Estuarine Risk Management Report for 24 Cabarita Road, Avalon

Authors:	Dr David Wainwright, Madeleine Leary
Prepared For	Bruce and Libby MacDiarmid (c/o Corben Architects)
Version	FINAL
Date	15/12/2022

Document Control

Version	Date	CHECKED BY	ISSUED BY	Distribution					
				BRUCE AND LIBBY MACDIARMID					
DRAFT FOR CLIENT REVIEW	6/09/2022	DJW	DJW	E					
FINAL	15/12/2022	DJW	DJW	E					

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1 Introduction

1.1 Northern Beaches Council's Requirements for an Estuarine Risk Management Report

Salients Pty. Limited was approached by Corben Architects, on behalf of Bruce and Libby MacDiarmid, to prepare an estuarine risk management report (this report) for a proposed boat shed and surrounding landscaping at 24 Cabarita Rd, Avalon Beach (Lot 9 of DP 17704). The property is located on the western foreshore of Careel Bay, which is an eastern side arm of Pittwater, north of Sydney. The site locality can be seen in Figure 1.

This report addresses the requirements of Northern Beaches Council (Council), through preparation of an Estuarine Risk Management Report (ERMR). Council require an ERMR as the proposed development will be affected by waves and tides.

Appendix 7 to the Pittwater 21 Development Control Plan (DCP)[1] contains the *"Estuarine Risk Management Policy for Development in Pittwater"*. That policy requires that risks arising from wave action and tidal inundation are properly considered by the development. Consideration of those risks is the main aim of this report.

1.2 Proposed Development

The proposed development comprises a new boat shed, surrounding landscaping, and access stairs. The proposed works are shown in Figure 2. With reference to those figures, the following have been considered by the present report:

- **Boat Shed:** The proposed boat shed has a footprint of 6m (shore normal) by 3.5m (shore parallel), and a floor level of 1.75m AHD. A storeroom and bathroom, with floor levels set at 2.46m AHD from the boat shed, some 9m landward of the seawall.
- **Landscaping:** The surrounding landscaping includes a level lawn in front of the boat shed, a series of retaining walls in line with and behind the front wall of the boat shed, and a seating area on top of the boat shed.
- **Access Stairs:** The access stairs lead from the main residence to the boat shed and waterfront lawn.

[1]Version incorporating Amendments 1 through 27 has been used throughout this report. The DCP for Pittwater is still in effect as of December 2022.

Figure 1: Site Locality

Estuarine Risk Report: 24 Cabarita Road Avalon

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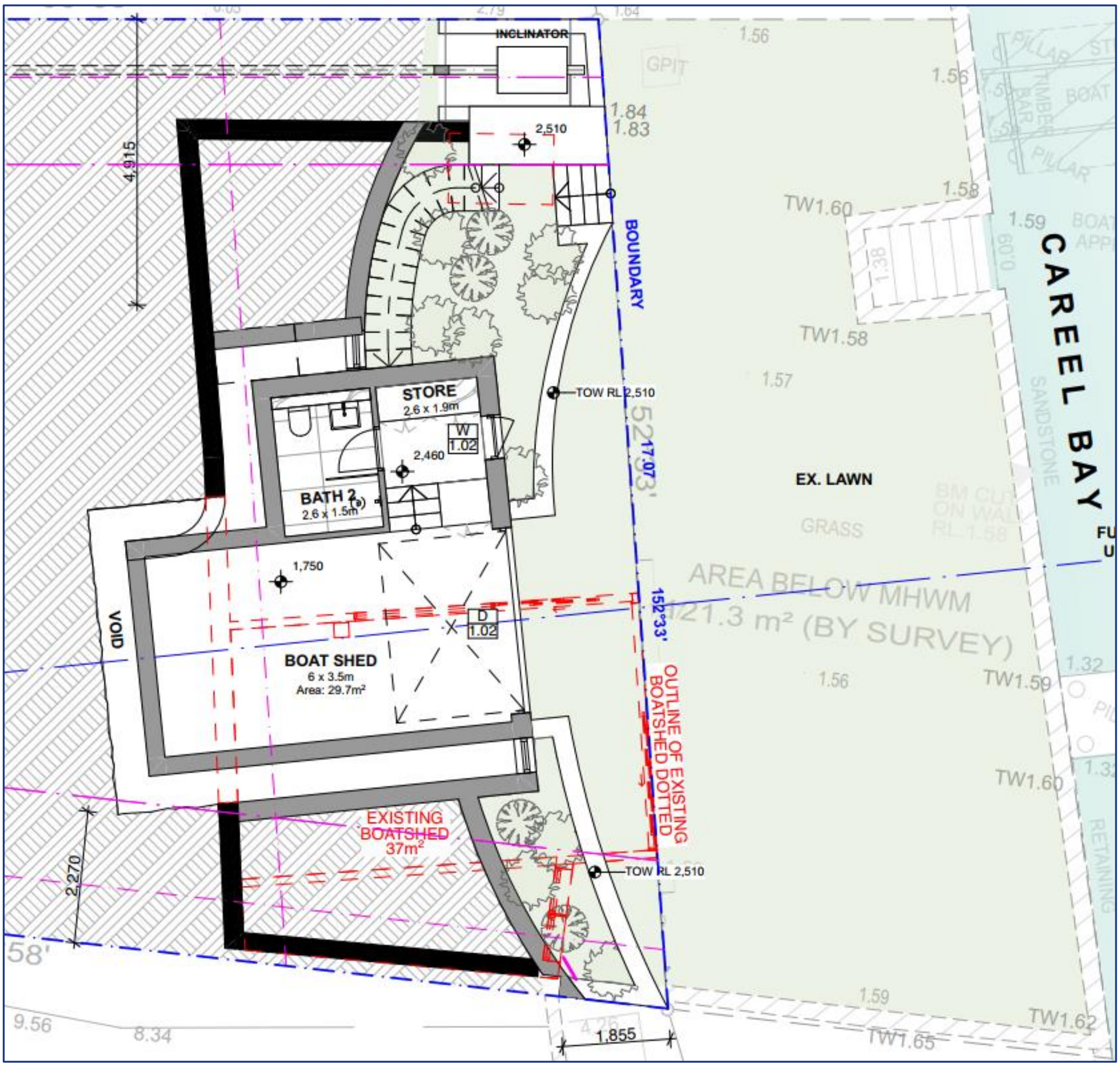

Figure 2 Plan View of Proposed Boat Shed and Landscaping (extract from drawings by Corben Architects (2022, provided in Appendix B))

1.3 Outline of Report

The requirements for this report have been determined through a review of Appendix 7 to the DCP and Section B3.7 *"Estuarine Hazard – Low Density Residential"* of the DCP. The identified requirements are presented in the remainder of this report as follows:

- Section 2 contains a description of the site locality and environment, as far as it relates to waves and water levels that could interact with the boat shed. The design life of the boat shed is also discussed, as this affects the allowance for sea level rise that needs to be made and the magnitude of design waves.
- Section 3 considers the nature of the existing foreshore and the structural loadings that need to be used during design. Issues surrounding durability and functionality are also discussed.

- Section 4 includes a risk assessment. Risks are identified and assessed. Where appropriate, mitigation strategies are outlined.

1.4 Confirmation

Salients Pty Ltd maintains public liability insurance and professional indemnity insurances consistent with the requirements of Council. Furthermore, the author of this report, Dr David Wainwright is a chartered engineer with the Environmental and Civil Colleges of Engineers Australia and has been a practicing coastal engineer for 25 years. David's PhD is in Coastal Engineering. A signed copy of "Form 1" which pertains to this Estuarine Risk Management Report is provided as Appendix A.

2 Details of the Environment at the Site

2.1 Site Locality

Appropriate design wave and tide conditions are governed by the location of the Site within Pittwater, Pittwater's connection to the ocean, and the Site's exposure to long fetches over which winds can blow to generate local waves. Due to its location, oceanic swell is highly modified and refracted before it reaches the site's foreshore. The location of the Site within Pittwater is shown in Figure 3.

Of interest is the fetch for local wind waves, which could approach from directions spanning clockwise from northwest to southeast.

2.2 Proposed Design Life for Facility

Council's policy specifies a design project life of one hundred years unless it can be *otherwise justified by the applicant* (and accepted by Council).

The proposed boat shed is non-habitable and will be used primarily for storage of a boat. An elevated bathroom and storage area (floor level 2.46m AHD) are accessible (internally) from the boat shed. Alternative external access from these two rooms is also available to proposed elevated ground (at 2.46m AHD). This elevated section has sits 9m landward of the seawall, and its elevation was set based on advice regarding the EPL, as provided in this report.

The Australian Standard for the design of maritime structures (Standards Australia, 2005) recommends that a design life of 25 years be adopted for a small craft facility[2]. This design life applies to a boat shed located at the foreshore. A 25-year design life is appropriate and has been adopted henceforth in this report.

Overall, the scale and relatively infrequent use of the structure (compared to use of residential buildings) lead to our assessment that the structure represents a *"low degree of hazard to life or property"*. A related table from the maritime structures standard indicates an appropriate wave height for a 25-year design life would be the 2% Annual Exceedance Probability (AEP) wave[3]. Put in perspective, such wave heights would have an approximate 40% chance of occurring over a 25-year design life.

Council's EPL includes an allowance for a 2% AEP wave.

[2] Refer to Table 6.1 of AS4997, 2005
[3] Refer to Table 5.4 of AS4997, 2005

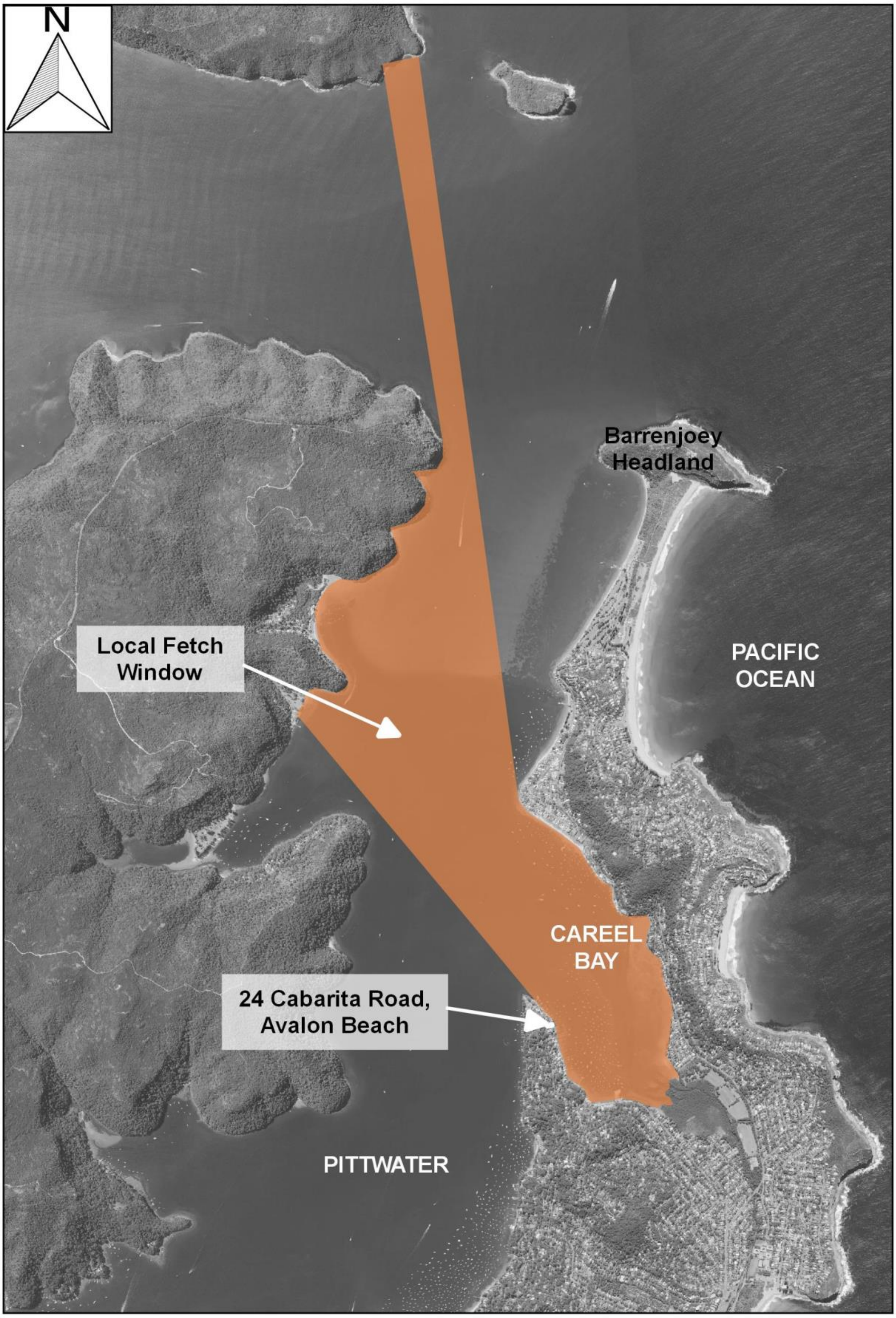

Figure 3: Site Locality and Fetch

0 0.5 1 1.5 km

APPROX SCALE

Estuarine Risk Report: 24 Cabarita Road Avalon

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2.3 Consideration of Wave Environment

2.3.1 Background

Previous work by Lawson and Treloar (2004, 2003), and Cardno (2015) examined the wind wave climate around Pittwater. Those studies applied extreme wind speed analysis to a wind record from Sydney Airport, which can be reasonably applied to Pittwater, resulting in estimated extreme wind speeds from directions between northwest and southeast as shown in Table 1.

Table 1 Estimated Extreme Wind Speeds for Pittwater (m/s) (from Lawson & Treloar (2003), Table 3.5)

Direction	North West	North	North East	East	South East
1% AEP Gust Speed	33.9	28.4	23.8	25.7	28.2
5% AEP Gust Speed	31.3	26.1	22.9	22.8	25.6
1% AEP 10 min Average	21.3	19.3	18.3	19.8	21.7
5% AEP 10 min Average	21.3	17.8	17.6	17.5	19.7
1% AEP 3hr Average	22.1	18.5	17.6	19.0	20.8
5% AEP 3hr Average	20.4	17.0	16.9	16.8	18.9

To estimate extreme nearshore wave conditions within Careel Bay, the response of a computational wave model to a range of wind speeds from 16 compass directions was assessed. Those responses were then used, by Lawson and Treloar, to transfer the time series of wind speeds from Sydney Airport to a corresponding time series of waves near the site. A similar process was also undertaken to determine the impact of ocean swell waves which pass Barrenjoey Head and refract heavily before propagating into Pittwater and Careel Bay. Statistical analysis was then used to determine the occurrence of extreme wave conditions at a variety of foreshores within Pittwater. The resulting local wind generated and refracted ocean swell waves that are indicated as being applicable to 24 Cabarita Road are replicated in Table 2.

Table 2 Estimated Extreme Wave Heights in the vicinity of 24 Cabarita Road ('Stokes' Point" from Lawson & Treloar (2003), Table 3.7)

Recurrence	Wind Wave Height (Hs,w, m)	Significant Swell Wave Height (Hs,sw, m)
5% AEP	0.87	0.50
2% AEP	0.92	0.55
1% AEP	0.98	0.60
0.5% AEP	1.02	0.64

A check of design wave heights, considering the length of wave generation fetch from directions ranging from northwest clockwise to southeast, was made using the simplified methods presented in the US Army Corps of Engineers Coastal Engineering Manual[4]. The values for significant wind wave height presented in Table 2 were found to be relatively high. For example, for the 1% AEP event, our calculations indicated a wind wave condition of 0.75m near the foreshore.

Reflecting on this apparent discrepancy, we note that the "Stokes Point" location referred to in Lawson & Treloar (2003) encompasses foreshores on both sides of Stokes Point (i.e. foreshores facing both westward into Pittwater, and eastward into Careel Bay). There is significant variation in the exposure to wind waves around the point and it is assumed that Lawson & Treloar adopted a "worst case" scenario considering the maximum of modelled wave conditions on both sides of Stokes Point. Accordingly, it seems likely that the wind wave conditions reported by Lawson & Treloar for "Careel Bay South" are more appropriate for application at 24 Cabarita Rd. Those wind wave values are replicated in Table 3.

The values in Table 3 are more appropriate for the foreshore at 24 Cabarita Rd. Regardless of the which of the foreshore "sectors" adopted from the Lawson and Treloar report, the governing design wave arises from winds which approach from a north – north westerly direction, due to the longer fetch across Pittwater.

This has been tested more rigorously using a computational wave model developed by Salients for Pittwater, as discussed in Section 2.3.2.

[4] http://www.publications.usace.army.mil/USACE-Publications/Engineer-Manuals/u43544q/436F617374616C/

Table 3 Estimated Extreme Significant Wind Wave Heights for "Careel Bay South" (from Lawson & Treloar (2003), Table 3.7)

Recurrence	Wind Wave Height (Hs,w, m)
5% AEP	0.66
2% AEP	0.69
1% AEP	0.74
0.5% AEP	0.77

2.3.2 Computational Wave Modelling

Updated Wind Analysis

Lawson and Treloar (2003) based their wind wave analysis on wind data recorded at Botany Bay between 1939 and 1999. We have completed an analysis based on the longer wind record now available and more up to date extreme value analysis techniques (Beirlant, 2004; Coles, 2001). The 2% AEP wind speeds from 16 compass points are listed in Table 4.

Updated SWAN Modelling

Salients has developed a more up to date SWAN model of Pittwater. While the version of the SWAN software used by Lawson and Treloar (2003) was state of the art at the time, the modelling software, and computational power, has improved significantly since 2003. Furthermore, more reliable bathymetric data are available. Perhaps of most importance is that it has long been realised that SWAN originally overpredicted wind generated waves for very high wind speeds (i.e., > 20.0 m/s). For at least the last decade, the SWAN model has incorporated options which recognise that the wind drag coefficient is reduced at higher wind speeds (Zijlema et al., 2012).

Our SWAN model is based on more recent and comprehensive bed elevation data across Pittwater (Fugro, 2019), a more recent version of the SWAN software (41.31A) and a refined 30m grid for calculation, which enables us to output design wave heights directly in front of the property. The extent of the model, showing bathymetry and the grid cell configuration offshore of the property are shown in Figure 4. The simulated extreme wind wave heights modelled around 50m offshore of 24 Cabarita Road, compared to those reported by Lawson and Treloar (2003) for the Stokes Point and Careel Bay South Precincts are shown in Table 5.

Table 4 2% AEP Wind Speeds based on Sydney Airport Recorder (1940-2021)

Direction	2% AEP Wind Speeds (m/s)
North	19.90
North-North-East	21.83
North-East	19.20
East-North-East	17.63
East	19.12
East-South-East	19.99
South-East	24.13
South-South-East	23.13
South	29.01
South-South-West	24.77
South-West	31.37
West-South-West	19.38
West	21.59
West-North-West	17.94
North-West	20.53
North-North-West	20.98

Table 5 Modelled Design Wind Wave Heights (H_S, m) at 24 Cabarita Rd, compared to Previous Values

Condition	24 Cabarita Rd (Present Analysis)	Stokes Point (Previous)	Careel Bay South (Previous)
5% AEP	Not Modelled	0.87	0.66
2% AEP[5]	0.65	0.92	0.69
1% AEP	0.72	0.98	0.74

[5] The 2% AEP value is used in determining the EPL.

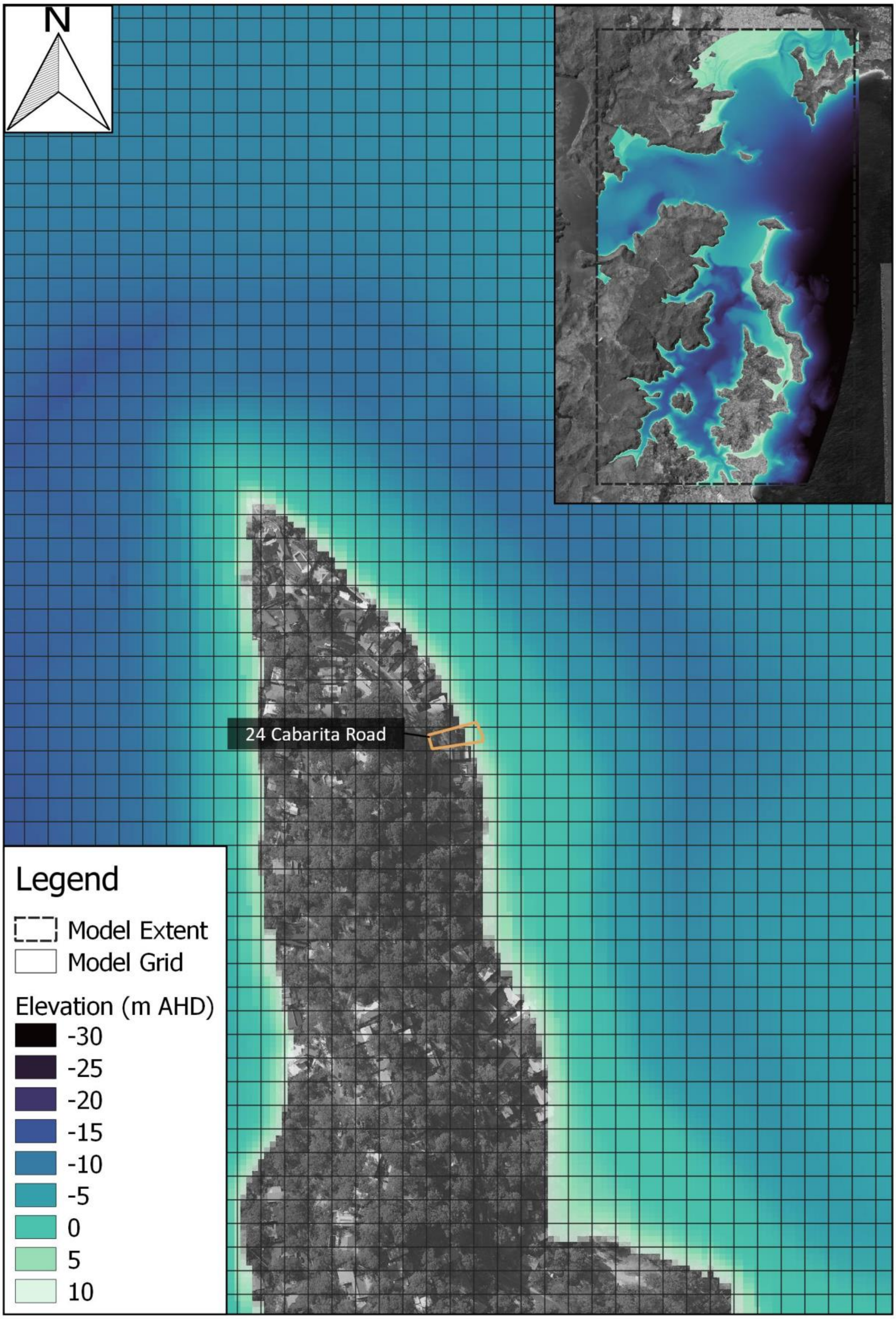

Figure 3: Swan Model Extent and Bathymetry

0 50 100 150 m
APPROX SCALE

24 Cabarita Road Avalon

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2.3.3 Summary of Wave Condition Information

For our final recommendations regarding the EPL, the 2% significant wave height (H_s of 0.65m) has been adopted, although Council's approach to the EPL, which uses a different wave height, is summarised in the next section.

The design wave applied in determining loads on structures should be an "H_1" wave, representing the highest 1% of waves occurring during a design storm instead of the significant wave height. AS4997 recommends a factor of 1.5 be applied to the H_s wave height to obtain the H_1 wave height. Accordingly, a wave with height 0.98m (1.50 × 0.65) can be used in deriving forces for structural design.

It is possible that a wave of this height may not make it to the site without breaking. This is governed by the following relationship:

$$H_b = \gamma \times h_b$$

Where H_b is the size of the wave that would break in water depth h_b and γ is the breaker index which is commonly given a value of 0.78. A nearshore depth of less than 1.25m is required for a 0.98m wave to pass without breaking before it reaches the foreshore. The bathymetric LiDAR data used in developing the SWAN wave model and was inspected to confirm the elevations of the foreshore. The bed elevations of the foreshore fronting the property were close to 0.0 m AHD. Considering these factors, we conclude that the design wave could propagate across the foreshore and break directly onto the foreshore during elevated water levels. The water level environment is discussed in the next section.

2.4 Consideration of Water Level Environment

Council's designated Estuarine Planning Level (EPL) for the site is 2.66m AHD. Under this condition, the design wave of 0.98m could easily propagate all the way in to the foreshore and the full wave height would govern design. It is important to understand how the EPL has been derived. It contains the following components:

- Storm Tide.
- Wind Setup.
- Wave Related Increment.
- Freeboard.
- Sea Level Rise.

Each of these are discussed in turn.

