

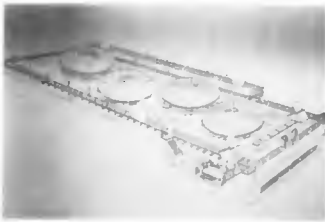
CHAPTER 216

DAY VISITOR PONTOON GREAT BARRIER REEF, AUSTRALIA

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1.0 ABSTRACT

This paper describes the structural and environmental aspects considered in the installation of a 45 metre x 16 metre steel pontoon equipped as a day visitor centre and installed at Wistari Reef, a southern section of the Great Barrier Reef, Australia.



In order to achieve environmental acceptability, any floating facility has to be structurally adequate and moored in such a way to withstand the most serious cyclonic weather without breaking free and damaging the reef.

The paper details the process of studying the reef environment, analyzing the structure, and obtaining the prerequisite approvals. It then discusses the actual installation of the pontoon and details ongoing monitoring requirements imposed by the Great Barrier Reef Marine Park Authority.

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2.0 INTRODUCTION

The Great Barrier Reef is a natural Coral Reef formation stretching from the northern tip of Eastern Australia parallel to the eastern coastline to its southern extremity near Bundaberg in Queensland, covering a distance of some 1850 km.

The reef is recognised as one of the wonders of the world, and is of major significance in both World Heritage terms and for its commercial value as a tourist destination.

It is protected by Federal and State Government legislation to ensure that any activity within its boundaries is environmentally acceptable.

Our client, P & O Resorts Pty Ltd, leases and operates a world famous Barrier Reef tourist resort at Heron Island on the Great Barrier Reef located some 88 km off the Queensland coast and almost on the Tropic of Capricorn.



The island is a renowned dive site to natural corals, has prolific bird life and is a major turtle nesting area.



P & O Resorts Pty Ltd purchased the nearly completed pontoon and thus commenced the task of modifying the pontoon for the exposed location proposed on the southern end of the Great Barrier Reef and obtaining the necessary statutory approvals for its installation.

As part of the statutory requirements a public environmental report was prepared and subjected to public scrutiny. The proposal was then modified to accommodate the requirements of the public and of the authorities and the pontoon was finally installed at the reef. The company agreed that it would obtain a Lloyd's classification on the reef pontoon and mooring system to satisfy the Marine Park Authorities requirements. In order to achieve this a full structural analysis of the pontoon, its mooring system and anchor components had to be completed and full detailed calculations submitted to Lloyd's register of shipping to obtain the necessary approvals. In addition many of the major components of the structure and in particular the mooring system including anchor chains, shackles and fasteners all had to be load tested and certified.

The Great Barrier Reef, and the pontoon installation, came ultimately under the control and standards of five bureaucracies and two permanent tenants on Heron Island. Finally the Lloyd's Register of Shipping certification had to be obtained for both the pontoon and its anchoring system.

It is fair to state that the frustrations, difficulties and, at times sheer pettiness and pedantic approach of some of these groups was certainly well beyond any expectations. By contrast some of the parties and bureaucrats were extremely helpful in the process.

3.0 ENVIRONMENTAL CONSIDERATIONS

Included in the environmental consideration of the site were:-

- (a) Existing Environment
 - . Physical
 - . Biological
 - . Socio Economic
- (b) Environmental Impacts
 - . During installation
 - . During operation
- (c) Control of Impacts
- (d) Monitoring of Impacts
- (e) Existing Environment

3.1 Existing Environment

The site initially chosen for the pontoon installation was on a reef shelf on the North Western end of Masthead Island and the Public Environment Report concentrated its attention to this preferred site. Seven alternatives were also considered in the P.E.R. and in the final result, it was not Masthead Island, but Wistari Reef, one of the seven alternatives for which approval was received.

Masthead Island is a typical tropical coral cay.

One of the major attractions of the Masthead site was the proximity of the island itself, affording visitors the opportunity to spend part of their day excursion on a typical tropical island paradise.

Regrettably, the approved site at Wistari reef does not have any island and guests are able to be taken ashore to reef walk only during low tides.

In the study of the existing environment, each of:

- . physical
 - . biological
 - . socio economics
- was addressed

Physical:-

The P.E.R. contained a complete description of the physical environment of Masthead.

