# Old Bar Coastal Protection Structure Preliminary Design

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## Background

Coastal recession rates at Old Bar Beach are currently some of the highest in NSW. In 2008, three houses at the southern end of Lewis Street were threatened by storms and demolished. Today more private and public property is under threat (**Photo 1**).

**Photo 1 – Geotextile covering to limit wind erosion of embankment at Meridan Resort, Old Bar Beach (photo date 9/9/13)**

Between 2008 and 2013 Greater Taree City Council prepared a Draft Coastal Zone Management Plan (CZMP) for its entire coastline, including the hot spot of Old Bar Beach (WorleyParsons, 2013). The cost estimates for beach protection run into tens of millions of dollars. Planned retreat was recommended as the preferred strategy, a default position based upon the non-affordability or availability of any other possible option canvassed within the Coastal Management Study.

The Draft CZMP has not been exhibited or adopted by Council nor has it been endorsed by the State Government. As such the Draft CZMP has no status. Council recognises that planned retreat is a difficult option for the community to accept.

Council retained Royal HaskoningDHV (RHDHV) in 2013 to investigate a structural solution, balancing the reasonable concerns of property owners in Old Bar regarding the protection of their land and assets, against beach public access and amenity. To be eligible for consideration of funding assistance from the State Government, Council and the community must first settle on a suitably robust and proven long-term protection strategy.

## Study Area

Old Bar Beach is located on the mid-north coast of NSW, due east of Taree and between Forster and Port Macquarie. The investigation area extends over 2 km, from the Old Bar Surf Life Saving Club in the north to the MidCoast Water facility (exfiltration ponds) in the south. The area includes the threatened shorefront properties at Lewis

Street, Pacific Parade immediately to the north, the Old Bar Public School and State Environmental Planning Policy 26 Littoral Rainforest (**Figure 1**).


**Figure 1: Study area at Old Bar Beach**

## Strategy and Guiding Principles

It was envisaged at the outset that any shore-based structural solution would need to be staged with the critical area for the first stage located opposite Lewis Street, extending north to about Rose Street, a distance of some 450 m.

Council, in conjunction with OEH, identified eight (8) guiding design principles to be achieved with the long term coastal protection option, namely:

(i) proven and cost-effective performance;
(ii) minimise impact on beach amenity and public access;
(iii) resilient and adaptable design;
(iv) attention to public safety;
(v) management of end effects;
(vi) management of entrance stability (Racecourse Creek);
(vii) management of shoreline recession;
(viii) feasible structural life

## Basis of Design

The preliminary design involved a consideration of design life, foreshore protection principles and staging (triggers). Other considerations comprised:

- public access and safety principles;
- ground conditions;
- construction footprint with respect to private/public property boundaries;
- design water levels (including effects of sea level rise, SLR);
- beach scour;
- breaking wave heights;

- wave runup and overtopping;
- acceptable damage to the structure in storms;
- workable maintenance regime;
- sources of construction materials (rock);
- construction access;
- stormwater drainage; and
- privacy of adjoining landowners.

**Photo 2 – Eroded dune at south end of Lewis Street subdivision (photo date 9/9/13)**

## Consideration of Options

The options investigated in the Draft CZMP were reviewed, namely:

- 'do nothing';
- planned retreat;
- groyne field;
- artificial offshore reef;
- beach nourishment (stand alone and in combination with other options);
- revetments.

### *Do Nothing*

'Do nothing' and resort only to emergency response is not acceptable to Council, OEH and the local community.

### *Planned Retreat*

The community at Old Bar is not supportive of planned retreat as a workable strategy. This was GTCC's original default policy stance given the non-affordability or availability of any other option. There was a broad concern that it would lead to a reduction in visitors impacting on business activity and property values. Also, these impacts would not be limited to the affected coastal strip, but would be felt more broadly within the village.

### *Groyne Field*

Multiple groyne structures are used in groyne fields, and these are often nourished at least initially. The structures are aligned perpendicular to the shoreline acting as a physical barrier to longshore sediment transport, effectively trapping sand on their updrift sides. Downdrift erosion occurs, but this is managed by progressively reducing groyne lengths downdrift and locating downdrift groynes away from sensitive coastal property.

Groynes are usually constructed on receding shorelines where longshore transport is the dominant process, and usually in one direction. The absence of groyne experience on the NSW open coast (none expect at river entrances), and the complexity and bi-directional nature of sediment transport at Old Bar as presently understood, casts too much uncertainty on groynes as a reliable coastal protection measure.

