

# COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR BEACHES IN WARRINGAH – THE STORY BEHIND THE STORY

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## Introduction

Warringah Council is located on Sydney's northern beaches. There are a number of public and private assets at risk of damage in Warringah at present due to coastal erosion, with these risks expected to increase under long term recession due to sea level rise. These assets include significant stretches of residential development at Collaroy-Narrabeen Beach, and public assets such as Surf Clubs at Freshwater, Curl Curl and Dee Why.

Given these risks, in 2009 Warringah Council planned a far more comprehensive assessment of how to appropriately manage emergencies along the Warringah coastline than was entertained under the subsequent NSW Government coastal reforms. The approach was based on the need for a well-researched and appropriately planned response to coastal erosion emergencies, primarily to assist stakeholders, to protect Council assets and to manage Council's liability. A detailed technical brief was prepared and WorleyParsons was engaged in May 2010 to prepare a Coastal Erosion Emergency Action Subplan for Warringah's beaches.

As part of this engagement and following the package of coastal reforms, an Emergency Action Subplan was prepared with the financial assistance of the NSW Office of Environment and Heritage. The Subplan was completed in accordance with the NSW *Coastal Protection Act 1979* and related guidelines, along with an accompanying detailed report entitled "Management of Coastal Erosion Emergencies at Beaches in Warringah" (WorleyParsons, 2011). The "story behind the story" of some of the key aspects of this study are discussed herein based on seven observations.

Note that the views expressed herein are those of the authors and not necessarily those of Warringah Council or WorleyParsons.

### **Observation 1: *SEPP Infrastructure* may be of More Relevance than the *Coastal Protection Act***

There has been significant bureaucratic effort in NSW developing legislation and guidelines relating to the use of temporary sand/sandbags "emergency coastal protection works" in authorised locations (as defined under Part 4c of the *Coastal Protection Act 1979*), denoted herein as "Part 4c sand/sandbags ECPW". However, the limitations of these types of works means that their use was not recommended to landowners in Warringah. Some of the key limitations of "Part 4c sand/sandbags ECPW" sandbags types of works are as follows:

- the designated bag (sand-filled geotextile container) size of 0.75m<sup>3</sup> is not stable under severe open coast wave action, with design wave heights to cause damage of bag structures at a slope of 1:1.5 (vertical:horizontal) of only about 1m to 1.5m (Coghlan et al, 2009);
- only limited beach excavation can be undertaken, meaning that the structure toe level would most likely be inadequate;
- the maximum allowable structure height of 1.5m would not be expected to provide adequate protection of eroded escarpments in the order of 3m to 5m high, as is typical at Warringah's beaches in severe storms (see Figure 1);
- the bags would be difficult to install in an emergency as they require adequate foundation and careful placement (it is also not allowable to install the works during storm conditions unless a professional engineer advises that such placement would not present a significant safety risk); and,
- the only location in Warringah where these works would be permissible is at Collaroy-Narrabeen Beach, but only in areas that do not have existing protective works (and the most at-risk southern section of the beach has extensive lengths of existing protective works).

For "Part 4c sand/sandbags ECPW" sand placement types of works, it is likely there would be a relatively low cost:benefit ratio, as the placed sand would generally be expected to wash away under ongoing coastal processes.

For these reasons, "Part 4c sand/sandbags ECPW" are likely to be irrelevant to most Warringah landowners.



**Figure 1: Erosion Escarpment at Narrabeen Beach in June 2007**

However, based on *State Environmental Planning Policy (Infrastructure) 2007* (denoted as *SEPP Infrastructure* herein), landowners can consider the installation of emergency or long-term coastal protective works of any form. As consent is required under *SEPP Infrastructure* for such works, Part 4 of the *Environmental Planning and Assessment Act 1979* applies. Therefore, before installing these general protective works it would be necessary for landowners to:

- undertake an environmental assessment, that is either a Statement of Environmental Effects or an Environmental Impact Statement (the latter if significant impacts were expected); and,
- lodge a Development Application (DA) with a consent authority.