The pontoon was to be moored in approximately 8 - 9m of water, with the underwater observatory looking onto a large (c. 4m diameter) living Porites coral bommie. This bommie, composed of two main colonies, rises to about 5m below the surface. Beyond this bommie the staghorn corals thin and the relatively flat substrate is covered by numerous small coral colonies dispersed in an otherwise sandy area.

In the original proposal, the human waste generated on the pontoon by 100 day visitors was to be treated in a twin three stage Microphor MC300 treatment system.

The effluent from the system is guaranteed within the following limits:-

- 100 guests per day maximum
- 4200 litres/day of diluted effluent
- 26 dumps each of 1.1 minutes each day
- 145 litres/minute dump
- less than 15mg/litre suspended solids
- better than 10mg/litre B.O.D
- Nitrate-Nitrogen 0.13mg/litre
- Soluble phosphates: Phosphate-phosphorus 2.14mg/litre
- Particulate phosphates: Phosphate-phosphorus 1.42mg/litre

The effluent standards were generally accepted as high, and quite suitable for the operation. The one reservation was that the treatment process did not remove nitrates and phosphates.

The presence of nitrates and phosphates in reef waters is undesirable as they can accumulate and act as nutrients for the growth of algae which in turn kills live coral. An extensive study was therefore undertaken to investigate the risk of such a nutrient build up.

Numerical simulations of hydrodynamic and advection/dispersion were completed to assess the potential contamination of reefs by sewerage effluent proposed to be discharged from the pontoon.

The models indicated that in one particular combination of spring tides and light onshore winds, retention of material around the reef chain was significant for several days.

In view of this perceived risk of nutrient accumulation during the combination of spring tides and light onshore winds, the decision was taken not to discharge the effluent into the sea but to take the treated effluent ashore for alternative disposal.

Other aspects of the physical environment impacts addressed included:-

- . Solid Waste Management
- . Disposal of shower water
- . Disposal of dish washing water
- . Disposal of deck washing
- . Fuel spill prevention
- . Disposal of food scraps
- . Effect of antifouling paint

Biological:-

The biological environment identified:-

- . terrestrial insects, birds and plants;
- . turtles;
- . sessile benthic (corals, algae and other);
- . fish.

Plants:

Plant species were predominantly *Pisonia* forest, fringed with *Casuarina* and *Pandanus* trees and grasses. A total of 41 plant species was identified.

Birds:

Masthead Island is a principal rookery for White-capped Noddies, a major rookery for the Wedge-tailed Shearwater, Silver Gulls, Crested Terns and Bridled Terns, and additionally supports colonies of Reef Heron, Roseate Tern, Black-naped Tern, Lesser-crested Tern, Sooty Oyster-catchers and Ospreys (Environment Science and Services, 1984).

Turtles:

The World Conference on Sea Turtle Conservation, held in Washington D.C., U.S.A. in November 1979 identified the Capricorn-Bunker Group as being of world significance for sea turtle conservation, being one of the eleven most important green turtle breeding areas and one of the worlds three major loggerhead turtle breeding areas. Masthead Reef, like other reefs in the region, supports resident populations of immature and adult green, loggerhead and hawksbill turtles throughout the year.

Coral:

A coral comparison for some of the alternate sites investigated shows the following results:-

Reef	Algae	Diversity	Size	Aesthetics
Erskine	1.38	1.88	1.38	2.13
Heron	0.63	2.17	1.80	2.74
Masthead	1.17	2.46	2.00	3.00
Polmaise	3.25	1.88	1.38	2.75
Wilson Is.	0.70	2.50	2.10	3.70
Wistari	0.59	2.55	1.90	2.79

Values given are means for the cover of each category where cover is marked on a scale 0 (0%) to 6 (76%-100%).

It can be seen from the table that the site finally chosen - Wistari Reef - was inferior in coral in all categories except diversity to the preferred site at Masthead.

This aspect was regarded as unfortunate, given that the prime attraction for visitors to a coral reef is the coral itself.

The figures, however do refer to average coral over the reef area, and the local site finally selected at Wistari Reef contains very attractive and impressive coral colonies and is not regarded as locally inferior to the local coral at the preferred Masthead site.

In order to minimize impact of the pontoon and its anchorage system on the coral, yet place the pontoon as close as possible to attractive coral colonies for viewing both by snorkeling and from the underwater observatory, a detailed site search was carried out in company with a marine biologist. The search was done from helicopter boats and finally in the water using scuba and snorkeling equipment. Once the actual site was selected, the pontoon shadow was pegged on the sea bed, as was the actual position of each anchor and anchor chain.

