%	**0.00%**

PM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	2.00%	
10 - 20km/h	2.80%	
20 - 30km/h	3.70%	
30 - 40km/h	2.20%	
> 40km/h	1.70%	
	12.40%	**0.00%**

OVERALL IMPACTS (AVERAGE OF AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	5.20%	
10 - 20km/h	6.25%	
20 - 30km/h	3.80%	
30 - 40km/h	1.75%	
> 40km/h	1.35%	
	18.35%	**0.00%**

JJ RYAN CONSULTING PTY LTD

CALM ANALYSIS	ALL	ALL	ALL

AM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	15.20%	
10 - 20km/h		
20 - 30km/h		
30 - 40km/h		
> 40km/h		
	15.20%	**0.00%**

PM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	4.40%	
10 - 20km/h		
20 - 30km/h		
30 - 40km/h		
> 40km/h		
	4.40%	**0.00%**

OVERALL IMPACTS (AVERAGE OF AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	9.80%	
10 - 20km/h		
20 - 30km/h		
30 - 40km/h		
> 40km/h		
	9.80%	**0.00%**

TOTAL ANALYSIS

AM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	41.70%	0.00%
10 - 20km/h	32.40%	0.00%
20 - 30km/h	10.20%	8.10%
30 - 40km/h	3.40%	1.50%
> 40km/h	2.10%	0.60%
	89.80%	**10.20%**

PM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	17.40%	0.00%
10 - 20km/h	32.90%	0.00%
20 - 30km/h	7.50%	27.00%
30 - 40km/h	4.30%	5.90%
> 40km/h	3.70%	1.30%
	65.80%	**34.20%**

OVERALL IMPACTS (AVERAGE OF AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	29.55%	0.00%
10 - 20km/h	32.65%	0.00%
20 - 30km/h	8.85%	17.55%
30 - 40km/h	3.85%	3.70%
> 40km/h	2.90%	0.95%
	77.80%	**22.20%**

JJ RYAN CONSULTING PTY LTD

AM WIND

Range of wind speed in	% of wind from (N)	% of wind from (NE)	% of wind from (E)	% of wind from (SE)	% of wind from (S)	% of wind from (SW)	% of wind from (W)	% of wind from (NW)	% of Calms	Row Total
>= 0 and < 10	3.3	2.4	1.4	1.4	1.7	1.9	6.0	8.4	15.2	41.7
>= 10 and < 20	1.9	3.1	2.0	2.2	2.8	2.9	7.8	9.7	0.0	32.5
>= 20 and < 30	0.1	0.7	0.8	1.9	3.0	1.7	6.2	3.9	0.0	18.2
>= 30 and < 40	0.0	0.0	0.1	0.4	0.7	0.3	2.1	1.3	0.0	4.9
>= 40	0.0	0.0	0.0	0.2	0.3	0.1	1.1	1.0	0.0	2.7
Column Totals	5.4	6.2	4.3	6.1	8.5	6.9	23.2	24.2	15.2	100

PM WIND

Range of wind speed in	% of wind from (N)	% of wind from (NE)	% of wind from (E)	% of wind from (SE)	% of wind from (S)	% of wind from (SW)	% of wind from (W)	% of wind from (NW)	% of Calms	Row Total
>= 0 and < 10	1.4	1.3	1.7	2.9	1.4	0.7	1.6	2.0	4.4	17.5
>= 10 and < 20	1.1	2.9	6.1	10.2	5.1	1.6	3.1	2.8	0.0	32.8
>= 20 and < 30	0.2	2.5	7.1	9.0	6.8	1.6	3.6	3.7	0.0	34.4
>= 30 and < 40	0.0	0.4	1.2	1.2	2.5	0.6	2.1	2.2	0.0	10.2
>= 40	0.0	0.0	0.1	0.2	0.8	0.2	2.0	1.7	0.0	5.1
Column Totals	2.7	7.2	16.1	23.5	16.7	4.7	12.3	12.4	4.4	100

HELICOPTER TAKE-OFF

NN ANALYSIS	0	315	45	Headwind
		315	45	Crosswind
AM IMPACTS		0	0	

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	3.30%	
10 - 20km/h	1.90%	
20 - 30km/h		0.10%
30 - 40km/h		0.00%
> 40km/h		0.00%
	5.20%	**0.10%**

PM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.40%	
10 - 20km/h	1.10%	
20 - 30km/h		0.20%
30 - 40km/h		0.00%
> 40km/h		0.00%
	2.50%	**0.20%**

OVERALL IMPACTS (AVERAGE OF AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	2.35%	
10 - 20km/h	1.50%	
20 - 30km/h		0.15%
30 - 40km/h		0.00%
> 40km/h		0.00%
	3.85%	**0.15%**

NE ANALYSIS	45	0	90	Headwind
		0	90	Crosswind
AM IMPACTS		90	90	

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	2.40%	
10 - 20km/h	3.10%	
20 - 30km/h		0.70%
30 - 40km/h		0.00%
> 40km/h		0.00%
	5.50%	**0.70%**

PM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.30%	
10 - 20km/h	2.90%	
20 - 30km/h		2.50%
30 - 40km/h		0.40%
> 40km/h		0.00%
	4.20%	**2.90%**

OVERALL IMPACTS (AVERAGE OF AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.85%	
10 - 20km/h	3.00%	
20 - 30km/h		1.60%
30 - 40km/h		0.20%
> 40km/h		0.00%
	4.85%	**1.80%**

EE ANALYSIS	90	45	135	Headwind
		45	135	Crosswind
AM IMPACTS		90	135	

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.40%	
10 - 20km/h	2.00%	
20 - 30km/h	0.80%	
30 - 40km/h	0.10%	
> 40km/h	0.00%	
	4.30%	**0.00%**

PM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.70%	
10 - 20km/h	6.10%	
20 - 30km/h	7.10%	
30 - 40km/h	1.20%	
> 40km/h	0.10%	
	16.20%	**0.00%**

OVERALL IMPACTS (AVERAGE OF AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.55%	
10 - 20km/h	4.05%	
20 - 30km/h	3.95%	
30 - 40km/h	0.65%	
> 40km/h	0.05%	
	10.25%	**0.00%**

SE ANALYSIS	135	90	180	Headwind
		90	180	Crosswind
AM IMPACTS		90	180	

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.40%	
10 - 20km/h	2.20%	
20 - 30km/h	1.90%	
30 - 40km/h	0.40%	
> 40km/h	0.20%	
	6.10%	**0.00%**

PM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	2.90%	
10 - 20km/h	10.20%	
20 - 30km/h	9.00%	
30 - 40km/h	1.20%	
> 40km/h	0.20%	
	23.50%	**0.00%**

OVERALL IMPACTS (AVERAGE OF AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	2.15%	
10 - 20km/h	6.20%	
20 - 30km/h	5.45%	
30 - 40km/h	0.80%	
> 40km/h	0.20%	
	14.80%	**0.00%**

JJ RYAN CONSULTING PTY LTD

SS ANALYSIS	180	135	225	Headwind
		135	225	Crosswind
AM IMPACTS		135	180	

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.70%	
10 - 20km/h	2.80%	
20 - 30km/h	3.00%	
30 - 40km/h	0.70%	
> 40km/h	0.30%	
	8.50%	**0.00%**

PM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.40%	
10 - 20km/h	5.10%	
20 - 30km/h	6.80%	
30 - 40km/h	2.50%	
> 40km/h	0.80%	
	16.60%	**0.00%**

OVERALL IMPACTS (AVERAGE OF AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.55%	
10 - 20km/h	3.95%	
20 - 30km/h	4.90%	
30 - 40km/h	1.60%	
> 40km/h	0.55%	
	12.55%	**0.00%**

SW ANALYSIS	225	180	270	Headwind
		180	270	Crosswind
AM IMPACTS		180	180	

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.90%	
10 - 20km/h	2.90%	
20 - 30km/h		1.70%
30 - 40km/h		0.30%
> 40km/h		0.10%
	4.80%	**2.10%**

PM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	0.70%	
10 - 20km/h	1.60%	
20 - 30km/h		1.60%
30 - 40km/h		0.60%
> 40km/h		0.20%
	2.30%	**2.40%**

OVERALL IMPACTS (AVERAGE OF AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.30%	
10 - 20km/h	2.25%	
20 - 30km/h		1.65%
30 - 40km/h		0.45%
> 40km/h		0.15%
	3.55%	**2.25%**

JJ RYAN CONSULTING PTY LTD

WW ANALYSIS	270	225	315	Headwind
		225	315	Crosswind
AM IMPACTS		0	0	

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	6.00%	
10 - 20km/h	7.80%	
20 - 30km/h		6.20%
30 - 40km/h		2.10%
> 40km/h		1.10%
	13.80%	9.40%

PM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	1.60%	
10 - 20km/h	3.10%	
20 - 30km/h		3.60%
30 - 40km/h		2.10%
> 40km/h		2.00%
	4.70%	7.70%

OVERALL IMPACTS (AVERAGE OF AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	3.80%	
10 - 20km/h	5.45%	
20 - 30km/h		4.90%
30 - 40km/h		2.10%
> 40km/h		1.55%
	9.25%	8.55%

