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Coastal Engineering Advice on New Upper Level Deck at 1130 Pittwater Road Collaroy

1. INTRODUCTION AND BACKGROUND

It is proposed to construct an upper level (second storey) deck on the seaward side of the existing dwelling at 1130 Pittwater Road Collaroy. Northern Beaches Council requires that a coastal engineering assessment is prepared as part of a Development Application (DA) for the works. Horton Coastal Engineering Pty Ltd was engaged to complete this assessment, as set out herein.

The report author, Peter Horton [BE (Hons 1) MEngSc MIEAust CPEng NER], is a professional Coastal Engineer with 27 years of coastal engineering experience. He has postgraduate qualifications in coastal engineering, and is a Member of Engineers Australia and Chartered Professional Engineer (CPEng) registered on the National Engineering Register. He is also a member of the National Committee on Coastal and Ocean Engineering (NCCOE) and NSW Coastal, Ocean and Port Engineering Panel (COPEP) of Engineers Australia.

In previous employment, Peter was the main author of the *Coastal Zone Management Plan for Collaroy-Narrabeen Beach and Fishermans Beach (CZMP)* prepared for Warringah Council in 2014, and the *Coastal Erosion Emergency Action Subplan for Beaches in Warringah* prepared for Warringah Council in 2012. He has also prepared coastal engineering assessments for DA's at numerous locations along Collaroy-Narrabeen Beach over the last decade. Peter has inspected the area in the vicinity of the subject property on many occasions in the last decade, including specific recent inspections of the property on 28 October 2018, 5 June 2019 and 19 September 2019.

Note that all levels given herein are to Australian Height Datum (AHD). Zero metres AHD is approximately equal to mean sea level at present.

2. INFORMATION PROVIDED

Horton Coastal Engineering was provided with 6 drawings (DA00 to 05) prepared by Canvas Architecture & Design, all dated 25 September 2019. Site surveys completed by Warren Eldridge and Associates (Plan No. GCN 475[1126,1130] dated 15 November 2016), CMS Surveyors (Drawing "15947detail" dated 8 February 2017) and TJ Surveyors (Drawing No. 6164 dated 11 August 2017) were also provided. The CMS Surveyors survey was completed as part of a DA (DA2017/0591) for coastal protection works at 1126-1144 Pittwater Road Collaroy, including the subject property, that was approved by Council on 25 September 2018.

3. EXISTING SITE DESCRIPTION

Collaroy-Narrabeen Beach is about 3.5km long, extending between Narrabeen Head and Narrabeen Lagoon entrance in the north, to a cliff at Collaroy Rock Baths in the south. At the subject property, which is located about 880m from the southern end of the beach, the beach faces east to ENE, and is partially sheltered from the dominant SE storm wave climate offshore of Sydney by Long Reef headland. A photograph of the property is provided in Figure 1.

In June 2016, a severe East Coast Low storm caused significant erosion at Collaroy-Narrabeen Beach, with ground and first floor decks undermined at the subject property and subsequently removed due to structural damage. A photograph of the post-storm damage, prior to deck removal, is provided in Figure 2. As part of the subject DA, a similar first floor deck is proposed to be reinstated.



Figure 1: View of subject property on 28 October 2018, facing WNW



Figure 2: View of subject property on 10 June 2016, facing approximately west, with the leaning first storey deck subsequently removed (photograph supplied by UNSW Water Research Laboratory)

Based on the site surveys provided and LiDAR data held by Horton Coastal Engineering, ground levels at the subject property vary from about 5m to 5.5m AHD on the seaward side of the dwelling (or lower after storm erosion) to about 5.6m AHD at the landward boundary. The ground floor level of the existing dwelling is about 5.8m AHD.

Since completion of the 3 surveys listed in Section 2, two retaining walls, landscaping and paving have been constructed seaward of the dwelling, with the retaining walls visible in Figure 2.

4. PROPOSED DEVELOPMENT

A non-covered first floor deck (balcony) is proposed on the seaward side of the existing dwelling, supported on two posts (at the NE and SE corners respectively). The footprint of the proposed works is depicted in Figure 4. The proposed floor level of the balcony is 9.0m AHD.

