Great Lakes Coastal Hazard Study

Appendix A – Coastal Storms

For: Great Lakes Council

Project Name:	Great Lakes Coastal Hazard Study
Project Number:	3001829
Report for:	Great Lakes Council

PREPARATION, REVIEW AND AUTHORISATION

Revision #	Date	Prepared by	Reviewed by	Approved for Issue by
1	22/08/2012	M. Glatz	C. Adamantidis	D. Messiter

ISSUE REGISTER

Distribution List	Date Issued	Number of Copies
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SMEC Australia Pty Ltd

PO Box 1346, Newcastle NSW 2300

Tel: **02 4925 9621**

Fax: **0249925 3888**

Email: **Dan.Messiter@smec.com**

www.smec.com

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1 INTRODUCTION

This Appendix documents the history of storms that have occurred on the Great Lakes coast.

Coastal processes at Great Lakes are impacted by intense tropical and non-tropical storms which occur along NSW coastline at irregular intervals. These storms are responsible for episodic events of sand transport and erosion which are evident when examining data such as photogrammetry in detail.

It is important to document the history of storms along the Great Lakes coastline in order to ascertain whether the observed beach changes can be related to specific occurrence of these storms. The ultimate goal is to delineate which observed changes are caused by episodic events such as large coastal storms and which changes have underlying causes which are due to long-term cycles, natural fluctuations or are caused by anthropogenic influences.

The drop in atmospheric pressure and the winds and waves which often accompany large coastal storms can cause the ocean to rise above its normal level and if this occurs concurrently with high astronomical tides, flooding of low-lying coastal land and beach erosion can result (Blain Bremner & Williams, 1985).

2 STORM CATEGORIES

Storms which affect the NSW coast can fall under one of several categories – namely:

- Tropical Cyclones
- Easterly Trough Lows
- Inland Trough Lows
- Continental Lows
- Secondary Lows
- Anticyclonic Intensifications

Major depressions near the coast between Sugarloaf Point and Jervis Bay are generally secondary developments of large coastal depressions in the Tasman Sea or coastal intensifications of inland lows which have moved eastwards and crossed the coast. Major southern ocean depressions and secondary lows tend to affect the area between Jervis Bay and Cape Howe (Blain Bremner & Williams, 1985).

Blain Bremner and Williams (1985) documented all storms along the NSW coast between 1880 and 1980, with estimates of *significant* wave height made by examining synoptic charts from these dates, as well as historical shipping and press reports. Storms were assigned a severity rating based on a gradation of the *significant* wave heights. The storms were compartmentalised in terms of their severity and their location along the coast, whether they affected the far north coast, mid north coast, central coast or south coast. Great Lakes is considered to be affected by storms impacting on both the central and north coasts of NSW.

The categories of storms are illustrated in Table A.1.

Table A.1 – Classification of Storms by Intensity (Blain Bremner and Williams, 1985)

Category	Significant Wave Height (m)	Severity
X	> 6.0 m	Extreme
A	5.0 m – 6.0 m	Severe
B	3.5 m – 5.0 m	Moderate
C	2.5 m – 3.5 m	Low

Further work was carried out by Lawson and Treloar (1986) expanding on the work of Blain Bremner and Williams to identify storms occurring between 1980 and 1985, using a combination of synoptic charts and Waverider buoy data.

Category X storms since 1942 were identified by examining Sydney, Coffs Harbour and Crowdy Head waverider buoy records obtained from the NSW Government Waverider buoys between 1986 and 2005, Sydney storm data from 1942 – 2001, and Coffs Harbour storm data from 1942 – 1986. A representative *significant* wave height at Great Lakes was estimated from the combination of this data, and this enabled the Category X storms (Hs ≥ 6.0 m) to be identified for the period from 1942 – 2005.

Category A, B and C storms (*i.e. significant* offshore wave heights less than 6.0 m) were not included in the analysis.

Figure A.1 documents the extreme storm events and estimated *significant* wave heights for these events, and also plots the dates for which beach photogrammetry was available for analysis.

