THIESS PTY. LTD.

ROYAL NORTH SHORE HOSPITAL & COMMUNITY HEALTH SERVICES PROJECT

AVIATION REPORT - ROOFTOP HELICOPTER LANDING SITE ACUTE BUILDING

ROYAL NORTH SHORE HOSPITAL REDEVELOPMENT

REP-CW-AV-0001

PREPARED BY: **AviPro**

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1 ESTABLISHMENT OF THE GUIDELINES

1.1 Establishment

Thiess are the design and construction company for the new Royal North Shore Hospital (RNSH) Acute Services Building at St. Leonards. The facility is required to include a roof top Helicopter Landing Site (HLS) for the receipt and dispatch of patients by helicopter.

AviPro as aviation advisors to NSW Health/ASNSW, is to provide advice to Thiess regarding aviation specific requirements relative to the construction of a suitable roof top HLS to meet the purpose. Considerations include size, shape, structural design standards, markings, lighting, flight paths, obstructions and approvals etc.

1.2 Terms of Reference and Applicability

Currently within Australia, there are no set rules or regulations applicable to the design, construction or placement of HLSs. There may however be local council planning, location and movement approvals required. The regulator of aviation in Australia, the Civil Aviation Safety Authority, effectively divested itself of responsibility in the early 1990s and now provides only basic operating guidelines via an out of date document (CAAP), and as policy does not provide design or structural information or advice.

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

Key documents are as follows:

- ICAO Annex 14, Vol II, Heliport Manual Doc 9261-AN/903.
- ICAO Heliport Manual Doc 9261-AN/903.
- US FAA Advisory Circular *AC 150/5390-2B, Heliport Design*, (covers both operational and design criteria, particularly for hospital based HLSs in Chapter 4, Hospital Heliports).
- Australian CASA Civil Aviation Advisory Publication, *CAAP 92-2 (1), Guidelines for the Establishment and Use of Helicopter Landing Sites. (*covers essentially operational specifications only).

1.3 Methodology

Criteria from all relevant references have been assessed. The structural design specifications for roof top HLSs have been drawn from the ICAO documents, with size, shape, marking, lighting, safety enhancement and operational features drawn from the guidelines of the US FAA AC pertaining to hospital HLSs. The guidelines of the Australian CAAP are effectively overshadowed by the ICAO and FAA documents.

1.4 Explanation of Terms

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

Approach/Departure Path. The flight track helicopters follow when landing at or departing from the FATO of a HLS. Extends outwards from the edge of the FATO and has an obstacle free gradient of 7.5º (1:8 vertical to horizontal) measured from the edge of the FATO to a height initially of 500 feet above the FATO at a distance of 1,200 m. The path may be curved left or right to avoid obstacles or to take advantage of a better approach or departure path. Changes in direction by day below 300 feet should be avoided and there should be no changes in direction below 500 feet at night.

Both the CASA CAAP and FAA AC describe the approach/departure path and both commence with the width of the FATO. As the AC is more prescriptive, these guidelines are used. The AC extends the width of the approach/departure path from the edge of the FATO out to a distance of ~150 m. at 500 feet above the level of the HLS, and then out to a distance of ~1,200 m.

Design Helicopter. The Agusta AW139 contracted to the ASNSW. The type reflects the new generation helicopters used in HEMS and reflects the maximum weight, maximum contact load/minimum contact area, overall length, rotor diameter, etc. expected to operate at the RNSH helicopter landing site.

Elevated Helicopter Landing Site (Heliport). A HLS located on a roof top or some other elevated structure where the Ground Effect Area/Touchdown and Lift-off Area (GEA/TLOF) is at least 76 cm. above ground level.

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

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

Ground Effect Area. (**GEA** - Australia) [also known as the **Touchdown and Lift-off Area** (**TLOF** – US). A load bearing, generally paved area, normally centered in the FATO, on which the helicopter lands or takes off, and that provides ground effect for a helicopter rotor system. Size is based on 1 x Main Rotor diameter of Design Helicopter.

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

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

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

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

Helicopter Landing Site Imaginary Surfaces. The imaginary planes, centred about the FATO and the approach/departure paths, which identify the objects to be evaluated to determine whether the objects should be removed, lowered, and/or marked and lit – or the approach/departure paths realigned.

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

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

> **NOTE:** *A designated helicopter landing site located at a hospital or medical facility is a HLS and **not** a medical emergency site.*

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

Landing Position. Also known as the **Landing and Liftoff Area** (**LLA**). A load-bearing, generally paved area, normally located in the centre of the GEA/TLOF, on which helicopters land and lift off. Minimum dimensions are based upon a 1 x metre clearance around the undercarriage contact points of the Design Helicopter.

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

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

Lift Off. To raise the helicopter into the air.

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

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

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

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

Prior Permission Required (PPR) HLS. A HLS developed for exclusive use of the owner and persons authorized by the owner.

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

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

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

Safety Net. Surrounds the outer edge of a rooftop HLS. Should be a minimum of 1.5 m. wide, not project more than 25 cm. above the HLS outer edge, have a load carrying capacity of not less than 122 kg/m^2., and be fastened to a solid structure.

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

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

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

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

Touchdown and Lift-off Area (TLOF – US**)** [also known as the **Ground Effect Area** (**GEA** – Australia)]**.** A load bearing, generally paved area, normally centered in the FATO, on which the helicopter lands or takes off, and that provides ground effect for a helicopter rotor system. Size is based on 1 x main rotor diameter of Design Helicopter.

Transitional Surfaces. Starts from the edges of the FATO parallel to the flight path centre line, and from the outer edges of approach/departure surface, and extends outwards at a slope of 2:1 (2 units horizontal in 1 unit vertical) for a distance of ~75 m. from the centreline. The transitional surfaces start at the edge of the FATO opposite the approach/departure surfaces and extend to the end of the approach/departure surface.

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

1.5 Applicable Abbreviations

AC	US FAA Advisory Circular.
CAAP	Civil Aviation Advisory Publication (Australia).
CASA	Civil Aviation Safety Authority (Australia).
CAOs	Civil Aviation Orders (Australia).
CARs	Civil Aviation Regulations (Australia).
CHC	CHC Helicopters (Australia).
FAA	Federal Aviation Administration, USA.
FATO	Final Approach and Take Off Area. (Australian CAAP = 2 x Length) (ICAO and US FAA AC = 1.5 x Length and is used)
FARA	Final Approach Reference Area.
GEA	Ground Effect Area (also TLOF) – min. 1 x main rotor diameter. Load bearing area.
GPS	Global Positioning System taking its data from orbiting satellites.
HAPI-PLASI	Pulse Light Approach Slope Indicator (see VGI).
HEMS	Helicopter Emergency Medical Service.

HLS	Helicopter Landing Site (also Heliport).
ICAO	International Civil Aviation Organisation.
IFR	Instrument Flight Rules.
IMC	Instrument Meteorological Conditions - requiring flight under IFR.
L	Length (overall), in relation to a helicopter, the total distance between the main rotor and tail rotor tip plane paths when rotating.
LLA	Landing and Lift Off Area. Solid surface with undercarriage contact points + l x metre in all directions.
MRI	Magnetic Resonance Imagers.
MRU	Medical Retrieval Unit (HQ Eveleigh). Responsible for control and tasking of HEMS.
MTOW	Maximum Take Off Weight.
NDB	Non Directional Beacon providing a radio signal to an aircraft ADF.
RD	Main Rotor Diameter.
RMI	Remote Magnetic Indicator (magnetic compass with flux valve system).
TLOF	Touch Down and Lift Off Area (US FAA), also (Australia GEA) - min. 1 x main rotor diameter. Load bearing.
VFR	Visual Flight Rules.
VHF	Very High Frequency radio.
VGI	Visual glideslope indicator.
VMC	Visual Meteorological Conditions - allowing flight under VFR.
VOR	VHF Omni-directional Radio - a ground radio transmitter for aircraft navigation purposes.

1.6 List of Figures

1.7 Concept Drawings

The following Concept Drawings were provided in relation to the project.

- DWG-CW-AR-01101-T01
- DWG-CW-AR-01102-T01
- DWG-CW-AR-01103-T01
- DWG-CW-AR-01104-T01
- DWG-CW-AR-01401-T01
- SKT-MH-AR-11828-T03
- SKT-MH-AR-11841-T08
- SKT-MH-AR-11842-T10
- SKT-MH-AR-11843-T05
- SKT-MH-AR-11844-T04

1.8 List of Appendices

A. Helipad Elevations Level 11.
B. Helipad Layout Level 11 (Lighting & “H” Orientation to Magnetic North).
C. HLS Approach Plan Regional Context.
D. HLS Approach Plan Local Context.
E. HLS Approach Plan Future Context.
F. Typical HLS Approach Section.

2 SUMMARY

Guidelines pertaining to the structural requirements for the static and dynamic loads to meet the Design Helicopter limitations are specified and based upon the ICAO Heliport Manual Doc 9261-AN/903 recommendations.

Guidelines for the dimensions, marking and lighting for the LLA, GEA/TLOF, FATO and the Safety Area for the Design Helicopter, plus the VFR Approach/Departure Transitional Surfaces, are specified and based upon the FAA document AC 150/5390-2B, Heliport Design.

Concept Drawings as per Sub-section 1.7 were provided by Thiess and reviewed by AviPro. Key drawings are attached as Appendices.

The rooftop area proposed at level 11 allows for a single HLS only without a designated parking position. The deck is raised above the roof at level 9 by approximately 8.4 m. Most of the FATO and thus Safety Area will be beyond the edges of the building, likening the HLS to an offshore elevated structure such as an offshore oil platform or drilling rig.

The report, *Qualitative Turbulence and Air Quality Study,* REP-CW-WI-0001 has been reviewed. It discusses the effects of wind shear and turbulence in the vicinity of the HLS, as well as the potential for engine exhaust gasses being drawn into the hospital building air intakes. Comments are valid and with the exception of prevailing wind direction and strength, apply to all hospital rooftop HLSs.

A decision on whether to land on this or any other HLS or landing area rests however with the captain of the aircraft and is based upon the prevailing weather conditions at the time. Turbulence and wind shear are particularly common experiences for helicopter operations to rooftops, offshore platforms, ships decks and mountain tops. On a hospital rooftop HLS, for clinical egress reasons, the pilot will normally try to position the helicopter for landing at 90º to the entry doors/walkway to the reception room. This will be dependant on the strength and direction of the wind at the time. The approach and departure direction/s of the helicopter have no bearing on the final landing position.

Two approach and departure arcs of approximately 125º - 225º and 045º - 100º Magnetic have been proposed. The suggested primary flight path is within the arc 125º - 225º, with an approach direction of approximately 355º and a departure direction of approximately 175º. It appears that these arcs and proposed flight paths provide acceptable VFR Approach/Departure and Transitional Surfaces. The arc 045º - 100º would only be used under extenuating weather conditions due to the proximity of occupied dwellings and commercial premises. Use of the proposed fight path should avoid a necessity for curved approached and departures below 500 feet under most weather circumstances.

Other approach and departure routes may be necessary within the arcs, dependant on the wind strength and direction.

3 AVIATION REQUIREMENTS

3.1 Site Location

The proposed new Royal North Shore Hospital complex is to be constructed on the eastern side of Reserve Road, abeam the existing hospital. It is proposed to construct a rooftop HLS above the new Acute Services Building. The southern edge of the HLS will overlook Eileen Street.

Draft plans and a model of the Acute Service Building complex have been produced that incorporate the proposed site of the HLS. The following aerial photograph shows the approximate location of the new hospital complex outlined in red, on the eastern side of Reserve Road. The proposed position of the new HLS is also shown. See Figure 1.