5. SUBSURFACE CONDITIONS

It is expected that the proposed deck area would be generally underlain by sand, with a harder cemented sand layer at around 0.6m AHD, as outlined below.

Based on a UNSW Water Research Laboratory (WRL) survey of cemented sand outcrops observed about 12m seaward of the subject property after the June 2016 storm, cemented sand levels were about 0.1 to 0.2m AHD.

Douglas Partners (2016) undertook a geotechnical investigation which included drilling of boreholes at the Council reserve south of Stuart Street, and at Ramsay Street. These boreholes were at a cross-shore position at an alignment approximately midway along the subject properties between these roads, that is about 40m landward of the cemented sand outcrops observed by WRL. Correcting approximately estimated surface levels of 5m AHD used by Douglas Partners (2016), which based on survey would be closer to 6.1m AHD at Stuart Street and 5.6m AHD at Ramsay Street, this would put dense to very dense sand at -2.4m AHD to 2.4m AHD at Stuart Street, and -2.1m AHD to 1.7m AHD at Ramsay Street. Analysing the cone penetration test results of Douglas Partners (2016), the upper surface of the cemented sand layer can be interpreted to be at 1.1m AHD at both locations¹.

Comparing the Douglas Partners (2016) and WRL cemented sand levels, this would indicate that the upper surface of the cemented sand layer dips at about 1:40 (1 to 2°) moving seaward.

A geotechnical investigation was completed by Jeffery & Katauskas (2000), which included boreholes at Stuart Street and Ramsay Street, located about 10m to 15m landward of the WRL cemented sand levels (that is, near the subject property boundary cross-shore alignment, to 5m landward). This indicated levels of the upper surface of the cemented sand layer at about 0m AHD at both locations.

Jeffery & Katauskas (2000) also completed two test pits, seaward of 1128 and 1140 Pittwater Road respectively, and at a cross-shore position about 5m to 10m landward of the WRL cemented sand levels (that is, near the subject property boundary cross-shore alignment, to 5m seaward). This indicated a cemented sand level of about 0.4m AHD at 1128, with the layer not encountered at 1140 above 0.2m AHD (but probably just below that level).

¹ As interpreted by Horton Coastal Engineering and reviewed by Paul Roberts of JK Geotechnics.

Coffey Partners International (1998) completed two test pits, seaward of Stuart Street and Ramsay Street respectively, at an alignment similar to or a few metres seaward of the WRL cemented sand levels (that is, about 10m seaward of the subject property boundary cross-shore alignment). They found cemented sand levels at around -0.5m AHD at both locations.

It is considered that the cemented sand level at the locations of the balcony supports is likely to be around 0.6m AHD.

6. EROSION/RECESSION COASTLINE HAZARDS

Nielsen et al (1992) has delineated various coastline hazard zones, as discussed below and shown in Figure 3, assuming an entirely sandy (erodible) subsurface (that is, ignoring the potential for protection works or less erodible materials above -1m AHD to limit the extent of erosion).

