

THE SEARCH FOR SUSTAINABLE BEACH PROTECTION FOR NOOSA MAIN BEACH

Rod Williams

dw@noosa.qld.gov.au

Director- Works, Noosa Shire Council, Qld, Australia

www.noosa.qld.gov.au

Abstract

This paper covers progress at Noosa on the search for a sustainable solution to beach erosion by construction of an artificial reef to reduce the necessity for nourishment by dredging sand. Studies showed that a submerged reef of complex shape could be constructed to modify wave direction and energy so as to reduce erosion and encourage sedimentation.

However, practicalities of the reef construction and public liability risk aspects are yet to be resolved.

Key Words: Noosa, beach erosion, artificial reef, sustainable beach protection.

Introduction

Noosa Shire Council has for some time been seeking a sustainable solution to the erosion of Noosa Main Beach. The periodical loss of the beach has an adverse impact on the tourism industry.

Maintenance of the beach since 1985 has primarily been by nourishment by pumping sand from within the Noosa River. Inactive sources of sand in the river were depleted by 1996. Limited nourishment of relatively small quantities from the active sources in the Noosa River estuary may be sustainable in the future, but only if the extent of erosion can be considerably reduced.

Investigations have identified a possible solution involving construction of an artificial reef using very large sand filled geo-textile containers. However, a number of aspects have yet to be resolved, including construction aspects, to allow the project to proceed.

This paper provides an overview and gives a progress report on the project.

History

Noosa Beach and the Noosa River Estuary have been affected by a number of construction works in the past as follows (refer Locality Plan Figure 1)

- 1968 - Rock Wall on the beach front
- 1972 - Hays Island residential canal estate
- 1978 - River Mouth Relocation/Spit Beach
- 1982 - Noosa Woods Groyne

Substantial quantities of sand have been extracted from the river mainly from the Noosa Inlet Inactive area as follows:-

- | | | |
|------|-----------------------|---|
| 1978 | 200,000m ³ | - In conjunction with training wall construction |
| 1982 | 220,000m ³ | - In conjunction with Noosa Woods groyne construction |
| 1988 | 140,000m ³ | |
| 1990 | 42,000m ³ | |
| 1994 | 146,000m ³ | |
| 1996 | 75,000m ³ | |
| 1999 | 80,000m ³ | - From offshore |
| 2000 | 60,000m ³ | |
| 2001 | 30,000m ³ | |

