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Balancing the Equation

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A Surfing Bathymetry for Harbord Headland

by
Andrew Pitt
Coastal Studies Unit - University of Sydney

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INTRODUCTION

The shape and form of the seafloor (bathymetry) at a surfing location is the most important factor in determining the quality of wave breaking transformations. The concept of a Recreational Reef is a reshaping of the seafloor to enhance wave breaking transformations more suitable to contemporary surfing.

Surfing is like other recreational pursuits such as football, tennis, basketball and cricket, in that the activity requires a "consistent surface". In this context, a Recreational Reef is comparable to an oval, a court or a pitch, the only difference being that the recreational facility is located in the coastal environment and dependent on additional climatic ingredients.

In response to a community need for additional and improved surfing venues, a group of surfers and divers established a working Committee to prepare a strategy for installing a Recreational Reef on the northern headland of Harbord, Sydney.

AIM AND SCOPE OF THIS PAPER

This paper presents a design philosophy based on the assumption that to achieve maximum recreational benefit with minimum environmental disruption, the natural topographic features inherent to existing surf spots must first be established in order to identify suitable features for replication.

This paper will present an overview of existing surf spots in the Sydney region. It will discuss opportunities, limitations, subaqueous topographical features, climatic ingredients and the need for a recreational reef.

The paper will also list design considerations and put forward a conceptual design for the Harbord Recreational Reef, to stimulate and focus community discussion to aid formal Preliminary Reef Design.

PART I

1.1 SURFING AND SURFERS

To surf is to slide across the ocean supported by the power of a breaking wave. Contemporary surfers use a variety of equipment, including surfboards, bodyboards, kneeboards, longboards, surf skis and even just a pair of swim fins to bodysurf. Surfing enjoys a high participation rate amongst all age groups in the community. There are an estimated 1.4 million surfers Australia wide according to research compiled by the Association of Surfing Professionals (1993). Surfing is popular worldwide and the sport gained "provisional recognition as a member" with the International Olympic Committee (IOC) and the Australian Olympic Committee (AOC) in early 1996.

1.2 ORIGINS OF SURFING

Surfing originated in the Polynesian islands. On the Hawaiian archipelago in particular it advanced as a sport of considerable skill and expertise (Margan & Finney,1970). Farrelly (1965) recognises a Polynesian boy called Tommy Tanna as the first surfer in Australia. At the turn of the century Tommy bodysurfed the breakers of Manly Beach on a regular basis. However the first skilful demonstration of surfboardriding in Australia was by the Olympic swimmer and surfing legend Duke Kahanamoku at Freshwater Beach in 1915 (Margan & Finney,1970).

Australian surfing skills were recognised in 1962 when Midget Farrelly won the world amateur championships at Makaha (Farrelly & McGregor, 1965). Many great Australian surfers have followed. Since the advent of the professional world surfing tour in 1976, an Australian has been crowned World Champion on ten separate occasions (ASP Year Book 1991). Surfing has become an Australian institution.

1.3 DEFINING A "GOOD" SURFING EXPERIENCE

Contemporary surfers ride across the face of a breaking wave. Therefore peeling waves are the most important prerequisite for a successful surfing experience. Furthermore, the maximum length of a surfing ride is directly proportional to the length of wave peel.

Walker (1974) identified parameters affecting the surfing experience. They include:- wave height, wave peel velocity, breaker type (tubes or foamies), wave period, water surface texture (winds, rips and backwash), crowd (size and aggression), accessibility, temperature (air and water), and perceived hazards (eg. sharks and bluebottles).

However, it is important to recognise that a premium surfing experience is open to subjective interpretation relative to surfing skill and individual wave taste. Ultimately, surfers are wave connoisseurs. In the early sixties Midget Farrally described his idea of the perfect surfing experience (Farrelly & McGregor 1965):-

> *"...(riding on) as big a wave as possible, as long a wall as possible, the surface as smooth as possible, the wave as hollow and as cleanly peeling as possible, and so fast that I would be just able to ride it. That would be perfection.".*

1.4 A SURF SPOT - A SURFING LOCATION

Surfing takes place at a surf spot, or a surf site (Walker 1971). Recognised surf spots are found off beaches, points, river mouths and reefs of all types (coral, granite, limestone and sandstone). Each surf spot is unique, some providing greater surfing experiences than others.

The following surf spots are well recognised by the media and indicative of a benchmark for an international standard, they include:- Tavarua in Fiji, Sunset in Hawaii, Puerto Escondido in Mexico, Jeffries Bay in South Africa, St Leu in Reunion and Grajagan in Java. At these internationally acclaimed surf spots, surfers experience both long lengths of ride (100+m) and the challenge of riding inside the "tube".

