1% AEP FLOOD STUDY

Client: **Northern Beaches Essential Services Accommodation**

Property: **Residential Boarding House Development 16 Wyatt Avenue, Belrose**

Date: **08 June 2021**

Document Identification

Our Reference: **NSW210450**

For and on behalf of ACOR Consultants Pty Ltd

Quality Information

Version	Description	Date	Author	Reviewed	Signature
1.0	Flood Impact Study (DA Design Report)	03/06/2021	Sam Mattheos	Gregory Lyell	
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Distribution

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TABLE OF CONTENTS

ANNEXURES

Annexure A — Bee & Lethbridge Survey Plan, 'Plan showing boundaries, relative heights & physical features over lots 2566 in D.P. 752038 known as No. 16 Wyatt Avenue, Belrose, Reference 11971, Revision 00, dated 12th February 2021.

Annexure B — Platform Architects Architectural Plans, Reference WAB2, Sheets A0.01 - A0.02, A1.01 - A1.13, A2.01 - A2.05 & A3.01 - A3.06, Revision DA03, dated 27th May 2021.

Annexure C — ACOR Flood Plans, Reference NSW210450, Sheets F1 to F20, Revision 1, dated 18th May 2021.

1.0 Introduction

ACOR Consultants Pty Ltd (ACOR) has been commissioned to prepare a Flood Study in accordance with the requirements of the Warringah Development Control Plan 2011 Part C4 Stormwater and Part E11 Flood Prone Land, Northern Beaches Council Water Management for Development Policy and Warringah Local Environmental Plan 2000. The Flood Study investigates flood behaviour throughout the overland flooding catchment impacting the subject site. This includes the analysis of:

- Surface runoff across the catchment;
- Flooding towards the lower part of the catchment; and
- Backwater flooding impact on the subject site.

A two-dimensional computer model of the catchment was established to analyse overland flood behaviour under existing and proposed catchment conditions. The model provides information on the extent of flood inundation, flood depths and flood velocities throughout the catchment for the 1% AEP overland flood event.

1.1 Objective

The objective of the study is to define local overland flooding in accordance with the Floodplain Development Manual (NSW DIPNR 2005) and Section 11 of the Northern Beaches Council Water Management for Development Policy. It involved the following steps:

- Attend the site to assess the anticipated extent and nature of flooding and identify hydraulic controls likely to impact on flooding behaviour;
- Develop a hydraulic model to determine 1% AEP flood levels, velocities and provisional hazard categories;
- Review the hydraulic model to ascertain flood impacts on the proposed development at 16 Wyatt Avenue, Belrose and neighbouring properties; and
- Provide recommendations to ensure that flood waters do not adversely impact the proposed boarding house development on 16 Wyatt Avenue, Belrose and neighbouring properties. This will be achieved with the inclusion of increased threshold levels provided by the proposed driveway and the design of flood management and diversion infrastructure.

In addition to this, the report and flood study has been undertaken with the approved flood study applicable to 14 Wyatt Avenue in mind. Synergy between the two reports in both the pre - development and post – development scenarios has been taken into account.

1.2 Site Description

The subject site consists of the proposed development at 16 Wyatt Avenue, Belrose and its neighbouring sites. In the pre-development condition, the site and neighbouring developments are primarily occupied for residential use and located along Wyatt Avenue and surrounding the intersection between Wyatt Avenue and Cotentin Road. A school and recreational parkland is also situated nearby. Dense bushland exists at the rear of the property, the majority of which drains into Fireclay Gulley.

In the post-development condition, water is conveyed from the southeast to the northwest, over the intersection between Wyatt Avenue and Cotentin Road and through the rear boundary of 14 Wyatt Avenue into 16 Wyatt Avenue. Additionally, some flows are conveyed through the drainage swale located within 12 Wyatt Avenue, later combining with the roadway flows along the eastern boundary of 14 Wyatt Avenue.

An approved Childcare Facility has been approved on 12 Wyatt Avenue and 14 Wyatt Avenue has been approved for boarding houses and the post development flood works proposed accommodate for the pre and post development scenarios for both.

1.3 Flood Characteristics

The subject site is impacted by overland flows draining towards the bushland at the rear of the property and into Fireclay Gulley. The catchment upstream of the site is dominated by residential land use. Elevations within the upstream catchment are generally within the range 155 m AHD to 197 m AHD.

The site is impacted by flooding during the 1% AEP flood event, with 1% AEP floodwater levels within the range of 155.10 m AHD to 181.30 m AHD, resulting in partial inundation of the site. Inundation depths vary between designated storage areas and overland areas, with flood depths in storage areas generally less than 0.50 m.

The 1% AEP floodwaters generally pose Low Hazard to occupants of the surrounding areas, with isolated pockets of High Hazard floodwaters located far to the northwest of the subject area.

Discharge from neighbouring sites as well as upstream sites and roads have been taken into account in the modelling and reporting of this works. The proposed approved works on 14 Wyatt Avenue have not been modelled in the post development scenario, however, flood storage capacity on 16 Wyatt Avenue and discharge has been accommodated for 14 Wyatt discharge locations.

2.0 Available Data

Council informed ACOR that no existing flood study or information is available for this area. ACOR have been tasked to undertake this flood study and have used topographic, flooding and rainfall data obtained from a number of sources. The origin and types of information underpinning the assumptions used in this study are presented below.

2.1 Published Flood Data

There is currently no published flood data for the site. The acknowledgement of flooding of the site is pursuant to the absence of a formalised stormwater drainage system in the surrounding area.

2.2 Survey Data

Survey information adopted for this study has been collated from the following sources:

- ALS survey provided by the NSW Land and Property Information Department (NSW LPI);
- GIS layers of cadastre and satellite imagery provided by the NSW LPI.

2.3 Design Storm Event Data

This study uses design rainfall intensity-frequency-duration (IFD) data, derived for the latitude and longitude of the Northern Beaches LGA. This IFD data was issued by the Hydrometeorological Advisory Service of the Australian Bureau of Meteorology. The IFD data provides average rainfall intensities of design storm events for recurrence intervals up to and including the 1% AEP storm event.

Uniform areal distribution of design storms has been assumed for the catchment due to its small area. Rainfall depths and temporal patterns were developed for the 1% AEP design storm events using the Australian Rainfall and Runoff 2016 (ARR2016).

Estimated average design storm rainfall intensities for the full range of 1% AEP storm events considered are presented in Table 1.

Table 1: Average design rainfall intensities.

Duration	Intensity (mm/hr)	Duration	Intensity (mm/hr)
5 min	279	2 hour	52.0
10 min	224	3 hour	40.5
20 min	160	6 hour	27.3
30 min	127	12 hour	19.1
1 hour	81.4		

3.0 Hydrologic Modelling

Hydrologic modelling was undertaken within TUFLOW using the Direct Rainfall ('rainfall on the grid') methodology. In the hydraulic model, rainfall is applied directly to the 2D terrain, and the hydraulic model automatically routes the flow as determined by the elevation and roughness grids and any included 1D pipeline network.

Direct rainfall modelling is a relatively new feature of hydraulic modelling and it is still being tested on a number of catchments to ensure it is reliably representing the flood behaviour of a given catchment. Runoff is generated over the entire catchment, rather than the more traditional approach of calculating an inflow hydrograph and lumping this in at an assumed location(s). This 'direct rainfall' approach means the whole catchment will be 'wet' and the hydraulic modelling results need to be filtered to show only those cells that genuinely represent areas of catchment flooding. This was achieved by only mapping inundation at cells with a flood depth greater than 0.05 metres.

The design storm events applied to the catchment during the direct rainfall simulation are the design storm events described in Section 2.3. Direct rainfall was applied to the area indicated as 'Catchment' in Figure 1 (refer NSW210450/F1/1, copy enclosed under Annexure C).

4.0 Hydraulic Modelling

A TUFLOW 1D/2D model was used to hydraulically route flows through the catchment and to derive flow depths, velocities and hazards for the pre-development and post-development scenarios. This section describes the hydraulic modelling approach and hydraulic model development.

4.1 Choice of Hydraulic Model

Different hydraulic modelling approaches can be applied according to the floodplain's hydraulic characteristics and the objectives of the study. The simpler methods lump the left and right overbank floodplain areas and the main channel into a one-dimensional (1D) representation. This approach is relatively simple and computationally fast and is generally appropriate for modelling flows through pipe networks and straight sections of formed open channels. The main limitation of such 1D modelling approaches is that flow is assumed to occur in a linear direction, and the water levels across the floodplain are assumed to be at the same level as the main channel.
A more detailed two-dimensional (2D) approach is recommended in areas where significant differences can occur between the channel flood level and the floodplain flood levels. This approach is also preferable where separate flow paths and flow around catchment obstructions occur, as is the case in this study. This is a more complex analysis, which requires greater data requirements and computational resources.

The TUFLOW 1D/2D model was chosen to model the catchment hydraulics. This modelling system dynamically couples the one-dimensional and two-dimensional flow paths in the floodplain.

4.2 TUFLOW 1D Model Domain

The piped drainage network within the catchment was not represented in the TUFLOW model, as it was determined that the worst-case scenario involved the stormwater inlet structures becoming 100% blocked during the 1% AEP flood event. In the post-development scenario, culverts were added to the site to alleviate flooding.

By not including piped flows external to the site, and letting the floodwaters flow via overland flow, we obtain an exacerbated flood level which given the appropriate analysis, will provide residents with a safer outcome.

4.3 TUFLOW 2D Model Domain

The 2D hydraulic model domain covers the area indicated as 'Catchment' in Figure 1 (refer NSW210450/F1/1, copy enclosed under Annexure C). A 1 metre square grid was utilised for this study. Each grid element contains information on ground topography (see Section 4.3.1), surface resistance to flow (see Section 4.3.4) and initial water level.

The grid cell size of 1 metre is considered to be sufficiently fine to appropriately represent the variations in floodplain topography and land use within the study area. It should be noted that TUFLOW samples elevation points at the cell centres, mid-sides and corners, as a consequence a 1 metre square cell size results in surface elevations being sampled every 0.5 m.

Linear features that potentially influence flow behaviour, such as gullies and levees were incorporated into the topography using 3D 'breaklines' to ensure that these were accurately represented in the model. It is noted that fences have not been explicitly incorporated into the model in urban areas unless deemed critical to the study, and were instead considered in the setting of appropriate Manning's 'n' values for these areas.

4.3.1 Topography

A 1 m grid Digital Elevation Model (DEM) was generated for the catchment using ALS survey data. This DEM was used to represent ground elevations throughout the catchment.

Land use categories were assigned to areas of the catchment based on examination of aerial photography and satellite imagery. These land use categories were used to assign roughness and infiltration parameters during modelling. Further detail on the modelling of infiltration and catchments roughness is contained in Section 4.3.3 and Section 4.3.4 respectively.

4.3.2 Building Footprint

The footprints of buildings surrounding critical flow paths are modelled as blocked elements within the 2D domain. Building outlines were determined from aerial photographs and site survey, and the building footprint was removed from the 2D active domain.

In general, buildings far away from the subject site or far from critical flow paths were modelled as full obstructions.

4.3.3 Infiltration

Infiltration losses were modelled using an Initial Loss/Continuing Loss (IL/CL) infiltration model. Initial losses and continuing loss rates were defined for each land use category. The adopted loss parameters are presented in Table 2 in Section 4.3.4, alongside the roughness parameters, for each land use category.

4.3.4 Roughness

The hydraulic roughness of a material is an estimate of the resistance to flow and energy loss due to friction between a surface and the flowing water. A higher hydraulic roughness indicates more flow resistance; for example, a concrete path has a lower hydraulic roughness than a rough vegetated channel as water flows more freely over concrete than through a vegetated channel. Roughness in TUFLOW is modelled using the Manning's 'n' roughness co-efficient. Table 2 lists the adopted Manning's roughness for each land use.

Table 2: Adopted roughness and infiltration parameters.

Land use category	Initial loss (mm)	Continuing loss (mm/hr)	Manning's n

Road	0	0	0.020
Residential lots	5	6	0.150

4.4 Boundary Conditions

This section describes the boundary conditions imposed upon the model. Typical model boundary conditions include flows entering the model domain from upstream, backwater effects from hydraulic controls such as chokes and streams downstream, and the flow predicted through the model domain by a separate hydrologic model.

4.4.1 Direct Rainfall

A direct rainfall boundary condition was applied to the area indicated as 'Catchment' in Figure 1 (refer NSW210450/F1/1, copy enclosed under Annexure C). The direct rainfall method is described in Section 3.

4.4.2 Upstream Boundary

The use of direct rainfall and selected 2D model domain means hydrologic and hydraulic modelling commenced at the top of the catchment. As such, no upstream boundary conditions were applied. Upstream flows are included via the direct rainfall method instead.

4.4.3 Downstream Boundary

A stage-discharge (water level vs. flow) hydrograph was used as the downstream boundary condition of the TUFLOW model. The stage-discharge relationship is generated by TUFLOW by specifying a downstream boundary slope.

5.0 Flood Model Results

This section summarises the results of the hydrologic and hydraulic modelling of overland flows within the catchment. The 1% AEP flood event critical duration and peak flowrate through the catchment are presented. The behaviour of the 1% AEP floodwaters within the vicinity of the subject site are described in general terms, and the impact of flooding on the subject site is discussed.

5.1 Flood Model Validation

No Council modelling is currently obtainable at the date of this report.

5.2 Critical Duration

The design storm from Table 1 which produced the highest peak discharge through the site was selected as the critical duration storm event. The critical duration for the 1% AEP storm event is 10 minutes.

5.3 Design Peak Flood Flow

The 1% AEP peak flowrate passing through the site area where the proposed buildings are to be located is approximately 1.21 m^3/s. Note the 1% AEP floodwaters enter the site via 14 Wyatt Avenue causing the discharge through the site and into the rear of the development.

5.4 Design Flood Characteristics

The flood velocity, flood depth, and provisional flood hazard of the 1% AEP flood event were mapped for the existing and proposed site conditions. The following flood maps are enclosed under Annexure C:

- Figure 1. Catchment Map & Model Boundary Condition (refer NSW210450/F1/1);
- Figure 2. 1% AEP Maximum Flood Depth – Pre-Development (refer NSW210450/F2/1);
- Figure 3. 1% AEP Maximum Flood Velocity – Pre-Development (refer NSW210450/F3/1);
- Figure 4. 1% AEP Maximum Flood Hazard – Pre-Development (refer NSW210450/F4/1);
- Figure 5. 1% AEP Maximum Flood Depth – Post-Development (refer NSW210450/F10/1);
- Figure 6. 1% AEP Maximum Flood Velocity – Post-Development (refer NSW210450/F11/1);
- Figure 7. 1% AEP Maximum Flood Hazard – Post-Development (refer NSW210450/F13/1);
- Figure 8. 1% AEP Maximum Flood Afflux Map – Post-Development (refer NSW210450/F20/1)

The 1% AEP flood level in the vicinity of the site is within the range of 155.10 m AHD to 171.90 m AHD, with depths of less than 0.80 m.