NW ANALYSIS	315	270	360	Headwind
		270	360	Crosswind
AM IMPACTS		0	0	

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	8.40%	
10 - 20km/h	9.70%	
20 - 30km/h		3.90%
30 - 40km/h		1.30%
> 40km/h		1.00%
	18.10%	6.20%

PM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	2.00%	
10 - 20km/h	2.80%	
20 - 30km/h		3.70%
30 - 40km/h		2.20%
> 40km/h		1.70%
	4.80%	7.60%

OVERALL IMPACTS (AVERAGE OF AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	5.20%	
10 - 20km/h	6.25%	
20 - 30km/h		3.80%
30 - 40km/h		1.75%
> 40km/h		1.35%
	11.45%	6.90%

CALM ANALYSIS	ALL	ALL	ALL

AM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	15.20%	
10 - 20km/h		
20 - 30km/h		
30 - 40km/h		
> 40km/h		
	15.20%	**0.00%**

PM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	4.40%	
10 - 20km/h		
20 - 30km/h		
30 - 40km/h		
> 40km/h		
	4.40%	**0.00%**

OVERALL IMPACTS (AVERAGE OF AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	9.80%	
10 - 20km/h		
20 - 30km/h		
30 - 40km/h		
> 40km/h		
	9.80%	**0.00%**

TOTAL ANALYSIS

AM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	41.70%	0.00%
10 - 20km/h	32.40%	0.00%
20 - 30km/h	5.70%	12.60%
30 - 40km/h	1.20%	3.70%
> 40km/h	0.50%	2.20%
	81.50%	**18.50%**

PM IMPACTS

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	17.40%	0.00%
10 - 20km/h	32.90%	0.00%
20 - 30km/h	22.90%	11.60%
30 - 40km/h	4.90%	5.30%
> 40km/h	1.10%	3.90%
	79.20%	**20.80%**

OVERALL IMPACTS (AVERAGE OF AM + PM)

Wind Speed Ranges	Acceptable Wind Condition	Unsuitable Wind Condition
< 10km/h	29.55%	0.00%
10 - 20km/h	32.65%	0.00%
20 - 30km/h	14.30%	12.10%
30 - 40km/h	3.05%	4.50%
> 40km/h	0.80%	3.05%
	80.35%	**19.65%**

Appendix E – Downwash Risk Assessment

JJ RYAN CONSULTING PTY LTD

Trinity Point Helicopter Downwash Assessment Risk Appetite

Risk Likelihood Ratings

Likelihood of Risk Materialising	Probability (%)	Definition
Almost Certain	**> 80%**	Expected to occur in most circumstances or occurs regularly
Likely	**40% - 80%**	Will probably occur
Possible	**10% - 40%**	May occur at some time
Unlikely	**2.5% - 10%**	Could occur at some time
Rare	**<2.5%**	Will only occur in exceptional circumstances

Risk Consequence Ratings

Consequence	Impact ($)	Definition
Catastrophic	**> $2.5M**	Equipment or system destroyed, wilful violation of safety regulations that results in serious injury or death
Major	**$500k - $2.5M**	Major equipment or system damaged
Moderate	**$250k - $500k**	Accident or incident with minor injury and/or minor aircraft damage
Minor	**$50k - $250k**	Minor incident resulting in slight to no damage to equipment or aircraft
Negligible	**< $50k**	Little consequence on operational safety

Inherent Risk Table

Likelihood	Consequence				
	Negligible	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost Certain	Medium	High	High	Extreme	Extreme
Likely	Low	Medium	High	Extreme	Extreme
Possible	Low	Medium	Medium	High	Extreme
Unlikely	Low	Low	Medium	High	High
Rare	Low	Low	Low	Medium	High

Levels of Risk

EXTREME	Requires immediate action where a fatality, major environment event or major loss of plant may occur. Detailed research, risk identification and control measures to be investigated with a detailed action plan to mitigate risk.
HIGH	Significant risks require timely attention so appropriate controls can be implemented.
MEDIUM	Monitor response procedures.
LOW	Manage by routine procedures.

Effectiveness of Controls

Control Effectiveness	Description	Reduction Value
Damaging	Control(s) in place actually increase the risk	**-10%**
None	No controls in place	**0%**
Deficient	Controls applied are not adequate for the job	**10%**
Marginal	Controls applied go part of the way to reduce the risk or impact	**30%**
Qualified	Controls applied go a reasonable way to reduce the risk or impact	**50%**
Effective	Controls applied reduce the risk of impact sufficiently or significantly	**70%**
Excessive	Controls applied are more than necessary to reduce the risk or impact. Potentially over controlled	**90%**

Trinity Point Helicopter Downwash Assessment Risk Appetite

Residual Likelihood

Effectiveness of Preventive Controls	Inherent Likelihood Rating				
	Almost Certain	**Likely**	**Possible**	**Unlikely**	**Rare**
Damaging	Almost Certain	Likely	Possible	Unlikely	Rare
None	Almost Certain	Likely	Possible	Unlikely	Rare
Deficient	Almost Certain	Likely	Possible	Unlikely	Rare
Marginal	Likely	Possible	Unlikely	Unlikely	Rare
Qualified	Possible	Unlikely	Unlikely	Rare	Rare
Effective	Unlikely	Unlikely	Rare	Rare	Rare
Excessive	Rare	Rare	Rare	Rare	Rare

Residual Consequence

Effectiveness of Corrective Controls	Inherent Consequence Rating				
	Negligible	**Minor**	**Moderate**	**Major**	**Catastrophic**
Damaging	Negligible	Minor	Moderate	Major	Catastrophic
None	Negligible	Minor	Moderate	Major	Catastrophic
Deficient	Negligible	Minor	Moderate	Major	Catastrophic
Marginal	Negligible	Minor	Moderate	Major	Catastrophic
Qualified	Negligible	Negligible	Minor	Moderate	Major
Effective	Negligible	Negligible	Minor	Moderate	Major
Excessive	Negligible	Negligible	Minor	Moderate	Major

![JJ Ryan Consulting Pty Ltd]

