A SEA LOCK AT THE PORT OF BOSTON

With the sea lock, Boston will win its full share of the growing traffic through the East Coast ports.

A SEA LOCK AT THE PORT OF BOSTON

INTRODUCTION

The Port of Boston

The town of Boston exists because of its port. In the Middle Ages the port was so large that it paid about one third more customs duties than London. During the 15th century the river silted up, much trade was lost and the town suffered.

Boston Dock was completed in 1882 and lies about 4 miles upstream of the mouth of the Haven near the south western limit of The Wash. Marine access to the dock is by an entrance lock 300 feet long and 45 feet wide (86x13.6 metres lockable). Some wharfage is also available in the river, but ships there rest on the bed of the Haven other than near high tides. Access to the port is available only for about one or two hours before and after each neap or spring high tide.

The trade of the port is roughly one quarter each of steel, grain, container traffic, and other traffic. Boston's total trade has fluctuated at around 1.2 million tonnes per year during the last ten years with growth in the last two years, while the total east coast trade has risen by about 35% over the same decade, from about 65 million tonnes to about 90 million tonnes.

The size of vessels using ports like Boston or destinations in continental Europe such as the Rhine ports is of course generally limited by the size of the waterways at each end of their journeys. However, the constraint at Boston is particularly severe. The current generation of "small" or "feeder" container ships is wide enough to carry five containers abreast and can just enter Boston Dock. The next generation, expected to come into common use during the next 5-10 years, will be significantly wider - six or seven "boxes" wide - and unable to enter the Dock in its present form. There is also a general trend towards wider and longer - but not deeper - cargo ships. The port is likely to decline as a result unless access is improved.

Coastal Defences

Increases in the sea level along this part of the east coast are expected by the NRA to continue at about 6mm per year. The Authority is responding to that in a variety of ways, depending on local circumstances. At Boston there is a choice. One option is to continue the historic practice of raising the defences throughout the tidal length of the Haven - defences which already reach to the ground floor window level of buildings on the waterfront, and which are becoming progressively more intrusive in the town. The second is to construct a tidal defence barrage to protect the river, as has been done at Hull, Swansea and elsewhere.

Road and Rail Access

The main road serving Boston is the A16 trunk road, feeding from Lincolnshire to the A1 and the south. Boston also stands close to the A17 trunk road running from Newark and South Yorkshire to East Anglia. Improvements to both routes are being carried out by the Department of Transport.

The Port is connected to the rail network, with direct routes to the East Coast main line and to the industrial Midlands.

THE STUDY

Being mindful of the circumstances outlined above, the National Rivers Authority in partnership with the County Council, the Borough Council and the Port of Boston engaged consultants Balfour Maunsell to investigate the feasibility of providing a combined sluice and sea lock in the Haven some distance downstream of the town. It was expected that this new feature would bring various benefits:

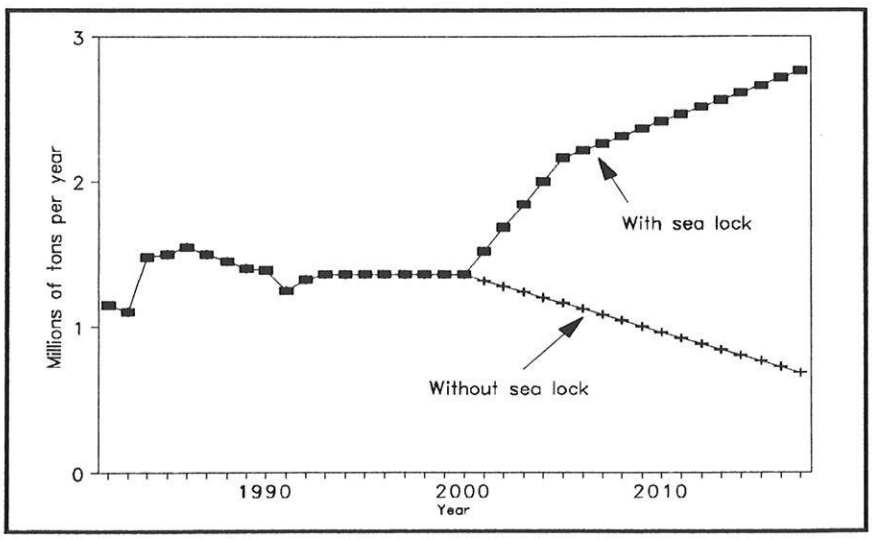
- Improved flood defences
- Improved access times for ships to the harbour
- Sufficient water retained upstream of the barrier at all times to enable seagoing vessels to stay afloat in the river
- Capability of accepting larger ships than at present

but a better understanding of the costs and other implications was required.

THE REPORT

The preliminary feasibility study report is now with the partners. It is a substantial document, soundly researched within its terms of reference. Its conclusions include:

- The construction of a sea lock and sluice is feasible in engineering terms.
- Such a lock and sluice, illustrated in cartoon form in appendix 1, would be capable of delivering the outcomes listed above. The expected effect on port traffic is illustrated below.



Estimated future port traffic - with and without the sea lock

- The optimum retained water level would be about 600mm (2 feet) below neap high tide (i.e. 1.3m AOD). There would be no more low tides in the town
- Of four sites investigated for the sea lock and sluice, a location near Hobhole is initially preferred
- It would be necessary to provide a new pumping station at Maud Foster Sluice and an extension to the pumping station at Black Sluice
- Dredging would continue to be needed in the Haven upstream of the sea lock, and a deeper channel should be maintained downstream
- The local fishing industry should benefit by the sea lock allowing the fishing grounds to be reached earlier and left later
- Local leisure boating could double to 500 craft
- There would be a loss of about 23 hectares of sites designated as having particular ecological value
- There may be changes in the water quality in the impounded area
- Commercial development on the south bank of the Haven would be stimulated
- The capital cost of the project would be of the order of £30 million
- Using a simple discounted cost:benefit analysis, the benefit/cost ratio has been calculated to be 1.55.

Allowing for further studies, a public inquiry, fund raising and construction, the sea lock might be operational around the end of the decade.

COMMENT ON FINDINGS

The preliminary feasibility study indicates that the initial hopes of the four partner organisations are achievable. It would therefore be worthwhile to pursue a more detailed understanding of the proposal.

Potential sources of funds for the project include:

- The NRA itself, through its flood defence role
- The County and District Councils, acting particularly to provide catalytic funding
- The European Regional Development Fund, through Objective 5b
- Port of Boston Ltd
- Commercial banks, some of whom have invested in comparable projects elsewhere on the east coast
- The European Investment Bank
- perhaps others.

Different funding sources may be appropriate at different times.

The Port of Boston is currently funding a worthwhile expansion of warehousing to accept expected increased traffic during the next few years. The underlying medium term trend is one of growth in the tonnage shipped through the port - Boston is very convenient for traffic between the English Midlands and the Ruhr. Through its Baltic trade Boston is particularly well placed to benefit from expanding business with Eastern Europe.

NEXT STEPS

As a prelude to final decision making, a number of issues need to be considered further:

- A fuller engineering investigation of the sea lock and sluice
- A fuller study of the land use changes that might accompany the sea lock, and of their consequences good and bad
- The preparation of a full environmental assessment
- The preparation of information needed to secure funds
- Shipping, road and rail traffic impact
- Perhaps others.

A study to address the first five of these might reasonably be expected to cost of the order of £300,000 or about 1% of the project cost. The preliminary study has cost £40,000, shared equally by the four local partners.

The four funding partners have agreed to commission this second stage study, through the NRA. The study will be commissioned by the NRA (in consultation with thepartners) by a competitive process early in 1995, and be complete by the spring of 1996. The partners envisage setting up a company to subsequently carry the project forward and to own and operate the lock.

FINANCIAL IMPLICATIONS

Only a small proportion - perhaps 10-20% - of the project cost is likely to be provided by the four partners or levered in directly by their contributions from ERDF. The balance must be secured from investment organisations such as the EIB and commercial banks. Actual and potential growth in port traffic is such as can support this approach.

POSSIBLE TIMETABLE

The planning approval and subsequent construction of the lock and sluice may now be authorised by the Secretary of State using the provisions of the Transport and Works Act 1992. Formerly a Private Bill would have been needed. The consultant's report suggests a timetable:

Decision to proceed with second stage study	September 1994
Appoint consultant for second stage study	March 1995
Receive full project appraisal	Summer 1996
Secure funding: decision to proceed	Autumn 1996
Statutory process and public inquiry to	Winter 1997/8
Detailed design	12 months
Construction	24 months

This implies completion in 2000 or 2001.

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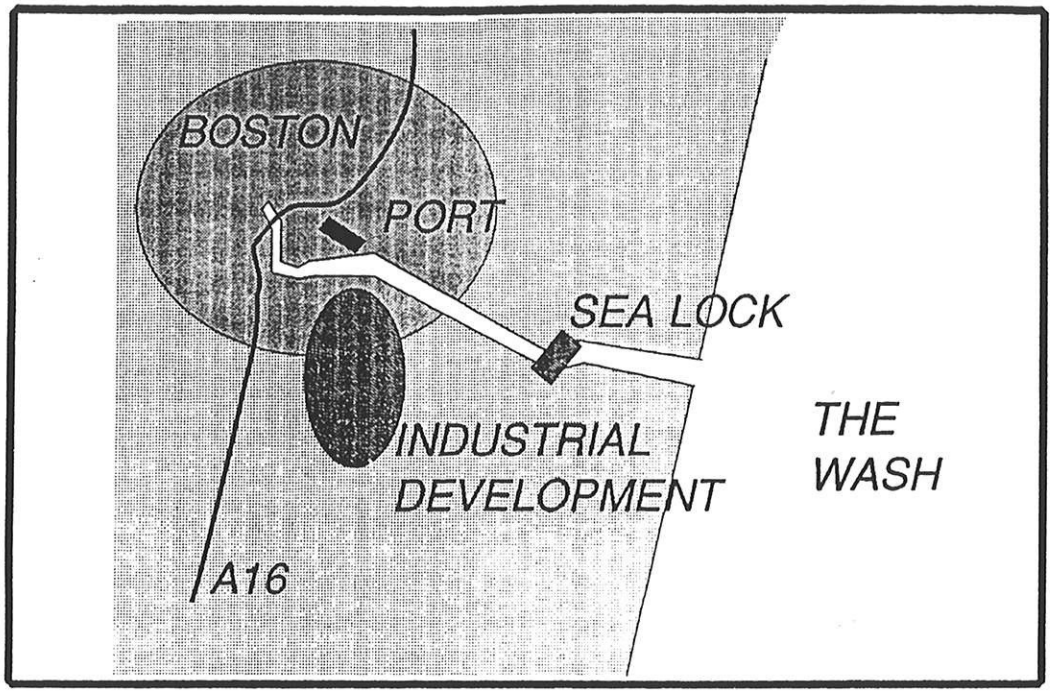
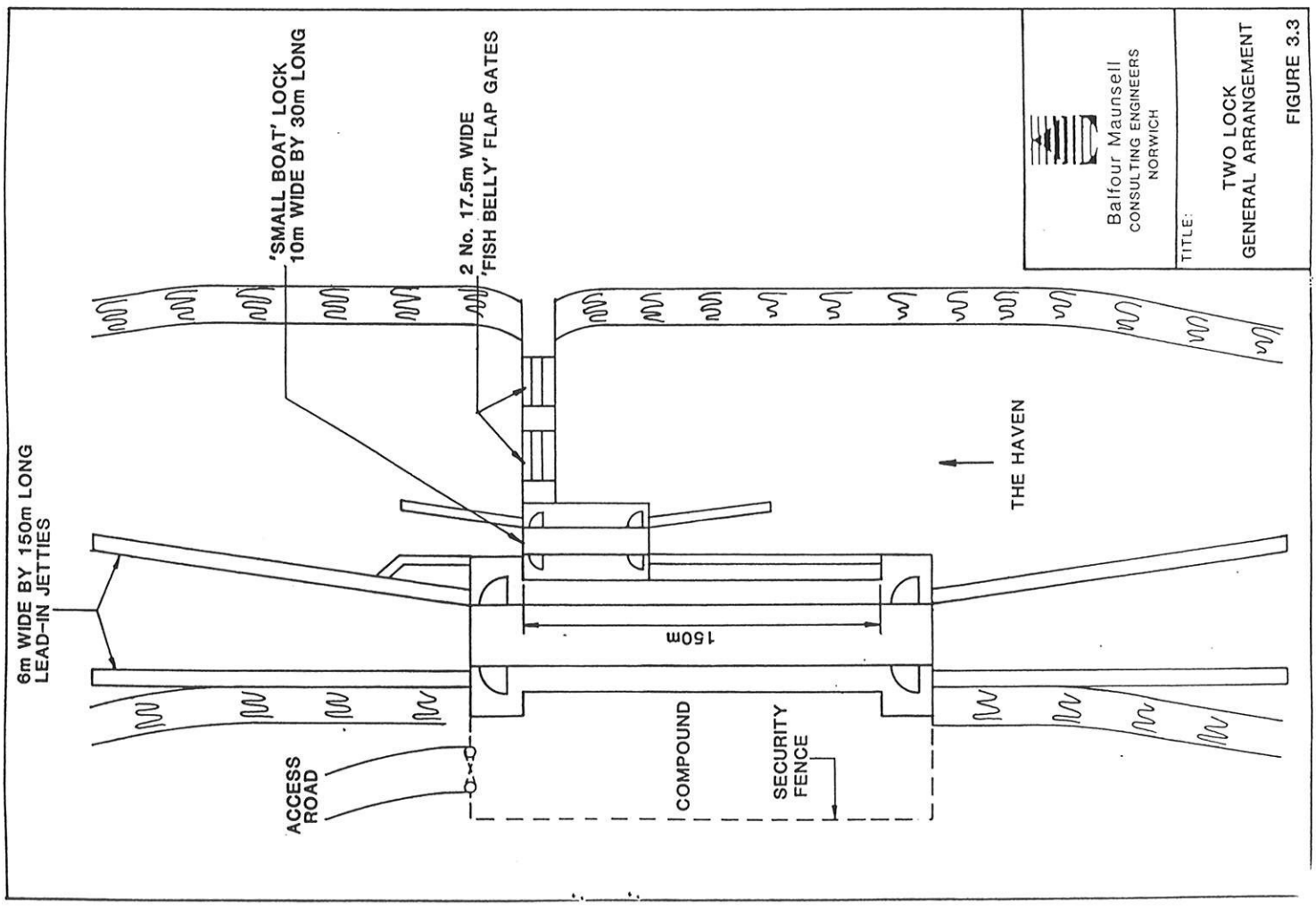
BOSTON SEA LOCK





NRA

National Rivers Authority
Anglian Region

PORT of BOSTON

BOSTON
BOROUGH COUNCIL

LINCOLNSHIRE COUNTY COUNCIL

BOSTON SEA LOCK
PRELIMINARY FEASIBILITY STUDY

EXECUTIVE SUMMARY

JULY 1994

Balfour Maunsell
Consulting Engineers
Sackville Place, 44 Magdalen Street, Norwich NR3 1JU

BOSTON SEA LOCK

EXECUTIVE SUMMARY

CONTENTS

1. Location

The town and Port of Boston are situated on the Haven some 8 km upstream from its outfall into the Wash (see fig 1). The Haven, which is the tidal section of the River Witham, is approximately 11km long from the outfall to the tidal limit at Grand Sluice.

2. The Problem

The tidal nature of the approaches to Boston Port severely restricts the movement of vessels entering or leaving to a short time around high tide. The existing lock into the Dock is 13.6m wide and is a constraint to wider vessels using the Port.

The tidal flood defences through the town of Boston have been and will continue to require progressive raising to provide adequate protection owing to the effective sea level rise. Raising the defences will worsen the aesthetic appeal of the river running through the town and further separate the river from the people.

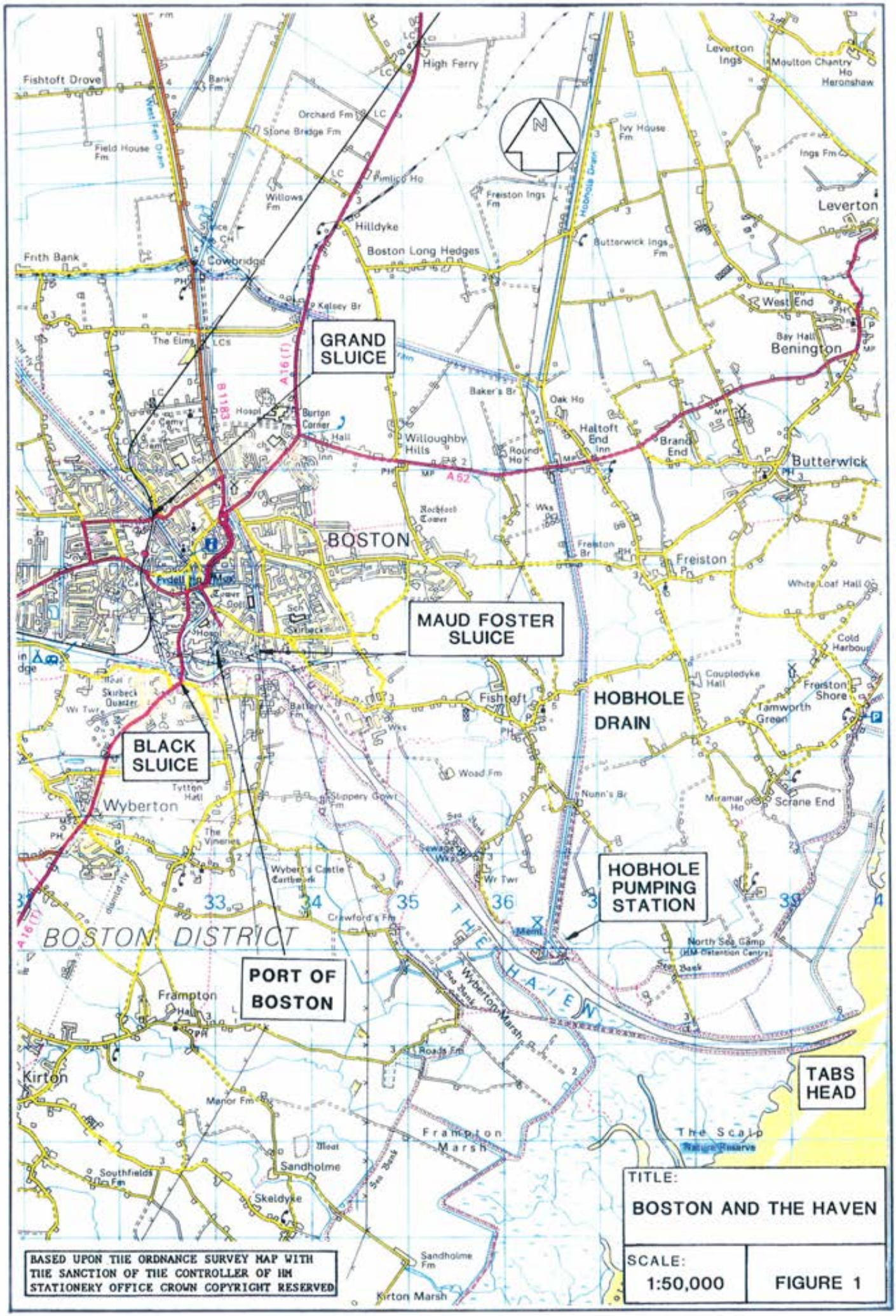
The Haven has potential to attract a substantial increase in leisure boat activities and additional tourists to the town. However, the tidal water movements and drying out at low tide are not conducive to continuous boating activity or general amenity use.

3. Sea Lock and Barrage as a Solution

A sea lock within a barrage in the lower reaches of the Haven could, by providing a minimum water level in the Haven and barrier gates for flood defence, assist in solving some or all of the problems mentioned above.

4. The Study

The purpose of the preliminary feasibility study was to investigate the engineering, economic and environmental aspects of constructing a sea lock and barrage on the lower section of the Haven to enable the four joint partners (NRA, Port of Boston, Boston Borough and Lincolnshire County Councils) to decide whether to proceed with the project.



BASED UPON THE ORDNANCE SURVEY MAP WITH THE SANCTION OF THE CONTROLLER OF HM STATIONERY OFFICE CROWN COPYRIGHT RESERVED

TITLE: BOSTON AND THE HAVEN	
SCALE: 1:50,000	FIGURE 1

The study covered the following aspects:-

- engineering
  - construction and operation of a barrage and sea lock
  - river and lowland drainage
  - siltation
  - flood defence
- port economics
  - increase in trade
  - commercial fishing
  - leisure boating
- planning
  - policies
  - existing problems
  - opportunities with a barrage and sea-lock
- environment
  - existing environment
  - potential impacts of the proposals
  - scope required for detailed assessment
- legal requirements and responsibilities
- economic evaluation
  - benefit/cost analysis
  - funding (including MAFF grant aid)
- evaluation of options
- project development
  - project appraisal requirements (including brief)
  - programme to completion

5. Results of the Study

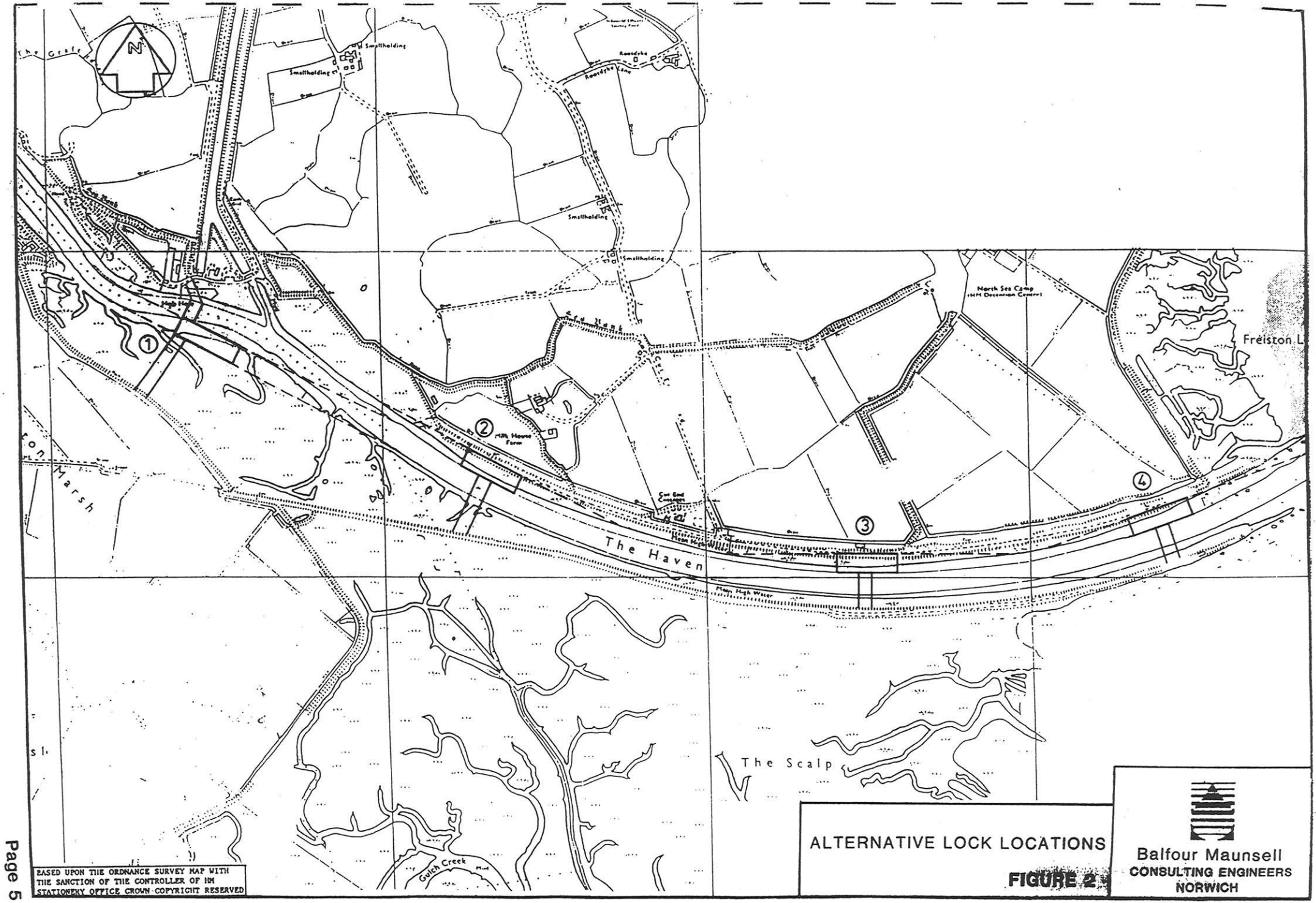
An intensive four month period of consultation, hydraulic modelling, outline design and study of all aspects associated with the project has resulted in the following conclusions.

ENGINEERING

Sea Lock and Barrage

A sea lock and barrage could be constructed on the lower reach of The Haven between Hobhole and Tabs Head - refer figure 2 for studied locations.

The sea lock would be 150m long and 22m wide to accommodate the maximum size of vessel which could use the Port.



ALTERNATIVE LOCK LOCATIONS

FIGURE 2

Balfour Maunsell
CONSULTING ENGINEERS
NORWICH

For smaller vessels and leisure craft either the main lock could be split with central gates or a separate smaller lock (30m long by 10m wide) could be provided alongside.

Preliminary layouts of the two options of sea-lock and barrage are shown in figures 3 and 4.

The water level in the Haven would be controlled by sluice gates in the barrage structure. 'Fish belly' type flap gates are considered most suitable and 2 gates each 17.5m wide with an invert level at 0m AOD have been shown to provide the required degree of water level control. These flap gates could be raised, as required, to exclude incoming tides to an appropriate sea defence level.

To maximise access to the Port of Boston whilst still affording access under bridges for leisure craft, a minimum retained water level (MRL) behind the barrage would be 1.3m AOD. Tides exceeding the MRL would be allowed to enter the Haven to afford greatest navigational freedom.

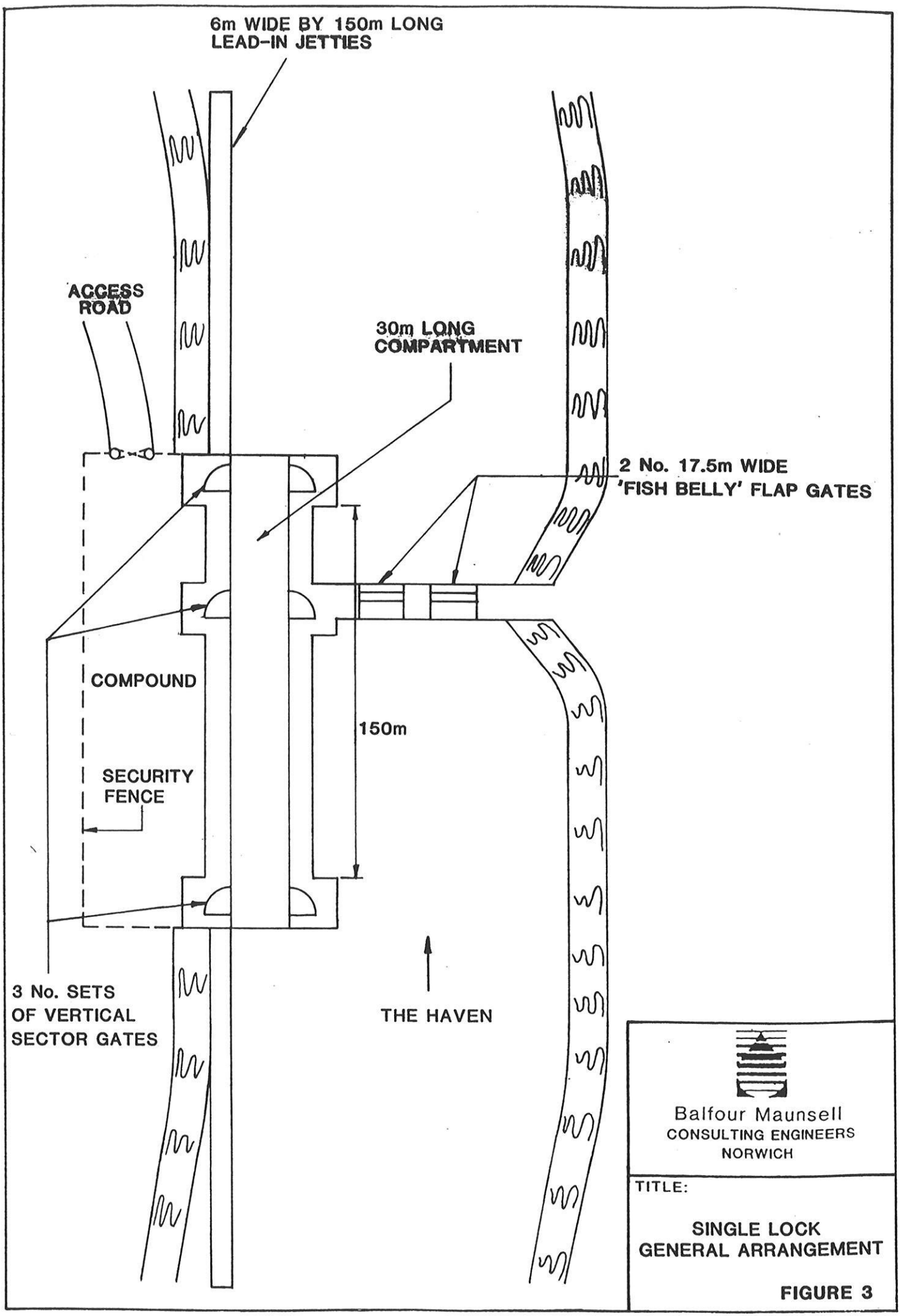
Sill levels in the lock ranging from -4.2m AOD to -5.7m AOD have been investigated. For a vessel with a 4m draft, access times vary between 13 and 24 hours for a neap tide and 12 to 16 hours for a spring tide, depending on the different lock depths.

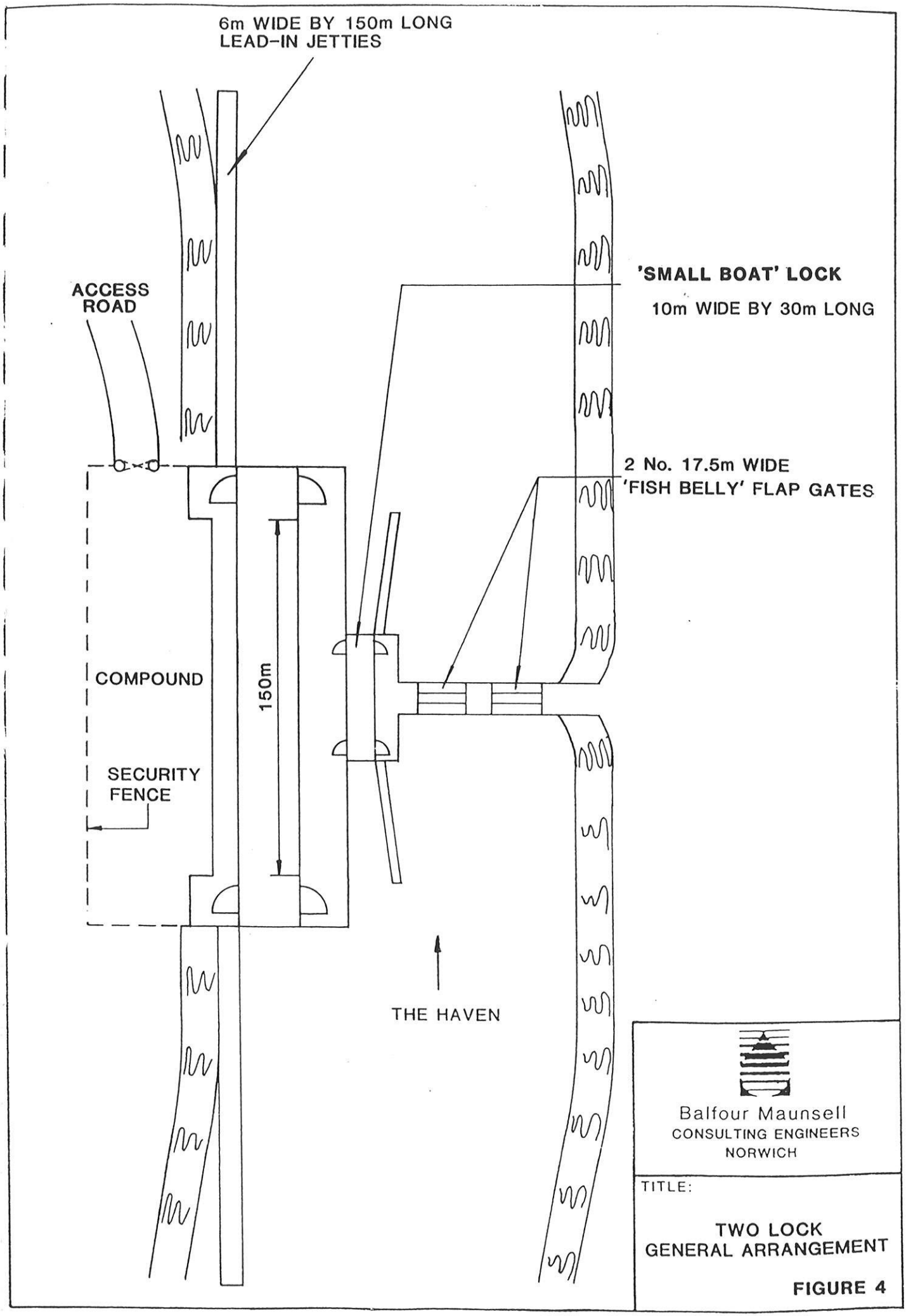
To provide equivalent approach channel depth from the Wash to the lock, excavation and dredging works vary from a minimum of 115,000 m^3 for a lock sill level of -4.2m AOD for a Tabs Head option to 423,000 m^3 for a sill level of -5.7m AOD at Hobhole.

Hydraulic Regime

Tidal velocities in the Haven would be substantially reduced by the barrage. Peak velocities would be approximately halved and quiescent periods (velocities <0.3 m/sec) increased from 2.5 hours to more than 8 hours on a spring tide.

The barrage would reduce the average tidal flux (i.e. the volume of water passing) by 60 % on a spring tide and by 93% on a neap tide.


6m WIDE BY 150m LONG
LEAD-IN JETTIES
ACCESS
ROAD
30m LONG
COMPARTMENT
2 No. 17.5m WIDE
'FISH BELLY' FLAP GATES
COMPOUND
150m
SECURITY
FENCE
3 No. SETS
OF VERTICAL
SECTOR GATES
THE HAVEN
Balfour Maunsell
CONSULTING ENGINEERS
NORWICH
TITLE:
SINGLE LOCK
GENERAL ARRANGEMENT
FIGURE 3


6m WIDE BY 150m LONG
LEAD-IN JETTIES
ACCESS
ROAD
'SMALL BOAT' LOCK
10m WIDE BY 30m LONG
2 No. 17.5m WIDE
'FISH BELLY' FLAP GATES
COMPOUND
150m
SECURITY
FENCE
THE HAVEN
Balfour Maunsell
CONSULTING ENGINEERS
NORWICH
TITLE:
TWO LOCK
GENERAL ARRANGEMENT
FIGURE 4

To maintain the existing drainage regime in the South Forty Foot and Maud Foster Drain for the proposed MRL in the Haven, a new pumping station at Maud Foster Sluice and an extension to the pumping station at Black Sluice would be required.

Control of water levels behind the sea lock and barrage during times of extreme fluvial flood could be controlled by the gates in the barrage alone or by a combination of both gates and sea lock. The latter would provide the most economic approach and was assumed for this preliminary study.

It is also possible that by appropriate operation of the barrage, real benefits to flood control in the River Witham could be achieved.

Siltation

The Haven carries a heavy silt load, the great majority of which is believed to enter from the Wash. The amount of sediment entering the Haven on flood tides would be substantially reduced by a barrage but because of the substantial reduction in velocities in the Haven, conditions would be more favourable for siltation. Approximate calculations show that quantities of siltation in the Haven upstream of the barrage are unlikely to be significantly changed by the barrage, however the siltation patterns may be different and will require further study.

Periodically retaining a high tide upstream of the barrage and releasing it at low tide to induce flushing of sediments is a possibility. Suitable flow velocities can be generated but their effectiveness in scouring settled silt which may have consolidated needs further investigation as will the impact on navigation and moored craft.

Downstream of the barrage, tidal flushing would be substantially reduced. The channels would be dredged to depths which provide equivalent access to those afforded by the sea lock and would be deeper than at present. Substantial maintenance dredging is anticipated in the range 25,000m^3 to 100,000m^3 per annum, depending on location of barrage and depth of sea lock.

Flood Defence

Current MAFF guidelines suggest a 1 in 200 year standard of flood protection for areas such as Boston. The current defences require raising by 300mm to provide 1 in 200 year protection for the next 45 years.

The barrage would obviate the need for raising the flood defences and would permit the lowering of hard defences in Boston where they are currently perceived to be obtrusive.

Construction and Operation

The construction of the sea lock and barrage must not impede navigation and therefore construction would require to be completed in at least 2 phases.

Depending on location and foundations the cost of the sea lock and barrage is estimated to be in the range of £22.1m to £30.1m with an additional cost of between £0.8m and £0.9m if two locks are preferred to a single lock.

Operating costs are estimated to be around £300,000/annum.

Maintenance dredging costs are likely to increase from present values by between £100,000 and £400,000 per annum.

Other associated costs for additional and extended pumping stations and for possible control of sewage overflow and diversion of effluent outfall pipelines are in the range of £1.5m to £2.0m.

PORT, FISHING AND BOATING

The Port

The Port trades almost exclusively with ports in the North Sea mainly in grain, steel and container traffic. Trade has begun to decline recently and currently stands at approximately 1.3m tons/annum.

The effects of the recent GATT Agreement and the likely policy of the EU to reduce grain production could result in a decline in trade. The sea lock would provide a better opportunity to retain the trade available to the port.