### *Artificial Offshore Reefs*

An offshore reef is essentially an underwater mound that reduces wave energy reaching the shore, encouraging sediment deposition in its lee and reducing the risk of beach erosion. An artificial offshore reef proposal was developed by ASR (2011). The proposal involves two small, submerged reefs; one shore-parallel and the second of angular planform, comprising a total 29,000 $m^3$ of material. The reef crests are set at Mean Low Water with the structures located some 250 m from the shore.

The ASR proposal was peer reviewed by the Water Research Laboratory of the University of New South Wales (WRL, 2012). For various reasons, WRL could not endorse the proposal. WRL subsequently undertook a comprehensive literature review of artificial offshore reefs worldwide (WRL, 2013). Thirty-two (32) existing reef structures were reviewed, of which 29 were designed to provide coastal protection. However, approximately half of these were found to have no significant accretionary impact on shoreline alignments compared to the predicted morphological response, with several of the structures actually resulting in increased erosion/recession. Those that were associated with some level of protection were used in conjunction with other strategies, making it difficult to attribute beneficial effect to the reefs. RHDHV shares the concerns enunciated in WRL (2013) regarding the poor efficacy of constructed artificial offshore reefs to manage beach erosion.

There is little prospect in our opinion that a cost-effective artificial offshore reef system would solve the erosion problem at Old Bar unless the reefs are emergent under most conditions, they extend over larger longshore distances (or more reefs of a similar size to that proposed are provided), and fundamentally, that there is a known and sufficient supply of sand to develop the salients to achieve the required level of protection. The latter alone is yet to be established at Old Bar Beach.

### *Beach Nourishment*

Beach nourishment involves the artificial placement of new sand on the beach to protect coastal property from erosion. It is a favoured strategy since the beach itself is preserved, and potentially unnatural structures are excluded. However, vast quantities of sand are required to protect open coast embayments such as Old Bar, and there are no cost-effective and environmentally sustainable sources of sand presently available. The total cost to implement a beach nourishment scheme at Old Bar has been estimated at $147 million (WP, 2010).

### *Revetments*

Coastal revetments can be designed with a high degree of certainty. Similar certainty is presently not available for any of the other structural options. As such, a revetment was considered to provide the most reliable and effective means of coastal protection at Old Bar Beach. However, revetments can exacerbate localised erosion. There are end effects and possible outflanking as adjacent shoreline continues to recede.

Revetments, while rejected in the draft CZMP, were considered further on the basis of their performance certainty, the unacceptability of planned retreat to the community, and the existing intractable issues associated with all the remaining options.

## Preliminary Revetment Design and Staging

Old Bar Beach is aggressively receding. This means that the water depth at the structure toe would increase over time, exposing it to increasingly severe wave attack. A design philosophy has been developed which permits the typical design life of 50 years to be achieved.

The key design parameters adopted are:

### *Coastal Loading*

- Design life — 50 years (planning date 2063)
- Breaking wave height (1% AEP H10) — 3.2 m (predicted at midlife 2038)
- Wave period (Tp) — 13 s
- Shoreline (budget) recession — 0.8 m/yr
- Storm erosion (1% AEP) — 220 $m^3/m$
- SLR recession — 10 m (2030), 20 m (2050)
- Wave runup level (R2%) — RL 6.2 (assessed at midlife 2038)

### *Revetment*

- Slope — 1:1.5
- Rock armour ($M_{50}$) — 5.2 T, 1.4m $\phi$ (dry density 2.65T/$m^3$), 2 layers
- Rock underlayer ($M_{50}$) — 520 kg (dry density 2.65T/$m^3$), 2 layers
- Rock armour berm — 4.3 m wide (3 rocks), RL 1.4
- Armour toe level — RL-1.0 (self launch level at 2063 RL-2.9)
- Armour crest level — RL 6.2
- Average storm damage — 0-5% (2013-2038), <30% (2063 for $H_{10}$=3.9 m)

### *Management and Amenity*

- Shareway details — 2.2 m wide, RL 5.0
- Maintenance regime (% capital cost) — 0.5% pa (2013-2038), 2% pa (2038-2063)
- Sand placement to manage end effects — 500-1,000 $m^3/yr$

The design principle involved developing a rock revetment structure which experiences "routine" 0-5% storm damage through to midlife (2038), but then experiences higher levels of damage as the coast at Old Bar continues to recede until end-of-life at 2063 when any design storm in that year would severely damage the revetment, but not to the point of full failure (ie damage <30% as described in CERC, 1984).

