THE UNIVERSITY OF NEW SOUTH WALES

Water Research Laboratory

School of Civil and Environmental Engineering

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Dear Phil/Ian,

Inspection of Clarence City Beaches following Winter 2011 Storm Events

A series of large storm events which have occurred during June and July 2011 have caused erosion and inundation along stretches of coastline within Clarence City. WRL staff inspected Roches Beach and Cremorne on Thursday 14 July to assess damage and to assist Council in formulating a response to any immediate hazards evident on site. This letter details on-site observations, attempts to quantify the severity of the event using available data and literature and provides recommendations for future work priorities.

1. Winter 2011 Storm Events

1.1 June 8 Storm Event

A small, intense low pressure system passed below Tasmania on 7th/8th June 2011. The system had a central pressure of 998 hPa with tight pressure gradients causing very strong south to south-westerly local winds (Figure 1). This resulted in a significant wave height (H_s) up to 10.7 m and Peak Period of 14.5 s being recorded at the Cape Sorell Wave Buoy (Figure 2) located off the West Coast of Tasmania. Based on extreme values calculated for this location by Shand et al. (2011), this peak wave height has an average recurrence interval of approximately 8 years.

Based on a wave group velocity of 11 ms^{-1} for the spectral peak period of 14 s, the storm peak is likely to reach Frederick Henry Bay and the Clarence City Coastline 4 to 6 hours after being observed at the Cape Sorell wave buoy. The storm peak wave height is therefore likely to have reached the Clarence City Beaches in the early hours of Wednesday 8th June. The high astronomical tide was predicted to reach 1.29 m Hobart LAT (0.46 m AHD) at 0007 8 June 2011 (NTC, 2011; Figure 3). This predicted tide falls between a mean higher high water (MHHW) and mean lower high water (MLHW) tide (Australian National Tide Tables, 2009). Storm surge levels during the event have not been assessed but could be done at a later date after gathering additional data.

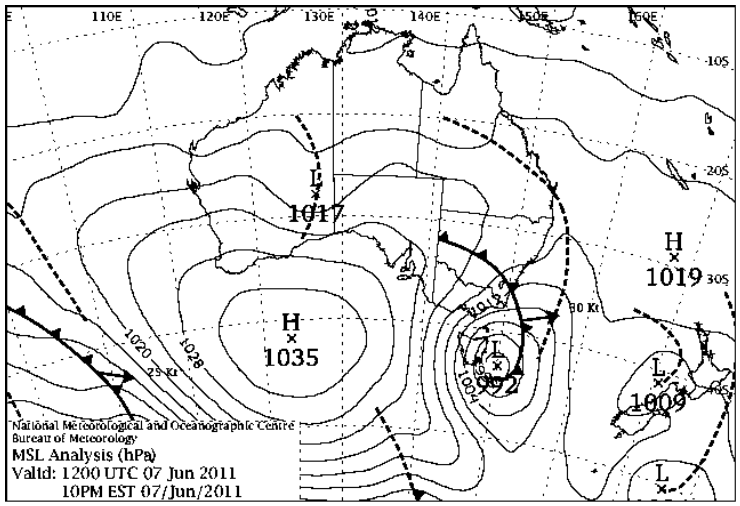

Figure 1 MSLP Chart for 7 June 2011 (source: BoM 2011)

