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Dear Sir

Review of Development Application DA2021/1612 for Coastal Protection Works at 1 Clarke Street and 1192, 1194, 1196 and 1204 Pittwater Road, Narrabeen

Please find below my coastal engineering advice for DA2021/1612. The advice is structured in the following way:

- Section 1 lists the information provided for review;
- Section 2 sets out a description of the main features of the proposed coastal protection works;
- Section 3 sets out a history of the existing coastal protection works in the subject area of the DA, from Clarke Street to Mactier Street;
- Section 4 sets out the relationship between the proposed coastal protection works, the existing coastal protection works and the existing building structures and infrastructure;
- Section 5 sets out a discussion of key coastal processes along Collaroy-Narrabeen Beach and the impact of coastal protection structures;
- Section 6 sets out a review of the DA in relation to relevant legislation, policies, guidelines and specifications, including:
 - Coastal Management Act, 2016
 - State Environmental Planning Policy (Resilience and Hazards) 2021,
 - Northern Beaches Coastal Erosion Policy (2016),
 - Coastal Zone Management Plan for Collaroy-Narrabeen Beach and Fishermans Beach (2016),
 - Collaroy-Narrabeen Beach Coastal Protection Works Design Specifications (2016),
 - Coastal Erosion Emergency Action Subplan for Beaches in Warringah (as amended, 2015),
 - Warringah Local Environmental Plan 2011,
 - Warringah Development Control Plan 2011,
- Section 7 sets out recommendations in relation to conditions of consent; and
- Section 8 provides a list of References.





1. INFORMATION PROVIDED FOR REVIEW

The following information submitted by the Applicant was initially provided for review:

- Horton Coastal Engineering (2021a), Coastal Engineering Report for Construction of Upgraded Coastal Protection Works at 1190-1196 and 1204 Pittwater Road, Narrabeen, Issue 2, 13 July 2021;
- James Taylor & Associates (2021), 1190-1196 and 1204 Pittwater Road, Narrabeen Seawall Structural Design, 26 July 2021;
- Horton Coastal Engineering (2021b), Statement of Environmental Effects for Construction of Upgraded Coastal Protection Works at 1190-1196 and 1204 Pittwater Road, Narrabeen, Issue 2, 13 July 2021;
- Detail & Level Survey of 1190-1196 and 1204 Pittwater Road Narrabeen prepared by Lawrence Consulting Group, dated 31 August 2021; and
- Drawings for the Coastal Protection Works prepared by Horton Coastal Engineering and James Taylor & Associates, comprising:

Drawing Number	Drawing Title
6355-S01 Rev G	General Notes
6355-S02 Rev G	Coastal Protection Works Plan
6355-S03 Rev G	Landscaping Plan
6355-S04 Rev G	Erosion and Sediment Control Plan & Waste Management Plan
6355-S10 Rev G	Section 1 (at 1204)
6355-S11 Rev G	Section 2 (at 1194)
6355-S16 Rev G	Deadman Anchor Alternative
6355-S20 Rev G	Access Stairs
6355-S30 Rev G	Eastern Wall Elevation

Following review of the above information, recommendations were made by the writer for supply by the Applicant of additional information. On the basis of these recommendations and consideration by Council, the following additional information was supplied by the Applicant:

- Horton Coastal Engineering (2023a), Response to Request for Information on Survey and Mean High Water Mark Matters for DA2021/1612, letter dated 17 February 2023;
- Horton Coastal Engineering (2023b), Response to Request for Information on Fencing, Maintenance Access and Seawall Alignment for DA2021/1612, letter dated 20 February 2023; and
- Horton Coastal Engineering (2023c), DA2021/1612 Safe Design Risk Assessment (v3), letter dated 23 February 2023.

In addition, the following documents prepared for Northern Beaches Council (Council) by the NSW Government Manly Hydraulics Laboratory (MHL) were supplied to assist with the review:

- MHL (2016), Collaroy-Narrabeen Beach Coastal Protection Assessment, MHL Report No 2491;
- MHL (2020), Review of Beach Width Impacts of Alternative Coastal Protection Works at Collaroy-Narrabeen Beach: Addendum to Collaroy-Narrabeen Beach Coastal Protection Assessment (MHL2491, 2016), Report MHL2491, March 2020;



- MHL (2022a), MHL2870 Collaroy-Narrabeen Beach Seawall: Additional Assessment Items Stage 1 Review of Previous Model Results, 8 June 2022; and
- MHL (2022b), MHL2877 Collaroy-Narrabeen Beach Seawall: Additional Assessment Items Stage 1 Review of Development Application for 1190 to 1196 & 1204 Pittwater Road, Narrabeen, 8 June 2022.

2. DESCRIPTION OF THE MAIN FEATURES OF THE PROPOSED COASTAL PROTECTION WORKS

2.1 General Design Cross Section

A cross-section of the proposed coastal protection works is shown in Figure 2-1 (1204 Pittwater Road) and Figure 2-2 (1194 Pittwater Road), as depicted in the DA drawings. The cross-sections also show the position of existing rock protection at these two locations based on a drone survey carried out shortly after the East Coast Low storm in June 2016. The relationship between the proposed works and the existing rock protection is further discussed in Section 4.

The proposed coastal protection works (works) as described in the Statement of Environmental Effects and Coastal Engineering Report comprise a vertical reinforced concrete wall with a wave return incorporated at the crest, supported on either secant piling, or contiguous piles with mass concrete/grout plug piling or jet grouting to fill the gaps between the contiguous piles¹.

The base of the vertical wall/top of the piles comprises a thickened footing/capping beam. Permanent ground anchors would be installed through the footing into the soil and cemented sand landward of the footing. The permanent ground anchors provide restraint to the works from overturning at times when the beach level is low on the seaward side of the works due to beach erosion.

Weepholes would be installed through the works, situated below the footing level, to allow drainage from landward areas and thereby reduce the water pressure on the landward side of the works.

2.2 Alignment of the Works and Crest Level

The vertical wall would be located 500mm landward of the private property boundary as defined in cadastre information included on the Drawings².

The wave return incorporated at the crest of the vertical wall, included to reduce wave overtopping of the wall, extends 500mm seaward of the face of the vertical wall and is therefore located on the private property boundary.

Notwithstanding the proposed works would be located wholly on private property, following initial review of the DA by the writer and Council, the Applicant was requested by Council to provide justification of the alignment of the proposed works, specifically whether the vertical wall could be located further landward

¹ The design Drawings submitted with the DA refer only to use of secant piling rather than use of either secant piling or contiguous piling. Adoption of secant piling would be preferred to contiguous piling to mitigate the risk of soil migration through the piled portion of the coastal protection works.

² The writer is aware of discussion relating to ambulatory boundaries and right-line boundaries on the open coast, eg. in Gordon (2022) and Corkhill (2013). For purposes of the assessment of the subject DA, the private property boundary as shown on the available cadastre has been adopted. It is also relevant that in the additional information supplied by the Applicant (Horton Coastal Engineering, 2023a), an analysis of the long-term position of Mean High Water Mark (MHWM) was presented based on 81 years of beach profile records (1941 to 2022). This analysis showed that the long-term average MHWM in the vicinity of the subject properties is located well seaward of the properties, in the order of 44 m. At the end of the design life of the works (60 years) and the predicted recession of the beach due to sea level rise (in the order of 15 m) the position of MHWM would still be well seaward of the properties and proposed works.



on the private property. A response to this request was provided by the Applicant (Horton Coastal Engineering, 2023b) advising that there are a number of reasons why a vertical should not be located further landward on the private property; namely, in summary, that:

- this would reduce the space available for dissipation of wave overtopping between the wall and existing residential development, thus increasing the risk of wave runup damaging the development over the design life;
- this would reduce the constructability of the works;
- garages are located on the seaward side of the residential flat buildings at two of the subject properties (1192 and 1204 Pittwater Road) and access to the garages would be affected;
- there is a requirement for a 4.5m wide maintenance setback width landward of the wall;
- the proposed works themselves are 850mm wide to accommodate the 500mm wide wave return; and
- at 1204 Pittwater Road, it would become more difficult to save the Norfolk Island Pine tree which is located only 5.0m from the seaward boundary.

The alignment of the proposed works is considered further in Section 6 of this letter. At this point it can be stated that, in relation to the last dot point above, the Applicant's Drawing Number 6355-S03 Rev G Landscaping Plan states that the Norfolk Island Pine at 1204 Pittwater Road is to be removed, so this particular dot point would not appear to be valid.

The proposed crest level of the vertical wall is 7.0m AHD, to generally match the ground levels within the subject properties which vary from 6.7 to 7.2m AHD.

2.3 Returns at the Ends of the Works

Landward returns at the ends of the works are proposed where the works adjoin public land. This occurs at four locations:

- Clarke Street;
- southern boundary of South Narrabeen SLSC;
- northern boundary of South Narrabeen SLSC; and
- Mactier Street.

The proposed returns are shown conceptually on the Drawings, together with a note stating that the length of the returns are to be determined on site by the Applicant's Coastal Engineer (in consultation with the Applicant's Structural Engineer) based on the level and extent of adjacent coastal protection works (rock revetments) on public land and/or the staging and type of adjacent upgraded coastal protection works on public land.

In the event that the existing coastal protection works on the adjacent public land have not been upgraded at the time of construction of the works on the private property, a portion of the existing works on public land would be temporarily removed, and then reinstated to the pre-works condition, to allow construction of the works on private property, as directed by the Applicant's Coastal Engineer and in agreement with Council.

In order to provide certainty that the lengths of the returns match the design of coastal protection works on the adjoining public lands, it is recommended that a suitable condition be imposed that at the Construction Certificate (CC) stage Council review and approve the returns. Such a condition has been included.





Figure 2-1 Cross-section through proposed coastal protection works (at 1204 Pittwater Road)





Figure 2-2 Cross-section through proposed coastal protection works (at 1194 Pittwater Road)



2.4 Beach Access Stairs

Two sets of reinforced concrete beach access stairs are proposed; one set at the common boundary of 1 Clarke Street and 1192 Pittwater Road, and one set at the common boundary of 1194 and 1196 Pittwater Road. The stairs would have an open width of 1,000mm. Each set of beach access stairs would be aligned perpendicular to the beach and recessed into the land behind the vertical wall.

The side walls of each set of stairs would be designed to accommodate a removable wave barrier located near the top of the stairs at approximately 6 m AHD. The barrier would be installed by residents at times of ocean storms to mitigate wave runup and overtopping at the location of the stairs.

A set of beach access stairs is not proposed at 1204 Pittwater Road, on the expectation that Council would install permanent beach access stairs at the adjacent Mactier Street as part of the proposed upgrading of coastal protection works at Mactier Street.

2.5 Maintenance Setback

A maintenance setback of 4.5m landward of the vertical wall is proposed except at the two sets of stairs where a 1m setback from the landward end of the stairs would be provided. Road plates would be installed over the stair indents as required, capable of accommodating maintenance plant up to 45 tonnes (assumed to be Gross Vehicle Mass (GVM)).

It is noted here that a setback of 4.5m is less than the minimum setback of 5 to 6m recommended in the Collaroy-Narrabeen Beach Coastal Protection Works Design Specifications (2016) (Specifications). Horton Coastal Engineering (2021a) states that the available space for maintenance could be readily increased to 5.35m by temporary removal of the proposed fence located along the top of the vertical wall³.

In assessing the proposed setback of 4.5m compared to the recommended distance of 5 to 6m it needs to be recognised that the recommended distance of 5 to 6m was established on the basis of the coastal protection works comprising a 'flexible' sloping rock revetment, where it would be customary to accept some damage (0-5%) in the design event⁴. The proposed structure is not a 'flexible' sloping rock revetment but rather a 'fixed' reinforced concrete structure, the design basis for which (Horton Coastal Engineering, 2021a and James Taylor & Associates, 2021) indicates that only minor, if any, maintenance would be required over the life of the works.

An insistence on the 5 to 6m distance recommended in the Specifications is not advised in this case as this may influence the ability to possibly achieve an alignment for the vertical wall further landward on the private property, as raised later in this letter.

Notwithstanding the above, it was considered appropriate to have the Applicant demonstrate whether achievement of the distance of 5.35m by temporary removal of the proposed fence along the top of the vertical wall would be feasible in practice and that the proposed works could accommodate the imposed vehicular loads. Accordingly, the Applicant was requested by Council to provide a response to these matters, which was included in Horton Coastal Engineering (2023b), wherein it was stated that:

³ It is likely the dimension of 5.35m is the sum of the proposed setback of 4.5m plus the combined thickness of the wave return wall (500mm at its widest point) and the reinforced concrete vertical wall (350mm).

⁴ Damage here refers to a relatively small degree of movement of individual rocks, which may be allowed by designers without the structure being considered as having failed or having been structurally compromised.



- the fencing attached to the top of the wall [is such that it] may be removed at any time without structural detriment to the wall; and
- the loads associated with the maintenance equipment surcharging the fill landward of the proposed wall and tracking directly on top of the wall, including the wave return, have been accommodated in the design of the wall.

2.6 Fence Along Top of Vertical Wall

A fence is proposed along the seaward edge of the top of the vertical wall. Details of the form of this fence were not provided in the information submitted with the DA. Such information would be necessary in order to form a view as to:

- the ability to readily remove the fence to provide adequate maintenance access behind the wall if required, as noted above; and
- the risk of damage to the fence and the potential for debris to enter the public beach in the event of storm waves overtopping the wall.

In view of the above, the Applicant was requested by Council to provide additional information in relation to the fence. A response was provided by the Applicant (Horton Coastal Engineering, 2023b) which indicated the following:

- the owners intend to install an open stainless steel wire fence at the top of the wall;
- being open, such a fence is highly unlikely to be damaged by wave action such that fence debris would enter the public beach; and
- there is less of a debris issue with the proposed works compared to the existing situation, given that mobile boulders and rubble may cause significant debris on the beach after storms at present [noting that certain existing rock on the beach is proposed to be removed as part of the proposed works refer Section 2.7].

It is recommended that a condition be imposed in relation to supply of design details for the fence, and confirmation that it has been suitably designed for coastal processes and hazards and will not create a public safety hazard during storm events. Such a condition has been included.

