The document that follows on subsequent pages is derived from a copy of the Original 'Bates Report' requested in March 2000. In a covering letter, Anthony Bates, the reports author states that…

*The only change that I might make today is to revise the design of the gabion work slightly to provide long-term flexibility in the form of a falling toe.*

*I recommended the use of dredged sand to backfill raising levels behind the training walls but this is not very clear on the cross section shown in Figure 1. This is because the levels of the natural bed profiles were assumed and the scale as drawn is very small.*

# HAYLE HARBOUR STUDY

MARCH 1978

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# HAYLE HARBOUR STUDY

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## AN ASSESSMENT OF PROBABLE CAUSES OF SILTATION AND POSSIBLE REMEDIES

### INTRODUCTION

At the risk of stating the obvious, it should be pointed out that the hydraulics of the Estuary is complex and an accurate analysis would require a more detailed study than time has allowed here. In consequence, general assumptions, based upon the author's observations and experience have been necessary. Whilst these assumptions are believed to be valid, they lack scientific confirmation.

The object of this report is to study one specific problem, namely the reducing water depth at the harbour entrance. In the long term a much broader study of the entire tidal system and its potential benefit to the community is indicated. The tidal lakes and industrial relics which currently tend to spoil the area's aesthetic appeal, could, with sympathetic treatment, become a significant recreational asset.

## THE PROBLEM

Sea bed levels in the channel downstream of the Cockle Bank are rising, making navigation difficult, except on the higher tides, or for vessels of exceptionally shallow draft.

Why is this happening?

The natural action of wind and tide strives to close the entrance. It is only prevented from doing so by the outfall of the River Hayle and various minor watercourses which drain into the Estuary.

Historically, the depth and course of the river's final flow into the sea has been influenced by the effort of local industry. By means of training walls and the release of impounded water on falling tides, the constantly encroaching sand was scoured away and the channel maintained. The magnitude of the problem is illustrated by the proliferation of impounding areas and sluices built, at considerable cost, solely to keep the channel open. Despite these measures, it appears from various accounts that the physical removal of sand by excavation was at times necessary.

Without human intervention, the river, tide and wind will continue their struggle until a state of equilibrium is reached. When and what that will be we can not say, but it certainly has not been reached yet.

When a bar forms across a river's outfall to the sea, the river seeks and alternative route. This is demonstrated at Hayle by the erosion of the shoreline on both flanks of the Harbour entrance.

In scientific terms, with the rising bed levels, the cross sectional area at the harbour entrance through which the Estuary must fill and drain, is reduced. As the time available for a given volume of water to pass is fixed, the mean velocity must increase. In a deeper channel of V shaped cross section velocities on the extreme flanks tend to be less than the mean.

As the centre channel fills tending towards a more rectangular section of reduced area, the mean velocity will increase, but in all probability, flank velocities will show a proportionally greater increase with a greater likelihood of scour occurring. Material scoured from the flanks will migrate towards the channel centre causing a further deterioration.

## POSSIBLE REMEDIES

The prime objective must be to concentrate the tidal flow into a relatively narrow width of channel, thereby increasing mid-stream velocities to encourage a self-scouring action and at the same time protecting the flanks.

Fig. 1. shows an idealised cross section which would achieve the above objective.

Depending upon the relative strengths of flood and ebb tides, sluicing may be necessary to ensure that the migration of scoured sand is ultimately in a seaward direction.

Sand being a highly mobile, free material, even if the ideal section advocated was formed by dredging, it would soon revert to a natural section, unless prevented from doing so. To maintain the section, some form of training walls would be required. These could be formed in brushwood, timber, loose stone or rubble, or with stone filled gabions.

Economics would dictate the final choice, but one important criteria must be satisfied, that of flexibility. Any material placed must be capable of adjusting to any reduction in bed levels.

All systems would involve tidal work and with the exception of the loose stone or rubble, would be labour intensive.

Figs. 2, 3 & 4 illustrate the options.

