

**GOLD COAST CITY COUNCIL**  
**BEACH REPLENISHMENT PROGRAM**  
**REPORT NO. 1**  
**BEACH INVESTIGATION PROGRAM - 1973**

SUMMARY

This report sets out the various activities being carried out by Council to accumulate information essential for the understanding of beach phenomena and provide guidelines for the selection of replenishment material.

In addition investigations into littoral drift behaviour are included to help to determine the necessity or otherwise of massive maintenance pumping of the replenished beaches.

1. INTRODUCTION

Council's Beach Replenishment program is based on the recommendations of the Delft report and the major work proposed in this program currently consists of pumping some 2.7 million cubic metres of sand onto Kirra, Palm Beach and Surfers Paradise Beaches. A critical part of the program at this stage however is the investigation work now being carried out to assess the suitability of the available sand resources for replenishment purposes together with other related aspects of beach behaviour. The consequences of placing unsuitable sand upon the Coast Beaches is too obvious to labour but there are other factors which might have a profound effect upon the beaches that are largely unresolved or only partly explored. The Delft report recognized this and states as follows:-

"The investigations already carried out by the Co-ordinator General's Department in accordance with the recommendations of the delft Hydraulics Laboratory serve as a sound base for a comprehensive study of coastal engineering problems in the area, as mentioned in section 1.1. This study includes the evaluation of the results of the investigations and the collection of other relevant information. In this way sufficient data has been obtained to deal in a practical way with the problems which have arisen on the Gold Coast. But this does not mean that all field investigations and studies of the behaviour of the coast under the eroding and accreting forces of nature should stop. With great emphasis it is stated that a continuation of the investigations is not only advisable but is a condition for the feasibility of present and future engineering projects along the Gold Coast as well as at other parts of the coast of Queensland. Besides, continuation of the present investigation and studies is the only way to increase knowledge about the behaviour of the coast and to check the long-term effects of the works and measure proposed."

This report sets out the various activities being carried out by Council to continue and extend the work of the Delft Report.

2. BASIC ROUTINE BEACH SURVEYS

This work consists of an extension of the basic measurement of standard cross sections of the beach commenced by the Co-ordinator General's Department for the Delft Report, Council's approach has been to re-survey a limited number of Eta lines (usually eight) on a monthly basis rather than survey a greater number of lines at wider time intervals. These surveys monitor the behaviour of the beach out to a depth of 25 metres of water by detecting the changes of shore profile. Unfortunately this type of program must continue for a considerable period before enough information is collected to provide a reliable basis for littoral drift calculations but Mr. B Thom of A.N.U. has requested copies of each survey for his basic work on littoral drift studies. In the short term the basic profile surveys will also provide essential information on natural beach shapes for comparison with the behaviour of artificially nourished beaches. As soon as any areas of beach are replenished then it will be necessary to extend this program to monitor the behaviour of the replenished beaches in greater detail.

### 3. GROUYNE SURVEYS

As each groyne or coastal structure is constructed the sea-bed profiles before work commences, during constructions and after completion are monitored by regular surveys, generally on a fortnightly or monthly basis. Most of these coastal structures exert a profound influence on local wave, sea-bed and littoral drift processes so it is essential to measure their actual behaviour. This survey information has many uses. It allows for calculating the littoral drift in the area of the structure, it provides invaluable information for predicting and checking the behaviour of further projected structures and accumulates basic data of actual structure behaviour to be compared with existing theoretical design bases.

### 4. HYDROGRAPHIC SURVEY METHODS

This survey work is carried out by an Engineering Surveyor and a crew of three to five chainmen and a charter vessel equipped with an echo sounder and at least two radio communication procedures using a level and a survey staff and the chainmen swim out through the surf to a water depth of 4 to 5 metres where the survey boat backs towards the beach and picks up the chainmen and staff and continues the traverse into deeper water using the echo sounder. A systematic analysis of existing results has suggested that the equipment and procedures are not yet sufficiently accurate for proper littoral drift calculations so an experimental development program has been commenced using sea-bed markers and it is already believed that this program will provide the desired improvement. Six staff members working on the investigation program are now experienced scuba divers, this number being about the minimum to allow the work to proceed.

### 5. STREAM GAUGING

For the design of structures at or near creek mouths such as Tallebudgera and Currumbin it is necessary to measure the stream flow velocities, cross sections and the tidal compartment. Both the Creeks mentioned have already been gauged, Council's Hydrographic Party has gauged Tallebudgera Creek over a full 27 hour period to measure two full tides (on the Coast one tide is larger than the other) and temporary tubular steel structures were jetted into the other) and temporary tubular steel structures were jetted into the creek bed to provide the gauging points. Each station was measured with a flow meter each hour and this information has been sent to Mr D Foster of water research Laboratory, Manly-vale, who is constructing a hydraulic model of various alignments for the Tallebudgera Creek groyne. This gauging exercise also provided some rather surprising differences in water level in the creek and the sea outside that will now form part of all future flood mitigation studies in the City. This work will in due course now be extended to the Nerang River where flooding is a very important matter.