Until a Coastal Zone Management Plan (CZMP) is in force on the land, the NSW Coastal Panel is the consent authority.

It is considered that *SEPP Infrastructure* would be relevant to any landowners considering protective works in Warringah, although it is recognised that applications may be more appropriate for long-term rather than emergency works (given the relative effort involved either way, there is likely to be more “bang for the buck” and more control over the construction attempting long term solutions). That is, it may be a wiser investment for landowners to avoid “Part 4c sand/sandbags ECPW” and emergency works under *SEPP Infrastructure*, and instead invest their resources in applying for (and if approved, constructing) long-term coastal protective works.

For Councils contemplating protecting their assets, based on *SEPP Infrastructure*, coastal protection works (of any form) can be carried out without consent on any land. Given this, Part 5 of the *Environmental Planning and Assessment Act 1979* applies to coastal protection works (emergency or long-term) undertaken by Council, unless the works can be considered to be exempt development.

If the works are not exempt development, before installing protective works it would be necessary for Councils to:

- undertake an environmental assessment, that is either a Review of Environmental Factors or an Environmental Impact Statement (the latter if significant impacts were expected); and,
- (until a CZMP is in force on the land) notify the NSW Coastal Panel before carrying out the works and take into consideration any response received from the Coastal Panel within 21 days of the notification (unless the proposed works only comprise the placement of sand or sandbags, or only replacement, repair or maintenance of works is proposed).

Council would generally be the determining authority for these works.

A number of emergency works may be considered to be exempt development under *SEPP Infrastructure*, including emergency works undertaken by Councils to protect roads and stormwater management systems, as long as the works are of minimal environmental impact and structurally adequate.

Given the relevance of *SEPP Infrastructure* to landowners and Councils, and general irrelevance of “Part 4c sand/sandbags ECPW”, it can be argued that the NSW Government has overinvested its efforts in the latter.

## **Observation 2: Not All Rock Emergency Works are Inappropriate**

As noted in the discussion under Observation 1, there are extensive lengths of protective works along Collaroy-Narrabeen Beach. This includes randomly placed rock boulders that

were installed as an emergency response to storms, particularly in 1967, 1974 and 1998 (see Figure 2 for example).



**Figure 2: Exposed Rock Protection at Narrabeen Beach in July 2007**

Although these rock works were often hastily installed without detailed designs, they have generally prevented damage to structures in Immediate Hazard Zones (had the works not been there) along Collaroy-Narrabeen Beach for almost 40 years, while causing no significant impact on beach amenity (being buried under sand) for most of the time, see Figure 3. The works have had no measurable effect on long term sediment transport or stability of the beach.



**Figure 3: Pre-Storm (March 2007) Conditions in Vicinity of Figure 2 Photograph at Narrabeen Beach**

As long as clean rock can be sourced and rock works can be placed sufficiently landward to only be exposed at times of storms, rock remains a valid material to use for emergency protection (also see discussion under Observation 4). Beach scraping can also be undertaken to accelerate burial of any exposed works after storms.

Of course, in an ideal world, natural processes of erosion and accretion should be allowed to continue without intervention and emergency works should be avoided. However, owing to the value of the lawfully constructed public and private assets along the Warringah beachfront, Council may need to protect public assets as required, and due consideration of the merits of landowners implementing appropriate protective works may be required of Council.

It is recognised that implementation of hard protective works would become increasingly difficult to justify under long term recession due to sea level rise (without intervention such as beach nourishment), as these works would become more likely to be exposed more regularly over time.

### **Observation 3: Landowners and Councils Must Act Months in Advance of an Emergency**

As described under the discussion on Observation 1, landowners and Councils cannot expect to be able to implement emergency protective works without a significant amount of planning in advance.

For landowners, although “Part 4c sand/sandbags ECPW” do not require a DA to be submitted, if landowners were considering these works they must act well in advance of a storm. This would include obtaining a certificate, pre-purchasing and stockpiling relevant resources, gathering knowledge of relevant plant and equipment suppliers, and identifying appropriate personnel to place the works. That stated, as discussed under Observation 1, the bags would be difficult to install in an emergency and were not recommended for use in Warringah.