Trinity Point Helicopter Downwash Assessment Risk Register

Context			Risk Description		Risk Details				Risk Treatment / Control			Risk Assessment After Treatment			Comments
				Risk Owner Who is accountable for managing this risk?	**Existing Controls** What controls are currently in place to manage this risk?	**Risk Analysis** Assess the risk considering Consequence & Likelihood			**Proposed Controls** What more needs to be done to manage this risk?			**Residual Risk**			
Risk No.	**Assessment Filter Name**	**Risk Name**	**Risk Description**			**Likelihood**	**Consequence**	**Level of Risk**		**Effectiveness of Likelihood Control Measures**	**Effectiveness of Consequence Control Measures**	**Residual Likelihood**	**Residual Consequence**	**Residual Level of Risk**	**Comments**
1	**Airspace**	Aircraft separation	Loss of separation between two aircraft resulting in near collision due to avoiding watercraft to minimise	Pilot	Aircraft flight manoeuvres and radio communications	**Rare**	**Moderate**	**Low**	Nil	None	None	**Rare**	**Moderate**	**Low**	
2	**Airspace**	Aircraft separation	Loss of separation between two aircraft resulting in colliion due to avoiding watercraft to minimise downwash impacts	Pilot	Aircraft flight manoeuvres, minimal helicopter movements (not antipated to occur simultaneously), operating in Visual Meteorological Conditions (VMC) and radio communications	**Rare**	**Major**	**Medium**	Pilots plan their route and assess airspace to identify other aircraft traffic. Utilise correct radio frequency / CTAF	Effective	Qualified	**Rare**	**Moderate**	**Low**	
3	**Consequential Events**	Emergency / precautionary descent	Maximum performance take-off results in an emergency descent due to engine failure	Pilot	Emergency procedures	**Rare**	**Moderate**	**Low**	Nil	None	None	**Rare**	**Moderate**	**Low**	
4	**Consequential Events**	Rejected take-off	Maximum performance take-off unable to be performed due to weather and other relevant conditions	Pilot	Helicopter flight manuals restrict aircraft take-offs to a maximum wind speed (and direction)	**Unlikely**	**Negligible**	**Low**	Nil	None	None	**Unlikely**	**Negligible**	**Low**	
5	**Environment**	Weather	High wind conditions that exacerbate downwash impacts on watercraft (marina berths and vessels in Bardens Bay)	Pilot	Helicopter flight manuals restrict aircraft take-offs to a maximum wind speed (and direction)	**Possible**	**Minor**	**Medium**	Helipad to be marked with a 50m safety zone based on the maximum extent of the 80km/h downwash envelope which considers the worst case wind	Qualified	Deficient	**Unlikely**	**Minor**	**Low**	
6	**Environment**	Weather	Inclement weather reduces pilot visibility of watercraft and overflies vessels in Bardens Bay	Pilot	Flight operations are restricted to VMC during the day	**Unlikely**	**Minor**	**Low**	Nil	None	None	**Unlikely**	**Minor**	**Low**	
7	**Environment**	Wildlife	Aircraft downwash injures birds in the vicinity of the aircraft during take-off or approach	Pilot	Pilots to avoid large groups of birds identified along route	**Unlikely**	**Minor**	**Low**	Nil	None	None	**Unlikely**	**Minor**	**Low**	
8	**Infrastructure**	Navaids	No wind indicator is provided reducing the accuracy of wind measurements leading to helicopter take-offs and approaches in undesirable conditions which results in a single aircraft incident	Johnson Property Group	Nil	**Unlikely**	**Moderate**	**Medium**	Visual assessment of wind conditions and Bureau of Meteorology data. Weather station to provide wind data to pilots	Effective	None	**Rare**	**Moderate**	**Low**	
9	**Operational**	Aircraft control	Control issues with maximum performance take-off to minimise downwash impacts	Pilot	Pilot experience, no R22 or R44 helicopters permitted to utilise the helipad	**Unlikely**	**Moderate**	**Medium**	Perform test take-off to validate aircraft performance and familiarise pilot with conditions	Qualified	None	**Rare**	**Moderate**	**Low**	
10	**Operational**	Aircraft control	Pilots take flight path that overflies watercraft and impacts sailing operations	Pilot	Helipad Operation Manual stating pilots required to avoid overflying watercraft where possible	**Likely**	**Minor**	**Medium**	Exclusion zone in place for when the helicopter is within the hover In Ground Effect (IGE)	Qualified	Qualified	**Unlikely**	**Negligible**	**Low**	
11	**Operational**	Aircraft control	Incorrect wind velocity identification resulting in downwind approach with hard landings and/or excessive power demands	Pilot	Planning for predicted weather conditions and utilising VFR.	**Possible**	**Minor**	**Medium**	Install weather station close to helipad to provide accurate on site wind conditions during take-off and landing	Effective	None	**Rare**	**Minor**	**Low**	
12	**Operational**	Aircraft control	Blade strike/tail strike on unseen obstacles/foreign object damage in the LS	Pilot	LS to be visually inspected prior to helicopter landing to ensure no objects or FOD can impact landing operations. Pilot to visually assess LS prior to landing and request movement of any obstacles identified. Helipad dimensions comply with CAAP 92-2(2)	**Unlikely**	**Moderate**	**Medium**	Marina / helipad operator to check for FOD prior to helicopter commencing approach and checking the exclusion zone prior to departing	Qualified	None	**Rare**	**Moderate**	**Low**	
13	**Operational**	Aircraft control	Damage to underside of aircraft due to landing on unseen obstruction	Pilot	LS to be visually inspected prior to helicopter landing to ensure no objects or FOD can impact landing operations. Pilot to visually assess LS prior to landing and request movement of any obstacles identified	**Unlikely**	**Minor**	**Low**	Nil	None	None	**Unlikely**	**Minor**	**Low**	
14	**Operational**	Aircraft loading	Helicopter loaded beyond maximum gross weight resulting in increased downwash	Pilot	Maximum gross weight specified in Helicopter Flight Manuals, warning system	**Unlikely**	**Moderate**	**Medium**	Perform test take-off to validate aircraft performance and familiarise pilot with conditions	Qualified	None	**Rare**	**Moderate**	**Low**	
15	**Operational**	Ground operations	Helicopter downwash generates sea spray that disperses salt water onto nearby berths	Pilot	Helipad proposed at a distance of 30m from marina berths	**Possible**	**Negligible**	**Low**	Nil	None	None	**Possible**	**Negligible**	**Low**	
16	**Operational**	Ground operations	Helicopter downwash generates waves that impact watercraft	Pilot	Safety and exclusion zones established to outline extent of significant downwash envelopes	**Unlikely**	**Negligible**	**Low**	Nil	None	None	**Unlikely**	**Negligible**	**Low**	
17	**Operational**	Ground operations	Persons struck by tail / main rotor blades of helicopter	Pilot	Marine / helipad operator checks safety of the helipad and then approves pilot to land. Pilots to visually assess the helipad prior to landing and only touch down once helipad is clear of personnel	**Rare**	**Catastrophic**	**High**	Helipad operational personnel to manage the exclusion zone during helicopter operations including the use of bollard and chains at each end of the marina walkway.	Effective	Effective	**Rare**	**Major**	**Medium**	
18	**Operational**	Miscellaneous	Marina walkway barriers fail during helicopter operations allowing personnel within downwash envelope	Johnson Property Group	Processes incorporated into the helipad flight manual to manage the general public i.e. bollards etc. to prevent access	**Rare**	**Minor**	**Low**	Provide temporary equipment on the helipad or personnel to control safety zone during helicopter operations	Effective	None	**Rare**	**Minor**	**Low**	
19	**Technical**	Power plant / propulsion	Engine failure during a maximum performance take-off results in an aircraft crash	Pilot	Emergency procedures and pilot training / experience	**Rare**	**Major**	**Medium**	Pilots to optimise rate of climb and flight profile to minimise downwash and ensure operator and passenger safety. Avoid going into the shaded zone of the velocity/height diagram	Effective	Marginal	**Rare**	**Major**	**Medium**	
20	**Technical**	Performance calculation	Pilot error in performance calculation or no calculation of performance	Pilot	Flight procedures	**Unlikely**	**Moderate**	**Medium**	Perform test take-off to validate aircraft performance and familiarise pilot with conditions	Qualified	Qualified	**Rare**	**Minor**	**Low**	

Appendix F – Memorandum Summarising Similar Helicopter Operations

JJ RYAN CONSULTING PTY LTD

ABN 69 145 797 726

Suite 1.02, Level 1
10 Ferntree Place
Notting Hill VIC 3168
+61 3 9850 8979
www.jjryan.com.au

Our ref JJR-2190111B
Your ref

MEMORANDUM

To:	Naomi Simmons, Special Counsel (Sparke Helmore Lawyers)
From:	Jason Ryan, Principal Engineer
Date:	8 March 2019
Subject:	Similar Helipad Operations in Australia
Revision:	2.2

Memorandum Purpose

JJ Ryan Consulting (JJR) have been engaged by Sparke Helmore Lawyers ('Sparke') on behalf of Johnson Property Group Pty Ltd (JPG).

The purpose of this memorandum is to provide an overview of similar helicopter operations adjacent to marine operations, as well as to summarise discussions with helipad operators of similar facilities to the proposed helipad development at Trinity Point.

Proposed Helicopter Operations

A minimum safety area of radius 30m from the edge of the helipad has been developed for calm conditions with a maximum safety area of radius of 56.5m for worst-case wind conditions. These safety areas are managed safety zones that will be implemented during take-off and landing movements at the helipad.

The safety zone will be managed by appropriately qualified marina staff in accordance with an operations manual, including access control on the marina breakwater structure (via use of bollards and chains) and the exclusion of persons and craft from within the waters that form part of the safety zone.

The safety zones will not apply during times when no helicopters are arriving at or departing the site. The helipad will however remain off limits to the general public at all times and this will be controlled by a bollard and chain on the marina breakwater where it connects with the gangway access to the helipad.

A 'prior permission' protocol is intended which will enable information to be communicated and agreed to by users of the helipad, including type of helicopter that can land, fly neighbourly procedures and avoid areas, exclusive area, take-off and landing area, operating hours, and can be used as part of registering and demonstrating compliance with maximum daily and weekly movements.

The typical helicopter type was identified to be a general turbine helicopter accommodating 2-5 passengers (or less passengers if includes luggage) plus the pilot. It is expected that helicopters utilising the helipad will commonly be small turbine engine helicopters, with the ability to fly from/to Sydney without the need to refuel, with the occasional medium sized helicopter utilising the helipad.

It is understood that it was agreed from the outset that no joy flights (e.g. up and down local scenic flights across 15 to 30 minute timeframes) should occur, and that Robinson R22/R44 helicopters would be excluded from having permission to utilise the helipad to encourage use of HLS by experienced pilots.

The proposal does not limit use of the helipad only to single engine helicopters, however it does limit use by larger/greater capacity helicopters by the design size of the pontoon. Two twin engine helicopters have been identified to potentially use the HLS, being Airbus 135 (twin engine, max passengers 5 + pilot, maximum weight of 2,835kg) and Agusta Westland AW109 (twin engine, max passengers 6 +

pilot, maximum weight of 2,850kg). The physical pontoon design has been based on the AW109, which is physically the largest of the helicopters identified in the likely-use category.

Similar Helipad Operators

A non-exhaustive review of Australian marinas with helicopter operations was undertaken and it has been determined that there are at least seven locations that have helicopter operations in the vicinity of marine activity, as outlined in Table 1 (note that there is additional reference material provided in the attachments. A montage of the various helipads outlined below are shown in Figure 1 for reference.

Table 1 – Summary of marinas with approved helicopter operations

Marina & Helipad Location	Relevance to Trinity Point	Reference
Whitsundays, Abell Point Marina	Two helipads, on rock protection wall. Yachts moored less than 20m from the edge of the closest helipad. Helicopters depart and approach over the water.	Attachment 1
Gold Coast, Sea World *(Sea World Helicopters were consulted by JJR)*	Two helipads, fixed pontoons. Helicopters depart and approach over the water.	Attachment 2
Gold Coast, Marina Mirage	Two helipads (main), heli-stand plus two additional floating helipads. Vessels moored immediately adjacent to the helipad. Helicopters depart and approach over the water.	Attachment 3
Gold Coast, City Marina & Shipyard	One helipad, fixed on the wharf. Vessels moored less than 50m from the edge of the helipad. Helicopters depart and approach over the water.	Attachment 4
Melbourne, City Helipad *(Microflite were consulted by JJR)*	Two helipads, floating. Public walkway less than 10m from the edge of the helipad. Helicopters depart and approach over the water.	Attachment 5
Geelong, Royal Geelong Yacht Club	One helipad, on rock protection wall. Vessels moored less than 20m from the edge of the helipad. Helicopters depart and approach over the water.	Attachment 6
Perth, Hillarys Boat Harbour	One helipad, on rock protection wall. Yachts moored less than 25m from the edge of the helipad. Helicopters depart and approach over the water.	Attachment 7

As part of the risk assessment process, the helicopter operators of Gold Coast Sea World and Melbourne City Helipad were consulted by JJR to discuss operations at helipads that are similar to the proposed helipad development at Trinity Point.