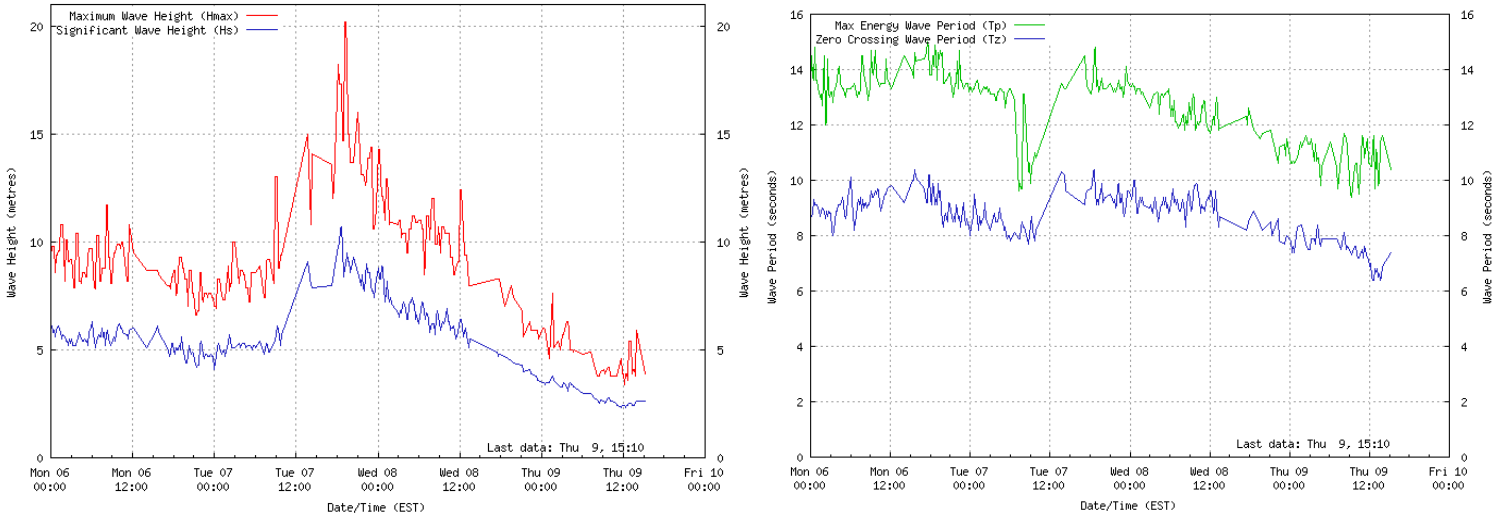

Figure 2 Wave height and period recorded at the Cape Sorell wave buoy 6 – 10 June 2011 (source: BoM, 2011)

Monday 6		Tuesday 7		Wednesday 8		Thursday 9	
Time	Height	Time	Height	Time	Height	Time	Height
0600	0.36	0644	0.38	0007	1.29	0116	1.22
1300	1.12	1335	1.16	0727	0.42	0809	0.47
1716	1.00	1831	0.95	1409	1.22	1445	1.28
2302	1.36			1945	0.88	2057	0.78

Figure 3 Predicted Astronomical Tides for Hobart (m LAT), source: BoM (2011)

1.2 July 9/10 Storm Event

In contrast to the June 2011 event, the July event was forced by an extremely large mid latitude cyclonic weather system centred at 55°S with a central pressure of 962 hPa (Figure 5). A fetch length of over 1500 km forced large and long period waves from a south-west direction towards Tasmania. The Cape Sorell wave buoy recorded a peak significant wave height of 10.0 m at 1300, 9th July with an associated peak period of 17.5 s (Figure 6). This peak Hs wave height is equivalent to a 4 year average recurrence interval (ARI) event based on Shand et al. (2011) but the long duration of large waves during this storm event is more exceptional, with waves over 7 m sustained for 48 hours with an ARI of around 40 years.

Wave direction is critical in terms of wave propagation into Frederick Henry Bay, with studies using nearshore wave models (Shand and Carley, 2011) showing offshore waves from the south to be more efficient in reaching Roches Beach. While the Cape Sorell wave buoy does not record wave direction, the fetch direction indicates the waves likely arrived from the south-west and may have therefore been slightly less effective at propagating to Roches Beach than storms of a more southerly direction.

While the storm peak likely reached Clarence Beaches on the afternoon and evening of the 9th July, sustained large waves persisted through the next two days. High tides during this period were predicted to reach up to 1.51 m LAT (0.64 m AHD) excluding storm surge at 1535 on 10 July (Figure 4). Additional storm surge analysis could be undertaken. This corresponds to a mean higher high water tide and while the joint probability of this water level coinciding with an event of this magnitude has not been undertaken, the probability is expected to be very low due to the general independence of astronomical tide and wave height.