Boston's steel trade consists principally of imports, mainly from similarly sized Continental and Scandinavian ports. Provided the sources remain unchanged, trade seems reasonably secure. However, the sea lock would provide insurance against the trade moving into bigger ships.

Boston's trade in containerised goods consists mainly of imports and currently represents only about 1% of east coast container traffic. It has retained its share whilst other similarly sized ports have lost out to major ports to the north and south. Container and Ro-Ro vessels are getting bigger and if Boston is to maintain or increase its market share the new sea lock is essential.

The sea lock together with improved storage and handling facilities on shore would allow the Port to return to its recent share of total east coast traffic of 1.4%. In the interim Boston's trade is expected to remain constant at 1.3m tons/annum.

Fishing

The local fishing industry, although having some apprehension about the new development, should benefit from the sea lock by allowing the fishing grounds to be reached earlier and left later.

The net additional profit is hard to gauge and, because of fixed quotas, is effectively that which can be gained from fishing brown shrimps over a five month season. It is estimated to be between £1m and £3m/annum for the whole 50 vessel fleet.

Leisure Boating

Leisure boating would be a net beneficiary of the sea lock and barrage. The raised water levels in the Haven would allow better access to the Wash and would encourage greater use of the Haven by leisure craft.

It is estimated that the present local fleet size of 250 craft could double. The resulting annual benefit to local shop keepers and marine operators would be approximately £136,000/annum.

PLANNING

The wider range of services and the additional number of ships that could be handled by the Port of Boston would potentially enable it to provide more employment and act as a catalyst for the development of other industries in the town. This could boost the local economy and lessen the present dependence upon a limited number of firms to provide employment in the Town.

Vacant land exists within the existing port for further development of services. Should there be a demand for further land to accommodate port related uses, then there is substantial supply of vacant land elsewhere in the town, particularly at Slippery Gowt Farm that could be utilised. Slippery Gowt not only has potential for substantial commercial development but could be developed for new wharfage and port related industries by virtue of its frontage to the Haven. There would also appear to be potential for further development at Slippery Gowt beyond the present allocation if further land is required.

If the expansion of the port were to facilitate the development of the Slippery Gowt area, this could hasten the construction of the A16 link road to the industrial area. This could potentially relieve traffic congestion in Boston particularly if there was a development of the port on this bank of the Haven. In the longer term, increased development of the port might also facilitate the construction of a further bridge across the Haven which could also serve the existing industry located to the east of the town.

An improved visual appearance and better access to the Haven in Boston resulting from higher water levels might encourage greater appreciation of the river resulting in the gradual re-orientation of existing vacant or derelict sites in the town centre possibly by means of mixed developments incorporating access to the river in the scheme. This could improve the built environment of the centre which in parts is in quite a run-down state. A more accessible river allied to such riverside development might also provide a focus for tourist and visitors to the town which could be of benefit to the local economy.

The stability of water levels to allow continuous navigation of the Haven would encourage greater use by leisure craft and possible pressure for improved moorings. There is scope in planning terms for the development of a marina on the Haven between the Port and the Wash although this would require a careful assessment in terms of its impact on the surrounding countryside and the local environment.

In planning terms it would appear that the development of a sea lock and barrage could directly create considerable potential for the development of derelict or vacant land bordering the Haven, much of which has already been identified for development by the Borough Council. There may also be potential for secondary development arising from the sea lock project in other parts of the town or the Borough such as the provision of new housing to accommodate new employees and the consequent demand for an improved infrastructure. Whilst it is not possible to directly evaluate the secondary impact of the project at this stage there would appear to be considerable scope in planning terms in Boston and this part of Lincolnshire for further development subject to normal planning considerations.

THE ENVIRONMENT

The sea lock and barrage could have a significant impact on the environment, particularly on the internationally important Ramsar/SPA/SSSI Wash conservation area and the habitats associated with the loss of estuary.

Initial indications suggest that the major potential impacts would include:

- Destruction/impairment of habitat and ecological damage, including:
  - Loss of intertidal habitat in The Haven and potential loss/change to sensitive saltmarsh.
  - Disturbance or reduction of internationally important bird populations.
  - Alteration, reduction or destruction of aquatic biota, such as macroinvertebrates and shellfish communities.

- Water quality problems in the impoundment and downstream of the barrage, including:

  - Alteration of the salinity regime
  - Reduced dilution and dispersion of wastewater discharges
  - Dissolved oxygen deficiencies
  - Changes to sedimentation patterns
  - Increase in algal blooms
  - Groundwater level increases

- Increased disturbance of sensitive receivers from noise and commercial traffic.

Environmental benefits of the sea lock and barrage arise from the provision of additional recreational facilities and the improved visual amenity of the area. The potential for increased commerce and employment in the region also exist.

Location of the sea lock and barrage at the site near Hobhole, is considered the most environmentally acceptable. This option minimises disturbance of the Ramsar/SPA/SSSI site and reduces the loss of fully tidal estuary and inter tidal area and allows effluent from the Boston STW to be most easily rerouted to the fully tidal zone. This option also affords the least volume of impounded water for quality management.

Planning permission for the sea lock and barrage would currently be opposed in principle by statutory authorities, including English Nature, and interested parties, such as the RSPB. English Nature has indicated that further information on environmental impacts and mitigation measures would be required for a satisfactory and reasoned judgement to be made on the application.

For a planning application to succeed, the economic advantages of the scheme would have to considerably outweigh any negative environmental impacts. Reduction of the impacts to a minimum and provision of sufficient mitigation, enhancement and compensatory measures could increase the likelihood of success. Careful consideration of the MRL, evaluation of hydrographic, sedimentation and water quality modelling and quantification of impact on habitat and ecology will need to be made.

An environmental assessment should be undertaken on the scheme proposal, leading to an Environmental Statement. The environmental assessment should be based on the scoping study contained in the report and should incorporate detailed consultation with all interested parties.

BENEFIT/COST

Costs have been referred to earlier under "construction and operation". Benefits are summarised as follows:-

Savings in not having to raise defences in the Haven	£1.5m
Capital increase of land values in the Boston area	£3.5m
General increase in property values in the Boston area	£7.0m
Increase in value of waterfront property	£1.5m
Increase in port trading revenue/annum up to	£3.9m
Increase in fishing profit (lower band assumed)/annum	£1.0m
Increased leisure boating/annum	£0.14m
Increase in tourism/annum	£0.3m
Increase in council tax/annum	£0.16m
Increase in business tax (realised by Borough)/annum	£0.20m

Benefits and costs have been discounted to present values using a discount rate of 6%/annum. The benefit/cost ratio has been calculated to 1.41.

OPTION EVALUATION

A weighted average multi-criterion analysis has shown that when navigation, engineering, environment and cost are weighted 30%, 15%, 40% and 15% respectively a sea lock and barrage at Hobhole is marginally the preferred option. However, it is considered judicious that all options be maintained through the detailed appraisal stage as many aspects of the proposals require further analysis and consultation to determine the ultimate merits of alternative sites.

6. Project Development

It is recommended that the project should proceed to Appraisal Stage, which is estimated to take up to 18 months and cost up to £300,000.

Figure 5 indicates the estimated project programme through to completion. 18 months has been allowed for an application to construct and public inquiry procedure, 12 months for design and 2 years for construction. It is estimated that the sea-lock and barrage could be operational by the end of the year 2000.

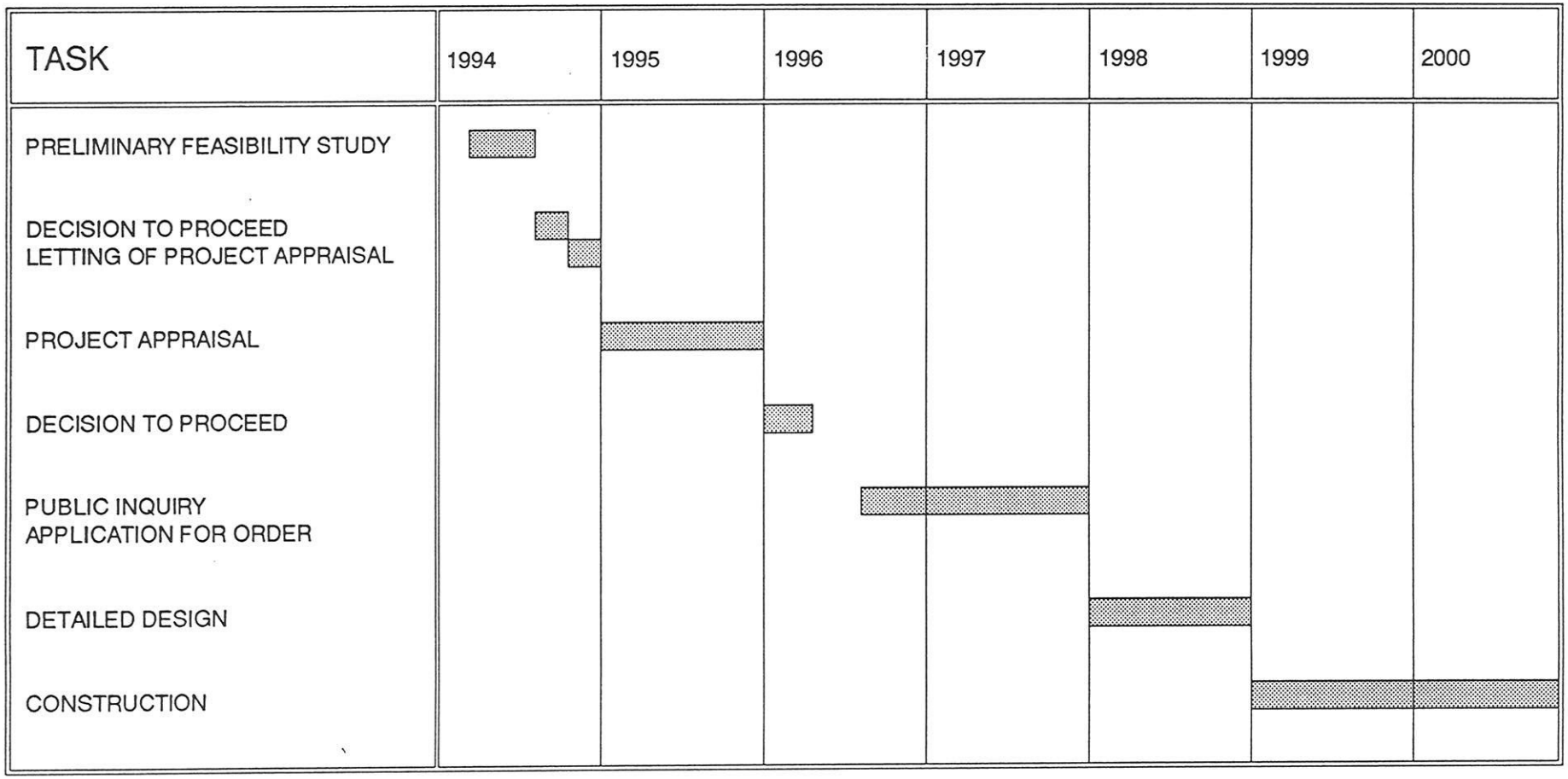


FIGURE 5 – PROJECT PROGRAMME

NRA

National Rivers Authority
Anglian Region

PORT of BOSTON

BOSTON
BOROUGH COUNCIL

LINCOLNSHIRE COUNTY COUNCIL

BOSTON SEA LOCK
PRELIMINARY FEASIBILITY STUDY

JULY 1994

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CONTENTS

1. SUMMARY

1.1 Location

The Port of Boston is situated on the Haven some 8 km upstream from its outfall into the Wash (see fig 1). The Haven, which is the tidal section of the River Witham, is approximately 11km long from the outfall to the tidal limit at Grand Sluice.

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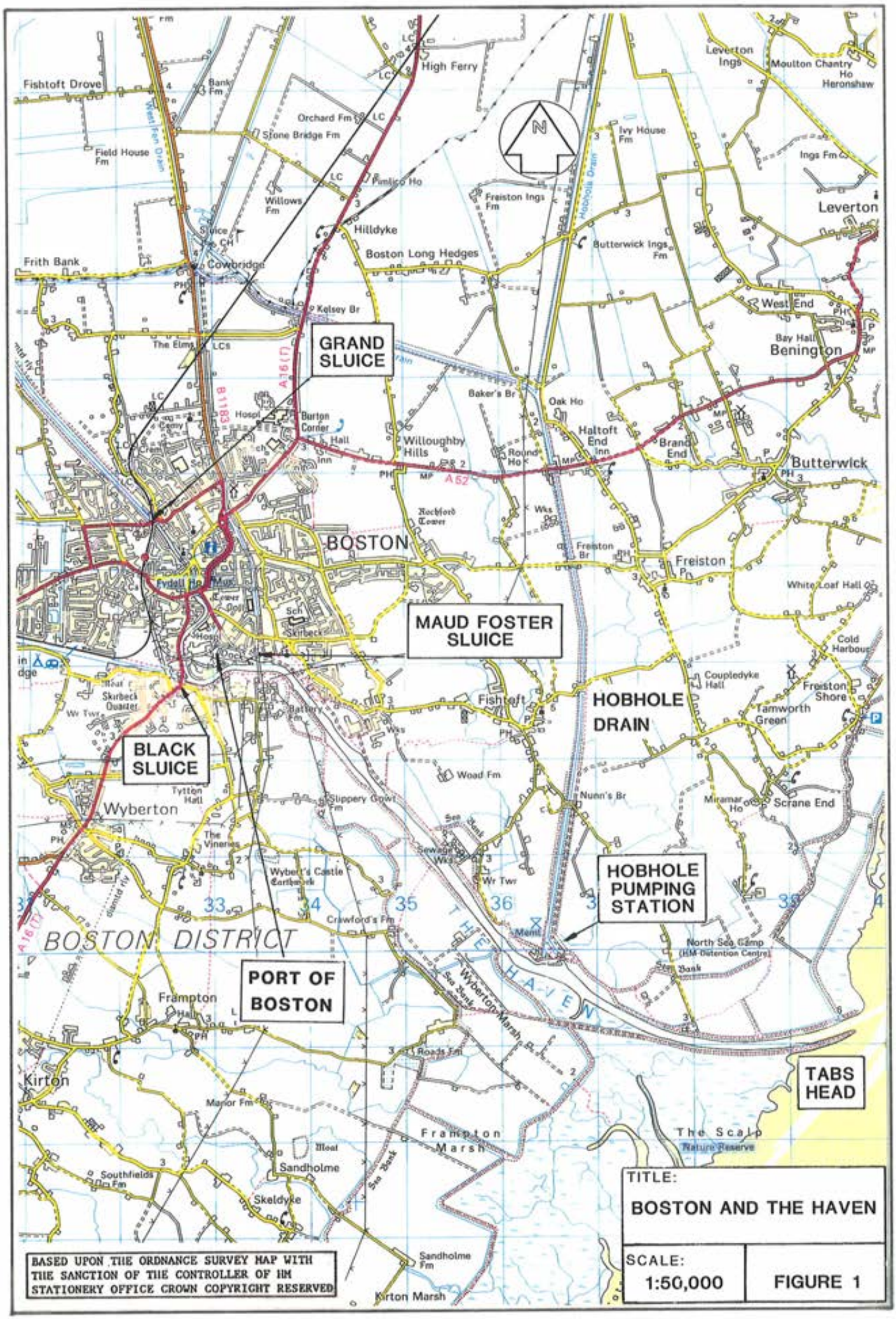
1.4 The Study

The purpose of the preliminary feasibility study is to investigate the engineering, economic and environmental aspects of constructing a sea lock and barrage on the lower section of the Haven to enable the four joint partners (NRA, Port of Boston, Boston Borough and Lincolnshire County Councils) to decide whether to proceed with the project.


GRAND SLUICE
MAUD FOSTER SLUICE
BLACK SLUICE
HOBHOLE DRAIN
HOBHOLE PUMPING STATION
PORT OF BOSTON
TABS HEAD
BOSTON
BOSTON DISTRICT
THE HAVEN
Wyberton
Frampton
Kirton
Sandholme
Skeldyke
Frampton Marsh
Kirton Marsh
Fishtoft
Freiston
Butterwick
Benington
Leverton
Haltoft End
Willoughby Hills
Cowbridge
Hilldyke
Boston Long Hedges
Fishtoft Drove
Frith Bank
Wyberton Marsh
The Scalp
Nature Reserve
North Sea Camp (HM Detention Centre)
Sea Bank
Wyberton Marsh R.
Hobhole Drain
West Fen Drain
A16(T)
A52
B1183
N
TITLE:
BOSTON AND THE HAVEN
SCALE:
1:50,000
FIGURE 1
BASED UPON THE ORDNANCE SURVEY MAP WITH THE SANCTION OF THE CONTROLLER OF HM STATIONERY OFFICE CROWN COPYRIGHT RESERVED

1.5 Results of the Study

An intensive four month period of consultation, hydraulic modelling, outline design and study of all aspects associated with the project has resulted in the following conclusions.

A sea lock and barrage could be constructed such that the drainage of the River Witham system and the Fens could be satisfactorily maintained.

The sea lock and barrage could be operated as a sea defence barrier, thereby reducing the overall length of defences by some 20km and obviating the need to raise the hard defences through the town of Boston.

It is considered that the sea lock would allow the Port to increase its market share of containerised traffic and to maintain its share of steel and grain trade.

Commercial fishing could benefit from better access to the Wash and it is anticipated that leisure boating would increase substantially with resultant benefits to the local economy.

There is ample allocation of industrial, commercial and housing land to provide for development that could be triggered by the sea lock project. Riverside properties would have potential for development to take advantage of improved aesthetics and better access to the river.

For the scheme to proceed successfully very sensitive attention to environmental impacts must be afforded. Loss and disturbance of habitats should be minimised and the possibility of creating alternative conservation areas should be explored.

The construction costs of the scheme are estimated to be between £24 and 33 million depending on ground conditions at the sea lock and barrage site.

The predicted benefits are savings in flood defence raising, increases in land and property values, increase in port trade, increase in fishing profit, increase in leisure boating and general tourism and increase in council tax and business rates due to additional housing and commercial ventures.

A benefit/cost analysis for the whole scheme projects a benefit/cost ratio of 1.41.

1.6 Project Development

It is recommended that the project should proceed to the Appraisal Stage, which is estimated to take up to 18 months and cost up to £300,000.

With an allowance of 18 months for an application to construct and public inquiry procedure, 12 months for design and 2 years of construction it is estimated that the sea-lock and barrage could be operational by the end of the year 2000.

2. OBJECTIVES

2.1 The Problem

2.1.1 Port Restrictions

The Port of Boston centres on Boston Dock situated on the Haven some 8km upstream from its outfall into the Wash (see fig 1). To reach the Port, sea going vessels are required to navigate the narrow tidal river channel as well as narrow channels through 'Cut End Bar' where the river enters the Wash.

The tidal water level variation restricts access for sea going vessels to a few hours at high water which results in waiting time and congestion.

The existing lock into the Dock is 13.6m wide and is a constraint to wider vessels using the Port.

The existing tidal regime at Boston results in a net input of silt into the Haven from the Wash. The Port currently dredges up to 60,000 tonnes of silt per year from the river and the dock and returns it to the Wash.

2.1.2 Flood Defences

The Haven, which is the tidal section of the River Witham, is approximately 11km long from the outfall to the tidal limit at Grand Sluice.

The tidal flood defences on the banks of the Haven have been progressively raised over the years to meet required levels of flood protection.

The defences along the rural sections of the Haven are earth banks but through the urban sections are generally hard defences of piled, concrete or masonry construction.

Further raising of these defences will be required if the current level of flood protection is to be maintained against predicted sea level rise, and also if the level of protection is increased to meet currently recommended standards.

Raising of defences will worsen the aesthetic appeal of the river running through the town and further separate the river from the people.

2.1.3 Navigation by Leisure Craft

The Haven does not lend itself to comfortable leisure boating. The almost continual movement of water in or out, and the drying out of possible berthing positions at low tide means that a passage must be carefully planned and leaves little room for error or contingencies.

In the summer months almost all privately owned leisure boats moor in the non-tidal reach above the Grand Sluice where the water level is maintained at an almost constant level. During the winter there are very few facilities for private craft mooring.

Access from Grand Sluice to the Wash is determined by tidal water levels and can result in inconvenient timings and perhaps whole tide outings before a return is possible.

Emergency access to the Haven from the Wash because of bad weather or breakdown is also limited by tidal conditions.

For the above reasons the use of the Haven by leisure craft is limited to necessary passages or to those willing to endure its difficulties.

2.1.4 River Aesthetics

The river through Boston is largely inaccessible to the public for two reasons:-

- flood defence walls
- fluctuating river levels with mud banks at low tide

It appears that because of this inaccessibility the use of the river as an amenity has been largely ignored.

At low tide, the Haven becomes a mud lined channel flanked in many places by stark and ugly steel flood defence walls (refer to photos 5 and 6 of Appendix 1). This mud, in time of hot weather, can produce a distinct aroma.

2.2 Sea Lock and Barrage as a Solution

A sea lock within a barrage in the lower reaches of the Haven could assist in solving some or all of the problems detailed in the previous section.

2.2.1 Port Restrictions

The barrage could retain a minimum water level in the Haven whilst allowing tides above the retained level to enter. Together with a sea lock the barrage would provide improved freedom of navigation.

2.2.2 Flood Defences

The barrage could provide additional protection from tidal flooding by excluding entry of exceptionally high tides. Sluice controls within the barrage could also be operated to exclude high tides at times of fluvial flood and provide additional storage in the Haven, thereby improving the level of fluvial flood protection in the River Witham.

2.2.3 Navigation by Leisure Craft

The retained level would improve navigation and allow better mooring facilities to be provided.

2.2.4 River Aesthetics

Access to the river could be improved by the reduction in level of flood defences. The retained minimum water level would also improve access to the river and improve the aesthetics through the town.

2.3 The Study

The purpose of the preliminary feasibility study is to investigate the engineering, economic and environmental aspects of constructing a sea lock and barrage on the lower section of the Haven.

The study will provide information to enable the four joint partners (NRA, Port of Boston, Boston Borough and Lincolnshire County Council) to make a decision on the feasibility of construction of a sea lock and barrage and whether to proceed to the detailed appraisal stage.

The study report will cover the following aspects:-

- engineering
  - construction and operation of a barrage and sea lock
  - river and lowland drainage
  - siltation
  - flood defence
- port economics
  - increase in trade
  - commercial fishing
  - leisure boating
- planning
  - policies
  - existing problems
  - opportunities with a barrage and sea-lock
- environment
  - existing environment
  - potential impacts of the proposals
  - scope required for detailed assessment
- legal requirements and responsibilities
- economic evaluation
  - benefit/cost analysis
  - funding (including MAFF grant aid)
- evaluation of options
- project development
  - project appraisal requirements (including brief)
  - programme to completion

3. ENGINEERING STUDIES

3.1 The Barrage and Sea Lock

3.1.1 Introduction

A barrage structure situated in the lower reaches of the Haven would consist of:-

- lock (or locks) - to allow the passage of ships and smaller craft
- a barrage across the river containing sluices to allow water flow through or over the structure

Two types of barrage have been considered, a high level type which could exclude the sea at any state of the tide and a low level type which would only act as an impounding device.

Figure 3.1 indicates the general concepts of high and low level barrage types.

3.1.2 The Barrage

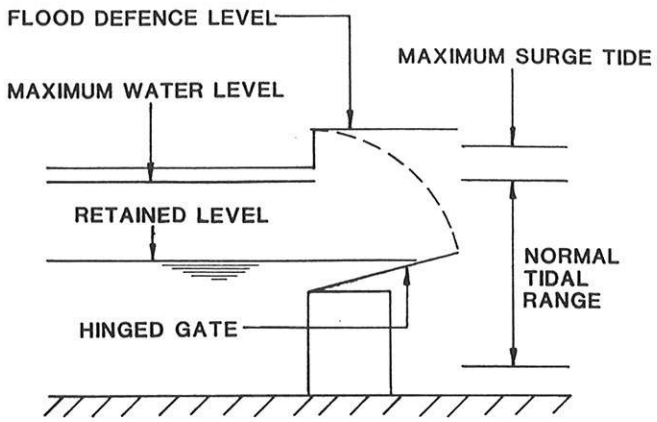
To control the water level above the barrage, alternative control devices (weirs, sluice gates, penstocks etc) have been considered.

Vertical lifting gates would require prominent headstocks and would not readily afford precise level and flow control. Radial gates whilst appropriate as barriers are not suitable for precise level control.

A simple weir set at the minimum retained level (MRL) would not provide sufficient control of water levels both during the tidal cycle and during fluvial events.

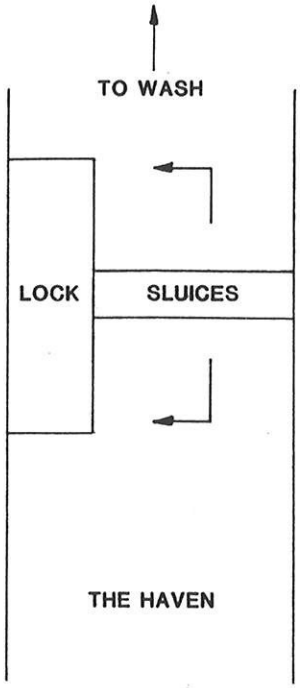
An adjustable weir would provide good level control and the commercially available 'fish belly flap gate' can be manufactured in sizes that could also act as the sea exclusion barrier (refer figure 3.1).

These fish belly flap gates have been used successfully in similar situations and, therefore, they have been selected as the most appropriate sluice gate for this barrage (reference 22 describes installation at Ipswich).

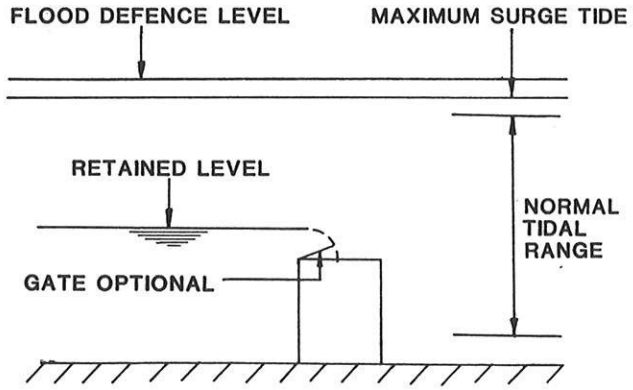


SECTION

HIGH LEVEL TYPE



PLAN



SECTION

LOW LEVEL TYPE

TITLE:

BARRAGE TYPES

FIGURE 3.1

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CONSULTING ENGINEERS
NORWICH

The MRL has been derived from consideration of navigation and river drainage requirements and provision of air-draft under the towns bridges.

The minimum air draft required by pleasure craft for this navigation is 3.66m (British Waterways). The lowest bridge soffit in the Haven is 5.1m at Town Bridge. The maximum level of water that can be retained without bridge alteration is therefore 1.44m AOD.

The summer retained level in the River Witham upstream of the Grand Sluice is 1.45m AOD. To allow river flows by gravity the MRL in the Haven must be lower than this.

Allowing for an adequate hydraulic gradient in the Haven an MRL of 1.3m AOD (5.0m chart datum) represents the maximum level from the navigation and drainage point of view. This level has been adopted as the main option for this study.

Under normal conditions, the sluices would be operated such that the minimum water level in the Haven is retained.

The port requires the additional water depth afforded by high tides for movement of deep draft vessels and therefore provision for incoming tides must be made.

As the tide rises and exceeds this MRL the sluice gates would be opened to allow the Haven to fill in a similar manner to the existing situation. On the falling tide and before the Haven level reaches the MRL the sluice gates would be adjusted to maintain the MRL during low tide. If agreeable to all parties, high tides could be retained for a period to allow deep draft vessel movement or enable 'flushing' at low tide through the barrage.

During times of high fluvial flow the sluices and even the lock would require special operating procedures. Although the MRL can be maintained, the sluices may need to be open for longer periods. Under extreme conditions the lock may need to be open and it may be necessary to preclude high tides from entering the Haven during critical periods.

It is envisaged that the high water levels in the Haven during high fluvial events would allow navigation to and from the port to continue but agreed operating procedures and close co-operation between NRA and port management will be essential at these times to minimise the risk of flooding.

3.1.3 The Lock

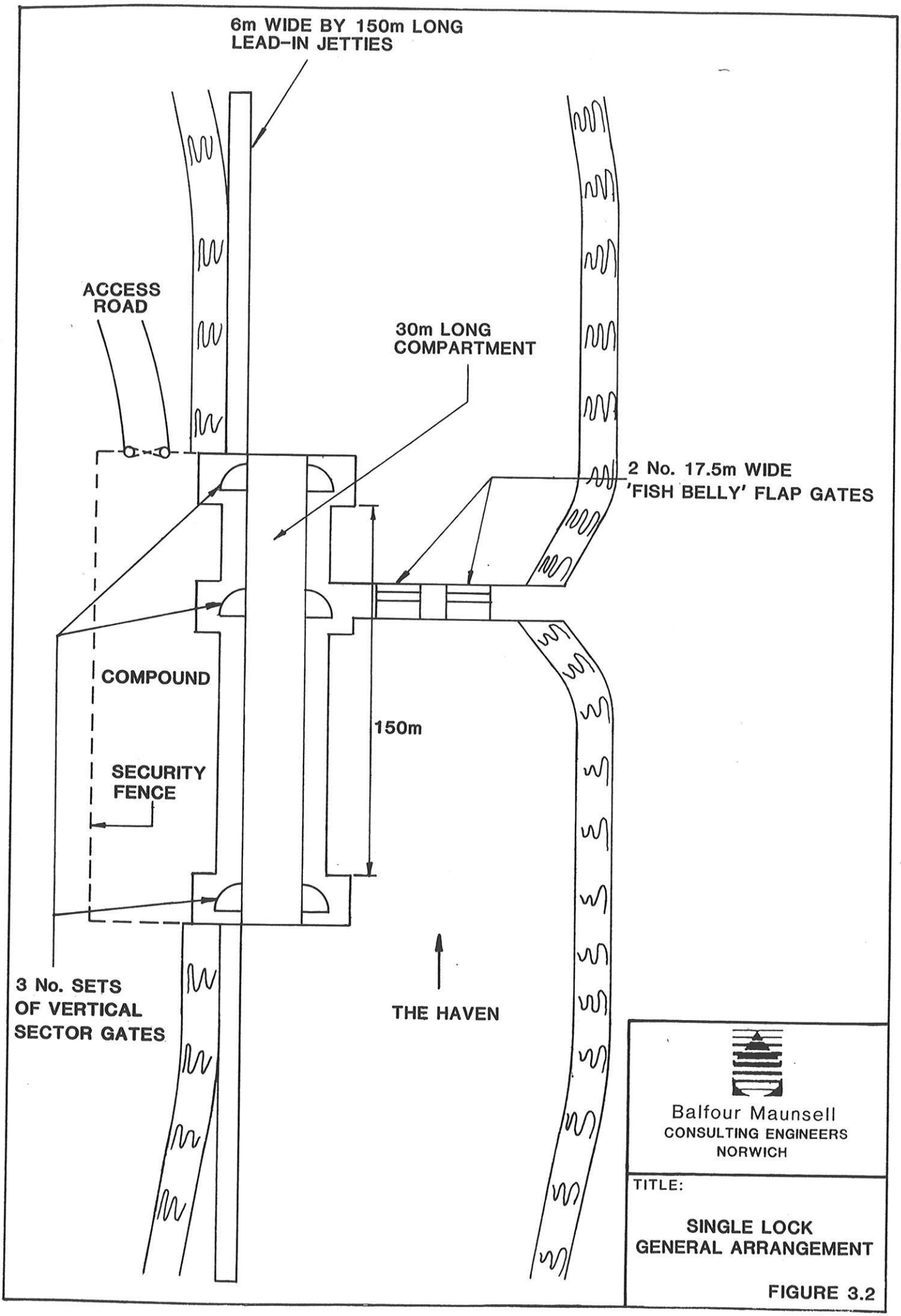
Lock dimensions have been discussed with the Port Authorities. A length of 150m was established early on in the discussions as being adequate for the maximum length of vessel likely to use the Port. A lock width in the range 22m to 25m was discussed. From an investigation of future trends in ship sizes and consideration of the practicality of lock gate construction, it was concluded that a 22m wide lock is appropriate.

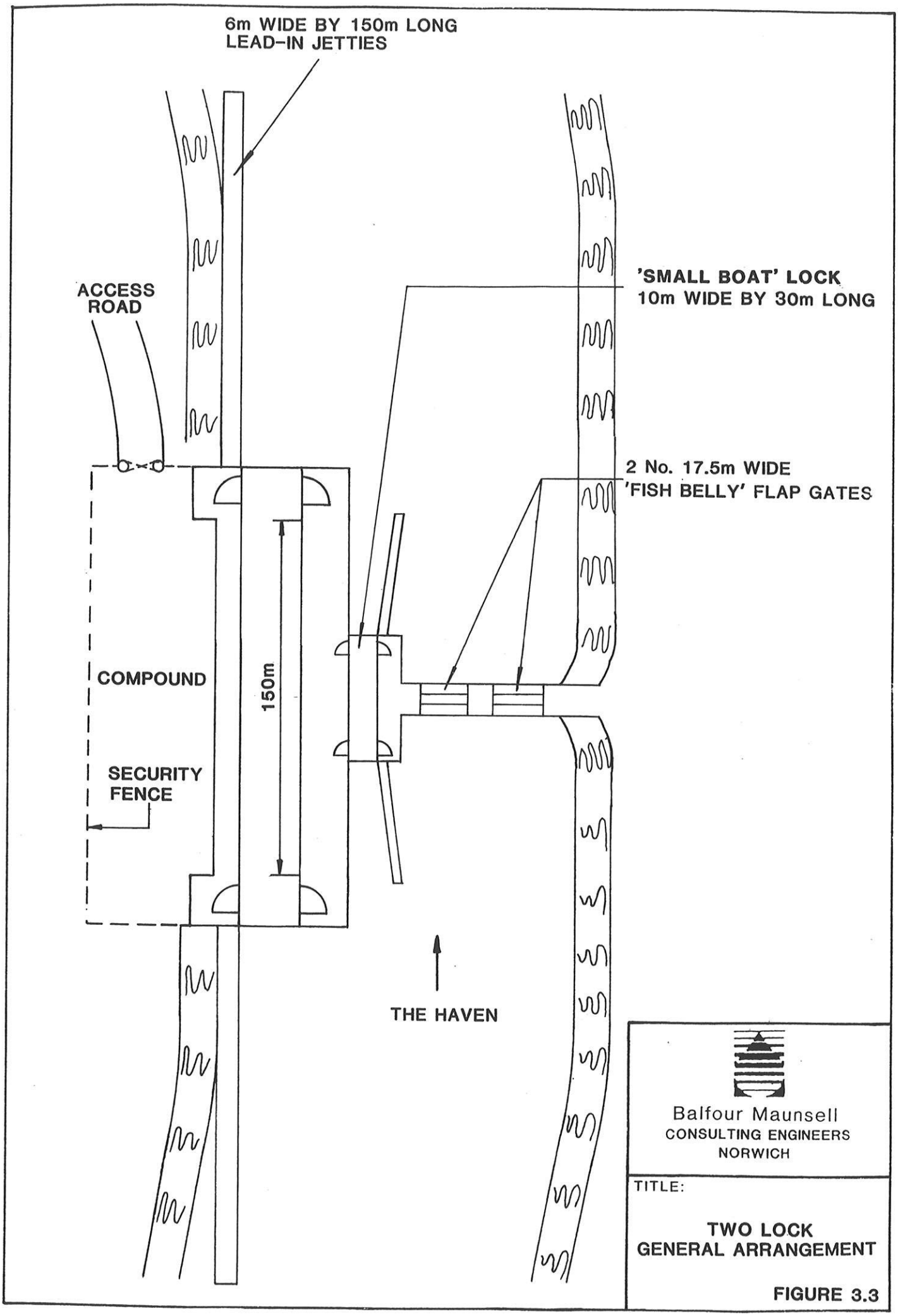
To allow smaller boats to lock in and out without using the main sea lock, two alternative schemes have been developed Fig 3.2 shows a third set of gates within the main lock to split it into smaller basins and Fig 3.3 shows a separate small lock, 30m long by 10m wide, alongside the main lock.

The lock gates must be able to resist a substantial differential head on either side of the gates. The most suitable type of gate for this situation are vertical sector gates which have the added advantage of being able to open with a differential head. This means very rapid lock movements and no complication of additional sluice gates. 22m is very wide for these type of gates but, from detailed discussions with both manufacturers and operators of recent installations it is believed that gates of these dimensions are feasible and the most appropriate.

150m long lead-in jetties would be required on either side of the lock and upstream and downstream. These lead-in jetties could be constructed from vertical and raked concrete piles with a 6m wide concrete capping. The fendering systems would need to be adequate to protect both vessels and structures at all states of the tide.

The depth of the main lock together with any required dredging on the downstream side determines the draft of vessel that can be locked in and out at low tides. Several lock depths have been studied.


6m WIDE BY 150m LONG
LEAD-IN JETTIES
ACCESS
ROAD
30m LONG
COMPARTMENT
2 No. 17.5m WIDE
'FISH BELLY' FLAP GATES
COMPOUND
150m
SECURITY
FENCE
3 No. SETS
OF VERTICAL
SECTOR GATES
THE HAVEN
Balfour Maunsell
CONSULTING ENGINEERS
NORWICH
TITLE:
SINGLE LOCK
GENERAL ARRANGEMENT
FIGURE 3.2


6m WIDE BY 150m LONG
LEAD-IN JETTIES
ACCESS
ROAD
'SMALL BOAT' LOCK
10m WIDE BY 30m LONG
2 No. 17.5m WIDE
'FISH BELLY' FLAP GATES
COMPOUND
150m
SECURITY
FENCE
THE HAVEN
Balfour Maunsell
CONSULTING ENGINEERS
NORWICH
TITLE:
TWO LOCK
GENERAL ARRANGEMENT
FIGURE 3.3

The sill levels are:-

a) -4.2m Ordnance Datum (-0.5m Chart Datum)

b) -4.7m Ordnance Datum (-1m Chart Datum)

c) -5.2m Ordnance Datum (-1.5m Chart Datum)

d) -5.7m Ordnance Datum (-2m Chart Datum)

The existing lock has a sill level of -3.7m A.O.D. Because vessels need to travel up or down from or to the open water of the Wash their movements are restricted to a short time on either side of high water. The minimum retained water level of 1.3m A.O.D. would provide a minimum water depth at the existing lock of 5m.

