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Our Ref:
Your Ref: A212/63

2/3/2021

Altius Unit Trust
1858 Pittwater Road
Church Point NSW 2105

Paul Peterkin

Dear Paul

ESTUARINE RISK MANAGEMENT ADDENDUM REPORT – MINOR MODIFICATIONS, "PASADENA", 1858 PITTWATER ROAD, CHURCH POINT.

This letter is an Addendum to the Advisian (2016) report that documents the estuarine risk for the proposed modifications to the development, in accordance with the Pittwater 21 DCP, and should be read in conjunction with that report (provided in Appendix A).

Background

A refurbishment and new fitout are being planned at the existing licensed premises at 1858 Pittwater Road, Church Point, known as "Pasadena".

Pittwater Council has outlined requirements for foreshore development along the Pittwater estuary. One of these requirements is for new development to be at or above the Estuarine Planning Level (or EPL). Pittwater Council has identified an EPL for locations all around the Pittwater Estuary, depending on the location, type of foreshore treatment (seawall or natural beach foreshore), and distance of the development from the shoreline.

An Estuarine Risk Management report for the development was prepared in April 2016 (Advisian 2016) which assessed independently the water levels and estuarine risk for the development, which was approved by Northern Beaches Council. Since that report was issued, minor modifications to the development application A212/63 have been sought by Altius Unit Trust. The modifications (Figure 1) include:

- The enclosure of the existing waste storage and keg pickup handling areas,
- The relocation of the existing bathroom facilities to facilitate the reconfiguration of the existing shop tenancies,

- The consolidation of 3 shop tenancies to create 2 shop tenancies,
- The expansion of the existing general store to include a new servery, access doors and roofed deck orientated towards the adjacent reserve, and
- The replacement of the existing external fire egress stair at the rear of the property.

Council Requirements

The development is subject to the provisions of Pittwater 21 DCP, in particular, Part B3.9 Estuarine Hazards. Under the provisions of the DCP, development must be protected from the effects of wave action or tidal inundation either by mitigation works or ensuring that the floor levels of the development are at or above the Estuarine Planning Level (EPL).

Where constructing the floor level at the Estuarine Planning Level or raising the floor level of the existing development to the EPL may be difficult to achieve, due to practical, heritage or other constraints, Council may give consideration to a floor level at a level lower than the Estuarine Planning Level for the non-residential component of the development, subject to demonstration through a Estuarine Risk Management Report that all precautions have been taken to minimise risk from the effect of wave action and tidal inundation up to the Estuarine Planning Level.

Northern Beaches Council has requested an updated Estuarine Risk Management Report as an addendum to the Advisian (2016) report, stating that:

> *"The proposed modifications are located below the base EPL at RL 2.15. An Estuarine Risk Management Report should consider development constraints due to estuarine hazard impacts on the proposed modifications, including an assessment of the degree of inundation, effects of wave action, impacts of waterborne debris, buoyancy effects, and other emergency issues during the design event (100 ARI event). The report should also contain recommendations as to any reasonable and practical measures that can be undertaken to remove foreseeable risk associated with estuarine hazards for the design life of the development."*

The proposed modifications and their effect on the estuarine risk for the property are discussed below.

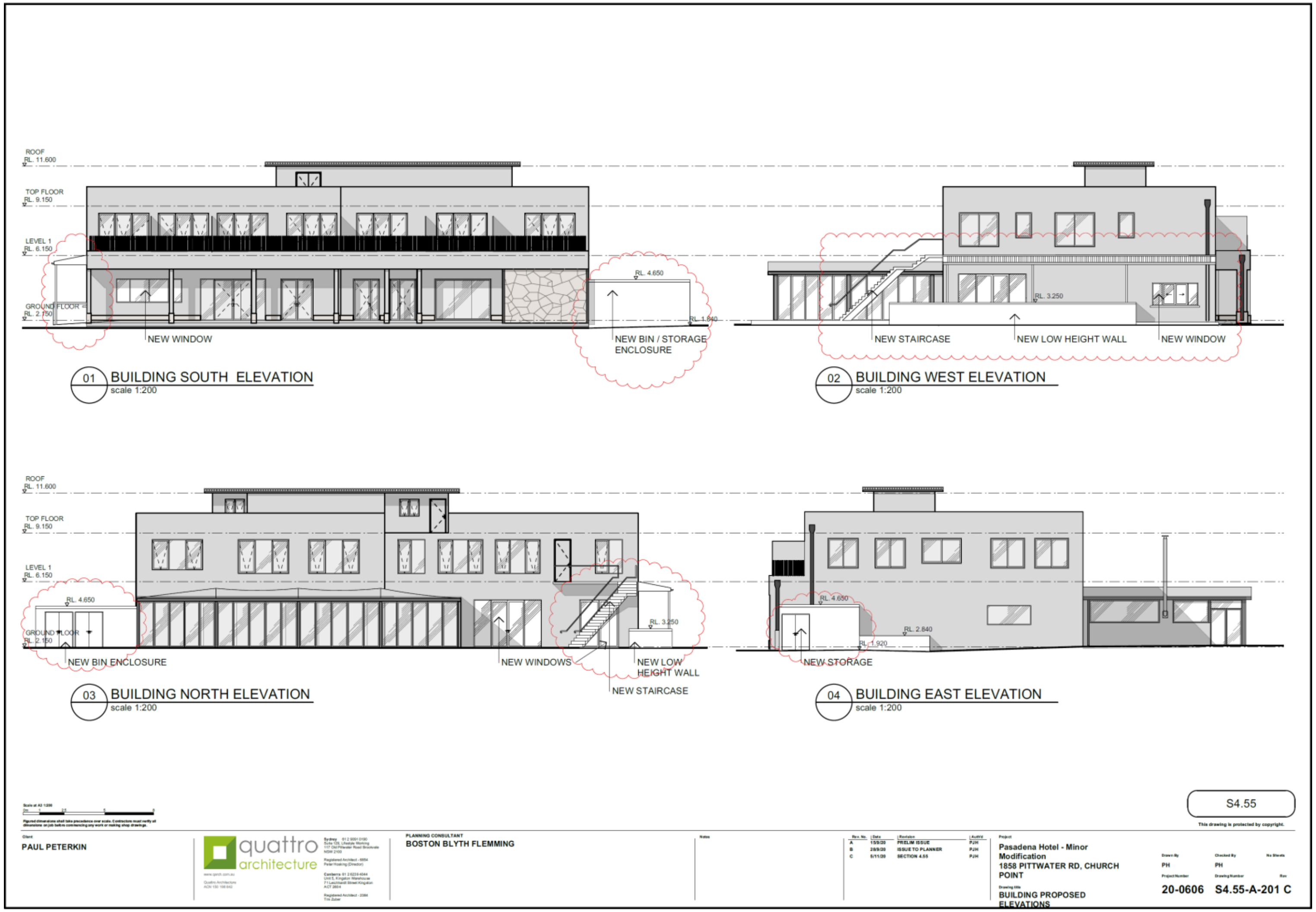

Figure 1 - Proposed modifications to approved DA (Quattro architecture, 2020)

Enclosure of existing waste storage and keg pickup handling areas

The enclosure of the waste storage and keg pickup handling areas is shown below in Figure 2. The enclosure is located on the southern side of the property, adjacent to the carpark and is located 40 m from the foreshore.

Advisian (2016) derived an EPL of 2.0 m AHD for the development, for a 2050 projected sea level rise of 0.4 m. This was based on a reduction factor for the design water level suggested by Lawson and Treloar (2004) for Church Point of 0.2 m, for the edge of the building being 10 m from the foreshore. For the garbage bin and keg storage area, located 40 m from the foreshore, the reduction factor for Church Point suggested by Lawson and Treloar (2004) is 0.5 m, providing an EPL of 1.7 m AHD for the 2050 planning period. It is assessed that the finished level of the enclosure (varying from 1.70 m AHD to 1.84 m AHD) is above this level.

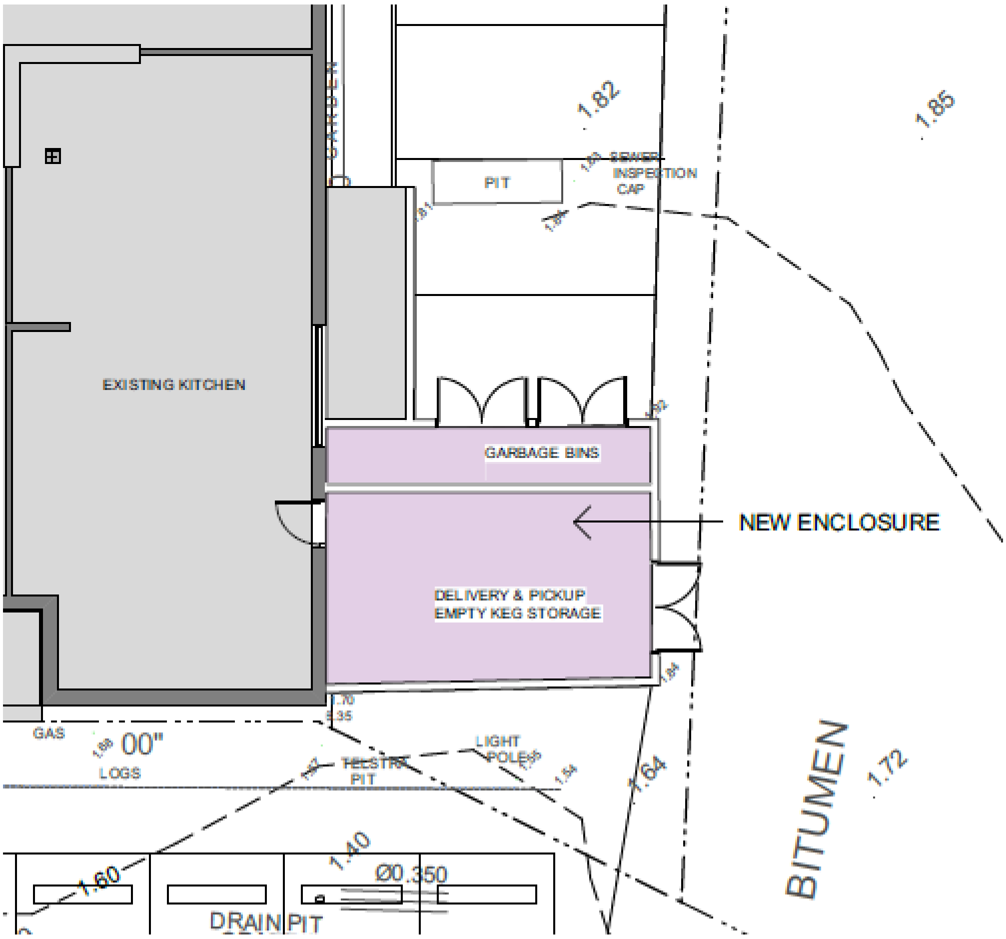

Figure 2 - Garbage bin and keg storage area enclosure

It should be noted that the development must comply with the provisions of the P21 DCP Part B3.9, i.e.