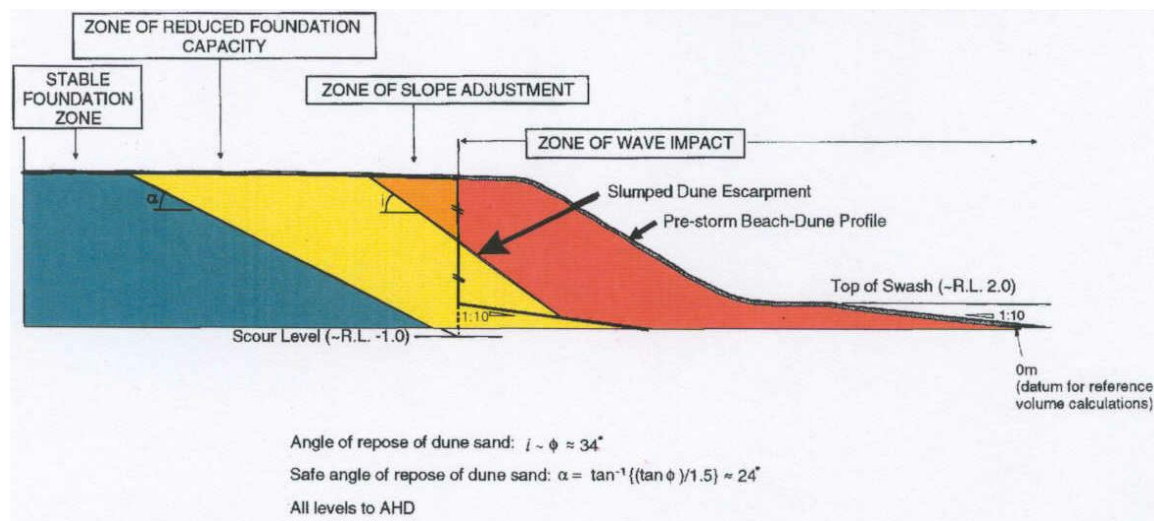


Figure 3: Schematic representation of coastline hazard zones (after Nielsen et al, 1992)

The Zone of Wave Impact (ZWI) delineates an area where any structure or its foundations would suffer direct wave attack during a severe coastal storm. It is that part of the beach which is seaward of the beach erosion escarpment.

A Zone of Slope Adjustment (ZSA) is delineated to encompass that portion of the seaward face of the beach that would slump to the natural angle of repose of the beach sand following removal by wave erosion of the design storm demand. It represents the steepest stable beach profile under the conditions specified.

A Zone of Reduced Foundation Capacity (ZRFC) for building foundations is delineated to take account of the reduced bearing capacity of the sand adjacent to the storm erosion escarpment. Nielsen et al (1992) recommended that structural loads should only be transmitted to soil foundations outside of the ZRFC (ie landward or below), as the factor of safety within the ZRFC is less than 1.5 during extreme scour conditions at the face of the escarpment. In general (without the protection of a terminal structure such as a seawall), dwellings/structures not piled and located within the ZRFC would be considered to have an inadequate factor of safety.

In Figure 4, various coastline hazard lines are depicted at the subject property.



Figure 4: Coastline hazard lines at subject property, with footprint of proposed balcony in yellow (aerial photograph taken 17 August 2018)

As part of the CZMP, coastline hazard lines were delineated at Collaroy-Narrabeen Beach for immediate, 2050 and 2100 planning periods. These CZMP hazard lines (Immediate ZSA, 2050 ZSA and 2100 ZSA) are depicted in Figure 4 (with all 3 lines at the landward edge of the ZSA). It is evident that the proposed development is seaward of the Immediate ZSA, ignoring future protection works.

In the CZMP, three lines defining the required minimum setback for new beachfront development in the vicinity of the subject property at Collaroy-Narrabeen Beach were delineated, including consideration of development on conventional foundations and piled foundations². These lines are depicted in Figure 4 as the:

- “minimum setback for piled development with protection works”,
- “minimum setback for piled development without protection works”, and
- “minimum setback for development on conventional foundations without protection works”.

It is evident that the proposed balcony is located seaward of the “minimum setback for piled development without protection works”. This would generally imply that the proposed balcony should be founded on deep piles and not granted consent until protection works are in place. However, it is considered that placing the proposed balcony on piles at the location adopted, which is seaward of the “minimum setback for piled development without protection works”, may be considered to be acceptable by Council prior to the protection works being in place. This is because of the ancillary nature of the balcony, the fact that it should be designed to withstand a severe storm (if the requirements outlined in Section 7 are followed), and given that a significant storm is unlikely to occur before the proposed protection works are installed³.

The proposed balcony straddles the “minimum setback for piled development with protection works”, and thus partially extends seaward of this line. This may be considered to be acceptable by Council as the balcony is proposed to be landward of the 7.5m setback line depicted in Figure 4. This line is located 7.5m landward of the seaward property boundaries at 1126-1144 Pittwater Road Collaroy.