Figure 1: Aerial View of the RNSH layout Including the Proposed New Location

Following is a plan of the proposed hospital complex and a photograph of a model, plus additional new buildings to the east and south east. See Figures 2 and 3.

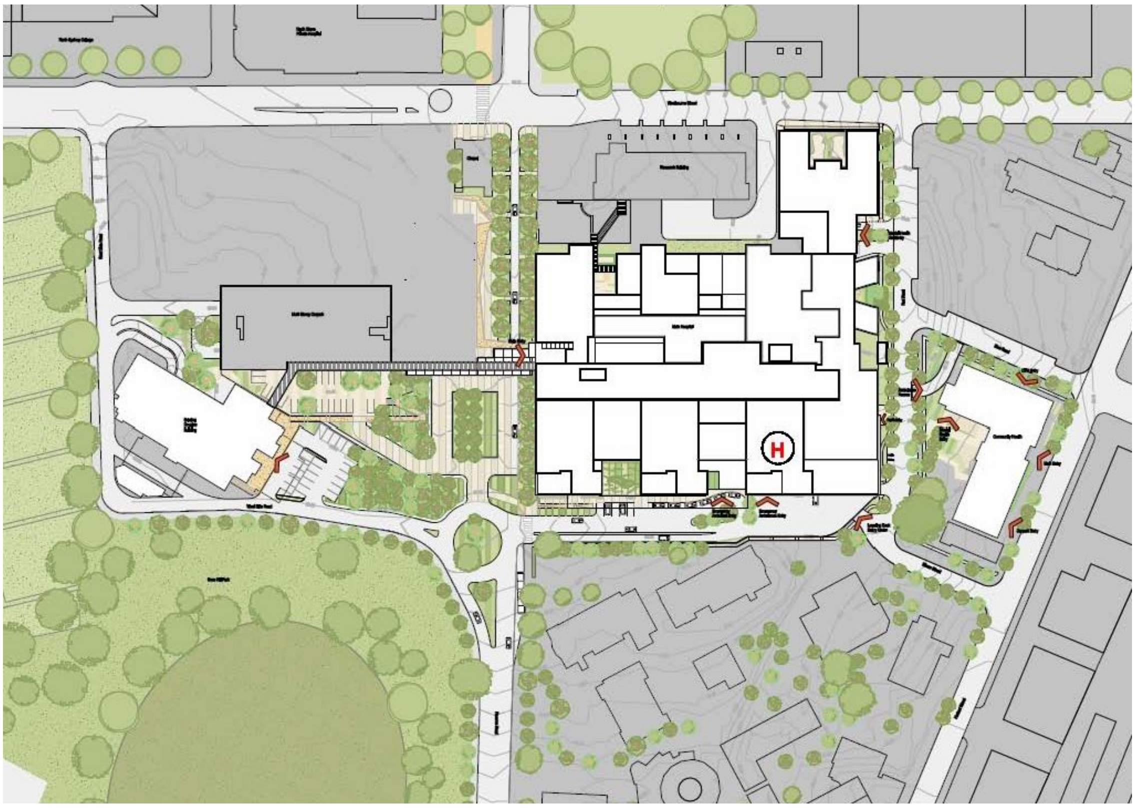


Figure 2: Plan Layout of New Hospital Complex Including HLS Position

Figure 3: Model of the New Hospital Complex as Observed from the South

Concept Drawings of an elevated structure based from level 9 and with the HLS deck at level 11, have been prepared and are attached at the Appendices. The elevation of the HLS deck is given as 128.7 m.

3.2 Design Helicopter

The "Design Helicopter" for the purposes of HLS size and structural design is the Agusta AW139, the type with the highest Maximum Take Off Weight contracted to the ASNSW. The type reflects the new generation helicopters used in HEMS and reflects the maximum weight, maximum contact load/minimum contact area, overall length, rotor diameter, etc. expected to operate at the RNSH helicopter landing site. See Figure 4.

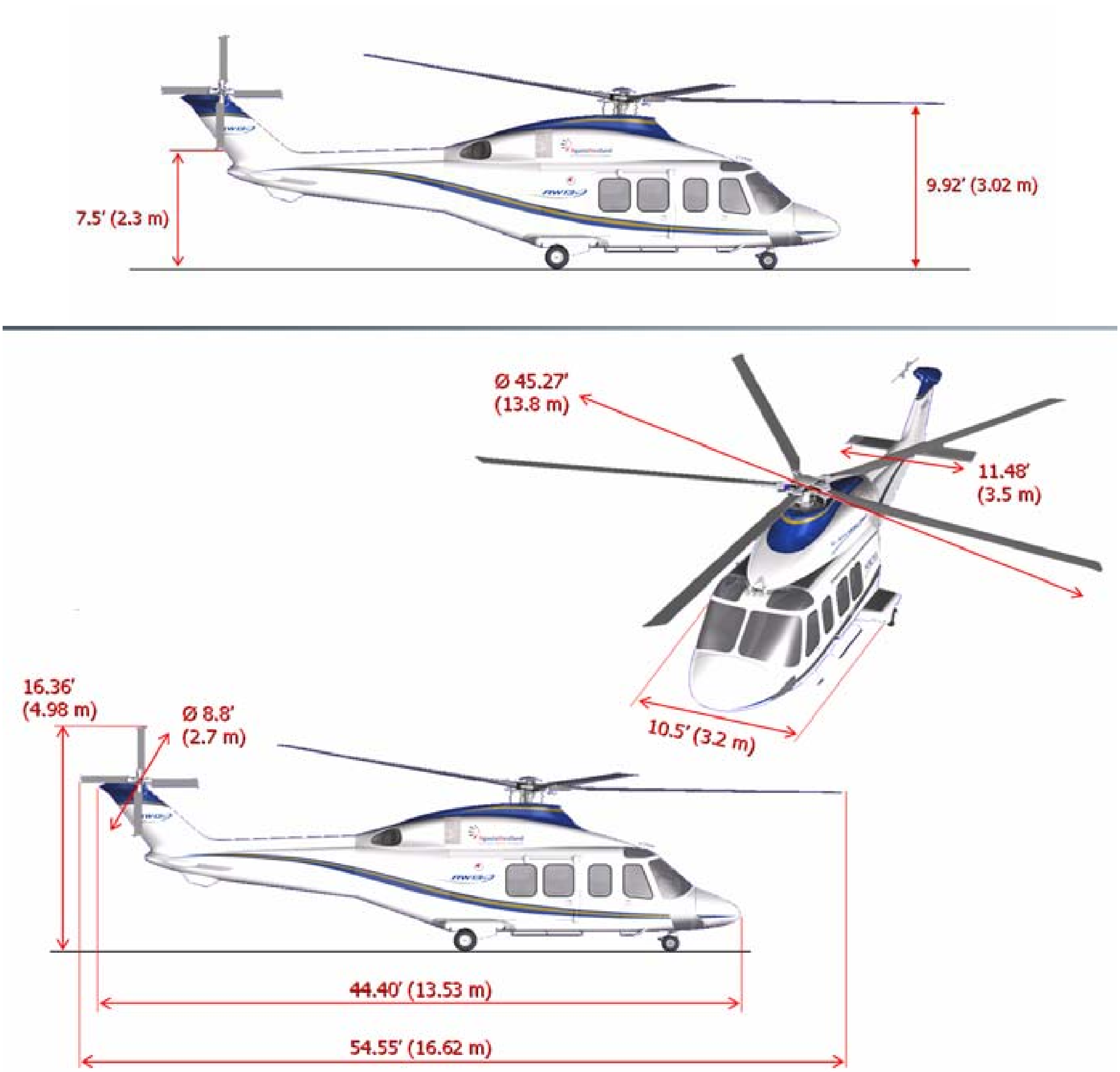


Figure 4: AW139 Dimensions

3.3 Structural Design

The FAA AC 150/5390-2B, Heliport Design states that the minimum design static load is to be equal to the helicopter's maximum takeoff weight applied through the total contact area of the wheels or skids. For dynamic loads, it specifies 150% of the maximum takeoff weight and assumes a dynamic load of one-fifth of a second or less duration occurring during a hard landing with the weight applied equally through the contact area of the two rear or main wheels. These recommendations however are more readily applied to surface level HLSs and heliports. For the construction of elevated or roof top HLSs, the structural design advice from the ICAO Heliport Manual is considered to be the most appropriate, as described following.

The HLS FATO should be designed for the largest or heaviest type of helicopter that it is anticipated will use the HLS, and account taken of other types of loading such as personnel, freight, etc. The heaviest helicopter contracted to ASNSW for the purpose of HEMS is the Agusta AW139 which has a maximum take off weight of 6,400 kg. At present the Bell 412 is still used on occasions but is to be phased out. The dimensions of this type are marginally larger but close enough to be considered as the same, however it has a MTOW 1,000 kg. less than the AW139. The AW139 is therefore to be considered as the Design Helicopter.

For the purpose of design, it is to be assumed that the helicopter will land on two main wheels, irrespective of the actual number of wheels in the undercarriage, or on two skids as fitted to other types of helicopter that may use the HLS. The loads imposed on the structure should be taken as point loads at the wheel centres. Refer to Sub-section 3.4 following.

When designing a FATO on an elevated HLS, and in order to cover the bending and shear stresses that result from a helicopter touching down, the following should be taken into account:

a Dynamic load due to impact on touchdown

This should cover the normal touchdown, with a rate of descent of 6 feet per second, which equates to the serviceability limit state. The impact load is then equal to 1.5 times the maximum takeoff mass of the helicopter.

The emergency touchdown should also be covered at a rate of descent 12 feet per second, which equates to the ultimate limit state. The partial safety factor in this case should be taken as 1.66.

Hence, the ultimate design load:

= 1.66 service load
= (1.66 x 1.5) maximum takeoff mass
= 2.5 maximum take-off mass.

To this should be applied the sympathetic response factor discussed at b. following.

b. Sympathetic response on the FATO

The dynamic load should be increased by a structural response factor dependent upon the natural frequency of the roof top slab when considering the design of supporting beams and columns. This increase in loading will usually apply only to slabs with one or more freely supported edges.

It is recommended that the average structural response factor (R) of 1.3 should be used in determining the ultimate design load.

It is recommended that the structural design based on the ICAO Heliport Manual specifications be considered.[1]

Other design considerations involving the over-all superimposed load from personnel and equipment on the HLS etc. are in this case negligible, however the Heliport Manual does provide an allowance of 0.5 kilonewtons per square metre.

3.4 Agusta AW139 Wheels Contact Area

The Agusta AW139 helicopter model Maximum Take Off Weight (MTOW) is 6,400 kg. The data following was provided by the aircraft manufacturer Agusta SPA, Construzioni Aeronautiche, Vergiate Italy. Calculations are based at the MTOW. On almost all occasions however the weight of the aircraft would be somewhat below 6,400 kg.[2]

The aircraft has a pair of nose wheels (together) and two single aft main wheels. Undercarriage layout is a triangle.

The contact area of the nose wheels:

2 x 11.2 sq ins = **22.4** sq ins.

The contact area of the aft main wheels:

2 x 23.01 sq ins = **46.02** sq ins.

[1] Heliport Manual Doc 9261-AN/903
[2] Agusta SPA, Construzioni Aeronautiche, Vergiate Italy

The distribution percentage of gross weight:

Nose wheels = **22**%, and total of both main wheels = **78**%.