Friday 8		Saturday 9		Sunday 10		Monday 11	
Time	Height	Time	Height	Time	Height	Time	Height
0127	1.15	0240	1.07	0400	1.02	0524	1.01
0742	0.58	0825	0.67	0904	0.75	0942	0.81
1413	1.38	1453	1.45	1535	1.51	1621	1.55
2103	0.63	2209	0.53	2310	0.43		

Figure 4 Predicted Astronomical Tides for Hobart (m LAT) (source: BoM, 2011)

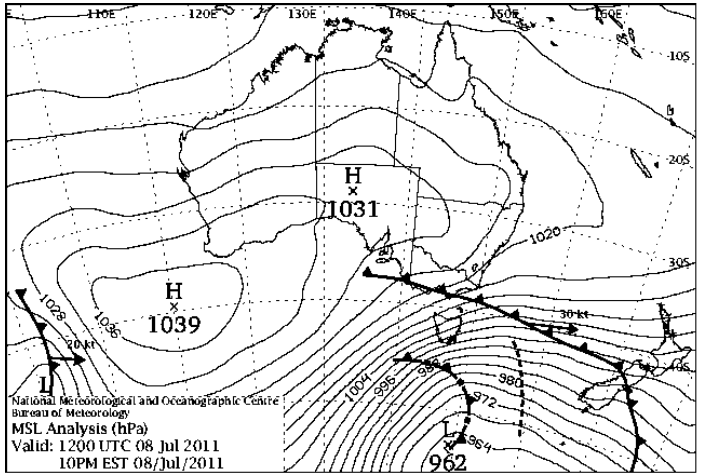

Figure 5 MSLP Chart for 8 July 2011 (source: BoM 2011)