It should be noted that it is known that there are other helicopter operations occurring in and around marinas.

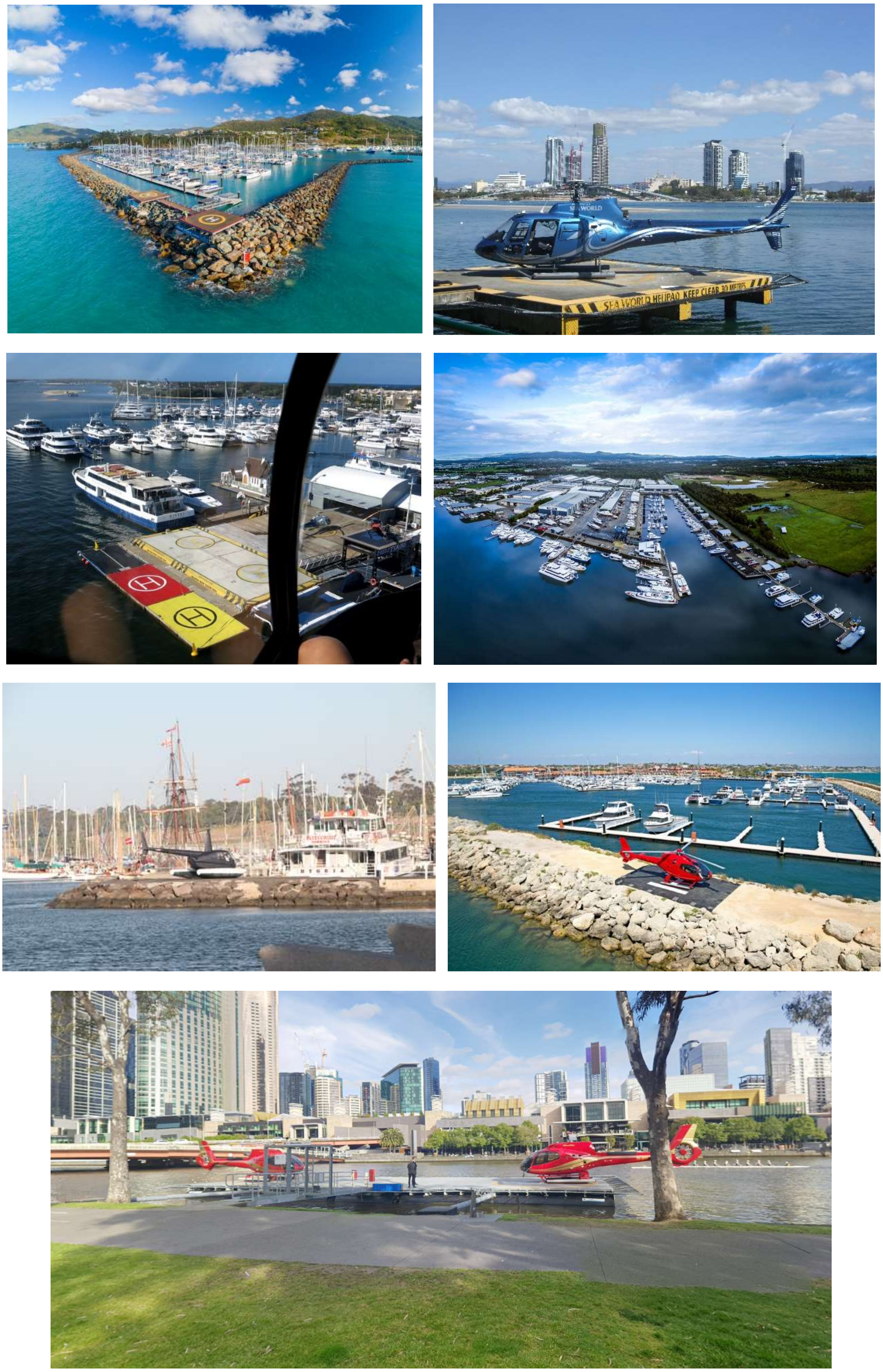


Figure 1 – Montage of helipads near operational marine zones

Sea World Helicopters Discussions

Sea World Helicopters (SWH) are located on Seaworld Drive in Main Beach, Gold Coast and specialise in providing high quality scenic tours and charter services throughout and beyond Southeast Queensland. They operate an extensive fleet of aircraft for luxury transfers, charters as well as aerial filming / photography work. SWH have aircraft capable of carrying up to six (6) adults

A summary of the discussions held with SWH on 1 February 2019 are outlined below:

- SWH have operated over-water helipads for several years.
- The main hazard for SWH is the impact of salt water which deteriorates the condition of the helicopters, however this is generally only a concern approximately 2m above the waterline (going lower does increase the salt pickup).
- SWH recommend ensuring that any helipad pontoon provides the minimum required size for the intended helicopters and operations.
- The SWH helipad is not in a protected area and therefore boats occasionally cruise past in relatively close proximity to the helipad.
- Helicopter operations can be impacted when there are a significant number of boats moored as the yacht mast heights can limit helicopter flight paths.
- SWH are exposed to a river with a 40kt zone where boats create up to 2-3ft wakes near the helipad.
- Boats often moor approximately 200ft south of the SWH helipad which is protected from the majority of boat wake.
- It is common for boats to cruise within 20-30m of SWH helicopter operations as the helipad is in a boat channel.
- SWH helicopter pilots conduct a visual check for nearby boats prior to take-off and landing to optimise their route and minimise impacts on boat users:
- SWH indicated that this would be suitable for implementation at Trinity Point, especially based on the low number of movements anticipated (i.e. maximum of 3 to 4 daily).
- SWH pilots give-way to nearby boat users to minimise or eliminate any impact of helicopter downwash, and it was noted that this is common practice for experienced helicopter pilots who can hover and allow boat users to continue on their route before continuing with their flight path.
- SWH have observed the generation of minor waves when close to boat users although these do not appear to impact their operations and do not impact safety (SWH reiterated that pilots aim to give-way to boat users to minimise this impact).
- SWH conduct approach and take-off over water only with their flight path over land during en-route operations.
- Regulations state that aircraft conducting charter operations over water must have floatation devices at a particular distance (however it was noted that this distance not relevant to Trinity Point).
- The requirement for flotation devices does not apply if helicopter operations are undertaken over water only during take-off and approach.
- SWH stated that the Trinity Point helipad appears to be an ideal location for helicopter operations because there are plenty of approach and departure paths.
- SWH utilise radios to communicate with the large Sea World boats to ensure helicopter operations do not impact on planned naval routes.
- SWH highlighted a risk that the proposed helipad may generate downwash around the helipad which can blow sea water onto nearby yachts moored at the marina.
- SWH indicated there were several other water-based helipad operators across Australia including but not limited to Great Barrier Reef (GBR) Helicopters in Cairns and Microflite in Melbourne (located on the Yarra River).

Microflite Discussions

Microflite provide helicopter services Australia wide and have 3x heliports in Melbourne including a heliport on the Yarra River at 2A Spencer Street. Microflite offer a premium range of tours, charter flights, air work applications, pilot training and aviation services.

It should be noted that the Microflite fleet is similar to the typical aircraft proposed for the Trinity Point helipad development, with the Microflite fleet summarised as follows:

- Airbus EC120B (single engine, 4 pax);
- Airbus EC130B4 / H130 (single engine, 6 pax);
- Airbus AS350 B2 (single engine, 5 pax);
- Airbus AS350 B3 / H125 (single engine, 5 pax);
- Airbus AS355 NP (twin engine, 5 pax); and
- Airbus EC135 P2+ (twin engine, 6 pax).

A summary of the discussions held with Microflite on 5 February 2019 is provided below:

- The Microflite helipad has been there for several years.
- The helipad itself is not built to mitigate noise or downwash impacts.
- Microflite have not had any incidents over the life of the helipad.
- Microflite recently (approximately 2 to 3 years ago) implemented a fly neighbourly agreement (provided in Attachment 8) which is publicly available via Melbourne City Council, noting that this was self-implemented (agreement between air operators and Council) and that the agreement provides mitigation measures for noise and other aircraft related impacts.
- Microflite utilise two approach paths along the Yarra River, specifically:
  - 1x flight path west over the Bolte Bridge.
  - 1x flight path east over the MCG precinct.
- The approach path chosen by the pilot is selected based on prevailing wind conditions, although the western approach over the Bolte Bridge is favoured to minimise impacts on neighbours as this area is less built up than to the east.
- Helicopters are required to climb to at least 1000ft above built areas.
- Microflite ensure their pilots climb as quickly as possible to minimise impacts on the public and nearby residents.
- Microflite operated in controlled airspace up to 1500ft.
- It is optimal for a single commercial operator to manage the helipad to provide a level of control over the helipads use noting that the helipad can be managed by a commercial operator and remain free for use and that the adoption of a single commercial operator will assist in management of helicopter flight movements otherwise anyone can simply fly in and out of the helipad.
- Microflite recommend the development and implementation of a Fly Neighbourly agreement.