The loading of the respective contact areas:

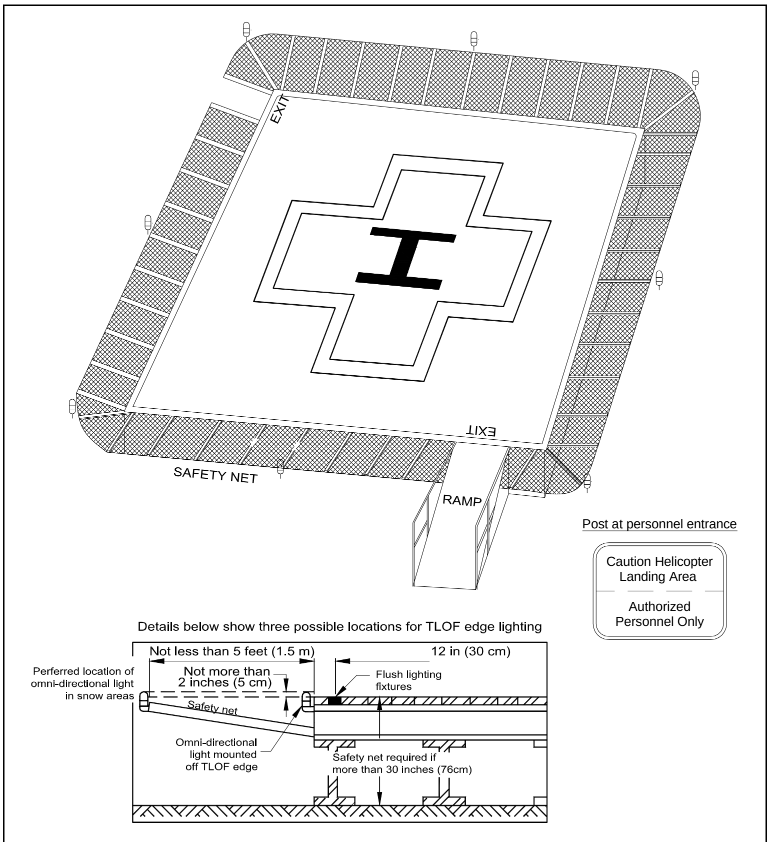
Nose wheels = **173** psi, and for each of the two main wheels, **239** psi.

Distance between contact areas:

The width of the main wheels is **3** m. and the distance from the nose wheels to a line joining the aft main wheels at a right angle, is **4.35** m.

3.5 HLS Size Requirements

The proposed HLS is to be roof top mounted. It may be round or square, incorporate round or square FATO and GEA/TLOF markings and lighting, will include a surrounding safety net, and be to the minimum dimensions and structural integrity required to meet the Design Helicopter specifications. The following diagram at Figure 5 depicts a typical roof top hospital HLS.



Note:

1. Hospital designator, maximum static weight and rotor diameter limitation markings are not shown for simplicity.
2. In this diagram, the perimeter lights are outside the safety net. Preferred location is at the edge of the FATO, inside the safety net.
3. No GEA/TLOF markings or perimeter lights are shown.

Figure 5: Elevated GEA/TLOF, Safety Net and Lighting

The minimum required dimensions are based upon the Design Helicopter, the AW139. The following information is relevant for a single HLS and thus single FATO.

3.5.1 FATO

Diameter minimum 1.5 x Length = 1.5 x 16.62 m. = 24.93 m., and a maximum slope in any direction not exceeding 3%. 2% is preferable. Rounded to a diameter of **25** m. or **25** x **25** m. square.

3.5.2 GEA/TLOF

Diameter minimum 1 x main rotor dia. of 13.8 m. Rounded to a diameter of **14** m. or **14** x **14** m. square.

3.5.3 LLA

Diameter minimum of **6.35** m. or **6.35** x **6.35** m. square If a load bearing GEA/TLOF is in place the LLA will fall within the GEA/TLOF. In such a case, the LLA will not be defined on the HLS deck.

3.5.4 Safety Area

The FATO shall be surrounded by a Safety Area which is to be free of all obstacles.

The purpose of a Safety Area is to:

a. reduce the risk of damage to a helicopter caused to move off the FATO by the effect of turbulence or cross-wind, mislanding or mishandling; and

b. protect helicopters flying over the area during landing, missed approach or take-off by providing an area which is cleared of all obstacles except small, frangible objects which, because of their function, must be located on the area.

A Safety Area surrounding a FATO intended to be used in visual meteorological conditions (VMC) shall extend outwards from the periphery of the FATO for a distance of 0.3 times the rotor diameter (RD) of the Design Helicopter. This size assumes that all markings and lighting will be in place.

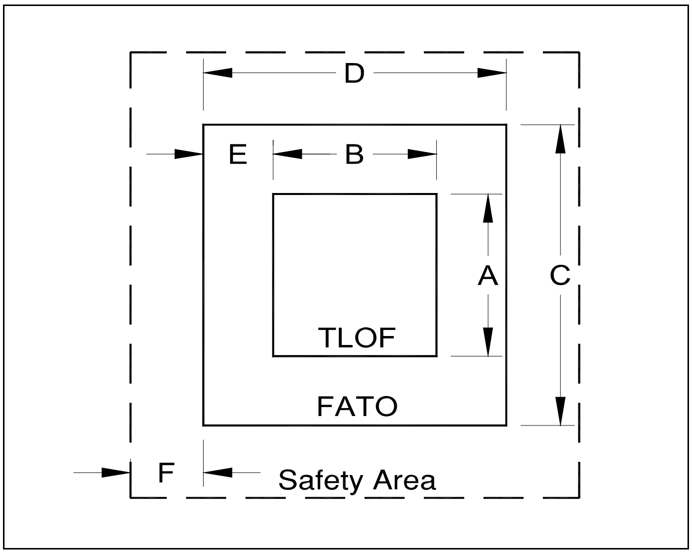
Therefore, 0.3 x L (13.8 m.) = 4.14 m. The Safety Area width surrounding the FATO is thus rounded to **4** m.

No fixed object shall be permitted on a Safety Area, except for frangibly mounted objects which, because of their function, must be located on the area. No mobile object shall be permitted on a Safety Area during helicopter operations.

Objects whose functions require them to be located on the safety area shall not exceed a height of 20-25 cm. when located along the edge of the FATO, nor penetrate a plane originating at a height of 20-25 cm. above the edge of the FATO and sloping upwards and outwards from the edge of the FATO at a gradient of 5%. The surface of the Safety Area shall not exceed an upward slope of 4% outwards from the edge of the FATO.

The surface of the Safety Area abutting the FATO shall be continuous with the FATO and the whole of the Safety Area shall be treated to prevent loose items and any other flying debris caused by rotor downwash.

The minimum recommended Safety Area surrounding the FATO is dependant upon whether there are suitable markings for the FATO, the GEA/TLOF and the central "H". In this situation, the FATO, GEA/TLOF and the "H" are to be appropriately marked with paint, and to meet night operations requirements, will be installed with the required lighting. With such markings, the Safety Area minimum is to be **4** m. in width and surround the FATO. The total diameter of a round HLS including the Safety Area will therefore be (25 + 8 m.) = **33** m. If square, it will be **33** x **33** m. See Figures 6 and 7.[3]



Note: HLS may be square or round. Length and Width dimensions also relate to diameter if round.

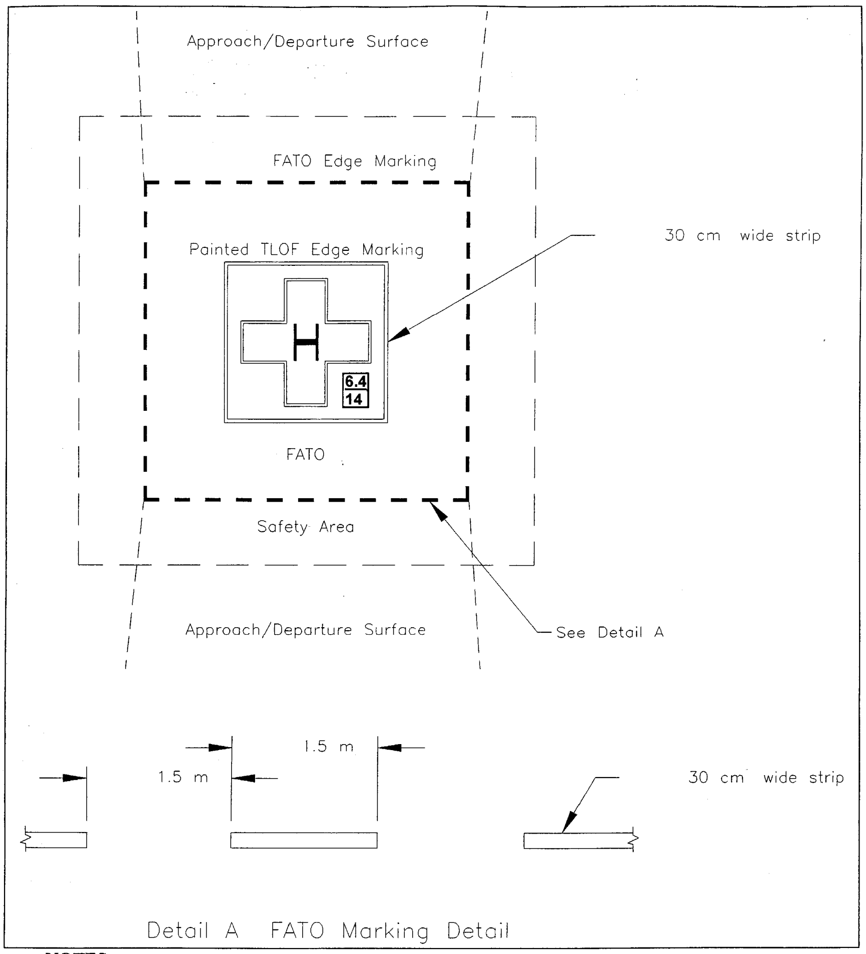
Design Helicopter: Agusta AW139

RD: Rotor diameter of the design helicopter
OL: Overall length of the design helicopter

A – Min GEA/TLOF Width: 1.0 x RD (14 m.) (if round, diameter is 14 m.)
B – Min GEA/TLOF Length: 1.0 x RD (14 m.)
C – Min FATO Width: 1.5 x OL (25 m.)
D – Min FATO Length: 1.5x OL (25 m.)
E – Min separation between perimeters of the GEA/TLOF and FATO: 0.5(1.5 x OL – 1.0 x RD) (5.5 m.)
F – Min Safety Area Width: 0.3 x RD (4 m.)

Figure 6. GEA/TLOF and FATO/Safety Area Relationships and Minimum Dimensions

[3] AC 150/5390-2B



Note:

1. The "H" should be orientated to Magnetic North.
2. The perimeter of the GEA/TLOF should be defined with a continuous, 30 cm. wide white line.
3. The perimeter of the FATO should be defined with a 30 cm. dashed white line approximately 1.5 m. in length, and with end-to-end spacing of approximately 1.5 m.
4. The corners of the FATO should be defined.
5. The positions/directions of the Approach/Departure Surfaces are examples only.

Figure 7: GEA/TLOF, FATO, "H" and Weight/Rotor Diameter Markings

3.6 Parking Position

Not applicable to the new RNSH rooftop HLS.

3.7 Perimeter Safety Net

A perimeter safety net is required to surround the edge of the HLS/rooftop/elevated HLS. It must be not less than 1.5 m. wide, have a minimum load carrying capability of 122 kg/m^2 and not project more than 25 cm. above the HLS deck. Both the inside and outside edges of the safety net are to be secured to a solid structure.

3.8 Slope and Drainage

The maximum slope in any direction should not exceed a maximum of 3% and is recommended at 2%. Adequate water/spill drainage is required to account for prolonged heavy rain.

3.9 Fuel/Water Separator

Arrangements are required to ensure that any spilt fuel or lubricants do not enter the water drainage system. A suggested solution follows.

