Pittwater coastal inundation assessment 3 Sturdee Lane, Elvina Bay

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3 STURDEE LANE, ELVINA BAY

by

J T Carley

Technical Report 2004/08
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1. INTRODUCTION

The approval of foreshore developments within Pittwater Shire rests with Pittwater Council. The Council requires that new developments meet specified design criteria in relation to extreme water level and wave conditions, such that land based structures are not subject to inundation or wave action during extreme design events.

This report provides a professional coastal engineering assessment of the potential for inundation from Pittwater at the property Lot 17, DP 2545 (3 Sturdee Lane, Elvina Bay) as shown in Figure 1. Height contours relative to AHD (Australian Height Datum) from a survey by Souter & Associates (their reference no: 99-181) were provided to the Water Research Laboratory (WRL) by the client.

Information contained within the report "Design Guidelines for Water Level and Wave Climate at Pittwater" by Australian Water and Coastal Studies (AWACS, 1991a) was used to determine water levels and wave conditions at the site.

2. PITTWATER COUNCIL REQUIREMENTS

Pittwater Council's requirements in relation to this study are contained in the document "The Pittwater Estuary Wave Action and Tidal Inundation Policy" – Reference: 65573_1/JH7 – Agenda for the Council Meeting 7th April 1997, (Pittwater Council, 1997). In summary, Council's policy requires that:

- The 100 year ARI (average recurrence interval) designated wave and water level conditions be adopted as the design event. That is, the design event has a 1% chance of occurring each year.

- Site specific wave and water levels from the report "Design Guidelines for Water Level and Wave Climate at Pittwater" (AWACS, 1991a) be used to assess the design event.

- The design floor level for habitable buildings is to include an allowance of 0.5 m for freeboard. This freeboard includes allowances for localised hydraulic effects and anticipated global sea level rise ("Greenhouse Effect").

Verbal advice from Pittwater Council on 6 September 2002 (Tim Meaker of Pittwater Council to James Carley of WRL) is that for boatsheds:

- The 0.5 m freeboard is not required for the floor level of a boatshed, however;

- Non-waterproofed electrical services and stored materials (eg fuel) must be located 0.5 m above the design inundation level;

- If subject to wave forces (for the 100 year ARI design event), the structure must be designed to withstand these forces.

3. SITE DESCRIPTION

3.1 Site Location

Pittwater is a relatively sheltered embayment, protected from the open ocean by Sydney's northern peninsula.

The site is on the western shore of Pittwater (Figure 1) on the Rocky Point peninsula between Elvina Bay and Lovett Bay, and faces towards Scotland Island. The Pittwater frontage consists of natural rock.

3.2 Site Inspection

A site inspection was undertaken by James Carley of WRL on 5 March 2004. The inspection of the property, foreshore and adjacent properties was made at approximately 2:00 pm. At this time the predicted tide was low (approximately 0.4 m, Sydney tide datum) or –0.5 m AHD (Australian Height Datum – approximately mean sea level). At the time of the inspection a north-east wind of approximately 10 knots prevailed.

3.3 Description of the Proposed Development

It is proposed to construct a new dwelling on the site. A jetty and boatshed are proposed as part of a separate development application.

3.4 Neighbouring Properties

The house to the north (*Trincomalee*) has a floor level of 14.81 m AHD, while the house to the south has a floor level of 16.73 m AHD (Souter & Associates, 1999). *Trincomalee* also has a boatshed with a floor at approximately 1.3 m AHD.

4. DESIGN WATER LEVEL AND WAVE CONDITIONS

4.1 General

A comprehensive guide to the assessment of extreme water levels and waves within Pittwater is detailed in AWACS (1991a). The results of the AWACS study were used as the basis of this assessment in accordance with Pittwater Council's requirements. For this study, additional site specific scenarios were also examined and general comments provided on other possible influences.