Furthermore, these spots are referred to as "consistent" surf spots because they "work" (or certain sections of reef work) under a broad variety of climatic conditions;- including a broad range in wave heights, swell angles and tides. These surf spots are also aligned to blow offshore (or at least sideshore/offshore) under predominant seasonal winds, thus providing a reliably smooth water surface texture.

Part II

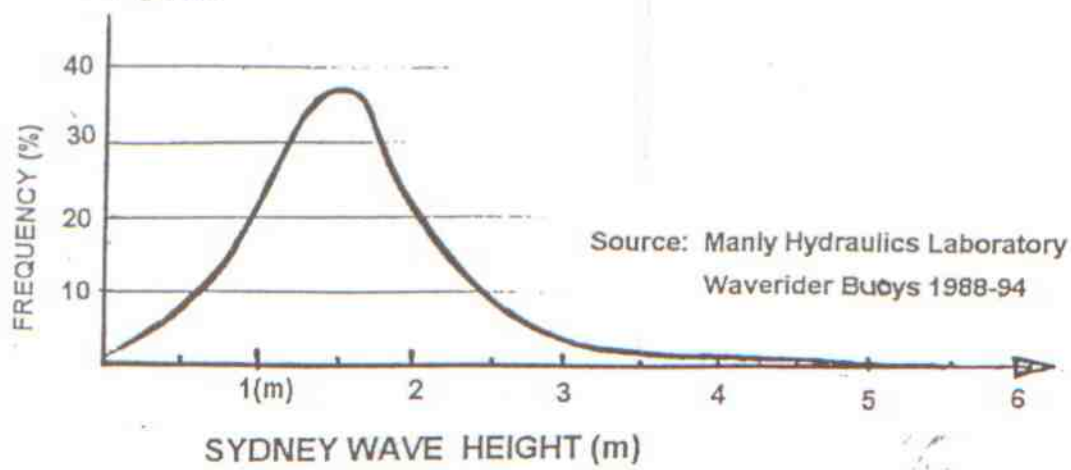
2.1 THE SYDNEY SURFING CLIMATE

Walker (1974) formally identified parameters affecting the surfing experience (see Section 1.3), many of which are intrinsic to a particular surf spot. In the Sydney Region, the primary climatic ingredients affecting a surf spot are:- wave height, swell angle and wind (direction and strength).

2.11 LOCAL WAVE HEIGHT

Surfers ride waves of all heights, though most have a preference for a particular range in wave heights based on skill, fitness and prowess. Data records for deepwater wave height have been maintained by the Manly Hydraulics Laboratory (Annual Report 1993/4). Further analysis provided by Short & Trenaman (1992) suggests Sydney has an energetic and highly variable wave height, though the overall annual mean is 1.6m. For any month of the year Sydney can and does experiences large waves (over 3m), or at the other extreme, waves under 1m for weeks at a time. Figure 1 is an adaptation of the Manly Data (Occurrence Statistics 1988 to 1994) showing wave height frequency. Figure 1 suggests Sydney surfers on exposed coastlines have an 88% probability of observing wave heights between 0.5m and 2.0m.

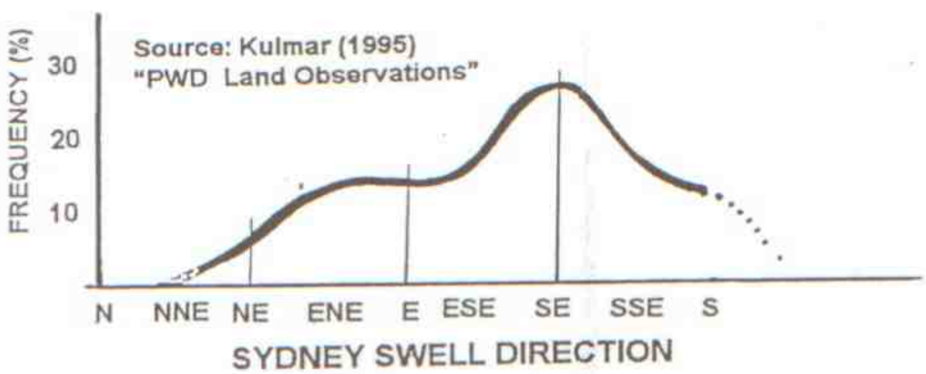
Figure 1



2.12 LOCAL SWELL DIRECTION

Surfers ride swells from any direction, though preferences arise when a specific surf spot has a particular swell window. Kulmar (1995) presents simplified wave direction data (Figure 2) and notes that Sydney experiences swells from the NNE through to S, with SE being the predominant quarter, particularly for waves over 3m. Kulmar also confirms that occasionally swells arrive from more than one direction at the same time. Short (1993) identifies monthly trends in swell direction and classifies swell generating sources to include;- tropical cyclones, east coast cyclones, mid-latitude lows and summer nor'east wind swells,

