Salients

Estuarine Risk Management Report for 1772 Pittwater Road, Bayview

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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 Gartner Trovato Architects to prepare an estuarine risk management report (this report) for a proposed boatshed at 1772 Pittwater Road, Bayview (Lot 51 of DP 740538). The development is in Bayview, on the foreshore of Pittwater as shown in Figure 1. The relative locations of the property boundary and the proposed boatshed are not reproduced precisely in Figure 1, but this is immaterial to our findings. A more precise representation is shown in the attachments to this report.

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 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 and deck adjoining an existing timber jetty at the northern corner of the property. The proposed works are shown in Figure 2 and Figure 3. With reference to those figures, the following have been considered by the present report:

- **Boat Shed:** The proposed boat shed comprises a 3.5m (shore parallel) by 6.05m (shore normal) building. The proposed floor level is 1.42m AHD. The footprint is completely landward of the mean high-water mark (property boundary).

- **Timber deck:** A deck is proposed on the northwest, northeast, and southeast sides of the boat shed, joining the existing jetty. The proposed elevation of the deck is 1.42m AHD. The deck will be accessed via stairs adjacent to the deck along the southeast edge of the building. The proposed deck is completely landward of the mean high-water mark.

[1]Version incorporating Amendments 1 through 25 has been used throughout this report. The DCP for Pittwater is still in effect as of April 2022.

Figure 1: Locality Plan

1772 Pittwater Road Bayview

REV	DRAWN	CHECK
A	EN	DJW

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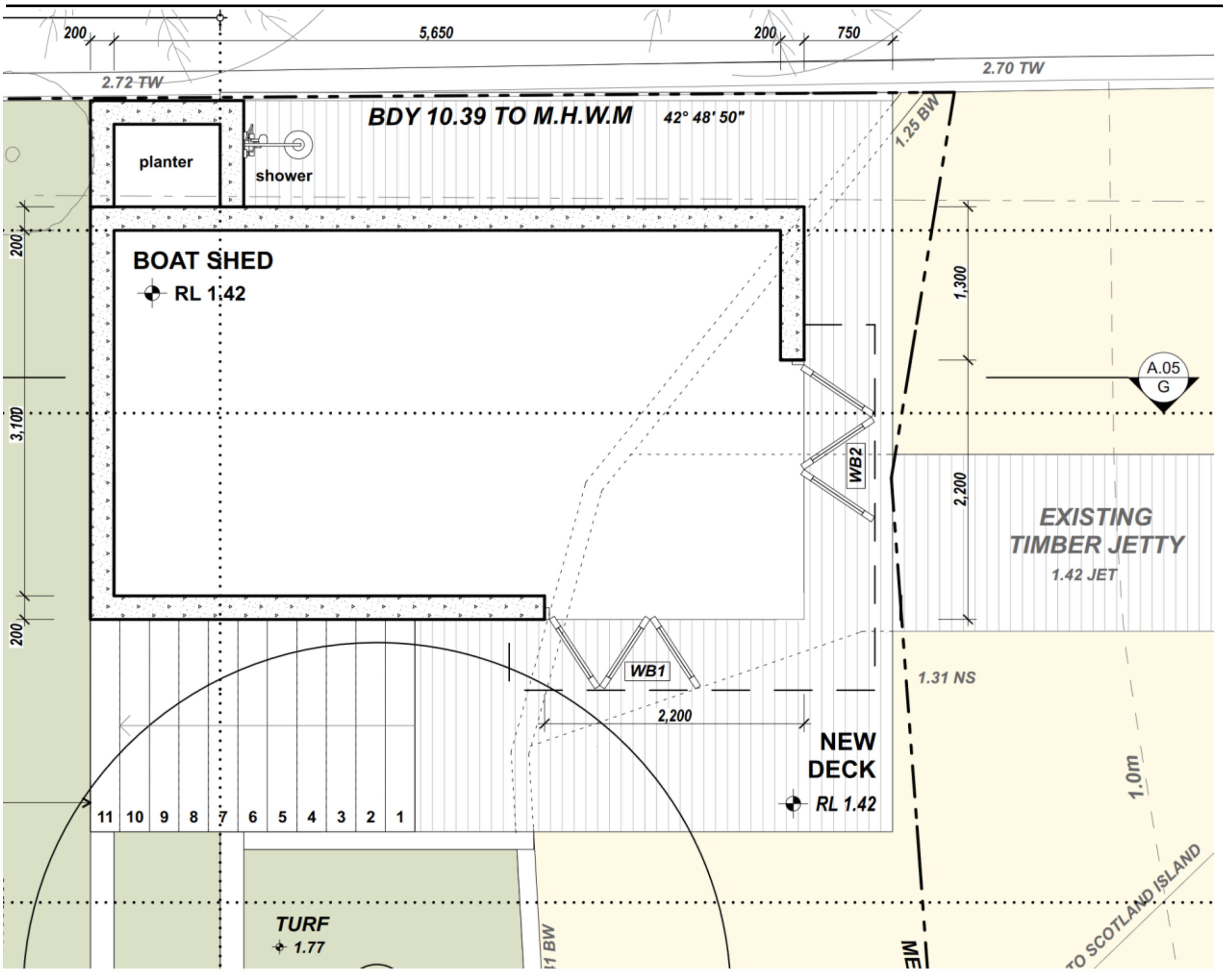

Figure 2 Plan View of Proposed Development (extract from drawings by Gartner Trovato Architects (2022, provided in Appendix B))

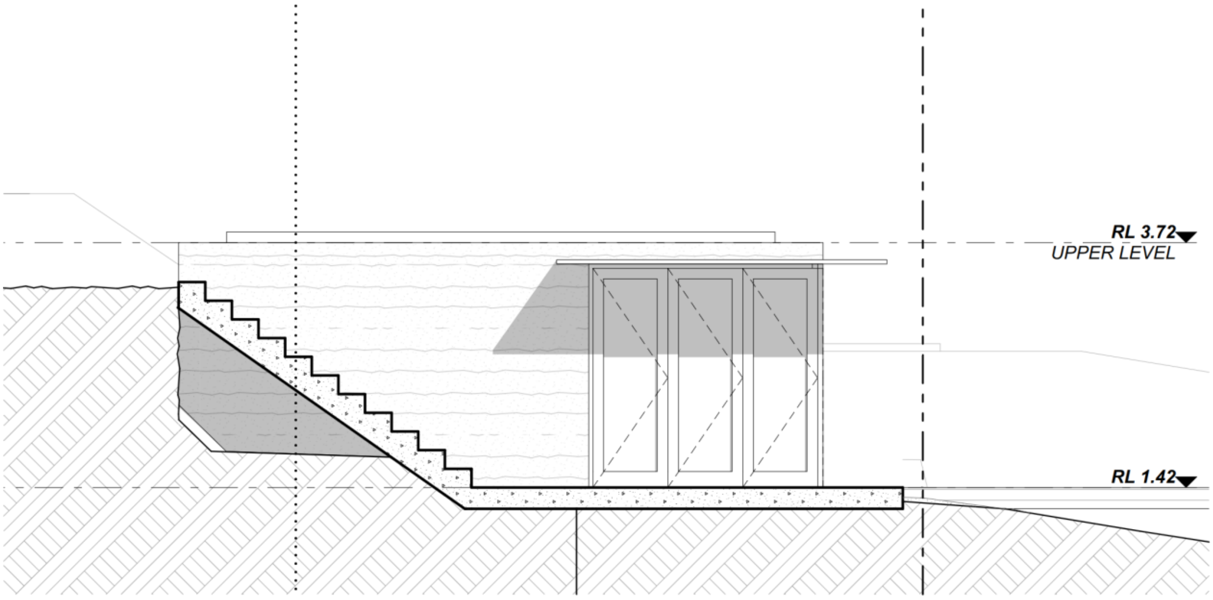

Figure 3 East Elevation of Proposed Development (extract from drawings by Gartner Trovato Architects (2022, provided in Appendix B))

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 new structures. The design life of the development 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 could be applied in 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 close to 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 fetches over which winds can blow to generate local waves. Due to its sheltered location, oceanic swell is not a significant issue at the Site. The location of the Site within Pittwater is shown in Figure 4.