4.2 Design Extreme Water Levels (Tide + Storm Surge)

Historical water level data within Pittwater is limited, particularly during storm periods. As part of the AWACS (1991a) study, two tide gauges were deployed in Pittwater, with approximately 2 years of data available for analysis. Water levels were found to be closely correlated with those of Fort Denison and Middle Head, Sydney Harbour. The Fort Denison tide gauge has been operational since 1872, with numerous analyses made of the data. This long term data could therefore be used to provide good estimates of water levels for various recurrence intervals within Pittwater.

Table 1 shows design still water levels for Pittwater presented in AWACS (1991a) for average recurrence intervals (ARIs) of 20, 50 and 100 years. The 100 year ARI event is required to be used in this study.

Table 1
Design Still Water Levels for Pittwater from AWACS (1991a)

Average Recurrence Interval (years)	Design Still Water Level (m AHD) (without local effects)
20	1.43
50	1.47
100	1.50

The water level data analysis undertaken by AWACS (1991a) showed that there were no significant tidal or flood gradients within Pittwater. However, the final extreme water level at any particular site may vary due to the action of wind and waves.

4.3 Design Waves

4.3.1 Ocean Swell Waves

AWACS (1991a) undertook detailed numerical modelling of ocean swell wave propagation into Pittwater. Modelling was undertaken only for locations north of Soldiers Point and Sand Point. South of this ocean swell propagation was considered to be insignificant as a design condition. Ocean swell does propagate south of these points, however, its height was considered to be small compared with wind wave potential.

Therefore the subject property at Elvina Bay is not subject to ocean swell as a design condition.

4.3.2 Locally Generated Wind Waves

A computer model was developed by AWACS (1991a) to determine design conditions for locally-generated wind waves at 37 specific locations within Pittwater. An estimate of the maximum locally-generated wind wave height at each location was calculated on the basis of non-directional wind strength probability data, combined with the direction-dependent maximum average fetch available at each site. The wind wave heights and design wind speeds nearest to the subject property (Location SC1 – north-west Scotland Island, and W1 – Elvina Bay) given in AWACS (1991a) are shown below in Table 2.

Table 2
AWACS (1991a) Locally Generated Wind Wave Heights for Locations near Elvina Bay Site

Average Recurrence Interval (ARI, years)	Design Wind Speed, 10 minute duration (m/s)	Significant Wave Height (m) Site SC1	Spectral Peak Wave Period (s) Site SC1	Significant Wave Height (m) Site W1	Spectral Peak Wave Period (s) Site W1
		2565 m fetch from NE		1383 m fetch from SE	
20	28.1	1.1	3.0	0.8	2.4
50	30.8	1.2	3.1	0.9	2.5
100	32.9	1.4	3.2	1.0	2.6

For the subject property, there is partial exposure to north-east wind waves, however, these would reach the shoreline at an angle rather than square on.

4.3.3 Boat Waves

Power boats, including pleasure and commuter craft, can generate a range of wave conditions which impact a fixed shoreline position for only a brief duration as the boat passes. However, during higher use times such as weekends, heavy waterway traffic can cause sustained high wave conditions.

Walker (1999) reported on typical boat wave characteristics from Sydney Harbour which cited wave heights of up to 0.3 m as listed in Table 3 below. Wave periods of up to 2.5 s were reported for vessels up to 9 m length and speeds of up to 20 knots. For high speed ferries, wave periods of up to 7 s were reported, though these do not operate on Pittwater. Measurements of a police launch travelling at 8 knots within the low wash area of Church Point found waves of up to 0.3 m and 2.5 s. In the absence of site specific measurements for the subject property, a boat wave condition of 0.3 m and 3 s has been considered in design for this project.