The second stream gauging was carried out in assistance from Council's Hydrographic Party from the old Railway Bridge. This survey extended throughout only one tidal cycle of 13 hours and has served the dual purpose of providing data for Mr Haydock's thesis program and at the same time Council's flood mitigation data. However the results of this gauging have suggested that more work is required at the creek outlet, particularly to assess the behaviour of the proposed new outlet that is to be dredged after Currumbin Groyne is complete.

### 6. SEISMIC SURVEYS

The initial offshore drilling program has detected offshore sea-bed structures that are a cause for considerable concern. Off Kirra and Tugun deposits of peat have been found at depths as close as six metres below the sea-bed. Off Palm Beach and Mermaid Beach reef structures have also been detected below shallow covers of sand. These structures may severely restrict the volume of offshore sand available. So it is essential to determine the extent of these sea-bed discontinuities. Council's Hydrographic Party have already carried out underwater surveys using a jet probe from the survey vessel but this work is extremely slow and hard physical work operating on the sea bed in 15 to 20 metres of water. It is also somewhat dangerous being in the de-compression work zone. Accordingly arrangements have been made with Prof. Sargent of Queensland University for Mr A Haydock and Council's Hydrographic Party to use the University "pinger" and "boomer" seismic survey equipment to survey the sub-surface sea-bed. It is hoped that this survey will elucidate many of the unknown sea-bed conditions.

It is intended to commence with Kirra and extend the work to Palm Beach and Surfers Paradise. Again the information gained from the surveys will provide invaluable data both for Council's offshore dredging program and Mr Haydock's Geological thesis. If more unexpected structures or sea-bed discontinuities are located it may still be necessary to drill such areas to find out what they are made of.

## 7. SAND RESOURCES SAMPLING PROGRAM

The Delft Report went to the stage of recommending that the gold Coast Beaches should be replenished with sand but did not set out any specific details of what sand resources were available or what sand properties would make for a suitable replenishment material. To update the Delft data therefore Council instituted a drilling program to sample the principal sand resources these being the Broadwater and the offshore sea bed beyond 10 metres depth of water. Council therefore instituted a drilling program using an aluminium shallow draft barge for the Broadwater and an ex-Army D.U.K.W. for drilling offshore, both arranged by contract with the Southport firm of "Offshore Drillers P.L." In all some eight offshore profiles were drilled thus recovering some 325 original in-situ sea-bed sand samples together with six profiles in the Broadwater recovering some 88 sand-bank samples. A small sub-program was also carried out in the entrance of Tallebudgera Creek with a drilling rig and another in Currumbin Creek using the Hydrographic Survey Party divers taking surface samples of the Creek bed and suction samples recovered to depths of up to two metres below the creek bed.

The Delft Report contained data for the offshore sea bed based on something of the order of 2,000 samples but the samples were recovered from only the top 30mm of the sea bed. While these samples determined some of the properties of the sea-bed sand moved on the sea bed surface by the larger waves and material deposited in this zone by sand taken into suspension during cyclonic conditions and subsequently deposited during calmer weather this information could hardly be applied to assessing the real sea bed resources available. In general therefore council's drilling program recovered a continuous sample to a depth of 4½ metres below the sea-bed. This depth of recovery was expected to encompass the maximum depths of cut likely to be acceptable for a single cut dredging operation. This drilling program (as previously indicated) has demonstrated sub sea-flow discontinuities in the form of peat deposits and submerged reefs that have raised considerable concern as to the apparently strictly limited resources that may actually be available, both offshore and in the coastal estuaries. Indeed proper conservation of the available sand resources will become a matter of almost national interest in the near future.

The samples recovered to date by Council have generated a completely unexpected outside interest. Three university research groups have requested either the use of the samples or the data derived from testing the samples. The Federal Bureau of Mineral Resources has also requested a section of the samples for its offshore mineral resources investigation. The material investigation program being carried out on the samples is set out below but the extent of the variation in the offshore seabed conditions in particular leads to the inevitable conclusion that before any offshore replenishment contract could be finalised then additional offshore drilling should be carried out to provide enough data to ensure a reasonably accurate survey of the actual existing offshore sea-bed conditions and resources. Similarly some further drilling would be required for the Tweed river (where no drilling at all has been undertaken) and in Currumbin Creek (where only near sea-bed surface samples have been recovered) if Tenders for the dredging of these areas are to be accepted. It must be an engineering truism that it could well be folly to enter into any type of beach nourishment contract unless it can be shown that adequate amounts of replenishment material are actually available and that the material is likely to be suitable for the purpose in any case. Only by adequate sampling can these essential criteria be determined.