Fig 3.4 shows typical Spring and Neap tidal cycles at Tabs Head. Depending on the design sill level the access times for vessels with 4m draft have been computed as below:-

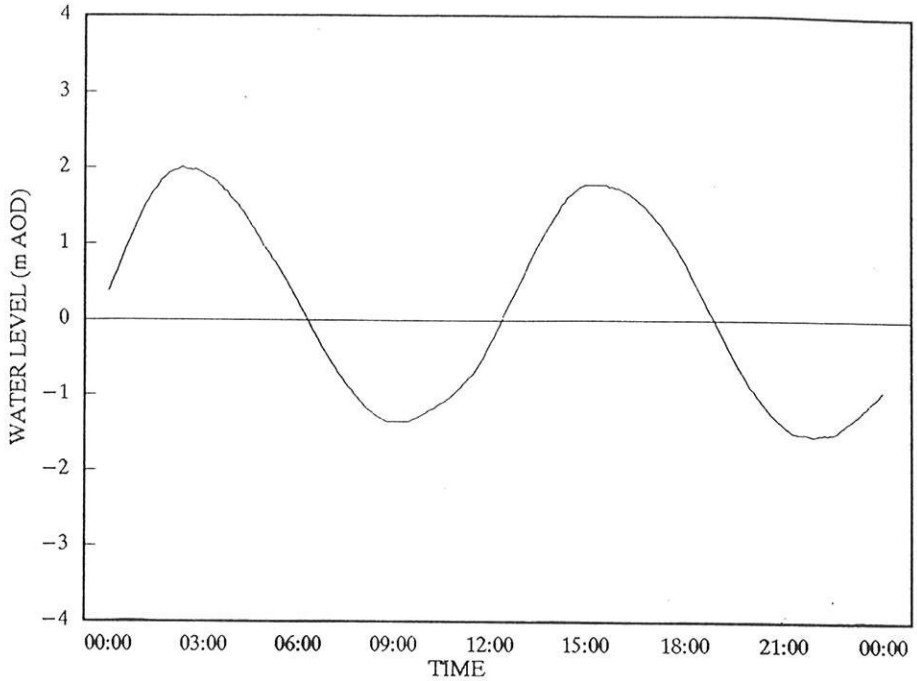
SILL LEVEL AOD	ACCESS IN HOURS PER 24 HOURS FOR 4M DRAFT VESSEL	
	NEAP TIDES	SPRING TIDES
-4.2m	13.5	12
-4.7m	15.5	13.2
-5.2m	19	14.7
-5.7m	24	16

The clearance for a 4m draft vessel at different states of Neap and Spring tides is shown diagrammatically on fig 3.5.

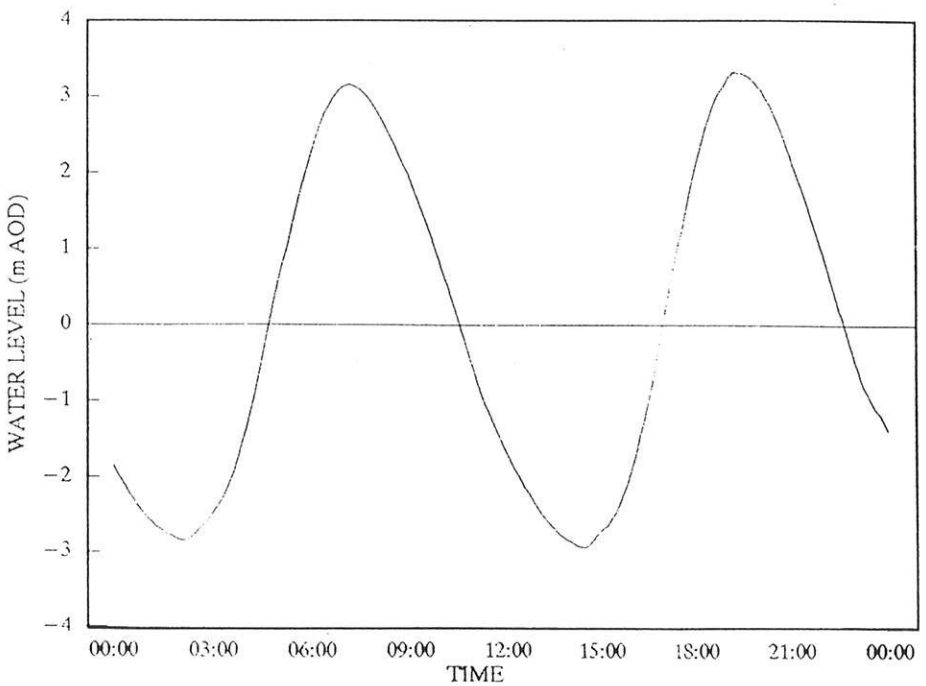
3.1.4 Location

The study brief stipulated that sites for the "sea lock" should be investigated between "Pilgrims Memorial" and Tabs Head. Figure 3.6 shows four possible sites that have been studied for feasibility and costing purposes.

The construction of the barrage and lock must not interfere with navigation and therefore only positions off-line of the existing channel have been considered. If it were absolutely essential to locate the barrage and lock in the centre of the existing channel then a dredged diversion channel could be investigated but at this early stage this was regarded as an unnecessary complication.



NEAP TIDE



SPRING TIDE

TITLE:

TYPICAL TIDAL PROFILES

FIGURE 3.4

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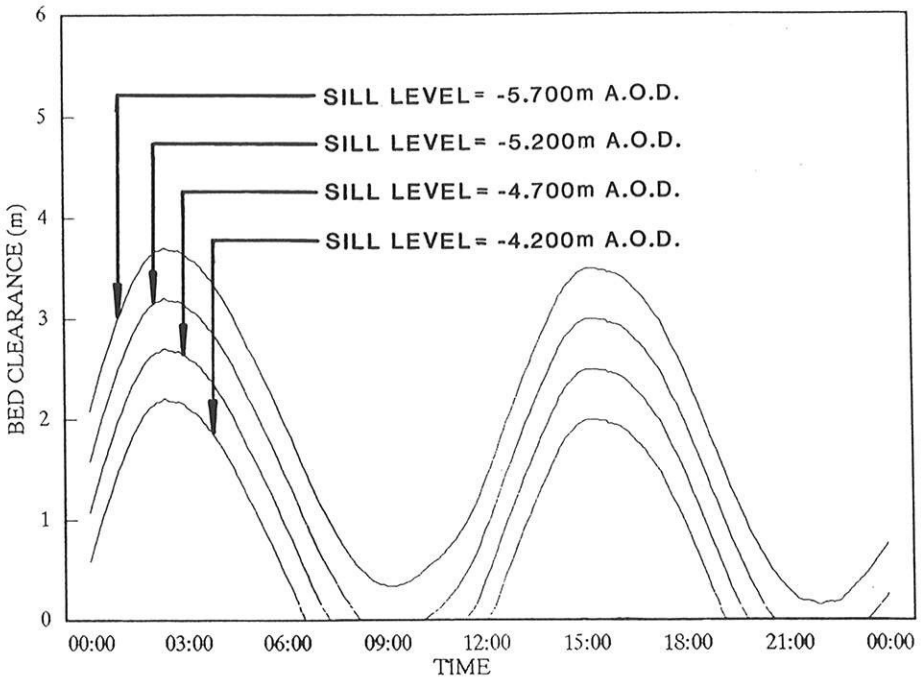
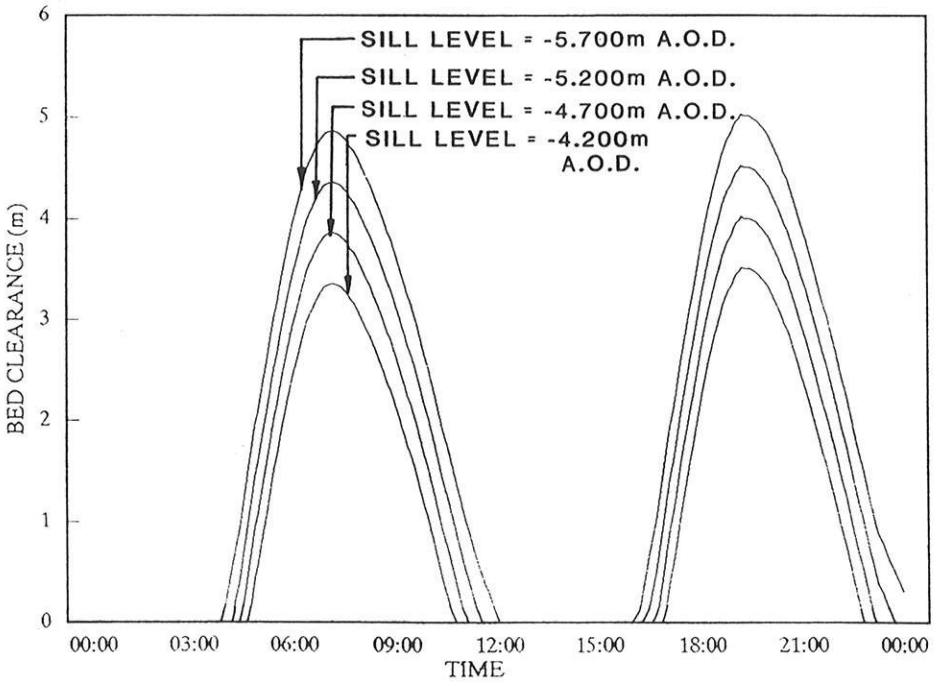
NORWICH



TYPICAL NEAP TIDE



TYPICAL SPRING TIDE

TITLE:

BED CLEARANCE FOR 4m DRAFT VESSEL

FIGURE 3.5

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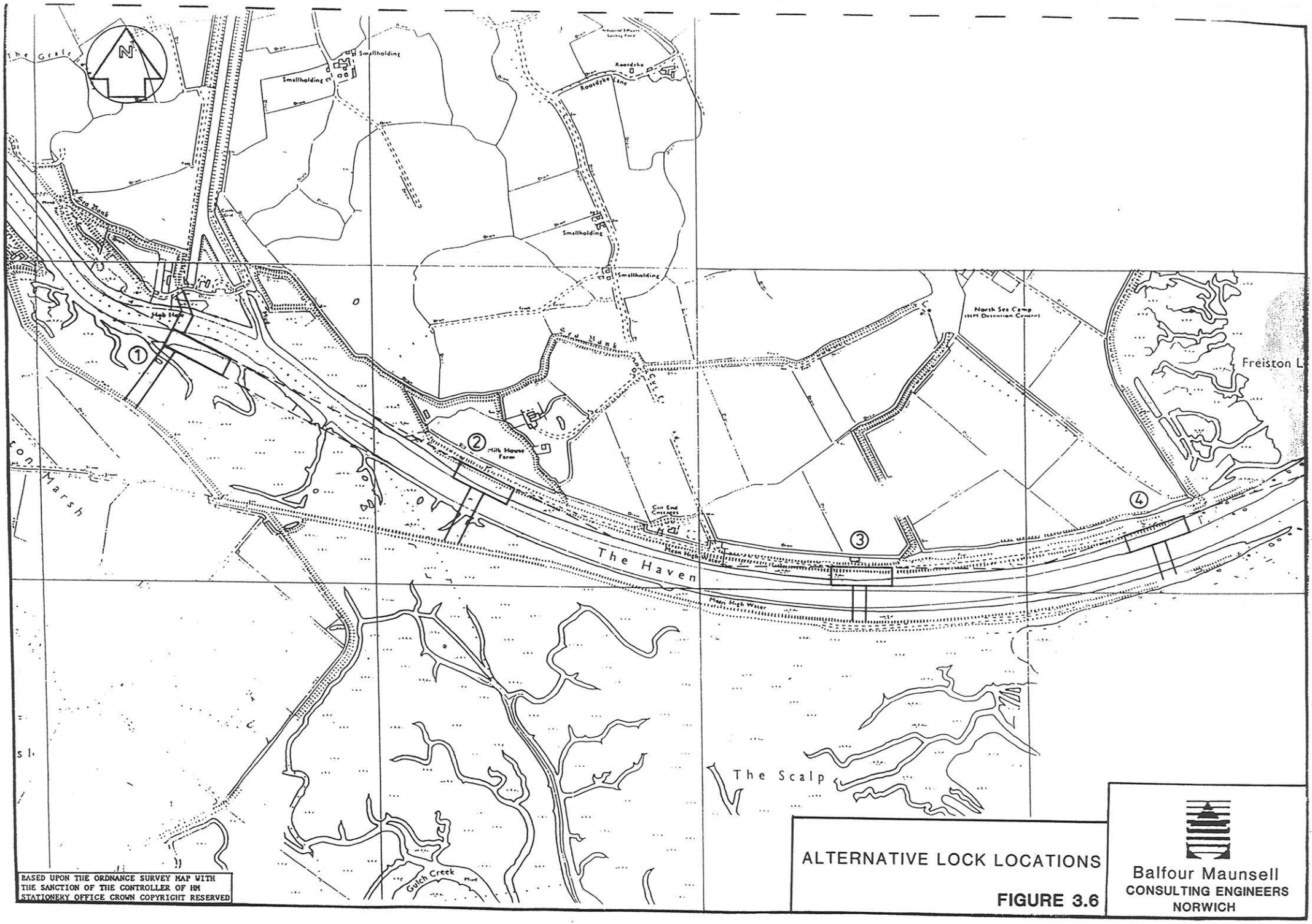

ALTERNATIVE LOCK LOCATIONS

FIGURE 3.6

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NORWICH

Site 1, opposite Hobhole, has several advantages from an engineering viewpoint:-

- Construction could take place away from the channel without compromising any flood defences.
- When the river channel is realigned through the lock the river alignment would be much improved.
- The drainage of Hobhole drain would be largely unaffected by the proposals.
- If the diversion of the sewage works effluent discharging adjacent to the sewage works (see Fig 1) to a point downstream of the barrage and sea lock were required from water quality considerations this would be the least cost option.

Site 4, close to Tabs Head, is the preferred location for navigational reasons.

This location would minimise the river section subject to low tides and therefore would reduce the possibility of congestion.

Site 4 would also minimise any dredging necessary downstream of the lock to provide low water access. Deep dredging within the Haven could lead to bank destabilization. Flushing from site 4 would be more effective in maintaining the channels through Cut End Bar.

Sites 2, 3 and 4 would require channel realignment through the lock producing non symmetrical river alignments.

Sites 2, 3 and 4 would require shorter barrage for river closure.

Sites 2, 3 and 4 would require some raising and strengthening of the southern training wall for it to become part of the flood defence embankments (refer to section 3.6.1 for further explanation).

Access requirements to each of the sites from existing roads are not significantly different.

3.2 Hydraulic Regime in the Haven

3.2.1 Catchment Description

The Haven is the outfall for the drainage of over 3,000 sq km of land through the following main water courses:-

(i)	River Witham	(2,000 sq km)
(ii)	South Forty Foot Drain	(700 sq km)
(iii)	Maud Foster Drain	(100 sq km)
(iv)	Hobhole Drain	(350 sq km)

Currently the River Witham and the Maud Foster Drain discharge only by gravity. Tidal doors at Grand Sluice and Maud Foster Sluice only permit discharge when river and drain levels exceed The Haven levels (generally at low tide).

South Forty Foot Drain and Hobhole Drain are maintained at lower levels and although they can discharge by gravity they also have large pumping stations to discharge their flows into The Haven.

The normal tidal ranges at Tabs Head are:-

Mean Spring tides	-	3.8m to -3.0m AOD (7.5m to 0.7m chart datum)
Mean Neap tides	-	1.8m to -1.3m AOD (5.6m to 2.4m chart datum)

At the Port the tides lag by a few minutes and the tide heights are approximately 0.13m higher.

The River Witham system has gauging stations at Claypole above Lincoln and Fulsby on the River Bain. Long term average flows are available for these locations which represent approx 30% of the whole catchment above the Grand Sluice.

For this preliminary study the average fluvial flows for the catchments entering the Haven have been based on the above gauged flows and are as follows:-

River Witham	10 cumecs
South Forty Foot	3.5 cumecs
Maud Foster	0.65 cumecs
Hobhole	1.75 cumecs
TOTAL	15.9 cumecs

The flood flows for this preliminary study have been estimated from 1 in 10 year event data supplied by the NRA from Lower Witham Flood Relief Study interim results.

The peak flow during a 10 year event in the Witham was 150 cumecs. The estimated peak flows for a 1 in 10 year event in the other catchments are as follows:-

South Forty Foot	60 cumecs
Maud Foster	10 cumecs
Hobhole	36.5 cumecs

3.2.2 Hydraulic Modelling

The Haven from Grand Sluice to Tabs Head was modelled using MicroFLUCOMP, a software package produced by Wallingford Software.

The following input data were used in the model:-

i) Cross-sectional data were received from the NRA. Cross-sections had been surveyed for the Lower Witham Flood Relief Study, between the Grand Sluice and Tabs Head, 13 cross-sections were used.

ii) Roughness data for the river bed and flood plains were estimated and subsequently adjusted during the calibration of the model. Values of Manning's 'n' finally adopted were 0.025 for the river bed and 0.040 for the flood plains.

iii) The level of the river bed/flood plain interface (i.e. permanent vegetation line) was estimated from observation and discussion with the Port of Boston hydrographer to be +3.30m AOD.

iv) Average and flood fluvial flows are detailed in the preceding section. A continuous flow of 150 cumecs has been taken as the modelled fluvial flood from the River Witham which will represent a return period in excess of 10 years. Flows proportional to catchment size have been assumed for the other catchments which will further increase the overall return period.

v) The downstream boundary condition for the model was the tide level at Tabs Head. Typical Neap and Spring tide profiles at Tabs Head were provided by the Port of Boston hydrographer.

vi) The upstream boundary condition was the fluvial flow through the Grand Sluice.

vii) The lock and barrage were modelled at 500m upstream of Tabs Head i.e. approximately at site 4.

viii) The lock and barrage dimensions and configuration used in the model are described in the following section.

The bridges which cross the Haven did not require any particular modelling. They span from bank to bank with no central piers and have sufficiently high soffit levels to not interfere with flows.

Water level data are continuously recorded at Tabs Head and at the Port. The model was calibrated by comparing water levels predicted by the model at the Port with measured water levels. Calibration curves showed good correlation in magnitude and phase between predicted and actual levels.

The model was used to investigate various sea lock and barrage configurations and to assess the changes the barrage would have on the hydraulic regime of the Haven.

3.2.3 Sea Lock and Barrage

The lock was modelled as being 22m wide and 150m long and as having an upstream sill level of -4m AOD.

The hydraulic characteristics of various sluice configurations were investigated. A configuration comprising 2 gates 17.5m wide with an invert level of 0m AOD was selected as the most appropriate at this stage.

Alternative sluice configurations may prove to be preferred in subsequent modelling studies. The currently adopted configuration is preliminary and requires refinement and optimisation if and when the project progresses.

3.2.4 Changes in Hydraulic Regime - Normal Conditions

Under average fluvial flow conditions the sluice gates would be adjusted to maintain a minimum upstream water level of +1.300m AOD during low tide. The lock would only be used for navigation and not as a flow control device.

Spring tide water levels are plotted in figure 3.7 for conditions with and without the barrage and sea lock. The upper plot is for water levels immediately upstream of the barrage and sea lock location and the lower plot represents conditions near to the Grand Sluice.

The barrage has the effect of attenuating the tidal wave by 0.3m in the Haven and increasing the phase difference between conditions in the upper and lower reaches by 50 minutes.

Neap tide water levels are plotted in figure 3.8 for conditions with and without the barrage and sea lock, at locations immediately upstream of the barrage and sea lock and just downstream of the Grand Sluice.

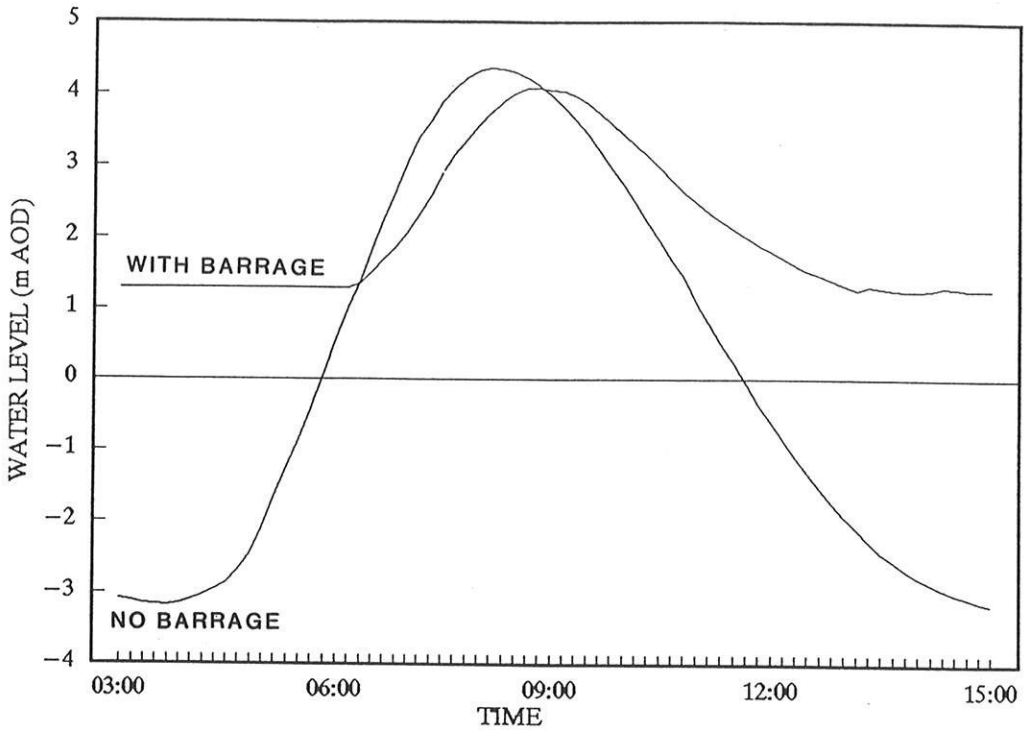
The barrage has little attenuating effect on the tidal wave although the phase difference is again increased by approximately 50 minutes.

Average river velocities during spring tides, with and without the barrage and sea lock are plotted in figure 3.9.

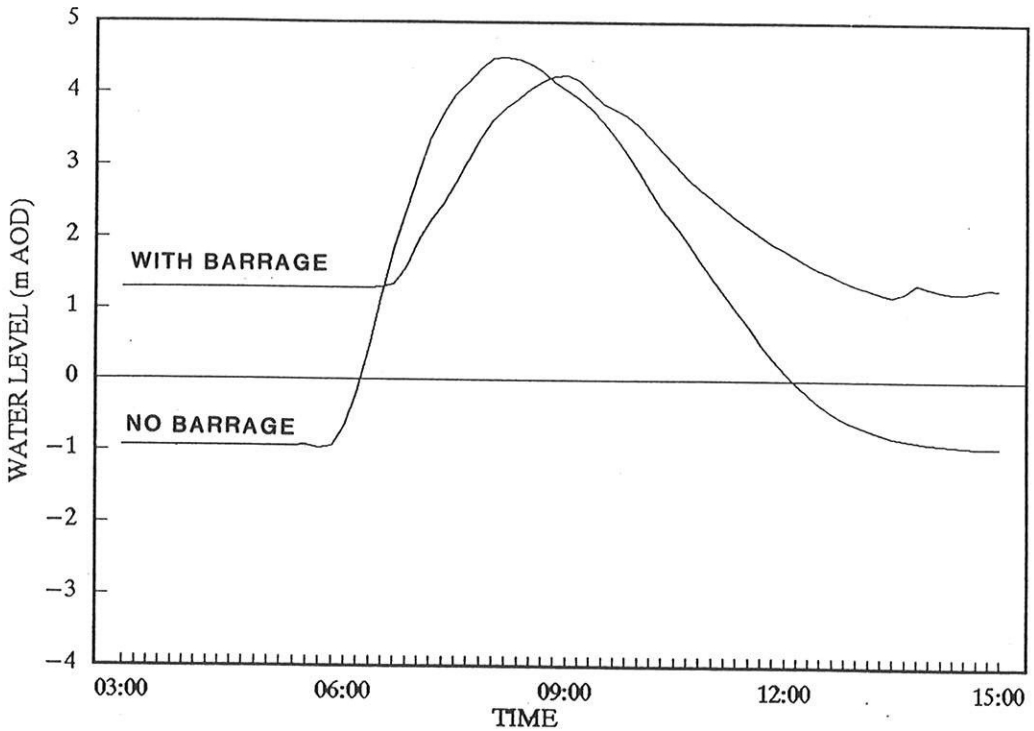
The barrage generally reduces velocities in the Haven. Small seaward velocities are produced at low tide times due to fluvial flows. Maximum flood tide velocities are reduced from 1.2m/sec to 0.7m/sec and ebb tide velocities from 0.8m/sec to 0.5m/sec.

It should be noted that the duration of tidal velocities is significantly reduced by the barrage and that flood tide velocities are reduced to a greater extent than ebb tide velocities.

Neap tide river velocities shown in figure 3.10 show similar characteristics to spring tide velocities but on a reduced scale.



a – 1Km UPSTREAM OF TABS HEAD



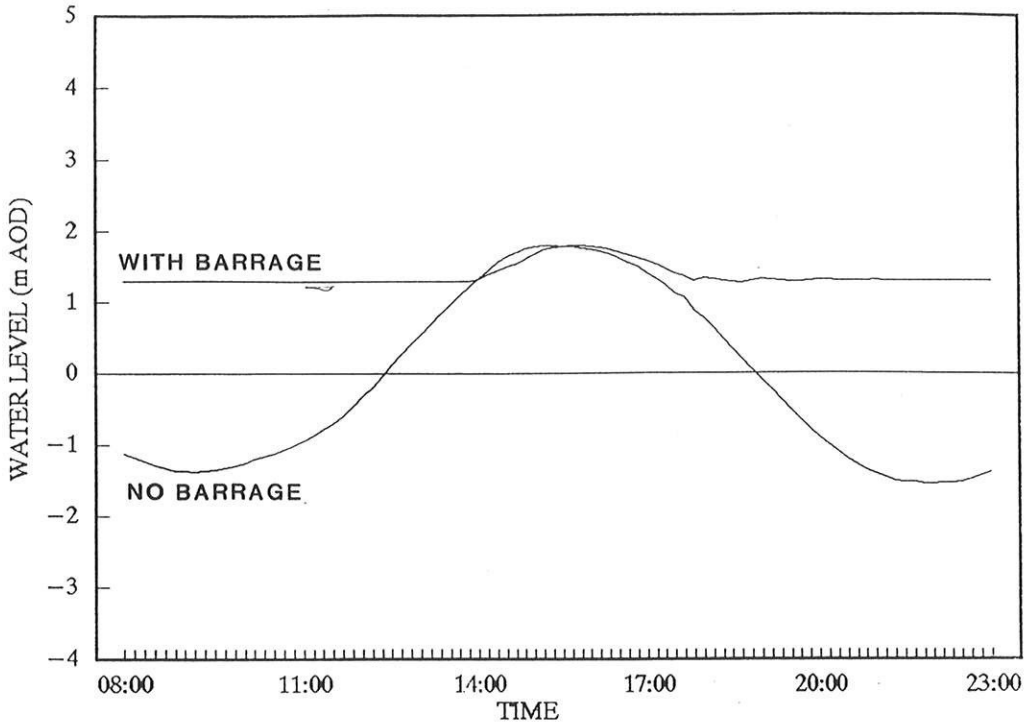
b – 1Km DOWNSTREAM OF GRAND SLUICE

TITLE :

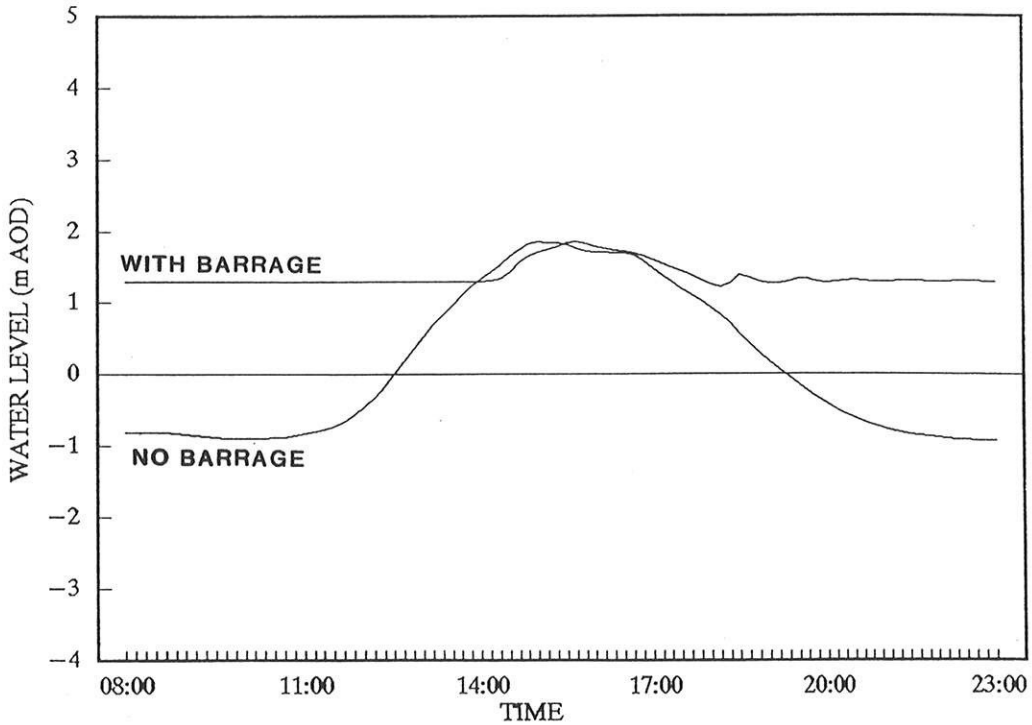
WATER LEVELS FOR A SPRING TIDE
WITH AVERAGE FLUVIAL FLOWS

FIGURE 3.7

Balfour Maunsell
CONSULTING ENGINEERS
NORWICH



a – 1Km UPSTREAM OF TABS HEAD



b – 1Km DOWNSTREAM OF GRAND SLUICE

TITLE :

WATER LEVELS FOR A NEAP TIDE
WITH AVERAGE FLUVIAL FLOWS

FIGURE 3.8

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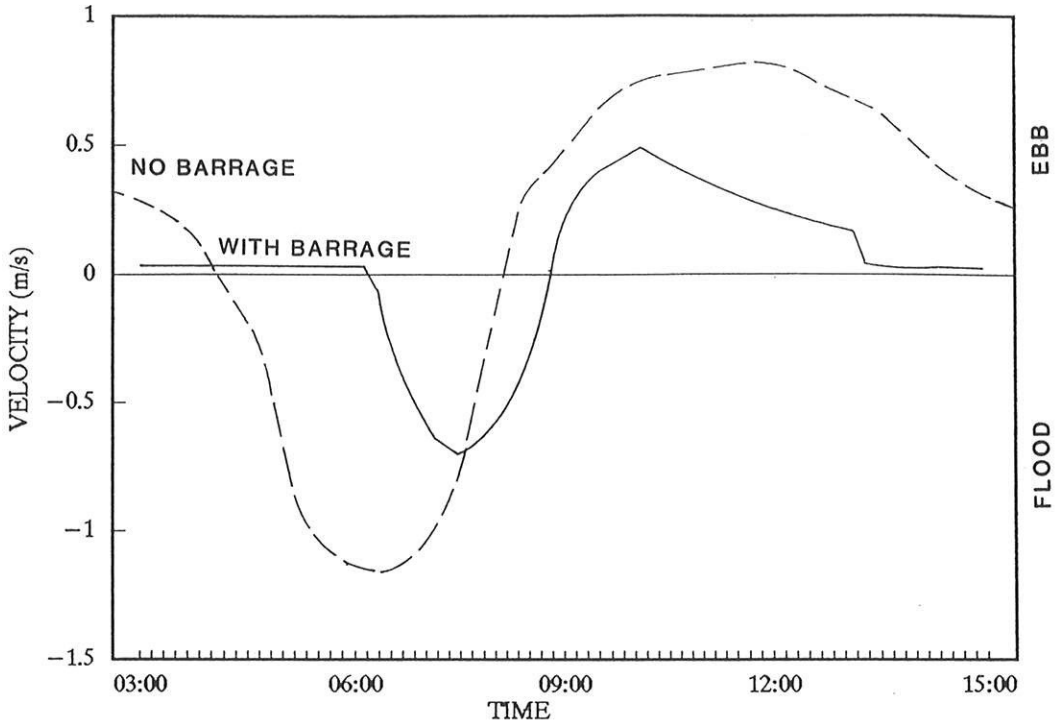

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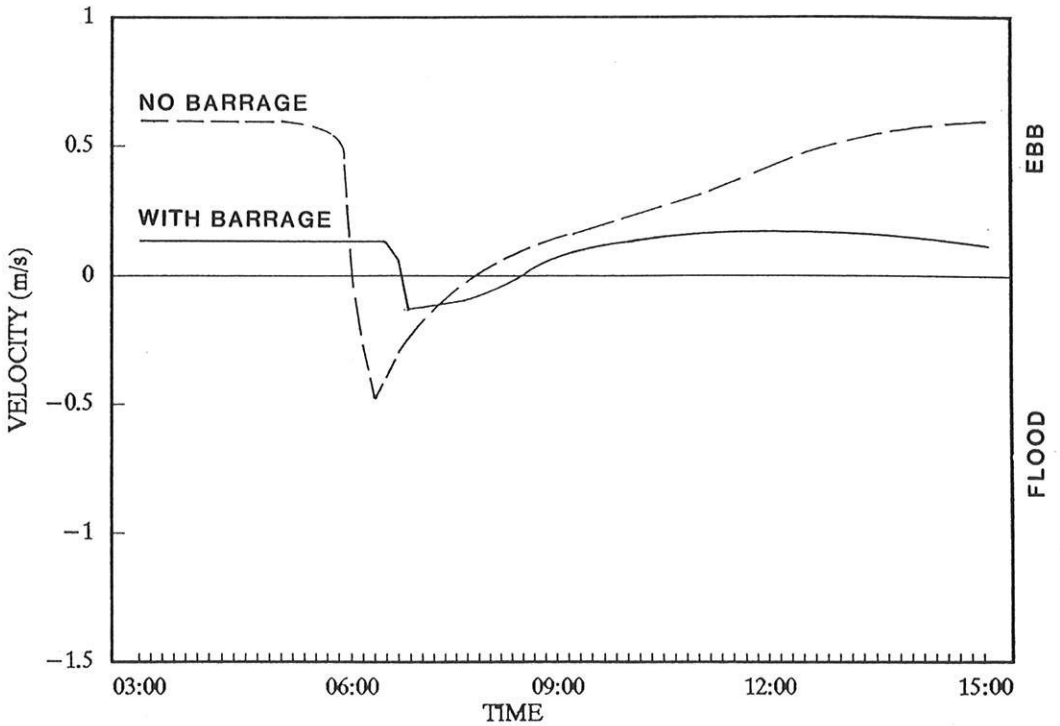

b – 1Km DOWNSTREAM OF GRAND SLUICE

TITLE :

AVERAGE VELOCITIES FOR A SPRING TIDE WITH AVERAGE FLUVIAL FLOWS

FIGURE 3.9

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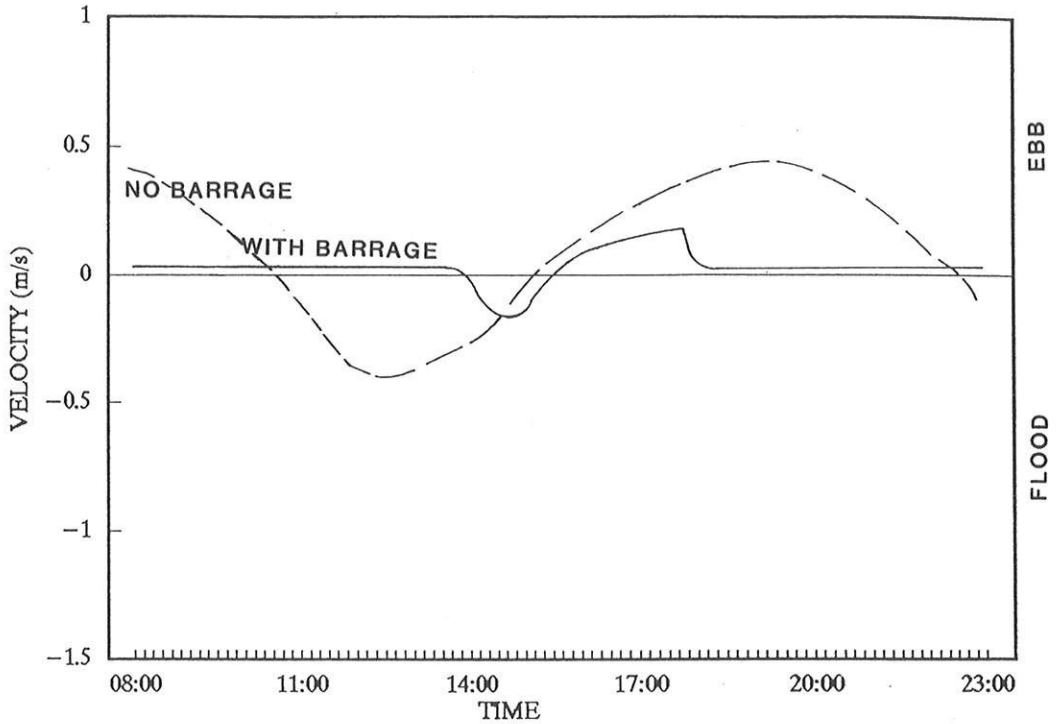
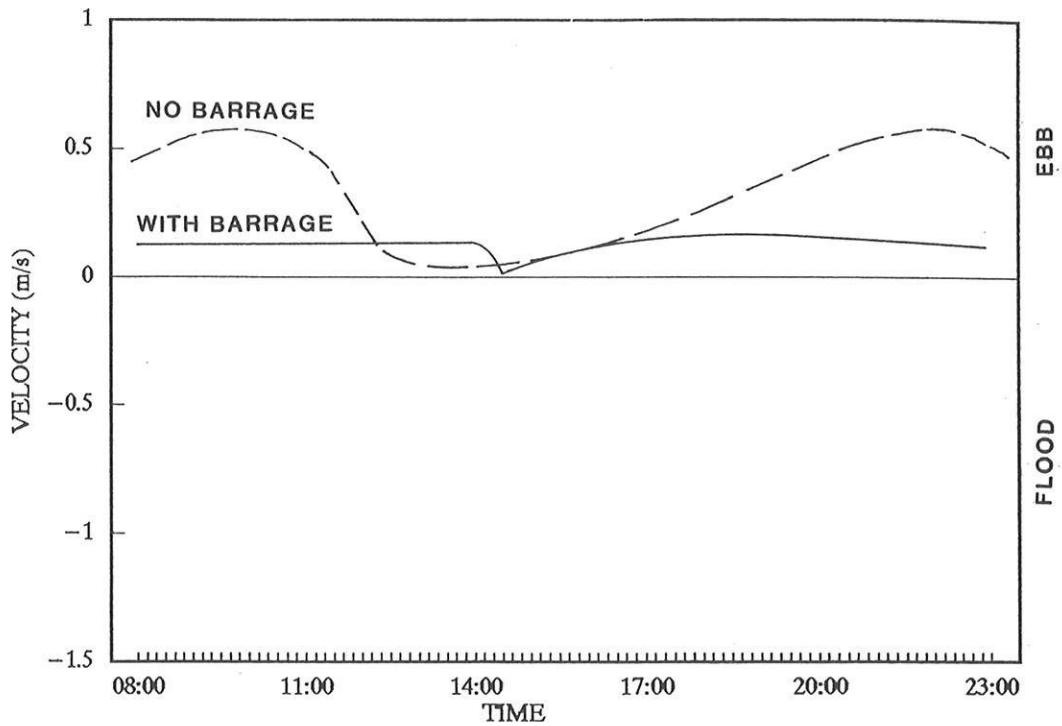


a – 1Km UPSTREAM OF TABS HEAD



b – 1Km DOWNSTREAM OF GRAND SLUICE

TITLE :

AVERAGE VELOCITIES FOR A NEAP TIDE WITH AVERAGE FLUVIAL FLOWS

FIGURE 3.10

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Permanently raising the water level in The Haven would preclude normal gravity discharge from South Forty Foot Drain, Maud Foster Drain and Hobhole Drain. This assumes that current water levels in the drains are maintained. The alternative of raising the water levels within the Drains to achieve gravity drainage above the MRL would require intermediate pumping to effect local drainage, and has not been considered suffficiently attractive to pursue.