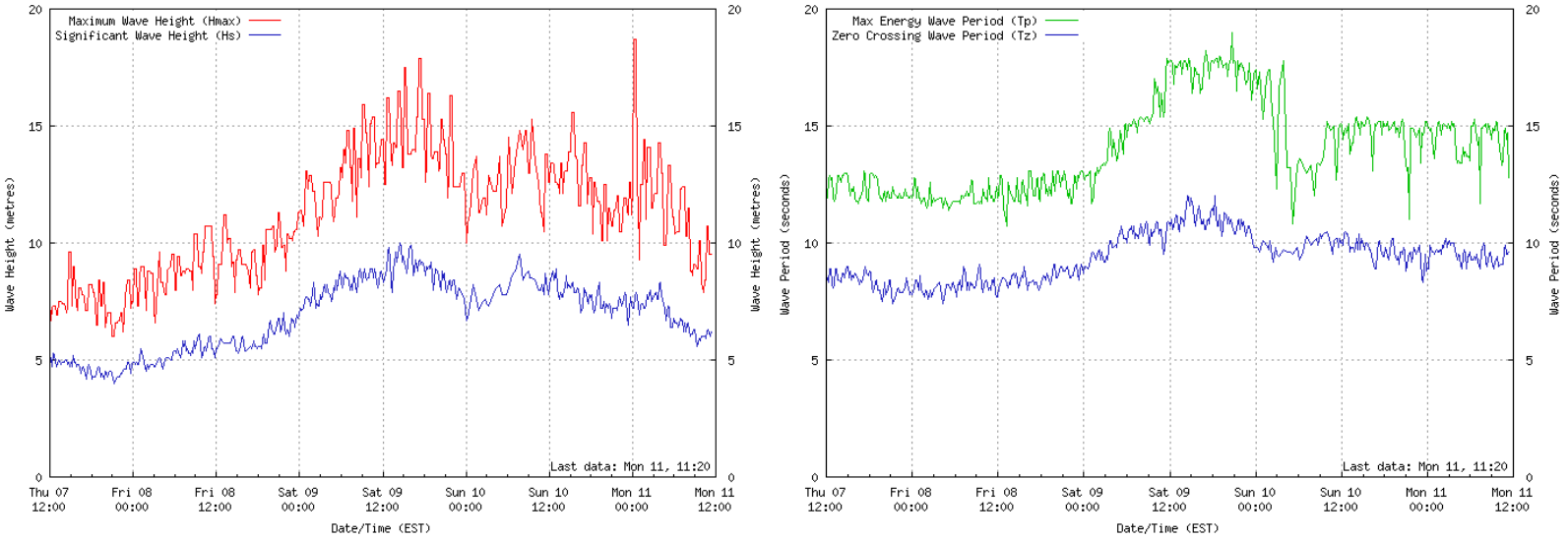

Figure 6 Wave height and period recorded at the Cape Sorell wave buoy 7 – 11 June 2011 (source: BoM, 2011)

2. Site Observations

Roches Beach and Cremorne Beach were inspected by Dr Tom Shand, of the Water Research Laboratory together with Clarence City Council staff on Thursday 14th July. Both beaches appeared in generally eroded states with recent storm scarps evident in the foredune along most of the beaches. Key observations along the sites (from north to south) include:

Roches Beach

- An accumulation of sediment noted immediately south of the Lauderdale Yacht Club in front of the stream entrance;
- The footbridge over the stream was destroyed during the event, possibly due to wave run-up impacts;
- Substantial runup of the backshore vegetation between Bambra Reef and the Yacht Club (Photograph 1);
- Erosion to the north of Bambra Reef (Photograph 1) and evidence of large overtopping flows (Photograph 2). This is likely due to the combination of large waves and elevated water levels reducing the effectiveness of Bambra Reef in reducing transmitted wave energy;
- Newly placed riprap rock at No. 1 Bambra St (Photograph 3). The structural integrity or appropriateness of wall design was not assessed within this inspection, although rock appeared slightly undersize and a geotextile underlay was not observed;
- Substantial recent erosion of land immediately south of the rock wall fronting No. 2 Bambra St. (Photograph 4) including where a small (undersize) sandbag wall was formerly located. This erosion scarp is up to 2 m high in places, and places the fence line and possibly other structures at No. 2 Bambra St within a zone of reduced foundation capacity;
- Over-steepened dune scarps of up to 1.5 m high along much of Northern Roches Beach (Photograph 5) posing a possible stability hazard to pedestrians;
- Small hessian sandbags placed along dune crest at No. 118 Balook Street (Photograph 6). While these bags may assist in reducing overtopping volumes for smaller waves by elevating the crest level, they are substantially smaller than the 0.75 or 2.5 m3 geobags typically used for coastal protection and are unlikely to survive large wave impacts. The Hessian material will also decay over time;
- Many areas of overtopping evident, particularly at low points in the dune crest. Particularly severe overtopping apparently occurred at Balanada Street where additional sand has since been placed to raise the crest level (Photograph 7);
- Long vegetation behind the dune crest, particularly marram or native grasses, appears to have substantially reduced the extent of overtopping flows with little damage to the vegetation evident;
- Substantial runup flows into the car park at Lauderdale canal due primarily to the low elevation of the concrete boat ramp;
- Erosion at either end of the low geotextile and timber ‘retaining wall’ near the Lauderdale canal car park;
- Continued erosion and over-steepened dune scarps between the Lauderdale canal car park and the southern revetment;
- The southern revetment now holds land at least 5 m further seaward than the adjacent shoreline (Photograph 8);
- The northern part of the revetment where rocks are generally larger appears to be structurally stable, although is in imminent danger of being outflanked by adjacent erosion to the north (Photograph 9);