Flood waters enter the site from 14 Wyatt Avenue and the frontage of 16 Wyatt Avenue, flows are then guided to a proposed flood storage area located behind the proposed driveway. A culvert to relieve the flood storage area is then provided to cater for the 1% AEP flood event. A proposed floodwall is introduced to the western boundary (Refer to ACOR Consultants Stormwater Plans - NSW210450 C1.01 – C7.01) to provide protection and guidance to the neighbouring and proposed buildings.

Inundation is largely confined to the drainage depression passing through the north and west of the site, with floodwaters also flowing between the proposed buildings.

The 1% AEP floodwater velocities are generally between 0.5 – 3.0 m/s, which, whilst high, are in accordance with pre-development conditions.

The proposed development results in a minimal increase in flood levels external to the site. A change in flood level of less than 0.03 m occurs external to the site which is considered within the acceptable model tolerance.

5.5 Provisional Flood Hazard

The degree of Provisional Hazard attributed to flooding at the subject site is a function of Hydraulic Hazard (relating to the depth and velocity of floodwaters) and is adjusted to account for the following factors:

- Size of flood;

- Effective warning time;
- Flood awareness;
- Rate of rise of floodwater;
- Duration of flooding;
- Evacuation problems;
- Effective flood access; and
- Type of development.

Hazard categories are defined as either high, intermediate or low and are based on the guidelines outlined in the Floodplain Development Manual (NSW DIPNR 2005), in particular Figure L.2.

Hazard categories on site include Low to High flood hazards. Generally, locations of high hazard are situated outside of habitable and trafficable areas. 1% AEP floodwaters generally pose Low Hazard to occupants of 16 Wyatt Avenue, Belrose.

5.6 Flood Affectation of the Site

The site is impacted by flooding during the 1% AEP flood event, with 1% AEP floodwater levels within the range of 155.10 m AHD to 171.90m AHD, resulting in partial inundation of the site. Inundation depths vary greatly by location. Building 1 (southern building / upper building) is not affected by flood waters during the 1% AEP flood event. The building is protected by driveway levels that exceed the closest overland flow on site. The driveway entrance to Building 2 (northern building / lower building) will need to be protected at 168.60 m AHD plus an additional 0.3 m freeboard (168.90 m AHD). Building 2 is also protected by a floodwall running adjacent to the inside edge of the driveway and is proposed at a height of 0.5 m above the 1% AEP flood level.

The PMF flood event was not modelled. PMF floodwater velocities and hazards are not presented in this flood study.

A flood planning level (FPL) for Building 2 is governed by a decreasing flood wall that is always providing 0.5 m freeboard and appropriate protection to inhabitants.

6.0 Flood Risk Management

Based on the foregoing, we offer the following response having due regard for the requirements of the Warringah Development Control Plan 2011 Part C4 Stormwater and Part E11 Flood Prone Land, Northern Beaches Council Water Management for Development Policy, Warringah Local Environmental Plan 2000 Part 6.3 and the Floodplain Development Manual (NSW DIPNR 2005).

6.1 Flood Levels

The proposed Building 2 (northern building / lower building) will receive protection to the internal habitable floor levels via the inclusion of proposed flood walls. These flood walls are to be constructed at 0.5 m above the 1% AEP running adjacent to the lower edge of the proposed driveway.

6.2 Building Components and Method

All building components below the 1% AEP flood level are to be constructed from flood compatible building materials. However, due to the mitigation nature of this development, it is proposed that flood walls constructed to the 1% AEP flood level plus 0.5 m freeboard will provide adequate protection to the proposed development. Suitable wall structure materials include solid brickwork, blockwork, concrete, timber stud walls constructed from Class 1 (highly durable), Class 2 (durable) or H3 treated timber.

Extensive guidance on flood compatible building materials and methods is provided in 'Reducing Vulnerability of Buildings to Flood Damage: Guidance on Building in Flood Prone Areas' (HNFMSC 2006).

6.3 Structural Soundness

Proposed flood walls and culvert works should be capable of withstanding the forces of the 1% AEP floodwaters, including hydrostatic, hydrodynamic, debris impact and buoyancy forces.

Due to the nature of the proposed works including concreting, it is unlikely that structural soundness will be required. Any slabs should be designed to be capable of withstanding the forces imposed by the 1% AEP floodwaters, including hydrostatic, hydrodynamic, debris impact and buoyancy forces. The concrete design should be certified by a practicing Civil Engineer.

6.4 Fencing

Due the flooded nature of the site, a mixture of light / open style fences and solid flood walls must be provided around all boundaries as noted on Civil and Architectural drawings to provide a safe passage for floodwaters.

6.5 Evacuation

The proposed boarding house provides multiple levels above the ground level where evacuation can be facilitated. Floor levels of 173.49 m AHD are available on the first floor of the dwelling which would provide adequate shelter in place scenarios for Building 2 (northern building / lower building).

We also note that low hazard access is available from the proposed driveway exiting the site during the 1% AEP flood events.

In the event that the 1% AEP flood event is expected to be exceeded, strategies should be adopted in accordance with NSW Government operational guidelines and NSW SES Emergency Evacuation operational guidelines.

7.0 Conclusion

The selection and development of the 1% AEP flood model has been described in Sections 2 to 4 of this report. Flood modelling results were presented and discussed in Section 5. Flood risk management measures are described in Section 6.

The subject site (16 Wyatt Avenue, Belrose) is subject to overland flooding. It has been confirmed through the flood study undertaken, that flood waters enter 16 Wyatt Avenue through the boundary of 14 Wyatt Avenue and drain towards the bushland at the rear of the property and into Fireclay Gulley.

The site is impacted by flooding during the 1% AEP flood event, with 1% AEP floodwater levels within the range 155.10 m AHD to 171.90 m AHD, resulting in partial inundation of the site. Inundation depths are generally less than 0.80 m.

Floodwaters which enter the site are guided to a proposed flood storage area located behind the proposed driveway where they reach depths generally between 0.50 m and 0.80 m. A culvert is then provided to relieve the flood storage area and cater for the 1% AEP flood event. A proposed floodwall is introduced to the western boundary (Refer to ACOR Consultants Stormwater Plans - NSW210450 C1.01 – C7.01) to provide protection and guidance to the neighbouring and proposed buildings. Floodwater depths behind the proposed floodwall are generally less than 0.30 m.

The 1% AEP floodwaters promote varied hazard categories on site, including Low to High flood hazards. Generally, locations of high hazard are situated outside of habitable and trafficable areas. 1% AEP floodwaters generally pose Low Hazard to occupants of 16 Wyatt Avenue, Belrose. The 1% AEP peak flowrate passing through the part of the site where the proposed buildings are to be located is approximately 1.21 m^3/s.

ACOR proposes flood management and diversion infrastructures in order to provide residents of 16 Wyatt Avenue with appropriate protection from flood waters. These have been documented in ACOR Consultants Stormwater Plans (NSW210450 C1.01 – C7.01).

It has been demonstrated through site specific flood study that the proposed development results in minimal increase of flood levels external to the site. A change in flood level of less than 0.03 m occurs external to the site which is considered within acceptable model tolerance.

Based on the forgoing, we are of the view the proposed works generally meets the intent of the provisions for sites affected by flooding outlined within Warringah Development Control Plan 2011 Part C4 Stormwater and Part E11 Flood Prone Land and Northern Beaches Council Water Management for Development Policy.

8.0 References

Northern Beaches Council. (2011). *Warringah Development Control Plan 2011*.

Northern Beaches Council. (2000). Warringah *Local Environmental Plan 2000*.

Northern Beaches Council. (2021). *Water Management for Development Policy*.

Hawkesbury-Nepean Floodplain Management Steering Committee (HNFMSC). (2006). *Reducing Vulnerability of Buildings to Flood Damage: Guidance on Building in Flood Prone Areas*. Available from http://www.ses.nsw.gov.au/content/documents/pdf/resources/Building_Guidelines.pdf

New South Wales Department of Infrastructure, Planning and Natural Resources (NSW DIPNR). (2005). *Floodplain Development Manual: the management of flood liable land*.

Pilgrim D H (Ed.). (1998). *Australian Rainfall and Runoff*. Institution of Engineers Australia. Barton ACT.

9.0 Glossary

Terminology in this Glossary has been derived or adapted from the Floodplain Development Manual (NSW DIPNR 2005), where appropriate.

Annual Exceedance Probability (AEP)	The chance of a flood of a given or larger size occurring in any one year, expressed as a percentage.
Australian Height Datum (AHD)	A common national surface level datum approximately corresponding to mean sea level.
Average recurrence interval (ARI)	The long-term average number of years between the occurrence of a flood as big as or larger than the selected event.
Catchment	The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.
Design flood	A flood event to be considered in the design process.
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.

Flood hazard	A measure of the floodwaters potential to cause harm or loss. Full definitions of hazard categories are provided in Appendix L of the Floodplain Development Manual (NSW Government, 2005). In summary: • High: conditions that pose a possible danger to personal safety; evacuation by trucks difficult; able-bodied adults would have difficulty wading to safety; potential for significant structural damage to buildings. • Low: conditions such that people and their possessions could be evacuated by trucks; able-bodied adults would have little difficulty wading to safety.
Flood planning area	The area of land below the FPL and thus subject to flood related development controls.
Flood planning levels (FPLs)	Combinations of flood levels (derived from significant historical flood events or floods of specific ARIs) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated in management plans.
Floodplain, flood-prone land	Land susceptible to inundation by the probable maximum flood (PMF) event, i.e. the maximum extent of flood liable land.
Floodplain risk management options	The measures that might be feasible for the management of a particular area of the floodplain.
Freeboard	Provides reasonable certainty that the risk exposure selected in deciding on a particular flood chosen as the basis for the FPL is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. (See Section K5 of Floodplain Development Manual).
Geographical information systems (GIS)	A system of software and procedures designed to support the management, manipulation, analysis and display of spatially referenced data.

Hydraulics	The term given to the study of water flow in a river, channel or pipe, in particular, the evaluation of flow parameters such as stage and velocity.
Hydraulic category	A classification of floodwater hydraulic behaviour. The categories are: • Floodway: those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels. • Flood storage: those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. Loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. • Flood fringe: remaining area of flood-prone land after floodway and flood storage areas have been defined
Hydrograph	A graph that shows how the discharge changes with time at any particular location.
Hydrology	The term given to the study of the rainfall and runoff process as it relates to the derivation of hydrographs for given floods.
Local overland flooding	Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.
Mainstream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
Peak discharge	The maximum discharge occurring during a flood event.
Probable maximum flood (PMF)	The PMF is the largest flood that could conceivably occur at a particular location.

Probable Maximum Precipitation (PMP)	The PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location.
Probability	A statistical measure of the expected frequency or occurrence of flooding.
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. For this study, it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
Runoff	The amount of rainfall that actually ends up as stream or pipe flow, also known as rainfall excess.

ANNEXURE A

Bee & Lethbridge Survey Plan, ‘Plan showing boundaries, relative heights & physical features over lots 2566 in D.P. 752038 known as No. 16 Wyatt Avenue, Belrose, Reference 11971, Revision 00, dated 12th February 2021.

NOTES:

1) CAUTION: SHOULD ANY DEVELOPMENT OR CONSTRUCTION BE PLANNED ON OR NEAR THE BOUNDARIES, THE BOUNDARIES SHOULD BE CLEARLY MARKED ON SITE.

2) A BOUNDARY SURVEY HAS BEEN UNDERTAKEN. AREA AND DIMENSIONS HAVE BEEN SURVEYED FROM PLANS MADE AVAILABLE AT LAND REGISTRY SERVICES.

3) CONTOUR INTERVAL 0.5 METRE.

4) CONTOURS ARE INDICATIVE OF GROUND FORM ONLY. ONLY SPOT LEVELS SHOULD BE USED FOR CALCULATIONS OF QUANTITIES WITH CAUTION.

5) TREE SPREADS ARE DIAGRAMMATIC ONLY AND ARE NOT SYMMETRICAL.

6) UNDERGROUND (NON VISIBLE) SERVICE LINES HAVE BEEN SHOWN FROM "DIAL BEFORE YOU DIG" SERVICE AUTHORITY RECORDS & ARE DIAGRAMMATIC ONLY IN REGARD TO THEIR POSITION & WIDTH UNLESS STATED OTHERWISE.

7) BEARINGS SHOWN ARE ON MAGNETIC MERIDIAN.

AXE 21°18'E MAGNETIC MERIDIAN TRUE NORTH

INVESTIGATION OF "DIAL BEFORE YOU DIG" UNDERGROUND SERVICES HAS BEEN MADE. DETECTION OF UNDERGROUND SERVICES IS NOT AN INTEGRAL PART OF THIS SURVEY. ALL RELEVANT AUTHORITIES SHOULD BE NOTIFIED PRIOR TO ANY EXCAVATION ON OR NEAR THE SITE

DEVELOPERS & EXCAVATORS MAY BE HELD FINANCIALLY RESPONSIBLE BY THE ASSET OWNER SHOULD THEY DAMAGE UNDERGROUND NETWORKS.

CARELESS DIGGING CAN:
- CAUSE DEATH OR SERIOUS INJURY TO WORKERS AND THE GENERAL PUBLIC
- INCONVENIENCE USERS OF ELECTRICITY, GAS, WATER AND COMMUNICATIONS
- LEAD TO CRIMINAL PROSECUTION AND DAMAGES CLAIMS
- CAUSE EXPENSIVE FINANCIAL LOSSES TO BUSINESS
- CUT OFF EMERGENCY SERVICES
- DELAY PROJECT COMPLETION TIMES WHILE THE DAMAGE IS REPAIRED

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FLOOR LEVEL 187.09
ONE & TWO STOREY BRICK RESIDENCE METAL ROOF No. 10
TILED
PATIO
PATIO 185.55

2565

101
D.P. 1244381

7520388

2616
No. 12

2597
No. 14

2566
SITE AREA
9345m²

2567

1
D.P. 1139826

D.P.

