RUNWAY EXTENSION FEASIBILITY STUDY

CONCEPT DESIGN REPORT

Lord Howe Island Board | 2 November 2018

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Lord Howe Island Concept Design Report

Client: Lord Howe Island Board

Co No.: N/A

Prepared by

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A	15-Aug-2018	Draft Issue	Jed Mills Project Manager	
B	27-Sep-2018	Final Issue	Jed Mills Project Manager	
C	02-Nov-2018	Updated Security Requirements	Jed Mills Project Manager	

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Executive Summary

In April 2018, AECOM completed a Detailed Assessment of Extended Runway Requirements and Suitable Aircraft which recommended that a 570m runway extension to the NW should be investigated further in order to continue the operation of 30+ seater regular passenger transport (RPT) services to the island beyond 2022.

This report provides a detailed assessment of two runway extension options, a land reclamation design and deck on pile structural design. In addition to the physical runway extension, civil work required around the airfield to accommodate the operation of the largest candidate Code C aircraft, a DHC8-400, was investigated. The following additional construction work required was identified;

- Expansion of the Eastern turning head
- Widening of the taxiway
- New RPT apron
- Realigned Island road
- Revised general aviation (GA) grass apron
- 2.4m high airfield security fenceline
- Terminal building expansion

Environmental and construction constraints associated with a remote World Heritage island were taken into consideration throughout the concept design process. In addition AECOM assessed outputs from the geophysical survey, historical geotechnical information and coastal design conditions to inform the final design solutions.

A preliminary environmental impact assessment has identified a number of impacts which are predicted to be of a high significance as a result of the runway extension, some of which have the potential to affect the Island's World Heritage significance. These will need to be managed as part of any subsequent design stages, but the assessment of significance of these impacts identified that the deck on pile solution had lower potential impacts during both construction and operation of the runway extension.

Conclusion

The recommendation of the report is to the deck on pile option provides the best solution, it will cause significantly fewer impacts to the Lord Howe Island's coastal processes and environment. It is also estimated to be 40% cheaper to construct and has a 6 month shorter project delivery program.

1.0 Introduction

1.1 Background

Lord Howe Island is located approximately 590 km from the closest town on the Australian mainland and 790 km from Sydney, it is one of the most remote communities in NSW and among the most remote of any Australian territory.

There are currently regular airline services operating from Sydney and Brisbane to the island, although the current route agreement is scheduled to end in March 2022 and Qantas have indicated they will no longer be operating the DHC8-200 aircraft servicing the island beyond this date. The existing runway at 888m long, does not allow for any candidate aircraft to take off or land without restrictions which limits the financial viability of the route for airline operators. Therefore an extension of the runway may be the only viable solution to ensure continued service of Lord Howe Island.

In April 2018, AECOM completed a Detailed Assessment of Extended Runway Requirements and Suitable Aircraft which recommended that a 570m runway extension to the NW should be investigated further. This recommendation was approved by the Lord Howe Island Board (LHIB) at their quarterly meeting held on Monday 14th May 2018.

1.2 Purpose

The concept design is required to achieve the following:

- Identify and resolve critical constraints;
- Confirm the scope for airfield work in addition to the runway extension;
- Provide the ability to develop a high level construction program;
- Provide the ability for early planning and discussions with stakeholders relating to the project delivery;
- Provide adequate information to develop construction costing (to + / - 30% accuracy) for the airfield work
- Determine the most viable construction solution to extend the runway

1.3 Scope of this report

The scope of work is detailed in the following documents:

a. Document - Request for Quote - LHI Airport Runway Extension Feasibility Study - Contract LHIB 2017-25 (August 2017)

b. AECOM Proposal for LHI Airport Runway Extension Feasibility Study - Contract LHIB 2017-25 (11th September 2017)

The scope generally comprises the following:

- Proposed airfield layout
- Key Environmental Design Constraints and Considerations
- Geotechnical design conditions
- Coastal design conditions
- Land reclamation design
- Deck on pile structural design
- Contour mastergrading of the runway extension
- Airfield drainage layouts and design
- Airfield pavement design

The outcome of each of the above scope items is described in the following sections with draft feasibility design drawings attached as Appendix A

1.4 Basis of Design Report

AECOM's technical approach to the works including design criteria are included within the Basis of Design Report issued 26th September 2018, this is a live document that will continue to be used through any subsequent design stages beyond concept design.

The report sets out the following:

- Key environmental design constraints and considerations
- Construction constraints
- Design datum
- Design standards, codes and guidelines
- Design life
- Design parameters

A copy of this document can be found in Appendix B

2.0 Proposed Airfield Layout

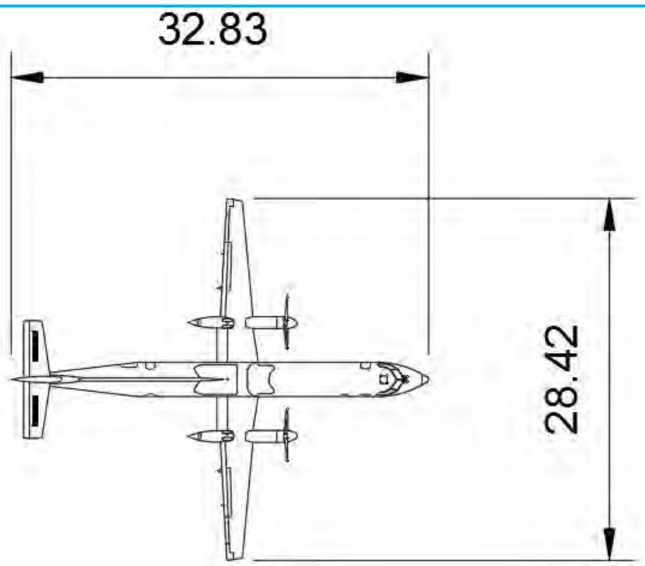
DHC8-200 aircraft currently operate at the existing airfield on Lord Howe Island, in order to ensure the largest candidate aircraft (Table 1) is able to operate to the island; the existing airfield requires significant upgrades to meet Civil Aviation Safety Authority (CASA) standards.

CASA advised that the applicable Manual of Aerodrome Standards (MOS139) is currently undergoing detailed review. A final draft is currently out for industry consultation and is expected to be adopted by the end of 2018.

Should a runway extension be commissioned at LDH, it is highly likely the final design would be completed following approval of the draft MOS. Therefore, this design has been based on the draft MOS139; this is consistent with other major Australian airports which are completing all new airfield design work to the draft version of the document.

Table 1 Largest candidate aircraft design characteristics

Aircraft	Manufacturer	Runway Code[1]	Aircraft Code[2]	OMGWS	Tail Height
DHC8-400	Bombardier	3	C	9.54m	8.38m



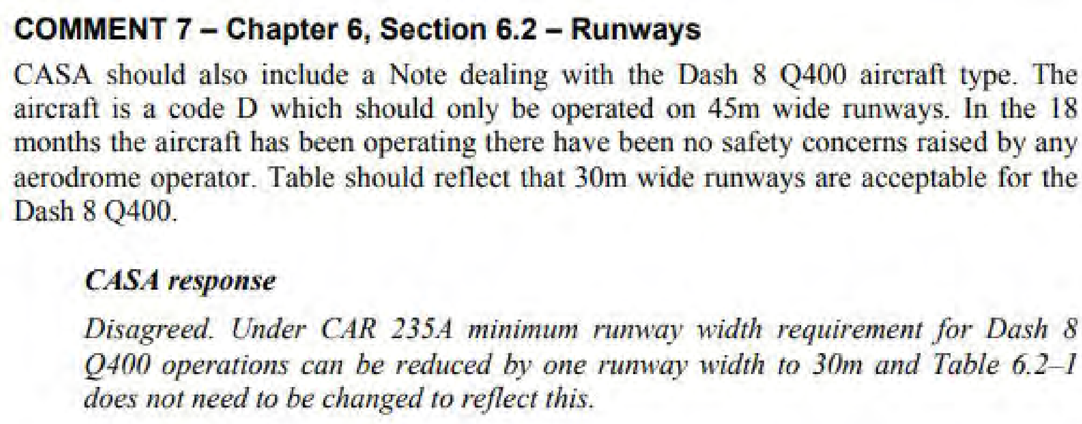
Note

1. *Runway code refers to the aeroplane reference field length*
2. *Aircraft code is determined by the wing span of an aircraft*
3. *OMGWS = outer main gear wheel span*

2.1 Runway extension

As recommended in AECOM's *Detailed Assessment of Extended Runway Requirements and Suitable Aircraft (issued April 2018)* a 570m physical extension to the existing Northwest end of the runway has adopted for this concept design.

In accordance with CASA Manual of Standards 139 (MOS139) a code 3 aircraft with OMGWS greater than 9m would require a 45m wide runway, under Civil Aviation Regulations 235A (CAR 235A) the minimum runway width requirement for DHC8-400 operations can be reduced by one runway width to 30m as shown in Figure 1.



COMMENT 7 – Chapter 6, Section 6.2 – Runways

CASA should also include a Note dealing with the Dash 8 Q400 aircraft type. The aircraft is a code D which should only be operated on 45m wide runways. In the 18 months the aircraft has been operating there have been no safety concerns raised by any aerodrome operator. Table should reflect that 30m wide runways are acceptable for the Dash 8 Q400.

CASA response

Disagreed. Under CAR 235A minimum runway width requirement for Dash 8 Q400 operations can be reduced by one runway width to 30m and Table 6.2–1 does not need to be changed to reflect this.

Figure 1 DHC8-400 runway width requirement (*Document NFC 139/03)*

The existing 30m wide runway meets the minimum width requirements and therefore the width of the runway extension has been designed to match. As shown in Figure 2 the extension is over water, this will require either a structural deck on piles to be constructed or land reclamation; these options are discussed further in section 8.0 and 9.0.

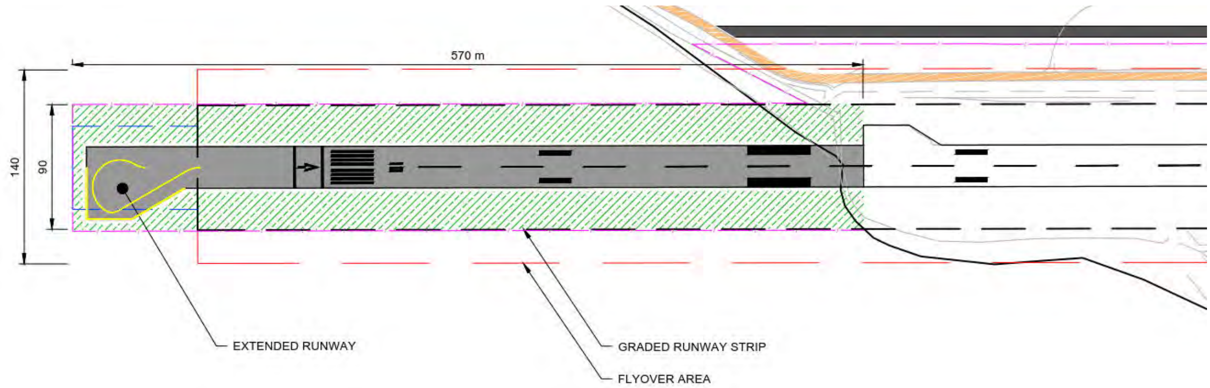


Figure 2 Runway Extension Layout

2.2 Runway strip

The runway strip is a defined area which is provided to reduce the risk of damage to aircraft running off a runway and to protect aircraft flying over the runway during take-off or landing operations.

The existing runway has Global Navigation Satellite System (GNSS) approaches available in each runway direction, supplemented by a Non Directional Beacon (NDB) and Distance Measure Equipment (DME) circling approach. Therefore it is designated an instrument non-precision approach runway.

Code 3 instrument non-precision approach runways require a 90m wide graded runway strip in addition to 25m wide fly-over area on each side. No portion of the fly-over area of a runway strip, and no object or structure on the fly-over area, may project through a plane that:

a) starts along each outer side of the graded runway strip; and

b) has an upward slope away from the graded runway strip of more than 5%.

Based on these requirements the runway extension only provides a physical surface for the 90m wide graded runway strip out over the lagoon, the sea level is significantly lower than both the deck on pile and reclaimed land options and therefore nothing permanent will project through the fly-over area "plane". Boating activities in the area will be allowed as long as the vessel and personnel are not higher than the runway level.

2.3 Runway turning heads

The existing runway turning heads were designed to allow DHC8-200 aircraft to turn round at either end of the runway, the turning head at the current RWY 10 threshold will be retained in order to allow suitable aircraft to turn round at the runway midpoint instead of taxiing the full runway extension. The turning head at the RWY28 threshold will require an additional 445m^2 of pavement to ensure DHC8-400 aircraft have sufficient wheel gear clearance to the edge of pavement.

A turning head has been provided on the southern edge of the runway at the new RWY 10 threshold, as per industry standard the aircraft has been tracked making the turn in a clockwise direction. This is contrary to current operations on Lord Howe Island, as land constraints enforced the original turning heads to be constructed for anti-clockwise turning.

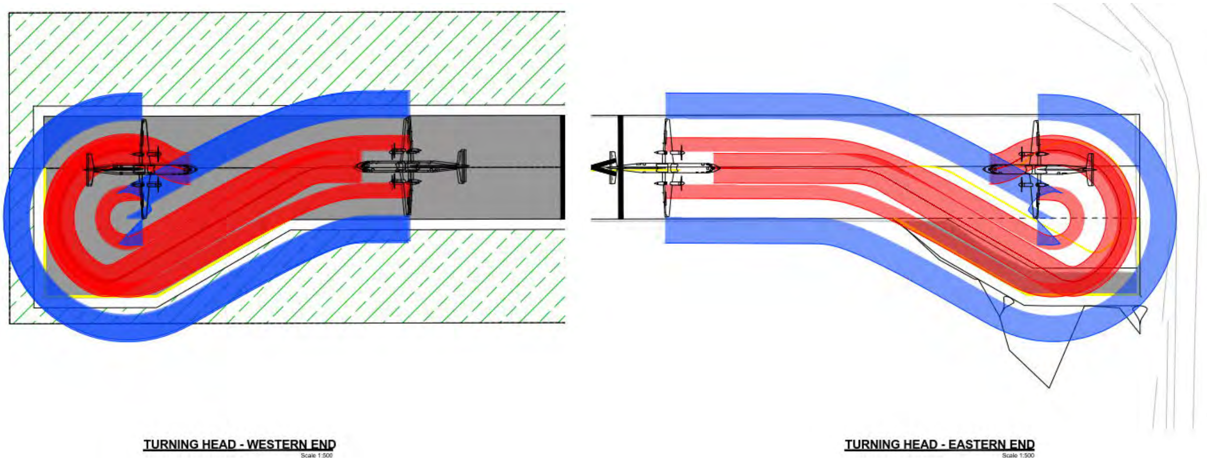


Figure 3 Turning Head Layout and Tracking

2.4 Taxiway

The existing 15m wide Code C taxiway has been widened to by 4m either side in order to meet the minimum taxiway width requirements for aircraft with OMGWS over 9m. In addition aircraft manoeuvres have been tracked between the runway and taxiway to ensure the sufficient main wheel gear clearance is provided on the taxiway fillets. An additional 490m^2 of airfield pavement has been provided.

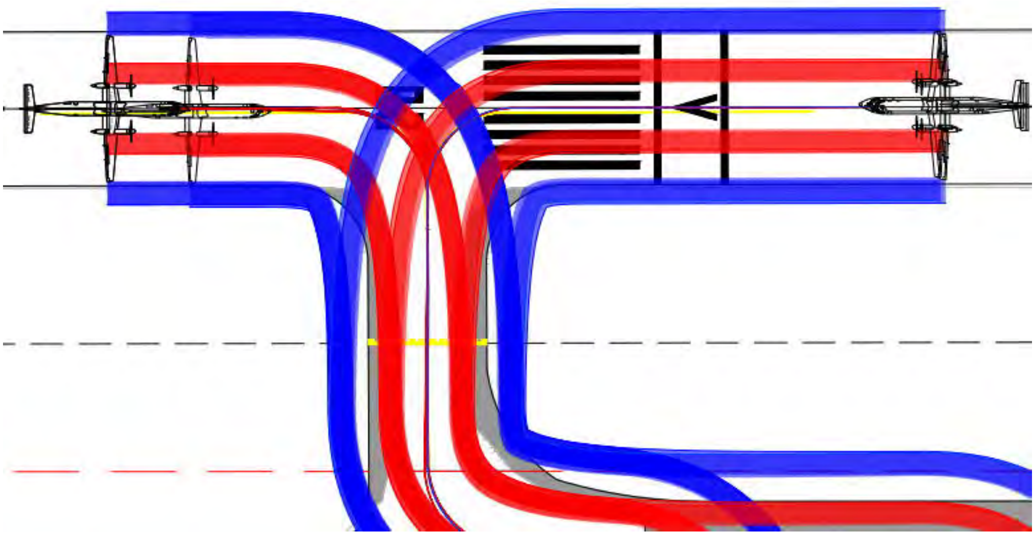


Figure 4 Taxiway Layout and Tracking

2.5 Apron & Terminal

The new Regular Passenger Transport (RPT) apron has been sized to accommodate 2 x DHC8-400 aircraft, based on the following scenarios;

- Lord Howe Island continues being serviced by 2 aircraft per day
- Lord Howe Island is serviced by 1 aircraft per day
    - A second aircraft may be required to deliver an engineer/parts for another broken down aircraft

As per the existing apron, the aircraft stands will operate as power in/power out stands because of the lack of aircraft pushback tug on the island. Sufficient wing tip clearance has been provided to ensure each stand can operate independently of the other. An additional 7275m^2 of apron pavement is required.

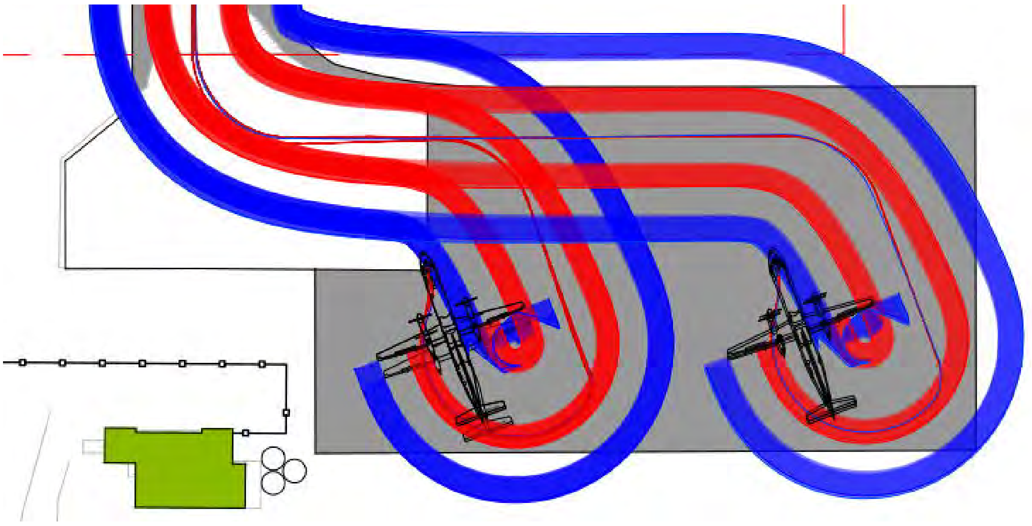


Figure 5 Apron Layout and tracking

General Aviation (GA) aircraft will be required to taxi to the eastern extent of the expanded apron in order to access the existing grass GA apron and associated hangars; an indicative layout has been shown in Figure 6. This has been sized based on the largest Code A aircraft which has visited the island since 2014, the BN2B Islander aircraft. Given the restrictive footprint available for aircraft manoeuvres, both the RPT apron and GA grass apron have been sized based on only 1 aircraft manoeuvring at a time in order to maximise the aircraft parking areas. In addition, access has been maintained to the existing Code A aircraft hangar.

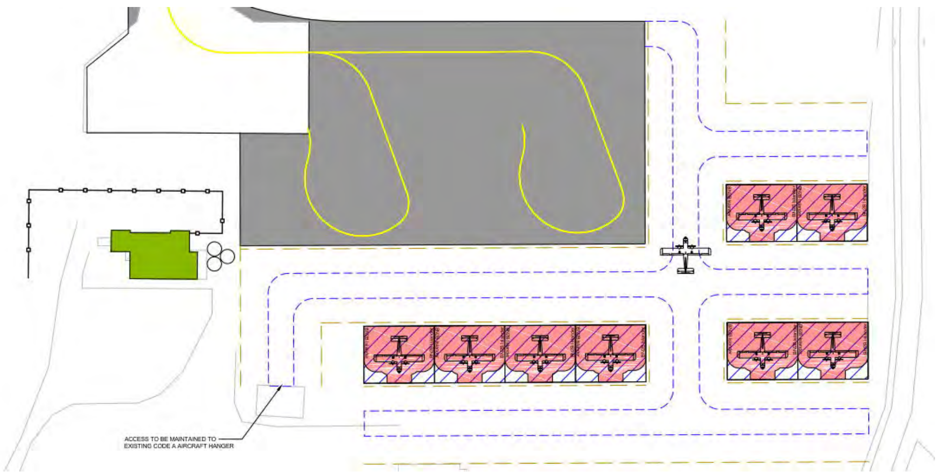


Figure 6 Indicative Code A general aviation grass apron layout

The obstacle limitation surface (OLS) is a series of 3d planes associated with the runway that define the desirable limits to which objects or structures may project into the airspace around the aerodrome so that aircraft operations at the aerodrome may be conducted safely.

One of these surfaces is the transitional surface which begins at the edge of the runway strip (beyond the fly-over area), as the runway strip will widen by 50m should Code 3 aircraft such as the DHC8-400 begin to operate at Lord Howe Island, the terminal and aircraft parking positions have been assessed to ensure they don’t infringe upon the transitional surface of the OLS.

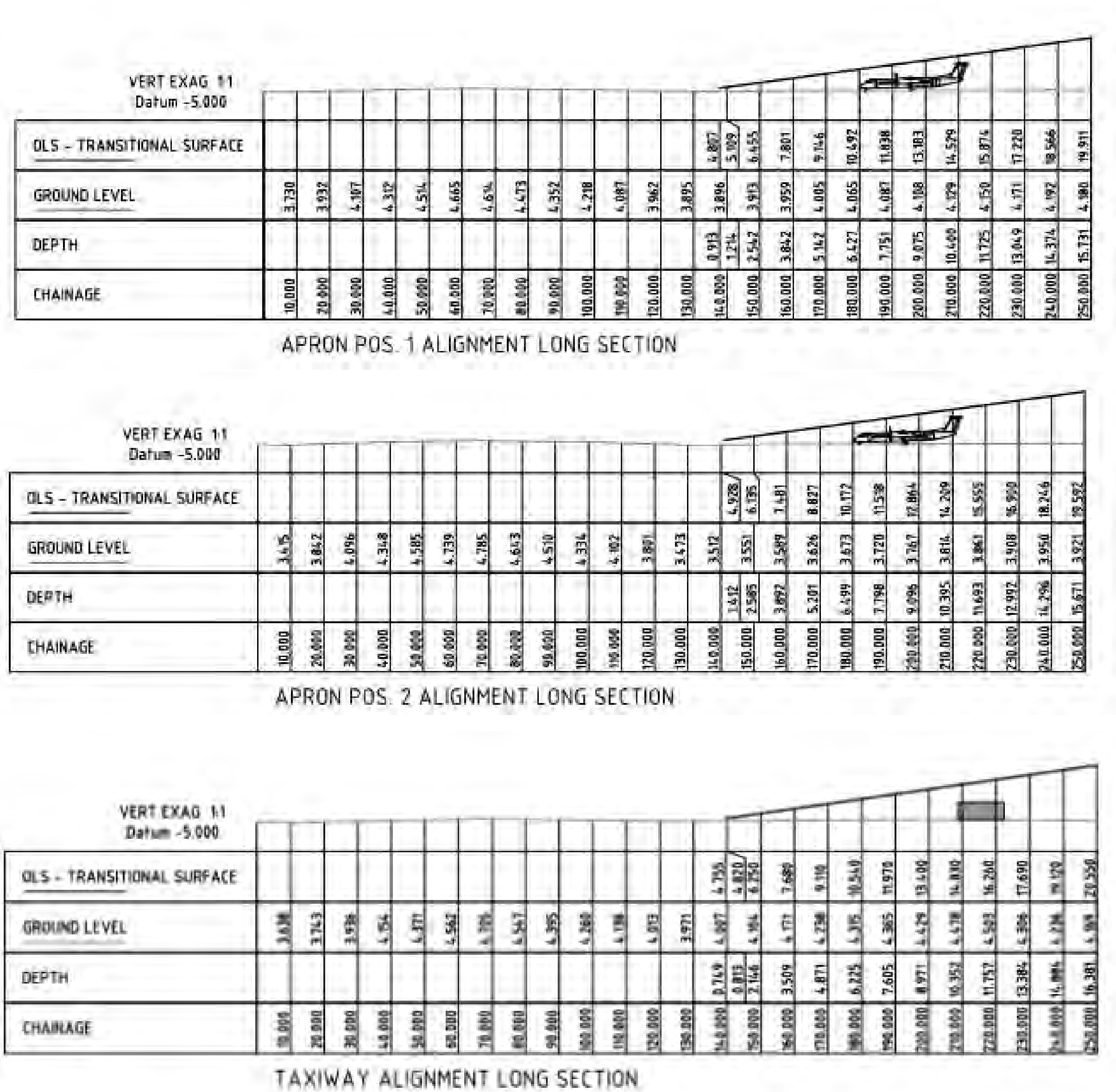
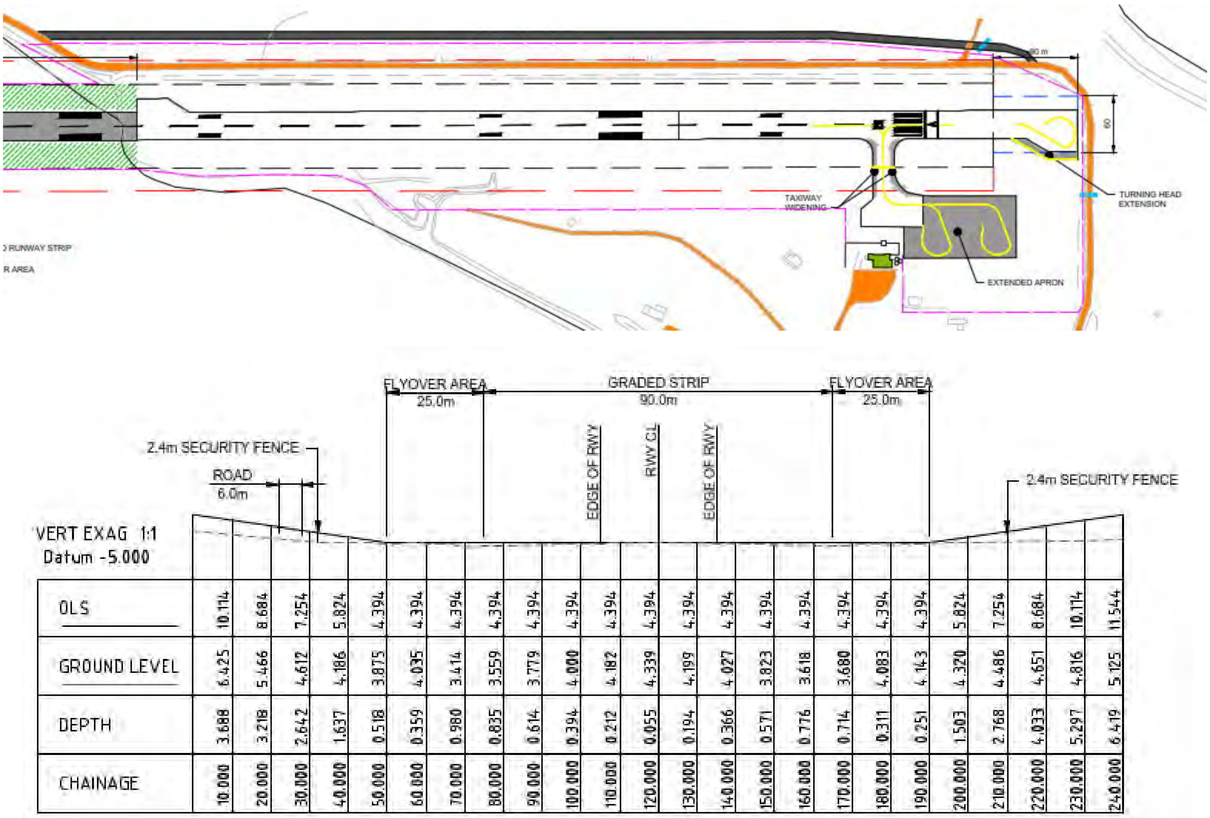


Figure 7 OLS assessment of aircraft and terminal

2.6 Potential OLS Infringements

As shown in Figure 8 the existing island road and fence alignment (north and south of the runway) would be located within the fly-over area of the runway strip and therefore would need to be relocated. As there is only inaccurate ground level LiDAR survey data available in this area, the new security fence has been aligned to ensure that a standard 8ft security fence will not impinge the OLS where possible, further information on security requirements is contained within section 13.0. Once detailed topographical survey data is obtained during subsequent design stages the fence alignment and potential OLS impact will need to be reviewed and modified. The island road has been realigned to be north of the new security fence line in order to maintain a secure perimeter around the airfield.



OLS	10.114	8.684	7.254	5.824	4.394	4.394	4.394	4.394	4.394	4.394	4.394	4.394	4.394	4.394	4.394	4.394	4.394	4.394	4.394	5.824	7.254	8.684	10.114	11.544
GROUND LEVEL	6.425	5.466	4.612	4.186	3.875	4.035	3.414	3.559	3.779	4.000	4.182	4.339	4.199	4.027	3.823	3.618	3.680	4.083	4.143	4.320	4.486	4.651	4.816	5.125
DEPTH	3.688	3.218	2.642	1.637	0.518	0.359	0.980	0.835	0.614	0.394	0.212	0.055	0.194	0.366	0.571	0.776	0.714	0.311	0.251	1.503	2.768	4.033	5.297	6.419
CHAINAGE	10.000	20.000	30.000	40.000	50.000	60.000	70.000	80.000	90.000	100.000	110.000	120.000	130.000	140.000	150.000	160.000	170.000	180.000	190.000	200.000	210.000	220.000	230.000	240.000

Figure 8 Realigned Island Road layout and OLS assessment of fence line

In addition there is no available survey data for the trees & bushland either side of the airport (as shown in Figure 9), these should be assessed at further design stages to determine if the vegetation is required to be cut back in order to not infringe upon the OLS.

Figure 9 Vegetation on either side of the airfield

Beyond the airfield, the current boat moorings within the vicinity of Rabbit Island will be required to be relocated in order to avoid yacht masts impinging upon the take-off and approach slopes of the OLS.

3.0 Key Environmental Design Constraints and Considerations

Based on the initial background environmental research, the key constraints in relation to the environment which were considered as part of the concept design process extension are as follows:

- Direct and indirect impacts on the World Heritage values of the Island, including:

  Direct impacts:

  - impacts to algal and coral reefs, during construction or operation (e.g. via scouring due to surface water run-off), for example by limiting the physical footprint of the project within the lagoon. Within the lagoon, coral areas have dominant coverage in the western portion located seaward of Blackburn Island, while the landward (eastern) portion of the lagoon is generally comprised of sandy substrate;
  - impacts to items of the Lord Howe Island Group (listed on the NSW Office of Environment and Heritage (OEH) State Heritage Register (SHR 00970)), including the "Kentia" on Lagoon Road, Portion 111, to the west of the existing airport terminal and apron area;
  - physical impact to species (and their habitats) listed as threatened under the EPBC Act (Figure 10) in particular the following species:
    - the only breeding habitat of the Providence Petrel (*Pterodroma solandri*) between March to November and they nest on the tops of Mount Gower and Mount Lidgbird and to a less extent, on the lower slopes of the mountains;
    - the breeding habitat of the Lord Howe Woodhen (*Gallirallus sylvestris*) between spring and early summer, within a territory of around 3 hectares primarily within the Lord Howe Island Permanent Park Preserve (nesting on the ground in thick vegetation, under tree roots and fallen logs). They are not found in the northern hills area;
    - the foraging habitat of the migratory Red Knot (*Calidris canutus*) on coastal areas in sandy estuaries with tidal mudflats on the island, between September and April;
    - the foraging habitat of the migratory Curlew Sandpiper (*Calidris ferruginea*) on intertidal mudflats of lagoons, and beaches and rocky shores between August and mid-April;
    - the foraging habitat of the migratory Eastern Curlew (*Numenius madagascariensis*), on intertidal mudflats and sandflats, on sheltered coasts, especially lagoons, from August each year;
    - the foraging and nesting habitat of the Loggerhead Turtle (*Caretta caretta*) particularly from late October to late February;
    - the foraging habitat of the migratory Leatherback Turtle (*Dermochelys coriacea*) which are found in tropical and temperate waters; and
    - the critical habitat of the Lord Howe Island skink, listed on the NSW threatened species list, at the receding dunal area at the southern end of Lagoon Beach (to the north of Windy Point).

  Indirect impacts:

  - impacts to existing wave patterns due to the runway extension structure, which could cause beach/lagoon erosion and impacts to algal and coral reefs and/or threatened species (such as the Lord Howe Island skink) or their habitat;
  - noise impacts during breeding season to species listed as threatened under the EPBC Act (Figure 10), in particular:
    - the breeding habitat of the Red-tailed Tropicbird (*Phaethon rubricauda*), which nests on cliffs of the northern hills and southern mountains on the main island at Lord Howe Island; and
    - the Lord Howe Island Phasmid (on Balls Pyramid).

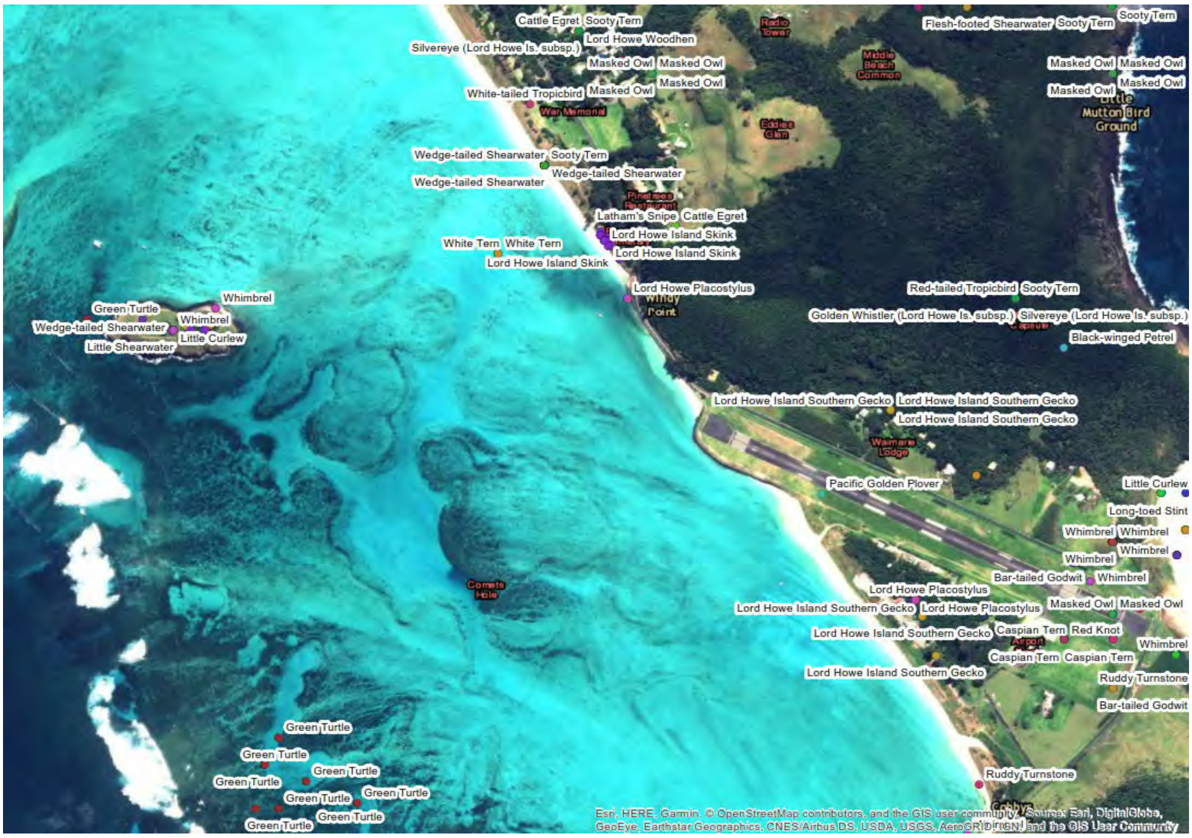


Figure 10 Threatened species located in the vicinity of the proposed project

- Consideration of the likely impacts of climate change in any flood modelling and related design for the project, including factoring in:
  - Increased intensity of rainfall events (using an approach in accordance with relevant guidelines (e.g. *Practical Responses to Climate Change*, Engineers Australia);
  - Sea level rise of between 45 to 82 cm by 2090 (as projected for the NSW coastline under Representative Concentration Pathway 8.5), coupled with extreme sea level events, with increases in storm surge and the extent of inundation across the island; and
  - Increased tailwater levels or sensitivity testing undertaken for various projected rises in mean sea levels.
- Other important considerations for the design of the project include:
  - Prevention of pollution of waterways, including lagoon or coastal waters, by sediments, oils/petrols and other contaminants, during construction or operation;
  - Ensuring the design process and runway structures consider the opportunity to provide suitable habitat for flora/fauna, where possible; and
  - The use of sustainably sourced and/or recycled construction materials which do not contravene the requirements of the *Marine Estate Management (Management Rules) Regulation 1999*.

Further information with regards to environmental impacts is provided in section 14.0.

4.0 PFAS Assessment

As part of a separate project, AECOM was engaged by the Lord Howe Island Board to complete a Preliminary Per- and Poly-fluoroalkyl Substances (PFAS) Assessment at three sites on Lord Howe Island.

The three sites were selected based on evidence of historical storage and use of Aqueous Film Forming Foam (AFFF) associated with historical firefighting training exercises, one of which was Lord Howe Island Airport and surrounds.

The purpose of the Preliminary PFAS Assessment was to gain a preliminary understanding of potential PFAS impacts to soil, sediment, surface water, and/or groundwater at the airport and other sites, in addition to assessing the potential risk to human health and / or the environment.

Samples of soil, sediment, surface water and groundwater were collected at the airport and submitted for laboratory analysis for a suite of PFAS; locations are shown in Figure 11.

Figure 11 PFAS testing locations

Concentrations of PFAS were detected in soil, sediment and groundwater at the following locations:

- Existing Western runway end (BORE001, SED002, HA004 and HA005)
- Adjacent to the existing aircraft apron (HA006)
- Proposed aircraft apron (HA007 & HA008)
- Eastern end of the runway (SED005).

Concentrations were reported at less than the PFAS National Environmental Management Plan (NEMP) human health assessment criteria however were greater than the PFAS NEMP interim ecological assessment criteria. Additionally, leachable concentrations of PFAS were reported in the soils and sediments indicating the PFAS impacts may mobilise if in direct contact with water.

Therefore the following measures should be applied during excavations in these areas:

- Workers should wear Personal Protective Equipment (PPE).
- Excavated soils should be appropriately handled and stored to prevent mobilisation of PFAS impacted materials.
- Surface and groundwater should be managed to prevent mobilisation of PFAS impacted materials

The NSW Environmental Protection Authority (EPA) has requested further testing and a detailed PFAS assessment be completed where PFAS concentrations were discovered on the island, which will further determine the PFAS concentration levels and locations.

5.0 Construction Constraints

The construction methodologies for both the land reclamation and deck on pile extension options have been strongly influenced by the need to accommodate a number of constraints during construction.

5.1 Airport Operations

It is expected that unrestricted access for construction during daylight hours will be limited to four consecutive days per week, as was the case during the 2015 runway overlay project. Although this would need to be agreed upon by the incumbent operating commercial airline

The airport does not operate at night. Access for construction activities at night may be possible, subject to additional constraints including but not limited to those described below in addition to intensive community consultation

It is assumed that construction plant, materials and personnel can be located along the runway extension during airport operations, subject to the obstacle limitation surface (OLS) restrictions of the existing runway.

5.2 Seasonal Restrictions

Construction activities during both day and at night may be limited during the breeding season of certain migratory birds and marine mammals, as detailed in section 3.0. The winter months would potentially be the best construction period because of breeding season restrictions in combination with fewer visitor numbers over winter.

5.3 Noise Restrictions

As a minimum noise restrictions are expected to apply during any night works. It is assumed that over water pile driving will not be allowed. Although quieter construction activities such as welding, steel fixing and concrete pouring may be allowed.

5.4 Light Restrictions

Light spill restrictions are expected to apply during night time construction activity.

5.5 Vibration Restrictions

Restrictions on significant underwater vibrations due to pile driving may apply during turtle breeding seasonal restrictions described in 3.0. Vibratory equipment may be required in place of piling hammers.

5.6 Supply & storage of Plant, Labour and Materials

It is assumed that there is no local availability of plant or materials, all such items must be brought in by air or by sea. There are very limited construction personnel on the island, requiring the majority to be brought in from the mainland.

The island is serviced by the MV Island Trader vessel which runs freight between Port Macquarie and Lord Howe Island on average every two weeks.

Table 2 MV Island Trader Vessel Characteristics

Deadweight Tonnage	Gross Register Tonnage	Overall Length	Beam	Draft
242t	485t	38.8m	9m	TBC

The vessel enters the lagoon at high tide before ballasting down to sit on the seabed at the island's only wharf during cargo transfer. Based on the vessel characteristics shown in Table 2, the wharf should be suitable to accommodate a small crane barge.

Figure 12 MV Island Trader at Lord Howe Island

It is to be noted that the use of the wharf structure was deemed unsuitable for the 2014 runway overlay project due to concerns over its structural loading capacity. Fulton Hogan delivered plant and material via shallow barges across the Lagoon which docked at the SW extent of the runway.

Figure 13 Plant and material delivery for the 2014 runway overlay project

Limited onshore area is available for the storage of construction plant and materials, and this may be required to be stored on barges moored outside the reef until a sufficient portion of the runway extension has been constructed to provide the required storage area without penetrating the OLS.

6.0 Geotechnical Design Conditions

The preliminary geological model in the Lagoon is based on information interpreted for the desktop geotechnical study contained within AECOM's "Geotechnical Interpretative Report" and is presented in Table 3 and Table 4 .

Table 3 Interpreted geological model

Geotechnical Unit	Simplified Description	Depth to Top of Unit (m)	Unit Thickness (m)
1. Upper Sand	Carbonate sands trace gravel	0.0	0.0 to1.9
2. Lower Sand	Carbonate silty gravelly sands	0.0 to 2.0	7.3 to 10.4
3. Interbedded Sands and Clays	Interbedded Sands and Clays	7.9 to 9.5	2.8 to 4.9
4. Calcarenite	Calcarenite (calcareous sandstone)	11.0 to 13.8	
a. Calcarenite-W	Weathered calcarenite		1.8 to 3.1
b. Calcarenite-FR	Fresh calcarenite		0.7 (proven)
5. Volcanic bedrock	Basalt, Breccia and Tuff	Not encountered	

Table 4 Interpreted Ground Profile

Geotechnical Unit	Density/Consistency	Bulk Unit Weight (kN/m^3)	Effective Cohesion (kPa)	Effective angle of internal shearing resistance (°)
Upper Sand	Loose	16	0	25
Lower Sand	Very loose / very soft	16	0	25
Interbedded Sands and Clays	Loose to medium dense	16	0	30
Calcarenite	Weathered	18	10	32
	Sound	20	50	35

6.1 Further geotechnical investigations

The unit depths, thicknesses and material properties presented in Table 3 and have been adopted for the concept design but should not be assumed to represent the extremes that may be encountered across the site. AECOM's Geotechnical Interpretive Report (6th August 2018) study was based on a limited number of historic boreholes from within and surrounding the site in addition to interpreted geophysical survey (non-intrusive) data. Intrusive drilling will be required to inform future design stages, subject to Marine Park permits and Environment Protection and Biodiversity Conservation (EPBC) referral. The investigation programme should:

- include the western section of the alignment to cover the existing gap in information
- correlate with the 1972 investigation
- Collect samples of the overlying soils for laboratory characterisation testing (PSD, Atterberg limits, and
- core the calcarenite (with acceptable core recovery) to carry out rock strength testing (UCS and Point Load Testing)
- prove the depth to top of the volcanic rock

7.0 Coastal Design Conditions

As stated in the basis of design report, all coastal structures have been designed for a 50 year design life, with a design horizon of 2070. To account for climate change a sea level rise of 0.4m has been adopted for the 50 year design life (2070); this is applied to the ambient water levels.

7.1 Design Events

Lord Howe Island airport is defined as critical infrastructure due to the need to remain operational after major events in order to allow emergency services access to the island. The runway and associated structures (deck on piles or land reclamation) must remain functional after a major event, therefore in accordance with AS4997-2005 it is designated as a function category 3 (High property value or high risk to people)

7.1.1 Ultimate (failure)

Based on the design life and function category the coastal structures are to be designed to be damaged but must retain functionality for a 1,000 year Average Recurrence Interval (ARI), this is defined as the failure event.

7.1.2 Working (no damage)

In addition the airport shall be expected to withstand moderate storm events without needing repair; this is described as the no damage event and has been set at 100 year ARI.

7.1.3 Operational (planes landing)

Finally the runway operations should not be impacted by waves/overtopping during anticipated airport open conditions. The operating conditions are not directly linked to a marine event but shall be assumed to be moderately large marine conditions with depth limited waves.

7.2 Water Levels

Water levels in the Lagoon vary with astronomical tide and other processes. Manly Hydraulics Laboratory (MHL) has operated a water level recorder on Lord Howe Island since 1994, analysis of the data collected between 1994 and 2013 at 15 minute intervals indicate the still water level can vary considerably above nominal tidal range with maximum recorded level of 2.84 m AHD over the lagoon reef.

Wave setup is the increase in mean water level due to the presence of breaking waves; this governs the extreme water levels over the reef. Based on the equations described by Gourlay in his 1997 paper "Wave Set-up on Coral Reefs: Some Practical Applications" water levels over the reef have been assessed. The critical equation is:

$$\bar{\eta}_r = \frac{3 \times K_p \times g^{1/2} \times H_0^2 \times T}{64 \times \pi \times (\bar{\eta}_r + h_r)^{3/2}}$$

Where: η_r is depth of wave setup

K_p is reef profile characteristic, defined based on reef edge slope (0.4 adopted).

H_o and T are offshore wave characteristics.

h_r is the depth of ocean level over reef edge (reef edge assumed to be -1.5m AHD).

Analysis of the extreme water levels for various design events was completed, and the results are presented in Table 5. To account for the 50 year design life of the coastal structures an additional 0.4m has been added for sea level rise by 2070, presented in Table 6.

Table 5 Adopted Reef Top Water Levels (today)

Variable	Ultimate	Working	Operational
Approximate ARI (years)	1,000	100	N/A
Offshore wave H_0 (m)	10	8	4
Wave period T (s)	12	10	8
Ocean water level (m AHD)	2.0	2.0	1.8
Wave Setup on reef η_r (m)	1.8	1.2	0.3
Extreme Water Level (m AHD)	**3.8**	**3.2**	**2.1**

Table 6 Adopted Reef Top Water Levels (2070)

Variable	Ultimate	Working	Operational
Approximate ARI (years)	1,000	100	N/A
Offshore wave H_0 (m)	10	8	4
Wave period T (s)	12	10	8
Ocean water level (m AHD)[1]	2.4	2.4	2.2
Wave Setup on reef η_r (m)	1.7	1.1	0.3
Extreme Water Level (m AHD)	**4.1**	**3.5**	**2.5**

Note

1. *This accounts for current day tidal water level plus 0.4m for sea level rise*

7.3 Waves

Large waves impacting the runway extension will be limited by the shallow depth of water over the reef and the flat bathymetry; therefore the biggest waves will typically occur during extreme water level events.

The reef top area undulates but is relatively flat, sitting at approximately -1.5 m AHD off shore from the proposed works. Wave break conditions with this type of foreshore were assessed in a 1997 study by Nelson. His equation indicates that the breaker limit will be 0.55 of the depth.

$$H_{br} = 0.55 \times depth$$

Depth limited breaking results in a compressed wave distribution with the proportional difference between the largest waves and statistically more common waves reduced. To define the wave spectrum after breaking shallow water wave characteristics as defined in the method presented by Battjes and Groenendijk (2000) have been adopted. The wave height distribution was developed assuming the 1% exceedance wave height was the depth limited breaking wave.

$$H_{1\%} = H_{br}$$

The wave crests represent the combined influence of lagoon top water level and wave excursion. The shallow water conditions result in a cnoidal wave profile, with the crest excursion significantly greater than the trough. Cnoidal waves typically have a crest elevation that equivalent to 70% of the wave height.

$$\eta_{1wave\ crest} = 0.7 \times H + WL$$

Based on the above relationships, the design the wave conditions presented in Table 7 have been adopted.

Table 7 Near Shore Waves

Variable	Extreme	Working	Operational
Approximate ARI (years)	1,000	100	N/A
Offshore wave H_0 (m)	10	8	4
Wave period T (s)	12	10	8
Reef Top Water Level (m AHD)	4.1	3.5	2.5
Reef bed level (m AHD)	-1.5	-1.5	-1.5
Still Water Depth h_r (m)	5.6	5.5	4.1
Breaker factor g_{br}	0.55	0.55	0.55
Significant wave height H_{m0} (m)	2.44	2.18	1.74
Mean of 10% largest waves $H_{1/10}$ (m)	2.80	2.50	2.00
2% waves height $H_{2\%}$ (m)	2.96	2.64	2.11
1% waves height $H_{1\%}$ (m)	3.09	2.76	2.21
Significant wave crest elevation η_s (m AHD)	5.81	5.03	3.71
2% wave crest elevation $\eta_{2\%}$ (m AHD)	6.17	5.35	3.98

7.4 Observed Geological Features

Images presented in Figure 14 reveal there are a series of parallel dune lines on the lagoon beaches north and south of the existing runway. These features are typical of extreme event dune systems seen in a number of locations; research in Queensland reveals that similar features mark the sediment deposition lines during extreme cyclonic events (~500 year ARI). Wind forced dune formations typically aren't parallel.

Figure 14 Dune ridges north and south of the runway

Based on the elevation data shown in Figure 15, the dune crests at this site are at approximately 6m AHD, this is consistent with the ultimate event as presented in Table 7.

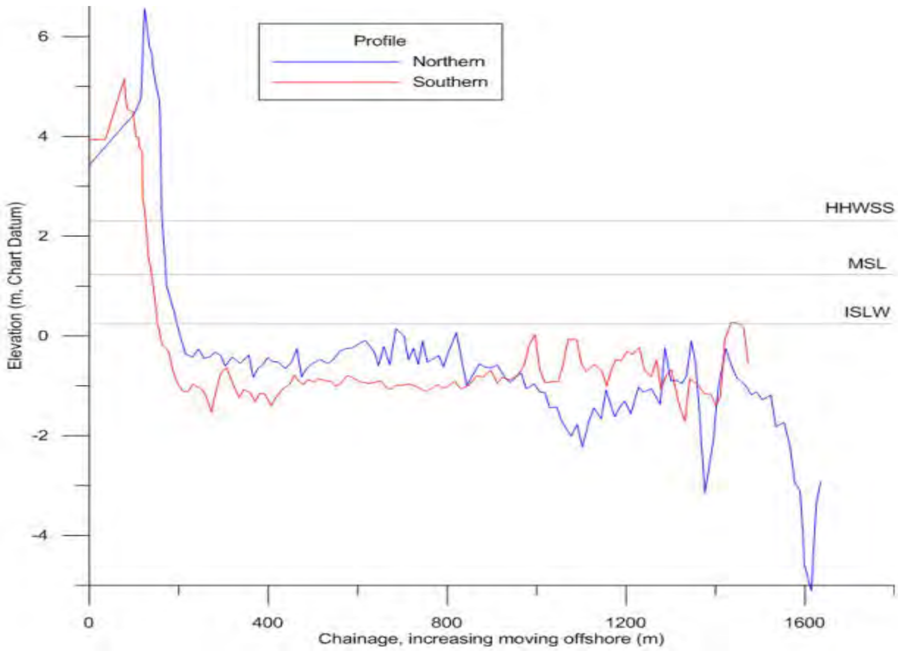


Figure 15 Sections across the reef

Although the observed geological features reinforce the values shown in Sections 7.2 and 7.3, the values are derived based on simplistic models and indicative calculations. This information is suitable to inform the concept design of the runway extension, but it is highly recommended that 2d or 3d computational modelling of the water dynamics within the lagoon is carried out at subsequent design stages of the project.

7.5 Currents

Significant currents can develop on the reef flats during the extreme wave events. The adopted shore parallel current is 1 m/s under operational conditions. During extreme events (beyond recorded data) a design current of 1.5 m/s has been adopted. For works that substantially block the flow paths on the reef top (reclamation) the adopted current is 2 m/s at choke points (seaward edge).

8.0 Land Reclamation Design

8.1 Wave Trip Structure

To ensure the land reclamation design complies with the coastal design requirements in section 7.1, the western extent of the new runway would need to be at 6.0m RL and the western extent of the existing runway would need to be raised to 5.0m RL to prevent damaging overtopping and inundation of the runway.

The current level at the western extent of the existing runway is 4.6m, in order for the extension to avoid overtopping and inundation the existing runway and surrounding earthworks levels would need to be raised by roughly 500mm in addition to the increased height of the reclaimed land or deck on piles.

This solution would have significant construction cost and duration implications in addition to the reclamation and due to the significant level increases it may not be achievable to keep the airfield operational during construction work. Therefore a wave trip structure has been introduced along the western and southern edges of the extension, this will absorb wave energy and reduce wave crest impacting the runway extension structure to 5.76m RL.

The structure has been designed to have the minimal impact in ambient conditions while offering sufficient protection during extreme events to preserve airport functionality. The structure works by inducing waves to trip (break), with the resultant wave reduced in height beyond the trip structure.

The crest of the structure was determined using a breaker index of 0.8 (which reflects the stepped nature of the face) to assess the breaking wave. The structure has been located 50m offshore from the runway revetment to provide a body of water that would absorb the wave breaking as shown in. Figure 16.

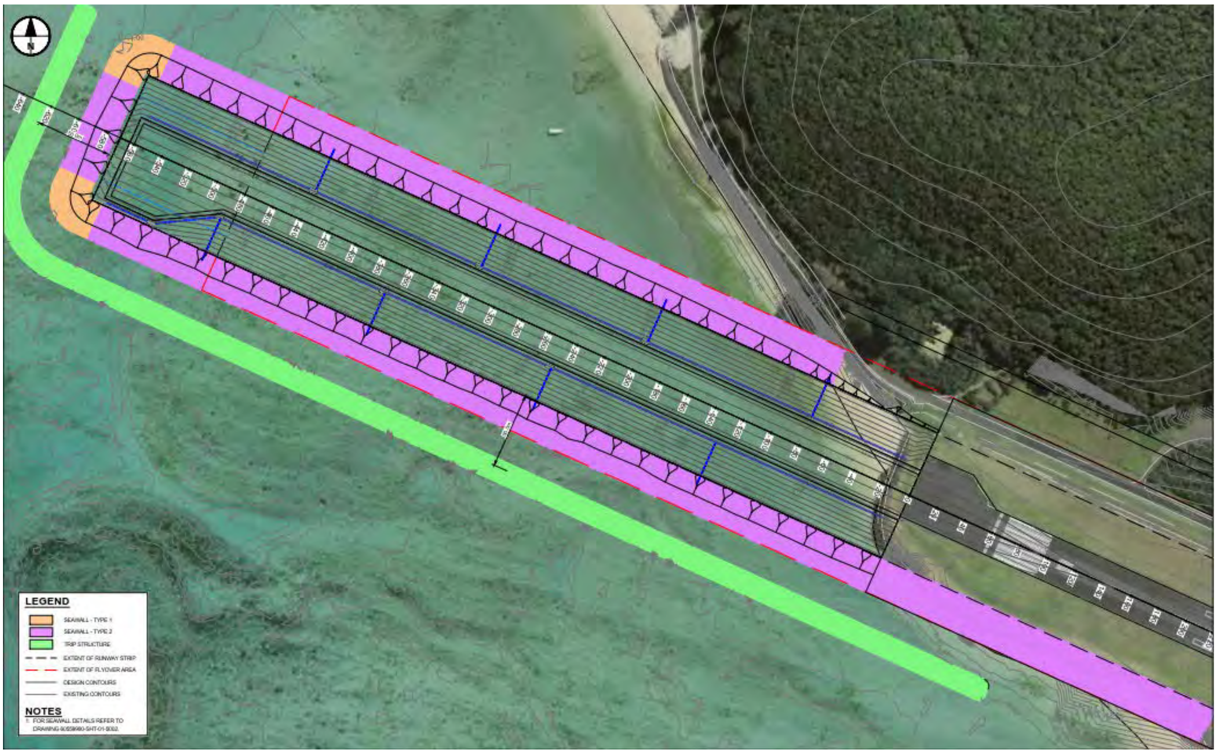


Figure 16 Wave Trip Structure Layout

The armour used in the trip structure has been based on a conventional armour stability assessment under design waves and is shown in Figure 17.

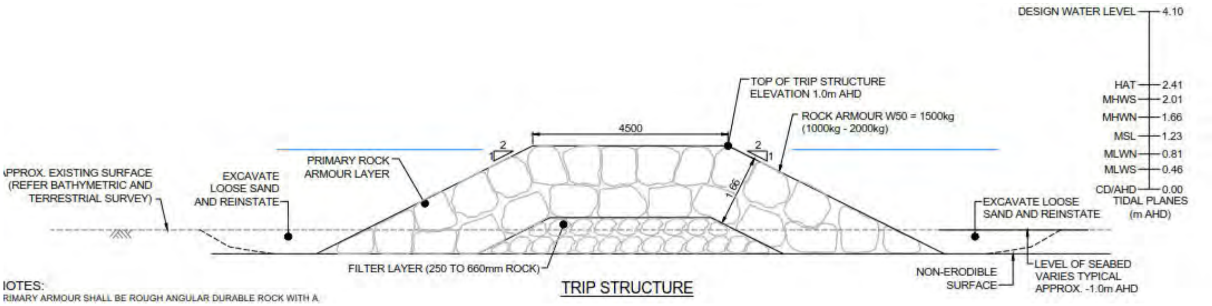


Figure 17 Wave Trip Structure

8.2 Reclamation Revetment Design

As discussed in Section 7.1, coastal structures have been designed for Ultimate, Working and Operational events. Steep sloped rock armour design criteria have been based on the guidance in Table 5.4 of the Rock Manual, as shown in Table 8.