Conclusion & Recommendations

The discussions with similar water-based helipad operators across Australia indicates that the proposed helipad development at Trinity Point is consistent with similar operators.

Operational measures can be implemented to ensure the safe operation of helicopters particularly in the vicinity of boat users as well as any neighbouring residents.

A summary of JJR's key findings and recommendations based on the consultations with similar helipad operators to the proposed helipad development at Trinity Point are provided below:

- Helicopter pilots should conduct visual line of sight checks for nearby boats and liaise with the helipad landing officer prior to take-off and landing to minimise downwash impacts on boat users;
- Helicopter pilots should give-way to boat users to minimise or eliminate the impact of helicopter downwash;
- Radio contact with regular boat users could be considered to provide a communication channel;
- A Fly Neighbourly agreement should be developed to ensure pilots fly with consideration of nearby residents and boat users;
- Helicopter pilots should climb as quickly as possible to minimise impacts on the public and other water users;
- The helipad operations should be managed by an operator who manages all helicopter movements and operations, including wind and weather checks, prior permission and management of the safety zone; and
- There are various other water-based helipad operators across Australia that operate in a similar manner to the helipad and operations proposed at the Trinity Point helipad.

Please do not hesitate to contact the undersigned via mobile phone (+61 424 783 638) or email (jason.ryan@jjryan.com.au) if you require any further information or clarification of any elements of this memorandum.

Jason Ryan
For and on behalf of **JJ Ryan Consulting Pty Ltd**
Principal Engineer (Aviation)

BEng(Hons) GCEng(Man) GCEng(Ports) MEng
MIEAust CPEng NER IntPE(Aus) APEC Engineer
RPEQ RBP(EC) MAICD

Attachments
Attachment 1 – Whitsundays, Abell Point Marina
Attachment 2 – Gold Coast, Sea World
Attachment 3 – Gold Coast, Marina Mirage
Attachment 4 – Gold Coast, City Marina & Shipyard
Attachment 5 – Melbourne, City Helipad
Attachment 6 – Geelong, Royal Geelong Yacht Club
Attachment 7 – Perth, Hillarys Boat Harbour
Attachment 8 – Fly Neighbourly Agreement

Attachment 1 – Whitsundays, Abell Point Marina

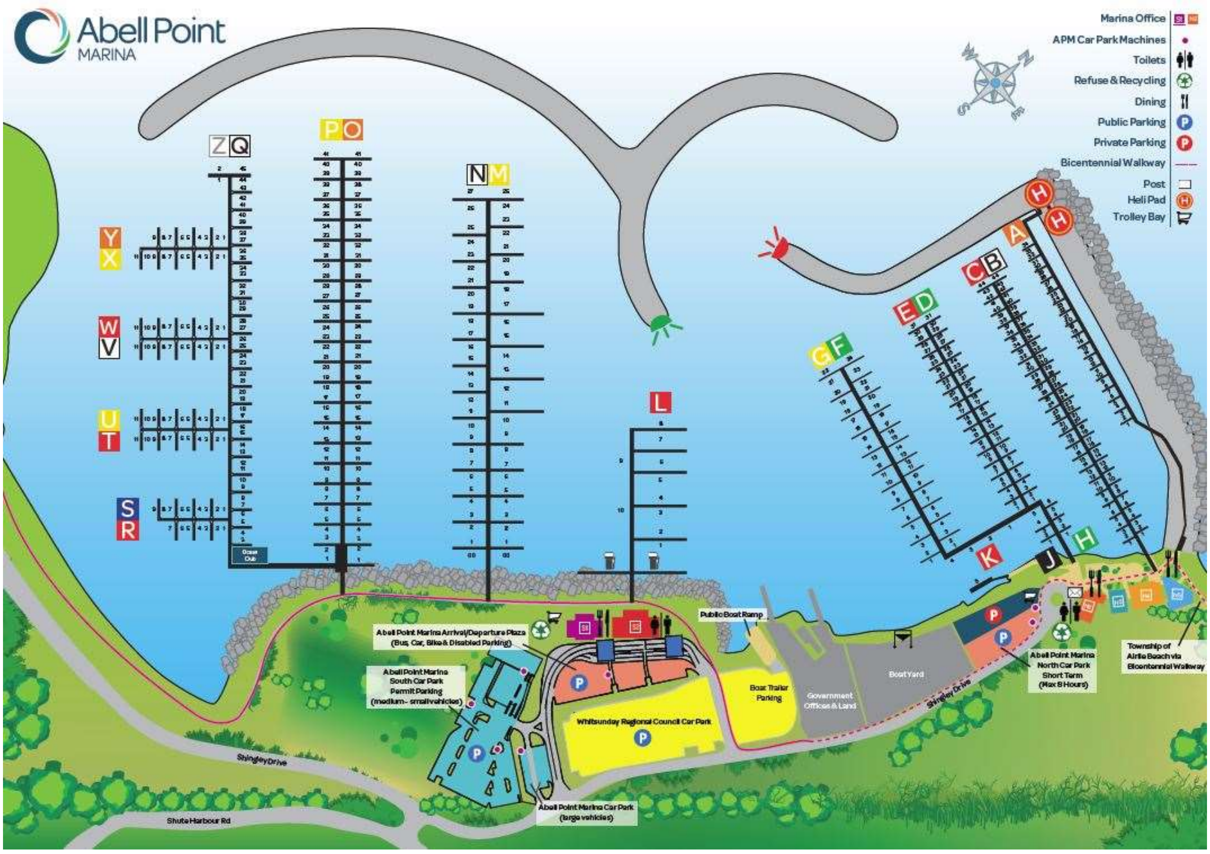


Figure A1.1 – Overview of the Abell Point mariner showing the two helipads

Figure A1.2 – Photograph of the Abell Point mariner showing the two helipads

Figure A1.3 – Photograph of the Abell Point helipads in relation to moored yachts

Figure A1.4 – Photograph of the Abell Point helipad being utilised by two helicopters

Figure A1.4 – Photograph of the approach to the Abell Point helipad (note older picture with single helipad)

Attachment 2 – Gold Coast, Sea World

Figure A2.1 – Aerial photograph showing location of the Sea World helipads

Figure A2.2 –Photograph showing location of the Sea World helipads

Figure A2.3 –Photograph showing helicopter utilising one of the Sea World helipads

