

DESIGN OF ARTIFICIAL REEFS FOR BEACH PROTECTION & SURF AMENITY AT PALM BEACH, GOLD COAST, AUSTRALIA

Angus Jackson, International Coastal Management
PO Box 7196, Gold Coast Mail Centre, Australia 9726
ph 61-7-55640564, fax 61-7-55329147, email a.jackson@coastalmanagement.com.au

[Prof] Rodger Tomlinson, Griffith Centre for Coastal Management
PMB 50, Gold Coast Mail Centre Australia 9726
ph 61-7-55528499, fax: 61 07 55528067, email R.Tomlinson@gu.edu.au

David Skelly, GeoSoils, Inc.
5741 Palmer Way Suite D, Carlsbad, CA 92008
dsKelly@geosoilsinc.com

1.0 Introduction

Palm Beach [Gold Coast, Australia] is 4km stretch of beach extending between the Currumbin and Tallebudgera Creeks. There are 3 Surf Life Saving Clubs to cater for bodysurfers / swimmers. While the surf is primarily a beach break that is not included in surf guides, it is flanked by world renowned surf (board) locations, Burleigh Heads to the north and Currumbin Alley to the south. The Superbank is 8 km to the south. Surf and beach amenity is adversely affected by periodic erosion that leaves no high tide beach seaward of the boulder walls along the central section of the beach. In an attempt to clear the estuaries and mitigate the erosion, sand is pumped once or twice annually onto the beaches from the 2 creeks. However, this beach nourishment causes turbidity and complaints from surf users.

Conventional erosion protection works, including groynes and nourishment, over 30years have reduced the erosion problem but the central section of beach is still vulnerable to regular storm erosion (Photos 1 & 2). In response to this, Gold Coast City Council commissioned Griffith Centre for Coastal Management (GCCM) to develop a strategy that would widen the beaches as well as optimising the dredging from the two creeks for flood mitigation and navigation.



Photos 1 & 2; Typical Erosion, 1967 and 2000

The proposed Palm Beach Protection Strategy is comprehensive and includes:

- Initial and maintenance nourishment of the beach
- Staged construction of up to 3 offshore, submerged reefs to stabilise the nourishment (and enhance recreational activities including surfing, fishing and diving).

- Completion of the boulder wall to protect private and public lands in severe erosion events
- Improved public access

The first stage is nourishment of the most vulnerable section after construction of the first of the reefs.