2.7 Management of Existing Rock and Inappropriate Materials

Rock encountered during excavation for the proposed coastal protection works is proposed to be managed in the following way:

- rock located seaward of the private property boundary over a distance of about 5 to 10m, encountered in excavation for the works, would be removed and:
 - stockpiled in an area agreed with Council for potential reuse in coastal protection works for public land, and/or
 - crushed and used as backfill behind the proposed works, and/or
 - taken offsite, and
- rock removed temporarily from public land to facilitate construction of returns for the private works would be reinstated to the pre-works condition.



Materials encountered during excavation for the proposed coastal protection works which are inappropriate to leave on the public beach are proposed to be managed in the following way⁵:

- placed landward of the proposed works, if suitable from an engineering perspective; and
- taken to a licensed waste management facility.

It is recommended that a suitable condition be imposed in relation to management of existing rock and unsuitable materials. Such a condition has been included.

2.8 Colouring and Finish of Concrete

It is proposed to use a sand-matching colour for the vertical wall and a minimum Class 3 finish for the wall as per Australian Standard AS3610-1995 Formwork for Concrete⁶.

The above measures are proposed in order to mitigate the visual impact of the proposed works.

2.9 Maintenance of the Works

The works are proposed to be maintained by the Principal Asset Owner (the private property owners) in accordance with the requirements of the Northern Beaches Coastal Erosion Policy (2016). This includes ensuring compliance with all requirements of any development consent that permitted the erection or modification of the works.

3. HISTORY OF EXISTING COASTAL PROTECTION WORKS

3.1 General

It is relevant to outline the history of the existing coastal protection works in the subject area of the DA, from Clarke Street to Mactier Street, inclusive of works protecting both private property and public land. This history is set out in the following Sections 3.2 to 3.8. A summary is provided in Section 3.9.

The history of the existing coastal protection works has been compiled from a number of sources including:

- Council development application records;
- University of New South Wales Water Research Laboratory (WRL) (1968);
- Foster (1975);
- Public Works Department (1985);
- Public Works Department (1987);
- Warringah Council (1997);
- Manly Hydraulics Laboratory (1999);
- Patterson Britton & Partners (1999);
- Patterson Britton & Partners (2001); and
- Northern Beaches Council (2016).

⁵ Inappropriate materials could include reinforced concrete, steel, timber, plastics, or the like.

⁶ According to a Fact Sheet prepared by the National Precast Concrete Association Australia, based on AS3610, a Class 3 finish is described in the following terms 'will give a good visual quality when the project is viewed as a whole'.



An oblique aerial view of the existing protection works from Clarke Street to Mactier Street, taken on 10 June 2016 following the major East Coast Low storm, is shown in Figure 3-1 (Clarke Street to South Narrabeen SLSC) and Figure 3-2 (South Narrabeen SLSC to Mactier Street).



Figure 3-1 Oblique aerial view of existing coastal protection works (10 June 2016) between Clarke Street and South Narrabeen SLSC (Figure 9 from Horton Coastal Engineering 2021b, original source UNSW WRL)





Figure 3-2 Oblique aerial view of existing coastal protection works (10 June 2016) between South Narrabeen SLSC and Mactier Street (Figure 10 from Horton Coastal Engineering 2021b, original source UNSW WRL)

3.2 1 Clarke Street and 1192 Pittwater Road

Firstly, it is noted that 1 Clarke Street was previously known as 1190 Pittwater Road. The latter address is adopted when referring to historical information prior to the change of address.

Documents supplied by Council show the rock seawall protection works at 1190 and 1192, designed by HG Small, Consulting Engineers, were approved by Council in July 1975. The documents include the following information:

- the works were in response to erosion experienced in early July 1975;
- the storm had exposed 'old rock filling normally covered by beach sand and which appears to have existed prior to Council adopting the wall line in 1968';
- the seawall works were approved on the basis that the rock the subject of the development application did not extend more than 3.5m beyond the private property boundary measured at mean sea level;
- Council did not object to the seawall works being carried across the end of Clarke Street, at the cost of the owner of 1190 and 1192 Pittwater Road⁷;
- a Building Application was submitted for the works in August 1975;

⁷ The extension of the seawall works across the end of Clarke Street was to prevent undermining of the southern end of the seawall protecting the private property.



- an inspection of the completed works was carried out by Council and a letter was issued to owners on 20 January 1976 stating that the works were found to be satisfactory for Council purposes; and
- the drawing for the proposed works at 1190 and 1192 Pittwater Road, dated 12 June 1975, indicated that at this time rock also existed in front of 1194 Pittwater Road.

Images of the rock protection works being constructed at 1190 and 1192 Pittwater Road in 1975 are shown in Figure 3-3 and Figure 3-4.



Figure 3-3 Rock protection works being constructed at 1190 and 1192 Pittwater Road in 1975 (photo courtesy of Don Champion)





Figure 3-4 Rock protection works being constructed at 1190 and 1192 Pittwater Road in 1975 (photo courtesy of Don Champion)

3.3 1194 Pittwater Road

Rock is known to have existed in front of 1194 Pittwater Road in 1975 since reference to the existence of this rock is included on the drawings for the proposed works at 1190 and 1192 Pittwater Road in 1975, as noted above in Section 3.2.

The exposure of rock protection works at 1194 and also at 1196 Pittwater Road in about 1974 is shown in Figure 3-5. By 1978 it is evident that rock protection works extended from Clarke Street all the way to 1222 Pittwater Road situated to the north of Mactier Street (refer lower panel of Figure 3-6).





Figure 3-5 Exposure of rock protection works at 1194 and 1196 Pittwater Road in about 1974 (Figure 5 from Horton Coastal Engineering 2021b)





Figure 3-6 Extracts from figures included in Public Works Department (1987) annotated with location of the subject DA



3.4 1196 Pittwater Road

In a similar manner to 1194 Pittwater Road, it is evident that rock protection existed at 1196 Pittwater Road in 1974 and 1978 (refer Figure 3-5 and Figure 3-6).

Figure 3-7 shows the rock protection works constructed at 1196 Pittwater Road, and also at the former 1198 Pittwater Road (now incorporated into the South Narrabeen SLSC), in about 1975.



Figure 3-7 Protection works constructed at 1196 and former 1198 Pittwater Road in about 1975 (Figure 6 from Horton Coastal Engineering 2021b)

3.5 1204 Pittwater Road

Rock protection works are evident at 1204 Pittwater Road as early as 1967 (refer top panel of Figure 3-6). Rock protection is also evident at 1204 in about 1974 in the background of the image included in Figure 3-5, and in 1978 in the lower panel of Figure 3-6.

3.6 South Narrabeen SLSC

An image of the erosion experienced at South Narrabeen SLSC in 1966 is included in Figure 3-8. Subsequently, rock protection works are evident in front of the SLSC in 1967 (refer top panel of Figure 3-6), in about 1974 (refer Figure 3-5), and in about 1975 (refer Figure 3-7).





Figure 3-8 Erosion at South Narrabeen SLSC in 1966 (Figure 4 from Horton Coastal Engineering 2021b)

3.7 Clarke Street

Based on documents supplied by Council in relation to rock protection works at 1190 and 1192 Pittwater Road, it is evident that rock protection was placed in front of Clarke Street during 1975 in conjunction with the works at 1190 and 1192 to prevent undermining of the southern end of the private works (refer Section 3-2). Rocks are also visible across the end of Clarke Street in 1978 (refer lower panel of Figure 3-6).

Additional rock protection was also placed across the end of Clarke Street as recently as June 2016 in response to the erosion caused by the East Coast Low storm. The placement of rock at this time is visible in Figure 3-1. This work was completed under the provisions of the State Emergency and Rescue Management Act 1989.

3.8 Mactier Street

Rock protection at Mactier Street is evident in about 1974 in the background of the image shown in Figure 3-5. It is also in place in 1978 as indicated in the lower panel of Figure 3-6.

3.9 Summary

Based on the available information outlined in the above sections, rock protection from Clarke Street to Mactier Street has been in place since the mid-late 1960s to early-mid 1970s, hence for a period close to 50 years or longer.

Placement of the rock has been in response to beach erosion emergencies. It has been carried out by residents and government. The rock protection has typically extended seaward of the property boundaries onto the public beach owing to the broad footprint of the works and location of existing building structures.

It is noted that the existing historical rock forms the base case for the coastal engineering assessment.



4. RELATIONSHIP BETWEEN PROPOSED COASTAL PROTECTION WORKS, EXISTING COASTAL PROTECTION WORKS, AND EXISTING BUILDING STRUCTURES

Figure 4-1 shows a plan view of the proposed works (in red) superimposed on a vertical aerial photograph that also shows the following:

- extent of existing rock protection works as at 8 June 2016 (post East Coast Low storm), including the landward edge (in green) and seaward edge (in blue);
- the private property boundaries (in black); and
- the numbering of the private properties and the South Narrabeen SLSC (in black).

Note that the seaward red line of the proposed works corresponds with the outer face of the vertical wall. The outer edge of the wave return at the crest of the vertical wall is a further 500mm seaward of the vertical wall and is situated on the private property boundary, as noted earlier.

A number of features are evident from Figure 4-1:

- the existing rock protection extends seaward of the private property boundaries onto the public beach by typically 3 to 5m along 1190 to 1196, and by up to around 9m at 1204;
- at the public land, the existing rock protection extends seaward of the property boundary by 3 to 7m (Clarke Street), 3 to 7m (South Narrabeen SLSC), and around 8m at Mactier Street; and
- at 1192 and 1204 there is paved vehicular access and parking located on the seaward side of the residential buildings. Vehicular access to the car parking at 1192 is off Pittwater Road and along the northern side of the building, whereas vehicular access to 1204 is off the seaward end of Mactier Street.

It is evident that the buildings and vehicular infrastructure at 1192 and 1204 would control the general overall alignment of coastal protection works between Clarke Street and Mactier Street, which preferably from a coastal processes impact perspective would be contiguous and co-linear.

The vehicular access off Mactier Street to 1204 Pittwater Road is shown in Figure 4-2. A view looking back towards Mactier Street from the rear (seaward) yard of 1204 is shown in Figure 4-3, with the garage doors visible on the left of the image. A manoeuvring width of 6m is required in front of the garages and corresponds approximately with the edge of the pavement. The timber fence visible in the right of the image is located inside the property boundary, which is approximately 8m seaward of the edge of the pavement (refer Figure 4-1).

The vehicular access off Pittwater Road along the northern side of 1192 Pittwater Road is shown in Figure 4-4. A view looking back towards the building with the garage doors visible is shown in Figure 4-5. Again a manoeuvring width of 6m is required in front of the garages and corresponds approximately with the edge of the pavement. The crest of the erosion escarpment came within 1 to 3m of the seaward edge of the pavement in the 2016 East Coast Low storm. The property boundary is located between approximately 7m and 9m seaward of the edge of the pavement (refer Figure 4-1).

The cross-shore position of the proposed coastal protection works relative to the existing rock protection, at 1204 and 1192, was previously shown in Figure 2-1 and Figure 2-2 respectively. Figure 4-6 shows the cross-shore position of the proposed coastal protection works relative to existing rock protection at all private properties, ie. 1190, 1192, 1194, 1196 and 1204. In all cases the existing rock protection is located seaward of the proposed works, being a maximum of around 10m at 1204, reducing towards the south to around 5m at 1190.





Figure 4-1 Proposed coastal protection works superimposed on aerial view of subject properties taken on 8 June 2016 following the 2016 East Coast Low storm (Figure 2 from Horton Coastal Engineering, 2021b)





Figure 4-2 View of vehicular access (driveway) to 1204 Pittwater Road off the seaward end of Mactier Street (October 2022)



Figure 4-3 View looking towards Mactier Street across the rear (seaward) yard at 1204 Pittwater Road (November 2022)





Figure 4-4 View of vehicular access off Pittwater Road along the northern side of 1192 Pittwater Road (November 2022)



Figure 4-5 View looking across the paved area within the rear (seaward) yard at 1192 Pittwater Road (November 2022)







1196

1194







	ELEVATION (m AHD)
	10.0 🗸
ENCE	9.00
VAVE RETURN	8.0 🗸
) MIN (T.B.C) THICK INFORCED	7.0▽
NCRETE WALL	6.0~
	5.0~
	4.0▽
	3.0▽
exchonien	2.00
Sund Rate	1.0マ
	0.0▽
COUR LEVEL T B.C.	-1.0▽
	-2.0▽
2750 SECANT PILE WALL PILE TOE -4.57 REFER TO DRAWING S10	-3.0▽
FOR NOTES AND DETAILS	-4.0▽
	-5.00
	-6.0▽
	-7.0▽
80 200 220 240 26	0 28.0

1192	
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1190

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5. DISCUSSION OF KEY COASTAL PROCESSES ALONG COLLAROY-NARRABEEN BEACH AND IMPACT OF COASTAL STRUCTURES

5.1 Key Coastal Processes

5.1.1 General

An understanding of the key coastal processes along Collaroy-Narrabeen Beach is fundamental to an assessment of the impact of coastal protection works.

Collaroy-Narrabeen Beach has been the subject of numerous coastal processes studies over many decades. It is useful to summarise the key coastal processes based on two recent studies carried out on behalf of Northern Beaches Council, namely:

- Manly Hydraulics Laboratory (MHL) (2016), Collaroy-Narrabeen Beach Coastal Protection Assessment, Report MHL2491, November 2016; and
- University of New South Wales Water Research Laboratory (WRL) (2019), Assessment of Present Beach Rotation at Collaroy-Narrabeen Beach, letter to Northern Beaches Council, WRL Ref: WRL2019083 MDH L20191118, 18 November 2019.

5.1.2 Manly Hydraulics Laboratory (2016)

MHL summarised the main physical processes relevant to Collaroy-Narrabeen Beach using a Quantitative Coastal Processes Model, as shown in Figure 5-1. The main features of the model can be summarised as follows:

- onshore transport of inner-shelf sand, although relatively small in scale relative to other crossshore and longshore processes, has the potential to balance the expected long-term sand losses attributable to post-storm headland bypassing and to potentially also influence natural shoreline recession in response to present and projected future sea level rise⁸;
- there is no evidence that Narrabeen Lagoon or existing stormwater systems that drain to the beach provide any significant net contribution of sand sized material to the beach;
- no significant net loss of sand from the beach occurs by aeolian (action of the wind) processes;
- management of sand at the entrance to Narrabeen Lagoon, by periodic entrance clearance operations and replenishment of the beach further to the south (south of Devitt Street), plus extra sand nourishment of the beach from time to time from building sites, have helped to maintain and even prograde the finely balanced sand budget of Collaroy-Narrabeen Beach; and
- Collaroy-Narrabeen Beach embayment is essentially a stable closed system, ie. no significant
 net sand loss or sand gain. The most significant processes in terms of beach fluctuations and
 shoreline alignment are cross-shore and longshore sand transport, including the alongshore
 variability in onshore and offshore sand movements and the time expected for beach recovery
 following major storms.