AVENUE

WYATT

CLAD FARM BUILDING METAL ROOF 109.3m²

CLAD FARM BUILDING METAL ROOF 66.8m²

TWO STOREY BRICK HOUSE TILE ROOF No. 16

RENDERED & CLAD RESIDENCE METAL ROOF No. 18

POOL
INGROUND
PAVING
TIMBER DECK
POND
GARDEN
GARAGE
CARPORT
CHICKEN COOP
SEPTIC TANK
WATER TANK
CLOTHES LINE
GAS
PIT
PLANTERS
SHRUB
HEDGE
GRASS
LAWN
CONCRETE
GRAVEL
BITUMEN
TRACK
DRIVEWAY
FENCE
WIRE
POST AND RAIL
METAL FENCE
TIMBER
BRICK
STONE
WALL
MESH
IRREGULAR
DEAD TREE
TREE
LINE

DRAINAGE PIT GRATE 184.96 INVERT 184.32
DRAINAGE PIT GRATE 184.90 INVERT 183.98
DRAINAGE PIT GRATE 184.35 INVERT 183.81
PIPE 0.40ø
PIPE 0.15ø (HIGH)
KERB OF TOP
BENCH MARK CUT ON KERB RL. 184.28 A.H.D.

(A) EASEMENT TO DRAIN WATER 2.05 WIDE VIDE GOV. GAZETTE 08/06/2007 FOLIO 3670

0 2 4 6 8 10 20 METRES
SCALE 1:250

Bee & Lethbridge
Quality Surveying & Development Solutions

Bee & Lethbridge Pty Ltd
Suite 2, 14 Starkey Street,
PO Box. 330, Forestville, NSW 2087
Phone: 9451 6757
Email: survey@beeleth.com.au
ABN: 13 003 194 447
www.beeleth.com.au

COPLAND C. LETHBRIDGE
REGISTERED SURVEYOR N.S.W.
IDENTIFICATION No. SU001470

LEGEND

TREE 0.10ø, 5H, 4S — DENOTES APPROX. 0.1m DIAMETER OF TREE; DENOTES APPROX. 5m HEIGHT OF TREE; DENOTES APPROX. 4m SPREAD OF TREE
GUTTER — DENOTES TOP OF GUTTER
UNDERGROUND ELECTRIC LINES
OVERHEAD ELECTRIC LINES
BOARDS SEWER
TELECOMMUNICATION LINES
WATER LINES
TOP OF BANK
BOTTOM OF BANK
ROCK OUTCROP
STOP VALVE
HYDRANT
TAP
WATER METER
TELECOM. PIT
LIGHT POLE
POWER POLE
DRAINAGE PIT
SEWER ACCESS CHAMBER

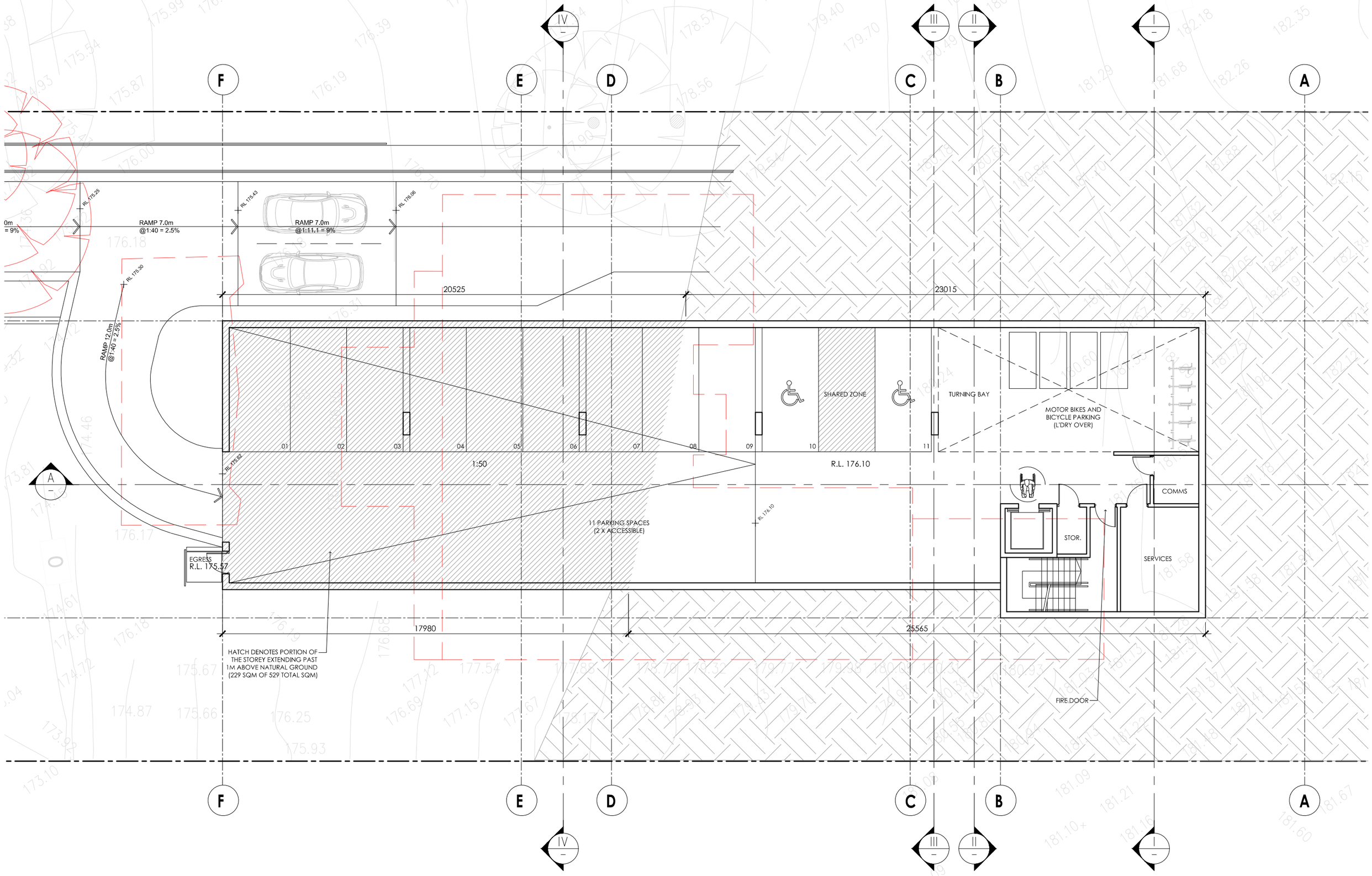
PLAN SHOWING BOUNDARIES, RELATIVE HEIGHTS & PHYSICAL FEATURES OVER LOTS 2566 IN D.P. 752038 KNOWN AS No. 16 WYATT AVENUE, BELROSE.

L.G.A.: NORTHERN BEACHES

CLIENT	Mr & Mrs J. & J. HOLMAN			REF No.	11971
PROPERTY	No. 16 WYATT AVENUE, BELROSE				
DATUM	A.H.D.	SCALE	1:250 @ B1	DATE	12/02/2021
SURVEYED	CL./AS./SB./JG.	DRAWN	TP./JS./HH./RM.	DWG No.	11971B
				SHEET No.	1 of 1
				REV No.	00

ANNEXURE B

Platform Architects Architectural Plans, Reference WAB2, Sheets A0.01 - A0.02, A1.01 - A1.13, A2.01 - A2.05 & A3.01 - A3.06, Revision DA03, dated 27th May 2021.



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REVISION	DATE	DESCRIPTION	BY
0	Jan '21	CONCEPT DRAWINGS	OH
P1	Apr '21	PRELIMINARY ISSUE	OH
DA02	Apr '21	DA ISSUE	BG
DA03	May '21	DA ISSUE	BG/OH
DA03	27/05/21	DA ISSUE (PRELIMINARY)	BG/OH

REVISION NOTES

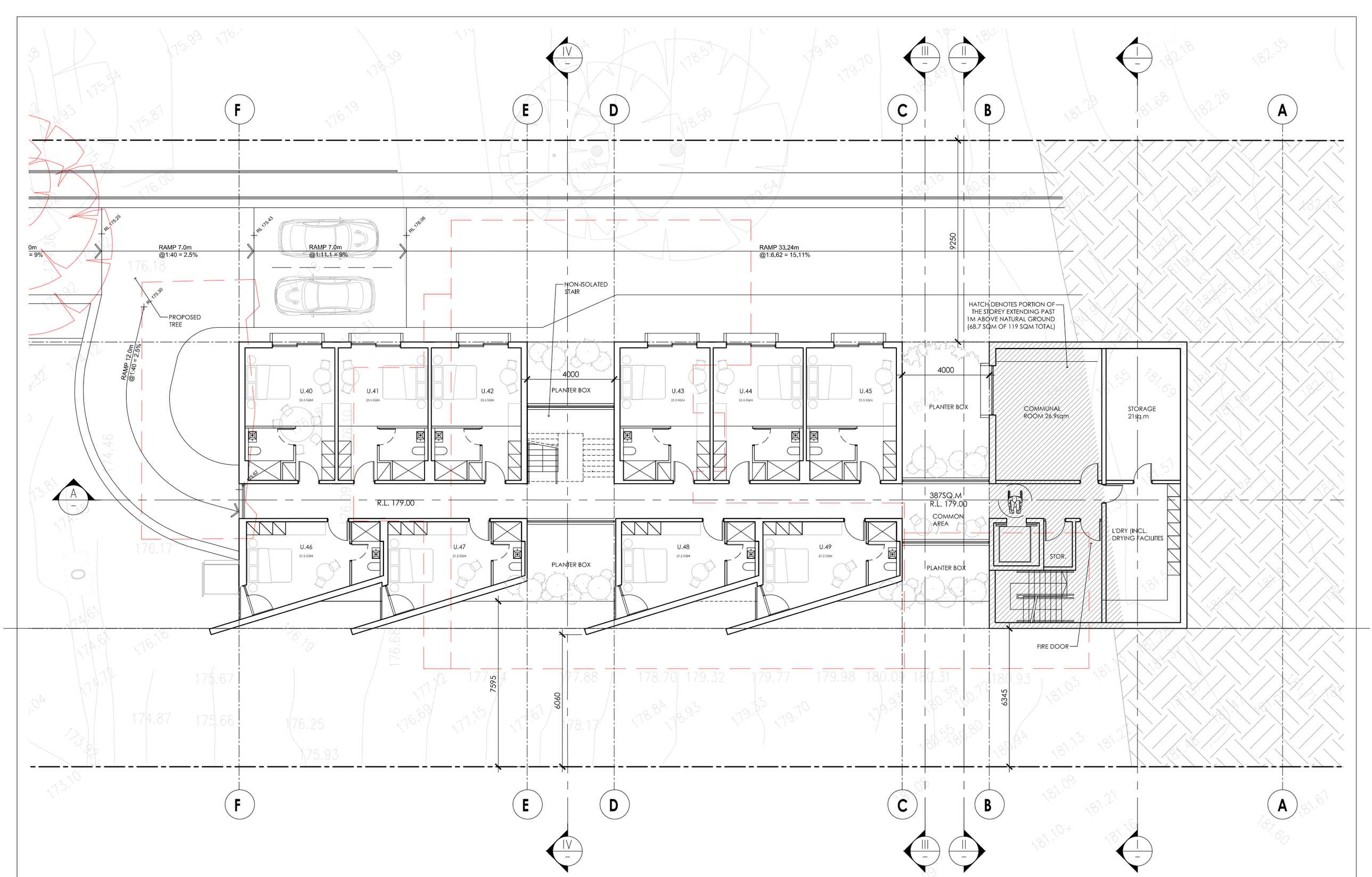
PRELIMINARY ISSUE

platform ARCHITECTS
Suite 503, 39 East Esplanade Manly 2095
p. 02 9976 6666 a.b.n. 7460256157
nominated architect Bridie Gough Reg No. 8280

CLIENT
NORTHERN BEACHES
ESSENTIAL SERVICES
ACCOMMODATION

DRAWING TITLE
UPPER BUILDING
BASEMENT PLAN

STATUS	NUMBER	SCALE	REVISION	PROJECT
DA	A1.01	1:150 @A3	DA03 PRELIMINARY	WAB2



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DA02	Apr '21	DA ISSUE	BG
DA03	May '21	DA ISSUE	BG/OH
DA03	27/05/21	DA ISSUE (PRELIMINARY)	BG/OH

REVISION NOTES

PRELIMINARY ISSUE

platform ARCHITECTS
Suite 503, 39 East Esplanade Manly 2095
p. 02 9976 6666 a.bn. 74602856157
nominated architect Bidie Gough Reg No. 8280

CLIENT
NORTHERN BEACHES
ESSENTIAL SERVICES
ACCOMMODATION

DRAWING TITLE
UPPER BUILDING
LOWER GROUND FLOOR PLAN

STATUS	NUMBER	SCALE	REVISION	PROJECT
DA	A1.02	1:150 @A3	DA03 PRELIMINARY	WAB2

RAMP 29.4m
@1:10.6 = 9.4%

RAMP 7.0m
@1:11.1 = 9%

RAMP 7.0m
@1:40 = 2.5%

RAMP 7.0m
@1:11.1 = 9%

RAMP 12.0m
@1:40 = 2.5%

RL 174.62
RL 175.25
RL 175.30
RL 175.43
RL 175.68
RL 176.08

FOOTPATH

COMMUNAL COOKING FACILITIES INCL. COOKTOP, OVEN, SINK & MICROWAVE

NON-ISOLATED STAIR

COMMON TERRACE

COMMON AREA
30.8 SQM

U.50
29.3 SQM

U.5
21.25

CONTINUATION A1.04

G F E D

1 2 3 4

A B IV

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0	Jan '21	CONCEPT DRAWINGS	OH
P1	Apr '21	PRELIMINARY ISSUE	OH
DA02	Apr '21	DA ISSUE	BG
DA03	May '21	DA ISSUE	BG/OH
DA03	27/05/21	DA ISSUE (PRELIMINARY)	BG/OH

REVISION NOTES

PRELIMINARY ISSUE

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Suite 503, 39 East Esplanade Manly 2095
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nominated architect Bidie Gough Reg No. 8280

CLIENT
NORTHERN BEACHES ESSENTIAL SERVICES ACCOMMODATION

DRAWING TITLE
UPPER BUILDING
GROUND FLOOR PLAN - SHEET 1

STATUS	NUMBER	SCALE	REVISION	PROJECT
DA	A1.03	1:150 @A3	DA03 PRELIMINARY	WAB2

CONTINUATION A1.03

RAMP 33.24m
@1:6.62 = 15.11%

RAMP 7.0m
@1:8 = 12.5%

RAMP 14.0m
@1:16.26 = 6.15%

RAMP 7.0m
@1:20 = 5%

RL 181.09

RL 181.86

RL 182.82

RL 183.12

U.50
25.5 SQM

U.51
25.5 SQM

U.52
25.5 SQM

U.53
21.2 SQM

U.54
21.2 SQM

U.55
ACCESSIBLE
25.5 SQM

U.56
ACCESSIBLE
25.5 SQM

U.57
ACCESSIBLE
25.5 SQM

R.L. 182.00

COMMON AREA

STOR.