Table 8 Steep sloped rock armour design criteria

Design Event	Storm Average Recurrence Interval (ARI)	Damage Level (S_d)	Damage Commencement Overtopping Rate	Mean Overtopping Discharge Limit (Q)
Ultimate	1000 years	8	≥ 0.2m³/s/m[1]	< 200 l/s/m
Working	100 years	2	≥ 0.05m³/s/m[2]	< 50 l/s/m
Operational	N/A	N/A	Minimal[3]	< 1 l/s/m

<u>Note</u>

1. *Based on damage to paved promenades (runway) behind a seawall*
2. *Based on damage to an unprotected promenade*
3. *Operating conditions are not directly linked to a marine event but shall be assumed to be moderately large marine conditions with depth limited waves.*

8.2.1 Armour sizing

Rock armour design has been based on Van der Meer's equation with results cross checked with the more robust Hudson equation. These equations are considered industry standard for the design of rock armour solutions.

Armour has been designed as a conventional double layer rubble structure with a slope of 1 in 2. The armour grading is narrow to maximise the armour performance. A double layer of secondary armour is included to enhance wave interactions with the revetment and to protect the geotextile. A heavy grade geotextile is used to separate the armour from the fill beneath the revetment.

The toe is assumed to be dug in and founded on a non-erodible surface. If suitable bed conditions cannot be exposed close to the surface a scour mat would need to be included in the toe detail. The crown of the revetment has been set at or below runway level to avoid impacting aviation operations. Primary armour is carried over the crest, with a concrete head wall used to ensure a robust clean edge detail that minimises fill volumes, as shown in Figure 18

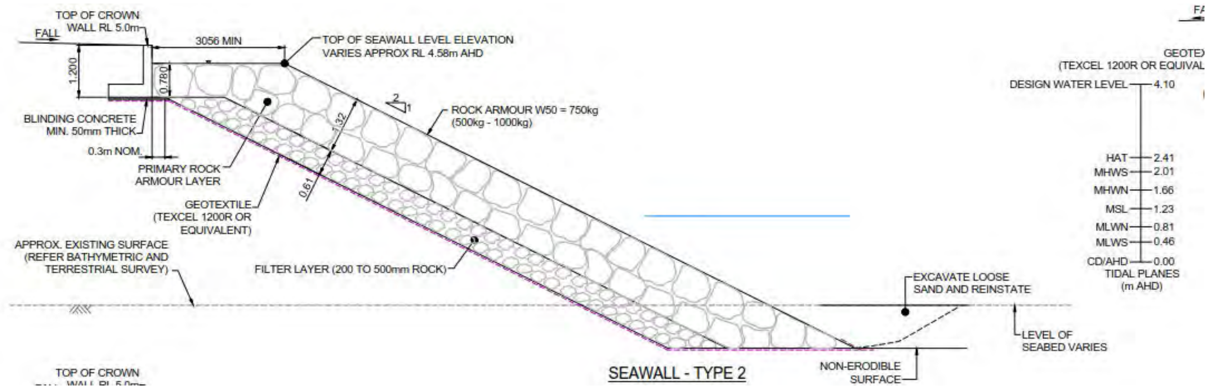


Figure 18 Seawall Cross Section

On the corners of the sea wall, 25% larger armour has been used to account for decreased armour stability on concave surfaces as shown in Figure 19

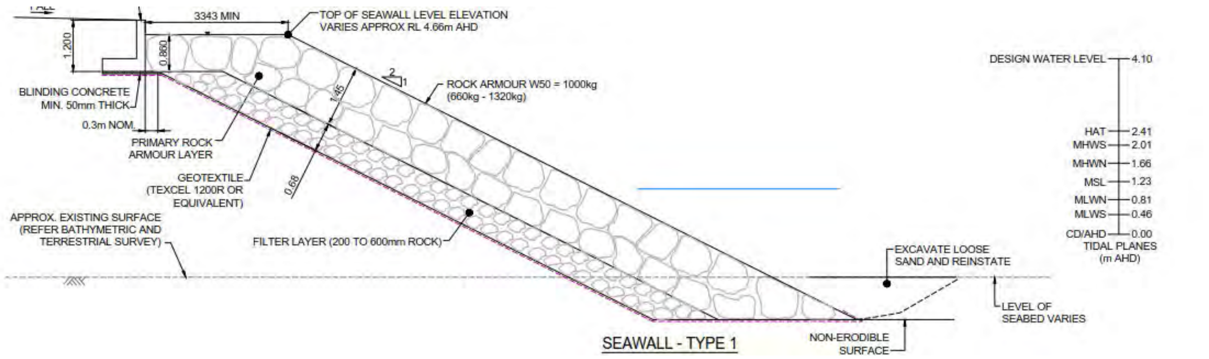


Figure 19 Corner Seawall Cross section

The use of the trip structure described in section 8.1 dissipates much of the wave energy which has allowed smaller armour to be used on the revetment.

Design profiles and armour sizing are presented in the concept design drawings. Armour sizes are summarised in Table 9.

Table 9 Armour Sizing

Location	Primary Armour	Secondary Armour
Trip Structure	1,500 kg (1,000 to 2,000 kg)	250 to 660 mm
Runway Corners (type 1)	1,000 kg (660 to 1,320 kg)	200 to 600 mm
Runway Revetments (type 2)	750 kg (500 to 1,000 kg)	180 to 500 mm

8.2.2 Overtopping and Crest Elevation

Desk top overtopping assessments are notoriously unreliable, with a wide range of equations giving widely varying estimates. Overtopping was assessed using a range of equations, though most reliance was placed on the recent Australian research paper published by Griffith University Academics Etemad-Shahidi & Jafari in 2014. This solution was adopted because it includes robust consideration of the impact of depth limited wave conditions. The overtopping equations were used to define the size of the trip structure required to achieve the performance criteria stated in section 7.1.

It is noted that this element of the design will need to be revisited in subsequent design stages using physical modelling to refine and assess the wave interactions with the structures.

8.3 Fill

8.3.1 Properties

The construction of the reclaimed land runway extension will require a large volume of fill (~360,000m^3). The fill material requires good geotechnical properties to provide a suitable compacted base for the runway construction. Key features of the fill material:

- Fill placed below the water level must be granular to allow saturated compaction under overburden.
- Unconfined fill in the lagoon must be clean (low fines content) to minimise plume impacts.
- Fill needs to have suitable engineering properties near the surface to facilitate airport works and maintenance (CBR 10%-15%)
- Fill material is required to be sterilised for bio security purposes

8.3.2 Sources

If fill could be won locally by dredging or from a land based source this would provide the project with an affordable, logistically simple solution. Of these, sand pumped from the dredge directly into the reclamation is a common technique around the world and represents the most affordable solution.

At this stage it is understood that fill cannot be won from Lord Howe Island or adjacent waters. As such fill will need to be imported. Importing fill provides opportunity to be more selective about the fill quality used. Industrial scale civil suppliers from anywhere in the region (Australia, New Zealand, New Caledonia) could be used, opening up an opportunity to adopt a material that is best fit for purpose at market driven prices. The major constraint for remote material sources are the logistical and financial impacts of the double and triple handling of material onto and off barges at remote locations along with the haulage.

8.3.3 Construction Considerations

The suggested construction methodology for the reclaimed land runway extension option is as follows:

1. Construction will begin onshore, creating access as it progresses.
2. Fill material will be tipped over the “end” of the reclamation with reworking of the external faces.
3. To manage turbidity, perimeter bunds will be constructed initially using high grade clean fill to allow confined placement of the remaining material. If perimeter bunds are used back filling can be undertaken in a controlled environment.
4. As works progress the external faces will be armoured with the final armour solution.
5. Material placed below the water level cannot be directly compacted and therefore compaction will begin once fill material is above the water level.
6. The use of granular fill should limit the risk of delayed settlement issues, although the use of overburden may be required to bring about final settlement of fill and underlying soils. However the materials on this project should not require extended periods of loading to achieve settlement (a method used with cohesive sediments).
7. After compaction is achieved the surface of the fill material will be trimmed and airport civil works would commence (drainage, pavements, etc.)
8. The trip structure would be constructed using floating plant or by working outwards from the shoreline if existing depths are too restrictive, largely independent of the runway works. This structure does not utilise fill and the methodology is primarily place and trim the relevant armour material.

Construction would occur around the aircraft flight schedules as required and around the clock subject to noise and light impact constraints.

The importation and transfer of large volumes of material will likely result in damage to local infrastructure. It is anticipated that the repair and remediation will need to be undertaken on roads and marine facilities.

8.4 Impact on Coastal Processes

The long term potential impacts and proposed solutions of the 570m reclaimed runway extension on coastal processes have been summarised in Table 10. These impacts have been discussed further in sections 8.4.1 to 8.4.7.

Table 10 Long term potential impacts and proposed solutions on coastal processes.

No.	Impact of Reclaimed Runway Extension	Solution
1	Act as a complete barrier to longshore sand transport along the Lagoon shoreline	Monitoring and management of sand volumes with mechanical intervention (pump or haul) and regular clean-up of foreshore deposition.
2	The SE corner of the extended runway would tend to become a sand trap, and an accumulation zone for floating and suspended matter	
3	The previously eroding area north of the Seabee revetment, where the Windy Point rock revetment was constructed in 2015, would have significantly reduced wave action, including reduced storm wave heights	N/A this is a benefit
4	Wave reflections from the extended runway would change wave patterns within the Lagoon causing scour	Rock armour sea wall toe design in addition to environmental management measures.
5	Scour could occur adjacent to the extended runway	
6	Water current patterns could change within the Lagoon	N/A minimal impact on the overall Lagoon
7	Sand Volumes would need to be monitored and managed after construction	Manual relocating of sand

It has been assumed that no dredging would be undertaken, particularly of the Lagoon, to provide fill for the runway reclamation due to the additional environmental impacts. If it was, there would be additional impacts on coastal processes beyond those listed above.

There would also be potential short-term construction impacts, such as sediment plumes generated as a part of reclamation. Any sediment plume generated would tend to either flow north or south towards the reef passages, given that circulation is understood to change direction near the runway location. Extended plumes would only be expected for finer materials such as silts and clays, with sandy plumes limited in extent due to the greater fall velocity of sand.

8.4.1 Impact 1: Barrier to Longshore Sediment Transport

The extent of the runway projection into the Lagoon would be such that longshore transport from Lagoon Beach to Cobbys Beach would no longer be possible, and vice versa. That stated, the magnitude and direction of longshore transport around the existing runway is uncertain, but is most likely to be limited already. If this is correct, the runway extension would not significantly alter the status quo with regard to longshore transport.

Therefore, the impact of the runway extension on longshore transport is considered unlikely to be significant. However, monitoring and management of sand volumes after construction would be necessary as discussed in Section 8.4.7.

8.4.2 Impact 2: Sand Trap and Accumulation Zone

The area at the SE corner of the extended runway, between the reclaimed runway and Lagoon Beach, would be expected to accumulate floating and suspended matter, including sand. The reduction of wave heights and current speeds in the area would cause this effect; in addition there would be no flow through the bay which would be formed. Although, some form of eddying current would be expected to be formed, allowing some flushing of the bay.

The reduced sand transport at the southern end of Lagoon Beach would be expected to reduce the supply of sand from south to north along Lagoon Beach that is presently assumed to be occurring. This would be beneficial in increasing sand volumes at the relatively denuded southern end of Lagoon Beach, but with reduced supply to the north, over the long term the northern end of Lagoon Beach may begin to recede. This would initially not be a concern, as there has been an oversupply of sand at the northern end of Lagoon Beach in the past. However, monitoring and management of sand volumes after construction would be necessary as discussed in Section 8.4.7.

8.4.3 Impact 3: Reduced Storm Waves at Seabee and Rock Revetment at Windy Point

The extended runway would provide some shelter from waves at the southern end of Lagoon Beach, potentially making the Seabee revetment, and southern portion of the Windy Point rock revetment, somewhat redundant and/or reducing their future maintenance requirements.

Diffracted waves around the NW tip of the extended runway would allow some wave action to continue to reach the Pinetrees Boatshed area.

8.4.4 Impact 4: Wave Reflections

Wave reflections off the extended runway, particularly its SW face, would cause greater wave energy to be reflected back into the Lagoon and towards the south compared to the present situation. In Figure 20 the vector-average offshore wave direction and its reflected angle off the extended runway are depicted. This does not take into account wave refraction over the Lagoon bed, which would cause some curvature of the incident and reflected wave directions.

It is evident that most of the incident wave energy would be reflected into the Lagoon, and not directly towards the shoreline. On this basis, wave reflection is unlikely to be a significant impact, except note the potential for scour in Section 8.4.5.

Figure 20: Reflected angle of vector-average offshore wave direction off extended runway (ignoring wave refraction over Lagoon bed)

8.4.5 Impact 5: Scour

Some seabed scour could occur at the toe of the rock armour sea wall; this process has been accounted for through the toe design of the revetment. Although there may be further environmental management measures required.

8.4.6 Impact 6: Changed Water Current Patterns

The extended runway would change current patterns in its vicinity. For example, the area between Blackburn Island and the NW tip of the runway would be expected to have higher current speeds than at present. As this area is relatively shallow, some seabed erosion may occur as a result. However, the impact of the extended runway on the overall Lagoon circulation and tidal exchange and residence times would not be expected to be significant.

8.4.7 Impact 7: Monitoring and Management of Sand Volumes after Construction

It would be necessary to monitor shoreline changes after construction, and manage accreting and eroding areas as appropriate. For example, this could involve mechanically relocating sand from accreting to eroding areas (e.g. with an excavator and truck), as was recommended to be undertaken at Lagoon Beach (moving sand from north to south) in Royal Haskoning's Lord Howe Island Coastal Study (2014).

9.0 Deck on Pile Structural Design

9.1 Deck System

The optimum form of deck system comprises precast concrete deck panels supported on precast reinforced concrete beams. This system will maximise the scope for prefabrication and minimise on-site construction time. The deck panels are fixed to the beams via in-situ concrete stitch pours. The main deck support beams run longitudinally (i.e. parallel to the runway) at 6m centres, and are supported on piles at 8m centres.

Typically the beams are approximately 1100mm wide and 1200mm deep, although certain beams have been widened to 1300mm in order to accommodate drain infrastructure to support deck panels designed for crawler crane access during construction.

The piles and beams are interconnected via an in-situ concrete stitch pour. The beam penetrations are oversized in order to accommodate the pile installation tolerances.

9.2 Pile System

The piles comprise steel tubes of 600mm diameter, with a wall thickness around 16mm. Reinforced concrete plugs will be formed inside the piles, extending from the soffit of the beams down to approximately RL-1.0m AHD.

The piles will either be pre-coated with a suitable paint system, or will be wrapped with a proprietary protection system after installation which would extend to the seabed.

9.3 Wave Action Consideration

Due to the low level of the existing runway, the inshore section of the deck structure will be subject to wave action during extreme events. These will reduce as the deck rises seawards.

The deck will be subject to uplift loads, which will be transferred to the piles. This will result in increased design loads for all elements. It is considered that this strengthening can be achieved with a marginal increase in construction cost over a conventional deck constructed above the wave zone. This is more economical than provision of a trip breakwater to reduce incident wave heights.

9.4 Accommodation of Drainage System

The longitudinal drains located between the runway and the outer runway strips comprise precast concrete base and walls, fitted with removable heavy duty cast iron grates. The drains are supported by widened longitudinal beams.

At drainage pit locations, the longitudinal beams are modified to accommodate the pit chambers and the drainage outfall. Additional pile support is provided to the beam as required. Incorporating the pits within the longitudinal beams maintains the simplicity of the deck system.

At the outer edges of the runway strip, the thickened edge detail of the deck panels facilitates shaping of the top surface to form a vee drain which will intercept runoff and direct it to discrete scuppers, through which the runoff will be discharged to the lagoon.

9.5 Potential Construction Methodology

9.5.1 Piles

Piles will be fabricated and coated offshore (most likely in Asia) and brought in by a large barge; several trips will be required over the piling period. This barge will moor outside the Lagoon. The piles will be offloaded using a smaller crane barge, which will transfer the piles to the island wharf or SW extent of the runway. Here the piles will be unloaded onto chassis for transport to a pile storage area adjacent to the airport. The piles will be offloaded from the chassis using a small mobile crane or fork lift. The piles will be stacked, using packing to protect the pile coating.

When required, the piles will be loaded onto a chassis and delivered to the piling rig via a temporary runway perimeter road (to avoid plant trafficking on the runway). A small stockpile of piles will be maintained at the piling rig in order that piling can continue during airport operating hours (subject to OLS restrictions), when shore access to the work front will be restricted.

9.5.2 Deck Slab Units and Deck Beams

Reinforced concrete deck slab units and deck beams will be precast offshore (probably Australia or NZ) and will be brought in by a large barge. They will be offloaded in similar fashion to the piles, and delivered to a storage area adjacent to the airport.

As for the piles, a small stockpile of deck units and beams will be maintained at the work front to enable installation work to continue during airport operating hours.

9.5.3 Construction Sequence

The concept design is based on construction using large crawler cranes which will operate over specific deck spans designed for this purpose. These spans are shown cross-hatched in Figure 21.

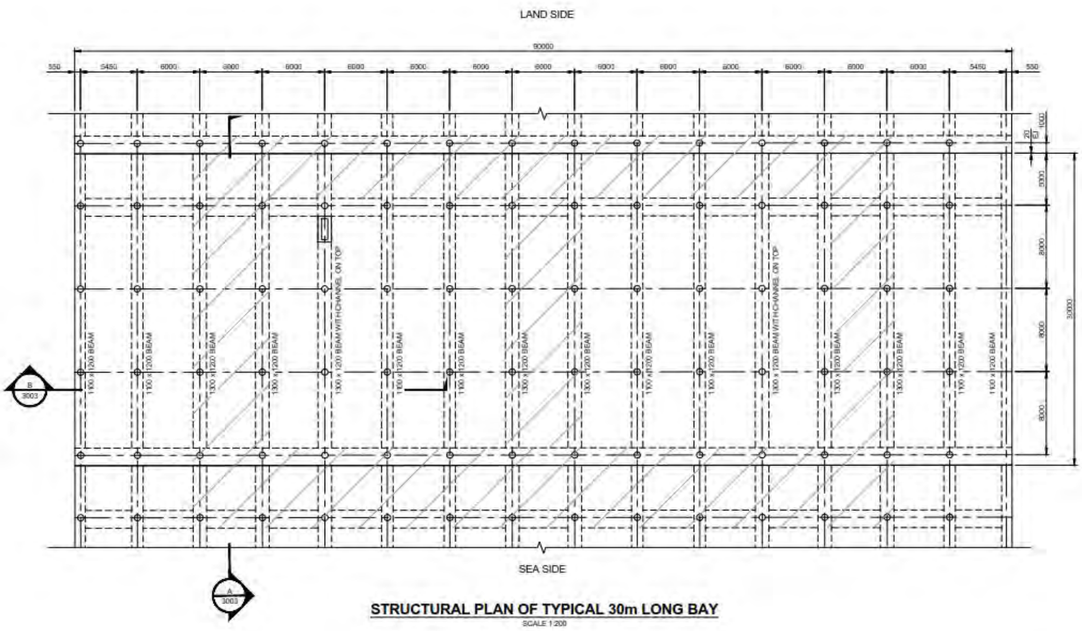


Figure 21 Crawler crane deck layout

Construction will commence at the outer end of the existing runway strip, working progressively seaward. This will only occur outside of airfield operations in order to avoid OLS infringements.

Initial construction will focus on a 30m wide section which will act as a roadway for construction activities. Construction will be by hand-over-hand installation of piles, beams and deck units, using a large crawler crane travelling on the central span. The crawler crane will be of sufficient size to reach an additional two spans each side; these will be completed as required to provide access for other construction plant, and for temporary stockpiling of materials, subject to OLS restrictions.

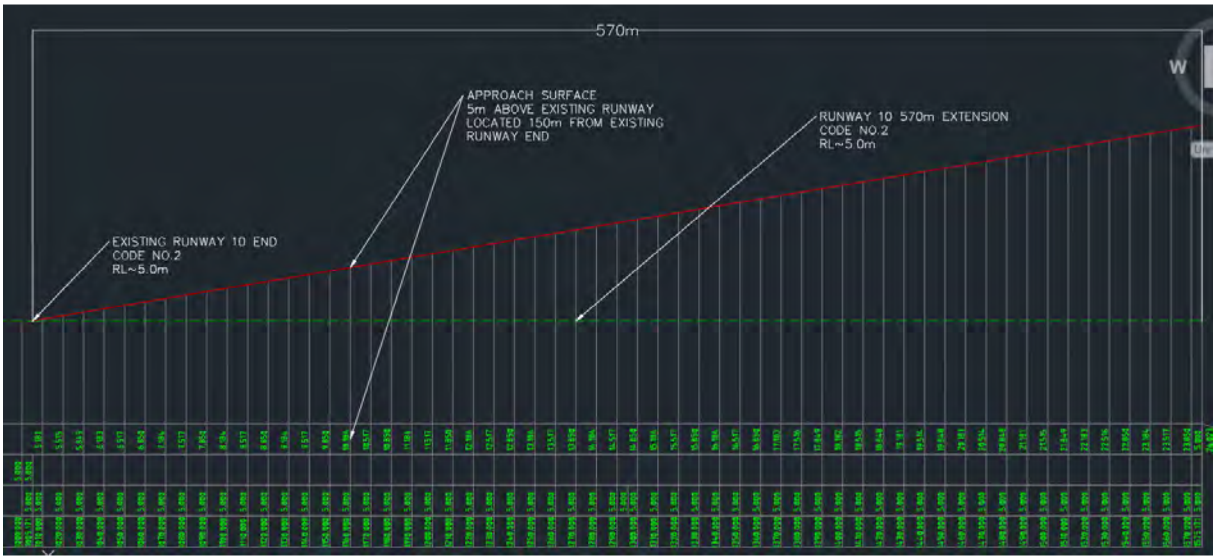


Figure 22 Runway Extension Profile and Existing OLS

Once the initial 30m wide section has been constructed 450m beyond the existing runway end, the crawler crane (assumed 15m height) will no longer infringe upon the OLS, therefore multiple construction fronts can be opened up using the designated crawler crane spans to move laterally as well as longitudinally.

Contractor’s plant and material stockpiles can be based at the outer end of the runway extension, clear of the OLS. As more deck area becomes available, more plant and materials can be stockpiled subject to height limitations, minimising conflict between airport operations and materials delivery.

Pile driving will be the activity most affected by the OLS, due to the crane boom height required. This is dictated by pile length, with a boom height in the order of 25m potentially being required. In addition for safety reasons, piling is usually only carried out during daylight and will be managed around aircraft flight schedules.

As previously stated the installation of beams and deck units will not require the same crane boom height (around 15m should suffice), and could be carried out under artificial light, subject to environmental constraints.

9.6 Impact on Coastal Processes

A 570m piled runway extension would not be expected to have any significant impacts on coastal processes, although if storm wave crests reached the slab soffit, then some attenuation of wave action would be expected at the shoreline, as per section 8.4.3, although not to the same magnitude.

10.0 Runway Extension Contour Mastergrading

Contour mastergrading modelling of the runway extension was based on the 3d geometric requirements of CASA as shown in Table 11.

Table 11 MOS139 3D Geometric Runway requirements

3D Geometric Runway Requirements	Runway Design Parameters[1]	MOS 139 reference section
Max. overall longitudinal slope	1%	6.05.1
Max. longitudinal slope	1.5%	6.05.2
Max. longitudinal slope changes	0.2% per 30m	6.05.6
Max. longitudinal slope on graded strip	2%	6.18.1
Sight distance	600m @ 3m above the surface	6.06.2
Transverse slopes	Maximum slope = 2.5% Minimum slope = 1%	6.07.2
Transverse slopes on shoulders	Maximum slope = 5% for the first 3m, then 2.5% Minimum slope =1%	6.12.1
Max. transverse slope on graded strip	2.5%	6.20.1
Flyover area transverse slope[2]	Nothing may project through an upward slope of 5% from the edge of the graded strip	6.20.3
RESA slopes	Max. longitudinal slope = 5% downwards Max. transverse slope = 5%	6.25.7

Contour mastergrading for the deck on pile solution has been developed to aid the stormwater drainage of the structure. The drainage infrastructure has been designed to be coincident with the decking and therefore a constant 0.25% longitudinal upward slope has been applied from east to west along the extension in order to provide “natural” fall within the grated drains. This methodology removes the structural complexity of the drainage infrastructure being underslung to the deck structure.

In order to reduce volume of fill material required for the land reclamation solution and therefore reduce capital costs and construction durations, the runway extension has been modelled with a constant level.

For both mastergrading designs, the runway will have a crowned cross sections falling at 1% from the runway centreline to the edge of the runway strip.

11.0 Airfield Drainage Design

It is assumed that the existing drainage infrastructure servicing the airport is suitable to meet the criteria in Table 12.

Table 12 Drainage design criteria

Design Storm Event	Design Criteria	Reference
5 year (minor event)	- No encroachment of runway (incl. paved shoulders) - No encroachment of taxiway (incl. paved shoulder.)	FAA Advisory Circular 150/5320-5D 2-2.4.2
10 year (major event)	- No encroachment of centre 50% of runway - No encroachment of centre 50% of taxiway	FAA Advisory Circular 150/5320-5D 2-2.5

The only existing form of stormwater treatment at Lord Howe Island is at the southern end of the runway which drains through a water course containing mangroves prior to discharging. It is recommended that prior to discharging into the ocean, any runoff from new pavement areas is collected and any oil or sediment is removed prior to discharging into the ocean.

11.1.1 Runway Extension Drainage

The additional runway extension will be drained through the use of grated drains along both edges of the runway falling into pits spaced at 120m centres. The deck on pile extension option will have the drains inbuilt into the deck infrastructure which will have natural fall due to the 0.25% longitudinal slope of the runway, the outlet pipes from the pits discharging vertically downwards into the ocean. Whereas the grates for the land reclamation option will have internal falls of 0.25% due to the flat longitudinal grade of the extension, the outlet pipes will extend horizontally to the edge of the runway strip and outfall along the seawall rock armour.

Rain water falling onto the runway strip will sheet flow to extent of the strip before being collected in a 150mm deep concrete drainage channel out falling vertically downwards at 150m centres for the deck on pile solution or simply flowing down the seawall rock armour for the land reclamation option.

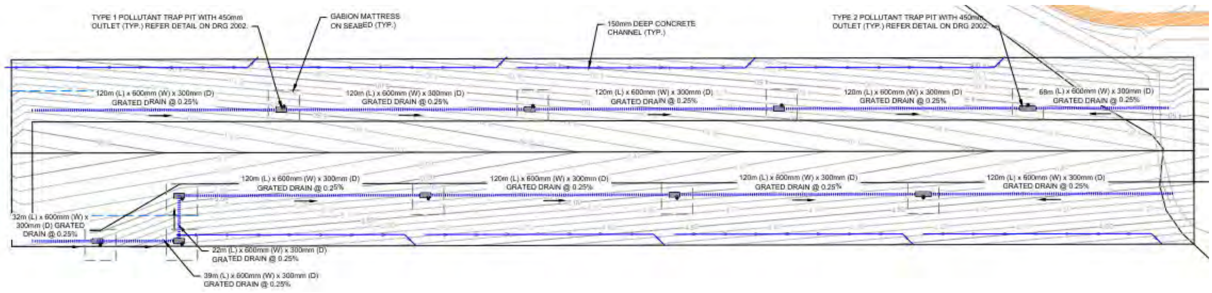


Figure 23 Deck on piles drainage layout

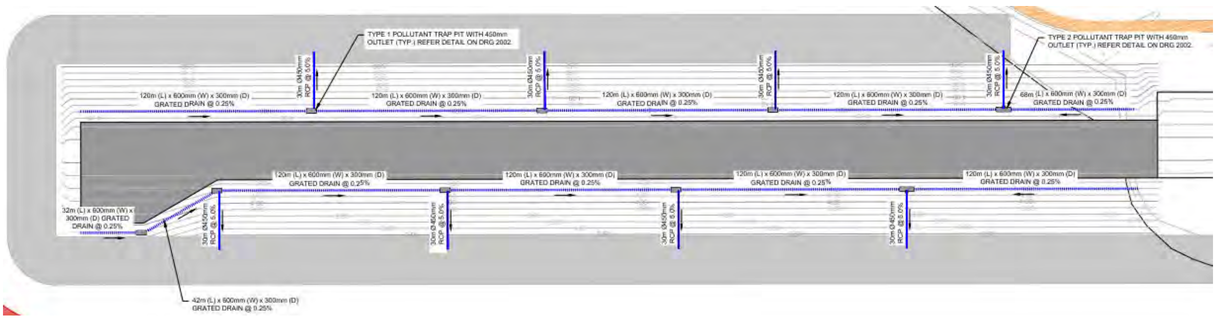


Figure 24 Land reclamation drainage layout

The runway drainage pits have been designed to intercept both oil and sediments through the use of an internal dividing wall (as shown in Figure 25). To ensure that collected fuel spills do not flow into the downstream drainage system, a constant water level needs to be maintained above the centre berm. During regular runoffs, the water within the pit will pond and this provides the necessary water level required to be above the centre berm. In addition to this, the airport's operation crew, whilst conducting regular routine maintenance, will need to ensure that the water level is kept at a minimum 400 mm from the invert of pit. The oil and sediment collection will also need to be included as part of the regular maintenance.

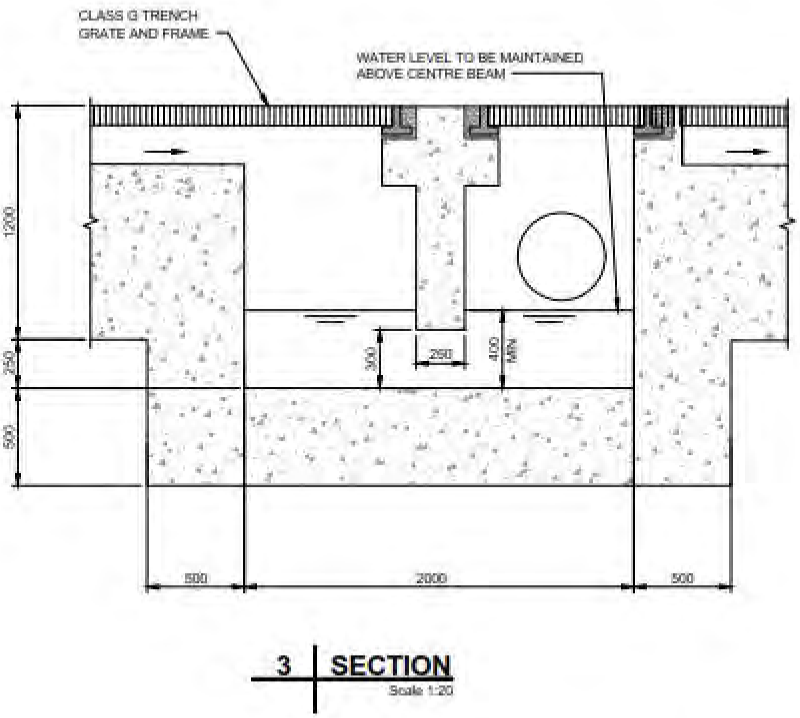


Figure 25 Drainage pit detail

Where stormwater discharge has the potential to cause scouring of the seabed, scour protection will be provided. The optimum form of protection is a sand-filled geotextile mattress, which can simply be laid on the seabed and will automatically adjust to variations in the shape of the seabed.

11.1.2 Apron Extension Drainage

It is assumed there will continue to be aircraft refuelling operations required on Lord Howe Island; therefore the stormwater drainage infrastructure for the additional 7275m^2 of apron pavement will include a downstream oil/water interceptor with a treatment flow rate of 130L/s for fuel spill mitigation purposes.

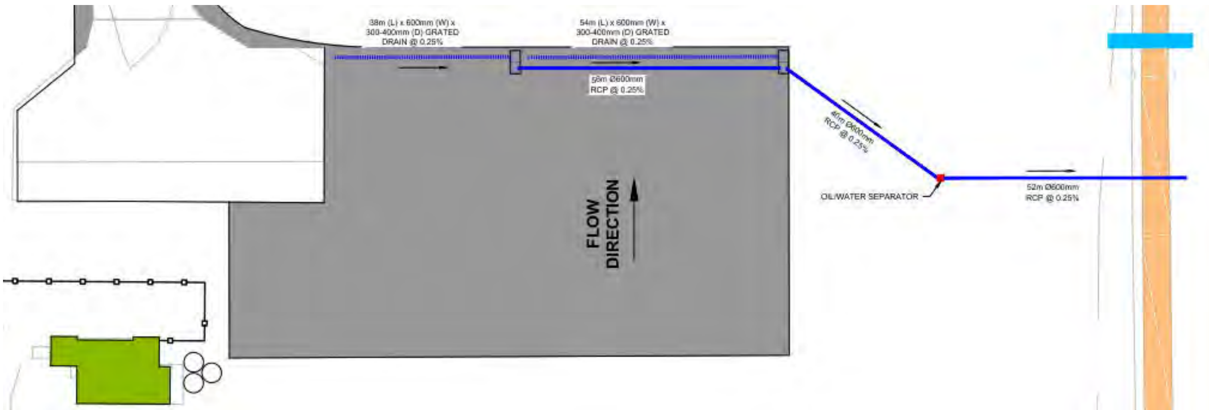


Figure 26 Apron drainage layout

12.0 Airfield Pavement Design

The airfield pavement design has been based on the requirements of the Federal Aviation Authority (FAA) and modelled using FAARFIELD v1.41 – Airport Design Software. It is recommended at subsequent advanced design stages that a more complex analysis of the pavement design should be completed using Airport Pavement Structural Design System (APSDS) software.

A flexible pavement has been designed for the reclaimed land runway extension; the concrete deck will act as the runway pavement for the deck on piles option.

In the absence of a full 20 year fleet mix, the design traffic loading within Table 13 have been adopted for the purpose of the concept design of airfield pavements and evaluation of existing airfield pavements.

Table 13 Aircraft Design Traffic Loading

Aircraft	Departures			Ad-hoc flights/annum[1]	Passes to Traffic Cycles[2]	Design Period (Years)	Cumulative Passes
	Daily	Monthly	Annual				
DHC8-400	2	-	730	70	2	20	32,000
C130	-	3	36	4	2	20	800

Notes

1. *Additional ad-hoc flights have been based on 10% of the annual departures*
2. *This is based on aircraft requiring to taxi along the runway to either end prior to take off*

As per section 8.3 the fill material used in the reclaimed land design will provided a subgrade California bearing ratio (CBR) of 10%-15%. The new pavement depth based on the assumed aircraft traffic mix and subgrade strength is shown in Figure 27, a design for a 10% CBR subgrade has also been completed.

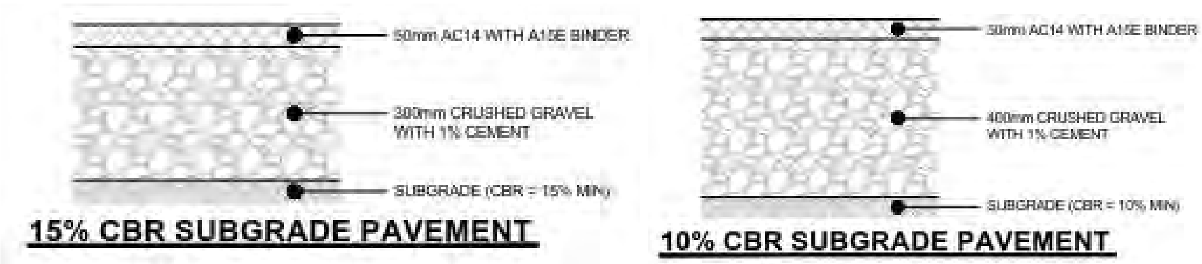


Figure 27 Pavement profiles

Pavement extensions of the existing eastern turning head, taxiway and apron are required in order to accommodate the DHC8-400 aircraft; the 10% CBR subgrade pavement profile in Figure 27 has been adopted for these extensions in order to keep materials consistent for ease of construction. Typically rigid pavements are designed for aircraft aprons, but given the difficulties in getting construction plant and materials to the island a flexible pavement design has been adopted at this stage. Increasing the cement content of the crushed gravel may be required within the aircraft manoeuvre areas of the apron. As detailed in section 6.1, there is limited geotechnical information across the existing airport and therefore further investigations are required to determine the in-situ subgrade CBR.

The existing airfield pavement structure (Table 14) have been assessed to provide sufficient structural capacity, the weakest area of pavement (area 2) was modelled in FAARFIELD with the proposed aircraft design traffic loading (Table 13).

Table 14 Existing airfield pavement structure

Area	Chainage		Asphalt Thickness (mm)	Basecourse		Sub-base	
	Runway	Taxiway		Thickness (mm)	Modulus (MPa)	Thickness (mm)	Modulus (MPa)
1	940 to 1400	-	45	200	300	225	200
2	1400 to 1945	15 to 40	45	200	250	225	200
3	-	40 to 76	-	200	300	200	300

Notes
1. *Existing pavement structural information has been taken from "Report for Lord Howe Island Board – Airport Pavement and Drainage Assessment, August 2014)*
2. *The above report stated CBR values of 15%, the concept design has conservatively adopted a CBR of 10%*

13.0 Security

13.1 Background

The Australian Government announced a “New Categorisation Model” on May 8 2018, in order to address changes to security requirements for security regulated airports. Based on these new definitions LHI Airport is currently rated as a Tier 4 airport, which is defined as “airports with annual departing passenger numbers greater than 15,000 and service by RPT or open charter aircraft with seating capacity of less than 40.

Historically only airports used by aircraft operating at a maximum take-off weight of more than 20,000 kilograms required security screening to be in place. As part of the new requirements, all persons (staff and passengers) and baggage will need to be screened for all RPT or open charter aircraft with seating capacity of 40 or more (Tier 3 airports and above).

Although the announcement states existing security and screening requirements remain in place until otherwise advised, it is assumed that the new requirements would be in place should the runway extension progress to subsequent design and construction stages.

Both candidate aircraft defined in AECOM’s *Detailed Assessment of Extended Runway Requirements and Suitable Aircraft (issued April 2018),* the ATR72 (68 seats) and DHC8-400 (74 seats) exceed the 40 seat threshold. Therefore any future operation of these aircraft to Lord Howe Island would trigger LHI airport to become Tier 3.

13.2 Upgraded Security Requirements

In order to address current and emerging threats, the Australian Government considers the introduction of advanced screening technology as the most effective measure to combat security risks to Airports across Australia.

In general, the upgraded security requirements expected for a Tier 3 airport include, but are not limited to:

- All baggage (cabin and checked) and goods to be screened using explosive trace detection (ETD);
- Bag searches will also be required on a random and continuous basis;
- All persons (passengers and staff) to be screened using ETD and metal detection (handheld or walkthrough); and
- Enhanced perimeter security fence type.

Based on the relatively recent announcement of the “New Categorisation Model”, the Australian Government has not provided further detail on the exact requirements of a Tier 3 airport. Further consultation will be required at subsequent design stages to determine the exact security requirements expected at LHI airport should the runway extension be completed.

13.3 Terminal Equipment

Equipment required within the terminal building to meet the expected Tier 3 airport requirements are shown in Table 15. AECOM understand that full body scanners are not required for Tier 3 airports so these have not been considered.

The existing terminal building footprint is insufficient to accommodate the additional equipment, and therefore an expansion of the terminal building would be required.

Table 15 Terminal Equipment required

Checked Luggage Screening

Rapiscan MVXR5000

Existing Situation
No baggage screening equipment

Proposed Equipment
Department of Home Affairs approved multi-view X-ray based system

Potential Issues
There is minimal space within the existing terminal; therefore an extension would be necessary to accommodate checked baggage screening.

Cabin Baggage Screening

Rapiscan 620DV

Existing Situation
No cabin baggage screening equipment

Proposed Equipment
Department of Home Affairs approved dual view X-ray based system. This includes furniture such as roller beds/conveyor belt.

Potential Issues
Minimal space to accommodate screening equipment, and an extension of the terminal would be required.

Explosives Trace Detection

Rapiscan Itemiser 4DX

Existing Situation
No explosive trace detection equipment

Proposed Equipment
Department of Home Affairs approved non-radioactive based explosives and narcotics detection system

Passenger Screening

Rapiscan Metor 6E

Existing Situation

No passenger screening equipment

Proposed Equipment

Department of Home Affairs approved walk through metal detector which has the ability to have a throughout rate of over 50 persons a minute.

Potential Issues

Minimal space to accommodate passenger screening and it is recommended that two (2) lanes be provided in case one lane has either a malfunction or is inactive due to maintenance.

Alternate Option

A less expensive alternative to the walk through metal detector is the use of a hand held metal detector such as the Rapiscan Metor 28 which has 3 sensitivity settings to detect all types of metal. These would have to be used by authorised screening staff and would limit the throughput of passengers compared to walk through metal detectors.

As previously stated, there is limited room within the existing terminal building to accommodate the additional security screening and detection equipment required. An initial concept of the revised layout has been shown in Figure 28; this is based on architectural floor plans (STEA, 2016).

All new passenger and cabin baggage screening equipment could be contained within the existing terminal footprint and therefore would only require interior refurbishment of this area. Although in order to provide a check in area, a minor extension to the existing entranceway would be required.

An 81m^2 building extension or standalone room would be required for the checked luggage screening facility; the initial concept has shown two Rapiscan MVXR5000 installed for redundancy. Any savings in building extension size & equipment costs associated with only providing one Rapiscan MVXR5000 may be offset in the future if the equipment requires maintenance or replacement due to Lord Howe Island's remote location.

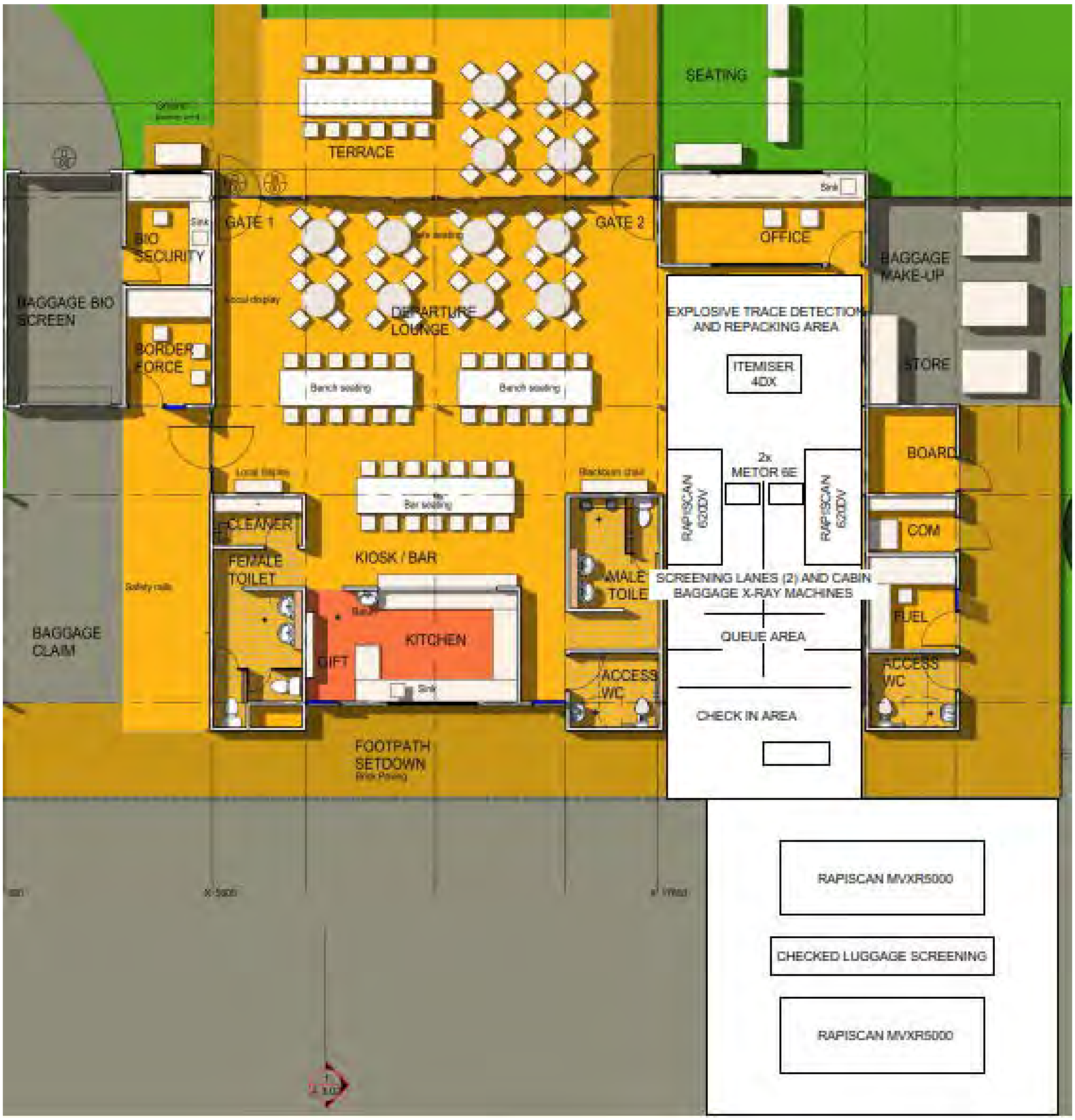


Figure 28 Initial concept of revised terminal security layout

13.4 Perimeter Security Fence

The current perimeter security fence at LHI Airport is a 1200mm high, 5 steel strand with concrete support post fence (see Figure 29). The fence provides satisfactory delineation between landside and airside however is not considered a robust solution in meeting Tier 3 airport requirements.

Figure 29 Existing perimeter security fence

AECOM note that the *Aviation Transport Security Regulations 2005* aren't prescriptive as to the type and specification of fencing required for a Tier 3 airport, so long as it adheres to the following requirements stated by the Transport Security Guidance Centre of the Department of Home Affairs):

- The airport operator's Transport Security Program (TSP) must set out procedures for physical security and access control [regulation 2.16(1)]. Any changes to the physical security measures (such as type and location of fencing) will require an update to the TSP.
- Additionally, the general requirements regarding fencing are outlined in regulation 3.15:
  - (1) The requirements for the fencing of, and the provision of other physical barriers to entry to, the airside area of a security controlled airport are:
    - (a) a barrier sufficient to delineate the airside area; and
    - (b) effective access control points to permit authorised access to the airside area.

Based on these requirements AECOM recommend that a suitable perimeter security fence (should LHI become a Tier 3 airport) should meet the following requirements and features:

- 1.8 metre high plus an additional outrigger height of 600mm, to achieve a total overall vertical height from ground of 2.4 metres;
- A 45 degree cranked outrigger fitted with minimum 3 off 1.6mm diameter galvanised, high tensile, tensioned barbed wire strands spaced at 100mm centres;
- Bracing as appropriate to ensure the structural / security integrity of the fence;
- The lower edge of the chain mesh is to be within 50mm of the top of the ground;
- The top edge of the mesh is to be braced with one strand of tensioned barbed wire;
- Barbed wire returns shall be provided from outriggers to any gate support posts or upright posts so that no gaps greater than 100mm are present;
- Galvanised pipe caps; and
- The chain wire security fence must be installed to suit the particular site conditions and in accordance with the appropriate Australian Standards.

A clear zone up to 5m wide on either side of the perimeter security fence should be provided to allow an appropriate security patrol to be undertaken and allow inspection of the perimeter fence to detect any damage or intrusion attempt. An indicative sketch of the perimeter security fence is shown in Figure 30.

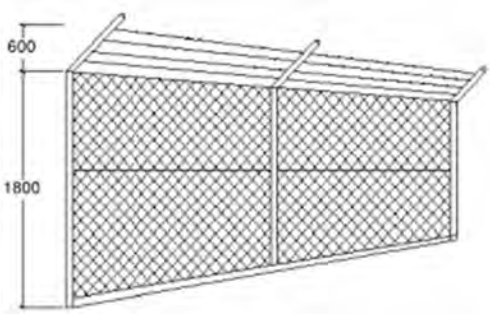


Figure 30 Proposed Perimeter Security Fence

Along the deck on pile extension, the fencing will be installed horizontally to maintain a secure perimeter from intrusions from beneath the runway whilst avoiding OLS infringements. Physical inspection beneath the runway expansion prior to any scheduled arrival or departure will be required to ensure the safety of the airplanes and any persons potentially beneath the overwater section of the runway. The proposed perimeter security fence alignment is shown in pink in Figure 31

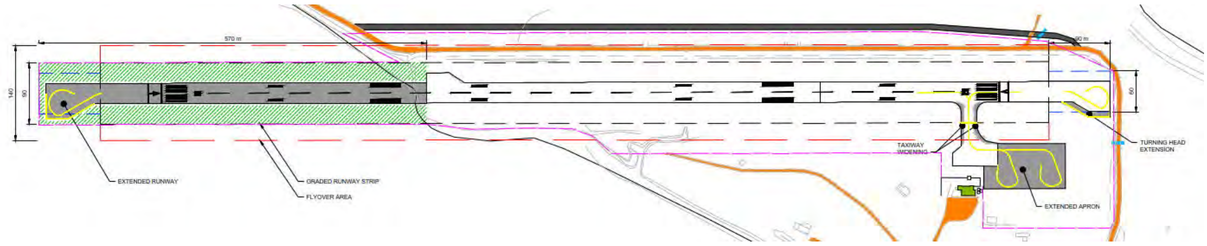
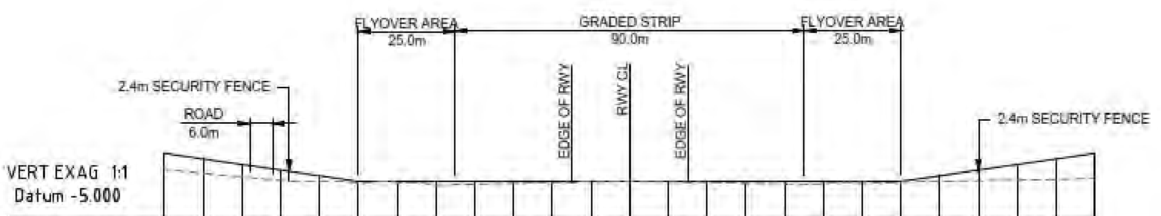


Figure 31 Proposed upgraded perimeter security fence line

The proposed security fence is double the height of the existing fence line and therefore would infringe upon the OLS if it was installed in the same location. The cross section in Figure 32 shows the required fence line location to avoid any OLS infringements.



OLS	10.114	8.684	7.254	5.824	4.394	4.394	4.394	4.394	4.394	4.394	4.394	4.394	4.394	4.394	4.394	4.394	4.394	4.394	4.394	5.824	7.254	8.684	10.114	11.544
GROUND LEVEL	6.425	5.466	4.612	4.186	3.875	4.035	3.414	3.559	3.779	4.000	4.182	4.339	4.199	4.027	3.823	3.618	3.680	4.083	4.143	4.320	4.486	4.651	4.816	5.125
DEPTH	3.688	3.218	2.642	1.637	0.518	0.359	0.980	0.835	0.614	0.394	0.212	0.055	0.194	0.366	0.571	0.776	0.714	0.311	0.251	1.503	2.768	4.033	5.297	6.419
CHAINAGE	10.000	20.000	30.000	40.000	50.000	60.000	70.000	80.000	90.000	100.000	110.000	120.000	130.000	140.000	150.000	160.000	170.000	180.000	190.000	200.000	210.000	220.000	230.000	240.000

Figure 32 Security fence OLS section

It is assumed that at subsequent design stages, accurate topographical survey information will be available which will allow accurate assessment of allowable heights under the OLS. Based on the limited level data available at this stage, the proposed layout is subject to change.

13.5 **Fuel Farm**

While not being considered as a mandatory requirement to be met as part of Tier 3 airport security upgrades, the current Fuel Farm (located adjacent to the south of the runway on landside) is freely accessible from the road off Lagoon Road. The space is also used as a storage area and has had instances of theft occur previously.

AECOM would recommend the following security enhancements for the Fuel Farm in conjunction with the mandatory Tier 3 requirements;

- New perimeter security fence around the Fuel Farm compound to mitigate against unauthorised access (as per the requirements of section 13.5);
- New automatic electronic sliding gate to the entry of the Fuel Farm;
- New dual height equipment pedestals with card reader and intercom capability (see example in Figure 33); and
- CCTV coverage of the electronic sliding gate.

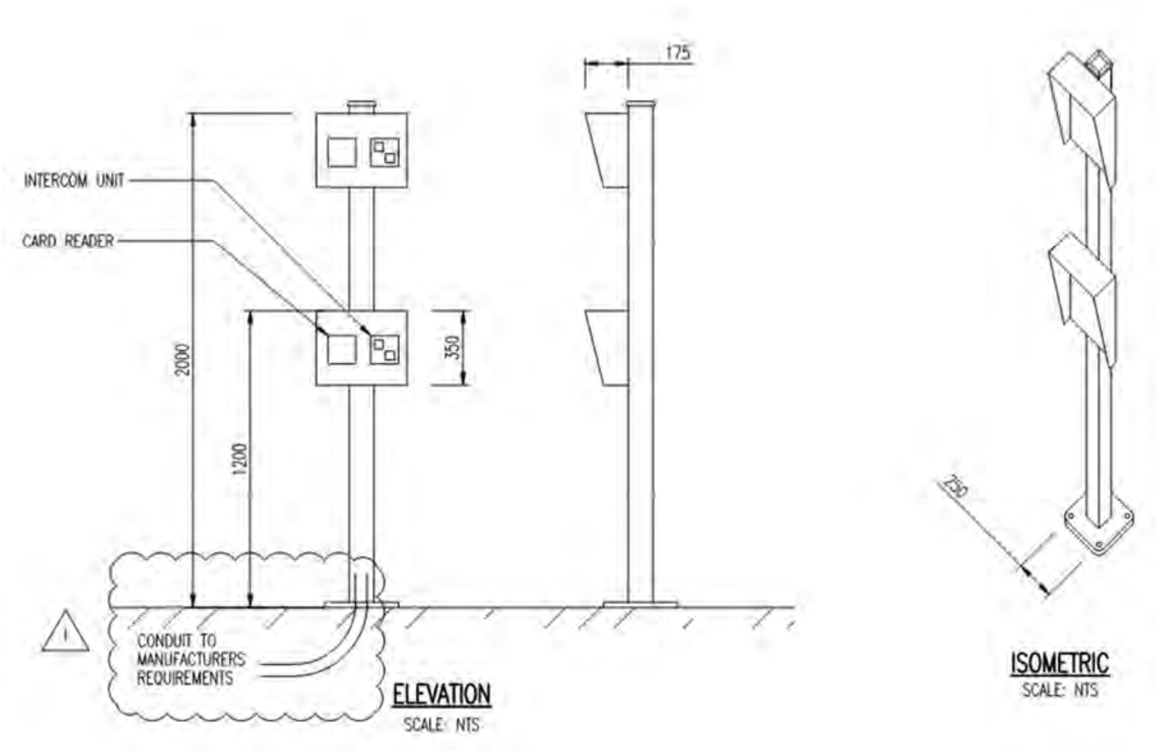


Figure 33 Example dual height equipment pedestal

14.0 Preliminary Environmental Impact Assessment

As part of this project AECOM have also completed a preliminary environmental impact assessment (PEA) *(issued 30th October 2018)*, which has determined potential environmental risks and approval risks associated with the environmental aspects of the marine and land based components of proposed works.

Environmental issues associated with the potential construction and operation of a runway extension which were identified to have a medium to high risk were assessed in this preliminary environmental assessment (PEA). Environmental impacts which are predicted to be of a high significance as a result of the project include:

- World Heritage;
- surface water (quality and hydrology);
- coastal processes;
- contamination;
- climate change and flooding;
- biodiversity and biosecurity;
- noise and vibration; and
- landscape and visual amenity.

The assessment identified that a runway extension has the potential to impact on the Lord Howe Island Group (LHIG) World, Commonwealth and State Heritage listings. Construction activities have the potential to affect the Island's heritage significance through the following;

- changing the visual amenity of the area;
- changing the land use;
- impacts to biodiversity;
- impacts to the environment by introducing pests and weed species;
- affecting water and air quality; and/or
- introducing or spreading contamination on the Island.

The assessment of significance for the potential impacts identified that the Deck on piles would have an overall lower level impact to the environment compared to the Land reclamation for construction and operational impacts. The primary differences between the two options are the potential impacts associated with coastal processes, surface water, traffic and transport and air quality.

The assessment involved a review of the legislative framework which is applicable to the project, and informed a relevant approvals pathway for a proposed future runway extension project. In summary, such a project would require multiple approvals at the State and Commonwealth levels, the certainty of which is not assured due to the potential approvals risks and environmental impacts associated with the project.

This PEA was limited to a desktop assessment and as such if the project is to progress, the environmental issues identified would need to be assessed in further detail including fieldwork based technical assessments. If it is decided that the runway extension would progress further, the next steps would be to begin with a formal planning application for the development, involving the preparation of a State significant scoping report to the Department of Planning and Environment (DP&E) and the preparation of an Environmental Impact Statement (EIS).

Indicative timeframes associated with the approvals pathway have been included in the project delivery program in section 16.0.

15.0 Construction Cost Estimate

Construction cost estimates have been developed for both the deck on piles and reclaimed land runway extensions options; these have been based on the assumptions in section 15.1. An upper and lower range (+/-30%) has been provided to indicate the potential range of costs and reflect the uncertainty in the estimates.

15.1 Assumptions

15.1.1 Labour

Work crews will operate on a fly in fly out (FIFO) basis, allowance of return flights from the mainland to the island have been accounted for to coincide with the 4 day work week and airfield operations. It's to be noted that a small number of construction crew may be available on the island for non-skilled labour; this could be further investigated at subsequent stages of the project.