Some large storms occurred during the 1970s and the late 1990s which can be evident when examining photogrammetric data. The devastating May 1974 oceanic storm event was determined to have a corresponding wave height recurrence interval in the order of 20 – 70 years (Lord and Kulmar, 2000). The storms of May – June 1974 caused widespread damage to coastal structures and beaches along the central coast of New South Wales and the highest significant wave height (H_s) determined during the event was 9.2 m (Foster et al., 1975). These storms were associated with an intense low pressure cell adjacent to the coast near Sydney. Moreover, the 1974 storm event was coincident with maximum spring tides, with a maximum storm surge measured at Fort Denison of 0.59 m and a maximum ocean water level of 1.48 m AHD (Kulmar and Nalty, 1997). Statistically, these water levels have been determined to have a recurrence interval of close to 280 years from recent extreme value analysis (Watson and Lord, 2008). This makes the 1974 storm event suitable for use as a design event for the beaches located along the Great Lakes coastline. Beach erosion caused by severe storms in 1974 is clearly visible in the photogrammetric data captured between 1972 and 1974.

Of particular note in the data is the occurrence of Cyclone "Violet" in early March 1995 which caused severe waves along the NSW north coast including north facing beaches of the Great Lakes coastline and had a peak wave height of around 7.4 m. A pressure of 980 hPa and a wind speed of around 55 knots were measured for the cyclone approaching within 400 km from the Great Lakes coastline, as shown in Figure A.2. It is generally accepted that water levels increase by 0.1 m for every 10 hPa below standard atmospheric pressure (i.e. 1013 hPa) due to intensive barometric setup effect. These pressures would have led to barometric water level setup of 0.33 m near the eye of the cyclone.

A large storm was recorded in the Sydney area in May 1997, the storm peaked during the night of 10 – 11 May, reaching 6.3 m (significant wave height (H_s)) at Crowdy Head. An East Coast Low produced gale force winds, large seas and heavy rainfall along parts of the NSW coast over the weekend of 10 – 11 May. A Sydney Ports Corporation buoy off Botany Bay recorded maximum wave heights (H_{max}) of 16.7 m on 10 May. The peak ocean water level was measured at 2.03 m ISLW during the storm. Photogrammetric data between 1994 and 2001 captured the signature of severe beach erosion which could have been caused by either the 1995 cyclone event or 1997 storm event.

The occurrence of a major storm in June 1967 caused severe erosion along the North Coast of NSW and had a peak significant wave height of around 7.7m at Great Lakes. The synoptic chart for this storm is shown in Figure A.3 (Bureau of Meteorology, 2008). The closely spaced isobars on the chart indicate strong wind speeds along the north coast of NSW and extensive erosion at the beaches, especially the ones facing to north-east such as Elizabeth Beach.

There was significant beach erosion recorded in many locations in June 2007 which resulted in severe rainfall and flash flooding in the areas of the Central Coast, Newcastle and the Hunter Valley. Watson et al (2007) provided a post-event analysis, from which relevant points are summaries here. The strongest observed wind gusts were 135km/h at Norah Head and 124 km/h at Newcastle and the lowest pressure recorded was 994hPa at Williamtown. The maximum H_{sig} recorded during the storm was 6.87 m from the MHL Sydney deepwater Waverider buoy and the H_{max} of 14.13 m recorded on 9 June 2007 is the largest hourly H_{max} recorded at Sydney. The co-incident 1.84 m ISLW tide level (recorded at Middle Head) and H_{sig} of 6.87 m was sufficient to deplete sand reserves and initiate erosion along many beaches in the Sydney-Central Coast region.

Figures A.4 and A.5 illustrated the erosion generated by Cyclone Violet and the May 1997 storm at One Mile Beach.