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

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 design life proposed has an impact on design conditions in terms of the sea level rise allowance applied.

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]. The boat sheds fit squarely into this category. A 25-year design life is appropriate and has been adopted henceforth in this report.

Overall, the scale and 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 that the 2% Annual Exceedance Probability (AEP) wave[3] would be an appropriate wave height for the 25-year design life. Such wave heights would have an approximate 40% chance of occurring at least once over a 25-year design life.

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

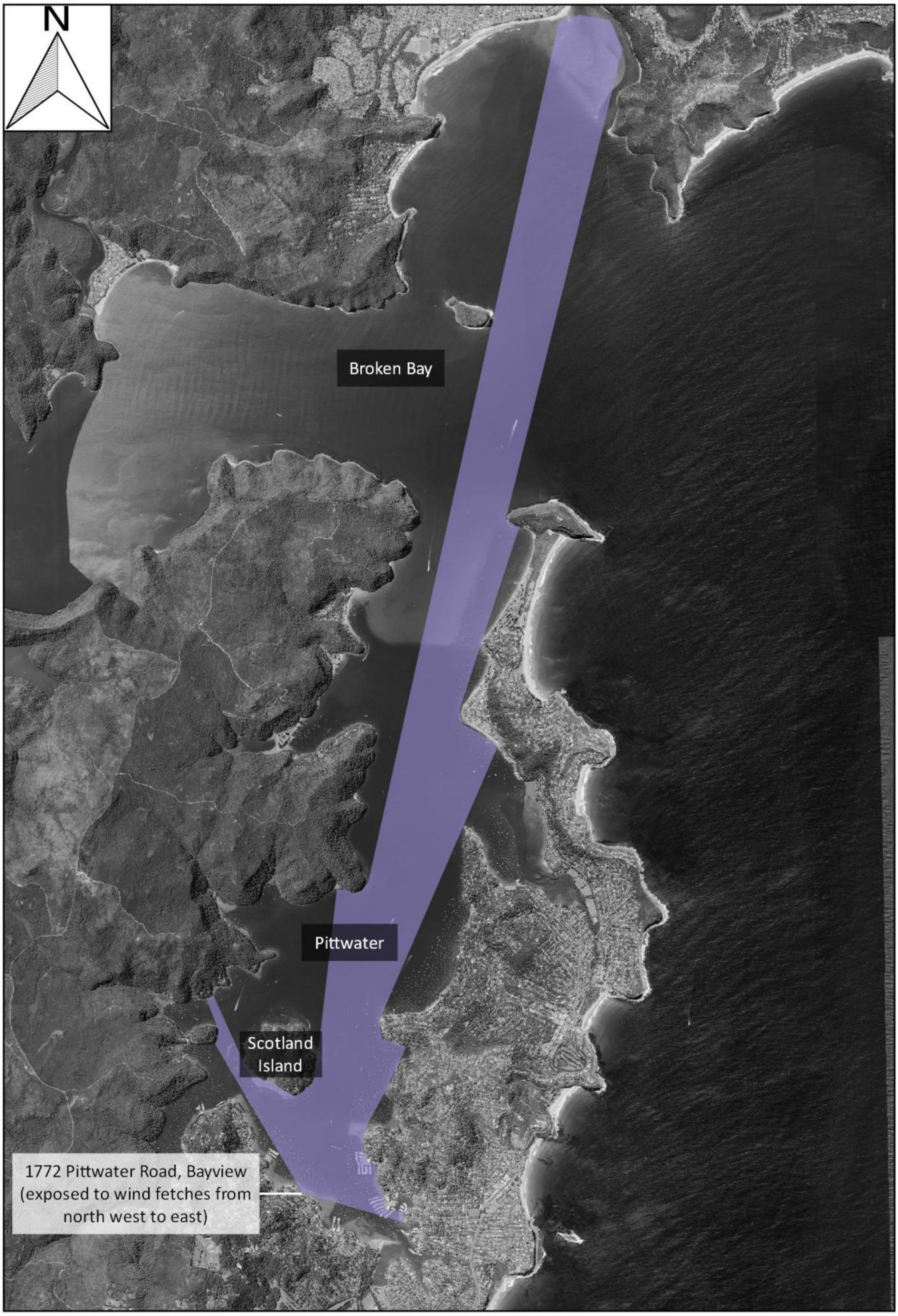

Figure 4: Site Locality and Fetch

0 0.5 1 1.5 2 km

APPROX SCALE

1772 Pittwater Road Bayview

REV	DRAWN	CHECK
A	EN	DJW

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2.3 Consideration of Wave Environment

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 north west and east shown in Table 1.

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

	Northwest	North	Northeast	East
1% AEP Gust Speed	33.9	28.4	23.8	25.7
5% AEP Gust Speed	31.3	26.1	22.9	22.8
1% AEP 10 min Average	21.3	19.3	18.3	19.8
5% AEP 10 min Average	21.3	17.8	17.6	17.5
1% AEP 3 hr Average	22.1	18.5	17.6	19.0
5% AEP 3 hr Average	20.4	17.0	16.9	16.8

To estimate extreme nearshore wave conditions near the Site, the response of a computational wave model to a range of wind speeds from sixteen compass directions was assessed. Those responses were used, by Lawson and Treloar, to transfer the time series of wind speeds from Sydney Airport to a corresponding time series of waves within Pittwater. Statistical analysis then determined the occurrence of extreme wave conditions at a variety of foreshores within Pittwater. The resulting local wind generated waves that are indicated as being applicable around Bayview are replicated in Table 2.

Table 2 Estimated Extreme Wind Wave Heights for Bayview Foreshore (from Lawson & Treloar (2003), Table 3.7)

Recurrence	Wind Wave Height ($H_{s,w}$, m)
5% AEP	0.87
2% AEP	0.92
1% AEP	0.98

A check of design wave heights, considering the length of wave generation fetch from directions ranging from northwest to east, 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 reasonable and have been adopted for design.

For this report, the 2% AEP significant wave height (H_s of 0.92) was adopted. AS4997 recommends a factor of 1.5 be applied to the H_s wave height to obtain the H_1 wave height, which represents the highest 1% of waves occurring during a design storm and should be used in determining structural loads. Accordingly, a wave with height 1.38m (1.50 × 0.92) 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 around 1.77m is required for a 1.38m wave to pass without breaking before it reaches the foreshore. Bed elevations of close to 1.0m AHD are present in front of the proposed boat shed and deck, meaning that the design wave (1.38m) would tend to break when the water level gets below 2.77m AHD immediately offshore of the site. Normally, this breaking wave condition would govern the design of foreshore structures. 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 2.76m AHD. Under this condition, the design wave of 1.38m AHD could propagate all the way to the

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

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., 100s 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 for Bayview (Lawson & Treloar, 2003):

- North Westerly Wind: +0.05m
- Northerly Wind: +0.09m
- North Easterly Wind: +0.09m
- Easterly Wind: +0.06m

For all other directions, winds across Pittwater indicated a set down of water levels. The value adopted for Bayview in the most recent analysis of water levels was +0.09m (Cardno, 2015). This is likely to occur concurrently with wind waves approaching from the north.

For climate change related sea level rise, Council has adopted a rise of 0.4m by 2050 and 0.9m by 2100. Within Cardno (2015), these were considered to be relative to a "present day level" of 0.0m. With sea level rise of 0.4m (by 2050), a total still water level of 1.93m AHD was determined.

A "Wave Related Increment" EPL component was also determined for Bayview. This component corresponds to the height of the run-up and overtopping of the foreshore and is therefore related to the type of foreshore (e.g., sloping natural, vertical sea wall etc.). The foreshore at 1772 Pittwater Road is best described as a sea wall with crest elevation 2m AHD. The 1% AEP still water level, including wind set up allowance, is

1.93m AHD (Cardno, 2015). For this condition, and a 1% AEP wave height of 0.98m, Cardno calculated a level of 2.46m AHD.