⁸ Sea level rise is predicted to cause shoreline recession on sandy shorelines due to the readjustment of the shoreline further landward in response to the sea level rise.





Figure 5-1 Quantitative coastal processes model for Collaroy-Narrabeen Beach (source: MHL 2016))

and supply

Beach recycling

Existing ad-hoc seawalls



5.1.3 Water Research Laboratory (2019)

WRL reviewed the beach profile monitoring data for Collaroy-Narrabeen Beach for five beach transects dating from 1976 (43 years of data) to provide insights into changes in beach volumes along the 3.6km long beach system. On the basis of this review, WRL stated that sand volume changes can be characterised by three different beach processes, namely:

- cycles of erosion and accretion along the entire beach (referred to as 'beach oscillation');
- cycles of erosion and accretion at opposite ends of the beach (referred to as 'beach rotation'); and
- long term recession trends.

WRL found based on the 43 years of beach volume measurements that there are no identifiable long term trends in sand volume at Collaroy-Narrabeen Beach, ie. the beach is a stable closed system. This finding is consistent with the finding in MHL (2016) and previous earlier studies based on photogrammetric assessment of vertical aerial photography, eg. Public Works Department (1987).

WRL concluded that sand volume changes are instead dominated by cycles of beach oscillation and beach rotation.

Beach rotation leading to cycles of erosion and accretion at opposite ends of the beach is a relatively recently understood phenomenon. To quantify and further understand the phenomenon, WRL defined a so-called Beach Oscillation Index (BOI), which is a measure of the orientation of the beach on any given day relative to the long term average orientation of the beach. It is calculated by the orientation of the mean sea level contour relative to the long-term (1976-2006) average orientation of this contour.

Figure 5-2 shows the time-series of the BOI at Collaroy-Narrabeen Beach between 1976 and 2019. A positive BOI means the beach has a more clockwise orientation relative to the long term average, whereas a negative BOI indicates a more anti-clockwise orientation. Extreme clockwise rotation of the beach occurred, for example, in November 1994 and November 2019.

It is evident that cycles of beach rotation are measured in years. Research has indicated that the rotation is strongly controlled by the 2 to 7 year cycles of the El Nino – Southern Oscillation climate oscillation, or ENSO.



Figure 5-2 Time-series of the Beach Orientation Index at Collaroy-Narrabeen (1976-2019). The November 1994 and November 2019 periods of extreme clockwise rotation are indicated in red



5.1.4 Summary

In summary, Collaroy-Narrabeen Beach is a stable closed system. Sand moves offshore into bars during storms and reworks onshore following storms. Superimposed on this behaviour is beach rotation. Beach replenishment in areas south of Devitt Street associated with periodic Narrabeen Lagoon entrance clearance operations (typically every 3 to 5 years) is an anthropogenic influence on beach volumes over time.

The main cause of the existing coastal hazards at Collaroy-Narrabeen Beach (south of Devitt Street) is that building development has historically taken place too close to the sea, within the active beach zone.

The behaviour of Collaroy-Narrabeen Beach has been extensively studied leading to a good understanding of the key coastal processes. This allows some confidence in the assessment of the impacts of proposed coastal protection works on coastal processes and beach amenity.

5.2 Coastal Protection Works Impacts on Coastal Processes Generally

5.2.1 Information in the literature

It is well accepted that coastal protection works (seawalls) located within the active beach zone will cause alongshore effects, often termed 'end effects' (increased erosion at the ends of the seawall). However, an accepted understanding of the impacts of coastal protection works, of different structural forms, on cross-shore processes such as scour seaward of the works and beach recovery following storm erosion has varied over time.

The Shore Protection Manual (SPM) (Coastal Engineering Research Centre, Department of the Army, US Army Corps of Engineers, 1984), a widely recognised reference for coastal engineering, stated at the time (1984), in reference to scour that:

"Because the sloping face of the quarrystone revetment is a good energy dissipater, revetments have a less adverse effect on the beach in front of them than a smooth-faced vertical bulkhead ... The use of vertical or nearly vertical-face walls can result in severe scouring when the toe or base of the wall is in shallow water."

"As a general guide, the maximum depth of a scour trough below the natural bed is about equal to the height of the maximum unbroken wave that can be supported by the original depth of water at the toe of the structure."

Hence the view in the 1980s was that a vertical seawall would create additional scour in front of the seawall compared to a sloping rock revetment, attributed to the greater wave reflection from a vertical wall or conversely less wave energy absorption.

Subsequently, in the Coastal Engineering Manual (CEM) (US Army Corps of Engineers, 2006), which is a much expanded replacement document for the SPM (1984), further discussion was included in regard to the interaction of seawalls with adjacent beaches (CEM page V-3-28)⁹.

⁹ The term seawall was taken to mean any type of coastal armouring that hardens the shoreline to a fixed position, hence it applied to bulkheads (vertical structures) and sloping revetments.



The CEM (2006) noted that Dean (1987) critically examined nine commonly expressed concerns about seawalls and adjacent beaches, including the degree of scour in front of seawalls and the rate of beach recovery following storm erosion. Dean made use in his analysis of conservation of sediment mass, laboratory and field data, and the theory of sediment transport. The findings from the assessment in relation to scour and beach recovery are summarised in Table 5-1.

The CEM (2006) further noted that Kraus (1988) reviewed over 100 references (laboratory, field work, theory, and conceptual studies) to make a thorough examination of the literature. This review, together with seven companion papers, were presented in Kraus and Pilkey (eds. 1988). An updated literature review was also presented in Kraus and McDougal (1996) who examined an additional 40 papers. In general, these extensive additional reviews agreed with Dean (1987) in relation those concerns regarding seawalls which were probably false.

Table 5-1	Assessment of commonly expressed concerns related to seawalls (Dean, 19	987)
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Concern	Assessment
Seawalls cause the beach profile to steepen dramatically	Probably false. No known data or physical arguments support this concern.
Seawalls result in a greatly delayed post-storm recovery	Probably false. No known data or physical arguments support this concern.

The CEM (2006) also specifically addressed 'frontal impacts' of seawalls (CEM page V-3-32). Here it was noted that beach profile change, toe scour during storms, and nearshore sand bar differences, have been attributed to seawalls, and that the conventional wisdom has been that these impacts were due to wave reflection. Quoting numerous references and physical model test results, it was however concluded from the studies that:

- wave reflection is not a significant factor in beach profile change or toe scour;
- in the field, toe scour is more dependent on local, sediment transport gradients and the return of overtopping water (through permeable revetments or beneath walls) than a result of direct, cross-section wave action; and
- the common perception that sloping and permeable surfaces produce less effects than vertical, impermeable walls was negated.

5.2.2 Observations at Collaroy-Narrabeen Beach

There are two observations of actual beach behaviour at Collaroy-Narrabeen Beach relevant to the consideration of the potential impacts of vertical coastal protection works versus, for example, a sloping rock revetment. These two observations relate to the existence of a cemented sand layer, which acts as a physical constraint on toe scour, and observed post-storm beach recovery in front of vertical coastal protection works that already exist along Collaroy-Narrabeen Beach. These matters are discussed in turn below.

Cemented sand layer

It is well established that a relatively inerodible cemented sand layer exists along Collaroy-Narrabeen Beach. Investigations in the area of Clarke Street to Mactier Street indicate that the surface of the



cemented sand along the seaward property boundaries is at a level of 0.4m AHD \pm 0.5m and has a thickness in the range of 3m to greater than 5m (Horton Coastal Engineering, 2021a).

It has been noted above in Section 5.2.1 through reference to literature discussed in CEM (2006) that it is the currently generally accepted view that vertical seawalls do not cause additional toe scour compared to sloping permeable rock revetments. Even if there remained some conjecture regarding this view, the existence of the cemented sand layer renders this argument somewhat unnecessary at Collaroy-Narrabeen Beach since scour during storms already reaches the surface of this layer in front of existing sloping permeable rock revetments and any additional scour in the case of a vertical seawall is essentially not likely (refer Figure 5-3).



Figure 5-3 Surface of cemented sand layer exposed in front of the sloping permeable rock revetment near Clarke Street (July 2022)

Post-storm beach recovery in front of existing vertical coastal protection works

There are known to be four existing (or recently existing) sections of vertical seawalls along Collaroy-Narrabeen Beach:

- north and south of Collaroy SLSC;
- Collaroy Beach Club;
- 1096 Pittwater Road ('The Breakers'); and
- 1150 Pittwater Road (recently replaced by a hybrid vertical seawall/rock toe during 2021).



General observations by the writer over many years has not indicated any significant differences in poststorm beach recovery in front of these vertical structures compared to other locations along the beach where sloping permeable rock revetments exist.

Similar post-storm beach recovery behaviour would be expected to be observed for any future vertical coastal protection works, having regard to the key coastal processes operating along Collaroy-Narrabeen Beach (essentially stable closed sediment system), providing the future vertical works are located suitably landward in the cross-shore beach profile. This has been the subject of assessment by MHL as discussed in the following Section 5.3.

5.3 Assessment by Manly Hydraulics Laboratory

5.3.1 General

Manly Hydraulics Laboratory (MHL), in association with the University of New South Wales Water Research Laboratory (WRL), developed a beach width model to assess the impact on coastal processes of three types of coastal protection works for Collaroy-Narrabeen Beach:

- vertical seawall;
- hybrid seawall, comprising a vertical seawall with a rock toe approximately 2m wide; and
- sloping rock revetment

The modelling also considered the impact on coastal processes of the existing ad-hoc rock protection works.

The model was used to estimate the percentage of time the dry beach width (width above the wave runup level) is less than 5m, using predominantly measured data. A 5m width was assessed by MHL as the minimum acceptable dry beach width based on a review of worldwide literature and knowledge of Collaroy-Narrabeen Beach.

Two wave runup cases were assessed:

- R_{2%}: The wave runup level that is exceeded by less than 2% of waves in an hour; and
- R_{max}: The maximum wave runup level over an hour.

The beach width model was run for a 10 year representative period of historical measured data covering the period January 2006 to May 2016.

For purposes of assessing the subject DA, beach width was examined at a total of seven profile locations, comprising two locations adopted in earlier modelling (MHL, 2020) denoted MP09 (Mactier Street) and MP10 (near South Narrabeen SLSC), and five locations established specifically for assessment of the subject DA, located at 1204, 1196, 1194, 1192 and 1190 Pittwater Road (MHL, 2022b). The total seven profile locations are shown in Figure 5-4.

MHL also gave consideration as to whether additional scour at the toe of a vertical seawall, should it occur, could affect the beach width modelling. It was concluded that the level of any additional scour was not sufficient to impact the beach width modelling results, noting in part that measured data from the beach indicates that any additional toe scour recovers quickly after storm events (MHL, 2020; Section 6.1).





Figure 5-4 Location of profiles for MHL beach width modelling (Figure 1 from MHL, 2022b)



5.3.2 Results of beach width modelling

The results of the beach width modelling are set out in Table 5-3 for MP09, MP10, and at each of the individual properties, for four types of coastal protection works, for both $R_{2\%}$ and R_{max} . The four types of coastal protection works and a description of each is provided in Table 5-2. It is noted that one of the coastal protection works types is a sloping rock revetment design, which was included to allow a comparison between the impacts of a vertical structure as opposed to a sloping rock revetment structure.

The relative alignments of the vertical seawall proposed in the DA and a rock revetment design alternative are summarised in Figure 5-5 at each property location. The alignment adopted for the rock revetment by MHL was based on information supplied by Council, which in turn was based on advice to Council from Royal HaskoningDHV (RHDHV). The alignment took into account a number of considerations including constructability issues (excavation proximity to existing buildings and infrastructure), the Collaroy-Narrabeen Beach Coastal Protection Works Design Specifications (2016) and the intent of placing the rock revetment as far landward as practicable. Even so, the rock revetment necessarily extends seaward of the private property boundary onto the public beach owing to its wide footprint.

The alignment adopted for the rock revetment for comparative modelling purposes can be compared to the alignment for rock revetment coastal protection works adopted in a previous concept design prepared by MHL (1999), as summarised in Table 5-4, which sets out the approximate distance that the rock revetment extends onto the public beach beyond the private property boundary, measured at 0m AHD. It is apparent that the rock revetment alignment established in MHL (1999) was significantly further seaward, covering a greater portion of the public beach, than that developed by RHDHV on behalf of Council for the purposes of beach width modelling in MHL (2022b). Had the MHL (1999) alignment been adopted for modelling, it would have led to a much poorer outcome for the rock revetment alternative than that summarised below¹⁰.

The results of the beach width modelling in MHL (2022b) can be summarised as follows:

- the vertical wall proposed in the DA is expected to result in a beach width of less than 5m for approximately 0.4% of the time in the R_{2%} case or a total of about 1.5 days per year;
- the R_{2%} and R_{max} findings suggest that the proposed vertical wall is expected to result in a beach width of less than 5m for approximately 0.3% to 1.3% more of the time compared to the existing ad-hoc rock protection works, or about an additional 1 to 5 days per year. However, the existing ad-hoc rock protection works do not meet current coastal engineering standards, or satisfy Council's Coastal Erosion Policy and the Coastal Protection Works Design Specifications;
- the rock revetment design alternative for the R_{2%} case was found to have a beach width less than 5m between 0.1% to 2.7% of the time, or less than 1 day and up to 10 days, depending on profile location; and
- overall, the vertical wall was found to have less impact on available beach width than the rock revetment design alternative due to reduced encroachment into the active beach.

¹⁰ The greater encroachment of the rock revetment onto the public beach in MHL (1999) compared to the concept developed by RHDHV is due to two main reasons:

MHL (1999) positioned the crest of the rock revetment such that excavation for the revetment construction would not
reduce the foundation capacity of the existing structures, whereas RHDHV considered temporary works could be
introduced to ensure stability of existing structures, with a consequent reduced distance between the crest and existing
structures; and

[•] RHDHV adopted a somewhat lesser footprint for the revetment structure itself than the value of 21m in MHL (1999).