TYPE 2
26 SQM
CARETAKER UNIT

CARETAKER UNIT PRIVATE YARD -
SOFT LANDSCAPING
18 SQM

FIRE DOOR

ENTRY
R.L. 182.00

LOW PLANTER

AWNING OVER ENTRY

RAMP @ 1:14

LANDING
FFL 182.51

RAMP @ 1:14

FFL 183.02

BOXES

TREE TO BE RETAINED

BIN STORAGE ROOM
FFL 183.00

C

B

A

1

2

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DA02	Apr '21	DA ISSUE	BG
DA03	May '21	DA ISSUE	BG/OH
DA03	27/05/21	DA ISSUE (PRELIMINARY)	BG/OH

REVISION NOTES

PRELIMINARY ISSUE

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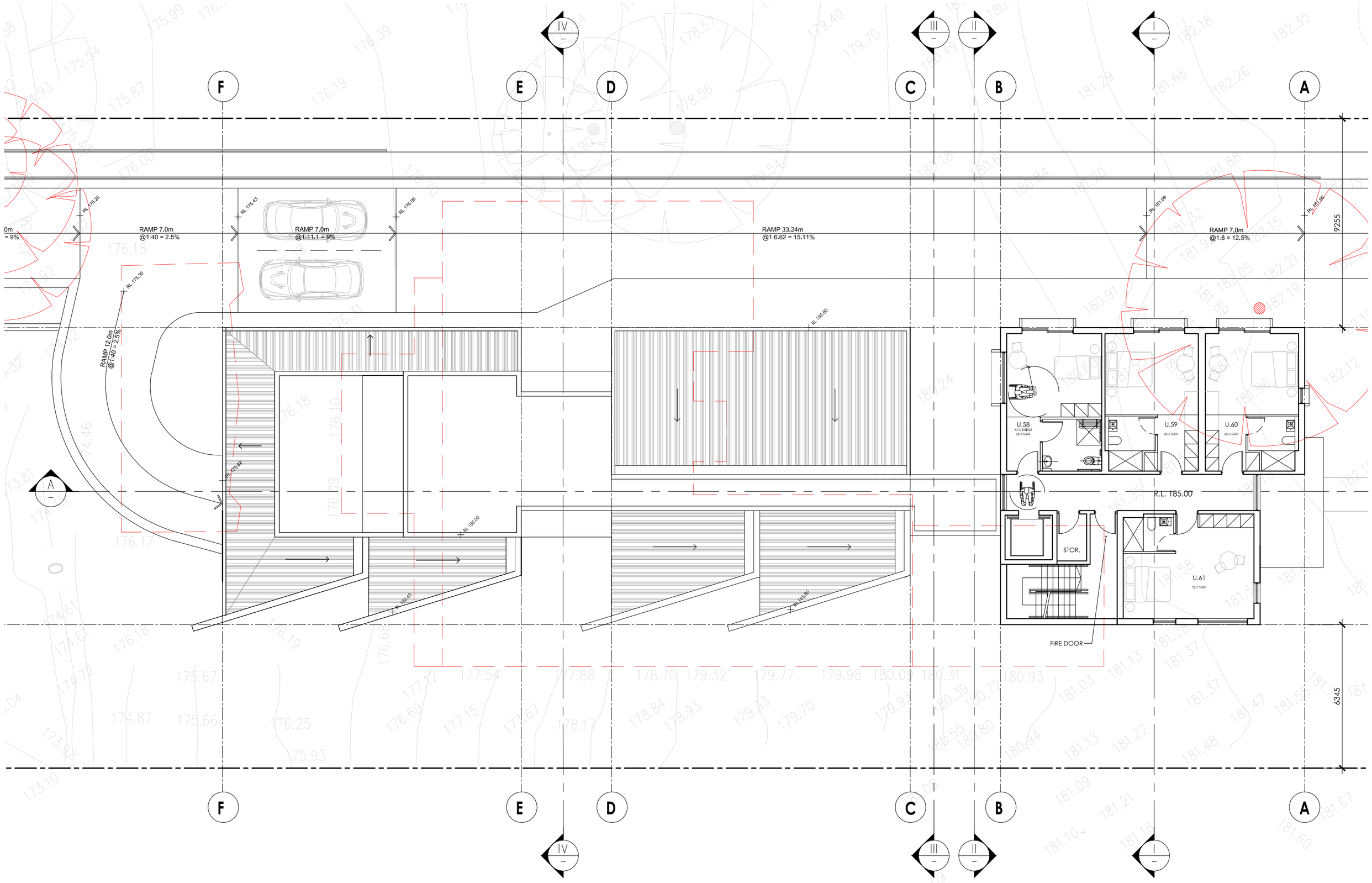
CLIENT
NORTHERN BEACHES
ESSENTIAL SERVICES
ACCOMMODATION

DRAWING TITLE
UPPER BUILDING
GROUND FLOOR PLAN - SHEET 2

STATUS	NUMBER	SCALE	REVISION	PROJECT
DA	A1.04	1:150 @A3	DA03 PRELIMINARY	WAB2



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DA02	Apr '21	DA ISSUE	BG
DA03	May '21	DA ISSUE	BG/OH
DA03	27/05/21	DA ISSUE (PRELIMINARY)	BG/OH

REVISION NOTES

PRELIMINARY ISSUE

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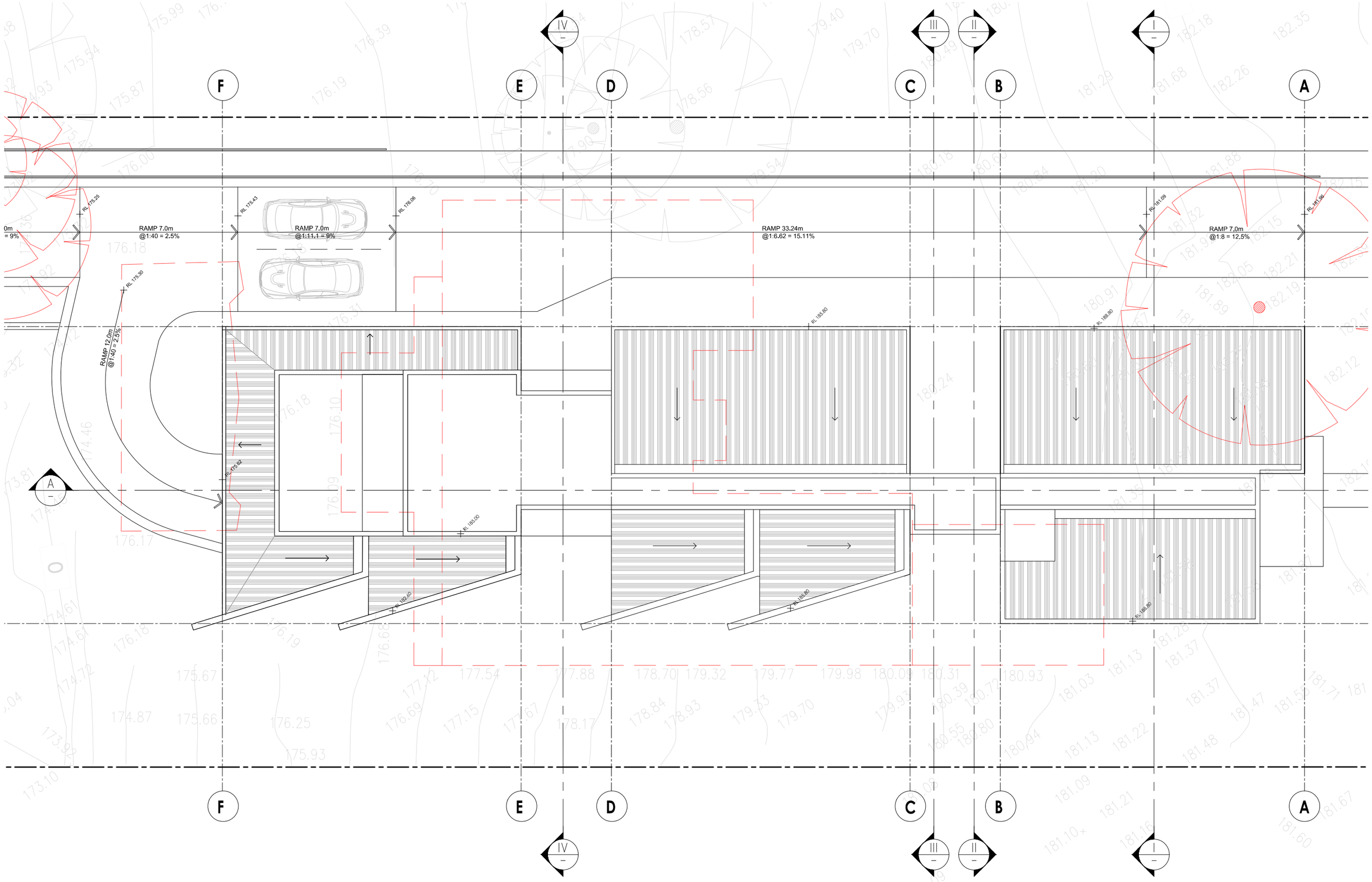
nominated architect Bidie Gough Reg No. 8280

CLIENT
NORTHERN BEACHES
ESSENTIAL SERVICES
ACCOMMODATION

DRAWING TITLE
UPPER BUILDING
GROUND FLOOR PLAN

STATUS	NUMBER	SCALE	REVISION	PROJECT
DA	A1.05	1:150 @A3	DA03 PRELIMINARY	WAB2



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P1	Apr '21	PRELIMINARY ISSUE	OH
DA02	Apr '21	DA ISSUE	BG
DA03	May '21	DA ISSUE	BG/OH
DA03	27/05/21	DA ISSUE (PRELIMINARY)	BG/OH

REVISION NOTES

PRELIMINARY ISSUE

platform ARCHITECTS
Suite 503, 39 East Esplanade Manly 2095
p. 02 9976 6666 a.b.n. 7460285157
nominated architect Bidie Gough Reg No. 8280

CLIENT
NORTHERN BEACHES
ESSENTIAL SERVICES
ACCOMMODATION

DRAWING TITLE
UPPER BUILDING
ROOF PLAN

STATUS	NUMBER	SCALE	REVISION	PROJECT
DA	A1.06	1:150 @A3	DA03 PRELIMINARY	WAB2

EGRESS
R.L. 166.67

BICYCLES

M01 M02 M03 M04 M05 M06

20 PARKING
SPACES
R.L. 166.72

RAMP 7.0m
@1:150 = 6.3%

RL 168.72

12 13 14 15 16 17 18 19

17500

HATCH DENOTES PORTION OF
THE STOREY EXTENDING PAST
1M ABOVE NATURAL GROUND

20 21 22 23 24 25 26 27 28 29 30 31

TURNING BAY

BIN ROOM
STORAGE

GF_B R.L. 170.39

FIRE DOOR

COMMS

LAUNDRY
(INCL. DRYING
FACILITIES)

M L J K I

3 4 5 6

VII VI

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REVISION	DATE	DESCRIPTION	BY
0	Jan '21	CONCEPT DRAWINGS	OH
P1	Apr '21	PRELIMINARY ISSUE	OH
DA02	Apr '21	DA ISSUE	BG
DA03	May '21	DA ISSUE	BG/OH
DA03	27/05/21	DA ISSUE (PRELIMINARY)	BG/OH

REVISION NOTES

PRELIMINARY ISSUE

platform ARCHITECTS
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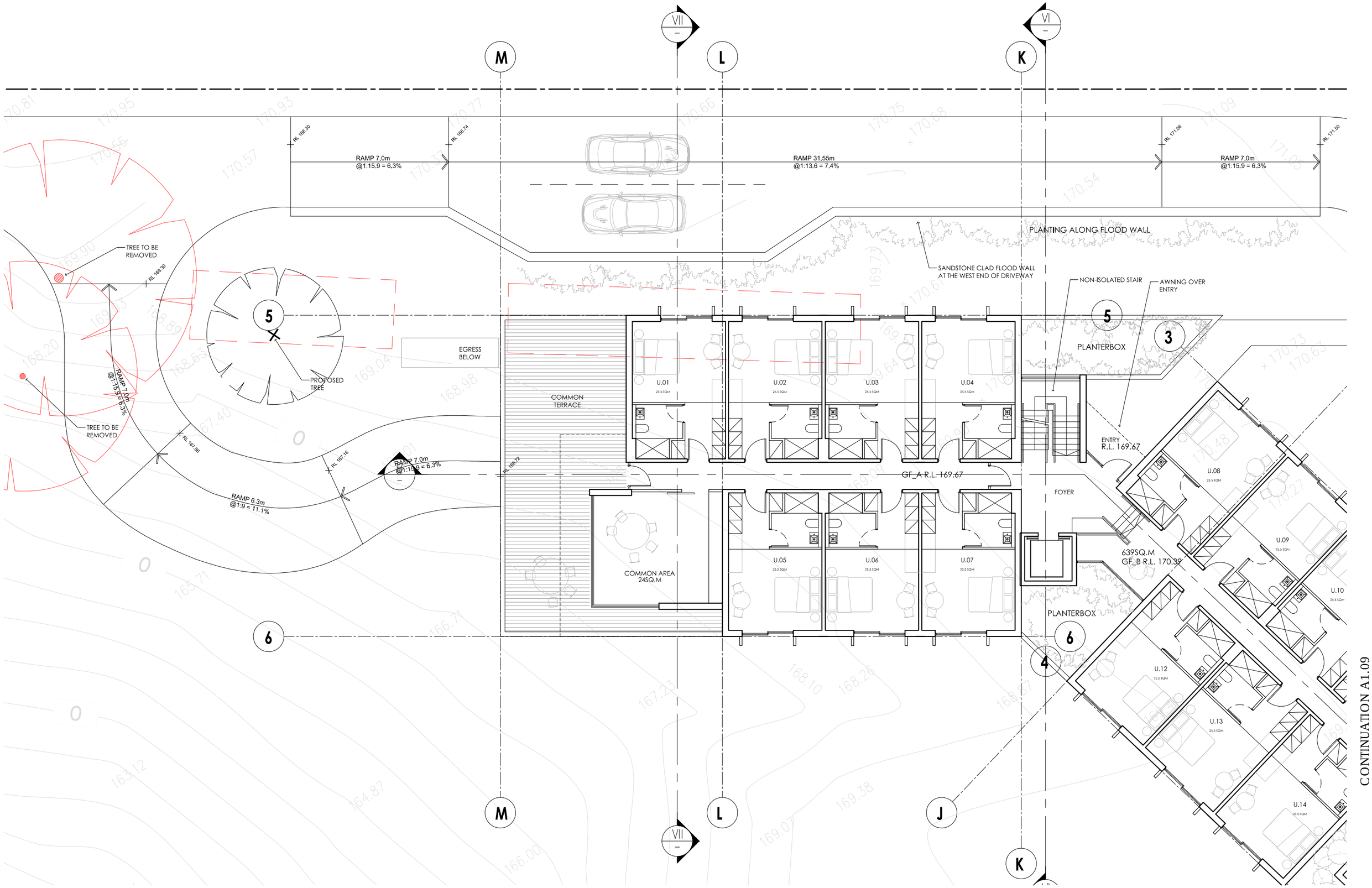
CLIENT
NORTHERN BEACHES
ESSENTIAL SERVICES
ACCOMMODATION