15.1.2 Plant and Equipment

There is little no construction plant available on Lord Howe Island, and therefore this will all be required to be shipped from the mainland. An indicative allowance for mobilisation/demobilisation has been included; this includes relevant portable batching plants.

15.1.3 Materials

No materials are able to be sourced from the island or surrounding marine sand deposits. All construction material is to be shipped from Australia, New Zealand or other surrounding islands.

15.1.4 Owners Team Costs

An allowance of 3% of direct costs has been included for the detailed design, procurement and other owner's team costs.

15.1.5 Project Management Contractor

An allowance of 5% of direct costs has been included assuming a PMC will manage the project execution on site.

15.1.6 Subcontractors Margin

Subcontractors Margin has been included at 10% of Direct Costs.

15.1.7 Contingency

Contingency has been included at 25% of Direct Cost, Indirect Costs and Margin.

15.1.8 Exclusions

The following exclusions apply to the cost estimate.

- GST is excluded from all costs
- Handling of and disposal of any contaminated materials
- Offsite disposal of excavated spoil, demolished materials and excess materials
- Statutory and approvals and regulatory costs

15.2 Cost Estimate Summary

A summary of the +/-30% construction cost estimate for the “land reclamation” and “deck on pile” runway extension options are shown in Table 16 and Table 17 below.

Table 16 Land Reclamation Construction Cost Estimate

Item	Description	Costs ($ AUD)
1	Subcontractors Preliminaries	$19,062,772
2	Mobilisation - Plant and miscellaneous materials	$431,280
3	Mobilise Work Crew	$1,526,129
4	Supply Rock, General Fill and Pavement Materials to site	$162,909,652
5	Place fill material	$5,817,480
6	Place Rock to runway extension	$2,201,775
7	Place Rock to Trip Structure	$1,811,401
8	Other Airfield Civil Works (Inc. runway extension pavement)	$10,417,200
9	Upgraded security requirements	$2,632,800
	Subtotal Direct Costs	**$206,810,489**
10.1	Owners Team Costs	$6,204,315
10.2	PMC	$10,340,524
10.3	Contractors Margin	$20,681,049
11	Contingency	$61,009,094
	Subtotal Indirect Costs	**$95,234,982**
	Total installed cost	**$305,100,000**
	Lower range	**$245,000,000**
	Upper range	**$397,000,000**

Table 17 Deck on Pile Construction Cost Estimate

Item	Description	Costs ($ AUD)
1	Subcontractors Preliminaries	$12,169,226
2	Mobilisation - Plant and miscellaneous materials	$551,040
3	Mobilise Work Crew	$1,717,637
4	Supply piles and precast items and other materials to site	$69,521,936
5	Pile installation	$27,989,280
6	Place precast beams	$6,578,484
7	Concrete Insitu stitch	$1,805,085
8	Other Civil Works	$6,576,000
9	Upgraded security requirements	$2,632,800
	Subtotal Direct Costs	**$129,541,488**
10.1	Owners Team Costs	$3,886,245
10.2	PMC	$6,477,074
10.3	Contractors Margin	$12,954,149
11	Contingency	$38,214,739
	Subtotal Indirect Costs	**$61,532,207**
	Total installed cost	**$191,100,000**
	Lower range	**$153,000,000**
	Upper range	**$249,000,000**

16.0 Project Delivery Program

Construction durations for each design option were determined based on the critical activities, based on the assumption that minor works and civil works are completed concurrently. The land reclamation extension would take between 18 and 24 months to complete, based on an estimated placement of 2000T of fill/filter rock and 650T of rock armour per day. The deck on pile solution would take between 12 and 18 months to construct, based on a daily installation rate of 8 piles and 8 precast units. Both construction programs include shipping and storage of the materials on site.

An indicative investigation and design timeframe of 12-18 months have been allowed for in the overall Project Delivery Program. This would occur concurrently with the NSW and Commonwealth planning approvals process which has the potential to require up to 36 months, this includes a 6-12 month baseline monitoring, field work and environmental survey period.

Table 18 Cumulative Project Delivery Program

Option	Duration per stage (months)				Total Duration (months)
	Design	Approvals	Tender	Construction	
Land reclamation	12-18	30-36	3-6	18-24	51-69
Deck on Piles	12-18	30-36	3-6	12-18	45-63

17.0 Conclusion

In order to continue the operation of 30+ seater RPT services to the island beyond 2022, significant construction work is required at Lord Howe Island Airport, not only for the physical runway extension but also the associated existing airfield expansion works required to accommodate candidate Code C aircraft which are significantly bigger than the existing DHC8-200 servicing the island.

Although the land reclamation and deck on pile design options proposed within section 8.0 and 9.0 respectively are both considered to be viable from an engineering perspective; it is AECOM's recommendation that the deck on pile option provides the best solution. A number of key differentiators were identified which can be seen in Table 19 below.

Table 19 Key differentiators for design options

Item	Land Reclamation	Deck on Piles	Differentiator
Coastal Processes	Significant impacts	Minor wave attenuation	Significantly lower impact
Preliminary Environmental Assessment	Higher construction and operation impact	Lower construction and operation impact	Lower potential impact
Construction Cost Estimate	$305,100,000	$191,100,000	40% reduction in estimated construction costs
Project Delivery Program	51-69 months	45-63 months	10% reduction in program duration

In order to inform subsequent design stages for of the runway extension, further assessment should at a minimum include the following;

- Intrusive geotechnical investigations
- Liaison with airlines to determine accurate candidate aircraft performance requirements
- Two dimensional or three dimensional computational modelling of the water dynamics within the lagoon
- Detailed (including fieldwork) environmental assessments
- Accurate topographic survey data

Appendix A

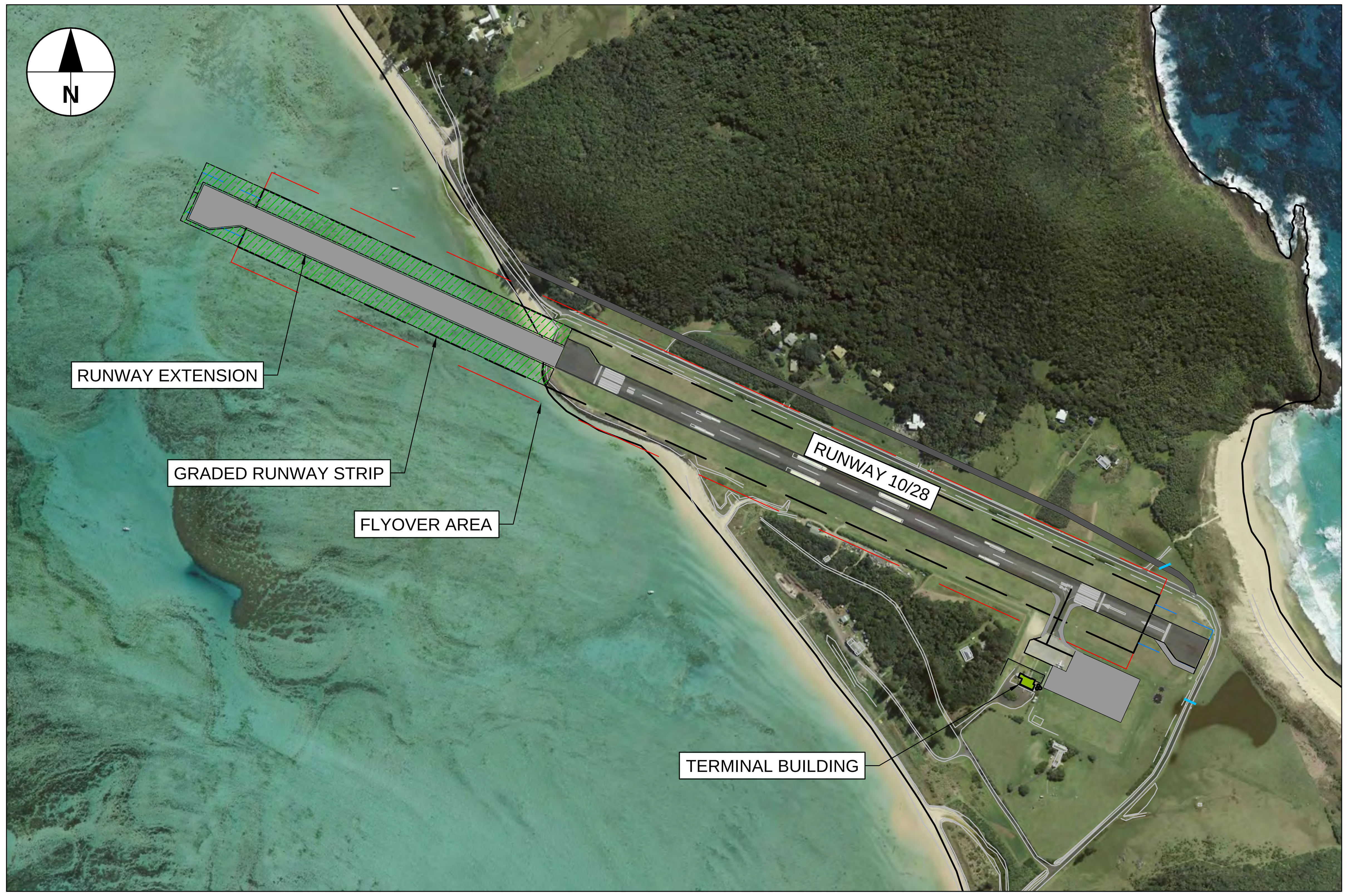
Concept Design Drawings

LORD HOWE ISLAND RUNWAY EXTENSION FEASIBILITY STUDY

AECOM

DRAWING LIST

60559990-SHT-01-CI-0001	COVER SHEET AND DRAWING INDEX
60559990-SHT-01-CI-1001	GENERAL ARRANGEMENT SITE PLAN
60559990-SHT-01-CI-1002	RUNWAY TURNING HEAD - AIRCRAFT TRACKING
60559990-SHT-01-CI-1003	APRON AND TAXIWAY - AIRCRAFT TRACKING
60559990-SHT-01-CI-1004	GENERAL AVIATION GRASS APRON LAYOUT
60559990-SHT-01-CI-1005	TERMINAL AND APRON - OLS SECTIONS
60559990-SHT-01-CI-1006	SECURITY FENCE ALIGNMENT PLAN
60559990-SHT-01-CI-2001	LAND RECLAMATION LAYOUT PLAN
60559990-SHT-01-CI-2002	LAND RECLAMATION LONG SECTION
60559990-SHT-01-CI-2003	LAND RECLAMATION DRAINAGE PLAN
60559990-SHT-01-CI-2004	LAND RECLAMATION TYPICAL SECTIONS
60559990-SHT-01-CI-3001	DECK ON PILES LAYOUT PLAN
60559990-SHT-01-CI-3002	DECK ON PILES LONG SECTION
60559990-SHT-01-CI-3003	DECK ON PILES DRAINAGE PLAN
60559990-SHT-01-CI-3004	DECK ON PILES DETAILED LAYOUT PLAN
60559990-SHT-01-CI-3005	DECK ON PILES DETAILED LAYOUT PLAN
60559990-SHT-01-CI-3006	DECK ON PILES STURCTURAL SECTIONS AND DETAILS
60559990-SHT-01-CI-4001	APRON DRAINAGE PLAN
60559990-SHT-01-CI-4002	DRAINAGE DETAILS
60559990-SHT-01-CI-5001	PAVEMENT LAYOUT PLAN AND DETAILS
60559990-SHT-01-CI-6001	LAYOUT AND DECLARED DISTANCES



SITE PLAN
1:5000

ISO A1 594mm x 841mm

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PROJECT
RUNWAY EXTENSION FEASIBILITY STUDY

CLIENT
LORD HOWE ISLAND BOARD

SCALE BAR
0 125 250 m
1:5000

KEY PLAN

PROJECT MANAGEMENT INITIALS

JM	RM	JM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM		SURVEY	

ISSUE/REVISION

I/R	DATE	DESCRIPTION
3	02.11.2018	UPDATED SECURITY REQ.
2	26.09.2018	FINAL ISSUE
1	15.08.2018	DRAFT ISSUE

PROJECT NUMBER
60559990

SHEET TITLE
COVER SHEET AND DRAWING INDEX

SHEET NUMBER
60559990-SHT-01-CI-0001

ISO A1 594mm x 841mm

LEGEND

- NEW AIRCRAFT PAVEMENT
- NEW ISLAND ROAD
- TERMINAL BUILDING
- EXISITNG ISLAND ROAD
- DECK ON PILES OR RECLAIMED LAND
- EXTENT OF RUNWAY STRIP
- EXTENT OF FLYOVER AREA
- NEW TRAFFIC LIGHTS OR PHYSICAL TRAFFIC BARRIER
- EXTENT OF RESA
- NEW 8ft AIRFIELD SECURITY FENCE ALIGNMENT

NOTES:

1. EXISTING PAINT MARKINGS ARE TO BE REMOVED.
2. NEW WHITE PAINT MARKINGS HAVE BEEN HATCHED BLACK FOR CONSPICUITY.
3. THE 8ft AIRFIELD SECURITY FENCE WILL BE CANTILEVERED HORIZONTALLY ALONG THE EDGE OF THE DECK FOR THE DECK ON PILES OPTION.
4. THE REALIGNED ISLAND ROAD WILL REQUIRE EXTENSIVE SHRUB CLEARING AND EARTHWORKS TO BE COMPLETED PRIOR TO CONSTRUCTION.
5. THE EXISTING SECURITY FENCE HAS BEEN REALIGNED TO REDUCE THE IMPACTS TO THE OLS. IF THE EXISTING FENCE IS REPLACED WITH A STANDARD 8FT SECURITY FENCE IT WILL RESULT IN SOME SECTIONS THAT IMPINGE THE OLS. THIS ASSESSMENT IS BASED ON LIDAR SURVEY AND THEREFORE THE FENCE ALIGNMENT AND POTENTIAL IMPACTS SHOULD BE REVIEWED AND MODIFIED FOLLOWING A DETAILED TOPOGRAPHICAL SURVEY.

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PROJECT
RUNWAY EXTENSION FEASIBILITY STUDY

CLIENT
LORD HOWE ISLAND BOARD

SCALE BAR
0 62.5 125 m
1:2500

KEY PLAN

PROJECT MANAGEMENT INITIALS

JM	RM	JM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM		SURVEY	

ISSUE/REVISION

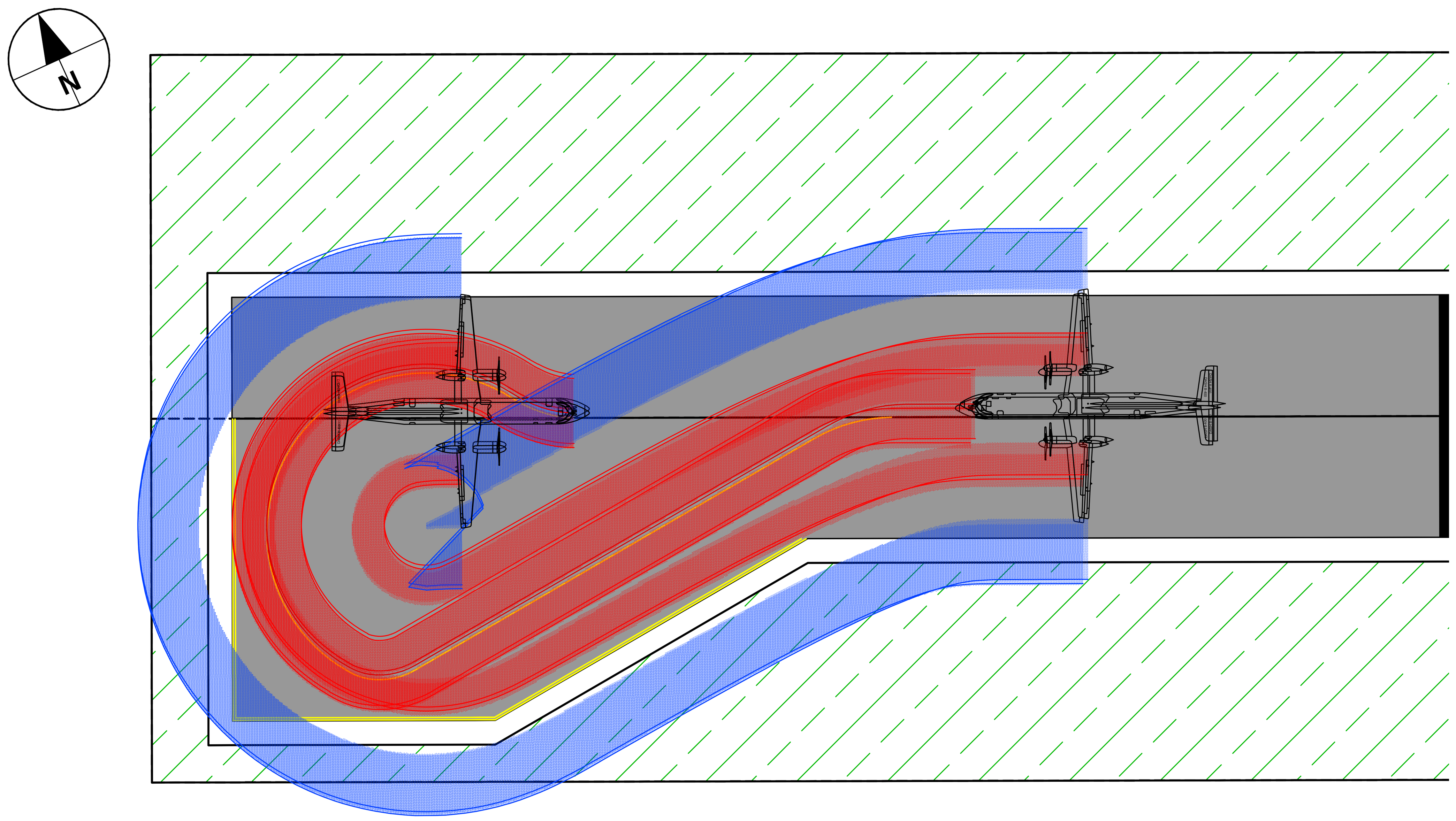
I/R	DATE	DESCRIPTION
3	02.11.2018	UPDATED SECURITY REQ.
2	26.09.2018	FINAL ISSUE
1	15.08.2018	DRAFT ISSUE

PROJECT NUMBER
60559990

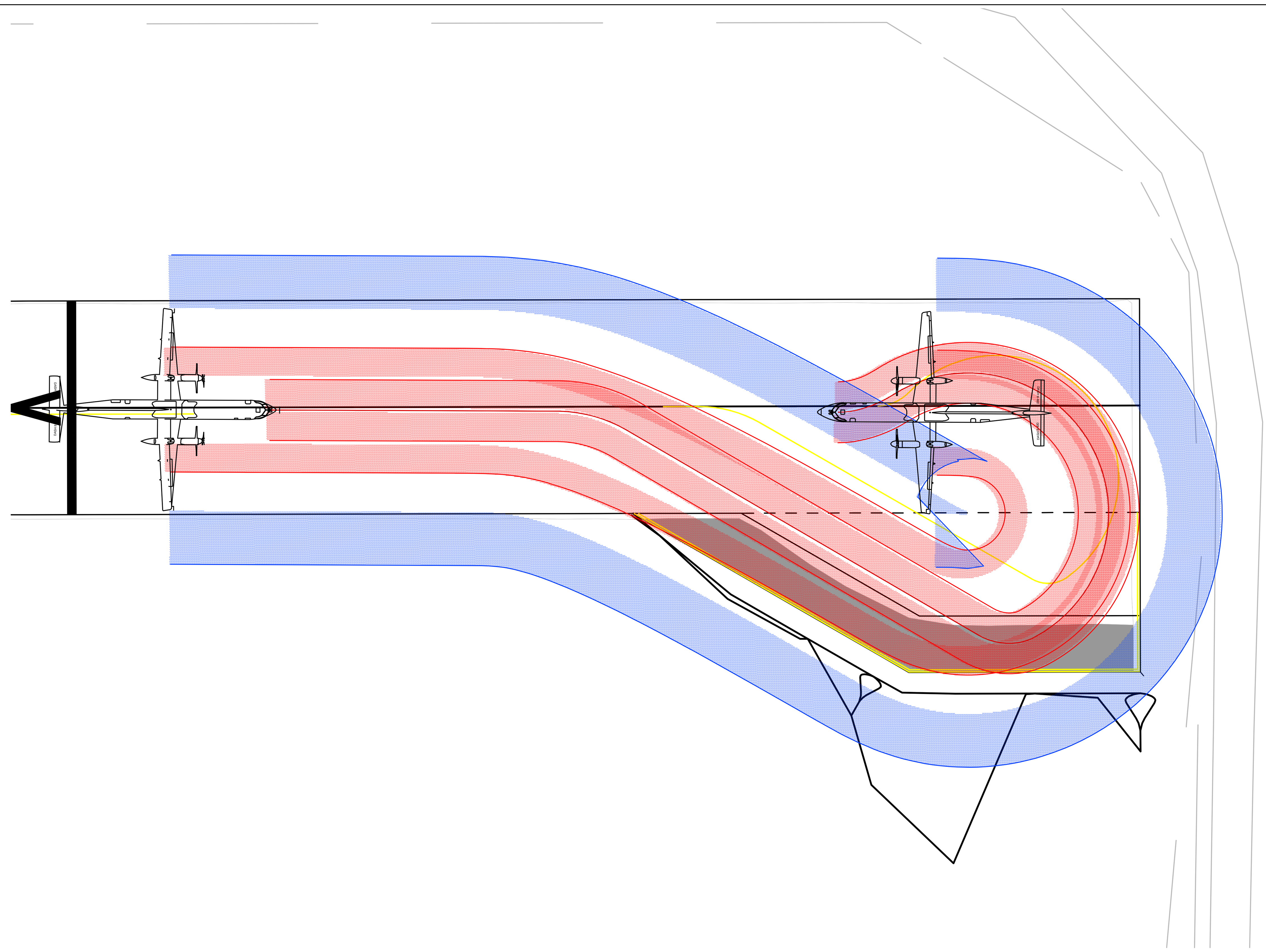
SHEET TITLE
GENERAL ARRANGEMENT SITE PLAN

SHEET NUMBER
60559990-SHT-01-CI-1001

ISO A1 594mm x 841mm



TURNING HEAD - WESTERN END
Scale 1:500



TURNING HEAD - EASTERN END
Scale 1:500

LEGEND

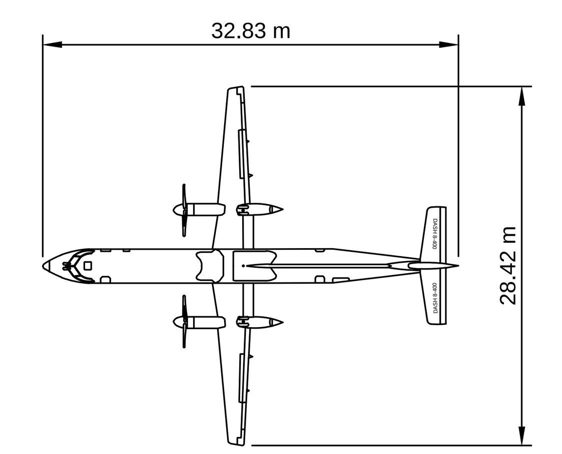
- NEW AIRCRAFT PAVEMENT
- TERMINAL BUILDING
- 4m WHEEL CLEARANCE
- 4.5m WINGTIP CLEARANCE
- DECK ON PILES OR RECLAIMED LAND

NOTES

1. AIRCRAFT HAVE BEEN TRACKED USING BOTH THE "PILOTS EYE" METHOD AND "NOSE WHEEL GEAR" METHOD.

AIRCRAFT CHARACTERISTICS

MANUFACTURER	BOMBARDIER
MODEL	DASH8-400
ICAO CODE LETTER	C
WINGSPAN	28.42 m
LENGTH	32.83 m
TAIL HEIGHT	8.38 m
DESIGN SPEED	5 km/hr
DESIGN NOSE GEAR ANGLE %	80



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PROJECT
RUNWAY EXTENSION FEASIBILITY STUDY

CLIENT
LORD HOWE ISLAND BOARD

SCALE BAR
0 12.5 25 m
1:500

KEY PLAN

PROJECT MANAGEMENT INITIALS

JC	RM	JM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM		SURVEY	

ISSUE/REVISION

I/R	DATE	DESCRIPTION
02	26.09.2018	FINAL ISSUE
01	15.08.2018	DRAFT ISSUE

PROJECT NUMBER
60559990

SHEET TITLE
RUNWAY TURNING HEAD AIRCRAFT TRACKING

SHEET NUMBER
60559990-SHT-01-CI-1002

LEGEND

- NEW AIRCRAFT PAVEMENT
- TERMINAL BUILDING
- 4m WHEEL CLEARANCE
- 4.5m WINGTIP CLEARANCE
- EXTENT OF RUNWAY STRIP
- EXTENT OF FLYOVER AREA
- EXTENT OF RESA

NOTES

1. AIRCRAFT HAVE BEEN TRACKED USING BOTH THE "PILOTS EYE" METHOD AND "NOSE WHEEL GEAR" METHOD.

AIRCRAFT CHARACTERISTICS	
MANUFACTURER	BOMBARDIER
MODEL	DASH8-400
ICAO CODE LETTER	C
WINGSPAN	28.42 m
LENGTH	32.83 m
TAIL HEIGHT	8.38 m
DESIGN SPEED	5 km/hr
DESIGN NOSE GEAR ANGLE %	80

ISO A1 594mm x 841mm

Last saved by: KCA(2018-09-19) Last Plotted: 2018-09-19
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PROJECT

RUNWAY EXTENSION FEASIBILITY STUDY

CLIENT

LORD HOWE ISLAND BOARD

SCALE BAR

0 12.5 25 m
1:500

KEY PLAN

PROJECT MANAGEMENT INITIALS

RS	RM	JM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM		SURVEY	

ISSUE/REVISION

I/R	DATE	DESCRIPTION
02	26.09.2018	FINAL ISSUE
01	15.08.2018	DRAFT ISSUE

PROJECT NUMBER

60559990

SHEET TITLE

APRON AND TAXIWAY AIRCRAFT TRACKING

SHEET NUMBER

60559990-SHT-01-CI-1003

LEGEND

- NEW AIRCRAFT PAVEMENT
- TERMINAL BUILDING
- 3m CODE A AIRCRAFT CLEARANCE
- GRASS GA AIRCRAFT STAND (CODE A)
- EXTENT OF RUNWAY STRIP
- EXTENT OF FLYOVER AREA
- EXTENT OF CODE A GRASS TAXILANE
- EXTENT OF CODE A TAXILANE CLEARANCE (12m FROM CENTERLINE)

NOTES:

1. THE GENERAL AVIATION (GA) GRASS APRON LAYOUT HAS BEEN SIZED FOR CODE A AIRCRAFT ONLY.
2. THE GRASS GA AIRCRAFT STANDS HAVE BEEN SIZED BASED ON THE LARGEST CODE A AIRCRAFT WHICH OPERATES ON LORD HOWE ISLAND, THE BN2B ISLANDER.
3. BOTH THE RPT APRON AND GA GRASS APRON HAVE BEEN SIGNED BASED ON ONLY 1 AIRCRAFT MANOEUVRING AT A TIME.

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PROJECT

RUNWAY EXTENSION FEASIBILITY STUDY

CLIENT

LORD HOWE ISLAND BOARD

SCALE BAR

0 12.5 25 m
1:500

KEY PLAN

PROJECT MANAGEMENT INITIALS

JC	RM	JM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM		SURVEY	

ISSUE/REVISION

I/R	DATE	DESCRIPTION
02	26.09.2018	FINAL ISSUE
01	15.08.2018	DRAFT ISSUE

PROJECT NUMBER

60559990

SHEET TITLE

GENERAL AVIATION GRASS APRON LAYOUT

SHEET NUMBER

60559990-SHT-01-CI-1004

ISO A1 594mm x 841mm

Last saved by: KCA(2018-09-19) Last Plotted: 2018-09-19
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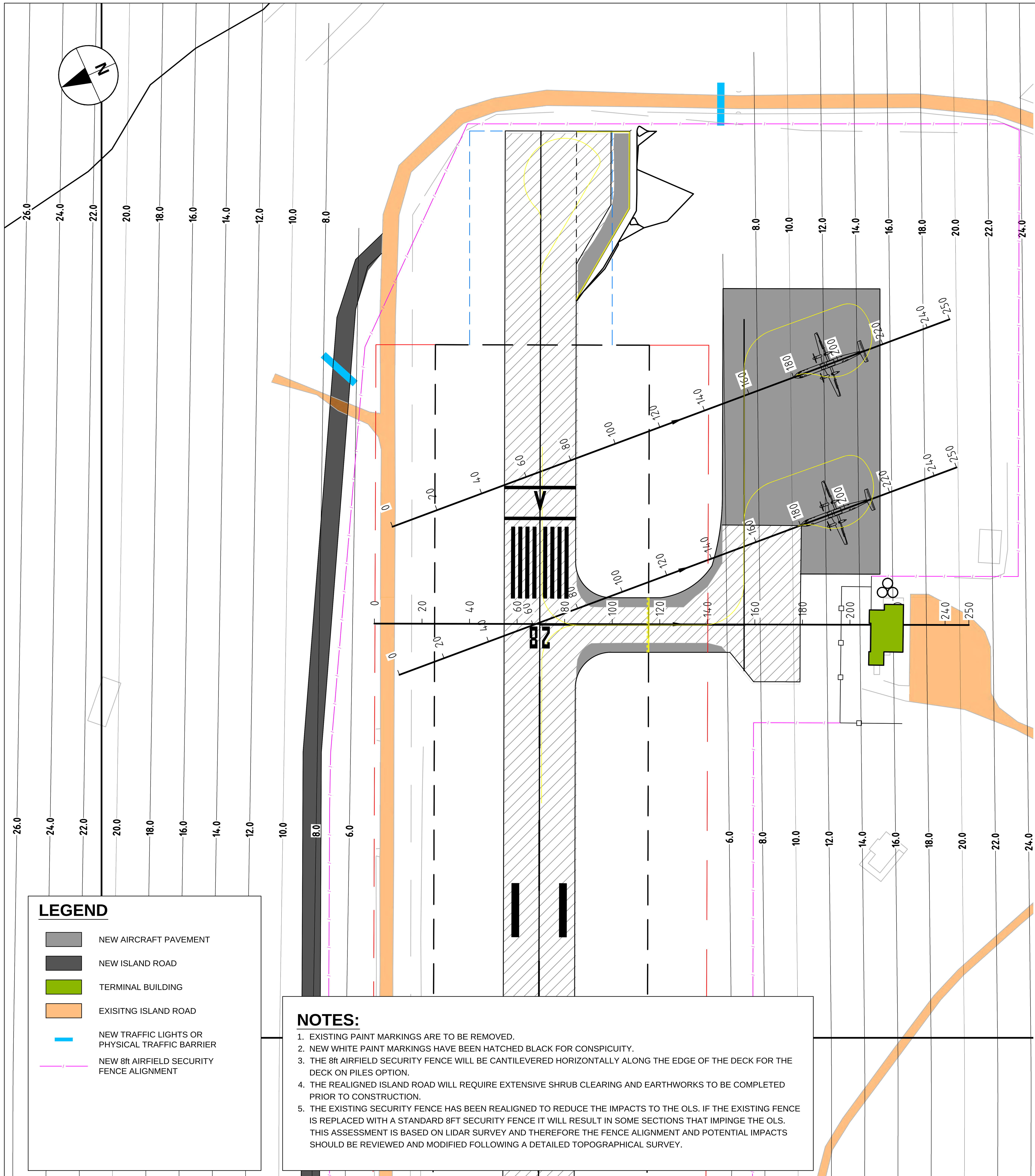

LEGEND

- NEW AIRCRAFT PAVEMENT
- NEW ISLAND ROAD
- TERMINAL BUILDING
- EXISITNG ISLAND ROAD
- NEW TRAFFIC LIGHTS OR PHYSICAL TRAFFIC BARRIER
- NEW 8ft AIRFIELD SECURITY FENCE ALIGNMENT

NOTES:

1. EXISTING PAINT MARKINGS ARE TO BE REMOVED.
2. NEW WHITE PAINT MARKINGS HAVE BEEN HATCHED BLACK FOR CONSPICUITY.
3. THE 8ft AIRFIELD SECURITY FENCE WILL BE CANTILEVERED HORIZONTALLY ALONG THE EDGE OF THE DECK FOR THE DECK ON PILES OPTION.
4. THE REALIGNED ISLAND ROAD WILL REQUIRE EXTENSIVE SHRUB CLEARING AND EARTHWORKS TO BE COMPLETED PRIOR TO CONSTRUCTION.
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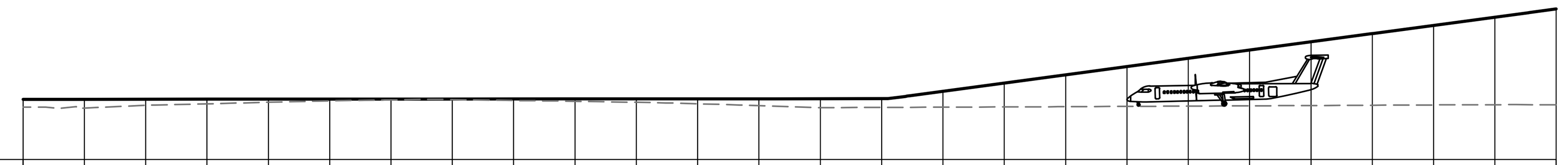
VERT EXAG 1:1
Datum -5.000



OLS	4.840	4.847	4.853	4.860	4.867	4.874	4.880	4.887	4.894	4.901	4.907	4.914	4.921	4.928	6.135	7.481	8.827	10.172	11.518	12.864	14.209	15.555	16.900	18.246	19.592
GROUND LEVEL	3.415	3.842	4.096	4.348	4.585	4.739	4.785	4.643	4.510	4.334	4.102	3.801	3.473	3.512	3.551	3.589	3.626	3.673	3.720	3.767	3.814	3.861	3.908	3.950	3.921
DEPTH	1.425	1.004	0.757	0.512	0.282	0.135	0.096	0.244	0.384	0.567	0.806	1.113	1.448	1.416	2.585	3.892	5.201	6.499	7.798	9.096	10.395	11.693	12.992	14.296	15.671
CHAINAGE	10.000	20.000	30.000	40.000	50.000	60.000	70.000	80.000	90.000	100.000	110.000	120.000	130.000	140.000	150.000	160.000	170.000	180.000	190.000	200.000	210.000	220.000	230.000	240.000	250.000

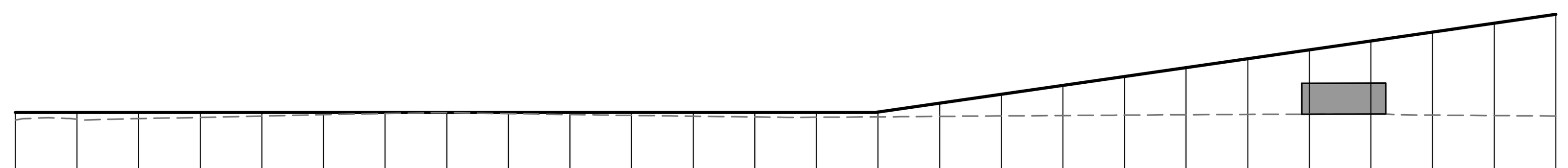
APRON POS. 2 ALIGNMENT LONG SECTION

VERT EXAG 1:1
Datum -5.000

OLS	4.720	4.727	4.734	4.741	4.747	4.754	4.761	4.768	4.774	4.781	4.788	4.795	4.801	5.109	6.455	7.801	9.146	10.492	11.838	13.183	14.529	15.874	17.220	18.566	19.911
GROUND LEVEL	3.730	3.932	4.107	4.312	4.514	4.665	4.614	4.473	4.352	4.218	4.087	3.962	3.895	3.896	3.913	3.959	4.005	4.065	4.087	4.108	4.129	4.150	4.171	4.192	4.180
DEPTH	0.991	0.795	0.627	0.429	0.234	0.089	0.147	0.294	0.422	0.563	0.701	0.832	0.906	1.214	2.542	3.842	5.142	6.427	7.751	9.075	10.400	11.725	13.049	14.374	15.731
CHAINAGE	10.000	20.000	30.000	40.000	50.000	60.000	70.000	80.000	90.000	100.000	110.000	120.000	130.000	140.000	150.000	160.000	170.000	180.000	190.000	200.000	210.000	220.000	230.000	240.000	250.000

APRON POS. 1 ALIGNMENT LONG SECTION

VERT EXAG 1:1
Datum -5.000



OLS	4.755	4.755	4.755	4.755	4.755	4.755	4.755	4.755	4.755	4.755	4.755	4.755	4.755	4.820	6.250	7.680	9.110	10.540	11.970	13.400	14.830	16.260	17.690	19.120	20.550
GROUND LEVEL	3.638	3.743	3.936	4.154	4.371	4.562	4.705	4.547	4.395	4.260	4.138	4.013	3.971	4.007	4.104	4.171	4.238	4.315	4.365	4.429	4.478	4.503	4.306	4.236	4.169
DEPTH	1.117	1.012	0.819	0.601	0.384	0.193	0.050	0.208	0.360	0.495	0.617	0.742	0.784	0.813	2.146	3.509	4.871	6.225	7.605	8.971	10.352	11.757	13.384	14.884	16.381
CHAINAGE	10.000	20.000	30.000	40.000	50.000	60.000	70.000	80.000	90.000	100.000	110.000	120.000	130.000	140.000	150.000	160.000	170.000	180.000	190.000	200.000	210.000	220.000	230.000	240.000	250.000

TAXIWAY ALIGNMENT LONG SECTION

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PROJECT
RUNWAY EXTENSION FEASIBILITY STUDY

CLIENT
LORD HOWE ISLAND BOARD

SCALE BAR
0 25 50 m
1:1000

KEY PLAN

PROJECT MANAGEMENT INITIALS

JC	RM	JM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM		SURVEY	

ISSUE/REVISION

I/R	DATE	DESCRIPTION
3	02.11.2018	UPDATED SECURITY REQ.
2	26.09.2018	FINAL ISSUE
1	14.09.2018	DRAFT ISSUE

PROJECT NUMBER
60559990

SHEET TITLE
TERMINAL AND APRON OLS SECTIONS

SHEET NUMBER
60559990-SHT-01-CI-1005

LEGEND

- NEW AIRCRAFT PAVEMENT
- NEW ISLAND ROAD
- TERMINAL BUILDING
- EXISITNG ISLAND ROAD
- NEW TRAFFIC LIGHTS OR PHYSICAL TRAFFIC BARRIER
- NEW 8ft AIRFIELD SECURITY FENCE ALIGNMENT

NOTES:

1. EXISTING PAINT MARKINGS ARE TO BE REMOVED.
2. NEW WHITE PAINT MARKINGS HAVE BEEN HATCHED BLACK FOR CONSPICUITY.
3. THE 8ft AIRFIELD SECURITY FENCE WILL BE CANTILEVERED HORIZONTALLY ALONG THE EDGE OF THE DECK FOR THE DECK ON PILES OPTION.
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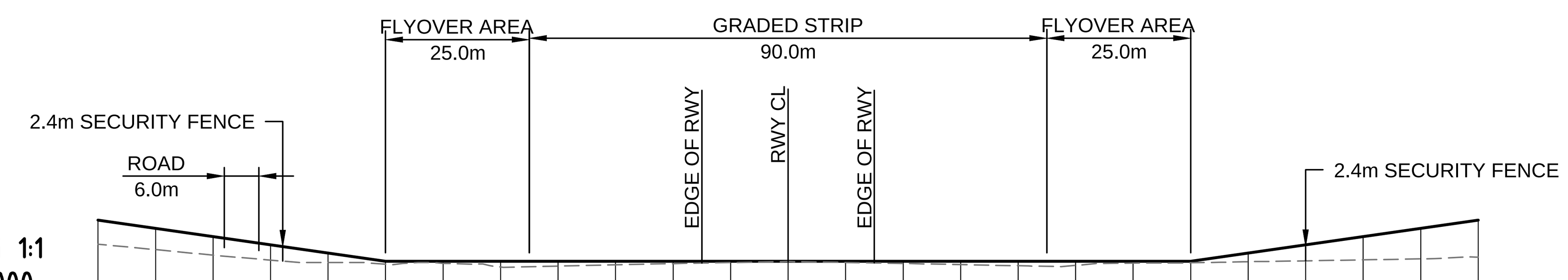

VERT EXAG 1:1
Datum -5.000

OLS	10.114	8.684	7.254	5.824	4.394	4.394	4.394	4.394	4.394	4.394	4.394	4.394
GROUND LEVEL	6.425	5.466	4.612	4.186	3.875	4.035	3.414	3.559	3.779	4.000	4.182	4.339
DEPTH	3.688	3.218	2.642	1.637	0.518	0.359	0.980	0.835	0.614	0.394	0.212	0.055
CHAINAGE	10.000	20.000	30.000	40.000	50.000	60.000	70.000	80.000	90.000	100.000	110.000	120.000

OLS	4.394	4.394	4.394	4.394	4.394	4.394	4.394	5.824	7.254	8.684	10.114	11.544
GROUND LEVEL	4.199	4.027	3.823	3.618	3.680	4.083	4.143	4.320	4.486	4.651	4.816	5.125
DEPTH	0.194	0.366	0.571	0.776	0.714	0.311	0.251	1.503	2.768	4.033	5.297	6.419
CHAINAGE	130.000	140.000	150.000	160.000	170.000	180.000	190.000	200.000	210.000	220.000	230.000	240.000

CL-RUNWAY CS LONG SECTION

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PROJECT
RUNWAY EXTENSION FEASIBILITY STUDY

CLIENT
LORD HOWE ISLAND BOARD

SCALE BAR
0 25 50 m
1:1000

KEY PLAN

PROJECT MANAGEMENT INITIALS

JC	RM	JM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM		SURVEY	

ISSUE/REVISION

I/R	DATE	DESCRIPTION
1	02.11.2018	UPDATED SECURITY REQ.

PROJECT NUMBER
60559990

SHEET TITLE
SECURITY FENCE ALIGNMENT PLAN

SHEET NUMBER
60559990-SHT-01-CI-1006

ISO A1 594mm x 841mm

LEGEND

- SEAWALL - TYPE 1
- SEAWALL - TYPE 2
- TRIP STRUCTURE
- EXTENT OF RUNWAY STRIP
- EXTENT OF FLYOVER AREA
- DESIGN CONTOURS
- EXISTING CONTOURS

NOTES

1. FOR SEAWALL DETAILS REFER TO DRAWING 60559990-SHT-01-5002.

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PROJECT

RUNWAY EXTENSION FEASIBILITY STUDY

CLIENT

LORD HOWE ISLAND BOARD

SCALE BAR

0 25 50 m
1:1000

KEY PLAN

PROJECT MANAGEMENT INITIALS

KP	SB	JM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM		SURVEY	

ISSUE/REVISION

I/R	DATE	DESCRIPTION
02	26.09.2018	FINAL ISSUE
01	15.08.2018	DRAFT ISSUE

PROJECT NUMBER

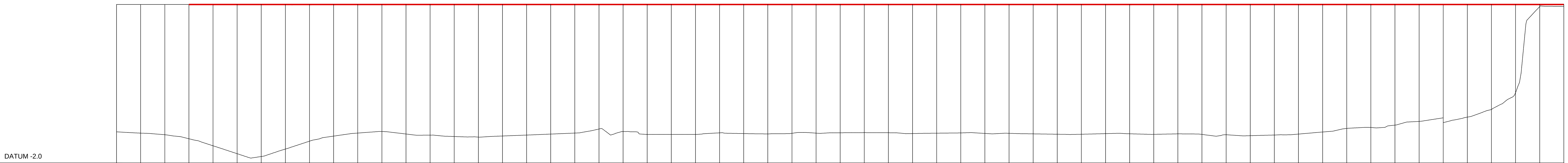
60559990

SHEET TITLE

LAND RECLAMATION LAYOUT PLAN

SHEET NUMBER

60559990-SHT-01-CI-2001



VERTICAL GEOMETRY	P=0.0% L=719.1
HORIZONTAL GEOMETRY	D=1905.9

CHAINAGE	DESIGN LEVELS	EXISTING LEVELS
-600.000	4.590	-0.694
-590.000	4.590	-0.748
-580.000	4.590	-0.814
-570.000	4.590	-0.981
-560.000	4.590	-1.272
-550.000	4.590	-1.601
-540.000	4.590	-1.718
-530.000	4.590	-1.409
-520.000	4.590	-1.081
-510.000	4.590	-0.871
-500.000	4.590	-0.745
-490.000	4.590	-0.680
-480.000	4.590	-0.784
-470.000	4.590	-0.830
-460.000	4.590	-0.888
-450.000	4.590	-0.912
-440.000	4.590	-0.867
-430.000	4.590	-0.828
-420.000	4.590	-0.787
-410.000	4.590	-0.745
-400.000	4.590	-0.576
-390.000	4.590	-0.684
-380.000	4.590	-0.803
-370.000	4.590	-0.803
-360.000	4.590	-0.803
-350.000	4.590	-0.736
-340.000	4.590	-0.766
-330.000	4.590	-0.780
-320.000	4.590	-0.755
-310.000	4.590	-0.747
-300.000	4.590	-0.732
-290.000	4.590	-0.727
-280.000	4.590	-0.731
-270.000	4.590	-0.765
-260.000	4.590	-0.750
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-240.000	4.590	-0.760
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-180.000	4.590	-0.774
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-160.000	4.590	-0.777
-150.000	4.590	-0.801
-140.000	4.590	-0.814
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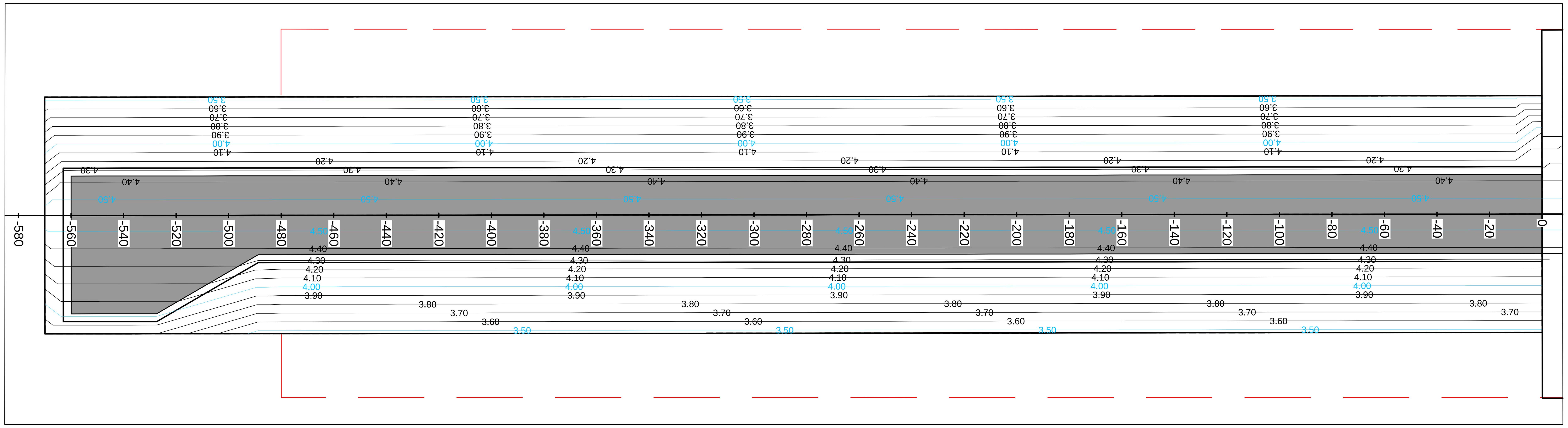
-100.000	4.590	-0.701
-90.000	4.590	-0.553
-80.000	4.590	-0.513
-70.000	4.590	-0.414
-60.000	4.590	-0.261
-50.000	4.590	-0.112 -0.311
-40.000	4.590	-0.084
-30.000	4.590	0.232
-20.000	4.590	0.936
-10.000	4.590	4.506
0.000	4.590	4.508

RUNWAY 10/28 CENTRELINE PROFILE - OPTION 2

A1 HORIZONTAL SCALE 1:1000
A1 VERTICAL SCALE 1:100



LEGEND

- NEW AIRCRAFT PAVEMENT
- EXTENT OF FLYOVER AREA
- MAJOR (1m) CONTOURS
- MINOR (0.1m) CONTOURS

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PROJECT

RUNWAY EXTENSION FEASIBILITY STUDY

CLIENT

LORD HOWE ISLAND BOARD

SCALE BAR

0 25 50 m
0 2.5 5
H=1:1000
V=1:100

KEY PLAN

PROJECT MANAGEMENT INITIALS

PM	RM	JM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM		SURVEY	

ISSUE/REVISION

I/R	DATE	DESCRIPTION
02	26.09.2018	FINAL ISSUE
01	15.08.2018	DRAFT ISSUE

PROJECT NUMBER

60559990

SHEET TITLE

LAND RECLAMATION LONG SECTION

SHEET NUMBER

60559990-SHT-01-CI-2002

ISO A1 594mm x 841mm

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PROJECT

RUNWAY EXTENSION FEASIBILITY STUDY

CLIENT

LORD HOWE ISLAND BOARD

SCALE BAR

0 25 50 m
1:1000

KEY PLAN

PROJECT MANAGEMENT INITIALS

JC	RM	JM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM		SURVEY	

ISSUE/REVISION

I/R	DATE	DESCRIPTION
02	26.09.2018	FINAL ISSUE
01	15.08.2018	DRAFT ISSUE

PROJECT NUMBER

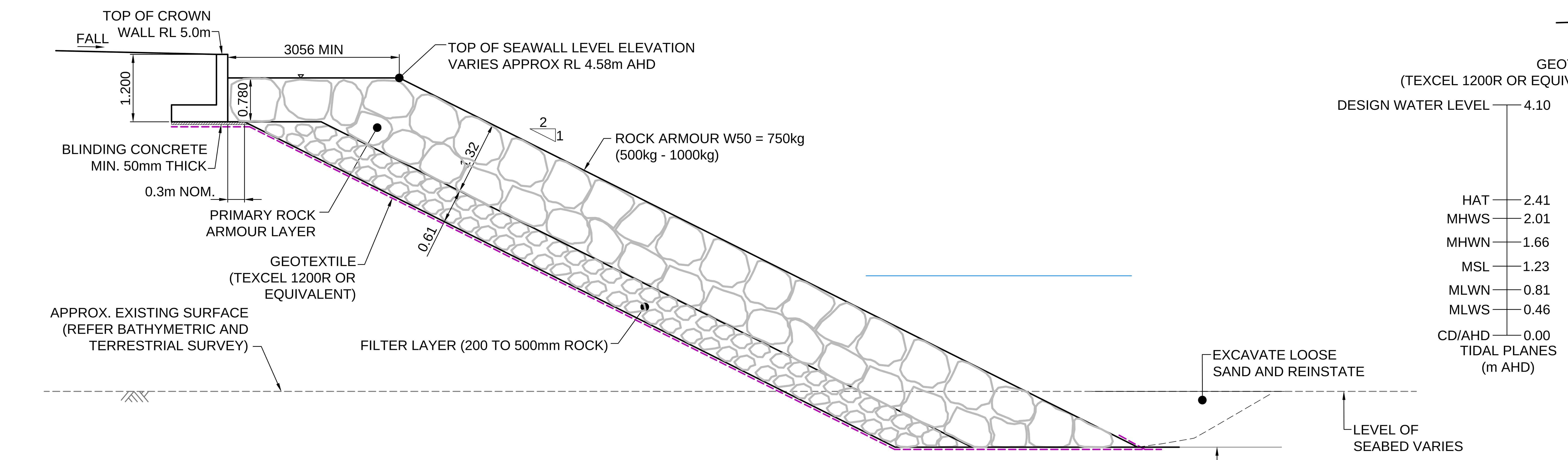
60559990

SHEET TITLE

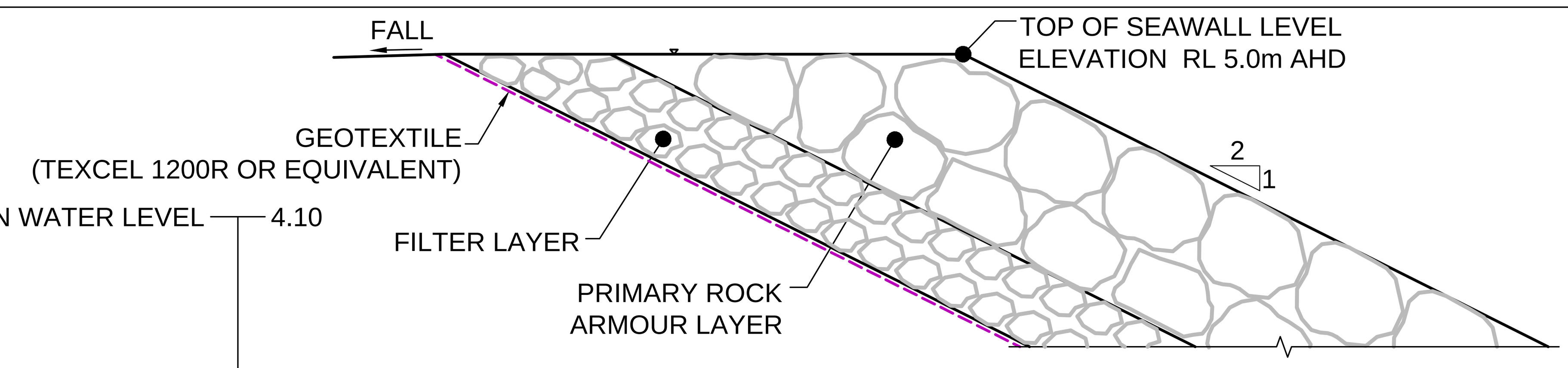
LAND RECLAMATION DRAINAGE PLAN

SHEET NUMBER

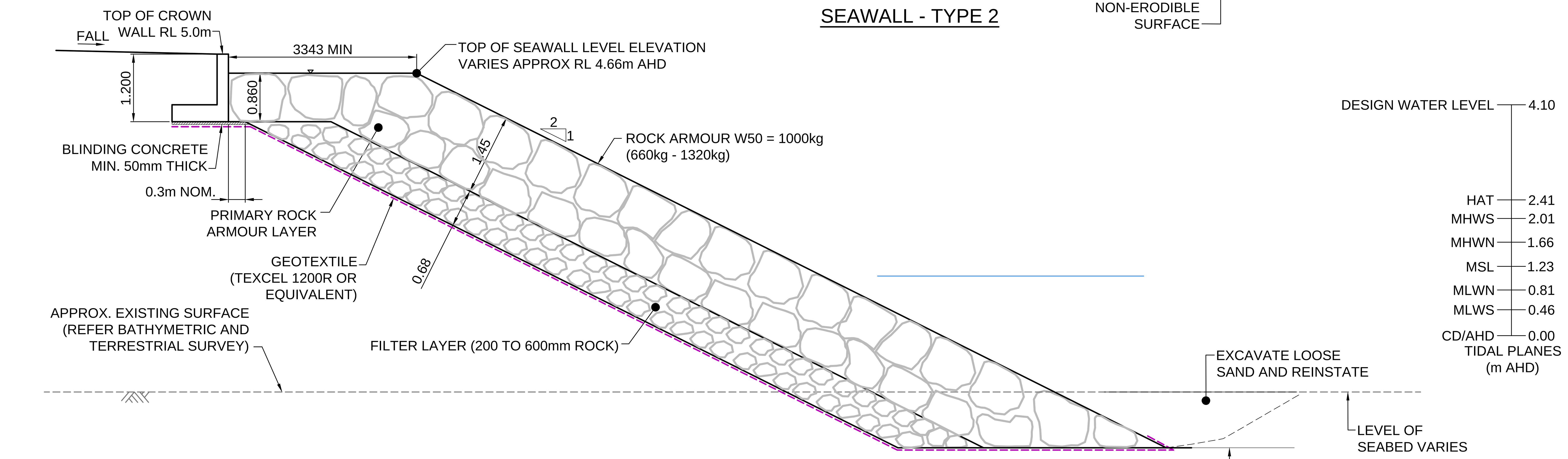
60559990-SHT-01-CI-2003



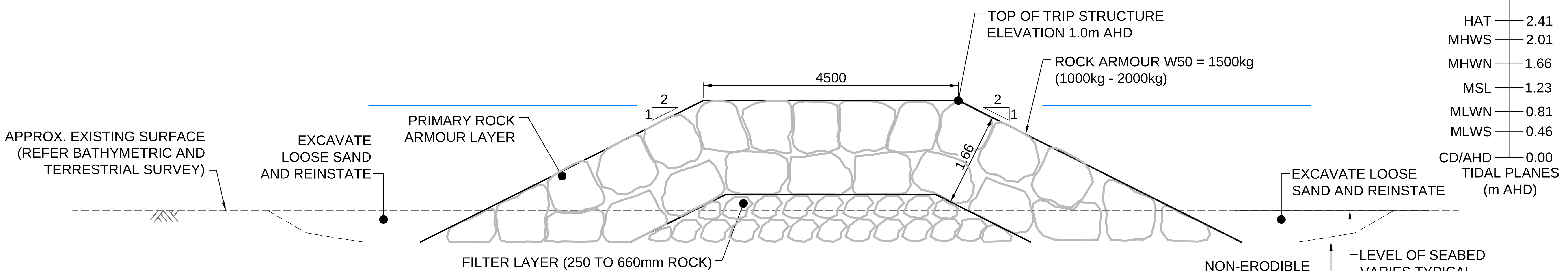
SEAWALL - TYPE 2



ALTERNATIVE SEAWALL CREST TREATMENT (NON-PREFERRED)



SEAWALL - TYPE 1



TRIP STRUCTURE

NOTES:

PRIMARY ARMOUR SHALL BE ROUGH ANGULAR DURABLE ROCK WITH A UNIFORM GRADE BETWEEN LIMITS PROVIDED WITH A MAXIMUM DIMENSION NOT MORE THAN 3x THE MINIMUM DIMENSION FOR ANY SINGLE ROCK.