- *All development or activities must be designed and constructed such that they will not increase the level of risk from estuarine processes for any people, assets or infrastructure in surrounding properties; they will not adversely affect estuarine processes; they will not be adversely affected by estuarine processes; and*

- *All structural elements below the Estuarine Planning Level shall be constructed from flood compatible materials; and,*
- *All structures must be designed and constructed so that they will have a low risk of damage and instability due to wave action and tidal inundation; and,*
- *All electrical equipment, wiring, fuel lines or any other service pipes and connections must be waterproofed to the Estuarine Planning Level; and,*
- *The storage of toxic or potentially polluting goods, materials or other products, which may be hazardous or pollute the waterway, is not permitted to be stored below the Estuarine Planning Level; and,*
- *For existing structures, a tolerance of up to minus 100mm may be applied to the Estuarine Planning Level in respect of compliance with these controls.*
- *To ensure Council's recommended flood evacuation strategy of 'shelter-in-place' it will need to be demonstrated that there is safe pedestrian access to a 'safe haven' above the Estuarine Planning Level.*

Addressing these factors, the proposed garbage bin and keg storage area:

- does not increase the level of risk from estuarine processes for any people, assets or infrastructure in surrounding properties. The proposed enclosure is located well landward of the estuary foreshore. However, should inundation occur, the enclosure would deflect inundation flows away from the building and garbage bin storage, and would result in a decreased level of risk for any people, assets and infrastructure compared with the existing situation.
- It is noted that the proposed enclosure would need to be constructed from flood compatible materials and must be designed and constructed so that it will have a low risk of damage and instability due to wave action and tidal inundation. It is recommended that the enclosure be constructed from cement-rendered brick to match the exterior of the surrounding building.
- All electrical equipment, wiring, fuel lines or any other service pipes and connections must be waterproofed to the EPL. It is recommended that any of these services within the storage area be set at 2.5 m AHD or above, as per the recommendations of Advisian (2016).
- Storage of potentially polluting goods must be above the EPL – while the base of the enclosure is above 1.7 m AHD (which is considered to be the EPL for this location 40 m away from the foreshore), the proposed enclosure would reduce the risk of estuarine processes affecting the potentially polluting goods (garbage bins) as the enclosure would deflect inundation flows away from this area. Construction of an elevated platform at approximately 2.0 m AHD or higher for stowing the garbage bins may be considered to cater for future increased inundation risk.
- The storage area would have direct access to the kitchen which has a floor level of 2.15 m AHD and would be a suitable area to seek shelter should the storage area be impacted by inundation.

Relocation of the existing bathroom facilities to facilitate the reconfiguration of the existing shop tenancies

This modification does not result in any changes to the external footprint of the building or changes to the finished floor levels, so there would be no impact of this amendment on the estuarine risk for the property.

The consolidation of 3 shop tenancies to create 2 shop tenancies

This modification does not result in any changes to the external footprint of the building or changes to the finished floor levels, so there would be no impact of this amendment on the estuarine risk for the property.

The expansion of the existing general store to include a new servery, access doors and roofed deck orientated towards the adjacent reserve

A new low-height wall would be added to the development as indicated in Figure 3. The new low height wall would enclose the deck area on the northern side of the development and would have a bottom level at existing ground level, which is below the EPL Other elements of this modification include a new awning, which would be constructed above the EPL and would not interact with the estuarine processes.

Addressing the factors to be considered in P21 DCP Part B3.9, the proposed new deck and low height wall:

- does not increase the level of risk from estuarine processes for any people, assets or infrastructure in surrounding properties. The proposed wall would deflect inundation flows away from the deck, providing some protection from inundation to the building and would therefore result in a decreased level of risk for any people, assets and infrastructure compared with the existing situation.
- It is noted that the proposed wall would need to be constructed from flood compatible materials and must be designed and constructed so that it will have a low risk of damage and instability due to wave action and tidal inundation. It is recommended that it be constructed from cement-rendered brick to match the exterior of the surrounding building.
- All electrical equipment, wiring, fuel lines or any other service pipes and connections must be waterproofed to the EPL. It is recommended that any of these services within the deck area be set at 2.5 m AHD or above, as per the recommendations of Advisian (2016).
- Storage of potentially polluting goods must be above the EPL – it is understood that the deck area would not be used for any storage of potentially polluting goods.
- The deck area would have direct access to the general store which has a floor level of 2.15 m AHD and would be a suitable area to seek shelter should the deck area be impacted by inundation.

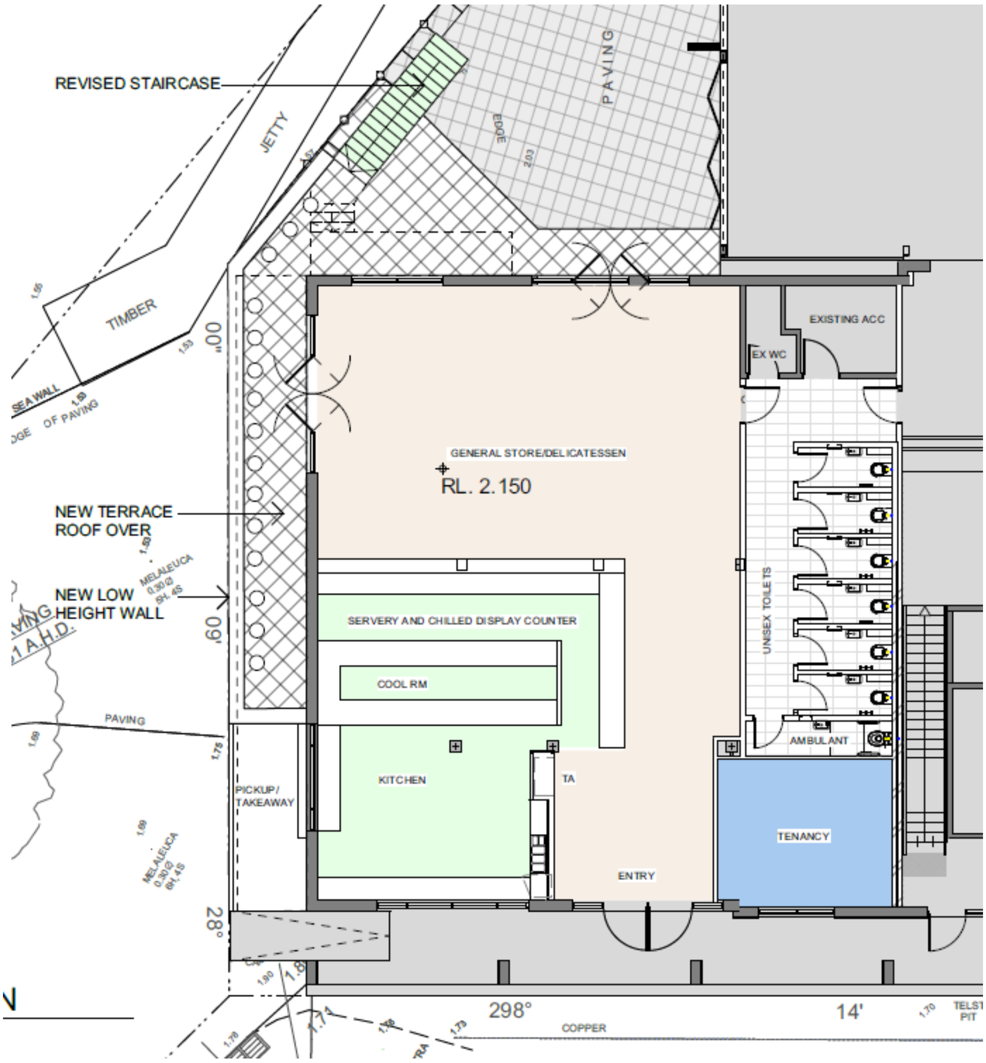

Figure 3 – Proposed new low-height wall and internal modifications

Replacement of the existing external fire egress stair at the rear of the property.

The proposed external fire egress stairway would provide improved shelter-in-place provision for the property as it would provide safe access to the upper floors of the building should there be an inundation event. It is considered that the provision of the stairway would improve the level of risk from estuarine processes for any people, assets or infrastructure on the property, and would not affect the estuarine risk at any surrounding properties.

The proposal involves replacement of the existing staircase with a new staircase as shown in Figure 3. The new staircase provides improved access to the deck area when compared with the existing staircase, and is located within the existing approved footprint of the development as shown in Figure 3.

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Conclusion and Recommendations

This Addendum report assesses the estuarine risk as a result of proposed modifications to the Pasadena development under the approved DA A212/63, in accordance with Northern Beaches Council's requirements under P21 DCP Part B3.9. It was found that:

- the proposed modifications do not increase the level of risk from estuarine processes for any people, assets or infrastructure in surrounding properties or at the property itself
- there are adequate shelter-in-place provisions as a result of the proposed modifications during an inundation event.

It is recommended that:

- the proposed modifications be constructed from flood compatible materials and designed and constructed so that they will have a low risk of damage and instability due to wave action and tidal inundation. For example, the low height wall and garbage bin storage enclosure may be constructed from cement-rendered brick to match the exterior of the surrounding building.
- All electrical equipment, wiring, fuel lines or any other service pipes and connections must be waterproofed to the EPL. It is recommended that any of these services be set at 2.5 m AHD or above, as per the recommendations of Advisian (2016).
- provision of an elevated platform set to at least 2.0 m AHD within the storage enclosure be considered for the storage of bins and kegs

Salutation

We trust that this suits your requirements. Should you require further information, please contact the undersigned.

Yours faithfully

Chris Adamantidis
Associate Coastal Engineer

Lex Nielsen
Principal Consultant, Coastal Engineering CPEng.

References

Advisian (2016) "1858 Pittwater Road Church Point Estuarine Risk Management Report", Report no. 301311-13295-001, April.

Lawson and Treloar (2004) "Estuarine Planning Level Mapping Pittwater Estuary", Report for Pittwater Council, September 2004.

Quattro Architecture (2020) S4.55 Modification Application MINOR MODIFICATIONS PASADENA 1858 PITTWATER RD, CHURCH POINT QUATTRO PROJECT NUMBER 20-0606, Architectural Drawings.

APPENDIX A – 2016 ADVISIAN REPORT – 1858 PITTWATER ROAD CHURCH POINT – ESTUARINE RISK MANAGEMENT REPORT

1858 Pittwater Road Church Point

Estuarine Risk Management Report

10-May-16

Level 17, 141 Walker St
North Sydney NSW 2060
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301311-13295-001

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WorleyParsons Group

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Project No: 301311-13295-001 – 1858 Pittwater Road Church Point: Estuarine Risk Management Report

Rev	Description	Author	Review	Advisian Approval	Date
A	Draft for Internal Review	C. Adamantidis	A. Nielsen		
B	Draft for Client Review	C. Adamantidis	A. Nielsen	A. Nielsen	19/4/16
0	Final	C. Adamantidis	A. Nielsen	A. Nielsen	10/5/16

Table of Contents

1 Introduction

A refurbishment and new fitout are being planned at the existing licensed premises at 1858 Pittwater Road, Church Point, known as "Pasadena" (Figure 1).