## 8. AERIAL PHOTOGRAPHS

Even the highest grade hydrographic survey available can only measure or detect sub-surface bed conditions at particular points or lines measured from the shore. These procedures pick only particular areas and the broad picture of beach processes may elude even a close network of survey traverses. There are however two other detection methods that have proven of significant value. These are coloured aerial photography and side-scan sonar. Side-scan sonar provides a graphic display of the sea-bed just as if the water were completely removed but the equipment is extremely expensive, highly repetitive survey runs are required and at this stage the use of this equipment is well beyond Council's financial resources. However aerial photography is relatively inexpensive and under the right sea and visibility conditions highly valuable data may be obtained. The movement of sand around estuaries and coastal structures in a qualitative sense can be much more economically recorded by aerial photographs than by any other agency. In addition photographs are the only known method available at present for detecting sand by-passing patterns around headlands, groynes and river training walls. It has also been found that aerial photographs in calm weather are capable of detecting a great deal of detail of offshore exposed sea-bed reefs and indeed one photo-sortie has already produced satisfactory details of reef structures in depths of water well exceeding 15 metres. This class of information saves a great deal of

tedious detailed hydrographic survey and at a fraction of the cost. Normally aerial photograph sorties have been flown on an approximately monthly basis or after significant changes in beach behaviour, either accreting or eroding phenomena.

#### 9. BEACH SAND SAMPLING PROGRAM

since it is not possible to assess the suitability of replenishment sand resources for beach nourishment purposes without determining the properties of the material existing naturally on current beaches for comparison, it has been necessary to instigate a suitable survey of this sand. Unfortunately the sand existing on current beaches demonstrates a high degree of variation depending on sea and wind conditions so an extended program of sampling is required to detect and assess this variation. It seems already that at least a full years sampling may be necessary to measure a full spectrum of seasonal variation. For economy beach sand extending out into the deepest workable surf is sampled only on each of the standard Eta line survey traverses generally monthly. In addition sand samples are also taken of the material filling each groyne as it is constructed since it appears that there is some unknown natural selection of the gradings of the material deposited in front of or behind these structures.

These beach sand samples are tested only for sieve grading but the preliminary analyses of the overall beach sands suggest that they tend to be finer than the Broadwater deposits but coarser than the overall offshore sand deposits although the reason for this indication has not yet been resolved. This matter is however being explored with considerable urgency since it may well effect the whole beach replenishment program.

#### 10. SAND RESOURCES SUITABILITY PROGRAM

All samples recovered from the Broadwater and offshore sand resource areas have now been sieved in the Laboratory to determine contents. The results of these laboratory analyses are now being plotted and analysed for comparison with the samples recovered off the existing beaches. This work in particular should provide the crucial information in assessing the suitability of the offshore resources for replenishment purposes. It is also expected that the proportion of silts, oozes and clays will provide information for estimating the degree of contamination that these materials will cause in the surf-zone if all the material is pumped directly onto the beaches. Naturally a heavy contamination of the surf will have a very poor public relations influence and will not be popular while the work is in progress. As an offshoot of this a preliminary investigation into methods of washing the sand before deposition on the beaches has been carried out and this appears to be a viable economic procedure.

#### 11. LITTORAL DRIFT INVESTIGATIONS

In the Delft Report calculations were made of the nett littoral drift along the gold Coast beaches together with the drift capacities of each section of the beach and a calculated nett annual loss of sand. From this the Delft Report calculated an amount of maintenance pumping that would be required to maintain the replenishment sand on the beaches. The cost of maintenance pumping would provide a continuing financial burden on the Council and at the moment the calculated volumes require and nominated in the scheme for ECD.11. are still based on approximate estimates made in 1969. Already the offshore drilling program has indicated that the reservoir of sand offshore at Kirra mentioned in the Delft Report does not exist and the sea-bed there – certainly in places – is underlain at comparatively shallow depths by peat. In addition therefore to the financial incentive to provide an updated estimate of probable maintenance pumping there is now a necessity to find out why the littoral drift is different to that expected and what effects these differences may have on the replenished beaches.