DRAWING TITLE
LOWER BUILDING
BASEMENT PLAN

STATUS	NUMBER	SCALE	REVISION	PROJECT
DA	A1.07	1:150 @A3	DA03 PRELIMINARY	WAB2



CONTINUATION A1.09

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REVISION	DATE	DESCRIPTION	BY
0	Jan '21	CONCEPT DRAWINGS	OH
P1	Apr '21	PRELIMINARY ISSUE	OH
DA02	Apr '21	DA ISSUE	BG
DA03	May '21	DA ISSUE	BG/OH
DA03	27/05/21	DA ISSUE (PRELIMINARY)	BG/OH

REVISION NOTES

PRELIMINARY ISSUE

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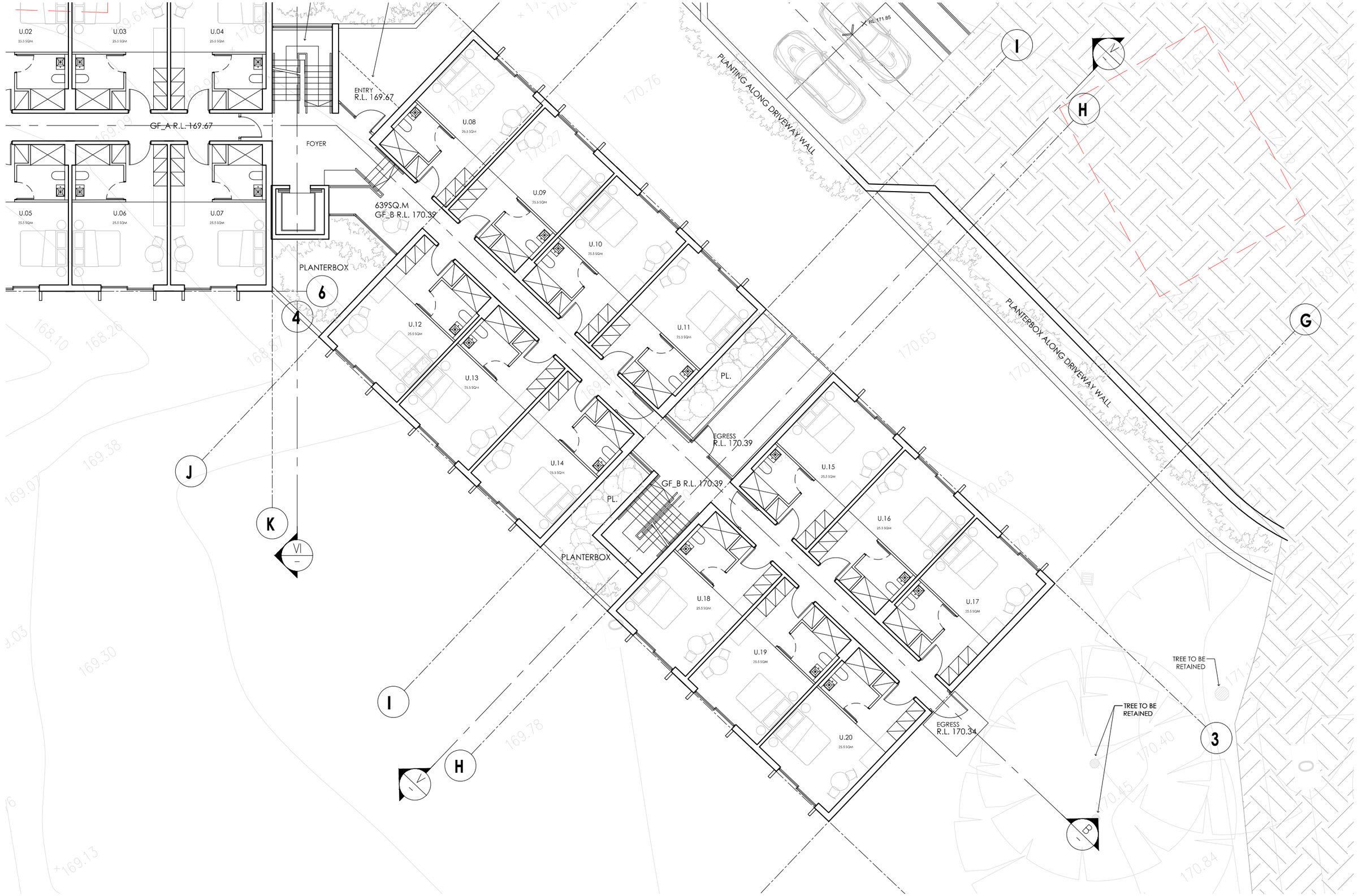
ESSENTIAL SERVICES
ACCOMMODATION

DRAWING TITLE
LOWER BUILDING
GROUND FLOOR PLAN - SHEET 1

STATUS	NUMBER	SCALE	REVISION	PROJECT
DA	A1.08	1:150 @A3	DA03 PRELIMINARY	WAB2

CONTINUATION A1.08



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P1	Apr '21	PRELIMINARY ISSUE	OH
DA02	Apr '21	DA ISSUE	BG
DA03	May '21	DA ISSUE	BG/OH
DA03	27/05/21	DA ISSUE (PRELIMINARY)	BG/OH

REVISION NOTES

PRELIMINARY ISSUE

platform ARCHITECTS
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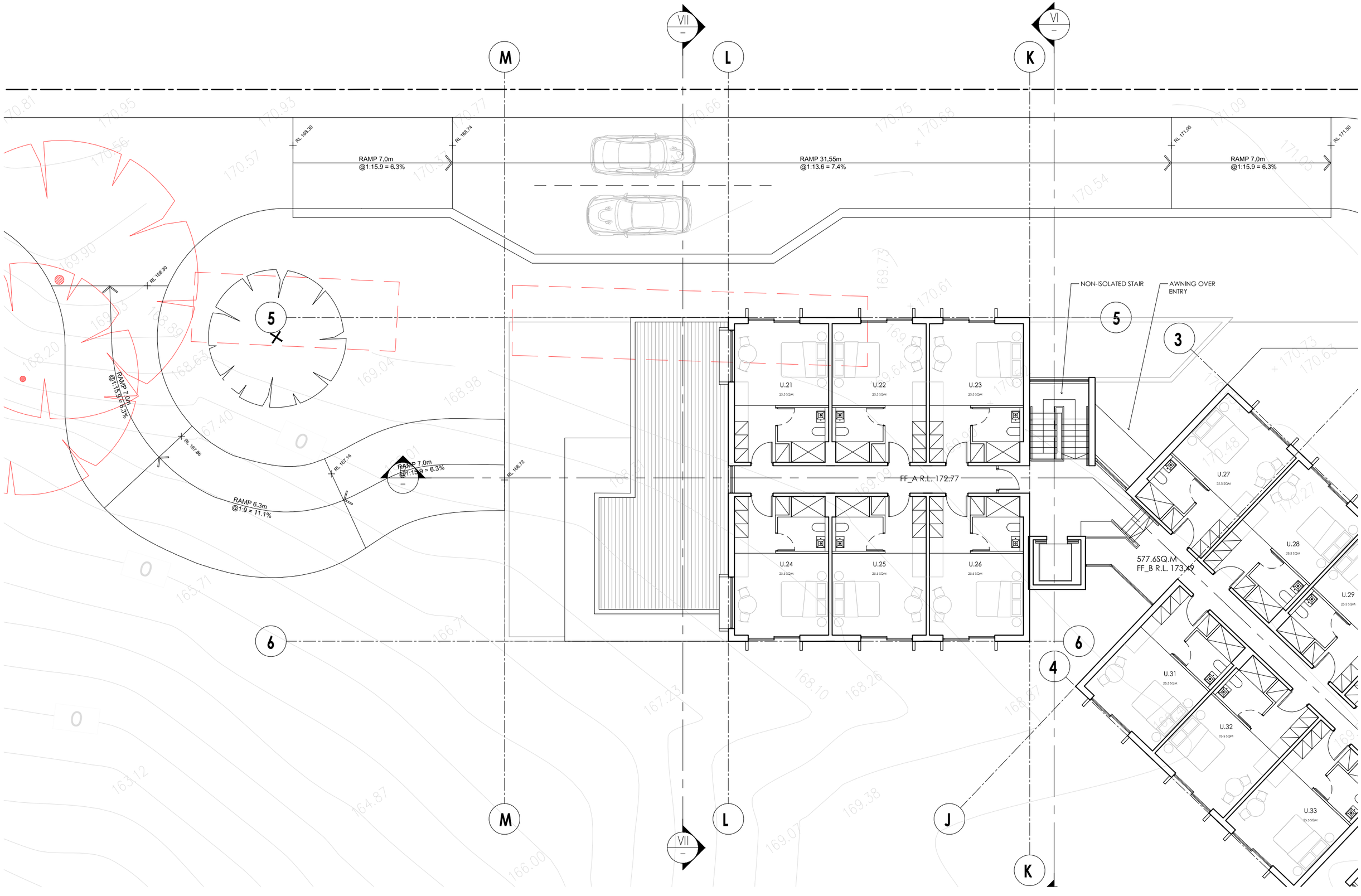
CLIENT

NORTHERN BEACHES
ESSENTIAL SERVICES
ACCOMMODATION

DRAWING TITLE

LOWER BUILDING
GROUND FLOOR PLAN - SHEET 2

STATUS	NUMBER	SCALE	REVISION	PROJECT
DA	A1.09	1:150 @A3	DA03 PRELIMINARY	WAB2



CONTINUATION A1.11

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P1	Apr '21	PRELIMINARY ISSUE	OH
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DA03	May '21	DA ISSUE	BG/OH
DA03	27/05/21	DA ISSUE (PRELIMINARY)	BG/OH

REVISION NOTES

PRELIMINARY ISSUE

platform ARCHITECTS
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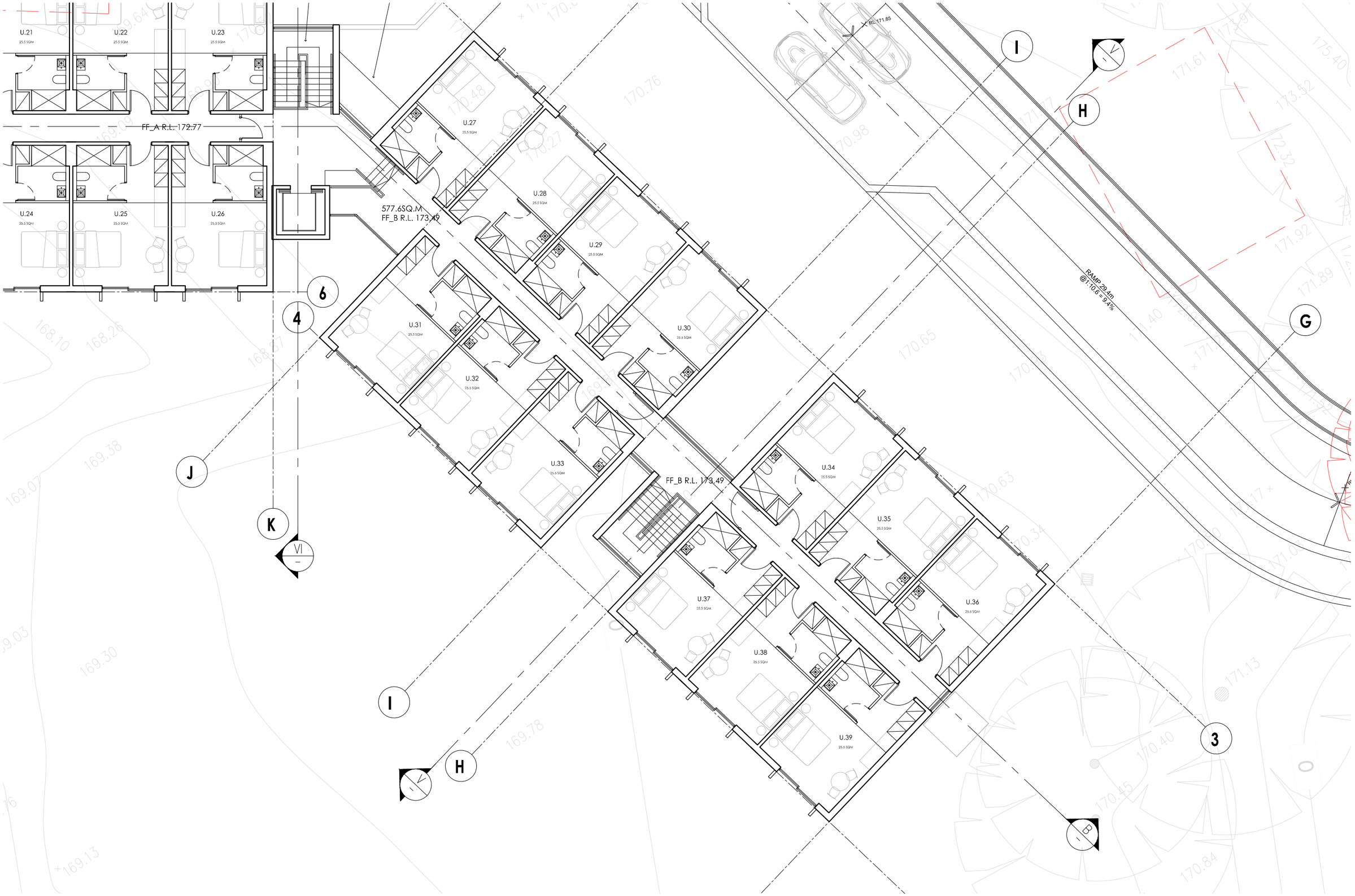
CLIENT
NORTHERN BEACHES
ESSENTIAL SERVICES
ACCOMMODATION