Pittwater Council has outlined requirements for foreshore development along the Pittwater estuary. One of these requirements is for new development to be at or above the Estuarine Planning Level (or EPL). Pittwater Council has identified an EPL for locations all around the Pittwater Estuary, depending on the location, type of foreshore treatment (seawall or natural beach foreshore), and distance of the development from the shoreline.

The development is subject to the provisions of Pittwater Council's 21 DCP, in particular, Part B3.9 Estuarine Hazards. Under the provisions of the DCP, development must be protected from the effects of wave action or tidal inundation either by mitigation works or ensuring that the floor levels of the development are at or above the EPL.

Where constructing the floor level at the Estuarine Planning Level or raising the floor level of the existing development to the Estuarine Planning Level may be difficult to achieve, due to practical, heritage or other constraints, Pittwater Council may give consideration to a floor level at a level lower that the Estuarine Planning Level for the non-residential component of the development, subject to demonstration through a Estuarine Risk Management Report that all precautions have been taken to minimise risk from the effect of wave action and tidal inundation up to the Estuarine Planning Level.

Advisian has been engaged by Altius Pty Ltd to submit an Estuarine Risk Management Report in accordance with Council's Estuarine Risk Management Policy, to provide an independent wave action and tidal inundation assessment for the redevelopment. This report documents the Estuarine Risk for the property, in accordance with Pittwater Council's 21 DCP.

Figure 1 – Study Area

2 Study Area

The location for this Estuarine Risk Assessment is shown in Figure 2. The site is located at Church Point, on the southern shore of Pittwater opposite Scotland Island. The site is protected largely from locally-generated seas by the presence of Scotland Island, but is subject to waves generated over a restricted fetch to the north of 1.4 km and a restricted fetch to the south-east of 1.6 km. Swell waves generated offshore do not penetrate into this area of Pittwater, so the site is protected from swell waves.

The proposed development involves an internal fitout of an existing building (currently located with a floor level below the EPL), refurbishment of an existing covered tiled area with outdoor seating, and refurbishment of the internal area of the existing building at the ground and first floor.

A site plan of the proposed development is shown in Figure 3, and an elevation view is shown in Figure 4.

2.1 Existing Facility

The existing facility is shown in Figure 5. The facility is fronted by a vertical sandstone seawall in good condition, with a crushed gravel pathway 2 m wide at the crest. The crest of the seawall is approximately 1.50 m AHD, with a gently sloping lawn area on the landward side with an average level of 1.75 m AHD. At the toe of the seawall, the shoreline is sandy with a uniform foreshore slope of around 1V:10H.

The existing floor level of the building is 2.15 m AHD, or approximately 0.4 m above the adjacent lawn level.

Views of the existing building are shown in Figure 5, Figure 6, Figure 7, Figure 8 and Figure 9.

2.2 Description of the Proposal

The proposed works involve demolition of internal walls and provision of a new covered dining area and lawn landscaping, with a finished floor level of 2.15 m AHD.

The redevelopment consists of retrofitting the existing two level building with bathrooms on the ground floor, amenities, dining area and kitchen with new accommodation rooms on the first floor. The proposed development is shown in Figure 3.

Figure 2 – Zoomed aerial view of subject site

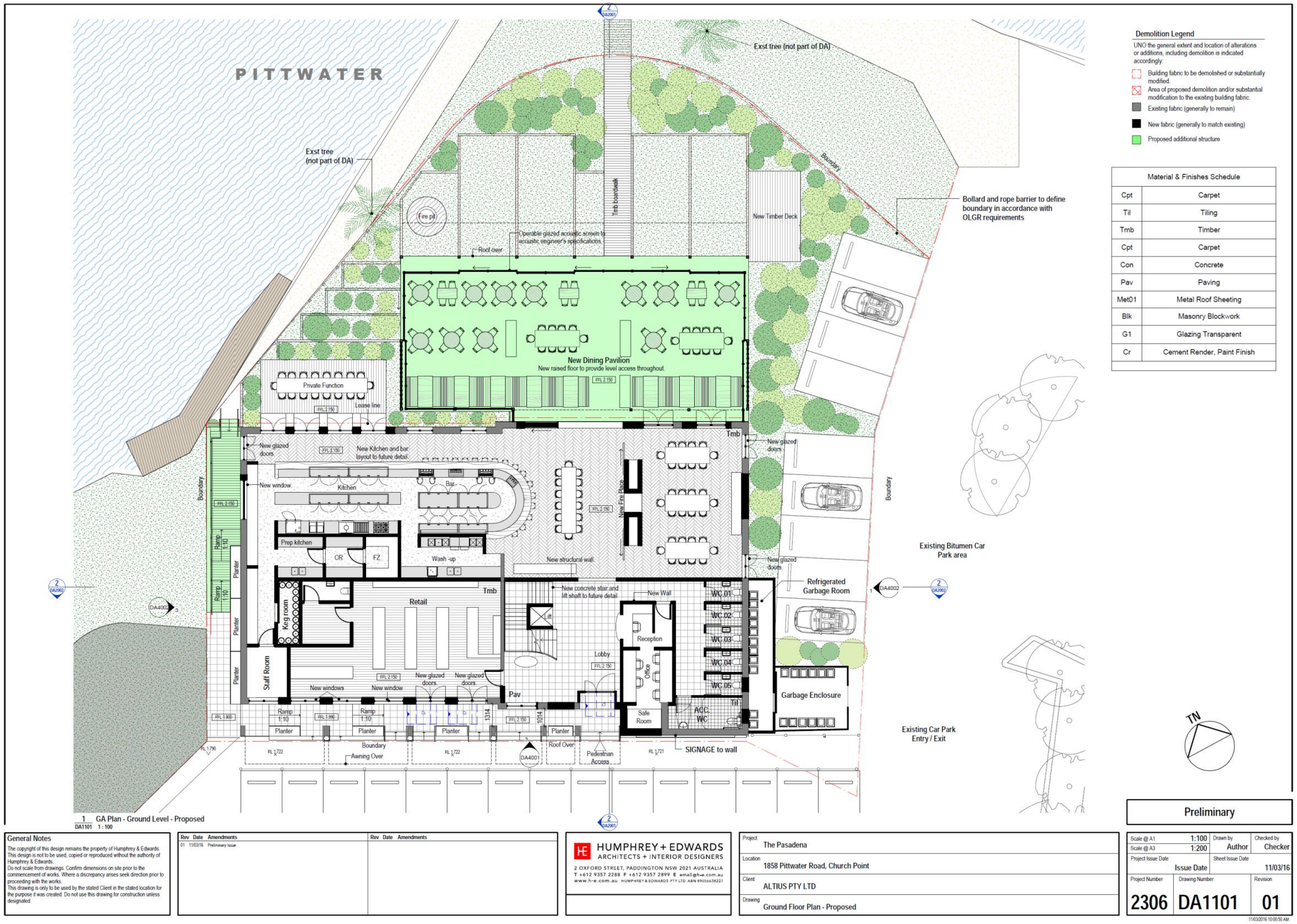


Figure 3 –Proposed development – Plan View

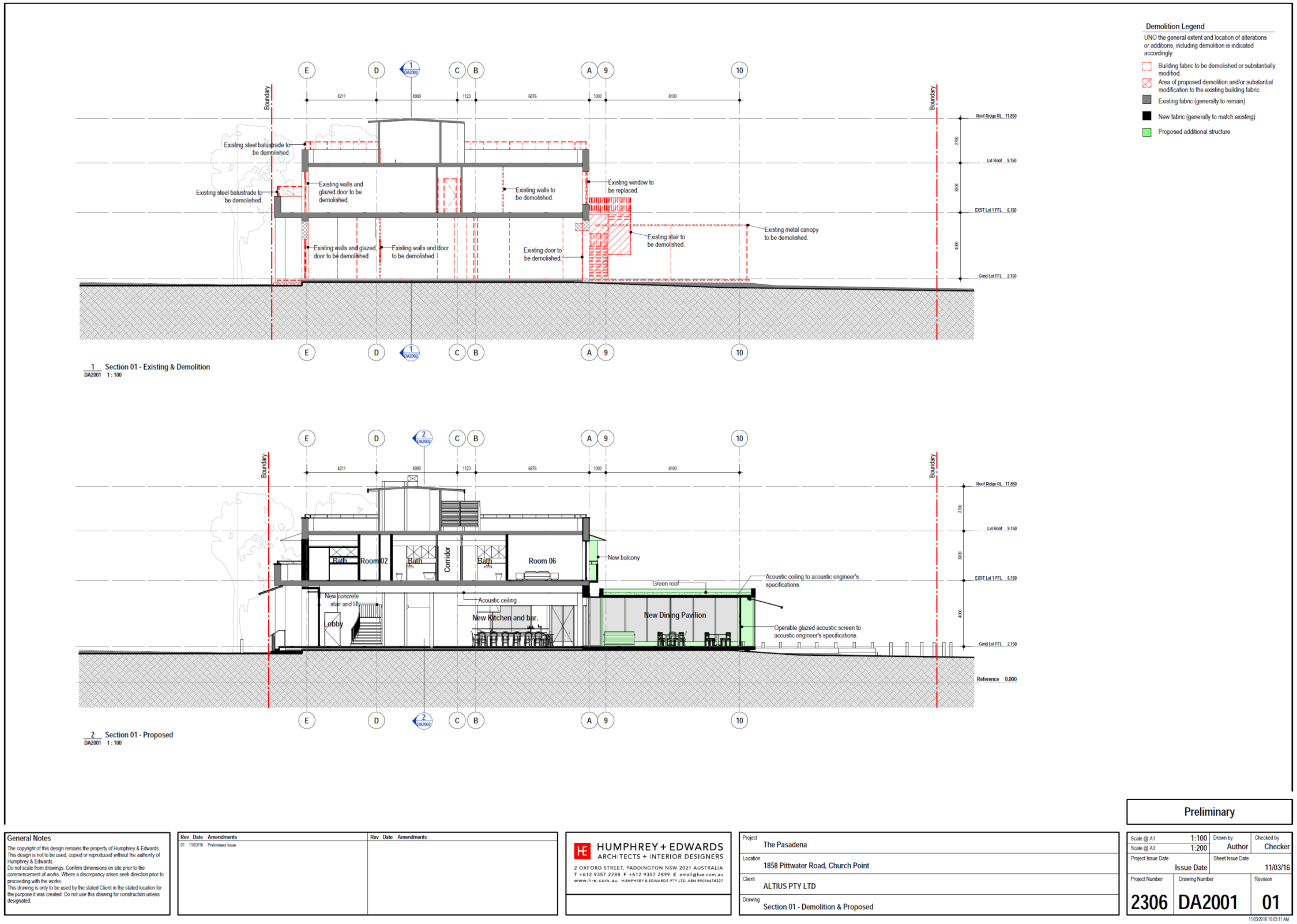


Figure 4 – Proposed Development – Section View

Figure 5 – View of existing building looking south from gravel path

Figure 6 – View of existing building and seawall from jetty adjacent to property

Figure 7 – View of seawall looking west

Figure 8 – View of proposed dining area with existing floor level and footprint to be retained

Figure 9 – View of existing lawn and proposed parking area looking north from proposed dining area

3 Pittwater Council Requirements

Pittwater Council has outlined requirements for foreshore development along the Pittwater estuary. One of these requirements is for new development to be at or above the Estuarine Planning Level (or EPL). Pittwater Council has identified an EPL for locations all around the Pittwater Estuary, depending on the location, type of foreshore treatment (seawall or natural beach foreshore), and distance of the development from the shoreline.