A pumping station would be necessary at Maud Foster Sluice and preliminary proposals are illustrated in figure 3.11.

An extension to the existing pumping station at Black Sluice would be required and preliminary proposals are illustrated in figure 3.12.

No work would be required at Hobhole as the existing electric and diesel pumps are adequate.

The operation of the Wyberton Marsh Pumping Station would be unaffected by the barrage proposals.

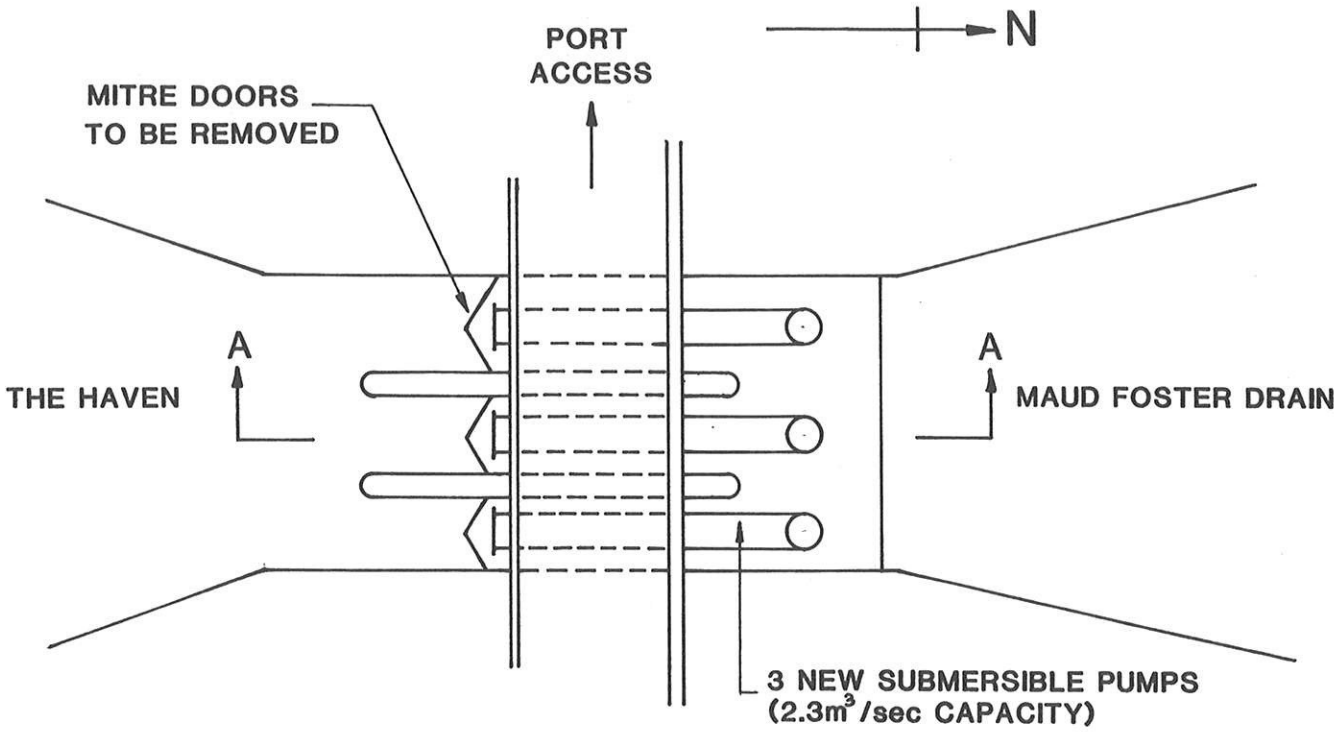
Permanently raising the water level in the Haven will also cause groundwater levels to rise locally. This is considered to be a very local effect and should not cause foundation instability or settlement in the centre of Boston where buildings are generally founded on clay. Any buildings founded on silt or alluvium would be more susceptible to groundwater level changes.

3.2.5 Changes in Hydraulic Regime - Fluvial Flood Conditions

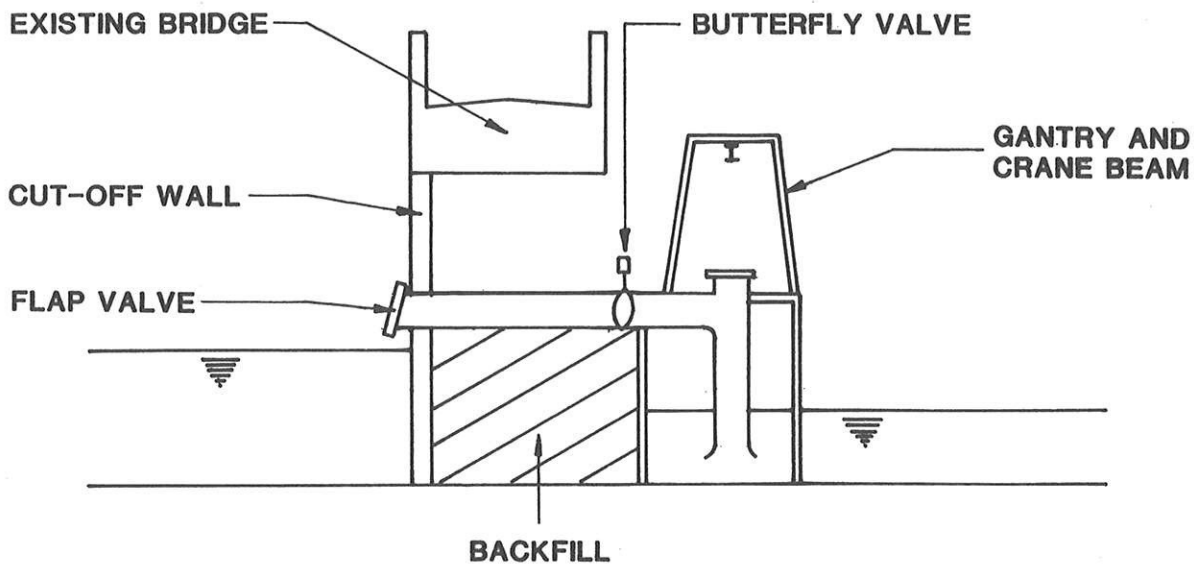
During a fluvial flood event the barrage gates would be permanently open during low tide, and closed during high tide to prevent the incoming tide entering the Haven.

Fluvial flows therefore back up behind the barrage until the gates are reopened on the ebb tide.

During an extreme flood event the lock could also be opened at low tide to lower the water level within the Haven, thus providing greater storage during the tide-locked period.



PLAN



SECTION A-A

TITLE :

NEW PUMPING STATION AT
MAUD FOSTER SLUICE

FIGURE 3.11

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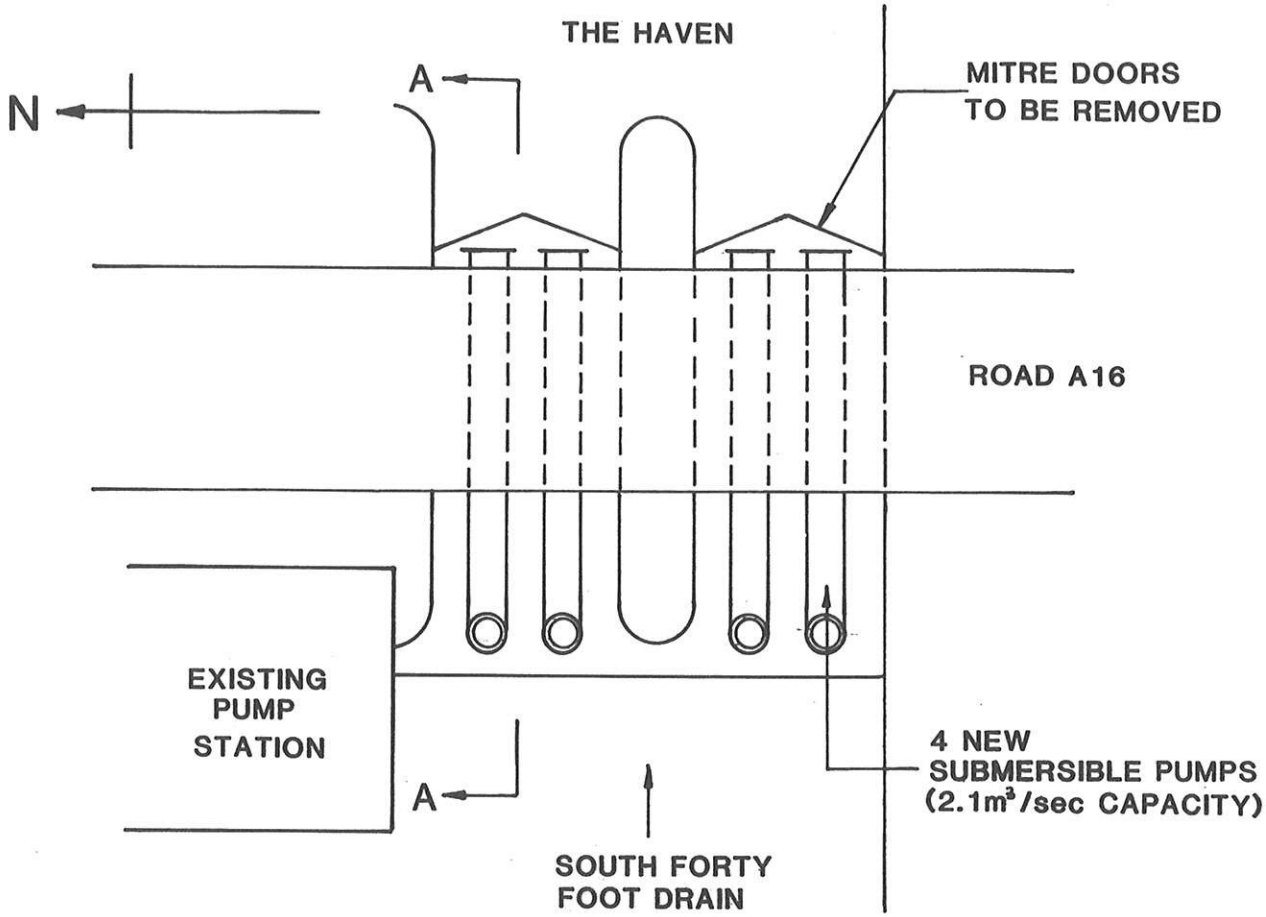
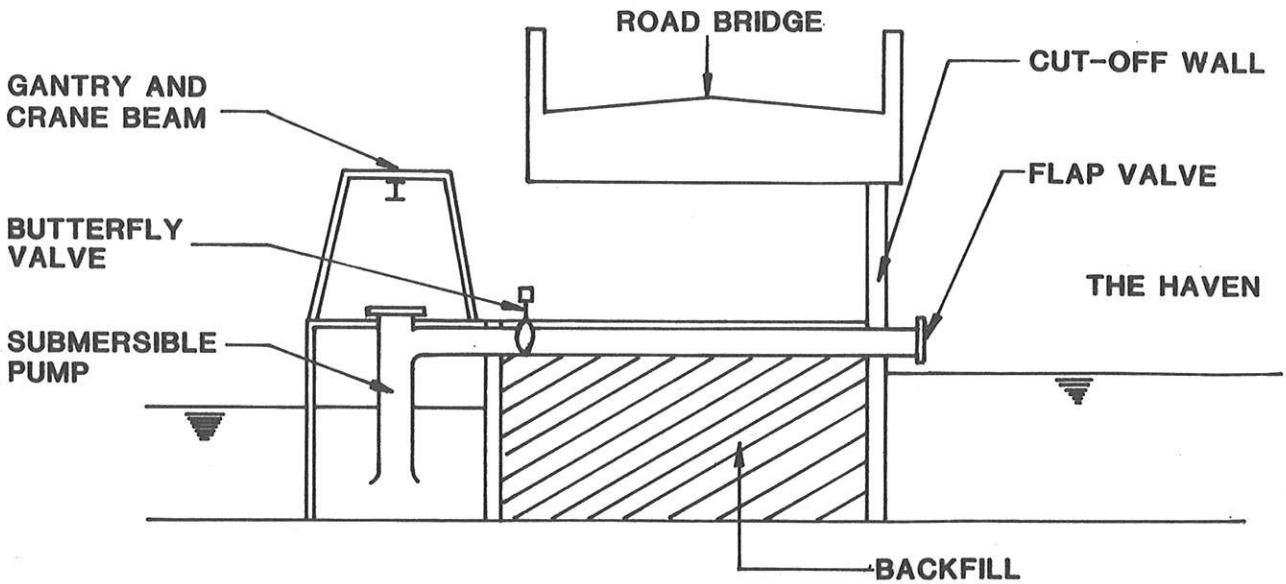


PLAN



SECTION A-A

TITLE:

NEW PUMPS AT
BLACK SLUICE

FIGURE 3.12

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Figure 3.13 compares water levels at a location just upstream of the barrage for a spring tide and for the fluvial flood event described in section 3.2.1 for the situation with and without a barrage.

The water levels are shown for the gates only being used and for gates and lock being used. In the case of the latter the water level upstream of the barrage is drawn down below the MRL to increase fluvial storage.

It can be concluded from this plot that maximum water levels in the Haven for this flood event are reduced with the barrage in either mode of operation.

If the mode of operation which precludes the use of the lock as a flow path during extreme fluvial events is preferred then the gate flow capacity will need to be increased from that assumed in the hydraulic model, by lowering the gate invert levels and also by widening or increasing the number of gates.

A detailed investigation of flood relief for the Lower Witham is currently being carried out for the NRA. A hydraulic model of flows in the river is in the final stages of preparation as well as recommendations for flood alleviation.

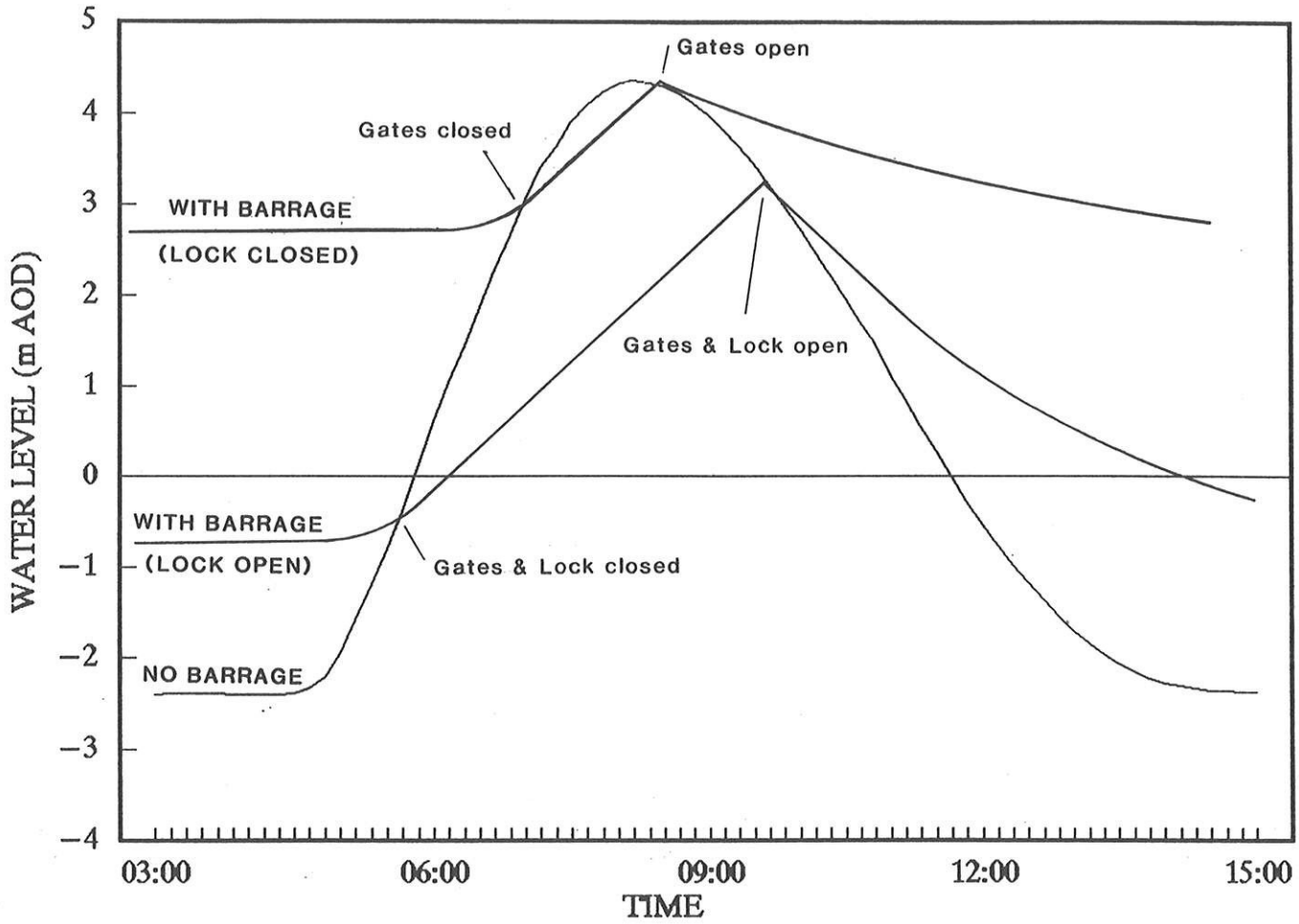
The retained levels in the River Witham above Grand Sluice are as follows:-

(summer)	1.45m AOD
(winter)	0.6m AOD

The level at Grand Sluice is reduced in winter (see above) to allow some additional storage in the river and also to induce a hydraulic gradient in what is in effect a canalised and flat section of river.

A MRL in the Haven of 1.3m AOD will not allow this practise to continue. The hydraulic gradient will not be achieved which may have some impact on siltation.

From a flood control point of view it is probable that the provision of an additional storage reserve offered by the lowering practise will not be required with the barrage in place. As discussed earlier it will be possible to control levels at Grand Sluice at times of extreme fluvial flood to ensure that river flows are less restricted than under existing tidal conditions.



TITLE :

WATER LEVELS FOR A SPRING TIDE
WITH A HIGH FLUVIAL FLOOD

FIGURE 3.13

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An option that could be pursued is the permanent lowering of the retained level in the Haven at particular times e.g. winter months. This lowering, say to 1.0m AOD or even less would allow the River Witham levels to be lowered and may be acceptable for normal shipping operations. As the retained level is reduced there may become a requirement for additional dredging.

For the fluvial discharge situation to be acceptable there must be the facility at the barrage to exclude high tides. This means that a low level barrage option is not a viable option and will not be considered further.

From the foregoing it is assumed that no pumping facility would be necessary at Grand Sluice and that the barrage would be operated in such a way as to enable the river flows to be discharged satisfactorily. Further studies of this system would be required at the detailed appraisal stage - see section 11.

3.3 Siltation

3.3.1 Upstream of The Barrage

The Haven carries a heavy load of silt. No data on the river borne sediments is available but it is believed that the great majority of the silt enters the Haven from the Wash. The silt is carried in on the flood tide and the majority is returned to the Wash on the ebb tide. A small amount of silt settles at slack water which is not resuspended during the ebb tide. This is especially so behind obstacles or at slow moving locations e.g. wide sections, turning basins, inside curves etc.

This settled silt can be resuspended by high fluvial flows and transported down to the Wash or it can be mechanically removed by dredging. The Port of Boston currently dredge up to 60,000 tonnes of silt each year mainly from the dock and river wharfages and return it to the Wash.

Any permanent obstruction in The Haven will affect siltation. If ebb velocities are reduced at any location then siltation could increase.

A barrage will reduce the quantity of silt laden sea water entering The Haven. The quantity of water retained behind the barrage at 1.3m AOD is approximately 2.5 million m^3. The amounts of water entering the Haven with barrage constructed on typical Neap and Spring tides(refer fig 4)would be 0.14 million m^3 and 2.2 million m^3 respectively. The amount of water entering without a barrage is approximately 2 million m^3 on a typical Neap tide and 5.5 million m^3 on a Spring tide.

Studies by HR of sedimentation in the Haven, (Ref. 3 and 4) showed that sediment concentration in the Haven reduced significantly with height above the bed. A barrage has the effect of cutting off flows between bed and the MRL and therefore has the effect of excluding a greater proportion of the sediment flux than is indicated by the reduced water flux.

Calculations of siltation rate based on existing sediment concentrations, and assumed concentrations landward of the barrage, indicate that increased sedimentation arising from a reduction in tidal velocities caused by the barrage is largely balanced by reduced siltation arising from the reduced sediment concentrations. The indication is that siltation from sediments entering from the Wash is not significantly changed.

The openings in the barrage i.e. the lock and the sluices could be operated in such a way as to produce a flushing effect in the Haven. This flushing would be most effective if a high Spring tide were retained by the barrage and then released rapidly to the MRL when the tide had fallen. It has been calculated that this method could produce similar (if not greater) velocities than those currently experienced with similar tides. However, there are some doubts about this flushing:-

(i) rapid drawdown may interfere with navigation and moored craft

(ii) periodic flushing may not be as effective as the normal tidal flushing i.e. settled silt may have consolidated.

It is therefore recommended, at this stage, that the existing level of maintenance dredging be incorporated in the overall economic analysis. However, it should be noted that unlike the current situation, dredging could be carried out almost at any time above the barrage as water levels will allow the continuous operation of floating equipment. Travel to and from spoil grounds would be much less restricted and therefore overall efficiency of the operation would be improved.

3.3.2 Downstream of the Barrage

Reduction in tidal flows up The Haven will have an effect on siltation downstream of the barrage. Because some flows over the barrage (high tides) are to be maintained then the situation is not as severe as a complete tidal exclusion barrage.

As noted in the previous section the amount of water entering The Haven on a Spring tide is approximately 2.2 million m^3 which represents 40% of the 'no barrage' case.

This tidal flow, as well as fluvial flows, barrage flushing flows and flows from the River Welland will assist in maintaining the channel through Cut End Bar.

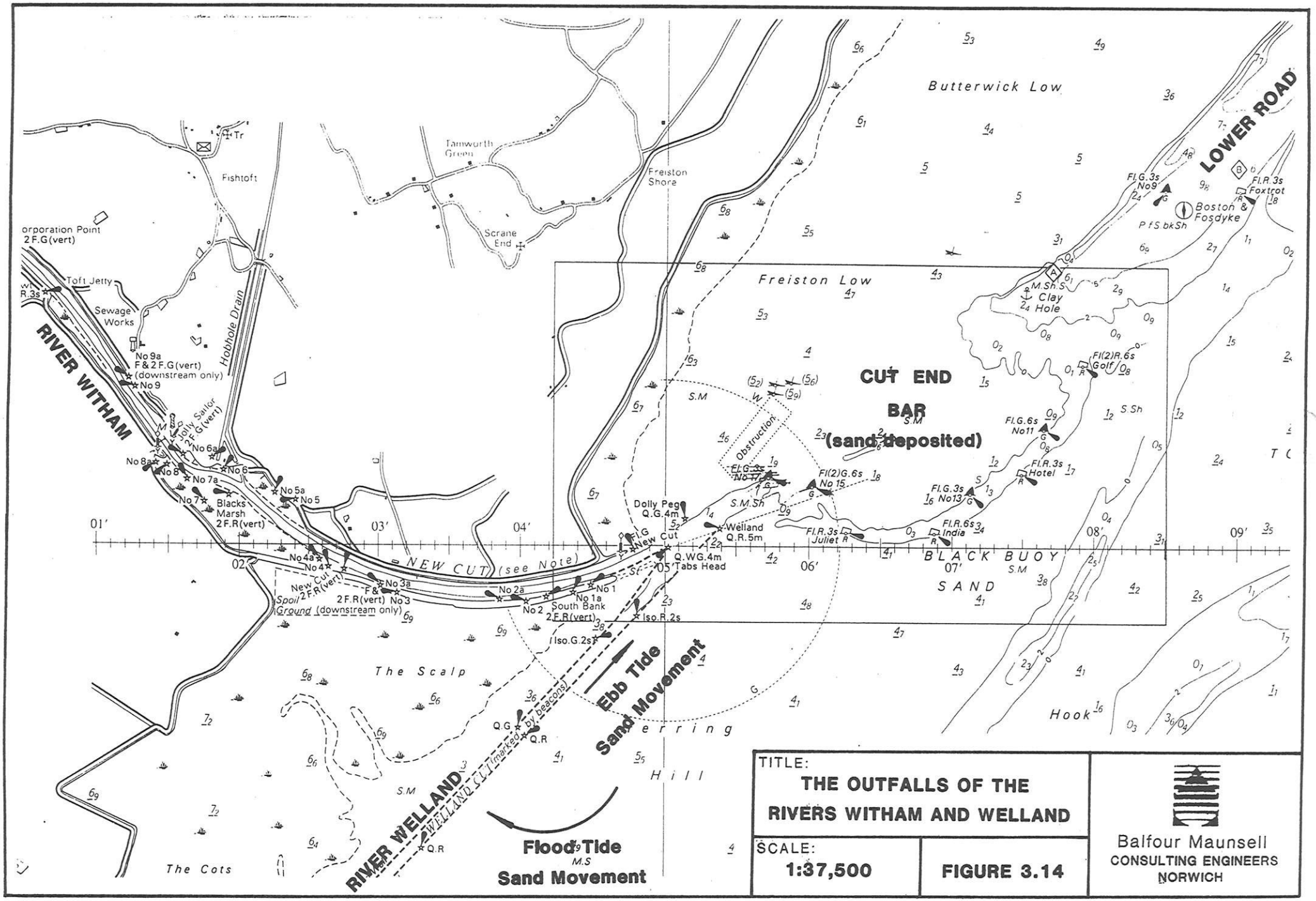
The tidal flushing volumes below the barrage, as stated above, are less than half those existing at present and their effect of maintaining depths will be reduced further if an option involving a deeper approach channel is adopted. Siltation below the barrage will be increased and the consequent requirement for maintenance dredging is discussed in section 3.6.3.

Methods of ensuring adequate outfalls for the Haven and other tidal rivers flowing into the Wash have been studied over many years and 'new cuts' and training walls, etc have been constructed from time to time to provide improvements. It is understood that NRA's current project to prepare a Shoreline Management Plan for the Wash will include the problems of siltation at river outfalls.

The Haven and the Welland, which now join at Tabs Head (refer figure 3.14) have been subject to progressive training which, in turn, has affected the siltation regime (see references 5 and 21). The optimum position and height of existing and possible future training walls to provide the best channel to deep water is still a topic for conjecture.

Cut End Bar, composed largely of fine sand, has grown in the deep channel between Freiston Low and Black Buoy Sand since the training works of the River Welland in 1950. Superimposed on the fairly well balanced oscillatory system of suspended material washed in and out with the tides is a unidirectional system of material washed over the South Training Wall of the Welland Cut on the flood tide and subsequently deposited at Cut End Bar on the ebb tide as the velocities reduce (refer figure 3.14).

Although it is not suggested that any training walls should be constructed solely for the barrage project it may be that as a combined scheme for continued efficient maintenance of the Haven and Welland outfalls a further extension of the training walls is a viable option.



TITLE:
THE OUTFALLS OF THE RIVERS WITHAM AND WELLAND

SCALE: **1:37,500**

FIGURE 3.14

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3.4 Flood Defence

The existing flood defences between the proposed barrage locations and the tidal limit at Grand Sluice consist of:-

(i) earth embankments

(ii) steel sheet piling

(iii) concrete walls

(iv) brick walls

The earth embankments are mainly downstream of the port while the hard defences are largely upstream of the port within the town of Boston.

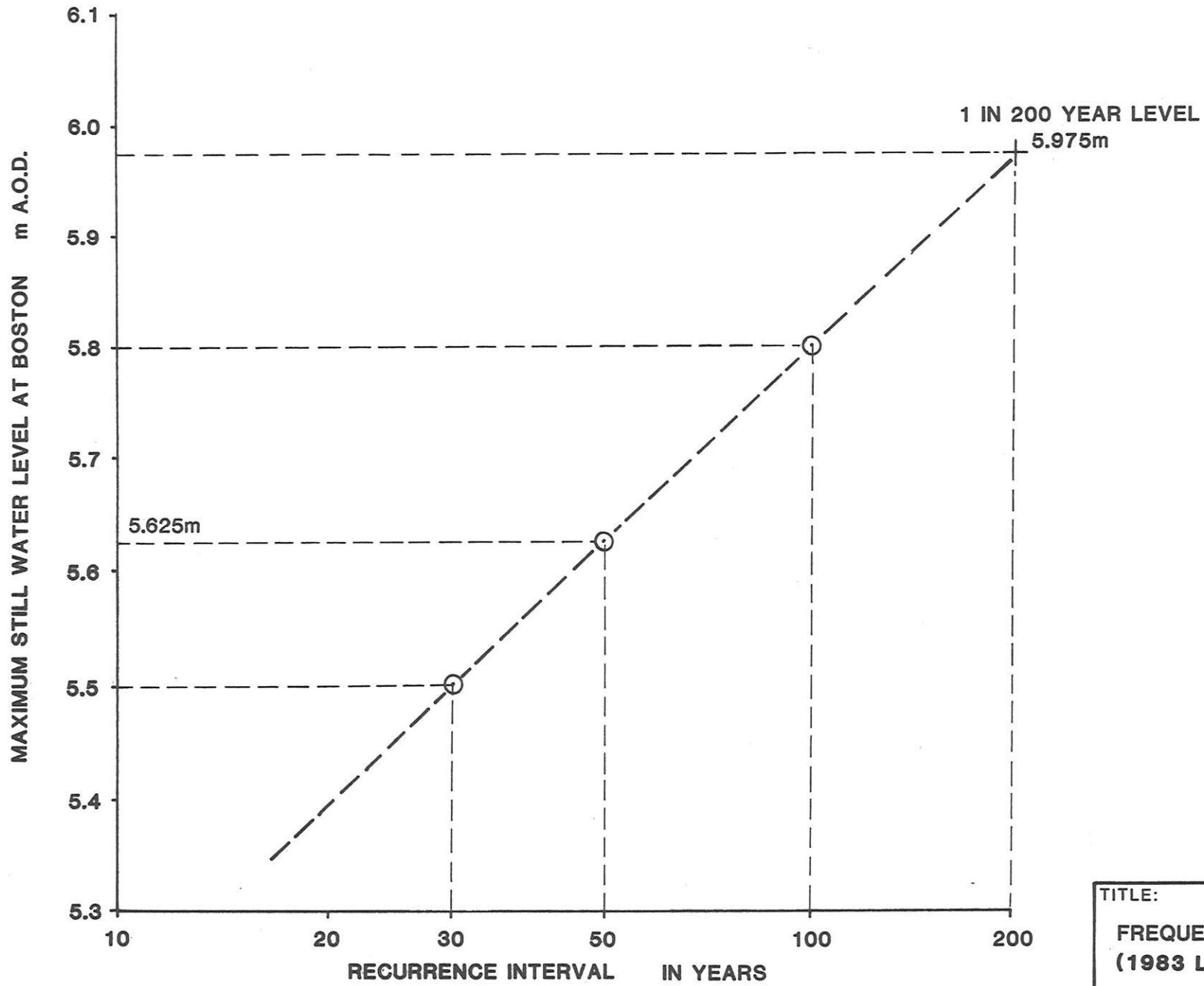
The tidal flood defences through Boston have been constructed to a 1 in 100 year standard of 6.00m AOD (refer to Engineers Report, 1983). The level is based on a maximum still water level of 5.80m AOD and 200mm of sea level rise over 60 years.

According to MAFF Flood and Coastal Defence guidelines (reference 14) the indicative standard of protection for high density urban areas is 1 in 200 year standard. This standard would be applicable to the Boston town area.

The 1 in 200 year still water level at Boston has been estimated from 30, 50 and 100 year levels given in NRA's detailed appraisal report 1992 (reference 11). Gumbel paper (see figure 3.15) was used to estimate the 1 in 200 year level as 5.98m AOD. The figures used are based on 1983 levels and adding 3mm sea level rise to 1992 and 6mm thereafter gives a current value of 6.01m AOD (refer to Annex H of MAFF guidelines for sea level rise figures).

To achieve the 1 in 200 year level of defence the defences require immediate raising.

Fig 3.16 indicates the current predicted still water levels at Boston and their estimated increases based on 6mm effective sea level rise per year. A defence level of 6.3m AOD would provide 1 in 200 year protection to the year 2040 and 6.15m AOD would provide 1 in 100 year protection to the year 2045.