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FIGURES

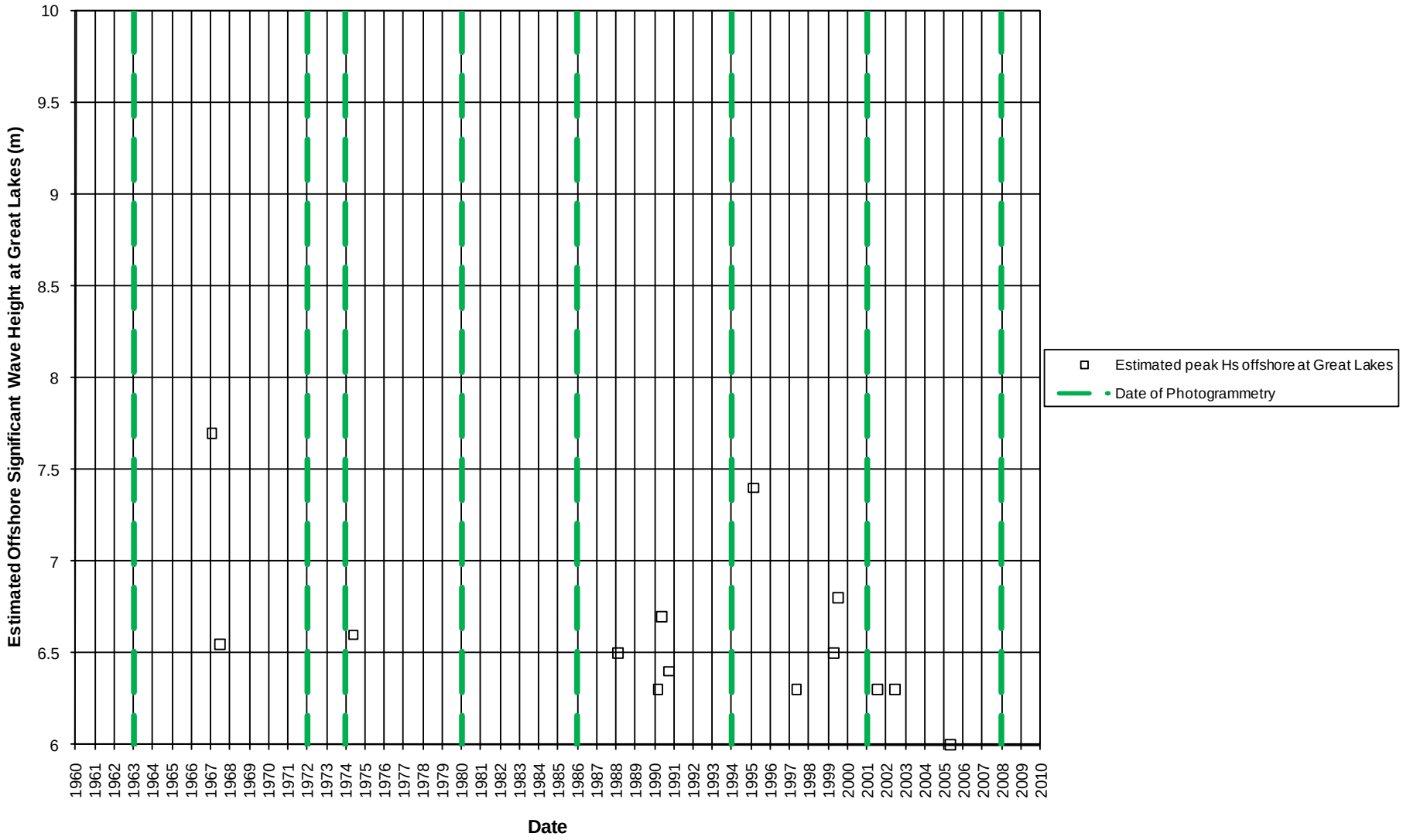

Figure A.1: Extreme Storm events vs. Photogrammetry Dates