## IS DREDGING OR EXCAVATION REQUIRED?

Ideally, upon completion of the training banks, the channel would be dredged and the material removed discharged to restore beach levels behind the training banks. There is not sufficient information available to make an accurate estimate of the quantities involved, but assuming about 27,000 M3, a small Cutter Suction Dredger would be suitable for the work, although working would have to stop if significant winds from the northern sector occurred. Cost might be about £39,000.

It has been suggested that any dredging undertaken might be financed, or at least subsidised, by the sale of the sand. It is preferable, however, that the sand removed from the channel be utilised to raise adjacent beach levels.
This is not to say that an excess of sand could not be dredged and stockpiled for ultimate sale.

It is possible that dredging can be avoided.

Upon completion of training bank construction, a programme of sluicing accompanied by regular observation and measurement in the channel would soon indicate the likelihood of restoring the channel by this means alone.

It is possible that the construction of the more extensive training banks suggested would result in the channel being self cleansing under tidal action alone. There is not sufficient data to make any reliable prediction.

## SHOULD LONG TERM DREDGING BE PERMITTED?

Providing that dredging is not excessive, (say a maximum of 500 tons per week), that it is confined to the main channel and care is taken not to undermine the training banks, it unlikely that any harm will be done. Properly controlled, it may be beneficial.

## OTHER OPTIONS

It is possible, though doubtful, that sluicing alone could restore the channel. To be effective in the current situation, impounded water would need to be released on two tides a day, about 1½ hours before low water on Spring Tides. Removal of the sill from Carnsew Reservoir would improve the chances of success.

The maximum amount of water should be discharged in the shortest possible time with the aim of draining out most of the reservoir capacity by low water plus one hour. There is a danger that the flow will be deflected by the bar on the North East flank towards the South West shore, causing accelerated erosion to both flanks.

The use of motor scrapers has been suggested. If they can be used to form a channel of the section and alignment shown, there can be no objection to their use. If, however, they remove sand from the high drying areas on the flanks, they will do only harm, causing further erosion, for the reasons described earlier.

## CONCLUSIONS

It is possible that the situation has deteriorated too far to allow the channel to be restored by sluicing alone. Perhaps it is worth trying, but careful observation of the effects would be prudent.

Training walls provide a solution which appears to have a reasonable chance of long term success, both in maintaining the channel and combating erosion.

The author spent one wet and windy day on site when tides were not ideal. If training banks are to be constructed, further observations to determine the most satisfactory configuration are desirable. Rubble from the Power Station demolition could be used. Efforts should be made to stabilise the sand dunes (Towans) by re-planting suitable grasses and restricting public access. Temporary timber slatted wind breaks may assist during the initial stabilisation.

Current dredging should be controlled, perhaps stopped, until training banks are completed. If allowed to continue, least harm will be done if dredging is confined to mid-stream off the point of the long bank which divides East and West channels.