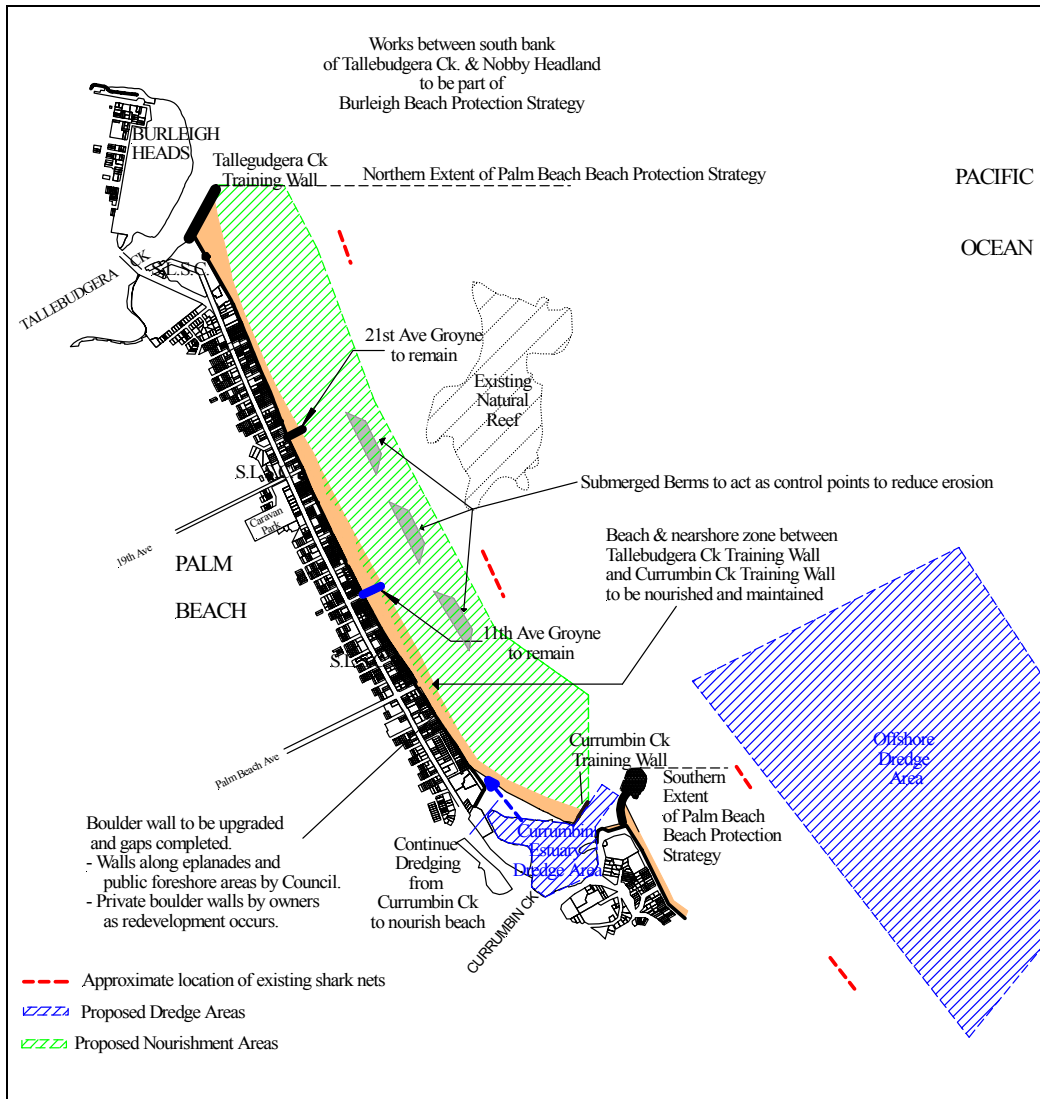


Figure 1; Palm Beach Protection Strategy

The design processes involved a number of elements, including the resolution of nourishment volumes to provide an adequate storm buffer, frequency of nourishment required, appropriate placement of material, identifying suitable sourcing locations, in addition to design of the reef structure, which serves to stabilise the nourished, widened beach and reduce erosion in storm conditions (GCCM 2004 a – f) .

The approval process for the works required modification of the gazetted Coastal Management Plan (CMP) for the Gold Coast. The process required extensive public consultation and advice was sought from Surfrider Foundation during the development of the strategy.

2.0 Reef Design

The reefs are to be primarily for beach protection but activities such as surfing were identified as important issues in the design process. A reef design was developed by International Coastal Management (ICM) for the site. The innovative design was based on co-operative research and the monitoring results from Narrowneck reef and Prattes reef. The “nearshore nourishment cell” design concepts developed by Skelly Engineering to reduce reef volume and costs without reducing beach protection efficiency or surfing amenity for reefs to protect Moonlight Beach and Sth. Carlsbad beaches in California were also used. This led to an innovative low risk design based on real world monitoring data (Figure 2).