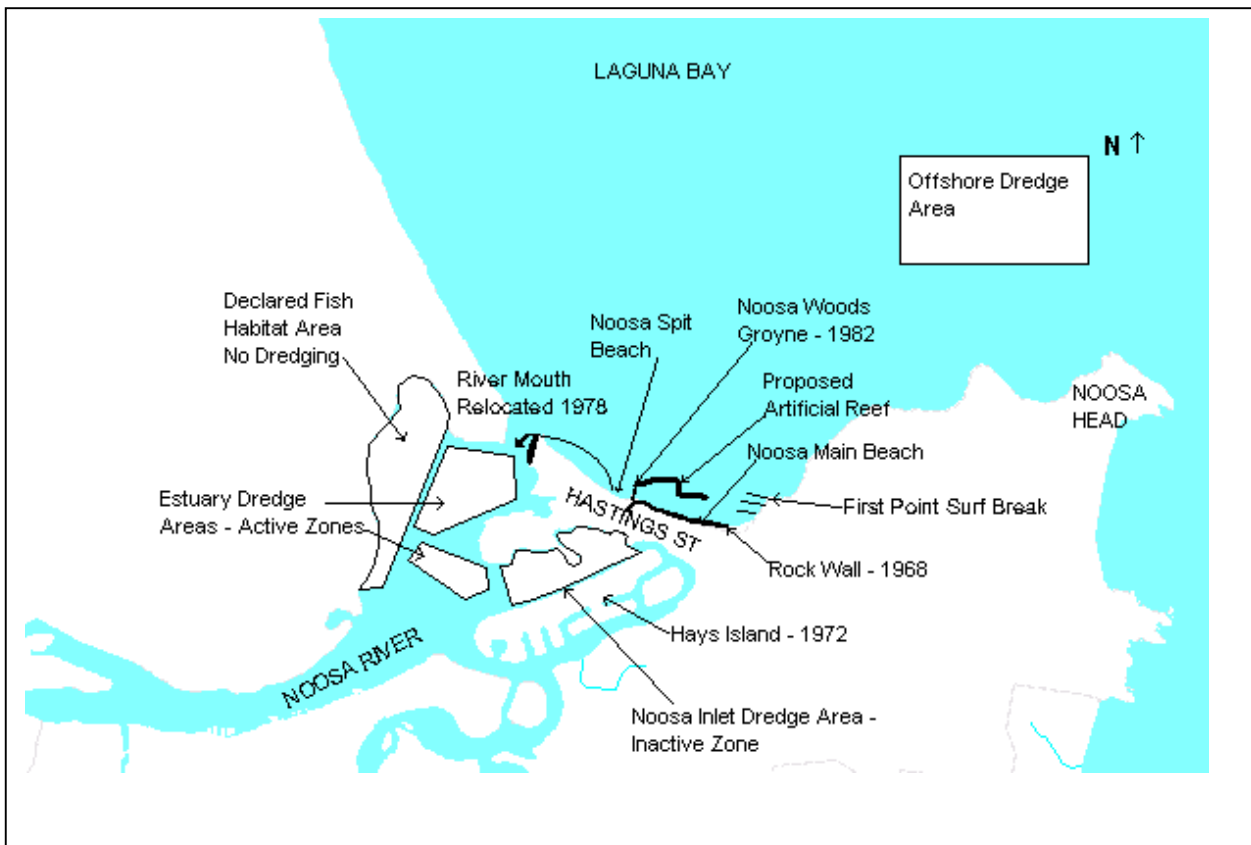


Figure 1 - Locality Plan

The last construction project carried out in 1982, the Noosa Woods rock groyne, has been beneficial. But the erosion problem remains.

Study Process

Severe erosion in 1988/89 resulted in loss of the beach back to the rock wall (refer figure 2). This led to a 3 year data collection study covering waves, currents, beach profiles etc to obtain information to assist in seeking a solution that “might” work.



Figure 2 - Eroded Beach April 1989

At that time there was no expectation of finding a “perfect” solution. The information provided a basis for further investigation.

Erosion events continued and in 2000 International Coastal Management (ICM) were commissioned to investigate the problem. The study team included Angus Jackson (ICM), Professor Kerry Black (ASR Ltd) and Assoc. Professor Rodger Tomlinson (Griffith University).

Council was independently advised on a peer review basis by Dr Michael Gourlay (Honorary Research Consultant from the Department of Civil Engineering at the University of Queensland).

Consultation took place during the study process through a Local Reference Group (consisting of representatives from various community groups) and a Technical Working Group (consisting of representatives of the Beach Protection Authority, DPI - Fisheries, and Environmental Protection Agency).

General objectives were that any works should:

- a) Stop or minimise loss of sand from the beach.
- b) Be sustainable in the long term
- c) Preserve the amenity for the existing stakeholders.
- d) If practical, improve the beach and surfing amenity.

Planning Report

Initially a planning report was prepared, identifying the causes of erosion and assessing possible solutions.

The die was cast around the turn of the century, when land was subdivided along Hastings Street on the frontal sand dune, within the range of natural shoreline movements.

The rock wall constructed in 1968 to protect these properties from erosion created problems for the beach, summarised as follows:

- a) Sand supply to the beach is mainly from the south and is irregular and unreliable. Large wave events are required to bring sand around the headlands into Laguna Bay.
- b) The rock wall alignment, which follows the property boundary alignment, is out of alignment with the waves. This is the direct cause of the erosion problem (refer Figure 3).



Figure 3 - Wave Crests are misaligned with the shoreline resulting in prevailing longshore currents to the west

- c) Strong currents are created westerly along the beach, mainly due to the misalignment and wave driven flows, causing sand to sweep past the Noosa Woods groyne.
- d) The amount of sand moving westwards exceeds by at least 40,000m³ per annum the amount being deposited on the beach.

The brief required the following options to be investigated:

- a) Ongoing beach nourishment
- b) Extension of Noosa Woods Groyne
- c) A submerged permanent near shore breakwater
- d) A near shore sand berm
- e) A submerged "V" shaped artificial reef structure
- f) Realignment of the Noosa River Mouth
- g) Energy absorbing sea wall

The study found that while none of the options examined would totally solve the problem, a solution merging the best components of the various options would modify the wave crests to match the existing sea wall alignment and thereby optimise beach stability.

To achieve this, an artificial reef structure consisting of a curved, submerged, low gradient reef, extending from the Noosa Woods groyne and running to the east towards First Point, was recommended (refer figure 4).