Based on the findings of the beach width modelling, MHL concluded that the proposed vertical wall would be expected to have no significant impact on beach width compared with the existing ad-hoc protection works and a rock revetment design alternative.

MHL noted that areas to the north and south of the proposed coastal protection works may be vulnerable to end effect erosion, since while these areas are currently protected by ad-hoc rock protection this protection is not to contemporary engineering standards. Particular attention was drawn to the South Narrabeen SLSC.

Council is aware of the erosion risk for South Narrabeen SLSC and at the road heads at Clarke Street and Mactier Street. It is understood that planning is underway for implementation of upgraded coastal protection works at these locations integrated with the upgraded coastal protection works on the adjacent private property.

MHL also noted that while the beach width modelling focussed on amenity impacts to available beach width, other amenity impacts not assessed in the modelling study included structure vertical relief, private/public access, visual aesthetics, and public safety considerations. A number of these matters are considered by the writer in the following Section 6.

Finally, it is noted that the MHL beach width modelling is based on present day conditions and does not account for shoreline recession due to sea level rise. However, the analysis is considered valid over the life of the works as shoreline recession due to sea level rise is proposed to be mitigated by beach nourishment in accordance with the Coastal Zone Management Plan 2016 and the proposed works would not affect the amount of sea level rise or the beach response to it.

Туре			Description	
•	existing ad-hoc rock works	:	The existing ad-hoc rock protection works currently at the back of the beach.	
•	rock revetment	:	Indicative rock revetment between Clarke Street and Mactier Street, if this form of coastal protection works had been adopted rather than a vertical wall.	
•	vertical wall in earlier modelling	:	The vertical wall previously modelled in MHL (2020) situated on an alignment coincident with the seaward private property boundary (not proposed in the subject DA).	
•	vertical wall proposed in DA	:	Vertical wall situated 0.5m landward of the seaward property boundary.	

Table 5-2	Four types of coastal p	protection works subject to	beach width modelling in MHL ((2022b)
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	Percentage of time with less than 5m width								
	R2%					R _{max}			
Profile	Existing ad- hoc rock works	DA Proposed vertical wall	Earlier modelling vertical wall	Rock revetment	Existing ad- hoc rock works	DA Proposed vertical wall	Earlier modelling vertical wall	Rock revetment	
MP09	< 0.1	-	< 0.1	< 0.1	< 0.1	-	< 0.1	< 0.1	
1204 Pittwater Road	< 0.1	< 0.1	-	< 0.1	< 0.1	< 0.1	-	< 0.1	
MP10	< 0.1	-	1.0	0.1	< 0.1	-	2.3	0.2	
1196 Pittwater Road	0.1	0.4	-	0.1	0.2	1.3	-	0.2	
1194 Pittwater Road	< 0.1	0.4	-	2.0	< 0.1	1.2	-	3.3	
1192 Pittwater Road	< 0.1	0.4	-	2.6	0.1	1.2	-	4.1	
1190 Pittwater Road	< 0.1	0.4	-	2.7	< 0.1	1.1	-	4.2	

Table 5-3 Results of beach width modelling (Table 2 from MHL, 2022b)

Table 5-4Position of the rock revetment alternative modelled in MHL (2022b) in comparison to previous rock
revetment concept design in MHL (1999)

Location	Approximate distance from property boundary to the external face of the rock revetment, measured at 0m AHD (refer Note 1)			
	MHL (2022b)	MHL (1999)		
1204	7.5m	15m		
1196	5.1m	13m		
1194	6.5m	13m		
1192	6.8m	15m		
1190	6.8m	15m		

Notes:

1. Distances for MHL (2022b) are taken from Figure 5-5 in this letter. Distances from MHL (1999) are estimated from Figures in that document, namely Figure 4.5 (for 1190) and Figure 4.1 (for 1204, 1194 and 1192)









6. REVIEW OF DEVELOPMENT APPLICATION

6.1 General

This section sets out a review of the DA in relation to relevant legislation, policies, guidelines and specifications including:

- Coastal Management Act, 2016;
- State Environmental Planning Policy (Resilience and Hazards) 2021;
- Northern Beaches Coastal Erosion Policy (2016);
- Coastal Zone Management Plan for Collaroy-Narrabeen Beach and Fishermans Beach (2016);
- Collaroy-Narrabeen Beach Coastal Protection Works Design Specifications (2016);
- Coastal Erosion Emergency Action Subplan for Beaches in Warringah (as amended, 2015);
- Warringah Local Environmental Plan 2011; and
- Warringah Development Control Plan 2011.

Prior to the review, Section 6.2 sets out a brief discussion of construction versus operational impacts.

6.2 Construction versus Operational Impacts

It is reasonable to consider that the most significant potential impacts of the proposed coastal protection works on the environment are operational as opposed to construction impacts.

Construction impacts are relatively short term, localised, and can generally be suitably mitigated by standard construction phase controls in relation, for example, to noise, traffic, access and the like.

However, one aspect of construction that warrants more detailed attention is the potential impact of a temporary bund which is likely to be constructed on the beach by the Contractor to provide a level of protection to the works from wave action and tides during the construction phase.

Such temporary bunds are a typical feature of construction activity on a beach in order to reduce the risk of storm damage to the partially completed works and to maximise effective construction hours.

When the bund potentially includes materials other than sand, it is necessary to ensure these materials are not mobilised by wave action and become strewn over the beach and in the surf zone causing adverse impacts for beach amenity, beach safety and coastal processes. This matter is considered to be of sufficient importance to warrant inclusion of a condition of consent relating to the design and maintenance of a temporary bund, as outlined in Section 7.

The remainder of the discussion in the following sections relates to potential operational impacts.

6.3 Coastal Management Act 2016

The relevant section of the Coastal Management Act 2016 is Section 27 within Part 5 Miscellaneous. This Section is reproduced below followed by a discussion.

27 Granting of development consent relating to coastal protection works

 Development consent must not be granted under the *Environmental Planning and Assessment* Act 1979 to development for the purpose of coastal protection works, unless the consent authority is satisfied that—



- (a) the works will not, over the life of the works—
 - (i) unreasonably limit or be likely to unreasonably limit public access to or the use of a beach or headland, or
 - (ii) pose or be likely to pose a threat to public safety, and
- (b) satisfactory arrangements have been made (by conditions imposed on the consent) for the following for the life of the works—
 - (i) the restoration of a beach, or land adjacent to the beach, if any increased erosion of the beach or adjacent land is caused by the presence of the works,
 - (ii) the maintenance of the works.
- (2) The arrangements referred to in subsection (1) (b) are to secure adequate funding for the carrying out of any such restoration and maintenance, including by either or both of the following—
 - (a) by legally binding obligations (including by way of financial assurance or bond) of all or any of the following—
 - (i) the owner or owners from time to time of the land protected by the works,
 - (ii) if the coastal protection works are constructed by or on behalf of landowners or by landowners jointly with a council or public authority—the council or public authority,
 - (b) by payment to the relevant council of an annual charge for coastal protection services (within the meaning of the *Local Government Act 1993*).
- (3) The funding obligations referred to in subsection (2) (a) are to include the percentage share of the total funding of each landowner, council or public authority concerned.

Note. Section 80A (6) of the *Environmental Planning and Assessment Act* 1979 provides that a development consent may be granted subject to a condition, or a consent authority may enter into an agreement with an applicant, that the applicant must provide security for the payment of the cost of making good any damage caused to any property of the consent authority as a consequence of the doing of anything to which the consent relates.

Discussion

In relation to (1)(a) - 'life of the works':

Reference is made to 'the life of the works', hence it is important to have an understanding of what this expression may mean.

It is considered reasonable to adopt 'the life of the works' for the proposed works to be 60 years on the basis that:

- a design life of 60 years has been adopted by the Applicant for the proposed works¹¹; and
- any consent for the proposed works would include a condition of 'time limited consent' requiring re-evaluation of the works leading up to the 60 years anniversary, as outlined further below.

It is customary for any approval of coastal protection works on Collaroy-Narrabeen Beach to include a condition of time limited consent stating that the consent operates for 60 calendar years from the date of the issue of the occupation certificate and such other period as may be extended only with the written approval of Council in accordance with a range of requirements.

These requirements include that, at a minimum of three (3) years prior to the date of 60 years, the owner(s) shall procure at no cost to Council, a Review Report, by a suitably qualified independent

¹¹ Design life in an engineering context is defined as the period of time over which a structure or a structural element remains fit for its intended purpose with appropriate maintenance, not major repairs.



coastal engineer. The report must review the performance of the works using the evidence and coastal hazard predictions at that time, including consideration of sea level rise for example. The time limited consent condition hence ensures the creation of a formal 'hold point' at 60 years at which time the performance of the works is evaluated and, among other things, the life of the works is re-assessed. This evaluation would include consideration of the planning laws in place at that time.

In conclusion, it is considered reasonable to adopt the life of the works as 60 years for purposes of the coastal engineering assessment.

In relation to (1)(a)(i) – the works will not, over the life of the works, unreasonably limit or be likely to unreasonably limit public access to or the use of a beach or headland:

Firstly, consideration of headlands is not relevant as these features are remote from the proposed works.

The proposed works are located entirely on private property. Access to the beach by the general public would be via the road heads at Clarke Street and Mactier Street or via South Narrabeen SLSC. It is an action of the CZMP (2016) for Council to ensure continuing and undiminished public access to beaches by such means. The proposed works would not limit provision of such access.

Access to the beach by the owners and occupiers of four of the five subject properties would be via two sets of beach access stairs; one set at the common boundary of 1 Clarke Street and 1192 Pittwater Road, and one set at the common boundary of 1194 and 1196 Pittwater Road. The owners and occupiers of 1204 Pittwater Road are proposed to access the beach via the adjacent Mactier Street¹².

Any works must have regard to potential impacts on beach width. The assessment of the impact of the proposed works on beach behaviour set out in Section 5 which included consideration of relevant information in the literature, observations of actual beach behaviour at Collaroy-Narrabeen Beach, and specific beach width modelling carried out by MHL (2022b), showed that the proposed works would not be expected to have any significant impact on beach width, when compared with the existing ad-hoc rock protection works or a rock revetment design alternative.

Over time, during the life of the works, access to the beach or use of the beach may be affected by shoreline recession due to projected sea level rise. In so far as the proposed works are concerned, two points are relevant:

- the proposed works would have no impact on projected sea level rise as this is a consequence of climate change due to global warming; and
- shoreline recession (a reduction in sandy beach width) due to a rise in sea level is the consequence of a cross-shore readjustment of the beach profile commonly predicted using the Bruun Rule (Bruun, 1962). Modelling by MHL (2022b), discussed in Section 5.3.2, has shown that the cross-shore behaviour of the beach in front of the proposed vertical wall would not be significantly different compared to that in front of the existing ad-hoc rock protection works or a rock revetment design alternative.

Council has recognised that shoreline recession due to sea level rise is a much broader issue beyond the capacity of individual property owners to manage. Accordingly, the CZMP notes that management actions (beach nourishment) to address the impacts of shoreline recession due to climate change are the responsibility of Local Government and State Government.

¹² It is noted that the owners and occupiers of the subject properties are also regarded as members of the public for purposes of this coastal engineering assessment.



On the basis of the above, it is concluded that, over the life of the works, the works would not unreasonably limit or be likely to unreasonably limit public access to or the use of a beach or headland.

Public access and use of the beach would benefit from the proposed removal, as part of the DA, of existing rock protection and inappropriate materials on the public beach over a distance of 5 to 10m seaward of the private property boundary where encountered during excavation for the proposed works. Any additional existing rock protection or inappropriate materials visible on the beach beyond the above distance should be removed by Council as part of general beach safety and beach amenity improvements, as was the case recently following construction of the new coastal protection works further south along the beach.

In relation to (1)(a)(ii) – the works will not, over the life of the works, pose or be likely to pose a threat to public safety:

The proposed works would not pose or be likely to pose a threat to public safety over the life of the works, for a number of reasons:

- the works have been designed taking into account sea level rise over the life of the works, noting that an increase in water level due to sea level rise affects (increases) the design wave conditions at the proposed works;
- the proposed works are not predicted to have a significant impact on beach behaviour compared to the existing conditions;
- the works have been designed to accommodate acceptably rare design conditions over the design life including consideration of water levels, wave conditions, scour levels and geotechnical stability;
- the design has been prepared in accordance with the relevant Australian Standards and would be certified prior to construction by suitably qualified structural, coastal and geotechnical engineers;
- the completed construction works would be certified by suitably qualified engineers;
- the completed works would be subject to a Maintenance Management Plan for their design life approved by Council; and
- conditions are recommended to address the public safety risk of wave overtopping (inundation), namely preparation of a Safety Management Plan and physical modelling to confirm the wave overtopping discharges, as discussed further in Section 6.4.2 and Section 7.

The proposed works would reduce the existing public safety risk over the life of the works for a number of reasons:

- existing rock protection and inappropriate materials, where encountered in excavation for the works, would be removed from the public beach where currently they are a hazard, at times, to beach users;
- there would be reduced debris and undersized rock strewn over the public beach during and following storms;
- it would not be necessary to carry out emergency erosion protection works during and following storms, at which times staff of emergency agencies and volunteers place themselves at some safety risk (refer also to Coastal Erosion Emergency Action Subplan in Section 6.8); and
- owners and occupiers of the subject properties would be protected from erosion and substantially better protected from inundation risks.



On the basis of the above, it is concluded that the proposed works will not, over the life of the works, pose or be likely to pose a threat to public safety.

In relation to (1)(b)(i) – satisfactory arrangements have been made (by conditions imposed on the consent) for the following for the life of the works – the restoration of a beach, or land adjacent to the beach, if any increased erosion of the beach or adjacent land is caused by the presence of the works:

It is considered that satisfactory arrangements could be made by way of a condition imposed on the consent.

It is noted that previous consent conditions imposed on similar coastal protection works included a requirement for a post storm inspection by a suitably qualified coastal engineer, preparation of a detailed report, and implementation by the property owners of recommendations within the report. It is recommended that the wording of the relevant condition(s) be reviewed to ensure alignment with the wording in Section 27 (1)(b)(i) of the Coastal Management Act 2016. This is noted in Section 7.