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PROJECT

RUNWAY EXTENSION FEASIBILITY STUDY

CLIENT

LORD HOWE ISLAND BOARD

SCALE BAR

0 1.25 2.5 m
1:50

KEY PLAN

REGISTRATION

PROJECT MANAGEMENT INITIALS

KP	SB	JM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM		SURVEY	

ISSUE/REVISION

I/R	DATE	DESCRIPTION
02	26.09.2018	FINAL ISSUE
01	15.08.2018	DRAFT ISSUE

PROJECT NUMBER

60559990

SHEET TITLE

LAND RECLAMATION TYPICAL SECTIONS

SHEET NUMBER

60559990-SHT-01-CI-2004

ISO A1 594mm x 841mm

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PROJECT

RUNWAY EXTENSION FEASIBILITY STUDY

CLIENT

LORD HOWE ISLAND BOARD

SCALE BAR

0 25 50 m
1:1000

KEY PLAN

PROJECT MANAGEMENT INITIALS

VW	PF	JM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM		SURVEY	

ISSUE/REVISION

I/R	DATE	DESCRIPTION
02	26.09.2018	FINAL ISSUE
01	15.08.2018	DRAFT ISSUE

PROJECT NUMBER

60559990

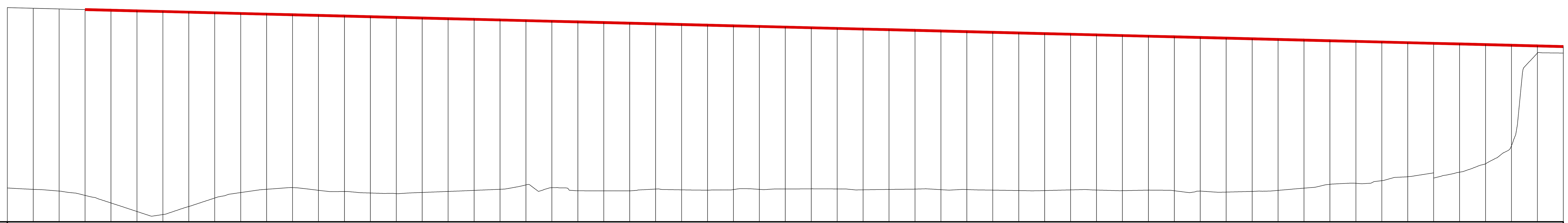
SHEET TITLE

DECK ON PILES LAYOUT PLAN

SHEET NUMBER

60559990-SHT-01-CI-3001

ISO A1 594mm x 841mm



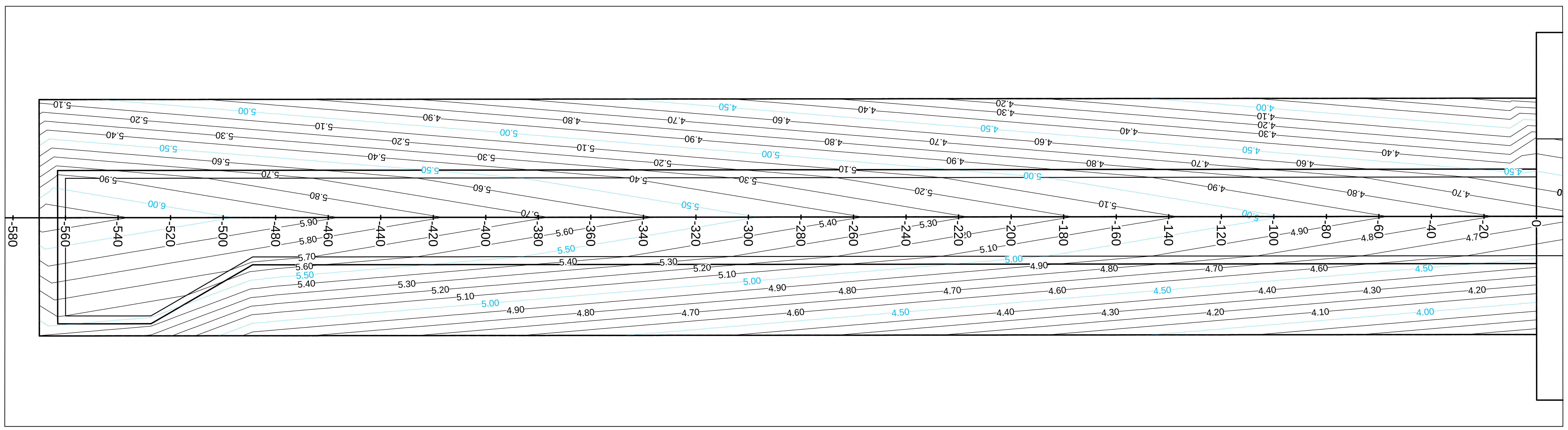
CHAINAGE	DESIGN LEVELS	EXISTING LEVELS
-600.000	6.260	-0.694
-590.000	6.235	-0.748
-580.000	6.210	-0.814
-570.000	6.185	-0.981
-560.000	6.160	-1.272
-550.000	6.135	-1.601
-540.000	6.110	-1.718
-530.000	6.085	-1.409
-520.000	6.059	-1.081
-510.000	6.034	-0.871
-500.000	6.009	-0.745
-490.000	5.984	-0.680
-480.000	5.959	-0.784
-470.000	5.934	-0.830
-460.000	5.909	-0.888
-450.000	5.884	-0.912
-440.000	5.859	-0.867
-430.000	5.834	-0.828
-420.000	5.809	-0.787
-410.000	5.784	-0.745
-400.000	5.759	-0.576
-390.000	5.734	-0.684
-380.000	5.709	-0.803
-370.000	5.684	-0.803
-360.000	5.659	-0.803
-350.000	5.634	-0.736
-340.000	5.609	-0.766
-330.000	5.584	-0.780
-320.000	5.559	-0.755
-310.000	5.534	-0.747
-300.000	5.509	-0.732
-290.000	5.484	-0.727
-280.000	5.459	-0.731
-270.000	5.434	-0.765
-260.000	5.409	-0.750
-250.000	5.384	-0.738
-240.000	5.359	-0.760
-230.000	5.334	-0.755
-220.000	5.309	-0.778
-210.000	5.284	-0.794
-200.000	5.259	-0.794
-190.000	5.234	-0.768
-180.000	5.208	-0.774
-170.000	5.183	-0.798
-160.000	5.158	-0.777
-150.000	5.133	-0.801
-140.000	5.108	-0.814
-130.000	5.083	-0.853
-120.000	5.058	-0.826
-110.000	5.033	-0.787
-100.000	5.008	-0.701
-90.000	4.983	-0.553
-80.000	4.958	-0.513
-70.000	4.933	-0.414
-60.000	4.908	-0.261
-50.000	4.883	-0.112 -0.311
-40.000	4.858	-0.084
-30.000	4.833	0.232
-20.000	4.808	0.936
-10.000	4.783	4.506
0.000	4.758	4.508

VERTICAL GEOMETRY: P=-0.3% L=828.2

HORIZONTAL GEOMETRY: D=1905.9

RUNWAY 10/28 CENTRELINE PROFILE - OPTION 1

A1 HORIZONTAL SCALE 1:1000
A1 VERTICAL SCALE 1:100



LEGEND

MAJOR (1m) CONTOURS
MINOR (0.1m) CONTOURS

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www.aecom.com

PROJECT
RUNWAY EXTENSION FEASIBILITY STUDY

CLIENT
LORD HOWE ISLAND BOARD

SCALE BAR
0 25 50 m H=1:1000
0 2.5 5 V=1:100

KEY PLAN

PROJECT MANAGEMENT INITIALS

PM	RM	JM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM		SURVEY	

ISSUE/REVISION

I/R	DATE	DESCRIPTION
02	26.09.2018	FINAL ISSUE
01	15.08.2018	DRAFT ISSUE

PROJECT NUMBER
60559990

SHEET TITLE
DECK ON PILES LONG SECTION

SHEET NUMBER
60559990-SHT-01-CI-3002

AECOM

CONSULTANT

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PROJECT

RUNWAY EXTENSION FEASIBILITY STUDY

CLIENT

LORD HOWE ISLAND BOARD

SCALE BAR

0 25 50 m
1:1000

KEY PLAN

PROJECT MANAGEMENT INITIALS

JC	RM	JM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM		SURVEY	

ISSUE/REVISION

I/R	DATE	DESCRIPTION
02	26.09.2018	FINAL ISSUE
01	15.08.2018	DRAFT ISSUE

PROJECT NUMBER

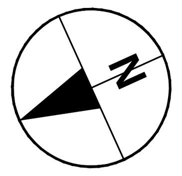
60559990

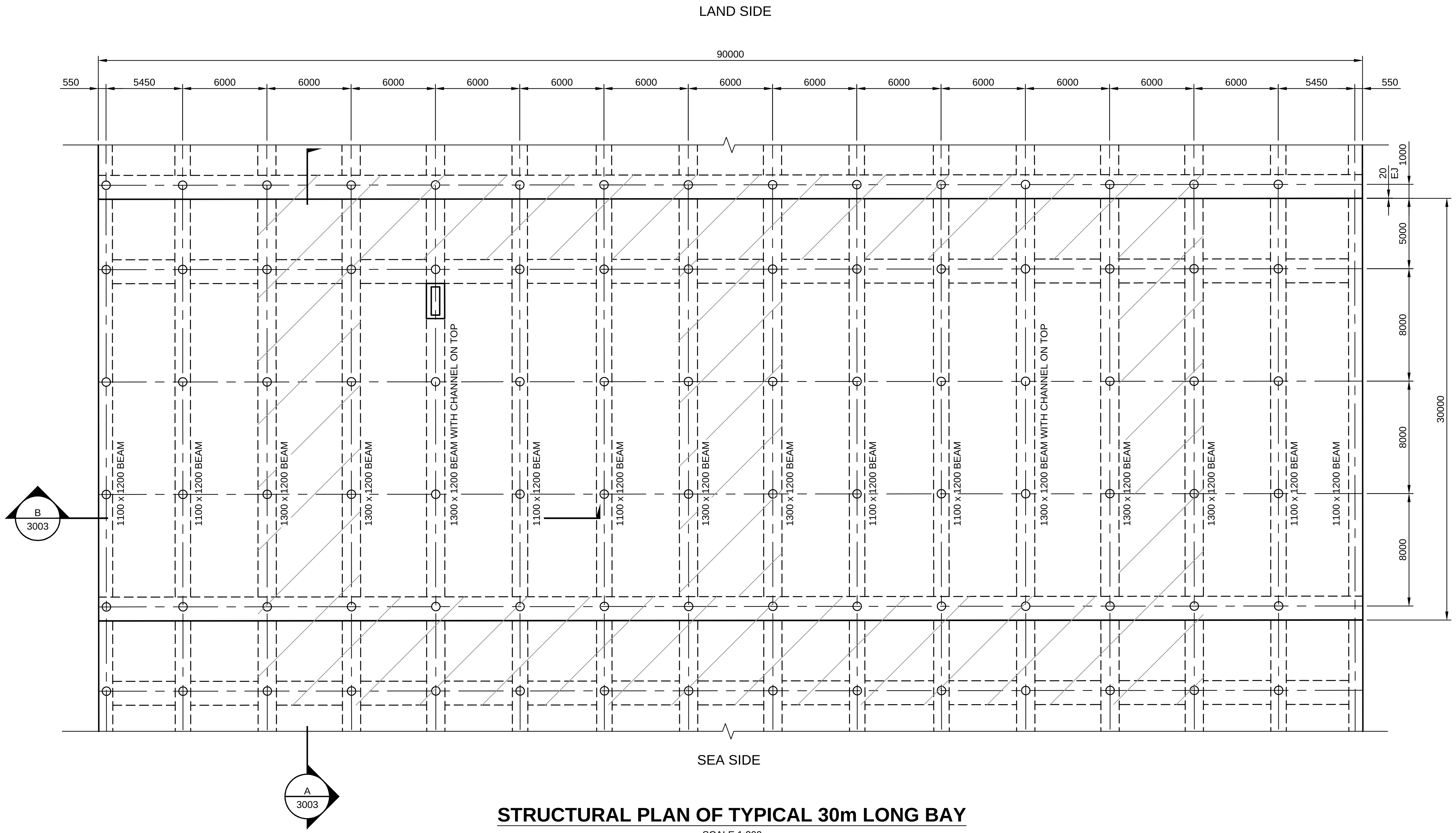
SHEET TITLE

DECK ON PILES DRAINAGE PLAN

SHEET NUMBER

60559990-SHT-01-CI-3003





STRUCTURAL PLAN OF TYPICAL 30m LONG BAY

SCALE 1:200

LEGEND

BAYS (SHADED AREA) DESIGNED FOR ACCESS CRAWLER CRANE

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PROJECT

RUNWAY EXTENSION FEASIBILITY STUDY

CLIENT

LORD HOWE ISLAND BOARD

SCALE BAR

0 5 10 m
1:200

KEY PLAN

PROJECT MANAGEMENT INITIALS

VW	PF	JM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM		SURVEY	

ISSUE/REVISION

I/R	DATE	DESCRIPTION
02	26.09.2018	FINAL ISSUE
01	15.08.2018	DRAFT ISSUE

PROJECT NUMBER

60559990

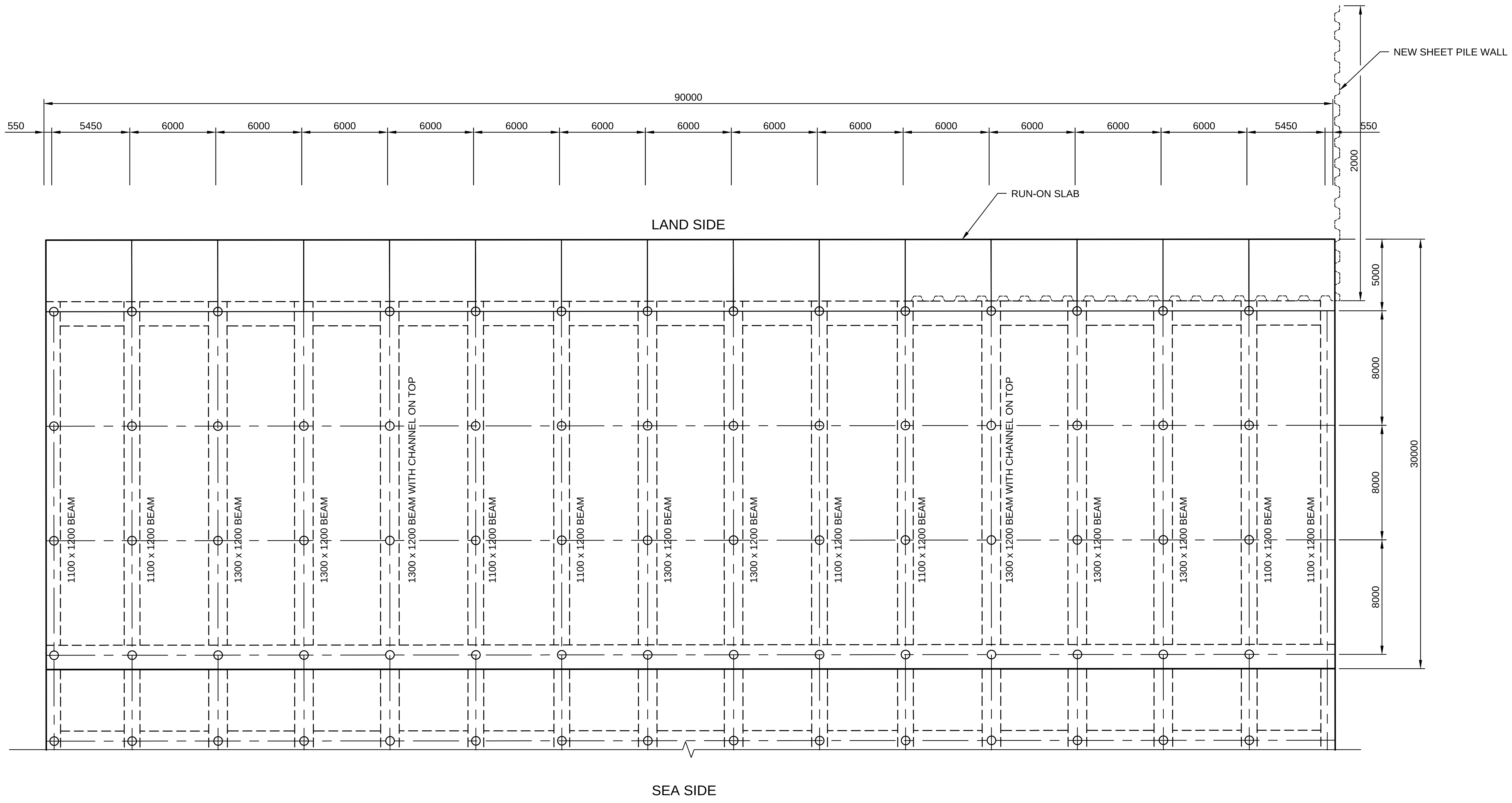
SHEET TITLE

DECK ON PILES
DETAILED LAYOUT PLAN

SHEET NUMBER

60559990-SHT-01-CI-3004

ISO A1 594mm x 841mm



STRUCTURAL PLAN OF LAND SIDE END BAY

SCALE 1:200

AECOM

CONSULTANT

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PROJECT

RUNWAY EXTENSION FEASIBILITY STUDY

CLIENT

LORD HOWE ISLAND BOARD

SCALE BAR

0 5 10 m
1:200

KEY PLAN

PROJECT MANAGEMENT INITIALS

VW	PF	JM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM		SURVEY	

ISSUE/REVISION

I/R	DATE	DESCRIPTION
02	26.09.2018	FINAL ISSUE
01	15.08.2018	DRAFT ISSUE

PROJECT NUMBER

60559990

SHEET TITLE

DECK ON PILES
DETAILED LAYOUT PLAN

SHEET NUMBER

60559990-SHT-01-CI-3005

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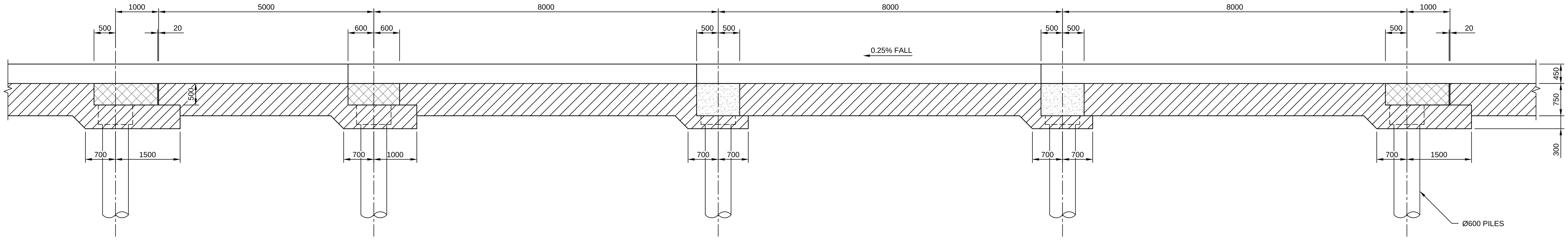
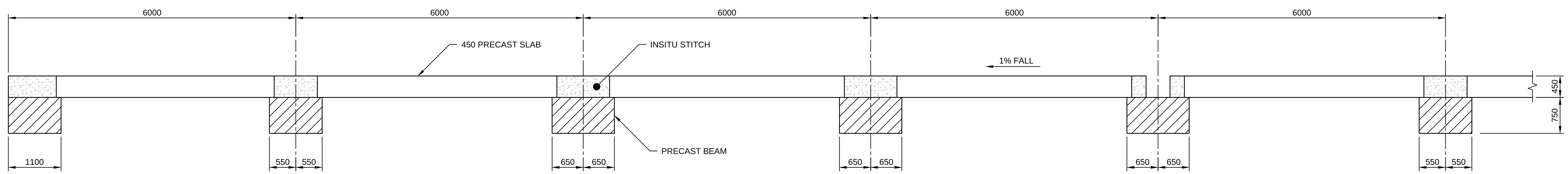


A | **SECTION**
CI-3002 | Scale 1:50



B | **SECTION**
CI-3002 | Scale 1:50

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PROJECT

RUNWAY EXTENSION FEASIBILITY STUDY

CLIENT

LORD HOWE ISLAND BOARD

SCALE BAR

0 1250 2500 mm
1:50

KEY PLAN

PROJECT MANAGEMENT INITIALS

VW	PF	JM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM		SURVEY	

ISSUE/REVISION

I/R	DATE	DESCRIPTION
02	26.09.2018	FINAL ISSUE
01	15.08.2018	DRAFT ISSUE

PROJECT NUMBER

60559990

SHEET TITLE

DECK ON PILES
STURCTURAL SECTIONS AND DETAILS

SHEET NUMBER

60559990-SHT-01-CI-3006

ISO A1 594mm x 841mm

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PROJECT

RUNWAY EXTENSION FEASIBILITY STUDY

CLIENT

LORD HOWE ISLAND BOARD

SCALE BAR

0 12.5 25 m
1:500

KEY PLAN

PROJECT MANAGEMENT INITIALS

JC	RM	JM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM		SURVEY	

ISSUE/REVISION

I/R	DATE	DESCRIPTION
02	26.09.2018	FINAL ISSUE
01	15.08.2018	DRAFT ISSUE

PROJECT NUMBER

60559990

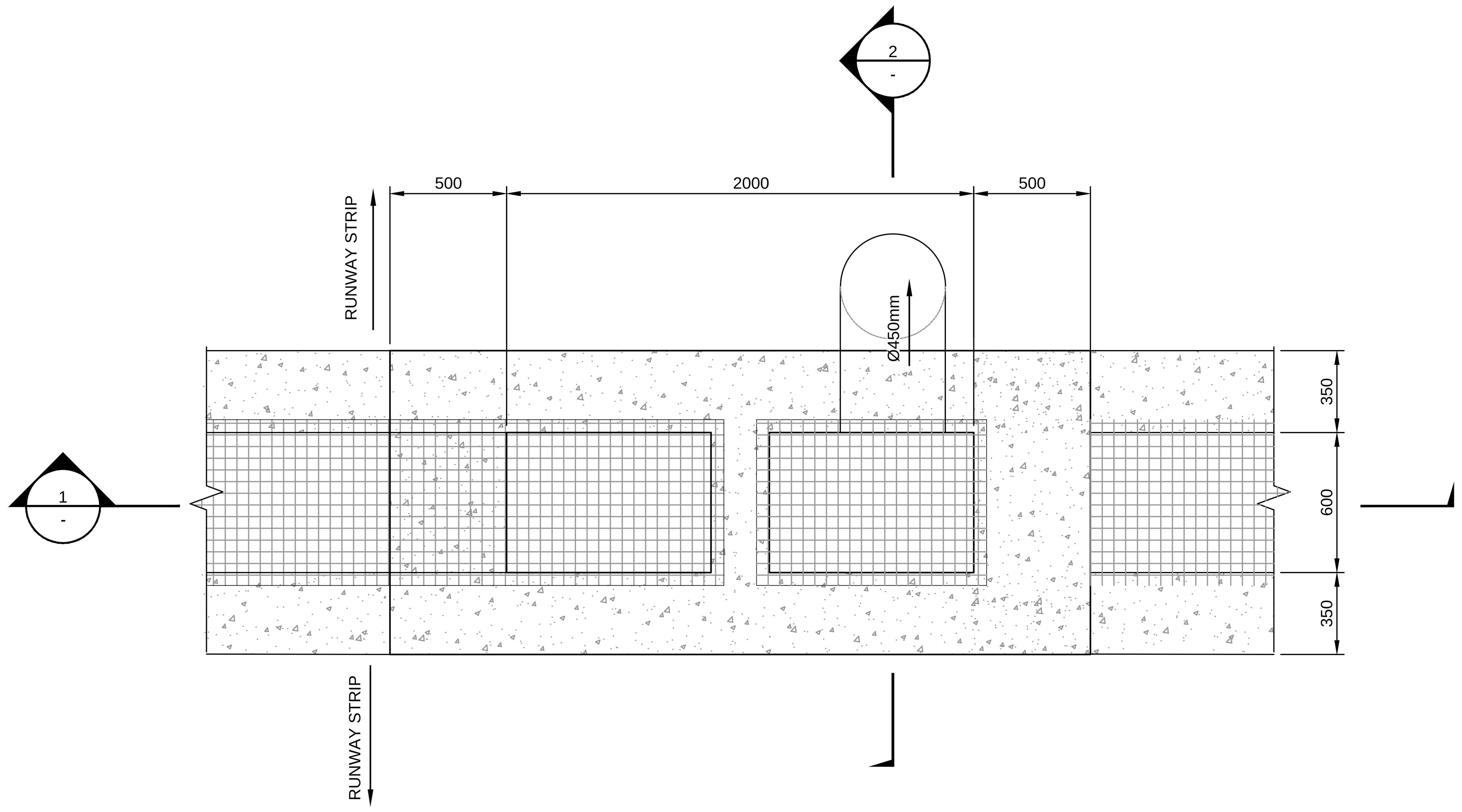
SHEET TITLE

APRON DRAINAGE PLAN

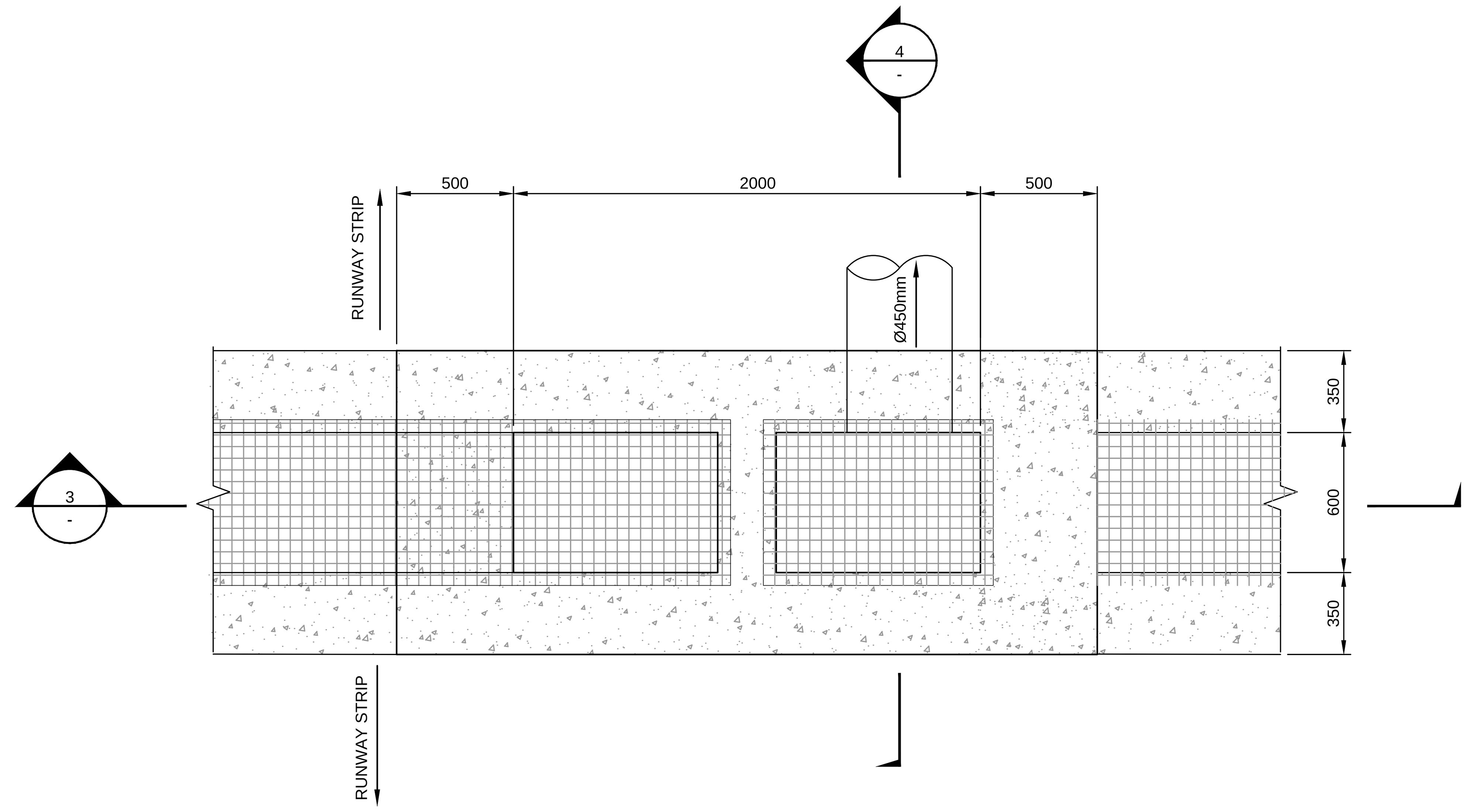
SHEET NUMBER

60559990-SHT-01-CI-4001

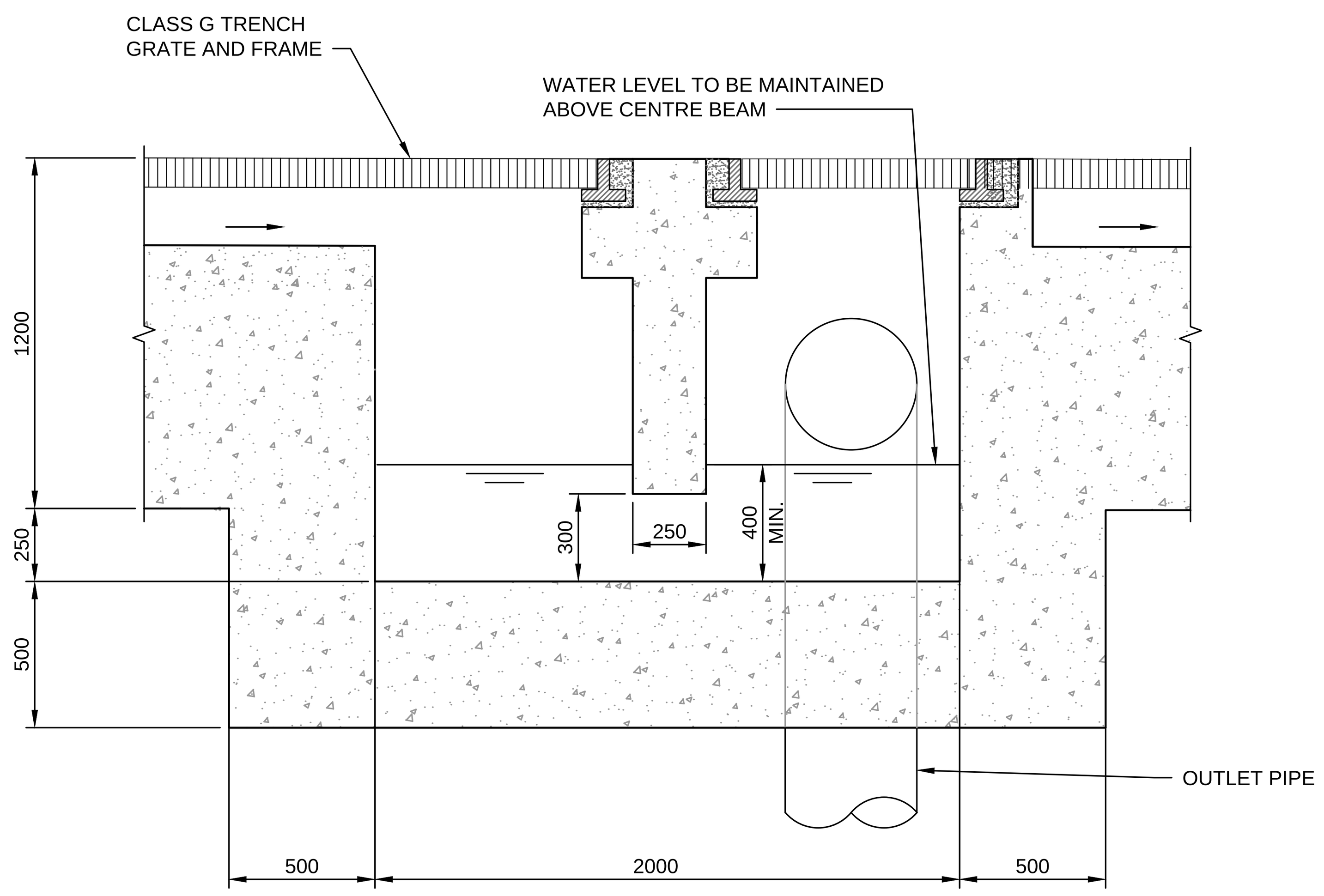
ISO A1 594mm x 841mm



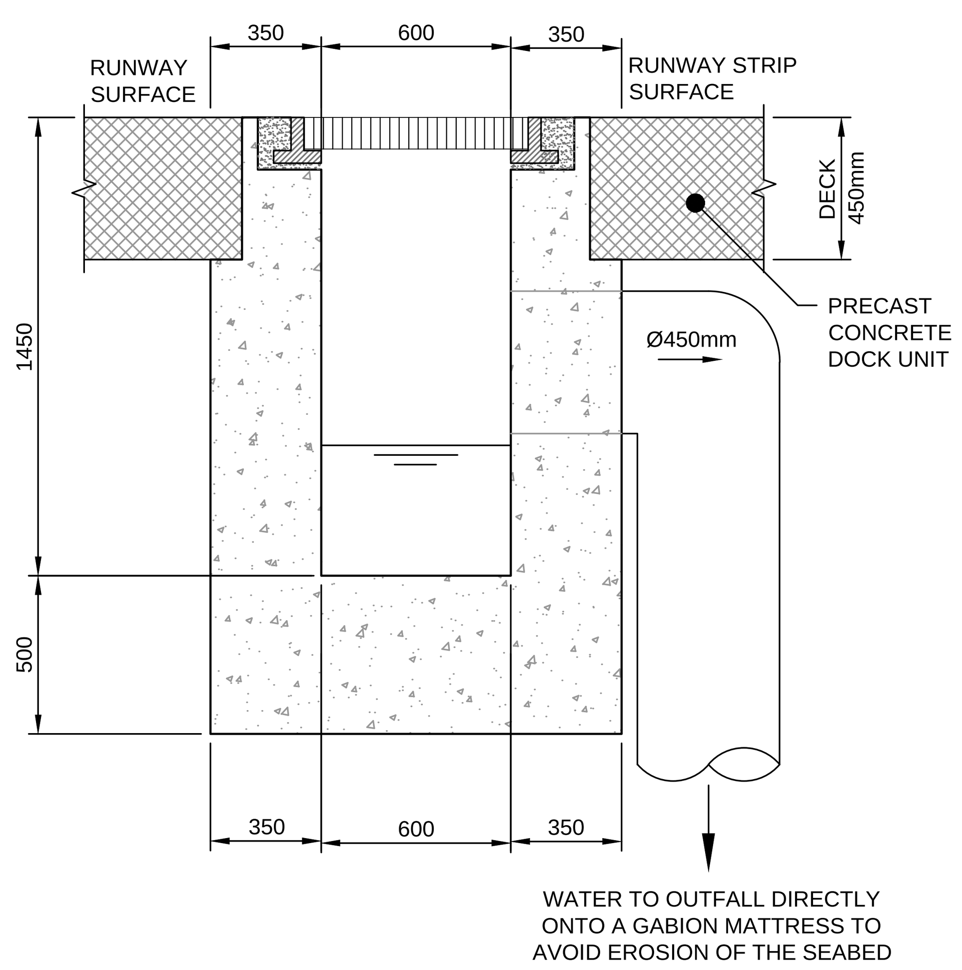
DECK OPTION - INLET PLAN
Scale 1:20



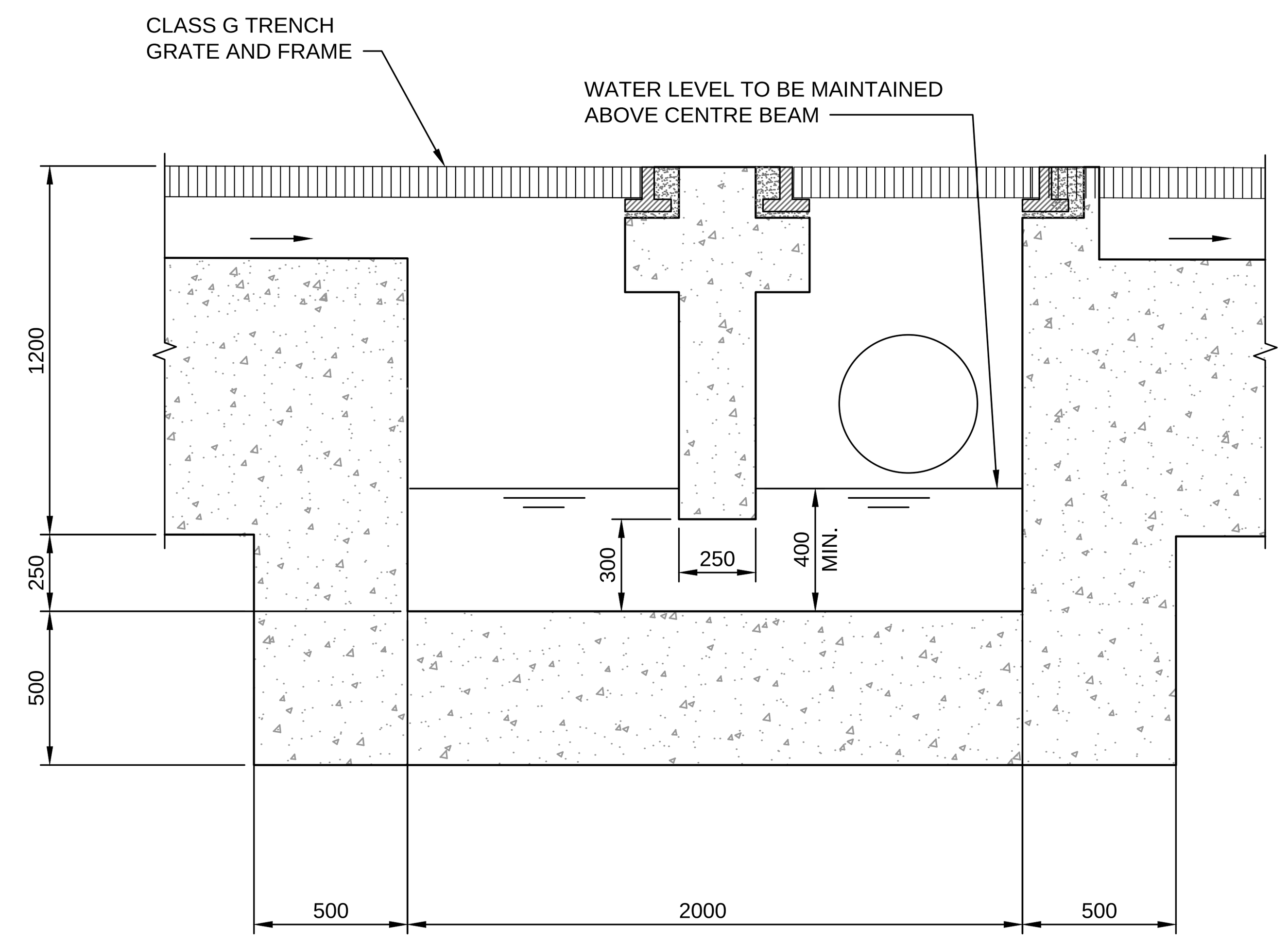
LAND RECLAMATION OPTION - INLET PLAN
Scale 1:20



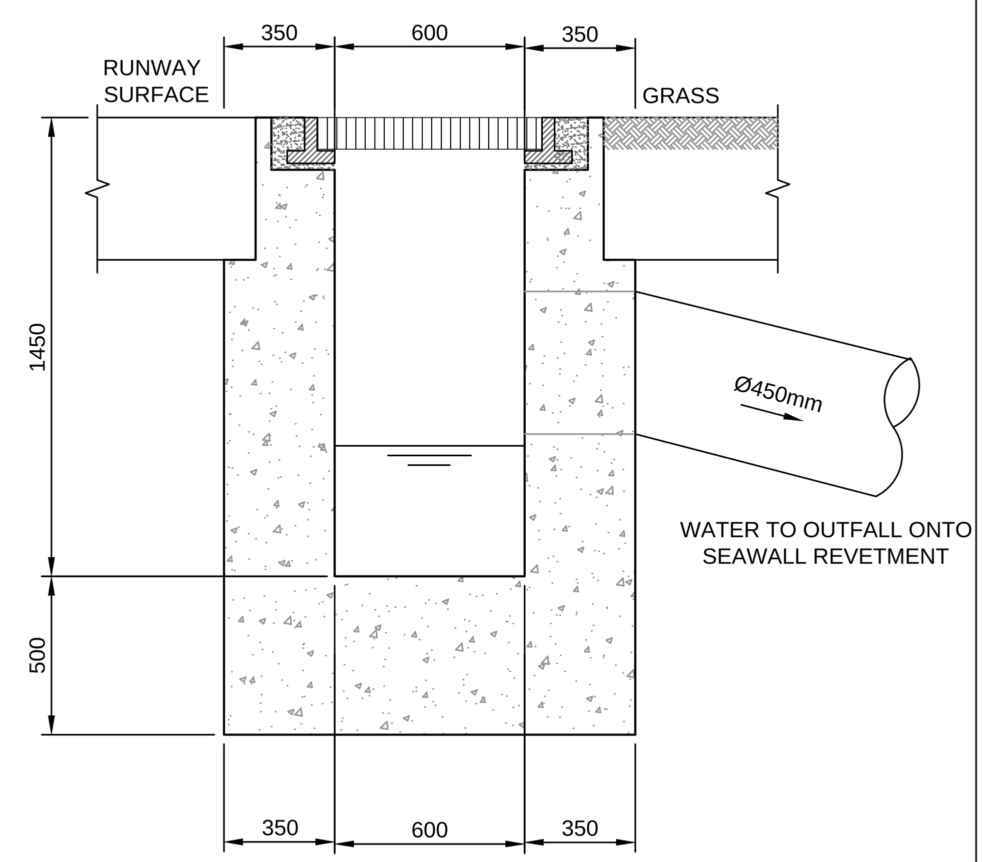
1 SECTION
Scale 1:20



2 SECTION
Scale 1:20



3 SECTION
Scale 1:20



4 SECTION
Scale 1:20

NOTES

1. INLET PITS HAVE BEEN DESIGNED IN ORDER TO SEPARATE HYDROCARBONS AND TO ALLOW SEDIMENT TO SETTLE. CONTAMINANTS ARE TO BE REGULARLY REMOVED AS PART OF THE AIRPORT MAINTENANCE REGIME.

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PROJECT
RUNWAY EXTENSION FEASIBILITY STUDY

CLIENT
LORD HOWE ISLAND BOARD

SCALE BAR
0 0.5 1 m
1:20

KEY PLAN

PROJECT MANAGEMENT INITIALS

JC/VW	RM/PF	JM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM		SURVEY	

ISSUE/REVISION

I/R	DATE	DESCRIPTION
02	26.09.2018	FINAL ISSUE
01	15.08.2018	DRAFT ISSUE

PROJECT NUMBER
60559990

SHEET TITLE
DRAINAGE DETAILS

SHEET NUMBER
60559990-SHT-01-CI-4002

NOTES

1. PAVEMENT PROFILES WILL BE ADOPTED FOR THE LAND RECLAMATION RUNWAY EXTENSION OPTION. THE STRUCTURAL DECKING WILL FORM THE "PAVEMENT" FOR THE DECK ON PILES RUNWAY EXTENSION OPTION.

PAVEMENT PROFILES

Scale 1:10

- 50mm AC14 WITH A15E BINDER
- 300mm CRUSHED GRAVEL WITH 1% CEMENT
- SUBGRADE (CBR = 15% MIN)

15% CBR SUBGRADE PAVEMENT

- 50mm AC14 WITH A15E BINDER
- 400mm CRUSHED GRAVEL WITH 1% CEMENT
- SUBGRADE (CBR = 10% MIN)

10% CBR SUBGRADE PAVEMENT

ISO A1 594mm x 841mm

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PROJECT

RUNWAY EXTENSION FEASIBILITY STUDY

CLIENT

LORD HOWE ISLAND BOARD

SCALE BAR

0 0.25 0.5 m — 1:10

0 12.5 25 m — 1:500

KEY PLAN

PROJECT MANAGEMENT INITIALS

ME/RS	RM	JM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM		SURVEY	

ISSUE/REVISION

I/R	DATE	DESCRIPTION
02	26.09.2018	FINAL ISSUE
01	15.08.2018	DRAFT ISSUE

PROJECT NUMBER

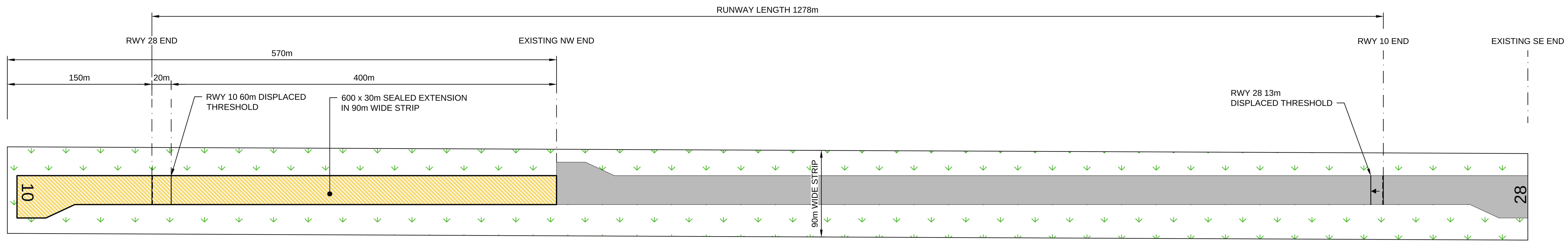
60559990

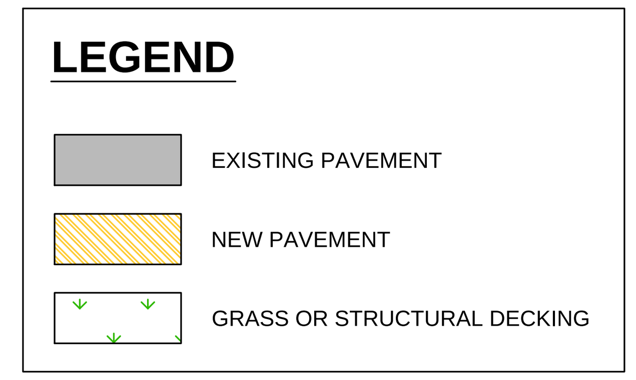
SHEET TITLE

PAVEMENT LAYOUT PLAN AND DETAILS

SHEET NUMBER

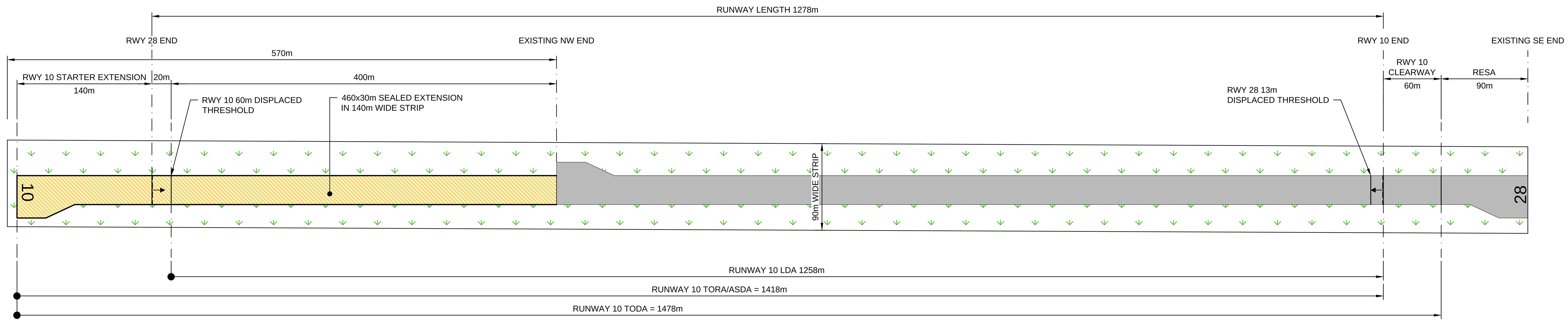
60559990-SHT-01-CI-5001





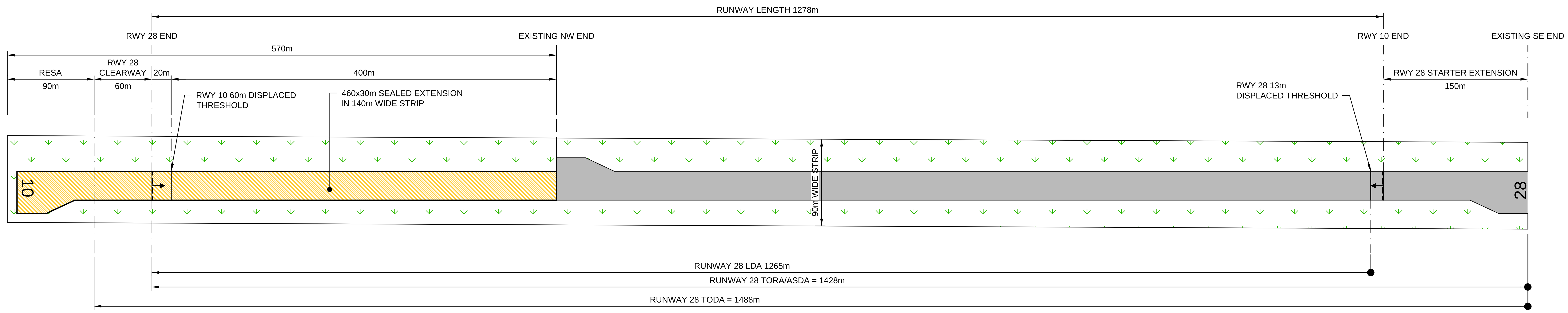
LORD HOWE ISLAND AIRPORT - 570m EXTENSION LAYOUT

NOT TO SCALE



LORD HOWE ISLAND AIRPORT - 570m EXTENSION
RUNWAY 10 DECLARED DISTANCES

NOT TO SCALE



LORD HOWE ISLAND AIRPORT - 570m EXTENSION
RUNWAY 28 DECLARED DISTANCES

NOT TO SCALE

AECOM

CONSULTANT

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PROJECT

RUNWAY EXTENSION FEASIBILITY STUDY

CLIENT

LORD HOWE ISLAND BOARD

SCALE BAR

NOT TO SCALE

KEY PLAN

PROJECT MANAGEMENT INITIALS

JM	RM	JM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM		SURVEY	

ISSUE/REVISION

I/R	DATE	DESCRIPTION
02	26.09.2018	FINAL ISSUE
01	15.08.2018	DRAFT ISSUE

PROJECT NUMBER

60559990

SHEET TITLE

LAYOUT AND DECLARED DISTANCES

SHEET NUMBER

60559990-SHT-01-CI-6001

Appendix B

Basis of Design Report

RUNWAY EXTENSION FEASIBILITY STUDY

BASIS OF DESIGN REPORT

Lord Howe Island Board | 26 September 2018

AECOM Imagine it. Delivered.

Basis of Design Report

Milestone 3 - Concept Design

Client: Lord Howe Island Board

Co No.: N/A

Prepared by

AECOM Australia Pty Ltd
Level 21, 420 George Street, Sydney NSW 2000, PO Box Q410, QVB Post Office NSW 1230, Australia
T +61 2 8934 0000 F +61 2 8934 0001 www.aecom.com
ABN 20 093 846 925

26-Sep-2018

Job No.: 60559990

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 AS/NZS4801 and OHSAS18001.

Quality Information

Document Basis of Design Report

Ref 60559990

Date 26-Sep-2018

Prepared by Jed Mills

Reviewed by Richard Murran

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	28-Jun-2018	Draft Issue	Jed Mills Project Manager	
B	26-Sep-2018	Final Issue	Jed Mills Project Manager	

Table of Contents

1.0 Introduction

1.1 Background

Lord Howe Island is located approximately 590 km from the closest town on the Australian mainland and 790 km from Sydney, it is one of the most remote communities in NSW and among the most remote of any Australian territory.

There are currently regular airline services operating from Sydney and Brisbane to the island, although the current route agreement is scheduled to end in March 2022 and Qantas have indicated they will no longer be operating the DHC8-200 aircraft servicing the island beyond this date. The existing runway at 888m long, does not allow for any candidate aircraft to take off or land without restrictions which limits the financial viability of the route for airline operators. Therefore an extension of the runway may be the only viable solution to ensure continued service of Lord Howe Island.

In April 2018, AECOM completed a Detailed Assessment of Extended Runway Requirements and Suitable Aircraft which recommended that a 570m runway extension to the NW should be investigated further. This recommendation was approved by the Lord Howe Island Board (LHIB) at their quarterly meeting held on Monday 14th May 2018.

1.2 Scope of Concept Design Services

The scope of concept design services to be provided by AECOM is defined in AECOM's proposal dated 11 September 2017 which forms the basis of the subsequent formal agreement with LHIB for this engagement.

In broad terms, the concept design services to be provided by AECOM comprise the following major work elements:

- **Airfield design:** including extension of the runway, widening of the runway strip, existing taxiway and apron alterations if necessary and associated earthworks, grading, pavements and stormwater infrastructure;
- **Physical runway extension design:** based on the consideration of a structural deck solution or land reclamation solution

In addition, the following elements will be key considerations throughout the design process;

- **Key environmental design constraints and considerations:** Summary of the key constraints / non-negotiables in relation to the environment which will need to be considered as part of the design process and avoided during construction and operation of the runway extension
- **Construction Constraints:** Summary of the key construction constraints which will influence the concept design process
- **Coastal Design Parameters:** Key coastal engineering parameters which will be incorporated into the concept design process

2.0 Key Environmental Design Constraints and Considerations

Based on the background environmental research undertaken for the project to date, the key constraints / non-negotiables in relation to the environment will need to be considered as part of the design process and avoided during construction and operation of the runway extension are as follows:

- Direct and indirect impacts on the World Heritage values of the Island, including:

  Direct impacts:

  - impacts to algal and coral reefs, during construction or operation (e.g. via scouring due to surface water run-off), for example by limiting the physical footprint of the project within the lagoon. Within the lagoon, coral areas have dominant coverage in the western portion located seaward of Blackburn Island, while the landward (eastern) portion of the lagoon is generally comprised of sandy substrate;
  - impacts to items of the Lord Howe Island Group (listed on the NSW Office of Environment and Heritage (OEH) State Heritage Register (SHR 00970)), including the “Kentia” on Lagoon Road, Portion 111, to the west of the existing airport terminal and apron area;
  - physical impact to species (and their habitats) listed as threatened under the EPBC Act (refer to Figure 1), in particular the following species:
    - the only breeding habitat of the Providence Petrel (*Pterodroma solandri*) between March to November and they nest on the tops of Mount Gower and Mount Lidgbird and to a less extent, on the lower slopes of the mountains;
    - the breeding habitat of the Lord Howe Woodhen (*Gallirallus sylvestris*) between spring and early summer, within a territory of around 3 hectares primarily within the Lord Howe Island Permanent Park Preserve (nesting on the ground in thick vegetation, under tree roots and fallen logs). They are not found in the northern hills area;
    - the foraging habitat of the migratory Red Knot (*Calidris canutus*) on coastal areas in sandy estuaries with tidal mudflats on the island, between September and April;
    - the foraging habitat of the migratory Curlew Sandpiper (*Calidris ferruginea*) on intertidal mudflats of lagoons, and beaches and rocky shores between August and mid-April;
    - the foraging habitat of the migratory Eastern Curlew (*Numenius madagascariensis*), on intertidal mudflats and sandflats, on sheltered coasts, especially lagoons, from August each year;
    - the foraging and nesting habitat of the Loggerhead Turtle (*Caretta caretta*) particularly from late October to late February;
    - the foraging habitat of the migratory Leatherback Turtle (*Dermochelys coriacea*) which are found in tropical and temperate waters; and
    - the critical habitat of the Lord Howe Island skink, listed on the NSW threatened species list, at the receding dunal area at the southern end of Lagoon Beach (to the north of Windy Point).

  Indirect impacts:

  - impacts to existing wave patterns due to the runway extension structure, which could cause beach/lagoon erosion and impacts to algal and coral reefs and/or threatened species (such as the Lord Howe Island skink) or their habitat;
  - noise impacts during breeding season to species listed as threatened under the EPBC Act (refer to Figure 1), in particular:
    - the breeding habitat of the Red-tailed Tropicbird (*Phaethon rubricauda*), which nests on cliffs of the northern hills and southern mountains on the main island at Lord Howe Island; and

- the Lord Howe Island Phasmid (on Balls Pyramid).