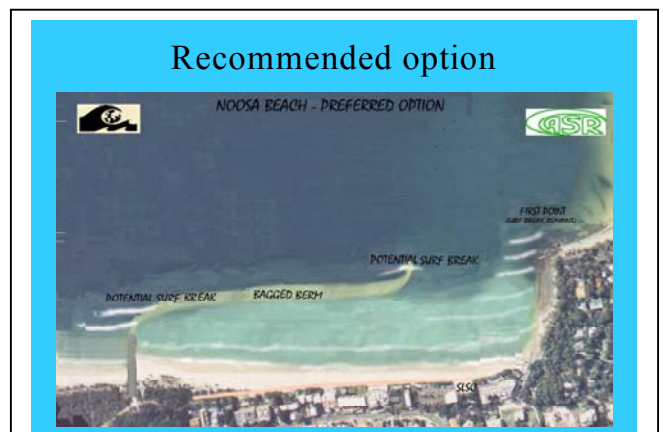


Figure 4 - Original reef proposal

Detailed design investigations proceeded in two distinct stages.

Stage 1 Design Investigations

Initial detailed design investigations were carried out involving the following:-

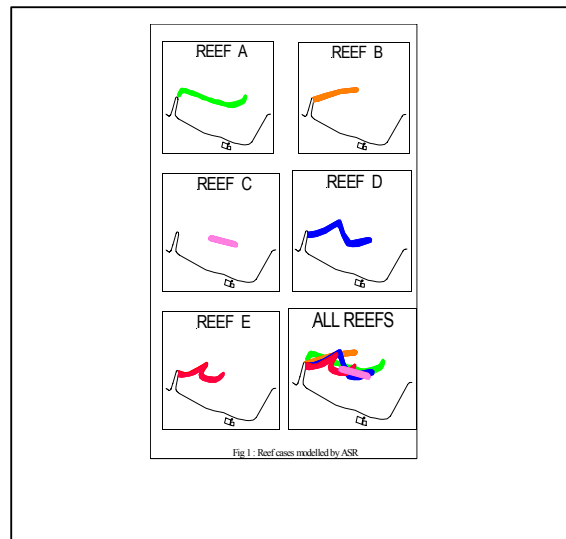
- a) Refining the understanding of coastal processes in Laguna Bay and analysis of erosion and accretion patterns for the beach.
- b) Using a group of numerical models to compare waves and currents generated by various reef options and to establish the changed patterns of erosion and sedimentation and;
- c) Subjecting the preferred design to various wave and storm conditions as follows:
 - i. 30 days of average conditions, followed by 1 in 10 year storm event, followed by 30 days of average recovery conditions.
 - ii. 30 days of average conditions, followed by 1 in 10 year storm event, followed by 30 days of northerly swell conditions.
 - iii. 30 days of average conditions, followed by 30 days of northerly swell conditions.
 - iv. 6 months of continuous simulation under average conditions, and
 - v. One in 100 year storm event.

Considerable care was taken in calibration of the numerical model, which was shown to provide convincing prediction of sand movement following offshore nourishment in 1999, against physical measurements.

The modelling predictions for the unprotected beach were intuitively in the right order.

28 options for possible reefs were modelled with different shapes, positions and crest depths and narrowed down for short listing (Refer Figure 5).

The preferred option (Option E) was then subjected to very detailed modelling which ultimately involved more than 3,000 individual model simulations being undertaken.



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The concept of the proposed reef is shown on Figure 6.

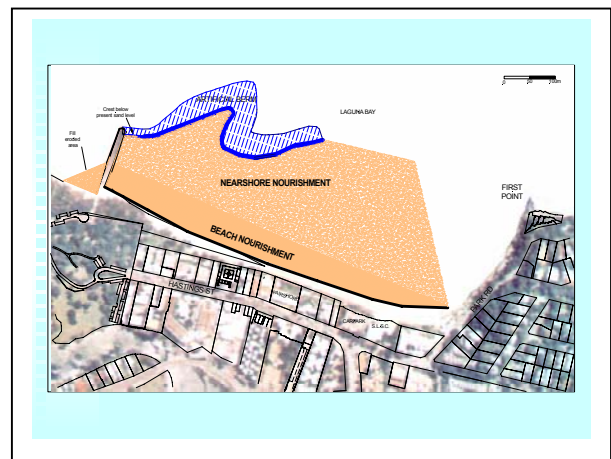


Figure 6 - Final proposed reef

The proposed reef consists of 2 concave arms to rotate the waves. The arms are in 2 sections to reduce the strong long shore current predicted off the original shore - parallel reef. Rotation of the waves and build-up of the water levels inside the reef are predicted to counteract, and overcome in places, the currents that sweep eroded sand away from Noosa Main Beach.