Figure 2



2.13 LOCAL WIND CLIMATE

Surfers are wind sensitive. Light winds provide smoother water surface texture and improved surfing experiences. Strong winds are uncomfortable and unsafe for surfing. Walker (1974) and Couriel & Cox (1996) confirm that surfers prefer wind from the offshore quarter. Pitt (1983) however, suggests winds from a sideshore quarter are also favourable to surfing unidirectional wave peels. His wind descriptions extend to "side-off" (sideshore offshore) and "side-on" (sideshore onshore).

Sydney experiences the alternating dynamics of morning landbreezes and afternoon seabreezes. Many surf spots are sheltered from nor'east seabreezes and sou'east winds because of topographic features such as the bold headlands at Whale Beach and Fairy Bower. While the south eastern aspect of a beach like Bondi provides a surfing location aligned sideshore/offshore under nor'east seabreezes. The wind direction most unfavourable to Sydney surfers are direct easterlies, which blow directly onshore at most surf spots.

2.2 SYDNEY SURF SPOTS

Sydney has many surf spots within one hours drive of the city centre. The Sydney surfing region stretches from Garie Beach in the south to Palm Beach and includes 29 recognised surfing beaches (Legge Wilkinson 1993, Young 1986, Warren 1988) and at least 39 recognised surfing reefbreaks (Young 1986, Warren 1988, Pitt 1996).

2.3.0 SYDNEY BEACHBREAKS

In general, the corner pockets on Sydney's exposed beaches are prized as surfing locations. This is due to reliable headland controlled rips (Short 1993) gouging channels perpendicular or acute to shallow sand banks, which in turn potentially induce peeling waves for some length. Furthermore, headland pockets are usually sheltered from sideshore seabreezes, providing smoother water texture. These locations are particularly favoured during summer afternoons with nor'easters.

However, it should be noted that the greater portion of Sydney's beaches are often plagued by wave transformations unsuitable for surfing, usually by waves that peel too fast ("close-out"), especially during the spring months with longer period southeast swells.

2.3.1 SEGREGATED BEACHES LEADING TO CONFLICT

As a measure for safer beaches, especially in the more crowded summer months, Sydney's beaches are segregated by flagged bathing areas and posted Surfcraft Areas. This segregation is strictly enforced and often leads to (ongoing) conflicts over the (re)location of flagged, non-surfboard areas.

These conflicts can be severe at flagged locations near the northern ends of beaches, especially at North Maroubra, Curl Curl and Queenscliff. Clearly, a beach is a limited recreational resource in great demand.

2.4.0 SYDNEY REEFBREAKS

Sydney reefbreaks provide a broad palate of surfing experiences. Some, like Thomsons Bay bombe offer a very short length of ride interrupted with hazardous protruding bedrock. Others, like Lurline Bay require large swells to commence breaking, but suffer from chaotic backwash. Many like Kurnell Point lay dormant for months at a time, indicating a preference for an intrinsic and rare combination of climatic conditions;- including an extra-large easterly swell, southerly winds and a specific tide. Surfing experiences at Kurnell Point are limited to less than a few days per year, making it a very "inconsistent" surf spot.

The most popular reefbreaks in the Sydney region include;- Shark Island, Cronulla Point, Voodoo Reefs, Fairy Bower, Dee Why Point and Little Avalon. Pitt and Crawford (1996) suggest these selected reefbreaks can, and do provide premium surfing experiences comparable to an international benchmark. However, they stress, the experiences are far less frequent.

2.4.1 DEE WHY POINT AT WORK

After surfing Dee Why Point for more than 25 years, Crawford (1996) has observed that The Point is "at its best" under a narrow set of climatic conditions including;- long period south-east swells over two and a half metres in height that are lightly brushed by offshore westerly winds. Under these conditions the "reef sections" link together to offer "firing backdoor tube sections as good as anywhere". How often is Dee Why Point "at its best"? Far less than 18 days per year, if you consider there is only a 5% probability of wave height exceeding 2.5 metres (Manly Hydraulics Laboratory data 1993/94). However, Crawford (1996) maintains The Point still offers reliable, though perhaps less exhilarating, basic surfing experiences under a much broader range of climatic conditions, including smaller wave heights, more easterly swells and onshore winds.