Table 3
Typical Boat Wash Characteristics

Vessel Type	Vessel Speed (knots)	Wave Period (sec)	Wave Height (m)
4 m Dinghy	5	1	0.05
5 m Speed Boat	20	1.5	0.11
6 m Skyliner	5	1.7	0.17
9 m Flybridge	8	2.5	0.30
6 m Workboat	10	2	0.10
Small Tug	3	2	0.15
High Speed Large Ferries *	15	Up to 7	Up to 0.30

* vessels not operating on Pittwater

4.3.4 Tsunamis

Tsunamis are generated by major displacements in the sea bed which are caused by earthquakes and/or landslides. Tsunamis are also referred to as tidal waves. Eastern Australia is relatively remote from the more active seismic areas of the world, and is partially sheltered by New Zealand and Pacific islands. However, minor tsunamis have been recorded on Sydney's Fort Denison tide gauge which has been operational since 1867. The largest tsunamis measured in Sydney Harbour were 1.07 m in 1868 and 1877, and 0.84 m in 1960 resulting from a severe earthquake in Chile (NSW Government, 1990). The 1960 tsunami caused the water level at Fort Denison to oscillate through a range of 0.84 m over a 45 minute period (compared with a tidal oscillation of 1 to 2 m over approximately

6 hours). Such a rapid water level change within the enclosed water body of Sydney Harbour induced strong currents which caused damage to moored boats and shoreline structures.

For Pittwater, as with Sydney Harbour, tsunamis occur on a random and very infrequent basis and are independent of all other effects causing elevated water levels. The simultaneous occurrence of a tsunami and elevated water levels from other causes has a very low probability, with an average recurrence interval far in excess of 100 years. Due to the low risk, the effects of tsunamis can be neglected in this study.

4.4 Long Term Sea Level Rise (Greenhouse Effect)

There is a consensus of opinion among atmospheric scientists that a global warming trend is occurring (also known as the "Greenhouse Effect"), and is likely to continue throughout this century. A consequence of this global warming is the subsequent thermal expansion of ocean waters. It is expected that this thermal expansion will result in a global rise in mean sea level which will, in turn, cause recession of unconsolidated shorelines.

Although global warming may be occurring, there is uncertainty in estimates of the projected rise in mean sea level. The United Nations Intergovernmental Panel on Climate Change (IPCC, 1996) has published projected rises for three scenarios, as shown below in Table 4. It can be seen from Table 4, that for the most likely mid range scenario, an increase in mean sea level of approximately 0.20 m is predicted for the year 2050.

For habitable structures, Pittwater Council (1997) requires a freeboard of 0.5 m which includes an allowance for sea level rise (and localised hydraulic effects).

Table 4
Estimates of Long Term Global Sea Level Rise

IPCC (1996) Scenario	Year and sea level rise relative to 1995 (m)	
	2050	2100
Low	0.062	0.133
Mid	0.195	0.487
High	0.394	0.942

4.5 Design Inundation Level for Proposed House

Two alternative design storm scenarios specific to the subject site are considered below, with the worst case used to set the design inundation level.

4.5.1 Scenario 1 – 100 year ARI Ocean Storm Induced Water Level with Wind Waves from the North-East

From AWACS (1991a) the 100 year ARI still water level for Pittwater is 1.50 m AHD. This water level would be associated with ocean storm conditions from the south to north-east, with the most severe condition for AWACS location SC1 offshore from the subject property being waves having 1.4 m significant height and 3.2 s period from the north-east.

Wave setup is a quasi-steady increase in water level inside the surf zone due to the conversion of wave kinetic energy into potential energy. Wave setup is estimated to be 15% of the significant wave height or 0.21 m for waves of 1.4 m.

Wave runup under this scenario was calculated with the software ACES-7E from the US Army Corps of Engineers. The survey information from Souter & Associates (1999) and observations from the site inspection indicate a steep slope of approximately 1V:1H between approximately +1 and +8 m AHD, fronted by a shore platform of approximately 1V:10H (Figure 2). This results in an estimated significant wave runup level on the cliff of 2.5 m AHD.

4.5.2 Scenario 2 – Boat Waves with 100 year ARI Ocean Storm Induced Water Level

The boat wave condition of 0.3 m, 3 s is less severe than the Scenario 1 condition referred to above and therefore has not been analysed further.

4.6 Coastal Inundation Impacts to Adjoining Properties

The ground levels around the subject property above the foreshore cliff and the adjoining properties are well above the wave runup level for the 100 year ARI design event for inundation from Pittwater. Any new house on the subject property having comparable setback to the neighbouring properties would cause no adverse coastal inundation impacts on the adjoining properties.