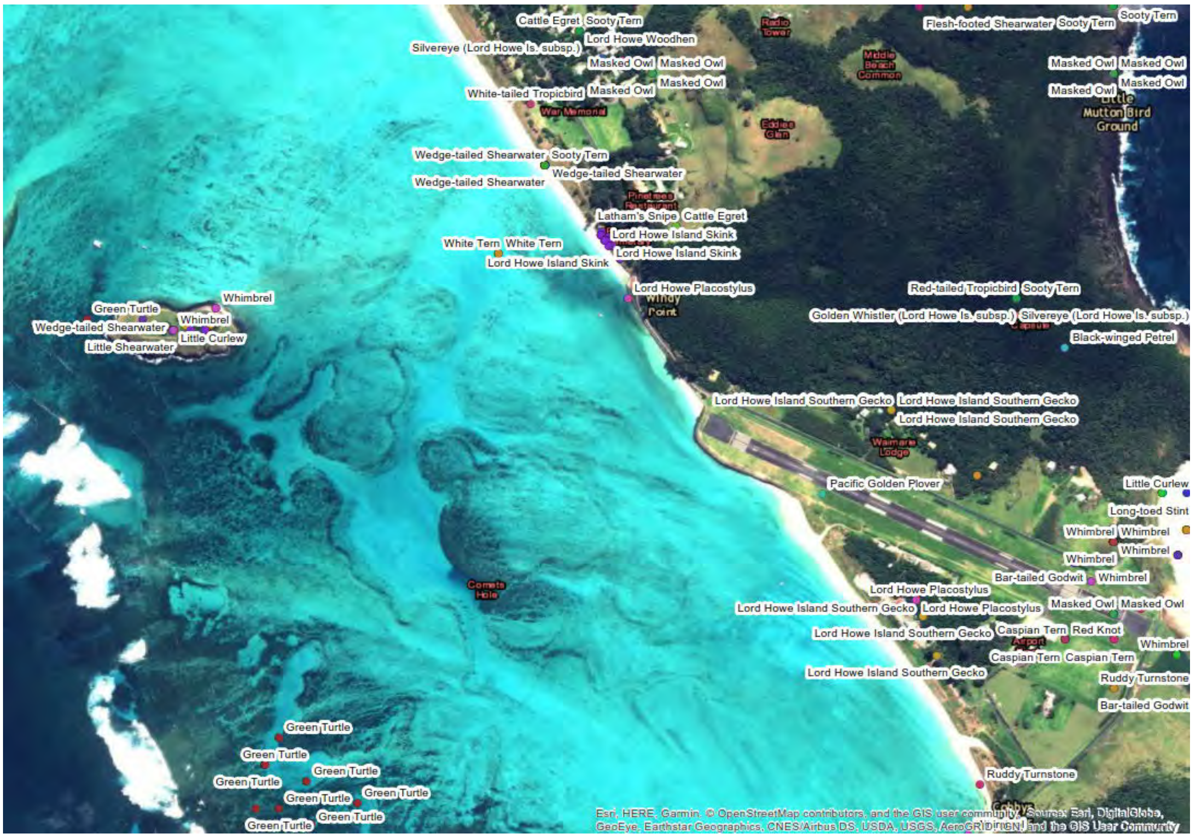


Figure 1 Threatened species located in the vicinity of the proposed project

- Consideration of the likely impacts of climate change in any flood modelling and related design for the project, including factoring in:
  - Increased intensity of rainfall events (using an approach in accordance with relevant guidelines (e.g. *Practical Responses to Climate Change*, Engineers Australia);
  - Sea level rise of between 45 to 82 cm by 2090 (as projected for the NSW coastline under Representative Concentration Pathway 8.5), coupled with extreme sea level events, with increases in storm surge and the extent of inundation across the island; and
  - Increased tailwater levels or sensitivity testing undertaken for various projected rises in mean sea levels.
- Other important considerations for the design of the project include:
  - Prevention of pollution of waterways, including lagoon or coastal waters, by sediments, oils/petrols and other contaminants, during construction or operation;
  - Ensuring the design process and runway structures consider the opportunity to provide suitable habitat for flora/fauna, where possible; and
  - The use of sustainably sourced and/or recycled construction materials which do not contravene the requirements of the *Marine Estate Management (Management Rules) Regulation 1999*.

Further information will be provided upon completion of Milestone 4 of the project in the form of a Preliminary Environmental Assessment.

3.0 Construction Constraints

The concept design of the runway extension will be strongly influenced by the need to accommodate a number of constraints during construction. These constraints include but are not limited to the following:

3.1 Airport Operational Restrictions

It is expected that unrestricted access for construction during daylight hours will be limited to four consecutive days per week, as was the case during the 2015 runway overlay project. Although this would need to be agreed upon by the incumbent operating commercial airline

The airport does not operate at night. Access for construction activities at night may be possible, subject to additional constraints including but not limited to those described below in addition to intensive community consultation.

It is assumed that construction plant, materials and personnel can be located along the runway extension during airport operations, subject to the obstacle limitation surface (OLS) restrictions of the existing runway.

3.2 Seasonal Restrictions

Construction activities during both day and at night may be limited during the breeding season of certain migratory birds and marine mammals, as detailed in section 2.0. The winter months would potentially be the best construction period because of breeding season restrictions in combination with fewer visitor numbers over winter.

3.3 Noise Restrictions

As a minimum noise restrictions are expected to apply during any night works. It is assumed that over water pile driving will not be allowed. Although quieter construction activities such as welding, steel fixing and concrete pouring may be allowed.

3.4 Light Restrictions

Light spill restrictions are expected to apply during night time construction activity.

3.5 Vibration Restrictions

Restrictions on significant underwater vibrations due to pile driving may apply during turtle breeding seasonal restrictions described in 2.0. Vibratory equipment may be required in place of piling hammers.

3.6 Supply & storage of Plant, Labour and Materials

It is assumed that there is no local availability of plant, or materials, all such items must be brought in by air or by sea. There are very limited construction personnel on the island, requiring the majority to be brought in from the mainland.

Limited onshore area is available for the storage of construction plant and materials, and this may be required to be stored on barges moored outside the reef until a sufficient portion of the runway extension has been constructed to provide the required storage area without penetrating the OLS.

4.0 Datum

4.1 Vertical Datum

Table 1 Project Vertical Datum

Datum	Basis
0m AHD	0m AHD at the site is equivalent to: • Chart Datum (established on Lord Howe Island in 1954) • NVM/C/447 • LHI-16 • PM 1030 This AHD on Lord Howe Island and is not equivalent to AHD on mainland Australia.

Note that Lord Howe Island Tidal Datum (LHITD) is the datum used for water level measurements that are currently undertaken by Manly Hydraulics Laboratory (MHL) at the jetty north of Signal Point in the Lagoon at Lord Howe Island. The current MHL tide gauge zero is 0.144m above the 1954 datum (that is, 0.144mm above AHD).

4.2 Horizontal Grid

Map Grid of Australia Zone 57 GDA 94 (MGA94-57) co-ordinates will be adopted for the horizontal grid.

5.0 Design standards, codes and guidelines

5.1 Coastal Design Standards

The coastal design elements of the Lord Howe Island Runway Extension will be designed to meet the relevant requirements nominated in Table 2 and will follow the guidelines nominated in Table 3.

Table 2 Coastal Design Codes

Document Reference	Description
BS6349	Maritime Structures

Table 3 Coastal Design Guides

Reference
US Army Corps of Engineers - "Coastal Engineering Manual (CEM)
Eurotop – Wave Overtopping of Sea Defences and Related Structures: Assessment Manual, 2016
The Rock Manual, CIRIA C683D, Second Edition, 2007

5.2 Airfield Design Standards

The airfield design elements of the Lord Howe Island Runway Extension will be designed to meet the relevant requirements of the Civil Aviation Safety Authority (CASA) nominated in Table 4 and will be designed to meet the requirements of other relevant standards, codes and guidelines nominated in Table 5 where CASA does not provide specific guidance.

Table 4 Relevant CASA Standards – Airfield Design

Document Reference	Description
Manual of Standards (MOS) Part 139	Draft Part 139 Manual of Standards (Aerodromes) Instrument 2017[1]
<u>*Note*</u> *1. CASA advised that the applicable Manual of Aerodrome Standards (MOS139) is currently undergoing detailed review. The final draft is currently out for industry consultation and is expected to be adopted by the end of 2018*	

Table 5 Other Relevant Standards, Codes and Guidelines – Airfield Design

Document Reference	Description
International Civil Aviation Authority (ICAO) Annex 14 Volume I	Aerodrome Design and Operations *(7th Edition, July 2016)*
ICAO Aerodrome Design Manual Part 1	Runways *(3rd Edition, August 2006)*
ICAO Aerodrome Design Manual Part 2	Taxiways, Aprons and Holding Bays *(4th Edition, July 2005)*
ICAO Aerodrome Design Manual Part 3	Pavements *(2nd Edition, October 1983)*
FAA Advisory Circular 150/5320-6F	Airport Pavement Design and Evaluation (October 2016)
FAA Advisory Circular 150/5320-5D	Airport Drainage Design (August 2013)

5.3 Structural Design Standards

The deck structure shall be designed using current editions of the relevant Australian and International Codes and Standards. In addition to the airfield design standards listed in section 5.2 the latest editions of the design standards, guidelines and references contained in Table 6, Table 7 and Table 8 shall apply:

Table 6 Australian Design Standards

Document Reference	Description
AS/NZS 1170	Structural design actions – General principles
AS/NZS 1170.1	Structural design actions: Part 1 – Permanent, imposed and other actions
AS/NZS 1170.2	Structural design actions: Part 2 – Wind actions
AS/NZS 1170.4	Structural design actions: Part 4 – Earthquake actions in Australia
AS 2159	Piling – Design and installation
AS/NZS 2312	Guide to the protection of structural steel against atmospheric corrosion by the use of protective coating
AS 3600	Concrete structures
AS 4997	Guidelines for design of maritime structures

Table 7 International Standards and Guidelines

Document Reference	Description
BS 6349-1	Maritime structures – Code of practice general criteria
BS 6349-2	Maritime structures – Design of quay walls, jetties and dolphins
PIANC WG 34	Seismic Design Guidelines for Port Structures, 2001

Table 8 Additional references

Reference
US Army Corps of Engineers - "Shore Protection Manual"
Eurotop – Wave Overtopping of Sea Defences and Related Structures: Assessment Manual, 2016
Royal Haskoning DHV, *Coastline Hazard Definition and Costal Management Study*, Issue 5, 9 September 2014 (RH Coastline Study Report)

6.0 Design Philosophy

6.1 Design Life

The required minimum design is shown in Table 9, for the purposes of this design the below durations will apply from year 2020.

Table 9 Design Lives by component

Element	Design Life
Revetment Armour	50 years
Deck structure	50 years
Deck sub-structure	50 years
Piles	50 years
Bearings	20 years
Cathodic Protection system	20 years
Steel coating systems	15 years
Drainage structures	50 years
Scour protection	10 years
Airfield Pavement	20 years

6.2 Infrastructure Function Category

Lord Howe Island airport is defined as critical infrastructure due to the need to remain operational after major events in order to allow emergency services access to the island. Therefore the runway and associated structures (deck on piles or land reclamation) must remain functional after a major event. As such the runway is deemed to be a high value property which is defined as function category 3 in accordance with Table 10.

Table 10 AS4997-2005 Annual Probability of Exceedance of Design Wave Events

TABLE 5.4

ANNUAL PROBABILITY OF EXCEEDANCE OF DESIGN WAVE EVENTS

Function category	Category description	Design working life (years)			
		5 or less (temporary works)	25 (small craft facilities)	50 (normal maritime structures)	100 or more (special structures/ residential developments)
1	Structures presenting a low degree of hazard to life or property	1/20	1/50	1/200	1/500
2	Normal structures	1/50	1/200	1/500	1/1000
3	High property value or high risk to people	1/100	1/500	1/1000	1/2000

6.3 Maintenance Considerations

<u>Structural Decking Requirements and Asset Management</u>

The structural deck components shall be designed such that no structural repairs are required over the design working life of the structure.

Replacement of non-structural components and fixtures is permitted in accordance with the design life schedule given above.

Routine inspection and replacement of bearings, CP systems etc. must be possible without interruption to airfield operations.

<u>Airfield Pavement Asset Management</u>

The following asset management considerations are identified as being necessary to achieve the overall design life for these elements:

- Visual pavement condition survey is recommended at least once per year to identify and document any pavement defects observed and to facilitate proactive maintenance (this is Lord Howe Island's current practice carrying out Annual Technical Inspections);
- Based on observations from mandatory visual pavement condition surveys (CASR 139.235) , proactive maintenance works to be carried out on an "as needed basis" may include:
    - Localised minor repairs to wearing course (crack sealing, joint maintenance, repair of surface spalls);
    - Localised heavy patching to repair pavement sublayers prior to milling; and
    - Asphalt mill and resheet

7.0 Coastal Design Parameters

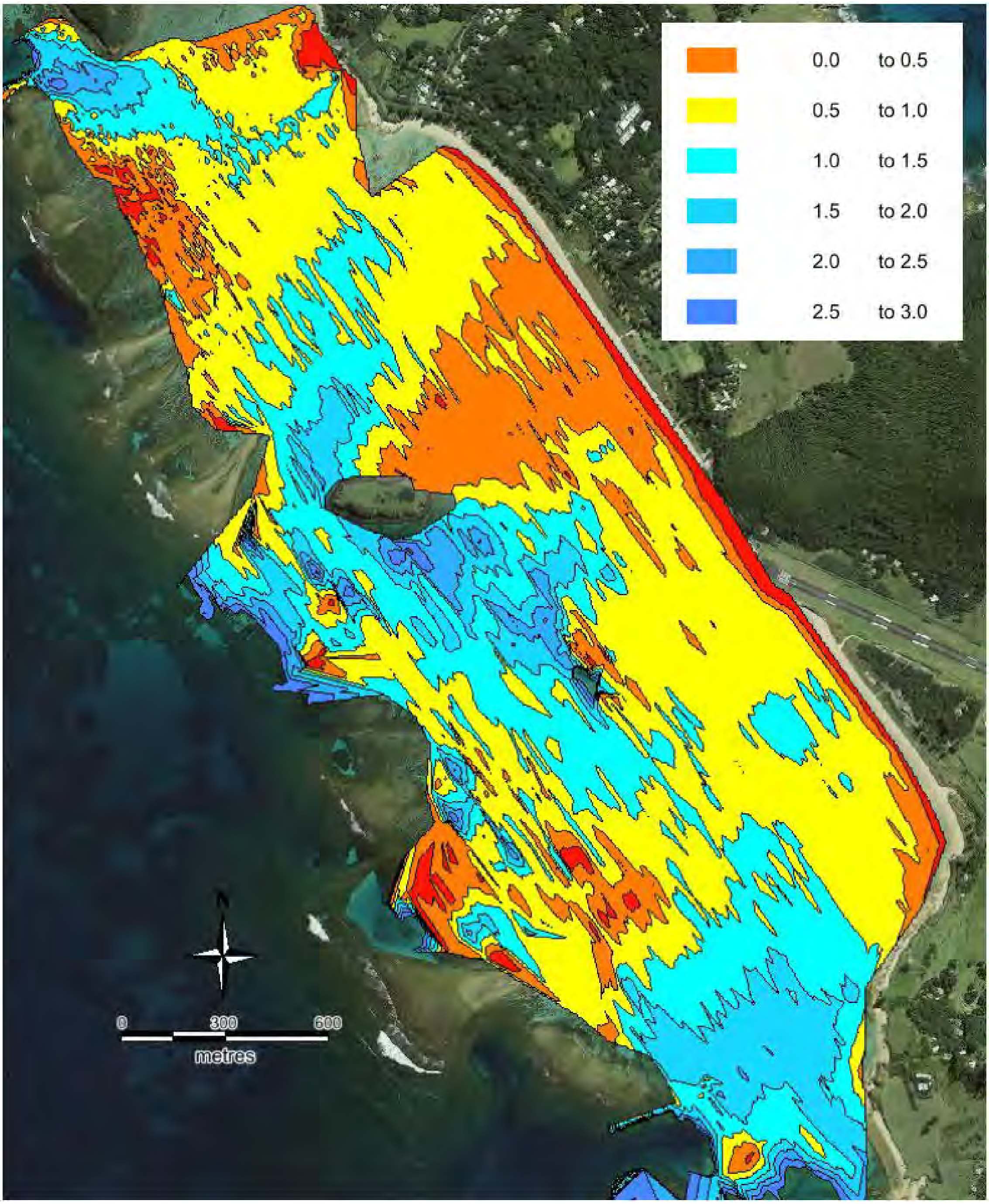
The following Coastal Design Parameters will be adopted to inform the concept design.

7.1 Bathymetric survey data

As surveyed by The Port Authority of New South Wales on the 23rd to 31st March 2015 and provided to AECOM in file: 201503_LHI_HydroDatum_MGA57_1m_TrueXY.

Seabed levels based on information provided by NSW Maritime are shown in Figure 2 where bathymetric contours are extracted from their 2008 survey. Depths are shown relative to AHD.

Figure 2 2008 bathymetric contours



7.2 Sea Water Levels

Based on the RH Coastline Study Report, the tidal planes for the site are presented in Table 11

Table 11 Tidal Planes in Lagoon at Lord Howe Island

Tidal Plane	Tidal Level (m AHD)
Highest Astronomical Tide (HAT)	2.41
Higher High Water Solstice Springs (HHWSS)	2.31
Mean High Water Springs (MHWS)	2.01
Mean High Water (MHW)	1.83
Mean High Water Neap (MHWN)	1.66
Mean Sea Level (MSL)	1.23
Mean Low Water Neap (MLWN)	0.81
Mean Low Water (MLW)	0.63
Mean Low Water Springs (MLWS)	0.46
Indian Springs Low Water (ISLW)	0.24
Lowest Astronomical Tide (LAT)	0.00

Note
1. *Australian Height Datum = Chart Datum, 1.23m below mean sea level*

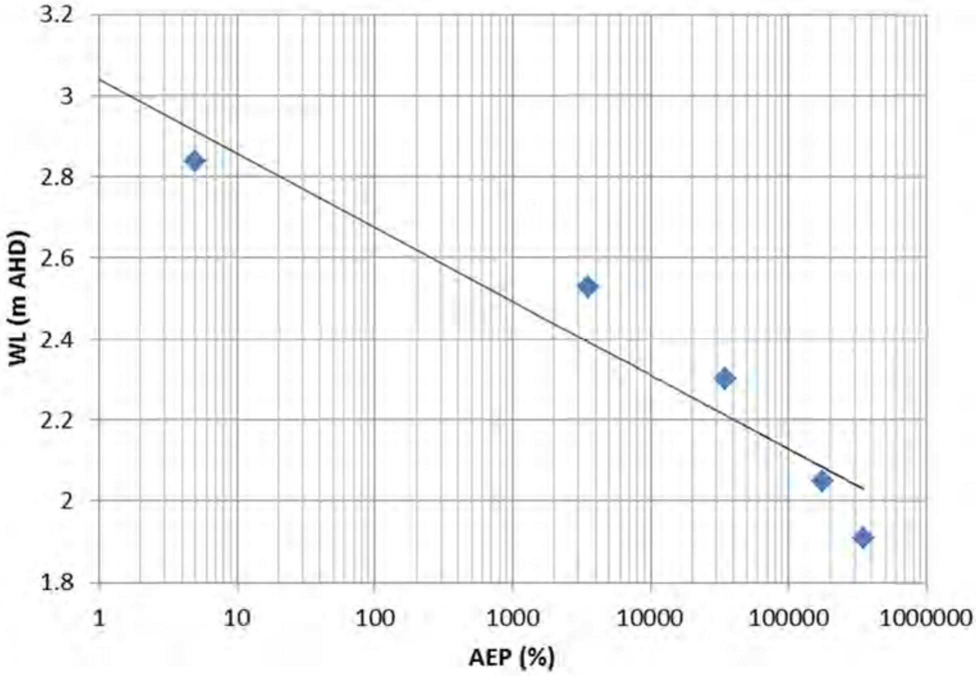
Based on 20 years of recorded water levels (including wave set-up) the exceedance probabilities for various water levels are presented in Table 12. The same data is presented graphically in Figure 1, with an extrapolation provided for rare events.

Table 12 Exceedance probabilities for water levels in Lagoon at Lord Howe Island

Probability of exceedance (%)	Tidal Level (m AHD)
0.00014	2.84
0.1	2.53
1	2.30
5	2.05
10	1.91
50	1.23
90	0.58

Note
1. *Based on 15 minute records (1% exceedance equates to approximately 350 times per year)*

Figure 3 Observed water levels (20 years)



7.3 Climate Change (Sea level rise to 2070)

The NSW Government no longer prescribes statewide sea level rise projections and the 2009 NSW Sea Level Rise Policy Statement is no longer NSW Government policy. However, this document provides reasonably conservative allowances for planning purposes.

Based on the 2009 Policy, national and international projections of sea level rise along the NSW coast are for a rise relative to 1990 mean sea levels of 40 cm by 2050 and 90 cm by 2100.

For the 50 year design life (2070) a sea level rise of 0.4m has been adopted. The sea level rise is applied to the ambient water levels.

7.4 Extreme Levels

The extreme water levels are governed largely by wave setup on the reef. Water levels will over the reef will be assessed based on the equations described by Gourlay in his 1997 paper “Wave Set-up on Coral Reefs: Some Practical Applications”. The critical equation is:

$$\bar{\eta}_r = \frac{3 \times K_p \times g^{1/2} \times H_0^2 \times T}{64 \times \pi \times (\bar{\eta}_r + h_r)^{3/2}}$$

Where: η_r is depth of wave setup

K_p is reef profile characteristic, defined based on reef edge slope (refer Figure 6),

H_o and T are offshore wave characteristics.

h_r is the depth of ocean level over reef edge.

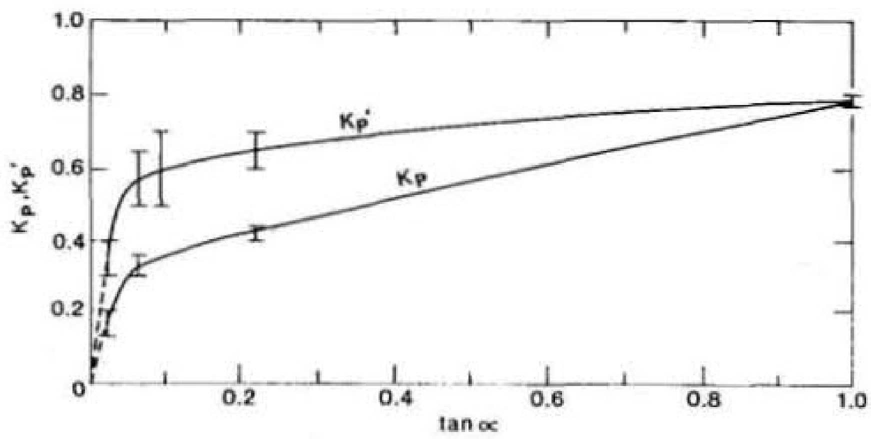


Figure 4 **Reef Profile Factor (Gourlay 1997)**

7.5 Wave Climate

From the RH Coastline Study Report, the statistical wave parameters derived from the analysis of 31 year WAVEWATCH **III** model are presented in Table 13.

Table 13 **Statistics from analysis of 31 year WAVEWATCH III® model wave hindcast at Lord Howe Island**

Statistic	Hs (m)	Tp(s)
Median	2.7	11.7
Mean	2.8	11.6
Minimum	0.7	3.8
Maximum	10.4	23.4
Standard Deviation	1.0	2.4
10% Probability of exceedance	4.2	14.5
5% Probability of exceedance	4.8	15.5
1% Probability of exceedance	6.0	17.6

The method of Goda (2010) for incipient breaking of significant (H_s) waves will be applied to determine the design wave height at the structure. This depends on the design water depth, offshore wavelength and bed slope.

Using the methodology in Battjes and Groenendijk (2000) for wave height distributions in the shoaling and breaking zone, $H_{10\%}$ and $H_{2\%}$ design wave heights at the structure can then be determined, which will be used in rock armour hydraulic stability calculations.

The deck on piles design will be based on the design parameter with a 5% probability of exceedance. The stability of the deck will be checked for the 1% wave condition, allowing for some yielding of the structure.

7.6 Design Current

From the RH Coastline Study Report the ocean current speed is between 0.5 and 1.0 m/s the adopted shore parallel current will be 1 m/s under operational conditions. During extreme events (beyond recorded data) a design current of 1.5 m/s has been adopted. For works that substantially block the flow paths on the reef top (reclamation) the adopted current is 2 m/s at choke points (seaward edge).

Accumulation of encrustations up to 100mm thick shall be allowed for in assessing loads due to currents on piles and other submerged elements.

7.7 Armour Stability and Sizing

7.7.1 General

Armour sizing will be carried out using Van der Meer's methodology modified for shallow water as appropriate, as outlined in the CIRIA Rock Manual C683.

Concrete armouring will be considered in the design where sourcing rock of the sizing derived from the above method is considered uneconomic.

7.7.2 Design Parameters for Rock Armour

Amour layers will be designed to have minimum damage under the extreme design events considered, levels corresponding to 'start of damage' in will be incorporated in design,

Table 14 Design Values of Damage Parameter Sd, for Double Layer Armouring, CIRIA C683

	Damage Level Sd		
Slope (cot α)	Start of Damage	Intermediate Damage	Failure
1.5	2	3-5	8
2	2	4-6	8
3	2	6-9	12
4	3	8-12	17
6	3	8-12	17

Hydraulic performance, i.e. notional permeability coefficients of the various armour configurations considered during design will be in line with recommendations of Section 5.2.2.2 of the Rock Manual, C683.

7.7.3 Design Parameters for Concrete Armour Units

Designs incorporating the use of concrete armour units will be based primarily on manufacturer's specifications and guidelines for the use of the respective units considered. As a guide, a summary of stability numbers, Ns and K_D values for the most common concrete armour layers are summarised from CIRIA C683 in Figure 5.

Figure 5 Stability Numbers for Concrete Armour Units

Armour type	Damage level	Stability number $H_s/(\Delta D_n)$				References/remarks	
		Trunk		Head			
		Non-breaking waves	Breaking waves	Non-breaking waves	Breaking waves		
Cube (2 layers)	0%	1.8–2.0		–		Brorsen *et al* (1975) slope: 1:1.5 and 1:2	
	4%	2.3–2.6		–			
	0% (N_{od} = 0)	1.5–1.7		–		Van der Meer (1988a) [1] slope 1:1.5	
	5% (N_{od} = 0.5)	2.0–2.4		–			
	< 5%	2.2	2.1	1.95	–	SPM (CERC, 1984)	slope 1:1.5
		2.45	2.35	2.15	–		slope 1:2
		2.8	2.7	2.5	–		slope 1:3
Cube [2,3] (1 layer)	0% (N_{od} = 0)	2.2–2.3		–		Van Gent *et al* (2000)	
Tetrapod	0% (N_{od} = 0)	1.7–2.0		–		Van der Meer (1988a) [1] slope 1:1.5	
	5% (N_{od} = 0.5)	2.3–2.9		–			
	< 5%	2.3	2.2	2.1	1.95	SPM (CERC, 1984)	slope 1:1.5
		2.5	2.4	2.2	2.1		slope 1:2
		2.9	2.75	2.3	2.2		slope 1:3
Dolos	2% (N_{od} = 0.3)	2.7 (r = 0.32) [4]		–		Burcharth and Liu (1993) [5] slope 1:1.5	
		2.5 (r = 0.34) [4]		–			
		2.3 (r = 0.36) [4]		–			
	<5% (N_{od} = 0.4)	3.2 (r = 0.32) [4]		–		Holtzhausen (1996) [6]	
Accropode	0% (N_{od} = 0)	2.7 (15)	2.5 (12)	2.5 (11.5)	2.3 (9.5)	Sogreah (2000) [7,8]	
Core-loc	0% (N_{od} = 0)	2.8 (16.0)		2.6 (13.0)		Melby and Turk (1997) [7,8]	
Xbloc	0% (N_{od} = 0)	2.8 (16.0)		2.6 (13.0)		DMC (2003) [7,8]	

7.8 Overtopping

Table 15 Overtopping Limits

Design Case	Design Wave Event	Design Water Level Event	Overtopping Limit	Source
Operational	Corresponding to ARI of the runway operational wind limit	5% exceedance	Mean: 0.16 l/s/m	Eurotop II: 3.3.7 (practical zero limit)
Survival	Combined exceedance probability of 1%		Mean: ≤1.0 l/s/m Peak: <1,000 l/m	Eurotop II: Table 3.2

Overtopping limits apply at the seaward edge of the runway pavement.

8.0 Ground Conditions and Geotechnical Design Parameters

The preliminary geological model in the Lagoon is based on information interpreted for the desktop geotechnical study contained within AECOM's "Geotechnical Interpretative Report" and is presented in Table 16 and Table 17 .

Table 16 Interpreted Ground Profile

Geotechnical Unit	Simplified Description	Depth to Top of Unit (m)	Unit Thickness (m)
1. Upper Sand	Carbonate sands trace gravel	0.0	0.0 to1.9
2. Lower Sand	Carbonate silty gravelly sands	0.0 to 2.0	7.3 to 10.4
3. Interbedded Sands and Clays	Interbedded Sands and Clays	7.9 to 9.5	2.8 to 4.9
4. Calcarenite	Calcarenite (calcareous sandstone)	11.0 to 13.8	
a. Calcarenite-W	Weathered calcarenite		1.8 to 3.1
b. Calcarenite-FR	Fresh calcarenite		0.7 (proven)

Table 17 Interpreted Ground Profile

Geotechnical Unit	Density/Consistency	Bulk Unit Weight (kN/m^3)	Effective Cohesion (kPa)	Effective angle of internal shearing resistance (deg)
Upper Sand	Loose	16	0	25
Lower Sand	Very loose / very soft	16	0	25
Interbedded Sands and Clays	Loose to medium dense	16	0	30
Calcarenite	Weathered	18	10	32
	Sound	20	50	35

The unit depths, thicknesses and material properties presented in Table 16 and are to be adopted for the concept design but should not be assumed to represent the extremes that may be encountered across the site. Further geotechnical investigations are required to define this information as actual unit boundaries and material properties can be highly variable.

9.0 Airfield Design

9.1 General

The airfield design elements of the works generally include the extension of the runway, modification to the existing taxiway and apron affected by the runway strip, review of the existing service infrastructure, grading and pavements.

This section defines the functional requirements and design standards applicable to the airfield design elements of the Lord Howe Island Runway Extension and outlines the approach adopted for the design of these elements at the concept design stage.

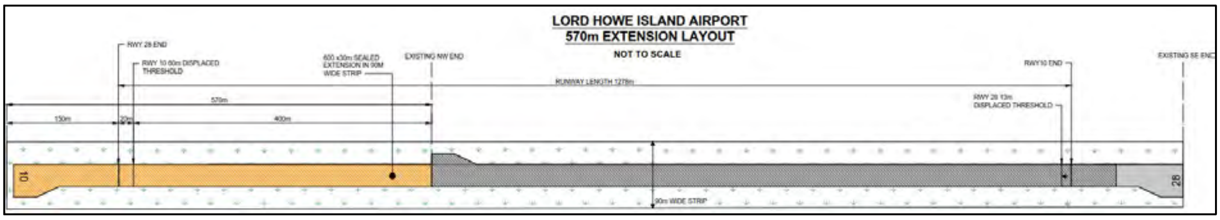
9.2 Functional Requirements

The Design Brief and the referenced *Detailed Assessment of Extended Runway Requirements and Suitable Aircraft* (Revision B, issued 20th April 2018) define the baseline functional requirements for the airfield design elements of the works.

Functional requirements for airfield design elements are summarised as follows.

The runway extension will be based on the 570m Extension layout as shown in Figure 6, the existing taxiway, apron and other infrastructure will be assessed based on a Code 3 runway strip and associated Obstacle Limitation Surfaces (OLS) surfaces being implemented.

Figure 6 570m Extension Layout



At this stage the aircraft servicing Lord Howe Island beyond 2022 is unknown, and therefore a specific design aircraft has not been adopted. Table 18 lists the candidate aircraft types and their specific design characteristics; the most onerous aircraft (shown in red) for each characteristic will be adopted for design purposes.

Table 18 Candidate Aircraft design characteristics

Aircraft	PCN	Runway Code[1]	Aircraft Code[2]	OMGWS[3](m)
Saab 340B	6	3	C	7.37
DHC8-100	-	2	C	8.49
DHC8-200	9	2	C	8.50
ATR42-500/600	9	2	C	4.68
DHC8-300	8	2	C	8.56
Fokker 50	9	3	C	7.90
ATR72-500/600	11	3	C	4.66
DHC8-400	14	3	C	9.54

Note

1. *Runway code refers to the aeroplane reference field length*
2. *Aircraft code is determined by the wing span of an aircraft*
3. *OMGWS = outer main gear wheel span*

9.3 Design Approach

9.3.1 Geometry and Grading

Modelling of the Lord Howe Island airfield design will be based on the geometric requirements of CASA, which have been split into three sections Runways (Table 19, Table 20 and Table 21), Taxiways (Table 22 and Table 23) and Aprons (Table 24).

The existing Apron will be evaluated based on the requirement that 2x DHC8-400 aircraft will need to be parked at the same time without causing any operational restrictions.

Table 19 MOS139 Runway Code Number

Code Number	Aeroplane reference field length	MOS139 reference section
1	Less than 800m	4.01.3
2	Not less than 800m	
3	Not less than 1,200m	
4	Not less than 1,800m	

Table 20 MOS139 2D Geometric Runway requirements

2D Geometric Runway Requirements	Runway Design Parameters[1]	MOS 139 reference section
Min. Runway width	30m[2]	6.02.1
Min. Runway strip width[4]	140m	6.16.5
Width of shoulders	N/A for Code C aircraft	6.10
Min. clearance of OMGWS to taxiway edge	4m	6.03.1
Graded RWY strip from CL	90m (if the runway is 30m)	6.16.2
Flyover area[3]	50m (if the runway width is 30m)	
Min. RESA length[5]	90m	6.25.5

<u>Note</u>

1. *Runway Design Parameters are based on a Code 3 Runway used by an aircraft with an OMGWS of greater than 9m*
2. *Under CAR 235A minimum runway width requirements for Dash 8 Q400 operations can be reduced by one runway width to 30m, as shown in Figure 7. This is sufficient width for all Code 3 aircraft with OMGWS under than 9m.*
3. *The runway extension is to be elevated over a body of water and therefore no physical structure is required within the flyover area, as long as no objects impinge the "Flyover area transverse slope" as defined in* ***Error! Reference source not found.***
4. *The graded area of a runway strip must extend before the threshold, and beyond the end of the runway or any associated stop way, for at least 60m.*
5. *A RESA must, as a minimum, be twice the width of the associated runway.*

COMMENT 7 – Chapter 6, Section 6.2 – Runways

CASA should also include a Note dealing with the Dash 8 Q400 aircraft type. The aircraft is a code D which should only be operated on 45m wide runways. In the 18 months the aircraft has been operating there have been no safety concerns raised by any aerodrome operator. Table should reflect that 30m wide runways are acceptable for the Dash 8 Q400.

CASA response

Disagreed. Under CAR 235A minimum runway width requirement for Dash 8 Q400 operations can be reduced by one runway width to 30m and Table 6.2–1 does not need to be changed to reflect this.

Figure 7 DHC8-400 runway width requirement (*Document NFC 139/03)*

Table 21 MOS139 3D Geometric Runway requirements

3D Geometric Runway Requirements	Runway Design Parameters[1]	MOS 139 reference section
Max. overall longitudinal slope	1%	6.05.1
Max. longitudinal slope	1.5%	6.05.2
Max. longitudinal slope changes	0.2% per 30m	6.05.6
Max. longitudinal slope on graded strip	2%	6.18.1
Sight distance	600m @ 3m above the surface	6.06.2
Transverse slopes	Maximum slope = 2.5% Minimum slope = 1%	6.07.2
Transverse slopes on shoulders	N/A for Code C Aircraft	6.10
Max. transverse slope on graded strip	2.5%	6.20.1
Flyover area transverse slope[2]	Nothing may project through an upward slope of 5% from the edge of the graded strip	6.20.3
RESA slopes	Max. longitudinal slope = 5% downwards Max. transverse slope = 5%	6.25.7

<u>Note</u>

1. *Runway design parameters are based on a Code 3 Runway used by an aircraft with an OMGWS of greater than 9m*
2. *The runway extension is to be elevated over a body of water and therefore no physical structure is required within the flyover area, as long no objects impinge the "Flyover area transverse slope"*

Table 22 MOS 139 2D Taxiway geometric requirements

2D Geometric Taxiway Requirements	Design Parameters[1] Code C aircraft	MOS 139 reference section
Min. taxiway width	23m	6.36.2
Min. taxiway strip from CL	26m	6.47
Width of shoulders	Not required for turboprop aircraft	6.43
Min. clearance of outer main wheel gear to taxiway edge	4m	6.37.2
Graded TWY strip from CL	15m	6.48

<u>Note</u>

1. *Taxiway design parameters are based on a Code C aircraft with an OMGWS of greater than 9m*

Table 23 MOS 139 3D Taxiway geometric requirements

3D Geometric Taxiway Requirements	Design Parameters[1]	MOS 139 reference section
Max. longitudinal slope	1.5%	6.39.1
Max. longitudinal slope changes	1% per 30m	6.39.2
Sight distance	300m @ 3m above the surface	6.41.2
Transverse slope	Maximum slope = 2.5% Minimum slope = 1%	6.40.2

Max. transverse slope on graded TWY strip	2.5% upwards and 5% downwards relative to the horizontal	6.49.1
Max. transverse slope on non-graded TWY strip	Should not exceed 5% upwards and downwards measure away from the direction of the TWY	6.49.4
<u>*Note*</u> 1. *Taxiway design parameters are based on a Code C aircraft with an OMGWS of greater than 9m*		

Table 24 MOS139 Apron geometric requirements

Apron Requirements	Design Parameter	MOS 139 reference section
Max. slope of Apron	2%	6.59.3
Max. slope on a designated aircraft parking position	1%	6.59.1
Min. clearance of outer main wheel gear to taxiway edge	4m	6.37.2

Existing surface levels have been adopted based on topographic survey data provided by LHIB

9.3.2 Apron Tracking

Assessment of proposed aircraft stand positions will be based on the minimum clearances stated within section *"6.57 Separation Distances on Aprons" of MOS 139. A separation distance of 4.5m is required between a Code C aircraft and an object or structure (including another aircraft).*

9.3.3 Obstacle Limitation Surface

Assessment of potential penetrations through the Obstacle Limitation Surface will be based on the CASA requirements contained within Table 7.15 of MOS139 for a Code 3 non-precision approach runway. These requirements are contained in Table 25 and illustrated in Figure 8, Figure 9 and Figure 10.

Table 25 MOS139 Code 3 non-precision approach runway OLS requirements

Surface	Requirements
Conical	Slope = 5% Height = 35m
Inner Horizontal	Length of inner edge = 140m Distance from threshold = 60m Divergence each side = 15% First section length = 3000m First section slope = 3.33% Second section length = 3600m Second section slope = 2.5% Horizontal section length = 8400m Total length = 15000m
Transitional	Slope = 20%
Take-off climb	Length of inner edge = 180m Minimum distance of inner edge from runway end = 60m Rate of divergence = 12.5% Final width = 1800m Overall length = 1500m Slope = 2%

Figure 8 Relationship of outer horizontal, conical, inner horizontal and transitional surfaces

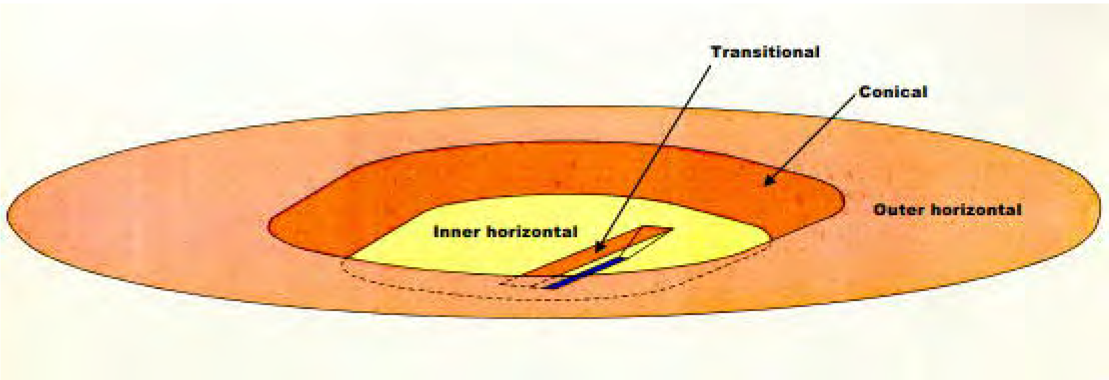


Figure 9 Approach surface for an instrument approach runway

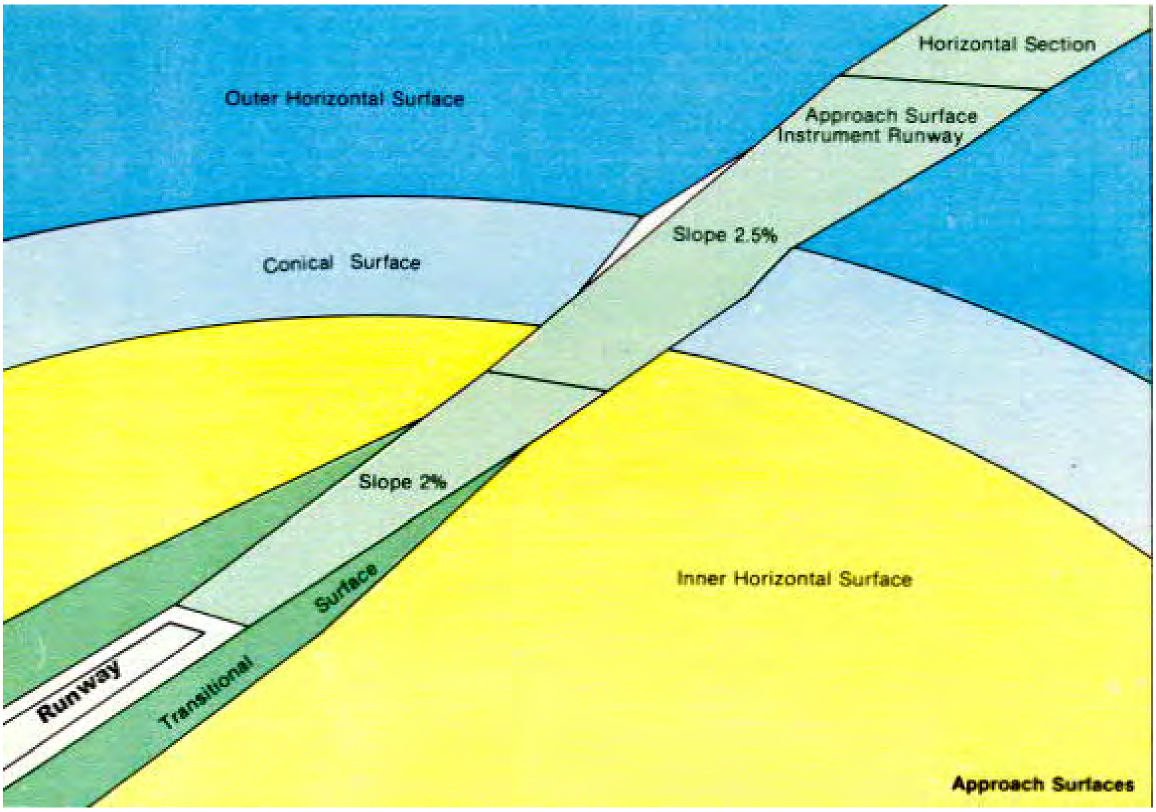
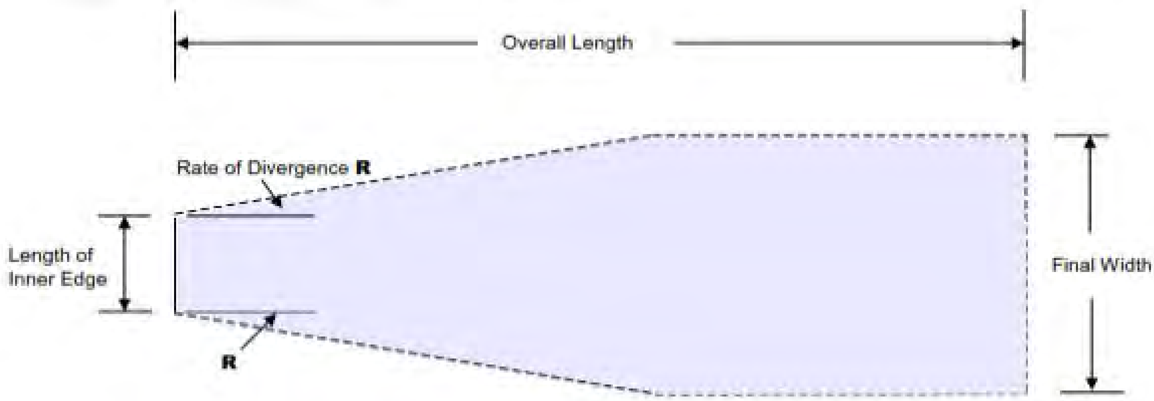


Figure 10 Take-off climb surface



9.3.4 Pavements

Pavement design at Lord Howe Island will be based on the requirements of the FAA and modelled using FAARFIELD v1.41 – Airport Design Software. At subsequent design stages a more complex analysis of the pavement design will be required using APSDS software.

A flexible pavement will be designed for the reclaimed land runway extension, for the deck on piles design the concrete deck will act as the runway pavement.

In the absence of a full 20 year fleet mix, the design traffic loading within Table 26 have been adopted for the purpose of the concept design of airfield pavements. The existing airfield pavements will also be assessed based on this traffic loading.

Table 26 Aircraft Design Traffic Loading

Aircraft	Departures			Ad-hoc flights/annum[1]	Passes to Traffic Cycles[2]	Design Period (Years)	Cumulative Passes
	Daily	Monthly	Annual				
DHC8-400	2	-	730	70	2	20	32,000
C130	-	6[3]	72	8	2	20	1600

Notes

1. *Additional ad-hoc flights have been based on 10% of the annual departures*
2. *This is based on aircraft requiring to taxi along the runway to either end prior to take off*
3. *C130 aircraft don't take on board any fuel on Lord Howe Island, and therefore have the same take-off and landing weight. There are only 3 visits per month, but both the landing and take-off are included in the pavement design.*

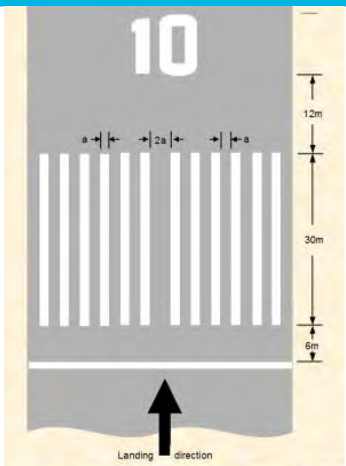
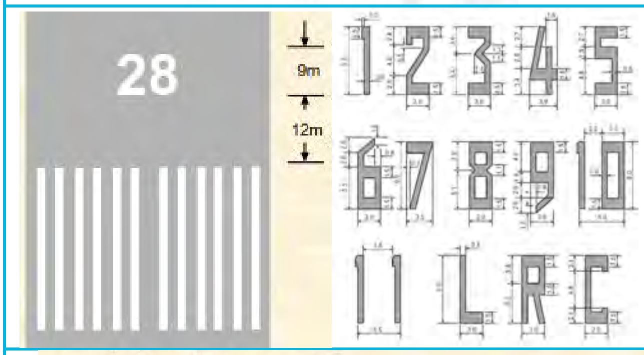
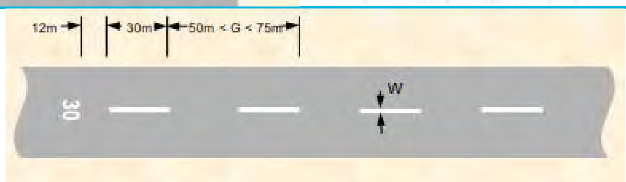
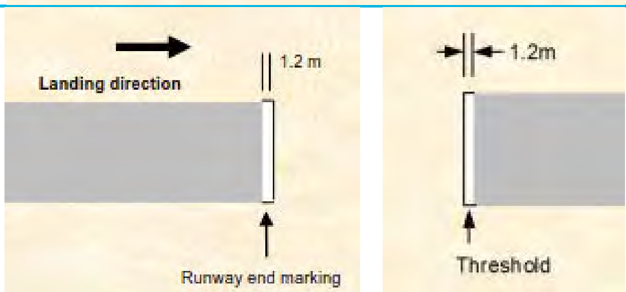
Should the existing apron not be sufficiently sized to accommodate two DHC8-400 aircraft, a rigid pavement design will be provided for the proposed apron extension.

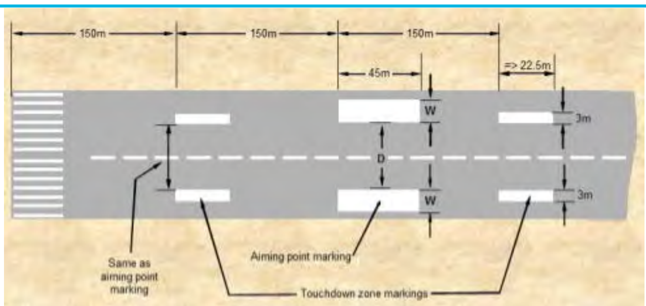
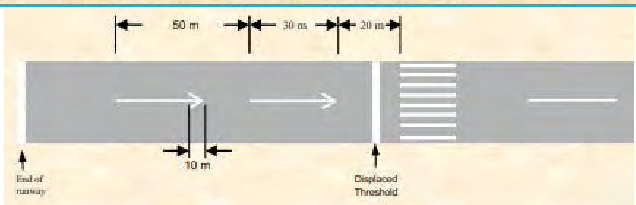
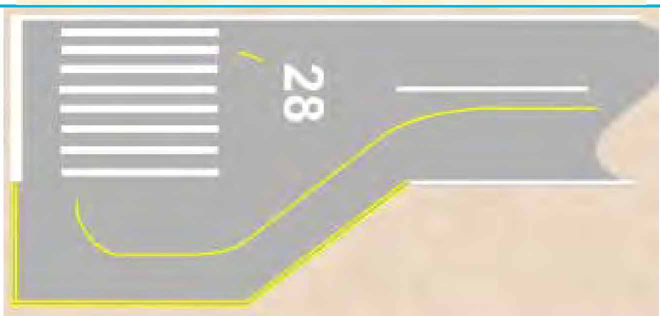
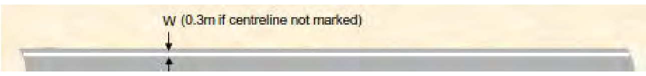
9.3.5 Line markings

9.3.5.1 Runway

The extended runway will be provided with all applicable mandatory markings, as shown in Table 27

Table 27 Runway Line Markings

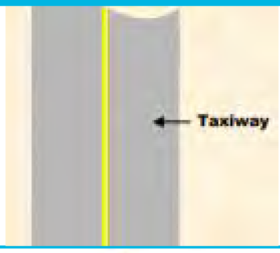
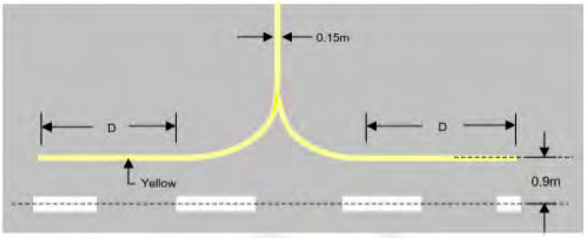
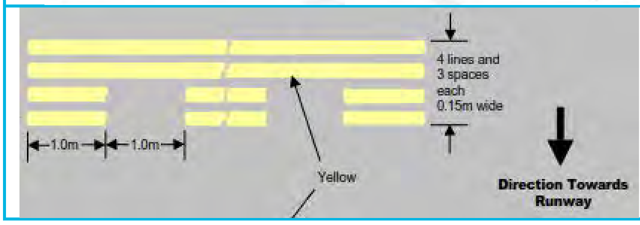
Runway Markings	Design Parameter	Reference
	<u>Threshold Markings</u> Runway width = 30m Number of strips = 8 Width of stripes (a) = 1.5m	MOS139 Section 8.17
	<u>Runway Designation Markings</u>	MOS139 Section 8.18
	<u>Centreline Markings</u> Width (w) = 0.45m	MOS139 Section 8.19
	<u>End & Threshold Markings</u> Width (w) = 1.2m	MOS139 Section 8.20

<table>
<tr>
<td>
</td>
<td><u>Aiming Point and Touchdown Zone Markings</u>
Width (W) = 6m
D = 17m</td>
<td>MOS139 Section 8.25</td>
</tr>
<tr>
<td>
</td>
<td><u>Permanently displaced threshold markings</u></td>
<td>MOS139 Section 8.26</td>
</tr>
<tr>
<td>
</td>
<td><u>Runway turn pad markings</u></td>
<td>MOS 139 Section 8.33</td>
</tr>
<tr>
<td>
</td>
<td><u>Runway starter extension markings</u>
Width (W) = 0.45m
If runway starter extension is provided, runway side stripes must be provided within the runway starter extension section.
The start of the runway starter extension before the threshold line must be marked by a transverse line with the same characteristics as the runway side-stripe marking.</td>
<td>MOS139 Section 8.34</td>
</tr>
</table>

9.3.5.2 Taxiway

The existing will be provided with all applicable mandatory markings, as shown in

Table 28 Taxiway Line Markings

Taxiway Markings	Design Parameter	Reference
	<u>Taxi guidelines</u> Width = 0.15m	MOS139 Section 8.36
	<u>Taxi guidelines on the runway</u> D = 60m	MOS139 Section 8.37
	<u>Runway Hold Position</u> To be positioned beyond the graded area of the runway strip	MOS139 Section 8.18

9.3.6 Stormwater Drainage

The FAA Advisory Circular 150-5320-5D recommends the 5-year ARI design storm event as the criteria for the design of the airfield drainage network. This criterion is often adopted in absence of any local design standards on airport drainage. The criteria from this document that will be adopted as part of the drainage design for Lord Howe Island Airport is summarised in Table 29 below.

Table 29 - Drainage Design Criteria (FAA Advisory Circular 150-5320-5D)

Design Storm Event	Design Criteria	Reference
5 year (minor event)	- No encroachment of runway (incl. paved shoulders) - No encroachment of taxiway (incl. paved shoulders)	FAA Advisory Circular 150/5320-5D 2-2.4.2
10 year (major event)	- No encroachment of centre 50% of runway - No encroachment of centre 50% of taxiway	FAA Advisory Circular 150/5320-5D 2-2.5

It is assumed that the existing drainage infrastructure servicing the airport is suitable to meet the criteria above. The additional runway extension will be drained through a separate drainage system.

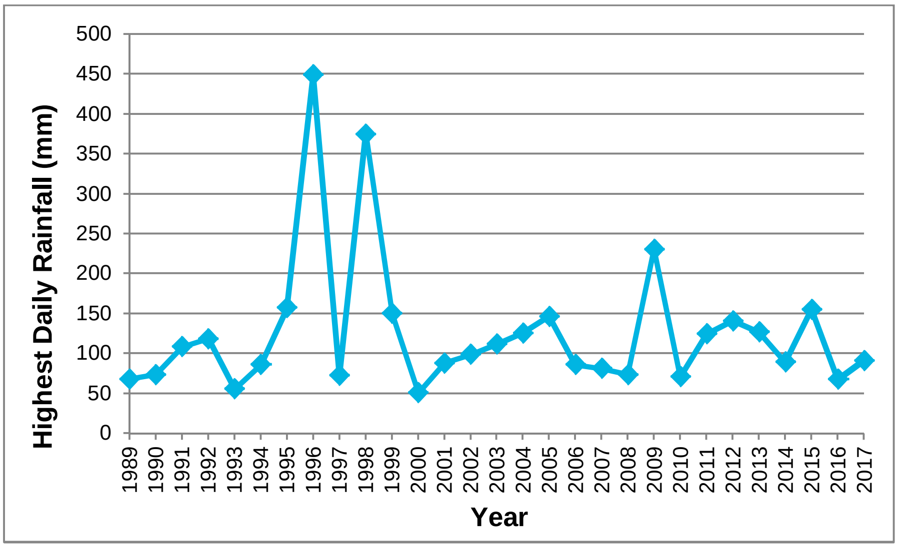
9.3.6.1 Rainfall

The Bureau of Meteorology has operated station No. 200839 at Lord Howe Island since 1988 collecting rainfall on a daily basis. The highest daily rainfall for each month for the years 1989 to 2017 is shown in Table 30 and the highest rainfall for each year is presented in Figure 11below. The data shows that the average highest rainfall for each month is 44mm and average highest rainfall for each year is 127mm. The lowest rainfall recorded was in 2000 with 50.6mm and the highest rainfall was in 1996 with 449mm recorded.

Table 30 - Lord Howe Island Highest Daily Rainfall by Month (Bureau of Meteorology Station No. 200839)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Highest Rainfall
1989	54.4	11.2	57.4	33	16.2	68.2	24.6	15.4	46.4	16.8	50.6	37.6	68.2
1990	48.4	33.2	65	73.2	69	28.8	70	73.6	45.2	53.8	24.8	20.4	73.6
1991	77.2	108.4	36.4	29.6	27	26.4	36.2	39.4	22.2	9.2	26	52.8	108.4
1992	19	47.4	33.2	38.2	36.6	28.2	24.2	18.6	27.8	27.4	33.2	118.4	118.4
1993	11.4	18	55.4	5.4	12.4	12.2	53.8	50.2	42.2	18.8	40.4	26.4	55.4
1994	63.4	11.2	45.4	46	19.4	77.4	23.4	16.2	13.8	86	30.8	35.4	86
1995	93.2	14.2	85.8	18.8	157.2	50.6	13.4	15.2	38	50	65.6	45	157.2
1996	238.6	57	33.4	48.4	10.4	449	30.6	40.4	34.2	96.6	27	17	449
1997	13.2	11	72.6	15.6	61.8	35.6	14.2	10.8	16.4	13	17.2	28.8	72.6
1998	43.6	374.6	88.8	23	60.8	100.6	29	29.2	26.2	87.2	48.4	60.6	374.6
1999	68.2	46.2	65.4	12.8	150	72	68.6	13.6	58.4	19.4	31.4	22	150
2000	25	1.4	13.8	40.8	50.6	22	30	35	13	32.4	50.2	36.8	50.6
2001	9	85	88.2	62.6	33.8	22.4	48.4	27.4	29.8	32.2	73.8	15.8	88.2
2002	26.4	53	71	99	90.8	33.4	13.8	34	35.8	21	18.2	19.2	99
2003	25	36.8	63.8	74.8	55.6	67.2	33.4	23.4	13.8	39	68.6	111.6	111.6
2004	48.8	125.8	20.4	21.8	26.6	26.4	48.4	10.4	71.6	40.2	18	42.8	125.8
2005	146.6	13	40	17.8	75.6	32.4	70.4	21.2	41.2	32.4	66.8	58.2	146.6
2006	27.6	5.6	16.4	86.2	69	33	18.2	51	33	13.6	25	22.8	86.2
2007	13.4	18.4	15.8	36.4	28.8	81.2	18	5.2	32.6	22.6	11.6	14	81.2
2008	73.6	35.6	9.4	24	28.4	24.6	54.2	33.6	35.8	18.6	48.4	25.8	73.6
2009	18.4	13.6	50	230.4	23.6	19.4	20	22	22	16.2	6.6	7	230.4
2010	41.2	13.2	27	53.6	46.4	26	46.6	34	27.8	27	3.8	71	71
2011	24.8	24.4	97.2	46.4	75.6	124.6	18.8	51.8	83.6	47.6	15.8	48.6	124.6
2012	141	60	81	78.4	86.8	33.6	49.6	31.4	35.4	24.2	43.6	8.8	141
2013	13.4	48.2	53.4	21.8	33.6	21.8	36.2	24.6	45.2	31.8	126.8	17.2	126.8
2014	8.2	5.2	21.8	16.6	18.2	37	27	38.2	47.2	89.2	22.2	54	89.2
2015	17.2	12.4	31.2	134.4	45.2	26.8	54.2	30	60.4	9.8	155.2	61	155.2
2016	40.4	25.8	17.4	31.4	15.8	23.5	37.8	48.8	67.6	24.4	26.4	12.6	67.6
2017	8	10.8	91.2	58.8	34.2	64.6	21.8	17	17.6	24	22	70.8	91.2

Figure 11 - Lord Howe Island Highest Daily Rainfall by Year (Bureau of Meteorology Station No. 200839)



To size drainage infrastructure to meet the design criteria it is important to have suitable data for different storm durations at different annual recurrence intervals. The rainfall data recorded by BOM measured every 24 hours; however it is not known what storm duration events each of the recording are from. Therefore further analysis on the data needs to be carried out to determine a complete set of rainfall data for hydraulic modelling. The table below shows the highest daily rainfall with the estimated exceedance probability based on the 29 years of recordings.