Cardno (2015) describe 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. A freeboard of 0.3 was included.

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 3. These do not include the wave related increment or freeboard.

Table 3 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	1.4[5]	1.8

2.5 Potential Justification for Modifying the Estuarine Planning Level

Considering the components of the EPL, the storm tide adopted is 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 50yr 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 around 0.37m of sea level rise by 2047, at the end of the 25-year design life for the boat shed. Allowing for this adjustment represents a potential reduction in the EPL by 0.03m.

[5] Note that a level of 1.44 (1.84 at 2050) was used in derivation of the Estuarine Planning Level

Finally, when calculating the wave related increment, adoption of the 2% AEP wave height (0.92m) instead of the wave height adopted by Cardno (2015) would reduce the EPL by 0.03m.

In total, considering a design life extending to 2047, an appropriate planning level for the foreshore of around 2.70m AHD could be applied. The design still water level, without freeboard, for this modified condition (~2.40m AHD) would still significantly exceed the proposed floor elevation of the boat shed (1.42m AHD). The potential for inundation should be considered as part of structural design, with the frequency of inundation increasing with time as sea levels rise. With a floor level of 1.42m AHD, the boat shed could experience inundation several times per year because of ordinary tides at the end of the design life for the boat shed.

We conclude that the EPL could be reduced by around 0.06m at this site. However, this would need to be approved by Council. It is not essential that the final design consider this path. Designing to a higher EPL would result in a more robust design that is likely to last longer and, depending on cost, this may be a more attractive option.

For the reasons outlined above and considering the nature of wave impact forces acting on the structure, we recommend that Council's EPL of 2.76m AHD be retained for design purposes.

3 Interaction of Water Levels and Waves with the Proposal

3.1 Existing Foreshore and Structural Conditions

Our assessment of the existing site is based on photographs provided to us by Sean Gartner (captured around low tide, 10 September 2019 at 10:30am), design plans prepared by Gartner Trovato Architects (Appendix B) and survey conducted by CMS Surveyors (Appendix C).

A photograph of the foreshore at 1772 Pittwater Road is presented in Figure 5. A low stone retaining wall is located at the back of the beach and can be seen in Figure 5. The crest of the retaining wall is between 1.65 and 1.77m AHD. A sandy beach is present in front of the retaining wall and along the foreshore to the southeast. A seawall with crest around 2m AHD is located along the foreshore on the northeast.

Figure 5 Foreshore at 1772 Pittwater Road, Captured 10th September 2019

3.2 Determination of Structural Design Conditions

As described in Section 2.5, Council's estuarine planning level for the site is 2.76m AHD, although it could be argued that an alternative, lower level of 2.70m AHD is justified. The proposed floor level of the boat shed and deck (1.42m AHD) is significantly lower than either the original or alternative estuarine planning levels.

To provide a safe, habitable floor level for a 25-year design life, the floor of the boat shed would need to be raised to at least 2.76m AHD. However, a boat shed used primarily for boat storage does not need a habitable floor and a lower floor is acceptable.

Clause B3.7 of Council's DCP notes that:

> *"Consideration may be given on a merit basis to a floor level of a boat shed at a level lower 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"*

With a floor level set at 1.42m AHD, the flooring and lower walls can (and should) be designed to manage 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 2.76m AHD, including allowances for the shrink and swell of any timber, fibre cement sheeting, or weatherboard 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 and across the horizontal surfaces, causing shear and uplift forces.
- Waves passing beneath the underside of the decking causing positive and negative pressures on the underside as the wave passes.
- Wave forces on vertical piles.

Due to the short-period waves and nature of the resulting forces, it is appropriate to consider that all the above wave forces could load the structure at the same time. A design wave height of 1.38m at the foreshore has been assumed. Waves that reach the foreshore will break and potentially slam against vertical surfaces of the structures 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 and the sides of structural members.

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. 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, but with a 2% AEP design wave, the design condition comprises a 1.38 m high wave propagating across a still water level of 2.23m AHD. Assuming some erosion of sand from the front of the structure, this is a foreseeable condition.

Using Goda's method, a peak wave pressure of around 9.3 kPa is calculated at the adopted "still water level" of 2.23m AHD. We recommend that this horizontal pressure be considered to act evenly on all parts of vertical surfaces below 2.23m AHD. Goda's method calculates that the waves could run up the face of a vertical surface to a height of 4.30m 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 2.23m and 4.30m AHD, from 9.3 kPa to zero.

This vertical pressure distribution represents the conditions at the peak of a temporally varying distribution that changes with a period equal to the incident wave period (around 2.9 seconds, derived from linear wave theory). There is also potential for a 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., Timber Deck)

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 timber walkway decking surfaces would occur when the full design wave height (1.38m) breaks across the deck. 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 Waves Acting on Piles

The forces acting on a pile can be calculated using the Morison equation as outlined in the USACE Coastal Engineering Manual. Importantly, the force will depend on the diameter and surface roughness of the pile, which will not be determined until detailed structural design is undertaken. While this should be assessed by the structural engineer designing the structure, the pressure force of a wave slamming into the boat shed walls is likely to be the major contributor of bending moments induced in the piles. The support of boat sheds on piers in Pittwater is common and structural design to accommodate the required forces is unlikely to be problematic.

3.2.4 Waves Acting on the Underside of Horizontal Surfaces

As a wave passes below the deck, a pressure force would alternate between pushing and pulling on that surface. AS4997 recommends that this can be estimated by the height of the wave crest above the structure, as if the structure were not there, increased by a factor of 2 (Section 5.9.4 of AS4997).

The still water level is 2.23 AHD. As the wave passes the wave crest elevation is at around 2.92m AHD and the trough at around 1.54m AHD. The crest elevation is around 1.50m above the deck. Multiplying this by two and converting to an equivalent hydrostatic pressure results in a pressure of 30.2kPa acting on the underside of the deck with that pressure able to act either upwards or downwards on the deck. It is recommended that a pressure of 31 kPa be adopted, unless otherwise justified by a structural engineer.

3.2.5 Summary of Structural Design Actions

In summary, the following load conditions should be considered during a review of the structural adequacy of the structures:

- Acting on vertical surfaces: An even pressure of 9.6 kPa up to 2.20m AHD, with a linearly decreasing pressure above 2.20m AHD, reducing from 9.6 kPa to 0kPa at 4.27m AHD. This pressure varies with time and the values presented above represent peak conditions as a 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 timber decks).

- Both negative and positive pressures (two separate cases) on the underside of the floor and decking as outlined in Section 3.2.4. These pressures should be considered to cover the entire floor.

- Drag and inertial forces acting on piles, which could be calculated using Morison's equation, once decisions are made regarding the diameter and materials to be used.

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 2.92 m AHD. The height of 2.92m is calculated from the design still water level of 2.23m AHD plus half the design wave height of 1.38m in accordance with AS4997.

The potential for fatigue to occur due to repeated but less severe loading, or deterioration of structural members, for example through the actions of marine borers, 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 members comprising the floor and lower walls of the boat shed and associated deck is required. These members should be designed to manage regular inundation 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 Council's Estuarine Planning Level of 2.76m AHD. If situated below the EPL fixtures should be of submersible grade. Any power outlets located below the maximum wave runup height (4.30m AHD, which is above the upper level at 3.72m 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 inundation elevation should also consider the need for drying and ventilation. The grade of all surfaces should encourage water to drain back into Pittwater.

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.
- Associated timber decking.

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 be of some concern (even minor) have been listed and numbered for further consideration.

4.3.1 Structural Risks

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

Risk 2: *There is a risk that the foreshore structures will deteriorate over time, making them 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 modification 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 improve safety, with more elevated fixed surfaces to which a vessel could be moored and/or safer exit from the water during periods of elevated water levels and waves. Therefore, risks associated with approaches from the water side are made less severe 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 4 (adapted from AS5334 (Australian Standards, 2013)).