Storm tide includes the astronomical tide and other large-scale processes that act to raise the ocean water level over large distances (i.e., 100's of km). For the most recent analyses (Cardno, 2015), a storm tide of 1.44m AHD was applied across Pittwater, which differed from that originally determined by the Pittwater Estuary Processes Study (Lawson & Treloar, 2003).

By applying the 1% AEP 3 hourly average wind speeds from Table 1 to a hydrodynamic model, the following wind setup values were determined along the Careel Bay South foreshore (Lawson & Treloar, 2003):

- North Westerly Wind: +0.03m
- Northerly Wind: +0.06m
- North Easterly Wind: +0.06m
- Easterly Wind: +0.04m

For all other directions, winds across Pittwater indicated a set down of water levels. The value adopted for the site in the most recent analysis of water levels was +0.06m (Cardno, 2015). This would occur concurrently with wind waves approaching from the north.

A "Wave Related Increment" EPL component was also determined for Stokes Point. This component accounts for run-up and overtopping of the foreshore and is therefore related to the type of foreshore (e.g., sloping natural, vertical seawall etc.). The foreshore fronting 24 Cabarita Road has a vertical seawall with a crest elevation of 1.6m-1.65m AHD. Cardno (2015) assesses EPL based on crest elevations at 0.5m intervals, so for this assessment a crest elevation of 1.5m AHD has been chosen as representative. The present day still water level, including wind set up allowance is 1.50m AHD, meaning that the still water level is at the seawall crest for the still water level considered (present day conditions).

For this condition, the overtopping level was calculated by adding half of the design wave height (2% AEP of 0.92 x 0.5 = 0.46m) to the still water level. By including a freeboard of 0.3m, a present day EPL (without sea level rise) of 2.26m AHD results. Cardno (2015) describes the freeboard as a "factor of safety" which provides a level of mitigation against risk exposure arising from uncertainties, particularly with relation to wave run-up.

For climate change related sea level rise, Council has adopted a rise of 0.4m in deriving the EPL. Within Cardno (2015), these were considered to be relative to a "Present Day Level" of 0.0m. With sea level rise of 0.4m, a total estuarine planning level of 2.66m AHD was determined.

In considering the degree of periodic foreshore infrastructure inundation that could be expected from tides of different frequencies within Pittwater, Cardno (2015) also presented more statistics as shown in Table 6.

Table 6 Comparison of Still Water Levels from Astronomical Tides (m AHD, to nearest 0.1m)

	"Present Day"	2050 (including 0.4m Sea-level rise)
Fortnightly High Tide	**0.6**	**1.0**
Monthly High Tide	**1.0**	**1.3**
Biannual (King) Tide	**1.2**	**1.6**
100yr Storm Tide	**1.46**	**1.8**

2.5 Potential Justification for Modifying the Estuarine Planning Level

2.5.1 Outcomes

Considering the components of the EPL, the storm tide adopted is reasonably typical for estimates based on the record available from Fort Denison. Varying the storm tide level to represent a 2% AEP event (applicable for a 25yr design life), instead of a 1% event would typically result in lowering the level by a few centimetres.

The sea level rise allowance applied in Cardno (2015) appears to be 0.4m between 2015 and 2050 and a further 0.5m between 2050 and 2100. Most widely accepted projections now indicate that the rate of sea level rise will accelerate over time. A comparatively conservative approach is to consider a linear increase between 2015 and 2050. This approach projects that by 2047, at the end of a 25-year design life for the boat shed, around 0.37m of sea level rise would have occurred. Allowing for this adjustment represents a potential decrease in the EPL by 0.03m.

In total, an argument could be made for reducing the EPL for the development by a few centimetres, using these values although the key issue at this site is the wave height adopted.

As outlined above, our modelling has indicated a site-specific wave height of 0.65m AHD is appropriate. Accordingly, an appropriate EPL, at the foreshore, without adjusting allowances for sea level rise is as outlined in Table 7.

[6] Note that a level of 1.44 (1.84 with 0.4m of sea level rise) was used in derivation of the Estuarine Planning Level

Table 7 Recommended EPL for 24 Cabarita Rd Foreshore

Component	Amount
Storm Tide	1.44m AHD
Wind Set up (for Careel Bay South, NE wind)	+ 0.07m
Sea Level Rise	+0.40m
Wave Related Increment (0.5*0.65m, NNE wave)	+0.32m
Freeboard	+0.30m
Total	**2.53m AHD**

We recommend that 2.53m AHD be adopted as the EPL at the foreshore. However, Council's DCP allows for the effect of the wave related increment to be diminished with distance, to zero at 40m landward of the foreshore. Accordingly, the EPL falls by 8cm every 10m landward of the foreshore. To set the level of any habitable floors, the EPL's outlined in Table 8 could be used, dependent on distance landward of the foreshore seawall. When applying values from this table, linear interpolation can be used, but we recommend the value derived from the table be rounded to the nearest centimetre.

Table 8 Variation of EPL with distance Landward from Foreshore

Distance Landward from Foreshore Seawall	EPL (to nearest mm)
2m	2.514
4m	2.498
6m	2.482
8m	2.466
10m	2.450
12m	2.434
14m	2.418

Considering Table 8, we discern that an Estuarine Planning Level of 2.46m AHD is appropriate at a distance of 9m landward of the foreshore.

3 Interaction of Water Levels and Waves with the Proposal

3.1 Existing Foreshore and Structural Condition

Our assessment of the existing site is based on photographs provided by Roxanna Viray (captured 18 July 2021 at around 4pm), design plans prepared by Corben Architects (Appendix B), and a survey of the Site prepared by ATS Land and Engineering Surveyors Pty Ltd (Appendix C).

A photograph of the foreshore at 24 Cabarita Road is presented in Figure 5. A vertical seawall is present along the foreshore, with a crest height of around 1.6m AHD. Behind this seawall is a lawn of a similar elevation. A boat shed is present which is to be demolished and replaced with the proposed new boat shed.

Figure 5 Existing Foreshore fronting 24 Cabarita Rd, Avalon Beach

3.2 Determination of Structural Design Conditions

As described in Section 2.5, our recommended estuarine planning level for the site is 2.46m AHD, 9m landward of the foreshore. To provide a safe, habitable floor level, it would need to be raised consistent with those values.

Clause B3.37 of Council's DCP notes that:

> *"Consideration may be given on a meris basis to a floor level of a boat shed at a lower level than the Estuarine Planning Level where it can be demonstrated through an Estuarine Risk Management Report that the boat shed is structurally designed to withstand periodic wave action and tidal inundation up to the Estuarine Planning Level"*

If a floor level is to be set below the appropriate EPL, the flooring and lower walls can (and should) be designed to handle temporary inundation to meet the requirements of Council at the end of the structure's design life. Structural design should consider inundation to at least 2.46m AHD, including allowances for the shrink and swell of any construction materials used (e.g., timber, weatherboard etc.) and the ability for these to dry out once water levels subside.

Waves will load the foreshore structures in several ways, which are dealt with in turn:

- Waves slamming against the vertical sides of structures.
- Waves breaking across the horizontal surfaces, causing shear and uplift forces.

A design wave height of 0.98m at the foreshore seawall has been assumed. Waves that reach the foreshore will break across the foreshore and potentially slam against the front face of the boat shed during an extreme wave condition at the end of the structure's design life.

3.2.1 Waves Acting against Vertical Planar Surfaces

The wave forces discussed below should be applied to all vertical planar surfaces such as boat shed walls, sides of structural members, and the face of retaining structures.

The method presented by Goda (2010) for calculating the wave forces on a vertical breakwater can be conservatively adopted. Goda's model produces a (roughly) triangular pressure distribution which varies with height, peaking at the 'still water level'. It is necessary to consider those components of the EPL that should be included in this force calculation. It is appropriate to include the storm tide, wind setup and sea level rise components in determining a still water level across which the wave will propagate. The wave related increment can be ignored in this instance as Goda's method calculates the amount which the wave will run up a vertical planar surface. An argument could be mounted for ignoring the freeboard as well, but in this instance, it is considered appropriately conservative to retain that component. Considering the information in Sections 2.3 through 2.5, and adopting Council's original EPL, with a 2% AEP design wave, the design conditions comprise a 0.98m high wave propagating across a still water level of 1.91m AHD.

Using Goda's method, a peak wave pressure of 4.3 kPa is calculated at the adopted "still water level" of 1.91m AHD. We recommend that this horizontal pressure be considered to act evenly on all parts of vertical surfaces below 1.91m AHD. Goda's method calculates that the waves could run up the face of a vertical surface to a height of 3.4m AHD, although this behaviour would be intermittent and only occur at the peak of the storm surge. The wave pressure distribution should be considered to reduce linearly between 1.91 m and 3.40m AHD, from 4.3 kPa to zero.

This vertical pressure distribution represents the conditions at the peak of a time varying condition which oscillates with a period equal to the incident wave period (around 3.5 seconds, derived from SWAN model results). There is also potential for a very high impulsive breaking wave force to impact on the structure. Goda notes that this can occur when there is:

1 A broad rubble berm at a high elevation. or

2 The sea bottom is steep, and the incident wave is not.

Neither of these conditions are met, so impulsive breaking wave forces are not a concern in this instance.

3.2.2 Waves Acting Across Upper Face of Horizontal Planar Surfaces (e.g., Pathways)

When a wave breaks and rushes across a horizontal surface a tangential shear stress acts across that surface. An appropriate value for this force has been determined considering that the maximum velocity flowing across the front lawn and surrounding pathways would occur when the full design wave height (0.98m) breaks across the surface. An estimate of the velocity was determined by adding:

- the approach wave speed, and
- a velocity equal to the height of the wave, converted to an equivalent velocity via Bernoulli's equation.

By rounding up, a conservative estimate of the shear stress is 0.5kPa. This force can be considered to work as both a tangential drag force and a lift force (also 0.5kPa), with both the drag and lift acting at the same time.

3.2.3 Summary of Design Considerations

In summary, the following load conditions should be considered during structural design.

- An even pressure of 4.3 kPa up to 1.91m AHD, with a linearly decreasing pressure above 1.91m, reducing from 3.3 kPa to 0kPa at 3.40m AHD. This pressure varies with time and the values presented above represent conditions as the peak of the wave slams into the structure.

- A shear stress and lift force of 0.5kPa, in accordance with Section 3.2.2 acting on horizontal surfaces (such as pathway surfaces and any decking).
- All forces should have factors applied in accordance with standard structural engineering practice. Some guidance on appropriate factors is also provided in AS4997 *Design of Maritime Structures.*

3.3 Other Design Considerations

Other structural loads, in accordance with normal structural design practice (winds, dead loads and pedestrian loads etc.) also need to be considered. Buoyancy forces should also be assessed with the structure considered empty and inundated to 2.40m AHD. The height of 2.40m is calculated from the design still water level of 1.91m AHD plus half the design wave height of 0.98m in accordance with AS4997.

The potential for fatigue to occur due to repeated but less severe loading, or deterioration of structural members due to the harsh environment needs to be considered. As part of structural design, an appropriate program for structural inspection and expected maintenance requirements is to be provided. This is discussed further under Section 4.7. Consideration of the durability of structural materials comprising the floor and lower walls of the boat shed is required. These members should be designed to handle some inundation (say, more than a couple of times a year) at the end of the boat shed's design life.

If electrical fixtures are to be provided to the boat shed, these should be kept above The Estuarine Planning Level as outlined in this report. If situated below the EPL fixtures should be of submersible grade. Any power outlets located below the maximum wave runup height (3.4m AHD) should also be of submersible grade.

The floor of the shed should enable draining, and a gap of 6mm between decking planks, or similar, is recommended to enable rapid draining, drying and ventilation after an inundation event. Alternatively, for a concrete floor, drainage could be easily achieved by sweeping following an inundation event. Structural member and connection design below the design below the design inundation elevation should also consider the need for drying and ventilation. The slope of all surfaces should encourage water to drain back into Pittwater and/or the design should allow for the floor to be swept or hosed out if it is inundated.

4 Risk Assessment and Management Strategy

4.1 Background

A risk assessment and management strategy for the works has been prepared using the guidance provided by the international risk management standard, ISO 31000. That standard suggests the following steps for risk assessment:

- Establish the risk management context.
- Identify the Risks.
- Assess the Likelihood and Consequences of those Risks.
- Evaluate the Risks.

Management strategies can then be suggested for those risks which are unacceptable.

4.2 Establish the Context

The risks assessed by this strategy relate to elevated water levels and waves, as far as they may impact on the following foreshore elements:

- Proposed boat shed,
- Surrounding landscaping (including retaining walls),
- Access stairs.

The different risks that are of relevance in the context of Council deciding about a development application fall into the following three categories:

1. Structural.
2. Safety.
3. Environmental.

4.3 Identification of Risks

The three risk categories listed above were considered in turn. Risks that could possibly be of concern (even minor) have been listed and numbered for further consideration.

4.3.1 Structural Risks

Risk 1: *There is a risk that the structure will fail under elevated water level and/or wave conditions.*

Risk 2: *There is a risk that the structure will deteriorate over time, making it more susceptible to failure under even moderate loads.*

4.3.2 Safety Risks

There are two types of safety risks broadly considered, those that arise during construction, and those that arise during use of the facilities. The proposed works are typical for foreshore structures of this type and abnormal construction risks are not expected. It is expected that the contractor completing the work will comply with standard safe building practice and Work Health and Safety legislation, considering the hazards present in a marine environment. Construction safety risks are not considered further here.

Regarding safety risks during use of the facilities, the assessment requires consideration of the existing situation, and how introduction of the facilities might impact on the exposure of individuals to dangerous wave and water level conditions.

Individuals may approach the facility from the water side or the land side. In terms of approaches from the water side, the modified facilities will not change the current safety conditions. Therefore, risks associated with approaches from the water side are not changed by the proposal and not considered further here.

With approaches from the land side, however, the following risk has been identified:

Risk 3: *There is a risk that construction of the facilities will create a perception that it provides a safe platform during periods of elevated water levels and waves, increasing the exposure of people to being knocked down by waves and potentially drowned.*

4.3.3 Environmental Risks

Facilities such as this can potentially interact with waves to have undesirable impacts on environmental processes. The proposed foreshore structures will not impact on water levels in Pittwater. One risk has been identified:

Risk 4: *There is a risk that construction of the facilities will affect wave reflection patterns, potentially focussing wave energy at other locations and causing problems for adjacent foreshore infrastructure.*

4.4 Method for Likelihood Assessment

The likelihoods of the identified risks have been assessed qualitatively using the descriptors provided in Table 9 (adapted from AS5334 (Australian Standards, 2013)).

Table 9 Likelihood Assessment Table.

Likelihood Rating	Descriptor
Almost Certain	Could occur several times per year
Likely	May arise about once per year
Possible	Maybe a couple of times in a generation
Unlikely	Maybe once in a generation
Very Unlikely	Maybe once in a lifetime

The assessment of likelihood for each of the identified risks is presented in Section 4.7.

4.5 Method for Consequences Assessment

The consequences of the identified risks have been assessed qualitatively using the descriptors provided in Table 10 (adapted from AS5334 (Australian Standards, 2013))

Table 10 Consequences Assessment Table.

Consequence Rating	Structural Factors	Safety/Health Factors	Environmental Factors
Insignificant	No damage	No adverse effects	No adverse effects on natural environment
Minor	No permanent damage, minor restoration required	Slight adverse human health effects	Minimal effects on the natural environment
Moderate	Limited damage, recoverable by maintenance and minor repair	Adverse human health impacts	Some damage to the environment including local ecosystems
Major	Extensive damage requiring major repair	Permanent physical injuries and fatalities to a single individual	Significant effect on the environment and local ecosystems. Remedial action required.
Catastrophic	Significant permanent damage or loss of structure	Injuries and/or fatalities involving multiple individuals	Very significant environmental loss with extensive remedial action required.

The assessment of consequences for the identified risks is presented in Section 4.7.

4.6 Method for Risk Evaluation

Using the likelihoods and consequences descriptors presented above, evaluation of the risks has been completed using Table 11 (adapted from AS5334 (Australian Standards, 2013)).

AS5334 regards that the following treatments are applicable:

- *Low* risks would typically be addressed through routine maintenance and day to day operations.
- *Moderate* risks would require a change to the design or maintenance regime of assets.
- *High* risks require detailed research and appropriate planning (or design)
- *Extreme* risks would require immediate action to mitigate.

The evaluation of each of the identified risks is presented in Section 4.7.

Table 11 Risk Rating Matrix

Likelihood	Consequences				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	Low	Moderate	High	Extreme	Extreme
Likely	Low	Moderate	Moderate	High	Extreme
Possible	Low	Low	Moderate	High	Extreme
Unlikely	Low	Low	Moderate	Moderate	High
Very Unlikely	Low	Low	Low	Moderate	Moderate

4.7 Risk Management Discussion and Treatment

The following discusses risk assessment, evaluation, and proposed management strategies for each of the three identified risks.

Risk 1: *There is a risk that the structures will fail under elevated water level and/or wave conditions.*

Overall, the force of waves during the design event and less severe events is destructive. These design events could be expected to occur once or twice in a generation (Possible) and, if the structure is under designed, extensive damage could be expected (Major). A "high" risk would be indicated for an under designed structure.

<u>Risk Management Action 1</u>

> The recommended action here is to ensure that structural design considers the loadings outlined in Section 3 of this report, and that other loads and suitable factors are applied in accordance with standard structural engineering practice. Allowance must be made for suitable drainage of overtopping waves back towards Pittwater.

This action would reduce the consequences to "Minor" in nature, resulting in a "Low" risk rating.

Risk 2: *There is a risk that structures will deteriorate over time, making them more susceptible to failure under even moderate loads*

It is likely that the structural members will deteriorate with time. However, the nature of the failure that could be expected is only partial failure, which could be remediated through minor repairs and maintenance (replacement of failing members etc.). This results in a moderate risk rating. However, if the following two actions are adopted, the risk rating would be reduced to "Low".

<u>Risk Management Action 2</u>

> Again, ongoing degradation of the structure can be addressed by design. Construction materials and connections should be suitable for exposure to harsh conditions, including occasional inundation and wave action. If appropriate, the design should allow for a loss of structural integrity (serviceability and strength) over time. All construction materials and connections below 2.46m AHD should be capable of withstanding inundation in sea water, with a design life of at least 25 years.

<u>Risk Management Action 3</u>

> A maintenance and inspection regime, appropriate for the construction materials adopted should be defined by the structural designer, so that any

abnormal deterioration of the structure is identified before it becomes problematic. Furthermore, the structural design should consider the accessibility of structural members if it is expected that they may need to be replaced.

Risk 3: *There is a risk that construction of the facilities will create a perception that it provides a safe platform during periods of elevated water levels and waves, increasing the exposure of people to being knocked down by waves and potentially drowned.*

The design event is a rare occurrence. Furthermore, it would take the occurrence of abnormal circumstances, or a lapse of judgement, for individuals to approach the foreshore during the height of a storm. This may happen, but the number of individuals that could approach the foreshore from the landward side during a storm would be limited to the residents of 24 Cabarita Road, and their visitors. Even if these people did approach the foreshore, the elevated and/or clear nature of landward approaches to the boat shed would normally mean that visibility is reasonable, except at night. Overall, it is considered that there is an extremely remote chance that problems would occur, but that the consequences would be "Major". A "Moderate" risk rating is implied.

However, it should be recognised that the design being considered will result in a boat shed which is further landward than the existing boat shed. It is therefore more distant from waves on Pittwater and less exposed.

Risk Management Action 4

The probability of occurrence is remote, but the consequences could be major. It is recommended that a motion sensing light be installed to illuminate the foreshore at night, so that dangerous water level and wave conditions can be more easily identified and avoided by persons approaching the foreshore from the land side. This light could also have the practical function of making the facility more usable at night. While this will not eliminate the potentially major consequences, it is considered that these actions are reasonably practicable and cost effective.

Furthermore, for events which exceed the design event, provision has been made to allow egress from the boat shed above the EPL via internal stairs and a door from the storeroom to elevated ground.

Risk 4: *There is a risk that construction of the facilities will affect wave reflection patterns, potentially focussing wave energy at other locations and causing problems for adjacent foreshore infrastructure.*

Overall, the wave and current climate is benign. Localised modification to wave and current patterns around the immediate vicinity of the foreshore will only occur during rare events and are inconsequential. The assessed risk rating is “Low” and does not require further consideration.

5 Summary and Endorsement

The proposed boat shed and associated development at 24 Cabarita Rd can be structurally designed to withstand appropriate water and wave loadings without failure. Appropriate environmental loadings are presented in Section 3 of this report and summarised in Section 3.2.3. Other considerations which a structural designer should regard are presented in Section 3.3.

A risk assessment was undertaken and the outcomes of that assessment, including the actions that should be taken to mitigate against those risks, are summarised in Section 4.7. The residual risks arising from the development are minor and can be easily addressed during design and construction.

The proposed facilities can be appropriately built and managed without undue impacts or negative consequences to public safety or the environment if the recommendations provided for in the above referenced sections are followed. A formal endorsement of the findings of this report is provided in Appendix A.

6 References

Australian Standards, 2013. AS 5334 Climate Change Adaptation for Settlements and Infrastructure.

Cardno, 2015. Pittwater Estuary Mapping of Sea Level Rise Impacts (Revised Draft Report No. LJ2882/R2658v7).

Goda, Y., 2010. Random Seas and Design of Maritime Structures, 3rd ed, Advanced Series on Ocean Engineering. World Scientific, Singapore.

Lawson & Treloar, 2004. Estuarine Planning Level Mapping Pittwater Estuary (No. J2230/R2075).

Lawson & Treloar, 2003. Pittwater Estuary Processes Study (No. J1942/R1945).

Standards Australia, 2005. AS4997-2005 Australian Standard Guidelines for the design of maritime structures.

Appendix A "Form 1" for Estuarine Risk Management Report Certification

FORM NO. 1

To be submitted with Estuarine Risk Management Report

Development Application for Bruce and Libby MacDiarmid (c/o Corben Architects)
Address of site 24 Cabarita Road, Avalon Beach

Declaration made by a Coastal Engineer as part of an Estuarine Risk Management Report

I, David Wainwright, on behalf of Salients Pty Ltd

on this the 15th December 2022

certify that I am a Coastal Engineer as defined by the Estuarine Risk Management Policy for Development in Pittwater and I am authorised by the above organisation/company to issue this document and to certify that the organisation/company has a current professional indemnity policy of at least $2 million.

Please mark appropriate box

X I have prepared the detailed Estuarine Risk Management Report referenced below in accordance with the Estuarine Risk Management Policy for Development in Pittwater

☐ I am willing to technically verify that the detailed Estuarine Risk Management Report referenced below has been prepared in accordance with the Estuarine Risk Management Policy for Development in Pittwater

☐ I have examined the site and the proposed development/alteration in detail and, as detailed in my report, am of the opinion that the Development Application only involves Minor Development/Alterations or is sited such that a detailed Estuarine Risk Management Report is not required.

Estuarine Risk Management Report Details:

Report Title: Estuarine Risk Management Report for 24 Cabarita Road, Avalon Beach
Report Date: 15th December 2022
Author: Dr David Wainwright

Documentation which relate to or are relied upon in report preparation:

Australian Standards, 2013. AS 5334 Climate Change Adaptation for Settlements and Infrastructure.
Cardno, 2015. Pittwater Estuary Mapping of Sea Level Rise Impacts (Revised Draft Report No. LJ2882/R2658v7).
Goda, Y., 2010. Random Seas and Design of Maritime Structures, 3rd ed, Advanced Series on Ocean Engineering. World Scientific, Singapore.
Lawson & Treloar, 2004. Estuarine Planning Level Mapping Pittwater Estuary (No. J2230/R2075).
Lawson & Treloar, 2003. Pittwater Estuary Processes Study (No. J1942/R1945).
Standards Australia, 2005. AS4997-2005 Australian Standard Guidelines for the design of maritime structures.

I am aware that the above Estuarine Risk Management Report, prepared for the above mentioned site is to be submitted in support of a Development Application for this site and will be relied on by Northern Beaches Council as the basis for ensuring that the estuarine risk management aspects of the proposed development have been adequately addressed to achieve an acceptable risk management level for the life of the structure, taken as at least 100 years unless otherwise stated and justified in the Report and that all reasonable and practical measures have been identified to remove foreseeable risk.