Based on the assessment set out in Section 5, in practice significant increased erosion of the beach by the presence of the works would not be expected. Nevertheless, an appropriate condition, as referred to above, should be imposed.

In regard to adjacent land; namely Clarke Street, Mactier Street, and South Narrabeen SLSC, there is existing rock protection in each of these areas as outlined in Section 3. This existing protection would provide a level of resistance to possible increased erosion due to enhanced 'end effects' from the proposed works, however the existing protection does not satisfy current coastal engineering standards and cannot be relied upon for complete protection of these lands¹³.

It is understood Council propose to upgrade the coastal protection at Clarke Street, Mactier Street and South Narrabeen SLSC, co-ordinated with the coastal protection works on private property, to resolve interaction between the respective works. Resolution of this interaction is in fact the responsibility of Council under the CZMP (2016), as noted in Section 6.6. These upgrading works are proposed to be completed within the next three years. In the interim, any increased erosion of the adjacent land would be expected to be limited to the upper face of the erosion escarpment as has been the case in past severe storm events. The assets behind the existing protection works, namely the roads and the SLSC, are considered to be at an acceptable level of risk from coastal hazards over this interim time frame.

In the event that increased erosion of the adjacent land did occur in the interim period, caused by the presence of the proposed works, the subject condition of consent would be triggered to restore the land.

In relation to (1)(b)(ii) – satisfactory arrangements have been made (by conditions imposed on the consent) for the following for the life of the works – the maintenance of the works:

It is considered that satisfactory arrangements could be made by way of a condition imposed on the consent.

It is noted that such conditions have been included in previous consent conditions imposed on similar coastal protection works, specifically the requirement for preparation and implementation of a Maintenance Management Plan and specification of maintenance obligations.

¹³ It is considered that the proposed works may enhance 'end effects' on the basis that a vertical wall would replace the existing sloping ad-hoc rock protection works.



In relation to (2) and (3) - (not repeated here):

These are not coastal engineering matters, although it is noted that calculation of the dollar amount to ensure financial assurance may require engineering input.

6.4 State Environmental Planning Policy (Resilience and Hazards) 2021

6.4.1 General

The relevant part of the State Environmental Planning Policy (Resilience and Hazards) 2021 is Part 2.2 Development controls for coastal management areas. Within this Part there are four relevant Divisions as follows:

- Division 2 Coastal vulnerability area
- Division 3 Coastal environment area
- Division 4 Coastal use area
- Division 5 General

The following sections consider each of these Divisions in turn.

6.4.2 Division 2 Coastal Vulnerability area

As yet no Coastal Vulnerability Area Map has been prepared and therefore no coastal vulnerability area has been identified. On the one hand it could be considered that due to the absence of a Map the matter of development within a coastal vulnerability area does not apply. However, it is clear that the proposed works would be located within a coastal vulnerability area once mapped, hence consideration is given to this matter below. The relevant Clause 2.9 is reproduced followed by a discussion.

2.9 Development on land within the coastal vulnerability area

Development consent must not be granted to development on land that is within the area identified as "coastal vulnerability area" on the *Coastal Vulnerability Area Map* unless the consent authority is satisfied that—

- (a) if the proposed development comprises the erection of a building or works—the building or works are engineered to withstand current and projected coastal hazards for the design life of the building or works, and
- (b) the proposed development—
 - (i) is not likely to alter coastal processes to the detriment of the natural environment or other land, and
 - (ii) is not likely to reduce the public amenity, access to and use of any beach, foreshore, rock platform or headland adjacent to the proposed development, and
 - (iii) incorporates appropriate measures to manage risk to life and public safety from coastal hazards, and
- (c) measures are in place to ensure that there are appropriate responses to, and management of, anticipated coastal processes and current and future coastal hazards.



Discussion

In relation to (a) – if the proposed development comprises the erection of a building or works – the building or works are engineered to withstand current and projected coastal hazards for the design life of the building or works:

The design life of the works adopted by the Applicant is 60 years. The key coastal hazards are beach erosion (including localised beach scour), shoreline recession and coastal inundation.

In particular it is noted:

- the proposed works have been designed assuming complete erosion of all beach sand in the design 100 year Average Recurrence Interval (ARI) storm event, including scour in front of the works to be level of -1.3m AHD (well below the existing cemented sand level) which is considered to be a greater than a 2,000 year ARI event;
- there is no shoreline recession due to net sediment loss predicted for Collaroy-Narrabeen Beach, being essentially a stable closed system (refer Section 5.1). There is, however, future shoreline recession predicted due to projected sea level rise. This has been taken into account for the design life of the works in the design scenario referred to above, notwithstanding it is an action in the CZMP (2016) for Council to manage future shoreline recession due to sea level rise by means of beach nourishment;
- structural design of the proposed works has been based on a projected sea level rise corresponding to the end of the design life. Since sea level rise affects water level and water depth (in conjunction with scour level), and water depth in turn affects design wave conditions and wave loading, adoption of the projected sea level rise corresponding to the end of the design life from 'day one' is a conservative approach, also reducing the potential need for implementation of adaption strategies; and
- in regard to coastal inundation, a crest level for the works of 7.0m AHD is proposed together with a wave return wall at the crest to manage wave overtopping (inundation) over the life of the works. Calculations of wave overtopping rates included in Horton Coastal Engineering (2021a), using desktop methods, indicated the following for the proposed crest level and wave return wall for the adopted 100 year ARI storm event and 100 year ARI water level combined with the greater than 2,000 year ARI scour level:
 - for the present day (then 2021), no significant wave overtopping would be expected and safety criteria for humans near the crest would be met¹⁴,
 - at the end of the 60 year design life (2081), only minor damage to landscaping is predicted but safety criteria for humans near the crest would not be met. It would be necessary for persons to remain landward of the wall crest in severe storms, over time, as recognised by the Applicant's Coastal Engineer, or adapt the crest to reduce overtopping.

Setting a crest level for coastal protection works is a balance between the risk associated with wave overtopping (risk to property and risk to life), visual impact, cost, and the ability to adapt the structure over time in response to increased overtopping due to sea level rise, if required. It would be uncommon to design a coastal protection structure for zero overtopping over its design life due to implications for cost and visual impact, and where other measures exist to manage the risk.

It is also well accepted that desktop methods for calculation of wave overtopping discharge may not be accurate and that where confirmation of overtopping discharges are important, for example in relation to risk to property and risk to life, and design of landward drainage, as is the case for the subject application, it is advisable for small scale physical modelling to be carried out.

¹⁴ Based on criteria set out in van der Meer et al (2018), known as the EurOtop Manual.



The outcome of physical modelling is unlikely to materially alter the proposed works for a number of reasons as set out below, hence addressing the wave overtopping by way of a condition of consent is considered reasonable:

- the proposed works should remain a vertical structure, to minimise its footprint and avoid encroachment onto the public beach;
- the proposed works should not be positioned further seaward, to avoid impacts on coastal processes and beach behaviour, and encroachment onto public land;
- the crest level should not be raised above the existing proposed level of 7.0m AHD, for visual impact reasons; and
- achievement of an engineered drainage solution landward of proposed works should be feasible for the current coastal protection works concept¹⁵.

Any modification of the proposed works would likely be confined to the engineering detail (geometry) of the wave return at the crest of the structure.

It is concluded that the proposed works themselves are engineered to withstand the assessed current and projected coastal hazards for the design life of the works.

To address the safety hazard to persons due to wave overtopping and to inform drainage design landward of the proposed works, it is recommended that conditions of consent require preparation of a Safety Management Plan and physical modelling to confirm wave overtopping discharges. This is noted in Section 7.

In relation to (b)(i) – the proposed development is not likely to alter coastal processes to the detriment of the natural environment or other land:

Section 5 of this letter has set out a discussion of the potential impact of the proposed works on coastal processes based on:

- an understanding of the key coastal processes along Collaroy-Narrabeen Beach;
- information in the literature, in particular the authorative Coastal Engineering Manual (CEM) (US Army Corps of Engineers, 2006);
- observations of post-storm beach recovery in front of existing vertical coastal protection structures along Collaroy-Narrabeen Beach; and
- numerical modelling of beach width behaviour in response to the proposed vertical wall compared to the existing ad-hoc rock protection works and a rock revetment design alternative, completed by MHL (2022b).

It was found that:

concerns that seawalls cause additional toe scour and greatly delay post-storm beach recovery
were probably false as there is no known data or physical arguments to support these concerns.
Further, the common perception that sloping permeable surfaces (rock revetments) produce less
effects on the beach than vertical, impermeable walls has been negated;

¹⁵ The drainage solution is likely to involve surface drainage and subsoil drainage, and could include grading the land toward the crest of the wall for the return of wave overtopping flows, if required.



- general observations of post-storm recovery in front of existing vertical walls along Collaroy-Northern Beah have indicated no significant differences compared to other locations along the beach where sloping permeable rock revetments exist; and
- modelling results showed that the proposed vertical wall would be expected to have no significant impact on beach width compared to the existing ad-hoc rock protection works or a rock revetment design alternative.

It is concluded that the proposed works are not likely to alter coastal processes to the detriment of the natural environment.

The proposed works have the potential to enhance 'end effects' on the adjacent land. This matter has been noted above in Section 6.3 wherein it has been indicated that:

- Council propose to upgrade the existing coastal protection on the adjacent public land within the next three years;
- any increased erosion of the adjacent land would be expected to be limited to the upper face of the erosion escarpment;
- assets behind the existing protection works are considered to be at an acceptable level of risk from coastal hazards over the interim time frame of three years prior to the upgrading works; and
- in the event that increased erosion of the adjacent land did occur in the interim period, caused by the presence of the proposed works, the condition of consent referred to in Section 6.3 would be triggered to restore the land.

The wording of sub-clause 2.9(b)(i) in the State Environmental Planning Policy (Resilience and Hazards) 2021 is somewhat at odds with sub-clause 27(1)(b)(i) of the Coastal Management Act 2016 which specifically anticipates that coastal protection works may increase erosion but that this is only acceptable if conditions can be imposed to restore it. It is understood that if there is any inconsistency between the Policy and the Act, the Act would override the Policy.

In relation to (b)(ii) – is not likely to reduce the public amenity, access to and use of any beach, foreshore, rock platform or headland adjacent to the proposed development:

Firstly, consideration of rock platforms and headlands is not relevant as these features are remote from the proposed works.

For reasons noted in Section 6.3 in the discussion in relation to the Coastal Management Act 2016, the proposed works would not be likely to reduce access to and use of the beach or foreshore adjacent to the proposed works. These reasons include:

- the proposed works are located entirely on private property and access to the beach by the general public would be via the road heads at Clarke Street and Mactier Street or via South Narrabeen SLSC; and
- the proposed works would not be expected to have any significant impact on beach width when compared with the existing ad-hoc rock protection works or a rock revetment design alternative.

As also noted in Section 6.3, the proposed removal of existing rock protection and inappropriate materials from the public beach as part of the DA would be a benefit for beach access.



In regard to the potential for the proposed works to reduce public amenity, it is firstly necessary to consider what may be meant by public amenity as there would not appear to be a definition in the State Environmental Planning Policy (Resilience and Hazards) 2021 or in the Coastal Management Act 2016.

Frampton (2010) in a paper which reviewed amenity beach management noted that 'amenity is identified as a perception of beach users of a location's elements that provide a positive, enjoyable benefit'. The paper identified a number of issues that affect the amenity provided by beaches and grouped them broadly as those involving direct interaction with the physical/natural environment and those involved with managing beach use. The latter included beach safety and the provision of facilities, services, and access.

MHL et al (2021) in a coastal protection amenity assessment for the proposed Wamberal Terminal Coastal Protection, considered the following potential beach amenity impacts:

- available dry beach width impact;
- end erosion impact;
- surf amenity impact;
- post-storm existing ad-hoc protection on the beach;
- visual amenity impacts;
- foreshore access impacts; and
- safety impacts.

Of the amenity considerations raised by Frampton (2010) and MHL et al (2021), the following have already been addressed earlier in this letter – dry beach width impact, end erosion impact, post-storm existing ad-hoc protection on the beach, foreshore access impacts, and safety impacts. Visual amenity is considered further below in response to Division 4 Coastal use area.

The issues raised by Frampton (2010) regarding the provision of facilities and services do not really apply to the subject DA, noting that facilities and services for beaches such as car parking, professional lifeguards, and beach cleaning, are the responsibility of Council.

The amenity consideration that remains from the above matters is the direct interaction of beach users with the physical/natural environment. This is considered below.

Collaroy-Narrabeen Beach is a significantly modified environment in the back beach area due to the history of building development and construction of erosion protection works dating from the 1920s. Consequently, the back beach area does not represent a natural environment as would be the situation for example, with a vegetated dunal system. Beach users would be accustomed to the built environment and the sight of rocks along the beach when the beach levels are low following erosion events and while the beach is recovering naturally.

The question would seem to be whether the construction of the proposed works, being a vertical wall located 500mm within the private property boundary (with wave return wall located at the crest coincident with the property boundary), would diminish the positive, enjoyable experience of beach users compared to the situation of existing ad-hoc rock protection, or for the existence of other forms of possible coastal protection works such as a rock revetment design meeting the Design Specifications (2016).

The relative impact on the beach experience is likely to be subjective and dependent on the state of the beach at the time, whether accreted or eroded.

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Figure 4-6 presented previously shows the relative position of the proposed works and the existing rock protection at each of the subject properties. Figure 5-5 presented previously shows the relative position of the proposed works and a rock revetment design alternative as modelled in MHL (2022b). Figure 6-1 and Figure 6-2 show the relative position of the proposed works, existing rock protection, and a rock revetment design alternative, at 1204 Pittwater Road and 1194 Pittwater Road respectively, together with 24 historical beach profiles from the NSW beach profile data base covering the 80 year period 1941 to 2021.

It is apparent from Figure 6-1 and Figure 6-2 that when the beach is well accreted sand levels along the property boundary are at 6m AHD and above. At such times the existing rock protection, the proposed works, and a rock revetment design alternative, would all be substantially buried with only the upper crest levels visible, if visible at all. At such times the relative beach experience between each situation is likely to be essentially the same, with a wide sandy beach berm in place¹⁶.