- Further south along the revetment, substantial slumping of the rock riprap has occurred due to undermining of the toe. Erosion of the backing land is evident where waves have overtopped the lowered wall (Photograph 10) and substantial overtopping flows were evident in the backshore. These overtopping flows have been particularly severe behind the concrete boat ramp which has assisted runup through minimal energy dissipation;
- Many of the riprap rocks appear to have broken during this and other past events, further reducing the average rock size and the structural integrity of the wall. While the wall appears to be largely fulfilling its intended purpose, it is progressively failing;
- Overall, recent storm events appear to have removed between 1 and 10 m^3 per metre of beach length (subject to confirmation by survey) from the upper beach. Much of the eroded sand appears to have been moved offshore below the low tide mark. This sand will likely return over time, dependent on future wave climate, but the persistent northward littoral drift may remove some material from the system before recovery.

Cremorne

- Erosion of the dune has undermined a corner of a boat shed at No. 62 Frederick Henry Parade (Photograph 11);
- Concrete block and timber walls along Frederick Henry Parade damaged by wave runup (Photograph 12);
- Higher dune systems have limited most overtopping along the central and southern portions of the beach but over-steepened erosion scarps are evident reaching over 2 m at the southern end (Photograph 13);
- Difficult foot access around the southern end of Cremorne Spit with erosion continuing around the distal (southern) tip.

3. Recommended work priorities

The following future work priorities are recommended to reduce imminent and medium to long-term hazard to property and infrastructure along Cremorne and Roches Beach:

Immediate

- Survey beach and analyse data to quantify change;
- Reduce hazard posed by over-steepened dune scarps along Cremorne and Roches Beach by a combination of limited beach scraping immediately in front of scarp (~0.5 to 1 m^3/linear m of beach length) and pulling seaward of over-steepened scarp crest. This should be undertaken in a manner to preserve vegetation and root system where possible.

Short Term (6 months – 1 year)

- Import sand to raise low points in dune crest along Roches Beach and revegetate with native grasses and sand binding species;
- Place sand (up to 10 m^3/li m) in critically eroded locations such as adjacent to the Bambra Street revetments and immediately north of the southern revetment. This sand could be imported or obtained in limited quantities from deposits at the southern end of Roches Beach and north of Bambra Reef (estimated up to 500m^3 available at each);
- Limited 'repair' of southern revetment by pushing existing slumped materials into steeper slope (~1V:2H);
- Siting of beach access steps further landward to reflect new shoreline position;

- Identify rock sources for possible future use. Assess potential rock for available size and durability;
- Identify possible land or offshore sand sources and estimate costs to transport and place on beach (initial start-up and subsequent per m^3).

Medium Term (2-5 years)

- Moderate beach nourishment to replace volume lost during recent events of 2010 and 2011 (5000 – 10,000m^3) from offshore or land-based source;
- Trial geotextile groyne structure with pre-fill nourishment and associated beach monitoring to assess effect and assist in design of more extensive works;
- Consideration of emergency geotextile or rock wall at severely eroded locations at Bambra Street;
- Local Government Association Project of Tasmania (LGAT) project to consider long-term management strategies for Cremorne and Roches Beach. The fundamental issue resolved during this process should be whether to *Protect* (e.g. seawall or backstop wall, major nourishment, groynes, etc.), *Accommodate* (minor nourishment, scraping, etc.) or *Retreat* (do nothing or managed retreat) in the long-term.

Long-term (>5 years)

- Subject to outcomes of ALGAT project but, if a decision is made to *Accommodate* or *Protect*, works may include:
    - Raising of dune crests to counter increased future run-up elevations with sea level rise;
    - Ongoing nourishment/sand relocation to counter sediment deficit and longshore movement with or without control structures depending on community sentiment and coupled physical-economic modelling;
    - Engineered backstop wall to limit shoreline retreat past a defined position.

4. Summary

Please do not hesitate to contact Dr Tom Shand or James Carley on 02 8071 9800 to discuss any aspects of the above letter report or if you require further information.