Signature:

Name: Dr David Wainwright

Chartered Professional Status: MIEAust, CPEng, NER (Civil and Environmental Colleges), APEC Engineer, IntPE(Aus)

Membership No. 884280

Appendix B Design Plans, Corben Architects, December 2022

rev	date	description
A	12/12/22	DA Issue

list of abbreviations

A/C	air conditioning
ALUM	aluminium
AP	access panel
AS	adjustable shelf
AW	awning window
BAL	balustrade
BALC	balcony
BDY	boundary
BLWK	block work
BS	bath spout
BSN	basin
BWBP	brickwork bagged & painted
BWF	brickwork faced
COF	concrete- off form
CPS	concrete- polished & sealed
CST	concrete- steel trowel finish
CONC	concrete
COS	check on site
CCTV	closed circuit TV
CFC	compressed fibre cement
COL	column
CPD	cupboard
CPT	carpet
CR	cement render
CT	ceramic tile
CTP	cooktop
DH	double hung
DP	down pipe
DPC	damp proof course
DRY	dryer
DR	drawer
DW	dishwasher
EDB	electrical switch board
EQ	equal
EX	existing
F	fridge
FC	fibrous cement sheet
FCL	finished ceiling level
FFL	finished floor level
FGL	finished ground level
FP	fixed panel
FR	freezer
FS	fixed shelf
FW	floor waste
G	glass/ glazing
GBL	glass balustrade
GL	glass- louvre
GO	glass- obscure
GALV	galvanised
GD	grated drain
GPO	general purpose outlet
GU	gutter
HR	hanging rail
HT	hose tap
HTR	heated towel rail
HWU	hot water unit
LAM	laminate
LV	louvre
MB	metal balustrade
MDF	medium density fibreboard
MI	mirror
MPBR	membrane pebble ballast roof
MR	metal roof
MSB	main switch board
MS	metal sheeting
MT	mosaic tile
MW	microwave
MX	mixer
∅	diameter
OF	overflow
PAV	paving
PB	plasterboard
PBFR	plasterboard- fire resistant 90/90/90
PBM	plasterboard- moisture resistant
PLY	plywood
PNT	paint
PU	polyurethane
PV	photo voltaic
RA	return air
RH	range hood
RHS	rectangular hollow section
RL	reduced level
RWH	rainwater head
RWO	rainwater outlet
SD	smoke detector
SH	shutters
SHA	shutters automated
SH	shingles
SHR	shower
SK	skirting
SP	set plaster
SPM	set plaster moisture resistant
SS	stainless steel
ST	stone
STL	steel
SWP	sewer pipe
T	timber
TB	timber- battens
TF	timber- frame
TFB	timber- floorboards
THR	timber- handrail
TOF	top of fence
TOW	top of wall
TRH	toilet roll holder
TR	tiled roof
TRZO	terrazzo
TS	timber screen
U/S	underside
VB	vapour barrier
VN	veneer- timber
VP	vent pipe
WB	weatherboards
WC	water closet
WM	washing machine
WPM	water proof membrane

BASIX notes

NatHERS Thermal Comfort Inclusions

Floors
Minimum 150 mm concrete slab on ground, no insulation
Minimum 150 mm Concrete slab between levels, no insulation required where habitable rooms are above and below
External Walls
Cavity brick with AIR-CELL Permicav insulaton for a minimum Total system R-value of RT1.47
FC cladding on stud wall with R2.0 insulation (insulation only value)
150mm concrete wall to lift, no insulation required
Note: No insulation is required to external Garage walls
External Colour: Medium (0.475 < SA < 0.7)
Walls within dwellings
Single skin brick, no insulation between habitable rooms
Plasterboard on stud, no insulation required
R2.0 insulation only required to walls between garage and foyer.
Glazing Doors/Windows
Glazed windows and doors:
Group A – awning/bifold/casement windows/hinged glazed doors U-value: 4.30 (equal to or lower than) SHGC: 0.47 (±10%)
Group B – sliding doors/windows/fixed glazing/louvred windows U-value: 4.30 (equal to or lower than) SHGC: 0.53 (±10%)
Given values are AFRC total window system values (glass and frame)
Skylights
U-value: 4.2 and SHGC: 0.72
Roof and Ceilings
Concrete roof, with R1.8 insulation (insulation only value) where habitable rooms below
Plasterboard ceiling, no insulation required
No insulation to garage where roof above.
External Colour: Medium (0.475 < SA < 0.7)
Ceiling Penetrations
No downlights modelled
Sealed exhaust fans: ceiling penetration 250mm diameter with 50mm clearance
Once lighting plan has been developed NatHERS certificate can be updated to improve specification.
Floor coverings
Exposed concrete to garage, tiles to wet areas, carpet with rubber underlay to bedrooms and timber elsewhere
External Shading
Shading as per stamped drawings
Ventilation
All external doors have weather seals, all exhaust fans and chimneys have dampers, and down lights proposed will have capped fittings

BASIX Water Commitments

Fixtures
Install showerheads minimum rating of 4 stars – High flow (> 6 and <= 7.5 litres/min)
Install toilet flushing system with a minimum rating of 4 stars in each toilet
Install tap with a minimum rating of 6 stars in the kitchen
Install taps with a minimum rating of 6 stars in each bathroom
Alternative water
Install rainwater tank, minimum 5,000L capacity collected from min. 212mC roof area. Tank connected to – at least one outdoor tap, and toilets
Pool
Maximum 42.6 kL outdoor pool
Pool will have a cover

BASIX Energy Commitments

Hot water system
Electric Heat Pump – performance not specified
Cooling system
3-phase air-conditioning to living areas and bedrooms: EER 3.0-3.5
Heating system
Ground source heat pump (direct exchange): EER < 2.5
Ventilation
Bathrooms – individual fan, externally ducted to roof or façade, manual on/off switch
Kitchen – individual fan, externally ducted to roof or façade, manual on/off switch
Laundry – individual fan, externally ducted to roof or façade, manual on/off switch
Pool
Heating system - Solar (electric boosted)
Other
Induction cooktop & electric oven
Outdoor clothes drying line
Alternative energy
3.0kW solar Photovoltaic system

drawing list

No.	Drawing Name	Rev.
DA00	Cover Sheet	A
DA01	Site Analysis Plan	A
DA02	Excavation and Fill Plan	A
DA03	Roof & Site Plan	A
DA04	Level 1 Plan	A
DA05	Level 2 Plan	A
DA06	Level 3 Plan	A
DA07	Level 4 Plan	A
DA08	Level 5 Plan	A
DA09	North Elevation	A
DA10	East Elevation	A
DA11	South Elevation	A
DA12	West, North (Boatshed) & South (Boatshed) Elevations	A
DA13	Section AA	A
DA14	Section AA Boatshed	A
DA15	Section BB & CC	A
DA16	Area Calculations	A
DA17	Building Envelope Analysis	A
DA18	Building Height Analysis	A
DA19	Shadow Diagram 9am	A
DA20	Shadow Diagram 12pm	A
DA21	Shadow Diagram 3pm	A
DA22	Sun Path Diagram 9am	A
DA23	Sun Path Diagram 12pm	A
DA24	Sun Path Diagram 3pm	A
DA25	Finishes	A
DA26	Perspectives	A

Development Application

MacDiarmid House Avalon

at

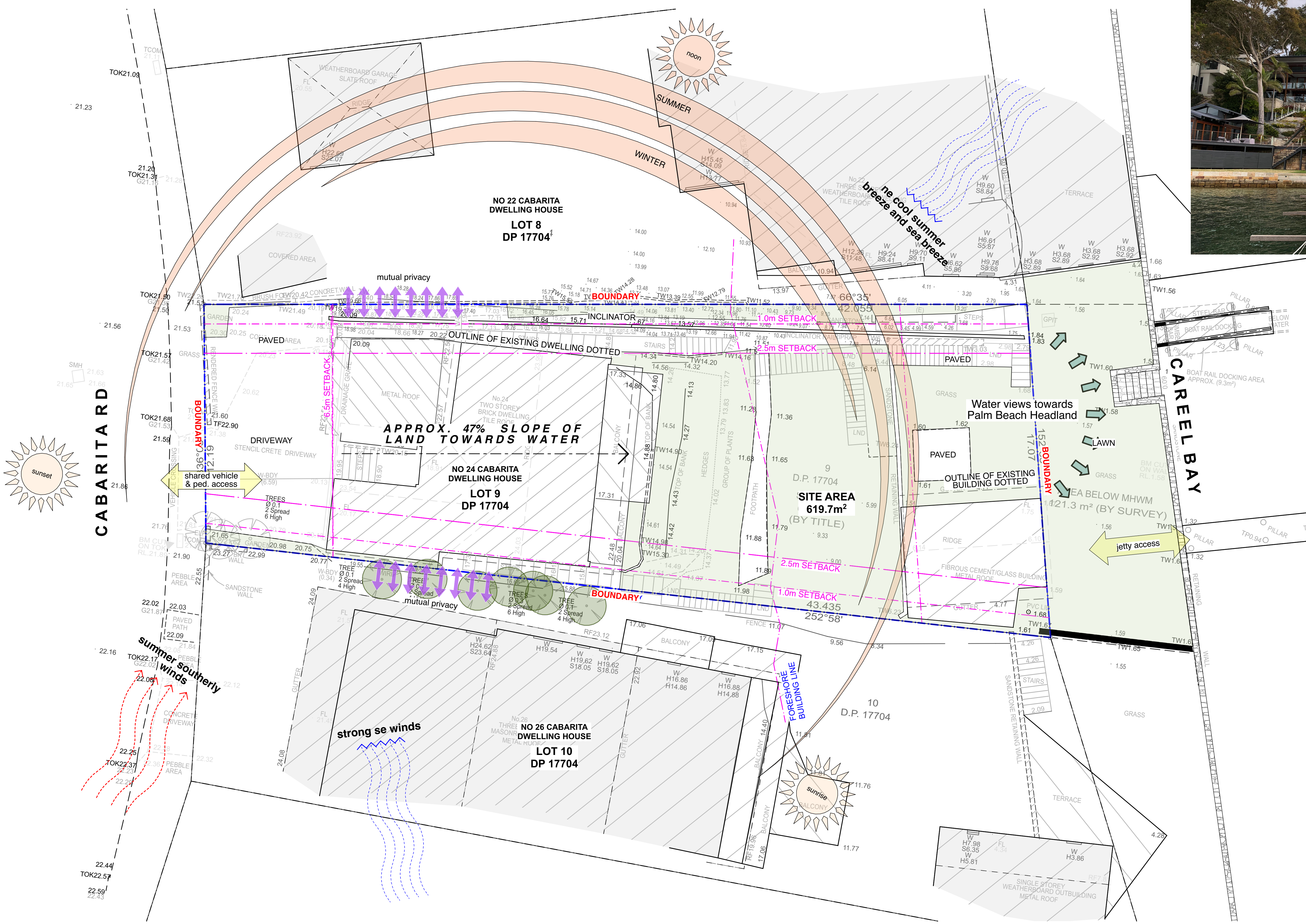
24 Cabarita Road, Avalon

for

Bruce & Libby MacDiarmid

CORBEN ARCHITECTS
PO Box 1021 Neutral Bay NSW 2089 Australia
02 9904 1844
mail@corben.com.au
corben.com.au
Nominated Architect: Philip Corben (Reg. No. 4616)

job no.	MACA	dwg no.	DA00
drawn	RV		
checked	MC	revision	A
scale			



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A	12/12/22	DA Issue

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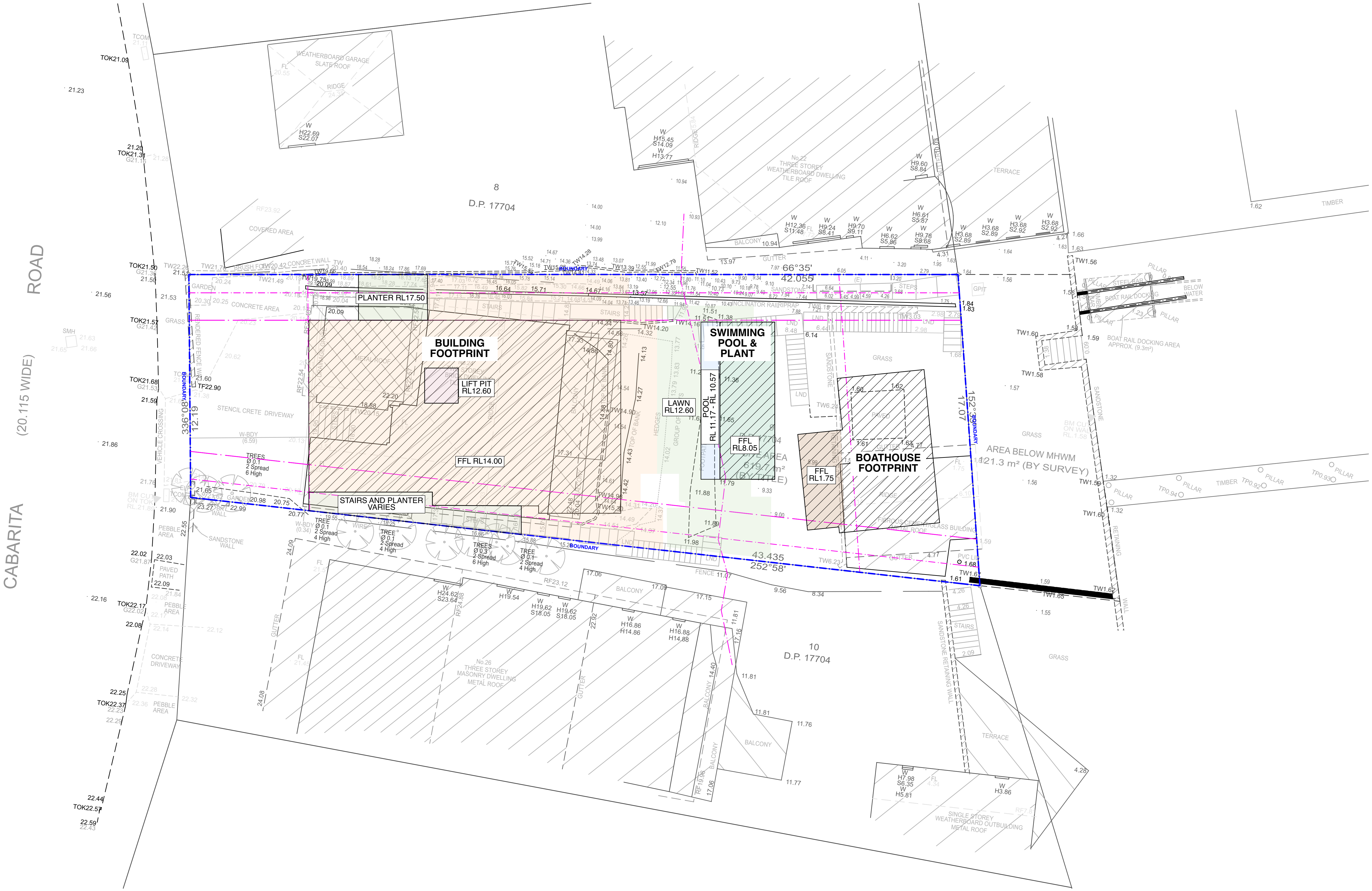
CORBEN ARCHITECTS
PO Box 1021 Neutral Bay NSW 2089 Australia
02 9904 1844
mail@corben.com.au
corben.com.au
Nominated Architect: Philip Corben (Reg. No. 4616)

project	MacDiarmid House Avalon	title	Site Analysis Plan	job no.	MACA
address	24 Cabarita Road Avalon NSW			drawn	RV
				checked	MC
client	Bruce & Libby MacDiarmid	issue	Development Application	scale	1:200

dwg no. DA01

revision A



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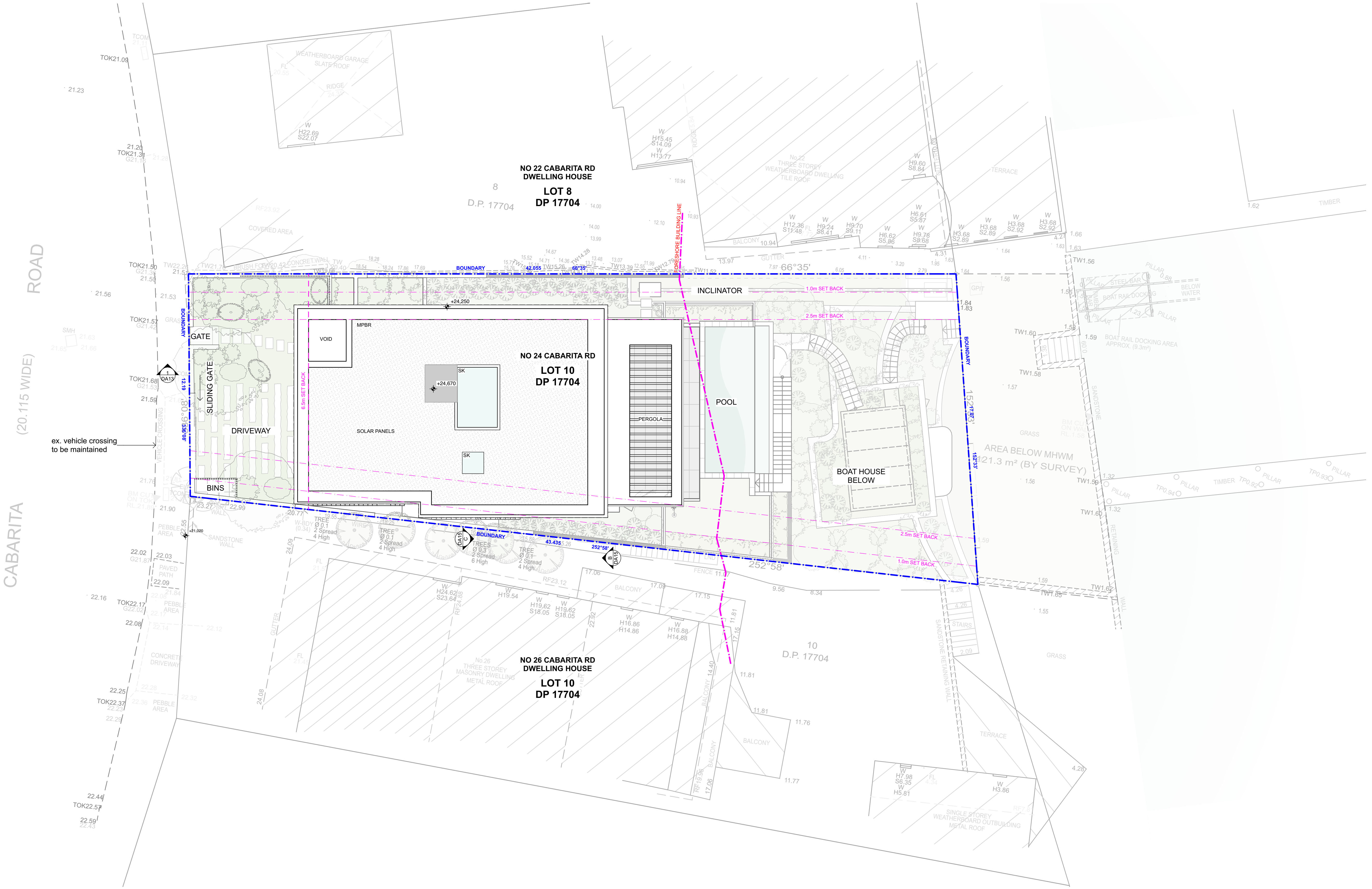
CORBEN ARCHITECTS

PO Box 1021 Neutral Bay NSW 2089 Australia
02 9904 1844
mail@corben.com.au
corben.com.au
Nominated Architect: Philip Corben (Reg. No. 4616)

project	MacDiarmid House Avalon	**title**	Excavation and Fill Plan	**job no.**	MACA
address	24 Cabarita Road Avalon NSW			**drawn**	RV
				checked	MC
client	Bruce & Libby MacDiarmid	**issue**	Development Application	**scale**	1:200

dwg no. DA02

revision A



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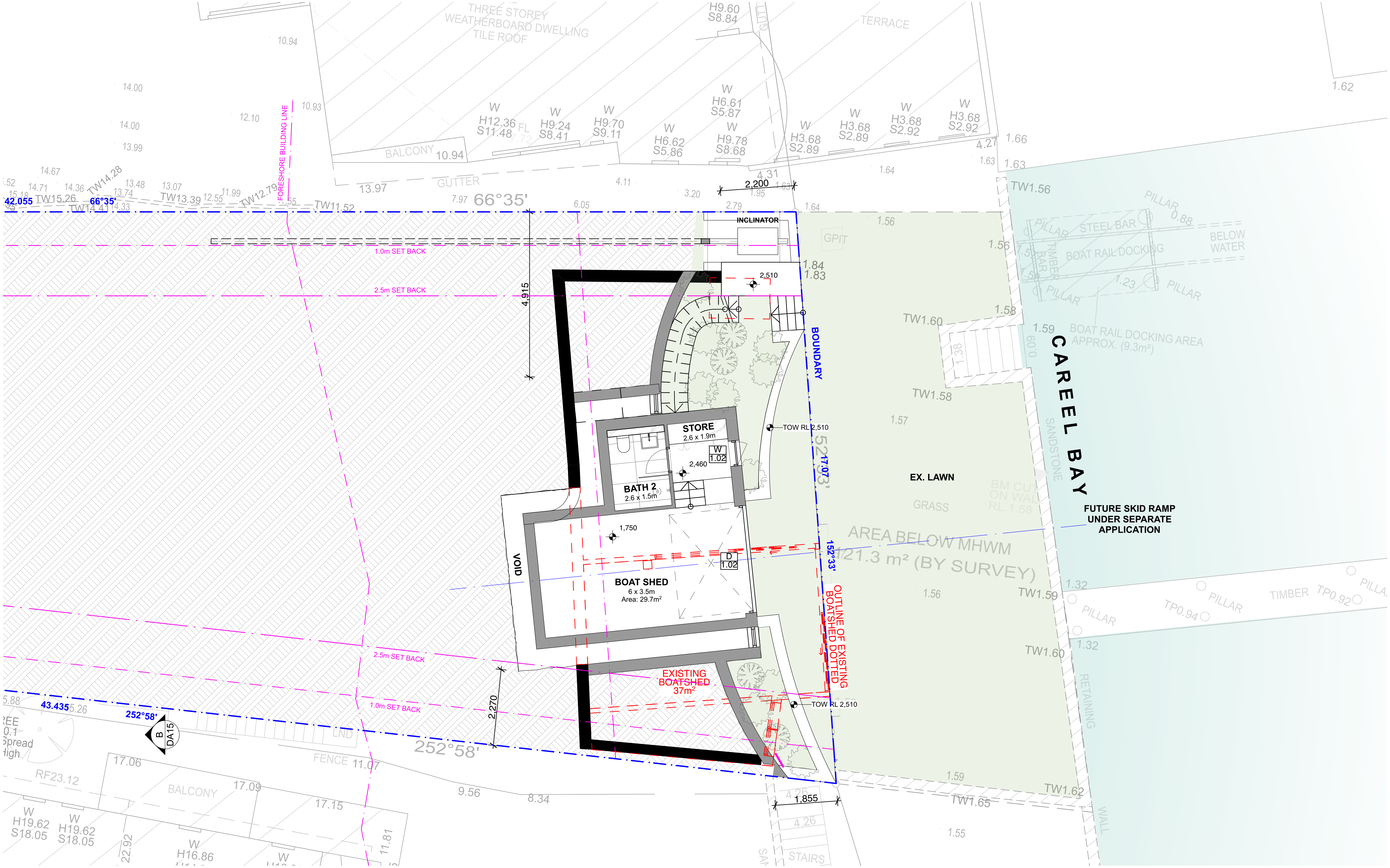
CORBEN ARCHITECTS

PO Box 1021 Neutral Bay NSW 2089 Australia
02 9904 1844
mail@corben.com.au
corben.com.au