Rotation of the waves can be seen from a demonstration model - Figure 7.

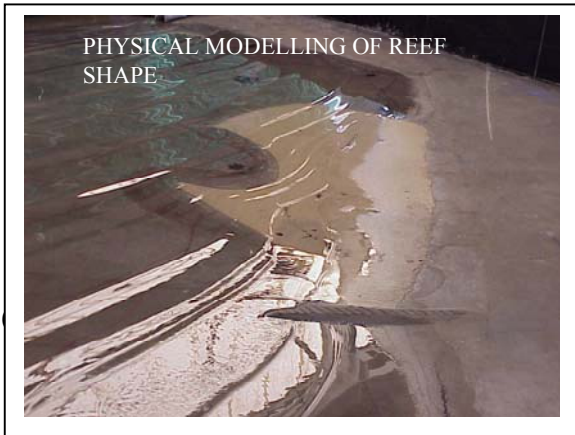


Figure 7 - Wave rotation in a physical model

Important outcomes predicted were:-

- a) By substantially reducing the size of waves reaching the protected section of shoreline, and changing the direction of the waves, loss of sand from the beach would be greatly reduced under storm conditions. This would allow a reasonable beach to be maintained on a more consistent basis, providing the outcome much sought after by the tourism industry.

It was found that the reef causes increased sedimentation at the beach. It also was found to reduce the loss of sand from the beach. The reef was predicted to meet the nourishment and beach protection design goals ie.

- That the boulder wall should remain buried in a 1 in 5 year event, and
 - That the volume losses should be less than 10,000m³ per year.
- b) The general visual amenity of Laguna Bay would be preserved.
 - c) Construction could be from offshore.
 - d) The situation could be reversed (at a cost) if there is some unforeseen serious negative impact.
 - e) The popular First Point surf break would be maintained.

- f) A small surf, ideal for families with younger children, would be retained.
- g) Requirements for sand to nourish the beach would be reduced from around 40,000 - 80,000 m³ per year to around 10,000 m³ per year.
- h) The beach would recover much more efficiently.

Disadvantages of the scheme include:-

- a) The length of the reef was constrained by the need to not impact on the existing First Point surfing break, resulting in reduced protection for the eastern half of the beach. This would result in a need for mechanical shifting of sand along the beach at times.
- b) There was potential for realignment of the Noosa Spit Beach shorewards by 10m (possibly increasing up to 20 - 30m at times) resulting in the need for maintenance of this beach. This is due to reduced artificial nourishment from Main Beach.

The solution was not perfect. But there was positive evidence that erosion would be reduced significantly.

Construction Aspects

Sand filled geotextile containers were considered the most user friendly, cost effective solution for the reef structure. The containers up to 4.75m diameter and 20m long, would be placed from a split hulled barge - refer figure 8.

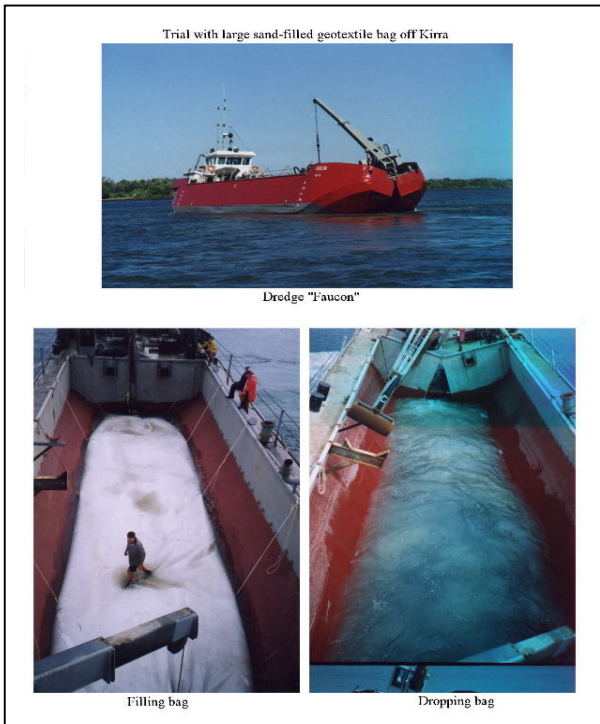


Figure 8 - Split Hulled Barge/Container placement

The scale of the proposed reef can be gauged from the following:

Crest height	RL-2.0m AHD (approx 1m below low tide)
Height	Up to approximately 3.5m
Width	
- Base	Up to 50m
- Crest	5m
Seaward Slope	1 in 10 to 1 in 12.5
Volume	Approximately 50,000m ³
Nourishment	
- Lower beach (from offshore)	70,000m ³
- Upper beach (from River)	50,000m ³
Estimated total project cost	Initially \$2.6 million Now \$4.2 million

The reef would be formed by Geocontainers as shown on figure 9.