Each and every one of Sydney's reefbreaks has a unique and specific set of climatic conditions that must combine before that particular surf spot has the potential to provide a premium surfing experience. Specific sets of climatic conditions vary from spot to spot and are usually well guarded secrets.

2.5 BATHYMETRY OF SYDNEY REEFBREAKS

Intensive subaqueous geomorphic studies by Crozier (1988) and Reffell (1978) show that the rocky seafloors off northern Sydney's headlands consist of sandstone boulder fields overlying sandstone platforms. Crozier's (1988) study of Fairy Bower identifies a boulder field spread around the base of the cliffs as cliffside debris.

The subaqueous topography at Lurline Bay and Cronulla Point on Sydney's southside are consistent with Croziers findings. Both these reefbreaks are dominated by a large field of sandstone boulders overlying a broad sandstone platform tilted slightly seaward in the initial wave breaking zone, or "take off area".

2.6 SUMMARY OF SYDNEY SURF SPOTS

Surf spots in Sydney that are offshore/sideshore under winds from the northern quarter are of limited quantity and in high demand as recreational areas, especially during the summer months when nor'east seabreeze conditions prevail and spatial conflicts arise between bathers and surfers.

Sydney reefbreaks occasionally offer premium surfing experiences. However, though our reefbreaks are diverse, they are not of an "international standard" because without exception, each Sydney reefbreak will only provide a surfing experience under a limited and infrequent combination of climatic conditions. On any given day, many of Sydney's reefbreaks will be "dormant", placing a greater demand on the "non-dormant" surf spots.

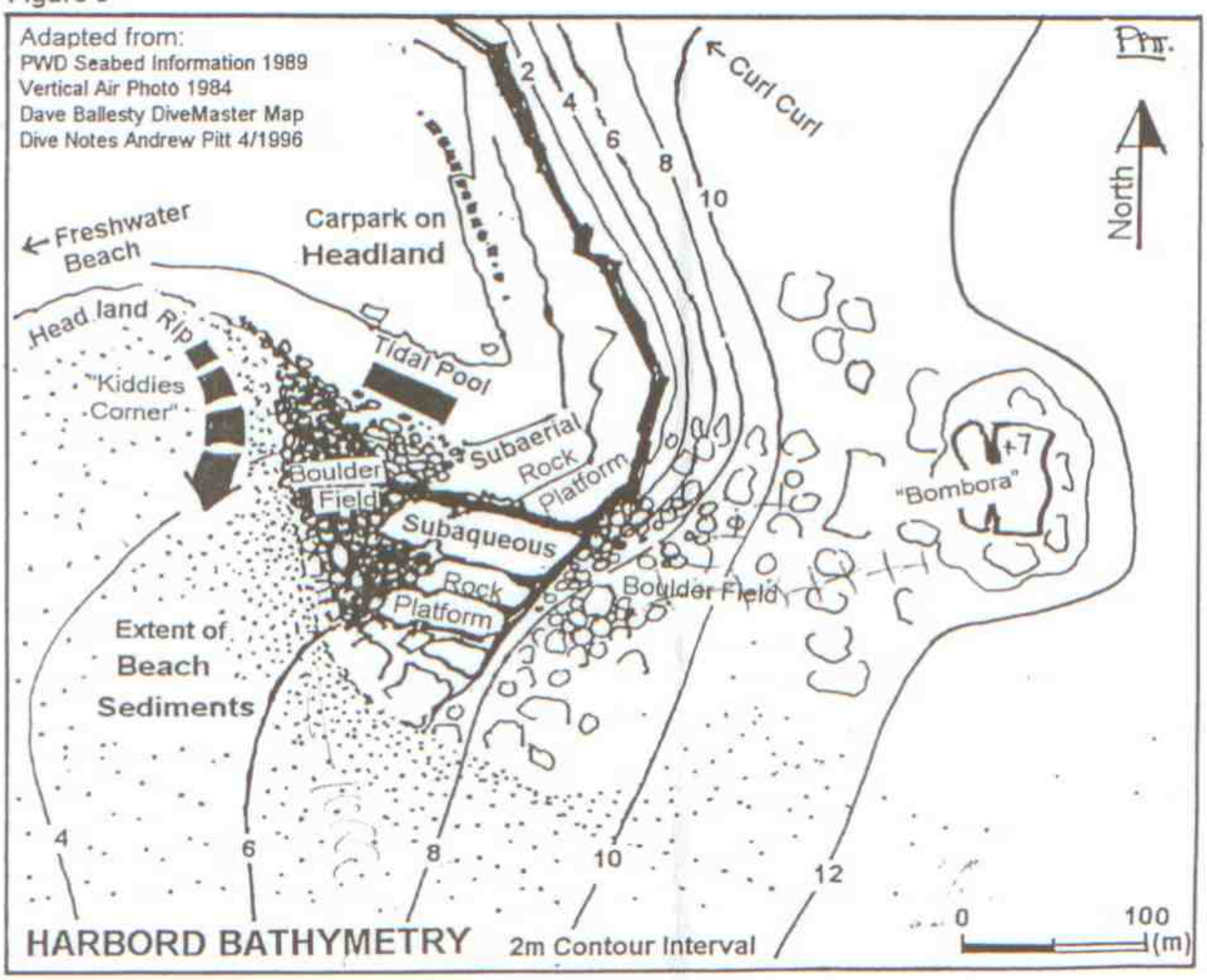
There is a need for a reliable surf spot to provide premium surfing experiences under the broadest set of climatic conditions. The Harbord Recreational Reef can fulfil that need and relieve conflict between bathers and surfers.