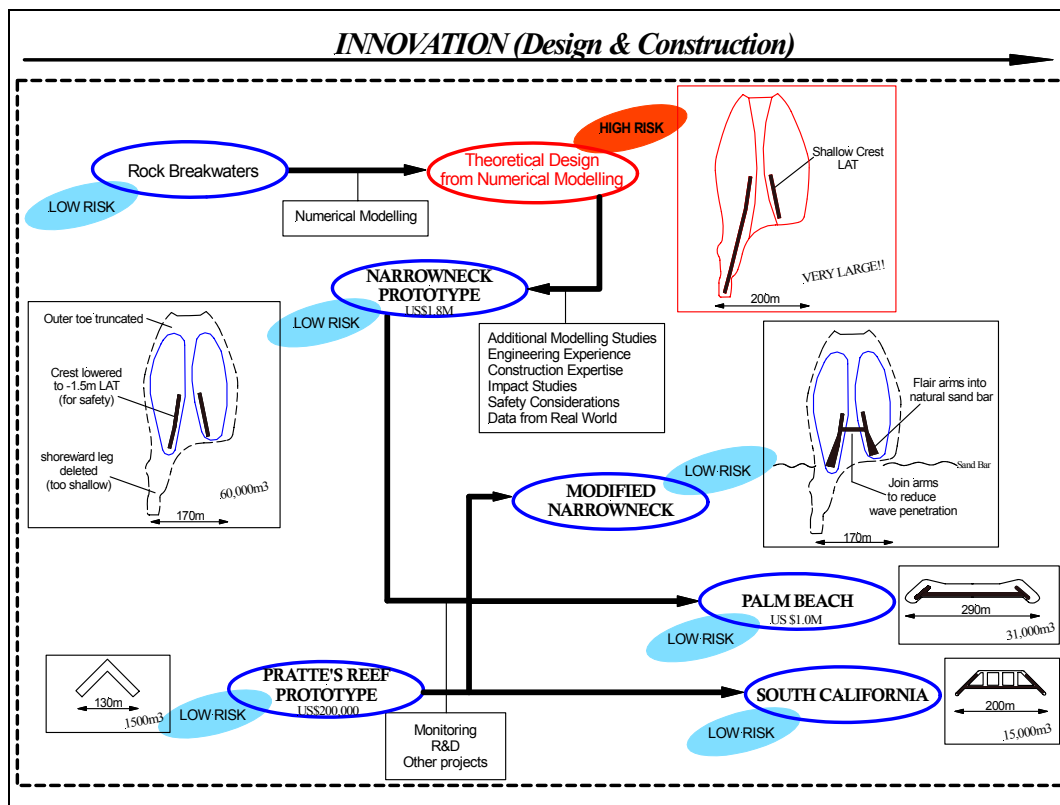


Figure 2; Reef design evolution

The reef was kept essentially shore-parallel to minimise groyne effects that would interfere with the downdrift sand flow and surf characteristics at Burleigh Heads. However, short angled components at each end provided strong diffraction and refraction components that improve the beach protection and allow the shore parallel, wave dissipation, section to be lowered [Figure 3]. Flume testing has shown that a shallow crest is not necessary to effectively dissipate storm wave energy. The reef was located on the back of the outer bar to avoid erosion effects and in this location the reef will break the linear bar system and the resultant closeout conditions. The end sections also improve the potential for surfing providing a takeoff zone seaward of the normal breakpoint. These arms could be easily extended as part of the staged design.

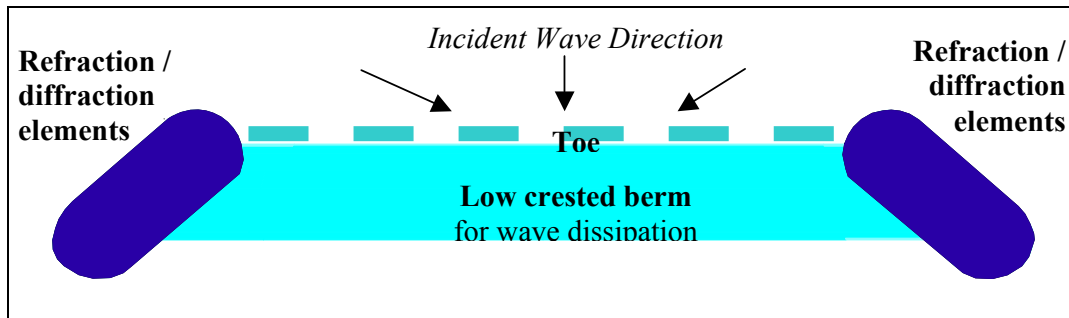


Figure 3 : Components of the Palm Beach Reef

A toe, similar to that developed for the Californian reefs (Figure 4), has been added to increase the effective width of the reef, and tripping waves earlier to promote spilling conditions along the central section.

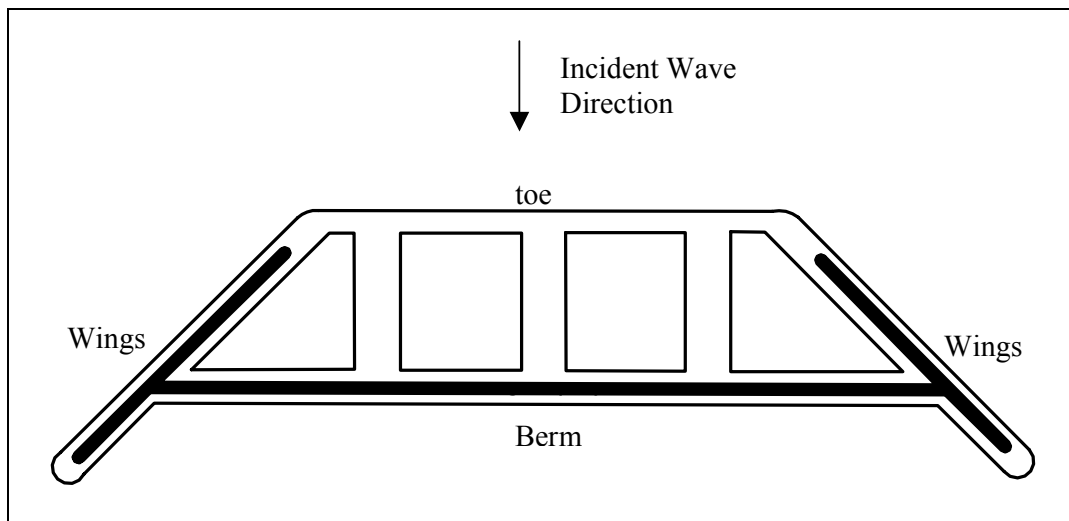


Figure 4: Plan of the Californian Reefs

It is becoming increasingly common to utilise sophisticated and very expensive numerical models for the design of coastal protection / improvement works and it is not uncommon to see the cost of modelling approach the cost of the actual structure. Such models, despite their colourful results, in some cases do not fully predict with sufficient accuracy the impacts of the works, particularly with the wide variability inherent in the coastal system. For this project, the methodology relied on the integration of numerical and empirical modelling using data from a wide variety of sources. However, it was recognised that the impacts (sediment transport, shoreline re-alignment, rip currents etc) of reef structures, particularly when constructed of permeable sand filled geotextile containers, are difficult to model accurately using conventional numerical models.