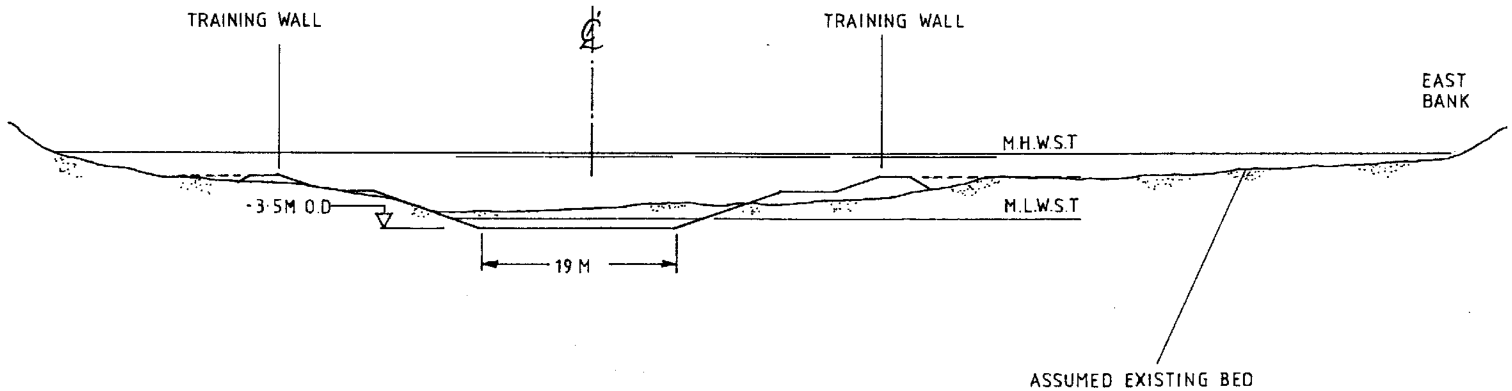
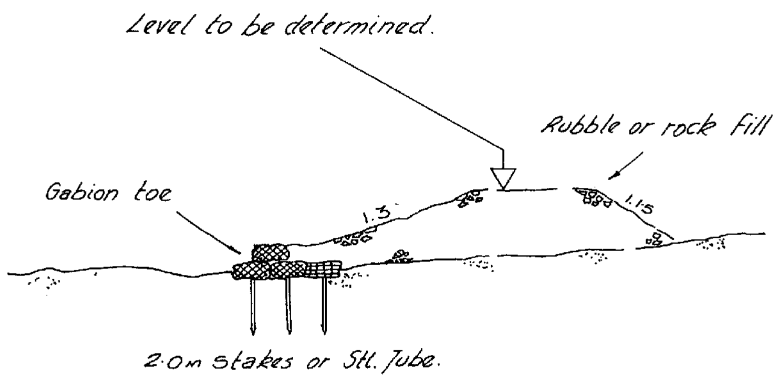



FIG.1 PROPOSED SECTION
Scale 1.500

TRAINING WALL
Rubble fill with Gabion toe



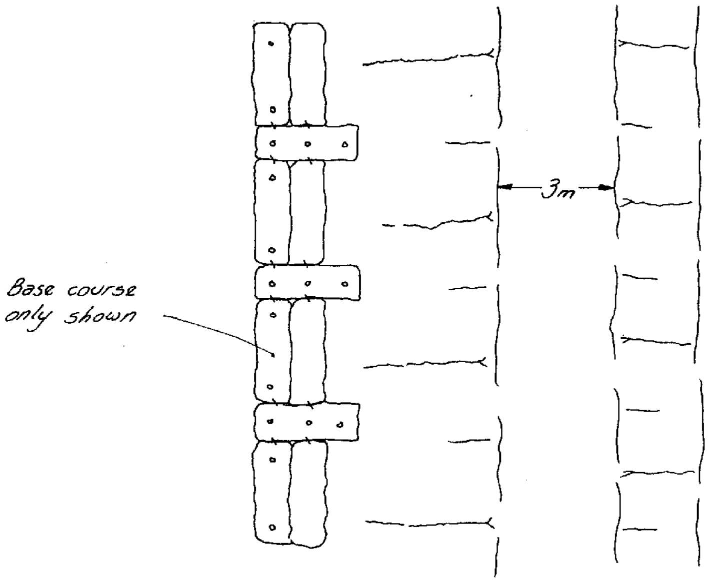
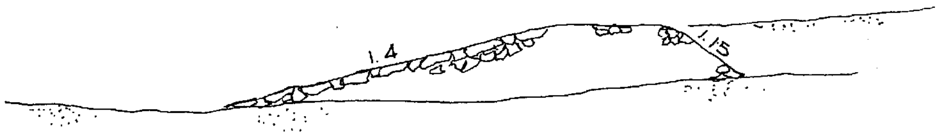
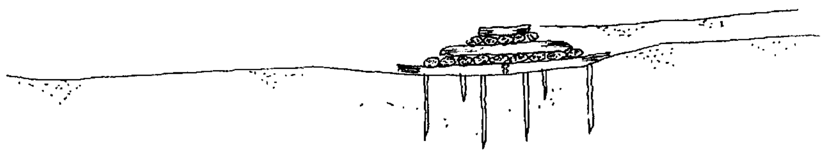




FIG.2
Scale 1.150

## TRAINING WALL OPTIONS




Rock or Rubble only.



Staked Faggots

NOTE. A variety of GABION layouts are possible.
Final choice would depend upon height, etc.