The redevelopment of the Pasadena building at Church Point is subject to the provisions of Pittwater DCP 21, B3.9 Estuarine Hazard (Business, Light Industrial and Other Development).

The site is currently zoned B1 “Neighbourhood Centre”.

To ensure that the development is compliant with the objectives of Council’s Estuarine Risk Management Policy, a technical Estuarine Risk Management Report is required to address estuarine level information, the management of estuarine risk and other criteria as it affects the subject land and its surrounds.

Under the DCP, the development is subject to the provisions of the ***Estuarine Risk Management Policy for Development in Pittwater***, which establishes the estuarine risk management approach for development on land affected by wave action and tidal inundation around the Pittwater waterbody. Under the Policy, development must be undertaken in accordance with the acceptable risk management criteria for a design project life (100 years). The objectives of the Policy are:

> *(a) To ensure that wave action and tidal inundation processes (affecting development or likely to be affected by development) are adequately investigated and documented by applicants or proponents of activities prior to the lodgement of any development application or Part 5 Assessment to carry out any development/activity subject to this Policy, or wherever an application is lodged for a Building Certificate; and*
>
> *(b) to establish whether or not the proposed development or activity is appropriate to be carried out having regard to the results of investigations; and*
>
> *(c) to ensure effective controls exist to guarantee that a development is carried out in accordance with the requirements of this Policy; and*
>
> *(d) to ensure that the preparation of wave action and tidal inundation related information and certificates required to be lodged by this Policy are carried out by suitably qualified professionals with appropriate expertise in the applicable areas of engineering; and*
>
> *(e) that developments are only carried out if estuarine and related structural engineering risks are identified and can be effectively addressed and managed for the life of the development at an acceptable level of risk.*

Under the Policy, an Estuarine Planning Level (EPL) applies to the site, depending on the type of foreshore treatment and the distance of the development from the foreshore (Figure 11).

Estuarine Risk refers to foreshore inundation from a very high tide (1% change of occurring in any one year) combined with the effect of a storm event and including the impacts of sea level rise up to the year 2100.

The calculation used by Council to determine the EPL takes into account:

- tidal level with a 1% chance of occurring in any one year with sea level rise;
- wind setup and wave heights specific to different areas of Pittwater;
- wave run-up and overtopping;
- freeboard (to allow for uncertainties with wave and wind action primarily).

The components of the EPL are illustrated in Figure 10. Note that freeboard is defined as the difference between the water surface and the floor level of the building, and is shown incorrectly in Figure 10.

The current EPL requires the selection of one of four foreshore types including sandy beach, vertical wall, sloping rock wall and natural rocky shoreline.

The EPL would include the tidal level with a 1% chance of occurring in any one year with sea level rise, wind setup and wave height as well as freeboard.

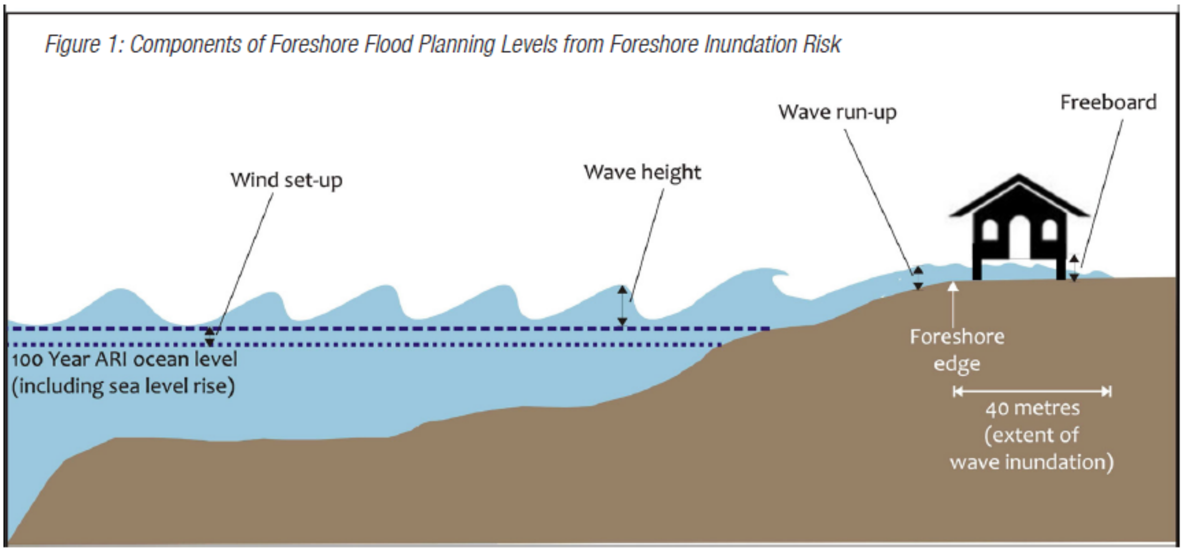


Figure 10 – Components of the FFPL (Cardno, 2011)

For the Pasadena development, located at Lot 142 DP752046, the base EPL is 2.68 m AHD at the shoreline according to information provided by Altius Pty Ltd (for a foreshore protected by a vertical seawall with crest level of 1.5 m AHD), with a reduction based on distance of the development from the shoreline. As the edge of the building will be over 10 m away from the foreshore, the reduction factor suggested by Lawson and Treloar (2004) for Church Point is 0.2 m, and the EPL for the development is 2.48 m AHD.

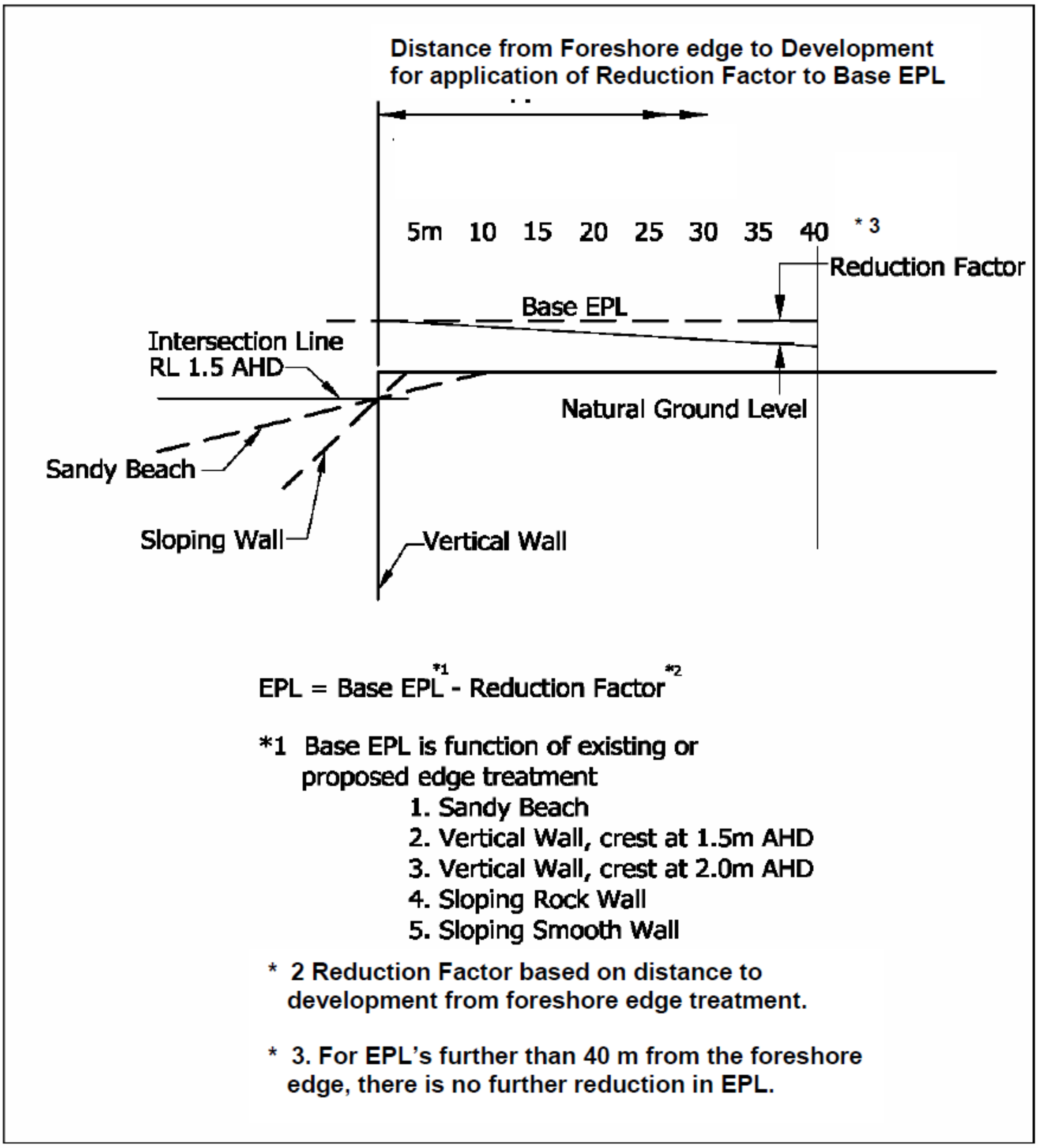


Figure 11 – Diagrammatic Representation for determining Estuarine Planning Level (from P21 DCP, Appendix 7)

Under the provisions of the DCP, development is to be protected from the effects of wave action or tidal inundation either by mitigation works or by ensuring that the floor levels are at or above the EPL.

Under the DCP, the following clauses apply:

- *All development or activities must be designed and constructed such that they will not increase the level of risk from estuarine processes for any people, assets or infrastructure in surrounding properties; they will not adversely affect estuarine processes; they will not be adversely affected by estuarine processes; and*
- *All structural elements below the Estuarine Planning Level shall be constructed from flood compatible materials; and,*
- *All structures must be designed and constructed so that they will have a low risk of damage and instability due to wave action and tidal inundation; and,*
- *All electrical equipment, wiring, fuel lines or any other service pipes and connections must be waterproofed to the Estuarine Planning Level; and,*
- *The storage of toxic or potentially polluting goods, materials or other products, which may be hazardous or pollute the waterway, is not permitted to be stored below the Estuarine Planning Level; and,*
- *For existing structures, a tolerance of up to minus 100mm may be applied to the Estuarine Planning Level in respect of compliance with these controls.*
- *To ensure Council's recommended flood evacuation strategy of 'shelter-in-place' it will need to be demonstrated that there is safe pedestrian access to a 'safe haven' above the Estuarine Planning Level.*

The finished floor levels of the ground floor of the development would be 2.15 m AHD, which is below the EPL of 2.68 m AHD provided by Council. For this section of the development, the following clause from the DCP applies:

> *Floor Levels - Change of Use and Alterations and Additions for Existing Premises - Business and Light Industrial Development Only*
>
> *Where constructing the floor level at the Estuarine Planning Level or raising the floor level of the existing development to the Estuarine Planning Level may be difficult to achieve, due to practical, heritage or other constraints, consideration may be given to a floor level at a level lower that the Estuarine Planning Level for the non-residential component of the development, subject to demonstration through a Estuarine Risk Management Report that all precautions have been taken to minimise risk from the effect of wave action and tidal inundation up to the Estuarine Planning Level.*

4 Review of Previous Studies

The Estuarine Planning Level has been derived based on a study undertaken by Lawson and Treloar (2004), "Estuarine Planning Level Mapping Pittwater Estuary". That report has been updated by Cardno (2015) to incorporate the sea level rise benchmarks adopted by Pittwater Council (0.4 m of sea level rise by 2050 and 0.9 m sea level rise by 2100).