DRAWING TITLE
LOWER BUILDING
FIRST FLOOR PLAN - SHEET 1

STATUS	NUMBER	SCALE	REVISION	PROJECT
DA	A1.10	1:150 @A3	DA03 PRELIMINARY	WAB2

CONTINUATION A1.10



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P1	Apr '21	PRELIMINARY ISSUE	OH
DA02	Apr '21	DA ISSUE	BG
DA03	May '21	DA ISSUE	BG/OH
DA03	27/05/21	DA ISSUE (PRELIMINARY)	BG/OH

REVISION NOTES

PRELIMINARY ISSUE

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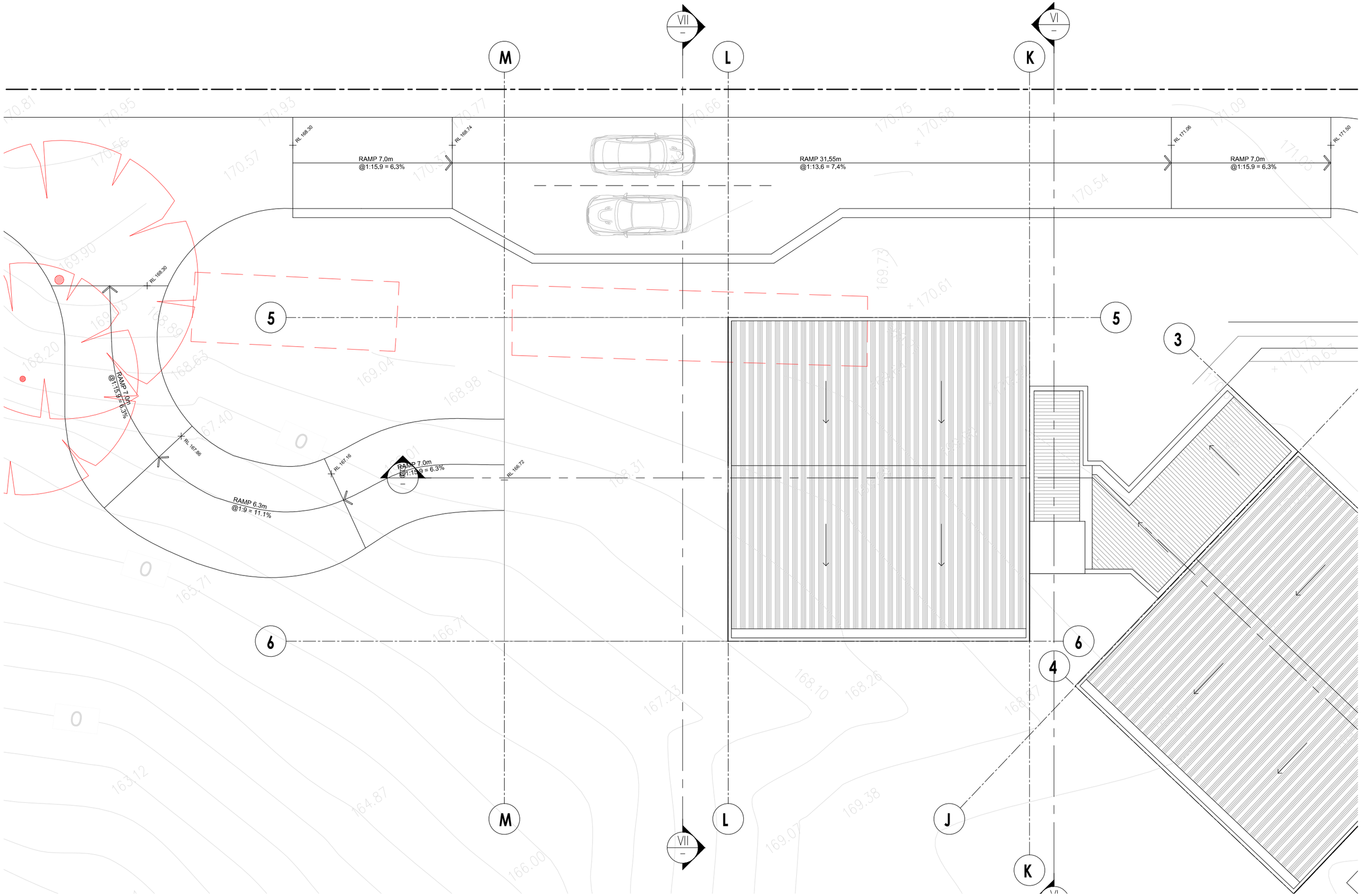
CLIENT
NORTHERN BEACHES
ESSENTIAL SERVICES
ACCOMMODATION

DRAWING TITLE
LOWER BUILDING
FIRST FLOOR PLAN - SHEET 2

STATUS	NUMBER	SCALE	REVISION	PROJECT
DA	A1.11	1:150 @A3	DA03 PRELIMINARY	WAB2



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DA03	May '21	DA ISSUE	BG/OH
DA03	27/05/21	DA ISSUE (PRELIMINARY)	BG/OH

REVISION NOTES

PRELIMINARY ISSUE

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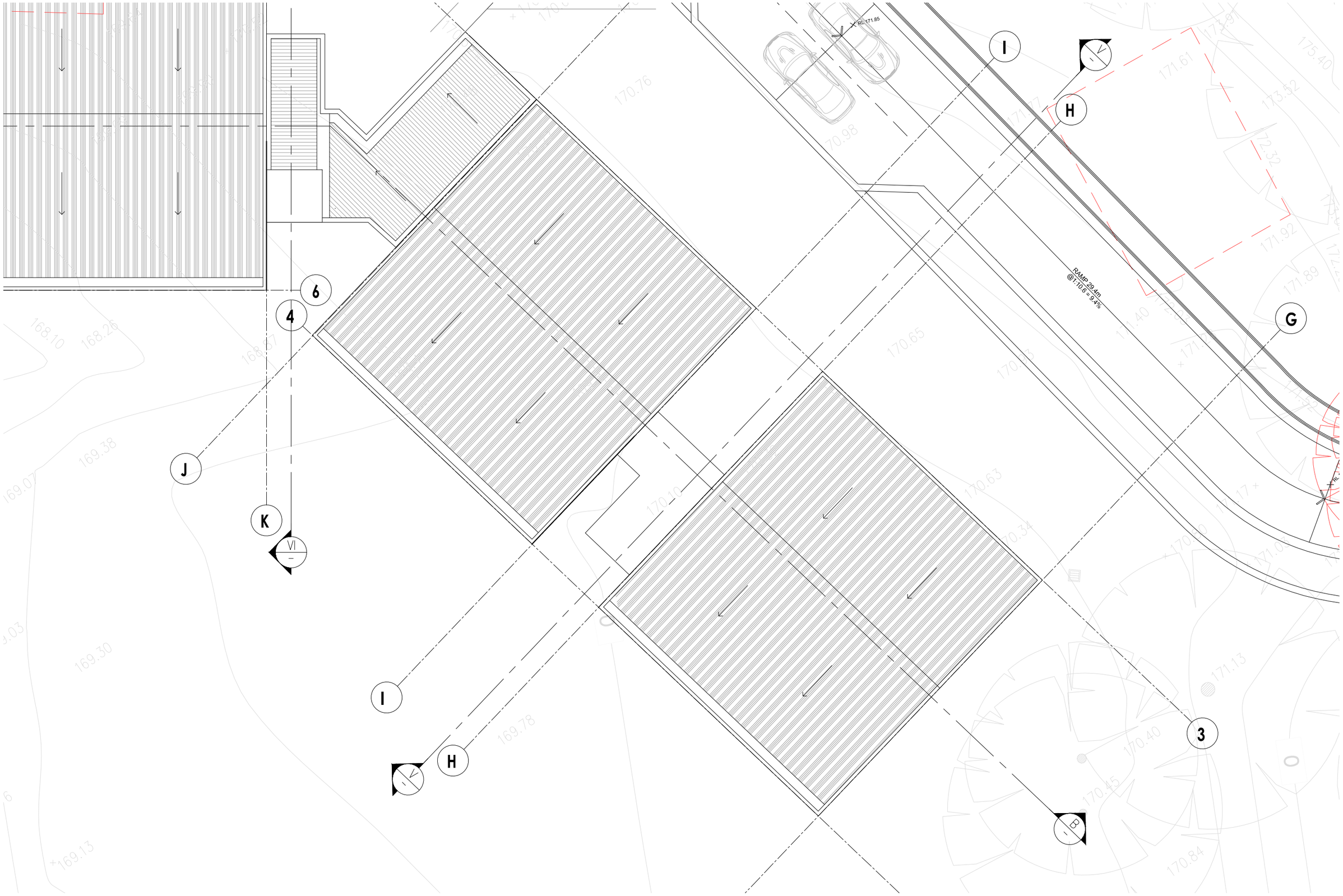
p. 02 9976 6666 a.bn. 74602856157
nominated architect Bidie Gough Reg No. 8280

CLIENT
NORTHERN BEACHES
ESSENTIAL SERVICES
ACCOMMODATION

DRAWING TITLE
LOWER BUILDING
ROOF PLAN - SHEET 1

STATUS	NUMBER	SCALE	REVISION	PROJECT
DA	A1.12	1:150 @A3	DA03 PRELIMINARY	WAB2

CONTINUATION A1.12



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DA02	Apr '21	DA ISSUE	BG
DA03	May '21	DA ISSUE	BG/OH
DA03	27/05/21	DA ISSUE (PRELIMINARY)	BG/OH

REVISION NOTES

PRELIMINARY ISSUE

platform ARCHITECTS
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p. 02 9976 6666 a.bn. 74602856157
nominated architect Bidie Gough Reg No. 8280

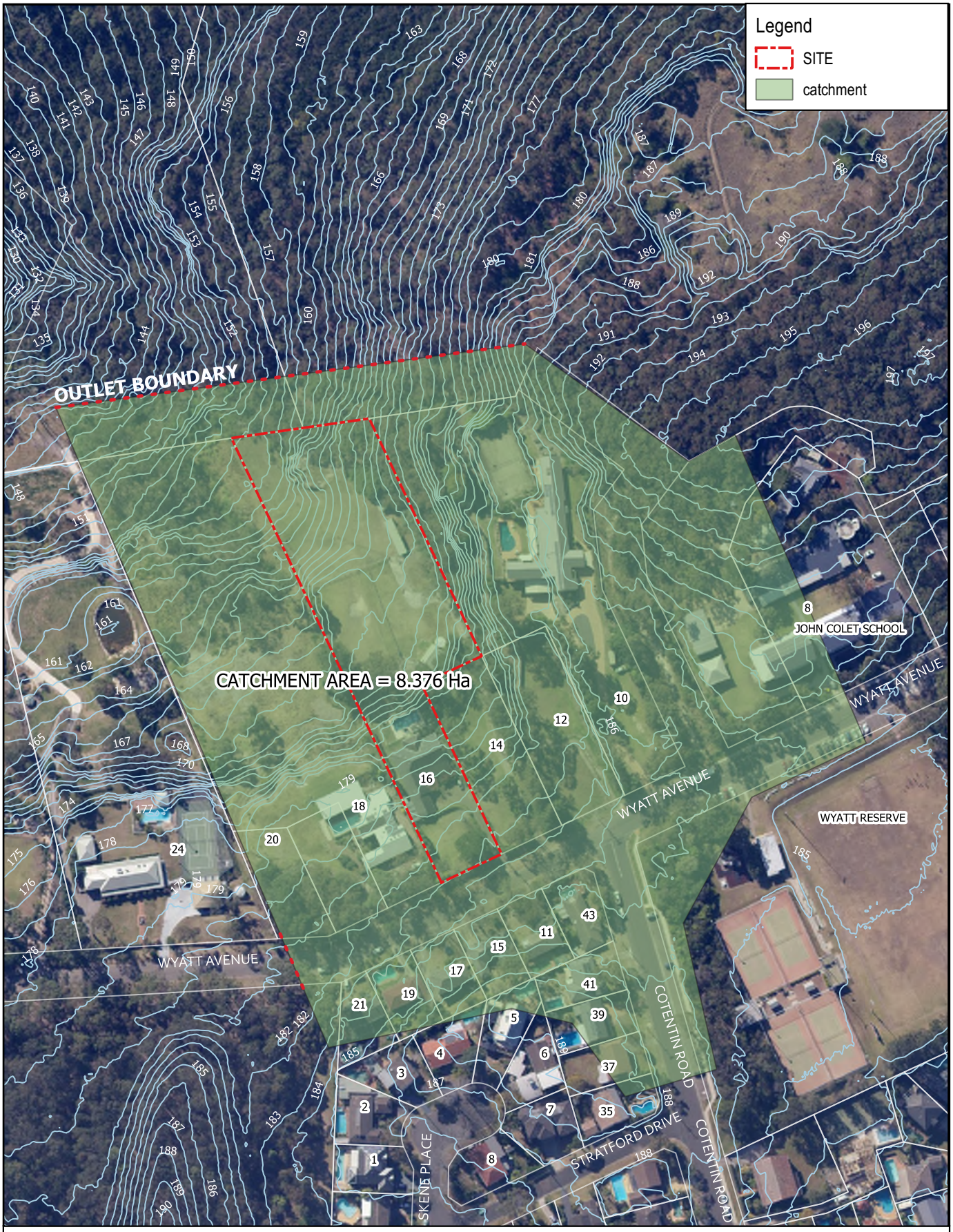
CLIENT
NORTHERN BEACHES
ESSENTIAL SERVICES
ACCOMMODATION

DRAWING TITLE
LOWER BUILDING
ROOF PLAN - SHEET 2

STATUS	NUMBER	SCALE	REVISION	PROJECT
DA	A1.13	1:150 @A3	DA03 PRELIMINARY	WAB2

ANNEXURE C

ACOR Flood Plans, Reference NSW210450, Sheets F1 to F20, Revision 1, dated 18th May 2021.