A comparison with the Sydney and Townsville 24 hour rainfall event (based on BOM AR&R87 IFD data) is all shown in Table 31 below. Sydney was chosen a suitable comparison because of its similar latitudinal position and Townsville was also selected due to its tropical climate. The comparison shows that the rainfall for an assumed equivalent ARI is lower than that of Sydney and Townsville. It is recommended that a complete AR&R87 IFD data set be adopted for the hydraulic modelling completed at the later design stages.

Table 31 - Lord Howe Island Highest Daily Rainfall Comparison (Bureau of Meteorology Station No. 200839)

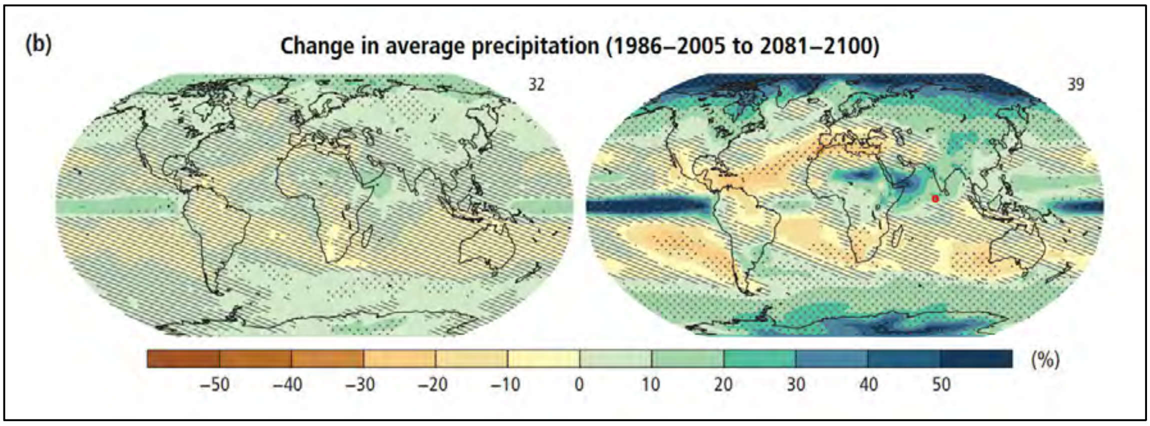
Year	Highest Daily Rainfall (mm)	Exceedance Probability	ARI	Sydney	Townsville
1996	449	0.00%			
1998	374.6	3.45%			
2009	230.4	6.90%			
1995	157.2	10.34%	10 Year	190.8	285.6
2015	155.2	13.79%			
1999	150	17.24%			
2005	146.6	20.69%	5 Year	167.52	244.8
2012	141	24.14%			
2013	126.8	27.59%			
2004	125.8	31.03%			
2011	124.6	34.48%			
1992	118.4	37.93%			
2003	111.6	41.38%			
1991	108.4	44.83%			
2002	99	48.28%	2 Year	127.92	180.72
2017	91.2	51.72%			
2014	89.2	55.17%			
2001	88.2	58.62%			
2006	86.2	62.07%			
1994	86	65.52%			
2007	81.2	68.97%			
1990	73.6	72.41%			
2008	73.6	72.41%			
1997	72.6	79.31%			
2010	71	82.76%			
1989	68.2	86.21%			
2016	67.6	89.66%			
1993	55.4	93.10%			
2000	50.6	96.55%	1 Year	98.88	137.28

9.3.6.2 Climate Change

The potential implications of climate change will be assessed with reference to the IPCC Climate Change 2014 Synthesis Report.

Review of this report indicates that average rainfall could be expected to remain the same (-10 to 10%) by 2100 (refer Figure 12). For the 50 year planning horizon, an increase of 5% in rainfall intensity will be adopted to include in a climate change sensitivity analysis.

Figure 12 - Change in average precipitation (IPCC Climate Change 2014 Synthesis Report)



Sea level rise information contained within section 0 will be adopted for the stormwater design.

10.0 Structural Deck Design

10.1 General

This section summarises the functional requirements, standards, and design criteria for the structural deck. These parameters in combination with coastal design parameters contained in section 7.0 will be used to develop a concept design for the deck, in sufficient detail for the purposes of this study, including preparation of a concept cost estimate.

10.2 Functional Requirements

10.2.1 Deck Geometry

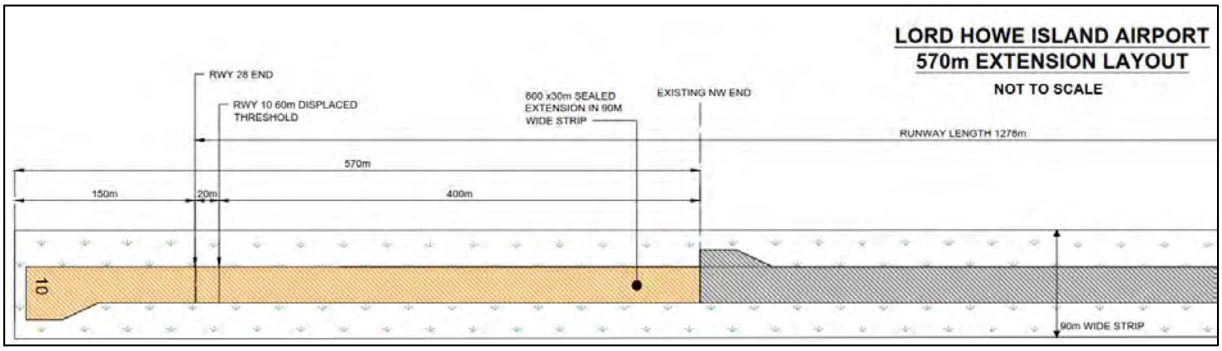
The horizontal and plan geometry of the deck surface is dictated by the requirements of section 9.3,

10.2.1.1 Plan Geometry Principle

The indicative plan geometry of the deck is shown in Figure 13 and summarised below;

- Length of deck = 570m
- Width of deck = 90m
    - Including 30m wide Runway and aircraft turning head

Figure 13 570m Extension Dimensions



10.2.1.2 Horizontal Geometry Principle

In principle the longitudinal gradient of the deck will rise from the end of the existing runway to the extent of the 570m extension. The transverse gradient of the deck will slope from down from the centreline to the outer edges.

10.2.2 Structural Form

The deck structure is required to cause minimum impact to the coastal processes. This is expected to be achieved via a deck on piles.

The deck will be connected to the existing runway via a link span to minimise the potential for differential settlement or movement at the interface.

10.2.3 Settlement and Movement Tolerances

The structural deck is to be designed for zero permanent settlements and movements under design loads. If settlements and movements occur at the seaward end of the existing runway, the link span connecting the existing runway to the structural deck will be designed to accommodate this.

Optimum economy is likely to be achieved using vertical piles to support the deck.

10.2.4 Design Deck Levels

The deck finished surface levels at the landward end shall match the existing pavement levels, which are believed to be approximately +5.0m AHD. Deck levels seaward of this interface shall be as required to minimise wave impacts on the deck and its substructure, subject to the restrictions on longitudinal and transverse gradients specified in section 9.3.1. Where possible the underside of the deck structure shall be located above the maximum predicted wave crest level for a 1 in 50 year event.

10.2.1 Deck Surface Requirements

For a concrete wearing course the runway surface shall have a broomed transverse finish, which meets the friction requirements of Table 3-1 contained in ICAO Doc 9137 Airport Services Manual – Part 2 Pavement Surface Conditions

10.2.2 Provision for Stormwater Drainage

Stormwater drainage requirements are contained in section9.3.6, the related infrastructure will be contained within the overall deck structure.

Where possible, stormwater system infrastructure shall be located above the maximum predicted wave crest level for a 1 in 50 year event.

10.2.3 Provision for Other Utilities

No provision is required for other services or utilities.

10.2.4 General design criteria and parameters

10.2.4.1 Units of Measurement

Calculations shall be in S.I. units. Units of stress for concrete and steel shall be MPa and loading intensity shall be kPa (kN/m^2). Loads shall be given in kN and moments in kN-m.

10.2.5 Structural Materials

10.2.5.1 Steel

Steel piles will be designed to meet the minimum requirements contained in Table 32, in accordance with AS4100.

Table 32 Steel Material Requirements

Grade	Yield Strength (fy)	Ultimate Strength (fu)
C350	350MPa	430MPa

10.2.5.2 Corrosion Allowances

In the tidal and splash zones, circular steel piles will be designed to be ultimately sacrificial, with transfer of stresses to a reinforced concrete plug extending to at least -3m AHD.

The outer surface of the piles will initially be coated with a protective paint system and/or a wrap system from top down to at least 1.5m below seabed level.

An additional 6mm corrosion allowance will be provided.

This combination should provide the required minimum design life without significant maintenance.

10.2.5.3 Concrete and Reinforcement

The concrete strength and reinforcement requirements contained within Table 33 will be adopted for the concept design;

Table 33 Concrete Material Requirements

Concrete Type	Concrete Strength (@ 28 days)	Steel Grade	Cover	Axial load transfer stress[1]
Reinforced in-situ	Min. 40 MPa	500MPa	Top of deck = 75mm Exposed faces = 75mm Interior surfaces = 30mm	0.248MPa
Reinforced precast	Min. 40 MPa	500MPa	Faces in tidal or splash zones = 65mm Other faces = 60mm Interior surfaces = 30mm	0.248MPa
Unreinforced	Min. 25MPa	-	-	-

Note
1. *Axial load transfer stress between the steel and concrete in the pile is limited in accordance with API Report 2A_LRFD Clause H4.3.1*

10.2.5.4 Crack control

To control cracking, reinforcement stresses are to be limited to those specified in Table 6.6 of AS4997 under the serviceability conditions (i.e. dead and 50% of the live UDL).

Table 34 Maximum Allowable Reinforcement Steel Stress at Serviceability Limit State

d_b (mm)	f_s (MPa)
≤12	185
16	175
20	160
≥24	150

10.2.6 Design Loads

The structural deck will be designed to support the loads shown in Table 35.

Table 35 Design Loads

Load	Load Type	Load Value	Description
Reinforced Concrete	Dead	25 kN/m^3 (2% of steel reinforcement)	Structural component of the deck
Steel	Dead	78.5 kN/m^3	Structural component of the deck
Deck Surcharge	Live	10kPa	For general operations and maintenance
Aircraft	Live	33 tonnes	Based on a DHC8-400
Construction	Live	400kPa	Based on a typical medium sized crawler crane

10.2.6.1 Seismic Loads

The seismic design load is based on AS 1170.4 – 2007, Amendment A2-2018.

For the purposes of the study it is assumed that the structure has a post-disaster function and therefore has an importance rating of 4, compared with a rating of 2 for a normal structure with no such requirement.

The significance of the importance rating will be checked during concept design and costing.

10.2.6.2 Design Load Factors

Ultimate Limit State (ULS) and Serviceability Limit State (SLS) load factors for various applied loadings are summarized in Table 36.

Table 36 Design Load Factors

Load Type	ULS	SLS
Dead load (DL)	1.2	1.0
Deck surcharge (LL)	1.5	1.0
Aircraft load (AL)	1.5	1.0
Construction load (CL)	1.5	1.0
Wind (Wi)	1.0	1.0
Wave (Wa)	1.0	1.0
Earthquake (EQ)	1.0	1.0
Thermal (TL)	1.25	1.0

10.2.6.3 Design Load Combinations

Design load combinations shall be in accordance with AS1170 and 4997, and are summarised below:

Table 37 Design Load Combinations

Combination Load Case Number	Combination
1	1.35 DL
2	1.2DL +1.5LL
3	1.2DL + 1.5AL
4	1.2DL + 1.5CL
5	1.2DL +0.9LL + Wi +Wa
6	0.9 DL + Wi + Wa
7	1.0DL + 0.9LL + EQ
8	0.9 DL + EQ
9	1.2DL+0.9LL + TL

11.0 Summary and Recommendations

11.1 General

This BOD report defines the functional requirements, applicable design standards and design approach adopted for the concept design.

It is recommended that the content of this BOD report is re-validated in consultation with relevant project stakeholders prior to commencement of subsequent detailed design stage.

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Appendix C

Preliminary Environmental Assessment

RUNWAY EXTENSION FEASIBILITY STUDY

PRELIMINARY ENVIRONMENTAL ASSESSMENT

Lord Howe Island Board | 30 October 2018

AECOM Imagine it. Delivered.

Preliminary Environmental Assessment

Lord Howe Island Airport Runway Extension

Client: Lord Howe Island Board

Prepared by

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Document Preliminary Environmental Assessment

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Prepared by Vi Doan and Kimberley Skellern

Reviewed by Kelly Pearsall and Andrew Cook

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Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
0	12-Sep-2018	Draft for review	Jed Mills Project Manager	
1	30-Oct-2018	Final Draft	Jed Mills Project Manager	

Table of Contents

Executive Summary

This preliminary environmental assessment has been undertaken based on a desktop review of the potential impacts of a runway extension at the Lord Howe Island Airport. Two runway extension options have been identified, a land reclamation design and deck on pile structural design. In addition to the physical runway extension, the additional civil works component required around the airfield to accommodate the operation of the largest 30+ seater candidate aircraft (expansion of the eastern turning head, widening of the taxiway, new apron, and realignment of Lagoon Road adjacent to the airstrip and associated fence line) have also investigated.

There are currently regular airline services operating from Sydney and Brisbane to the island, although the current route agreement is scheduled to end in March 2022 and Qantas have indicated they will no longer be operating the DHC8-200 aircraft servicing the island beyond this date. The existing runway at 888m long, does not allow for any candidate 30+ seater aircraft to take off or land without restrictions which limits the financial viability of the route for airline operators. Therefore an extension of the runway may be the only viable solution to ensure continuation of a 30+ seater aircraft service to Lord Howe Island.

The options analysis for the runway extension includes two design options - a land reclamation design or a deck on pile structural design. The proposed runway extension would protrude into parts of the Lord Howe Island Lagoon Sanctuary Zone. The desktop assessment carried out has determined potential environmental risks and approval risks associated with the environmental aspects of the marine and land based components of proposed works.

Environmental issues associated with the potential construction and operation of a runway extension which were identified to have a medium to high risk were assessed in this preliminary environmental assessment (PEA). Environmental impacts which are predicted to be of a high significance as a result of the project include:

- World Heritage;
- surface water (quality and hydrology);
- coastal processes;
- contamination;
- climate change and flooding;
- biodiversity and biosecurity;
- noise and vibration; and
- landscape and visual amenity.

The assessment identified that a runway extension has the potential to impact on the Lord Howe Island Group (LHIG) World, Commonwealth and State Heritage listings. Construction activities have the potential to affect the Island's heritage significance through the following;

- changing the visual amenity of the area;
- changing the land use;
- impacts to biodiversity;
- impacts to the environment by introducing pests and weed species;
- affecting water and air quality; and/or
- introducing or spreading contamination on the Island.

The assessment of significance for the potential impacts identified that Option 2 (Deck on piles) would have an overall lower level impact to the environment during compared to Option 1 (Land reclamation) for construction and operational impacts. The primary differences between the two options are the potential impacts associated with coastal processes, surface water, traffic and transport and air quality.

During operation, the assessment of significance identified that Option 2 (Deck on piles) would have an overall lower level of environmental impact compared to Option 1 (Land reclamation).During operation, Option 1 (Land reclamation) would act as a complete barrier and become an accumulation zone for sand and floating and suspended matter. This option would also impact on the wave patterns and sand volumes within the Lagoon.

The assessment involved a review of the legislative framework which is applicable to the project, and informed a relevant approvals pathway for a proposed future runway extension project. In summary, such a project would require multiple approvals at the State and Commonwealth levels, the certainty of which is not assured due to the potential approvals risks and environmental impacts associated with the project.

This PEA was limited to a desktop assessment and as such if the project is to progress, the environmental issues identified would need to be assessed in further detail including fieldwork based technical assessments. If it is decided that the runway extension would progress further, the next steps would be to begin with a formal planning application for the development, involving the preparation of a State significant scoping report to the Department of Planning and Environment (DP&E) and the preparation of an Environmental Impact Statement (EIS).

Abbreviations

Term	Meaning
AHD	Australian Height Datum
BC Act	Biodiversity Conservation Act 2016
BoM	Bureau of Meteorology
CASA	Civil Aviation Safety Authority
CLM Act	Contaminated Land Management Act 1997
CO	Carbon monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCP	Development Control Plan
DECC	Department of Environment Climate Change
EIS	Environmental Impact Statement
EPL	Environment Protection Licence
EP&A Act 1979	Environmental Planning and Assessment Act 1979
EP&A Regulation	Environmental Planning and Assessment Regulation 2000
EPBC	Environment Protection and Biodiversity Conservation Act 1999
IHO	Interim Heritage Order
ISEPP	State Environmental Planning Policy (Infrastructure) 2007
LEP	Local Environment Plan
LHIB	Lord Howe Island Board
LHIG	Lord Howe Island Group
LOR	Limit of Reporting
MNES	Matters of National environmental significance
MOWP	Methods of Work Plans
NEPM	National Environmental Protection Measures
NOTAM	Notice to Airmen
NPW Act	National Parks and Wildlife Act 1974
OEH	Office of Environment and Heritage
OLS	Obstacle limitation surface
PEA	Preliminary Environmental Assessment
PFAS	Per-and poly-fluoroalkyl substances
PIR	Preferred Infrastructure Report
PM	particulate matter
PMST	Protected Matters Search Tool
PoEO	Protection of the Environment Operations Act 1997
RCPs	Representative Concentration Pathways
RPT	Regular Public Transport
SEPP	State Environmental Planning Policy
SHR	NSW State Heritage Register
UNESCO	United Nations Educational, Scientific and Cultural Organization

1.0 Introduction

The Lord Howe Island Board (LHIB), a statutory authority responsible to the NSW Minister for the Environment, is undertaking a feasibility study of a proposed runway extension at the Lord Howe Island Airport. AECOM Australia Pty Ltd has been engaged to undertake a number of services as part of this feasibility study, including geotechnical investigations, the preparation of design options, construction cost estimations, environmental review of the identified options and a preliminary business case.

1.1 Purpose

This preliminary environmental assessment (PEA) provides an initial review of the potential impacts of the two design options developed for the proposed runway extension. The proposed runway extension would be constructed from the western extent of the existing runway. At this stage there are two design options:

- a land reclamation design – Option 1; and
- a deck on pile structural design – Option 2.

This PEA has been prepared on the basis of desktop research and a site visit to identify potential approval risks, environmental risks and environmental impacts that may be associated with the construction and operation of both the marine and land based components of the proposed runway extension for both design options.

This PEA will be utilised by the LHIB in their decision making and will form part of the preliminary business case for the project.

1.2 Overview of the project

Regular airline services currently operate from Sydney and Brisbane to Lord Howe Island, although the current route agreement is scheduled to end in March 2022. Qantas, currently providing between 1-3 flights per day to Lord Howe Island, has indicated they will no longer be operating the DHC8-200 aircraft which is currently servicing the island beyond this date.

The existing runway at 888 metres long provides insufficient length for 30+ seater aircraft commercially operating in Australia for take-off and landing without weight restrictions which places a limit on the financial viability of the route for airline operators. **Figure 1-1** shows the existing airport layout.

Figure 1-1 Aerial photo of the existing airport layout

In order to ensure an appropriate 30+ seat candidate aircraft (ATR 72 or DHC8-400) is able to operate to the island; the existing airfield requires significant upgrades to meet Civil Aviation Safety Authority (CASA) standards.

As recommended in the *Detailed Assessment of Extended Runway Requirements and Suitable Aircraft* report (AECOM 2018a) a 570 metre physical extension to the western end of the existing runway into the Lagoon has been adopted for the concept design. In order to meet CASA requirements, the physical extension has been designed to be a minimum of 90 metres wide, which includes a 30 metre wide runway pavement.

Two design options are being considered for the extension (refer to *Concept Design Report* (AECOM 2018)), which are both assessed in this PEA. The two design options are described further is **Section 3.0**.

2.0 Project location

Lord Howe Island is located in the Tasman Sea approximately 590 kilometres east of Port Macquarie and 790 kilometres north-east of Sydney. The island is part of the Lord Howe Island Group (LHIG).

2.1 Site description

The island was first settled in 1834 when three couples arrived from New Zealand. The existing airstrip was opened in 1974 which enabled twin-engine planes to begin flying to the island. As of 2016, there are 382 people living on Lord Howe Island (ABS 2016). The number of tourists on the Island at any one time is capped at 400 under the *Lord Howe Island Local Environment Plan 2010.* This is to ensure that stress on infrastructure and environmental impact is minimised and to maximise amenity.

Lord Howe Island airport is located in a 500 metre wide central section of the Island, between the Lagoon and Blinky Beach. This area is flat, with an elevation ranging from 3.1 to 4.5 m Local AHD. The airport is bounded by Lagoon Road.

The LHIG is a volcanic remnant that was included as a World Heritage Area in the UNESCO World Heritage List in 1982, as "*an outstanding example of oceanic islands of volcanic origin containing a unique biota of plants and animals, as well as the world's most southerly true coral reef*". Other significant values of Lord Howe Island include the landscapes, volcanic mountains, and diverse low-lying rainforests, palm forests and grasslands. There are also colonies of endangered seabirds and many species of native plants, many of which are endemic to Lord Howe Island.

The LHIG is one of six world heritage listings in NSW and comprises Lord Howe Island (main island), Admiralty Islands, Mutton Bird Island, Gower Island, Ball's Pyramid, and associated coral reefs and marine environments. Lord Howe Island is crescent shaped, approximately 11 kilometres long and 2.8 kilometres wide at its widest point (refer to **Figure 2-1**). The island encloses a coral reef Lagoon on the south-west side and is the only island within the LHIG with a settlement.

The proposed runway extension would be located on the western side of Lord Howe Island within the coral reef Lagoon, extending north-west of the existing airport runway.

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FIGURE 2-1 THE LORD HOWE ISLAND GROUP

AECOM

Legend

Lord Howe Island Airport

Source:

3.0 Project description and options

3.1 Project components

As recommended in the *Detailed Assessment of Extended Runway Requirements and Suitable Aircraft* (AECOM 2018) a 570 metre long and 90 metre wide physical extension to the existing western end of the runway has been adopted for the concept design.

The Lagoon sea bed level within the extension footprint is significantly lower than both reclaimed land (Option 1) and the deck on pile (Option 2) options.

The runway extension project includes the following components:

- runway extension (Option 1 and Option 2) – refer to **Figure 3-1**;
- existing turning head extension;
- existing apron extension;
- existing taxiway widening; and
- existing Lagoon Road adjacent to the airstrip realignment.

FIGURE 3-1 PROJECT COMPONENTS

0 100 200 m

Legend

- Extent of flyover area
- Extent of runway strip
- Terminal building
- Aircraft stand
- Existing island road
- New aircraft pavement
- Deck on piles or reclaimed land

Source:

3.2 Construction timing

The indicative duration for construction is expected to be up to 18 months for Option 1 (Land reclamation) and up to 12 months for Option 2 (Deck on piles). For both runway extension options, it is expected that unrestricted access for construction during daylight hours will be limited to four consecutive days per week for the duration of the construction period, as was the case during the 2015 runway overlay project. However, this would need to be agreed upon by the incumbent operating commercial airline. Flights to and from the airport would operate on the remaining three days per week.

The airport does not operate at night. Access for construction activities at night may be possible, subject to other constraints, approvals and community consultation.

Construction activities during both day and night may be limited during the breeding season of certain migratory birds, marine mammals and sea turtles. As a minimum, noise restrictions are expected to apply during any night works. It is assumed that over-water pile driving will not be allowed at night, although quieter construction activities such as welding, steel fixing and concrete pouring may be considered.

Light spill restrictions are expected to apply during night time construction activity.

Vibratory equipment may be required in place of piling hammers, as restrictions on significant underwater vibrations due to pile driving may apply, for example, during sea turtle seasonal restrictions where sea turtles migrate to tropical and temperate waters such as Lord Howe Island to breed.

It is assumed that there is no local availability of construction plant or materials and as such these must be brought in by air or by sea. There are very limited construction personnel on the island, requiring the majority to be brought in from the mainland.

The island is serviced by the MV Island Trader vessel which runs freight between Port Macquarie and Lord Howe Island on average every two weeks. The vessel enters the Lagoon at high tide before ballasting down to sit on the seabed at the island's only wharf during cargo transfer. The use of a wharf structure was previously deemed unsuitable for construction of the runway overlay project in 2015 due to concerns over its structural loading capacity. The construction contractor delivered plant and material via shallow barges across the Lagoon which docked at the south-west extent of the runway.

Limited onshore area is available for the storage of construction plant and materials, and this may be required to be stored on barges moored outside the reef until a sufficient portion of the runway extension has been constructed to provide the required storage area without penetrating the airport's obstacle limitation surface (OLS).

3.3 Runway extension: Option 1 – land reclamation design

3.3.1 Description

The land reclamation design of the runway extension portion of the project would involve the construction of a rubble/concrete berm with rock armour structure, and a wave trip structure adjacent to the rock armour structure.

3.3.1.1 Sea wall structure

The rock armour structure has been designed as a conventional double layer rubble structure, with fill underneath. The rubble and concrete fill is separated from the rock armour by a layer of geotextile.

Rock armour is carried over the crest of the berm structure, with a pre-cast concrete head wall installed.

3.3.1.2 Wave trip structure

A wave trip structure made out of rubble with a primary rock armour layer is proposed along and beyond the western and southern edges of the runway extension in order to prevent inundation of the runway due to wave movements. The trip structure would absorb wave energy and break the waves, with the resultant wave reduced in height beyond the trip structure, towards the sea wall structure.

The structure is proposed to be located 50 metres offshore from the runway to provide a body of water that would absorb the wave breaking as shown in **Figure 3-2**.

It is noted that this element of the design will need to be revisited in subsequent design stages using physical modelling to refine and assess the wave interactions with the structures.

3.3.1.3 Drainage system

The stormwater design system is considered as best practice given that the surface water from the additional runway extension will be drained through the use of grated drains along both edges of the runway extension, falling into pits spaced at 120 metre centres with outflows onto the seawall rock armour.

The runway drainage pits have been designed to intercept both oil and sediments through the use of an internal dividing wall. To ensure that collected fuel spills do not flow into the downstream drainage system, a constant water level needs to be maintained above the centre berm. The airport's operation crew, whilst conducting regular routine maintenance, will therefore need to ensure that the water level is kept at a minimum 0.4 metres from the invert of pit. The oil and sediment collection will also need to be included as part of the regular maintenance.

Where stormwater discharge has the potential to cause scouring of the seabed, scour protection will be provided. An example of this is a sand-filled geotextile mattress, which can simply be laid on the seabed and will automatically adjust to variations in the shape of the seabed.

3.3.2 Construction

Construction of the land reclamation option for the runway extension would involve the following activities and methodology:

1. construction will begin onshore, creating access as it progresses;
2. good quality fill material will be tipped over the "end" of the reclamation with reworking of the external faces. The quality of the fill material is used given the location of the works being in an extremely sensitive marine environment;
3. to manage turbidity, perimeter bunds will be constructed initially using high grade clean fill to allow confined placement of the remaining material. If perimeter bunds are used, back filling can be undertaken in a controlled environment. Silt curtains may be required;
4. as works progress the external faces will be armoured with the final armour solution;
5. material placed below the water level cannot be directly compacted and therefore compaction will begin once fill material is above the water level;
6. the use of granular fill should limit the risk of delayed settlement issues, although the use of overburden may be required to bring about final settlement of fill and underlying soils. However the materials on this project should not require extended periods of loading to achieve settlement (a method used with cohesive sediments);
7. after compaction is achieved, the surface of the fill material will be trimmed and airport civil works would commence (drainage, pavements, etc.); and
8. the trip structure would be constructed using floating plant or by working outwards from the shoreline if existing depths are too restrictive, largely independent of the runway works. This structure does not utilise fill and the methodology is primarily place and trim the relevant armour material.

The importation and transfer of large volumes of material may likely result in damage to local infrastructure. A pre and post construction condition assessment may need to be undertaken and it is anticipated that the repair and remediation may also need to be undertaken on roads and marine facilities if and where necessary.

3.3.2.1 Fill requirements

The construction of the reclaimed land runway extension will require a large volume of fill (~280,000m^3). The fill material requires good geotechnical properties to provide a suitable compacted base for the runway construction. Key features of the good quality fill material:

- fill placed below the water level must be granular to allow saturated compaction under overburden;
- unconfined fill in the Lagoon must be clean (low fines content) to minimise plume impacts;
- fill needs to have suitable engineering properties near the surface to facilitate airport works and maintenance (California bearing ratio (CBR) 10%-15%); and
- fill material is required to be sterilised for bio security purposes.

If fill could be sourced locally by dredging or from a land based source this would provide the project with an affordable, logistically simple solution. However the potential environmental impacts and approval requirements for such a solution would require further consideration.

At this stage it is understood that fill cannot be sourced from Lord Howe Island or adjacent waters. As such fill will need to be imported. Importing fill provides opportunity to be more selective about the fill quality used. Industrial scale civil suppliers from anywhere in the region (Australia, New Zealand, New Caledonia etc.) could be used, opening up an opportunity to adopt a material that is best fit for purpose at market driven prices. The logistical and handling risks for remote material sources are the double and triple handling of material onto and off barges at remote locations and long-distance haulage and the spill risks associated with this at those locations.

It has been assumed that no local or remote dredging would be undertaken for the project.

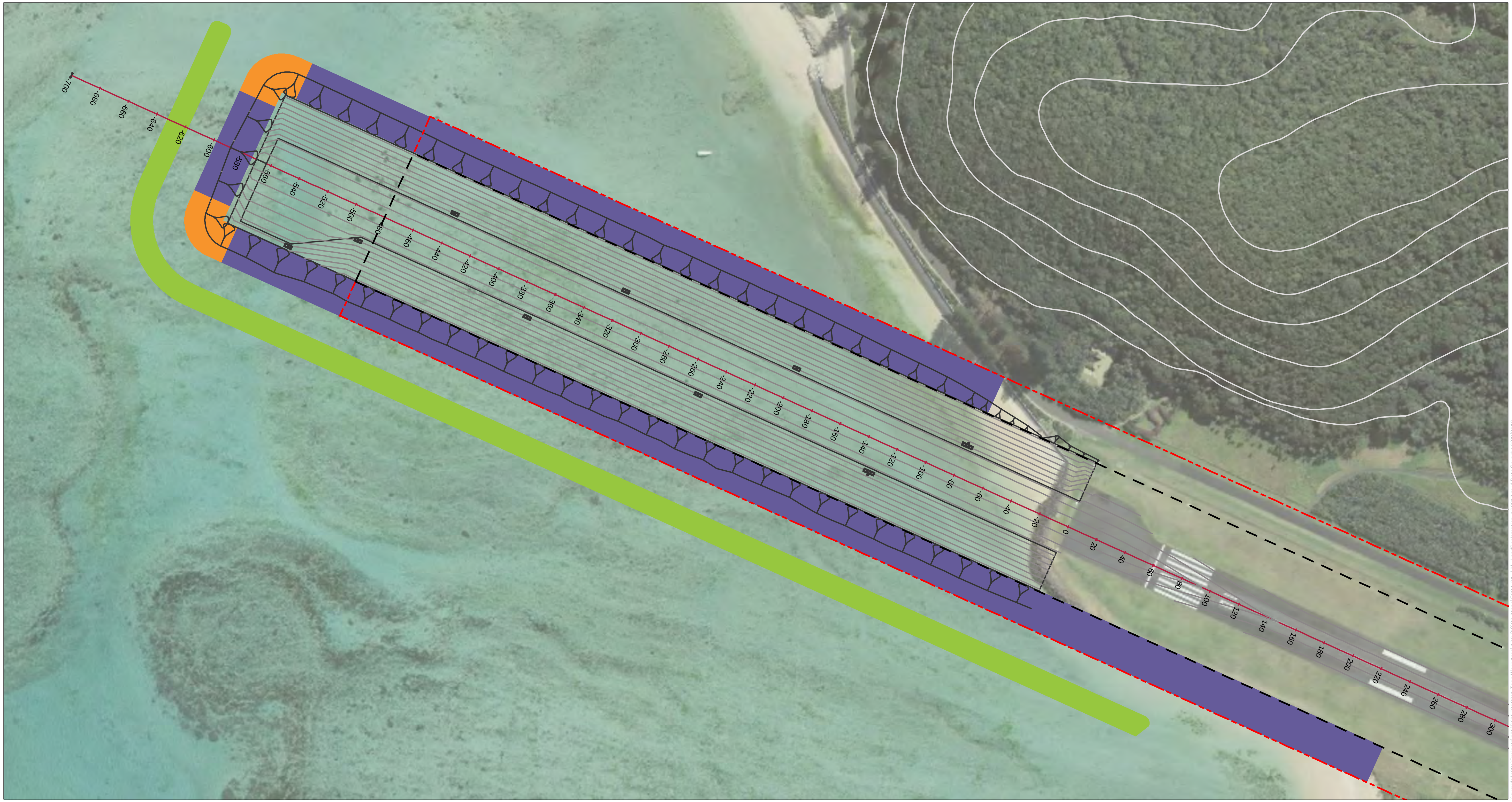


FIGURE 3-2 RUNWAY EXTENSION OPTION 1 – LAND RECLAMATION

Legend

- Extent of flyover area
- Extent of runway strip
- Design contour
- Existing contour
- Trip structure
- Seawall - Type 1
- Seawall - Type 2

Source:

3.4 Runway extension: Option 2 – deck on pile

3.4.1 Description

The deck on pile option would comprise precast concrete deck panels supported on precast reinforced concrete beams and steel pile footings. No wave trip structure is required for the deck on pile option. **Figure 3-3** illustrates the runway extension for Option 2, with the flyover area outlined in red.

This option would maximise the scope for prefabrication and minimise on-site construction time.

The deck panels are fixed to the beams via *in situ* small concrete pours. The main deck support beams run parallel to the runway 6 metres apart, and are supported on piles 8 metres apart.

Typically the beams would be 1.1 metres wide and 1.2 metres long. Some of the beams may be slightly wider (around 1.3 metres) in order to accommodate drainage infrastructure and to support deck panels designed for crawler crane access during construction.

3.4.1.1 Pile system

The piles comprise steel tubes of 0.6 metres diameter, with a wall thickness around 16 millimetres. Reinforced concrete plugs will be poured inside the piles, extending from the soffit (overhanging section) of the beams down to approximately RL-1.0m Australian Height Datum (AHD). The piles would be approximately seven to 10 metres deep into the seabed (this is subject to further geotechnical investigations).

The piles will either be pre-coated with a suitable paint system, or will be wrapped with a proprietary protection system after installation which would extend to the seabed.

Sheet piles would be used during construction around the abutment at the landward connection (i.e. closer to the existing runway).

3.4.1.2 Wave action consideration

Due to the low level of the existing runway, the inshore section of the deck structure will be subject to wave action during extreme events. These will reduce as the deck rises seawards.

3.4.1.3 Drainage system

The additional runway extension will be drained through the use of grated drains along both edges of the runway falling into pits spaced at 120 metres centres. The deck on pile extension option will have the drains inbuilt into the deck infrastructure, the outlet pipes from the pits discharging vertically downwards into the Lagoon. The runway drainage pits have been designed to intercept both oil and sediments through the use of an internal dividing wall. As with the land reclamation option, a constant water level needs to be maintained above the centre berm to ensure that collected fuel spills do not flow into the downstream drainage system. The airport's operation crew, whilst conducting regular routine maintenance, will therefore need to ensure that the water level is kept at a minimum 0.4 metres from the invert of pit. The oil and sediment collection will also need to be included as part of the regular maintenance.

3.4.2 Construction

3.4.2.1 Piles

Piles will be fabricated and coated offshore (most likely in Asia) and brought in by a large barge; several trips will be required over the piling period. This barge will moor outside the Lagoon. The piles will be offloaded using a smaller crane barge, which will transfer the piles to the island wharf or south-west extent of the runway.

The piles will be unloaded onto chassis for transport to a pile storage area adjacent to the airfield. The piles will be offloaded from the chassis using a small mobile crane or fork lift. The piles will be stacked, using packing to protect the pile coating.

When required, the piles will be loaded onto a chassis and delivered to a hammer piling rig via a temporary runway perimeter road (to avoid plant deliveries using the runway). A small stockpile of piles will be maintained at the piling rig in order that piling can continue during airport operating hours (subject to OLS restrictions), when shore access to the work front would be restricted.

3.4.2.2 Deck slab units and deck beams

Reinforced concrete deck slab units and deck beams will be prefabricated offshore (likely in Australia or NZ) and will be brought to the island via a barge. The slab units will be offloaded in similar fashion to the piles, and delivered to a storage area adjacent to the airfield.

As for the piles, a small stockpile of deck units and beams will be maintained at the work front to enable construction work to continue during airport operating hours.

3.4.2.3 Construction sequence

The concept design is based on construction using large crawler cranes which will operate over specific deck spans designed for this purpose. Construction will commence at the Lagoon end of the existing runway strip, working progressively seaward. This will only occur outside of airfield operations in order to avoid OLS infringements.

Initial construction will focus on a 30 metre wide section which will act as a roadway for construction activities. Construction will be by hand-over-hand installation of piles, beams and deck units, using a large crawler crane travelling on the central span. The crawler crane will be of sufficient size to reach an additional two spans each side; these will be completed as required to provide access for other construction plant, and for temporary stockpiling of materials on the extension, subject to OLS restrictions.

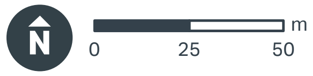
Once the initial 30 metre wide section has been constructed 450 metres beyond the end of the existing runway, the crawler crane (assumed 15 metre height) will no longer infringe upon the OLS, therefore multiple construction fronts can be opened up using the designated crawler crane spans to move laterally as well as longitudinally.

Contractor’s plant and material stockpiles can be based at the outer end of the runway extension, clear of the OLS. As more deck area becomes available, more plant and materials can be stockpiled subject to height and runoff limitations, minimising conflict between airport operations and materials delivery.

Pile driving will be the activity most affected by the OLS, due to the crane boom height required. This is dictated by pile length, with a boom height in the order of 25 metres potentially being required. In addition, for safety reasons, piling is usually only carried out during daylight and will be managed around aircraft flight schedules.

As previously stated the installation of beams and deck units will not require the same crane boom height (around 15 metres should suffice), and could be carried out under artificial light, subject to environmental and amenity constraints.

FIGURE 3-3 RUNWAY EXTENSION OPTION – DECK ON PILES



Source:

Legend

- - - Extent of flyover area

— · Extent of runway strip

3.5 Other project components

3.5.1 Turning head extension

The turning head at the south-eastern end of the existing runway would require an additional 445m^2 of aircraft pavement to ensure larger aircraft have sufficient space to turn around.

3.5.2 Apron extension

An addition 7,275m^2 of apron pavement is required. The new apron has been sized to accommodate two DHC8-400 aircraft (refer to **Figure 3-4**), based on the following scenarios:

- Lord Howe Island continues being serviced by two aircraft per day; or
- Lord Howe Island is serviced by 1 aircraft per day, and a second aircraft may be required to transport an engineer or parts for another broken down aircraft.

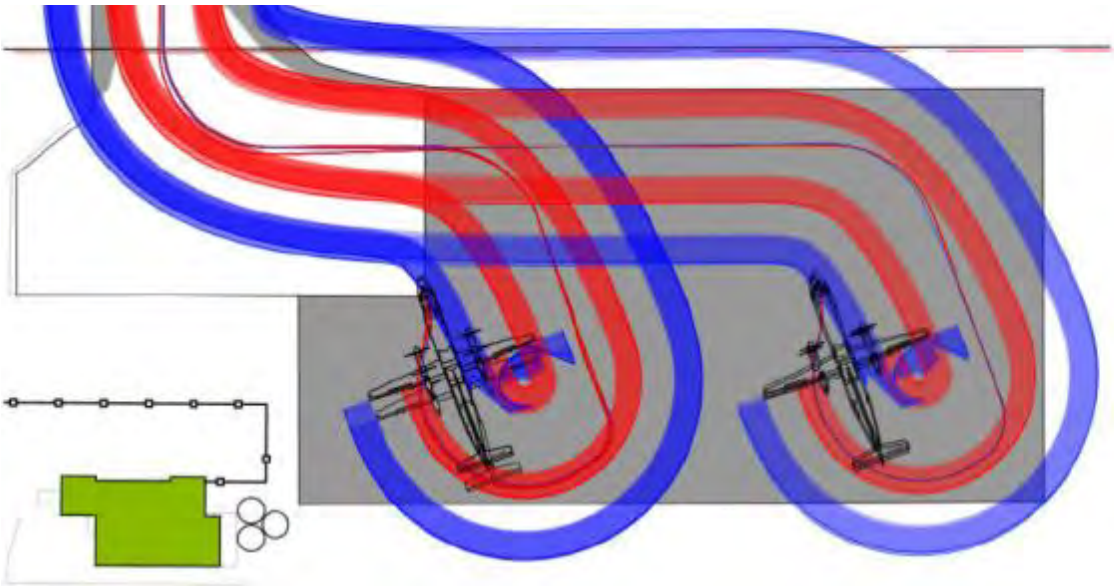


Figure 3-4 Apron layout and tracking

It is assumed there will continue to be aircraft refuelling operations required on Lord Howe Island; therefore the stormwater drainage infrastructure for the additional 7,275m^2 of apron pavement will include a downstream oil/water interceptor with a treatment flow rate of 130L/s for fuel spill mitigation purposes.

3.5.3 Taxiway widening

The taxiway between the existing runway and aircraft apron is currently 15 metres wide and would need an additional four metres of new aircraft pavement to be constructed on each side to accommodate larger aircrafts.

3.5.4 Lagoon Road adjacent to the airstrip traffic changes

The portion of Lagoon Road adjacent to the airstrip (refer to **Figure 3-5** and **Plate 7** of **Appendix C**) and existing security fence are currently located within the 'fly-over area plane' of the runway strip. In order to avoid vehicles and the fence line impinging the 'fly-over area plane' and OLS restrictions a new road alignment and fence line are to be constructed beyond the extent of the 'fly-over area' footprint. The current realignment of the road would result in the removal and some trimming of the vegetation (including Kentia palms) currently located north of the road, the alignment could be changed during subsequent design stages once accurate topographic survey information is available.

Figure 3-5 Lagoon Road adjacent to the airstrip (SIX Maps)

3.5.5 Drainage system

It is assumed that the existing drainage infrastructure servicing the airport is suitable to meet relevant drainage design criteria.

The only existing form of stormwater treatment at the airport is at the southern end of the runway which drains through a water course containing mangroves prior to discharging. It is recommended that prior to discharging into the ocean, any runoff from new pavement areas is collected and any oil or sediment is removed prior to discharging into the ocean.

3.5.6 Other

In addition to the above works, the following minor works would be completed:

- removal of existing paint markings along the existing taxiway, runway and apron;
- addition of new white and yellow paint markings along the taxiway, runway, apron and new runway extension;

The following works may be required either as part of the project or under a separate approval process:

- upgrade of wharf to north of the airport (refer to **Figure 2-1**), subject to the contractor's transportation methodology;
- terminal expansion and upgrade to meet new security requirements; and
- perimeter fence upgrades to meet new security requirements.

3.6 Indicative cost estimates

Initial cost estimates have been completed to +/- 30% accuracy for both options. Option 1 (Land reclamation) is estimated to be approximately $300 million to design and construct, whereas Option 2 (Deck on piles) is approximately $187 million.

Given that development has a capital investment value of more than $30 million and is included in Schedule 1 of the *State Environmental Planning Policy (State and Regional Development) 2011* (refer to **Section 5.2.3**), the project is considered to be a State Significant Development (SSD).

4.0 Methodology

This PEA has been based on a desktop assessment which identified potential environmental impacts and future planning approval pathways for the two runway extension design options. This included a review of publicly available information and databases, and previous investigations undertaken for relevant projects on Lord Howe Island to identify general environmental issues to be considered for the two runway extension design options. An environmental risk rating process was applied to identify those impacts that are likely to be associated with a medium to high risk to the environment (refer to **Section 7.6**). Those issues rated with a medium to high risk were then further assessed in **Section 9.0**, while environmental issues with a 'nil' or 'low' risk rating were not considered further in this assessment.

An assessment of the potential construction and operational environmental impacts associated with the two runway extension design options was undertaken. The level of significance of those potential impacts was determined (where possible) with respect to each design option (refer to **Section 8.0**).

Recommendations have been made where the need for further field-based investigations or studies may be required in order to assess specific environmental issues for the project.

5.0 Statutory framework

5.1 Commonwealth

5.1.1 Environment Protection and Biodiversity Conservation Act 1999

The *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides the legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places. These are defined in the Act as: 'matters of National environmental significance' (MNES), which include:

- World Heritage properties;
- National Heritage places;
- wetlands of international importance (listed under the Ramsar Convention);
- Nationally threatened species and ecological communities;
- migratory species;
- Commonwealth marine areas;
- Great Barrier Reef Marine Park;
- nuclear actions (including uranium mining); and
- a water resource, in relation to coal seam gas development and large coal mining development.

A search of the EPBC Protected Matters Search Tool (PMST) was conducted for the study area, including a 1 kilometre buffer. The PMST search identified:

- 1 World Heritage property – Lord Howe Island Group consisting Lord Howe Island (main island), Admiralty Islands, Mutton Bird Island, Gower Island, Ball's Pyramid, and associated coral reefs and marine environments;
- 1 National Heritage place – Lord Howe Island Group, detailed as above;
- 45 listed threatened species;
- 42 listed migratory species; and
- 43 listed marine species.

Refer to **Section 7.1** and **Section 7.5** for the discussion of the World Heritage listing and existing biodiversity.

Under the EPBC Act, proposed 'actions' that have the potential to significantly impact on MNES, the environment of Commonwealth land or actions that are being carried out by a Commonwealth agency, must be referred to the Commonwealth Government.

Assessments of significance based on criteria listed in Significant Impact Guidelines 1.1 issued by the Commonwealth (2013) are used to determine whether the proposed action is likely to have a significant impact (i.e. is likely to be considered a 'controlled action').

If the Commonwealth Minister for Environment and Energy determines that a referred project is likely to have a significant impact on a matter protected by the EPBC Act, (controlled action), the approval of that minister would be required for that project.

If a proposal requires approval under the EPBC Act, the proposal may be assessed by the NSW Government under the bilateral agreement between the Commonwealth and NSW Government under section 45 of the EPBC Act. In this case, the NSW Government assesses the proposal and prepares an Assessment Report and recommendation for the Commonwealth on whether the development should be approved, and what conditions should apply, considering impacts to MNES. The Commonwealth Government would then need to grant approval for the controlled action.

5.2 State Legislation

5.2.1 Environmental Planning and Assessment Act 1979

The Environmental Planning and Assessment (EP&A) Act is the primary legislation that governs land use and provides a framework for development control and environmental assessment in NSW. The EP&A Act is supported by the Environmental Planning and Assessment Regulation 2000 (NSW) (EP&A Regulation) and a number of Environmental Planning Instruments (EPI) which include State Environmental Planning Policies (SEPP) and Local Environment Plans (LEP).

Part 4 of the EP&A Act establishes a framework for assessing development that requires consent under an EPI. It allows development to be classified as 'development that does not need consent', 'development that needs consent', or 'prohibited development'. The term 'development' is defined under section 1.5 of the EP&A Act.

The project is considered to fall within the definition of 'development' as it involves categories of development, including 'the use of land' and the 'carrying out of a work'. The project is considered 'development that needs consent' and is classified as State significant development (refer to **Section 5.2.3**).

Section 5.5 of the EP&A Act requires the determining authority to take into account to the fullest extent possible, all matters affecting or likely to affect the environment. The environmental impact of the works would need to be assessed in an environmental impact statement taking into consideration the factors listed under clause 228 of the EP&A Regulation. These environmental matters would need to be assessed in order to satisfy the necessary environmental assessment requirements under the EP&A Act.

5.2.2 State Environmental Planning Policy (Infrastructure) 2007 (ISEPP)

Under the ISEPP, the project would be defined as development for the purpose of an 'airport', which includes a place used for the landing, taking off, parking, maintenance or repair of aircraft (including associated buildings, installations, facilities and movement areas and any heliport that is part of the airport).

Part 3, Clause 22 (1) of ISEPP states that "*development for the purpose of an airport may be carried out by or on behalf of a public authority without consent on land in any of the following land use zones or in a land use zone that is equivalent to any of these zones:*

a) RU1 Primary Production,

b) RU2 Rural Landscape,

c) IN4 Working Waterfront,

d) SP1 Special Activities,

e) SP2 Infrastructure,

f) W2 Recreational Waterways,

g) W3 Working Waterways."

Under the Lord Howe Island LEP, the land in the area of the proposed runway extension is zoned:

- Zone 5 Special Uses
- Zone 7 Environment Protection
- Zone 9 Marine Park

As only Zone 5 Special Uses may be equivalent to the land use zones listed in Clause 21(2) of ISEPP, proposed future runway extension works for an airport cannot be carried out by a public authority without consent under the ISEPP.

5.2.3 State Environmental Planning Policy (State and Regional Development) 2011

State Environmental Planning Policy (State and Regional Development) 2011 (SRD SEPP) identifies development that is State Significant Development (SSD), State Significant Infrastructure (SSI) and critical SSI based on the magnitude of the development and the likelihood of significant impacts resulting from the development.

Section 4.12(8) of the EP&A Act states that a "*development application for State significant development or designated development is to be accompanied by an environmental impact statement*

(EIS) prepared by or on behalf of the applicant in the form prescribed by the regulations". Schedule 2 of the EP&A Regulation sets out the requirements of an EIS and requires that the content of an EIS is "*subject to the environmental assessment requirements that relate to the EIS*".

Clause 8(1) outlines the criteria for a development to be considered SSD as:

a. the development on the land concerned is, by the operation of an environmental planning instrument, not permissible without development consent under Part 4 of the Act, and

b. the development is specified in Schedule 1 or 2.

Given that development for the purposes of air transport facilities has a capital investment value of more than $30 million is included in Schedule 1, and as outlined in section 5.2.2 the project is not permissible without development consent, the project is therefore considered SSD under clause 8(1) of the SRD SEPP.

The project requires approval from the NSW Minister for Planning under Section 5.14 of the EP&A Act, as it is SSD. A SSD scoping report would need to be prepared to support an application to DP&E for the project under section 5.15 of the EP&A Act. This PEA would help inform the scoping report. The DP&E would then issue Secretary Environmental Assessment Requirements (SEARs), which identify assessment requirements for the project. LHIB would then prepare the EIS and submit it to the DP&E for approval by the NSW Minister for Planning. The EIS would be placed on public exhibition by the Secretary of DP&E. LHIB would prepare a submissions report (and Preferred Infrastructure Report (PIR), if required) if submissions are received during the public exhibition period. If changes are proposed to the project then LHIB would also prepare a PIR to assess the environmental impacts associated with the project changes. This would be followed by assessment and determination by the NSW Minister for Planning, who would decide whether or not to approve the project and the conditions to be attached to the determination (if approved). This process may take in the order of 12-18 months depending on the complexity of the project and the number of submissions received during the public exhibition period.

5.3 Local legislation and regulations

5.3.1 Lord Howe Island Act 1953

Under the *Lord Howe Island Act 1953*, the LHIB is charged with the responsibility of administering the affairs of the Island. This Act is supported by the Lord Howe Island Regulation 2014.

Relevant to the proposed runway extension works, Part 3, section 12 of this Act states that the Board has the power and authority to "*do all things necessary from time to time for the promotion and preservation of public health, safety and convenience upon the Island*".

Part 3A, section 15A indicates that any reference to the consent authority within parts of the EP&A Act 1979, applies to the Island as reference to the LHIB wherein "*the Island is taken to be a region within the meaning of that Act*" and "*the Board is taken to be the council of an area situated in that region*".

5.3.2 Lord Howe Island Local Environmental Plan 2010

Environmental planning on Lord Howe Island is controlled by the *Lord Howe Island Local Environmental Plan 2010* (LEP 2010). This document overrides almost all SEPPs, except the Infrastructure SEPP, as stated under Clause 8(1) of the ISEPP. The proposed airport extension works would not be considered exempt development as defined under Part 1 Clause 9 as it does not constitute any of the activities listed in Schedule 1 Exempt development of LEP 2010. Examples of exempt development include an advertisement or sign, antenna, driveway, water tank, etc[1].

The proposed works would be located on land zoned Zone 5 Special Uses, Zone 7 Environment Protection and Zone 9 Marine Park under the LEP 2010 (refer to **Appendix A** for the land zoning map).

The objectives of Zone 5 are to:

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[1] List of exempt development under the Lord Howe Island LEP 2010 can be found here: https://www.legislation.nsw.gov.au/#/view/EPI/2010/88/sch1

a) to provide utility services that are essential to the community's needs in a manner that is in sympathy with the World Heritage values of the natural environment of the Island,

b) to maintain efficient services (such as education, health and transport services and the administration of the Island) and associated infrastructure.

Clause 15, subclause 3(l) of Part 2 states "*demolition and development for the purposes of [public utility undertakings] may be carried out on land within Zone 5 Special Uses only with the consent of the consent authority*."

Public utility undertakings means in this report any air transport undertaking, or uses associated with this undertaking, carried on by, or on behalf of, the Board or any government agency acting under any Commonwealth or State Act.

The objectives of Zone 7 are to:

a) to protect areas that may be vulnerable to erosion or that are a habitat, or corridor, for animals that are native to the Island or significant native vegetation,

b) to protect the scenic amenity of land in the zone,

c) to restore lost or disturbed natural resources, particularly if this may enhance the World Heritage values of the natural environment of the Island,

d) to provide utility services that are essential to the community's needs in a manner that is in sympathy with the World Heritage values of the natural environment of the Island.

Clause 17, subclause 3(c) of Part 2 states "*demolition and development for the purposes of [public utility undertakings] may be carried out on land within Zone 7 Environment Protection only with the consent of the consent authority*."

The objectives of Zone 9 are to:

a) to protect marine ecosystems, habitats and species within Lord Howe Island Marine Park,

b) to protect the scenic amenity of the Marine Park,

c) to permit appropriate uses, such as fishing and tourism, that are consistent with any zoning plan for the Marine Park made under Division 1A of Part 3 of the *Marine Parks Act 1997*.

Clause 19, subclause 2(h) of Part 2 states "*demolition and development for the purposes of public utility undertakings may be carried out on land within Zone 9 Marine Park only with the consent of the consent authority*."

Clause 35 of the LEP 2010 states that "*development on the foreshore area is prohibited… [but] may be carried out with consent if, in the consent authority's opinion:*

a) the proposed development is in the public interest and does not significantly reduce public access to the foreshore, and

b) the bulk and scale of the proposed development will not detract from the visual amenity of the foreshore area, and

c) the proposed development addresses any need to restore lost or disturbed plants that are native to the Island, particularly if restoring those plants may enhance visual amenity, and

d) there is a demonstrated Island community-based, or marine-based, business need for it, and

e) the proposed development will not be adversely affected by, or adversely affect, coastal processes, and

f) in the case of proposed development involving the erection of a structure—the purpose of that structure could not practicably be fulfilled by an existing structure, and

g) *in the case of development proposed to be carried out on land that is also within Zone 9 Marine Park—the proposed development is not inconsistent with any advice about the development that is provided to the consent authority by the Marine Estate Management Authority*."

The Marine Estate Management Authority advises the NSW Government on the management of the NSW marine estate, and the consent authority for the proposed development would need to consider advice provided by the Authority.

5.3.3 Lord Howe Island Biodiversity Management Plan (DECC, 2007)

This plan constitutes a formal National and NSW Recovery Plan for endangered and vulnerable species under the EPBC Act. The management plan assists with prioritisation of actions and provides management measures relevant to the LHIG's overall biodiversity, particularly for the rare and significant species and communities of the LHIG. For example, the management plan identifies management priorities for species such as *Elymus multiflorus* subsp. *kingianus,* which is in the immediate vicinity of the project. Clearing, trampling and grazing of this grass should be avoided where possible.

Some of the objectives of the plan include to reduce human impacts and to encourage the conservation and protection of significant species, populations and ecological communities.

5.3.4 Lord Howe Island Development Control Plan 2005

The Lord Howe Island Development Control Plan 2005 provides guidelines, design principles and objectives for certain types of development on Lord Howe Island. The plan is predominantly for building structures however, it provides relevant objectives, principles and guidelines for every proposed development to protect the community's interest and to protect the environmental integrity of the island. However a large part of these objectives, principles and guidelines apply to new buildings or dwellings, subdivisions or alterations to existing buildings.

Some relevant objectives and principles include:

- every proposed development should strive to achieve quality design outcomes, including to provide information on appropriate construction methods and materials and efficient use of resources; and
- assess how the landscaping of the proposed development could blend with or improve the surrounding environment.

5.4 Other NSW legislation and regulations

5.4.1 National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* (NPW Act), administered by OEH, is the primary legislation for the care, control and management of all National Parks, historic sites, nature reserves and Aboriginal areas in NSW.

Part 3A, section 15B of the *Lord Howe Island Act 1953 No 39* states that "*Part 5 of the National Parks and Wildlife Act 1974 applies to and in respect of land dedicated under [the Lord Howe Island Permanent Park Reserve]"*.