With the current state of the art all littoral drift calculations have to use extrapolated constants and approximations have to be used for various parameters such as ripple height, angle of wave attack and wave heights and periods. A considerable amount of discussion on this problem has been held with many eminent Coast behaviour experts in particular with Dr Silvester, Prof. Kamphuis, B N Thom and D M Foster amongst others. It is now clear that advances in coastal engineering made over the last few years will now enable some physical data to be collected that should allow for a re-assessment of littoral drift matters. Council is currently attacking the problem in several ways. Material collected by groynes is being surveyed and the volumes calculated to measure the rate of depositions. The movement of sea-bed sand is being traced by florescent tracers, this work having been initiated by Mr Haydock of Queensland University and agreement has been reached with Dept. of Harbours and Marine to consider more work offshore. At the recent Coastal engineering conference it was learnt of an American sea-bed drifter (a kind of weighted plastic umbrella) that is also a powerful tool to measure water drifts. It is hoped to initiate a pilot program using these drifters shortly. In the onshore and surf zones another program

continues with the use of Rhodamine dye to measure littoral currents and local water circulations. Additional data will also be collected by survey methods using sea-bed markers.

This littoral drift program can be carried out most inexpensively but it must extend for a significant period of time before the seasonal and overall nett effects can be assessed. It should be a matter of grave concern that no work at all along these lines was carried out on the Gold Coast between the compilation of the Delft Report and this year.

## 12. DETERMINATION OF ACTIVE ZONE

The determination of the extent seawards of the sea-bed active zone is of considerable economic consequence. Clearly any offshore material must be taken from beyond this zone but at the same time it is impossible to dredge below a comparatively shallow depth, currently of the order of 30 metres. This leaves only a narrow strip of sea-bed available as a replenishment source and greater pumping distances in any case call for a greater cost. A graphical model for the calculation of the distance to which the active zone extends offshore has been developed in the design Office but much work remains to be done to refine and calibrate this model. However it is anticipated that the offshore sand sample investigation will also provide valuable evidence and allow for a rational determination of the outer limits of the active zone.

## 13. OFFSHORE SAND SAMPLE INVESTIGATIONS

In a geological sense any marine sediment must contain within itself some evidence to show what forces have acted upon it since its depositions and probably how it was deposited in the first place. To this end a geological investigation of the actual sand samples is also being carried out. The investigation consists of chemical analysis for organic carbon (oozes) inorganic carbon (shell content), mineral determinations, shape factors, colour and microscopic examination. The principal aim of the investigation is detecting the shape and limits of the active zone through systematic variation in the properties being examined. Already significant trends in grain size, colour, ooze content and Echinoid carbonate distributions are leading towards suitable evidence. The tests fortunately are quite simple but the interpretation of the evidence is expected to be more difficult.

The collection of these sea-bed samples has generated a great deal of interest from other organisations. Bruce Thom of ANU has taken two peat and one shell sample for radio-carbon dating to determine the age of these deposits, this providing extra data to his geomorphology research. Mr Haydock of Queensland University is also studying some of the samples and both researchers are looking for seeds, pollen and fibrous peat suitable for identification of the source vegetable matter. The Federal Bureau of Mineralogy have asked that samples or mineral determination data be kept for their use and Dr Swann of the University of New England at Armidale has requested copies of all sieve grading data for part of his research program.

## 14. ACKNOWLEDGEMENTS

In any investigation many others than those actually involved in the work make significant contributions to the project. Council has been fortunate to have had the assistance, criticism and advice of many people generally quite for gratis or in exchange for data and samples collected by Council some of the major assistance has been provided by

(a) University of Queensland

Prof. Sargent – for discussions and the loan of “pinger” and “boomer” equipment.

A Haydock – for geological interpretations, operation of sonic equipment, techniques for sand tracer tests.

(b) Australian National University

B Thom – for carbon dating, geomorphological advice, testing procedures, tracer procedures.

(c) University of Western Australia

Dr R Silvester – for discussion on littoral drift.

- (d) University of NSW Water Research Laboratory  
D Foster – for discussions on littoral drift, testing procedures and loan of flow-meter.
- (e) Mineral Deposits Ltd  
Managing Director and staff – for critical appraisal of overall program, testing procedures, sample testing and loan and use of equipment.
- (f) Queens University of Kingston  
Professor J W Kamphuis – for valuable advice on determination of Littoral Drift.

## 15. CONCLUSION

Few engineering projects of the magnitude envisaged for the gold Coast Beach Replenishment would ever be launched in the face of the paucity of basic information as was available in late 1972. This investigation program was therefore instituted to attempt to gain this information and the work is being pushed at the fastest rate possible to not only make up for the lack of continuity subsequent to the Delft Report but also to complete the main conclusions before the main replenishment contract are let.

It could reasonably be stated that until the program begins to produce conclusions we really have little knowledge of either the materials we are dealing with or the forces and environment that the materials will be exposed to. There is no apparent precedent available which details the type of work envisaged in the replenishment program so the risks of a failure are there greater where knowledge is most sparse. As each sector of the program is completed it will be covered by subsequent reports.

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