A three staged development is envisaged as shown in **Figure 2** and summarised as follows:

| | | |
|---|---|---|
| • Stage 1 | Lewis Street properties | 450 m |
| • Stage 2 | Pacific Parade | 425 m |
| • Stage 3N | Old Bar Public School to Surf Club | 525 m |
| • Stage 3S | MidCoast Water assets | 1,600 m |

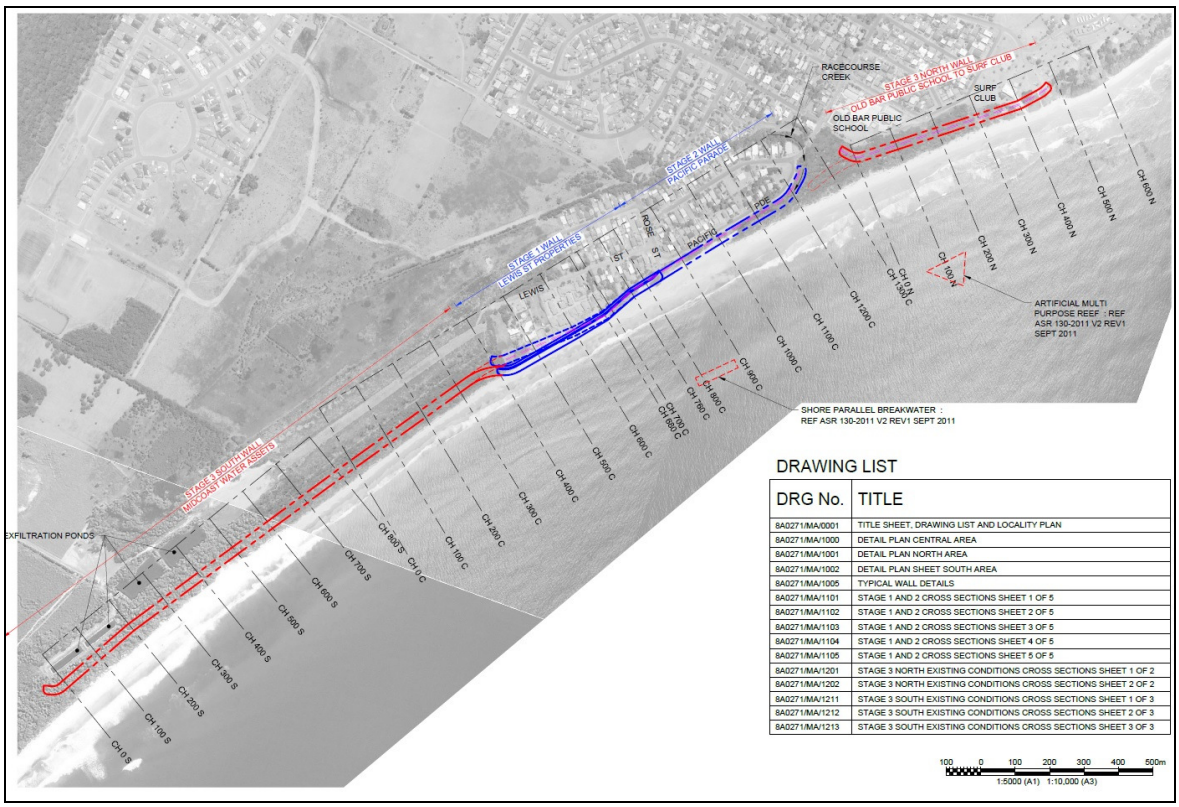


**Figure 2: Preliminary design layout for rock revetment constructed in three stages (Extract Dwg 8A0271-MA-0001C, Appendix D; RHDHV, 2013)**