5. SUMMARY AND CONCLUSIONS

A desktop study was undertaken to assess the coastal inundation hazard for a proposed new house development at Lot 17 DP 2545 (3 Sturdee Lane, Elvina Bay). The study was undertaken in accordance with the procedures documented by Pittwater Council (1997, 2003), based on water level information provided in AWACS (1991a) and other coastal engineering techniques.

Two alternative 100 year ARI (average recurrence interval) scenarios were considered for the site, namely oceanic storm conditions with local wind waves, and oceanic storm conditions with local boat waves. The most extreme of these three scenarios was adopted for design.

With the addition of 0.5 m freeboard, **the minimum design floor level for the proposed new house on the subject property is 3.0 m AHD**. It is noted that the topography of the site would result in a far higher floor level being attained.

No adverse coastal inundation impacts would occur to the neighbouring properties as a result of the proposed new development.

6. REFERENCES

AWACS (1991a), "Design Guidelines for Water Level and Wave Climate at Pittwater", Australian Water and Coastal Studies, *Report 89/23,* Sydney, Australia.

AWACS (1991b), "Pittwater Water Level and Wave Study – Application of Study Data", Australian Water and Coastal Studies, Sydney, Australia.

Dean, R.G. and Dalrymple, R.A.(1991), *Water Wave Mechanics for Engineers and Scientists*, World Scientific, Singapore.

Department of Defence (1998), *Australian National Tide Tables*, Hydrographic Service, Royal Australian Navy.

(IPCC) Intergovernmental Panel on Climate Change, Working Group I (1996), *Climate Change 1995 - The Science of Climate Change*, Cambridge University Press, UK.

NSW Government (1990), *Coastline Management Manual*, Sydney, Australia.

Pittwater Council (1997), "The Pittwater Estuary Wave Action and Tidal Inundation Policy" – Reference: 65573_1/JH7 – Agenda for the Council Meeting 7th April 1997, Sydney, Australia.

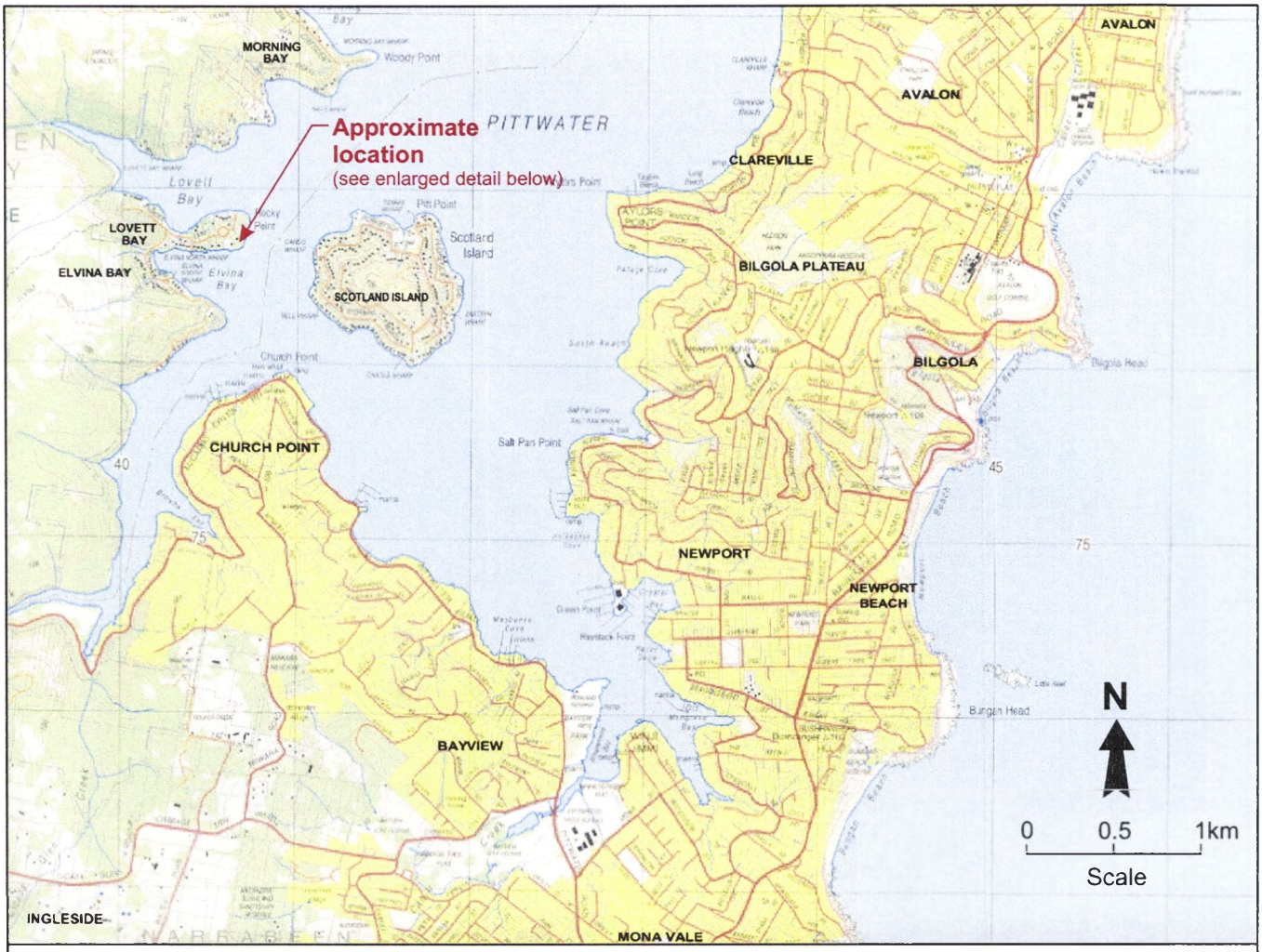
Pittwater Council (2003), "Pittwater 21 Development Control Plan", Pittwater Council, Adopted 8 December 2003, In force from 1 February 2004.