PART III

3.1 HARBORD HEADLAND- LOCATION OF RECREATIONAL REEF

The rocky seafloor off the northern headland of Harbord is an ideal location for installing a Recreational Reef because it is exposed to the brunt of the Sydney wave climate and partly sheltered under winds from the northern quarter. Located 10km from the city centre and to the north of Freshwater Beach, the Harbord Headland has the beginnings of a surfing reefbreak (it is an incipient surf spot) and has been surfed on rare occasions (Crawford 1996). An ocean-access channel near the tidal pool is used by Scuba divers on days with small wave height. There is an existing carpark on the headland for more than 50 cars as well as an adjacent bus route. The nearest residents are at least 200m distant.

Figure 3



3.2 HARBORD - EXISTING BATHYMETRY

The seafloor extending off the northern headland of Harbord is steep and cliff-like in places. It is composed of broad sandstone platforms and large sandstone boulders. Figure 3 is an adaptation of:- the PWD Coastal Survey Branch Seabed Information 1989, Sydney chart 1:25,000, a Divemaster map prepared by Dave Ballesty (no scale, unknown date), a 1984 vertical air photo, and dive notes taken by Andrew Pitt (April 1996).

An extensive boulder field dominates the subaerial and subaqueous topography immediately south of the tidal pool. The boulders vary in size from 300mm to more than 2000mm in diameter. They are well sorted and firmly interlocked. East of the pool and skirting the subaerial cliff is a broad sandstone platform tilted to the south. The platform extends into the water where it is referred to as "suck rock". The subaqueous platform is dissected by abrupt crevices, giving the impression of consecutive platforms descending southward in steps to the 10m depth.

An abrupt seacliff, or "wall" defines the eastern edge of the subaqueous platform. A submerged ridge runs off the tip of the headland rising as a deepwater bombora ("The Bombie") some 150 to 200m offshore. Shoreface sediments associated with Freshwater Beach are at least 50 to 80meters south and southeast from the tip headland (Figure 3).

3.2.1 MARINE ECOLOGY

The Harbord seafloor provides a mosaic of habitats for marine organisms. Subtidal marine ecology on the NSW coast has been investigated by Underwood and others (1990, 1991) who indicate it is an extremely variable environment, especially responsive to spatial and temporal scales. They also note marine algae are quick to recolonise following storm event disturbance and physical removal.

PART IV

4.1 DESIGN CONSIDERATIONS

To provide the maximum benefit with the minimum environmental disruption, primary design considerations for a recreational reef include;- wave length, wave peel rate(s) and slope(s) of the seafloor.