At times of an erosion event impacting on a well accreted beach, the rock protection would become visible on the beach, and effect beach use, earlier than the vertical wall, since the rock works would be located further seaward.

Following an erosion event which fully exposes the rock protection or a vertical wall, the rate of natural sand recovery for both forms of protection would be expected to be generally similar (refer discussion in Section 5). Studies by Phillips on beach recovery at Collaroy-Narrabeen Beach, referred to in MHL et al (2021), show that this rate of recovery is relatively quick at 0.1 to $0.2m^3/m/day$ in the initial 1-2 months following the storm. Within 12 months after a storm (using the 2016 East Coast Low as an example) MHL et al (2021) noted that the beach berm had recovered to a width of approximately 30m and to a height of 2 to 3m AHD¹⁷. Natural recovery of beach levels above about 3m AHD is a much slower process, being dependent on aeolian (wind) processes and can take years. Council often accelerates the natural recovery by the practice of beach scraping, as noted further below.

While the rate of natural sand recovery following an erosion event may be similar for rock protection and a vertical wall, there is likely to be some difference between the character and use of the beach in these two situations, for a period of time, which could influence the beach experience. In order to provide a sandy beach surface suitable for recreation (and access along the beach) the sand in the case of the rock protection must first fill the voids in the rocks and then cover the rocks, whereas for the case of a vertical wall the sand is able to immediately create a sand surface directly adjacent to the wall.

Based on the rates of sand recovery referred to above and the volume of voids to be filled to a level of say 2 to 3m AHD, the useability of the beach could be impacted for a period of possibly 3 to 6 weeks longer per recovery event for rock protection compared to a vertical wall.

In conclusion, the proposed works would be expected to have a neutral to slightly positive impact on beach amenity where considered in the context of use of the sandy beach area. Accordingly, the proposed works are not likely to reduce the public amenity of the beach in regard to beach use.

It is also worth noting from a beach amenity perspective that Council currently takes actions to address beach amenity by covering exposed rock protection through beach scraping, to assist natural beach recovery after storms, and by beach replenishment using sand from Narrabeen Lagoon entrance clearance operations. These actions are included in the CZMP (2016) and it is understood would

¹⁶ It is noted that the beach profiles in Figure 6-1 and Figure 6-2 are measured historic profiles determined by photogrammetric analysis of historical vertical aerial photography in the absence of any proposed works, but with the existing rock protection in place for most dates of photography. Use of the beach profiles to assess comparative beach state between the proposed works and the existing rock protection is considered reasonable based on the modelling results in MHL (2022b), discussed in Section 5.3.

¹⁷ As recorded in front of the rock protection works at Flight Deck.



continue into the future. As such, these actions would also assist in mitigating any beach amenity issues attributed to the proposed works.



Figure 6-1 Proposed works (in solid black) at 1204 Pittwater Road, existing rock protection (June 2016 profile), and rock revetment design alternative (dashed black), compared to 24 historical beach profiles



Figure 6-2 Proposed works (in solid black) at 1194 Pittwater Road, existing rock protection (June 2016 profile), and rock revetment design alternative (dashed black), compared to 24 historical beach profiles



In relation to (b)(iii) – incorporates appropriate measures to manage risk to life and public safety from coastal hazards:

The proposed works incorporate a range of measures to manage risk to life and public safety from coastal hazards, as noted below. The relevant coastal hazards are beach erosion and coastal inundation, noting that shoreline recession due to projected sea level rise would be managed by Local Government and State Government, as set out in the CZMP (2016)¹⁸:

- the proposed works have been satisfactorily structurally designed to combat the beach erosion hazard over the life of the works;
- the proposed works reduce the public safety hazard of rocks on the public beach by removing such rocks where encountered in excavation for the proposed works;
- the proposed works avoid the need to carry out emergency erosion protection works during and following storms at which times staff of emergency agencies and volunteers place themselves at some safety risk (refer also to Section 6.6); and
- the proposed works have been designed to address the risk to life and public safety from coastal inundation, over the life of the works, by virtue of the proposed crest level and inclusion of a wave return wall. At some point during the life of the works, due to projected sea level rise, the degree of wave overtopping is predicted to exceed safety criteria for humans near the crest of the wall. It is recommended that conditions of consent require preparation of a Safety Management Plan to manage this hazard, and the carrying out of physical modelling to confirm the wave overtopping discharges, as noted in Section 6.4.2.

In conclusion, it is considered that the proposed works include appropriate measures to manage risk to life and public safety from coastal hazards. Management of the wave overtopping risk by way of a Safety Management Plan informed by physical modelling is considered preferable to measures such as increasing the crest level of the wall.

In relation to (c) – measures are in place to ensure that there are appropriate responses to, and management of, anticipated coastal processes and current and future coastal hazards:

It is considered that suitable measures are in place to ensure that there are appropriate responses to and management of anticipated coastal processes and current and future coastal hazards, in that:

- the existing and future coastal processes and coastal hazards over the life of the works have been assessed;
- the design of the works has taken into account the future coastal processes and coastal hazards over the life of the works, to accepted practice;
- a Maintenance Management Plan would be prepared and implemented by the owners of the properties; and
- it has been recommended that conditions of consent be included to require preparation of a Safety Management Plan and the carrying out of physical modelling to manage the wave overtopping risk.

¹⁸ It is also reiterated, as discussed in Section 6.3, that the proposed works would have no impact on projected sea level rise, or on the cross-shore behaviour of the beach in response to sea level rise compared to the existing ad-hoc rock protection works or a rock revetment design alternative.



6.4.3 Division 3 coastal environment area

The relevant clause is reproduced below followed by a discussion.

2.10 Development on land within the coastal environment area

- (1) 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.
- (2) Development consent must not be granted to development on land to which this section 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 subsection (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.
- (3) This section does not apply to land within the Foreshores and Waterways Area within the meaning of *Sydney Regional Environmental Plan (Sydney Harbour Catchment)* 2005.

Discussion

In relation to (1)(a) – impact on the integrity and resilience of the biophysical, hydrological (surface and groundwater) and ecological environment:

From a coastal engineering perspective, the relevant considerations in (1)(a) are surface water and groundwater. Comment is also provided in relation to the biophysical and ecological environment.

Groundwater would not be expected to be significantly altered by the proposed works on the basis that free-draining granular backfill would be placed behind the vertical wall and weep holes would be included below the footing/capping beam at a level of approximately 2m AHD to allow groundwater to flow to the beach (refer Figure 2-1 and Figure 2-2). A local increase in groundwater level may temporarily occur behind the wall in heavy rainfall prior to the groundwater draining through the wall. This has been taken into account in the design of the proposed works¹⁹.

¹⁹ The proposed works have been conservatively designed for a groundwater level behind the wall of 3.5m AHD at the same time as an extreme low tide in front of the works, i.e. maximum head difference acting on the wall.



Surface water from the properties which is not directed to Council's stormwater systems in the adjacent roads, or which does not directly enter the groundwater system, could be captured and directed parallel to the alignment of the works, via an interallotment drainage system as required, to discharge through coastal protection works at the road heads (Clarke Street and Mactier Street), subject to details being confirmed with Council. It would also be possible to grade the private land towards the crest of the vertical wall so that any excessive wave overtopping water flowed back over the crest of the wall between waves. The final drainage solution would be dependent on the outcome of the recommended physical modelling of wave overtopping, over the life of the works, recommended as part of this review.

It is concluded that the proposed works are not likely to cause an adverse impact on the groundwater and surface water.

The DA was referred to Council's Natural Environment Unit – Biodiversity for review against the relevant environmental legislation and controls including the Biodiversity Conservation Act 2016, State Environmental Planning Policy (Resilience and Hazards) 2021, and Warringah Development Control Plan 2011 (Clause E2 Prescribed Vegetation, Clause E4 Wildlife Corridors, and Clause E6 Retaining Unique Environmental Features). The Natural Environment Unit supported the proposal and recommended a number of conditions be imposed. Those conditions have been included.

In relation to (1)(b) - impact on coastal environmental values and natural coastal processes:

The coastal environmental value of Collaroy-Narrabeen Beach of most significance from a coastal engineering perspective is that included as Objective 1 to guide preparation of the CZMP (2016), namely:

'1 Council seeks to maintain beach amenity, and surf quality in the future as its highest priority'.

A number of matters relating to beach amenity have been discussed above. It was considered that the proposed works would not impact adversely on those matters and in some cases would improve beach amenity, eg. in relation to the matter of beach safety and access along the beach following storms.

For the reasons outlined in Section 5, including the results of modelling by MHL (2022b), the proposed works are not likely to cause an adverse impact on natural coastal processes. As such, the proposed works would not be expected to cause an adverse impact on surf quality.

<u>In relation to (1)(c) – impact on the water quality of the marine estate in particular, the cumulative impacts of the proposed development on any of the sensitive coastal lakes identified in Schedule 1:</u>

The proposed works are not likely to cause an adverse impact on the water quality of the marine estate. The proposed works are constructed primarily of reinforced concrete which is essentially inert with no risk of leaching of contaminants or the like when in contact with surface water, groundwater or ocean waters.

It is noted that the proposed works would reduce the risk of debris from the subject properties entering the ocean at times of storms, which is a benefit.

The proposed works do not impact on any sensitive coastal lakes listed in Schedule 1 of the State Environmental Planning Policy (Resilience and Hazards) 2021.

In relation to (1)(d) – impact on marine vegetation, native vegetation and fauna and their habitats, undeveloped headlands and rock platforms



Firstly, consideration of undeveloped headlands and rock platforms is not relevant as these features are remote from the proposed works. Impacts on native vegetation and fauna and their habitats were considered by Council's Natural Environment Unit – Biodiversity. The proposal was supported with conditions, which have been included, as noted above.

The proposal works are located wholly on private property at the back of the beach, situated above the level of Mean High Water Mark (MHWM) at present and the predicted level of MHWM over the life of the works (refer to footnote in Section 2.2). At times when the sandy beach may be eroded back to the proposed works, natural beach recovery is relatively rapid and marine vegetation would not become established. Accordingly, impact on marine vegetation is not an issue.

In relation to (1)(e) – impact on 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:

The proposed works are not likely to cause an adverse impact on existing public open space, noting that the proposed works are located entirely on private property and are not expected to impact significantly on existing beach behaviour.

The proposed works are not likely to cause an adverse impact on safe access to and along the foreshore, beach, headland or rock platform for members of the public, including persons with a disability, as noted in Section 6.3 in the discussion in relation to the Coastal Management Act, 2016.

Safe access would be improved by the proposed removal of existing rock and inappropriate materials on the public beach over a distance of 5 to 10m seaward of the private property boundary where encountered during excavation for the proposed works.

In relation t (1)(f) – Aboriginal cultural heritage, practices and places

Not a coastal engineering consideration.

In relation to (1)(g) - impact on use of the surf zone:

The proposed works are not likely to cause an adverse impact on use of the surf zone as the works are not expected to impact significantly on existing coastal processes, as discussed in Section 5.

In relation to (2)(a)(b) and (c) – design, siting and management of the proposed works to avoid, minimise and mitigate impact on matters referred to under subsection (1):

It is considered that the proposed works have been generally designed, sited and managed to avoid, minimise and mitigate the impacts referred to under subsection (1). The following is noted:

- the proposed works are sited entirely on private property;
- the proposed works have been designed to satisfactorily accommodate the assessed future coastal processes and coastal hazards over the life of the works;
- a Maintenance Management Plan will be prepared and implemented by the owners of the properties;
- a condition of consent would be imposed to ensure satisfactory arrangements are in place, for the life of the works, for restoration of the beach and land adjacent to the beach, if increased erosion of the beach or adjacent land is caused by the presence of the works; and



• conditions of consent have been recommended for preparation of a Safety Management Plan and the carrying out of physical modelling to assist with management of the risk to property, and risk to life, and landward drainage design, due to wave overtopping (inundation) over the life of the works.

The outcomes of the physical modelling may lead to optimisation of the detailed geometric design of the wave return at the crest of the vertical wall.

The outcomes of the physical modelling should also form the basis for:

- review of the crest level of the wall, specifically whether the proposed crest level could be lowered below 7.0m AHD for some or all of the proposed works. The crest level should not be increased above 7.0m AHD; and
- review of the alignment of the proposed works, specifically whether the alignment could be shifted further landward, having regard to risk to property and risk to life, and the reasoning on the existing proposed alignment outlined in the additional information provided by the Applicant in Horton Coastal Engineering (2023b).

6.4.4 Division 4 Coastal use area

The relevant clause is reproduced below followed by a discussion.

2.11 Development on land within the coastal use area

- (1) 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.
- (2) This section does not apply to land within the Foreshores and Waterways Area within the meaning of *Sydney Regional Environmental Plan (Sydney Harbour Catchment)* 2005.

Discussion

In relation to (1)(a)(i) – impact on existing, safe access to and along the foreshore, beach, headland or rock platform for members of the public, including persons with a disability:



The matter of impact on safe access has been considered previously, refer Section 6.3 and Section 6.4.3. In summary, the proposed works are not likely to cause an adverse impact on existing safe access as the proposed works are located entirely on private property and would not impact significantly on the rate of beach recovery and beach width when compared to the existing ad-hoc rock protection. Safe access would be improved by the proposed removal of existing rock protection and inappropriate materials on the public beach. The proposed works would not impact on existing access to the beach from Clarke Street, Mactier Street, or South Narrabeen SLSC.

In relation to (1)(a)(ii) – impact on overshadowing, wind funnelling and loss of views from public places to foreshores:

Overshadowing, wind funnelling and loss of views from public spaces to foreshores are not coastal engineering considerations.

It is, however, noted in regard to overshadowing that the crest level of the proposed works matches approximately the existing ground levels in the rear (seaward) yards of the properties.

In relation to (1)(a)(iii) – impact on the visual amenity and scenic qualities of the coast, including coastal headlands:

The potential impact of the proposed works on visual amenity is known to be a concern with some stakeholders.

The writer acknowledges that he is not an expert in visual impact assessment, however coastal engineering considerations influence the potential for the works to impact on visual amenity hence it is considered reasonable to provide some commentary below. A detailed assessment of the impact of the proposed works on visual amenity and scenic qualities is to be provided by others.