The “minimum setback for piled development with protection works” was devised by the author of the report herein (and also author of the CZMP) as a (somewhat arbitrary) 10m setback from the seaward property boundaries in Council’s GIS⁴. The 7.5m setback line is considered to be a more appropriate setback line than the 10m line, as it reflects the current most seaward extent of development (at 1132). The 7.5m setback line would thus allow a consistent building setback for all of the 1126-1144 properties, including the proposed balcony. As the main author of the CZMP that derived the 10m setback, and understanding its rationale, the author has no concerns with modifying this to 7.5m at these properties to reflect the current building positions. Note that this has been discussed with Council prior to preparation of the report herein.

² Conventional foundations include slab-on-ground, strip footings and shallow piers, and can be distinguished from deep piled foundations. It is understood that the existing dwelling at the subject property is on conventional foundations.

³ It is important to note that the existing dwelling is at an unacceptably high risk of being damaged by coastal erosion/recession without the protection works in-place, which makes construction of the protection works imperative to protect the dwelling, but this is not a matter for the subject DA.

⁴ Council’s GIS boundaries were not survey accurate, particularly at 1142 and 1144, hence the kink in the “minimum setback for piled development with protection works” at these properties does not reflect setbacks from the true seaward boundary positions (derived from survey) as depicted in Figure 4.

The 7.5m setback line would also be consistent with the proposed coastal protection works in DA2017/0591, allowing a 1.7m wide corridor for sewer and stormwater infrastructure, and 5.5m wide revetment maintenance setback, seaward of the setback line and landward of the proposed revetment (with the revetment landward edge 0.3m into the properties).

7. FOUNDATION DESIGN REQUIREMENTS

The proposed balcony supports would need to be founded on deep piled foundations, assuming that the proposed coastal protection works are not in place. These piles should be designed allowing for the following coastal engineering parameters for a 100 year Average Recurrence Interval (ARI) storm occurring over a 60 year life:

- scour down to -1m AHD (this is likely to be conservative given the cemented sand level of about 0.6m AHD at the balcony supports);
- sand slumping forces on the piles as per Nielsen et al (1992), as calculated by a coastal engineer; and
- wave impact loading on the piles, as calculated by a coastal engineer.

Wave uplift on the balcony does not need to be allowed for over the design life, given the elevated balcony floor level of 9.0m AHD.

8. COASTAL INUNDATION COASTLINE HAZARDS

In the CZMP, a present day wave runup level of 8m AHD was adopted at Collaroy-Narrabeen Beach in the vicinity of the subject property (which can be taken as a 100 year ARI wave runup level exceeded by 2% of waves). Taking sea level rise into account, this level would increase to about 8.4m AHD at 2078, using the median sea level rise value adopted in the CZMP for a 60 year life.

That stated, in reality, any waves that overtopped the foreshore at the subject property (at a level of about 5m AHD, or 6.0m to 6.3m AHD after protection works construction) would 'fold over' the crest and travel as a sheet flow at shallow depth (less than about 0.5m), spreading out and infiltrating over the landward areas. There is the expectation of a significant reduction in the velocity and depth of the runup within the order of 10m from the foreshore crest.

The balcony, with a floor level of 9.0m AHD, is considered to be at an acceptably low risk of being damaged by wave runup over its design life.

9. CONSENT MATTERS

9.1 Coastal Zone Management Plan

The *Coastal Zone Management Plan for Collaroy-Narrabeen Beach and Fishermans Beach* (CZMP) has been considered in terms of setbacks in Section 6 and coastal inundation in Section 8. Variations to the setback requirements in the CZMP have been considered on merit in Section 6.

9.2 Warringah Local Environmental Plan 2011

Based on Clause 6.5(3) of the LEP, development consent must not be granted "unless the consent authority is satisfied that the development:

- (a) will not significantly adversely affect coastal hazards, and
- (b) will not result in significant detrimental increases in coastal risks to other development or properties, and
- (c) will not significantly alter coastal hazards to the detriment of the environment, and
- (d) incorporates appropriate measures to manage risk to life from coastal risks, and
- (e) avoids or minimises exposure to coastal hazards, and
- (f) makes provision for relocation, modification or removal of the development to adapt to coastal hazards and NSW sea level rise planning benchmarks”.