Cardno (2015) report the 100 year ARI storm tide level as:

- 1.4 m AHD for present day (based on analysis of long term recorded water level data at Fort Denison)
- 1.8 m AHD by 2050 (incorporating 0.4 m sea level rise)
- 2.3 m AHD by 2100 (incorporating 0.9 m sea level rise)

Local effects were considered to include the following:

- wind setup (caused by wind piling the water up against the shoreline, estimated by Lawson and Treloar, 2003 to be 0.06 m at Church Point)
- Wave setup/wave runup (which depends on the foreshore edge treatment, estimated by Lawson and Treloar, 2003 to be 0.4 m for a vertical wall at 1.5 m AHD, and 0.2 m for a vertical wall at 2.0 m AHD)
- Freeboard allowance 0.3 m (which was considered by Cardno, 2011 to be an appropriate freeboard accounting for the uncertainties).
- Total EPL at the site = 1.4 + 0.4 + 0.06 + 0.3 = 2.16 m AHD (present day), 2.56 m AHD (2050) and 3.06 m AHD (2100).

The EPL is reduced based on distance from the site, due to attenuation of the wave runup by percolation and friction. It was assumed that the wave runup component diminishes to zero at a distance of 40 m from the foreshore.

Lawson and Treloar (2003) undertook wave modelling in the Pittwater estuary, using the SWAN wave transformation model. They derived *significant* wave heights (average of the highest one-third of the waves) at various locations around the Pittwater foreshore. The modelling found that ocean swell waves do not affect the site, as they do not penetrate beyond Salt Pan Point. For sea waves, the SWAN model was used to create a wind speed/wave height matrix for 16 different wind directions, and the model was run for wind speeds up to the 100 year ARI wind speed. The wind speed was derived using recorded wind data from 60 years of wind records at Botany Bay, with an increase of 5% to allow for greater exposure at the Pittwater site. Using this method, design wave heights for wind driven waves were derived for varying probabilities of exceedance. For Church Point, the model-derived 100 year ARI wave height was found to be 0.88 m. The 50 year ARI local sea significant wave height at the same location was found to be 0.82 m.

To estimate the EPL for the eastern half of the estuary (east of Church Point), Lawson and Treloar (2004) combined a 100 year ARI storm tide with a 50 year ARI local sea, as it was considered that the 100 year ARI storm tide would likely not be associated with a 100 year ARI local sea. This is because the sea wave climate is dominated by north-easterly to north-westerly sector storms, whereas the storms that cause high water levels at the estuary entrance are south-easterly sector storms. For this reason, the joint occurrence of the highest water levels and highest wind-generated waves was considered to be very rare on the eastern side of the estuary.

The parameters used to define the EPL are derived independently in the next section, including wave and water level parameters appropriate specifically for the site.

5 Derivation of Wave and Water Level Parameters

The wave and water level information for the Pasadena development is derived independently below.

There are four separate conditions providing various wave and water level parameters for design:

1. Present-day south-east storm conditions generating the maximum water levels at the mouth of the estuary

2. Present-day northerly and easterly wind wave conditions generating the maximum wave conditions incident onto the subject site

3. South-east storm conditions generating the maximum water levels for the year 2050.

4. Northerly and easterly wind wave conditions incident onto the subject site for the year 2050.

5.1 Ocean water levels

During storms, the ocean water level and that at the shoreline is elevated above the normal tide level. While these higher levels are infrequent and last only for short periods, they may exacerbate any storm damage on the foreshore.

The components of these elevated water levels comprise the astronomical tide, barometric water level setup, wind setup, wave setup and runup (Figure 12). All of the components do not act or occur necessarily independently of each other but their coincidence and degree of inter-dependence, generally, is not well understood.

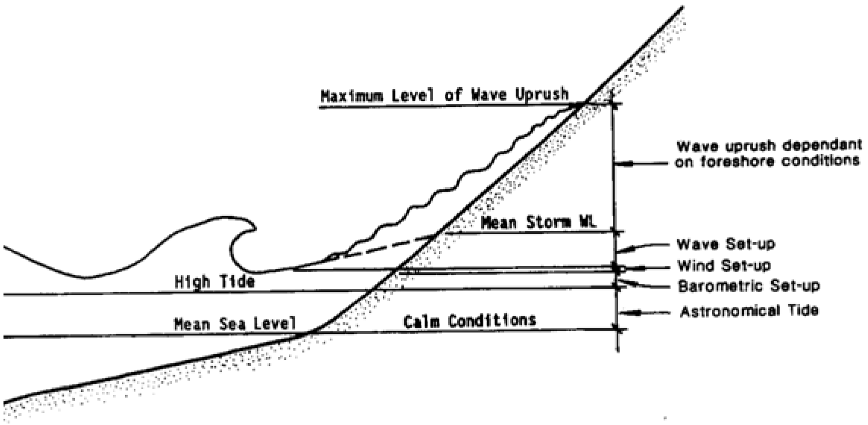


Figure 12 - Components of elevated water levels on the coast (NSW Government, 1990)

The tides of the NSW coast are semidiurnal with a diurnal inequality. This means that there are two high tides and two low tides each day and there is a once-daily inequality in the tidal range. The mean tidal range is around one metre and the tidal period is around 12.5 hours. Tides vary according to the phases of the moon. The higher spring tides occur near and around the time of new or full moon and rise highest and fall lowest from the mean sea level. The average spring tidal range is 1.3 metres and the maximum range reaches two metres. Neap tides occur near the time of the first and third quarters of the moon and have an average range of around 0.8 metres.

Storm surge is the increase in water level above that of the normal tide that results from the low barometric pressures, which are associated with severe storms and cause sea level to rise, and strong onshore winds that pile water up against the coast. Measured values of storm surge at Sydney include 0.59 m for the extreme storm event of 25–26 May 1974 and 0.54 m for the extreme storm event of 31 May – 2 June 1978 (Haradasa et al., 1991). Both of these extreme events were coincident with spring high tides with the water level in the 1974 event reaching the maximum recorded at Fort Denison of 1.48 m AHD[1].

Return periods for ocean water levels comprising tidal stage and storm surge for Sydney, which are representative of the study region, are presented in Figure 13. The 100 year ARI ocean water level from Figure 13 is 2.36 m ISLW, which is equivalent to 1.435 m AHD.

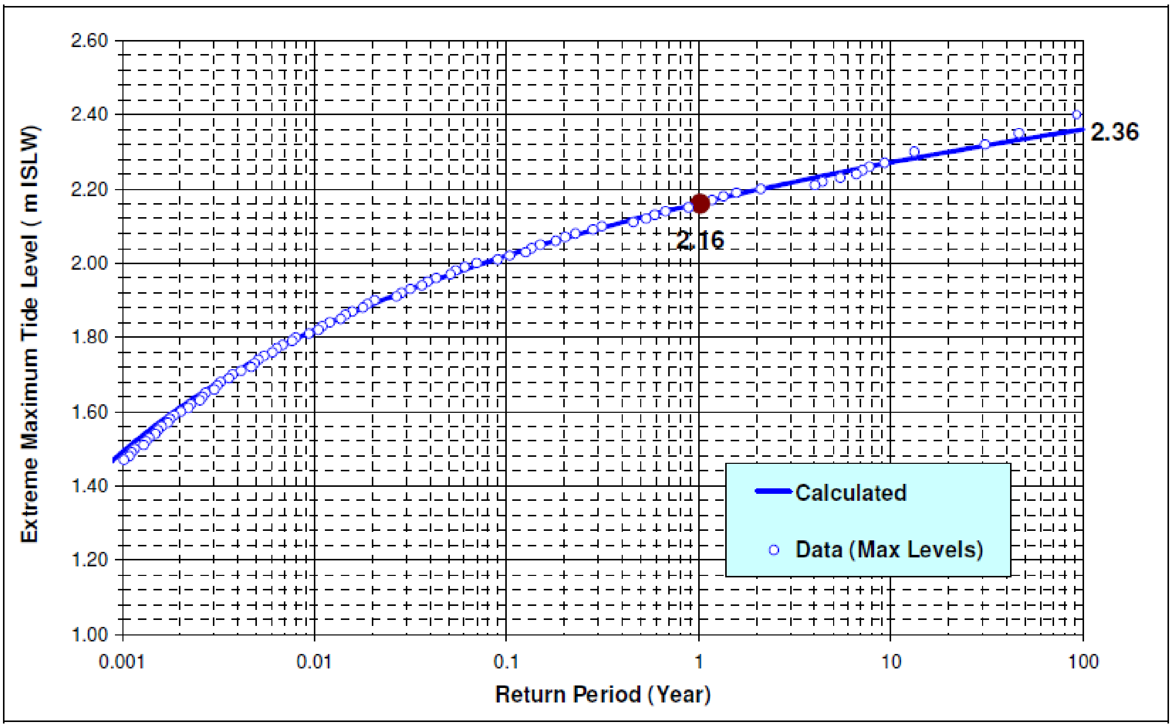


Figure 13 - Design Still Water Levels for Fort Denison (Watson and Lord, 2008)

[1] This level was not actually recorded due to the failure of the tide gauge at the peak water level. The level was inferred by interpolation from adjacent records.

Other high water level events recorded at the Fort Denison tide gauge include:

- 27/4/1990 (2.35 m ISLW, or 1.425 m AHD)
- 19/8/2001 (2.27 m ISLW, or 1.34 m AHD)
- 14/6/2007 (2.21 m ISLW, or 1.29 m AHD).

5.2 Wind waves

The site is sheltered from waves from most directions, due to the presence of Scotland Island directly opposite the site. Therefore, wind waves are able to arrive at the site only from a very narrow range of directions (within a 20° window from the north and a 35° window from the east-southeast), as shown in Figure 14.

Over this range, the maximum fetch is 1.4 – 1.7 km, as shown in Figure 14. A view over this fetch from the site is shown in Figure 15. It can be seen that there are some obstructions to the waves, such as numerous boats, and that waves can only arrive at the site from an oblique angle (especially for the easterly fetch).