Attachment 3 – Gold Coast, Marina Mirage

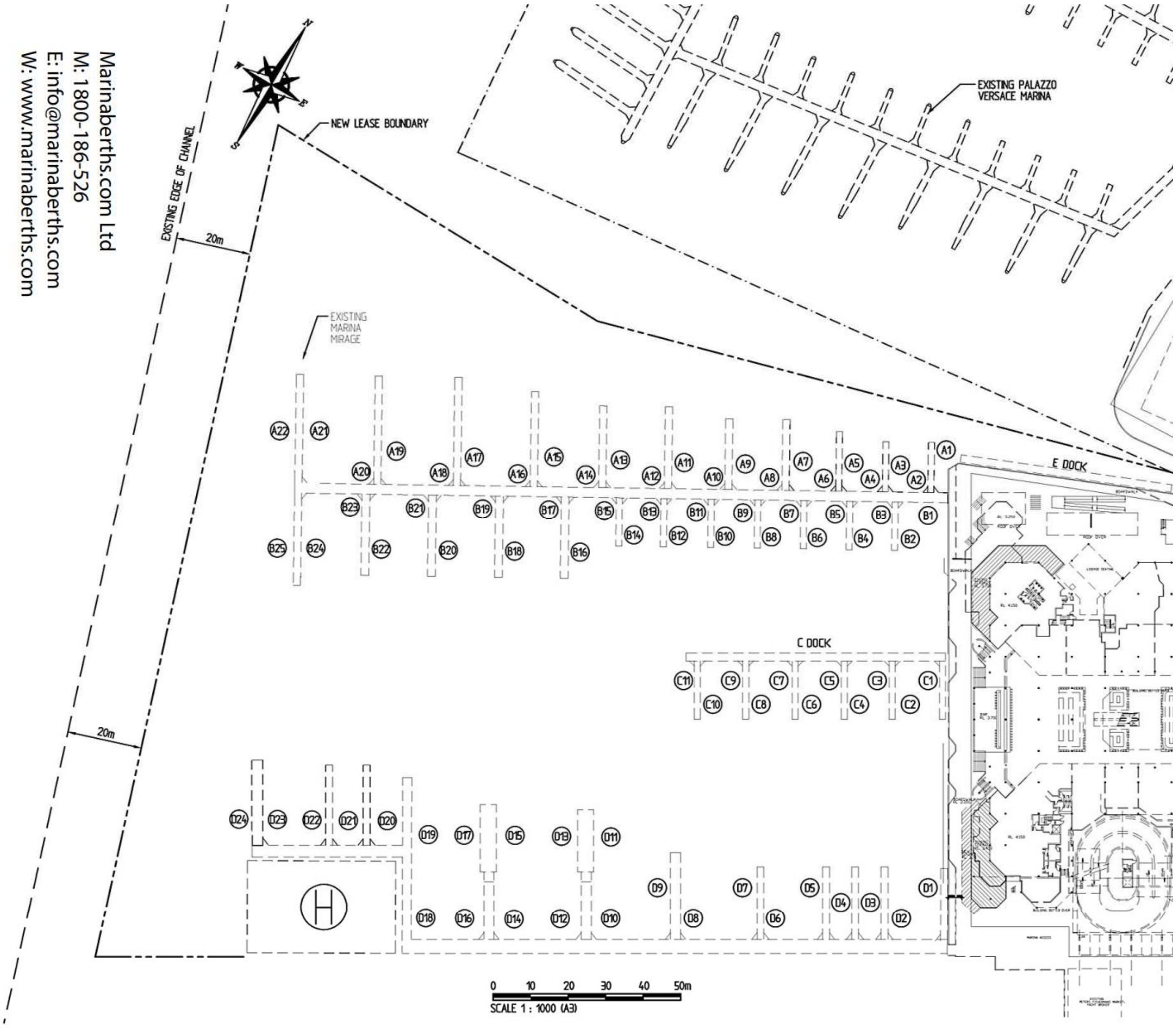


Figure A3.1 –Plan of Marina Mirage showing location of the leased helipad site

Figure A3.2 –Photograph of the Marina Mirage helipads

Figure A3.3 –Photograph of the Marina Mirage helipads, helistands and proximity to vessels

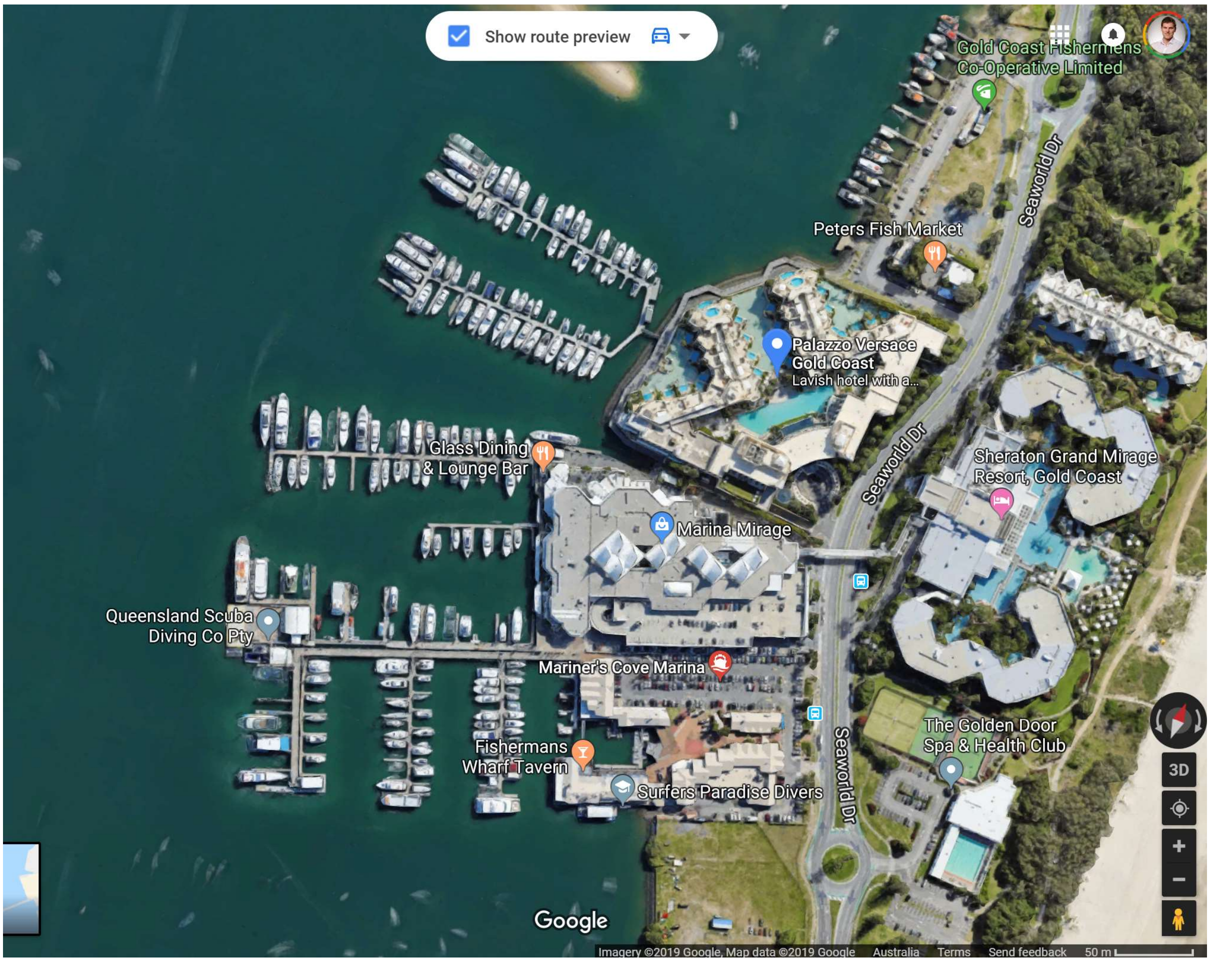


Figure A3.4 – Aerial photograph of Marina Mirage demonstrating proximity to marine operations