Table 4 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 5 (adapted from AS5334 (Australian Standards, 2013)).

Table 5 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.

Consequence Rating	Structural Factors	Safety/Health Factors	Environmental Factors
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 described above, evaluation of the risks has been completed using Table 6 (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 6 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 four risks in turn.

Risk 1: *There is a risk that the foreshore 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 the structure is assessed by a qualified structural engineer, considering 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 water 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 the foreshore structures will deteriorate over time, making them more susceptible to failure under even moderate loads.*

It is likely that the structures will deteriorate with time. However, the nature of the failure that could be expected is only partial failure of a structure, 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 regular wave action. A storm generating waves of 0.5m could be expected at least once a year. If appropriate, the design should allow for a loss of structural integrity (serviceability and strength) over time.

<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 would 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 over 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 1772 Pittwater 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 could be "Major". A "Moderate" risk rating is implied.

<u>Risk Management Action 4</u>

> The probability of occurrence is remote, but the consequences could be major. It is recommended that a motion sensing light be installed to

illuminate boat shed and deck 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.

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 structure is almost certain. However, these would only affect a limited area. While there will be impacts, the impacts are going to be insignificant. <u>The assessed risk rating is "Low" and does not require further consideration.</u>

5 Summary and Endorsement

The proposed foreshore facilities at 1772 Pittwater Road, Bayview 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 3.2.5. 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 boatshed and deck can be constructed and used without undue impacts or negative consequences to public safety or the environment. 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 Andrew Bursill and Georgie Torrens

Address of site 1772 Pittwater Road Bayview

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 3rd of May, 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 1772 Pittwater Road, Bayview

Report Date: 3rd May, 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.

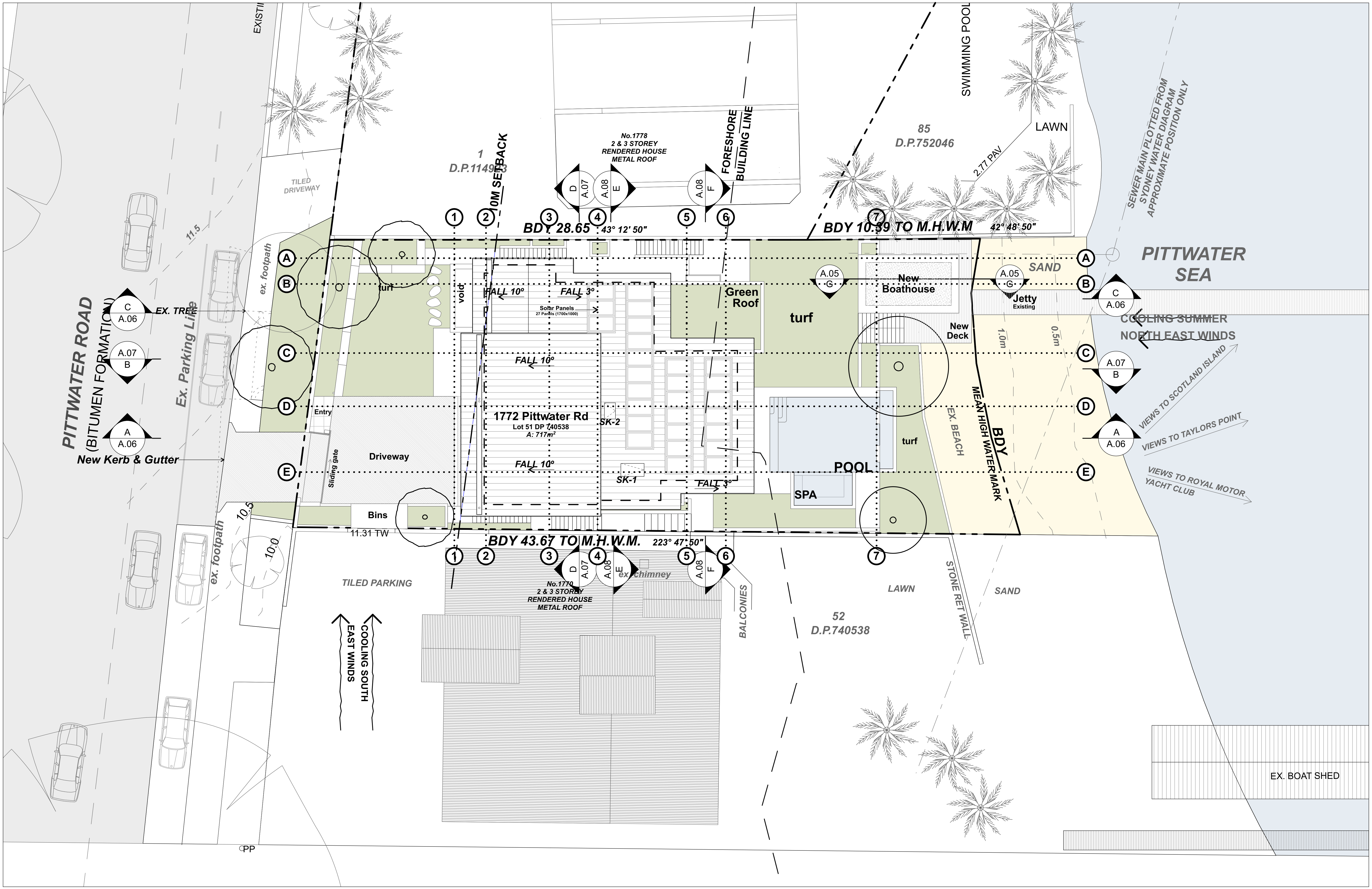
Signature:

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, Gartner Trovato Architects, January 2022