In order to satisfy the State Environmental Planning Policy (Resilience and Hazards) 2021 the proposed coastal protection works must be engineered to withstand current and projected coastal hazards over the design life of the works, and must incorporate appropriate measures to manage risk to life and public safety from coastal hazards, eg. refer clause 2.9(a) and 2.9(b)(iii) of the Policy.

The requirement to satisfy the Policy dictates that the proposed works must have a certain structural robustness, eg. be able to accommodate without failure the design wave conditions, beach scour level, geotechnical conditions, etc. and must have a minimum crest level. eg. to manage the wave overtopping and inundation risk to life and risk to property to an acceptable level. The outcome is necessarily a substantial structure.

In relation to (1)(a)(iv) and (v) – (not repeated here):

1(a)(iv) and (v) are not coastal engineering considerations.

In relation to (1)(b)(i)(ii) and (iii) – design, siting and management of the proposed works to avoid, minimise and mitigate impact on matters referred to in paragraph (a):

It is considered that the proposed works have been generally designed, sited and will be managed to avoid, minimise and mitigate the impacts referred to under (a)(i), which is related to coastal engineering. Matters (a)(ii)(iii)(iv) and (v) are not coastal engineering matters.

Refer also to comments in Section 6.4.3 in relation to matters (2) (a)(b)(c) in that section.



In relation to (1)(c) – taking into account the surrounding coastal and built environment, and the bulk, scale and size of the proposed development:

The bulk, scale and size of the proposed works are driven by satisfying the requirements of State Environmental Planning Policy (Resilience and Hazards) 2021, as noted above in response to (1)(a)(iii).

The Applicant has sought to reduce the bulk, scale and size of the proposed works by adopting a design solution having the minimum cross-shore footprint (vertical wall, less than 1m width) and for which the structural systems that support the wall, comprising the vertical secant piles and permanent ground anchors, are mostly or wholly always out of view below beach level or ground level in the rear (seaward) yard of the private properties.

The alternative design solution to the proposed works would be a sloping rock revetment conforming to the requirements of the Coastal Protection Works Design Specifications (2016). Such a revetment would have a minimum cross-shore footprint of approximately 15m and, by necessity, owing to this footprint and the location of the beachfront buildings and infrastructure, would extend beyond the private property boundary onto the public beach by up to around 8m measured at 0m AHD²⁰.

6.4.5 Division 5 General

The two relevant clauses are reproduced below followed by a discussion.

2.12 Development in coastal zone generally-development not to increase risk of coastal hazards

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.

Discussion

The proposed works are not likely to cause increased risk of coastal hazards on the subject land, in fact the proposed works eliminate the beach erosion hazard and mitigate the coastal inundation hazard on the subject land over the life of the works.

The risk of increased erosion on adjacent public lands at Clarke Street, Mactier Street and South Narrabeen SLSC due to possible enhanced 'end effects' from a vertical wall is mitigated by the existing rock protection in these areas. The risk would be fully addressed by Council's proposal to upgrade the existing protection in these areas, discussed in Section 6.3, noting that the resolution of interaction between public land and coastal protection works on private property in a co-ordinated manner is the responsibility of Council under the CZMP (2016).

The wording of sub-clause 2.12 of the State Environmental Planning Policy (Resilience and Hazards) 2021 above is somewhat at odds with sub-clause 27 (1)(b)(i) of the Coastal Management Act 2016 which specifically anticipates that coastal protection works may increase erosion but that this is only acceptable if conditions can be imposed to restore it. It is understood that if there is any inconsistency between the Policy and the Act, the Act would override the Policy.

²⁰ Assumes temporary works are included to ensure stability of existing structures during excavation and thereby minimise encroachment onto the public beach. Encroachment onto the public beach would be greater without temporary works, eg. as proposed in the concept design in MHL (1999). Refer Section 5.3.



2.13 Development in coastal zone generally – coastal management programs to be considered

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 program that applies to the land.

Discussion

A certified Coastal Zone Management Plan (CZMP) is in place for Collaroy Narrabeen Beach. The proposed works have been specifically assessed in relation to the objectives and relevant provisions of the CZMP as set out in Section 6.6 of this letter. The proposed works are considered to be consistent with the objectives of the CZMP and to comply with the relevant provisions of the CZMP.

6.5 Northern Beaches Coastal Erosion Policy (2016)

The Northern Beaches Coastal Erosion Policy (2016) guides Council's approach to the protection of public and private property from coastal hazards identified in the certified Coastal Zone Management Plan for Collaroy-Narrabeen Beach and Fishermans Beach (2016).

The Policy includes a number of considerations relevant to the subject DA including:

- principles;
- designing and siting protection works;
- alignment of protection works;
- impact assessment for protection works;
- maintenance of beach amenity and access; and
- maintenance of protection works.

The impact assessment for the proposed protection works, maintenance of beach amenity and access, and maintenance of the protection works, have been considered earlier in relation to the Coastal Management Act (2016) and State Environmental Planning Policy (Resilience and Hazards) 2021.

A number of Principles and other matters in the Policy relevant to the subject DA and not considered earlier are listed below in Table 6-1, together with a comment in relation to the proposed coastal protection works.

4

		Statement in the Policy	Comment
2.	d)	Principles Property owners (including government) are responsible for protecting their property from the impacts of coastal processes, and are responsible for ensuring their property does not adversely impact on adjoining properties or coastal processes	 Property owners have accepted the responsibility for protection of their property; Refer to impact assessment discussion earlier; Satisfactory arrangements would be made, by conditions imposed on the consent, for the life of the works, that the property owner would be responsible for restoration of the beach, or land adjacent to the beach, due to any increased erosion of the beach or adjacent land caused by the presence of the works.



		Stat	ement in the Policy	Comment
4.		Des	igning and site protection works	
 a) Private protection works should be built on private proposed works would be built on private property unless it can be demonstrated that this is not private property. appropriate due to site constraints, adverse impact on adjoining private and public properties, or adverse impact on the long-term amenity of the beach and surf zone. b) All protection works shall be designed and constructed: 		 Private protection works should be built on private property unless it can be demonstrated that this is not appropriate due to site constraints, adverse impact on adjoining private and public properties, or adverse impact on the long-term amenity of the beach and surf zone. 		The proposed works would be built entirely on private property.
		:		
		(iii)	Such that the works are only visible temporarily during and after significant erosion events	Not fully met, the upper section of the works may be visible more than temporarily after significant erosion events (refer Note 1).
		(iv)	To be contiguous, similar and integrated with adjoining protection works constructed in the embayment	This is the intention of the works. It will require coordination between the Applicant and Council at common boundaries. It is noted that resolution of the interaction between coastal protection works on private property and public land is the responsibility of Council under the CZMP (refer Section 6.6).
		(vii)	In accordance with the minimum criteria outlined in the Collaroy-Narrabeen Beach Coastal Protection Works Design Specifications.	Refer to Section 6.7 for discussion in relation to the Specifications.

Notes:

1. This requirement is difficult to fully meet for any private or public coastal protection works along Collaroy-Narrabeen Beach which satisfy the Design Specifications, due to the position of property boundaries relative to the beach and the requirement for a minimum crest level for the coastal protection works to address public safety issues due to wave overtopping in severe storms. Beach scraping, and beach replenishment as part of Narrabeen Lagoon entrance clearance works, activities carried out by Council in accordance with the Coastal Zone Management Plan (CZMP), would assist in mitigating the visual impact of the proposed works as is the case with the existing ad-hoc rock protection. It is also noted that the proposed works would involve the removal of existing ad-hoc rock and inappropriate materials off the public beach adjacent to the private properties over a seaward distance of about 5 to 10m which would be a benefit visually, as well as a benefit to public amenity and public safety. Refer also to discussion in Section 6.4.4 relating to development of land within the coastal use area.

On balance, the benefits of a vertical wall in terms of its reduced footprint, its landward position off the public beach, the need to ensure public safety in wave overtopping events, and the proposal to remove existing rock and inappropriate materials off the public beach, are considered to justify the Policy requirement under 4(b)(iii) not being fully met.

6.6 Coastal Zone Management Plan for Collaroy-Narrabeen Beach and Fishermans Beach (2016)

The Coastal Zone Management Plan (CZMP) for Collaroy-Narrabeen Beach and Fishermans Beach (2016) was prepared in order to best manage these beaches in a balanced and sustainable manner for current and future conditions.

Following stakeholder consultation, four overarching objectives were defined to guide the management of Collaroy-Narrabeen Beach and Fishermans Beach, as follows:

- Council seeks to maintain beach amenity and surf quality in the future as its highest priority;
- Council seeks to allow property owners to carry out new development on beachfront and near beachfront land adjacent to Collaroy-Narrabeen Beach and Fishermans Beach where risk of damage to development from coastline hazards can be demonstrated to be acceptably low;



- property owners are responsible for protecting their property from the impacts of coastal processes; and
- Council seeks to maintain its own public beachfront and near beachfront assets where the risk of damage from coastal processes can be demonstrated to be acceptably low²¹.

In terms of seeking to allow property owners to carry out new development on beachfront land and near beachfront land, the CZMP accepted that this could be achieved through stipulating a number of controls including the provision of new and upgraded coastal protection works where required south of Devitt Street (where environmental impacts of such works can be demonstrated to be acceptable).

On balance, based on the discussion in Sections 6.3, 6.4 and 6.5, and the recommendations in Section 7, the proposed coastal protection works are considered acceptable and therefore consistent with the objectives of the CZMP.

The CZMP also sets out a number of specific requirements for upgrading or constructing new coastal protection works. These specific requirements are set out in Table 6-2 together with a comment in relation to the proposed coastal protection works.

Table 6-2	Specific requirements in CZMP for upgrading or constructing new coastal protection works and
	comment in relation to the proposed works

Sp	ecific Requirements in CZMP	Comment
•	Only location where coastal protection works by property owners are considered to be generally suitable is south of Devitt Street	Complies. The subject properties are south of Devitt Street.
•	Property owners are responsible for protecting their property from coastal erosion and inundation hazards	Complies. Property owners will be responsible for construction and maintenance of their coastal protection works.
•	To assist in mitigating any impacts of landowner protection works on public beach amenity any upgraded/new works should be built entirely on private properties unless	Complies. The proposed works would be built entirely on private property.

The CZMP also includes two other relevant management actions for consideration in the assessment of the DA. These are set out in Table 6-3 together with a comment in relation to the proposed coastal protection works.

²¹ The CZMP notes that Council will resolve the interaction between public land and coastal protection works on private property in the specifications for new or upgraded coastal protection works.



Table 6-3	Additional relevant management actions in CZMP and comment in relation to the p	proposed works

Ade	ditional Relevant Management Action	Comment	
•	Beach amenity: Actions currently undertaken by Council, namely beach scraping to assist in accelerating the recovery of beach amenity after storms and beach replenishment using sand from Narrabeen Lagoon entrance clearance operations, are also actions that will continue to be implemented to enhance beach amenity.	As stated in Note 1 to Table 6-1, beach scraping and beach replenishment would assist in mitigating the visual impact of the proposed works. It is further noted that Mactier Street is the current preferred location for supply of replenishment sand to the beach and, accordingly, would generally always receive a proportion of the nourishment sand.	
•	Beach amenity: A wide sandy beach is attractive to beach users, but will be a challenge to maintain if beaches recede due to sea level rise the application of beach nourishment is essential to achieving the maintenance of beach amenity in the future tasks to investigate and implement beach nourishment to protect beach amenity are likely to be undertaken by Council in conjunction with the NSW Government and other Sydney Coastal Councils.	Maintenance of beach amenity into the future due to recession associated with sea level rise is not a matter for individual private property owners, but rather Local Government and the NSW Government. The proposed works would not	
		affect sea level rise, or the beach response to sea level rise compared to the existing ad-hoc rock protection works or a rock revetment design alternative.	

6.7 Collaroy-Narrabeen Beach Coastal Protection Works Design Specifications (2016)

The Collaroy-Narrabeen Beach Coastal Protection Works Design Specifications (2016) (Specifications) were prepared with the aim of ensuring all coastal protection works along Collaroy-Narrabeen Beach are of a consistent design standard that provides an appropriate level of protection.

The Specifications include, among other things, a range of design criteria. These criteria were principally established for rock revetment structures but are also relevant in a number of instances to alternative proposals for coastal protection works not comprising rock revetments as is the case for the subject DA.

Table 6-4 sets out the relevant criteria in the Specifications together with a comment in relation to the proposed coastal protection works.



Table 6-4 Relevant criteria in the Design Specifications and comment in relation to the proposed works

Relevant Criteria		Comment
•	Minimum Average Recurrence Interval (ARI) for Design Event: 50 years	Complies (refer Note 1)
•	Minimum design life: 60 years	Complies
•	Minimum crest level: 6.5m AHD	Complies
•	Global slope stability: Minimum factor of safety 1.5	Complies
•	Cross-shore positioning: The seawall shall be located as far landward as practicable to minimise impact on coastal processes and beach amenity, and shall be located fully on private land wherever feasible	Complies (refer Note 2)
•	Interaction with adjoining properties or works: The seawall design shall aim to integrate with adjacent seawalls and shall not adversely affect the performance of adjacent seawalls	Complies (refer Note 3)
•	Criteria for assessing sea level rise: The following sea level rise projections may be adopted relative to 1990 (2050, 0.4m; 2100, 0.9m). Variations to these values may be considered supported by a report prepared by a suitably qualified engineer	Complies (refer Note 4)
•	Access for maintenance: The seawall design shall include consideration of the need for access for future maintenance. A minimum distance of 5 to 6m is recommended from the landward edge of the seawall crest to adjacent building structures.	A setback of 4.5m is provided landward of the vertical wall. It is stated that this could be increased to 5.35m by temporary removal of the proposed fence located on top of the vertical wall. Refer to discussion in Section 2.5. The proposed works are considered to comply.
•	Basis of Design statement: A Basis of Design (BoD) statement shall be submitted with the DA.	Complies
•	Minimum level of geotechnical investigation prior to design: A geotechnical investigation shall be conducted by a suitably qualified engineer, with a minimum of three test pits along seaward property boundary.	Complies (refer Note 5)
•	Certification post construction: The construction shall be certified by a suitably qualified engineer	Complies. Such certification would be standard practice and this requirement would be included in any condition of consent.