The reef design was based on data which included monitoring of past works (particularly the Narrowneck reef), evaluation of natural reef salients along Australia's eastern coastline, numerical modelling and flume testing, in addition to the results of research undertaken by others. The monitoring of the prototype

Narrowneck artificial reef provided data on impacts and response of the coastal system to artificial reef structures. This monitoring included hydrographic and beach surveys, video imaging, dive inspections, aerial oblique photography, surf parameter observation and pressure measurements (Jackson et.al, 2002). It has significantly improved our understanding of the behaviour of these types of structures. This understanding has highlighted the fact that there is, in actual fact, less risk with reef structures involved than might initially be assumed provided an appropriate crest height is used. Research showed that a very shallow crest height was not required for good wave energy reduction and storm cut reduction and could increase scour in storm wave conditions as well as being a safety hazard to users.

This design methodology has aided in the development of a number of robust design principles and guidelines for a range of aspects of reef design, including salient size, likely storm cut, safety, surf quality, and diversity of marine habitat. This allowed us to optimise the proposed reef shape, locations and construction materials to best meet the design objectives at reasonable cost.

4.0 Monitoring

The ARGUS camera system to monitor pre and post beach width conditions are already operational. Proposed monitoring is to include data collection and evaluation of:

- Beach width change and storm cut.
- Wave breaking characteristics and energy reduction.
- Beach and surf amenity improvement and usage.
- Rate and extent of new marine ecosystem development.
- Effect on property prices, rate income and tourism.
- Shape and stability of individual sand filled containers.
- Changes in reef shape due to seabed changes in storms.
- Durability of sand filled containers.

This data will allow the continued refinement and validation of existing design principles and guidelines.

5.0 Implementation

The public consultation was extensive and included Surfrider Foundation, but a last minute protest by a small group of local short board surfers after contract award has escalated into widespread concern in response to an extensive misinformation campaign including:

- “No suitable surfing ride”
- The reefs when completed will stretch for over a kilometre long resulting in a closeout from 21st to 7th Ave when the swell is over 4’.
- “Any waves that do get through will have no power or shape” (no shorebreak).
- “The hidden agenda must be a marina at Currumbin Alley”
- Narrowneck reef was a failure.

As part of the extended public consultation, a peer review was requested and carried out. The review concluded:

"The reviewer has identified two options for advancing the construction of a submerged reef if this is to proceed.

OPTION 1

- *Trust the experience, expertise and judgement of GCCM.*
- *From personal knowledge, the reviewer can confirm that the leading members of the GCCM team (Tomlinson and Jackson) have very extensive experience and expertise in coastal engineering and particularly with respect to the coastal processes at the Gold Coast. Their experience with submerged reefs is very substantial, though more recent.*
- *Proceed with construction of the reef, following the staged approach with extensive monitoring recommended by GCCM, and setting the maximum crest levels 1 m lower than the original levels, as recently proposed in GCCM (2004f).*
- *Accept that it may be necessary to stop construction or, at worst, remove part or all of the work if the monitoring indicates this is necessary.*

OPTION 2

- *Use a physical hydraulic model to check the effectiveness of the reef for beach protection and to assess its impact on surfing amenity.*
- *Use modelling to assess whether the proposed multiple reefs will be effective for beach protection. This may require a combination of physical and numerical modelling."*

Despite this, the local protestors have warned that they will still stop construction of the reefs. As a result Gold Coast City Council has presently suspended reef construction.

5.0 Summary

Loss of the beach and damage to shoreline development (public and private) as a result of periodic erosion has significant adverse impacts on Palm Beach. The Palm Beach reefs have been designed as part of an integrated coastal management strategy using real world data from Narrowneck as well as modelling to minimise adverse economic, social and safety impacts due to the beach erosion while enhancing the recreational activities. The implementation of the Palm Beach reefs are presently being deferred and it is likely that Narrowneck will be the only surf reef on the Gold Coast for some time.

Surfing represents a wide community involved in different activities widely differing skill levels and expectations (Jackson et al 2001). This makes acceptance of man made "surf" structures in the surf zone challenging, particularly in countries such as Australia and USA where there is a very deep surf culture and the surfing community is concerned with past adverse impacts on "their" surf areas.

Reefs will generally have to be multi-purpose and if future reefs are to proceed, localism and elitism will need to be overcome and surf organisations need to better co-ordinate and liaise between themselves to provide a good level of input into the process.

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