4.1.1 WAVE LENGTH

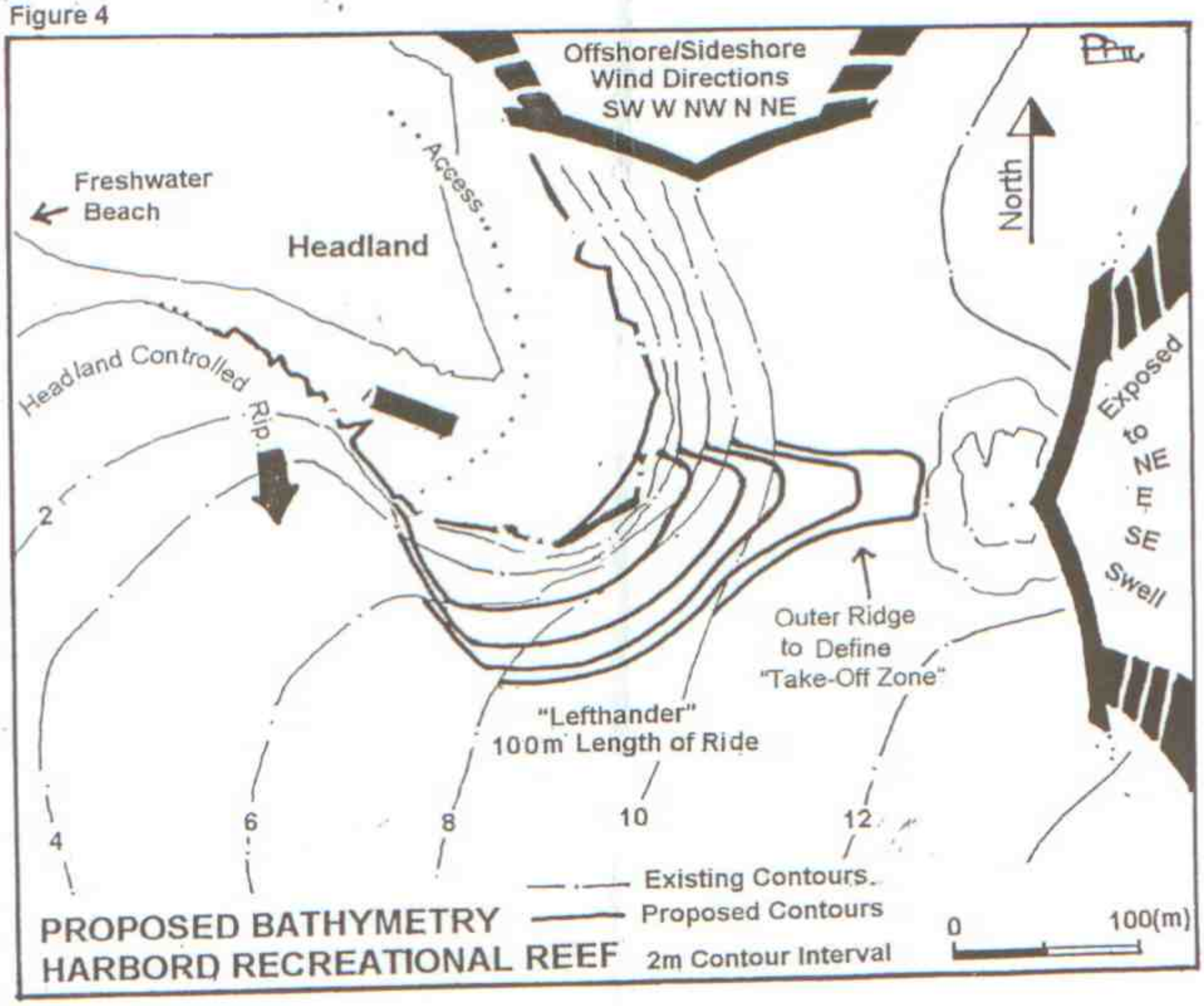
The length a wave peels is related to the scale of the surf spot. Moffatt and Nicholl (1989) maintain 100m is the minimum length of wave peel for a reef installation to be "worth the effort". Topographical and beach process considerations at Harbord may deem the maximum length of wave peel to be 100m. The wave will peel in one direction only, a "lefthander", peeling around the southern side of the northern headland (Figure 4).

4.1.2 VARIABLE RATES OF WAVE PEEL

The rate of wave peel is related to the speed of wave advance and ***peel angle,*** the angle between swell direction and contour alignment (Walker 1974). The more acute the angle, the faster the wave peel. A peel angle of 30° approximates to a fast ride suitable for advanced surfers, while a peel angle of 60° is recommended by Couriel & Cox (1996) to accommodate a broader range of surfers.

As Harbord experiences waves from varied directions (NE, E and SE), the rate of wave peel will vary with prevailing swell direction. Couriel & Cox (1996) make the worthy suggestion that reef design should incorporate a variety of peel rates and that it's preferable for a surfer to commence a ride with a slower peel rate. Other desirable features (Pitt 1992) would include enhancing the bombora ridge feature as a swell focusing device for a more defined and safer take-off zone (Figure 4).

Figure 4



4.1.3 SLOPE OF THE SEAFLOOR

Seafloor slope influences wave profile during breaker transformations. Wave breaking profiles also vary at a surf spot in relation to swell direction. The slope of the existing seafloor at Harbord ranges from approximately 1:50 (vertical: horizontal) on the beach, to 1:8 and cliff-like off the headland. The bottom profile off the headland is too steep to provide wave breaking transformations suitable for safe and regular surfing.