A gravity operated fuel/water separator of sufficient size (total capacity of ~2,700 litres [static holding capacity of ~1,500 litres and integral storage of 1,200 litres]) should be installed below the rooftop HLS deck or elevated HLS to ensure that any fuel, oils and greases are appropriately collected in the event of spillage. The separator should have an adjustable oil draw-off, a contents indicator and integral baffle system. Desirable construction material is stainless steel.

3.10 HLS Capacity and Load Limitations

Refer to Sub-section 3.3 Structural Design for maximum load limits. In the case of the proposed rooftop HLS, there is sufficient area only for a single HLS and thus FATO with a diameter to the circumference of the Safety Area of at least 33 m. There must also be sufficient area beyond the FATO to the main access point for the unloading and loading patients.

3.11 HLS Surface Covering and Marking

Where possible, all paint used on the HLS deck is to be hard wearing (road type), fuel resistant, non slip and UV resistant. The HLS deck to at least the perimeter of the FATO is to painted light grey. Surface markings should identify the facility as a HLS. Lines/markings for the FATO and GEA/TLOF are to be 30 cm. wide and of a contrasting colour (white) to enhance conspicuity. The following markers and markings are to be used.

3.11.1 GEA/TLOF and FATO Perimeter Marking

The perimeter of the GEA/TLOF and the FATO is to be defined with markers and/or lines.

(1) GEA/TLOF. The perimeter of the GEA/TLOF is to be defined with a continuous white line 30 cm. wide. Refer to Figure 6.

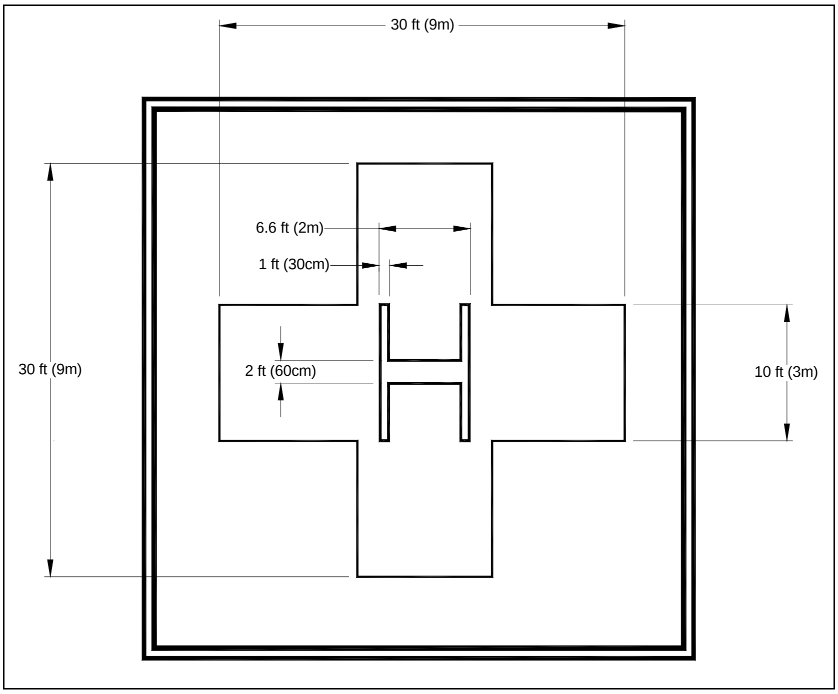
(2) FATO. The perimeter of the FATO is to be defined with a 30 cm. wide dashed white line. The corners of a square FATO should be defined, and the perimeter marking segments are

to be 30 cm. in width, approximately 1.5 m. in length, and with end-to-end spacing of approximately 1.5 m. Refer to Figure 6.

3.11.2 Hospital HLS Identification Marking

The identification marking is intended to identify the location as a hospital HLS, mark the GEA/TLOF, and provide visual cues to the pilot.

Standard marking is a red "H" in a white cross, on a red background, defined by the GEA/TLOF continuous white line. The "H" is to be oriented to magnetic north. Arrows and landing direction lights (see Sub-section 3.12.3 and Figure 11) are also be used to indicate one or more preferred approach/departure directions. Figure 8 illustrates the requirements of the standard hospital marking.



Note:

1. The standard hospital identification is a red "H" surrounded by a white cross.
2. The area outside of the cross to be coloured red.
3. The surrounding box is a continuous 15 cm. wide white GEA/TLOF perimeter marking.

Figure 8: Standard Hospital HLS Identification and Markings

3.11.3 Hospital Identifier

The name of the hospital and its identifier should be painted on the HLS deck on the northern side and beyond the FATO perimeter markings, or if there is insufficient space, between the FATO and GEA/TLOF lines. The letters should be 1 m. high, in white and be marked as follows: "**RNSH (YXNS)**".

3.11.4 Weight and Rotor Diameter size limitation Markings

The GEA/TLOF on the roof top/elevated HLS is to have the Maximum Take Off Weight limit marking in metric units, i.e. a marking of "**6.4**" equating to the Design Helicopter limit of 6,400 kg. This marking is to be located in the centre of the upper section of a GEA/TLOF weight/size limitation 'box'.

The GEA/TLOF is also to be marked to indicate the rotor diameter of the Design Helicopter. This marking is to be in metres, i.e. in this case a figure of "**14**", and be centred in the lower section of a GEA/TLOF size/weight limitation 'box'.

When viewed from the preferred approach direction, these markings should be located on the GEA/TLOF in the lower right-hand corner or the lower right-hand quadrant of a circular GEA/TLOF. The numbers should be 0.9 m. high and black with a white background and in a box of dimensions indicated in Figure 9.

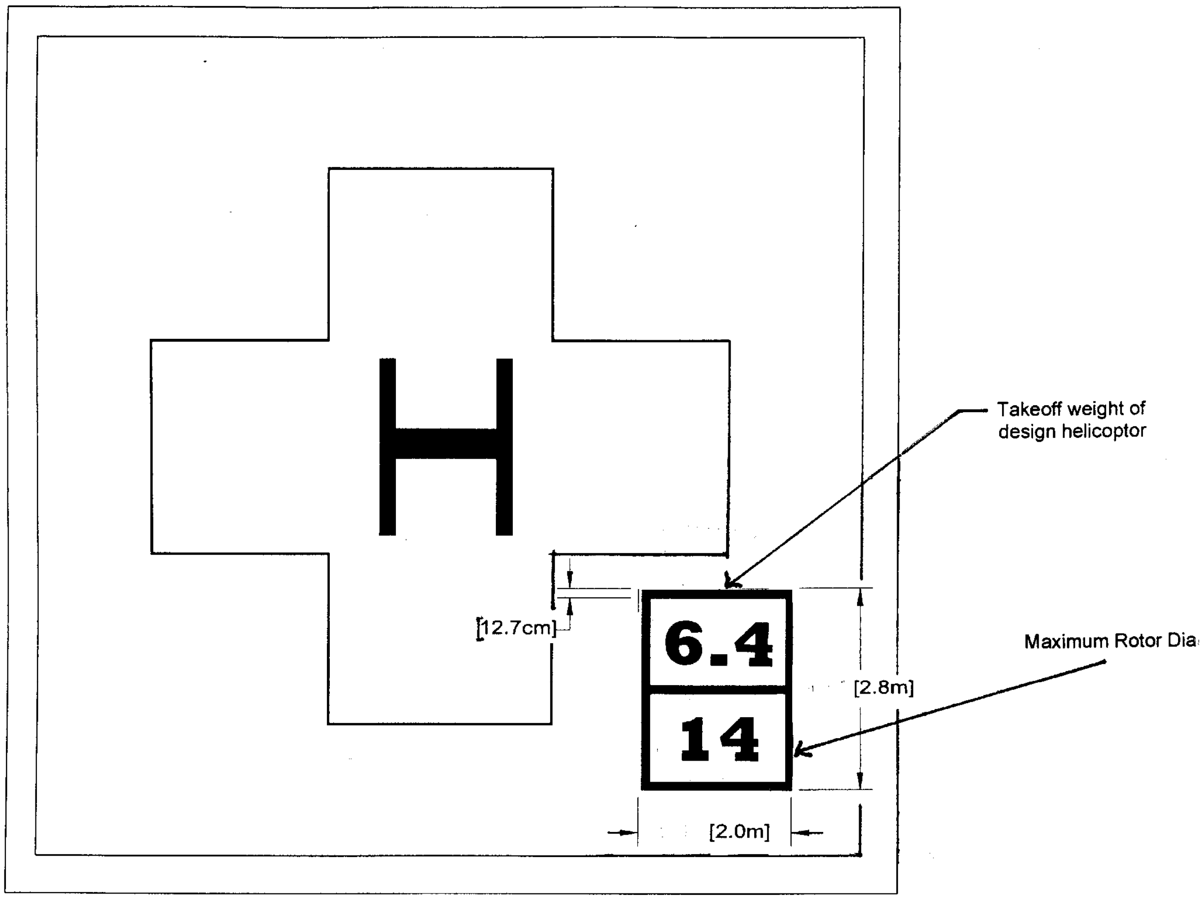


Figure 9: HLS Maximum Weight and Rotor Diameter Limits

3.11.5 HLS Deck Walkways

Painted walkway markings are to be positioned on the HLS deck. They are to be direct from the primary deck access point entry doors to the edge of the TLOF/GEA. Walkways should be at least 1.8 m. wide and be painted in UV resistant yellow and black diagonal lines.

The pavement should be designed so that spilled fuel or lubricants do not drain onto passenger walkways or toward a parked helicopter.

3.11.6 Magnetic North Orientation

The “H” marker and thus its background is to be orientated towards Magnetic North.

3.12 HLS Lighting

For night operations, the GEA/TLOF, the FATO, approach/departure direction, and the windsock must be illuminated.

3.12.1 Elevated GEA/TLOF-Perimeter Lights

The GEA/TLOF perimeter is to be lit with green lights. Flush mounted lights are to be used, and they should be located within 30 cm. of the outside edge of the GEA/TLOF perimeter. Lighting on the outside edge provides better visual cues to pilots when at a distance from the HLS, since they outline a larger area.

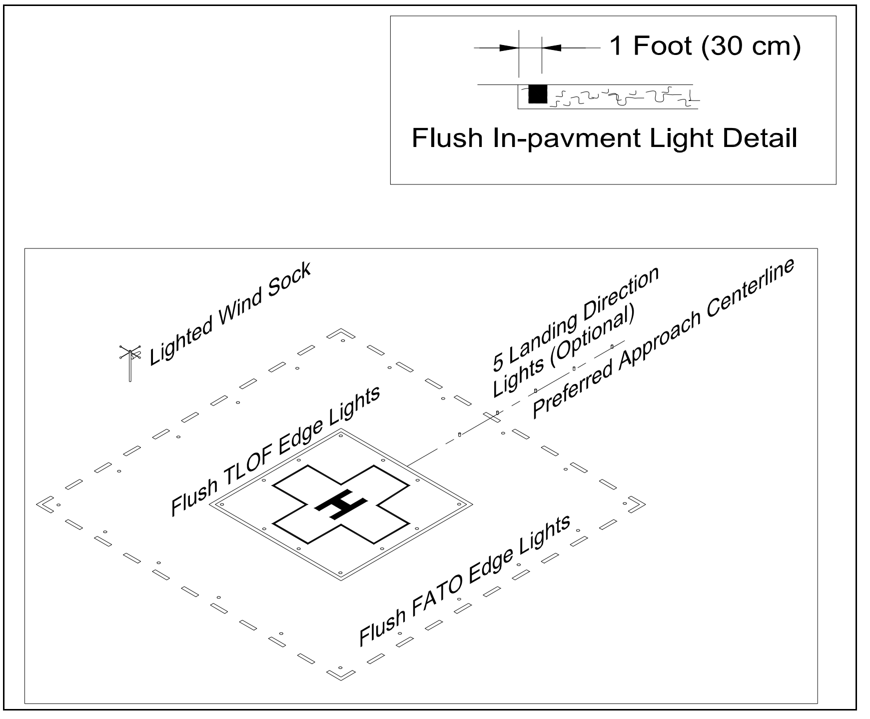
3.12.2 Load Bearing FATO-Perimeter Lights

Green lights are to define the perimeter of a load-bearing FATO. A minimum of three flush or raised light fixtures per side of a square FATO is recommended. If round, lights should be no more than 8 m. apart. If square, a light should be located at each corner with additional lights uniformly spaced between the corner lights. An even number of lights (at least eight should be used) uniformly spaced with a maximum interval of 8 m. between lights.