For general protective works under *SEPP Infrastructure*, landowners would have the added requirement of submitting a DA and preparing an environmental assessment, as well as allowing time for the approvals process.

For Councils desiring to install works under *SEPP Infrastructure*, there is again the requirement to complete an environmental assessment, and the added necessity to notify the Coastal Panel (if a CZMP is not in place) and wait up to 21 days for a response. Damaging coastal storms do not have 21 days of warning time! Other tasks would also need to be undertaken before a storm as discussed under Observation 6.

In reality, this means that if a storm occurred today and emergency protective works were considered to be required, most landowners and Councils in NSW would not be ready to utilise emergency protective works (or would be breaking the law if they installed works without following the processes described).

### **Observation 4: the Only Emergency Works Likely to be Effective are Rock or Concrete**

In WorleyParsons (2011), a number of potential emergency protective works materials were evaluated. Works that were considered comprised rock (both basalt and sandstone), sand-filled geotextile containers (both 0.75m<sup>3</sup> and 2.5m<sup>3</sup> bags) and concrete blocks (using

both “standard” concrete and high density concrete). These works were assessed in terms of:

- compatibility of material with existing insitu conditions;
- available design criteria/standards;
- performance under design conditions, including post-storm configurations;
- consequences should design thresholds be exceeded;
- availability of material sources;
- material storage requirements;
- construction methodology and logistics;
- feasibility of installation during storm conditions;
- post storm hazards; and,
- cost.

Some of the key findings were as follows:

- densities of the materials vary from 1.7 tonnes/m<sup>3</sup> for the bags, 2.2 tonnes/m<sup>3</sup> for sandstone, 2.4 tonnes/m<sup>3</sup> for standard concrete, 2.6 tonnes/m<sup>3</sup> for basalt and 3.0 tonnes/m<sup>3</sup> for high density concrete;
- as discussed under Observation 1, both 0.75m<sup>3</sup> and 2.5m<sup>3</sup> bags are unlikely to be stable as protective works for either toe or escarpment protection along the Warringah coastline in severe storms, and thus cannot be expected to provide adequate protection;
- there is also a risk in using bags along beaches such as Collaroy-Narrabeen that the bottom layer of bags could be damaged if placed on existing rock works;
- rock and concrete blocks can be dropped in place (random placement), achieved by specification of a minimum rock strength and other requirements such as maximum rock aspect ratio for rock, and by specifying a minimum concrete strength for concrete;
- the cheapest protection option is sandstone rock, costing about \$1,000/m for toe protection and \$1,800/m for escarpment protection, with basalt rock costing about 20% to 30% more;
- concrete blocks are significantly more expensive, costing about \$2,500/m (standard mix) and \$3,700/m (high density mix) for toe protection;
- using a commercial sand source, 2.5m<sup>3</sup> bags are more expensive still, and would cost about \$2,700/m for toe protection and \$5,900/m for escarpment protection (if a "free" local source of sand was used, these costs would reduce by about 25%);
- vandal deterrent fabric sand-filled geotextile containers would cost more still;
- rock and concrete blocks have well established and accepted design guidelines, and can be sized to provide adequate protection;
- rock and concrete blocks have much faster placement rates than sand-filled geotextile containers, and can generally be placed at times of storms;
- for more severe events than the design event, rock and concrete blocks would be more likely to interlock (since these materials are randomly placed) after any movement and suffer damage more progressively than bags; and,
- exposed rock and concrete blocks after a storm may be unacceptable, and would generally require removal except when they would be covered with sand during natural beach recovery.

So, in essence, to achieve effective protection during an emergency only rock or concrete blocks can be considered to be appropriate, with rock also being the cheapest option.

## **Observation 5: Risk Assessments are a Useful Tool, Particularly in Areas with Protective Works**

### ***Preamble***

As part of the WorleyParsons (2011) study, coastline hazards were defined for the entire Warringah coastline for the first time (for Immediate and 2050 planning periods). These were defined assuming an entirely sandy subsurface, as per standard coastal engineering practice.