With regard to (a) and (b), the proposed balcony would be elevated well above wave processes and would allow erosion to continue unhindered, so would not adversely affect coastal processes or coastal hazards, nor detrimentally increase the level of coastal risk to other development or properties. Some minor additional scour may be expected around the balcony foundations in a severe erosion event, but this would be contained within the subject property.

With regard to (c), the proposed balcony would be elevated well above wave processes and would not significantly alter coastal hazards to the detriment of the environment.

With regard to (d), founding the proposed balcony on deep piles as outlined in Section 7 would mean that it is at an acceptably low risk of being damaged by coastal erosion/recession, and hence is also an appropriate measure to reduce risk to life from coastal hazards. The existing dwelling should be evacuated at times of severe storms, given the risk of it being undermined and damaged, and there would be advance warning of such an event.

With regard to (e), founding the proposed balcony on deep piles minimises its exposure to coastal hazards, as this reduces its risk of being damaged in a severe coastal storm.

With regard to (f), there would be no opportunity to relocate the proposed balcony given the extent of existing development on the site. Given that the proposed balcony should be designed to not be damaged for a severe storm over a 60 year life, there should be no need to modify or remove the development over that life, and the CZMP does not enforce any requirement for relocatable or removable development. The balcony would be at an acceptably low risk of being damaged over its design life if founded as outlined in Section 7, which includes consideration of sea level rise.

Based on Clause 6.5(4), development consent must not be granted “unless the consent authority is satisfied that the foundations of the development have been designed to be constructed having regard to coastal risk”.

The proposed development would be designed with deep piled foundations having regard to coastal risk if the requirements in Section 7 are followed.

9.3 Warringah Development Control Plan 2011

Part E9 of the *Warringah Development Control Plan 2011* (DCP)⁵ has discussion on “Coastline Hazard”. Based on the DCP, the risk of damage from coastal processes is to be reduced through having appropriate setbacks and foundations. Development at Collaroy-Narrabeen Beach should generally be setback to be landward of the acceptable risk setbacks in the CZMP, but as discussed in Section 6 the proposed development is considered to be acceptable at the adopted setback (as it is ancillary, has been designed to withstand a severe storm, and given that a

⁵ Amendment 15 of the DCP was reviewed, which commenced on 14 September 2019.

significant storm is unlikely to occur before protection works are installed and it would not interfere with those protection works).

Furthermore, based on Part E9 of the DCP, the applicant must demonstrate compliance with the *Northern Beaches Coastal Erosion Policy*, the CZMP and the *Collaroy-Narrabeen Protection Works Design Specifications*. As no protection works are proposed, neither the *Northern Beaches Coastal Erosion Policy* (except as noted below) nor *Collaroy-Narrabeen Protection Works Design Specifications* are generally applicable for the subject DA. Compliance with the CZMP has been considered in Section 9.1.

With regard to the *Northern Beaches Coastal Erosion Policy*, as noted above this is mostly focussed on the construction of coastal protection works. However, it can be noted that:

- as per 2(b), the risk of damage to the proposed development from coastal processes is acceptably low as it has been designed to not be damaged in severe coastal storm and is to be supported on deep foundation piles; and
- as per 2(d), the proposed development would not adversely impact on adjoining properties or coastal processes.

Therefore, the proposed development complies with the *Northern Beaches Coastal Erosion Policy*, where relevant.

Also, based on the DCP, development must be constructed with a suitable floor level or in a manner that minimises the risk of coastal inundation for severe coastal storms occurring over the next 50 years. This is the case for the proposed development, as discussed in Section 8.

9.4 State Environmental Planning Policy (Coastal Management) 2018

9.4.1 Preamble

Based on *State Environmental Planning Policy (Coastal Management) 2018* (SEPP Coastal) and its associated mapping, the subject property is within a “coastal environment area” and “coastal use area”.