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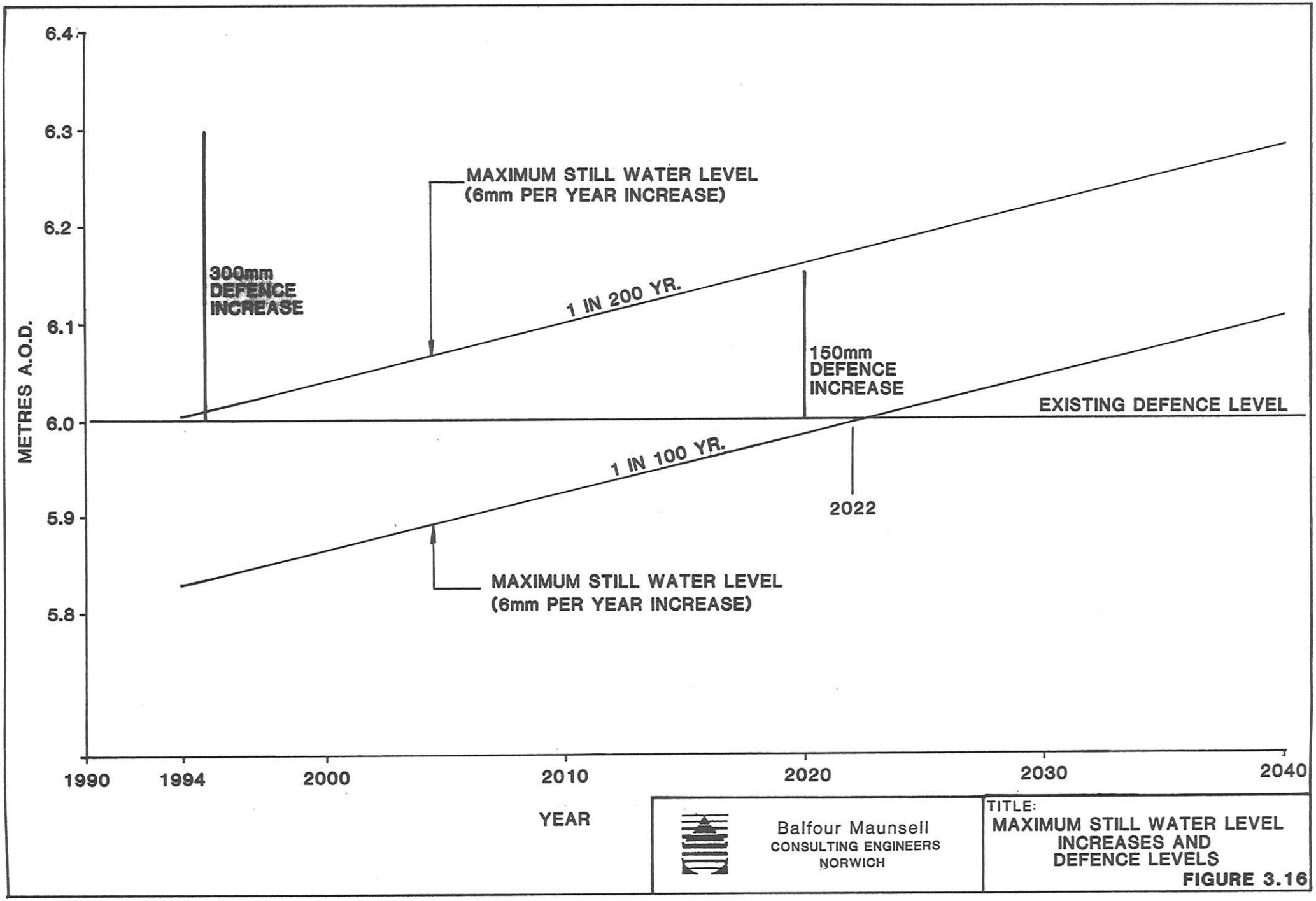
TITLE:

FREQUENCY V WATER LEVEL
(1983 LEVELS)

FIGURE 3.15


6.4
6.3
6.2
6.1
6.0
5.9
5.8
METRES A.O.D.
300mm
DEFENCE
INCREASE
MAXIMUM STILL WATER LEVEL
(6mm PER YEAR INCREASE)
1 IN 200 YR.
150mm
DEFENCE
INCREASE
EXISTING DEFENCE LEVEL
1 IN 100 YR.
2022
MAXIMUM STILL WATER LEVEL
(6mm PER YEAR INCREASE)
1990
1994
2000
2010
2020
2030
2040
YEAR
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NORWICH
TITLE:
MAXIMUM STILL WATER LEVEL
INCREASES AND
DEFENCE LEVELS
FIGURE 3.16

To provide protection to the given standards the following works are required:-

for 1 in 200 year protection
- add 300mm to walls through Boston immediately
- add 300mm to Haven embankments that are currently at 6.4m AOD (Note the additional height is required for embankment allowance)

for 1 in 100 year protection
- add 150mm to walls through Boston in year 2020
- add 150mm to Haven embankments currently at 6.4m AOD in year 2010

The raising of the flood defences has both financial and environmental costs.

The financial cost of raising the walls through the town of Boston is significant because several of the walls are freestanding and would require additional support and where the walls are parts of buildings structural amendments e.g. filling in window openings are required.

The estimated construction costs at present values of the additional height of flood defences is as follows:-

	1 in 100 year standard	**1 in 200 year standard**
Hard defences through Boston	**£322,000**	**£650,000**
Earth embankments to The Haven	**£578,000**	**£850,000**
TOTAL	**£900,000**	**£1,500,000**

Already the existing walls tend to be obtrusive and cut off the river from the town. Any additional height of walls will make matters worse. The environmental consequences are discussed in planning and environmental sections which follow.

If the barrage were constructed these additional walls would not be required. The primary defence against sea flooding would be the barrage which could be closed when high surge tides were forecast. Not only would the raising not be required but the existing flood defence walls could be lowered - for example at Custom

House Quay (Appendix 1, photos 1 and 2). This would improve the appearance of the riverside area and improve access to the river.

The training wall on the southern bank of the Haven from a position almost opposite Hobhole Drain to the outfall does not act as a flood defence embankment currently but only to maintain the river alignment. If a barrage were to be built downstream of Hobhole then part of this training wall would need to be upgraded to full flood defence standard and linked to the existing defences. A cost item has been included where this upgrading is required.

For the barrage to act as a flood defence barrier providing the required level of confidence the structure and the gates must all be constructed and operated to the NRA's approval. As mentioned in section 3.1.2 agreed operating procedures are essential covering all eventualities.

3.5 Construction of the Sea Lock and Barrage

3.5.1 Ground Conditions - Barrage Foundations

Ground conditions have been estimated from existing borehole data and geological maps. Information is relatively sparse in this area and further site investigations will be required in following stages of the project.

The underlying strata is Boulder Clay overlain by more recent deposits of soft clays, silts, peats and sands.

The depths to the Boulder Clay, which would provide an adequate foundation, vary from 6m below Ordnance Datum to approx 15m below O.D.

The foundations would depend on depth to the clay and would either be:-

a) direct on to the clay
b) poor ground above clay replaced by mass concrete
c) on piles into the clay

It is envisaged that sheetpiling around the lock and barrage would be required in all cases as a temporary 'coffer dam' and as part of the permanent works. The sheetpiling would act to exclude water from the excavation or completed foundations.

The lock and sluice sections of the barrage would be connected to the existing flood defence (or southern training wall) embankments by earth embankments. The length of these embankments vary with the location. The construction of these embankments will not necessarily involve removal of all material down to boulder clay. Soft surface material will be removed and imported clay placed and compacted to the required profile. Stone protection of the embankment slopes has been allowed for.

The cost estimates at this stage will necessarily show a wide variation reflecting these unknown ground conditions.

3.5.2 Construction Constraints

As referred to in section 3.1.4 the construction of the lock and barrage must not impede navigation to and from the Port. This would require work to be completed in at least 2 phases. The lock would be constructed initially and only when

completed and put into service, the remainder of the barrage and sluices could be constructed.

The works would require careful planning and execution to ensure that flood defence would not be compromised at any stage.

There would inevitably be construction constraints related to access to the site, protection of adjacent property and protection of environmentally significant areas. These subjects are dealt with in more detail in chapter 6 covering Environmental Studies.

3.5.3 Capital Dredging

Dredging would be required during the barrage construction project in two general locations:-

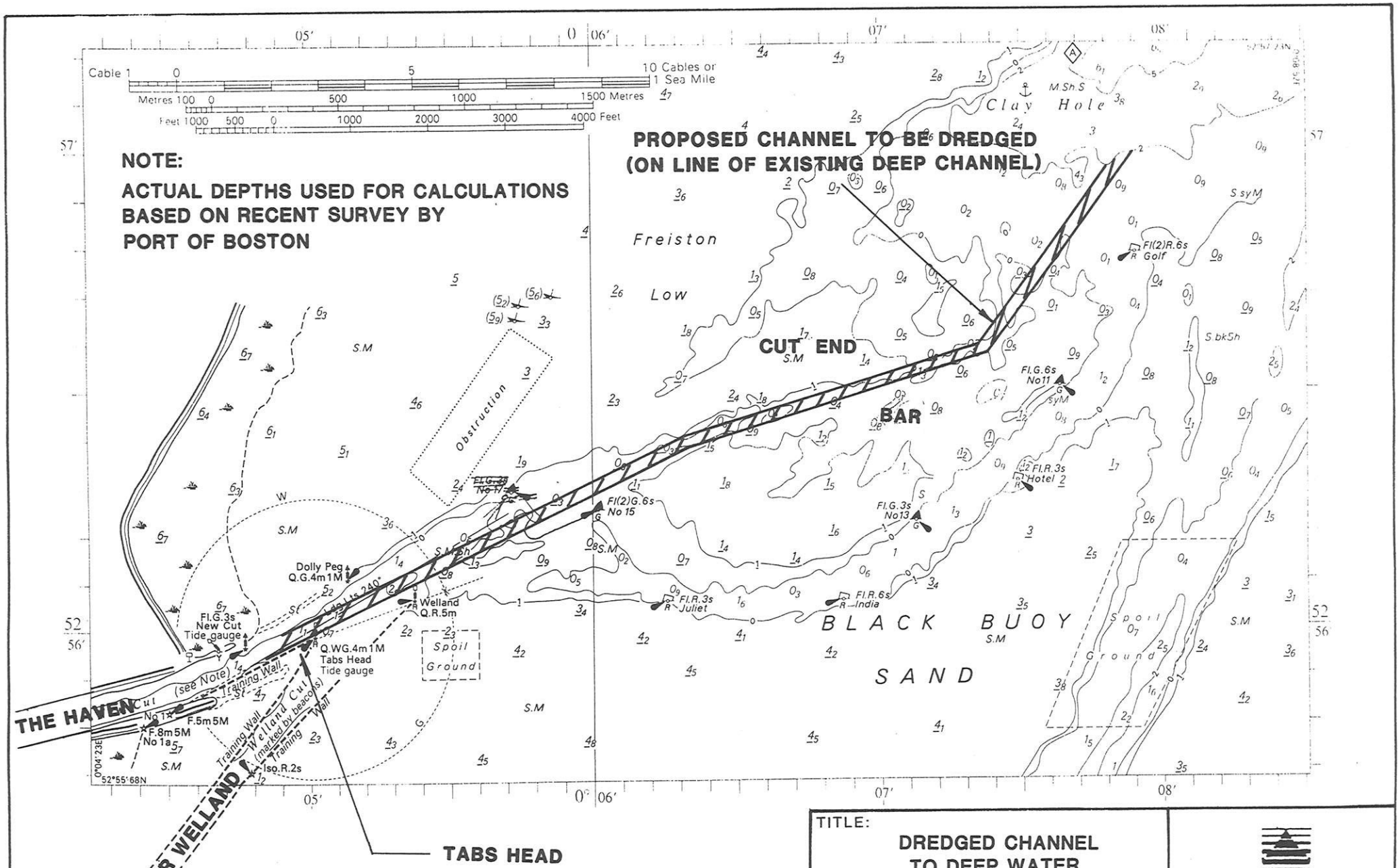
(i) within the Haven to direct the main channel through the newly constructed lock

(ii) downstream of the lock in the Haven and beyond Tabs Head through Cut End Bar and part of Freiston Low to deepen the approach channel to at least the chosen level of the lock. Refer to figure 3.17.

The quantities to be dredged for the above two categories depend on chosen location and depth of lock. The locations are shown on figure 3.6 and the depths are as given in section 3.1.3.

The estimated total dredging quantities for the combinations of location and lock depth are given below:-

	1000's m³ for Lock Sill Level (ordnance datum)			
Location	-4.2m	-4.7m	-5.2m	-5.7m
1	144	227	322	423
2	147	224	311	405
3	135	198	272	350
4	115	175	246	323



TITLE:
DREDGED CHANNEL TO DEEP WATER

SCALE:
1:20,000

FIGURE 3.17

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The costs of dredging depend very largely on availability of suitable dredging equipment and means of disposal of the arisings. For the purposes of this study a generous total cost of £4 per m^3 has been adopted.

The Port of Boston currently has a licence to deposit 70,000m^3 of dredging arisings per year at the spoil ground south east of Welland buoy (refer figure 3.17).

Depending on the type of material to be dredged and the contractors preferred methods, the dredged material could be deposited at one or more of the following:-

(i) on land close to the construction site

(ii) at the licensed spoil ground

(iii) at a new licensed spoil ground within or outside the Wash

(iv) as part of a minor beach or saltmarsh replenishment project

Disposal of dredged material and methods of dredging could have significant environmental implications and would require detailed assessment - refer to section 6.

3.6 Scheme Costs

3.6.1 Sea Lock and Barrage Construction Costs

Construction costs are based on a detailed outline design for the structure and its foundations and on current (April 1994) rates for similar work. Contingency sums have been incorporated in the estimates to provide the anticipated overall construction costs.

The different depths of lock (refer section 3.1.3) have made insignificant changes to overall lock cost estimates at this preliminary stage. The greater amounts of structural concrete with the deeper options were offset by less foundation costs.

The sluices, have been costed as 2 No. 17.5m wide fish belly gates with inverts at 0.0m Ordnance Datum and top level of 7.0m O.D. These gates would be hydraulic cylinder operated at one end only and would be operated so that the chosen upstream level can be maintained.

A walkway has been allowed for over the sluices and lock(s) but no vehicular access. Maintenance involving heavy equipment would require special provision for access or access from the sides of the barrage.

The following table sets out the itemised estimated costs for the various option locations:-

Common to the estimates for each option are the following allowances for major components:-

Vertical Sector Gates	(22m wide)	£1.13 million per pair
	(10m wide)	£0.50 million per pair
Lock Fenders and Rubbing Strips		£0.15 million total
Jetty Fenders		£0.14 million total
Fish Belly Flap Gates		£0.5 million each

	(All estimated costs in £million)			
	Location 1	**Location 2**	**Location 3**	**Location 4**
Lock including access, gates, fenders etc (all depths)	**15.4**	**15.4**	**15.4**	**15.5**
Additional cost for two locks	**0.5**	**0.5**	**0.5**	**0.5**
* Lead-in jetties including fenders	**1.4 to 2.0**	**1.4 to 2.0**	**1.4 to 2.0**	**1.4 to 2.0**
* Additional cost for two locks	**0.3 to 0.4**	**0.3 to 0.4**	**0.3 to 0.4**	**0.3 to 0.4**
Sluices	**2.7**	**2.7**	**2.7**	**2.7**
* Foundations	**1.8 to 7.0**	**1.8 to 7.0**	**1.8 to 7.0**	**1.8 to 7.0**
Side Embankments	**0.4**	**0.1**	-	-
Raising of Training Wall	-	**0.1**	**0.3**	**0.5**
** Capital Dredging	**0.6 to 1.7**	**0.6 to 1.6**	**0.5 to 1.4**	**0.5 to 1.3**
TOTALS (excluding additional cost for two locks)	**22.3 to 30.1**	**22.1 to 29.8**	**22.1 to 29.7**	**22.4 to 29.9**
Additional Cost for two locks	**0.8 to 0.9**	**0.8 to 0.9**	**0.8 to 0.9**	**0.8 to 0.9**

* the variation in estimates is because of uncertain ground conditions - refer to section 3.5.1.

** the dredging quantities vary with alternative depths of lock sill

According to the preliminary estimates tabulated above the overall variation of barrage and sea lock cost is between £22.1 million and £31.0 million depending on ground conditions, depth of sill and whether one split lock or two separate locks are provided.

3.6.2 Sea Lock and Barrage Operating Costs

The operating costs of the sea lock and barrage comprise the operating personnel and the maintenance costs.

The estimated costs for operating personnel are based on 24 hour manning by a controlling officer and two attendants.

Including routine maintenance on all the mechanical equipment, the total operating costs have been estimated at £300,000 per annum.

3.6.3 Maintenance Dredging Costs

Siltation and consequent maintenance dredging has been discussed in section 3.3.

In section 3.3.1 it is recommended that the existing level of Port dredging be included in the economic analysis to allow for continued siltation above the barrage.

The maintenance dredging downstream of the barrage and across Cut End Bar to Clayhole (refer fig 3.17) could be substantial. Depending on the chosen depth of channel the amount of maintenance dredging could vary from 25,000m³ to 100,000 m³ per year which corresponds to a range of total costs from £100,000 to £400,000.

3.6.4 Drainage Pumping Stations

The estimated capital and operating costs of the pumping stations described in section 3.2.4 are tabulated below:-

Pumping Station	Capital Cost	Additional Annual Maintenance Costs
Maud Foster	**£420,000**	**£39,000**
Black Sluice	**£560,000**	**£110,000**
Hobhole	-	**£50,000** *

* only for barrage sites downstream of Hobhole

Maintenance costs have been estimated from anticipated electricity charges and maintenance requirements.

3.6.5 Sewerage Amendments

It is considered highly likely that some current raw and treated sewage discharges to the river would require improvement if the Haven were to become partially impounded with a barrage. Several properties with direct discharges of sewage to the river have recently received cessation notices from the NRA. It is believed that all these situations will be rectified soon.

There are several large storm overflows to the river from sewage pumping stations. The frequency of use and potential pollution impact will require further study.

For this preliminary study it has been agreed with Anglian Water personnel that only 2 areas warrant consideration at this time:-

(i) overflows from East Side Pumping Station

(ii) final effluent from the Boston sewage treatment works

To reduce the overflows from East Side Pumping Station, additional storage tanks could be provided at an estimated cost of £350,000.

To prevent any polluting effects from the sewage treatment works effluent it has been assumed that the effluent could be pumped to the seaward side of the barrage. The estimated costs of the required pumping main vary between £110,000 and £575,000 depending on barrage location.

4. PORT, FISHING AND BOATING STUDIES

4.1 Introduction

This part of the study deals with the potential benefits to three elements of the economy and makes a quantitative forecast of the net benefits. The three elements concerned are: the port; professional fishing; and leisure boating.

Information has been obtained from:

- statistical sources and reports
- contact with the local port, fishing and leisure organisations together with their suppliers and customers, for example ship owners, ships' agents and other organisations concerned with goods flowing through the port.

4.2 Trade Flows

Boston is well located for goods travelling between England and the near Continent and Scandinavia. Geographically the port lies almost midway between the south coast of England and the Scottish border, is directly opposite the industrial heartlands of the West Midlands. Goods are distributed from Boston to the whole country but in particular serves the major connurbations in industries within about a 60-mile radius.

Two disadvantages that the port faces are:

- limitations on access to the port: beam, draft and duration during 24 hours
- lack of direct motorway access.

Many ports on the east coast are tidal and so limit the draft of vessels which can get in and also the time periods during the day and month when ships can enter or leave these ports. However, many of the ports on the Continent and in Scandinavia are limited in a similar fashion and in some cases also by air draft. Origins and destinations on the Continent may be some distance inland up canals, the Rhine, etc. The vessels that can reach such places are limited in size often to about 2,000 dwt and most of these are able to obtain access to a port like Boston on enough tides during the month, and for a sufficient time window in each day, to operate reasonably economically. However, Boston does not provide easy access to all the vessels that can obtain reasonable access to, for example, the Rhine.

4.2.1 Developments in Marine Transport

Optimum Ship Size

Over time, and particularly in recent years, ship sizes have increased provided there is sufficient cargo to fill a vessel, and the bigger it is the more cost effective it will be. In particular the capital cost and crew costs per unit of cargo carried drop sharply as size increases.

Apart from the obvious physical limitations of available ports, optimum size is limited by a number of other factors. The most important of these is the time the ship must spend in port which consists of unloading time and manoeuvring in the confines of approach channels in the port itself. In a sense the vessel is only earning money while it is en route and apart from fuel costs, the other costs of running the vessel remain much the same as when it is at sea. Another major factor is frequency of service: for a given volume of trade, the frequency of service decreases as size increases and the cost to the shipper increases as the goods lie idle. Such costs are now a major consideration to management.

A major factor allowing ship sizes to increase since the Second World War has been the introduction of completely new cargo handling systems and practices. Gangs of men working with small bags and individual items of cargo with the help of a small crane have been replaced by containerisation and rapid handling by high capacity long-outreach cranes, by roll-on roll-off and by efficient palletisation. Labour, now a high cost ingredient, has been reduced to a fraction of former levels.

Port Sizes and Numbers

The result of these changes has been a concentration of traffic on bigger ports. This in turn has enabled those ports to invest in order to increase both the efficiency of their cargo handling facilities and, on the marine side, to cater for the bigger ships with bigger quays and basins.

At the same time, overland transport has become more efficient with the introduction of motorways and bigger, more efficient vehicles. The effect on ports has been similar to the effect on the marine side: concentration on fewer, efficient trunk routes has provided economies of scale which in turn have reinforced the position of the major ports.

There will certainly continue to be a role for smaller ships while production facilities remain as smaller units and continue to be located on their own and in places where access is limited. If their future is insecure then the role for smaller vessels may also be insecure. As far as the trading-partner ports are concerned, small vessels can be accommodated at big ports and so the small ports are threatened to a degree. However, smaller ports may have lower charges and, as the costs of the vessels they serve are lower, may not need to invest in such sophisticated, high capacity equipment as the bigger ports. A port such as Boston has as a principal advantage its location which minimises both sea and overland journey lengths for small volumes of cargo for which a high capacity service does not offer a cost reduction.

4.2.2 Boston's Recent and Current Traffic

The Port of Boston has provided information about imports and exports from 1990 to the present and other data is available from Customs & Excise, the Department of Transport and other sources about trade through Boston and other east coast ports.

A summary of trade in recent years is given in Table 4.1. Tables 4.2 and 4.3 give commodity imports and exports and Table 4.4 shows container traffic.

From Table 4.1 it is readily apparent that container traffic steel imports and grain exports are the principal trades on which the port currently depends and, taking imports and exports together, steel grain and containers, each account for approximately a third of the total traffic. This is illustrated in Figure 4.1. Broadly the balance of trade is one third exports and two thirds imports.

Figure 4.2 gives the development of trade for East Coast as a whole, and for Boston, over a ten year period. East Coast trade has increased steadily faster than Gross Domestic Product, GDP.

Boston traffic represents a very small percentage of East Coast as a whole and this percentage has declined from around 2% at the beginning of the period to around 1.4% at the end of it.

Over this period Boston traffic has first increased and then declined. Figure 4.3 illustrates the variation and also shows that in relation to GDP, traffic has remained effectively constant.

Table 4.1 - Breakdown of Total Traffic

				12 months
	1990	1991	1992	1993
Steel Imports	258973	288920	377160	291000
Steel Exports	4332	3688	1256	789
Total Steel	263305	292608	378416	291789
Grain Imports	19090	27673	70645	82563
GrainExports	386532	321736	373849	430233
Total Grain	405622	349409	444494	512796
Container Impor	308397	285606	269098	285289
Container Export	139229	128414	109908	140887
Total container	447626	414020	379006	426176
Other Trades	274007	190187	132155	130835
Total Trade	**1390560**	**1246224**	**1334071**	**1361596**

Table 4.2 - Commodity Imports

				12 months
	1990	1991	1992	1993
Steel	258973	288920	377160	291000
Timber	61165	36170	22899	31801
Soya Bean Meal	33706	18714	36838	48347
Chipboard	8711	4090	3090	952
Solid Fuel	18350	21476	18368	9279
Potatoes	1728	1230	3345	900
Malt	3055	5701	7318	3794
Oats	605	656	627	0
Rice	9611	8801	2308	6909
Wheat	1018	9652	55847	67246
Barley	7856	7251	3317	3727
Sunflower	0	1313	8546	4681
General	109297	92986	36695	32134
Other	34211	7914	1936	626
Total	**548286**	**504874**	**578294**	**501396**

Source: Port of Boston

Table 4.3 - Commodity Exports

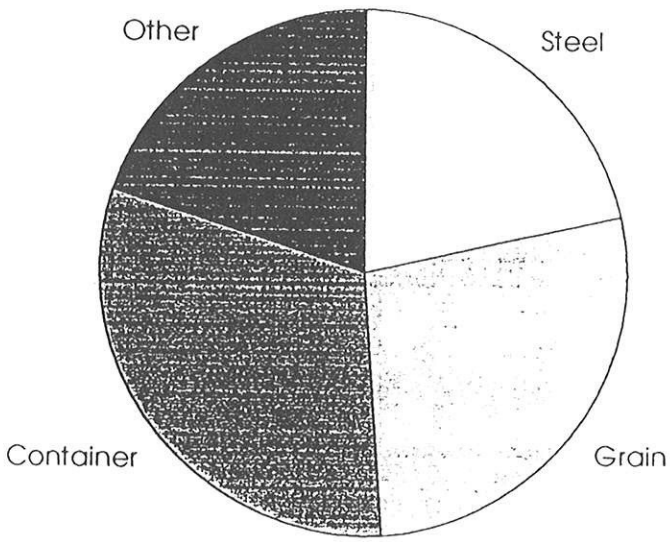
	1990	1991	1992	1993
Grain	386532	321736	373849	430233
Steel	4332	3688	1256	789
General	3784	1906	1554	2614
Timber	0	0	0	388
Loaded Trailers	0	0	83	0
Empty Trailers	0	0	29	0
TOTAL	394648	327330	376771	434024

Table 4.4 - Container Traffic

	1990		1991		1992		1993	
							Actual	
	Tonnes	Units	Tonnes	Units	Tonnes	Units	Tonnes	Units
Imports Loaded	307751	19627	285017	17703	268954	15360	284552	16672
Imports Empty	646	172	589	152	144	36	737	187
Exports Loaded	81378	5863	83103	6115	74356	5079	112124	8097
Exports Empty	57851	14683	45311	12003	35552	9821	28763	8453
TOTAL	447626	40345	414020	35973	379006	30296	426176	33409

Source: Port of Boston

Figure 4.1 - Boston, Breakdown of Total Trade in 1993



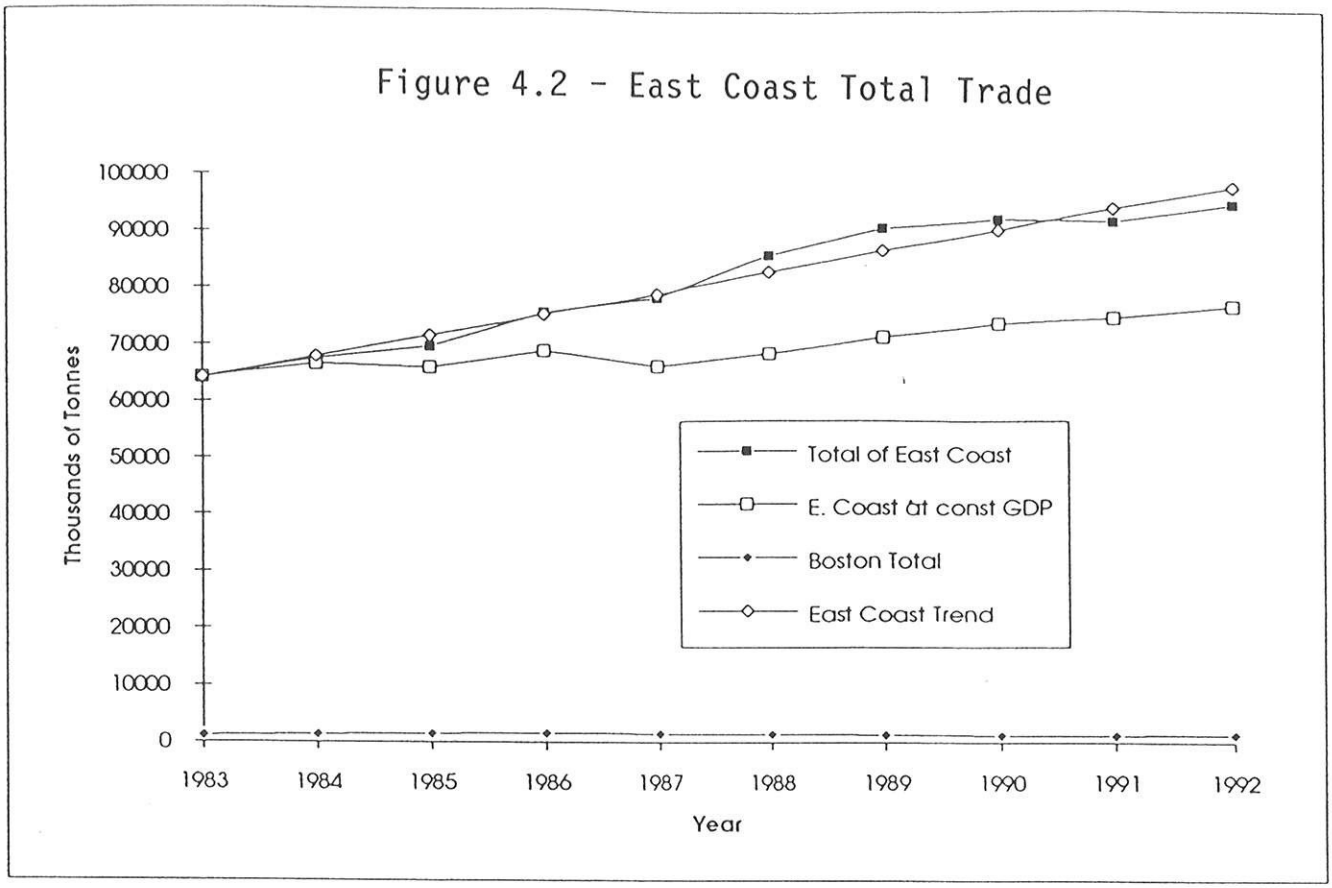


Figure 4.2 - East Coast Total Trade
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
Thousands of Tonnes
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
Year
Total of East Coast
E. Coast at const GDP
Boston Total
East Coast Trend

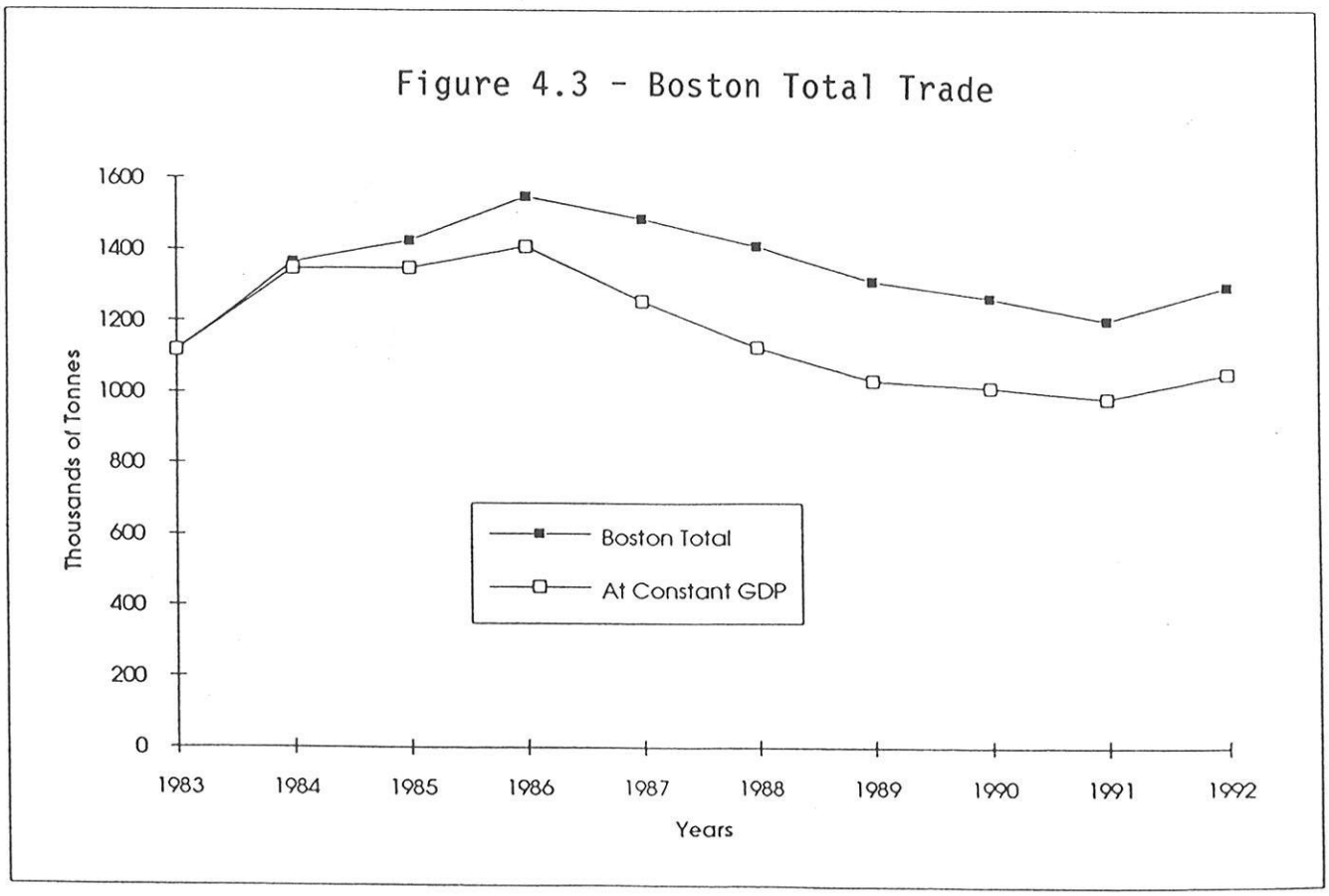


Figure 4.3 - Boston Total Trade
1600
1400
1200
1000
800
600
400
200
0
Thousands of Tonnes
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
Years
Boston Total
At Constant GDP

4.2.3 Grain

Grain exports are generated largely by the agricultural hinterland surrounding the port. This is one of the country's richest agricultural areas. The area also imports a certain amount of animal feed and other grain not grown locally for human consumption (such as hard wheat).

However, Boston does not handle a particularly high proportion of the local grain exports, much of which moves to bigger ports to be loaded into the larger vessels of 6,000 - 25,000 tonnes. According to Lingrain, the local grain loading and storage facility, only about 20% of grain travels in ships of less than about 2,500 tonnes and bigger ships have only limited access to Boston.

Lingrain can store 45,000 tonnes at Boston and load or discharge at over 300 tonnes/hour although the net rate may be only 200 tonnes/hour because of the need to move the ship under the shore equipment. There are other agents which handle grain using mobile elevators. At Immingham Lingrain has a much bigger facility capable of handling ships up to about 30,000 deadweight tonnes and loading at a rate of 1,000 tonnes per hour. Storage is rather less than at Boston, approximately 28,000 tonnes.

Approximately 75% of the UK's imports and exports of barley and wheat have origins and destinations in the EEC/North Sea area (and sometimes include Russia). The proportions are given in Table 4.5 and illustrated in Figures 4.4 and 4.5.

In recent years Boston has accounted for about 8% of the UK's exports of wheat and barley combined but percentages of the individual crops, of imports and exports (separated), and in different years, vary quite a lot.

Over a 10-year period, wheat and barley imports and exports can be seen to have changed significantly between one year and another but there is no apparent overall trend, up or down. Grain imports and exports around the European area vary as different countries experience different weather conditions, resulting in shortages and surpluses, and are affected by currency fluctuations.