A detailed coral and fish survey of the site was completed.



General Comments on Fishes

Fish communities observed over the duration of the survey (12 - 14 December 1988), appeared typical of similar reefs in terms of species, composition, and numbers of individuals, with respect to the two principle habitat types encountered. Associated with the major inshore bommies, staghorn thickets and to a lesser extent the scattered hard coral patches, there was a much more diverse assemblage of fishes. Families Apogonidae, Chaetodontidae (eg. Cheetodon spp.), Haemulidae (Plectorinchus sp.), Labridae (eg. Thalassoma spp.) Pomacentridae and, Serranidae (eg. Epinephelus spp., Plectropomus maculatus) were visually dominant.

Dolphins, green turtles and game fish (probably long-tail tuna, Thunnus tongol) were seen from the dive boat when on station over the survey site.

Socio Economic

The examination of socio economic effects considered:-

- . existing private use of the area;
- . existing commercial tourist oriented use;
- . tourist impact on the local community in Gladstone, the adjacent mainland city;
- . impact on the central Queensland tourist trade.

The studies concluded that the facility would provide a positive socio economic effect on the area; that it would not intrude unduly on the existing private use and that the extensive international advertising, conducted by a major tour operator (P&O) would bring more positive impact to the only existing operator that the negative effect resulting from increased competition.

3.2 Environmental Impacts

Environmental impacts were divided into two categories:-

- . impacts during installation; and
- . impacts during operation.

Impacts during installation included:-

- . Towing to site and associated risks;
- . Accidental grounding of pontoon or tug;
- . Disturbance of Benthos and Substratum;
- . Disturbance to Marine Life.

To minimize accidents in the towing and installation phase, the operation was planned to occur, and did in fact occur, during very calm clear weather. Visibility both above and below water was excellent.

Some coral transplanting occurred before the anchors were laid to ensure minimum disturbance to coral by either physical damage or as a result of shading from the pontoon. All coral transplanting was done by qualified marine biologists under the direct supervision of an officer of the National Parks and Wildlife Service.

Impacts during operation included:-

- . Shading of coral;
- . Damage from mooring chain movement;
- . Damage from snorkeling, coral viewing, reef walking;
- . Collecting;
- . Disposal of wash water;
- . Effects of fish feeding.

Impacts during operation have been minimized by a number of operational procedures, limitations imposed both by the operator and the authorities and general care and attention to detail.

For example:-

- . sewerage effluent and all solid waste is taken ashore for disposal;
- . all coral in shade footprint has been transplanted;
- . coral in the anchor and anchor chain corridors have been transplanted;
- . an extensive educational program, and trained guides and observers ensure snorkeling, coral viewing and reef walking are confined to specific areas and paths, collecting is prohibited etc;
- . environmentally unacceptable antifouling paint is not used;
- . fish feeding occurs by releasing the food well below surface level to prevent the attraction of seagulls.
- . the pontoon is moved to a cyclone mooring whenever a cyclone alert reaches predetermined levels;
- . procedures and precautions are in hand for accidents such as fuel spills, equipment failure, fire, collision, explosion, weather, etc.

For cyclonic waves, Design Wave Characteristics for Tropical Cyclones in the Australian Region by R L Nelson was the text. Analysis based on these texts, and cross checked against hindcasting by Gourlay/McMonagle led to design criteria of:-

	<u>Non Cyclonic</u>	<u>Cyclonic</u>
Wind Speed	75 knots	110 knots
Wave Height	7.3 metres	9.0 metres
Wave Period	11.1 seconds	12.5 seconds

All forces have been applied in three directions viz:-

- (a) Abeam;
- (b) Fore and Aft; and
- (c) Shoulders/Quarters.

The hull structure has been analyzed in two wave support conditions viz:-

- (a) spanning between wave crests at extreme ends; and
- (b) straddling a single central wave crest and unsupported each end.

Early analysis of the pontoon and mooring system showed that the hull and mooring system were competent to withstand all applied force combinations except that of a wave breaking on the beam. The forces from a breaking wave or cyclonic winds on parts of the superstructure elements would certainly be destructive. The mooring system is such as to restrain the pontoon on all four corners.



To take best advantage of the coral and local currents for boat activities, the pontoon is moored with its long axis NE - SW and its short axis SE - NW. This places the major beam directly into the NW, the direction from which maximum waves are generated. In all other directions, the site is protected by reefs and islands.