However, the presence of substantial existing protective works at some locations means that the usefulness of hazard lines so defined (by this standard practice) is limited, as they do not provide an indication of the relative risk of damage to particular assets.

WorleyParsons (2011) completed a risk assessment for Warringah's coastal structures, including both private development (such as residential houses) and public assets such as Surf Life Saving Clubs. The risk assessment comprised the development of:

- an inventory of individual property details relevant to consideration of risk;
- resistance ratings for existing protective works located along the beachfront;
- procedures for assigning likelihood ratings for occurrence of damaging events;
- procedures for assigning consequence ratings to expected property damage; and,
- an overall risk analysis matrix used to derive a risk rating from different combinations of likelihood and consequence ratings.

These five tasks are described below. Further discussion on the risk assessment methodology is also provided in Roberts and Horton (2011).

### ***Property Inventory***

An inventory of 230 properties along Warringah's beaches was compiled from Council GIS information, knowledge of historical protective works, and site inspections. This included details on the presence of protective works, whether development at the property was supported on piles, and significant assets within each property boundary.

### ***Protective Works Storm Resistance Rating***

The protective works along Warringah's beaches were rated based on an assessment of their ability to resist storm erosion. This was considered to be dependent on a number of factors including:

- the depth of the founding level or toe level relative to typical beach scour levels of -1m AHD;
- reliance of the structure on toe support for stability;
- type of protective structure (for example rock, sheet piling, concrete seawall); and,

- adequacy of the size of protective elements (such as rock mass).

A “low”, “medium” or “high” storm resistance rating was given to different sections of protective works along Warringah’s beaches based on the following criteria:

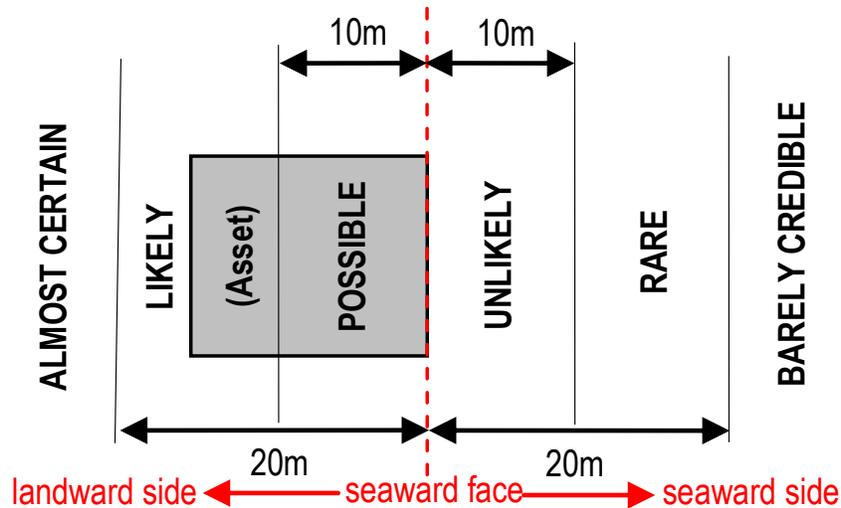
- “low” storm resistance: structures that rely on toe support for stability, but are founded metres above beach scour levels and could therefore fail in a catastrophic manner; or, structures that do not provide coverage over the entire lot or have significantly undersized rock;
- “medium” storm resistance: boulders that would be expected to have some movement in storms or that are present in only limited volumes or heights, or that are founded metres above beach scour levels;
- “high” storm resistance: boulders of high mass that generally resist movement or structures (such as sheet pile walls and concrete seawalls) covering most of the height of any erosion escarpment that would form, founded to near or below typical beach scour levels.