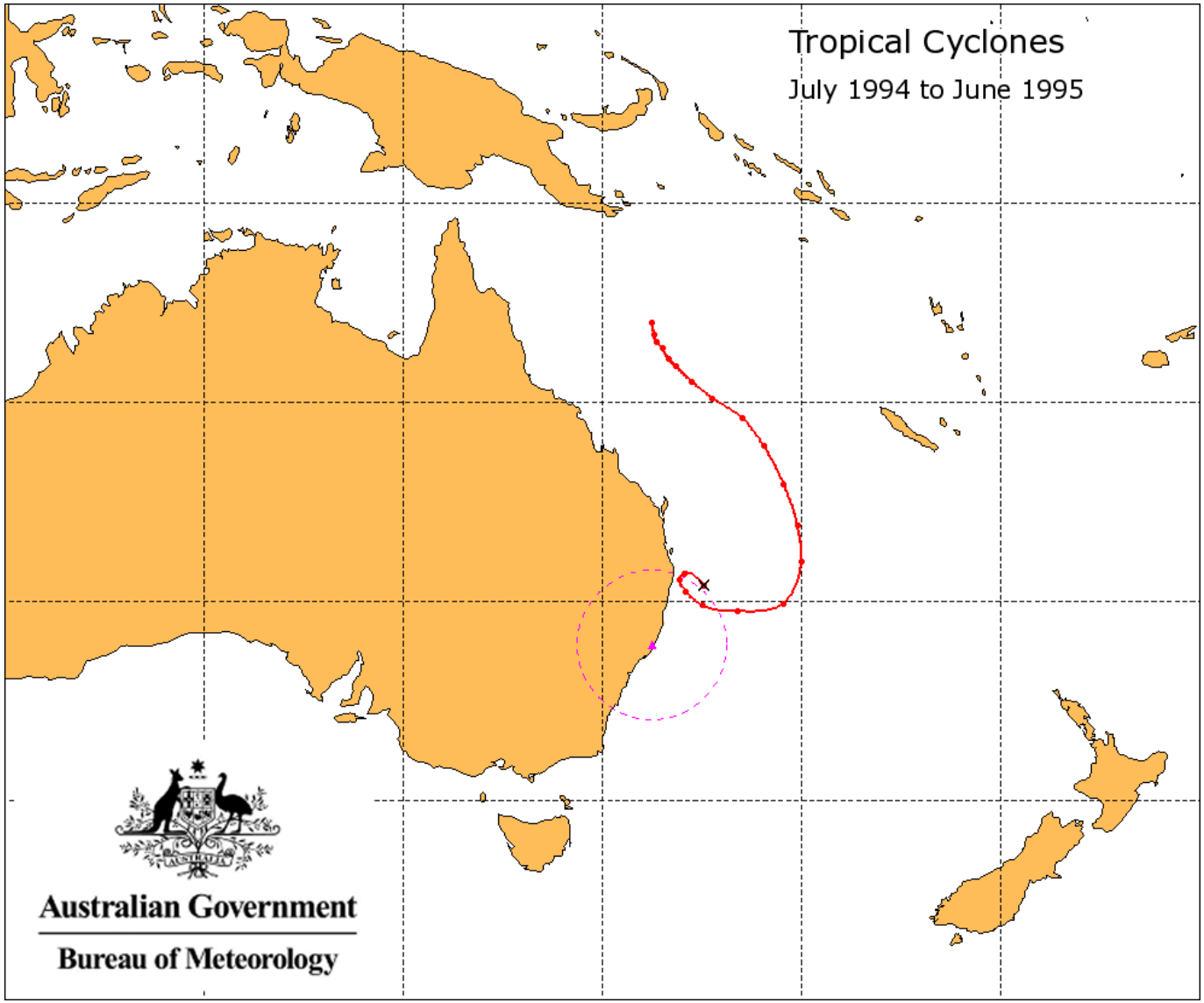

Figure A.2: Pathway track of Cyclone Violet (1995) which crossed within 400 km of Great Lakes.