9.4.2 Clause 13

Based on Clause 13(1) of SEPP Coastal, “development consent must not be granted to development on land that is within the coastal environment area unless the consent authority has considered whether the proposed development is likely to cause an adverse impact on the following:

- (a) the integrity and resilience of the biophysical, hydrological (surface and groundwater) and ecological environment,
- (b) coastal environmental values and natural coastal processes,
- (c) the water quality of the marine estate (within the meaning of the Marine Estate Management Act 2014), in particular, the cumulative impacts of the proposed development on any of the sensitive coastal lakes identified in Schedule 1,
- (d) marine vegetation, native vegetation and fauna and their habitats, undeveloped headlands and rock platforms,
- (e) existing public open space and safe access to and along the foreshore, beach, headland or rock platform for members of the public, including persons with a disability,
- (f) Aboriginal cultural heritage, practices and places,

(g) the use of the surf zone”.

This is not a coastal engineering matter, but it can be noted that with regard to (a), the proposed balcony would not be expected to adversely affect the biophysical, hydrological (surface and groundwater) and ecological environments, being in an existing developed area and not altering the present drainage arrangements at the property.

With regard to (b), the proposed balcony would not be expected to adversely affect coastal environmental values or natural coastal processes over an acceptably long design life, as it would be founded well above wave and erosion processes for an acceptably rare storm and acceptably long life.

With regard to (c), the proposed balcony would not be expected to adversely impact on water quality, with the residential land use (as long as appropriate construction environmental controls are applied). No sensitive coastal lakes are located in the vicinity of the proposed balcony.

With regard to (d), the proposed balcony would not impact on marine vegetation, and no significant impacts on marine fauna and flora would be expected as a result of the proposed balcony, as the development would not interact with subaqueous areas for an acceptably rare storm and acceptably long life. Native vegetation and fauna and their habitats (of significance) are not known to exist at the property, and assuming that this is the case then these would not be impacted by the proposed development. There are no undeveloped headlands nor rock platforms in proximity to the development.

With regard to (e), it can be noted that the proposed development is entirely within the subject property boundary and will not alter existing public access arrangements seaward of the property, or north and south of the property.

With regard to (f), a search of the Office of Environment and Heritage “Aboriginal Heritage Information Management System” (AHIMS) was undertaken on 12 November 2019. This indicated that there were no particular Aboriginal sites recorded or Aboriginal places declared within at least 1km of the subject property.

With regard to (g), the proposed balcony would not interact with the surf zone for an acceptably rare storm occurring over an acceptably long life, so would not impact on use of the surf zone.

Based on Clause 13(2) of SEPP Coastal, “development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that:

- (a) the development is designed, sited and will be managed to avoid an adverse impact referred to in subclause (1), or
- (b) if that impact cannot be reasonably avoided—the development is designed, sited and will be managed to minimise that impact, or
- (c) if that impact cannot be minimised—the development will be managed to mitigate that impact”.

Given that the proposed balcony is to be supported on piles, and if the requirements outlined in Section 7 are followed, the balcony would be at an acceptably low risk of damage over an acceptably long life. On this basis, the proposed development has been designed and sited to avoid any potential adverse impacts referred to in Clause 13(1).

9.4.3 Clause 14

Based on Clause 14(1) of SEPP Coastal, “development consent must not be granted to development on land that is within the coastal use area unless the consent authority:

- (a) has considered whether the proposed development is likely to cause an adverse impact on the following:
 - (i) existing, safe access to and along the foreshore, beach, headland or rock platform for members of the public, including persons with a disability,
 - (ii) overshadowing, wind funnelling and the loss of views from public places to foreshores,
 - (iii) the visual amenity and scenic qualities of the coast, including coastal headlands,
 - (iv) Aboriginal cultural heritage, practices and places,
 - (v) cultural and built environment heritage, and
- (b) is satisfied that:
 - (i) the development is designed, sited and will be managed to avoid an adverse impact referred to in paragraph (a), or
 - (ii) if that impact cannot be reasonably avoided—the development is designed, sited and will be managed to minimise that impact, or
 - (iii) if that impact cannot be minimised—the development will be managed to mitigate that impact, and
- (c) has taken into account the surrounding coastal and built environment, and the bulk, scale and size of the proposed development”.

With regard to Clause (a)(i), the proposed development is entirely on private property and will not affect public foreshore, beach, headland or rock platform access.