Note:

(1) *At a distance during night operations, a square pattern of FATO perimeter lights provides the pilot with better visual cues than a circular pattern, however either is acceptable.*

(2) *Although raised lights are acceptable, flush lights are recommended, and they should preferably be located within 30 cm. of the outside of the FATO perimeter and within the safety net area. However if the deck area is large enough, the AC does allow the FATO perimeter lights to extend out to as much as 3 m. beyond the FATO markings. See Figure 10.*



Note:

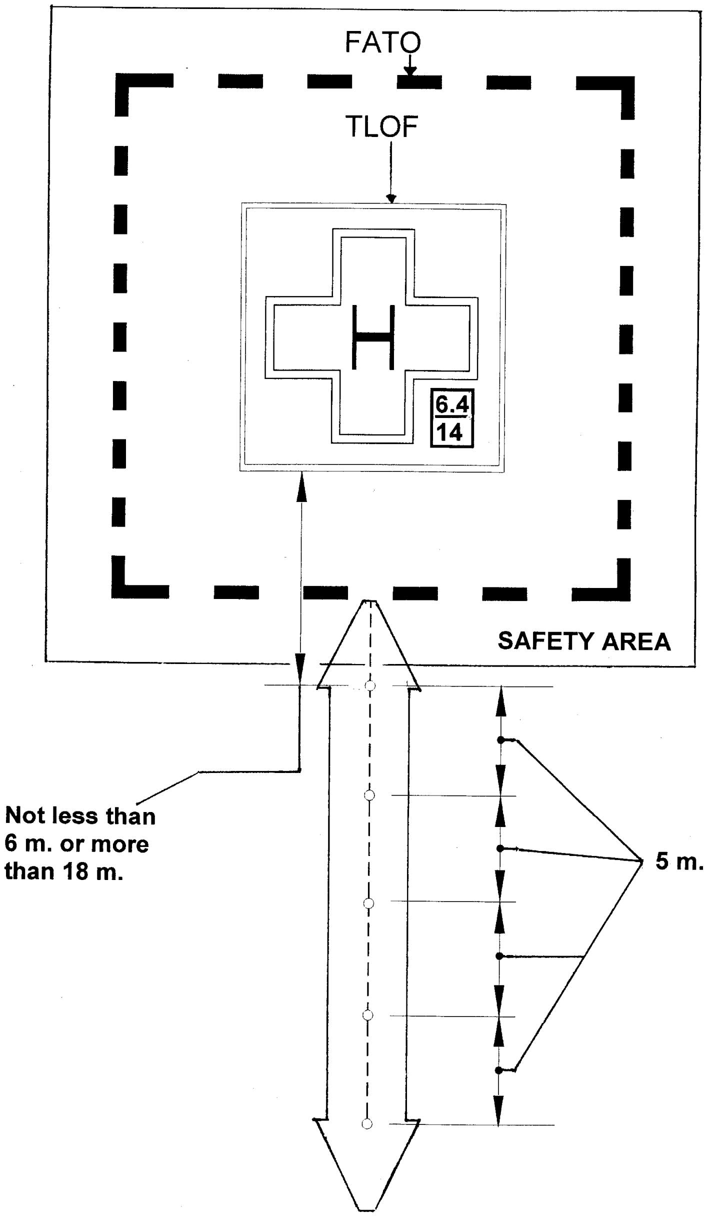
1. Flush green FATO and GEA/TLOF lights may be installed inside or outside ± 30 cm. of the FATO and GEA/TLOF respective perimeters.
2. It is preferable however that flush FATO lights are outside of the FATO ± 30 cm.
3. Rotor diameter and weight limitation markings are not shown for simplicity.

Figure 10: Flush FATO and GEA/TLOF Perimeter Lighting

3.12.3 Landing and Take-Off Direction Lights

Landing and Take-Off direction lights are an optional feature, however if at all possible they should be installed on the deck to provide landing and take off directional guidance at night. Landing direction lights are ideally a configuration of five yellow, flush mounted omni-directional lights on the centreline of a yellow two headed arrow with black borders painted on the deck, and showing the preferred approach/departure path/s. These lights are normally spaced at 5 m. intervals beginning at a point not less than 6 m. and not more than 8 m from the GEA/TLOF perimeter and extending outward in the direction of the preferred approach/departure path, as illustrated in Figure 11. If however the area does not allow for such a size, the arrow/s may be proportionally reduced in size and less lights may be used.

As the size of the proposed RNSH HLS structure is restricted to that of a single FATO plus safety net, there is little room for the incorporation of landing and take-off direction lights as per the desired layout. It is however possible to place a yellow arrow/s with black borders and perhaps three flush yellow direction lights on the deck inboard of the perimeter and extending to the GEA/TLOF marking.



Note:

1. The direction of arrow and lights are an example only.
2. Lights are flush mounted yellow omni-directional.
3. Arrow is yellow with a black border.
4. FATO and GEA/TLOF lights not shown.

Figure 11: Approach/Departure Directional Arrow and Lights

3.12.4 Taxi Route and Taxiway Lighting

N/A.

3.12.5 Windsock Lighting

The windsock is to be illuminated by four closely mounted white lights to ensure that it may be seen clearly from all directions. A red obstruction light is also to be positioned on the top of the mast. Refer to Sub-section 3.19 and see Figure 12.

Figure 12: Approach/Departure Directional Arrow and Lights

3.12.6 Floodlights

A minimum of two floodlights are to be located in the northern wall area to illuminate the GEA/TLOF and the FATO for the purposes of aiding in helicopter loading and unloading. To eliminate the need for tall poles, these floodlights may be mounted on the building wall if it is high enough. The floodlights are to be clear of the GEA/TLOF, the FATO, the Safety Area, and the approach/departure surfaces and any required transitional surfaces. Care should be taken to ensure that floodlights and their associated hardware do not constitute an obstruction hazard. Floodlights should be aimed down and provide a minimum of 3-foot candles (32 lux) of illumination on the HLS surface. Floodlights can interfere with pilot vision during takeoff and landings and are therefore to be capable of being manually turned off. They are to be on a separate circuit to that of the FATO, GEA/TLOF, windsock, obstruction and approach/departure lights.

3.12.7 HLS Identification Beacon

A HLS identification beacon is recommended equipment. The beacon is to be located as close as is practical to the HLS, and on the highest point of the hospital reasonably available. It is to be capable of flashing white/green/yellow at the rate of 30 to 45 flashes per minute. Such a beacon may be activated via a PAL system, which is also recommended.

3.13 Object Marking

HLS maintenance and servicing equipment, as well as other objects used in the airside operational areas, should be made conspicuous with paint, reflective paint, reflective tape, or other reflective markings.

Particular attention should be given to marking objects that are hard to see in marginal visibility, such as at night, in heavy rain, or in fog.

3.14 Obstruction Lighting

Marking and lighting of obstructions relates to those objects considered an obstruction on or in the vicinity of the HLS and within the approach/departure airspace, and obstructions in close proximity but outside and below the approach/departure surface. Obstruction lights are red.

3.14.1 Obstructions on or in the Vicinity of the HLS

The adverse effect of an object presumed or determined to be a hazard to air navigation may be mitigated by:

(1) Removing the object.

(2) Altering the object, e.g. reducing its height.

(3) Marking and/or lighting the object, provided that the object would not be a hazard to air navigation if it were marked and lit.

An example of an obstruction light required close to the HLS would be that required to be positioned on the top of the windsock. Refer to Figure 12. Other obstacles in close proximity to the HLS deck may include radio aerials or exhaust stacks etc. attached to the main building or other buildings in the vicinity. It may also be prudent to place obstacle lights along the roof line of the wall at the northern end of the proposed HLS. All such obstacles are required to have red obstacle lights fitted.

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

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

If difficult-to-see objects penetrate the object identification surfaces as illustrated in Figure 13, these objects should be marked to make them more conspicuous. As operations to and from RNSH will be 24 hours, any difficult-to-see objects should be lit.

3.14.3 Object Identification Surfaces

The object identification surfaces can be described as follows:

(1) In all directions from the Safety Area, except under the approach/departure paths, the object identification surface starts at the Safety Area perimeter and extends out horizontally for a distance of ~30 m.

(2) Under the approach/departure surface, the object identification surface starts from the outside edge of the FATO and extends horizontally out for a distance of ~250 m. From this point, the object identification surface extends out for an additional distance ~1,000 m. while rising on a 7.5º or 8:1 slope (8 units horizontal in 1 unit vertical). From the point ~200-250 m. from the FATO perimeter, the object identification surface is ~30 m. beneath the approach/departure surface.

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

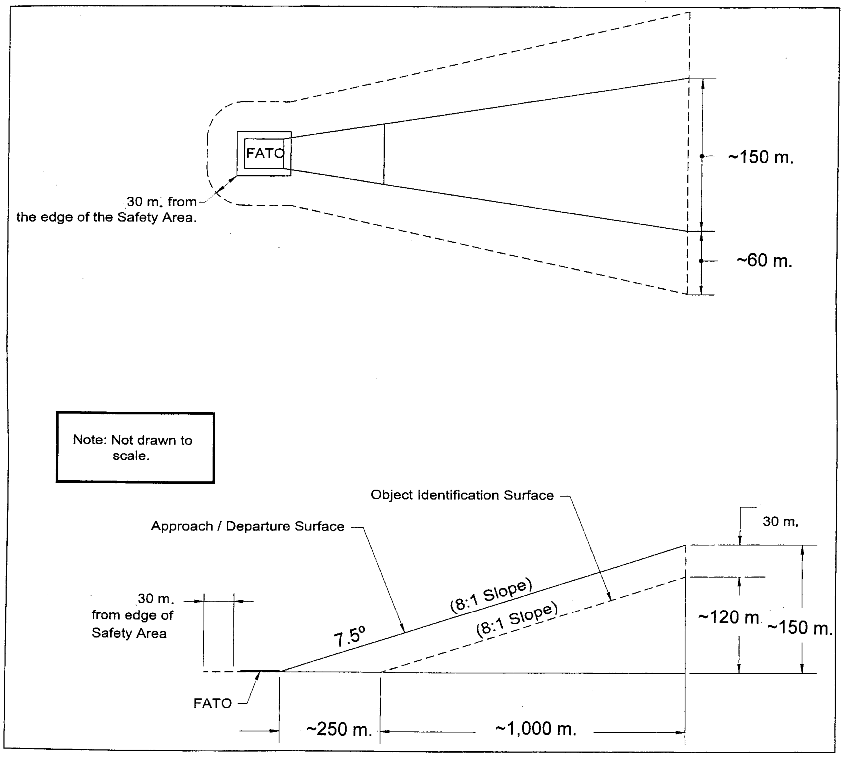


Figure 13: Airspace Where Marking and Lighting are Recommended

3.14.4 Shielding of Objects

If there are a number of obstacles in close proximity, it may not be necessary to mark/light all of them if they are shielded. To meet the shielding guidelines a object would be shielded by existing structures of a permanent and substantial character or by natural terrain or topographic features of equal or greater height, and would be located in the congested area of a city, town, or settlement where it is evident beyond all reasonable doubt that the structure so shielded will not adversely affect safety in air navigation.