Table 4.5 - UK trade in Barley and Wheat - 1984/5 to 1992/3

Inports

Barley

	84/5	85/6	86/7	87/8	88/9	89/90	90/1	91/2	92/3
Total EEC	88	315	195	240	306	295	203	223	161
East Germany	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Poland	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Total Above	88	315	195	240	306	295	203	223	161
All countries	91	333	195	275	306	296	203	223	162

Wheat

Total EEC	194	1221	537	1654	713	474	452	555	1093
East Germany	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Poland	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Total Above	194	1221	537	1654	713	474	452	555	1093
All countries	1019	2069	1251	2146	1187	794	742	863	1305

Wheat & Barley Import

EEC/North Sea	282	1536	732	1894	1019	769	655	778	1254
All Countries	1110	2402	1446	2421	1493	1090	945	1086	1467

Exports

Barley

Total EEC	1303	1023	2245	1100	336	342	1563	1165	754
East Germany	10	27	11	279	526	100	-	-	-
Poland	43	13	47	23	n.a.	n.a.	n.a.	n.a.	n.a.
Norway	n.a.	n.a.	n.a.	n.a.	75	49	-	-	19
former USSR	n.a.	n.a.	n.a.	n.a.	1218	1011	6	419	508
Total Above	1356	1063	2303	1402	2155	1502	1569	1584	1281
All countries	3614	3116	4567	2967	2939	2210	2223	1871	1541

Wheat

Total EEC	1002	1940	2936	1299	758	1116	3162	2925	2764
East Germany	18	-	113	49	n.a.	n.a.	n.a.	n.a.	n.a.
Poland	207	42	377	93	n.a.	n.a.	n.a.	n.a.	n.a.
Norway	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
former USSR	324	257	1272	142	333	1172	-	360	1572
Total Above	1551	2239	4698	1583	1091	2288	3162	3285	4336
All countries	2053	2527	5401	2433	2216	3851	4062	4647	4690

Wheat & Barley Exports

EEC/North Sea	2907	3302	7001	2985	3246	3790	4731	4869	5617
All Countries	5667	5643	9968	5400	5155	6061	6285	6518	6231

Source: Home Grown Cereal Authority (based on Custms and Excise figures)

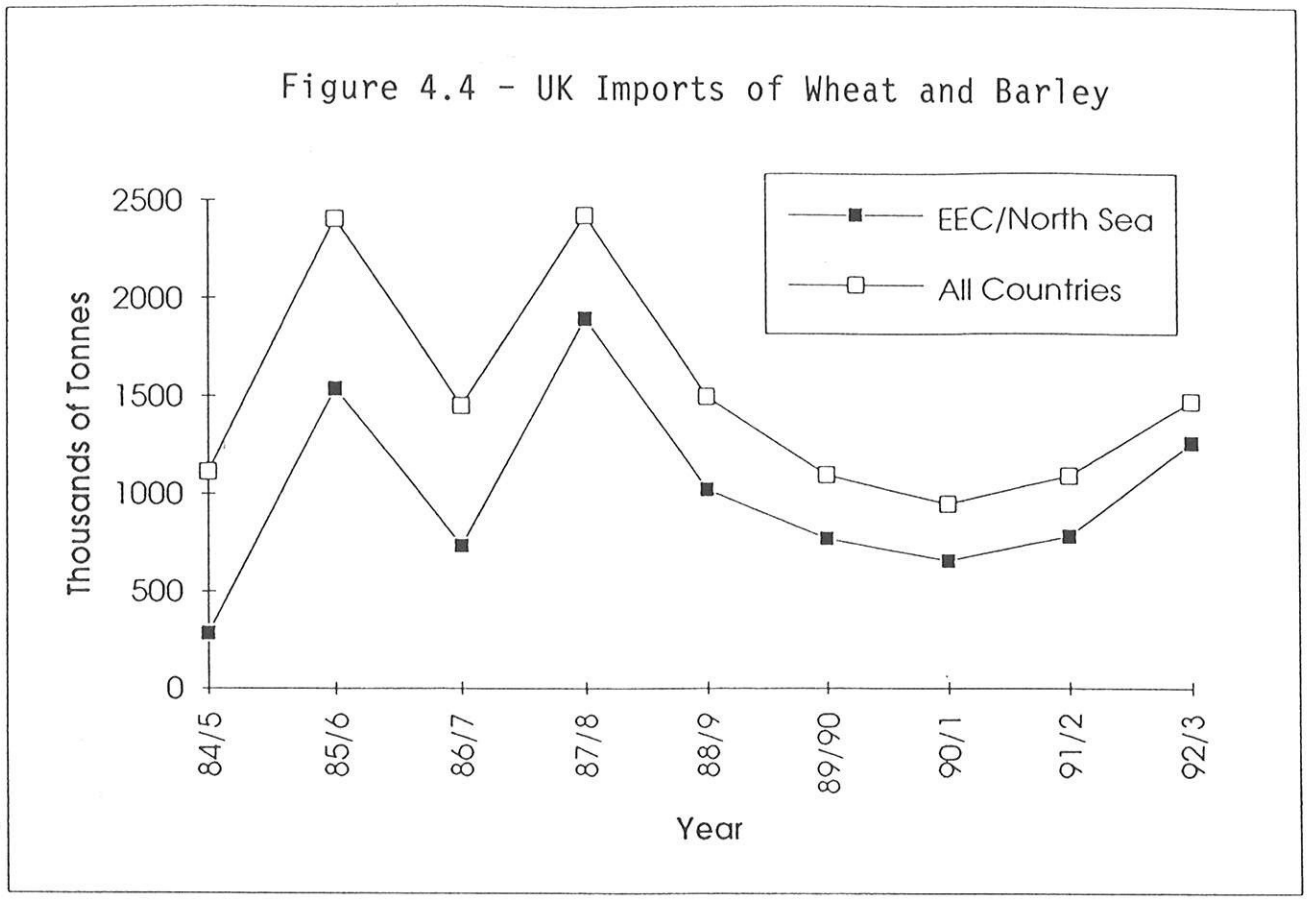


Figure 4.4 - UK Imports of Wheat and Barley
EEC/North Sea
All Countries
Thousands of Tonnes
2500
2000
1500
1000
500
0
84/5
85/6
86/7
87/8
88/9
89/90
90/1
91/2
92/3
Year

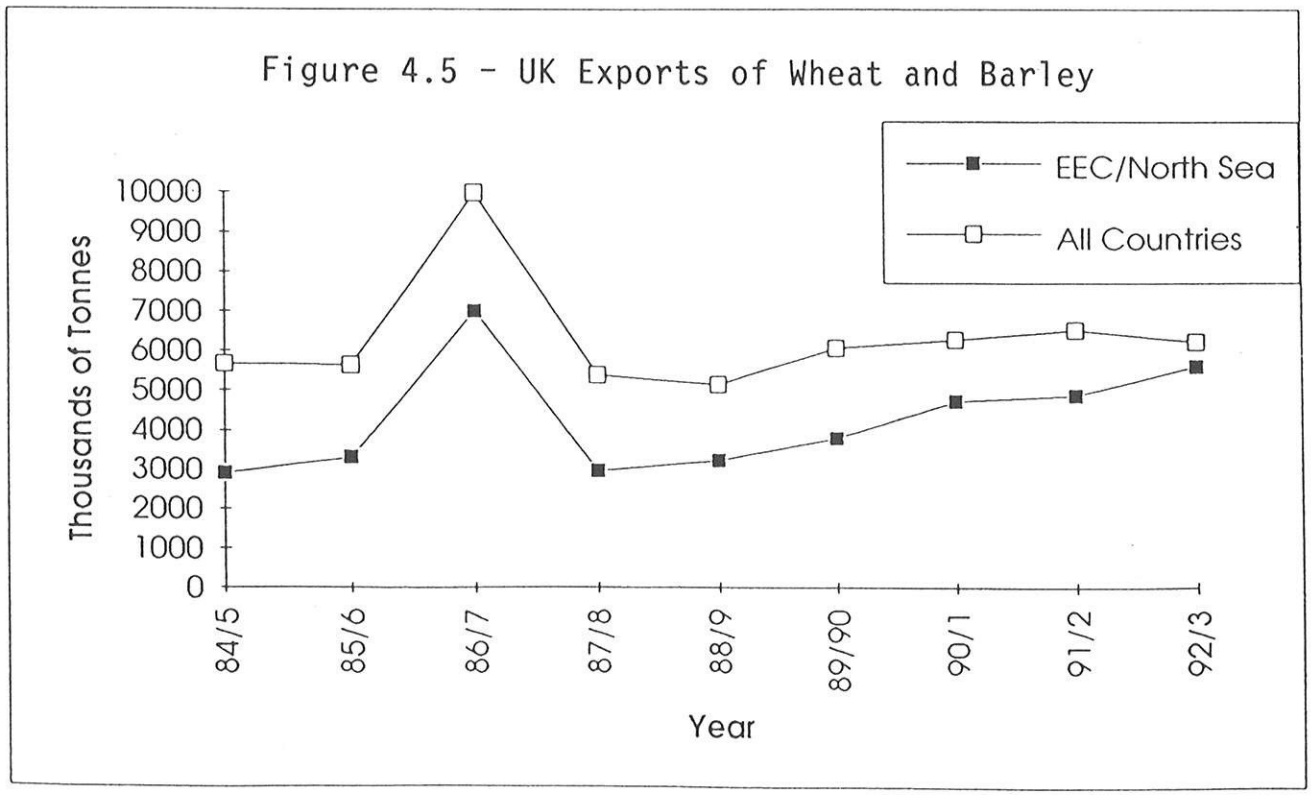


Figure 4.5 - UK Exports of Wheat and Barley
EEC/North Sea
All Countries
Thousands of Tonnes
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
84/5
85/6
86/7
87/8
88/9
89/90
90/1
91/2
92/3
Year

The small ships that Boston can handle are particularly well suited to serving inland grain processing facilities on the continent to which access is by river or canal. Whether UK grain exports are going principally to such destinations or to others, which can be reached by bigger ships, depends on the influencing conditions of weather and currency.

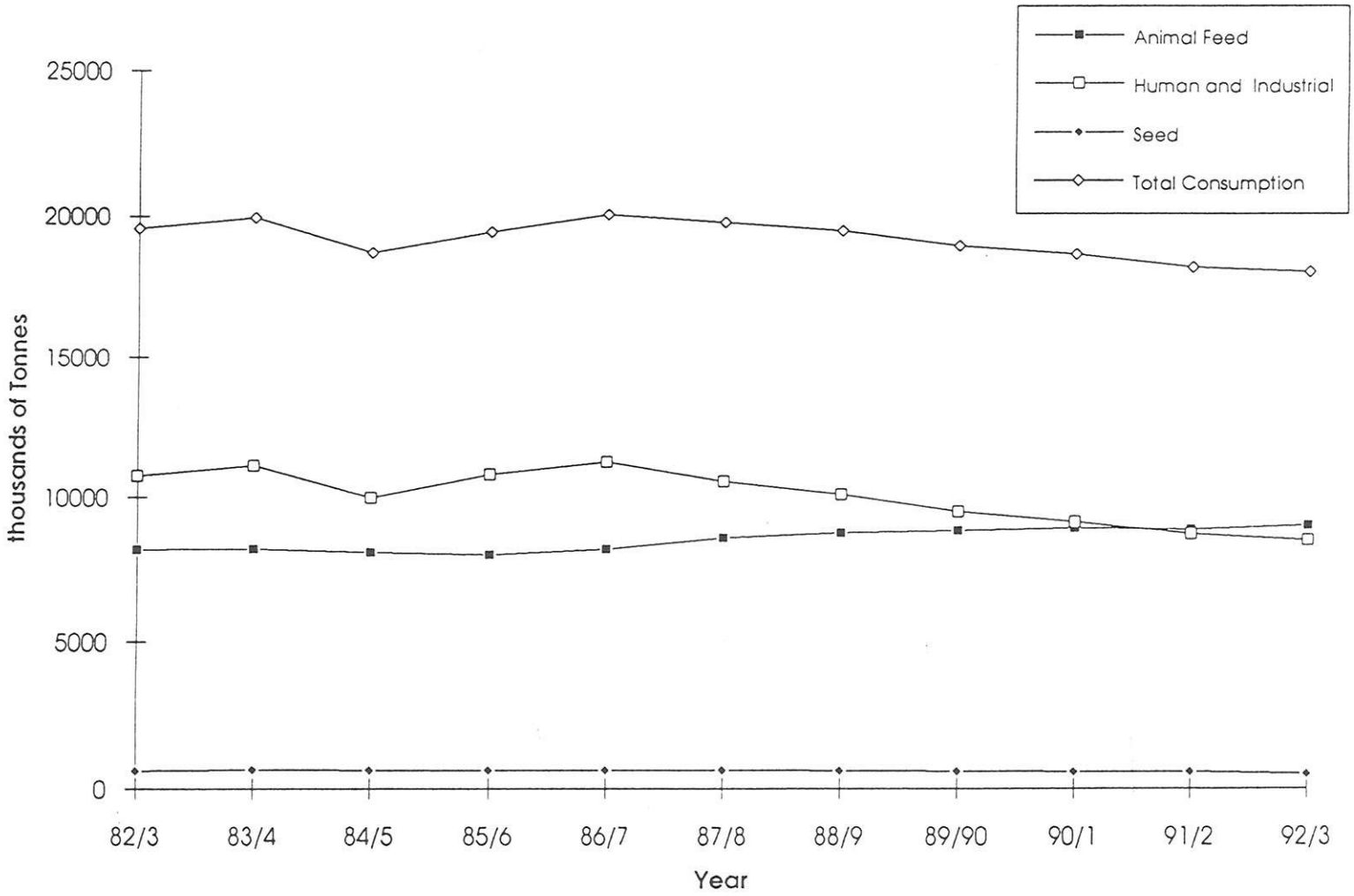
For example in years when the UK has a good harvest and less grain is available in France and Germany, English grain may flow to these inland destinations. In the past one shipping company used to trade regularly into the Seine, but does not do so now. Currently grain is going into inland ports in Germany but this could easily change. When the areas of shortage are further afield, say in the Mediterranean or elsewhere in the world, bigger ships will be used because they are more economical over these distances, and the bigger ships must load and discharge in bigger ports.

Lingrain expect grain exports from Europe to decline in future years in order to comply with the recent GATT agreement. This calls for a 20% drop in the exports of subsidised European grain to countries outside the Common Market. However, this will not necessarily affect trade within the European Union although the significance of large and small ports will no doubt vary with local conditions from year to year.

Current CAP policies appear to be largely ineffective in limiting production. Various set-aside arrangements are in force but in many cases the land removed from production is relatively unproductive and what was meant to have achieved a 15% drop has resulted in a drop of about 2%, or in some cases, a maximum of 5%. Nevertheless, there will be repeated attempts to reduce production in line with the accepted policy of subsidising farmers and not what they produce. The possible effect on European trade of any reduction in overall production is not obvious as weather and currency fluctuations will continue to occur.

Grain consumption in the UK is declining marginally. The major uses of grain are: for direct human consumption and industrial use; as animal feed; and for seed. As illustrated in Figure 4.6, seed is a relatively small and constant component of consumption. Animal feed began to rise in 1985/6 and has increased consistently, but marginally, since then. Human consumption and industrial use varied in the earlier part of the last decade but has declined steadily since 1986/7.

Figure 4.6 - UK Grain Consumption - All Types



Grain Forecast

The information available suggests that Boston's trade in grain will fluctuate substantially around a total, import and export, of approximately 400,000 tons. In the medium term, grain exports for the country as a whole, and taking one year with another, are likely to remain constant.

Ship sizes at the small end of the range are likely to increase steadily to 4,500 tons or larger, and these will be largely unavailable to Boston unless the sea lock is built. Information currently available does not suggest a rate at which this decline will take place, and this needs further assessment. A rate for preliminary forecast purposes might be that 50% of the fleet increases in size beyond Boston's capabilities over a period of 20 years.

4.2.4 Steel

There has been a steady trade in steel between the UK and the rest of the world over the past ten years and this situation is likely to continue. The UK is a net exporter of steel and exports have risen faster than GDP, maintaining growth through the recession. The principal exporter, British Steel, is unlikely to export very much through Boston which is not particularly well located for any of their works. See Table 4.6 and Figures 4.7 and 4.8.

Boston is a significant import port for steel accounting for approximately 7.5% of UK imports. Many of the sources of this trade are in locations where only small ships can obtain access and Boston's favourable location in relation to Birmingham and other industry locations on the west coast mean that trade should continue. However, the steel trade has become extremely competitive and consequently a high level of service is demanded particularly by the customers for steel products. Steel which was once allowed to rust on a quayside must now be kept in covered, heated and ventilated storage, well organised and laid out so that individual coils can readily be picked and dispatched at short notice. Customers demand that the sellers carry the stock costs and are able to deliver at short notice.

The importance of facilities and a high level of service seem to be confirmed by the success enjoyed by Seacon which has two efficient depots on the Thames and also takes ships into Boston. All Seacon ships are small, the largest being well within Boston's capabilities. However, they take as much to each of their Thames-side handling facilities as Boston imports from all sources, and they have enjoyed a growth in trade during the recession. They attribute their success to the quality

Table 4.6 - Steel Trade (Code 72 *)

Units: Thousands of Tonnes

Actual Trade

Year	84	85	86	87	88	89	90	91	92	93
Imports	3157	3505	3825	4270	5288	5537	5338	5031	2003	5060
Exports	3389	4136	4687	5635	9677	9280	9730	10545	10412	11460
Total	6546	7641	8512	9905	14965	14817	15068	15576	12415	16520
Ex. - Imp.	232	631	862	1365	4389	3743	4392	5514	8409	6400

Steel Trade at Constant GDP

Imports	3157	3458	3622	3884	4474	4416	4200	4029	1636	4102
Exports	3389	4080	4438	5125	8188	7400	7656	8444	8504	9291
Total	6546	7538	8060	9009	12662	11816	11856	12473	10139	13393
Ex. - Imp.	232	623	816	1242	3713	2985	3456	4415	6868	5188

Source: Cuatoms Data via Datastar Dialog Europe

* Note: This category comprises basic iron and steel and items such as sheet steel in coils, bar, simple sections etc.

Figure 4.7 - UK Steel Trade

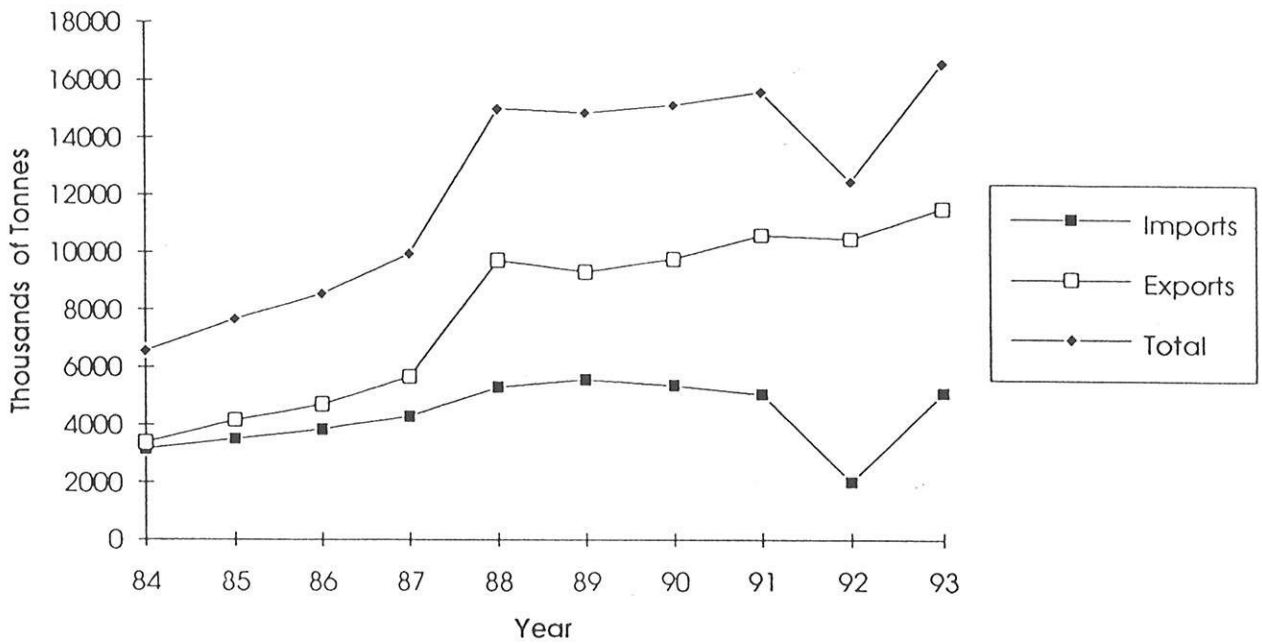
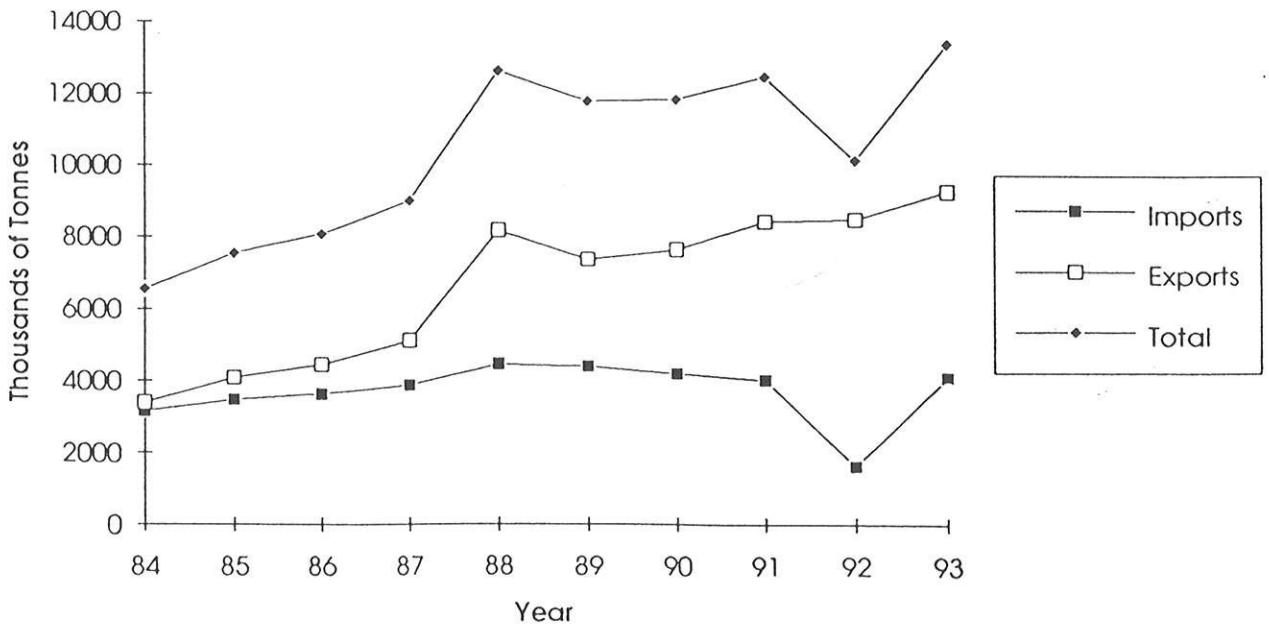


Figure 4.8 - UK Steel Trade at Constant GDP



of the on-shore facilities.

There are indications that Boston needs to improve the standards of its facilities to provide the level of service currently expected. People speak of sheds which are sub-standard and Boston has lost steel traffic due to the poor quality of its facilities. The port has plans to improve conditions and, if they do this, this should give them a good chance of retaining existing traffic and possibly winning new traffic. RMS, who have recently left Boston believe they can provide steel customers in Birmingham with a better service through London or the Humber because of the improved depot (and inland transport) facilities there.

As far as ship size is concerned, this may increase slightly (but only up to the limit of the source ports). Some of these locations can take larger vessels than can now obtain access to Boston and so for a continuation of the trade, extra beam and draught are highly desirable and, looking well ahead, probably essential. Increased beam is probably more desirable than increased draft.

Steel Forecast

At constant GDP UK steel imports are broadly constant over the past ten years. A reasonable forecast is to say that UK steel imports will rise and fall in line with fluctuations in GDP and this view is confirmed by the people we have contacted who are involved in the steel trade.

Provided the port improves its on-shore facilities, it should retain or increase its share of UK steel imports. Road access may inhibit trade to some extent but this is probably more of a psychological barrier than an actual one. The sea-lock may make only a minor difference, considering that many of the ships in this trade are small, but it will act as an insurance against future increases in ship size.

4.2.5 General Cargo

General cargo comprises a variety of consumer and industrial goods and will be destined to the port's hinterland and industrial areas in the Midlands, with occasional consignments to all points in Great Britain. The commercial manager for Boston defines the hinterland as approximately 60 miles from Boston which includes a number of major conurbations such as Peterborough, Cambridge, etc.

Amongst the miscellaneous goods travelling in both directions are a number of particular commodities of significance to Boston:

- Timber used to be a principal trade for Boston in past years and at present volumes are increasing. The two principal sources of timber are Scandinavia and Canada, and Russia is also a supply source. From Canada timber crosses the Atlantic in fairly large vessels which are generally far too big to be accommodated at Boston. However, from Scandinavia many of the source ports are small and small vessels are therefore suitable for the trade which is also over a relatively short distance. Vessels from Russia are rather bigger than those that serve Scandinavia. At present timber is increasing because housing is beginning to pick up as the recession comes to an end. Furthermore, because the USA is taking most of the available Canadian timber, Scandinavia is becoming more important as a UK source of supply.

There are at least two large timber companies in Boston but these do not necessarily import through Boston and at least one has its larger depots elsewhere. This company would need to be able to import approximately 5,000 cubic metres of timber per vessel, but at present can only bring in approximately half that quantity. They therefore only take about 10% of their timber via Boston. Ahlmark brings in some timber from Scandinavia.

- Paper. This is another important trade to Boston and is brought in on a variety of vessels. Both the remaining liner services, Ahlmark and Lys have contracts to bring in paper from Scandinavia. Recently a new paper contract has been signed which will bring 70,000 tons of paper into the port each year over the next five years. (This will have an important side effect in that a new terminal area is to be provided for paper and this will be something of a prestige facility.)

- Other dry bulks. Various minerals are traded through the port. One company is bringing minerals from the Mediterranean; another transports clay; and another coal (mainly anthracite, from Germany, for heating glasshouses).

Some shipping companies bring in a variety of goods. One, for example, carries bulk including grain; paper, in reels; and steel. The company which imports coal also exports grain.

One agent specialises in wine and acts as the sole import agency for a German

producer. From Boston, wine is distributed to all points in the UK.

Forecast

In the past these items have varied from one year to another in terms of total and the breakdown into the different items. It is reasonable to assume that in total they will remain at about present volumes, perhaps rising and falling in line with GDP.

4.2.6 Container/Ro-ro Traffic

A large variety of goods are carried within containers and on trailers, and may be regarded as a form of unitisation of general cargo. The handling methods used are extremely efficient and offer major advantages in cost.

Table 4.7 gives the development of container and Ro-Ro traffic on the East Coast from 1983 to 1992. They show that Felixtowe is gaining not only in absolute terms but also in market share of this expanding market. However, Felixstowe handles a lot of deep sea trade for which Boston, and other small ports, are not competing. Hull has gained traffic but recently its market share has remained static. Trade through Grimsby/Immingham has risen and declined and its market share has followed this pattern. Ipswich and Great Yarmouth are in decline, the latter declining steeply. Of the small ports, Boston has done well but its share is very small at approximately 1% of the total.

Container and Ro-Ro traffic is likely to travel mainly on liner services and liner services need to follow a regular timetable regardless of tides. Furthermore, small container vessels are getting bigger, as the port has already noted, and the most significant dimension in this respect is probably the beam. It would seem desirable to be able to handle vessels approximately 21-22 metres wide. Without making such provision, the port will always find it difficult to attract new liner trades in future years.

Forecast

The port's success in recent years has been largely attributable to attracting three liner services, one of which has now left. An increase or decrease of one such trade will add or subtract up to 20% of its total traffic and is therefore a more crucial consideration than trend information. Unfortunately it is also much more difficult to forecast as it depends on a wide variety of individual circumstances such as the origins and destination ports of available lines in the North Sea and new liner services that might be formed in future.

Table 4.7 - East Coast Container and RoRo Tonnages 1983-1992 (000's tonnes)

Port	1983		1987		1990		1991		1992	
	Tonnes	%	Tonnes	%	Tonnes	%	Tonnes	%	Tonnes	%
Hull	1406	9.4	3330	12.9	3321	10.2	3605	11.2	4304	12.6
Grimsby/Immingham	2165	14.5	3598	13.9	5174	16	4682	14.6	4588	13.4
Goole	69	0.5	216	0.8	156	0.5	182	0.6	226	0.7
River Trent	n.a.	0	n.a.	0	0	0	0	0	2	0
Boston	71	0.5	202	0.8	309	1	368	1.1	343	1
King's Lynn	50	0.3	32	0.1	39	0.1	32	0.1	23	0.1
Great Yarmouth	1028	6.9	996	3.9	1096	3.4	821	2.6	32	0.1
Lowestoft	n.a.	0	39	0.2	92	0.3	63	0.2	70	0.2
Felixstowe	5642	37.7	12154	47.1	15514	47.9	15417	48	17486	51.2
Ipswich	1869	12.5	2893	11.2	2820	8.7	2857	8.9	2831	8.3
Harwich	2677	17.9	2344	9.1	3898	12	4120	12.8	4278	12.5
Total East Coast Ports	**14977**	**11**	**25804**	**100**	**32419**	**100**	**32147**	**100**	**34183**	**100**
All UK Ports	**n.a.**		**65144**		**79615**		**80770**		**86191**	

Source: Department of Transport, Port Statistics

4.3 Advantages of the New Sea Lock

The new sea lock will enable bigger ships to enter Boston over a longer period of each day. It will make little difference to small ships with relatively low operating costs but should enable the port to attract larger vessels and so ensure its survival. The extent to which this is an advantage varies according to the trade concerned and depends on the amount of traffic available, the sizes of the other ports involved in the trade and the voyage length.

4.3.1 Ship Sizes at Boston

At present access to the enclosed dock is limited by the width of the dock gate which is 13.6 metres. Draft is limited by the sill of the dock gates and the state of the tide. This sill depth is 5.4 metres at MHWN. Neither dimension imposes an absolute limit on the size of ship that can use the port outside the enclosed dock. Quite a large ship can be accommodated if it is lightly loaded, and can afford to wait until the top of the spring tide. However, this is clearly a severe limitation. (Apparently the biggest vessel to enter Boston took 4,300 tonnes of grain).

As far as breadth is concerned, there are riverside berths outside the dock and, provided they can rest on the mud at low tide, vessels which are too wide to pass through the dock gates can be accommodated. However, the length must then be no more than 90 metres because turning space in the river imposes this limitation. If a vessel is sufficiently narrow to enter the enclosed dock and can be turned in there, it can then be accommodated at a riverside berth even it its length is over 100 metres.

There are also other factors to consider in deciding on the size limitation. A ship which presents a lot of windage, perhaps because it is lightly loaded, may be difficult to control in high side wind conditions within the narrow confines of the river. Also long vessels will not be able to turn and may have to enter ahead and leave astern, with assistance from a tug.

Discussions with agents and shipping companies suggest that the present maximum practical draft of vessel as loaded is about 5 metres and 3.5 metres is preferable: such ships can enter on neaps.

A number of companies specialise in small vessels, as already noted, and a typical size or vessel with low draft, and low air draft, capable of accessing difficult ports around the North Sea can be:

- 1800 dwt, 84 metres loa, 11.4 metres beam, 3.4 metres draft and 4-5 metres air draft.

The particular proportions of a ship of a given dwt may vary considerably and in recent years the tendency has been to reduce draft and increase beam for a given DWT.

However one company which specialises in small ships and carries a variety of cargoes says that they will be bigger in future. The present fleet consists of vessels between 800 and 5,000 dwt but new vessels will not be less than 2,500 dwt and mainly in the 4-5,000 dwt range. A typical new vessels may be:

- 4,000 dwt; beam 14.3 metres and draft 6.4 metres.

A shipping line which carries grain had a fleet of 10 vessels varying between 1,500 and 2,000 dwt and built between 1970 and 1988. Though small, these had a relatively deep draft, one at 1,500 dwt drawing 4.8 metres. Between 1989 and 1993 they have built nine new vessels ranging from 3,000 to 5,000 dwt, seven of them 4,000 dwt and drawing 7 metres.

Canals in Sweden will take vessels up to about 6,000 dwt.

The three lines which have used Boston recently are RMS Eurobox Services Limited, Lys Line and Ahlmark. RMS has recently ceased its services to Boston.

RMS has used vessels of approximately 2,500 dwt with an overall length of 96 metres, a beam of 14.5 metres and a draft of about 4.2 metres loaded. Access to the Rhine would still be possible with vessels at least 12 metres longer and a greater beam, which would allow them to carry one or two extra containers across the ship. They have considered using vessels 118 metres long, with a beam of approximately 20 metres.

Lys Line uses ships of about the same dimensions which carry approximately 130 teu's. They have another vessel which would carry 185 teu's but which would not

permit regular services to Boston. To retain a reasonable level of service they could not increase ship size too much but would prefer to use two slightly larger ships than the three present vessels.

Ahlmark use a similar size of vessel again: it is 2,400 dwt, slightly smaller in length and breadth and draws 5 metres. They believe it would be possible to have a 3,000 ton vessels drawing only about 3.7 metres which could be accommodated at Boston without any improvement, although it would be slightly more restricted in access times than is desirable. Clearly if Ahlmark need even larger ships in future, Boston will not be able to accommodate them without the new sea lock.

Lines such as DFDS, which use bigger ports north and south of Boston, have vessels which range in size from about 165 metres to beyond 200 metres in overall length. Typical dimensions are:

- loa 165 metres: beam 22 metres: draft 6.5 metres.

Some vessels have been increased in size by lengthening. DFDS are having a dock specially prepared for them at Immingham and otherwise call at Harwich.

Norfolk Line, which runs between Scheveningen in the Netherlands and Felixstowe, have ships which may be typically:

- loa 123 metres: beam 21 metres: draft 5 metres.

To retain a regular service they cannot sail further up the coast than Felixstowe and so would not necessarily use Boston even if wider access, and a longer access period, was provided.

4.3.2 Extended Access Time to the Port

If a new sea lock is built, it will enable ships to enter and leave the harbour at virtually all states of the tide. The water will be maintained at a high level in the river.

The potential benefits may be considered as three types:

- Reduced time in port;
- Increased flexibility of scheduling;

- Easier operations within the port.

Each of these factors enable the ship owner to improve the utilisation of the vessel so that its earning power is increased.

A vessel may be delayed because it has to:

- Wait outside the harbour before being able to enter it;
- Wait within the harbour to leave.

Clearly delays in entering the harbour will not be planned but may be caused by delays in a previous port or adverse weather conditions. In theory a ship might arrive off Boston and have to wait, say, 10 hours before it can get in.

Within the harbour if a vessel has finished unloading it may have to wait before it can again put to sea. However, discussions with agents and ship owners suggested that this was not a particularly important consideration for many of the ships which actually use Boston as they take approximately one tide to unload and can then move on the next high water. However there could well be delays within the harbour, for example because of the need to move vessels from one berth to another, which could result in the need to wait for a further tide.

Some vessel owners are simply used to these conditions and would have to rethink and replan their operations if the situation improved. Due to other operational considerations (such as availability of cargoes at other ports and the location of those cargoes) they might not, in fact, wish to leave earlier. However most operators are likely to be able to find additional work for their ships if they can leave Boston earlier.

Scheduling is extremely important to the liner trades which run regular services between two of more points. Delay is also a vital consideration because the profitability of their operations depends on using their vessels extremely efficiently.

In port movements of vessels is important in order to maximise the utilisation of quays and also to get vessels into and out of the harbour with the minimum of delay. Some vessels are unable to lie aground (outside the dock) at low water, and so must be accommodated within a trench. If the water level in the river is always high, these movements can take place over a much longer period than if

movements can only take place at high water. Also movement of smaller vessels within the port may have to wait if larger vessels, which can only move on high tide, are blocking them.

The increased water depth will have a double advantage as far as big vessels are concerned. Firstly, it will provide the physical capacity for the harbour to handle big ships. Secondly, it will enable these ships to enter and leave without delays and this is more important to them because their operating costs and earning capacity per hour are higher than for smaller vessels.

4.4 Professional Fishing and Leisure Boating

A number of the principal organisations concerned with fishing and leisure boating have been contacted in order to learn what they perceived to be the advantages and disadvantages of the new sea lock as it affects their activities. Generally a new sea lock is perceived as being beneficial and the perceptions of disadvantage can mostly be seen to be misconceived or, at least, avoidable.

4.4.1 Professional Fishing

Two organisations have been contacted.

- Boston and District Inshore Fishermen's Association
- Eastern Sea Fisheries (the statutory authority)

The local fleet consists of 50 vessels up to approximately 40 ft length overall. 75% of these are owned by the co-operative. The number of fishermen directly involved is approximately 77.

An important catch is cockles which they fish for six months of the year. In the remainder of the year, the principal catch is brown shrimps and they also catch sprats and skate. Molluscan fishing is strictly controlled by quotas limiting size of boat, equipment used, number of people, etc. and in a good year the limits on cockle fishing are reached relatively easily.

It is only possible to fish over the sandbanks for about 2-2.5 hours when they are covered by the tide. The new sea lock would not extend this period. However it would reduce the amount of time taken to get to the mouth of the river on the landward side and would mean that they could be waiting at the lock ready to fish

at the earliest possible opportunity. This would maximise their access to the high water periods.

The extra time at sea would permit them to catch an additional 6-8 boxes of shrimp per vessel per day.

Other benefits from maintaining a higher water level in the river are ease of maintenance and less stress on the hull when vessels no longer ground. Maintenance is easier when the water level is high and the vessel is nearer the level of the quayside. When vessels ground, at low tide, the hull tends to be stressed (a problem which affects steel vessels more than wooden ones).

A possible problem is the reduction of nutrient flow from the Witham and Welland at their juncture which could, via the food chain, affect the feeding grounds of fish. There is also concern that the river might silt up more quickly (although this appears to be a misconception). It would be necessary to dredge a channel seaward to maintain access at all states of the tide.

Incidental benefits are that there would be less work on the banks if the water level was to be maintained inland from the lock gates and the appearance and amenity of the town would be improved.

The fishermen would need a smaller lock beside the main lock, or some other suitable arrangement so that they could pass through the new lock quickly.

There is some concern that once the river has been impounded it would no longer be classified as a haven and the fishermen might then lose their right by charter to moor free of charge. For some years the NRA has been anxious to charge them £250 a year for mooring.

4.4.2 Leisure Boating

There are two organisations and two yacht clubs providing moorings upstream of the Grand Sluice.

- Boston Marina Ltd
- British Waterways
- Witham Sailing Club
- Boston Motor Yacht Club

There is concern that the lock and changes brought about by it, could change the boating environment and result in extra charges being levied. However, informed opinion considers that the development would be a significant benefit.

Concerns, some of which seem illogical, include:

- reduction of air draught in the town
- silting of the river once it is impounded
- removal of enjoyment of seeing tidal changes
- fees levied to get through the new lock
- fees levied by the harbour authority for use of the impounded river
- delayed access to the sea because of the need to negotiate the new lock
- possibility of access to inland waterways at the Grand Sluice being discontinued

It can be seen that most of the concerns are likely to be ill-founded (although the additional charges would seem to be a strong possibility).

The perceived advantages are that the new development would

- encourage visitors resulting in extra berths and moorings and additional income for the town

- this in turn should result in enhanced property values in the town leading to an increase in 'Council Taxes', perhaps by as much as 40%

- British Waterways believes that commercial traffic will also increase on the rivers and canals

- new areas downstream of the harbour will be open for leisure use, possibly leading to the construction of new marinas

One individual expressed the view that local boating was worth between £1m. and £2m per annum turnover to the town but no supporting evidence was provided.

The two marinas have between them nearly 100 berths and charges vary between £250 and £290 for the period of approximately 7 months during which they are occupied.

The two yacht clubs have approximately 100 members each and provide moorings at a very low cost: approximately £40 per annum.

British Waterways and one of the yacht clubs believe that the sea lock would double the market for moorings.

4.5 Forecasts and Benefits

There are likely to be income-producing benefits from three categories of economic activity in the Boston area: the port, professional fishing, and leisure boating.

4.5.1 Trade Through the Port

Since the end of the dock labour scheme, and with privatisation, the larger ports have been freed from major disadvantages in that they can now offer a competitive stevedoring and handling service and have received investment. As noted earlier in this report, provided ports are efficient, and trade increases, vessels sizes can increase and there is likely to be a repetitive process in which ports get bigger, vessels get bigger and costs decrease. The limit to this process is imposed by the limit of trade available and the need to maintain a reasonable frequency of service.

Examining the history of east coast trade over the past ten years shows a steady increase slightly above the growth of GNP. A trend forecast therefore suggests a continuing rise of about 6% per annum (linear from 1982). Boston's share of this traffic over the last ten years has fallen slightly from 2% at the beginning to 1.4 in recent years. The fall took place in 1987 (1.9%), 1988 (1.6%), and 1989 when it arrived at 1.4%. In 1991 the proportion was 1.3%.

This shows that the process of big ports becoming stronger and weak ports taking a lower share of the market is well established on the east coast. It may well be that in the longer term only the ports to the north and the south, on the Humber and around Colchester and the Thames, will survive. However with an investment in a new sea lock providing better harbour conditions and access to the larger vessels, Boston's location should provide it with continuing trade.

The four principal divisions of trade through Boston have been reviewed in Section 4.2 and are: grain, steel, general cargo, and container Ro-Ro traffic. The trade reviews conclude that:

- Grain is likely to decline unless the sea lock is constructed. Once the sea lock is in place, grain is likely to remain roughly constant although some decline is possible as subsidies are progressively removed from European grain.

- Steel is likely to remain broadly constant provided the Port of Boston invests in improved storage facilities. It is possible that steel, in this case, will increase as

market share is taken from other ports.

_ General cargo is likely to remain fairly static.