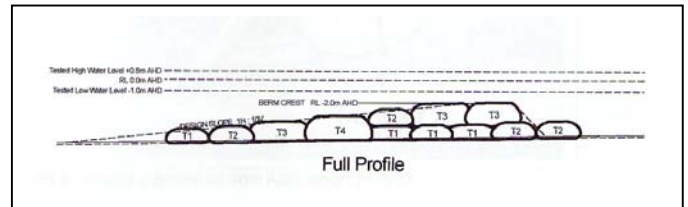


Figure 9 - Reef Cross Section

Stage 2 Design Investigations

These additional investigations, which are incomplete, include review of the geocontainer layout and construction methods, possible extent of short and long term settlement, adequacy of potential construction tolerances and sensitivity of performance to variations in the reef size and shape. The consultants were requested to also provide more information on public safety aspects.

Physical modelling in a flume tank, in which scale models of the reef were placed and tested for varying wave conditions, was carried out at the Queensland Government Hydraulic Laboratories at Deagan.

A glass panel in the tank allowed wave breaking characteristics to be observed and measured - refer figure 10.

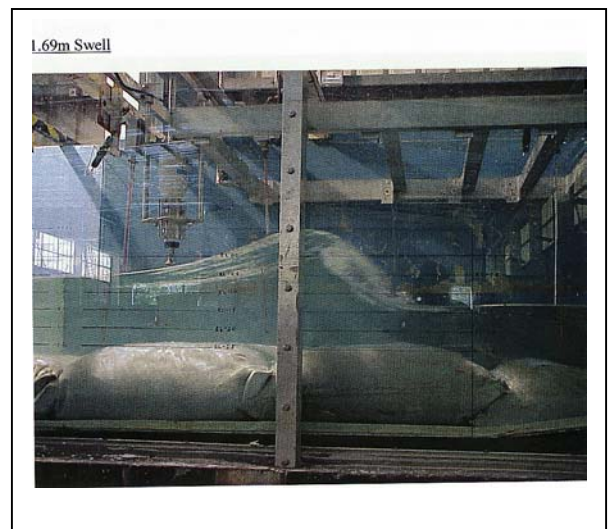


Figure 10 - Flume tank testing of wave breaking characteristics

Outcomes of Stage 2 Investigations

The main issues are as follows:-

Public Safety

The existing beach at the Noosa Woods Groyne end is characterised by plunging (“dumping”) waves (refer figure 11) under moderate to large swell conditions, which have resulted in a number of injuries to swimmers. It was considered desirable to make the conditions safer if possible.

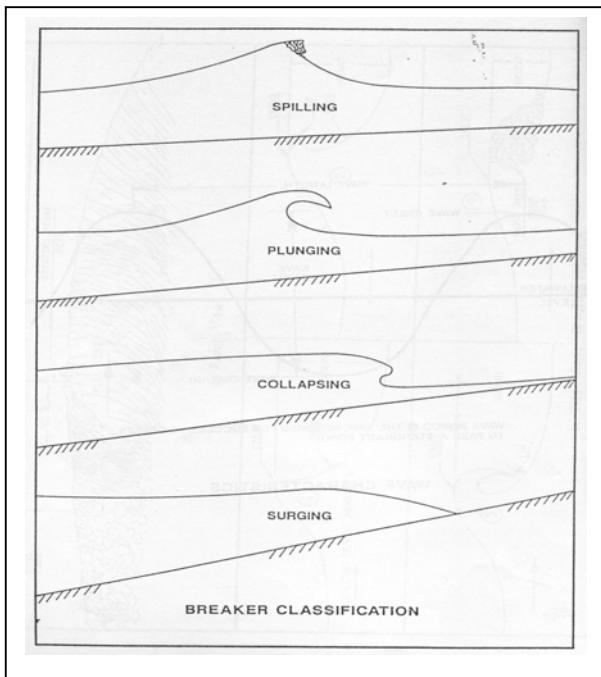


Figure 11 - Wave Types

Plunging waves were found to still occur during the tank testing for the reef at the original crest level (RL -2.0 m AHD - approximately 1m below low tide). Lowering of the crest by 0.5m to RL -2.5m AHD (approximately 1.5m below low tide) resulted in a change under most circumstances (up to 1.7m waves) to much safer spilling waves, breaking onto an increased water depth (approx. 1m). Lowering of the crest was found to be necessary.