An example nearby obstructions with appropriate red obstruction lighting, are the ABC and Channel 9 television transmission towers in the Gore Hill area to the north of RNSH. The ABC tower is approximately 800 m. North West of the proposed HLS.

3.15 Lighting Activation

All HLS lighting must be capable of manual activation and deactivation. Flood lighting should be on a separate circuit to that of the FATO, GEA/TLOF, approach/departure directional lighting, windsock, local obstruction lighting and any visual glideslope indicator installed. These latter lights may be on a common circuit.

All but flood lighting may also be activated via a Pilot Activated Lighting (PAL) system. This utilises a hospital based VHF radio and timed switching device. The pilot is able when within range (~20 nm.), to activate via a VHF radio transmission on a pre set frequency from the aircraft. The PAL system allows for 30 minutes duration. Lights may be manually turned on and may be manually turned off within the 30 minutes, or they automatically turn off at 30 minutes prior to a flashing warning. The installation of PAL equipment is recommended.

The manual activation switching must be readily accessible to the HLS attendant staff.

3.16 Access Points/Dimensions

Two access points to the roof top HLS are required as a minimum. The primary access point is at the same level as the HLS deck and should involve security controlled double doors with an entry width of at least 1.8 m. This would normally lead directly into the Emergency Department or a lift.

The second access point should where possible be on the opposite side of the HLS to the primary access, and allow for emergency evacuation of the HLS if necessary. This access would normally be in the form of stairs leading down from deck level to an emergency egress stair well. Due to design limitations, it has not been possible/practical to position the second (emergency) access point (stairs) on the opposite side of the HLS deck. Its location however does allow for a distance of approximately 18 m. between the extremities of the access points. Refer to Appendix B.

3.17 Visual Glideslope Indicators

N/A

3.18 Exhaust Gas Ingestion

Hospital air conditioning air intake systems should not be positioned in the vicinity of a rooftop HLS deck. Under particular wind conditions the exhaust gases emitted from the helicopter engines exhausts can travel for some distance.

3.19 Windsock

A 30 knot windsock is required to show the direction and magnitude of the wind. The windsock should provide the best possible colour contrast to its background. It may be either white or yellow, with a preference for yellow. It is to be located so it provides the pilot with valid wind direction and speed information in the vicinity of the HLS under all wind conditions. It must be clearly visible to the pilot on the approach path when the helicopter is at a distance of 150 m. from the GEA/TLOF, and be clearly visible when on the GEA/TLOF.

To avoid presenting an obstruction hazard, the windsock is to be located outside the Safety Area and it is not to penetrate the approach/departure or transitional approach/departure surfaces.

For night operations, the windsock is to be illuminated by four closely mounted white lights and a red obstruction light to ensure that it is clearly visible in all directions. Refer to Sub-section 3.12.5 and see Figure 12.

3.20 Fuel

No refuelling facilities are necessary.

3.21 Magnetic Resonance Imagers Interference

Magnetic Resonance Imagers (MRI) are located in hospitals and used in diagnostic work. A MRI can create a strong magnetic field that will cause temporary aberrations in the helicopter's magnetic compass and may interfere with other navigational systems. It is the responsibility of RNSH to provide the helicopter operator/pilot with details of the location of the MRI and similar equipment. A warning sign is to be placed on the HLS deck alerting pilots to the presence of an MRI, should there be a possibility of interference. See the example at Figure 14.

Figure 14: Example MRI Direction and Distance Marker

3.22 Radio Communication

It is assumed that the RNSH Security Department will be responsible for HLS deck access, manual lighting activation, emergency fire fighting with available appliances, and be provided with hand held UHF FM radio containing the necessary frequencies for communication with the HEMS helicopters.

The FM system in use at present is duplex with two common frequencies, Rx 505.500MHz and Tx 515.500MHz. Advice from the ASNSW MRU should be sought to confirm the frequencies and call signs in use.

3.23 Fire Appliances

A fire hose and fire water point is to be located on the wall adjacent to the primary HLS deck access point. In the vicinity of the primary access point, are to be located fire fighting appliances suitable for liquid and electrical fires. In particular, as a minimum the following are required:

- 1 x CO_2 3.5 kg.
- 1 x Dry Powder 9.0 kg.
- 1 x Foam 90 litres.
- 1 x Fire Blanket.

The advice of the fire authorities should be sought to seek the latest information.

3.24 Approvals

Aviation authority approval is not required. Council and planning approvals however may be necessary.

4 OPERATIONAL REQUIREMENTS

4.1 VFR Approach and Departure Paths

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

Approach/departure paths should be such that downwind operations are avoided and crosswind operations are kept to a minimum. To accomplish this, a HLS should have more than one approach/departure path which provides an additional safety margin and operational flexibility. The preferred flight approach/departure path should where possible, be aligned with the predominate wind when taking account of potential obstacles. Other approach/departure paths should also be based on an assessment of the prevailing winds and potential obstacles. The separation between such flight paths should where possible be at least 135 degrees and preferably greater than 150 degrees.

4.1.1 VFR Approach/Departure and Transitional Surfaces

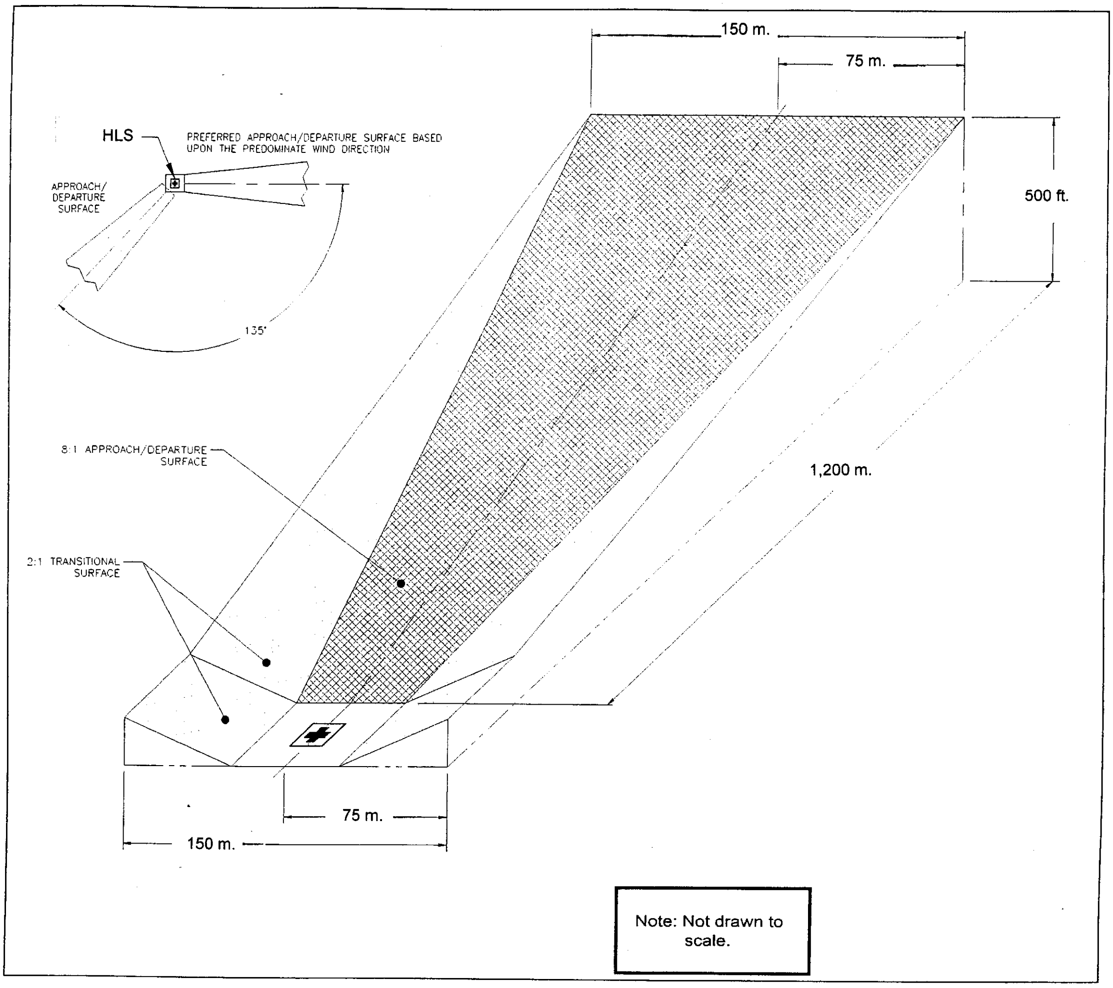
An approach/departure surface is centered on each approach/ departure path. Figure 15 illustrates the approach/ departure (primary and transitional) surfaces.

The approach/departure path starts at the edge of the FATO and slopes upward at 7.5º or 8:1 (8 units horizontal in 1 unit vertical) for a distance of ~1,200 m. where the width is ~150 m. at a height of 500 feet above the elevation of GEA/TLOF surface.

The transitional surfaces start from the edges of the FATO parallel to the flight path centre line, and from the outer edges of approach/departure surface, and extend outwards at a slope of 2:1 (2 units horizontal in 1 unit vertical) for a distance of ~75 m. from the centreline. The transitional surfaces start at the edge of the FATO opposite the approach/departure surfaces and extend to the end of the approach/departure surface. See Figure 15.

<u>Note</u>: *The transitional surface is not applied on the FATO edge opposite the approach departure surface.*

The approach/departure surface should be free of penetrations. Any penetration of the transitional surface should be considered a hazard. Refer to Sub-sections 3.13 and 3.14.



Note:

1. Rotor diameter and weight limitation markings not shown for simplicity.

Figure 15: VFR HLS Approach/Departure Transitional Surfaces

The transitional surfaces need not be considered if the size of the approach/departure surface is increased for a distance of ~600 m. as shown in Figure 15. The lateral extensions on each side of the 8:1 approach/departure surface starts at the width of the FATO and is increased so that at a distance of ~600 m. from the FATO, it is 30 m. wide. Penetrations of area A or area B, but not both, shown on Figure 15 by obstacles may be allowed providing the penetrations are marked or lit and not considered a hazard.

Note: When the standard surface is incompatible with the airspace available at the HLS site, no operations may be conducted unless helicopter performance data supports a capability to safely operate using an alternate approach departure surface.