Wind speeds from the north or east direction have reached speeds above 50 km/h at Sydney Airport on several occasions since records began in 1939, most recently in September 2006. The highest wind speed (3 second gust) measured from the east was 64.8 km/h in June 1952, and the highest recorded wind speed from the north (3 second gust) was 57.6 km/h, occurring in September 1942, October 1942 and July 1966.

5.2.1 Joint occurrence of wind speed with water level

The highest recorded water levels generally are associated with south-southeasterly storm events. During the high water level event of 25-26 May 1974, the highest recorded 10 minute average wind speed at Sydney Airport was 79.6 km/h, coming from the south. During the 1978 water level event, the 10 minute average wind speed at Sydney Airport reached 68.4 km/h, also from the south. During these events, there would have been no waves generated at the site as it is not exposed to a southerly fetch.

The highest ranking recorded wind speeds from the sector which would generate wind waves at the site were compared with the associated recorded water levels at Fort Denison. It was found that wind speeds at Sydney Airport of up to 60 km /h from the critical directions (from the north and east sectors) have occurred in the historical record, but that there was no association between the highest ranking recorded wind speeds and the highest ranking recorded water levels.

Inspection of the available data revealed that the highest recorded wind speeds from the north or east sector (which would generate waves at the site) could be associated with a maximum tidal anomaly of up to 0.2 m at Fort Denison. Higher tidal anomalies are typically associated with storms that generate winds from the south-east sector, which would not result in waves at the site. Historically, from analysis of the available data, a 100 year ARI water level has not been associated with a northerly or easterly wind speed greater than a 1 year ARI at the site.

While this has not occurred over the historical record, should a 0.2 m tidal anomaly occur in conjunction with the Highest Astronomical Tide (2.07 m ISLW), the water level could reach 2.27 m ISLW (which, from Figure 13, is approximately equivalent to a 10 year ARI water level).

To estimate the local *significant* wave height generated by northerly winds blowing over the Pittwater estuary to the site, the ACES wave transformation algorithms (Leeknecht et al., 1991) were used. These algorithms hindcast the local wave conditions, based on the distance over water which the wind blows (the *fetch*), the *duration* over which the wind blows, the velocity of the wind, the depth of the water and how restricted the fetch is. As the fetch is relatively short (1.4 – 1.7 km) and the range of wind directions over which waves can be generated is small, the locally generated waves will be fetch-limited at the site. This simple approach is considered appropriate when compared with using a two-dimensional model such as SWAN for sea waves within the estuary, as wave refraction effects would be negligible for wind waves generated within the relatively short fetch distance within the waterway.

The results from the ACES analysis for waves from the north resulting from an hourly wind speed of 43 km/h (converted from 64.8 km/h 3-second gust, equivalent to the highest measured wind speed from the north) are shown below. It can be seen that such a wind would result in a *significant* wave height of 0.23 m at the site. For waves from the east, the *significant* wave height would be 0.25 m.

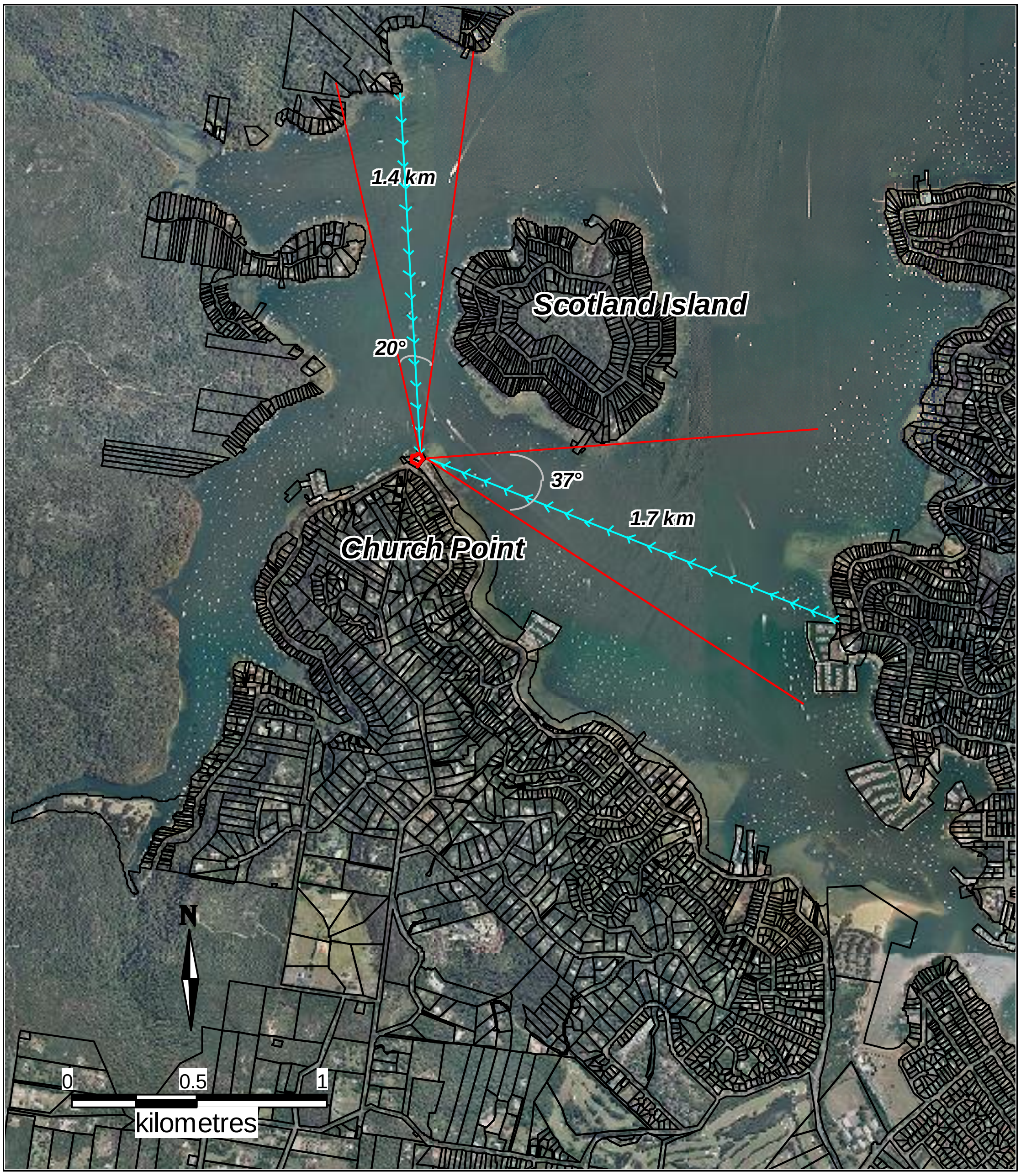
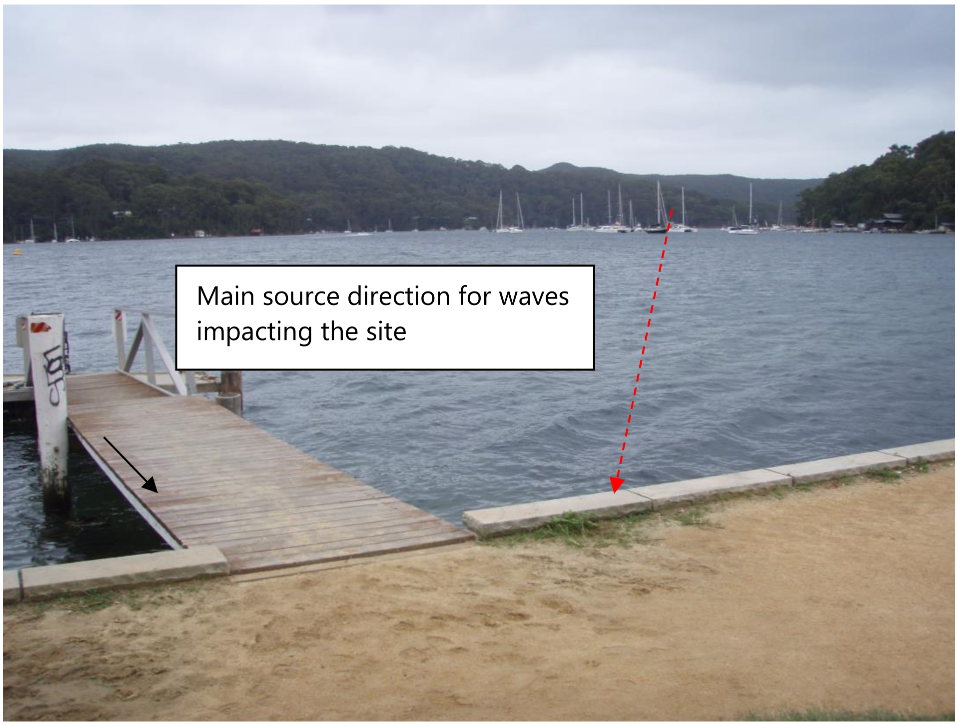


Figure 14 - Fetch distances and range of directions over which waves can impact the site



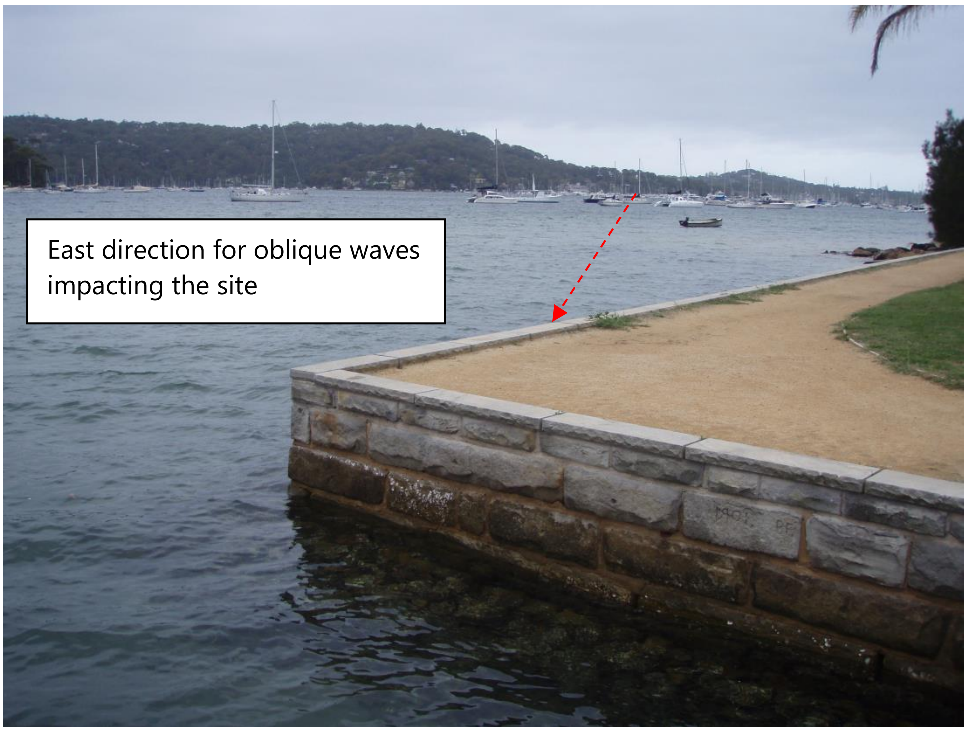


Figure 15 - View from site over main wave source directions (Top – View to north; Bottom – View to east)