Legal advice on appropriate exercising of “duty of care” is yet to be finalised, particularly in respect of depth of water over the reef during wave breaking.

Tolerances/Construction Aspects

The investigations have shown that:-

- a) Tight tolerances are required on the crest level (particularly minimal upwards variations).
- b) Large steps in the reef face are beneficial for reducing wave energy - and hence reducing waves transmitted inshore of the reef. But large steps are undesirable in creating a “messy” surf.
- c) Tolerances on the reef face should desirably be a maximum of +/- 0.3m.
- d) Construction is complicated by an estimated settlement allowance of 0.6m, for settlement of bags into the sea bed and migration of sand within the bags, which needs to be built into the construction procedures

The desired construction tolerances cannot be achieved by the original construction method proposed

Coastal Protection

Lowering of the crest height will reduce the level of protection against erosion of the beach, due to reduced effectiveness in breaking and refracting waves. Implications have yet to be modelled.

Outstanding Investigations

Outstanding investigations are focusing on the following issues:-

- a) Ensuring that construction techniques are available to give reasonable certainty of outcomes, consistent with desired construction tolerances. This will have implications for the cost of the project.

The best prospect at present seems to be to construct the reef wholly or partially with smaller containers.

- b) Checking further on potential life of geotextile containers and risk of failure.

If the above can be satisfactorily resolved, the additional further investigations will follow:-

- a) Proceeding with model simulations to assess performance of the reef with a lowered crest height.
- b) Reviewing duty of care issues regarding public liability risk.

Conclusion

Extensive investigations have been carried out in the elusive search for a sustainable solution to a long term erosion problem effecting Noosa Main Beach. Maintenance in the past has been mainly by pumping sand from the Noosa River onto the beach. The desired rate of nourishment from this source is not sustainable.

The concept of an artificial reef was identified as a recommended solution. Numerical modelling provided reasonable evidence to demonstrate that the reef would be beneficial in reducing erosion and nourishment to a sustainable level.

However, construction of the reef has presented greater difficulties than originally understood. And the crest height originally proposed will need to be lowered for public safety reasons, reducing the effectiveness of the reef.

Whilst technology is available to scientifically analyse possible outcomes for beach

protection by construction of an artificial reef, construction methods are still in a research and development phase.

A number of aspects still need to be resolved before construction proceeds, particularly construction methods available to give reasonable certainty of required accuracy, and public safety aspects.

Acknowledgements

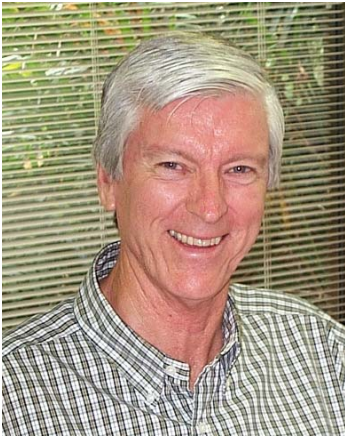
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Author Biography



Rod graduated with a B.Sc. (Tech) in Civil Engineering at the University of New South Wales in 1966.

He had a 2-year stint with Thiess Bros working on construction of the last power station on the Snowy scheme, Tumut 3, but his career has mainly been in local government.

After 9 years at Sutherland Shire Council in Sydney Rod moved to Noosa in 1981 firstly as Deputy Shire Engineer and then for the past 17 years as Shire Engineer, now Director-Works.

In his 21 years with Noosa Shire Council Rod has been involved in the whole gamut of local government engineering including roads, water supply, sewerage, development, parks and beaches, etc.

Rod and his team at Noosa have been able to find solutions to many of the usual problems presented in delivery and maintenance of infrastructure in a rapidly growing area. They have also put in place innovative approaches in areas such as urban design and landscaping of public spaces, alternative delivery strategies for water and waste water treatment, etc. But solution to Noosa's beach erosion problem has been elusive, to say the least.

Postal Address: Rod Williams, Director-Works, Noosa Council, PO Box 141, Tewantin QLD 4565

E-mail: dw@noosa.qld.gov.au