### ***Likelihood Rating***

Likelihood was defined as “the likelihood of the erosion scarp caused by the 100 year average recurrence interval (ARI) storm reaching the seaward face of an asset in the next 10 years, ignoring protective works”. The likelihood rating was related to the position of the Immediate Coastline Hazard Line relative to the seaward face of an asset in accordance with the criteria outlined in Table 1, as represented schematically in Figure 4. The description of the six likelihood ratings is consistent with that adopted by AGS (2007).

**Table 1: Criteria for Assigning Likelihood Ratings**

<b>Position of Immediate Hazard Line Relative to Seaward Face of Asset</b>	<b>Description</b>	<b>Descriptor</b>
> 20m landward	The event is expected to occur	Almost Certain
Between 10m and 20m landward	The event will probably occur under adverse conditions	Likely
<10m landward or intersecting asset	The event could occur under adverse conditions	Possible
< 10m seaward	The event might occur under very adverse conditions	Unlikely
Between 10m and 20m seaward	The event is conceivable but only under exceptional circumstances	Rare
> 20m seaward	The event is unconceivable or fanciful	Barely Credible



**Figure 4: Schematic Representation of Likelihood Rating Criteria in Relation to Position of Immediate Hazard Line**

For example, if the seaward face of an asset such as a house was located 15m seaward of the Immediate Coastline Hazard Line (assuming no protective works), the likelihood rating would be “likely”. Conversely, if the seaward face was located 15m landward of the Immediate Coastline Hazard Line (assuming no protective works), the likelihood rating would be “rare”. Note that these distances are particular to Collaroy-Narrabeen Beach, and although they would generally be expected to be reasonable for most other Sydney open coast beaches, it should be recognised that they could vary depending on exposure to wave energy, offshore bathymetry and dune morphology.

### ***Consequence Rating***

Consequence was defined as “the degree of damage to assets and surrounding property resulting from coastal erosion associated with the occurrence of a 100 year ARI storm event”. The severity of the consequence (or damage) was defined by five consequence ratings consistent with AGS (2007).

The level of damage that could be experienced at beachfront properties in a coastal storm is dependent on several factors including:

- the position of the Immediate Hazard Line (assuming no protective works) relative to assets (as per the likelihood rating described above);
- whether the asset is supported on piles;
- whether there are existing protective works seaward of the asset; and
- the effectiveness of any protective works (related to the storm resistance rating, refer above).

To address all of the above factors, an iterative procedure was developed to derive a final consequence rating. This involved assigning an initial Immediate Hazard consequence rating to an asset based on the position of the Immediate Hazard Line (assuming no protective works) relative to assets in accordance with Table 2.

**Table 2: Positional Criteria for Assigning Immediate Hazard Consequence Ratings**

<b>Position of Immediate Hazard Line Relative to Asset</b>	<b>Description</b>	<b>Descriptor</b>
Landward of the landward face of the asset	Structure completely destroyed and/or large scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.	Catastrophic
Intersecting at more than 50% of asset cross-shore width landward of seaward face	Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.	Major
Intersecting at less than 50% of asset cross-shore width landward of seaward face	Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage.	Medium
< 10m seaward of seaward face	Limited damage to part of structure, and/or part of site requiring some reinstatement stabilisation works.	Minor
> 10m seaward of seaward face	Little damage.	Insignificant

If the asset was not supported on piles and did not have existing seaward protective works, then the initial Immediate Hazard consequence rating above was adopted as the final consequence rating for the asset. If the asset was supported on piles then the initial Immediate Hazard consequence rating was adjusted in accordance with Table 3. If the asset had existing seaward protective works then the initial Immediate Hazard consequence rating was adjusted in accordance with Table 4 based on the associated storm resistance rating of the protective works seaward of the asset under consideration (as discussed above). If the asset was supported on piles and had existing seaward protective works, then the highest of the adjusted consequence ratings was adopted.