_ Container Ro-Ro traffic is unlikely to increase until the new sea lock provides access for vessels with a greater beam and slightly increased draft and, in particular, is able to provide access at most states of the tide so that vessels can operate to a definite schedule.

On balance Boston's traffic is likely to remain broadly constant until the sea lock is built and, if it is not built, its long term future is under threat. A pessimistic scenario is that the remaining container lines will remain small and become uncompetitive in relation to other services at other ports, or that they will become so successful that they need bigger ships and will have to go to other ports. If they are not replaced by other up and coming container lines, this will remove tranches of traffic similar to the loss due to the departure of RMS and the port itself might then become uneconomic.

If the sea lock is built, the potential for increased traffic is likely to be in container/Ro-Ro services. To realise this potential, it will be necessary to divert liner traffic from other ports to Boston (or to attract any new lines which are formed in future).

In 1989 there were about 35 container and 18 Ro-Ro services operating between the UK and Scandinavia/Baltic/Continent. Many will have commercial constraints preventing their diversion to Boston, assuming their ships are not too big. In further study it will be necessary to make a more detailed assessment of this potential trade and verify the forecast.

Each time a new line is attracted it will produce between 100,000 and 200,000 tonnes per annum in trade through the port. It has been assumed that up to the time the new sea lock is installed there may be gains but that these will be balanced by losses leaving the situation much as it is at present. Then, when the sea lock is in operation, extra trade will be attracted to the port and allow tonnage to build up at 150,000 tonnes p.a. until it again accounts for 1.4% of east coast traffic. The result and tonnage forecast is shown in Table 4.8 and Figure 4.9.

Table 4.8 - Cash Flow

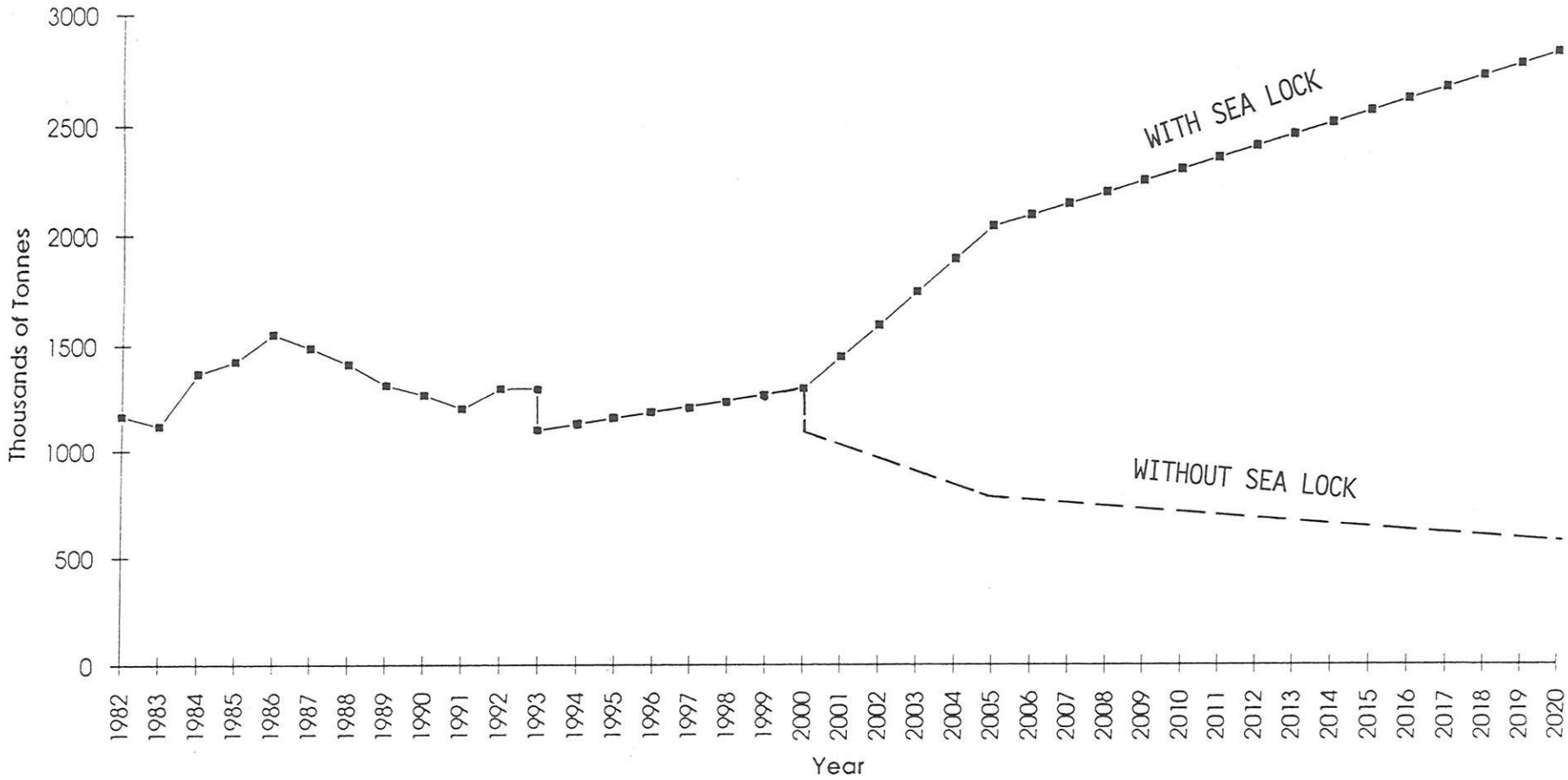
This table give the tonnages, expenditure and income relating to the port and attributable to the New sea lock

Year	Port	Additional	Total *	Lo Lo					Ro Ro					Total	Total	Net
	Total	Lo Ro	Lo Ro	port Invest	Traffic	Income at	Maintnce	Labour	port Invest	Traffic	Income at	Maintnce	Labour	Expend.	Income	Income
	Tons	tons	tons	£ '000's	Tons	£2.67/ Ton	£ '000's	£ '000's	£ '000's	Tons	£2.67/ Ton	£ '000's	£ '000's	£ '000's	£ '000's	£ '000's
2000	1300	0	500	250	0	0	50	50	250	0	0	50	50	700	0	-700
2001	1450	150	650		101	268	50	50		50	132	50	50	200	401	201
2002	1600	300	800		201	537	50	50		99	264	50	50	200	801	601
2003	1750	450	950		302	805	50	50		149	396	50	50	200	1202	1002
2004	1900	600	1100		402	1073	50	50		198	529	50	50	200	1602	1402
2005	2047	747	1247		500	1336	50	50		246	658	50	50	200	1994	1794
2006	2099	799	1299		535	1430	50	50		264	704	50	50	200	2134	1934
2007	2151	851	1351		570	1523	50	50		281	750	50	50	200	2273	2073
2008	2204	904	1404		605	1617	50	50		298	796	50	50	200	2413	2213
2009	2256	956	1456		640	1710	50	50		315	842	50	50	200	2552	2352
2010	2308	1008	1508		675	1803	50	50		333	888	50	50	200	2692	2492
2011	2360	1060	1560		710	1897	50	50		350	934	50	50	200	2831	2631
2012	2413	1113	1613		745	1990	50	50		367	980	50	50	200	2971	2771
2013	2465	1165	1665		780	2084	50	50		384	1026	50	50	200	3110	2910
2014	2517	1217	1717		815	2177	50	50		402	1072	50	50	200	3250	3050
2015	2569	1269	1769		850	2271	50	50		419	1118	50	50	200	3389	3189
2016	2622	1322	1822		885	2364	50	50		436	1164	50	50	200	3529	3329
2017	2674	1374	1874		920	2458	50	50		453	1210	50	50	200	3668	3468
2018	2726	1426	1926		955	2551	50	50		471	1256	50	50	200	3808	3608
2019	2778	1478	1978		990	2644	50	50		488	1303	50	50	200	3947	3747
2020	2831	1531	2031		1025	2738	50	50		505	1349	50	50	200	4086	3886

47952

* This column give the new and existing Lo Ro tonnage.

Figure 4.9 - Total Traffic at Boston - Past and Forecast



4.5.2 Port Costs and Benefits

At present the port is operating profitably, but needs to make some investments in order to replace traffic lost recently. This will stabilise the current position and may result in an increase of traffic. However, for the purposes of this study it has been assumed that traffic remains constant and also that no further investment is made in container or Ro-Ro handling facilities until further Ro-Ro and container traffic can be taken through the new sea lock.

The port investments required are in:

- A new, higher capacity, higher outreach container crane;
- A link span for Ro-Ro vessels.

The new container crane will be located between the river and the present dock so that it can serve vessels on both sides and be much closer to the container park. The Ro-Ro facility will be positioned near the entrance to the present dock, in the river. In each case there may be some investment in ancillary equipment.

There will be running costs associated with both these handling facilities attributable to maintenance and labour. The port has provided estimates of these and they are incorporated in the cash-flows.

Income attributable to the new sea lock is the net revenue from tonnage about 1.3 million tonnes. The resulting cash-flow is shown in Table 4.8.

4.5.3 Benefits from Fishing and Leisure Boating

Leisure and fishing are reviewed in Chapter 4 and a broad estimate of the effects of the sea lock is that:

- Leisure boating may well double;
- Fishermen's profits from brown shrimps will increase.

Fishing

As noted in Section 3, the new sea lock would enable fishermen to spend an extra three hours fishing. In terms of income, it is unlikely to affect their overall take of cockles because they are limited more by regulation than by access time. At certain times when cockles are in relatively short supply, and the regulation limit would not be reached, the extra access time might make it possible to increase the catch.

Taking the figures for shrimps, the net benefits may be calculated as follows:

Marginal Income per Boat

- 6-8 boxes (i.e. 7 boxes) per day
- Price per box £45 - £100 (say £75) per box
- Days fished: five twelfths of a year at, say, 300 days per year, i.e. 125 days
- Marginal income from extra shrimps, say £65,625 p.a. per boat

Marginal Costs per Boat

- Maintenance cost: £1 per hour
- Fuel costs: £1.9 per hour
- Maintenance & fuel costs per day, at 3 hours per day, say £9 per day
- Marginal costs from shrimping £1,125 per boat

Net Income

Income less costs £64,500 per boat
i.e. for 50 boats £3,225,000

This will be a maximum because it will not be possible to fish on all days for an extra three hours. Nevertheless the income appears to be substantial.

Leisure Boating

From time to time surveys are carried out which give the spending of yachtsmen on items directly or indirectly connected with this pursuit. One survey carried out by Gerry Levens and Company for the British Marine Industries Federation during the summer of 1991 revealed the following information on the breakdown of spending applicable to inland power cruisers. (Expenditure by coastal power cruisers is rather less, and the breakdown is different):

	Weekend	Seven Days
	£	£
Moorings	7	11
Fuel	14	32
Provisions	21	56
Eat/drink ashore	34	84
Chandlery	11	15
Other boating related	3	17
Total	**90**	**215**

Average nights away from home		35.6
Say :	Seven day period	7.0
	Balance as weekends	**28.6**

	Cost	Profit
28.6 weekends @ 15% profit	2,574	
1 seven day @ 15% profit	215	
	2,789 @ 15%	**418**

Assuming the present mooring numbers are doubled there will be 250 new boats yielding a turnover of £1.2 million and a profit (at 15%, assumed) of £104,587.

In addition there will be a profit from the "home" moorings themselves. We do not know the profit from these (although this is known to British Waterways) but would suggest 50%. The related figures are therefore:

- Income from 250 new moorings: £62,500 @ 50% profit yields £31,250.

The annual benefit to all suppliers of new leisure boating related goods and services in the area is therefore £135,837.

British Waterways has its own surveys which give figures of a similar order.

5. PLANNING STUDIES

5.1 Planning Policies

Development in the Borough of Boston in recent times has been steady and guided by the various statutory and non statutory development plans that have been in force. The great majority of this development has taken place in the main centres of the Borough and particularly in Boston which has experienced slow but steady growth in recent years. Various problems and constraints to development have become apparent and are being addressed in the current development plans.

Future development in Boston Borough up to the end of the century will be controlled by the policies contained in the statutory development plan when finally approved. This consists of the Lincolnshire Structure Plan and Alterations prepared by Lincolnshire County Council and the Local Plans prepared by Boston Borough Council.

Regional Planning Guidance for the East Midlands including Lincolnshire has recently been issued by the Secretary of State for the Environment which provides a regional framework for the development plans affecting the area. A consultation draft of a "strategy for sustainable Management of the Wash Estuary" has also been published to provide a co-ordinated approach to the development of the area in the future.

None of these plans contains specific reference to the development of a sea lock at Boston. There is however reference in all of the plans to the Port of Boston and other development in the Borough that could be affected by a sea lock proposal. The relevance of these plans is as follows:

5.1.1 Regional Planning Guidance For the East Midlands - RPG 8

It is an objective of the RPG to secure and stimulate economic prosperity in all parts of the East Midlands region consistent with the objective of sustainable development and environmental considerations. In particular, the RPG recognises the need for diversification of the employment base and the importance of a good supply of sites for industrial and commercial development in towns such as Boston which have good range of local facilities.

The RPG also recognises the importance of the Port of Boston and states that its significance should be recognised in development plan policies with provision made for its operational needs. The implications of the growth of traffic through the port on road and rail lines are also to be considered.

The RPG also requires that planning authorities should take fully into account all environmental implications of planning decisions.

5.1.2 The Strategy for the Wash Estuary

This is currently a consultation document which seeks to develop a "Broad Brush" statement of general intent on the management of the Wash. It sets out a series of goals to cover the various activities and attributes of the Wash.

The strategy acknowledges that the Wash is an internationally recognised estuary in terms of its nature conservation value but there are other important activities on or near the coast that need to be accommodated. The plan therefore seeks to co-ordinate the approach by the various organisations responsible for the Wash. This is to ensure that any economic activities that need to operate in the area are able to do so in harmony with the international nature conservation status of the Wash but fully recognising the need to safeguard the statutory designated nature conservation areas when considering any development proposals.

5.1.3 The Lincolnshire Structure Plan

The Structure Plan sets out the strategic planning policies for Lincolnshire and provides the framework for the preparation of Local Plans. The latest Structure Plan Alterations Nos. 1.2 and 3 all contain specific reference to Boston Borough and propose:

a) Provision for substantial new housing development in the Borough and particularly in Boston. 3,900 dwellings in Boston Borough between 1988-2001 with 2,250 in Boston.

b) The encouragement of economic development in the County and provision for large scale (over 25 ha) industrial, warehousing and office development in Boston.

c) Recognition of the importance and potential development opportunities of the Lincolnshire ports and a requirement to allocate appropriate land to assist the development of the Port of Boston.

The structure Plan also contains policies to encourage economic growth and the development of tourism and recreation. There is also emphasis put on the need to protect the County's natural assets and to ensure that all development enhances the built environment and the countryside.

5.1.4 The Boston District Draft Local Plan

This document contains the detailed planning policies affecting future development in Boston and the surrounding administrative district. The plan is currently at consultation draft stage and therefore it is possible that the policies could be amended or changed before the plan is finally adopted by the Borough Council. Nevertheless the draft Local Plan is a strong indicator of the planning policies that are likely to finally be approved and of the aim of the Borough Council with regards to development in the District.

The central theme of the Local Plans strategy is 'to promote and encourage new development in the Borough provided it can be accommodated without harming the area's environment and character'.

Of particular note with regards to the sea lock project are the following policies and proposals concerning land bordering the Haven. Further details are shown on Inset Maps 13, 29 and 30 of the Consultation Draft Local Plan.

1. The identification of the Port of Boston and the surrounding commercial area and the need to safeguard this area for port related development and activities (Policy ED2).

2. The allocation of approximately 75 ha of industrial/commercial land at Slippery Gowt Farm as a continuation of the existing Marsh Lane Industrial Estate (Policy ED1).

3. The inclusion of 'road safeguarding corridor' to allow the construction of a link road from the Riverside Industrial estate to the A16 Boston to Sutterton Road (Policy T1).

4. Proposals for a Haven Country Park along the Eastern bank of the haven from Skirbeck to the Hobhole drain.

5. The allocation of land between Slippery Gowt Farm and the Haven as a Waste Disposal Site (Policy CF1). **NB** That additional land to the north of the original waste disposal allocation is also being proposed for inclusion in the deposit version of the Local Plan.

6. The redevelopment of sites in Boston and particularly to the north of the Haven Bridge (Former Johnsons Warehouse) (Policy RTC 11).

7. The need for protection from development of the land bordering the Haven from the Pilgrim Fathers memorial to the Wash which is identified as being a Site of Special Scientific Interest, a Ramsar site and a special protection area. (Policy C17).

8. The encouragement for new development bordering the Haven to take into account the recreational potential of the site (Policy C7).

9. A presumption in favour of granting planning permission for development associated with water based uses of the Haven and the Maud Foster Drain. Subject to normal planning and environmental considerations (Policy R4).

5.2 Existing Planning Problems

Boston experiences a series of problems many of which have resulted in the planning policies of the draft Local Plan. The following problems would appear to have the most bearing on the sea lock proposal.

5.2.1 Traffic Congestion and Circulation

The town of Boston is bisected by the River Witham/The Haven and to a slightly lesser extent by the South Forty Foot Drain and the Maud Foster Drain. Thus traffic circulation through the town is constrained by the availability of river crossing points; the main road routes through the town cross the Haven at the Haven bridge and the secondary route across the Grand Sluice. This limited availability of river crossing points can result in considerable traffic congestion particularly at peak hours and creates problems in gaining access between the east and west of the town. This problem is heightened during the holiday season when the town experiences significant through traffic destined for the east coast resort of Skegness.

Access to the Town from the west has recently been improved by the construction of the re-aligned A16 trunk road along the disused railway line providing a direct road link to the A17(T). This new route has not however overcome the problems of gaining access to the eastern half of the town in which the main employers including the Port of Boston are located.

There are also problems in gaining access from the re-aligned A16 to other parts of the town including the Marsh Lane/ Slippery Gowt area which is currently proposed as the main area for commercial expansion in the town.

5.2.2 Employment and the Local Economy

The level of employment in Boston is currently better than the County, National or Regional rate but nevertheless has suffered in the current recession. There is concern that the main employment in the Borough relies on a relatively small number of employers and that a contraction of any of these concerns could have a severe impact on the local job situation.

The Borough Council is aware of this vulnerability in the local economy and there has been some success in encouraging new firms to locate in the area. It has not been easy to attract firms however because of Boston's relatively remote location

on the east coast which means that all things being equal, there is a likelihood that firms will choose a more accessible location unless they have specific and compelling reasons for setting up in Boston.

5.2.3 The Port

One Employer that has compelling reasons to locate in Boston is the Port of Boston which uses the direct access to the Wash and the North Sea provided by the Haven. The tidal nature of the Haven requires the Port to mainly operate within a lock controlled dock so that wharves are preserved at low tide. This effectively means that the capacity of the port in terms of number and size of boats is constrained by the size of the dock and the dimensions of the lock apart from some specialized vessels that are able to moor outside the dock on the river bed at low tide.

The tidal nature of the Haven also restricts the passage of vessels to and from the Wash to two 3-4 hour periods of high tide each day. This restriction caused by tide times greatly reduces the free passage of vessels and also creates potential congestion in that all vessels including the fishing fleet, leisure craft and those using the Port must pass along the Haven to and from the Wash within the restricted time slots.

The tidal nature of the river virtually rules out the possibility of creating full time Wharves elsewhere along the Haven apart from those already existing in the Port. Establishment of a regular Ro-Ro and a Ferry Service is also impractical at the present time. Both of these possible expansions in port services could be the source of significant expansion in port activity which could attract more employment to the Borough.

5.2.4 The Built Environment

Boston is a town with an historic core and many fine buildings. Much of this historic core is situated close to the Haven but traditionally, Boston "has turned its back on the river" and regarded it as a functional waterway and a drainage route rather than an environmental asset.

The river currently has few direct access points and is flanked mainly by the backs of properties and some poorly developed, run down or derelict sites. At low tide, this situation is worsened by the presence of sheet steel piling, areas of mud and old boats and debris which give a rather depressing appearance to the area.

The dramatic difference in tide levels that occurs throughout the town up to the Grand Sluice has also meant that flood defence walls have had to be erected along the banks of the Haven throughout the historic core of the town (refer to photos in Appendix 1). These impair views of the river and also of some of the historic buildings. An example of this is at St. Botolphs Church where a substantial brick wall has had to be constructed along the river bank to counter the possibility of flooding in this area.

It is possible to see the potential attraction of the River in the few areas of the town where development has taken advantage of the water. This is clearly evident in the non tidal river above the Grand Sluice but also in the area known as Haven Bank just below the Grand Sluice where the river bank forms an attractive tree lined frontage to the facing houses set behind it.

5.2.5 Tourism and Leisure

Boston as a historic centre clearly has great potential for tourism; the presence of water right in the heart of the town adds to its appeal and also provides potential for leisure use.

The potential has been acknowledged by the East Midland Tourist Board which identifies:
"The River Witham at Boston as an important resource in terms of waterways tourism" and
"The Waterways facilities of Boston and particularly its location as an entry from the Wash to the inland waterways of the East Midlands are a strength to Boston".

Whilst Boston has an interesting and in many ways attractive historic core, the problems of run down sites and the general lack of accessibility to the river described above (see section 5.2.4) does not enhance its tourist appeal.

Use of the river by leisure craft within the town is also hampered by the tides effecting the Haven. Although some leisure craft do use the Haven as an access to the Wash, numbers are limited by the tidal restrictions and the lack of mooring facilities within the town and along the banks of the Haven. There is for example no marina or designated mooring point for leisure craft on the Haven between the Grand Sluice and the Wash. Thus the majority of leisure craft currently moor in the non tidal section of the River above the Grand Sluice which tends to act as a barrier to leisure craft movements through the town.

5.3 Planning Opportunities Resulting from the Sea Lock Proposal

The immediate impact of the construction of a sea lock on the Haven downsteam of the Port would be to largely negate tidal patterns and stabilize water levels upstream and throughout the waterways in Boston.

The stability of the water levels in the Haven at a depth that would allow continuous navigation on the river could have a great impact on the town and its development opportunities. Although initially the main opportunities are likely to be directly related to the use of the river, in the longer term secondary development triggered by the project could well arise. For example, any commercial development generated by the project could eventually lead to a need for more housing in Boston and a demand for improved infrastructure. The most likely development opportunities that could arise and their planning implications are as follows:

5.3.1 The Development of the Port

The development of the Port is currently clearly constrained by the size of the existing lock and basin and the availability of navigable water in the Haven during high tide. If these two constraints were removed, then subject to economic considerations there would be considerable opportunity for an expansion in services and in particular the creation of a "round the clock" ferry service. A suitably sized sea lock would also enable larger ships to enter the port. The introduction of larger ships and more regular services would be likely to attract more trade into the port and the possibility of more services being provided to cater for the additional trade.

If the economic circumstances prevailed to allow the above expansion in trade and services to occur, then the Port would almost certainly require additional wharves particularly to cater for the larger ships presently unable to enter the existing basin. Some river wharfage already exists on the Haven to the South of the existing Port which caters for vessels that currently sit on the River bed during low tide and it is probable that these could be used on a full time basis. Wharfage on this bank of the Haven could take advantage of the existing port facility at Boston. Demand for further services such as warehousing and storage resulting in the need for development could if necessary make use of the vacant land already owned by the Port of Boston both within and adjacent to the Port. This would be in accordance with the policies of the draft Local Plan which seeks to protect these areas for port

related uses (refer to fig 5.1).

In the longer term however if the Port developed as a result of increased demand for the services, there may also be the need for the development of additional wharves elsewhere along the banks of the Haven. Apart from the vacant land owned by the Port on the former timber yard to the south east of the port, this is unlikely to be on the northern/eastern bank of the Haven because of the presence of the Haven Country Park along the majority of this bank of the River.

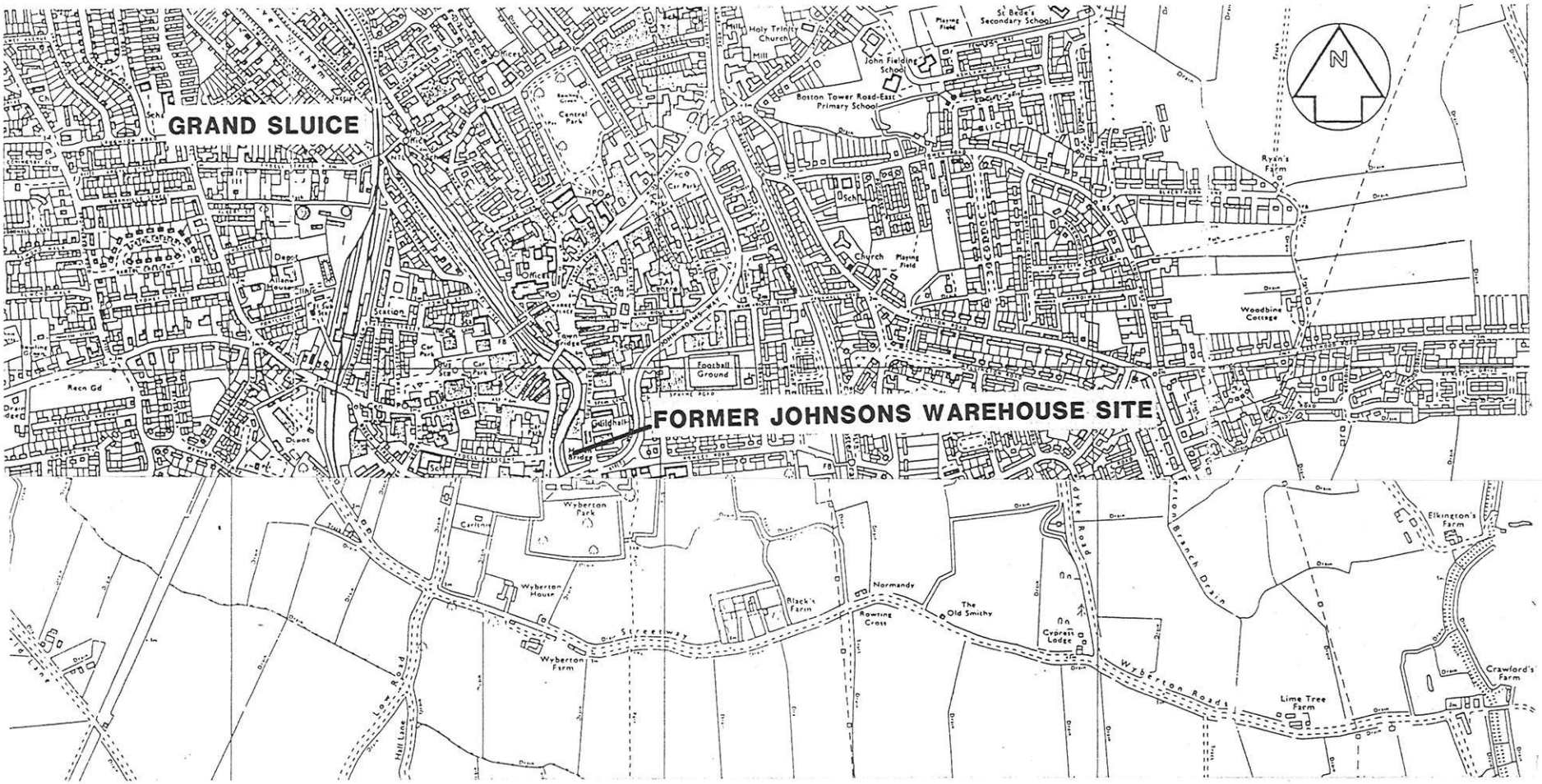
There are also constraints on the southern (western) bank to the creation of new wharves by virtue of the electricity transformer station and the substantial area of land to the east of Slippery Gowt Farm which is being used or intended for use for waste disposal. There would however appear to be considerable potential for additional wharfage on the unused river bank to the north of Slippery Gowt farm on the land currently allocated for industrial development (refer to fig 5.1). Such uses of this river frontage although not expressly intended for port related development would be in accordance with the policies of the plan to develop this area for industrial or commercial use.

5.3.2 Tourism and Leisure

It is apparent from the outcome of meetings with relevant organizations and a report from the East Midlands Tourist Board that the river below the Grand Sluice, the Haven, is an underused resource both in terms of leisure and tourist uses. This is almost certainly due to the limited availability of the river for navigation during low tide and the lack of accessibility and mooring points along the Haven, and its present appearance.

The stability of water levels following the construction of a sea lock downstream would largely overcome the problem of limited availability of the river for navigation and could well encourage its use by leisure craft that would not be restricted by limitations on time caused by the tides. This would not only be an encouragement for vessels using the Haven and into the Wash but also would make Boston an attractive destination for inland waterway and sea going vessels that presently are deterred from entering the Haven because of the tides.

The increased attractiveness of the Haven for leisure use may well result in a demand for improved mooring facilities which are presently very limited below the



BASED UPON THE ORDNANCE SURVEY MAP WITH THE SANCTION OF THE CONTROLLER OF HM STATIONERY OFFICE CROWN COPYRIGHT RESERVED

POTENTIAL DEVELOPMENT SITES

FIGURE 5.1

Balfour Maunsell
CONSULTING ENGINEERS
NORWICH

Grand Sluice. There may also be the potential for the development of a marina to serve the East Midlands and this part of the east coast which presently has no such facility. The construction of a marina would inevitably need to be subject to considerable assessment both technically and from an environmental stand-point. There would however appear to be scope for the development of a marina along the Haven in the presently underdeveloped areas to the south east of the current industrial allocations in the vicinity of Corporation Point, although the environmental implications of building in a largely undeveloped area would need to be carefully assessed.

An increase in use of the river by leisure craft would inevitably bring more visitors to Boston. The very presence of an attractive accessible river can also create a considerable visitor-attraction as occurs in places such as Cambridge, Ely and Norwich where tourist related developments have been focused on the river.

In the case of Boston, it may take some time for developments to occur because of the limited access to the river at the present time. Nevertheless, opportunities do exist for riverside development along the Haven and the greater attractiveness of the river to visitors could well provide the catalyst for the uptake of these sites. If development of the existing vacant or "soft" sites commenced, it is quite possible that in the longer term, development in the town would begin to take more account of the Haven and gradually make better provision for access to the water than exists at present.

5.3.3 The Built Environment

The stretch of the River Witham from the Grand Sluice to the Wash (ie the Haven) provides a dramatic physical feature in Boston effectively dividing the town in two. The tidal nature of this stretch of waterway results in a continuously changing view of the river from a full flowing river at high tide to a relatively narrow channel flanked by mud, beached vessels and stark flood defence walls at low tide.

The raising and stability of the river following the construction of a sea lock would therefore undoubtedly change the character of the Haven through Boston and remove the dramatic change of its appearance resulting from the change in the tides.

It is our opinion that although the loss of the low tide would change the character

of the Haven, there would be significant benefits to the built environment following a general raising of the water level through the town. These are as follows:-

i) Visual Appearance

At low tide, the Haven becomes a mud lined channel flanked by a rather stark and in many cases ugly steel flood defence walls (refer photos in Appendix 1). The low tide also reveals marine wrecks and debris which it is difficult to describe as attractive.

A raised water level would not only improve the present appearance of the Haven through the town at low tide but might also provide an opportunity for the existing raised flood defence walls to be removed or modified. These are presently quite prominent in certain parts of the town such as in the vicinity of St. Botolphs Church (The Stump). They not only detract from the appearance of prominent buildings on the river bank such as The Stump but also impair views of the river from the town.

ii) Unused Sites

The riverside through Boston contains several undeveloped sites or uses which could be improved in appearance by redevelopment or a change of use. The former Johnsons Warehouse site in the centre of the town is of particular concern in this respect and presently is a derelict site in a very prominent position in the town (refer fig 5.1). Further 'soft' sites with development potential exist close to the Haven towards the Grand sluice and in the vicinity of the Port.

It is understood that there have been development proposals for these unused sites in the past but few to date have come to fruition. This may, of course, change when economic conditions improve again and development begins to take off. An improved appearance of the river through the centre of the town with potentially greater access may well however provide a strong catalyst to the redevelopment of the riverside sites particularly if of a mixed development associated with the tourism/leisure industry. Such redevelopments would enable the Borough Council to provide guidance on the redevelopment of these sites to ensure that they are in keeping with the historic character of Boston Town Centre and are developed in harmony with the River such that it becomes more integrated into existing developments within the town.

5.3.4 Economic Development

If the development opportunities arising from an expansion of the Port of Boston and further development of the leisure and tourism industry were to arise as a result of the sea lock being developed, this would undoubtedly provide a boost to the economy of the town and could well relieve some of the existing concerns over employment on the reliance on a limited number of firms.

The current strategic and local planning policies encourage commercial development in Boston and substantial allocations have been made for industrial/commercial development particularly to the south of the town in the Slippery Gowt/ Marsh Lane area to accommodate such development. At current rates of development, it would appear unlikely that this land will be taken up during the plan period without a marked improvement in the local economy which an expansion to the port might generate. There would appear to be scope for further expansion of this area in planning terms if this allocation were to be completely taken up. In addition there are also significant areas of former railway land adjacent to the A16 within Boston that are allocated for industrial development.

A serious problem at the present time particularly with regard to Commercial development in Boston is traffic congestion and access to the main trunk roads and rail routes. The recent improvements to the A16 road have greatly improved accessibility to Boston from the A17 trunk road but there still remains the problem of congestion within the town and access to the A16, particularly from the main employment areas. Access to the port is presently via the heavily used Haven Bridge whilst access to the Marsh Lane area presently passes through a residential estate.

The Boston Borough Local Plan makes provision for a new road to provide a direct link from the Marsh Lane/Slippery Gowt Industrial allocation to the A16 to overcome the present problems (refer fig 5.1). It is understood however that this road link is not included within any definite road programme and therefore is most likely to be funded as a result of the eventual development of the area. There would therefore be great benefits to the town if the sea lock proposal were to result in the attraction of further firms into Boston if their development resulted in the construction of the link road to the A16. Furthermore congestion within the town would also be reduced if an alternative access to the port could be constructed that did not require traffic to pass through the centre of the town. The construction of new wharfage

quays on the southern and western side of the Haven would greatly assist this process.

There is also a possibility however that the expansion of the Port might enable the construction of a direct link from the existing port to south bank of the Haven and the improved A16 that could remove the need for port traffic to cross the A16 bridge in the centre of town and thus reduce the level of traffic congestion in this area. An additional river crossing of this nature might also have potential to cater for other commercial traffic from the industry located to the east of the Haven.

The Port also has the advantage of the presence of an existing rail link to the main rail network, which although presently disused might be able to be incorporated into future expansion plans. Whilst the practicalities of the re-use of the rail link would have to be carefully examined, it could reduce the present reliance of the port on the road network in accordance with the advice given in RPG 8.

6. ENVIRONMENTAL STUDIES

6.1 Study Introduction

The environmental appraisal first describes the existing environmental conditions of The Haven, as the Witham estuary is commonly known. The description focuses on statutory designations, the water quality and the conservation/ ecological aspects of the area. The potential environmental impacts during the construction and operational phases of the Barrage are then considered separately. Four possible locations for the Barrage have been selected and the relative impacts of the four options are then assessed, before selection of the preferred option.

The requirements of, and likely objections to the scheme of the statutory authorities and consultees are identified and discussed. A scoping study for a full environmental assessment of the preferred option is detailed, including recommendations for further research to identify the magnitude and significance of potential environmental impacts. An estimation is then made of the monitoring and modelling requirements necessary for the environmental assessment, giving an indication of likely costs.

6.1.1 Data Acquisition and Consultations

The study involved acquisition of data from a variety of sources. Initial consultation with statutory authorities, developers and certain interested parties took place at the inception of the study. Meetings were convened in Lincoln with the NRA, Lincolnshire County Council, English Nature and Lincolnshire Trust for Nature Conservation, and in Boston with the Port of Boston, Boston Borough Council, Anglian Water and Boston Fisherman's Co-operative Limited, on the 22 and 23 February 1994 respectively.

A letter describing the Boston Barrage project and requirements for environmental data was circulated more widely. After initial selection of the preferred option a second round of consultation was undertaken. A document was circulated summarising the alternative option locations, the potential impacts of the scheme and the reasons for preferred-option selection, and called for comments and likely objections to the scheme. This document was circulated to the main parties expressing an interest in the original request and included the National Rivers Authority (NRA), English Nature, Countryside Commission, Lincolnshire Trust for Nature Conservation, MAFF (LTNC), Eastern Sea Fisheries Joint Committee (ESFJC),

RSPB, Anglian Water Plc, Boston Borough Council, Lincolnshire County Council, Port of Boston, Boston Inshore Fisherman's Co-operative, British Association of Shooting and Conservation (BASC), English Heritage, Heritage Lincolnshire and the Marine Conservation Society.

Other sources of information included literature searches and contact with research establishments.