As project works are not proposed to encroach onto the Permanent Park Reserve (located around 250 metres south of the project) the NPW Act does not apply.

5.4.2 Marine Estate Management Act 2014

Clause 55 (1) of the *Marine Estate Management Act 2014 No 72* states that "*before determining a development application under Part 4 of the Environmental Planning and Assessment Act 1979 for the carrying out of development within a marine park or an aquatic reserve, a consent authority must:*

(a) take into consideration:

> *(i) if there are management rules for the marine park or aquatic reserve (refer to Part 4 of the Marine Estate Management (Management Rules) Regulation 1999), the purposes of the zone within which the area concerned is situated as specified in those management rules, and*
>
> *(ii) the permissible uses of the area concerned under the regulations or the management rules, and*

(iii) if a management plan for the marine park or aquatic reserve has been made, the objectives of the marine park or aquatic reserve, and

(iv) any relevant marine park or aquatic reserve notifications, and;

(b) if the consent authority intents to grant consent to the carrying out of the development, obtain the concurrence of the relevant Ministers to the granting of the consent."

Consultation would be required with the Marine Estate Management Authority, and a marine park permit may be required. The proposed development must be consistent with any advice about the development that is provided to LHIB by the Marine Estate Management Authority.

The proposed runway extension falls partially within the Lagoon sanctuary zone and habitat protection zone as defined under Part 4 of the *Marine Estate Management (Management Rules) Regulation 1999*. Refer to **Figure 5-1**.

The objects of the sanctuary zone are:

(a) to provide the highest level of protection for biological diversity, habitat, ecological processes, natural features and cultural features (both Aboriginal and non-Aboriginal) in the zone, and

(b) where consistent with paragraph (a), to provide opportunities for the following activities in the zone:

(i) recreational, educational and other activities that do not involve harming any animal or plant or causing any damage to or interference with natural or cultural features or any habitat,

(ii) scientific research.

The objects of the habitat protection zone are:

(a) to provide a high level of protection for biological diversity, habitat, ecological processes, natural features and cultural features (both Aboriginal and non-Aboriginal) in the zone, and

(b) where consistent with paragraph (a), to provide opportunities for recreational and commercial activities (including fishing), scientific research, educational activities and other activities, so long as they are ecologically sustainable and do not have a significant impact on any fish populations or on any other animals, plants or habitats.

However, Clause 1.41 of *Management Rules* states that provision of this Regulation (other than clause 1.11[2], 1.13[3], 1.16[4], 1.17[5], 1.19[6], 1.20[7], 1.22[8] or 1.23[9]) does not require the consent of the relevant Ministers to the carrying out of any activity if planning approval has been given with respect to that activity in accordance with section 55 of the Act. If the project is to progress, the EIS stage would assess the project against the considerations outlined in section 55 of the Act.

[2] Protection of animals, plants and habitat in sanctuary zone
[3] Dredging and beach replenishment activities not permitted in sanctuary zone
[4] Protection of animals, plants and habitat in habitat protection zone
[5] Limited fishing activities in habitat protection zone
[6] Protection of animals, plants and habitat in general use zone
[7] Limited fishing activities in general use zone
[8] Protection of animals, plants and habitat in special purpose zone
[9] Limited fishing activities

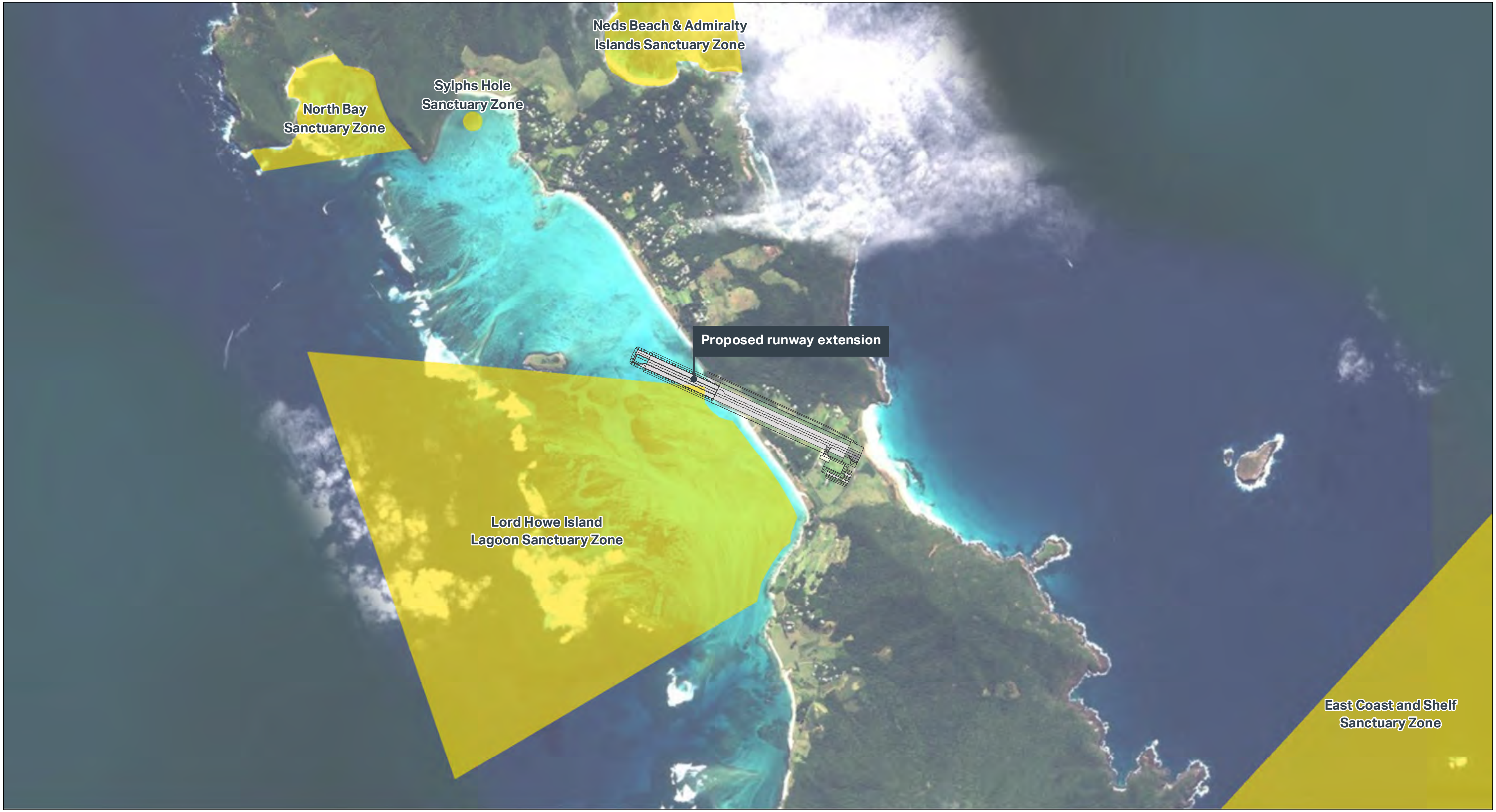

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FIGURE 5-1 MARINE SANCTUARY ZONE

N

0 400 800 m

Legend

Sanctuary Zone

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

5.4.3 Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* (BC Act) aims to maintain a healthy, productive and resilient environment for the greatest well-being of the community now and into the future, consistent with the principles of ecologically sustainable development. Section 7.3(1) of the BC Act outlines criteria that are to be taken into account when determining whether a proposed development is likely to significantly affect threatened species or ecological communities, or their habitats.

Should a development be deemed to have a significant effect on threatened species or ecological communities, or their habitats, a biodiversity development assessment report is required to determine the full extent of the impacts and associated offsets that would be required.

An ecological assessment for the purpose of assessing the proposed works against the relevant criteria under section 7.3(1) of the BC Act would be required to determine if a significant effect on threatened species or ecological communities, or their habitats is likely.

5.4.4 Biosecurity Act 2015

The Biosecurity Act was enacted to provide for the identification, classification and control of Priority Weeds with the purpose of determining if a biosecurity risk is likely to occur, i.e.:

- the introduction, presence, spread or increase of a pest into or within the State or any part of the State; and
- a pest plant has the potential to; harm or reduce biodiversity or out-compete other organisms for resources, including food, water, nutrients, habitat and sunlight.

Given the remoteness of Lord Howe Island, biosecurity would be a prominent risk to the ecological health of the Island.

5.4.5 Heritage Act 1977

The NSW *Heritage Act 1977* was enacted to conserve the environmental heritage of NSW. Under section 32, places, buildings, works, relics, movable objects or precincts of heritage significance are protected by means of either Interim Heritage Orders (IHO) or by listing on the NSW State Heritage Register (SHR).

Lord Howe Island Group is listed on the NSW State Heritage Register (SHR ID 00970) for its significant cultural heritage associations in the history of NSW. The State Heritage listing also recognizes that it is inscribed on the World Heritage List for its unique landforms and biota, its diverse and largely intact ecosystems, natural beauty, and habitats for threatened species.

Proposals to alter, damage, move or destroy places, buildings, works, relics; movable objects or precincts protected by an IHO or listed on the SHR require an approval under section 60. The ‘relic’s provision’ requires that no archaeological relics be disturbed or destroyed without prior consent from the Heritage Council of NSW. Therefore, no ground disturbance works may proceed in areas identified as having archaeological potential without first obtaining an excavation permit pursuant to section 60 of the Heritage Act 1977 or an archaeological exemption.

Refer to **Section 7.2** for an overview of the World Heritage values on the Island.

5.4.6 Roads Act 1993

Section 138 of the *Roads Act 1993* (Roads Act), requires applicants to obtain approval from the relevant roads authority for the erection of a structure, the carrying out of work on or over a public road, or the digging up or disturbing the surface of a road.

The LHIB is the road authority for the construction, maintenance, repair and draining of all public roads on the Island (refer to section 12(1) (a) of the *Lord Howe Island Act 1953* and section 263 of the Roads Act).

5.4.7 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (PoEO Act) is the key piece of environment protection legislation administered by the NSW Environment Protection Authority (EPA). The object of the PoEO Act is to achieve protection, restoration and enhancing of the quality of the NSW environment.

Section 120 of the PoEO Act states that "*a person who pollutes any waters is guilty of an offence*". However, Section 121 (1) of the PoEO Act states that "*the regulations may, for the purposes of this Part, regulate the carrying out of an activity that pollutes waters*".

The PoEO Act provides for the issue of an Environment Protection Licence (EPL) for scheduled activities pursuant to Section 48 of the PoEO Act, in relation to pollution and waste disposal caused by development or operation of developments. Activities requiring an EPL are listed in Schedule 1 of the Act.

The proposed works (either design option) is not defined as a Scheduled Activity under the PoEO Act and therefore an EPL is not required.

5.4.8 Contaminated Land Management Act 1997

The primary objective of the *Contaminated Land Management Act 1997* (CLM Act) is to establish a process for investigating and remediating land where contamination presents a significant risk of harm to human health or another aspect of the environment. Where land is identified as potentially contaminated, consultation with the NSW EPA should be undertaken.

Further assessment to identify whether land is contaminated would be required. A PFAS investigation carried out by AECOM in early 2018 found that PFAS materials were above the limit of reporting at some sites across the airport (refer to **Section 7.4**).

5.5 Local Strategies

5.5.1 Lord Howe Island Weed Management Strategy 2016 – 2025

The management of noxious weeds is mandatory and prescribed under the *NSW Noxious Weeds Act 1993*. The Lord Howe Island Weed Management Strategy provides a framework to prevent the introduction of new weed incursions, detect and contain newly emerging weed risks and to continue to address weed risks at the island scale. The implementation of this strategy will benefit the island ecosystems but also the local community and economy by protecting the integrity of the island's nature-based tourism assets and World Heritage values.

One of the goals of this strategy is to prevent the establishment of new invasive weeds. Equipment and materials imported for construction of the project should be inspected for weeds prior to being transported to the island.

5.5.2 Strategic Plan for the Lord Howe Island Group World Heritage Property 2010

The strategic plan provides a ten-year framework for "*consistent and coordinated management of the LHIG World Heritage Property by the Lord Howe Island Board and the various NSW and Commonwealth government agencies with responsibilities in the area*". The plan is to "*ensure that day-to-day management of the Property complies with Australia's obligations under the World Heritage Convention to protect, conserve, rehabilitate, present and transmit World Heritage values*".

5.5.3 Lord Howe Island Biosecurity Strategy 2016

The Biosecurity Strategy provides guidelines to ensure the biodiversity and natural values of Lord Howe Island, including the economies those values support, and the health and safety of the community are protected from biosecurity risks. These risks come from pests and diseases entering, emerging, establishing or spreading.

The Strategy identifies recommendations to protect the economy and health and safety of the environment and community on the island. It is recommended that construction contractors be made aware of the Biosecurity risks and the Strategy prior to import of materials and equipment for construction.

6.0 Consultation

6.1 Community engagement for the feasibility study

In order to undertake a preliminary environmental impact assessment for the project, clear and effective consultation with key stakeholders and the community is required. AECOM has been undertaking community consultation as part of the project, with the following objectives:

- inform the community, tourists and key stakeholders about the feasibility study through timely, understandable and accessible communication channels;
- early and regular engagement so that the community is informed and involved in decision-making, where relevant, in the project;
- promote the feasibility study's purpose and necessity;
- understand the community, tourist and stakeholder's values and opinions of the project;
- identify objections to the proposed extended runway and potential impacts to the community; and
- help the community, tourists and stakeholders understand that a runway extension is not a certain conclusion and that the feasibility study will help decide this.

The communication channels for consultation involve:

- updated project webpage;
- updated Frequently Asked Questions;
- article in The Signal;
- community update;
- article in LHIB bulletin;
- project phone number and email address for community;
- information sessions x 2;
- online feedback form;
- community consultation report (to be published on project webpage); and
- letters to key stakeholders.

6.2 Target audiences

Listed below are the target audiences for the feasibility study:

- local community;
- visitors;
- tourism industry; and
- aviation industry.

Further measures to reduce adverse effects on the community and promote the positive impacts of the runway extension project would be identified in the EIS if the project further progresses.

6.3 Community issues

On October 3 2018, three community consultation sessions were held to obtain community issues and feedback regarding environmental impacts for the proposed extended runway. The general concerns the community raised were in regards to the following issues:

- impacts to World Heritage values;
- impacts on the coastal processes;
- climate change, particularly sea level rise;
- biodiversity and biosecurity;
- traffic and transport during construction, particularly access along Lagoon Road adjacent to the airstrip;
- marine access in the Lagoon during construction and operation;

- amenity impacts to receivers and residents nearby such as noise and vibration and visual impacts; and
- socio and economic impacts, particularly the impacts from additional tourists on the existing management systems on the island (waste, water, etc.), impacts on the existing 'lifestyle' perceived by residents and compensation for leaseholders for the loss of land associated with the realignment of Lagoon Road.

There were other concerns raised regarding the project cost, alternatives to the proposed runway extension and design enquiries.

The community was informed that the PEA has been undertaken as part of a feasibility assessment of the proposed future extension of the LHI Airport runway. The purpose of the PEA is to provide an overview of potential impacts of the two design options developed for the proposed runway extension.

The concerns raised by the community and stakeholders and responses to the issues raised during the consultation process will be captured in the Community Consultation Report. If the project does proceed further, these concerns would also be addressed in the EIS that would be prepared for the project.

7.0 Existing environment

7.1 World Heritage listing

The LHIG was included as a World Heritage Area on the United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage List in 1982, for being "*an outstanding example of oceanic islands of volcanic origin containing a unique biota of plants and animals, as well as the world's most southerly true coral reef*".

An extensive barrier coral reef protects the Lagoon and sandy beach on the western side of the island and fringing coral reefs could be found adjacent offshore of the beaches on the eastern side. The Lagoon sanctuary zone supports a significant amount of marine biodiversity, including various species of coral, seagrass, and algae, some of which are endemic to the Lord Howe Island Marine Park. Within the Lagoon, coral areas have dominant coverage in the western portion located seaward of Blackburn Island, while the landward (eastern) portion of the Lagoon is generally comprised of sandy substrate. The reef is unique given the large proportion of calcareous (coralline) algae occurring with coral. This mixture of algae and coral occurs because LHIG is affected by both warm and cold currents. The LHIG meets criteria (vii) and (x) identified by UNESCO on the World Heritage List, as outlined in **Table 7-1**.

Table 7-1 UNESCO World Heritage criteria

Criteria		Justification
vii	To contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance	• example of an island system formed from submarine volcanic activity and demonstrates a nearly complete phase in the destruction of a large shield volcano; • example of a significant topographic change within a particular area (topographic relief) with exceptional diversity of scenic landscapes within a small area; • has the most southerly coral reef in the world as it demonstrates a rare example of a zone transition between algal and coral reefs; • many species are only found on this island group where there are unique assemblages of temperate and tropical forms cohabit; and • the islands support extensive colonies of nesting seabirds, where it provides the only breeding locality for the Providence Petrel and has the largest breeding concentrations of the Red-tailed Tropicbird.
x	To contain the most important and significant natural habitats for *in situ* conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation	• example of the development of a characteristic insular biota that has adapted to the island environment through speciation; • significant number of endemic species or subspecies of plants and animals have evolved in a very limited area; • example of independent evolutionary processes due to the diversity of landscapes and biota and the high number of threatened and endemic species; • Lord Howe Island supports a number of endangered endemic species or subspecies of plants and animals, such as Lord Howe Woodhen and Lord Howe Island Phasmid, the largest stick insect in the world, still exists on Balls Pyramid; and • example of an oceanic island group with a diverse range of ecosystems and species that have been subject to human influences for a relatively limited period.

7.2 Heritage

The LHIG is also listed on the following NSW State heritage registers:

- NSW Office of Environment and Heritage (OEH) State Heritage Register (SHR 00970): The LHIG was inscribed on the World Heritage List for its unique landforms and biota, its diverse and largely intact ecosystems, natural beauty, and habitats for threatened species. It also has significant cultural heritage associations in the history of NSW. The earliest European discovery of Lord Howe appears to have been in 1788 by the British colonial vessel HMS Supply. There is no recognised evidence of prior Polynesian or Melanesian discovery or settlement. A small permanent settlement was established in the 19th century, subsisting on trade with passing ships. With numerous fluctuations over the years, the settlement slowly expanded and consolidated, developing a distinctive social structure and culture with the passage of time. The island is an interesting example of restricted island settlement, although the World Heritage nomination was not made on cultural grounds (OHE, 2018);
- NSW State agency heritage register under section 170 of the NSW *State Heritage Act 1977* ; and
- National Heritage list, in recognition of its National heritage significance.

Individual local heritage items on Lord Howe Island are managed by the *Lord Howe Island Local Environment Plan 2010* which includes the “Kentia” (formerly house of A. Christian) on Lagoon Road, Portion 111. This site is located to the west of the existing airport terminal and apron area.

In relation to Island heritage, there is no known association with the original inhabitants of the landmass from which the Australian mainland was derived, given that Lord Howe Island has had no geological relationship with Australia. Furthermore, there has been no evidence to date to suggest that Lord Howe Island had an early settlement by peoples of the Pacific region, including Polynesians, Melanesians or from other eastern coastal tribes. A survey was undertaken in 1996 by archaeologists from the University of Wollongong which found no evidence in analysis of pollens and deposits to indicate human colonisation prior to the time of the European discovery in 1788.

Under the *Lord Howe Island Act 1953*, a “Lord Howe Islander” is a person who has either resided on the Island continuously for the previous 10 years or resided on the Island immediately before 1 January 1982 and held, or have been closely related to someone who held, a permissive occupancy before 22 April 1954.

Given the above, there has been no previous and limited potential for there to be archaeological items present on the Island that predated European discovery in 1788.

7.3 Geology and hydrology

The existing runway occupies a sedimentary plain that developed by sand accumulating in a sheltered area between rocky outcrops. To the west of the existing runway is a coral reef Lagoon system, which is characterised by a reef platform (weak variable strength limestone) with sand accumulating in deeper areas. To the east of the existing runway is the eastern coastline of Lord Howe Island and the Pacific Ocean beyond.

Within the Lagoon, coral areas have dominant coverage in the western portion (seaward of Blackburn Island), while the landward (eastern) portion of the Lagoon is generally comprised of sandy substrate. The proposed runway extension area is expected to comprise loose coarse sands above bedrock, consisting of calcarenite over volcanic rocks (mostly basalt).

As mentioned in **Section 3.5.5**, the only existing form of stormwater treatment at Lord Howe Island is at the southern end of the runway which drains through a water course containing mangroves prior to discharging.

According to the NSW Office of Environment and Heritage using the bore construction data layer, there are no existing groundwater bores constructed on the island. However, there are multiple water bores on the island for domestic use by local residents for irrigation, domestic supply and other uses. Additionally, there are a series of groundwater monitoring wells along the southern shoreline used by the LHIB for groundwater monitoring. Review of the monitoring well log for ACMW5 indicates sand from surface to 4.8 metres below ground surface (m bgs), underlain by coarse sand with increasing shell/coral fragments to depth of completion at 7.3 m bgs.

The PFAS investigation completed by AECOM in April 2018 included monitoring from existing groundwater monitoring wells and private bores. The standing water level (SWL) was monitored in each of the bores (refer to **Table 7-2** and **Figure 7-1)**.

Table 7-2 SWL of groundwater (meters below ground surface)

Sample ID	Location	Depth to water (m bgl)
ACMW5	Near the Aquatic Club, end of Middle Beach Road, towards the Lagoon	2.00
BORE001	Western end of the existing runway	3.50
BORE003	Situated halfway on Lagoon Road	2.00
BORE005	Near the Bureau of Meteorology	2.45
BORE006	South west of the Bureau of Meteorology	2.10
CCMW1	Southern coastline of Lovers Bay	3.52
PPMW3	Situated on Lagoon Road between the Bowling Club and Pinetrees Lodge	2.10
WMFMW10	Waste Management Facility	4.80

A Preliminary PFAS Assessment (AECOM 2018b) indicated that there may be up to two different groundwater bearing zones attributed to the geology on the Site. It is the opinion of AECOM that a shallow aquifer may exist in the alluvial geology, with a separate deeper aquifer likely present in the underlying basalt.

7.4 Contamination

A search of the NSW Office of Environment and Heritage Acid Sulfate Soil Risk Map has shown that there is no risk of Acid Sulfate Soils on the Island, however due to the geomorphology of Lord Howe Island; the Island is susceptible to developing potential acid sulfate soils if development occurs in low lying areas.

A Preliminary PFAS Assessment (AECOM 2018b) was completed for the LHIB in April 2018. Soil and sediment samples were analysed for PFAS and concentrations found were detected above the LOR (Limit of Reporting) in the Preliminary PFAS Assessment study area. The study area consisted of the following sites:

- Site A: LHI Airport and surrounds comprising the following:
  - LHI Airport
  - Bureau of Meteorology (BoM) Lord Howe Island Aero Station
  - Waste Management Facility
  - Pond
  - Various private properties
- Site B: Lord Howe Island Board Depot
- Site C: LHI Lagoon

A PFAS investigation carried out by AECOM in early 2018 found that PFAS materials were detected in soil, sediment and groundwater at the following locations:

- western end of the existing runway (BORE001, SED002, HA004 and HA005);
- adjacent to the existing aircraft apron (HA006);
- proposed aircraft apron (HA007 and HA008); and

- eastern end of the existing runway (SED005).

The concentrations in soil were less than the adopted human health assessment criteria however were greater than the National Environmental Management Plan (NEMP) interim ecological assessment criteria. This means the levels of PFAS present at the island may present a risk to the environment, but not to human health.

FIGURE 7-1 LOCATION OF SOILS AND SEDIMENT SAMPLES ANALYSED FOR PFAS

N

0 200 400 m

Legend

- Groundwater sample location
- Hand auger location
- Sediment sample location
- Surface water sample location
- Surface water flow direction

Source:

7.5 Biodiversity

LHI is the only major breeding locality for the Providence Petrel (*Pterodroma solandri*) and contains one of the world's largest breeding concentrations of Red-tailed Tropicbird (*Phaethon rubricauda*). LHIG supports a number of endangered endemic species or subspecies of plants and animals, for example the Lord Howe Woodhen (*Gallirallus sylvestris*), which at time of World Heritage listing was considered one of the world's rarest birds.

Endangered and critically endangered species listed under the EPBC protected matters search tool previously recorded within 1 kilometre of the proposed extension area are shown in **Table 7-3**. Species highlighted below have been identified to have a higher risk of being impacted by the extension works given their status and likelihood of occurrence. A full list of species including those identified as 'vulnerable', such as the Lord Howe Island Skink, Currawong and Black Rock Cod is provided in **Appendix B**.

The vegetation located on either side of the existing paved runway is dominated by kikuyu grass. Beyond this grass is significant native vegetation (refer to **Appendix C**, **Plate 4**). Kentia palms are also located to the north of Lagoon Road, north of the airfield.

Being the most southerly coral reef in the world, Lord Howe Island comprises a unique zone of transition between algal and coral reefs. The Lagoon sanctuary zone supports a significant amount of marine biodiversity, including various species of coral, seagrass, and algae, some of which are endemic to the Lord Howe Island Marine Park. Within the Lagoon, coral areas have dominant coverage in the western portion located seaward of Blackburn Island, while the landward (eastern) portion of the Lagoon is generally comprised of sandy substrate. The Lagoon contains suitable potential foraging and breeding habitat for marine species such as the Loggerhead Turtle and Leatherback Turtle. Common habitat types in the Lagoon include brain coral, branching coral, soft coral, microalgae, sponge, rubble, sand and seagrass (NSW Marine Parks Authority, 2002).

A thorough marine investigation would be undertaken if the project were to progress further in order to identify specific marine species in the Lagoon where the proposed runway extension would be constructed.

The Lagoon supports a significant amount of marine biodiversity, including various species of coral, seagrass, and algae, some of which are endemic to the Lord Howe Island Marine Park. A thorough marine investigation would be undertaken if the project were to progress further in order to identify specific marine species in the Lagoon where the proposed runway extension would be constructed.

Table 7-3 EPBC Endangered and Critically Endangered Listed Species

Species	Status	Likelihood of occurrence	Habitat
Red Knot (*Calidris canutus*)	Endangered	Known to occur	Coastal areas in sandy estuaries with tidal mudflats. They breed in North America, Russia, Greenland and Spitsbergen.
Curlew Sandpiper (*Calidris ferruginea*)	Critically Endangered	Known to occur	Intertidal mudflats of estuaries, Lagoons, mangroves, as well as beaches, rocky shores and around lakes, dams and floodwaters. Its breeding habitat is the lowland tundra of Siberia.
Northern Royal Albatross (*Diomedea sanfordi*)	Endangered	Foraging/feeding likely to occur	The breeding range is restricted to the Chatham Islands. The majority of the population spends their non-breeding period off both coasts of southern South America.

Species	Status	Likelihood of occurrence	Habitat
Lord Howe Woodhen (*Gallirallus sylvestris*)	Endangered	Breeding likely to occur	Found only on Lord Howe Island. Breeding season is between spring and early summer. Highly territorial with a territory of around 3 hectares.
Northern Siberian Bar-tailed Godwit (*Limosa lapponica menzbieri*)	Critically Endangered	May occur	Breed in northeast Asia and Siberia, spending its winters in coastal areas of Australia and New Zealand.
Southern Giant-Petrel (*Macronectes giganteus*)	Endangered	May occur	Breeds on numerous islands throughout the southern oceans. The range is quite large and ranges from Antarctica to the subtropics of Chile, Africa, and Australia.
Eastern Curlew (Numenius madagascariensis)	Critically Endangered	Known to occur	Intertidal mudflats and sandflats, often with beds of seagrass, on sheltered coasts, especially estuaries, mangrove swamps, bays, harbours and Lagoons. Breeds in Russia and north-eastern China.
Herald Petrel (*Pterodroma heraldica*)	Critically Endangered	May occur	Highly pelagic, rarely approaching land except at colonies. Nests on tropical and subtropical islands, atolls, cays and rocky islets
Gould's Petrel (*Pterodroma leucoptera leucoptera*)	Endangered	May occur	Nesting predominantly occurs in natural rock crevices among the rock scree and also in hollow fallen palm trunks, under mats of fallen palm fronds and in cavities among the buttresses of fig trees. They breed colonially and the nests are clumped and often less than 1 m apart. Breeding takes place over a six week period commencing in early November.
Chatham Albatross (*Thalassarche eremita*)	Endangered	May occur	The species nests on level or gently sloping ledges, summits, slopes and caves of rocky islets and stacks.
Southern Right Whale (*Eubalaena australis*)	Endangered	May occur	Most feeding areas are thought to be in deeper offshore waters. Breeding habitat for the southern right whale is generally near-shore, shallow water depths and being in close proximity to other individuals whilst in calving grounds in Australian waters.
Magnificent Helicarionid Land Snail *(Gudeoconcha sophiae magnifica)*	Critically Endangered	May occur	Confined only to Mount Gower and Mount Lidgbird on Lord Howe Island.
Masters' Charopid Land Snail (*Mystivagor mastersi)*	Critically Endangered	Likely to occur	Located on the summit of Mount Lidgbird, Mt Gower, Blinky Beach and Boat Harbour. The species is now suspected to be restricted to the rugged areas at the southern end of the island

Species	Status	Likelihood of occurrence	Habitat
Lord Howe Flax Snail (*Placostylus bivaricosus*)	Endangered	Known to occur	Abundant under cover in shady, damp situations and on scrubby calcarenite (chalky) hillsides, was sparingly represented at higher altitudes and appeared to avoid open areas.
Calystegia affinis (a twining plant)	Critically Endangered	May occur	Occurs mainly in open higher areas along ridge tops. On Lord Howe Island, the species occurs in lowland areas in the north of the island, and high in the southern mountains. Both habitats are on basalt-derived soils.
Phillip Island Wheat Grass (*Elymus multiflorus subsp. Kingianus*)	Critically Endangered	Likely to occur	Occurs between exposed basalt-derived cliffs and upslope littoral rainforest.
Rock Shield Fern (Polystichum moorei)	Endangered	Likely to occur	Entire population occurs within the southern part of Lord Howe Island; however the species ranges across two disjunct habitats, namely calcarenite boulders on the coastal fringe and ledges on the southern mountains.
Loggerhead Turtle (Caretta caretta)	Endangered	May occur	Occur in coral reefs, bays and estuaries in tropical and warm temperate waters. Loggerhead turtles nest from late October and finish nesting in late February.
Leatherback Turtle (Dermochelys coriacea)	Endangered	Likely to occur	Occur in tropical and temperate waters. Most leatherback turtles living in Australian waters migrate to breed in neighbouring countries, particularly in Indonesia, Papua New Guinea and the Solomon Islands.

The NSW BioNet is the repository for biodiversity data products managed by the OEH. This data includes species sightings of plants, mammals, birds, reptiles, amphibians, some fungi, invertebrates and fish. A search of the NSW OEH BioNet species sightings records identifies previous records of a number of threatened species located in the vicinity of the proposed runway extension area. **Figure 7-2** shows species that have been previously recorded and entered into the database.

FIGURE 7-2 NSW BIONET ATLAS RESULTS

Legend

Fauna

Flora

1: Australasian Bittern
2: Australian Painted Snipe
3: Bar-tailed Godwit
4: Black-tailed Godwit
5: Black-winged Petrel
6: Brown Booby
7: Caspian Tern
8: Cattle Egret
9: Common Greenshank
10: Common Noddy
11: Common Sandpiper
12: Common Tern
13: Curlew Sandpiper
14: Eastern Curlew
15: Flesh-footed Shearwater
16: Glossy Ibis
17: Golden Whistler (Lord Howe Is. subsp.)
18: Green Turtle
19: Grey Plover
20: Grey-tailed Tattler
21: Gull-billed Tern
22: Island Thrush (Lord Howe Is. subsp.)
23: Latham's Snipe
24: Lesser Frigatebird
25: Lesser Sand-plover
26: Little Curlew
27: Little Shearwater
28: Little Tern
29: Long-toed Stint
30: Lord Howe Island Skink
31: Lord Howe Island Southern Gecko
32: Lord Howe Placostylus
33: Lord Howe Woodhen
34: Marsh Sandpiper
35: Masked Booby
36: Masked Owl
37: Oriental Plover
38: Oriental Pratincole
39: Pacific Golden Plover
40: Pectoral Sandpiper
41: Pied Currawong (Lord Howe Is. subsp.)
42: Pied Oystercatcher
43: Providence Petrel
44: Rainbow Bee-eater
45: Red Knot
46: Red-necked Stint
47: Red-tailed Tropicbird
48: Ruddy Turnstone
49: Sand Spurge
50: Sharp-tailed Sandpiper
51: Short-tailed Shearwater
52: Silvereye (Lord Howe Is. subsp.)
53: Sooty Tern
54: Southern Giant Petrel
55: Swift Parrot
56: Tasman Starling (Lord Howe Is. subsp.)
57: Terek Sandpiper
58: Wandering Albatross
59: Wandering Tattler
60: Wedge-tailed Shearwater
61: Whimbrel
62: White Tern
63: White-bellied Storm-Petrel
64: White-tailed Tropicbird
65: White-throated Needletail
66: White-throated Pigeon (Lord Howe Is. subsp.)
67: White-winged Black Tern

AECOM

Source:

7.5.1 Biosecurity risks

Due to the remoteness of Lord Howe Island, biosecurity is a prominent risk to the ecological health of the Island. A Biosecurity Strategy (AECOM 2016) for the LHIB was developed to provide a gap analysis of the 2003 Quarantine Strategy by identifying the environmental and economic values of the Island, identifying stakeholders and most importantly identifying a range of pathways that exist for the spread of biosecurity since 2003. Table 7 of the Biosecurity Strategy lists an extensive list of potential biosecurity pathways and they are summarised as follows:

- By sea:
  - sea freight Island Trader;
  - project specific vessels such as barges;
  - yachts and other vessels;
  - military vessels; and
  - natural pathways: ocean currents, weather events, animal migration/dispersion.
- By land:
  - regular passenger flights;
  - Mac Air Freight Plane (from Port Macquarie);
  - light aircraft;
  - military aircraft; and
  - natural pathways: animal migration/dispersion, climate change events.
- On land dispersal
  - movement of people and vehicles; and
  - natural dispersal: pests and weeds existing on the island.

The AECOM 2016 report provides recommendations for the Lord Howe Island Board and its residents to implement on the island. These recommendations include increasing awareness for residents and suppliers both before and after import and increasing inspections at the LHI wharf and airport.

7.6 Flooding

As oceans warm, they expand and sea level rises. Global mean sea levels have risen around 20 centimetres since the late 19th century and are expected to continue to rise under future climate change (CSIRO, 2016). It is expected that mean sea level will rise 0.4 metres above 1990 levels by 2050 and 0.9 metres by 2100. Climate change projections are currently reported for a range of possible future emissions scenarios, referred to as Representative Concentration Pathways (RCPs). Global emissions are currently tracking along the RCP8.5 pathway, which arises from little effort to reduce emissions and represents a failure to prevent warming by 2100. Over the next 15 years, in the absence of global action on curbing emissions, this trajectory is unlikely to change significantly, suggesting that the most extreme emissions scenario is more likely to occur through to 2030.

All coastal structures have been designed for a 50 year design life, with a design horizon of 2070. To account for climate change a sea level rise of 0.4m has been adopted for the 50 year design life (2070); this is applied to the ambient water levels.

However in 2014, a Lord Howe Island Coastline Hazard Definition and Coastal Management Study undertaken (Haskoning Australia Pty Ltd, 2014) identified that areas below the 3 metre AHD elevation are expected to be at risk of inundation, and areas between 3 metre and 4 metre AHD elevation may become subject to inundation over the long term under sea level rise. The airport was recognised as the most extensive area to be subject to coastal inundation with elevations around 4 metre AHD, refer to **Figure 7-3**.

Storm surge is a raised mass of water, generally several metres higher than normal tide levels, which results from strong onshore winds and reduced atmospheric pressure. An individual storm surge is measured relative to the tide level at the time. The combination of storm surge and normal (astronomical) tide is known as a “storm tide”.

The worst impacts occur when the storm surge arrives on top of a high tide. When this happens, the storm tide can reach areas that might otherwise have been safe.

Storm surge is often associated with cyclones and can cause flooding and damage through raised tides and waves. The height of storm surge is influenced by many factors, including the intensity and speed of an associated cyclone, the angle at which the cyclone crosses the coast and the topography of the affected area. Cyclonic tidal surges are associated with the passage of intense tropical cyclones on particularly critical paths, combined with a high state of the astronomical tide. Surge levels significantly above the predicted levels are possible.

Coastal areas surrounding Lord Howe Island are exposed to periodic flooding and inundation hazards when the sea level rises above normal heights during tropical cyclones or storm activity. This information is suitable to inform the concept design of the runway extension, but it is recommended that 2 dimensional or 3 dimensional computational modelling of the water dynamics within the Lagoon is carried out at subsequent design stages of the project. The runway extension has been designed to account for both sea level rise and storm surge. The recommended additional modelling would verify the assumptions regarding sea level and storm surge.

Figure 7-3 3m, 4m and 5m AHD contours along the Lagoon shoreline (Haskoning Australia, 2014)

8.0 Environmental risk identification

An environmental risk analysis was carried out for the two runway extension design options to identify the environmental issues which require assessment in **Section 9.0**.

8.1 Methodology

To determine the risk for each potential environmental issue, the likelihood of an environmental aspect occurring is assessed using the categories provided in **Table 8-1**.

Table 8-1 Likelihood categories

Likelihood	Description
Certain	Expected to happen routinely during the project life.
Possible	Could easily happen and has occurred on a previous similar project.
Unlikely	Possible, but not anticipated.

The consequence of the impact if it was to occur was assessed using the categories provided in **Table 8-2**.

Table 8-2 Consequence categories

Consequence	Description
Minor	Minor effects on biological, social, economic or physical environment, both built and natural. Minor short to medium term damage to small area of limited significance, easily rectified.
Moderate	Moderate effects on biological, social, economic or physical environment, both built and natural. Moderate short to medium term widespread impacts. More difficult to rectify.
Major	Serious effects on biological, social, economic or environment, both built and natural. Relatively widespread medium to long term impacts. Rectification difficult or impossible

Based on the assessment of the likelihood and consequence of a given impact occurring, a risk rating was derived from the risk matrix presented in **Table 8-3**.

Table 8-3 Risk Rating Matrix

Risk rating				
Likelihood	**Nil**	**Minor**	**Moderate**	**Major**
Certain	-	Medium	High	High
Possible	-	Low	Medium	High
Unlikely	-	Low	Low	Medium

8.2 Preliminary environmental risk assessment

Table 8-4 and **Table 8-5** provide a preliminary environmental risk ranking wherein environmental issues with a ‘nil’ or ‘low’ risk rating have not been taken forward for further assessment in this report. Environmental risks that were identified as Low or Nil risk are highlighted in green and have not been taken forward for further assessment in this report. This preliminary risk assessment assumes no mitigation or management measures. If mitigation and management measures are applied the level of risk would likely be reduced in most instances.

Table 8-4 Environmental risk identification during construction

Environmental impact	Option 1 Land reclamation			Option 2 Deck on pile		
	Likelihood	Potential Consequence	Risk rating	Likelihood	Potential Consequence	Risk rating
Local Island heritage	Unlikely	High	Moderate	Unlikely	High	Moderate
World heritage during construction	Certain	Major	High	Certain	Moderate	High
Surface water (quality and hydrology)	Certain	Major	High	Certain	Moderate	High
Coastal processes	Certain	Major	High	Likely	Minor	Medium
Contamination	Possible	Moderate	Medium	Possible	Moderate	Medium
Groundwater and geology during construction	Unlikely	Low	Low	Unlikely	Low	Low
Climate change and flooding	Certain	Major	High	Certain	Major	High
Aviation safety during construction	Unlikely	Major	Medium	Unlikely	Major	Medium
Construction traffic, transport and access (includes marine access)	Possible	Moderate	Medium	Possible	Moderate	Medium
Biodiversity and Biosecurity	Certain	Major	High	Certain	Moderate	High
Air quality	Possible	Moderate	Medium	Possible	Minor	Medium
Construction Noise and vibration	Certain	Major	High	Certain	Major	High
Landscape and visual amenity	Certain	Major	High	Certain	Moderate	High
Resource use and waste management during construction	Certain	Major	High	Possible	Moderate	Medium

Environmental impact	Option 1 Land reclamation			Option 2 Deck on pile		
	Likelihood	Potential Consequence	Risk rating	Likelihood	Potential Consequence	Risk rating
Socio-economic during construction	Certain	Moderate	High	Certain	Moderate	High
Cumulative impacts[10] during construction[11]	Unlikely	Moderate	Low	Unlikely	Moderate	Low

Table 8-5 Environmental risk identification during operation

Environmental impact	Option 1 Land reclamation			Option 2 Deck on pile		
	Likelihood	Potential Consequence	Risk rating	Likelihood	Potential Consequence	Risk rating
Local Island heritage	Unlikely	High	Moderate	Unlikely	High	Moderate
World heritage	Certain	Major	High	Certain	Moderate	High
Surface water (quality and hydrology)	Certain	Major	High	Certain	Moderate	High
Coastal processes	Certain	Major	High	Likely	Minor	Medium
Contamination	Possible	Moderate	Medium	Possible	Moderate	Medium
Groundwater and geology during operation	Unlikely	Low	Low	Unlikely	Low	Low
Climate change and flooding	Certain	Major	High	Certain	Major	High
Change in aviation safety during operation	Unlikely	Low	Low	Unlikely	Low	Low

10 Cumulative impacts are determined by an assessment of developments that are proposed, have been approved (but not yet under construction) and/or those that would be constructed or operating in the vicinity of and/or at the same time as the planning, construction or operation of the project.

11 & 14There are currently no major projects on the Island that is expected to be constructed.

Environmental impact	Option 1 Land reclamation			Option 2 Deck on pile		
	Likelihood	Potential Consequence	Risk rating	Likelihood	Potential Consequence	Risk rating
Operational traffic, transport and access (includes marine access)	Unlikely	Moderate	Low	Unlikely	Moderate	Low
Biodiversity and biosecurity	Certain	Major	High	Certain	Moderate	High
Air quality	Possible	Moderate	Medium	Possible	Minor	Medium
Change in operational noise and vibration	Possible	Minor	Low	Possible	Minor	Low
Landscape and visual amenity	Certain	Major	High	Certain	Moderate	High
Resource use and waste management during operation	Unlikely	Minor	Low	Unlikely	Minor	Low
Socio-economic	Possible	Moderate	Medium	Possible	Moderate	Medium
Cumulative impacts during operation[14]	Nil	Nil	Nil	Nil	Nil	Nil

9.0 Preliminary environmental impact assessment

This section provides a description of the potential environmental impacts associated with the two design options of the proposed runway extension at Lord Howe Island Airport. Impacts have been grouped into construction related impacts and operational related impacts, with sub-groupings in relation to the land component, the water component or general impacts of works for both design options. Potential issues identified as being of ‘high’ or ‘medium’ risk in **Section 8.0** are discussed in this section, while issues identified as having ‘nil’ or ‘low’ risk have not been considered further in this report.

9.1 Potential construction impacts

9.1.1 World Heritage and Local heritage

As discussed in **Section 7.1** and **Section 7.2**, the LHIG is identified as having heritage significance at a World Heritage, Commonwealth and State level, as it provides natural, scientific and cultural values to the local community of the island, to the people of New South Wales and globally. Lord Howe Island also has local heritage items in the vicinity of the proposed runway extension works. Given this, World Heritage is one of the key issues for consideration during construction.

The potential impacts to World heritage as a result of construction activities for the two design options are discussed in **Table 9-1**.

Table 9-1 Potential construction impacts on World heritage

Construction activities	Potential impact
Land based component (design Option 1 and Option 2)	
Construction of extended turning and apron area, and taxiway. Realignment of Lagoon Road to the north of the airfield.	Construction of the extended turning area, apron area and taxiway would be within the existing airfield and cleared area. Kentia palm trees (and potentially other types of vegetation) may be cut down for the new road alignment and fence line. Some existing grass either side of the taxiway, turning and apron area (not know to contain any threatened species) would be impacted by the works. In addition, as the LHIG is a World, Commonwealth and State Heritage listed area, all construction activities have the potential to affect its heritage significance by causing damage to the environment by introducing pests and weed species, affecting water and air quality and interacting with existing contamination within the airport site.
Water based component (design Option 1 and Option 2)	
Construction activities required for construction of the runway extension.	As the LHIG is a World, Commonwealth and State Heritage listed area, all construction activities have the potential to affect its heritage significance by changing the amenity of the area, the land use and causing damage to the environment by affecting biodiversity through direct and indirect impacts, introducing pests and weed species, affecting water and air quality and introducing work activities with the potential to contaminate the existing environment. The works have the potential to detrimentally impact water quality in surrounding waters as a result of introduced fill, disturbance of sediments, erosion and surface water run-off during construction, therefore impacting on the heritage values of the Island. This is particularly the case for design Option 1.

Future consultation with the relevant stakeholders and additional heritage impact assessment would need to be undertaken as part of an Environmental Impact Statement (EIS) that would be required to accompany any future project application for a proposed runway extension.

9.1.2 Surface water (quality and hydrology)

Table 9-2 outlines the potential impacts on surface water from construction activities, these relate to water quality and hydrology.

Table 9-2 Potential construction impacts on surface water

Construction activities	Potential impact
Land based component (design Option 1 and Option 2)	
The following land based activities may produce dust and have the potential to increase sediment or contaminant laden erosion to surface waters: • general site access to the land either side of the existing airstrip, causing disturbance of vegetated areas; • stripping of grassed areas for extension either side of the runway may cause disturbance of soils which may result in erosion and sediment runoff • excavation and mobilization of known PFAS containing material either side of the runway, due to past firefighting activities; • asphalting activities from construction of the runway pavement and associated airfield pavements and access roads; • refuelling of construction vehicles and machinery, including hammer piling rigs, loaders and excavators; • adhoc concrete work required to tie in stormwater pits; and • stockpiling of sub base materials.	An increase in dust and erosion of exposed or stockpiled soil can enter the water from wind and rain respectively, increasing sediment load and reducing light and oxygen available to aquatic flora and fauna. Potential to change the chemical content on land and water resulting in contamination. Asphalting, concreting and refuelling chemicals can change the pH, salinity and oxygen significantly. A change in land and water conditions has the potential to be detrimental to land and aquatic flora and fauna.
Water based component for Option 1 (Land reclamation)	
Disturbance of the Lagoon bed due to pushing the rock armour structure and wave trip structure into the Lagoon to build up the runway base and trip structure, causing mobilised sediment into the water column. Concrete fill surrounding the rock armour may produce dust and have the potential to increase sediment or contaminant laden erosion to surface waters.	Mobilised sediment would increase the turbidity in the water reducing the light and oxygen available to aquatic flora and fauna. Concreting has the potential to change the chemical content of water (pH, salinity and oxygen). A change in water conditions is detrimental to aquatic flora and fauna.
Water based component for Option 2 (Deck on piles)	
Disturbance to the Lagoon bed due to driven or vibratory piling of the steel tubes into the Lagoon bed (at approximately RL-1.0m AHD), causing sediment to be mobilized into the water column. In-situ concrete stitching used to join the pre-cast concrete.	Similar to Option 1, the mobilised sediment will increase the turbidity in the water reducing the light and oxygen available to aquatic flora and fauna. The disturbance and mobilization of sediments will be considerably less than in Option 1, however.

In order to further assess the extent of potential impacts on surface water, background surface water quality monitoring should be undertaken within the surface water drains and Lagoon. Ideally the data captured would be collected over a sufficient duration to capture any seasonal changes in conditions.

9.1.3 Coastal processes

Table 9-3 outlines the potential impacts on coastal processes. The Lagoon is more protected from wave action than the eastern and southern sides of the Island as it is shallower water and is partially protected by the coral and algal reef habitat on the edge of the Lagoon.

With regard to Option 2 (Deck on piles), a 570 metre piled runway extension is not expected to have significant impacts on coastal processes, although if storm wave crests reached the slab edge, then some attenuation of wave action would be expected at the shoreline, although not to the same magnitude as Option 1.

Table 9-3 Potential construction impacts on coastal processes

Construction activities	Potential impact
Option 1 (Land reclamation)	
Pushing out of large rock armour material from the shoreline, which would progressively change the topography of the Lagoon coast line in this location. Development of wave trip structure 50 metres off shore from the rock amour structure would progressively alter the incoming wave action to the Lagoon.	The construction of both structures would cause progressive wave refraction, changing the wave energy and velocity in the Lagoon and at the shoreline. This would reduce the tidal inundation area along the area of the shoreline immediately adjacent to the rock armour structure.
Option 2 (Deck on piles)	
The deck on pile option would comprise precast concrete deck panels supported on precast reinforced concrete beams and steel pile footings. No wave trip structure is required for the deck on pile option.	The construction of the piled runway extension would be expected to have reduced impacts by comparison to Option 1 on coastal processes given that this option would maximise the scope for prefabrication and minimise on-site construction time.

The impact of the proposed runway extension on coastal processes would require further investigation and assessment in the EIS.

9.1.4 Contamination

Table 9-4 discusses the potential impacts of contamination during construction.

Table 9-4 Potential contamination construction impacts

Construction activities	Potential impact
Land based component (design Option 1 and Option 2)	
Use of plant and machinery during existing airfield pavement works. Activities include stripping of vegetation, placing aggregate, compaction of sub base and asphalting of airfield pavements. Use of machinery can result in contamination from oil leaks, refuelling operations and chemical storage required for maintenance.	Chemical and fuel content on land can be leached into the soil and taken up by vegetation either side of the runway, potentially leading to die back. Potential migration of PFAS contamination over land and into water.

Construction activities	Potential impact
Excavation of previously contaminated materials i.e. PFAS containing material may result in further contamination in the form of dust and storm water runoff.	
Water based component (design Option 1 and Option 2)	
Option 1 (Land reclamation) Similarly to the land based component, the use of plant and machinery to push out the rock armour will present some risk to the surface water from the same activities mainly through refuelling, hydraulic oil spills and maintenance predominantly through untreated stormwater discharges and potentially where crane and booms are used over water, PFAS contamination is not expected to be a risk because excavation of existing material will not be required. Option 2 (Deck on piles) Construction activities to build Option 2 are likely to include working over water for majority of the works. The risk from hydraulic oil and diesel from refuelling of equipment is high.	Chemicals have the potential to be absorbed and ingested by aquatic flora and fauna. An increase of untreated chemicals and fuels in drainage run off may cause degradation in aquatic flora and fauna over time. Chemicals can change surrounding water properties such as pH, salt content, oxygen and temperature causing changes to ecosystem functions.

It is recommended that further soil testing is completed prior to any potential future construction for a runway extension, so as to understand the extent of potential contamination likely to be encountered. Additional PFAS investigations for the purposes of further assessing the nature and extent of identified PFAS impacts would be undertaken.

9.1.5 Climate change and flooding

Lord Howe Island Airport is considered critical infrastructure and needs to remain operational during emergencies in order to allow emergency services access to the island. Any proposed future runway extension and associated structures (deck on piles or land reclamation, for example) must remain functional after a major event, therefore in accordance with AS4997-2005 the airport is designated as a function category 3 (high property value or high risk to people).

Potential climate change and flooding impacts during construction for the two design options are discussed in **Table 9-5**.

Table 9-5 Potential impacts of climate change and flooding during construction

Construction activities	Potential impact
Land based component (design Option 1 and Option 2)	
Storm surge, periodic flooding and inundation hazards when the sea level rises above normal heights during tropical cyclones or storm activity during the construction of the land based components of the project.	There is the potential for flooding and land inundation in the areas surrounding the airport. The airport was recognised as the most extensive area to be subject to coastal inundation with elevations around 4 metre AHD (Haskoning Australia, 2014). Major impacts from flooding and land inundation would include: • bank erosion and scouring of the landscape surrounding the airport runway; • erosion of construction stockpiles containing site materials; • damage to airport assets, in particular the existing airport runway, apron and administration buildings;

Construction activities	Potential impact
	• damage to construction machinery, equipment, plant laydown areas, site compounds etc.; • loss of vegetation, flora and fauna habitat in surrounding areas of the airport runway; and • safety risk to construction personnel,
Water based component (design Option 1 and Option 2)	
Storm surge, periodic flooding and inundation hazards when the sea level rises above normal heights during tropical cyclones or storm activity during the construction of the runway extension.	A storm surge may damage infrastructure, release contaminants and is a risk to personnel working on the construction of the runway extension. These impacts would have a flow on effect and have the potential to impact on aquatic flora and fauna. Crushing of aquatic flora will result in habitat loss for aquatic fauna. Displacement of Lagoon sediments would increase the turbidity on the water and potentially temporarily displace nutrient availability to aquatic flora and fauna.

9.1.6 Aviation safety

Construction of the runway extension is based on no aircraft operations occurring for four consecutive days, as described in **Section 3.2**. This is typically managed through the use of Method of Work Plans (MOWP) which sets out the work required on the airfield and indicates restrictions to aircraft operations and a Notice to Airmen (NOTAM) which alerts pilots of potential hazards along a flight route or at a location that could affect the safety of the flight. Typically these documents contain protocol for the restoration of the airfield to operational considerations to accommodate emergency aircraft.

Should construction work be required outside of the four consecutive days of airport shutdown, stakeholder consultation with Air Services, CASA, the incumbent aircraft operator and the community would be required to ensure aviation safety is maintained.

In addition to the information above, future stages of development for the runway extension would need to consider potential aviation safety hazards and implement additional appropriate mitigation measures during construction if required.

9.1.7 Traffic, transport and access

The road network on the Island is managed by the LHIB. Background traffic volumes are expected to be low due to the limited number of vehicles on the Island. The roads are mostly used by light vehicles, cyclists and pedestrians. Access to the airport is via Lagoon Road, a sealed road in good condition.

The runway extension works may not have an increase in traffic on the local road network during construction for the transport of construction materials as plant and materials may be stored on barges moored outside the reef and delivered straight to the existing western end of the runway, as per the 2015 runway overlay project. No road upgrades would be expected to be required as a result of construction and movement of equipment; however an appraisal of the suitability of the wharf to the north of the airport to accommodate suitably sized barges and vessels during construction would be required if it were to be used.

Potential impacts to traffic, transport and access due to construction activities for the two design options are discussed in **Table 9-6**.

Table 9-6 Potential construction impacts on traffic, transport and access

Construction activities	Potential impact
Land based component (design Option 1 and Option 2)	
General site access and vehicle movement, together with loading and unloading of materials. Construction traffic would use Lagoon Road.	Increase in traffic on the surrounding road network during construction somewhat affecting road safety for local road users. Traffic and transport of construction materials would result in a risk of collision with the wildlife on the island.
Water based component (design Option 1 and Option 2)	
Construction activities required for both piling and reclamation of land for the extended runway component would increase marine traffic due to the importation of construction materials (most notably for Option 1 (Land reclamation)).	Increase of marine traffic for the transportation of construction materials would negatively impact on the marine life and environment (e.g. due to propeller disturbance or boats running aground) in terms of vegetation area, fauna and flora habitat values and habitat connectivity within the Lagoon. An increase in marine traffic may also impact on the movement of other vessels and Lagoon users.

Further assessment of the traffic and transport impacts of the proposed runway extension would be undertaken as part of the EIS.

9.1.8 Biodiversity and biosecurity

Biodiversity threatened flora

Vegetation surveys north and south of the runway (beyond the cleared and grassed areas) have not been completed as part of this PEA. The likelihood of having threatened ecological communities in the vicinity of the proposed runway extension area is high due to the habitat that the Island provides for threatened migratory and endemic species, including four threatened species in the immediate vicinity:

- *Elymus multiflorus* subsp. *kingianus* Phillip Island Wheat Grass
- *Calystegia affinis*
- *Geniostoma huttonii*
- *Polystichum moorei* Rock Shield Fern

A study completed by the LHIB in 2016 noted that two communities are threatened, one of them being the *Lagunaria* Swamp Forest, more widespread on the low-lying flats of the Island. This community may be relevant to the proposed works due to the low lying location of the Airport and runway.

Biodiversity threatened fauna

According to the protected matters search, 16 fauna species have been found likely to be distributed on the Island and a search on the NSW Bionet Atlas has identified eight species previously visually observed within the vicinity of the proposed runway extension area. **Table 9-7** lists the eight threatened fauna sighted within 3 kilometres of the proposed runway extension area. Other endangered species listed under the EPBC protected matters search tool that would be potentially impacted are also identified under **Section 7.5**. All species listed under the EPBC protected matters search tool previously recorded within 1 kilometre of the proposed extension area is discussed in **Section 7.5.**

Table 9-7 Threatened fauna previously recorded within 3 kilometres of proposed runway extension area

Scientific name	Common name	Commonwealth status	State status	No. of sightings
Birds				
Calidris canutus	Red Knot	Endangered		1
Gygis alba	White Tern		Vulnerable	2
Limosa lapponica menzbieri	Northern Siberian Bar-tailed Godwit	Critically Endangered		2
Phaethon rubricauda	Red-tailed Tropicbird		Vulnerable	1
Pterodroma nigripennis	Black Winged Petrel		Vulnerable	1
Onychoprion fuscata	Sooty Tern		Vulnerable	3
Invertebrates (including fish)				
Placostylus bivaricosus	Lord Howe Island Placostylus	Critically Endangered	Endangered	1
Reptiles				
Chelonia mydas	Green Turtle	Vulnerable	Vulnerable	9

Biosecurity risk

Potential impacts to biodiversity and biosecurity due to construction activities for the two design options are discussed in **Table 9-8**.

Table 9-8 Potential biodiversity and biosecurity impacts during construction

Construction activities	Potential impact
Land based component (design Option 1 and Option 2)	
Removal of vegetation either side of the existing airfield pavement works may result in a loss of vegetative habitat. Tracking of plant and storage of equipment in containers may result in soil remnants being carried over from the mainland.	Vegetation removal or trimming may result in habitat loss for migratory and endemic species and loss of threatened vegetation. Vegetation beyond the grassed areas on either side of the runway has the potential to be covered in dust from excavation works; this would limit the sunlight and oxygen available to plants along the extent of the runway. Furthermore, construction works may potentially inhibit bird movement around the runway area, therefore potentially affecting bird propagation dependent vegetation of localised species either side of the runway Kentia palm trees and potentially other types of vegetation located adjacent to Lagoon Road may be trimmed or removed during the realignment of Lagoon Road and the fence. Deposition of soil remnants from the mainland has the potential to introduce pest and disease to the Island.
Movement of construction vehicles and equipment.	Vehicle strike of fauna may result in injury or mortality of species (including threatened species).