Nominated Architect: Philip Corben (Reg. No. 4616)

project	MacDiarmid House Avalon	**title**	Roof & Site Plan
address	24 Cabarita Road Avalon NSW		
client	Bruce & Libby MacDiarmid	**issue**	Development Application

job no.	MACA
drawn	RV
checked	MC
scale	1:200
dwg no.	DA03
revision	A



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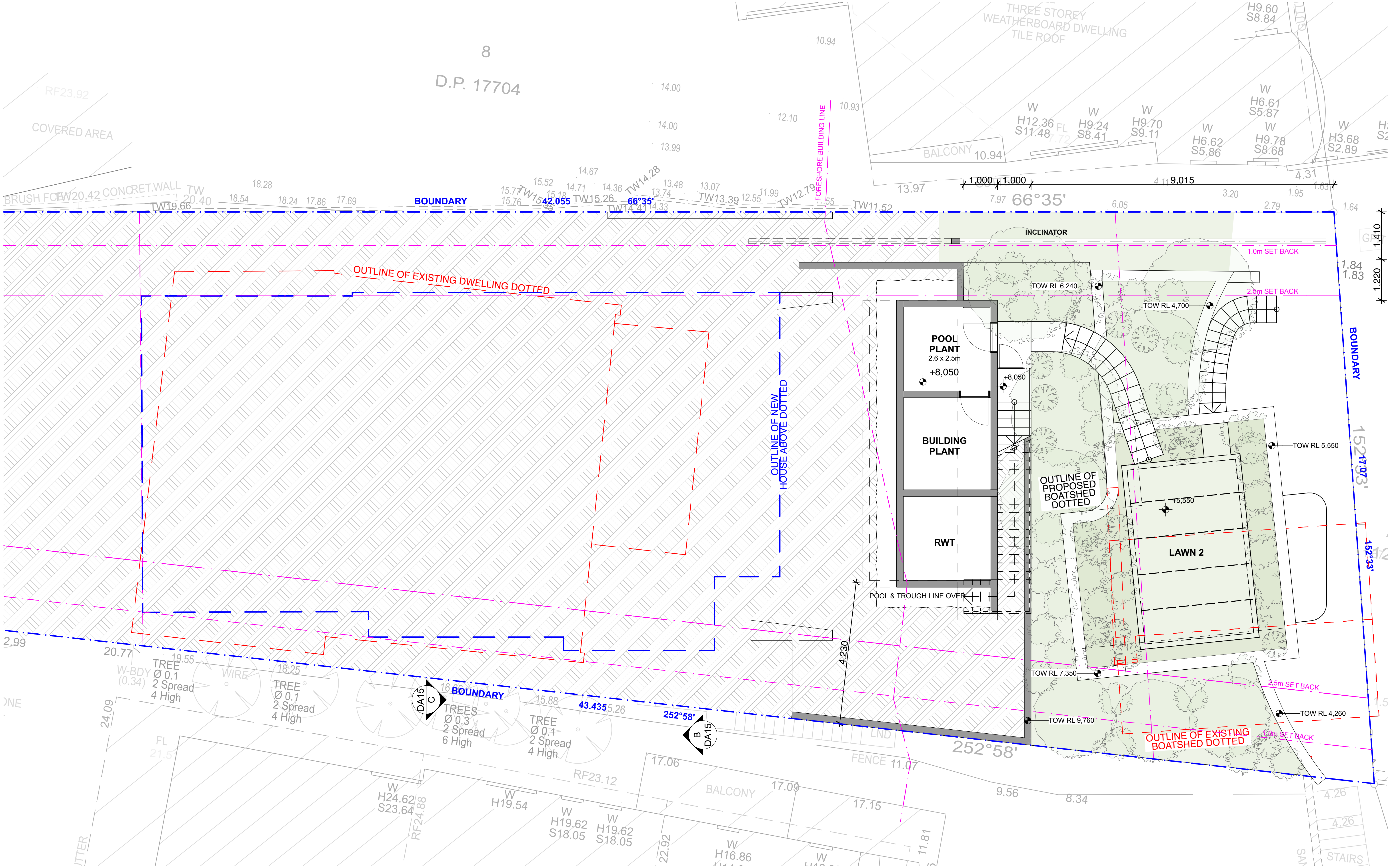
CORBEN ARCHITECTS

PO Box 1021 Neutral Bay NSW 2089 Australia
02 9904 1844
mail@corben.com.au
corben.com.au

Nominated Architect: Philip Corben (Reg. No. 4616)

project	MacDiarmid House Avalon	**title**	Level 1 Plan	**job no.**	MACA	**dwg no.**	DA04
address	24 Cabarita Road Avalon NSW			**drawn**	RV		
				checked	MC	**revision**	A
client	Bruce & Libby MacDiarmid	**issue**	Development Application	**scale**	1:100		



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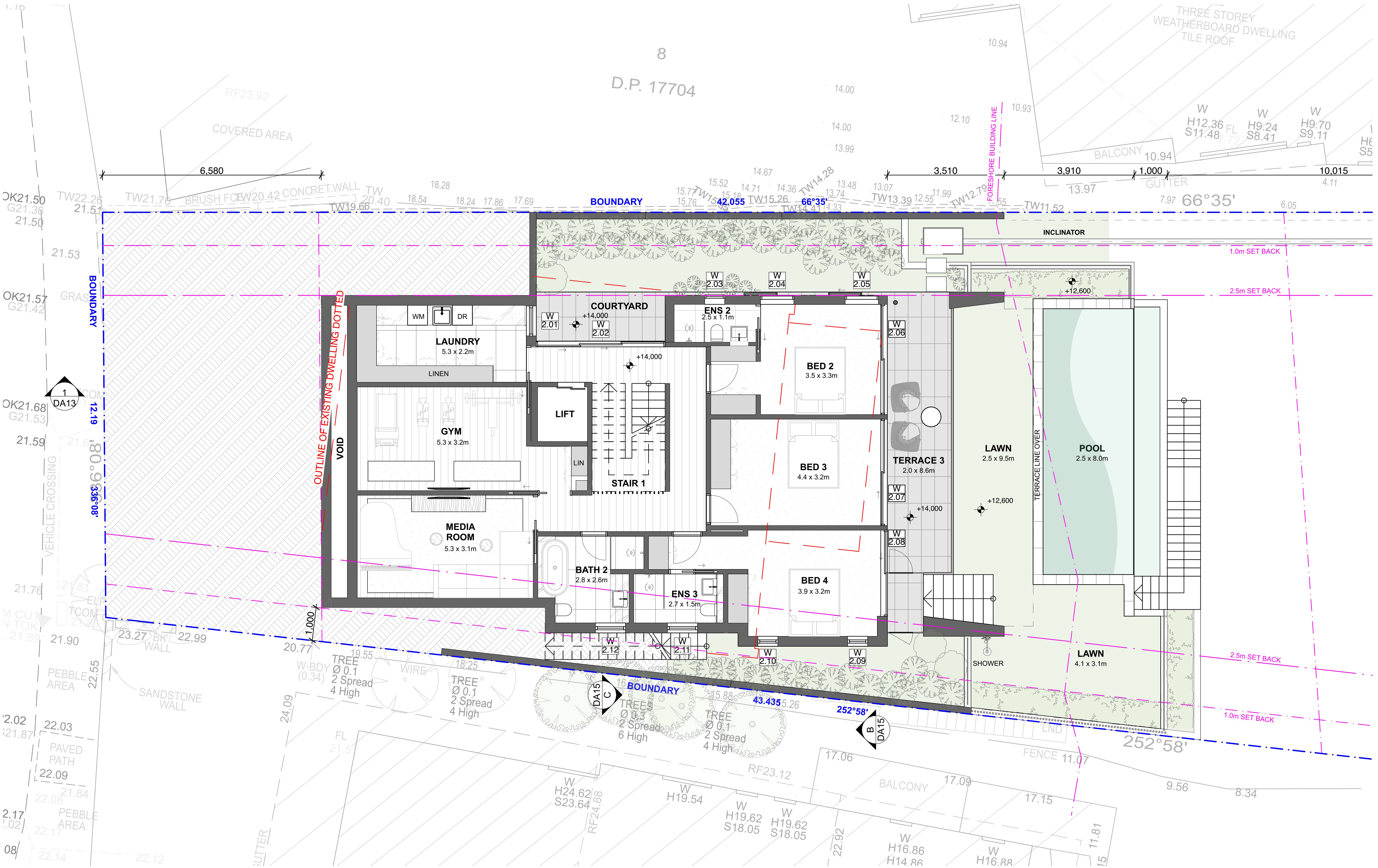
CORBEN
ARCHITECTS

PO Box 1021 Neutral Bay NSW 2089 Australia
02 9904 1844
mail@corben.com.au
corben.com.au

Nominated Architect: Philip Corben (Reg. No. 4616)

project	MacDiarmid House Avalon
address	24 Cabarita Road Avalon NSW
client	Bruce & Libby MacDiarmid
title	Level 2 Plan
issue	Development Application
job no.	MACA
drawn	RV
checked	MC
scale	1:100
dwg no.	DA05
revision	A



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CORBEN ARCHITECTS

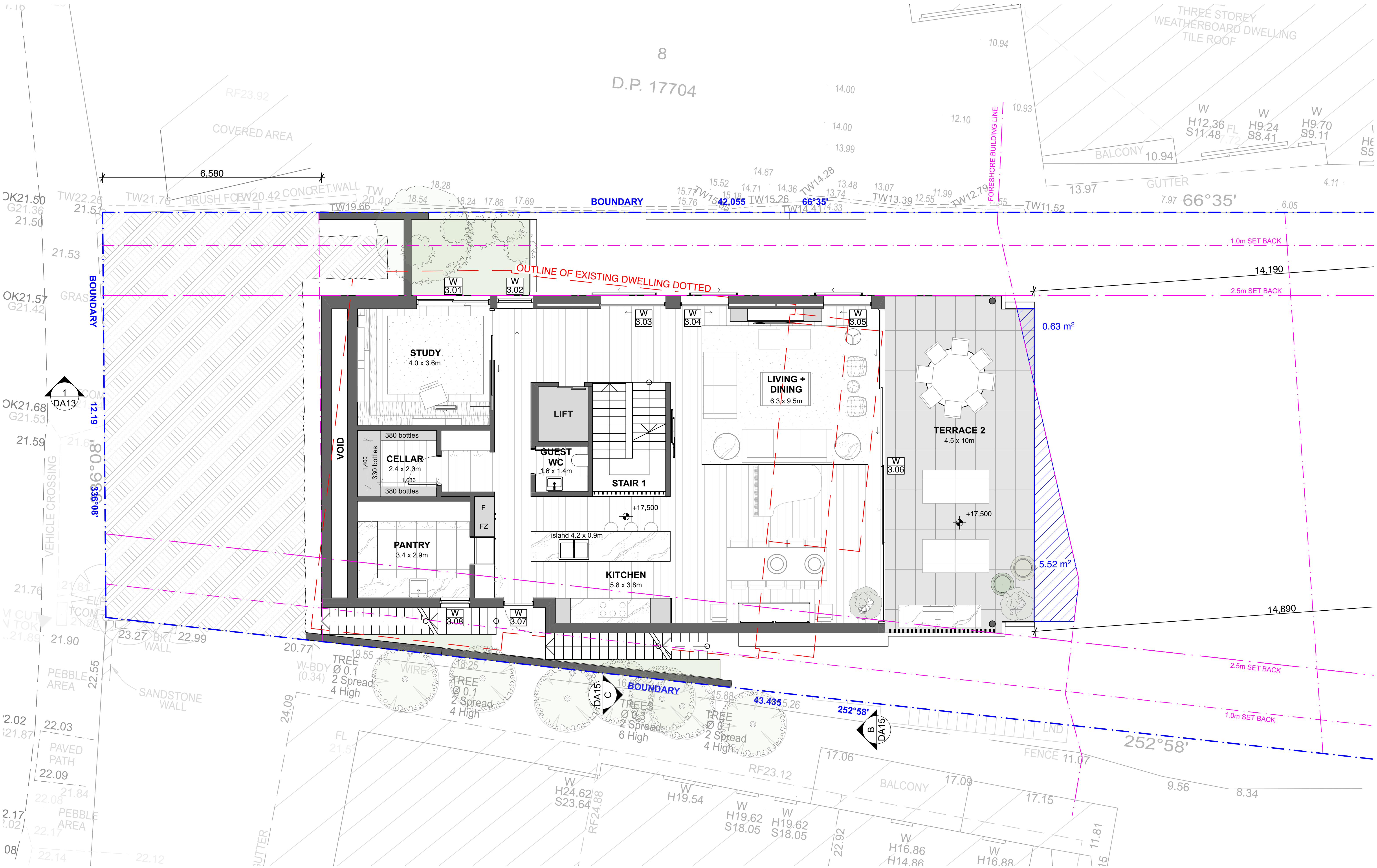
PO Box 1021 Neutral Bay NSW 2089 Australia
02 9904 1844
mail@corben.com.au
corben.com.au

Nominated Architect: Philip Corben (Reg. No. 4616)

project	MacDiarmid House Avalon	title	Level 3 Plan	job no.	MACA
address	24 Cabarita Road Avalon NSW			drawn	RV
				checked	MC
client	Bruce & Libby MacDiarmid	issue	Development Application	scale	1:100

dwg no. DA06

revision A



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notes

CORBEN ARCHITECTS

PO Box 1021 Neutral Bay NSW 2089 Australia
02 9904 1844
mail@corben.com.au
corben.com.au

Nominated Architect: Philip Corben (Reg. No. 4616)

project MacDiarmid House Avalon

address 24 Cabarita Road Avalon NSW

client Bruce & Libby MacDiarmid

title Level 4 Plan

issue Development Application

job no. MACA

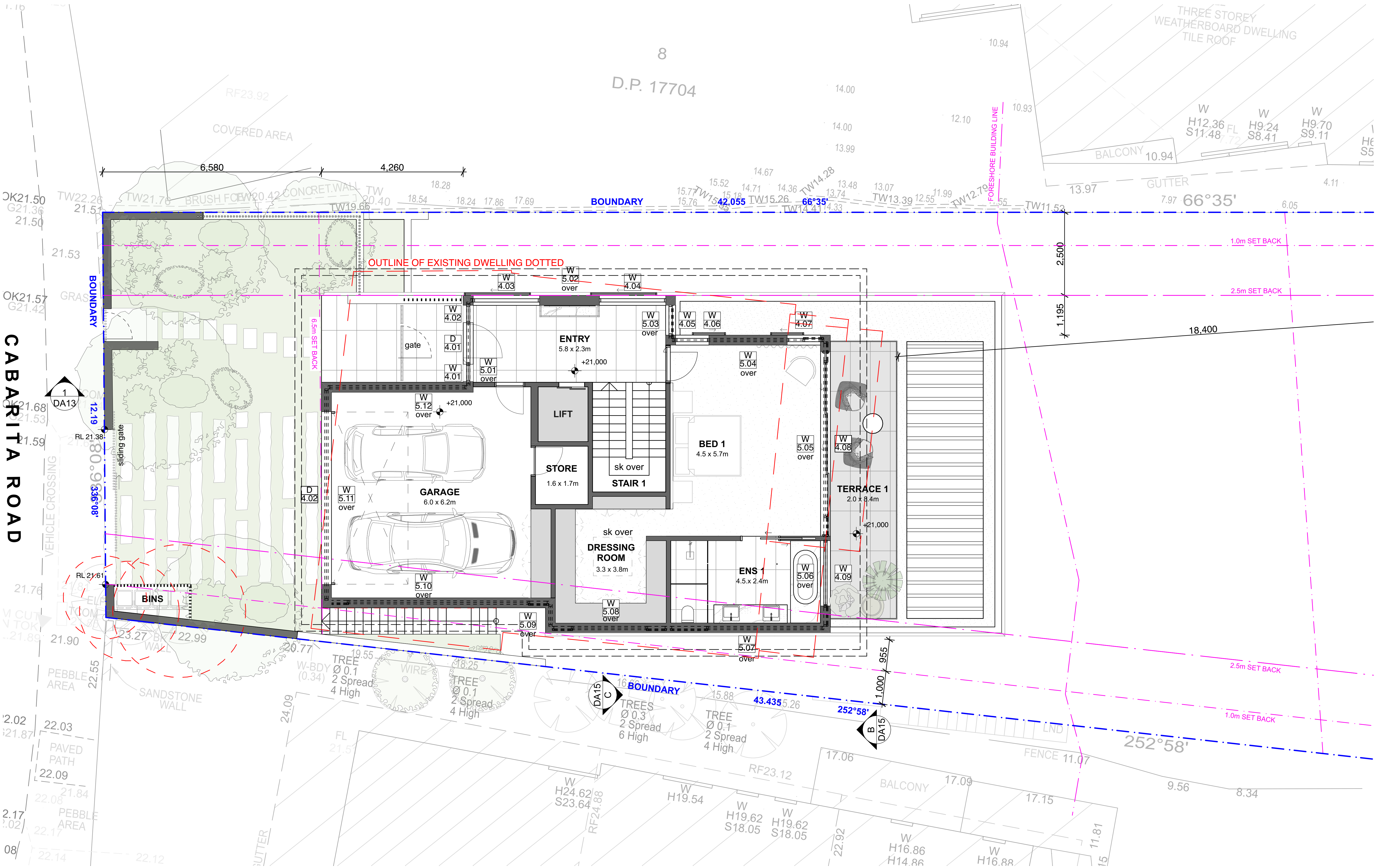
drawn RV

checked MC

scale 1:100

dwg no. DA07

revision A



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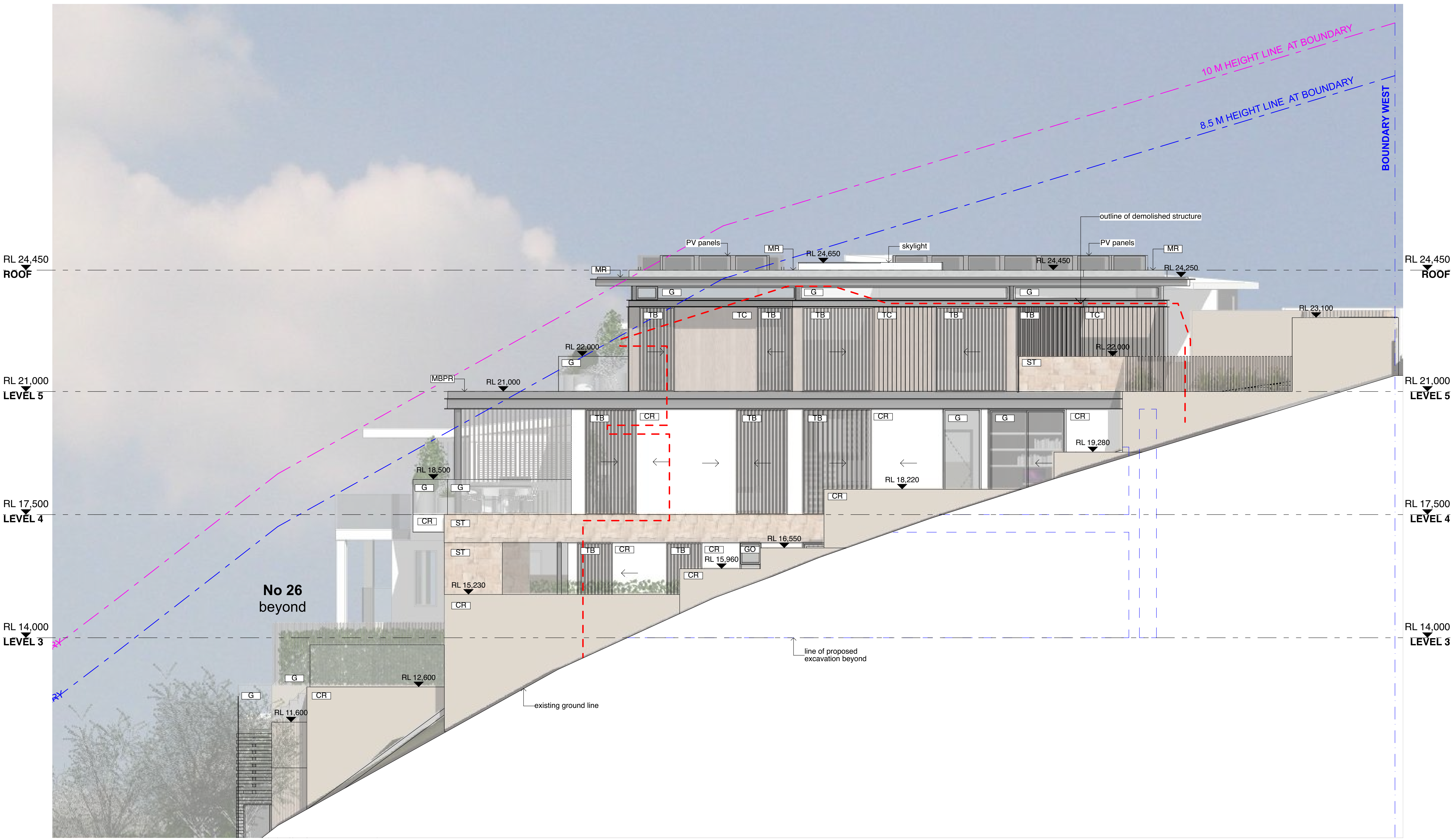
PO Box 1021 Neutral Bay NSW 2089 Australia
02 9904 1844
mail@corben.com.au
corben.com.au
Nominated Architect: Philip Corben (Reg. No. 4616)

project	MacDiarmid House Avalon	**title**	Level 5 Plan	**job no.**	MACA	**dwg no.**	DA08
address	24 Cabarita Road Avalon NSW			**drawn**	RV	**revision**	A
				checked	MC		
client	Bruce & Libby MacDiarmid	**issue**	Development Application	**scale**	1:100		



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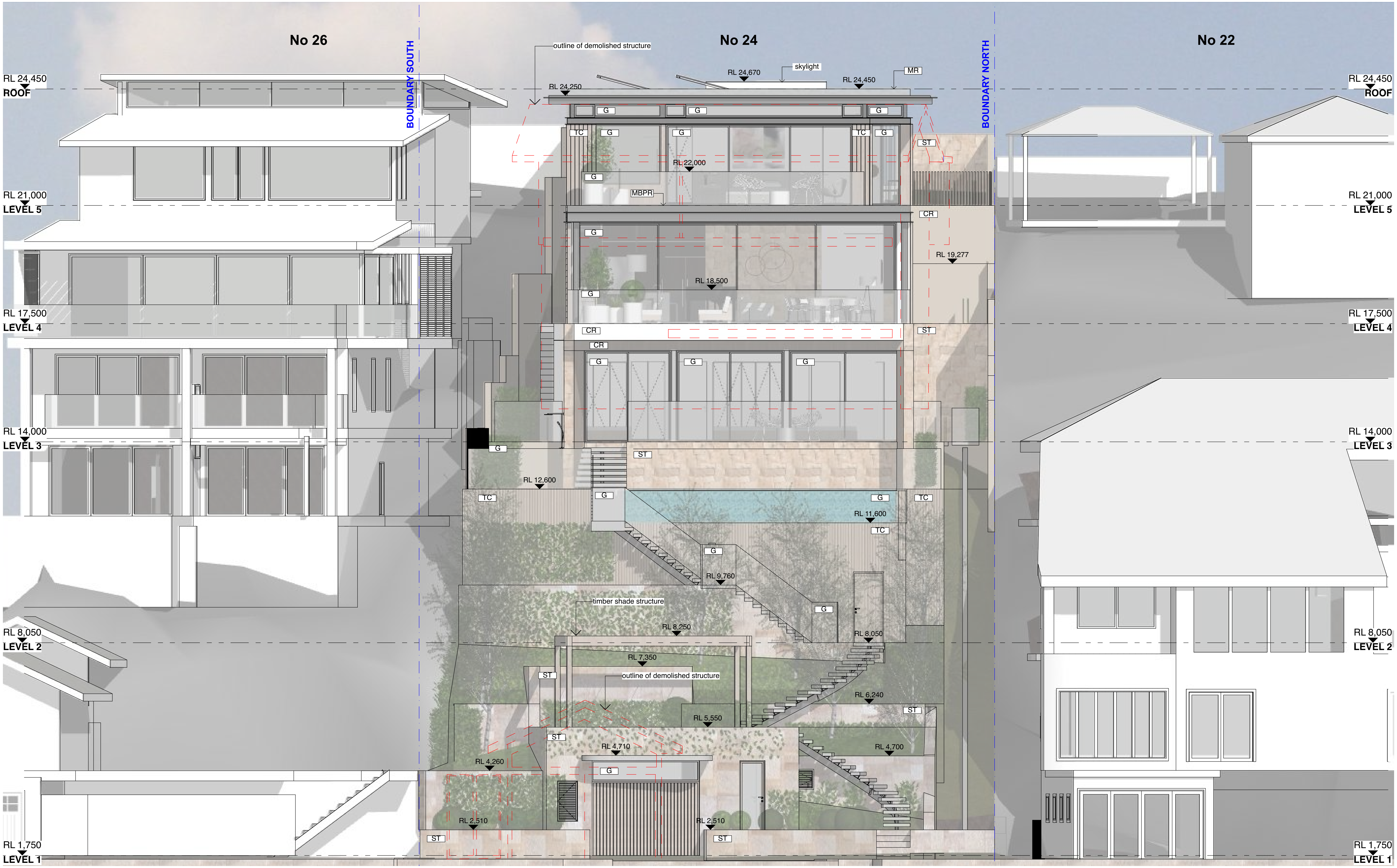
mail@corben.com.au
corben.com.au