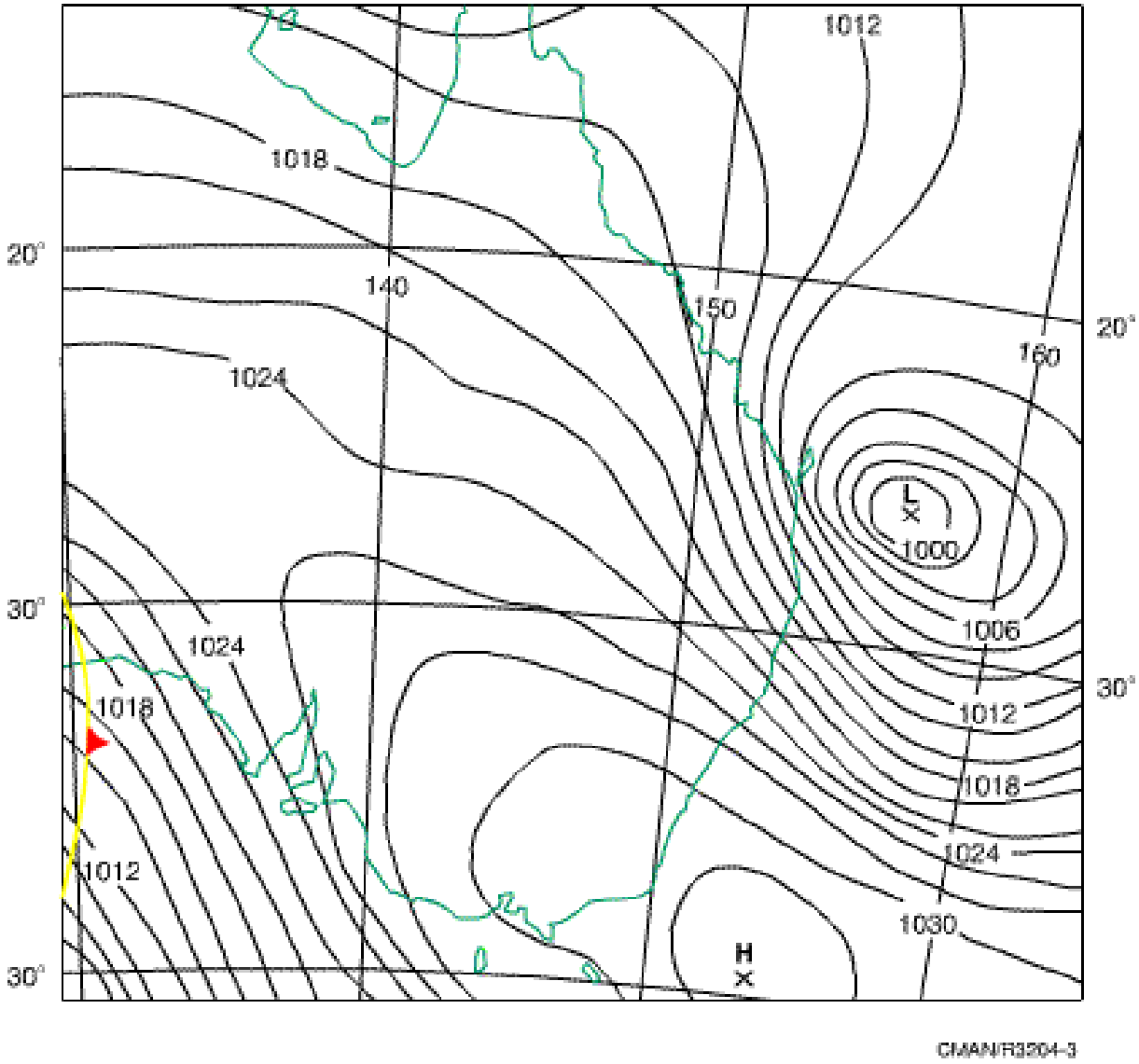

Figure A.3: Synoptic chart for the storms of late June 1967.

(The tight gradient indicates very strong winds; the long "fetch" of these strong winds across the oceans off eastern Australia resulted in huge swells that greatly damaged the coastlines of southern Queensland and northern NSW.)

Figure A.4: Erosion generated by Cyclone Violet in March 1995, One Mile Beach (courtesy Great Lakes Council)

Figure A.5: Erosion generated by May 1997 storm event, One Mile Beach (courtesy Great Lakes Council)