GARTNERTROVATO
ARCHITECTS

PITTWATER PLACE
L1/13 10 PARK STREET
PO BOX 1122
MONA VALE, NSW 2103
+61 2 9979 4411
GTA@G-T.COM.AU

DATE	REV	DESCRIPTION
12/1/22	A	DA

PROJECT
DEVELOPMENT APPLICATION
NEW BOATHOUSE
1772 PITTWATER ROAD, BAYVIEW NSW
LOT 51, DP 740538

FOR ANDREW BURSILL & GEORGIE TORRENS

DRAWING TITLE
SITE PLAN

SCALE	DRAWN BY	PLOT DATE
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PROJECT NO.	**DRAWING NO.**	**REVISION**
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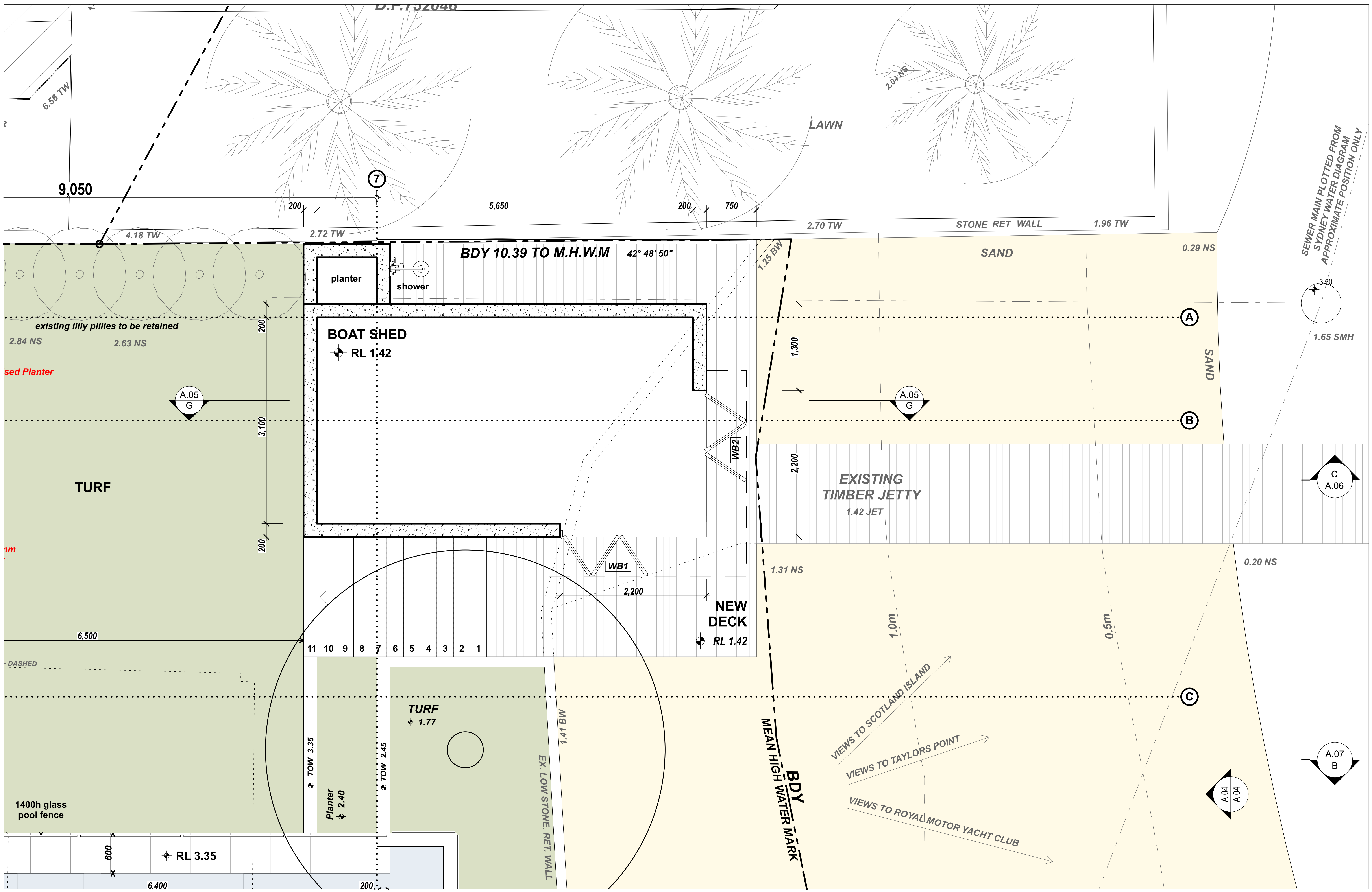

GARTNERTROVATO
A R C H I T E C T S

PITTWATER PLACE
L1/13 10 PARK STREET
PO BOX 1122
MONA VALE, NSW 2103
+61 2 9979 4411
GTA@G-T.COM.AU

N

DATE	REV	DESCRIPTION
12/1/22	A	DA

PROJECT
DEVELOPMENT APPLICATION
NEW BOATHOUSE
1772 PITTWATER ROAD, BAYVIEW NSW
LOT 51, DP 740538

FOR ANDREW BURSILL & GEORGIE TORRENS

DRAWING TITLE
GROUND FLOOR

SCALE	DRAWN BY	PLOT DATE
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PROJECT NO.	**DRAWING NO.**	**REVISION**
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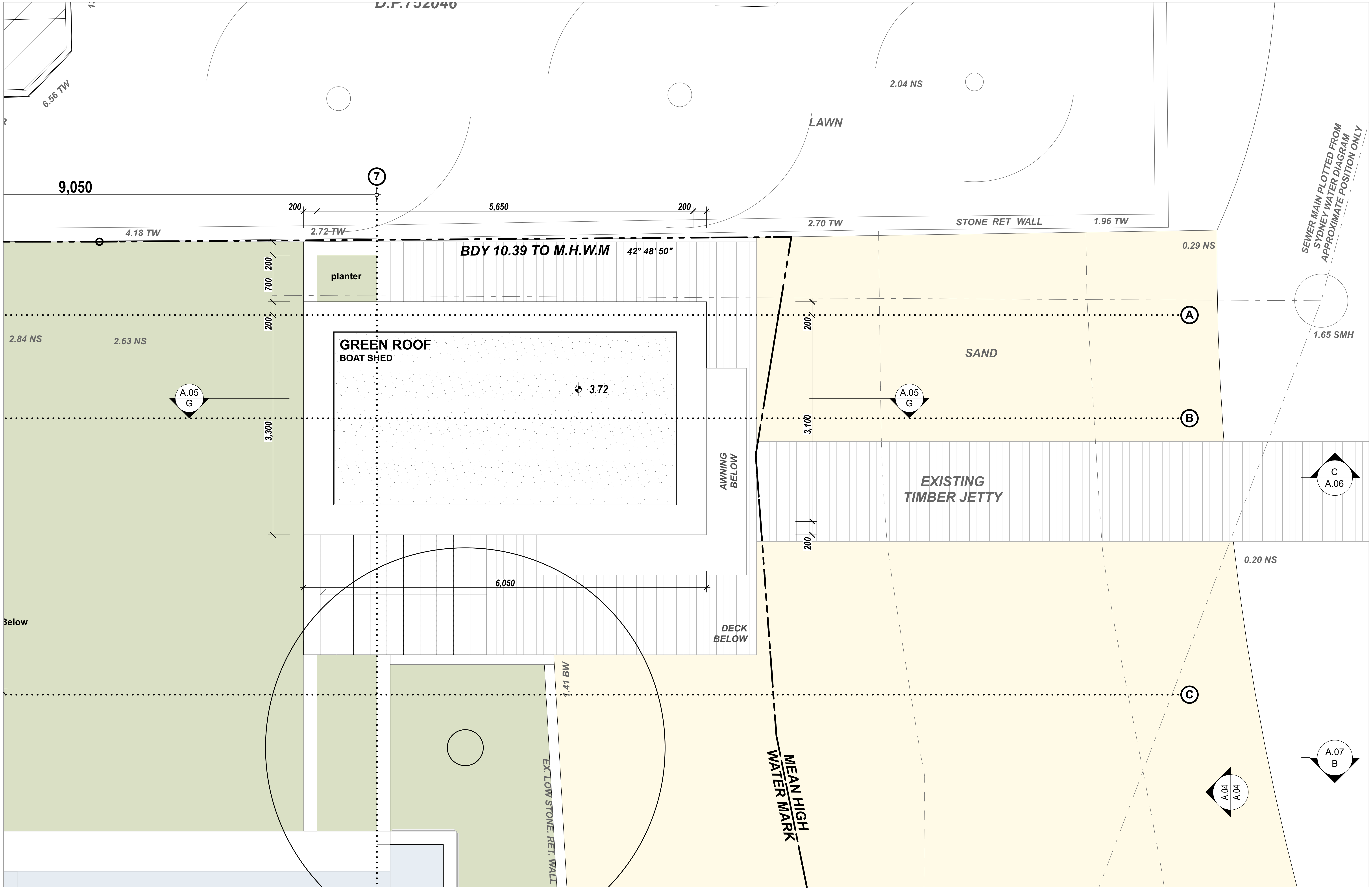

GARTNERTROVATO
ARCHITECTS

PITTWATER PLACE
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+61 2 9979 4411
GTA@G-T.COM.AU