Title: CATHMENT MAP & MODEL BOUNDARY CONDITION

ACOR Consultants Pty Ltd
Suite 2, Level 1, 33 Herbert Street
St Leonards NSW 2065
T +61 2 9438 5098
ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

Project: PROPOSED BOARDING HOUSE DEVELOPMENT
16 WYATT AVENUE
BELROSE

Client: JOHN HOLMAN

North:

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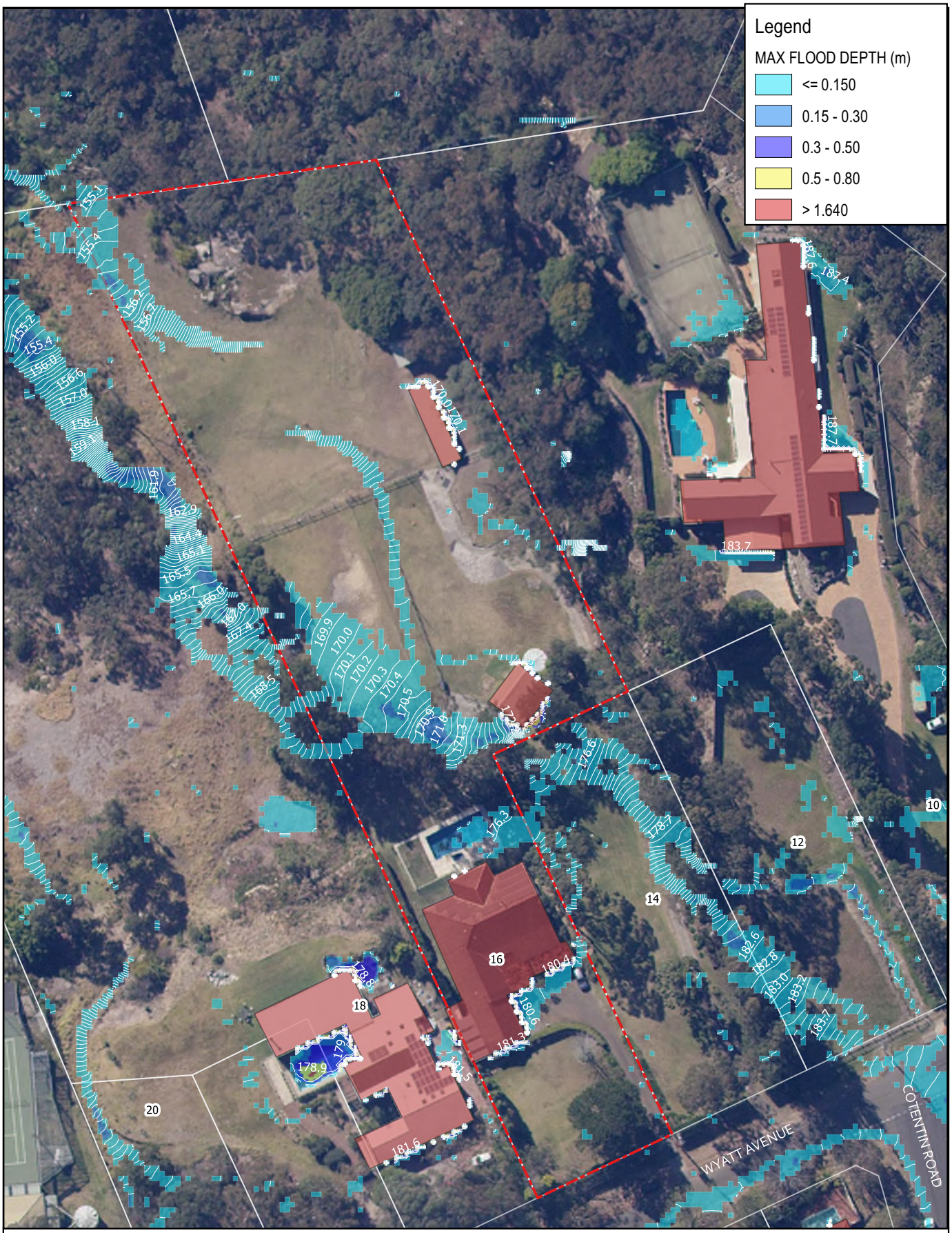

Title: 1% AEP MAXIMUM FLOOD DEPTH - PRE DEVELOPMENT

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ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

Project: PROPOSED BOARDING HOUSE DEVELOPMENT
16 WYATT AVENUE
BELROSE

Client: JOHN HOLMAN

North:

Job Number:	Sheet:	Revision:	Date:	Designed:	Reviewd:	Scale:
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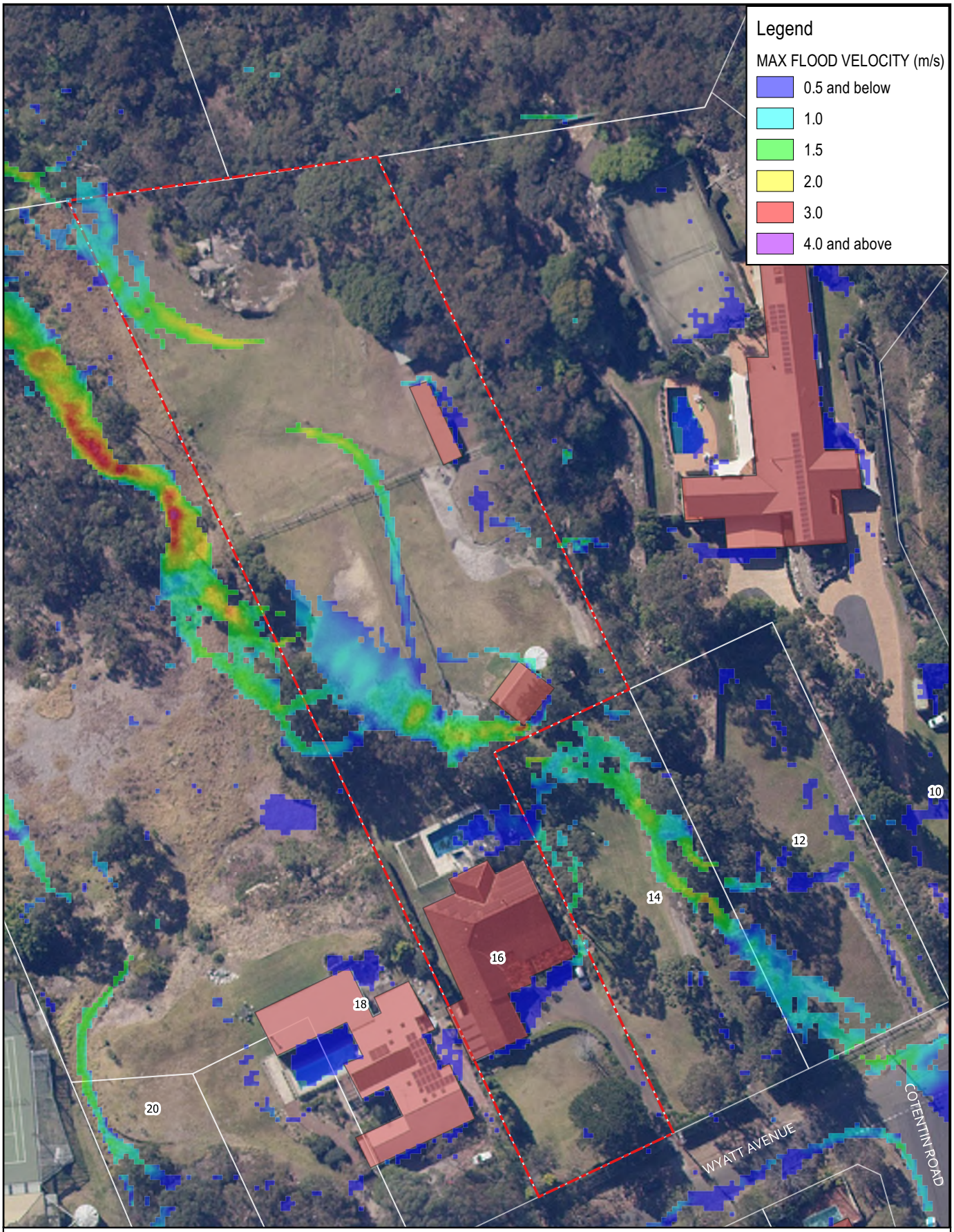

Title: 1% AEP MAXIMUM FLOOD VELOCITY - PRE DEVELOPMENT

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Project: PROPOSED BOARDING HOUSE DEVELOPMENT
16 WYATT AVENUE
BELROSE

Client: JOHN HOLMAN

North:

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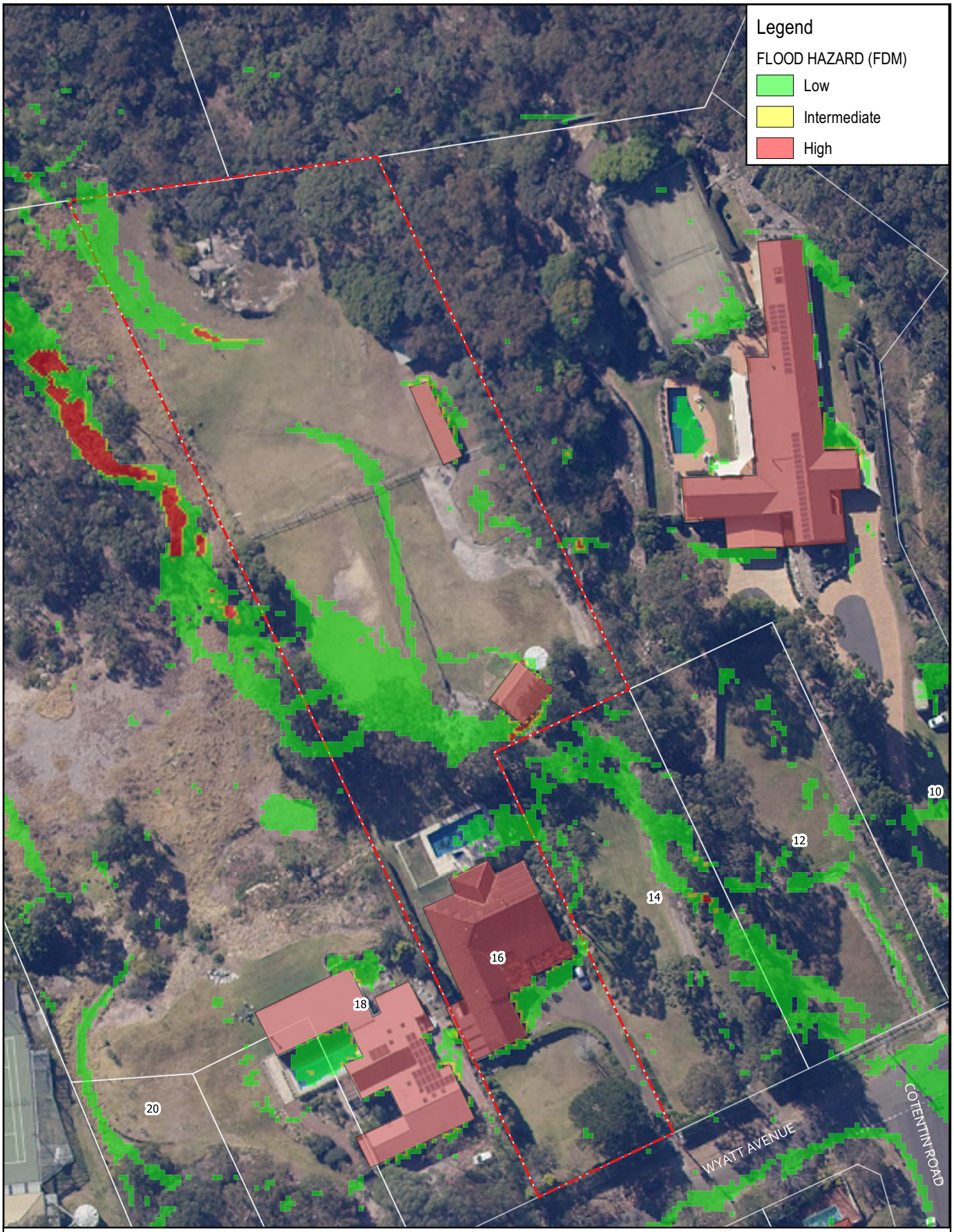

Title: 1% AEP MAXIMUM FLOOD HAZARD - PRE DEVELOPMENT

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Suite 2, Level 1, 33 Herbert Street
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Project: PROPOSED BOARDING HOUSE DEVELOPMENT
16 WYATT AVENUE
BELROSE

Client: JOHN HOLMAN

North:

Job Number:	Sheet:	Revision:	Date:	Designed:	Reviewd:	Scale:
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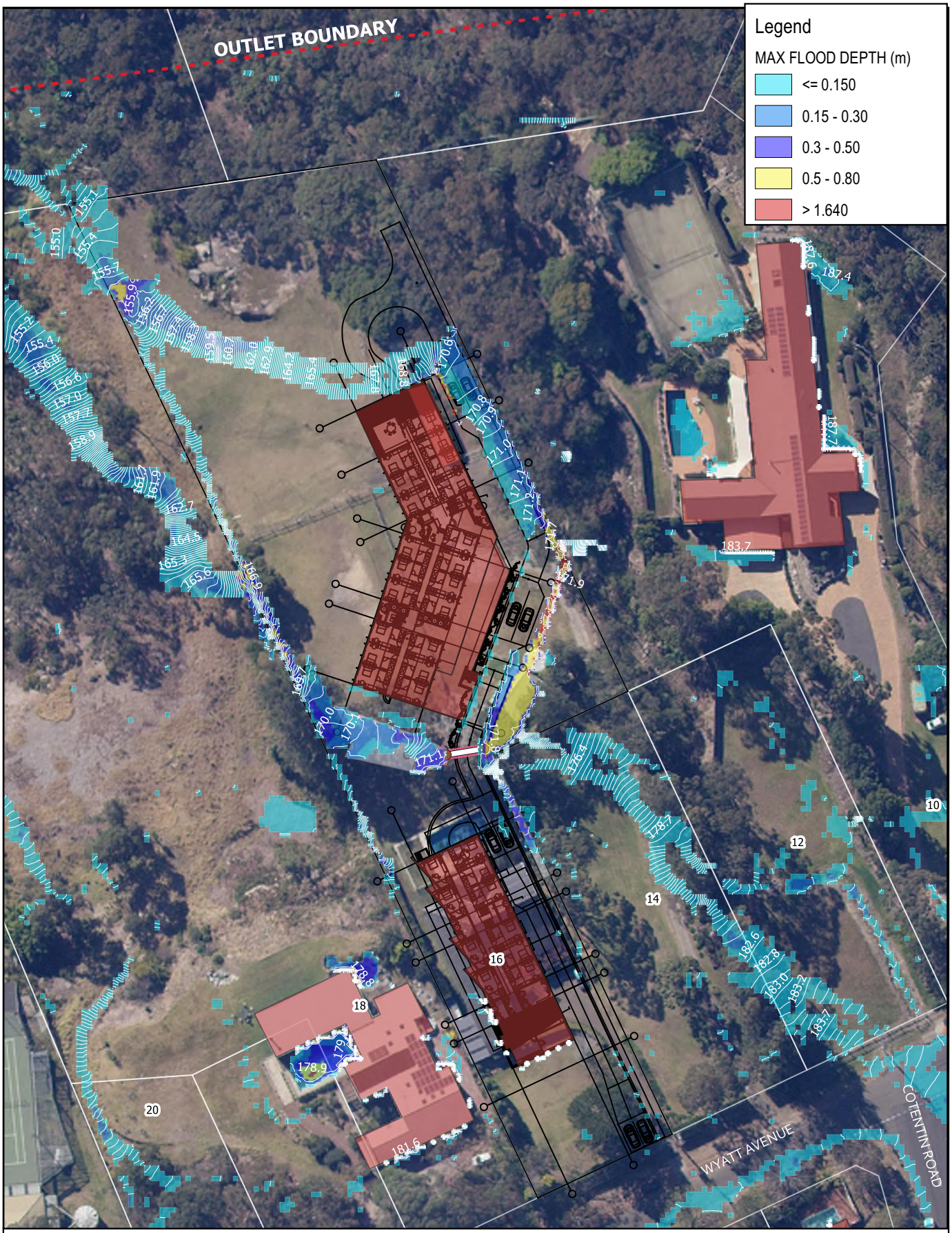