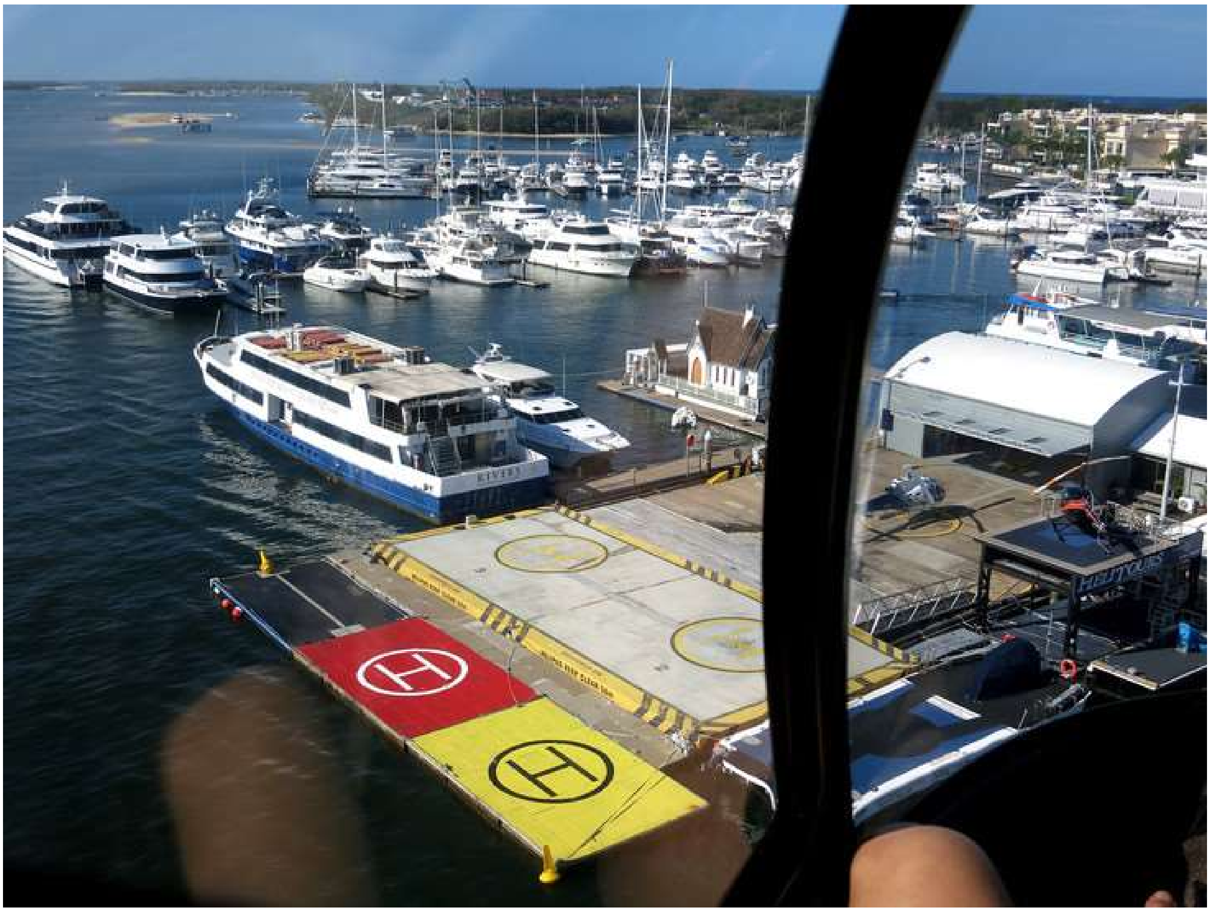


Figure A3.5 – Photograph showing additional floating helipads

Figure A3.6 – Photograph showing helicopter operations around Marina Mirage

Attachment 4 – Gold Coast, City Marina & Shipyard

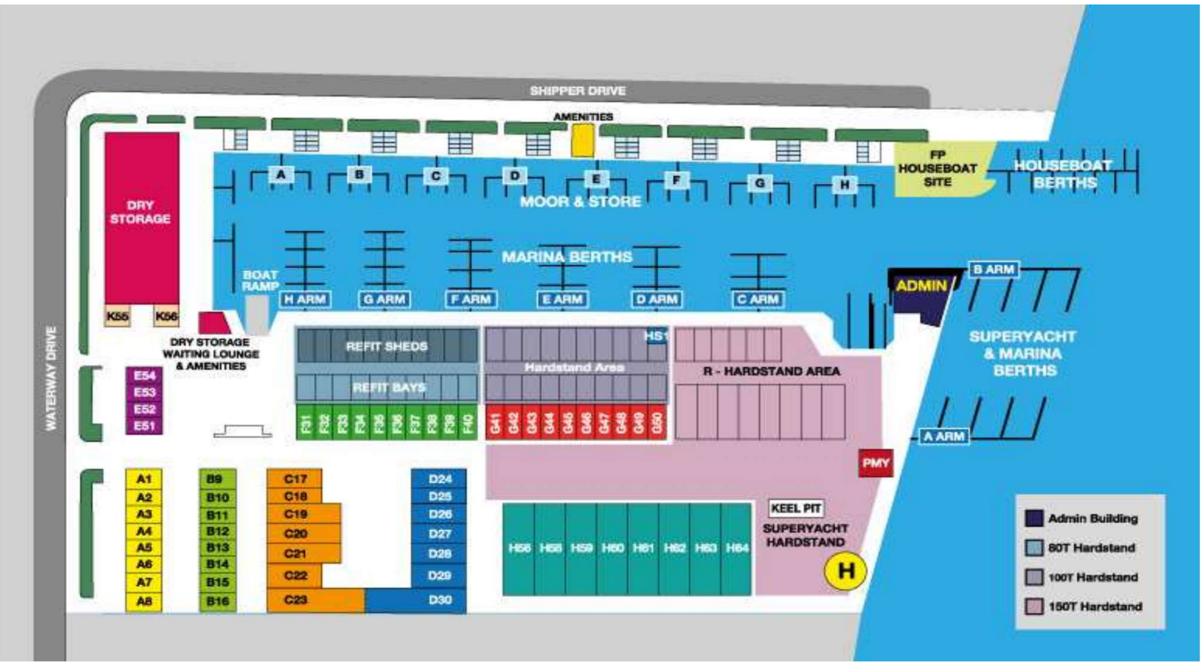


Figure A4.1 – Plan of the Gold Coast City Marina & Shipyard and location of the helipad

Figure A4.2 – Photograph of the Gold Coast City Marina & Shipyard

Figure A4.3 – Photograph of the Gold Coast City Marina & Shipyard and associated vessel movement channels

Attachment 5 – Melbourne, City Helipad

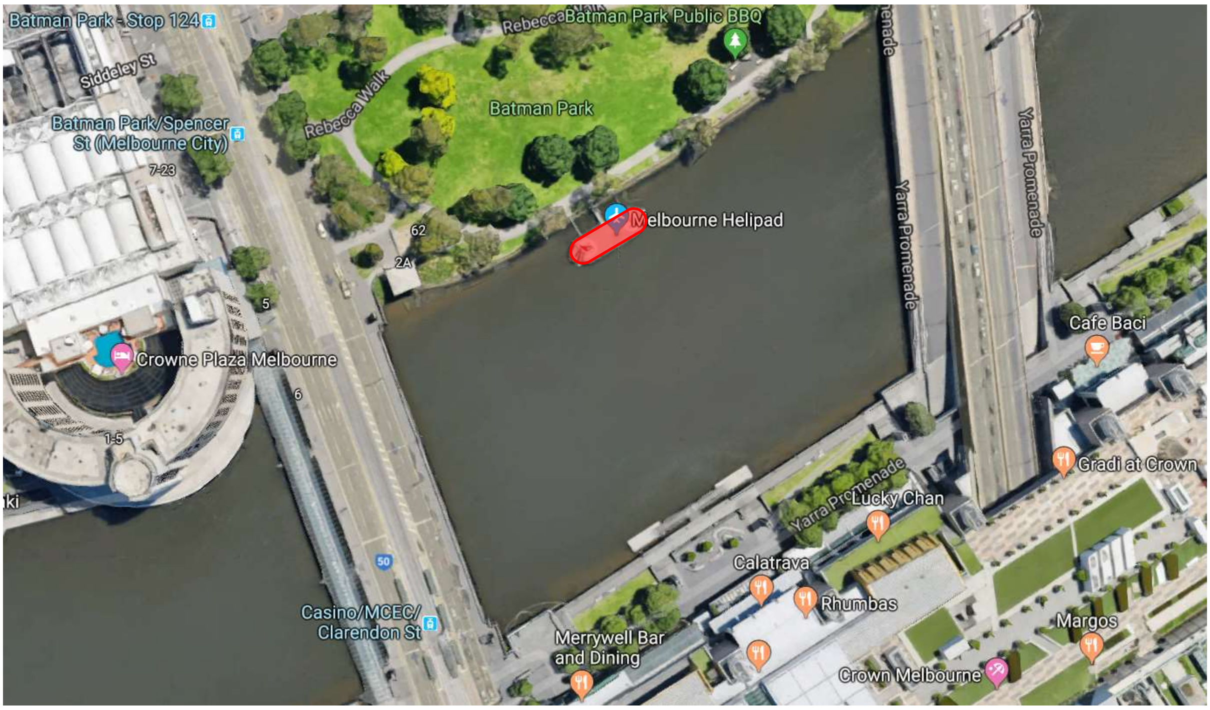


Figure A5.1 – Melbourne City helipad location in relation to public infrastructure