**Table 3: Adjusted Consequence Ratings for Assets Supported on Piles**

<b>Immediate Hazard Consequence Rating</b>	<b>Adjusted Consequence Rating</b>
Catastrophic	Medium
Major	Medium
Medium	Minor
Minor	Minor
Insignificant	Insignificant

**Table 4: Adjusted Consequence Ratings for Assets with Protective Works**

<b>Immediate Hazard Consequence Rating</b>	<b>Adjusted Consequence Rating</b>		
	<b>Low Resistance</b>	<b>Medium Resistance</b>	<b>High Resistance</b>
Catastrophic	Medium	Medium	Minor
Major	Medium	Minor	Minor
Medium	Medium	Minor	Minor
Minor	Insignificant	Insignificant	Insignificant
Insignificant	Insignificant	Insignificant	Insignificant

For example, if the Immediate Hazard Line (assuming no protective works) was located landward of the entire structure, the Immediate Hazard consequence rating would be

“Catastrophic”. If the structure was piled but had no protective works seaward, this rating would reduce to “Medium”. If the structure was not piled but had “high resistance” protective works seaward, the rating would reduce to “Minor”. If the structure was piled and had “high resistance” protective works seaward, the rating would again be “Minor”.

### **Risk Analysis Matrix**

The likelihood and consequence ratings were combined into a risk analysis matrix, in which the effect of both of these components of risk were considered, and an overall risk level was assigned to a given asset. The adopted risk matrix is summarised in Table 5.

**Table 5: Risk Analysis Matrix**

Likelihood	Consequence				
	Catastrophic	Major	Medium	Minor	Insignificant
Almost Certain	Very High	Very High	Very High	High	Medium
Likely	Very High	Very High	High	Medium	Low
Possible	Very High	High	Medium	Medium	Very Low
Unlikely	High	Medium	Low	Low	Very Low
Rare	Medium	Low	Low	Very Low	Very Low
Barely Credible	Low	Very Low	Very Low	Very Low	Very Low

For example:

- if the likelihood of the erosion scarp caused by the 100 year ARI storm reaching the seaward face of an asset in the next 10 years (ignoring protective works) was “possible” (eg if the Immediate Hazard Line was at the seaward face of the asset, or up to 10m landward of the seaward face); and,
- the consequence (degree of damage to assets and surrounding property resulting from coastal erosion associated with the occurrence of a 100 year ARI storm event) was “medium” (the Immediate Hazard Line intersected at less than 50% of the asset cross shore width landward of the seaward face, and there were no protective works and the asset was not piled),

then the risk of damage to the asset would be defined as “medium”.

A total of 230 properties were assigned a risk rating as part of this analysis, with 52% rated at “Very Low” risk, 7% “Low”, 20% “Medium”, 8% “High” and 7% “Very High” (6% of properties did not have a rating assigned as there were no assets on them).

The risk assessment indicated that most of the private development along the southern portion of Collaroy-Narrabeen Beach was at “medium” risk, with the risk mainly lowered due to the presence of substantial protective works seaward. Assets in this area that were not piled and did not have protective works seaward were generally found to be at “very high” risk.

Some public assets were found to be at “high” or “very high” risk, including three Surf Life Saving Clubs.

## **Observation 6: Emergency Action Subplans will be “Do Nothing” Documents, Unless Further Studies Accompany them**

As discussed under Observation 3, it would be necessary for Councils to undertake an environmental assessment before undertaking emergency protective works. In making a decision about whether implementation of protective works would be appropriate (if required) at a particular asset, it would be prudent for other studies to be undertaken by Councils such as:

- a cost:benefit assessment of the protection of the relevant assets, to determine whether protection would be justified (eg a high value asset would be more likely to have a higher benefit:cost ratio);
- assessment of insurance implications;
- development of specific designs and methods of works for protective actions that it is intended to undertake (where justified); and,
- forming a priority ranking of the order in which assets may be protected based on the relative cost:benefit of protection.

The risk assessment process described under Observation 5 would also be useful in informing the above process.

Based on the level of funding for Emergency Action Subplans in NSW and the experience of the process of submitting an Emergency Action Subplan to the Minister, it is evident that it is expected that these Subplans will say that Councils will do no protective works. The only way to avoid this would be to have completed the extensive prior investigations as noted above. However, it is unlikely that these investigations would be able to be completed prior to the due date of Ministerial directives in Councils in any areas with significant assets warranting protection (and these investigations have not been funded).