(PWD) NSW Public Works Department (1984), "Opera House Forecourt Study – Boat Wave Measurement", Manly Hydraulics Laboratory *Report No 423*, Sydney, Australia.

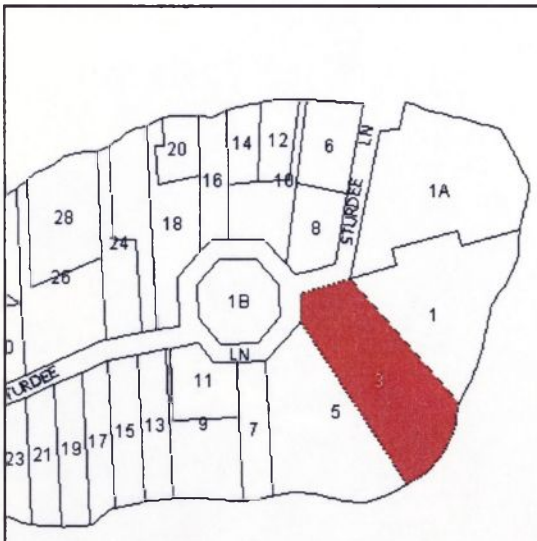
Shore Protection Manual (1984), Coastal Engineering Research Center, Department of the Army, Vicksburg, Mississippi USA.

Souter & Associates (1999), "Plan showing details & levels over Lot 17 of Sec A in DP 2545 Elvina Bay", Ref No. 99-181.

Walker, J.W., (1999) "Church Point – Pontoon Assessment", *WRL Technical Report No. 99/42,* Water Research Laboratory, University of New South Wales, Sydney, Australia.



Map courtesy of Land Information Centre



DETAIL MAP (supplied by Pittwater Council)

WRL Report No. 2004/08	LOCATION	Figure 1 04012-01.cdr

SUBJECT PROPERTY LOOKING NORTH
(neighbouring boatshed in background)

SUBJECT PROPERTY LOOKING SOUTH

WRL Report No. 2004/08	PHOTOS OF SITE	Figure 2