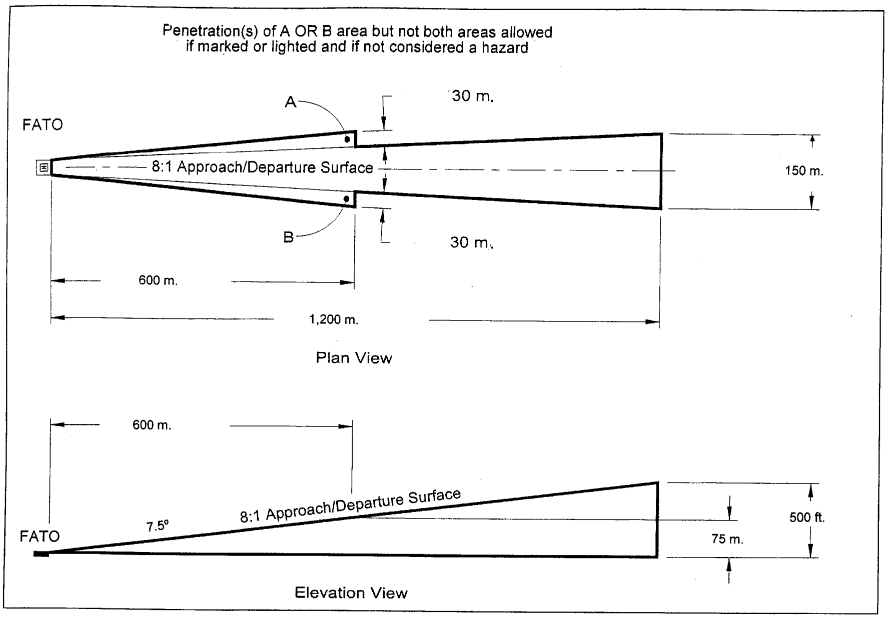


Figure 14: VFR HLS Lateral Extension of the 1:8 Approach/Departure Surface

4.1.2 HLS Approach Plans

Concept Drawings have been provided which cover the proposed available approach and departure arcs and the primary flight path. As the HLS "H" marker is orientated to Magnetic North, all measurements of bearing are relative to Magnetic North. It therefore appears that the primary arc extends from approximately 125º to 225º, with a secondary arc between 045º and 100º. Between these two arcs (100º to 125º) there are either buildings presently forming obstructions with the VFR Approach/Departure and Transitional Surfaces, or there is potential for future obstructions within this area.

It appears from the drawings that the two arcs, and in particular the arc 125º to 225º, allows for obstruction free VFR Approach/Departure and Transitional Surfaces, which will allow for straight in approaches under most weather circumstances. In the proposed scenario, the primary approach direction is approximately 355º, and the primary departure direction is 175º. From the information available, this appears to be satisfactory.

The secondary arc between approximately 045º to 100º would only be used if the weather conditions were such that an approach or departure was not possible in the primary arc. A requirement for the use of this arc is not expected to exceed 5% of the total movements. It should be noted however that pilots will apply a "fly neighbourly" policy and avoid whenever possible, low flight over occupied buildings.

4.1.3 Curved VFR Approach/Departure Paths

VFR approach/departure paths may curve in order to avoid objects or noise-sensitive areas. More than one curve in the path is not recommended. Changes in direction by day below 300 feet should be avoided, and there should be no changes in direction below 500 feet at night.

4.2 Periodic Review of Obstructions

RNSH in association with the ASNSW should re-examine obstacles in the vicinity of approach/departure paths on at least an annual basis. This re-examination should include an appraisal of the growth of trees and new building constructions in close proximity to approach and departure paths. Additionally RNSH must advise ASNSW as soon as it has knowledge of any potential local obstructions such as cranes etc.

4.3 Turbulence

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

Turbulence from wind effect is usually more pronounced on a roof top HLS, when compared with a HLS which is elevated 1.8 m. or more above the level of the roof top. The reason is that the turbulent effect of air flowing over the roof edge is minimised if the HLS is elevated. As the proposed HLS is elevated above the level 9 roof top, the turbulence effect from the side walls of the building will be reduced.

Strong winds however can cause considerable updrafting on the windward side of a building supporting a rooftop HLS.

Refer to the report, Qualitative Turbulence and Air Quality Study, REP-CW-WI-0001.

4.4 Airspace

Airspace above RNSH is within Sydney MBZ. Current frequency is 120.8 MHz. Information is within the ERSA under SYDNEY (Kingsford Smith), Harbour and North Shore Lanes.

No specific approvals from Airservices are necessary for the new RNSH HLS, as the flight path will follow existing routes until the helicopter is in close proximity to the hospital.

4.5 Security

Appropriate security measures are required to restrict access to the HLS, to manage the HLS on a day-to-day basis, to manually activate lighting and to coordinate maintenance.

APPENDICES

A. Helipad Elevations Level 11.

B. Helipad Layout Level 11 (Lighting & "H" Orientation to Magnetic North).

C. HLS Approach Plan Regional Context.

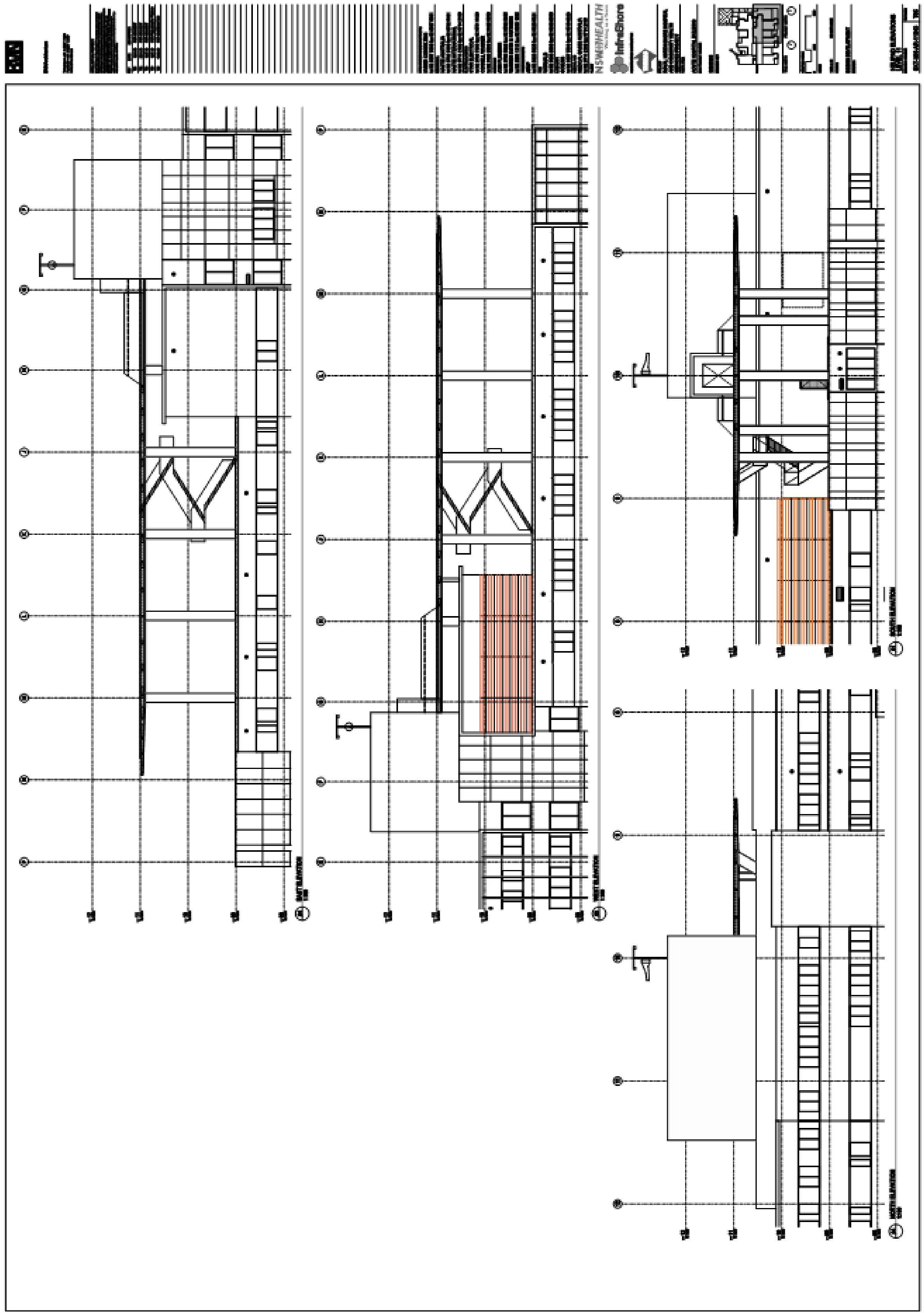
D. HLS Approach Plan Local Context.

E. HLS Approach Plan Future Context.

F. Typical HLS Approach Section.

APPENDIX A

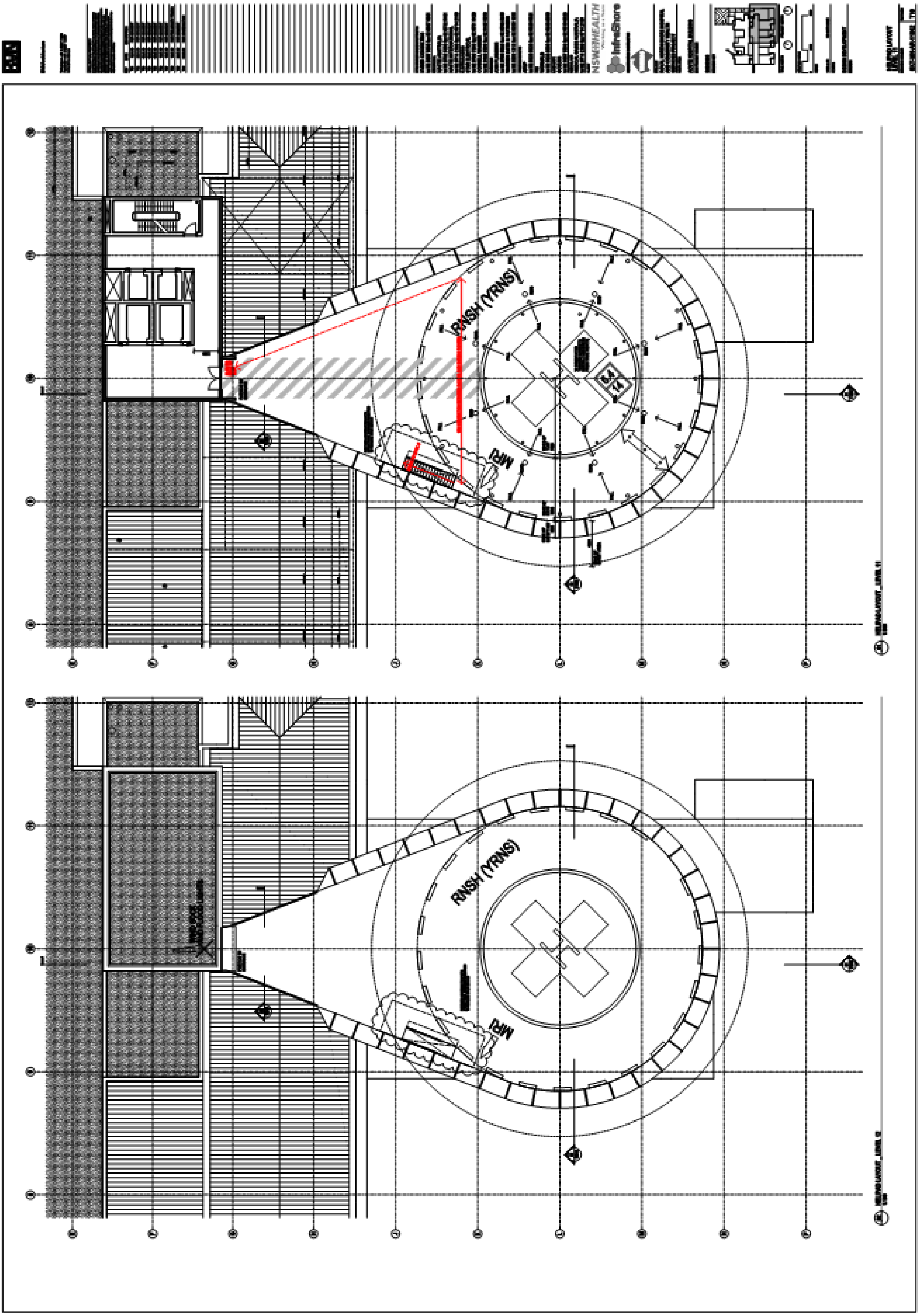
HELIPAD ELEVATIONS LEVEL 11



Helipad Elevations Level 11
(SKT-MH-AR-11843-T05)