N

DATE	REV	DESCRIPTION
12/1/22	A	DA

PROJECT
DEVELOPMENT APPLICATION
NEW BOATHOUSE
1772 PITTWATER ROAD, BAYVIEW NSW
LOT 51, DP 740538

FOR ANDREW BURSILL & GEORGIE TORRENS

DRAWING TITLE
ROOF PLAN

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PROJECT NO.	**DRAWING NO.**	**REVISION**
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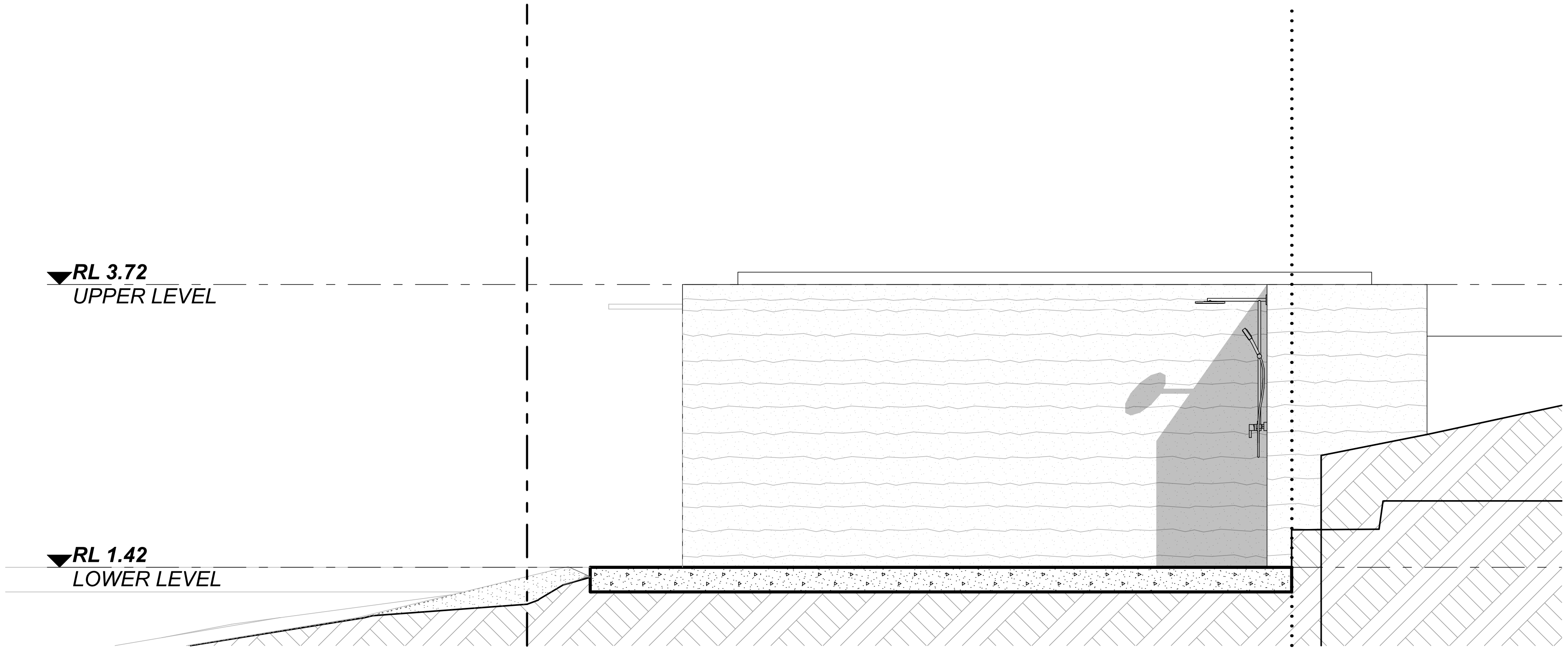
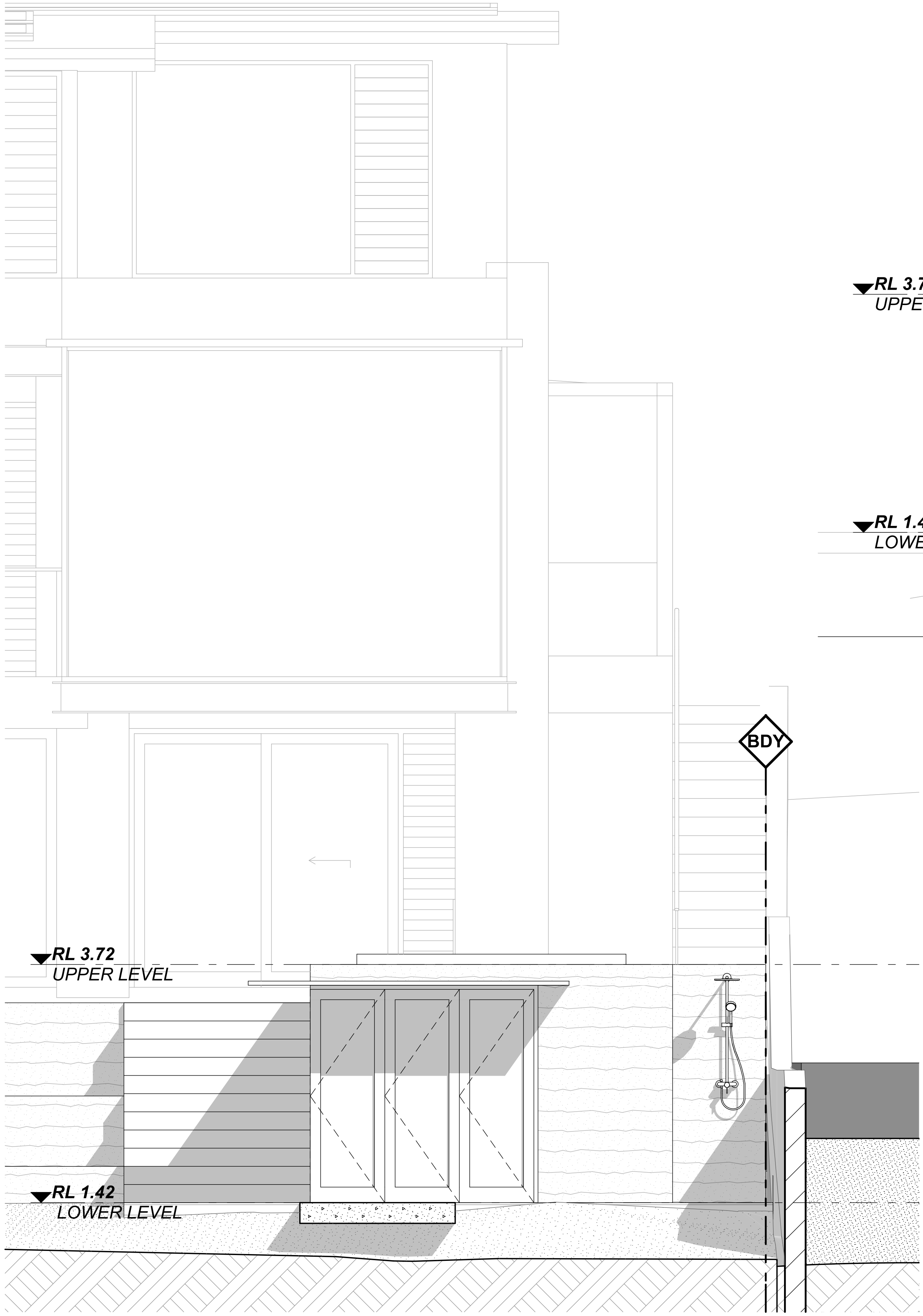