Notes:

- The minimum ARI for the design event in the Specifications of 50 years relates to a 'flexible' rock structure. The
 proposed structure is a 'fixed' structure and reference for the appropriate ARI for the design event for this case has been
 to Australian Standard AS4997-2005 *Guidelines for the design of maritime structures*, which is considered appropriate.
 The adopted ARI for design is in the order of 2,000 year ARI or rarer, comprising a 100 year ARI water level combined
 with 100 year ARI wave conditions, a greater than 2,000 year ARI scour level, all occurring at the end of the 60 year
 design life following projected sea level rise.
- 2. The proposed works are located fully on private property. The modelling carried out by MHL (2022b) concluded that the proposed coastal protection works would have no significant impact on beach width. Refer also to discussion in



Relevant Criteria

Comment

Section 5. Even so, it has been recommended that the alignment of the proposed works is reviewed following the outcome of the physical modelling (refer to Section 6.4.3).

- 3. It is the stated intention of the proposed works to integrate with adjacent seawalls on public land and not adversely affect the performance of adjacent seawalls. This will require coordination between the Applicant and Council at common boundaries. The Coastal Zone Management Plan (CZMP) notes that Council will resolve the interaction between public land and coastal protection works on private property. Council propose to upgrade the existing coastal protection works on the adjacent land within the next three years. A condition of consent should be imposed such that, for the life of the proposed works, the Applicant is responsible for restoration of the beach, or land adjacent to the beach, if any increased erosion of the beach or land adjacent to the beach, is caused by the presence of the proposed works.
- 4. The sea level rise projections relative to 1990 of 0.4m (2050) and 0.9m (2100) are no longer NSW Government policy. The Applicant has proposed sea level rise projections over the 60 year life (2081) based on Intergovernmental Panel on Climate Change (IPCC) (2013), for a median exceedance probability and the average of the five emission scenarios. This is considered reasonable having regard to other conservative assumptions.
- Geotechnical information is available from a number of investigations dating from 2000. In the area from Clarke Street to Mactier Street, the investigations comprise seven Boreholes, 12 Dynamic Cone Penetrometer (DCP) tests and three Test Pits. This level of geotechnical information is considered reasonable for DA purposes.

6.8 Coastal Erosion Emergency Action Subplan for Beaches in Warringah (as Amended, 2015)

The Coastal Erosion Emergency Action Subplan for Beaches in Warringah sets out, among other things, the approvals required for emergency protection works, and the roles and responsibilities of various parties including Council, State Emergency Service (SES) and NSW Police.

The proposed works have the benefit of reducing the requirement for an emergency response during erosion events since the works would be appropriately designed and certified, and replace the existing coastal protection works which are not of an adequate standard.

This in turn would reduce the risk to public safety at times of coastal erosion events since Council staff, SES, NSW Police, technical advisors, volunteers and the like, would not be required to place themselves at personal risk. The potential hazards at such times can include the following, noting also that an emergency coastal erosion response can often take place at night:

- slips, trips, and falls;
- injury due to debris mobilised by waves and wind;
- drowning;
- land collapse;
- building collapse;
- collision with plant and equipment;
- strains; and
- exposure to ruptured utility services.

Figure 6-3, Figure 6-4 and Figure 6-5 show images of the emergency response during the June 2016 East Coast Low at Collaroy-Narrabeen Beach, near Stuart Street. It is evident that significant numbers of people can be involved in the emergency response during hazardous conditions.





Figure 6-3 View of persons who mobilised to assist with the coastal erosion emergency at Collaroy-Narrabeen Beach near Stuart Street in June 2016



Figure 6-4 View of persons and selected plant mobilised to assist with the coastal erosion emergency at Collaroy-Narrabeen Beach near Stuart Street in June 2016 (photo courtesy of Rural Fire Service)





Figure 6-5 Rural Fire Service worker conducting emergency activities in lower right of image during the coastal erosion emergency at Collaroy-Narrabeen Beach near Stuart Street in June 2016. Note the extensive debris (photo courtesy of Rural Fire Service)

6.9 Warringah Local Environmental Plan 2011

The relevant clause of Warringah Local Environment Plan 2011 (LEP 2011) is Clause 6.5 in Part 6. This is reproduced below followed by a discussion.

6.5 Coastline hazards

- (1) The objectives of this clause are as follows—
 - (a) to avoid significant adverse impacts from coastal hazards,
 - (b) to enable evacuation of coastal risk areas in an emergency,
 - (c) to ensure uses are compatible with coastal risks,
 - (d) to preserve and protect Collaroy Beach, Narrabeen Beach and Fishermans Beach as national assets for public recreation and amenity.
- (2) This clause applies to the land shown on the Coastline Hazard Map as—
 - (a) Area of Wave Impact and Slope Adjustment, and
 - (b) Area of Reduced Foundation Capacity.
- (3) Development consent must not be granted to development on land to which this clause applies 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.



- (4) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that the foundations of the development have been designed to be constructed having regard to coastal risk.
- (5) A word or expression used in this clause has the same meaning as it has in the *NSW Coastal Planning Guidelines: Adapting to Sea Level Rise* (ISBN 978-1-74263-035-9) published by the NSW Government in August 2010, unless it is otherwise defined in this Plan.

Discussion

In regard to (3)(a), the proposed works would prevent the beach erosion and shoreline recession hazards affecting the subject properties, and would mitigate the wave overtopping (inundation) risk.

In regard to (3)(b), any increases in coastal risks to other development or properties due to possible enhanced 'end effects' from the vertical wall would be mitigated by the existing rock protection in these areas (Clarke Street, Mactier Street and South Narrabeen SLSC). The risk would be fully addressed by Council's proposal, within a period of three years, to upgrade the existing protection in these areas, as discussed in Section 6.3.

In regard to (3)(c), Section 5 of this letter set out a discussion of the potential impact of the proposed works on coastal processes based on an understanding of the key coastal processes operating along Collaroy Narrabeen Beach, information contained in the coastal engineering literature, observations of actual post-storm beach recovery in front of existing vertical coastal protection structures along Collaroy Narrabeen Beach, and numerical modelling of beach width behaviour completed by MHL (2022b). It was concluded that the proposed works are not likely to alter coastal processes to the detriment of the natural environment.

In regard to (3)(d), the proposed works have been designed to prevent the risk to life from beach erosion and shoreline recession hazards and to mitigate the risk to life from wave overtopping (inundation). A condition of consent has been imposed to carry out physical modelling to confirm wave overtopping discharges, and to prepare a Safety Management Plan, to ensure an acceptable risk to life outcome due to wave overtopping.

In regard to (3)(e), as noted earlier, the works have been purposely designed to avoid and minimise exposure of the subject properties and life to coastal hazards.

In regard to (3)(f), a time limited consent condition has been imposed which would facilitate, if required, the relocation, modification or removal of the proposed works to adapt to coastal hazards and sea level rise. The most likely potential adaption strategy would be modification to the crest of the works to mitigate wave overtopping in the event sea level rise predictions were well exceeded. This could be achieved by modifying the fence design and/or incorporating a low wall landward of the proposed works and/or raising the floor level building structures when redeveloped.

In summary, the consent authority can be satisfied that the proposed works comply with Clause 6.5(3)(a) to (f) of LEP 2011.

In regard to (4), the consent authority can be satisfied that the foundations of the proposed works have been designed for a suitably rare coastal risk event, Councils relevant Design Specifications, and relevant Australian Standards.

6.10 Warringah Development Control Plan 2011



The relevant section of the Warringah Development Control Plan 2011 (DCP 2011) is Part E9 Coastline Hazard. This is reproduced below followed by a discussion.

E9 Coastline Hazard

Applies to Land

This control applies to land identified on the Warringah LEP Coastline Hazard Map.

Objectives

• To minimise the risk of damage from coastal processes and coastline hazards for proposed buildings and works along Collaroy Beach, Narrabeen Beach and Fisherman's Beach.

• To ensure that development does not have an adverse impact on the scenic quality of Collaroy, Narrabeen and Fisherman's Beaches.

• To ensure that development does not adversely impact on the coastal processes affecting adjacent land.

• To retain the area's regional role for public recreation and amenity.

Requirements

1. The risk of damage from coastal processes is to be reduced through having appropriate setbacks and foundations, as detailed in Criteria for the Siting and Design of Foundations for Residential Development (see Policy volume).

2. For development in the area affected by the certified Coastal Zone Management Plan for Collaroy-Narrabeen Beach and Fishermans Beach (Coastal Zone Management Plan), the applicant must demonstrate compliance with the Northern Beaches Coastal Erosion Policy, the Coastal Zone Management Plan and the Collaroy-Narrabeen Protection Works Design Specifications (as amended from time to time).

Note

Council will take the following principles into account when it assesses development:

i. When applications for development are lodged with Council both the Area of Wave Impact and Slope Adjustment and the Area of Reduced Foundation Capacity are to be marked on the plans submitted to Council;

ii. In the Area of Reduced Foundation Capacity, account is made of the reduced bearing capacity of the sand adjacent to the escarpment of a potentially fully eroded Area of Wave Impact and Slope Adjustment. Structures within the Area of Reduced Foundation Capacity should be designed such that loads are transmitted to soil foundations outside it. This would generally be achieved by piling structures within the Area of Reduced Foundation the Stable Foundation Area below it as per Criteria for the Siting and Design of Foundations for Residential Development;

iii. For development within the Area of Reduced Foundation Capacity, geotechnical/ structural design of foundations (including specialist coastal engineering advice) may be required for the whole structure;

iv. A suitably qualified engineer must undertake the geotechnical/structural design of the foundations in accordance with coastal engineering considerations and the Criteria for the Siting and Design of Foundations for Residential Development, and the provisions of this part; and

v. 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 year.

Discussion



In regard to Objective 1, the proposed works would avoid or minimise the risk of damage from coastal processes and coastline hazards for the subject properties, to an acceptable degree.

In regard to Objective 2, the impact of the proposed works on the scenic quality of Collaroy Narrabeen is the subject of assessment by others.

In regard to Objective 3, discussion in Section 5 and Section 6 of this letter has concluded that the proposed works would not adversely impact on coastal processes affecting the public beach. The potential for impacts on adjacent land (Clarke Street, Mactier Street, South Narrabeen SLSC) would be addressed by the existing coastal protection works in these areas and the proposed upgrading of these works by Council.

In regard to Objective 4, based on the assessment of the proposed works on public access, public safety, beach amenity, coastal processes and surf quality, as outlined in Section 5 and Section 6 of this letter, it is considered that the areas regional role for public recreation and amenity would be retained.

In regard to Requirement 2, the proposed works have been assessed in relation to the Northern Beaches Coastal Erosion Policy (refer Section 6.5), the Coastal Zone Management Plan (refer Section 6.6), and the Collaroy Narrabeen Protection Works Design Specifications (refer Section 6.7). It was considered the proposed works are compliant with these documents.

7. RECOMMENDATIONS IN RELATION TO CONDITIONS OF CONSENT

Eight matters are noted for particular attention in any conditions of consent as discussed further below:

- the design and maintenance requirements for a temporary bund during construction;
- the minimum required Class of finish for the vertical wall (Class 3) and adherence thereto;
- washing of sand into any restored rock revetments at adjoining properties to ensure sink holes will not form;
- the wording of conditions relating to the maintenance and restoration of the beach following erosion events;
- removal of rocks/unsuitable materials along the beach;
- preparation of a Safety Management Plan to address the future risk to persons from wave overtopping;
- physical modelling; and
- the matter of a 'time limited consent'.

A temporary bund during construction has the potential to impact adversely on the beach if it includes materials other than sand, eg. rock and concrete, and if these materials are not hydraulically stable in a design storm event which may reasonably be expected to occur during the construction period. For this reason, it is recommended that a condition of consent be included setting out the minimum requirements and responsibilities for the design and maintenance of a temporary bund.

It is apparent from site inspections along Collaroy Narrabeen Beach that the Class 3 finish specified for the existing vertical walls constructed to the south of the subject DA may not have been achieved in all cases for these walls. A minimum Class 3 finish is considered reasonable, but must be achieved to assist in achieving a good visual quality when the wall is viewed as a whole.

The condition relating to the washing in of sand should cover the following:



- the washing is to take place thoroughly and progressively to minimise the risk of sink holes emerging; and
- the Applicant should inspect the restored rock revetments at adjoining properties for sink holes
 regularly during the defects liability period for the proposed works, particularly any sections of the
 revetments on the public beach, and undertake remedial works as required to the satisfaction of
 Council.

In relation to the wording of conditions of consent relating to maintenance and restoration of the beach following erosion events, it is necessary to ensure the wording aligns with the wording in Section 27(1)(b)(i) of the Coastal Management Act 2016.

Rocks and unsuitable materials being left on the beach as a consequence of construction of private coastal protection works is not acceptable. Conditions of consent should ensure this does not happen.

Preparation of a Safety Management Plan is necessary to satisfactorily manage the risk to life from increased wave overtopping of the vertical wall over the life of the works. The Safety Management Plan should be informed by the results of the recommended physical modelling.

Physical modelling is recommended as a condition of consent to confirm the wave overtopping discharges over the life of the works. The results of the physical modelling would inform the Safety Management Plan, as noted above, the detailed design of the wave return, and the drainage design landward of the proposed works. In addition, it is recommended that the results of the physical modelling form the basis for review of the crest level of the vertical wall, specifically whether the crest level could be lowered below 7.0 m AHD for some or all of the proposed works, and for review, together with other relevant factors, of the alignment of the proposed works, specifically whether the alignment could be shifted further landward. These reviews should be prepared by the Applicant and submitted to Council with the CC documentation.

The Applicant's Coastal Engineer has referred to the matter of a 'time limited consent' and noted that the owners would be dissatisfied with a determination of Council that included a time limited consent condition (refer Section 7.3 of Horton Coastal Engineering, 2021b). I am aware that a time limited consent condition can be a vexed issue and is a matter essentially for Council's planners and legal advisors. As previously advised, the intent of the condition is considered technically sound. The judgement of the NSW Land and Environment Court supports Council's position. Furthermore, the time limited consent condition is highly relevant in relation to the interpretation of the 'life of the works'.

A draft set of consent conditions for the subject DA has been reviewed by the writer and comments provided to Council under separate cover.

8. REFERENCES

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I trust the above is satisfactory and meets your current requirements. Please contact me should you require any clarification or additional information.

Yours faithfully

WAX.

Greg Britton Technical Director Water