Construction activities	Potential impact
Water based component for Option 1 (Land reclamation)	
Pushing out of aggregate and rock armour material to build the platform may result in crushing aquatic flora and immobile fauna. Rock armour placement would displace Lagoon sediments.	Crushing of aquatic flora would result in habitat loss for aquatic fauna and crushing aquatic fauna. Displacement of Lagoon sediments would increase the turbidity in the water and potentially temporarily displace nutrient availability to aquatic flora and fauna.
Movement of the barge and other construction equipment within the water column.	Vehicle strike of fauna may result in injury or mortality of species such as fish (including threatened species).
Water based component for Option 2 (Deck on piles)	
Hammer or vibratory piling causing significant vibrations in the water column.	Vibration can potentially stun aquatic fauna and also cause disorientation, particularly for fauna which rely on sonar and echolocation to orientate themselves within their habitat. For example the project may result in vibration above exposure limits for some species and result in permanent hearing damage and impact navigational mechanisms. Vibration impacts may also damage surrounding coral habitat in the Lagoon.
General impacts	
Both design options and the land based component of the potential works may require night works causing associated light spill.	Light spill can be significantly detrimental to flora and fauna on land and in water. Artificial lighting can potentially disorientate fauna, affect breeding cycles and affect plant reproduction.
Importation of construction equipment and materials	Potential to introduce biosecurity risks (e.g. invasive and exotic species) to the island if they are present on the construction equipment and materials imported for the project.

In order to further assess the extent of potential impacts on biodiversity, additional monitoring and field surveys should be undertaken within the Lagoon and in the vicinity of the study area to inform the EIS.

9.1.9 Air quality

Constructions works have potential to generate vehicle and plant emissions and dust, particularly during the drier months.

The potential impacts on air quality as a result of construction activities for the two design options are discussed in **Table 9-9**.

Table 9-9 Potential construction impacts on air quality

Construction activities	Potential impact
Land based component (design Option 1 and Option 2)	
General site access and vehicle movement, together with loading and unloading of materials may cause dust, loose soil and gravel fines to be dissipated from their origin into the surrounding environment either side of the airport runway. The use of diesel fuelled plant and machinery	Dust would potentially create air pollution to nearby residents around the airport and those located on the northern side of the runway. Dust could also be a safety concern for the air traffic control and drivers of vehicles along Lagoon Road as well as recreational users of the Lagoon. Dust also has the potential to smother localised

Construction activities	Potential impact
would cause exhaust fumes to be emitted into the ambient air.	vegetation along either side of the runway which may potentially affect sunlight and nutrient absorption. Diesel fumes emitted in the ambient air can reduce air quality for residents of the island and local fauna surrounding the runway area.
Water based component (design Option 1 and Option 2)	
The use of diesel fuelled plant and machinery would cause exhaust fumes to be emitted into the ambient air.	Diesel fumes emitted in the ambient air can reduce air quality for residents of the island and local fauna surrounding the runway area particularly sea birds.
Water based component for Option 1 (Land reclamation)	
Pushing out of aggregate and rock amour has the potential to emit gravel fines into the ambient air.	Gravel fines may potentially pollute the surface water and potentially be ingested by aquatic fauna. Gravel fines may settle on aquatic vegetation reducing sunlight and nutrient absorption.

Background monitoring should be completed for any future EIS for the potential works and prior to construction, to gain an understanding of the mean ambient levels against the NEPM for Carbon monoxide (CO), Nitrogen Dioxide, particulate matter (PM_{10} and $PM_{2.5}$).

9.1.10 Noise and vibration

The potential impacts of noise and vibration as a result of construction activities for the two design options are discussed in **Table 9-10**.

Table 9-10 Potential noise and vibration construction impacts

Construction activities	Potential impact
Land component (design Option 1 and Option 2)	
General site access and vehicle movement, together with loading and unloading of materials	Noise impacts during construction are likely to range in severity, from minor to potentially significant, depending on the nature of background or ambient noise in any given location, work hours or the duration of the works in that location and the nature and extent of the work being undertaken. Given the low density residential nature of the island, it is considered likely that the community would be impacted by the noise generated by construction activities, particularly if night works are undertaken. The majority of construction works would be undertaken during standard construction hours with occasional night works required for specific construction activities but these would generally be of limited duration. Quantitative noise assessment, noise modelling and/or noise logging would be required to be undertaken as part of any future EIS for the works. Community consultation and assessment of potential noise and vibration impacts should also be conducted as part of any future environmental assessment.
Water based component (design Option 1 and Option 2)	
Construction activities required for	Impacts arising from vibration during construction are most

Construction activities	Potential impact
both piling and reclamation of land	likely to be associated with piling or reclamation of land for the water based component where unmanaged vibration has the potential to cause damage to coral substrate, structures and/or roads, and the potential to contribute to a disturbance in human comfort. There is also potential for vibration from proposed works to impact upon sensitive marine life found within the Lagoon and wildlife near the construction area. Quantitative noise assessment, noise modelling or noise logging should be undertaken as part of any future EIS for the works. Community consultation and assessment of potential noise and vibration impacts should be conducted.
Water based component for Option 2 (Deck on piles)	
Construction activities required for piling. Potentially a hammer piling rig. If there was a problem, an option would be to vibrate the piles in depending on the hardness of the corals. Another alternative would be roto-piling, where the steel piles are fitted with a toothed bit and are rotated in the (special) piling rig to core their way into the corals.	Impacts arising from vibration during construction for this option includes: • if the piles are drilled in (roto-piling),; • if the piles are vibrated in, the deck on piles option will mean localised vibration in the founding corals; and • if the piles are driven using a standard piling hammer, the deck on piles option will mean more noise and more vibration than Option 1. Impacts arising from vibration during construction have the potential to cause damage to coral substrate, structures and/or roads, and the potential to contribute to a disturbance in human comfort. There is also potential for vibration from proposed works to impact upon sensitive marine life found within the Lagoon and wildlife near the construction area. As such, future design options would need to specify the piling method accordingly in order to reduce noise and vibration impacts. Quantitative noise assessment (noise modelling) based on background noise logging measurements should be undertaken as part of any future EIS for the works. Community consultation and assessment of potential noise and vibration impacts should be conducted.

9.1.11 Landscape and visual amenity

Construction activities would be temporary and would change throughout the different stages of construction. Views toward construction activities would be partially restricted by the undulating topography of the surrounding area.

Potential impacts to landscape and visual amenity due to construction activities are discussed in **Table 9-11**.

Table 9-11 Potential construction impacts on landscape and visual amenity

Construction activities	Potential impact
Land based component (design Option 1 and Option 2)	
Onshore storage activities, general site access and vehicle movement, together with loading and unloading of materials would cause visual amenity impacts on the surrounding receivers. Temporary elements likely to be introduced into the visual environment during the construction period include: • fencing and hoarding; • road barriers, signage and VMS systems; • earthworks and stockpiles of material; • erosion and sediment control devices; • lighting for night time works; • construction equipment/plant; and • site office and amenities.	The works may result in visual intrusion into adjacent residents around the airport. Visual intrusion impacts occur when a project allows a new intrusive view from a public area into an otherwise private area of a residential property. The presence of a temporary construction compound and lighting required for night-time works would be visible from adjacent residents around the airport.
Water based component (design Option 1 and Option 2)	
Limited onshore area is available for construction storage, and plant and materials may be required to be stored on barges moored outside the reef for periods of time. Temporary elements likely to be introduced into the visual environment during the construction period include: • construction equipment/plant such as cranes, drill rigs, trucks, used for the construction of the runway extension,; • fencing and hoarding; • erosion and sediment control devices; and • lighting for night time works.	Plant and materials stored on barges moored outside the reef would be visible from the mainland, though may only form background views from onshore receivers. Construction materials and equipment would be offloaded using a smaller crane barge, which would transfer the materials and equipment to the island wharf or south-west extent of the runway. Construction materials would be delivered to a storage area adjacent to the airfield. This will be visible to residents around the airport and has the potential to cause visual intrusion impacts. Additionally, construction works within the Lagoon would also contribute to visual impacts. As such, the project may result in visual intrusion into residents and sensitive receivers located to north of the runway extension at Windy Point. The presence of a temporary construction compound and lighting required for night-time works would be visible from all residents around the airport and receptors at Windy Point.

9.1.12 Resource use and waste management

The proposed runway extension works would not use any materials derived from the Island and all construction materials would be imported. The Island has no landfill capability and as such all non-compostable waste produced during construction would be taken off the Island. All waste which is not able to be composted or used on the Island would be shipped to a Waste Management Facility on the mainland for recycling, reuse or land fill disposal. The potential impacts on resource use and waste management as a result of construction activities for the two design options are discussed in **Table 9-12**.

Table 9-12 Potential construction impacts on resource use and waste management

Construction activities	Potential impact
General impacts (design Option 1 and Option 2)	
Waste produced from construction activities	Waste generated during the construction phase is anticipated to include: • excess spoil material from piling and/or infilling activities; • materials associated with demolition of existing infrastructure; • waste fuels, oils and grease generated during plant and vehicle maintenance; • effluent generated at site amenities during construction; • packaging materials from items delivered to the site, such as pallets, crates, cartons, plastics and wrapping materials; • domestic waste, including paper, aluminium cans, glass, plastics, packaging and other material generated by site construction personnel; and • contaminated soils that may be exposed during construction, and if exposed, may require off-site disposal. The potential for waste generation could potentially contaminate and consequently cause impact on biodiversity and the general environment of the Island if managed incorrectly. Waste material would require to be transported appropriately and effectively managed upon final disposal.

9.1.13 Social and economic

The construction of the runway extension and associated works has the potential to have a socio-economic impact on community amenity and the visitor economy.

Social amenity impacts from the construction of the runway extension have been discussed in **Sections 9.1.7**, **9.1.9**, **9.1.10** and **9.1.11**.

As discussed in **Section 3.0**, it is assumed that there would be very limited local availability of construction plant or materials and as such these must be brought in by air or by sea. There would also be limited personnel available locally. During construction, there would be a demand for local services including accommodation and health services due to the influx of construction workers onto the island during this period, and the presence of the project workforce could also be beneficial to the local economy due to the need for goods and services. Local construction jobs may also be an opportunity and socio-economic benefit for the local community.

The existing Lagoon Road adjacent to the airport would need to be moved north, which would impact some properties located along Lagoon Road. The proposed alignment of Lagoon Road adjacent to the airfield is subject to change at subsequent design stages once accurate topographic survey is available. **Figure 9-1** shows the special and perpetual leases which would be impacted and partially acquired for the new alignment of Lagoon Road. Residents of these properties would likely experience health and psychological wellbeing impacts, such as stress, due to the partial acquisition of their property. There may also be a reduction in amenity due to the removal or trimming of the vegetation located along Lagoon Road within or adjacent to these properties (refer to **Figure 9-1**).

Impacts associated with property acquisition may be reduced and/or managed through an effective process of consultation and compensation that is designed to be equitable to property owners. Further investigation of the property acquisition process would be required.

During construction the marine traffic within the Lagoon area may be impacted by the movement of the barge and other vessels delivering/handling construction plant and materials. Commercial and private boats currently utilise the passage between the existing runway end and Blackburn/Rabbit Island as a preferred thoroughfare between north (boat shed ramp and sheds) and the south (e.g. snorkeling locations).. This thoroughfare would likely be unavailable during construction and an alternative route would need to be used.

A detailed social and economic impact assessment at subsequent stages of the project is recommended to better identify the magnitude and severity of social and economic impacts associated with construction of the project.

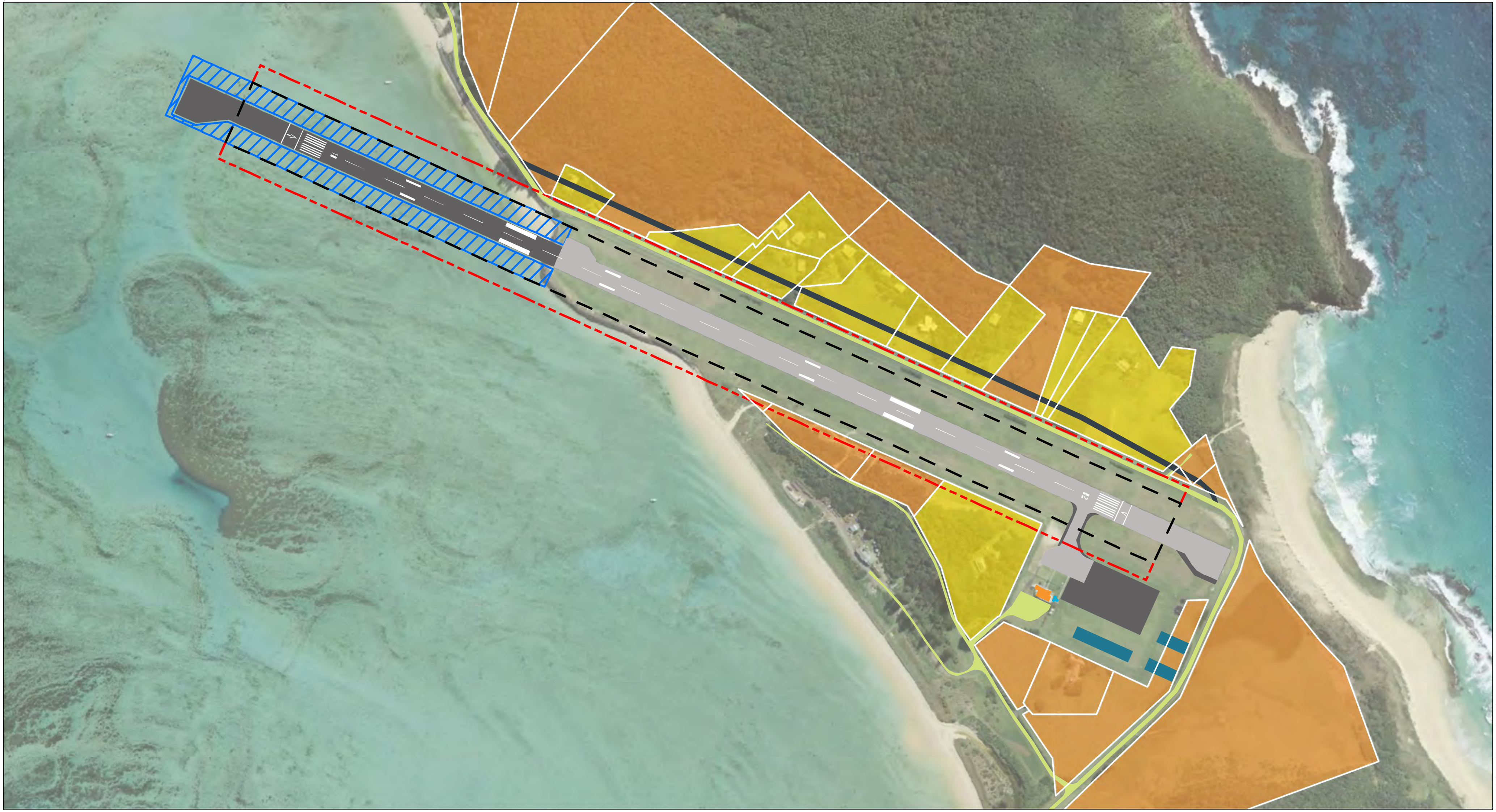

FIGURE 9-1 POTENTIAL PROPERTY ACQUISITION FOR LAND BASED COMPONENT OF EXTENDED RUNWAY

0 100 200 m

Legend

- Perpetual lease
- Special lease
- Extent of flyover area
- Extent of runway strip
- Terminal building
- Aircraft stand
- Existing island road
- New aircraft pavement
- Deck on piles or reclaimed land

Source:

9.2 Potential operational impacts

9.2.1 World heritage

Table 9-14 discusses the potential impacts to World heritage from operational activities relating to the runway extension.

Table 9-13 Potential operational impacts to World heritage

Potential operational impacts
Water based component (design Option 1 and Option 2)
Scenic values on Lord Howe Island are contributing factors to the heritage listing. The extension of the runway structure into the Lagoon would have a permanent visual impact on the landscape which in turn affects the world heritage and National Heritage values of the Island.

A visual impact assessment including photomontages of the before and after impacts from key viewing locations on land and water would be undertaken as part of the EIS.

9.2.2 Surface water (quality and hydrology)

Table 9-14 discusses the potential impacts to surface water from operational activities relating to the runway extension.

Table 9-14 Potential operational impacts to surface water

Potential operational impacts
Land based component (design Option 1 and Option 2)
• Diesel and oil spills on runway washed into stormwater drains from rainfall causing pollution of surface water.
Water based component (design Option 1 and Option 2)
• Diesel and oil spills on runway washed into Lagoon from rainfall causing pollution of the Lagoon.

Further assessment would be undertaken as part of the EIS including best practice surface water management measures.

9.2.3 Coastal processes

Table 9-15 discusses the potential impacts on coastal processes from both design options. It is unlikely that impacts would occur from the land based component of either option.

Table 9-15 Potential operational impacts on coastal processes

Potential operational impacts
Water based component for Option 1 (Land reclamation)
• The potential extended runway would act as a complete barrier to longshore sand transport along the Lagoon shoreline; • the SE corner of the potential extended runway would become a sand trap, and an accumulation zone for floating and suspended matter; • alteration of the coastal processes, including wave action, sediment movement or accretion, or water circulation patterns in the Lagoon; • potential to permanently alter tidal patterns and water flows in the Lagoon; • potential wave scouring on the seaward side at the base of the wave trip structure and deposition of sediments further away from the base of the wave trip structure; • operation of the wave trip structure 50 metres off shore from the rock amour structure has the potential to change the incoming wave action to the Lagoon, for example through wave refraction changing wave energy and velocity. This would reduce the tidal inundation area along the existing coastal line either side of the base of the rock armour structure. As the wave would be refracted,

Potential operational impacts
water would arc around the structure and potentially scour the Lagoon bed at the base of where the coastline meets the armour structure. Adversely, at the top of the arc that the water would travel around the structure, sediment would be deposited, changing the coastline; • in the case of longshore drift, further north of the runway along the coastline would be impacted by increased deposition; and • indirect impacts to biological diversity or species composition in the Lagoon in particular to seagrasses, coral reefs and marine species as a result of sediment deposition changes.
Water based component for Option 2 (Deck on piles)
A 570 metre piled runway extension would be expected to have reduced impacts by comparison to Option 1 on coastal processes, although if storm wave crests reached the slab soffit, then some attenuation of wave action would be expected at the shoreline, although not to the same magnitude as Option 1. Furthermore, due to the low level of the existing runway, the inshore section of the deck structure will be subject to wave action during extreme events. These will reduce as the deck rises seawards. Notwithstanding the above, some specific coastal processes impacts may occur for Option 2 including: • sediment deposition is expected on the leeward side of the piles, which may build up over time to create small peaks and troughs on the Lagoon bed; • wave energy will be slowed by the piles dropping sediment and therefore sediment could potentially build up over time underneath the runway extension footprint; and • scouring at the base of the piles may occur on the seaward side causing small troughs around piles which can potentially dissipate wave energy. Further investigations would be undertaken to assess wave energy and coastal processes at the EIS stage.

9.2.4 Contamination

Potential contamination impacts caused by operational activities have been considered within the surface water (**Section 9.2.1**) and biodiversity sections (**Section 9.2.7**) of this report.

9.2.5 Climate change and flooding

In regards to the likely impacts of climate change during the operational phase of the proposed runway extension, the following flood modelling and related design needs to be considered in detailed design and to inform the EIS:

- increased intensity of rainfall events (using an approach in accordance with relevant guidelines (e.g. Practical Responses to Climate Change, Engineers Australia);
- sea level rise of between 45 to 82 centimetres by 2090 (as projected for the NSW coastline under Representative Concentration Pathway 8.5), coupled with extreme sea level events, with increases in storm surge and the extent of inundation across the island; and
- increased tailwater levels or sensitivity testing undertaken for various projected rises in mean sea levels.

Table 9-16 discusses the impacts of climate change and flooding during operational activities. If the project is to progress further, the EIS stage would assess the existing levels of the airport and runway in regards to climate change and flooding levels.

Table 9-16 Potential operational impacts on climate change and flooding

Potential operational impacts
Land based component (design Option 1 and Option 2)
If design does not consider climate change and rising sea levels, particularly the impact of extreme sea level events and increases in storm surge, then flooding and land inundation is likely to occur resulting in the following impacts: • bank erosion and scouring of the landscape surrounding the airport runway; • damage to airport assets, in particular the airport runway, apron and administration buildings; • loss of vegetation, flora and fauna habitat in surrounding areas of the airport runway; and • safety risk to airport personnel.
Water based component for (design Option 1 and Option 2)
If design does not consider climate change and rising sea levels, in particular storm surge, periodic flooding and inundation hazards when the sea level rises above normal heights during tropical cyclones or storm activity, then flooding and land inundation is likely to occur resulting in the following impacts: • damage or complete failure of the rock armour structure and wave trip structure; • a release of contaminants from the runway into the ocean environment and subsequent damage to aquatic flora and fauna; and • risk to personnel working on the airport runway or maintenance work extended runway structure.

9.2.6 Traffic, transport and access

If the runway extension was found to be a feasible option, it would increase the potential number of passengers per flight to the Island which would increase the need for transport to and from the airport. The island has an existing visitor capacity of 400 visitors and a proposed runway extension would not increase this limit. It is not likely that the increase in passenger capacity and tourist transport would have a significant impact on the traffic and transport on the island, nor significantly change the traffic numbers along the Lagoon Road adjacent to the airfield; as such traffic impacts during operation are expected to be low.

9.2.7 Biodiversity and biosecurity

Table 9-17 discusses the potential impacts on biodiversity and biosecurity from operational activities.

Table 9-17 Potential operational impacts on biodiversity and biosecurity

Potential operational impacts
Land based component (design Option 1 and Option 2)
• An increase in aircraft noise levels due to an increase in plane size may potentially impacti on the roosting and foraging activities of birds in the adjacent areas of the airstrip; and • the realignment of the existing Lagoon Road adjacent to the airfield may isolate populations of ground dwelling fauna as these species would need to travel further distances to find similar habitats.
Water based component for Option 1 (Land reclamation)
• Rock amour may potentially provide habitat for species otherwise not known to occur in the local area, this may have a flow on effects to the existing food chain. However, this could also provide habitat for some species that are known to occur; • impacts on long-term coastal processes, sedimentation and longshore drift, resulting in impacts on the existing flora and habitat composition on or close to the shore, and within the shallow waters close to shore; and • scouring of rock armour may dissipate detrimental minerals into the water column to be ingested by aquatic flora and fauna; and

Potential operational impacts
Water based component for Option 2 (Deck on piles)
• The bridge deck will create shadow to the water and Lagoon bed underneath, which may impact the life cycle of flora and/or fauna; • peaks and troughs created by the wave energy under the deck may allow vegetation to establish as seeds, sediment and minerals will be captured in the troughs and protected by the peaks; and • the piles may allow aquatic vegetation to establish at the base providing habitat for marine fauna.
Water based component (design Option 1 and Option 2)
• Oil/fuel spills from aircraft and vehicles may run into the Lagoon during high rainfall events and not be captured by the stormwater drainage.

Further assessment and field surveys would be required to inform the EIS stage.

9.2.8 Air quality

Table 9-18 discusses the potential impacts on air quality from operational activities.

Table 9-18 Potential operational impacts on air quality

Potential operational impacts
Land based component (design Option 1 and Option 2)
• Emissions emitted in the ambient air from larger planes can impact on air quality for residents, particularly the residents around the airport, receptors at Windy Point, and local fauna surrounding the runway area.
Water based component (design Option 1 and Option 2)
• Emissions emitted in the ambient air from larger planes have the potential to impact on air quality for residents of the Island and local fauna surrounding the runway area, particularly sea birds.

9.2.9 Landscape and visual amenity

Table 9-19 discusses the potential impacts on landscape and visual amenity from operational activities. It is noted that without doing an on ground visual impact assessment, the visual landscape impacts to receptors can't be determined. A visual impact assessment including photomontages of the before and after impacts from key viewing locations on land and water would be undertaken as part of the EIS.

Table 9-19 Potential operational impacts on landscape and visual amenity

Potential operational impacts
Land based component (design Option 1 and Option 2)
As the runway for the airport is already in existence the proposed works for the land component of the project is unlikely to pose significant visual impacts on the landscape during airport operation. Through realigning Lagoon Road adjacent to the airfield, there would be more areas cleared to the north of the runway which would slightly change the visual landscape. The Kentia palm trees located adjacent to Lagoon Road may be trimmed or removed during the realignment of Lagoon Road and the fence, resulting in a reduction in amenity along the road for passers-by/onlookers and residents. Larger aircraft would be landing and taking off from the airport and may have some impact on visual amenity in the adjacent area. Larger aircraft have the potential to cause visual intrusion impacts for the residents around the airport and receptors at Windy Point, however this impact would be temporary in nature.

Potential operational impacts
Water based component (design Option 1 and Option 2)
The extension of the runway structure would have a permanent visual impact on the landscape. The project is likely to result in a visual intrusion for residents and sensitive receivers located around the airport. Other receivers that would be impacted by the proposed runway includes Pinetrees boat shed, the aquatic club, the Lagoon foreshore, users of the Lagoon, Blackburn Island, viewing platforms on Transit and Intermediate Hill, Mt Gower, Signal Point. The landing and taking off a larger aircraft would have some impact on visual amenity in the adjacent area. Larger aircraft have the potential to cause visual intrusion impacts for the nearby residents around the airport and Windy Point to the north, however, this impact would be temporary in nature.

9.2.10 Social and economic

If the runway extension was found to be a feasible option, it could expand services and tourism opportunities in the future, up to the existing visitor capacity of 400 visitors. The larger planes may result in an increase in the number of tourists visiting the island at the one time, which may result in expanded services, tourism services, etc.

Once in operation, the runway extension is likely to have a negligible impact on the surrounding environment and associated amenity, with only minor increases in operational noise level associated with larger plane arrivals and departures. As such, negative socio-economic impacts associated with the operation of the project are anticipated to be minor and generally consistent with existing airport. No additional permanent workforce is anticipated to be required for the operation of the project.

The project may result in positive low or moderate social and economic impacts. A number of businesses may be able to operate all-year (as opposed to being closed in winter, which they are currently) as more customers are likely to visit if flight prices are lowered due to the use of more commercially viable aircraft.

However an increase in visitor traffic and the expansion of tourism services may also negatively impact residents on the Island. An increase in visitor traffic may affect the existing ‘lifestyle’ perceived by residents, and impact their psychological wellbeing. This was an issue raised by the community during consultation undertaken in October 2018.

During operation, marine traffic movements would be impacted by the runway extension in the Lagoon. Commercial and private boats currently utilise the passage between the existing runway end and Blackburn/Rabbit Island as a preferred thoroughfare between the north (boat shed ramp and sheds) and the south (e.g. snorkeling locations). This thoroughfare would likely be unavailable once the runway extension has been built and an alternative route would need be used. A detailed community consultation and socio-economic assessment would need to be undertaken as part of any future environmental assessment to verify these preliminary conclusions.

10.0 Significance of potential impacts

Based on the preliminary (desktop) environmental assessment undertaken in **Section 9.0**, an initial comparison of the significance of potential impacts for the runway extension with respect to each design option during construction and operation are provided in **Table 10-1** and **Table 10-2**. Where there is a difference between the significance of an environmental aspect between Option 1 and Option 2, the more significant potential impact has been highlighted.

Table 10-1 Summary of significance of potential impacts per design option during construction

Environmental aspect	Significance of potential impacts during construction	
	Option 1 (Land reclamation)	Option 2 (Deck on piles)
World heritage	High	High
Surface water (quality and hydrology)	High	Medium
Coastal processes	High	Low
Contamination	High	High
Climate change and flooding	High	High
Aviation safety	Low	Low
Traffic, transport and access	High	Medium
Biodiversity and biosecurity	High	High
Air quality	High	Medium
Noise and vibration	High	High
Landscape and visual amenity	High	High
Resource use and waste management	Medium	Medium
Social and economic	Low	Low

Table 10-2 Summary of significance of potential impacts per design option during operation

Environmental aspect	Significance of potential impacts during operation	
	Option 1 (Land reclamation)	Option 2 (Deck on piles)
Surface water (quality and hydrology)	High	High
Coastal processes	High	Low
Contamination	High	High
Climate change and flooding	High	High
Traffic, transport and access	Medium	Medium
Biodiversity and biosecurity	High	Medium
Air quality	Medium	Medium
Landscape and visual amenity	High	High
Social and economic	Low	Low

Should the project proceed, further investigations would be required to support preparation of an EIS. The EIS would assess the potential impacts of the project in more detail and would detail mitigation and management measures to reduce impacts to acceptable levels.

11.0 Planning approval pathways and associated risks

The Lord Howe Island Board is a statutory authority responsible to the NSW Minister for the Environment. The Board is charged with the care, control and management of the Island and the affairs and trade of the Island. A review of the relevant NSW and Commonwealth legislation, planning instruments (Local Environmental Plans and Development Control Plans) and strategic policy documents to determine the planning approval pathways and potential approval risks for both of the design options for the proposed runway extension has been undertaken and is presented in **Table 11-1**. The following planning pathways are for either design option, unless stated otherwise.

Table 11-1 Planning pathways required to obtain necessary approvals

Legislation	Planning requirements	Risks
Commonwealth		
Environment Protection and Biodiversity Conservation Act 1999	The EPBC Act requires Commonwealth approval be obtained for certain actions, and establishes an assessment and approvals system for actions that have or are likely to have, a significant impact on MNES. Before taking an action that could have a significant impact on a matter protected by the EPBC Act, the proposed action must be referred to the Minister. The purpose of a referral is to determine whether the proposed action will need formal assessment and approval under the EPBC Act. The referral will be the principal basis for the Minister's decision as to whether approval is necessary and, if so, the type of assessment that will be taken. The required assessment would then be undertaken under the bilateral process for assessment as described in **Section 5.1.1**. MNES relevant to the proposed works include the presence of threatened and migratory species listed under the EPBC Act and the location of the proposal within a World Heritage Area. These issues need to be considered as part of a detailed environmental impact assessment in order to assess the significance of potential impacts (either direct or indirect) of the works and identify recommended safeguards and mitigation measures.	Refusal if the Minister considers the project to have significant impacts on social, environmental and economic matters, particularly the impacts on the value of the heritage listing. Past example of refusal for a major development on Lord Howe Island was for the wind turbines. The proposed development was refused as the Federal Government (Federal Environment Minister) considered the development would create an intrusive visual impact on the island and affect the World Heritage value. The Minister for the Environment and Energy stated that the proposal "*would have clearly unacceptable impacts on a matter protected by a provision of Part 3 of the EPBC Act, and that Division 1A of Part 7 of the EPBC Act should apply to the referral of the proposed action*."
State		
Environmental Planning and Assessment Act 1979 (including aims and objectives of relevant environmental planning instruments, zoning and permissible uses, development controls, etc.)	Under the SRD SEPP, the project is a development that meets the definitions of 'air transport facilities' and also exceeds $30 million capital investment value and therefore would be classified as State Significant Development (SSD) under this SEPP. 1. A development application for a SSD proposal requires that: the proponent seek Secretary's Environmental Assessment Requirements (SEARs) for the project prior to lodging the development application; and	Refusal if the determining authority considers the project to have significant impacts on social, environmental and economic matters, particularly the impacts on the community and the value of the heritage listing. Risk of project refusal on the grounds of community objections and concerns. Refusal if the project does not meet

Legislation	Planning requirements	Risks
	2. the application be accompanied by an EIS. **Figure 11-1** provides a detailed process of approval with consideration of state and commonwealth processes.	the considerations set out under Clause 228 of the EP&A Regulation, and/or the objectives or zone purposes of the marine park or aquatic reserve.
	Lord Howe Island Airport is subject of the Lord Howe Island Local Environmental Plan 2010 (LHI LEP). Clause 10(2) of the LHI LEP provides that potential future runway extension works would require development consent from the Board as works would involve: (2)(a) the construction of a new building or a new work, such as an airport, wharf or way, that is related to a public utility undertaking In addition to this, as discussed in section 4.3.2, development on the foreshore area and also within Zone 9 Marine Park may be carried out with consent if the consent authority finds that the proposed development is not inconsistent with any advice about the development that is provided to the consent authority by the Marine Estate Management Authority (MEMA). As the carrying out of works requires development consent, the determining authority is required under Part 4 of the EP&A Act to examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the proposed activity. Clause 228 of the EP&A Regulation sets out the factors that must be taken into account when determining the impact of an activity on the environment. If the project is to progress further, the EIS would consider and assess the relevant issues raised in the LEP and DCP.	As above.
	Lord Howe Island Airport is subject of the *Marine Estate Management Act 2014.* Refer to section 55 (1) of this Act. In general before determining a development application under Part 4 of the EP&A Act for the carrying out of development within a marine park or an aquatic reserve, a consent authority must: (a) take into consideration: i. if there are management rules for the marine park or aquatic reserve, the purposes of the zone within which the area concerned is situated as specified in those management rules, and ii. the permissible uses of the area concerned under the regulations or the management rules, and iii. if a management plan for the marine park	As above. The risks associated with obtaining a permit from MEMA is if the project is not inconsistent with any advice about the development that is provided to the consent authority by the Marine Estate Management Authority. As such, it is recommended to consult with MEMA if the project progresses further.

Legislation	Planning requirements	Risks
	or aquatic reserve has been made, the objectives of the marine park or aquatic reserve, and iv. any relevant marine park or aquatic reserve notifications. The proposal may require a permit from MEMA.	
	Lord Howe Island Airport is subject of the *Biodiversity Conservation Act 2016*. Under Part 7, section 7.8(3) of the BC Act, should a development be deemed to have a significant effect on threatened species or ecological communities, or their habitats, the environmental impact statement under Part 5 of the EP&A Act is to include or be accompanied by: 1. a species impact statement, or 2. if the proponent so elects—a biodiversity development assessment report.	As above.
	Lord Howe Island Airport is subject of the *Fisheries Management Act 1994*. Design option 1 includes the use of fill material and other excavated material stockpiled on the Island, wherein the modification of 'water land' means that the proposal therefore fits the definition of reclamation work under the BC Act. In accordance with section 200(1) of the BC Act, a local government authority must not carry out reclamation work except under the authority of a permit issued by the Minister.	As above.
Lord Howe Island Regulation 2014	The LHI Regulation prohibits the importation of soil or rock, removal or destruction of substances forming part of the Island, or removal or destruction of vegetation except in accordance with the approval of the Board.	Risk of refusal if the determining authority considers the importation of soil or rock or the removal or destruction of vegetation or parts of the Island to have significant impacts on environmental matters, particularly the impacts on the value of the heritage listing.
Lord Howe Island Local Environmental Plan 2010	Clause 35 of the LEP 2010 states that "*development on the foreshore area is prohibited… [but] may be carried out with consent if, in the consent authority's opinion:* *i. the proposed development is in the public interest and does not significantly reduce public access to the foreshore, and* *ii. the bulk and scale of the proposed development will not detract from the visual amenity of the foreshore area, and* *iii. the proposed development addresses any need to restore lost or disturbed plants that are native to the Island, particularly if restoring those plants may enhance visual amenity, and*	Risk of refusal if the determining authority considers that the project would not align with these requirements. The project would have to be consistent with any advice about the development that is provided to LHIB by MEMA.

Legislation	Planning requirements	Risks
	iv. there is a demonstrated Island community-based, or marine-based, business need for it, and *v. the proposed development will not be adversely affected by, or adversely affect, coastal processes, and* *vi. in the case of proposed development involving the erection of a structure—the purpose of that structure could not practicably be fulfilled by an existing structure, and* *in the case of development proposed to be carried out on land that is also within Zone 9 Marine Park—the proposed development is not inconsistent with any advice about the development that is provided to the consent authority by the Marine Estate Management Authority.*"	

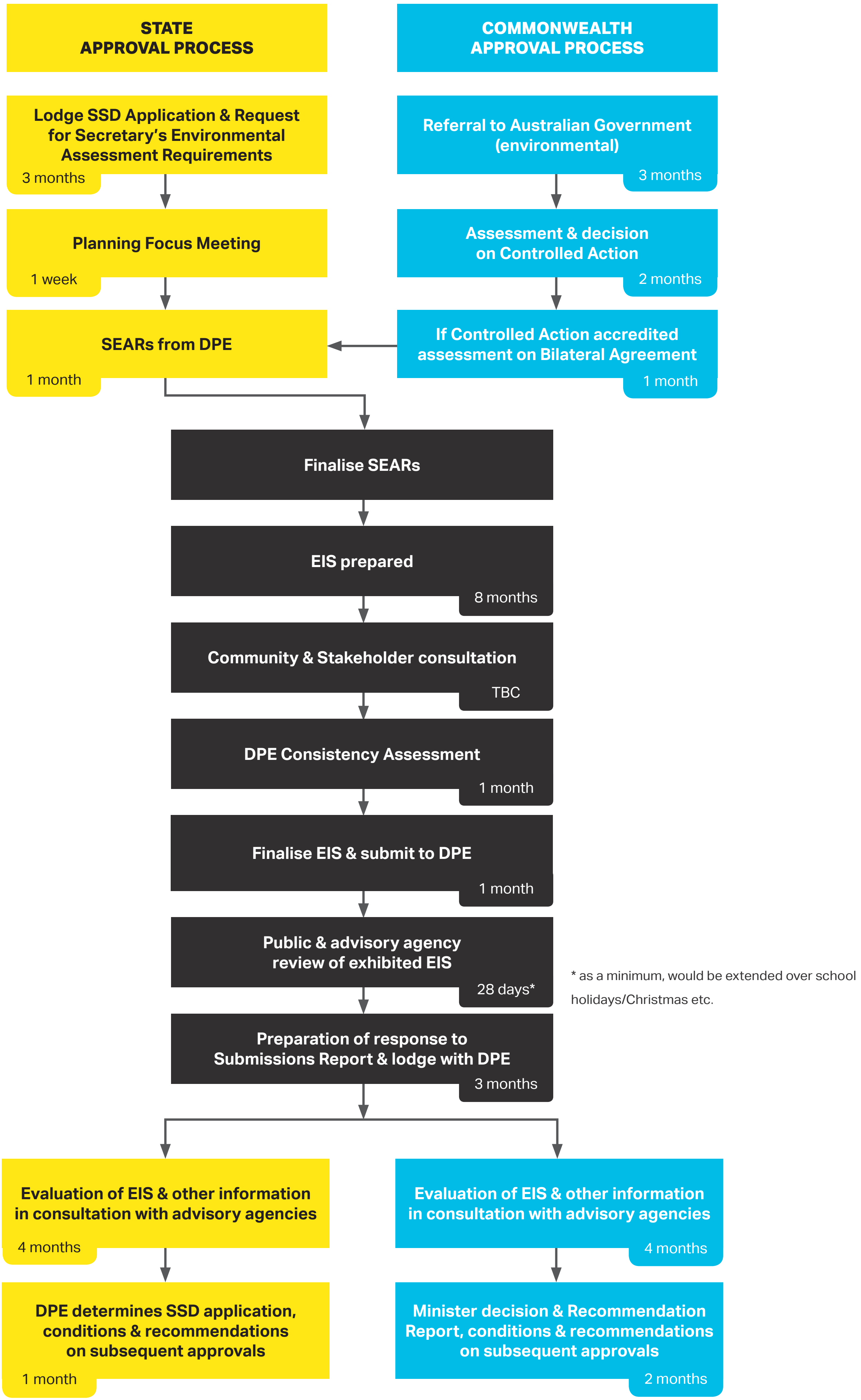

FIGURE 11-1 PROCESS OF APPROVAL WITH CONSIDERATION OF STATE AND COMMONWEALTH APPROVAL PROCESSES

12.0 Conclusion and recommendations

This preliminary environmental assessment has been undertaken based on a desktop review of the potential impacts of a runway extension at the Lord Howe Island Airport. The options analysis for the runway extension includes two design options of either a land reclamation design or a deck on pile structural design. The proposed runway extension would protrude into parts of the Lord Howe Island Lagoon Sanctuary Zone. The desktop assessment carried out has determined characteristics, potential environmental risks and approval risks associated with the environmental aspects of the marine and land based components of proposed works. This is discussed in **Section 9.0**.

A number of environmental issues associated with the potential construction and operation of a runway extension which were identified to have a medium to high risk were assessed. The assessment found that a runway extension has the potential to impact on the LHIG World, Commonwealth and State Heritage listings. Construction activities have the potential to affect the Island's heritage significance by either changing the visual amenity of the area, the land use, causing damage to biodiversity, to the environment by introducing pests and weed species, by affecting water and air quality and/or introducing to or spreading contamination on the Island.

The assessment of significance for the potential impacts identified that Option 2 for deck on piles would have an overall lower level impact to the environment during compared to Option 1 for land reclamation. The primary difference between the two options is the difference in the significance of coastal processes, surface water, traffic and transport and air quality impacts.

During operation, the assessment of significance identified that Option 2 for deck on piles would have an overall lower level impact to the environment compared to Option 1 for land reclamation. This is demonstrated during the assessment for coastal processes and biodiversity and biosecurity. During operation, the land reclamation option would act as a complete barrier and become an accumulation zone for sand and floating and suspended matter. The land reclamation option would also impact on the wave patterns and sand volumes within the Lagoon.

This PEA was limited to a desktop assessment and as such if the project is to progress, the environmental issues identified would need to be assessed in detail through additional, detailed and fieldwork based technical assessments. Based on the preliminary findings in **Section 9.0**, it is recommended that a more in-depth investigation to ascertain the accurate location, distribution and extent of potential constraints and impacts is undertaken. Further assessment should at a minimum include the following:

- further consideration of the potential impact to World heritage;
- further soil testing to understand the extent of existing land-based contamination and additional PFAS investigations for the purposes of further assessing the nature and extent of identified PFAS impacts;
- the extent of impacts on surface water, based on background surface water quality monitoring, including further assessment as part of the EIS with considerations to best practice surface water management measures;
- further assessment as part of the EIS regarding the traffic and transport impacts of the proposed runway extension, including field surveys;
- background monitoring of the mean ambient levels against National Environmental Protection Measures (NEPM);
- a quantitative noise assessment, noise modelling and/or noise logging;
- likelihood and extent of impacts to specific threatened ecological communities and threatened species;
- a field-based landscape and visual impact assessment of proposed changes including photomontages of the before and after impacts from key viewing locations on land and water would be undertaken; and

- detailed community consultation and socio-economic assessment as part of any future environmental assessment.

If it is decided that the runway extension would progress further, the next steps would be to begin with a formal planning application for the development. A legislative framework was established for the potential works, and informed a relevant approvals pathway for a potential future runway extension project, as outlined in **Section 11.0**.

A State significant development scoping report would need to be prepared to support an application to DP&E for the project under section 5.15 of the EP&A Act. The scoping report would present potential environmental impacts that have been identified for the project. The DP&E would then issue Secretary Environmental Assessment Requirements (SEARs), which identify assessment requirements for the EIS. This PEA could be used to inform the scoping report.

LHIB would then prepare the EIS. The EIS would need to present outcomes of any alternatives such as the 'do-nothing' approach and options studies undertaken for the project, including justification of why the project was chosen as the preferred option. Preparation of the EIS would also involve undertaking detailed technical assessments and field surveys, for example the detailed studies recommended in this report.

The EIS would then be submitted to the DP&E for approval by the NSW Minister for Planning and Commonwealth Environment Minister (refer to **Section 11.0**) for further details. **Figure 11-1** provides the approval process that would need to be undertaken if the proposed runway extension were to progress further.

In summary, such a project would require multiple approvals at the State and Commonwealth levels, the certainty of which is not assured due to the potential approvals risks associated with the preliminary construction and operational environmental impacts identified. As such, a more detailed assessment would be undertaken for the legislative requirements and approval processes in the later stages if the project does progress.

13.0 References

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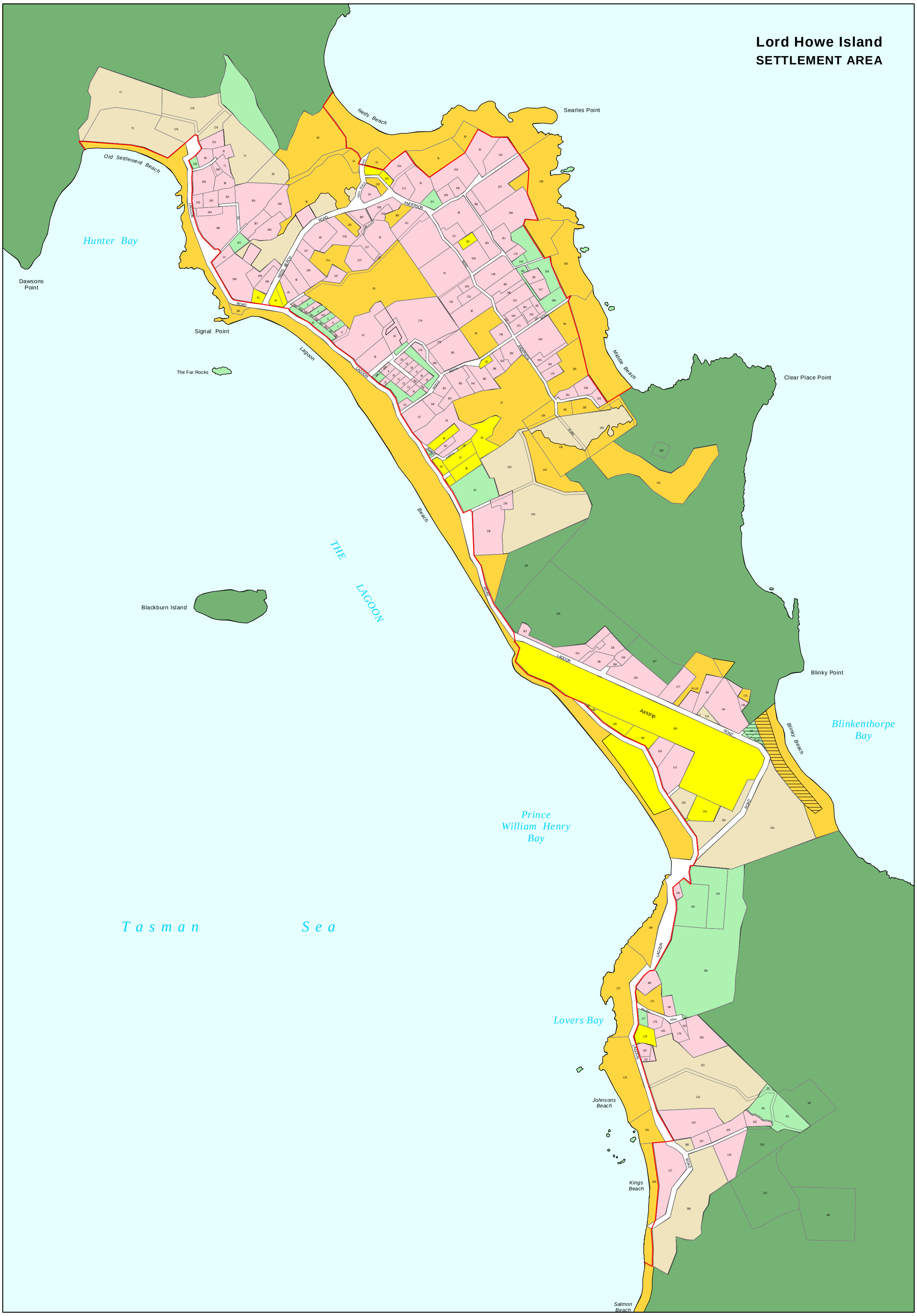
Appendix A – Land use zoning map (Lord Howe Island LEP 2010)



Legend

Zones

- Zone No. 1 - Rural
- Zone No. 2 - Settlement
- Zone No. 5 - Special Uses
- Zone No. 6 - Recreation
- Zone No. 7 - Environment Protection
- Zone No. 8 - Permanent Park Preserve
- Zone No. 9 - Marine Park

General

- Land Referred to in Clause 37
- Foreshore Building Line

NSW Planning & Environment

Environmental Planning and Assessment Act 1979

Lord Howe Island
Local Environmental Plan 2010

Sheet 2 of 3 Sheets

N

Scale 1:5000

0 50 100 200 300
Metres

Geocentric Datum of Australia 1994 (GDA94)
Map Grid of Australia 1994 (MGA94) - Zone 57
(MGA94 is a Universal Transverse Mercator Projection)

Sheet Index

Sheets 2 & 3
Lord Howe Island
Sheet 1

Notations:

This plan repeals Lord Howe Island Regional Environmental Plan 2005.

Map produced by Department of Planning and Environment 12 May 2014.

Data supplied by Land and Property Information (LPI), Office of Environment and Heritage, and Planning and Infrastructure

Map identification number: 6380_COM_LZN_002_005_20140512

Appendix B – EPBC Protected Matters Search Tool Search Results

Australian Government
Department of the Environment and Energy

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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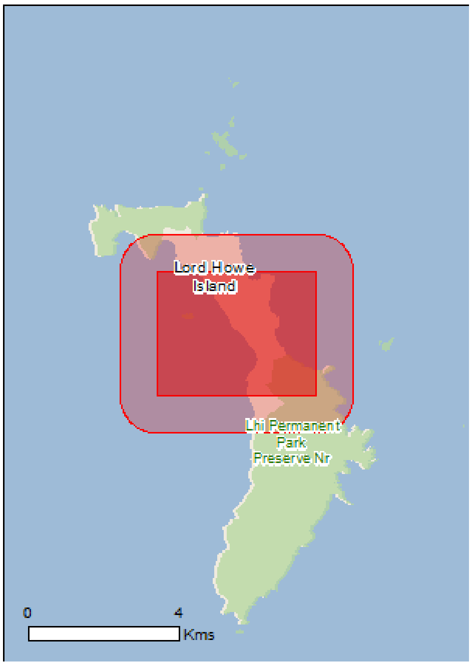
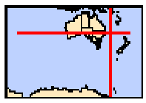


Coordinates
Buffer: 1.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	1
National Heritage Places:	1
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	48
Listed Migratory Species:	42

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	43
Whales and Other Cetaceans:	29
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	13
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

World Heritage Properties		[Resource Information]
Name	State	Status
Lord Howe Island Group	NSW	Declared property

National Heritage Properties		[Resource Information]
Name	State	Status
Natural		
Lord Howe Island Group	NSW	Listed place

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Calidris canutus		
Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Diomedea antipodensis		
Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea antipodensis gibsoni		
Gibson's Albatross [82270]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora		
Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans		
Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi		
Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregetta grallaria grallaria		
White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
Hypotaenidia sylvestris		
Lord Howe Woodhen [87732]	Endangered	Breeding likely to occur within area
Limosa lapponica baueri		
Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica menzbieri		
Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Pterodroma heraldica Herald Petrel [66973]	Critically Endangered	Species or species habitat may occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma neglecta neglecta Kermadec Petrel (western) [64450]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Strepera graculina crissalis Lord Howe Island Currawong, Pied Currawong (Lord Howe Island) [25994]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta steadi White-capped Albatross [82344]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Fish		
Epinephelus daemelii Black Rockcod, Black Cod, Saddled Rockcod [68449]	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat may occur within area
Other		
Gudeoconcha sophiae magnifica Magnificent Helicarionid Land Snail [82864]	Critically Endangered	Species or species habitat may occur within area
Mystivagor mastersi Masters' Charopid Land Snail [81247]	Critically Endangered	Species or species habitat known to occur within area
Placostylus bivaricosus Lord Howe Flax Snail, Lord Howe Placostylus [66769]	Endangered	Species or species habitat known to occur within area
Pseudocharopa ledgbirdi Mount Lidgbird Charopid Land Snail [85279]	Critically Endangered	Species or species habitat may occur within area
Pseudocharopa whiteleggei Whitelegge's Land Snail [81249]	Critically Endangered	Species or species habitat may occur within area
Plants		
Calystegia affinis [48909]	Critically Endangered	Species or species habitat known to occur within area
Elymus multiflorus subsp. kingianus Phillip Island Wheat Grass [82413]	Critically Endangered	Species or species habitat known to occur within area
Geniostoma huttonii [56368]	Endangered	Species or species habitat known to occur within area
Polystichum moorei Rock Shield Fern [40755]	Endangered	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat may occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Christinus guentheri Lord Howe Island Gecko, Lord Howe Island Southern Gecko [59250]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat may occur within area

Name	Status	Type of Presence
Oligosoma lichenigera Lord Howe Island Skink [82034]	Vulnerable	Species or species habitat known to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat likely to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Breeding known to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Breeding known to occur within area
Ardenna pacifica Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Sula dactylatra Masked Booby [1021]		Breeding known to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat likely to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat may occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat may occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Breeding known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea gibsoni Gibson's Albatross [64466]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Procelsterna cerulea Grey Noddy, Grey Ternlet [64378]		Breeding known to occur within area
Pterodroma nigripennis Black-winged Petrel [1038]		Breeding known to occur within area
Pterodroma solandri Providence Petrel [1040]		Breeding known to occur within area
Puffinus assimilis Little Shearwater [59363]		Breeding known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Breeding known to occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding known to occur within area
Sula dactylatra Masked Booby [1021]		Breeding known to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Thalassarche eremita Chatham Albatross [64457]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche sp. nov. Pacific Albatross [66511]	Vulnerable*	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area
Fish		
Cosmocampus howensis Lord Howe Pipefish [66208]		Species or species habitat may occur within area
Halicampus boothae Booth's Pipefish [66218]		Species or species habitat may occur within area
Hippocampus kelloggi Kellogg's Seahorse, Great Seahorse [66723]		Species or species habitat may occur within area
Solegnathus dunckeri Duncker's Pipehorse [66271]		Species or species habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat may occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within

Name	Status	Type of Presence
		area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat may occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat may occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon grayi Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area

Name	Status	Type of Presence
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Lord Howe Island	NSW

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Sturnus vulgaris		
Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula		
Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Turdus philomelos		
Song Thrush [597]		Species or species habitat likely to occur within area
Mammals		
Mus musculus		
House Mouse [120]		Species or species habitat likely to occur within area
Rattus rattus		
Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Plants		
Anredera cordifolia		
Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus asparagoides		
Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera subsp. rotundata		
Bitou Bush [16332]		Species or species habitat likely to occur within area
Lantana camara		
Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum		
African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Salvinia molesta		
Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-31.52559 159.05323,-31.52559 159.09091,-31.55105 159.09091,-31.55105 159.05323,-31.52559 159.05323

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Appendix C – Site Photos

Plate 1: DHC8-200 aircraft parked in existing apron area, looking north-east from outside existing terminal building

Plate 2: DHC8-200 aircraft travelling along existing taxiway, looking north-east from outside existing terminal building

Plate 3 – Looking north-east from outside the existing terminal building. DHC8-200 aircraft in distance travelling along existing runway

Plate 4 – Looking south-west from the northern side of the runway. The existing airfield and existing security fence can be seen. Significant native vegetation beyond the kikuyu grass on the other side of the airfield can be seen in the distance.

Plate 5 – Looking south-west from Windy Point towards the Airport. The end of the existing runway can be seen on the rock/reclaimed land structure.

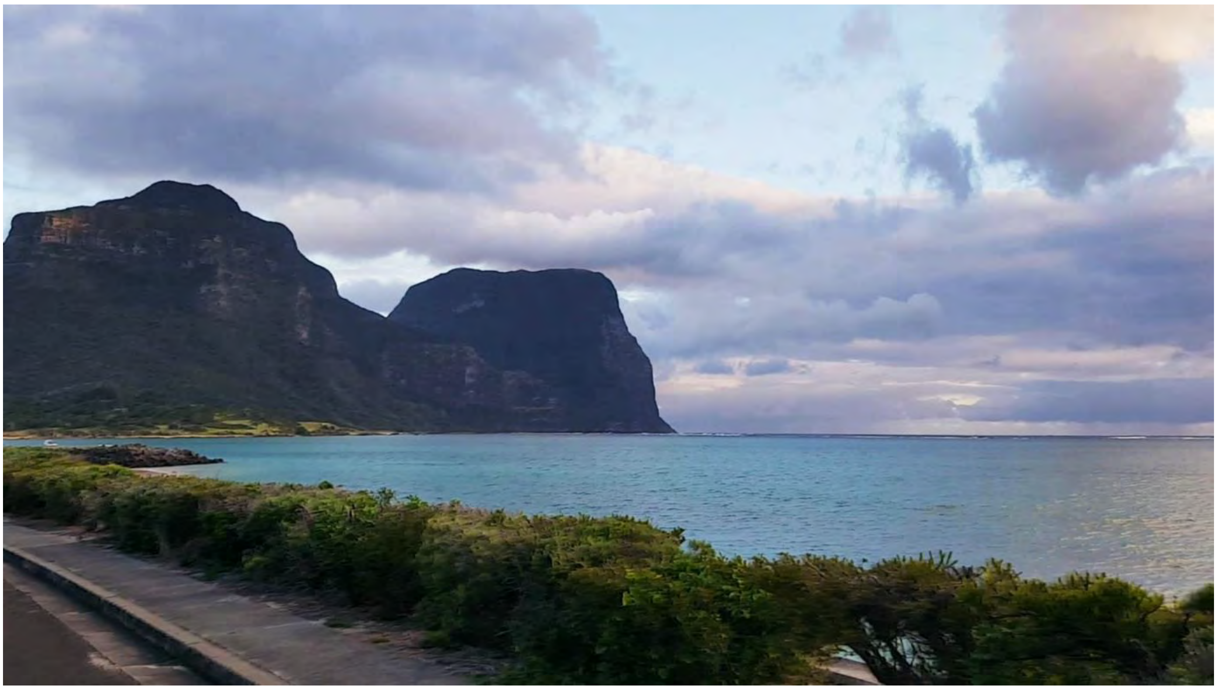

Plate 6 – Looking south-west from Windy Point towards the Airport and Lagoon. This section of the Lagoon is where the proposed runway would extend into starting from the end of the existing runway (rock/reclaimed land structure on the left).

Plate 7 – Looking north-west from Lagoon Road adjacent to the airstrip towards the Lagoon. If the proposed runway extension were to progress further, this portion of the road would need a new realignment in order to avoid vehicles and the fence line impinging the ‘fly-over area plane’ and OLS restrictions.

Plate 8 – Lord Howe Island terminal located adjacent to the apron.

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