Nominated Architect: Philip Corben (Reg. No. 4616)

project	MacDiarmid House Avalon	**title**	North Elevation
address	24 Cabarita Road Avalon NSW		
client	Bruce & Libby MacDiarmid	**issue**	Development Application

job no.	MACA
drawn	RV
checked	MC
scale	1:100
dwg no.	DA09
revision	A



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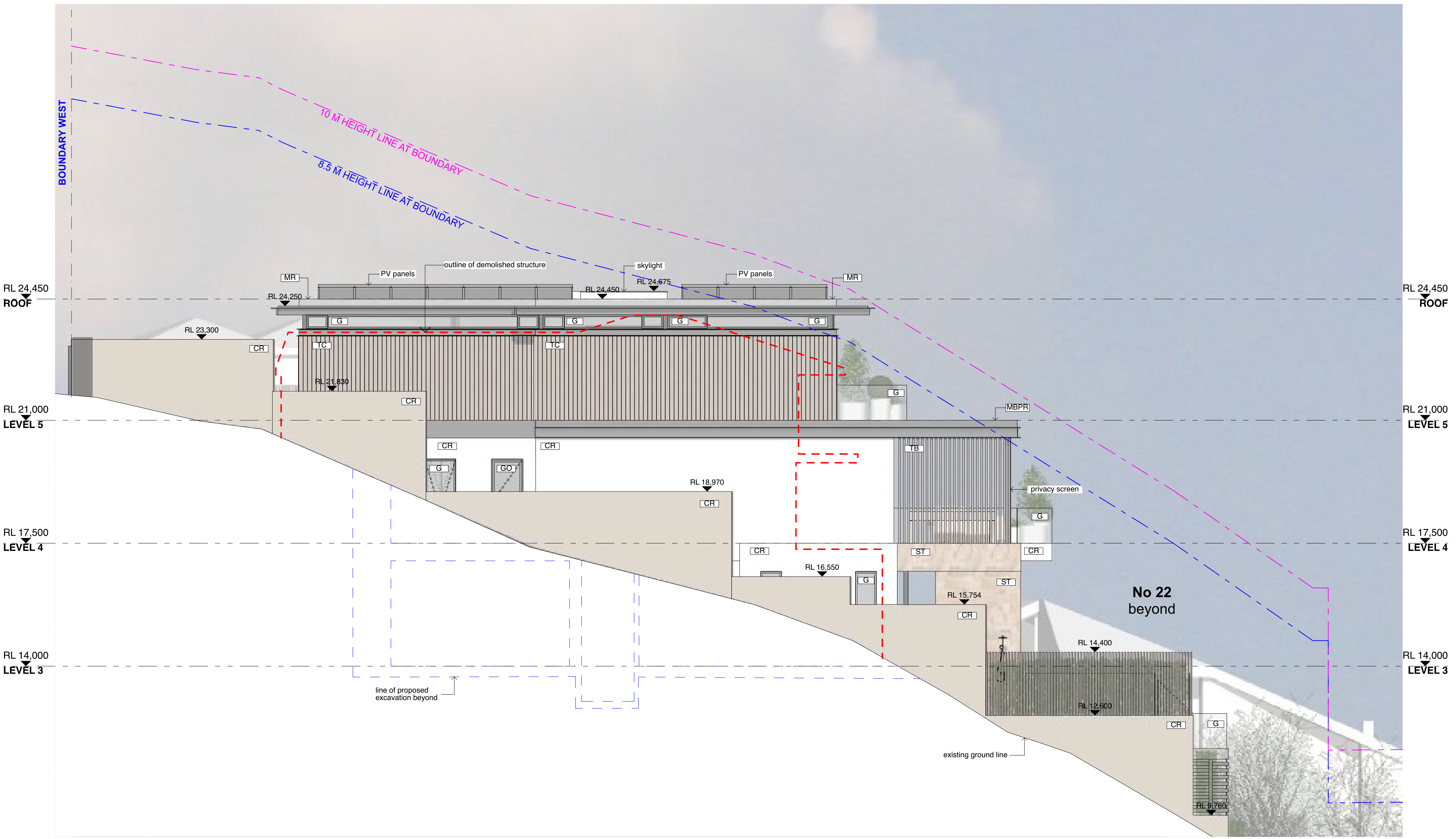
02 9904 1844
mail@corben.com.au
corben.com.au

Nominated Architect: Philip Corben (Reg. No. 4616)

project	MacDiarmid House Avalon	**title**	East Elevation	**job no.**	MACA
address	24 Cabarita Road Avalon NSW			**drawn**	RV
				checked	MC
client	Bruce & Libby MacDiarmid	**issue**	Development Application	**scale**	1:100

dwg no. DA10

revision A



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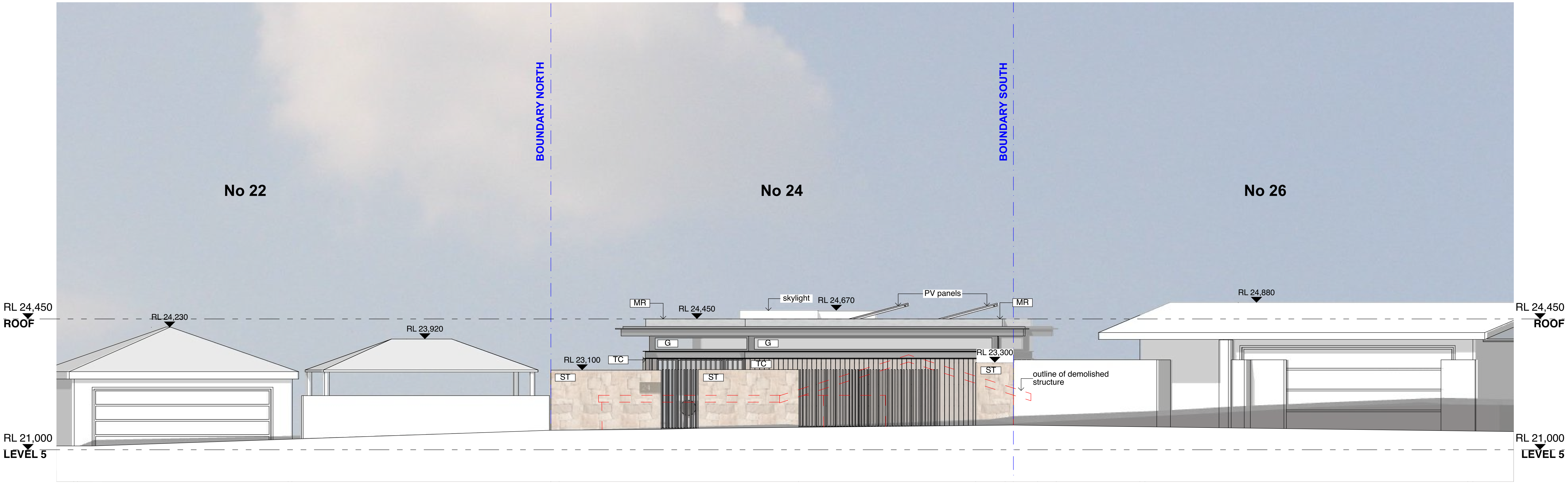
PO Box 1021 Neutral Bay NSW 2089 Australia
02 9904 1844
mail@corben.com.au
corben.com.au

Nominated Architect: Philip Corben (Reg. No. 4616)

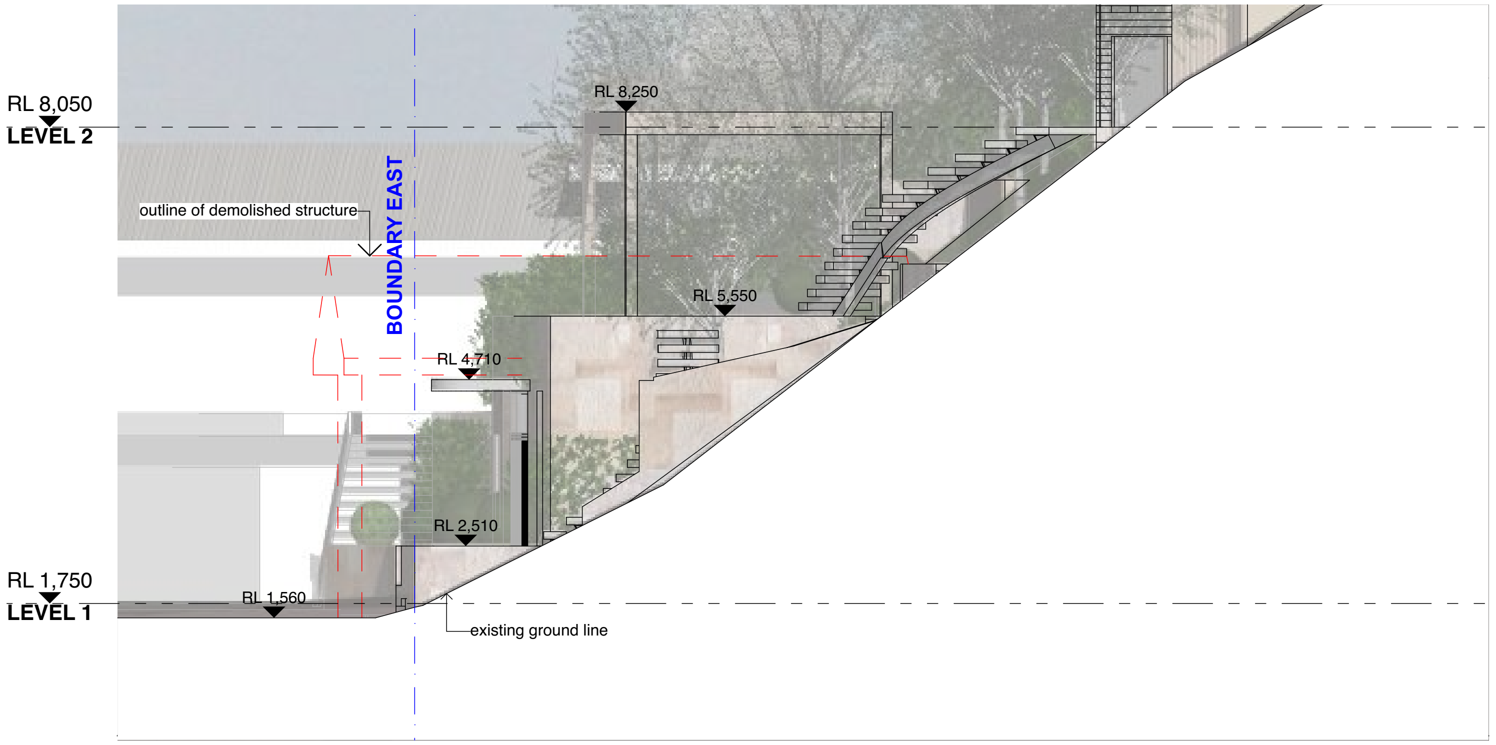
project	MacDiarmid House Avalon	**title**	South Elevation	**job no.**	MACA
address	24 Cabarita Road Avalon NSW			**drawn**	RV
				checked	MC
client	Bruce & Libby MacDiarmid	**issue**	Development Application	**scale**	1:100

dwg no. DA11

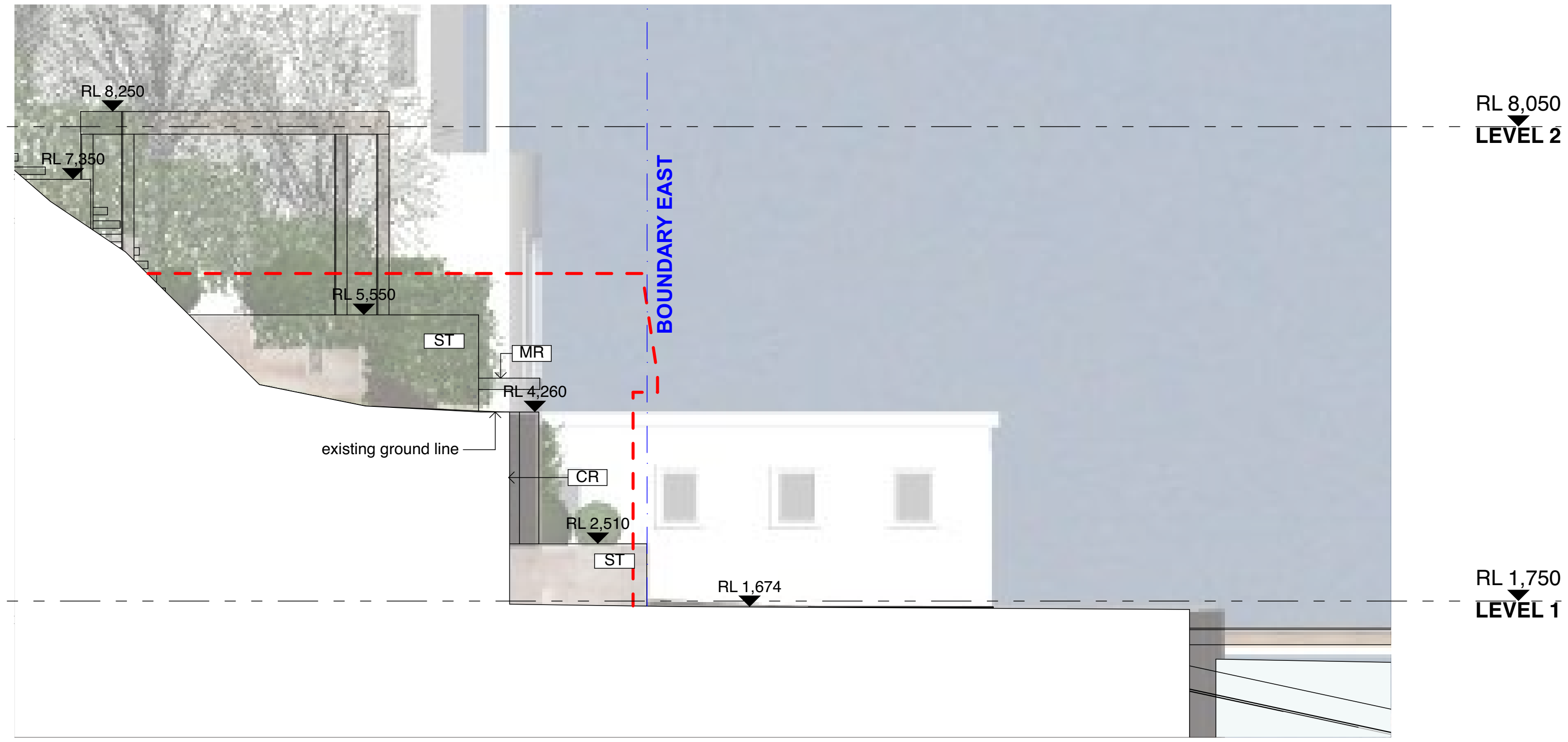
revision A



W West Elevation



N North Elevation - Boatshed



S South Elevation - Boatshed

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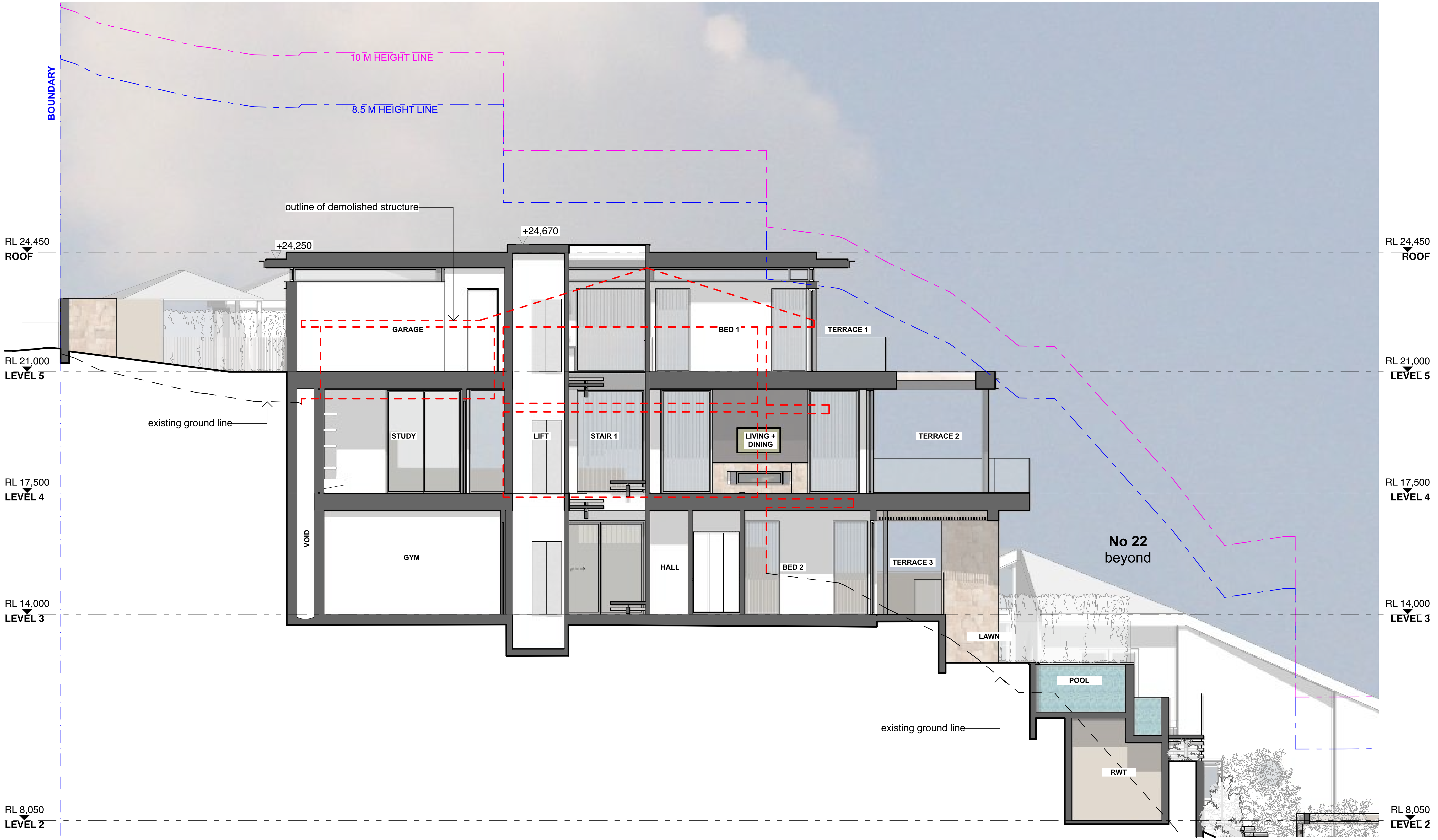
PO Box 1021 Neutral Bay NSW 2089 Australia
02 9904 1844
mail@corben.com.au
corben.com.au

Nominated Architect: Philip Corben (Reg. No. 4616)

project	MacDiarmid House Avalon
address	24 Cabarita Road Avalon NSW
client	Bruce & Libby MacDiarmid
title	West, North (Boatshed) & South (Boatshed) Elevations
issue	Development Application
job no.	MACA
drawn	RV
checked	MC
scale	1:100
dwg no.	DA12
revision	A



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02 9904 1844
mail@corben.com.au
corben.com.au

Nominated Architect: Philip Corben (Reg. No. 4616)

project MacDiarmid House Avalon

address 24 Cabarita Road Avalon NSW

client Bruce & Libby MacDiarmid

title Section AA

issue Development Application

job no. MACA

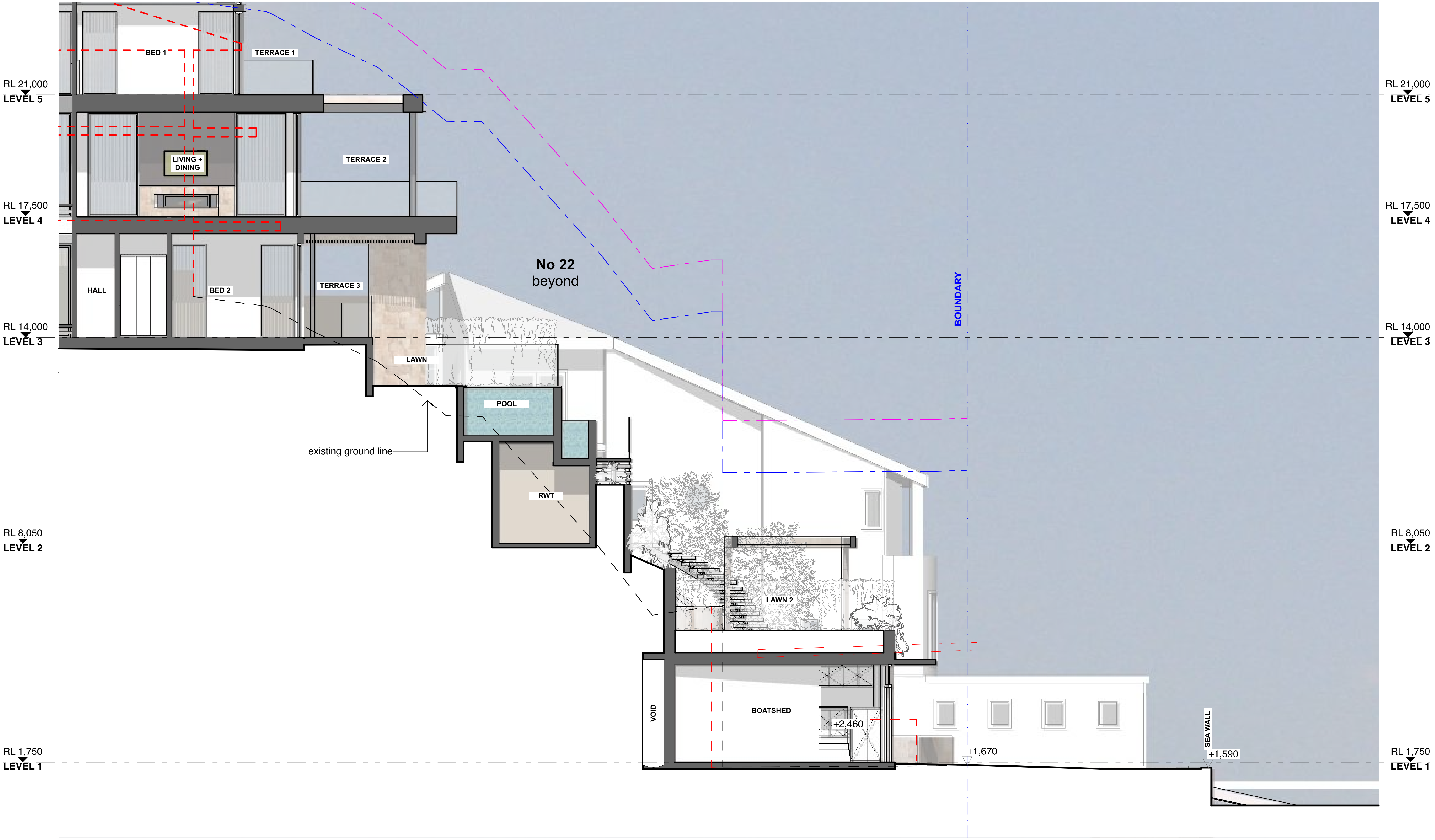
drawn RV

checked MC

scale 1:100

dwg no. DA13

revision A



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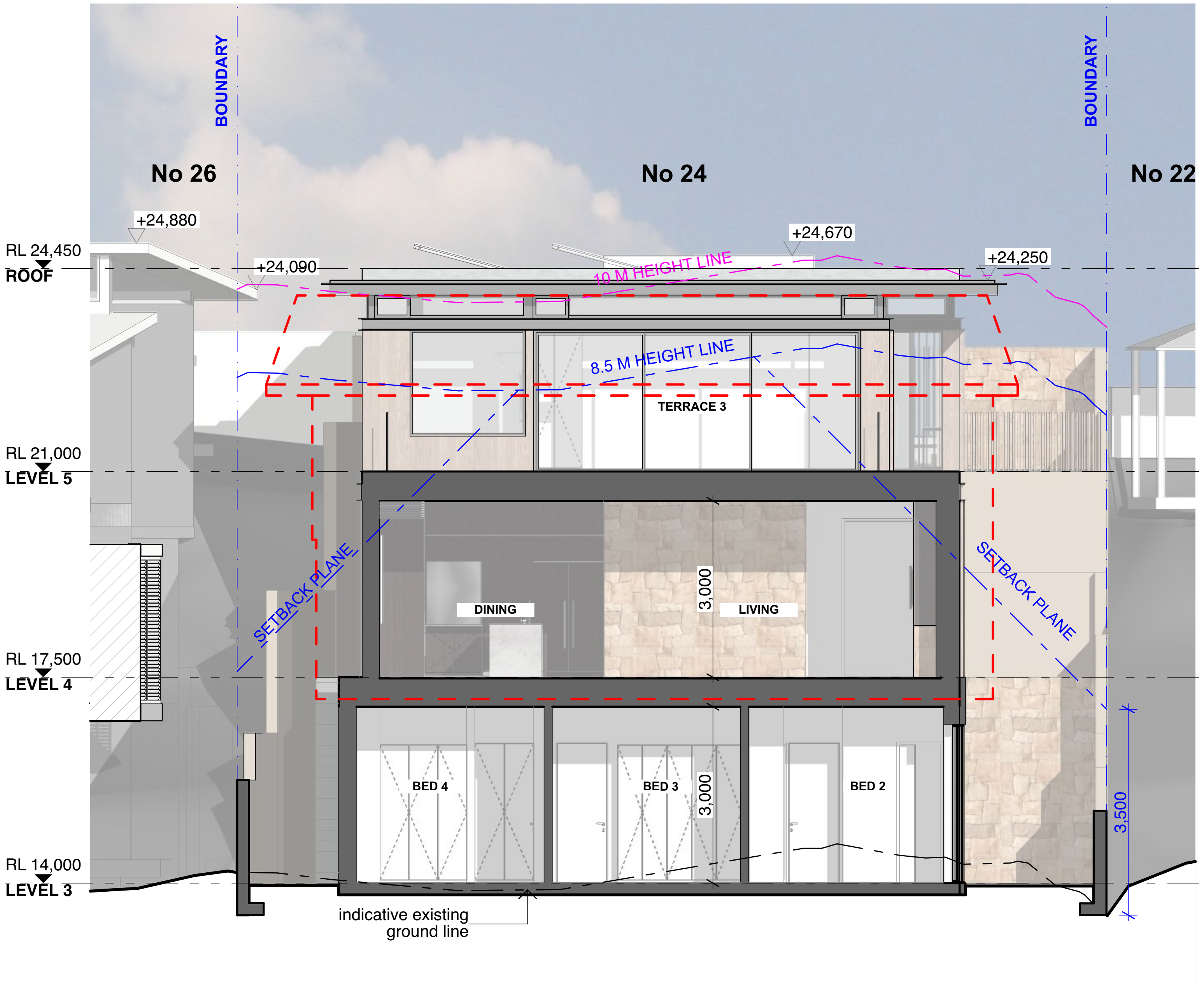
corben.com.au