Clauses (a)(ii) and a(iii) are not coastal engineering matters so are not considered herein.

With regard to (a)(iv), as noted in Section 9.4.2, there are no particular Aboriginal sites recorded or Aboriginal places declared within at least 1km of the subject property.

With regard to (a)(v), the nearest environmental heritage item to the subject property listed in Schedule 5 of *Warringah Local Environmental Plan 2011* is the house “Chez Nous” at 19 Frazer Street Collaroy. The proposed balcony is 220m from this house and would not be expected to impact on it.

With regard to (b), the proposed development has been designed and sited to avoid any potential adverse impacts referred to in Clause 14(1) for the matters considered herein.

Clause (c) is not a coastal engineering matter so is not considered herein.

9.4.4 Clause 15

Based on Clause 15 of SEPP Coastal, “development consent must not be granted to development on land within the coastal zone unless the consent authority is satisfied that the proposed development is not likely to cause increased risk of coastal hazards on that land or other land”.

As discussed in Section 9.2, the proposed balcony would be elevated well above wave processes and would allow erosion to continue unhindered, so would not adversely affect

coastal processes or coastal hazards, nor detrimentally increase the level of coastal risk to other development or properties. That is, it is unlikely to have a significant impact on coastal hazards or increase the risk of coastal hazards in relation to any other land.

9.4.5 Clause 16

Based on Clause 16 of SEPP Coastal, “development consent must not be granted to development on land within the coastal zone unless the consent authority has taken into consideration the relevant provisions of any certified coastal management program that applies to the land”. The CZMP can be considered to be a certified coastal management program, and was considered in Section 9.1.

9.4.6 Synthesis

The proposed development satisfies the requirements of *State Environmental Planning Policy (Coastal Management) 2018* for the matters considered herein.

10. CONCLUSIONS

The proposed balcony at 1130 Pittwater Road Collaroy is located seaward of the “minimum setback for piled development without protection works”. Placing the proposed balcony on piles at this location may be considered acceptable by Council prior to the protection works being in place. This is because of the ancillary nature of the balcony, the fact that it would be designed to withstand a severe storm, and given that a significant storm is unlikely to occur before the protection works are installed.

The proposed balcony straddles the “minimum setback for piled development with protection works”. This may be considered to be acceptable by Council as the balcony is proposed to be landward of a 7.5m setback line, which reflects the current most seaward extent of development at the 1126-1144 Pittwater Road properties, and thus allows a consistent building setback for all these properties, including the proposed balcony. The 7.5m setback is also consistent with the proposed coastal protection works.

The proposed balcony supports would need to be founded on deep piles following the requirements outlined in Section 7, and if so would be at an acceptably low risk of damage from coastal hazards. If founded in this manner, the proposed balcony is considered to be consistent with the coastal engineering requirements listed in the CZMP, *Warringah Local Environmental Plan 2011*, Part E9 of the *Warringah Development Control Plan*, the *Northern Beaches Coastal Erosion Policy*, and *State Environmental Planning Policy (Coastal Management) 2018*.

11. REFERENCES

Coffey Partners International (1998), *Collaroy / Narrabeen Seawall Geotechnical Investigation*, for NSW Department of Public Works & Services, 13 October, S10962/1-AE

Douglas Partners (2016), *Report on Geotechnical Investigation, Proposed New Foundations, 1130 Pittwater Rd Collaroy*, prepared for KPH Consulting, Project 85598.01, October

Jeffery & Katauskas (2000), *Report to Patterson Britton & Partners Pty Ltd on Geotechnical Investigation for Collaroy/Narrabeen Sea Wall Upgrade at Collaroy/Narrabeen Beach, NSW*, 11 July

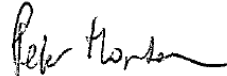
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12. SALUTATION

If you have any further queries, please do not hesitate to contact Peter Horton via email at peter@hortoncoastal.com.au or via mobile on 0407 012 538.

Yours faithfully

HORTON COASTAL ENGINEERING PTY LTD



Peter Horton

Director and Principal Coastal Engineer

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