FIG. 3

N.T.S.

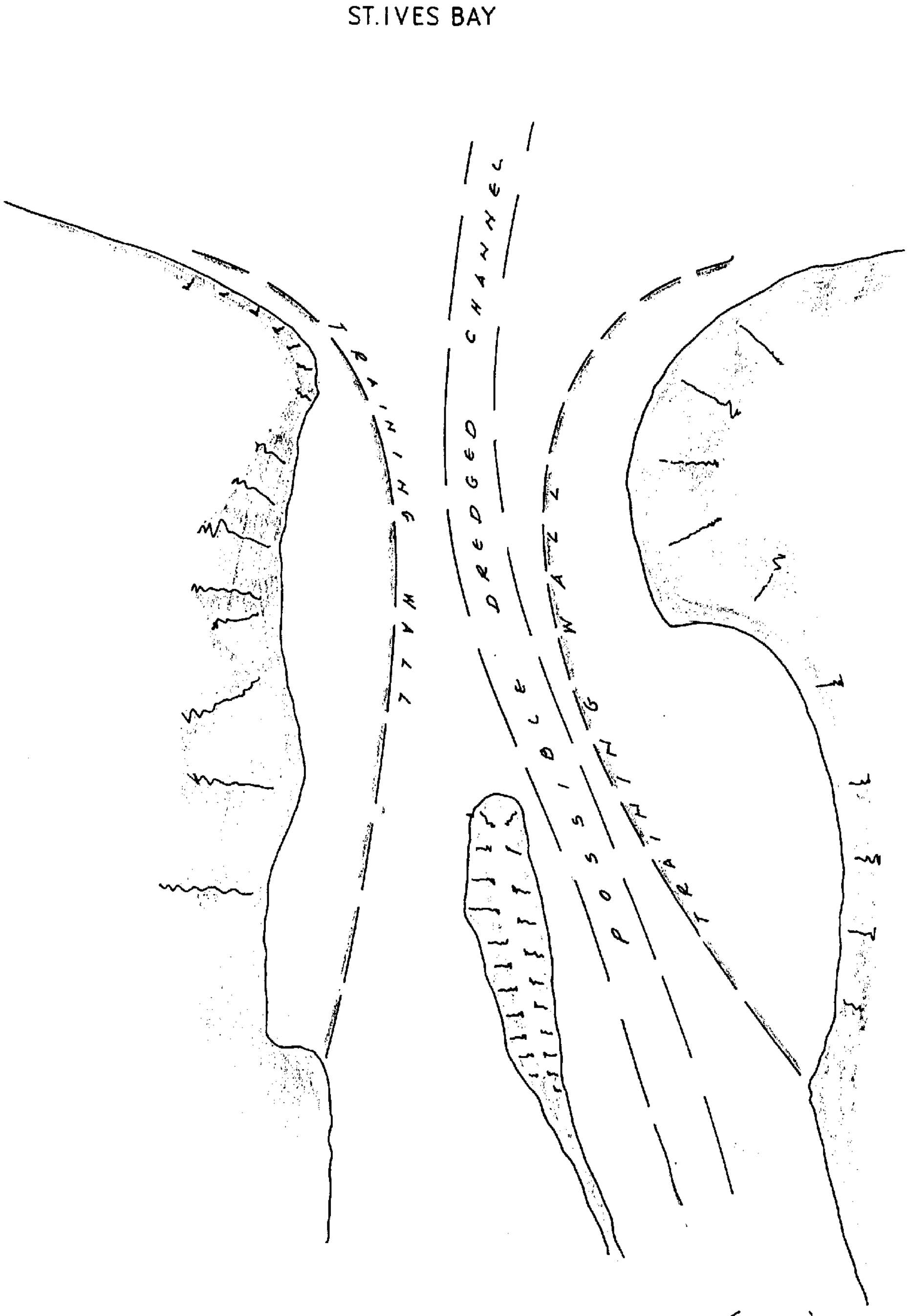



FIG. 4 POSSIBLE ALIGNMENT OF TRAINING WALLS (N.T.S)