WEST ELEVATION



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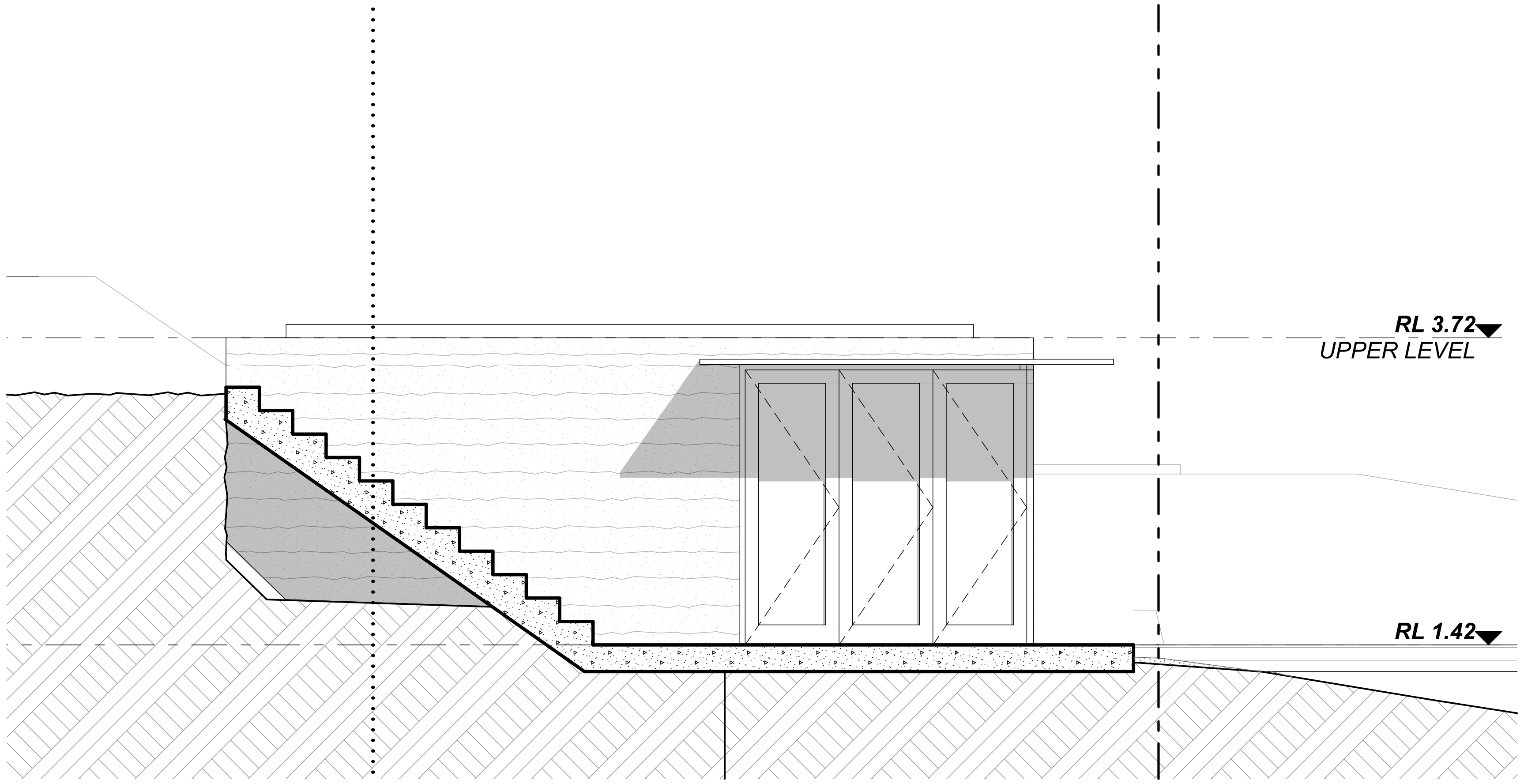

EAST ELEVATION

GARTNERTROVATO
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DATE	REV	DESCRIPTION
12/1/22	A	DA

PROJECT
DEVELOPMENT APPLICATION
NEW BOATHOUSE
1772 PITTWATER ROAD, BAYVIEW NSW
LOT 51, DP 740538

FOR ANDREW BURSILL & GEORGIE TORRENS

DRAWING TITLE
ELEVATIONS

SCALE	DRAWN BY	PLOT DATE
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PROJECT NO.	**DRAWING NO.**	**REVISION**
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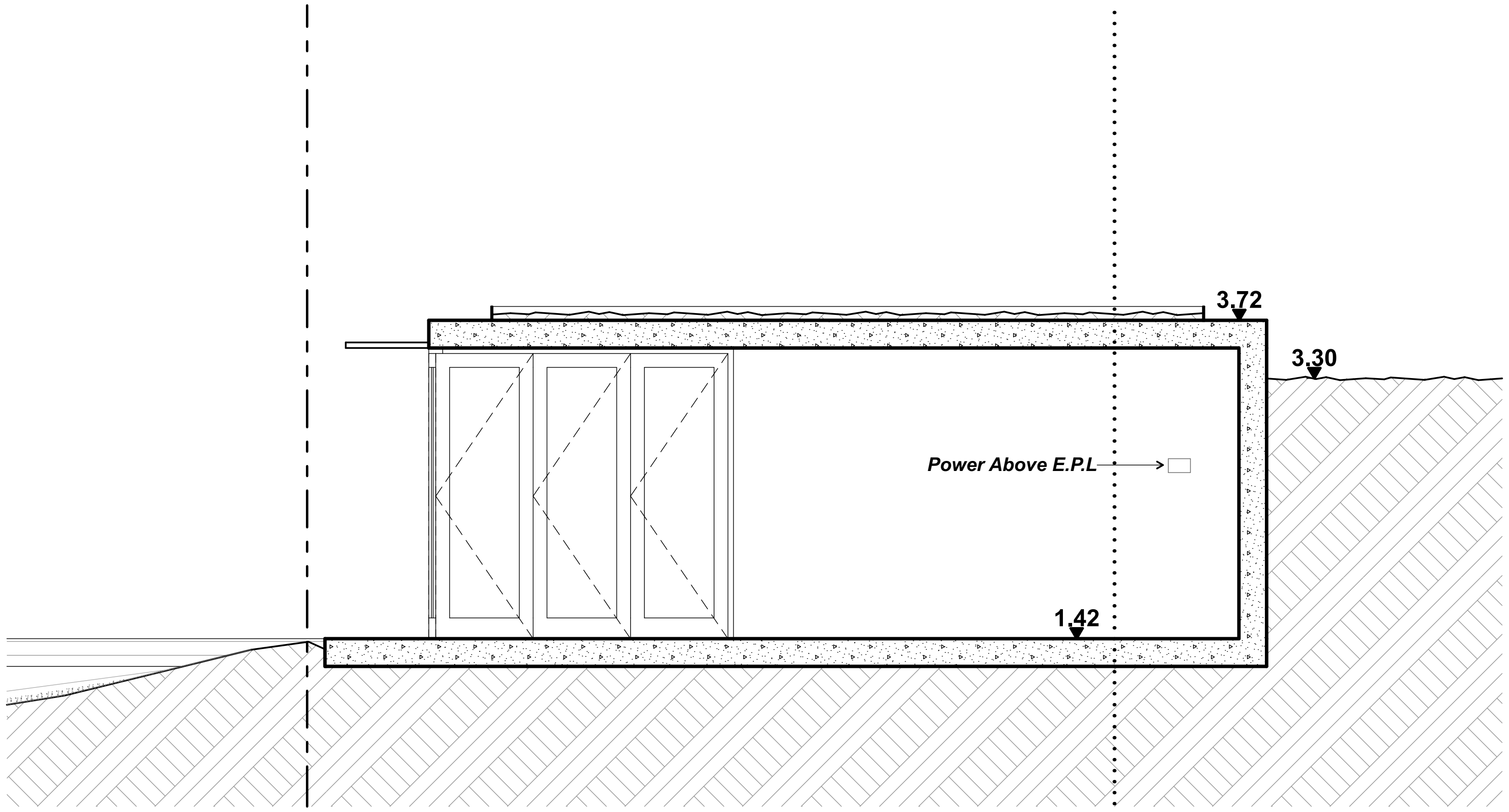
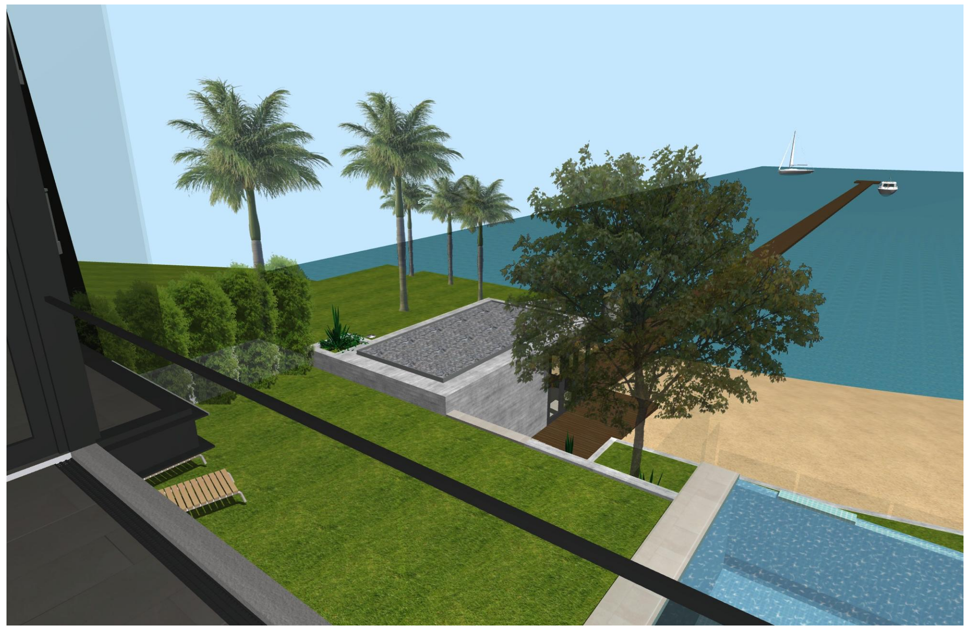