ACES | Mode: Single Case | Functional Area: Wave Prediction

Application: Wind Adjustment and Wave Growth

Item	Value		Units
El of Observed Wind	Zobs:	10.00	m
Observed Wind Speed	Uobs:	11.90	mps
Air Sea Temp. Diff.	ΔT:	0.00	deg C
Lat. of Observation	LAT:	33.00	deg
Wind Fetch Length	F:	1.40	km
Avg Fetch Depth	d:	12.00	m
Wind Direction		5.00	deg
Eq Neutral Wind Spd	Ue:	10.69	mps
Adjusted Wind Speed	Ua:	12.94	mps
Mean Wave Direction		7.00	deg
Wave Height	Hmo:	0.23	m
Wave Period	Tp:	1.64	sec

Wind Obs Type: Overwater (ship) / × Overwater / Shore (windward) / Shore (leeward) / Inland / Geostrophic

Wind Fetch Options: Open Water / × Restricted

Options:
F1: New Case
F3: Print
F10: Exit Applic

Wave Growth: Shallow-water Fetch-limited

ACES | Mode: Single Case | Functional Area: Wave Prediction

Application: Wind Adjustment and Wave Growth

Item	Value		Units
El of Observed Wind	Zobs:	10.00	m
Observed Wind Speed	Uobs:	11.90	mps
Air Sea Temp. Diff.	ΔT:	0.00	deg C
Lat. of Observation	LAT:	33.00	deg
Wind Fetch Length	F:	1.70	km
Avg Fetch Depth	d:	12.00	m
Wind Direction		5.00	deg
Eq Neutral Wind Spd	Ue:	10.69	mps
Adjusted Wind Speed	Ua:	12.94	mps
Mean Wave Direction		7.00	deg
Wave Height	Hmo:	0.25	m
Wave Period	Tp:	1.72	sec

Wind Obs Type: Overwater (ship) / × Overwater / Shore (windward) / Shore (leeward) / Inland / Geostrophic

Wind Fetch Options: Open Water / × Restricted

Options:
F1: New Case
F3: Print
F10: Exit Applic

Wave Growth: Shallow-water Fetch-limited

Table 1 - ACES wave prediction for 43 km/h northerly wind speed (top), easterly wind (bottom)

5.2.2 Wind speed occurrence from Australian Standard

The wind speed at the site for estimation of the local wave height has been estimated from the Australian Standard, AS/NZS 1170.2 using terrain Category 2 (water surfaces, open terrain, grassland with few well scattered obstructions having heights generally 1.5 to 10m).

The resulting wave height hindcast from the wind speeds for winds from the west-northwest estimated using the Australian Standard is shown in Table 2, below.

Table 2 - ACES results for ARI wind speeds from north or east

ARI	ARI wind speed (north and east) (m/s)	Significant Wave Height (Hs, m)	Peak Wave Period (Tp, s)
100 year ARI	22.2	0.47	1.6
50 year ARI	21.2	0.45	1.5
20 year ARI	20.1	0.42	1.5
10 year ARI	18.4	0.38	1.5
5 year ARI	17.4	0.35	1.4
1 year ARI	14.1	0.28	1.3

It can be seen that the 100 year ARI significant wave height is around 0.5 m, and the 1 year ARI significant wave height is around 0.3 m.

It is likely that wave heights at the site would be significantly lower than the values shown in Table 2, due to obstruction of wave energy from the numerous vessels in the estuary.

5.2.3 Wave Setup and Wind Setup

Wave setup refers to the elevation of the local water level due to wave breaking. Wave runup refers to the maximum level that the waves will run up to. Wind setup refers to the piling up of water against the shoreline due to the effect of onshore wind. Due to the bathymetry of the site, the wind setup component is expected to be negligible.

From the survey for the site, the crest of the seawall fronting the site is at 1.5 m AHD. The toe of the seawall is about 1.5 m below the crest, at around 0 m AHD, and the slope of the shoreline in front of the seawall is approximately 1V:10H.

The 100 year ARI offshore water level is 1.44 m AHD (from Figure 13). The 100 year ARI significant wave height is approximately 0.47 m. As the water is relatively deep in front of the seawall when the water level is high, the approaching waves will not break before reaching the seawall and there will be negligible wave setup experienced at the site.

As noted by Lawson and Treloar (2004), it is conservative to apply joint occurrence of a 100 year ARI offshore water level with a 100 year ARI wave height for this area of Pittwater (due to differing weather systems associated with these events within the south-eastern corner of Pittwater). Based on examination of 70 years of wind data at Botany Bay and 40 years of water level data at Fort Denison, the highest wind speed from the north that has occurred is 64.8 km/h (in June 1952, or around a 10 year ARI wind speed), leading to a local significant wave height of 0.38 m at the site. From examination of 40 years of water level records, a 100 year ARI water level has not been measured historically to coincide with a northerly wind speed at the site greater than a 1 year ARI. While the joint probability of occurrence of northerly waves and high ocean water levels is not known precisely, based on examination of the data it has been assumed conservatively that a 100 year ARI ocean water level could be associated with a 10 year ARI wave height at the site. From Table 2, the 10 year ARI *significant* wave height at the site would be 0.38 m. The wave height exceeded by 10% of waves in a wave train, H_{10}, is normally used for design purposes – this is equivalent to 1.27 times higher than the significant wave height, or 0.48m.

As the waves approaching the seawall are in relatively deep water, there will be only minor steepening of the waves. According to stream function wave theory, in 1.44m water depth, for a wave height of 0.48m with period 1.5s, the trough of the wave is 0.17m below the still water level and the crest of the wave is 0.30m above the still water level. This is illustrated in Figure 16, below.

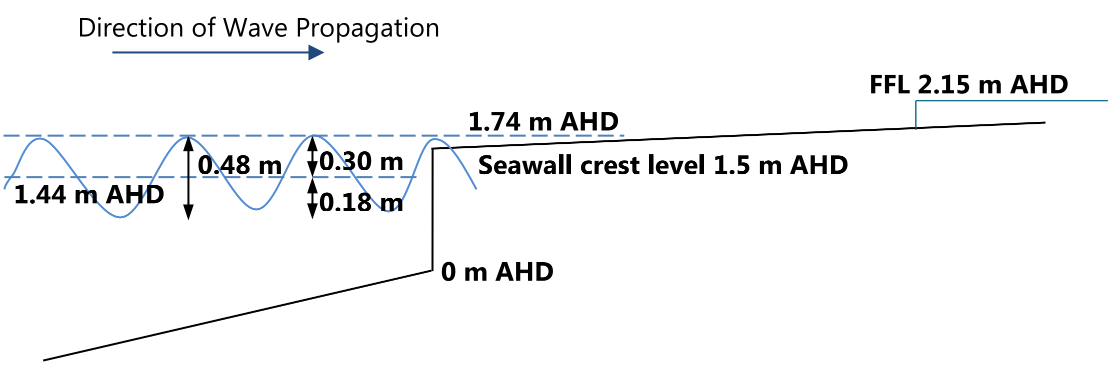


Figure 16 - Wave train approaching shoreline at the site (not to scale)

The combined effect of the offshore water level and amplitude of the wave would lead to a 100 year ARI water level at the boundary of the site of 0.30 + 1.44 = 1.74 m AHD. Allowing for the minor effects from wind setup, the 100 year ARI water level at the boundary of the site would be 1.8 m AHD. This level would lead to minor overtopping of the existing seawall (which has a crest level at 1.5 m AHD).

The present day 100 year ARI design water level at the shoreline would therefore be 1.8 m AHD, diminishing with distance from the edge of the shoreline. As the site consists of a relatively permeable grassed surface and gravel path, it is expected that the waves would percolate into the soil and that the water depth over the flat portion of the site would diminish rapidly with distance from the foreshore. Further, the ground level slopes upward from the crest of the seawall and is mostly above the 1.8 m AHD level. As the edge of the building will be over 10 m away from the foreshore, the reduction factor for the design water level suggested by Lawson and Treloar (2004) for Church Point is 0.2 m. This gives a water level of 1.6 m AHD, which is 0.55 m below the finished floor level of the building.

5.3 Impact of Sea Level Rise due to Climate Change

The Australian Tax Office allows the construction cost of a new residential rental property to be deducted at 2.5% per year over 40 years, implying a 40 year economic lifespan for a typical residential building (ATO 2012) and other references cite an economic lifespan of a typical residential building of 30 – 40 years (International Energy Agency, 2008). This would imply that the 2050 planning horizon may be sufficient for planning purposes for this proposed development.

Adopting a sea level rise of 0.4 m by 2050 in accordance with Pittwater Council's sea level rise projections, the design water level at the shoreline in 2050 would be 2.2 m AHD. An appropriate EPL for the site would therefore be 2.2 m AHD which, due to the conservative allowance for sea level rise and wind setup, includes an allowance for freeboard, with the EPL diminishing with distance from the edge of the site. As the edge of the building will be over 10 m away from the foreshore, the reduction factor for the design water level suggested by Lawson and Treloar (2004) for Church Point is 0.2 m, providing an EPL of 2.0 m AHD for the site. This EPL is lower than the proposed finished floor level of the development (2.15 m AHD) and, for this condition, a freeboard of 0.15m is adequate.

By 2100, with 0.9 m sea level rise, the EPL could reach 2.5 m AHD. Should inundation levels exceed 2.15 m AHD in the future, ready pedestrian access is provided from the ground floor to the second floor which is well above the EPL.

6 Measures to Mitigate Risk

From the analysis presented in this report, it is apparent that the proposed refurbishment to the building would be above the safe design water level in the present day and accounting for sea level rise by 2050. However, beyond 2050, sea level rise may increase the EPL above the finished floor level. A provision of the P21 DCP Part B3.9 states that:

> *Where constructing the floor level at the Estuarine Planning Level or raising the floor level of the existing development to the Estuarine Planning Level may be difficult to achieve, due to practical, heritage or other constraints, consideration may be given to a floor level at a level lower that the Estuarine Planning Level for the non-residential component of the development, subject to demonstration through a Estuarine Risk Management Report that all precautions have been taken to minimise risk from the effect of wave action and tidal inundation up to the Estuarine Planning Level.*

In accordance with the above provision, the following comments can be made:

- The proposed dining area of the building, on the seaward side of the lower section, is above the 2050 EPL of 2.0 m AHD as determined in this report. The lower section is sufficiently far back from the shoreline that it would not be affected by wave action and tidal inundation, and is not residential.
- Minor landscaping features such as a low (0.3 m high) retaining wall could be used within the lawn area to deflect any wave overtopping to prevent it reaching the seaward edge of the property.
- By 2100, with 0.9 m sea level rise, the EPL could reach 2.5 m AHD. Should inundation levels exceed 2.5 m AHD in the future, ready pedestrian access is provided from the ground floor to the second floor which is well above the EPL. This would ensure compliance with Council's recommended flood evacuation strategy of 'shelter-in-place', as there is safe pedestrian access to a 'safe haven' above the Estuarine Planning Level. As this level of inundation would result in overfloor flood depth of less than 0.4 m, it would be classified as “Low Hazard” according to the NSW Floodplain Development Manual (Figure 17, 2005).