Nominated Architect: Philip Corben (Reg. No. 4616)

project	MacDiarmid House Avalon	**title**	Section AA Boatshed	**job no.**	MACA	**dwg no.**	DA14
address	24 Cabarita Road Avalon NSW			**drawn**	RV		
				checked	MC	**revision**	A
client	Bruce & Libby MacDiarmid	**issue**	Development Application	**scale**	1:100		



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Section BB
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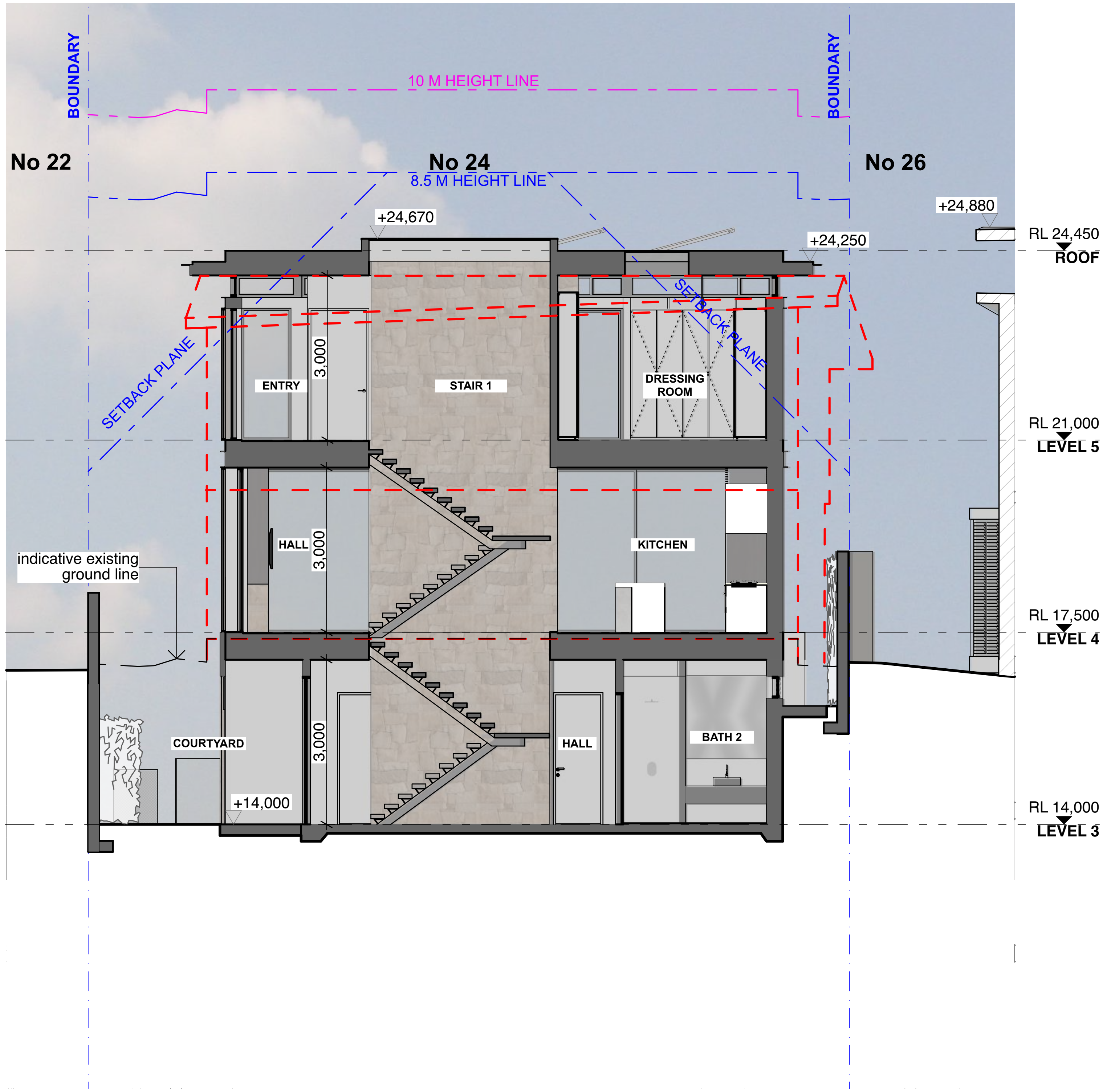

C
Section CC
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PO Box 1021 Neutral Bay NSW 2089 Australia
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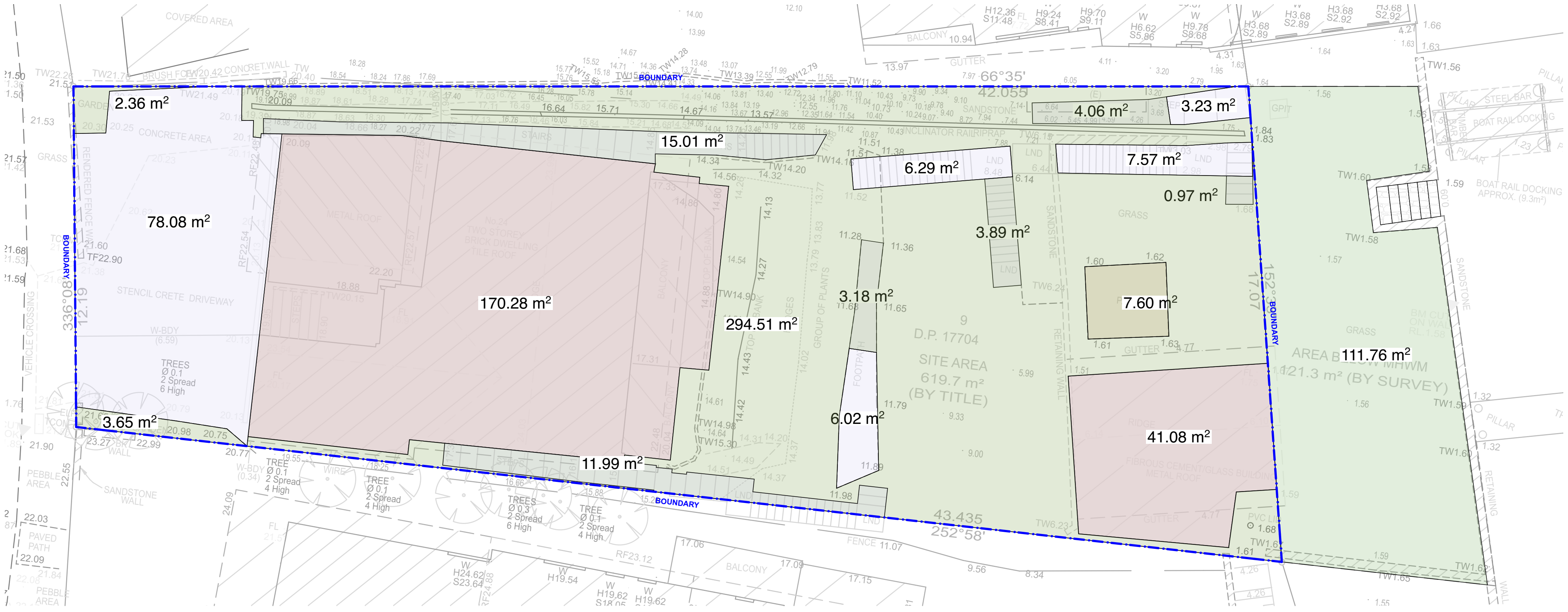
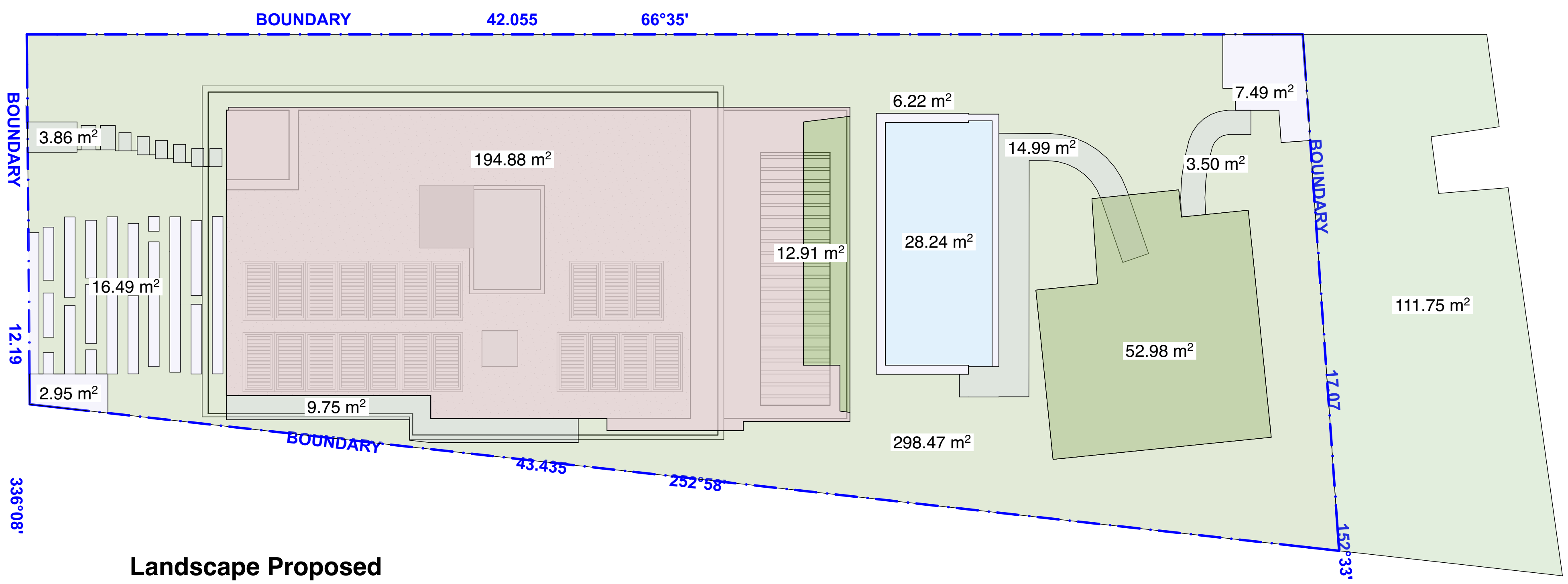
mail@corben.com.au
corben.com.au

Nominated Architect: Philip Corben (Reg. No. 4616)

project	MacDiarmid House Avalon	**title**	Section BB & CC	**job no.**	MACA	**dwg no.**	DA15
address	24 Cabarita Road Avalon NSW			**drawn**	RV		
				checked	MC	**revision**	A
client	Bruce & Libby MacDiarmid	**issue**	Development Application	**scale**	1:100		



Landscape Existing



Landscape Proposed

CALCULATIONS

Site Area	619.7 m²	
Foreshore Area	111.8 m²	
LANDSCAPE AREA		
Required (minimum)	371.8 m²	60%
Existing	300.5 m²	48%
Proposed	**298.5 m²**	**48%**
LANDSCAPE AREA INCLUSIONS		
Permissible Impervious Rec. Area	37.2 m²	6%
Existing	7.6 m²	1%
Proposed	**0 m²**	**0%**
Impervious areas <1m width	no maximum control	
Existing	39.1 m²	6%
Proposed	**32.1 m²**	**5%**
ADDITIONAL LANDSCAPING (NOT INCLUDED ABOVE)		
Landscape area above/below structure (300mm soil depth min)		
Existing	0 m²	0%
Proposed	**65.9 m²**	**11%**
Landscaped foreshore area	111.8 m²	
TOTAL LANDSCAPING		
Existing	412.3 m²	56%
Proposed	**476.2m²**	**65%**

KEY

- Landscape Area
- Impervious Recreational Area
- Impervious Area <1m
- Impervious Area
- Building Footprint
- Pool Surface
- Landscape Area above/below structure
- Foreshore Area

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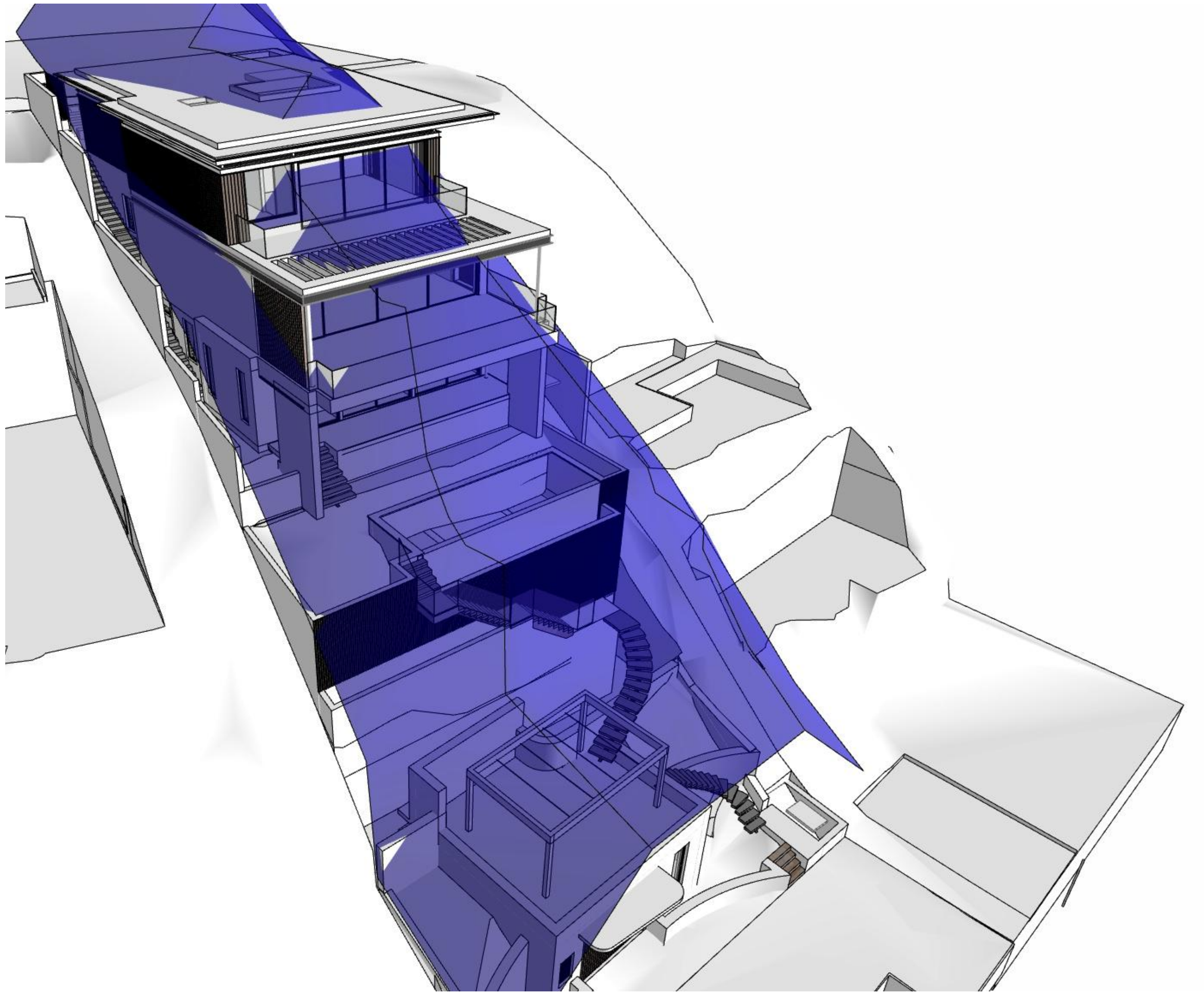
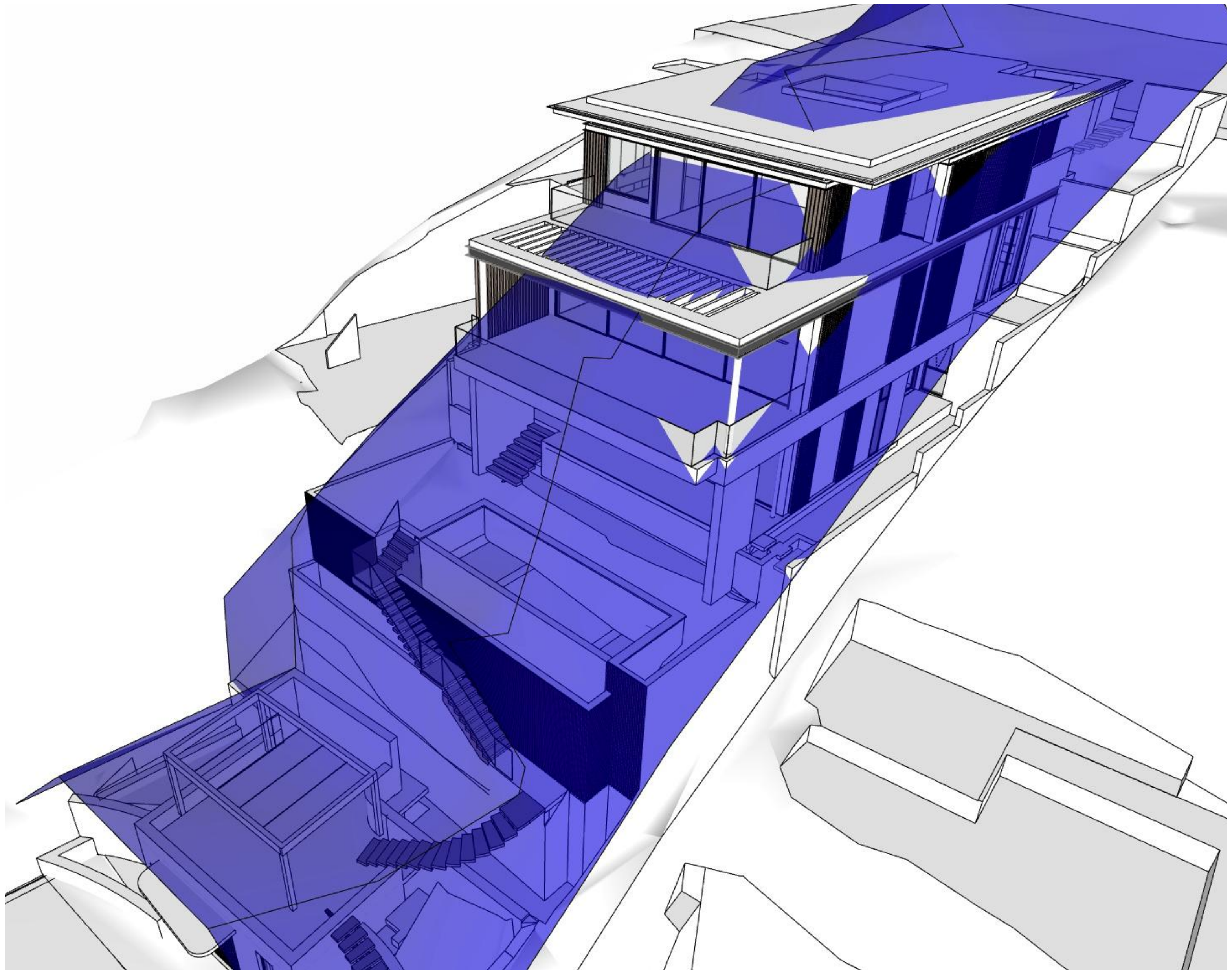
CORBEN ARCHITECTS

PO Box 1021 Neutral Bay NSW 2089 Australia
02 9904 1844
mail@corben.com.au
corben.com.au

Nominated Architect: Philip Corben (Reg. No. 4616)

project	MacDiarmid House Avalon	**title**	Area Calculations	**job no.**	MACA	**dwg no.** DA16
address	24 Cabarita Road Avalon NSW			**drawn**	RV	
				checked	MC	**revision** A
client	Bruce & Libby MacDiarmid	**issue**	Development Application	**scale**	1:200	





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PO Box 1021 Neutral Bay NSW 2089 Australia
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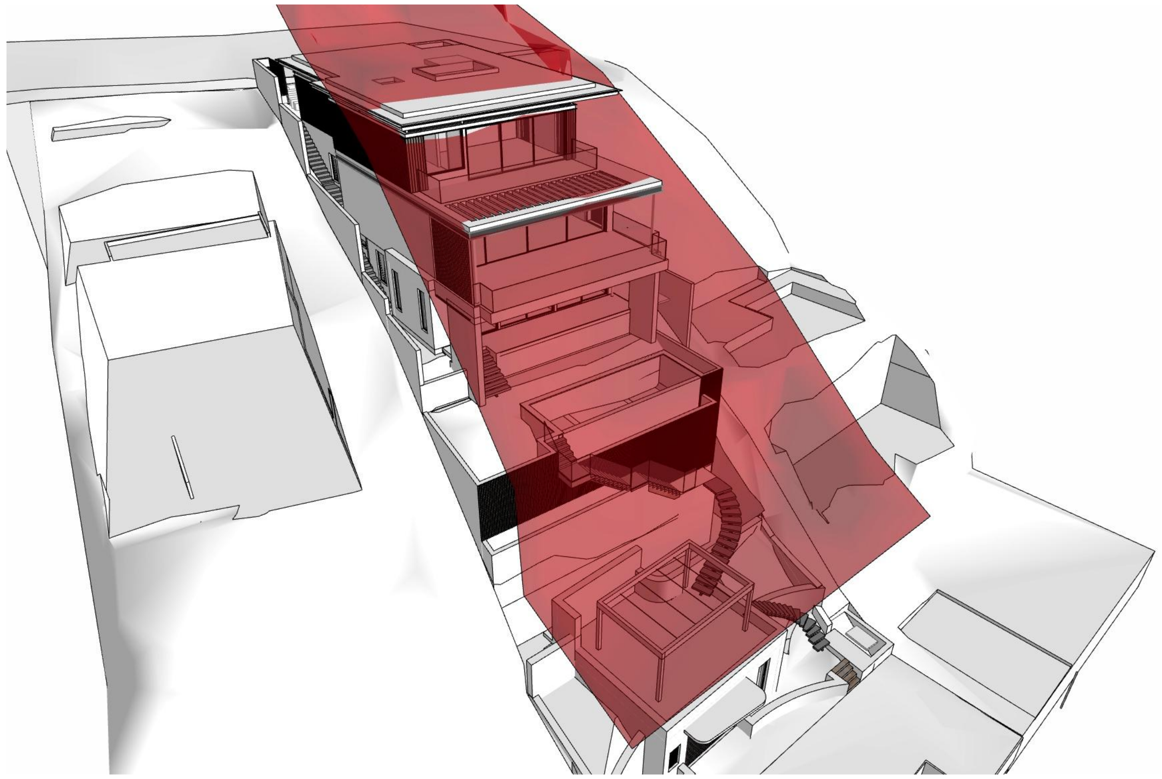
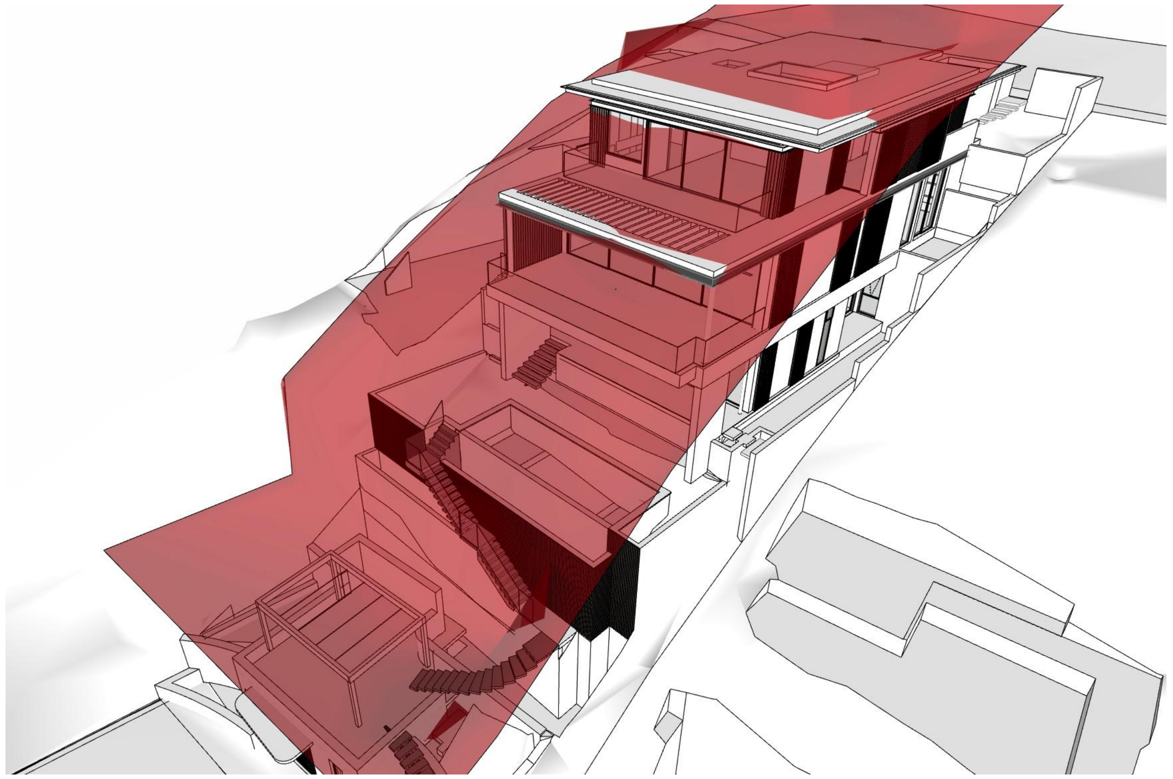
mail@corben.com.au
corben.com.au
Nominated Architect: Philip Corben (Reg. No. 4616)