Yours sincerely,

B M Miller
Manager

References

Bureau of Meteorology. 2011. Analysis Chart Archive.
http://www.bom.gov.au/australia/charts/archive/index.shtml

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http://www.bom.gov.au/products/IDT65014.shtml

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http://www.bom.gov.au/oceanography/tides/MAPS/tas.shtml

Shand, T D, Mole, M A, Carley, J T, Peirson, W L and Cox, R J (2011), Coastal Storm Data Analysis: Provision of Extreme Wave Data for Adaptation Planning. Report prepared for the Australian Climate Change Adaptation Research Network for Settlements and Infrastructure (ACCARNSI). WRL RR242, 53p + Appendices.

Shand, T D and Carley, J T (2011). Roches Beach Hazard Line Reassessment. Report prepared for Clarence City Council WRL TR2011/05, 34p + Appendices.

Site Photographs 14 June 2011

Photograph 1 Erosion north of Bambra Reef

Photograph 2 Wave overtopping north of Bambra Reef resulting from run-up

Photograph 3 Bambra Reef and either newly placed riprap rock evident at end of Bambra St (photo: M. Dell, 15 July 2011)

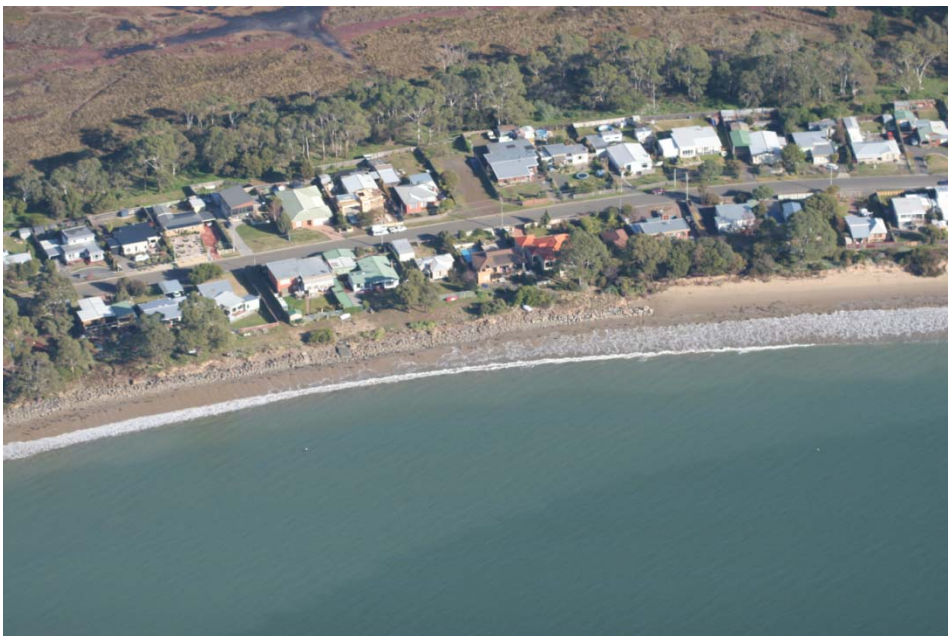
Photograph 4 Erosion immediately south of rock revetment fronting No. 2 Bambra Street

Photograph 5 Over-steepened dune scarps of up to 1.5 m high along much of Northern Roches Beach

Photograph 6 Small hessian sandbags placed along dune crest at No. 118 Balook Street

Photograph 7 Additional sand placed to raise the crest level at Balanada Street

Photograph 8 Southern revetment now holds land at least 5 m further seaward than adjacent shoreline



Photograph 9 Northern end of southern revetment with outflanking evident (Photo: M. Dell, 15 July 2011)

Photograph 10 Erosion of land backing the southern revetment evident where waves have overtopped the lowered wall

Photograph 11 Erosion of the dune has undermined a corner of a boat shed at No. 62 Frederick Henry Parade

Photograph 12 Timber wall along Frederick Henry Parade damaged by wave runup

Photograph 13 Over-steepened erosion scarps reach over 2 m at the southern end of Cremorne Beach