An indicator of maximum bottom slope is "Guillotines" on the NSW south coast. This reefbreak has a bottom slope of 1:12 to a depth of 3m (Kelly 1923), which provides a viscous plunging "righthander" that either tubes or surges up an abrasive volcanic shoreline. Surfing at Guillotines, as the name suggests, is dangerous. Cronulla Point, on Sydney's southside has a bottom slope of 1:20 on the outer sections, mellowing to 1:30 and 1:40 on the inside sections (Pilz 1977). Many of Sydney's reefbreak platforms emerge from deep water with steep, even cliff like seafloors, including Voodoo Reefs, Little Avalon and sections of Dee Why point. As a design consideration, Moffatt and Nichol (1989) suggest a bottom slope of 1:30 to 1:40 for a proposed artificial surfing reef installation at Ventura, California.

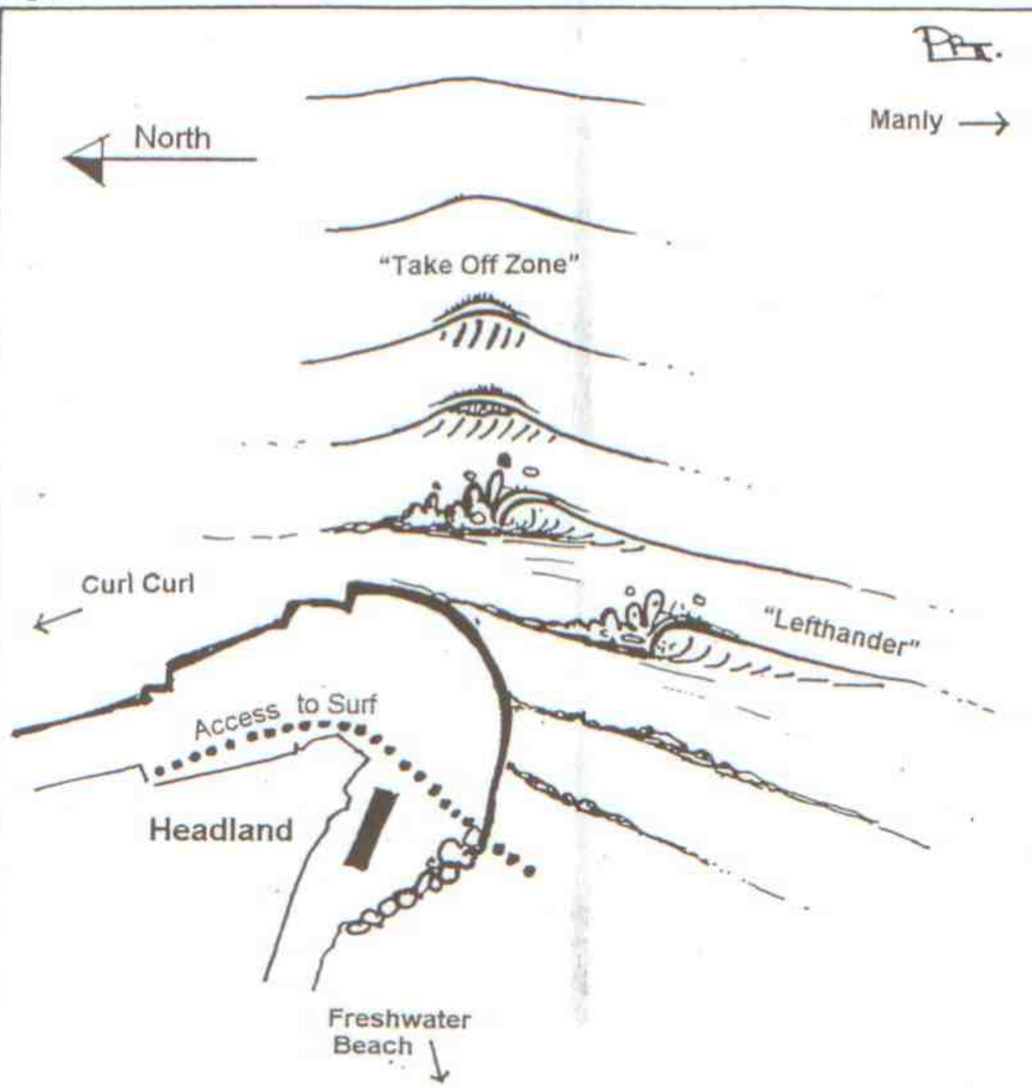
4.2 ADDITIONAL DESIGN CONSIDERATIONS

In the strategy outlined in the Submission to Warringah Coastal Committee prepared by the Harbord Recreational Reef Committee (1996), additional design considerations will arise during the testing of a reef model under laboratory conditions. These include structural stability testing, impact studies on coastal processes, installation constraints and budgetary constraints.