APPENDIX B

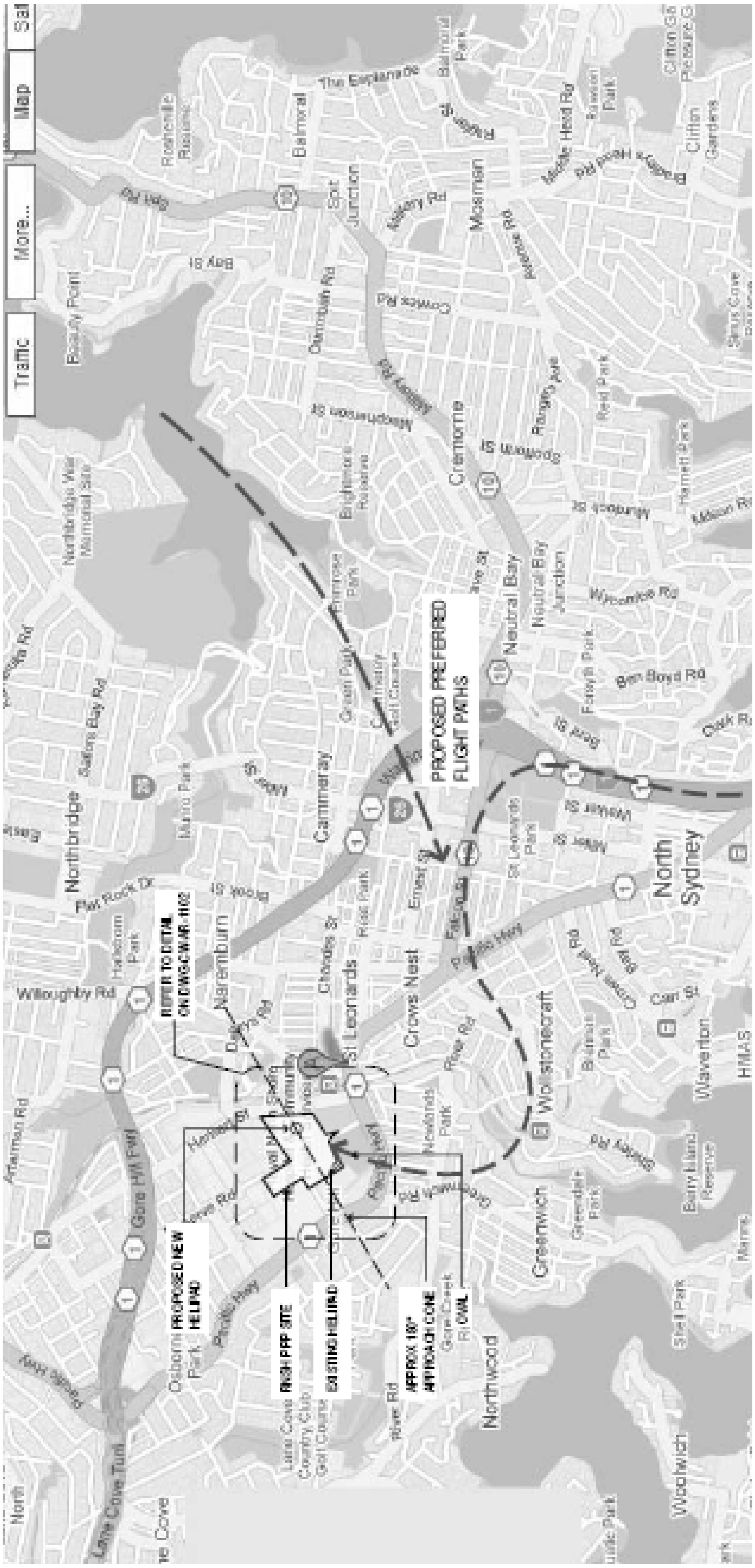
HELIPAD LAYOUT LEVEL 11
(Lighting & “H” Orientation to Magnetic North)



Helipad Layout Level 11 (Lighting & "H" Orientation to Magnetic North)
(SKT-MH-AR-11842-T10)

APPENDIX C

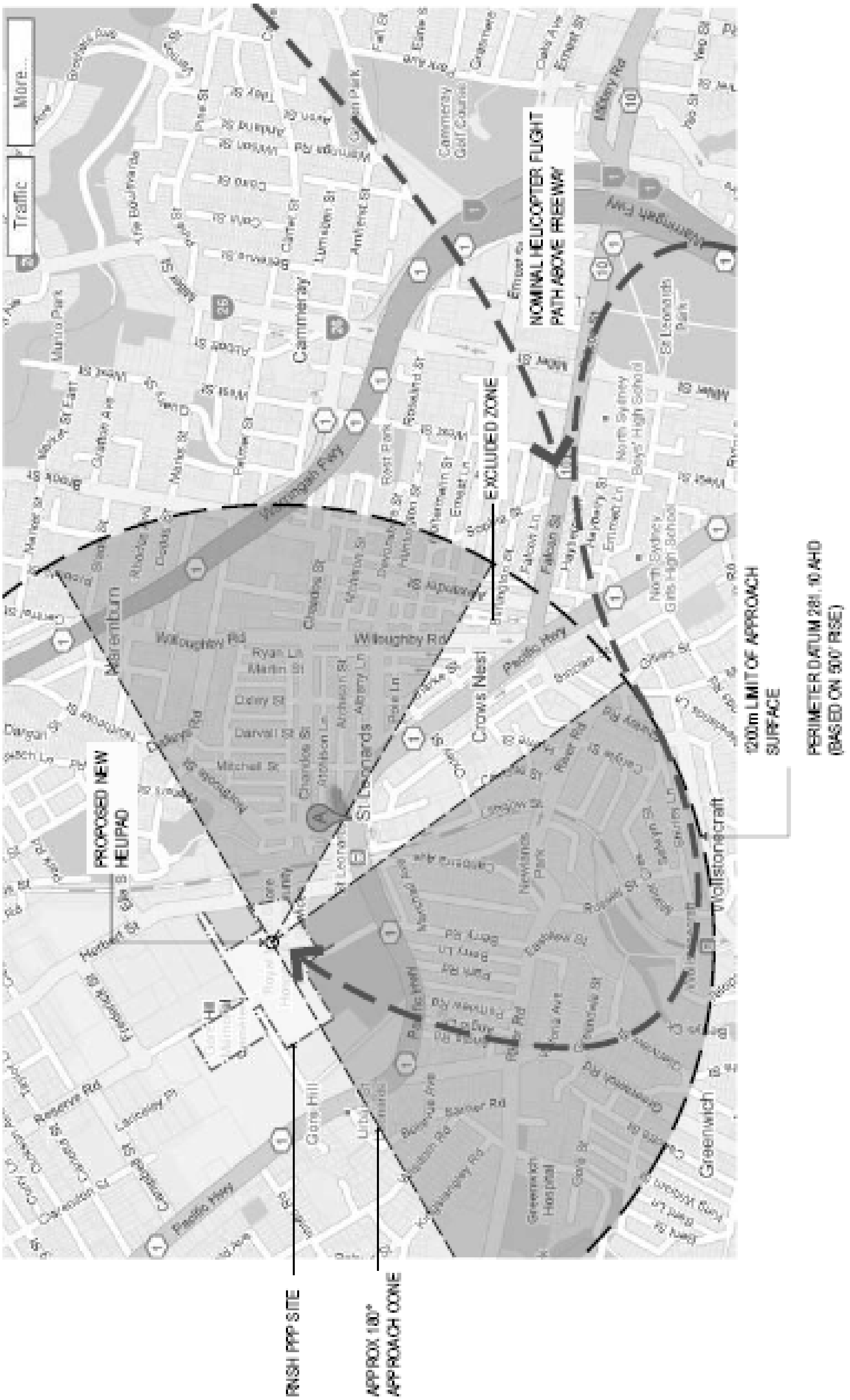
HLS APPROACH PLAN REGIONAL CONTEXT



HLS Approach Plan Regional Context
(DWG-CW-AR-1101-T01)

APPENDIX D

HLS APPROACH PLAN LOCAL CONTEXT



HLS Approach Plan Local Context
(DWG-CW-AR-1102-T01)

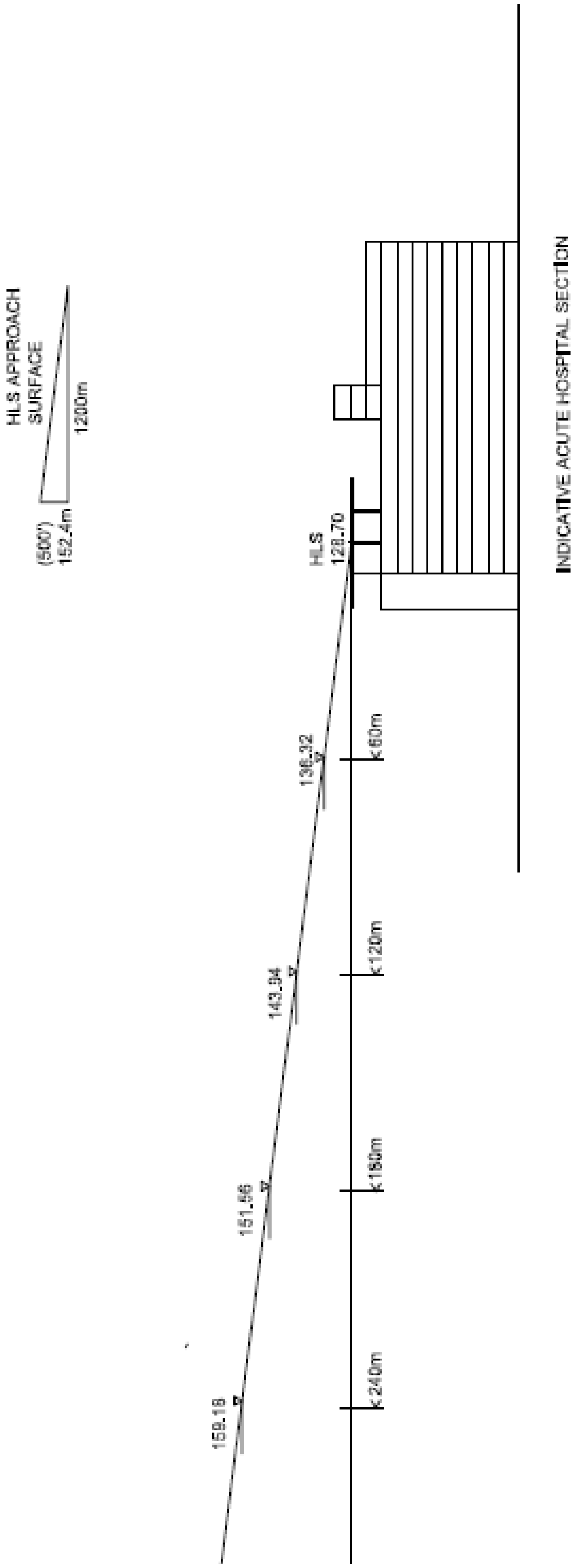
APPENDIX E

HLS APPROACH PLAN FUTURE CONTEXT

HLS Approach Plan Future Context
(DWG-CW-AR-1104-T01)

APPENDIX F

TYPICAL HLS APPROACH SECTION



Typical HLS Approach Section
(DWG-CW-AR-1401-T01)