It is considered that the risk from estuarine processes for people, assets or infrastructure at the property is not increased when compared with the existing situation, and can be reduced/managed with minor landscaping works in the lawn on the seaward edge of the property.

It is recommended also that electrical wiring and switches be located above 2.5 m AHD or above the local flood level (whichever is higher).

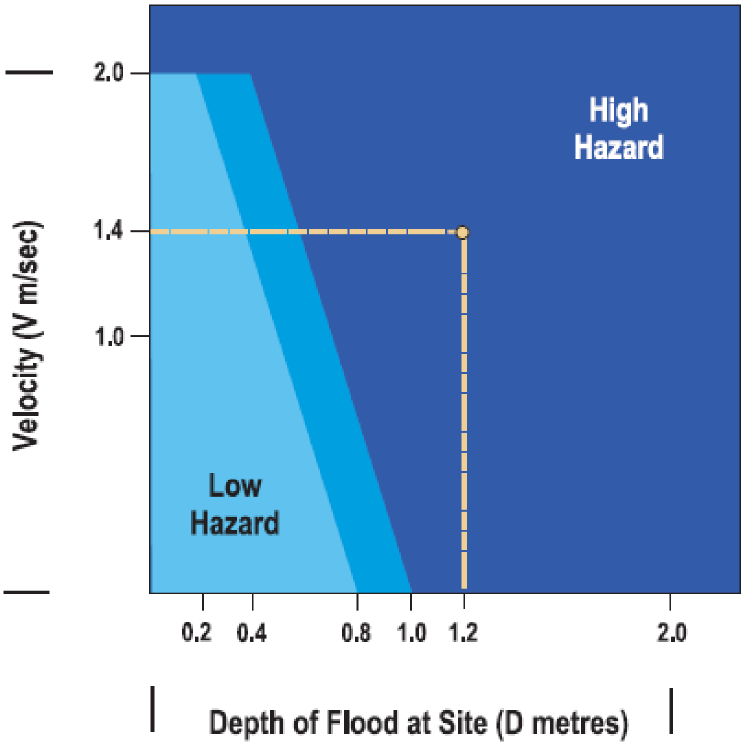


Figure 17 - Flood Hazard Classification (after NSW Government 2005)

It is also considered that the development would have no impact on the estuarine processes and that there would be no impact on assets or infrastructure in surrounding properties, as the development is sited well landward of the estuary foreshore, and no modification to the foreshore structures is proposed.

It should be noted that the development must comply with the provisions of the P21 DCP Part B3.9, i.e.

- *All structural elements below the Estuarine Planning Level shall be constructed from flood compatible materials; and,*
- *All structures must be designed and constructed so that they will have a low risk of damage and instability due to wave action and tidal inundation; and,*
- *All electrical equipment, wiring, fuel lines or any other service pipes and connections must be waterproofed to the Estuarine Planning Level; and,*
- *The storage of toxic or potentially polluting goods, materials or other products, which may be hazardous or pollute the waterway, is not permitted below the Estuarine Planning Level; and,*
- *For existing structures, a tolerance of up to minus 100mm may be applied to the Estuarine Planning Level in respect of compliance with these controls.*

7 Summary and Conclusion

This report has documented the Estuarine Risk Management for the Pasadena development at 1858 Pittwater Road, Church Point. An independent assessment of water levels and wave heights has been documented, considering local conditions as gleaned from the site survey.

It has been demonstrated that the proposed development complies with Pittwater Council's Estuarine Risk Management Policy, as well as the provisions of the Pittwater DCP 21, B3.9 Estuarine Hazard – Business, Light Industrial and Other Development.

It is considered that the proposed development does not increase and may reduce the estuarine risk of the existing site in relation to risk to people, assets and infrastructure.

8 Glossary

Accretion	The accumulation of (beach) sediment, deposited by natural fluid flow processes.
ACES	A computer program, developed by the US Army Corps of Engineers, that is used to determine, among other things, levels of wave runup on natural beaches.
Aeolian	Adjective referring to wind-borne processes.
Astronomical tide	The tidal levels and character which would result from gravitational effects, e.g. of the Earth, Sun and Moon, without any atmospheric influences.
Backshore	(1) The upper part of the active beach above the normal reach of the tides (high water), but affected by large waves occurring during a high. (2) The accretion or erosion zone, located landward of ordinary high tide, which is normally wetted only by storm tides.
Bar	An offshore ridge or mound of sand, gravel, or other unconsolidated material which is submerged (at least at high tide), especially at the mouth of a river or estuary, or lying parallel to, and a short distance from, the beach.
Bathymetry	The measurement of depths of water in oceans, seas and lakes; also the information derived from such measurements.
Beach profile	A cross-section taken perpendicular to a given beach contour; the profile may include the face of a dune or sea wall, extend over the backshore, across the foreshore, and seaward underwater into the nearshore zone.
Berm	A nearly horizontal plateau on the beach face or backshore.
Breaker zone	The zone within which waves approaching the coastline commence breaking, typically in water depths of around 2 m to 3 m in fair weather and around 5 m to 10 m during storms
Breaking depth	The still-water depth at the point where the wave breaks.
Chart datum	The plane or level to which soundings, tidal levels or water depths are referenced, usually low water datum.
Coastal processes	Collective term covering the action of natural forces on the shoreline, and the nearshore seabed.
Datum	Any position or element in relation to which others are determined, as datum point, datum line, datum plane.
Deep water	In regard to waves, where depth is greater than one-half the wave length. Deep-water conditions are said to exist when the surf waves are not affected by conditions on the bottom, typically in water depths of around 60 m to 100 m.
Dunes	Accumulations of wind-blown sand on the backshore, usually in the form of small hills or ridges, stabilised by vegetation or control structures.
Dynamic equilibrium	Short term morphological changes that do not affect the morphology over a long period.
Ebb tide	A non-technical term used for falling tide or ebb current. The portion of the tidal cycle between high water and the following low water.
Elevation	The distance of a point above a specified surface of constant potential; the distance is measured along the direction of gravity between the point and the surface.
Erosion	On a beach, the carrying away of beach material by wave action, tidal currents or by deflation.

Fetch	Distance over which the wind blows leading to wave growth.
Flood tide	A non-technical term used for rising tide or flood current. In technical language, flood refers to current. The portion of the tidal cycle between low water and the following high water.
Geomorphology	That branch of physical geography that deals with the form of the Earth, the general configuration of its surface, the distribution of the land, water, etc.
High water (HW)	Maximum height reached by a rising tide. The height may be solely due to the periodic tidal forces or it may have superimposed upon it the effects of prevailing meteorological conditions. Nontechnically, also called the high tide.
ICOLL	An acronym for Intermittently Closed or Open Lake or Lagoon
Inshore	(1) The region where waves are transformed by interaction with the sea bed. (2) In beach terminology, the zone of variable width extending from the low water line through the breaker zone.
Inshore current	Any current inside the surf zone.
Inter-tidal	The zone between the high and low water marks.
Littoral	(1) Of, or pertaining to, a shore, especially a seashore. (2) Living on, or occurring on, the shore.
Littoral currents	A current running parallel to the beach, generally caused by waves striking the shore at an angle.
Littoral drift	The material moved parallel to the shoreline in the nearshore zone by waves and currents.
Littoral transport	The movement of littoral drift in the littoral zone by waves and currents. Includes movement both parallel (long shore drift) and perpendicular (cross-shore transport) to the shore.
Longshore	Parallel and close to the coastline.
Longshore drift	Movement of sediments approximately parallel to the coastline.
Low water (LW)	The minimum height reached by each falling tide. Non-technically, also called low tide.
Mean high water (MHW)	The average elevation of all high waters recorded at a particular point or station over a considerable period of time, usually 19 years. For shorter periods of observation, corrections are applied to eliminate known variations and reduce the result to the equivalent of a mean 19-year value. All high water heights are included in the average where the type of tide is either semidiurnal or mixed. Only the higher high water heights are included in the average where the type of tide is diurnal. So determined, mean high water in the latter case is the same as mean higher high water.
Mean high water springs (MHWS)	The average height of the high water occurring at the time of spring tides.
Mean low water (MLW)	The average height of the low waters over a 19-year period. For shorter periods of observation, corrections are applied to eliminate known variations and reduce the result to the equivalent of a mean 19-year value.
Mean low water springs (MLWS)	The average height of the low waters occurring at the time of the spring tides.
Mean sea level	The average height of the surface of the sea for all stages of the tide over a 19-year period, usually determined from hourly height readings.
Morphology	The form of a river/estuary/lake/seabed and its change with time.
Nearshore	In beach terminology, an indefinite zone extending seaward from the shoreline well beyond the breaker zone.

Rip current	A strong current flowing seaward from the shore. It is the return of water piled up against the shore as a result of incoming waves. A rip current consists of three parts: the feeder current flowing parallel to the shore inside the breakers; the neck, where the feeder currents converge and flow through the breakers in a narrow band or "rip"; and the head, where the current widens and slackens outside the breaker line.
Runup	The rush of water up a structure or beach on the breaking of a wave. The amount of run-up is the vertical height above still water level that the rush of water reaches. It includes wave setup.
Setup	Wave setup is the elevation of the nearshore still water level resulting from breaking waves and may be perceived as the conversion of the wave's kinetic energy to potential energy.
Shoal	(1) (noun) A detached area of any material except rock or coral. The depths over it are a danger to surface navigation. (2) (verb) To become shallow gradually.
Shore	That strip of ground bordering any body of water which is alternately exposed, or covered by tides and/or waves. A shore of unconsolidated material is usually called a beach.
Shoreface	The narrow zone seaward from the low tide shoreline permanently covered by water, over which the beach sands and gravels actively oscillate with changing wave conditions.
Shoreline	The intersection of a specified plane of water with the shore.
***Significant* wave**	A statistical term relating to the one-third highest waves of a given wave group and defined by the average of their heights and periods.
***Significant* wave height**	Average height of the highest one-third of the waves for a stated interval of time.
Spring tide	A tide that occurs at or near the time of new or full moon, and which rises highest and falls lowest from the mean sea level (MSL).
Storm surge	A rise or piling-up of water against shore, produced by strong winds blowing onshore. A storm surge is most severe when it occurs in conjunction with a high tide. This component is also known as **wind setup**.
Surf zone	The nearshore zone along which the waves become breakers as they approach the shore.
Swell	Waves that have traveled a long distance from their generating area and have been sorted out by travel into long waves of the same approximate period.
Tide	The periodic rising and falling of the water that results from gravitational attraction of the moon and sun acting upon the rotating earth. Although the accompanying horizontal movement of the water resulting from the same cause is also sometimes called the tide, it is preferable to designate the latter as tidal current, reserving the name tide for the vertical movement.

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