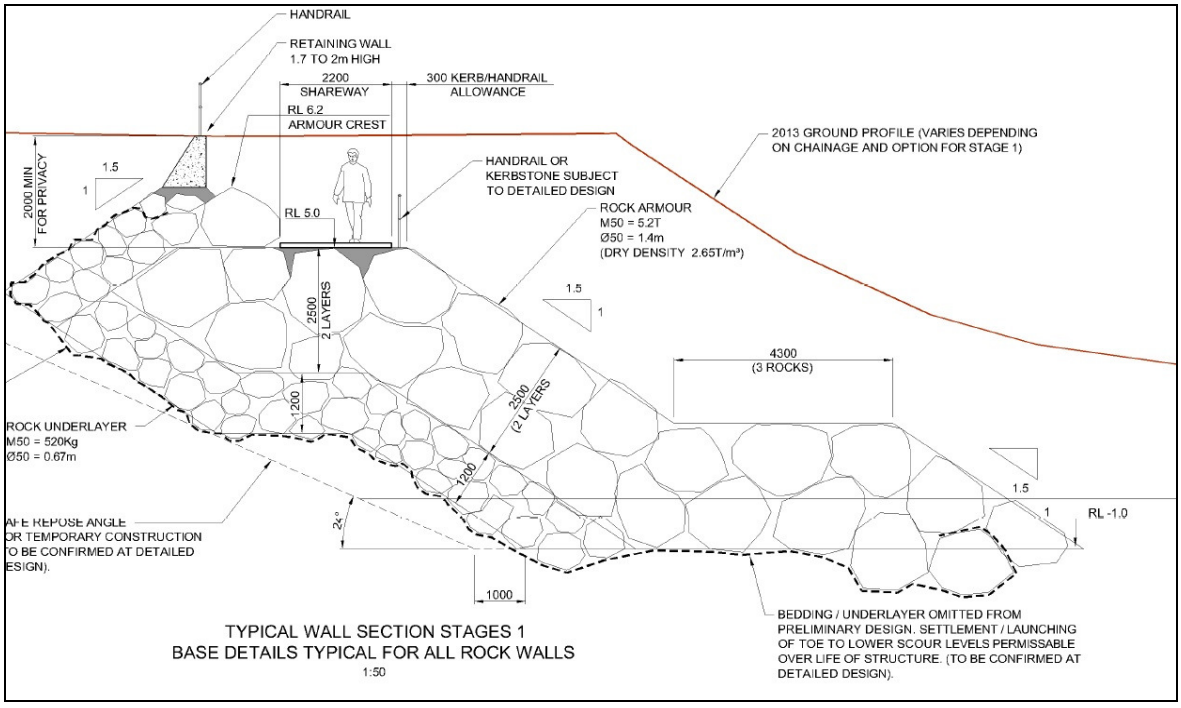

**Figure 3: Preliminary design detail section for Stage 1 (Extract Dwg 8A0271-MA-1005 C, Appendix D; RHDHV, 2013)**

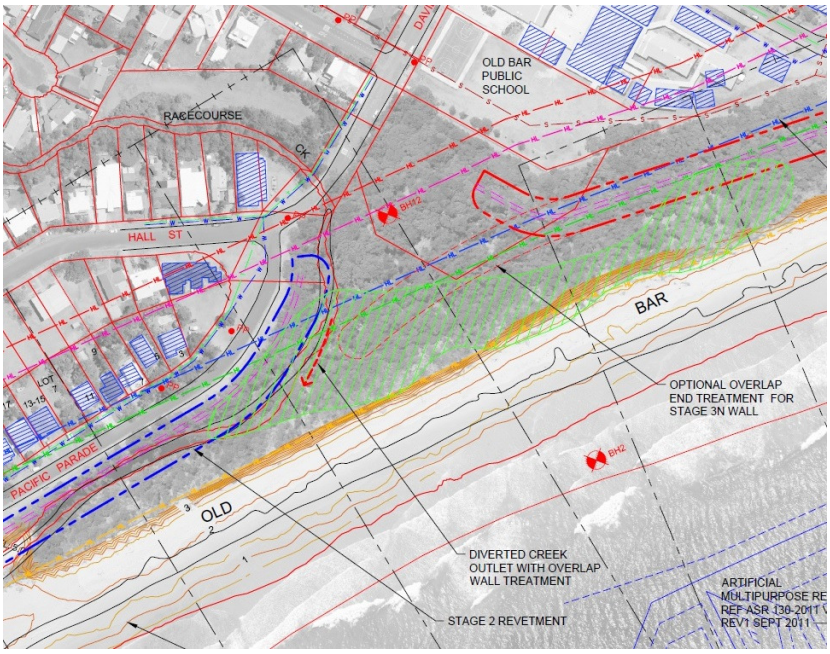


**Figure 4: Proposed staged arrangements about the entrance to Racecourse Creek with preliminary revetment design (RDHDV, 2013)**

Based on an updated average long term recession rate of 0.8 m/year, and assuming sea level rise of 0.4 m to 2050 and 0.9 m to 2100 (both relative to 1990 levels), estimates of trigger dates for commencement of detailed designs for the various stages were established as follows:

- Stage 1 2013
- Stage 2 2013
- Stage 3N 2021
- Stage 3S 2037

The trigger dates would be continuously revised on the basis of the actual recession rates.