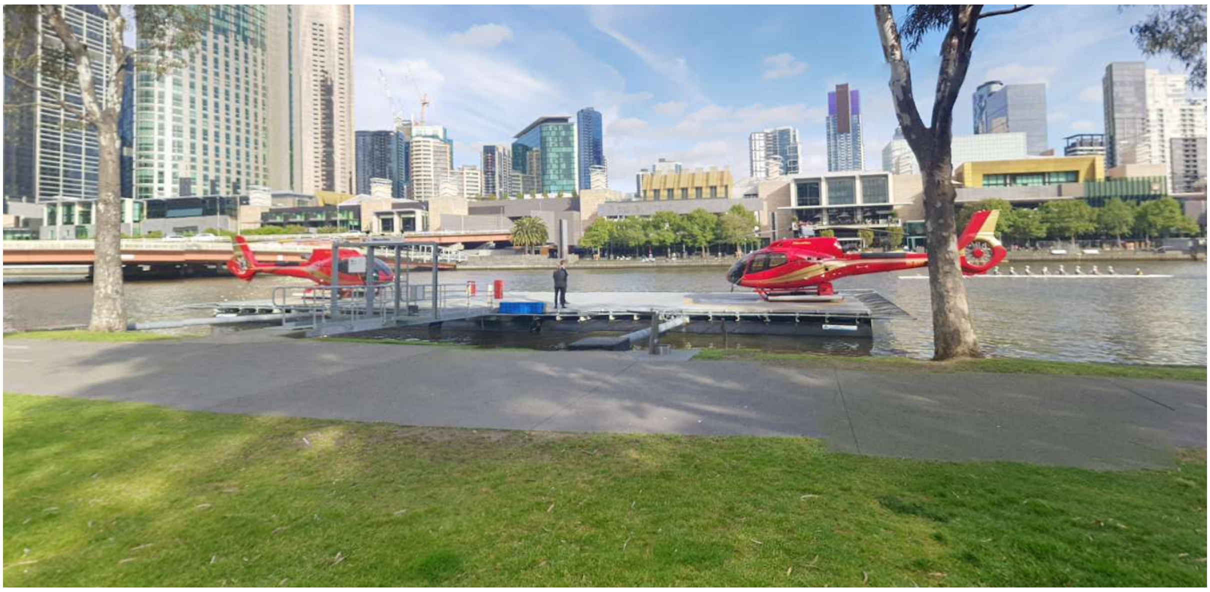


Figure A5.2 – Photograph of the Melbourne City helipad taken from public areas

Attachment 6 – Geelong, Royal Geelong Yacht Club

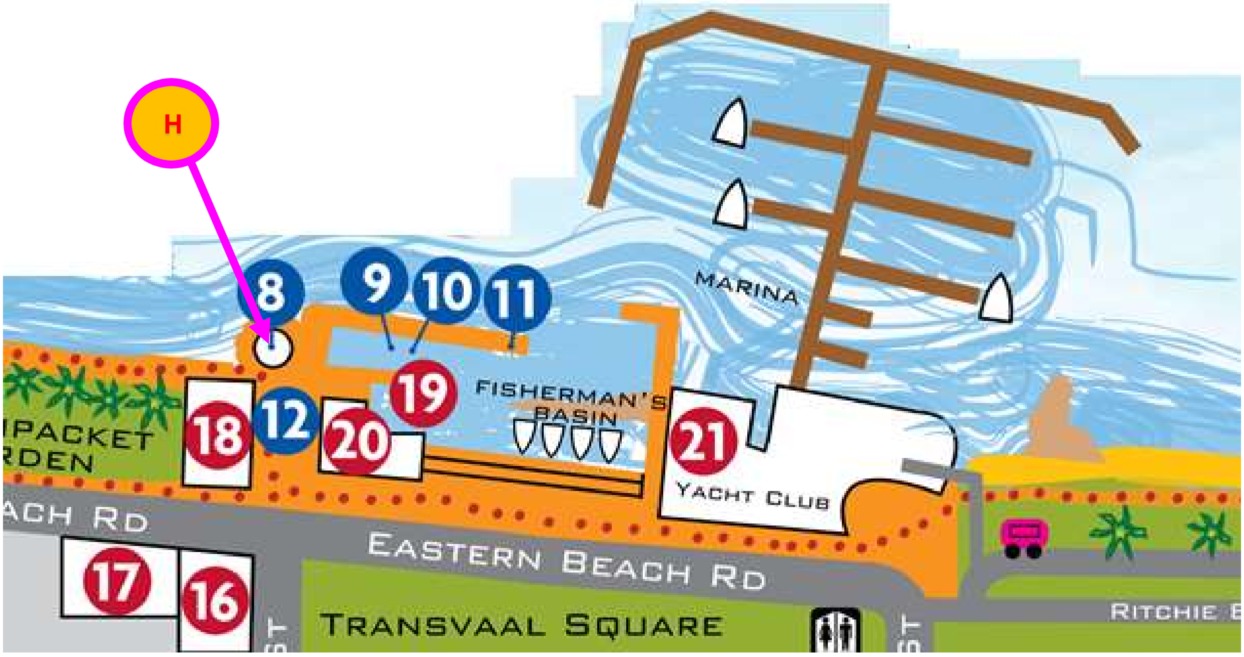


Figure A6.1 – Map showing location of the helipad in relation to marine activity at the Royal Geelong Yacht Club

Figure A6.2 – Photograph of the helicopter landed at the Royal Geelong Yacht Club

Figure A6.3 – Photograph of the helicopter landed at the Royal Geelong Yacht Club

Attachment 7 – Perth, Hillarys Boat Harbour

Figure A7.1 – Map showing layout of the Hilary's Boat Harbour

Figure A7.2 – Aerial photograph showing the location of the helipad within Hilary's Boat Harbour

Figure A7.3 – Photograph showing a helicopter on approach to the helipad

Figure A7.4 – Photograph showing a helicopter landed on the helipad

Attachment 8 – Fly Neighbourly Agreement

CITY OF MELBOURNE

Fly Neighbourly Agreement 2016 (Final)

Voluntary guidelines to manage aircraft noise in residential areas

Introduction

The City of Melbourne is a local government body. As prescribed by the Local Government Act (1989), the City is responsible for (in part):

- planning and providing services, facilities and infrastructure for the local community
- strategically planning and regulating land use in the municipality.

This Agreement applies to helicopters only although some general conditions apply to all aircraft operating in proximity to Melbourne. The City of Melbourne municipal area is covered by the Melbourne Control Zone (CTR) and Class G airspace. In Class G there are limited restrictions although helicopters are required to ensure they are 1000 feet over a populated area unless they have a dispensation from CASA, or are landing /taking off or involved in an emergency operation.

The main helicopter activity within the City of Melbourne relates to:

- tourist joy flights (operating from several origins, not just the central city helipads. This includes Essendon airport and to a lesser extent Moorabbin airport)
- police helicopter operations over the city and suburbs
- traffic reporting where the helicopter from departing from Essendon Airport operates mostly in the early morning and the evenings
- television reporting including sport and news events.

There are currently six main companies flying helicopters within City of Melbourne boundaries.
Airspace management above and within the City of Melbourne

This Fly Neighbourly Agreement is made between aircraft operators and the City of Melbourne to guide procedures when operating in the airspace above and within the City of Melbourne.

These procedures include minimum heights for aircraft, scheduled times for pilot training, recommendations for considerate flying and adoption of flight curfews so as to help protect resident amenity while still maintaining tourist and business activity.

Safety is always paramount. Pilots are expected to the best of their ability comply with the Fly Neighbourly Agreement, however there will be times where weather or operational and safety factors may lead to not all the Fly Neighbourly procedures being complied with.

1. Considerate flying

Aircraft pilots are expected to demonstrate consideration for nearby residents and operate in a Fly Neighbourly manner at all times. Pilots are asked to:

- Be conscious of the times of operation and the noise generated
- Avoid prolonged engine run-ups
- Climb to cruising altitude as soon as practical after departure
- Avoid rotor slap noise
- Avoid tight manoeuvres and turns when flying over residential areas
- Minimise time taken for approach and departure from the Melbourne city helipads
- Fly in accordance with extended final approach and departure procedures so as to avoid cutting corners and overflying built up areas adjacent to the river corridor.

Aircraft operators should use aircraft with low noise signatures wherever possible.

2. Flying above residential areas

Aircraft pilots are encouraged to operate in a Fly Neighbourly manner when flying over densely populated residential areas. Wherever possible, flight tracks that avoid sensitive areas should be selected. East Melbourne has been identified as a particularly noise sensitive area.

Where practical, hovering should take place over freeways, commercial areas and industrial precincts. If hovering must take place over residential areas, operators should maintain a hover/circling altitude as high as possible above 1,000 feet. This recognises that flying heights are subject to many factors including weather, control zones and air traffic control clearances.

3. Flying high to reduce noise impacts

Pilots are required by Air Navigation regulations to fly at a minimum of 1,000 feet over residential areas. This however does not apply when a helicopter is in the process of departing or arriving at a helipad.

While most of the flying near the Melbourne city helipads will be below 1,000 feet (as the aircraft are either departing or arriving), pilots will as soon as practical climb to at least 1,000 feet to decrease the noise impact on nearby residents.

All aircraft operators should aim to operate at the maximum height permissible where possible.

4. Helipads

The two Melbourne city helipads (at Batman Park and North Wharf) are popular bases for aircraft operators due to the proximity of the city. It is recognised that the helipads are located in close proximity to residential areas. To decrease the noise impact on residents, signatories to this document will limit operations at helipads to between the following hours:

- Monday to Friday 7am and 8.00pm*
- Weekends and Public Holidays: 9am and 8pm*.

*Note: Dispensation will be given to existing bookings outside these times. This agreement also recognises that helicopters may land and take off outside these times for 'special purposes'. This acknowledges that especially in summer there are assignments involving photography or return from events that occur in twilight.

Any flights landing or taking off after 8pm will be notified in advance via email to the Flinders Wharf apartment concierge.

Licences for the helipads are issued by Parks Victoria under the Water Industry Act (1994) and are subject to the guidelines set out in the Crown Land Reserve Act (1978). When determining licence renewals, Parks Victoria will consider the requirements of other external agencies and stakeholders.

5. Training

To ensure pilots operate to the highest possible safety standard, pilot training is required at the Melbourne city helipads. Wherever possible, aircraft operators will limit training exercises to weekdays between 11am and 2pm.

Environmental awareness and noise levels are to be included in pilot training. The City of Melbourne will provide relevant information regarding resident's amenity for inclusion in any formal training.

6. Ground running of engines

Aircraft operators are encouraged to minimise the use of ground running while located at the Melbourne city helipads. Any ground running required for maintenance or testing purposes will, as far as practical, be conducted elsewhere.

7. Special Conditions

All parties recognise that there are a number of special events throughout the year that will lead to more aircraft operations in and around the city. These include the Australian Open, Australian Grand Prix and Melbourne Cup. Residents should anticipate increased aircraft activity during these times.

8. Emergency services

All parties to this agreement acknowledge that emergency services, including police, fire, search and rescue, and infrastructure-monitoring operations, may not always be able to comply with this Fly Neighbourly Agreement.

Although Victoria Police cannot be a signatory to this Agreement given the nature of police operations, they will endeavour to operate in a Fly Neighbourly manner where possible. This includes keeping pro-active patrols of the CBD to a minimum outside of the designated operating times.

9. Noise complaint line

Residents that wish to register an aircraft noise complaint or make further enquiries about aircraft noise matters can contact the Noise Complaints and Information Service (NCIS) at Airservices Australia:

- Telephone 1800 802 584 (note Airservices generally records all calls to or from the NCIS)
- Web form[1]

10. Roles and Responsibilities

Aircraft operators agree to abide by the terms of this agreement.

---

[1] https://complaints.bksv.com/asa

The City of Melbourne will issue Fly Neighbourly certificates to all participating aircraft operators which will then be recorded and publicised on the City of Melbourne website and other relevant forums.

Copies of this Fly Neighbourly Agreement will be lodged with Airservices Australia, Parks Victoria, the Civil Aviation Safety Authority (CASA) and the Aircraft Noise Ombudsman.

All complaints will be recorded. The City of Melbourne will discuss any breaches of the agreement with operators.

11. Review process

The City of Melbourne will review the Fly Neighbourly Agreement each year in collaboration with aircraft operators and residents, taking into account:

- Aircraft noise concerns raised by Airservices, City of Melbourne, Parks Victoria or any other agency.
- Any opportunities to improve the noise outcome.

Updates to the Fly Neighbourly Agreement will be sent to Airservices Australia, CASA, Parks Victoria, and the Aircraft Noise Ombudsman and published on the City of Melbourne website.

SIGNATURES

………………………………….	………………………………….
Date ………………….	Date ………………….
Name	Geoff Robinson
Name	Manager Engineering Services
Name	City of Melbourne