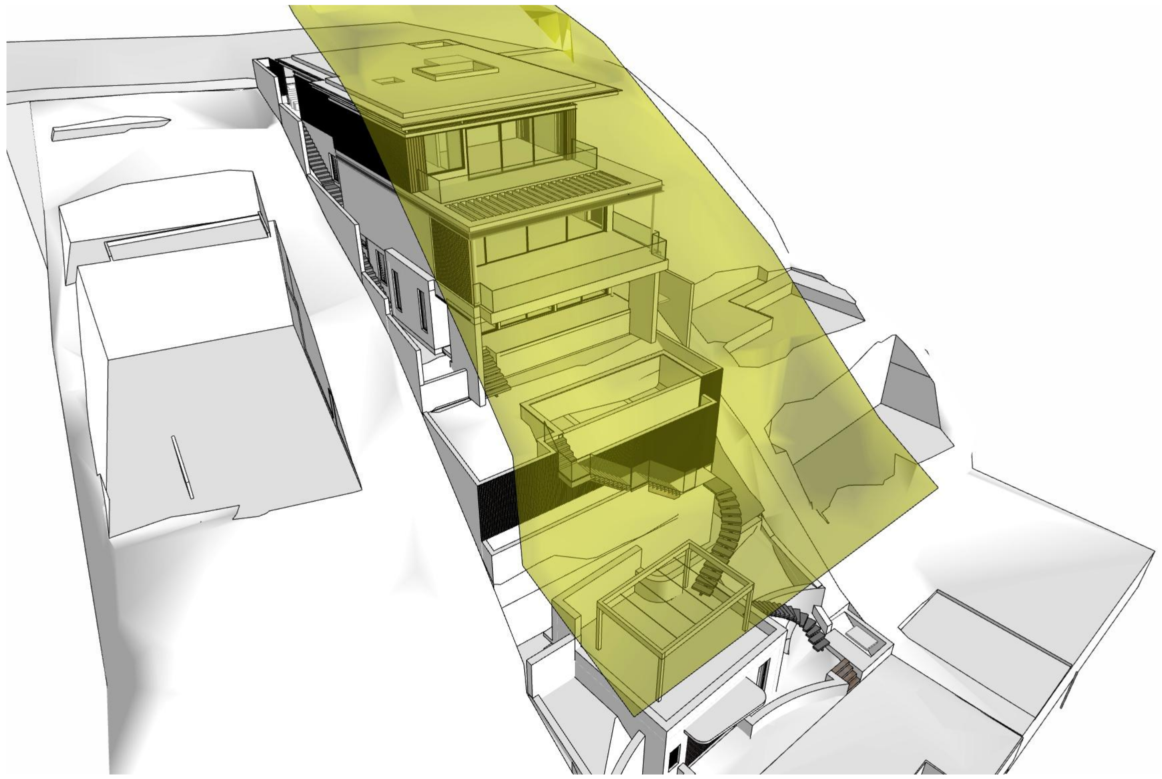
project MacDiarmid House Avalon
address 24 Cabarita Road Avalon NSW
client Bruce & Libby MacDiarmid
title Building Envelope Analysis
issue Development Application
job no. MACA
drawn RV
checked MC
scale
dwg no. DA17
revision A



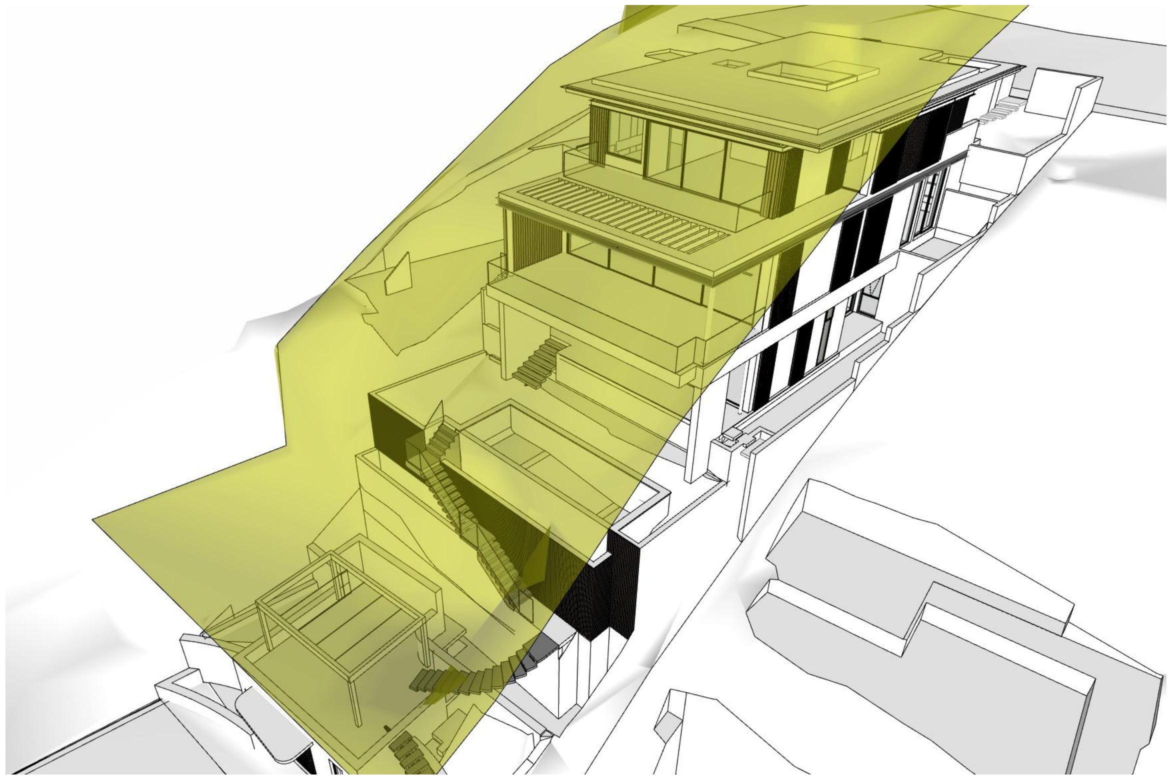
8.5m Building Height



8.5m Building Height



10m Building Height



10m Building Height

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corben.com.au

Nominated Architect: Philip Corben (Reg. No. 4616)

project	MacDiarmid House Avalon	**title**	Building Height Analysis	**job no.**	MACA	**dwg no.**	DA18
address	24 Cabarita Road Avalon NSW			**drawn**	RV		
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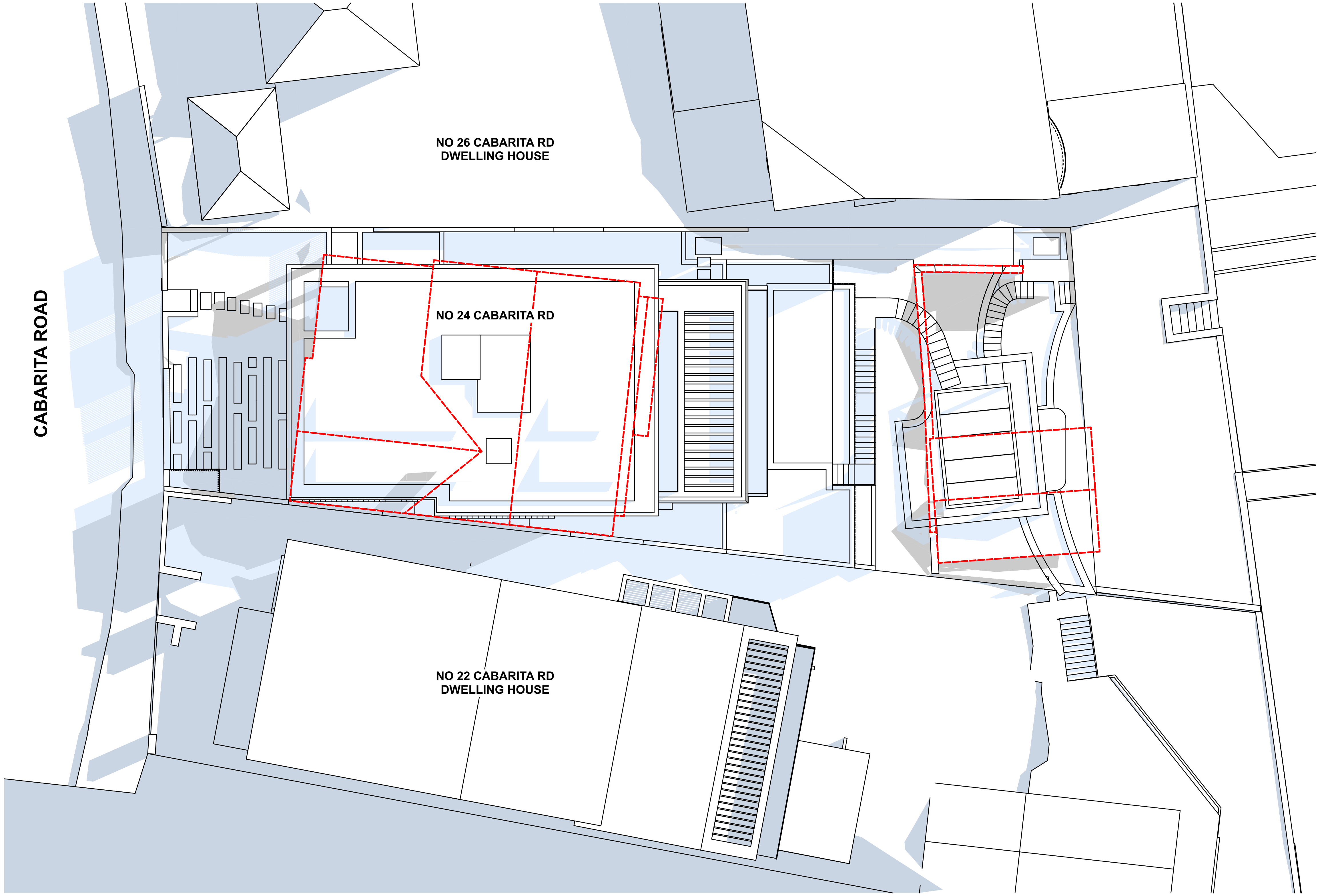
client	Bruce & Libby MacDiarmid	**issue**	Development Application	**scale**	1:400		



1 June 9am Shadows

KEY

- EXISTING SHADOW
- PROPOSED SHADOW

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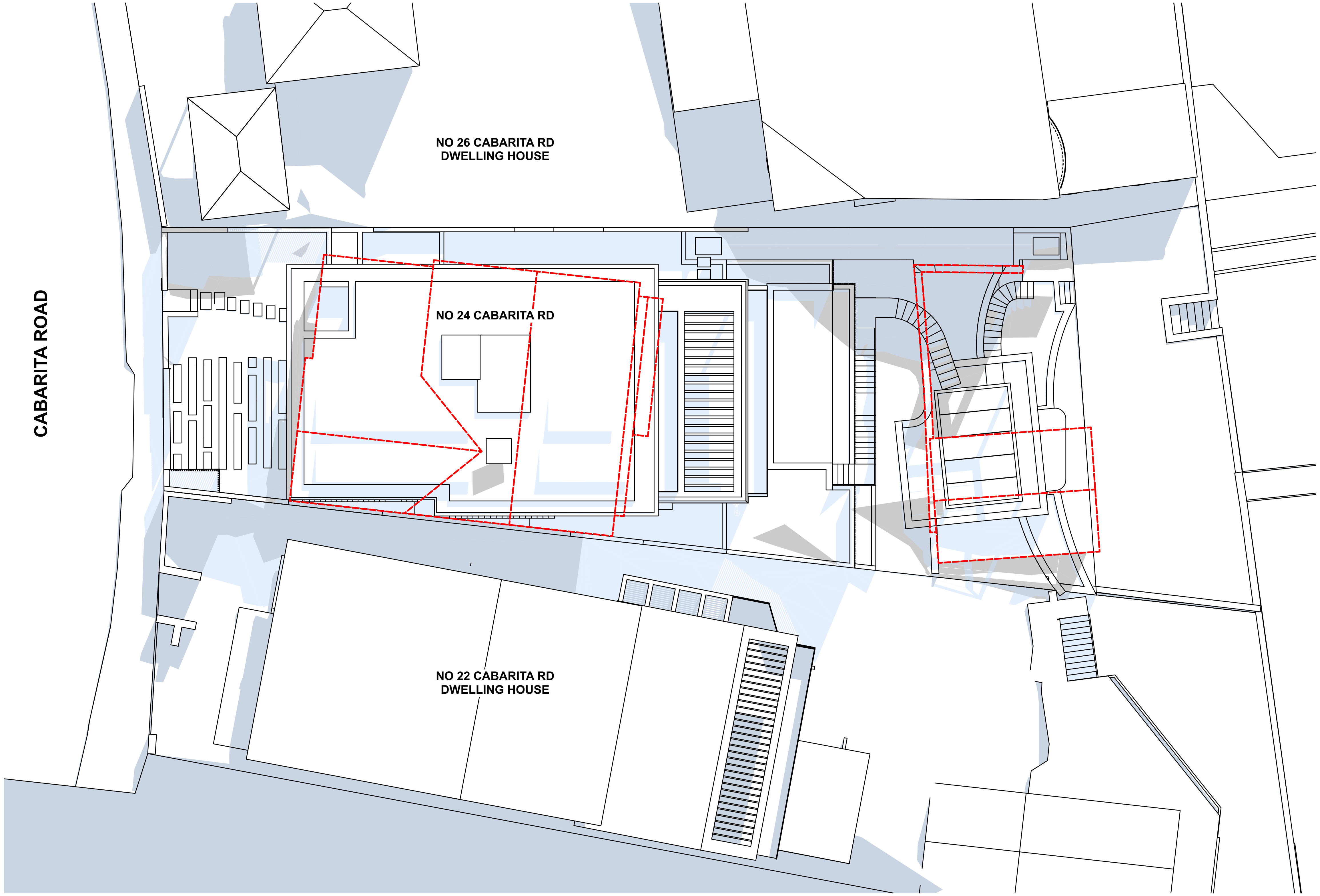
Nominated Architect: Philip Corben (Reg. No. 4616)

project	MacDiarmid House Avalon
address	24 Cabarita Road Avalon NSW
client	Bruce & Libby MacDiarmid
title	Shadow Diagram 9am
issue	Development Application
job no.	MACA
drawn	RV
checked	MC
scale	1:200
dwg no.	DA19
revision	A



1 June 12pm Shadows

KEY

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- PROPOSED SHADOW

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PO Box 1021 Neutral Bay NSW 2089 Australia
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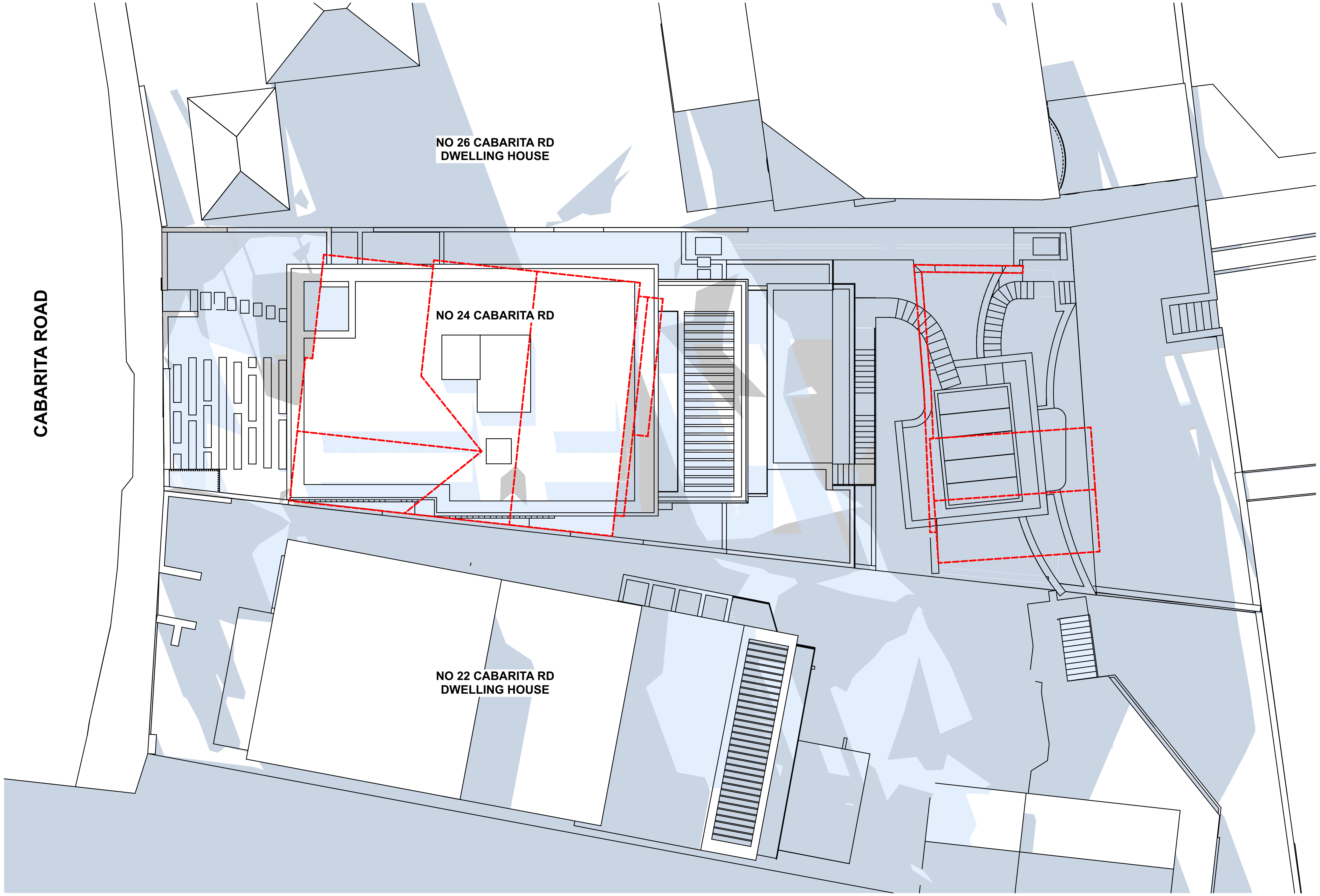
mail@corben.com.au
corben.com.au
Nominated Architect: Philip Corben (Reg. No. 4616)

project	MacDiarmid House Avalon	**title**	Shadow Diagram 12pm	**job no.**	MACA
address	24 Cabarita Road Avalon NSW			**drawn**	RV
				checked	MC
client	Bruce & Libby MacDiarmid	**issue**	Development Application	**scale**	1:200

dwg no. DA20

revision A



1 June 3pm Shadows

KEY

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- PROPOSED SHADOW

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PO Box 1021 Neutral Bay NSW 2089 Australia
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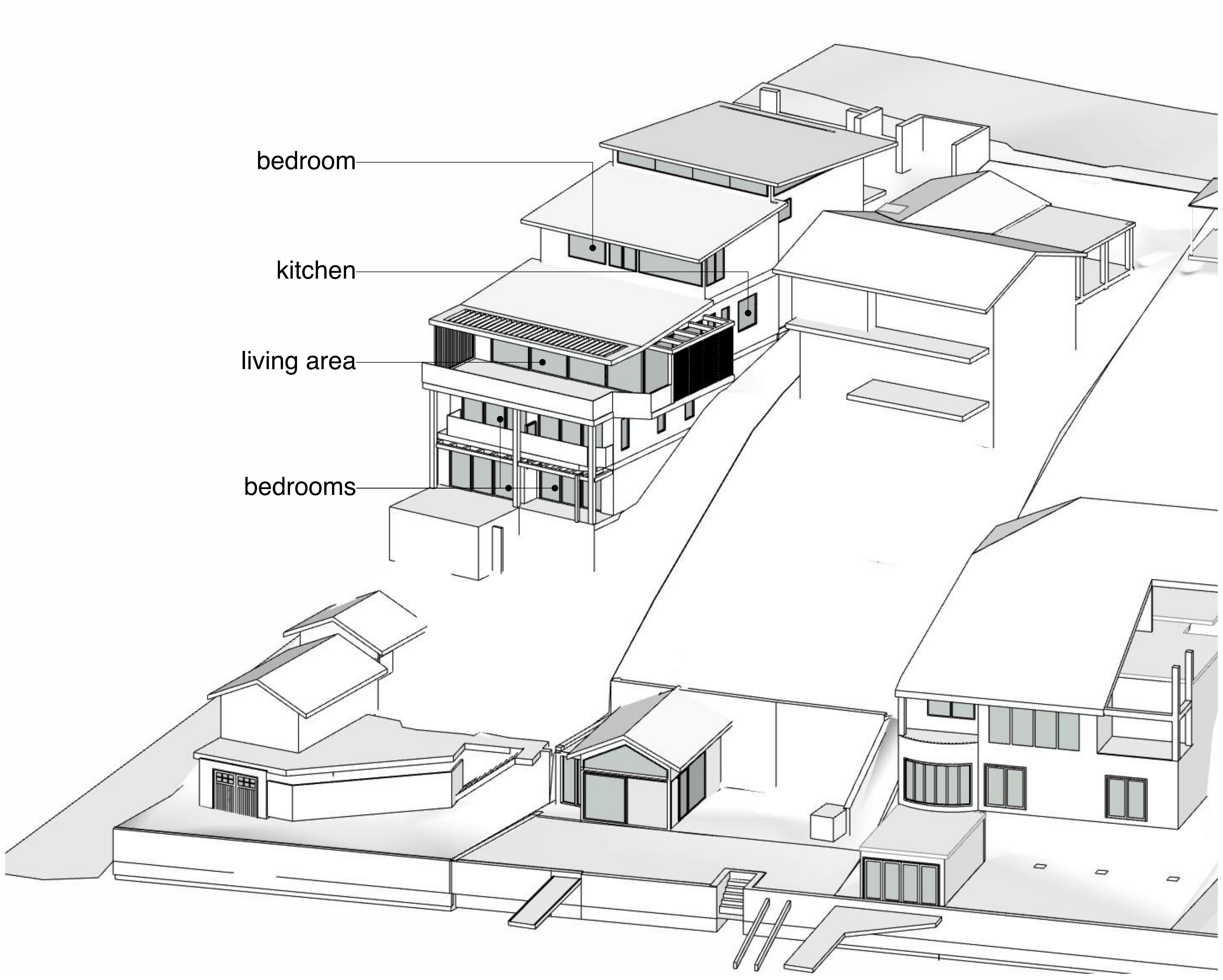
mail@corben.com.au
corben.com.au
Nominated Architect: Philip Corben (Reg. No. 4616)

