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ADVICE REPORT FOR THE NATURE CONSERVANCY COUN

PRELIMINARY REPORT ON POSSIBLE CHANGES IN SEDIMENTATION PATTERNS/BED TOPOGRAPHY OF THE RIBBLE ESTUARY RESULTING FROM LAND RECLAMATION PROPOSALS

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ADVICE REPORT FOR THE NATURE CONSERVANCY COUNCIL

PRELIMINARY REPORT ON POSSIBLE CHANGES IN SEDIMENTATION PATTERNS/BED TOPOGRAPHY OF THE RIBBLE ESTUARY RESULTING FROM LAND RECLAMATION PROPOSALS

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Background

Recent proposals have been made for reclaiming part of the intertidal marshes on the southern shore of the Ribble Estuary. Because of the international value of the area to wintering and passage waders and wildfowl, the area is of considerable importance and a proper assessment is required of the changes that might be brought about by reclamation. The Institute of Oceanographic Sciences (Taunton) was approached by the Chief Scientist Team of the Nature Conservancy Council in August 1978 for a qualitative and broad quantitative assessment of the probable changes in the accretion regime and bed topography of the estuary. In particular the effects on the sedimentation pattern of three schemes of reclamation were requested, with specific comments:

1. Accretion of new banks, intertidal flats and, if possible, their surface area for various tidal ranges.
2. Erosion of existing banks or flats.
3. Consequent effects on navigation.
4. Consequent effects on sedimentation on the beaches of Southport.
5. Consequent effects on the drainage depending on the River Douglas.

Proposals

The location of the proposed reclamation is shown in Fig 1. and would enclose the intertidal marshes and mud flats of Banks Marsh fronting Banks Enclosed Marsh north east of Crossens. The available coastline stretches from Crossens Marsh to Hundred End Gutter, a distance of about 6km. The position of the proposed retaining banks is unknown, but alternative, or successive areas of 1125, 2500 and 3000 acres (455, 1012 and 1214 hectares) have been outlined. The whole of the frontage could not be used directly unless special provision was made at Crossens for discharges from Back Drain and the Sewage Works. Consequently the available frontage is in the region of 4.7 km and the widths of the three schemes would have to be a minimum of 966, 2148 and 2576 m. Larger widths would result from matching the retaining banks into the existing coastline.

A possible configuration for the three proposals is shown in Fig 1.

Estuarine Sedimentation

The Ribble Estuary has the appearance of a typical well mixed estuary, where the mixing of salt and fresh water is dominated by the tidal movement rather than by river flow. Its cross section is almost triangular with wide intertidal mudflats especially on the southern side. At low water only a shallow flow occurs in the central channel which is trained by gravel banks. The tidal range is high being 7.9 m at Lytham St Annes at Spring tides (Table 1). The range at Preston is considerably less, implying that because of its shallowness considerable dissipation of tidal energy occurs within the estuary.

A common feature of this type of estuary is that the cross sectional area and the intertidal volume both increase exponentially towards the mouth. This is considered to be a balance between the tidal velocities and the sedimentation pattern. Consequently any change in cross sectional area will react on the tidal velocities and cause deposition or erosion of sediment to retain the balance. The Ribble has an outline which gives almost exponentially increasing width towards the mouth, despite considerable reclamation in the past.

The current velocity pattern that is likely in the cross section of interest will be highly asymmetrical. As the higher tidal flats cover and uncover just before and after high water the volume change per unit time is maximum. Consequently the peak currents are likely to occur close to high tide, both for the ebb and the flood. A further peak may well occur close to low water because of the reduced cross sectional area through which the water can flow, especially during the early flood tide.

The normal pattern of sedimentation in these estuaries is for muddy sediments within the estuary and sandier material towards the mouth. A high suspended sediment concentration in the water in the upper part of the estuary is associated with the turbidity maximum. This is an area where mud is preferentially deposited. Generally much of the mud enters the estuary from the sea on the estuarine circulation, some comes from the river during times of flood but much of the high concentration of suspended sediment is being created by exchanges of mud within the estuary. The mud flats are crossed by narrow gullies which erode the mudflats by meandering and sideways migration. Waves also mobilize the sediments intermittently at high water and deposition occurs in temporarily protected areas, especially those being colonized by plants, between the gullies. Thus the intertidal mudflats and saltings can show both erosional and depositional features and there are cycles of change which can have periods of up to several years which tend to obscure the slow, underlying progressive changes.