On the Wistari Reef site, it therefore became necessary to install a cyclone mooring in adjacent deep water outside the breaking wave zone in the wave climate profile anticipated, and to plan to move the weather conditions in the region are predicted to exceed preset values. These predictions are provided by the Australian Bureau of Meteorology Cyclone Strike Probability Service, in the form of a percentage probability that wind speeds will exceed preset values within the coming 36 hours.

This service commences at a time when the probability of winds in excess of a predetermined velocity at the site within 36 hours is 1%. The three hourly updates then continue until the probability no longer exists.

If...

- . the probability of winds exceeding 50 knots exceeds 70%,
 - . the cyclone path is adverse, and
 - . the maximum wind speed in the cyclone exceeds 70 knots,
- the TOW decision is taken.

5.0 INSTALLATION

In preparation for the installation of the pontoon the immediate footprint of the pontoon together with a strip 4 metres wide around each side of the pontoon, the position of the anchors, the alignment of the anchor chains together with a strip 2 metres each side of the anchor chains, were all cleared of live coral by transplantation. Much of the coral transplanted was able to be moved by hand by the marine biologists working with scuba gear. For the larger pieces, airbags were used as lifting devices and large coral sections were gently prized away from the surrounding sand bed, lifted by airbag and shifted from the anchoring position to a temporary site some distance away. After the installation these large coral pieces were returned to the south east corner of the pontoon where they added to the existing coral to form an enhanced coral garden immediately visible to the underwater observatory.

The need for careful planning, attention to the detail of how the pontoon was to be received, taken over from the tug, attached to the anchors and finally secured in position, and the need for skilled seamanship to prevent grounding of the tug and/or the pontoon were all prerequisites.

By the afternoon of Easter Saturday 1989 the pontoon was secured in its final operation position and preparation began to make it ready to receive its first visitors. Some time later the cyclone anchorage was installed using similar techniques so as to avoid damage to any of the adjacent coral.

After all systems had been checked the first paying guests arrived at the pontoon on the high speed passenger catamaran Reef Adventure II on the 30th of April 1989. Since then the pontoon has been operating successfully as a commercial venture and a large number of day visitors has had the opportunity to enjoy the beauty of Australia's Great Barrier Reef.

6.0 INSERVICE MONITORING

As part of the approval process a condition imposed on the installation of the pontoon by the Great Barrier Reef Marine Park Authority following the completion of the preliminary site selection and site environmental study, was that a baseline study be established at the site and that an ongoing environmental monitoring programme be introduced in order to assess, over time, the effect which the pontoon had on the environment. The baseline study conducted by approved marine biologists was such as to produce a complete coral map of the area and a complete fish survey of the area.



In addition two remote sites were selected as control sites to monitor variations which were independent of the pontoon itself. These two sites were located, permanently marked, and were also accurately mapped for both coral and fish populations.

As part of the baseline study each outcrop of coral was tagged and catalogued. Additionally each outcrop was photographed to show its position relative to the pontoon and anchor lines and as a series of closeups using a one metre square grid to provide a scale. The grid was fitted with a photographic standard colour spectrum enabling accurate colour correction.

A balanced three factor analysis of variance performed on the resulting data for total percentage cover indicated that:-

1. there was no significant difference between the pontoon and control sites;
2. there was a significant difference between zones (footprint, north anchor line, east anchor line, etc.);
3. there was a significant difference between strata; and
4. samples within strata were not significantly different.

An Anova table was generated. Cochran's homogeneity of variance test was applied prior to analysis of variance: data was analysed untransformed.

Data pertaining to percent cover by species was collated in readiness for similar analyses based on sampling over time. This will provide an indicator of change-over-time in community structure.

At the time of preparation of this paper one subsequent site study has been completed and the data obtained from this study has been compared against the baseline data. To date no significant variation from the baseline state has been determined and no remedial works or procedures have been found to be necessary. Already some of the acropora which had suffered minor damage is showing remarkably good recovery and regrowth.

So the final word is the area is alive and well, and the facility and Heron Island well worth a visit.



APPENDIX - BIBLIOGRAPHY

Some 31 references were used in the environmental studies alone. Many of these were papers reporting specific environmental studies of particular elements of the ecosystem. Additional references for the mooring and structural analyses were:-

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