Two preliminary seawall designs were developed, a conventional rock armoured coastal revetment and a concrete piled seawall, both as non-overtopped structures. The rock revetment comprises two layers of 3.9-6.6 tonne igneous armour over underlayer and geotextile (Figure 3). The piled wall, nominally a contiguous secant-pile structure, is not favoured due to higher wave reflections, complicated construction and price.

## Cost Estimates

The preliminary capital cost estimates developed for the seawall projects based on the preliminary rock revetment designs are as follows:

- Stage 1 (Option 1) $8.0 million ($17,900/m)
- Stage 1 (Option 2) $8.3 million ($18,500/m)
- Stage 2 $7.0 million ($16,500/m)
- Stage 3N $8.8 million ($16,900/m)
- Stage 3S $24.3 million ($15,200/m)

The preliminary design was developed for two cross-shore positions for Stage 1: Option 1 with the crest of the wall coinciding with the current dune escarpment, and Option 2 with the wall located as far landward as possible but without compromising the stability of existing building foundations and providing for future maintenance access. At the time of reporting in late 2012, the affected landowners preferred Option 1 which maximised the amount of land protected, while the OEH preferred Option 2 which minimised the impact on the beach.

For preliminary costing of revetment maintenance, 0.5% of the capital cost per year is proposed between 2013 and 2038 (mid-life), increased to 2% per year between 2038 and 2063. The notional step up in maintenance spend accounts for expected increasing damage over the full life of the installation, culminating in a structure which is no longer serviceable at 2063.

An additional maintenance provision for sand placement to manage end effects is required, in the order of 500-1,000 $m^3$/year per wall end on average following exposure of that wall end as a consequence of long term recession and storms. The cost estimates presented above are as developed in the report, and these make no allowance for any costs associated with property acquisition.

## Further Comment on Staging

While Stages 1 and 2 are required in the short term, Stages 3N and 3S are not expected to be implemented for a number of years. The time taken to progress to the latter stages of the seawall project at Old Bar provides the adaptive benefit of being able to monitor the wall and beach behaviour. If beach recession trends change, then the time for implementation of Stages 3N and 3S would also change. For these latter stages, it would also be prudent to explore any cost-benefits associated with possible relocation of selected public assets rather than their protection. In particular, it is unlikely that Stage 3S could be justified economically.

Proposed arrangements between Stages 2 and 3 separating the entrance to Racecourse Creek are shown in **Figure 4**.

## Draft Coastal Zone Management Plan (CZMP) for Greater Taree

GTCC prepared its draft CZMP for its entire coastline in 2013 (WP, 2013). The draft plan adopted a policy stance of planned retreat involving the removal or relocation of development or structures when the erosion escarpment reaches a pre-determined (trigger) distance from the seaward edge of a structure, or when road access and/or services (water, sewage and electricity) are no longer available to a property. Planned retreat was considered the best strategic approach to the management of the uncertainty associated with the impact of coastal hazards particularly as GTCC is not in a position to fund costly active management options.

The preliminary design for a back-beach revetment was incorporated into an Addendum CZMP for Old Bar (RHDHV, 2014), adopted by GTCC, and submitted to the Minister for the Environment for certification. Following an examination in recent months, of all available documents including a social and economic impact study into the potential wall option by the NSW Coastal Panel the revetment option was rejected by the Minister. Rejection was followed by a request that Council review its adopted position of protection by way of a rock revetment, that some amendments to the 2013 CZMP be made and that a recommendation be returned for certification of a plan that identified planned retreat as the preferred option.

## References:

ASR Ltd (2011)
*Old Bar Beach Stabilisation Investigation: Feasibility Study*
ASR Ref: 130-2011, September 2011

CERC (1984)
Shore Protection Manual
US Army Corps of Engineers, Vicksberg, 1984

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*Addendum to Coastline Zone Management Plan for Old Bar*
Report 8A0271-03A, Issue 4, 7 April 2014

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*A Review of Artificial Reefs for Coastal Protection in NSW*
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Water Research Laboratory [WRL] (2012)
*Old Bar Submerged Artificial Reef Review*
WRL2012001 JTC:MJB LR20120530, 30 May 2012

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*A Coastal Zone Management Plan for Greater Taree*
Draft report prepared for Greater Taree City Council, March 2013

Worley Parsons (2010)
*Greater Taree Coastline Management Study, Black Head to Crowdy Head*
Prepared for Greater Taree City Council, October 2010