Assessment

It is impossible to provide an accurate assessment of the changes in view of the vagueness of the present proposals. Additionally the requirement of a swift assessment has meant that no site visits or field work has been undertaken. For a full assessment it would be necessary to supplement field observations with mathematical or hydraulic modelling. Both of these, however, cannot give much more than a qualitative prediction of the effects of reclamation because of the cohesive nature of the sediments and the likely importance of wave action and of the salt marsh flora in the shallow water areas. Neither can be modelled accurately with present knowledge. Nevertheless broad conclusions can be made, now based largely on experience of the possible results that could occur.

Scheme C (3000 acres)

This scheme appears to cover the whole of the area between high water spring tides and high water neap tides. Rough calculations have shown that the cross sectional area at high water spring tides would be reduced by at least 15% and that the total spring tide tidal prism landward of line Lytham St Annes to Crossens, would be reduced by about 20%. This is sufficient to have a significant effect on the estuary. The decreased cross sectional area would have the effect initially of increasing the current velocities at the beginning of the ebb tide at the inner end of the reclaimed area, but slightly decreasing them seaward of the area because of the reduced tidal prism. Thus a slight local deepening of the channel would be expected near Hesketh Sands (Fig 2) and a subsidiary scour hole would be likely to develop close to the angle of the retaining wall. In time, however, because of the constriction and of the shelter from wave action, Hesketh Out Marsh would accrete, initially in the corner where Hundred End Gutter flows out but spreading to the River Douglas. Thus the tidal prism would become reduced and this would have the effect of reducing the peak current velocities through the cross section, leading to a later infilling of the overdeepened area. Thus the total volume of the estuary would become reduced and in time the original navigable depth should be retained. The process is thus similar to that described by Inglis and Kestner (1958) in an investigation of training walls on the Rivers Wyre and Lune. Reduction in the tidal prism may also result from a reduction in the tidal amplitude. At present the spring tide range at Preston is two thirds of that at Lytham St Annes. The constriction of the estuary will tend to decrease the amplitude of the tide propagating up the estuary. However the effective narrowing will tend to increase the mean depth and produce the opposite tendency. The final balance is not clear.

The area of proposed reclamation is sufficiently large that some interference with the stream issuing from Crossens, and across the intertidal flats between Great Bank and George's Brow, is inevitable. This could cause a fairly major readjustment of the topography on Marshside Sands, but depending on the extent of the diversion. Because of wave action on the retaining wall a relatively deep area is likely to be maintained close to the base of the wall and the stream would probably follow this northwards until the wall bends away towards the north east. The trend of the stream would then be affected by flow along the northern face of the reclaimed area. It is conjectural whether the position and extent of Great Bank would be affected, but Marshside Sands would probably shoal and intertidal marshes become more extensive on Crossens Marsh. The northern face of the reclaimed area would, because of wave action at high water, be unlikely to develop fronting salt marshes.

The probable decrease in the overall tidal prism of the estuary, together with the narrowing, would have the effect of decreasing the tidal mixing and making the estuary slightly less well mixed. One of the most noticeable effects of this would be a reduction in the length of salt penetration and an alteration in the flushing time of the estuary.

Scheme A (1125 acres)

This scheme could be entirely accommodated within the area of the presently mapped salt marsh covered by water only at spring tides. Consequently its overall effect on the sedimentation pattern would be small and, other than locally, any alteration it caused would be hidden in the present day trends and in the natural variability. Locally some small scale readjustment of the drainage pattern over Banks Sands might be expected and locally increased deposition might occur at Crossens Marsh and in the corner where Hundred End Gutter flows out.

Scheme B (2500 acres)

The effects of this scheme, being between the other two in extent, is the most difficult to predict. If the restriction to the cross sectional area is the same as that of the larger scheme then the same consequences are likely to occur. Should the restriction be appreciably reduced, then its effect on the total sedimentation pattern of the estuary and its flow is likely to be noticeable, but probably not important other than locally. Increased accretion on Hesketh Out Marsh would be most likely to occur.

Conclusions

Because of the lack of detail in the proposals and the lack of basic field data it is impossible to provide a confident prediction of the effects of reclamation on the Ribble Estuary. However, since estuaries are fairly finely balanced hydraulic systems any major change in topography is likely to have significant consequences. The largest scheme would probably have significant consequences. The smallest would probably produce effects only locally.

Accurate predictions to answer in detail the questions posed in the brief by the Nature Conservancy Council would require more extensive field work combined with hydraulic and/or mathematical modelling.