SECTION G



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DATE	REV	DESCRIPTION
12/1/22	A	DA

PROJECT
DEVELOPMENT APPLICATION
NEW BOATHOUSE
1772 PITTWATER ROAD, BAYVIEW NSW
LOT 51, DP 740538
FOR ANDREW BURSILL & GEORGIE TORRENS

DRAWING TITLE
SECTION + VIEWS

SCALE	DRAWN BY	PLOT DATE
1:50 @ A3	AB / SG	12/1/22
PROJECT NO.	**DRAWING NO.**	**REVISION**
1925	A.05	A

Appendix C Site Survey, CMS Surveyors, 15/07/2019

Notes:

- **BOUNDARIES HAVE NOT BEEN DEFINED (TITLE DIMENSIONS ONLY) - BOUNDARY DEFINITION IS SUBJECT TO FURTHER SURVEY.**
- **A BASIC BOUNDARY SURVEY HAS BEEN UNDERTAKEN SUITABLE FOR COUNCIL DA SUBMISSION (TITLE DIMENSIONS ONLY) - BOUNDARY DEFINITION IS SUBJECT TO FURTHER SURVEY.**
- **IF CONSTRUCTION ON OR NEAR BOUNDARIES IS REQUIRED IT IS RECOMMENDED THAT THE BOUNDARIES OF THE LAND BE MARKED.**
- **AREA IS APPROXIMATE ONLY AND HAS BEEN CALCULATED BY TITLE DIMENSIONS. ALL TITLE DIMENSIONS OF THE LAND HAVE NOT BEEN CONFIRMED BY SURVEY. IF AREAS ARE CRITICAL WE RECOMMEND A BOUNDARY SURVEY FOR PUBLIC RECORD.**
- TREE SIZES ARE ESTIMATES ONLY.

THIS PLAN HAS BEEN PREPARED FOR THE EXCLUSIVE USE OF ANDREW BURSILL

- RELATIONSHIP OF IMPROVEMENTS TO BOUNDARIES IS DIAGRAMMATIC ONLY. WHERE OFFSETS ARE CRITICAL THEY SHOULD BE CONFIRMED BY FURTHER SURVEY.
- EXCEPT WHERE SHOWN BY DIMENSION LOCATION OF DETAIL WITH RESPECT TO BOUNDARIES IS INDICATIVE ONLY.
- ONLY VISIBLE SERVICES HAVE BEEN LOCATED. UNDERGROUND SERVICES HAVE NOT BEEN LOCATED. DIAL BEFORE YOU DIG SERVICES (ph 1100) SHOULD BE USED AND A FULL UTILITY INVESTIGATION, INCLUDING A UTILITY LOCATION SURVEY, SHOULD BE UNDERTAKEN BEFORE CARRYING OUT ANY CONSTRUCTION ACTIVITY IN OR NEAR THE SURVEYED AREA.
- SEWER MAIN PLOTTED FROM SYDNEY WATER SEWER DIAGRAM. LOCATION SHOULD BE MARKED ON SITE IF CRITICAL.
- CRITICAL SPOT LEVELS SHOULD BE CONFIRMED WITH SURVEYOR.
- THIS PLAN IS ONLY TO BE USED FOR THE PURPOSE OF DESIGNING NEW CONSTRUCTIONS.
- CONTOURS SHOWN DEPICT THE TOPOGRAPHY. THEY DO NOT REPRESENT THE EXACT LEVEL AT ANY PARTICULAR POINT. ONLY SPOT LEVELS SHOULD BE USED FOR CALCULATIONS OF QUANTITIES WITH CAUTION.
- CONTOUR INTERVAL - 0.5 metre. - SPOT LEVELS SHOULD BE ADOPTED.
- POSITION OF RIDGE LINES ARE DIAGRAMMATIC ONLY (NOT TO SCALE).
- THE INFORMATION IS ONLY TO BE USED AT A SCALE ACCURACY OF 1:100.
- DO NOT SCALE OFF THIS PLAN / FIGURED DIMENSIONS TO BE TAKEN IN PREFERENCE TO SCALED READINGS.

LEGEND:

AW = AWNING
BAL = BALCONY
BIT = BITUMEN
BLD = EXTERNAL BUILDING
BW = BOTTOM WALL
CHI = CHIMNEY
CL = CENTRELINE
CON = CONCRETE
DS = DOOR SILL LEVEL
GF = GUTTER LEVEL
GM = GAS METER
GRT = GRATE
IL = INVERT LEVEL
JET = JETTY
LH = LAMP HOLE
LIN = LINTEL
LM = LINE MARKING
NS = NATURAL SURFACE
PAR = PARAPET
PAT = PATIO
PAV = PAVING
POOL = POOL
RF = TOP OF ROOF
RR = ROOF RIDGE
SMH = SEWER MAN HOLE
SMHS = SEWER MAN HOLE SQUARE
STR = STAIRS
TB = TOP OF BANK
TG = TOP OF GUTTER
TIL = TILE
TKB = TOP OF KERB
TOP = TOP OF PIPE
TPIT = TELSTRA PIT
TR = TREE
TW = TOP OF WALL
WM = WATER METER

EO = ELECTRICITY OVERHEAD
S = SEWER UNDERGROUND
TREE
SPREAD-DIAMETER-HEIGHT

0 1 2 3 4 5 6 7 8 9 10
SCALE 1:100

1	FIRST ISSUE	15/07/19

HORIZONTAL DATUM:
CO-ORDINATE SYSTEM: MGA
MARKS ADOPTED:
PM 27882 - PM 27883
L.G.A. NORTHERN BEACHES

VERTICAL DATUM:
DATUM: AUSTRALIAN HEIGHT DATUM (AHD)
B.M. ADOPTED: PM 27882
R.L. 12.826 (ORDER L2)
SOURCE: S.C.I.M.S. (28/06/19)

CLIENT:
ANDREW BURSILL
20 BURRAWONG AVENUE
MOSMAN NSW 2088

SURVEY PLAN
SHOWING DETAIL & LEVELS
OVER LOT 51 IN D.P.740538
No. 1772 PITTWATER ROAD
BAYVIEW NSW 2104

CMS SURVEYORS
C.M.S. Surveyors
Pty Limited
ACN: 096 240 201
PO Box 463 Dee Why NSW 2099
2/99A South Creek Road, Dee Why NSW 2099
Telephone: (02) 9971 4802 Facsimile: (02) 9971 4822
E-mail: info@cmssurveyors.com.au

SURVEYED	DRAWN	CHECKED	APPROVED
PB/MB	MC	PB/MB	DL

SURVEY INSTRUCTION	SCALE	DATE OF SURVEY
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CAD FILE: 18660detail 2.dwg
SHEET 1 OF 1
ISSUE 2