Title: 1% AEP MAXIMUM FLOOD DEPTH - POST DEVELOPMENT

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Project: PROPOSED BOARDING HOUSE DEVELOPMENT
16 WYATT AVENUE
BELROSE

Client: JOHN HOLMAN

North:

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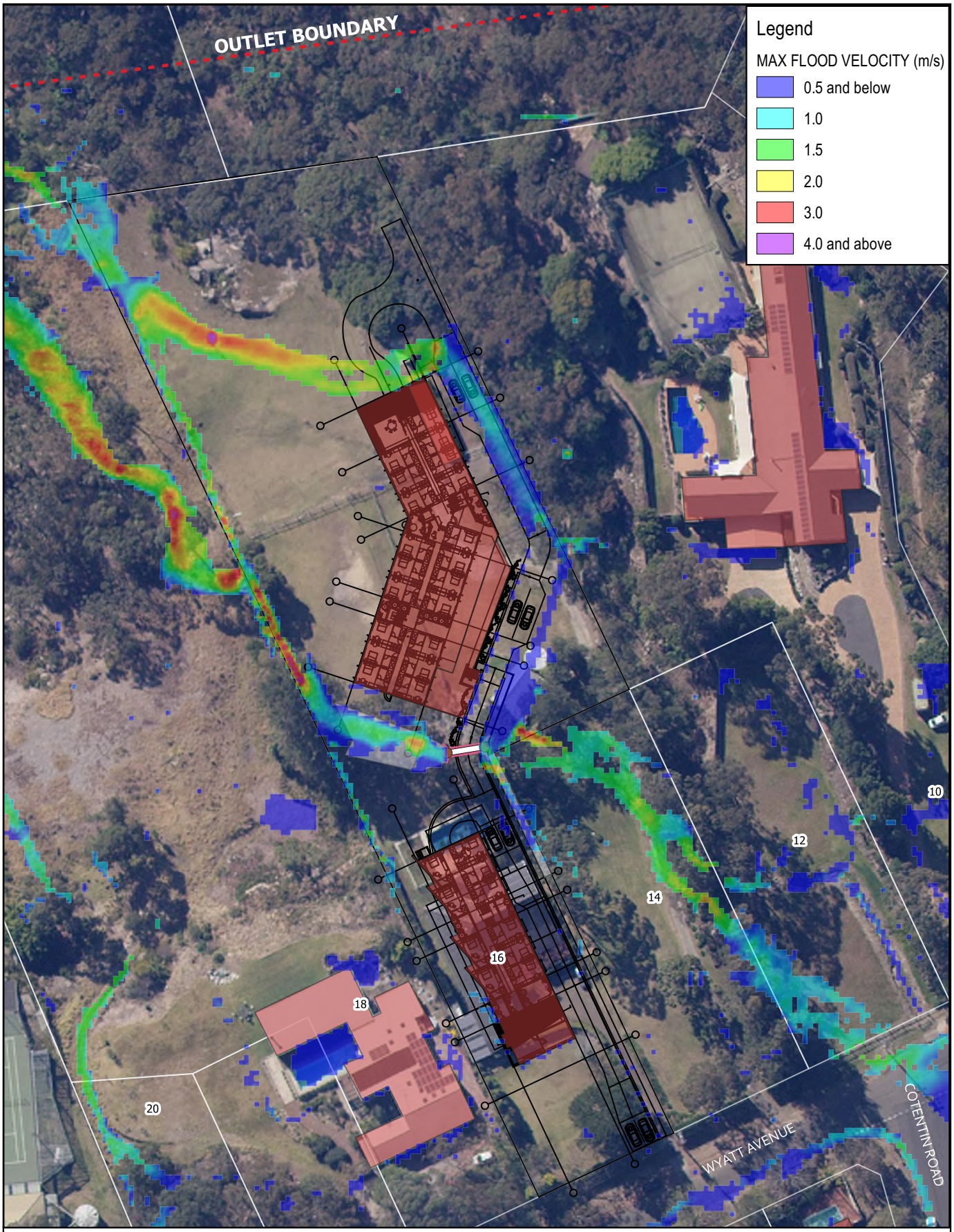

Title: 1% AEP MAXIMUM FLOOD VELOCITY - POST DEVELOPMENT

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Project: PROPOSED BOARDING HOUSE DEVELOPMENT
16 WYATT AVENUE
BELROSE

Client: JOHN HOLMAN

North:

Job Number:	Sheet:	Revision:	Date:	Designed:	Reviewd:	Scale:
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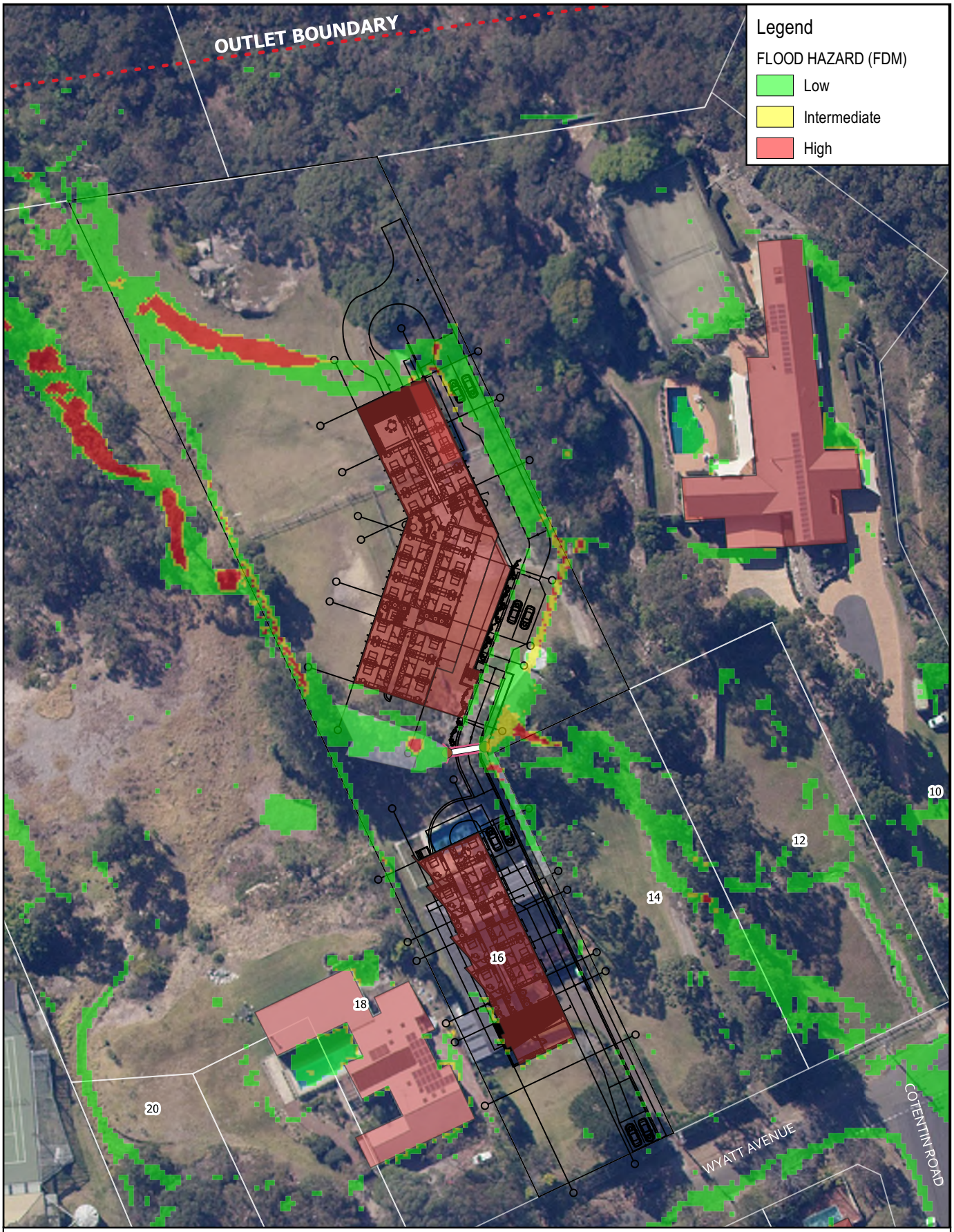

Title: 1% AEP MAXIMUM FLOOD HAZARD - POST DEVELOPMENT

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Project: PROPOSED BOARDING HOUSE DEVELOPMENT
16 WYATT AVENUE
BELROSE

Client: JOHN HOLMAN

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Job Number:	Sheet:	Revision:	Date:	Designed:	Reviewd:	Scale:
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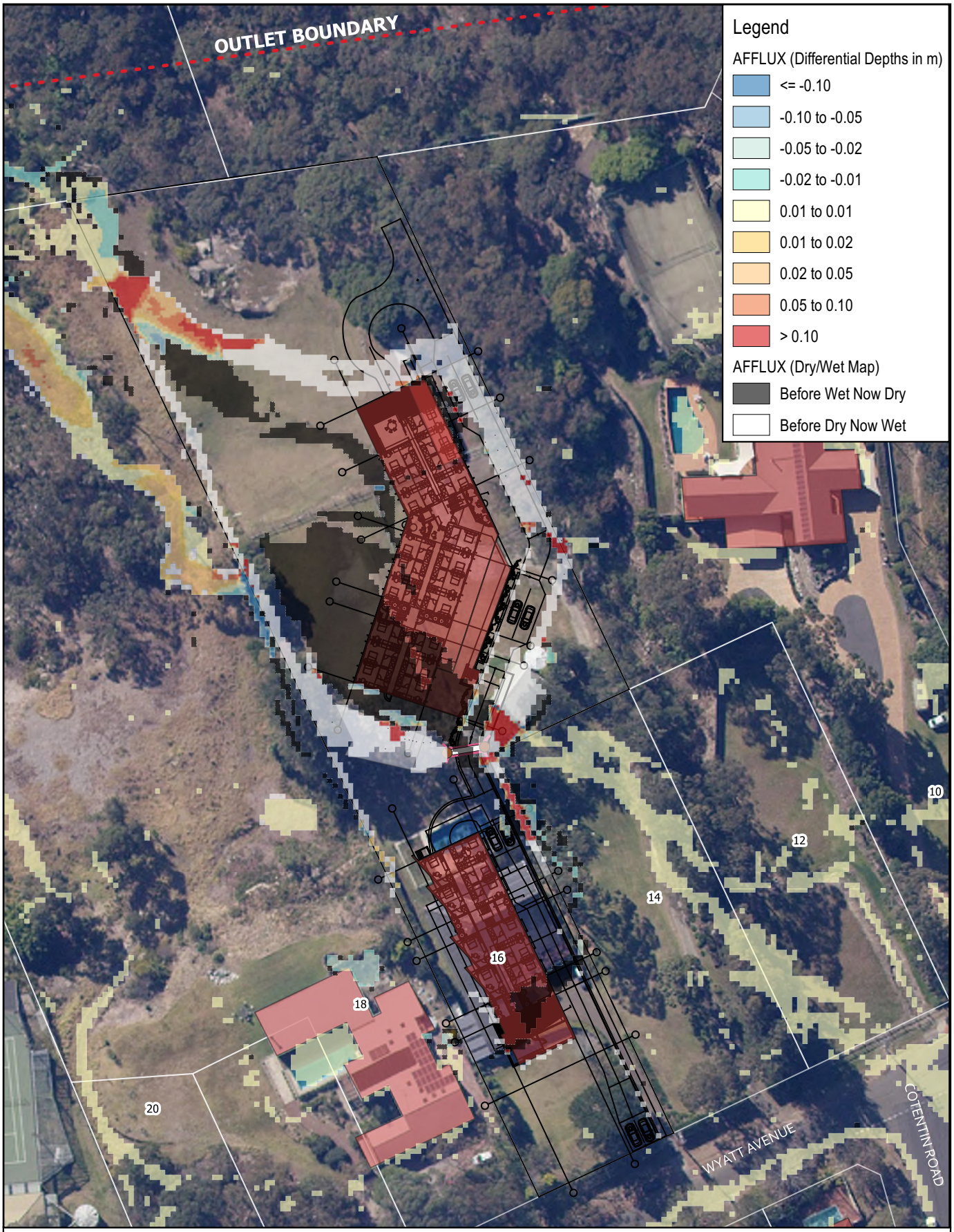

Title: 1% AEP MAXIMUM FLOOD AFFLUX MAP - POST DEVELOPMENT

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Project: PROPOSED BOARDING HOUSE DEVELOPMENT
16 WYATT AVENUE
BELROSE

Client: JOHN HOLMAN

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Job Number:	Sheet:	Revision:	Date:	Designed:	Reviewd:	Scale:
NSW210450	F20	1	18.05.2021	KP	RE	1:1000