Reference

INGLIS, Sir C C & KESTNER F J T, 1958. The long term effects of training walls, reclamation and dredging on estuaries. Proc Inst Civil Eng. 9, 193-216.

TABLE 1

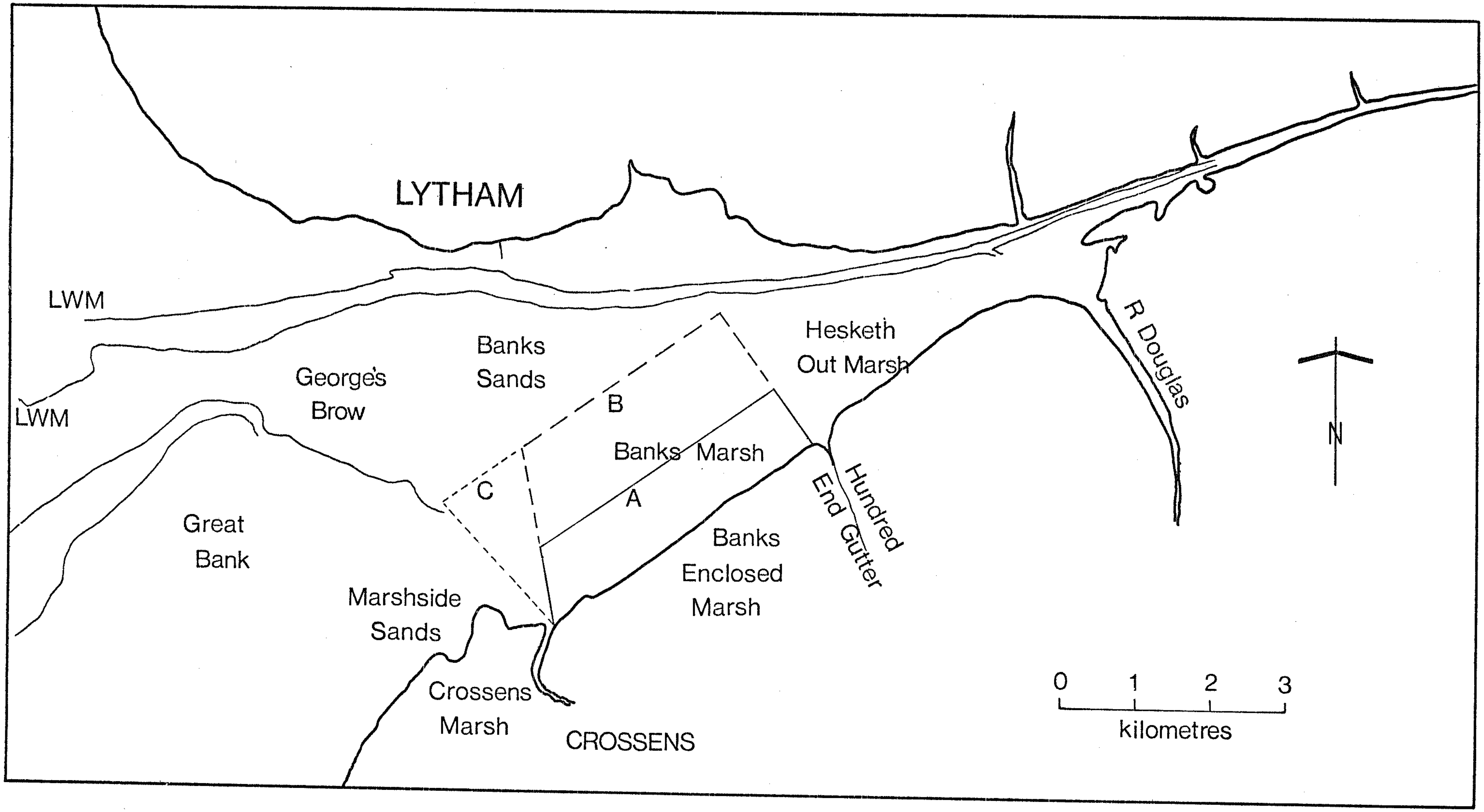
Tidal Ranges within the Ribble Estuary

	Spring tidal range m	Neap tidal range m
Lytham Pier	7.9	3.7
Preston	5.3	3.3

FIG 1

Site plan and possible extent

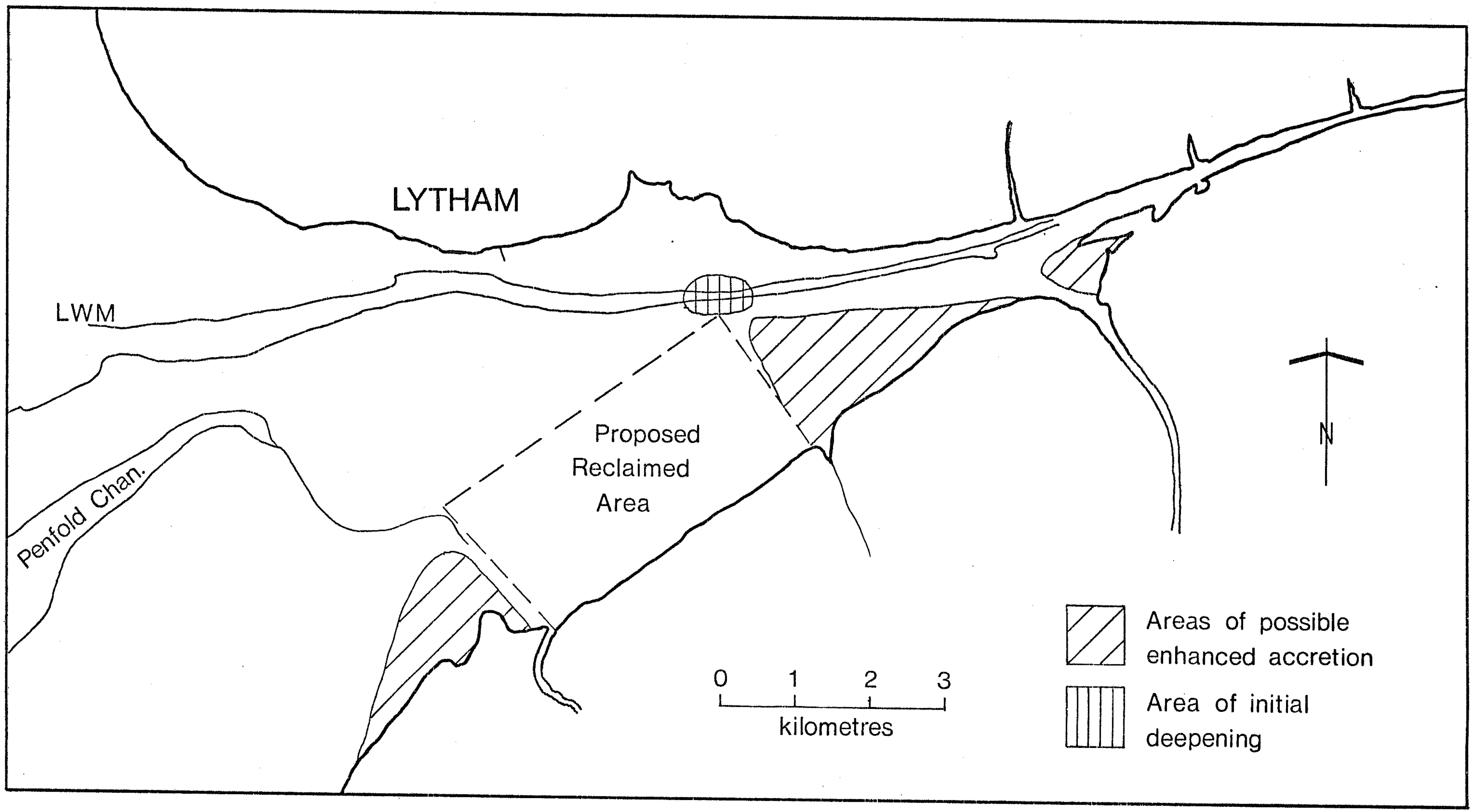
of three proposed reclamation schemes



LYTHAM
LWM
LWM
Banks
Sands
George's
Brow
Hesketh
Out Marsh
R Douglas
B
Banks Marsh
C
A
Great
Bank
Banks
Enclosed
Marsh
Hundred
End Gutter
N
Marshside
Sands
Crossens
Marsh
CROSSENS
0 1 2 3
kilometres

FIG 2

Possible areas of shoaling and accretion produced by Scheme C


LYTHAM
LWM
Penfold Chan.
Proposed
Reclaimed
Area
N
0 1 2 3
kilometres
Areas of possible
enhanced accretion
Area of initial
deepening