4.3 REEF MATERIAL - SANDSTONE BOULDERS

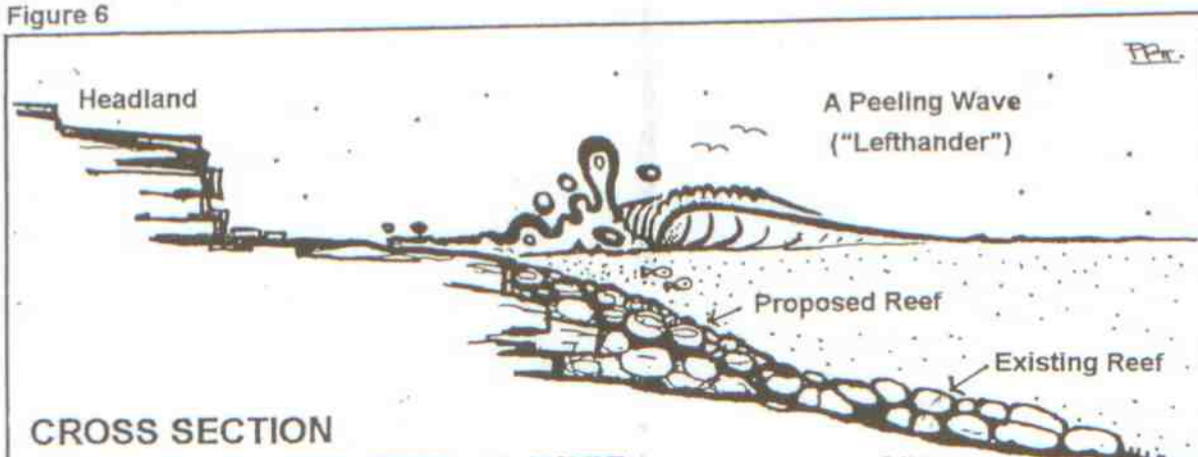
There is an initial preference to construct the reef using sandstone boulders, as this material is indigenous to the location and provides a non-intrusive and similar habitat to existing conditions. Maddox (1994) proposed a surfing reef be built at Malabar on Sydney's southside using sandstone material excavated ("spoil") during the enlargement of a nearby tidal rock pool. The seafloor texture or surface irregularity (Couriel & Cox 1996) presented by freshly excavated material needs to be considered in relation to its hazard potential and effect on water texture during wave breaking transformations. Further study is required to determine the structural integrity and armouring arrangement required to successfully install a sandstone boulder field. Periodic maintenance of the boulder field should be considered as an acceptable component of using natural materials.

Figure 5



ANTICIPATED WAVE BREAKING TRANSFORMATIONS
HARBORD RECREATIONAL REEF

Figure 6



CROSS SECTION
HARBORD RECREATIONAL REEF

5.0 CONCLUSION

The installation of a surfing reef at Harbord is technically possible and would satisfy the demand for more and improved surfing locations. Minimal environmental disruption can be achieved by limiting the scale and design of the recreational reef. For long term environmental management, emphasis should be placed on utilising construction materials indigenous to the location.

Recreational reefs must be recognised as recreational infrastructure comparable to cricket pitches, football fields, golf courses, boat ramps and tennis courts. Public funding for recreational reefs should reflect the value of surfing as an institution within the youth of our coastal communities.

Coastal managers need to insist that if coastal works are necessary, then the works must be "multi-purpose" (Moffatt & Nichol 1981). A contemporary example is the proposal for retreating coastline at Surfers Paradise (Jackson 1995) which includes a surfing reef in conjunction with a coastal protection structure modified as a headland.

Coastal Management Plans need to recognise existing surf spots as "sacred sites" and appreciate the present and future needs of surfers.

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Balancing the Equation

ANDREW PITT

POSITION: Postgraduate Candidate for Master of Science by Research

ORGANISATION: Coastal Studies Unit - University of Sydney

Andrew's first surfing experience was at age 3 on a green zippy board in the Mollymook shorebreak. He was hooked. Andrew went on to complete an Undergraduate Degree in Landscape Architecture at the University of NSW, where he spent several terms as President of the University of NSW Surfriders Club. His final year thesis was on Submerged Coastal Landscapes which included case studies on Artificial Surfing Reef proposals in Perth and California.

Andrew has been a regular contributor to Tracks Magazine, Australian Bodyboarder and Waves Magazine where he wrote and illustrated a regular column called "Australia's Best Waves". He is active in the Surfrider Foundation Eastern Beaches Chapter and remains concerned that coastal engineering works do not adequately consider the potential for improving local surfing opportunities. Andrew is researching Surfing Topographies at the University of Sydney and is a member of the Harbord Recreation Reef Committee.

The Zippy board has been replaced with a surfboard.