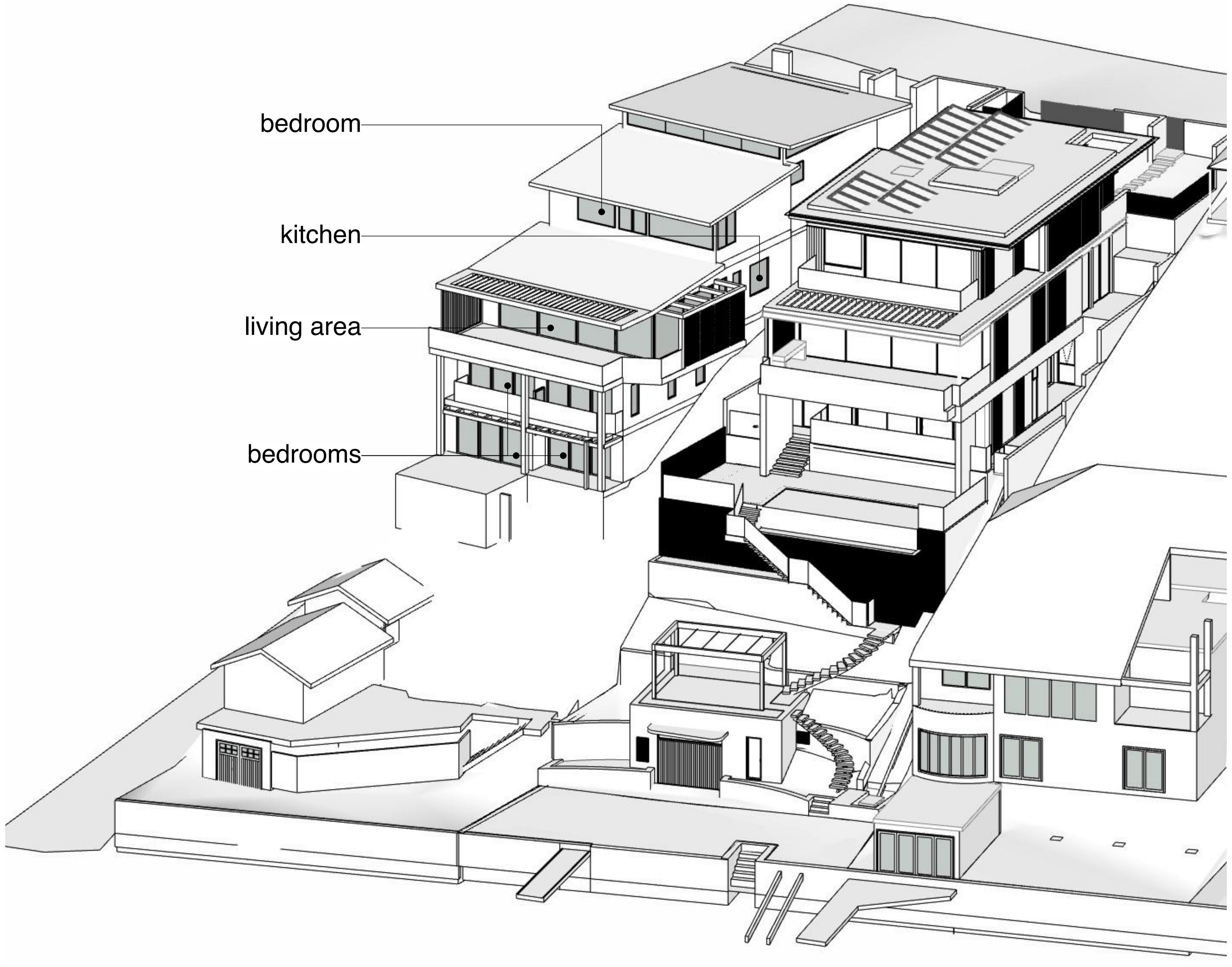
project	MacDiarmid House Avalon	**title**	Shadow Diagram 3pm	**job no.**	MACA
address	24 Cabarita Road Avalon NSW			**drawn**	RV
				checked	MC
client	Bruce & Libby MacDiarmid	**issue**	Development Application	**scale**	1:200

dwg no. DA21

revision A



1 9am Iso existing



2 9am Iso proposed

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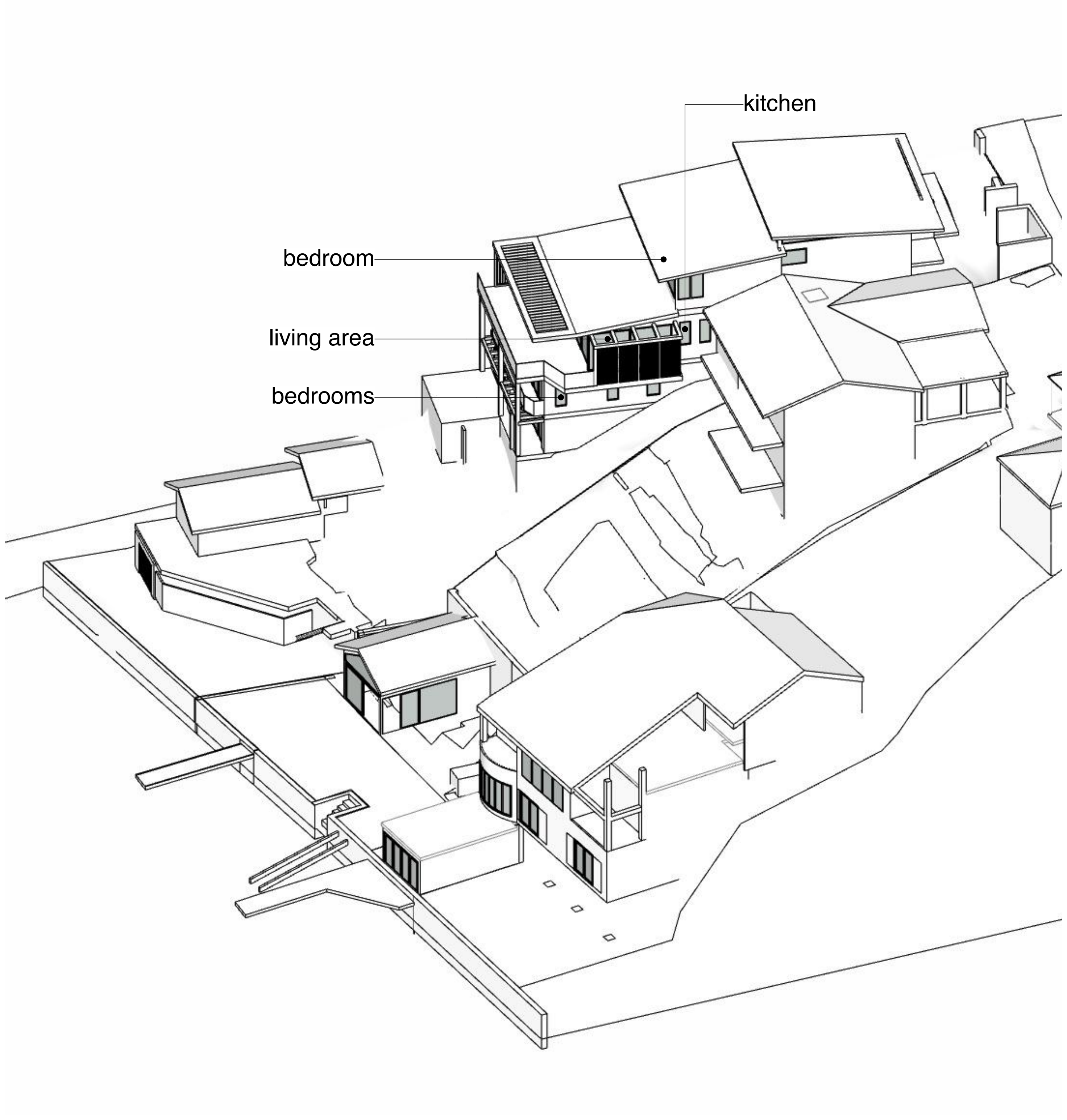
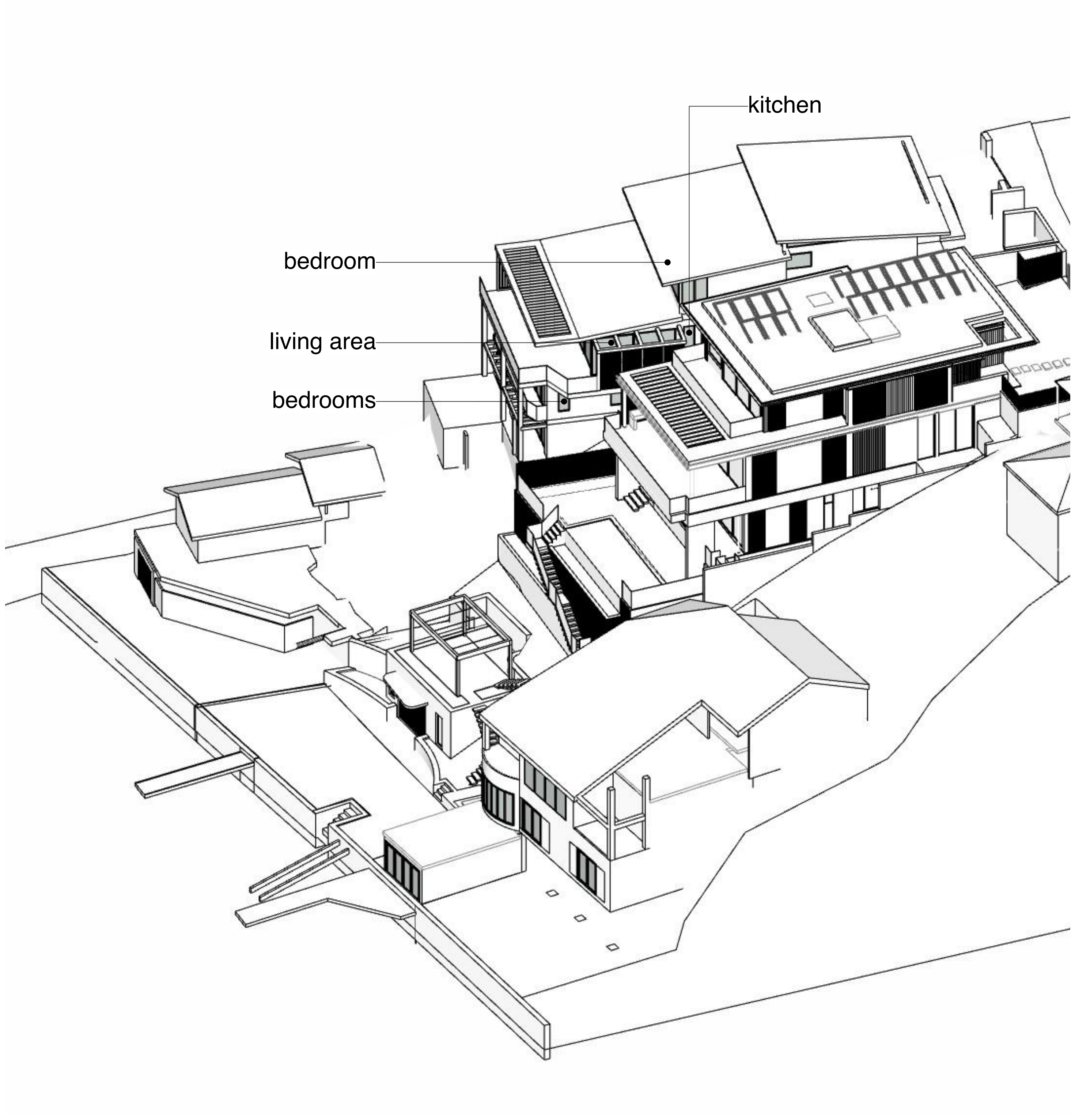
02 9904 1844
mail@corben.com.au
corben.com.au

Nominated Architect: Philip Corben (Reg. No. 4616)

project	MacDiarmid House Avalon	**title**	Sun Path Diagram 9am	**job no.**	MACA	**dwg no.**	DA22
address	24 Cabarita Road Avalon NSW			**drawn**	RV		
				checked	MC	**revision**	A
client	Bruce & Libby MacDiarmid	**issue**	Development Application	**scale**	1:250		



1 12pm Iso Existing



2 12pm Iso Proposed

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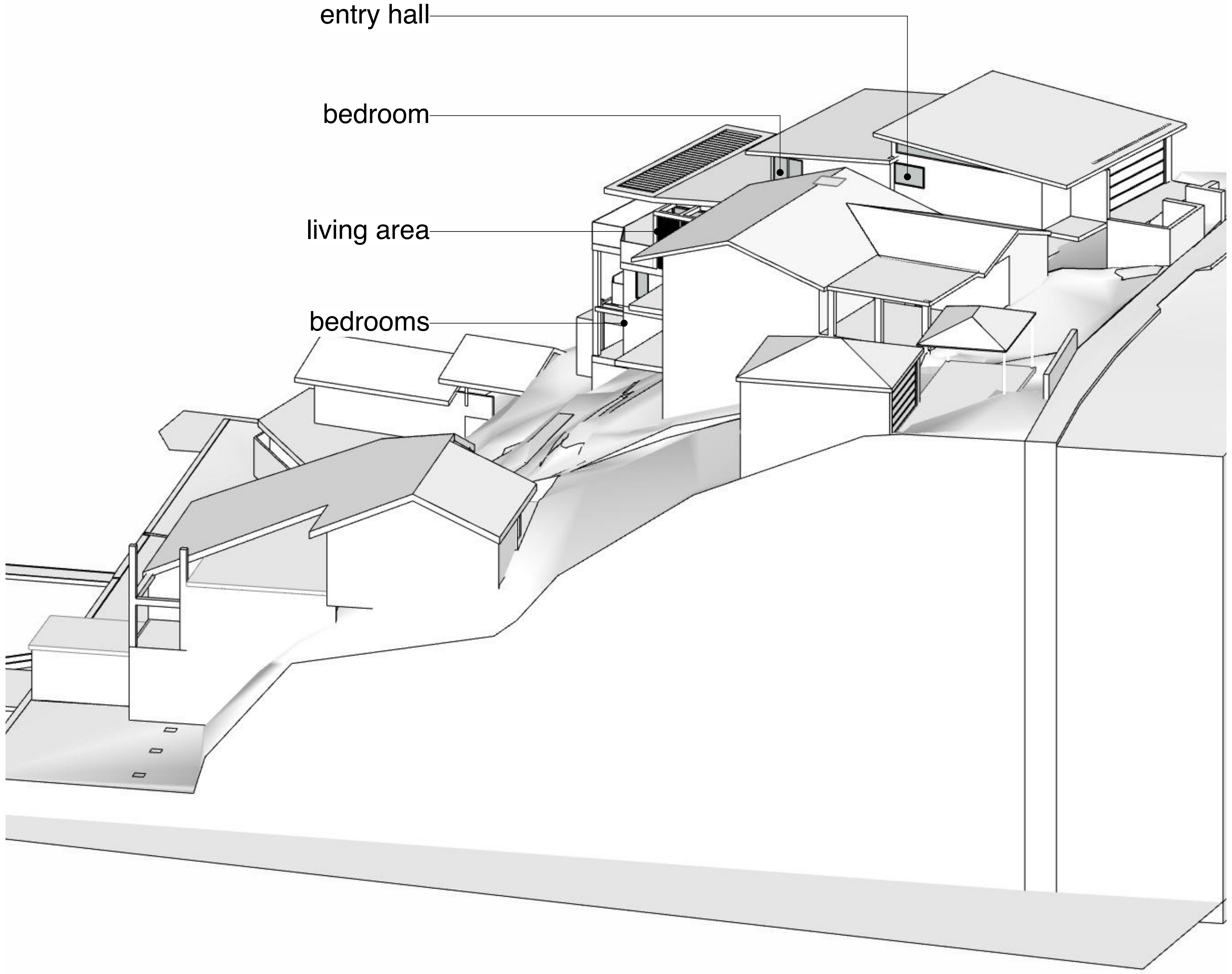
Nominated Architect: Philip Corben (Reg. No. 4616)

project	MacDiarmid House Avalon	**title**	Sun Path Diagram 12pm	**job no.**	MACA
address	24 Cabarita Road Avalon NSW			**drawn**	RV
				checked	MC
client	Bruce & Libby MacDiarmid	**issue**	Development Application	**scale**	1:200

dwg no. DA23

revision A



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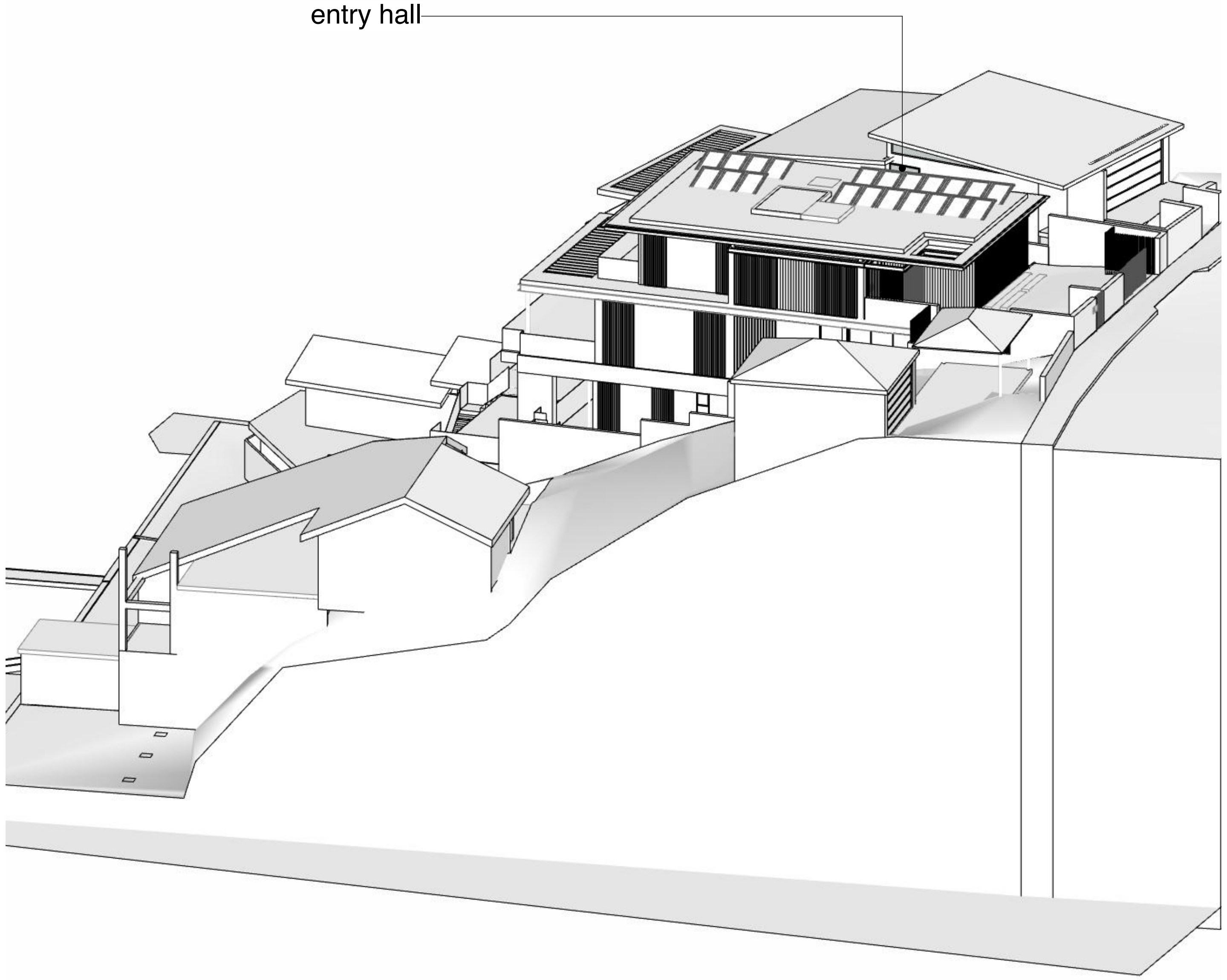

2 3pm Iso Proposed

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mail@corben.com.au
corben.com.au

Nominated Architect: Philip Corben (Reg. No. 4616)

project	MacDiarmid House Avalon	**title**	Sun Path Diagram 3pm	**job no.**	MACA	**dwg no.**	DA24
address	24 Cabarita Road Avalon NSW			**drawn**	RV		
				checked	MC	**revision**	A
client	Bruce & Libby MacDiarmid	**issue**	Development Application	**scale**	1:250		

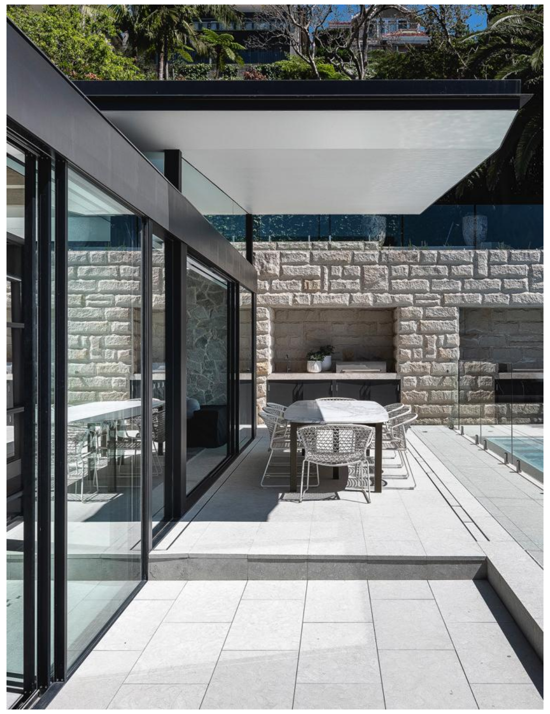

1


2


3


4


5


6


7


8


9


10

1	steel frame slim line roof edge
2	white render
3	timber battens / sandstone
4	steel frame painted dark
5	timer look battens / cladding
6	dark aluminium framed windows and doors
7	sandstone against dark steel frame
8	white render / timber battens / steel frame
9	paving inlay to landscape area
10	pebble ballast roof

revisions

RevID	Date	Description
A	12/12/22	DA Issue

notes

CORBEN ARCHITECTS

PO Box 1021 Neutral Bay NSW 2089 Australia
02 9904 1844
mail@corben.com.au
corben.com.au

Nominated Architect: Philip Corben (Reg. No. 4616)

project	MacDiarmid House Avalon	**title**	Finishes	**job no.**	MACA
address	24 Cabarita Road Avalon NSW			**drawn**	RV
				checked	MC
client	Bruce & Libby MacDiarmid	**issue**	Development Application	**scale**	

dwg no. DA25

revision A

Appendix C Site Survey, ATS Land & Engineering Surveyors Pty Ltd, February 2021

NOTE:

(E) - EASEMENT FOR SUPPORT (VIDE J379592) & (DP503627)

IMPORTANT NOTE:

This plan is prepared from a combination of field survey and existing record for the purpose of designing new constructions on the land and should not be used for any other purpose.

The title boundaries shown hereon were not marked by the author at the time of survey and have been determined by plan dimensions only and not by field measurement.

Services shown hereon have been located where possible by field survey. If not able where possible by field survey. If not able to be so located, known services have been plotted from the records of relevant authorities where available and have been noted accordingly on this plan.

Where such records either do not exist or are considered inadequate, a notation has been made hereon.

Prior to any demolition, excavation or construction on the site, the relevant authority should be contacted for possible location of further underground services and detailed locations of all services.

This note is an integral part of this plan.

LEGEND:

BM-BENCH MARK
RL.- REDUCED LEVEL
FL.- FLOOR LEVEL
G.- BOTTOM OF KERB
TOK.-TOP OF KERB
Ø -DIAMETER OF TRUNK
W.-WINDOW
PAPT - PARAPET
RF.- ROOF
TW - TOP OF RETAINING WALL
BK - BRICK
LND - LANDING

REVISION	AMENDMENT	DATE

SCALE: 1: 100
HORIZ. 1: VERT. 1:
CONTOUR INTERVAL:
MAJOR : 1 MINOR : 0.5
A0

HORIZONTAL ORIGIN
COORD. SYSTEM: M.M.
MARK ADOPTED:
COORDINATES:
E
N

VERTICAL DATUM
DATUM: AHD
BM ADOPTED: SS 38107
RL: 22.60

ATS LAND & ENGINEERING SURVEYORS PTY. LTD.
A. C. N. 003 402 426
Suite 3, 75 Ryedale Road, WEST RYDE 2114
(P.O. Box 331 GLADESVILLE 1675)
Phone: (02) 9808 6854 Fax: (02) 9808 6853
E–Mail: ats1@atssurveyors.com.au

SURVEYED	DRAWN	CHECKED	PASSED
S.S.	ALE	L.A.	A.T.S.

PROJECT:

TOPOGRAPHICAL SURVEY PLAN OF No.24 CABARITA ROAD, AVALON BEING LOT 9 IN D.P.17704

CLIENT: BRUCE & ELIZABETH MACDIARMID

M.M.

DATE
18 - 02 - 2021

SHEET 1 OF 1

DRAWING No.	REV.
11267 - 00	