That is, unless a Council truly wants to do no protective works (which may be somewhat unwise if the cost of protection is far less than the value of the asset), an Emergency Action Subplan may be a relatively limp and incomplete document without these further studies being undertaken (even though the Minister may have certified it).

Warringah Council has been well served by the comprehensive investigation that was undertaken by WorleyParsons (2011) . Indeed such research should underpin any document that purports to be an emergency response tool (eg as is already expected of documents that underpin a floodplain management plan).

Warringah Council, at its meeting on 26 July 2011, resolved to submit the Draft Coastal Erosion Emergency Action Subplan to the Minister for the Environment by 31 July 2011, in accordance with a Ministerial Direction received 31 January 2011, and requested that the Minister referred the Subplan to relevant NSW Government Departments and the NSW Coastal Panel. The submission was made on 29 July 2011 and at this stage, no formal correspondence has been received from the Minister or the NSW Coastal Panel regarding the Subplan or any required amendments.

## **Observation 7: Consultation with Landowners should be Undertaken to Enable them to Understand the Issues**

As part of the WorleyParsons (2011) study, a community consultation programme was implemented, including two public forums held on Sunday mornings, each attended by 100 to 150 people. Reports were also placed on public exhibition and comment was invited.

It was evident that a number of community members were previously uninformed of what the risks to development were from coastline hazards and the options that were available to beachfront landowners for emergency protection. This is why the community engagement meetings were important, as they proved to be informative, with many community members clearly understanding the issues after having them explained in the meetings. For example, most beachfront landowners recognised the extensive planning and approvals that were required to be able to implement effective emergency works.

This not only gave landowners a sense of empowerment to manage their properties, but also built confidence in Warringah Council to work with them. Giving landowners the opportunity to be presented with the information and ask questions face to face strengthened the likelihood of community support.

Nonetheless, there was evidence of frustration from landowners with regard to the level of support being offered and potentially conflicting policy positions, for example:

“If property owners are to be financially responsible for defending their own land and property from ...natural disasters arising from the sea, in what way does this differ from Australian families defending their land and property from disasters in bushfires zones and flood zones? Do these families also receive bills for helicopter water bombs and other emergency services, offered to protect their property in times of disaster? Please clarify as policy should not discriminate against families who choose to live by the sea, other than the bush or anywhere else”.

“It is a common misconception that families who live by the beach are wealthy people... We do not expect that others should subsidise our lifestyle. We recognise that we have a level of responsibility to protect our own property. However we do not believe that it should be made difficult by following complex policy or be made financially ridiculous by the need to use private firms..., to achieve this. We also do not accept that given the full picture, families living in the beaches suburbs expect this small strip of homes to wear the burden of coastal erosion caused by the environment entirely on our own”.

## **Conclusions**

Based on completion of an Emergency Action Subplan to guide responses to coastal erosion emergencies at beaches in Warringah, seven observations can be made:

1. *SEPP Infrastructure* may be of more relevance than the *Coastal Protection Act 1979*, as temporary sand/sandbags “emergency coastal protection works” (as defined under Part 4c of the Act) can be expected to be ineffective and unable to be implemented in an emergency, and *SEPP Infrastructure* provides the

- mechanism for installing emergency or long-term coastal protective works of any form;
2. not all rock emergency works are inappropriate, as (for example) they have successfully prevented damage to extensive lengths of development at Collaroy-Narrabeen Beach, while generally causing no significant impact on beach amenity or long term sediment transport (being buried under sand) for most of the time;
  3. landowners and Councils must act months in advance of an emergency;
  4. the only emergency works likely to be effective are rock or concrete;
  5. risk assessments are a useful tool, particularly in areas with protective works;
  6. Emergency Action Subplans will be “do nothing” documents, unless further studies accompany them (such as environmental assessments, cost:benefit analyses, and designs and methods of works); and,
  7. it is important to undertake consultation with landowners so they can understand the key issues with protective works.

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