6.2 Description of the Existing Environment

6.2.1 Introduction

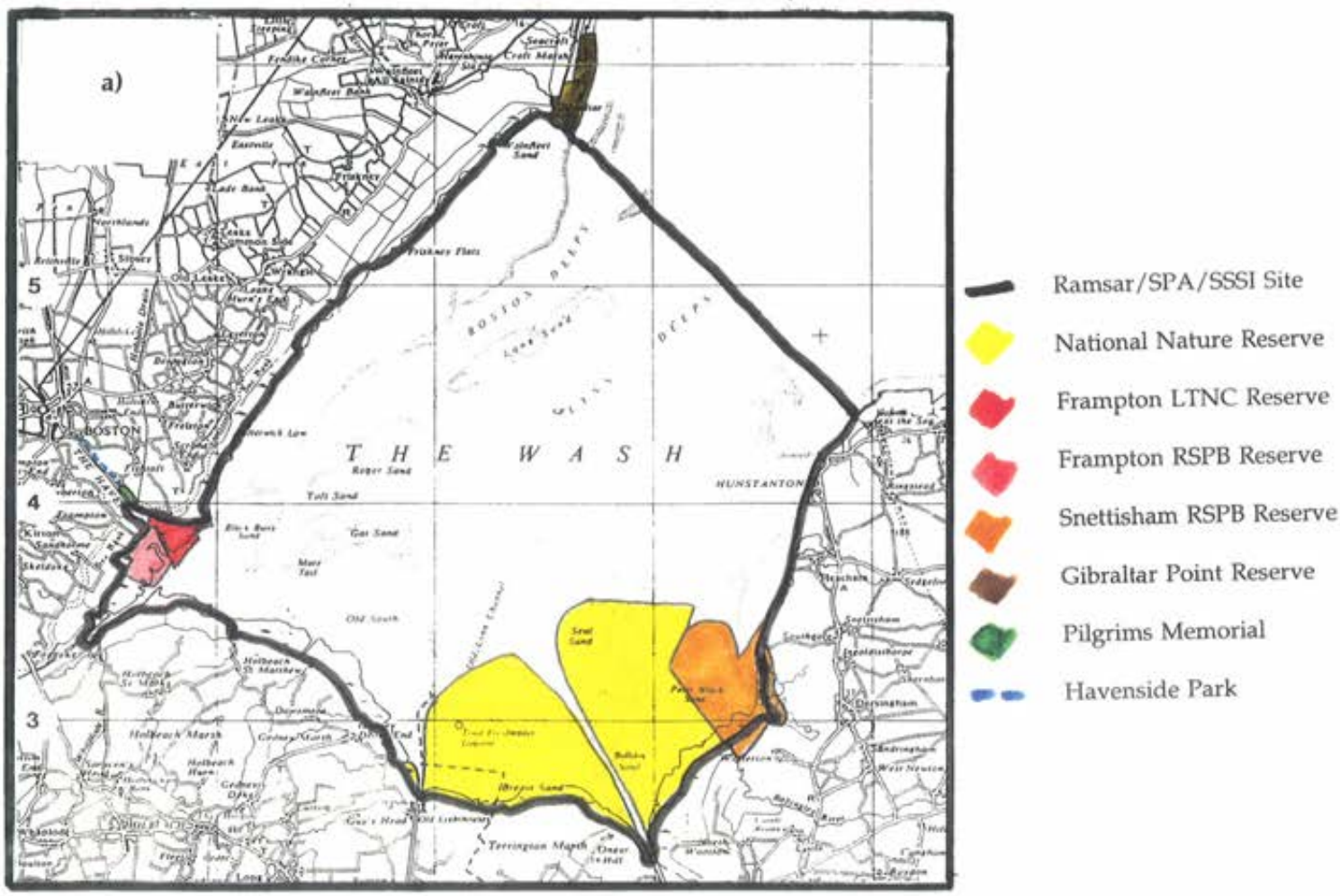
The Haven is an integral part of the Wash estuarine system, which is of international importance for nature conservation. The proposed Barrage development has the potential to cause significant impact on The Haven and certain areas of the Wash within the designated area. The environmental appraisal therefore considers both the regional and international ramifications of the proposed project.

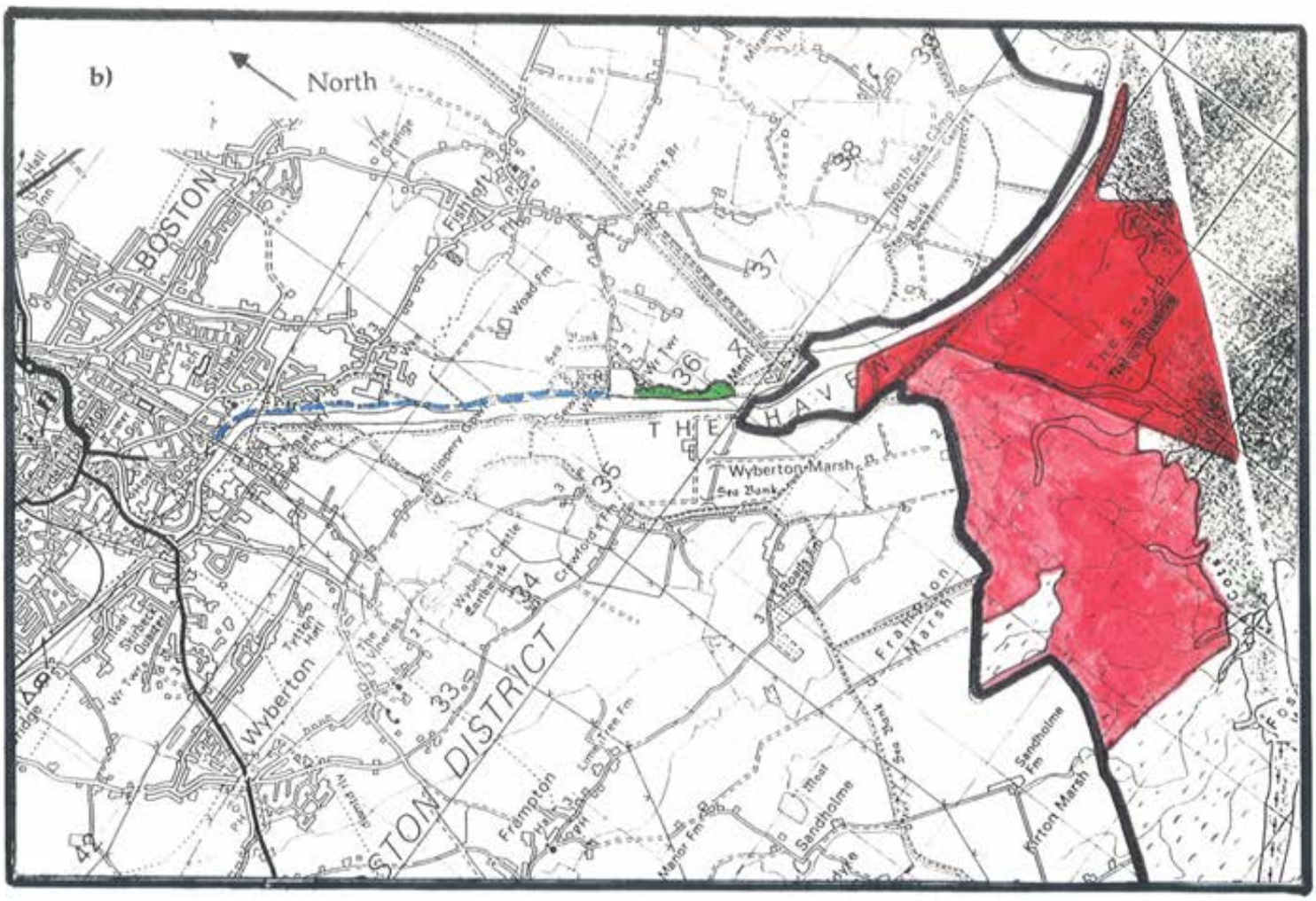
The Haven is constrained by flood banks for approximately 11 km, from Boston down to the Wash. Agriculture is the dominant land use of the non-urban land inland of the new sea banks. Seaward of the new sea banks saltmarsh predominates, giving way to mud/sandbanks at Freiston Low on the north bank and the more extensive area of Frampton Marshes, administered by the LTNC, to the south (see Figure 6.1).

6.2.2 Statutory and Non-Statutory Designations

The Haven is classified under several national and international designations as part of the larger Wash conservation area. The region of The Haven incorporated into the designated areas is shown in Figure 6.1b, and encompasses an area to a point upstream of the confluence of the Hobhole Drain with the Witham Estuary. The Wash was designated a Site of Special Scientific Interest in 1984, under Section 28 of the Wildlife and Countryside Act 1981. Reasons for the notification include the exceptional biological interest created by the mudflat and saltmarshes, the rich supply of invertebrate food available, and the importance of the area as the winter feeding grounds for internationally significant numbers of waders and wildfowl.

Figure 6.1 a) Designated Wash Conservation and Recreation Areas, and
b) Designated Conservation and Recreation Areas in The Haven.





In 1988 the Wash was notified as a Ramsar site, a wetland of international importance under the Convention of Wetlands of International Importance, and a Special Protection Area, as defined in the EC Directive on Conservation of Wild Birds (79/409/EEC). Both Ramsar and SPA status are enacted under Section 28 of the Wildlife and Countryside Act 1981. The designation reflected the international importance of the area for wintering wildfowl and waders, autumnal moulting waders, wintering passerines, certain breeding waders and terns, and specified seabirds. The saltmarshes and mudflats around Frampton are listed as a particularly good example of their type and qualify for protection under criterion 3 of the convention. The Wash may also be designated under proposals in the EC Directive on Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC), because of it's habitat type and SPA designation. An explanation of the Directive and its implications is given in Appendix 3.

The Countryside Commission has three Countryside Stewardship sites within the project area, at Pilgrim Memorial Pastures on The Haven, at Frampton Marsh on the Lincolnshire Trust for Nature Conservation reserve, and on the RSPB Frampton Marsh reserve. The stewardship agreements stipulate that the holder of the agreement will protect and enhance the environmental value of the land by management as set out in the schedule. Management agreements include prohibition of many fertilizers, biocides, cultivation, and of particular significance, no new or modified drainage.

The area of Slippery Gowt to the south east of Boston, on the south bank of The Haven, has a rare colony of *Equisetum ramosissimum*, protected under the Wildlife and Countryside Act 1981 as a Schedule 8 protected species.

The Havenside "linear country park" has been created along the north bank of The Haven, running from Boston Docks to the Pilgrims Memorial.

6.2.3 Water Quality of The Haven and Associated Watercourses

6.2.3.1 Freshwater Inputs and Potential Sources of Pollution

The Witham catchment is mostly agricultural, including few large urban areas. Industrial production, of which there is little, is primarily associated with agriculture. It is likely that much of the pollutant input to the river system is from diffuse agricultural sources (Dyer *et al* 1993).

The River Witham and the South Forty Foot, Maud Foster and Hobhole drains provide the freshwater input into The Haven and are considered to be of at least fair quality (Class 2 or above in the 1990 NRA Survey). The river and drains are considered to exert little detrimental influence on the estuarine water quality, although increased heavy metal levels and pesticides/herbicides have been recorded on occasion (Dyer *et al* 1993). It must be noted that the most recent survey and review covers a period of unusually low flows and may not represent the typical water quality situation in The Haven.

Industrial sources of pollution to The Haven have been limited by NRA's recent efforts to restrict discharges. The sites of Swell Foods, Van Smirren Seafoods, Hunter Timber Engineering and Calders and Granidge should all now comply with NRA wishes to cease or treat surface water runoff before discharge. Leachate concentrations and occurrence from the Slippery Gowt landfill, owned by LCC, are currently unknown.

Boston Sewage Treatment Works (STW) provides the major sewage discharge to The Haven. The STW generally operates well within its consent conditions of 10,000 m^3/d at a maximum BOD of 35 mg/l and suspended solids of 70 mg/l. Potentially more problems may be created during high rainfall events with discharges of untreated storm overflows at East Side, London Road, Lincoln Lane, Norfolk Street and South Terrace. Their relative impact on water quality is unquantified at present. A smaller wastewater discharge from Fishtoft STW enters The Haven via the Hobhole Drain, but no information is currently available on its impact.

6.2.3.2 Physico-Chemical Water Quality of The Haven

The NRA have two regular sampling points on The Haven, at the Swing Bridge in Boston and at Cut End, half way down the estuary. In recent years monthly data has been generated for a wide variety of parameters. This report concentrates on the more commonly used water quality indicators, but highlights other parameters which are considered noteworthy. A 1993 report by Anglian NRA "Welland and Witham Estuaries - Ecological Study Final Report" summarises much of the data and is used as the basis for the water quality description.

Classification

The Haven is classified as a Class A Good Quality estuary in the 1990 NRA water quality report "Quality of Rivers, Canals and Estuaries in England and Wales" (NRA

1991). The classification is largely qualitative, with points scored for biological quality, pollution status and water quality (represented by dissolved oxygen).

Salinity

The salinity regime of the estuary is difficult to assess as only two surface water sample sites are reported. The surface salinity at Boston ranged from less than 1 ppt to 26 ppt, with an average of 8.5 ppt (equivalent to approximately a quarter of seawater salinity). The site at Cut End had a salinity range of 2 ppt to 32 ppt, and an average of 23 ppt. High water salinity was usually above 25 ppt at Cut End, with reduced low tide salinity, particularly in the Spring.

Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD)

The Haven generally had good DO levels, with yearly averages above 80% saturation and seldom dropping below 70% at all states of the tide. The longitudinal oxygen profile appeared uniform, with no reported oxygen depletion from discharges into The Haven. Data from the JoNuS survey indicates that The Haven has comparatively better DO levels than the other Wash rivers (Welland, Nene and Great Ouse). Sporadic supersaturation (>100% DO) can be attributed to algal activity.

The BOD concentrations were generally less than 10 mg/l and often under 5 mg/l. High and low water values were usually similar, with more variability at the Boston site. Slightly higher concentrations were sometimes recorded in the Spring.

Ammonia

Ammonia concentrations had median values of 0.2 to 0.5 mg/l, with a maximum of 1 mg/l. Lower median ammonia values at Cut End probably reflected the greater seawater influence at that site during high water.

Nutrients

Nitrogen concentrations, measured as total organic nitrogen, varied widely. Median yearly concentrations for 1989 to 1992 ranged from <0.5 mg/l N to 4.9 mg/l N, with maxima often over 10 and up to 22 mg/l N. The reasons for the wide variation in median yearly values were not explained.

Phosphate concentrations, measured as organophosphate, were less variable than the nitrate. Median levels of between 0.2 and 0.6 mg/l were recorded, with an unusually high peak level of 1.53 mg/l. As with the ammonia concentration, nutrient levels were generally similar at all states of the tide except for high water at Cut End, where nutrient levels were reduced.

Heavy Metals and Organic Compounds

Heavy metal concentrations in The Haven are generally below their proposed estuarine Environmental Quality Standard (EQS) levels. Variation in sampling frequency and analytical methodology have led to uncertainties in data interpretation and no clear trends in metal levels. However, several parameters have been recorded at elevated concentrations, particularly copper and zinc, which have approached or exceeded their proposed EQS (5 μg/l and 40 μg/l respectively) on some occasions, with sporadic peaks of others such as TBT. The origin of the metals is unknown, but high levels in the river and inputs from the dock could be responsible. Higher river flows, after the unusually low flows in recent years, could have a significant influence on estuarine metal levels.

The bioavailability of heavy metals to benthic biota was investigated in 1990, by assessing levels in the seaweed *Fucus vesiculosus* (Dyer *et al* 1993). Heavy metal and pesticide levels were generally low and reflect the good water quality of the estuary. Elevated lead concentration at one site was unexplained. The concentrations of pesticides which were measured (the 'drins) were generally below detection.

No sediment heavy metal data are currently available.

Organic compounds such as PCBs, DDT and other pesticides were generally below detection limits in The Haven. The compound γ HCH (Lindane) was present in higher concentrations and exceeded its estuarine EQS of 20 μg/l on several occasions. It is thought that the high levels may originate from the river.

6.2.3.3 Microbiological Water Quality

No microbiological data is currently available for The Haven. Studies for MAFF and Anglian Water Plc have included microbiological parameters, but the information has not been made available. Evidence of elevated microbiological concentrations on the

shellfish areas at the mouth of The Haven (Dyer *et al* 1993) would suggest that increased levels of faecal bacteria, viruses and other microorganisms may be present in The Haven.

6.2.3.4 Conclusions

The Haven appears to be a well mixed estuary, having relatively good water quality. The oxygen concentrations in the estuary are good, with no sign of summer oxygen sag which can affect polluted estuarine systems. Nutrient concentrations in the estuary are generally reasonable, although high levels have been reported on occasions. The presence of certain chemical compounds and heavy metals in elevated concentrations is cause for concern, although the concentration of heavy metals in sediments are not currently known. Similarly, no microbiological data is available to assess the dilution and dispersion characteristics of the wastewater inputs from Boston STW.

6.2.4 Fauna and Flora

6.2.4.1 Aquatic Ecology

Relatively little research has been undertaken on the biota of The Haven, and no long term data are available to identify dynamic community fluctuations. A survey programme in 1990-91 by Unicomarine for the NRA has furnished information on the current status of fauna and flora in the estuary (Dyer *et al* 1993).

The substrate in The Haven changes from fine mud at Boston to coarse sand downstream, with some mud/sand areas, and a shell/stone substrate at the estuary mouth. The changing substrate and variation in salinity in The Haven determine the species diversity of aquatic biota.

Benthos

The Haven has a reasonably diverse benthic assemblage, with the greatest number of species and individuals towards the Wash. The upstream assemblage is typical of a low salinity muddy substrate, dominated by oligochaete worms. Most of the species recorded were characteristic of estuarine communities, such as the annelids *Nephtys hombergii* and *Pygospio elegans*, mollusca represented by *Macoma balthica* and *Hydrobia ulvae*, and the crustacea *Carcinus maenas* and *Gammarus spp.*.

A site adjacent to Hobhole Drain and the STW showed reduced species diversity, which is currently unexplained, but may reflect the influence of freshwater from the drain or inputs from the STW.

Plankton

Zooplankton data indicated a typically diverse estuarine community, although problems with sampling make interpretation difficult. Smaller zooplankton of less than 250 μm were not recorded, and copepods were not enumerated. The crustacean *Neomysis intiger* dominated the samples, with *Crangon crangon* and *Carcinus maenas* larvae also commonly occurring. At the more seaward site *Pranus flexosus* was present.

Phytoplankton data are available from one sample taken during the Joint Nutrient Study (JoNuS), and a limited number of surface samples. The sampling programme was not sufficiently detailed to draw reasonable conclusions. Low numbers of phytoplankton were recorded of characteristically freshwater and marine species. Diatoms appeared to dominate the community, although on one occasion a number of chlorophyte species were recorded. Only one sample was taken during the Spring when phytoplankton numbers would be potentially elevated.

Fish

Only limited data is available from the NRA on the fishery status of The Haven, with no data available from MAFF or ESFJC. Problems with survey equipment used by the NRA have hindered fisheries investigations, a situation common to many estuaries. Poor catches of fish have been reported, consisting mainly of low numbers of marine species. Fisheries data suggests that species commonly occurring in estuaries, including flounder (*Platichthys flesus*), goby (*Pomatoschistus microps*), smelt

(*Osmerus eperlanus*), sprat (*Sprattus sprattus*) and 3 spined stickleback (*Gasterosteus aculaetus*) all occur regularly. Other marine species such as cod (*Gadus morhua*) and plaice (*Pleuronectes platessa*) also occur sporadically. The lack of juvenile fish such as herring (*Clupea harengus*) and sprat (*Sprattus sprattus*) in larger numbers suggest that the fishing gear used is missing the juvenile lifestages which use estuaries as nursery areas. Commercial eel (*Anguilla anguilla*) catches have also been reduced in recent years, perhaps due to decreased freshwater flows.

Conclusions from the Witham study suggested that, although the Wash is an important nursery area, The Haven is not an ideal fish habitat (Dyer *et al* 1993). The difficulties with sampling and gear selection may influence this opinion. Sampling of the docks and use of smaller mesh nets may give a more representative estimate of fish populations (see Conlan *et al* 1988).

Shellfish

Mussel beds are confined to the shallows around the estuary mouth, with cockle beds occupying the deeper areas offshore. Eastern Sea Fisheries Joint Committee records show that mussel stocks have fluctuated greatly over the last decade, with little recruitment in the past few years (ESFJC 1993). Cockles also vary considerably in abundance and condition between years, but have been more stable than mussels in recent years. Faecal contamination of the shellfish stocks adjacent to the estuary mouth has been reported, although the source of the pollution is unresolved.

The Wash is of national importance as the most important molluscan fishery in England and Wales. At present the shellfish areas close to The Haven are classified as Category B, requiring any harvested stocks to be depurated before sale. The potential need to remove and purify shellfish stocks before sale has prompted the Boston Fisherman's Co-operative to build a purification plant at Cut End for this purpose, abstracting water from The Haven. In 1991 a total of 9114 tonnes of shellfish with a value of £1.2 million were landed at Boston.

6.2.4.2 Terrestrial Ecology

The inter-relationship of habitat and ecology dictate that several organisations are responsible for and/or have a vested interest in collecting and collating information on habitat types and the associated biota. The following review takes information from a variety of sources supplied by, *inter alia*, the NRA, English Nature, LTNC, RSPB and

the Countryside Commission.

Habitat Descriptions

Several terrestrial habitat types are represented in areas adjacent to The Haven. The Grand Sluice and upper estuary are within the urban conurbation of Boston. Leaving the town, the estuary follows the course dictated by maintained flood banks, flowing into the Wash at Tabs Head. The land adjacent to the estuary is largely taken for agriculture, with the areas beyond the sea walls containing significant areas of saltmarshes and mudflats. Several areas within the study radius are of international, regional and local ecological significance, and these are listed below:

- ☐ The Haven
- ☐ Frampton Marshes - Lincs Trust for Nature Conservation
- ☐ Frampton Marshes - RSPB
- ☐ Pilgrims Memorial countryside stewardship site
- ☐ Havenside linear park
- ☐ Slippery Gowt to the south east of Boston
- ☐ Boston STW ecology area

The saltmarsh and mudflat habitats are the most vulnerable to future development and are one of the main conservation features in the region. A total of 4228 hectares, representing 10% of the total British saltmarsh is represented in the Wash area. The zonation patterns characteristic of saltmarshes, from pioneer zones through the mid-marsh and into the rarer upper marsh swamps are all exhibited at the Frampton and Freiston Marshes. The species composition of these specific saltmarshes is currently not available, although communities representative of the Wash region are given in the Wash Management Strategy Paper - Saltmarsh Conservation. The saltmarshes and mudflats provide ideal habitat for a wide variety of flora and fauna, many of which are reliant on the specialised ecosystem. The saltmarshes function as bird breeding, feeding and over-wintering grounds is seen as central to their conservation potential.

An Anglian NRA river corridor survey from 1989 has been made available in an unprocessed form, and is briefly reviewed here. The survey generally incorporates land and vegetation within 50 m of the bank and includes identification of land use, plant communities and associated fauna. The Haven is canalised through Boston, with vertical fabricated retaining walls of little ecological value. Beyond Boston Docks the estuary banks run for 8 km to Tabs Head, with the retaining banks between 3 and

5 m above the surrounding land, the bank top becomes wider towards the Wash. The estuarine banks were generally colonised by sea couch, yorkshire fog, creeping thistle and sea wormwood communities. The landward side of the banks were colonised *inter alia* by false oat, rye grass, creeping thistle, cocksfoot and sea couch.

Between the bank bottom and the estuary the area was often taken up with saltmarsh species, including sea arrowgrass, saltmarsh grass, sea purslane and annual sea-blite. The saltmarsh gave way to netted man-made ballast (bank protection) containing sea plantain, sea arrowgrass and sea saltmarsh grass, replaced by mud and sand towards the estuary. No channel vegetation was apparent.

To the landward side of the banks the areas were generally taken up with agriculture, predominantly with cereal and potato cultivation. Tree and shrub vegetation often separated the fields from the banks, with areas of saltmarsh and ditches (containing reeds and rushes) often found behind the estuary banks. After the Sea Bank, towards the mouth of The Haven, saltmarsh became the major vegetation type.

Slippery Gowt, to the south of The Haven adjacent to an industrial/landfill area, has a colony of Boston Horsetail, *Equisetum ramosissimum.* The species only occurs in this location and is a scheduled species under the Wildlife and Countryside Act 1981 and a Red Data Book species. One colony exists along a 200 m section of the bankside. *E. ramosissimum* is susceptible to disturbance and attempts at transplanting have not been successful.

No details are currently available on the vegetation or fauna for the other areas of interest.

Birds

The Wash area supports over a quarter of a million wintering and migrating waterfowl, many in national and internationally significant numbers, and is numerically the most important area in Britain for wintering waterfowl. The *Wash Management Strategy Paper - Wildfowl Conservation* details the numbers and distribution of significant species and discusses the management of the region to enhance the conservation potential.

The species and numbers of birds using the Wash and more specifically The Haven are regularly monitored by the British Trust for Ornithology (BTO), RSPB and LTNC,

which between them hold a detailed data record for the area. The Birds of Estuaries Enquiry (BoEE), administered through the BTO, has a monthly survey of the region, including two sections at Frampton North and Witham/Witham Mouth. Other data is available through the Institute of Terrestrial Ecology, who have monitored Wash bird and invertebrate numbers for several of years (for example Goss-Custard and Yates 1992). A recent study for the NRA, however, has found that much of the previously recorded data does not meet with NRA reporting standards for wildfowl and further data is necessary on feeding patterns (NRA 1994).

In the Wash twenty four species of bird are reported as nationally or internationally important wintering species, including the pink-footed and brent geese, Berwick swan, shellduck, pintail, oystercatcher, ringed and grey plovers, knot, dunlin, bar-tailed godwit, redshank and turnstone. Migratory species include the sanderling, black-tailed godwit, spotted redshank and the greenshank (from Kirby *et al* 1991). Breeding birds of particular importance include little and common tern. Many of these and certain other waterfowl are susceptible to disturbance and habitat degradation (Wash Management Strategy 1992). Both can impact on breeding and migratory success, making provision of disturbance-free refuges a management priority.

Many of the species listed above are recorded in The Haven in significant numbers. Brent Geese are often present in large numbers near the Hobhole Drain outfall (and often at North Sea Camp), with high concentrations of Eider duck at the Witham Mouth. The full and extensive list of bird species, numbers, locations and disturbance factors is available through BTO.

The river corridor birdlife is less well monitored. The NRA river corridor survey recorded bird territories along the estuary banks on only one occasion, and therefore cannot be regarded as a comprehensive data set. A total of 31 species were reported, mostly of common urban and rural species such as blackbird, thrush, wren, wagtail and goldfinch. The banks were inhabited most frequently by meadow pippit, skylark and linnet with a few other common grassland species. Reedbed communities such as sedge warbler, reed bunting and willow warbler were present in the saltmarsh/reedbed areas behind the banks. A few waders and wildfowl commonly recorded in BoEE surveys were also noted.

Other Fauna

No data is currently available on other phyla in The Haven corridor. An otter survey

of the Hobhole Drain is currently underway, but data is not yet available.

The Wash supports the largest single group of common seals, *Phoca vitulina*, in Europe. Their utilisation of The Haven, if any, is unknown.

6.2.5 Current Problems Associated with The Haven

Saline Intrusions

The drought in eastern England between 1989 and 1992 has had a significant influence on the upstream intrusion of saline waters from The Haven into freshwater reaches of the River Witham and associated drains. Reduced freshwater flows have allowed saline estuarine waters further up The Haven during high tides. Seepage of the saline waters through tidal gates and sluices at drain exits and overtopping of sluices has resulted in the ingress of saline waters into the freshwater systems.

The denser saline waters have tended to form a layer beneath the freshwater, often encroaching significant distances upstream. Reports of saline intrusions 25 km up the South Forty Foot Drain, 15 km up the River Witham, and intrusions up the Hobhole and Maud Foster Drains have been recorded (W. Forbes, *pers comm*). Engineering works have been installed to prevent or reduce saline ingress, including scavenger pumps at Black Sluice pumping station and the Maud Foster Drain, with some success.

Although a natural phenomenon in low flow conditions, saline intrusions can have a significant effect on the water quality and ecology of freshwater. Many freshwater species are intolerant of saline waters and will move away. Sessile organisms may be severely affected and mortality can occur. Fish kills were recorded on seven occasions by the NRA (W. Forbes, *pers comm*) and invertebrate benthos was killed. Fish were also shown to move from regions of salinity ingress and benthos may have become dominated by saline tolerant species. Salinity tolerance problems can be exacerbated by the formation of a halocline, a distinct boundary layer restricting oxygen transfer, resulting in sub-surface oxygen depletion.

The use of the surface waters and groundwater (where saline intrusion also occurs) for irrigation may be severely hampered, as excessive salinity can ruin crops. In recent years the increases in salinity of irrigation water sources has caused some farmers to suspended their crop irrigation in the Boston region.

Contamination of Shellfish Stocks

Shellfish stocks in the lower reaches of The Haven and in the Wash adjacent to the mouth of the Witham have registered elevated microbiological concentrations in recent years (W. Lart *pers comm*). MAFF reports on the microbiological concentrations in the shellfish are not currently available, but it is thought that reported microbiological contamination may be a result of wastewater discharges into The Haven and/or Welland estuary.

6.3 Identification of Potential Impacts

The majority of the following effects, and their perceived benefits or disadvantages, will to some degree be exhibited regardless of the positioning of the proposed Barrage (see Table 6.1). The magnitude and significance of the impacts will, however, be a function of the siting of the Barrage. At present many of the aspects which may be considered to have potential environmental impact cannot be substantiated, as insufficient data is currently available. Therefore, the review of the various options will be largely qualitative, relying on interpretation of known processes and/or impacts to the proposed development. Construction and operational phases are considered, with the magnitude of each impact indicated for the various environmental aspects.

Operation of a Barrage would necessitate the replacement of the gravity flow structures on the Black Sluice and Maud Foster Sluice with pumping stations. The impacts of these developments are also briefly discussed.

6.3.1 Construction Impacts

The majority of the impacts which are expected from construction activities will be caused by vehicle access requirements, site plant operation and the construction and installation of the Barrage itself (see Table 6.1). The magnitude of environmental impact will vary with the relative position of the Barrage on the estuary and the mitigation measures proposed.

The installation of additional pumps at the Black Sluice and restructuring of the Maud Foster Sluice will involve local disruption, and may have implications for short term influence on water quality and noise. The effects should be minor and are not considered further at this stage.

6.3.1.1 Ecology

The ecology of The Haven will be adversely affected, primarily by increased construction traffic, plant operation and Barrage installation. The terrestrial ecology will be impacted by disturbance, associated with increases in noise and vibration, and potential land-take for construction areas. The aquatic ecology may be similarly impacted by disturbance. Destruction of habitat during dredging operations, which will be required to improve shipping access along the Haven and at the Cut End Bar, may have significant environmental impact (refer to section 3.5.4).

Table 6.1: Potential Impacts on the Environment of the Construction and Operational Phases of the Proposed Boston Barrage

Environmental Consideration		Construction			Operation				
		Access	Plant Operation	Installation	Flood Protection Alternative	Increased Impounded Water Levels	Increased Trade and Recreation	Secondary "Planned" Development	Increased Access to Estuary
Ecology	Terrestrial	-	-	-	o	- -	-	-	- -
	Aquatic	o	-	- -	o	- -	-	-	-
Water Quality	Impoundment	o	-	- -	o	- -	- -	- -	o
	Estuary	o	-	- -	o	- -	-	- -	o
Geology		o	o	o	o	-	o	-	o
Human Population		-	-	+	o	o	+	+ +	+
Traffic and Transport		- -	- -	- -	o	o	- -	- -	- -
Air Quality		-	-	o	o	o	-	-	o
Noise and Vibration		- -	- -	- -	o	o	- -	- -	- -
Cultural Heritage and Archaeology		-	o	o	+	+	-	-	o
Landscape and Visual Aspects		-	-	-	+ +	+ +	+	-	o
Recreation	Water Contact	-	- -	-	+	+ +	+ +	-	+
	Conservation	-	-	- -	o	- -	- -	-	- -
Health and Safety/Hazards		-	-	-	+	-	-	-	-

Key: + + Significant positive impact + Moderate positive impact o Insignificant impact

- - Significant negative impact - Moderate negative impact

6.3.1.2 Water Quality

Water quality may decline depending on plant operating procedures and Barrage installation methods. Dredging and caisson installation will result in disruption of sediments and disturbance of flow, which can have implications for estuary dispersion characteristics and potential release of contaminants/nutrients from the sediment. Plant operation may also cause adverse impacts if inappropriately located and/or if allowed to discharge pollutants to the environment.

6.3.1.3 Geology

The effects of construction on geological sites in the area is thought to be insignificant.

6.3.1.4 Human Impacts

Impacts on the human population will probably be moderately negative, owing to disturbance from increased traffic and plant operations. The positive aspect of increased employment opportunity during construction should be considered, if local labour is to be used on the scheme.

6.3.1.5 Traffic and Transport

Traffic and transport will increase as a result of construction. The relatively inaccessible position of The Haven, and the potential Barrage sites, may increase the disturbance on local communities. Plant movement by water may reduce traffic impacts. Building works on The Haven will also lead to disruptions to shipping, which will require careful scheduling to minimise impacts.

6.3.1.6 Air Quality

Air quality is unlikely to be affected significantly by construction, although dust generation from batching plants, earthworks etc may create problems.

6.3.1.7 Cultural Heritage

Detail of the impacts on cultural heritage of the area, including the listed buildings etc, are currently scarce. It is thought that increased vibration from traffic movement and

the potential for local decline in air quality may have a moderate negative effect on these sites.

6.3.1.8 Landscape and Visual Amenity

During the construction phase the landscape and visual amenity may be affected, principally due to increased traffic movements, the presence of construction plant on site and the local reduction in visual amenity caused by the Barrage installation. This will be particularly acute if the barrage is to be built adjacent to the Pilgrims Memorial Site.

6.3.1.9 Recreation

Recreational activities on The Haven will be moderately impacted by all aspects of construction, primarily through disturbance of the ecology of the area and decreased public access during development.

6.3.1.10 Health and Safety/Hazards

An increased likelihood of accidents, combined with potential for decreased water quality, may add to risks for health and safety and poses a significant increase in hazard potential.

Many of the negative impacts of the construction phase may be successfully mitigated against using suitable operating methods, in combination with a rigorous monitoring programme and set procedures for breaches of conditions (see Section 6.4.2).

6.3.2 Operational Impacts

6.3.2.1 Impacts on Ecology

Statutory Designations

The impact of the Barrage on the habitats and ecology of The Haven and the Wash are potentially very significant. Any disturbance to, or destruction of, habitats in the Ramsar/SPA/SSSI designated area, and consequent reduction in habitat and ecological value, which the designations are intended to protect, must be considered. The implications of the designations for development in the area are discussed in Section 6.4.3.

Reduction in Length of Fully Tidal Estuary

The length of fully tidal estuary will be significantly reduced. The changes to the hydraulic characteristics of The Haven have been discussed in section 3.2 and may alter the salinity regime of the estuary. This in turn could have a significant impact on the ecology of The Haven. The loss of relatively scarce estuarine environment must be considered environmentally significant.

Aquatic Ecology

A change in salinity regime within the impoundment could have a significant impact on the aquatic community structure. The relative change in faunal and floral species composition will depend upon the resultant salinity and the temporal variation, which will require detailed modelling. The brackish/estuarine character of the estuary has the potential to be replaced by a freshwater system in times of high river and drain runoff, reverting to a high salinity system in drought conditions. The potential for large variations in salinity on a long term cycle, unlike the variations seen during natural tidal cycles, will have a significant impact on the aquatic ecology. Certain Barrage operating regimes, for example periodic low level flushing, may assist in mitigating these salinity changes.

Changes to the mudflat communities will result from the permanent covering of the low shore mudflats (nominally below high neap tide). The biotic community will change to one reflecting the salinity regime of the submerged mudflats. The mudflats above the new water level may retain their character and species composition, although changes to the substrate from changes in groundwater may alter the habitat suitability.

Problems with colonisation due to changing salinity may be compounded by changes in the substrate type brought about by altered sedimentation patterns. The relatively stable impoundment may enhance deposition of suspended solid load, thereby having a significant effect on the suitability of substrates for benthic colonisation. The alteration of deposition and erosion zones in the impoundment and downstream of the barrage may have a significant influence on colonisation by benthic communities. Phased release of impounded waters to maintain a shipping channel may produce scour, leading to adverse effects on benthic communities downstream.

Concern over the alteration of deposition and erosion zones in the estuary and Wash, and consequent effects on sedimentation patterns has been raised by several authorities. Potential impacts of changing sedimentation patterns on the saltmarshes at the LTNC and RSPB nature reserves are currently unknown. English Nature is concerned by the potential impacts of changing sedimentation patterns on the Wash generally.

Fish communities both upstream and downstream of the Barrage will be affected by the scheme. Movement of migratory species and those using the estuary as a spawning, nursery or feeding ground may be impeded. Potential decline in water quality may restrict fish movement, particularly if oxygen levels are reduced or unionised ammonia concentrations increase. Changes to salinity regimes both upstream and downstream of the Barrage may also influence migratory fish homing activity. Occurrence of migratory fish in The Haven is currently unknown. Insufficient data is available to draw conclusions on the current species composition of the fish community in The Haven or predict the effects of the Barrage scheme. Passage of migratory fish to the River Witham is currently restricted by the Grand Sluice.

The installation of pumped discharges at the Black and Maud Foster sluices may have an influence on localised fish stocks. Impingement of fish on the pumps can lead to mortality or injury, although the scale of the problem cannot currently be quantified.

A brackish or freshwater impoundment will encourage algal growth, particularly in relatively nutrient rich, clear and stable waters. Phytoplankton may form unsightly blooms, including the potentially toxic blue-green algae such as *Oscillatoria spp.* and *Microcystis spp.*. Die-off and sedimentation of the blooms may also increase the BOD burden of sub-surface layers, further exacerbating water quality problems.

Maintenance dredging, (refer to section 3.6.3) which may be required for channel clearance in the Haven and at Cut End Bar, has the potential to cause significant ecological damage, by direct habitat destruction and smothering of surrounding substrates.

Shellfish Distribution

Shellfish constitute an important local fishery, primarily at the mouth of The Haven beyond Tabs Head. Six shellfish lay areas have been designated and are licensed by the Eastern Sea Fisheries Joint Committee (ESFJC), consisting of North Lays, Clay

Hole, Black Buoy, Hook Hill, Mid Tofts and Tofts. New regulations under negotiation between the ESFJC and the lay owners will increase the area of each lay to 10 hectares, from the old 5 acre lays.

Alteration of the flow regime out of The Haven, compounded by changes in sedimentation patterns, may have a significant effect on the productivity and hence profitability of the shellfish lays. Effects on microbiological contamination at the lays is unknown, but may alter their MAFF categorisation. Diversion of wastewater discharges beyond the Barrage may result in increased contamination of the lays.

Terrestrial Ecology

Any changes to the terrestrial ecology adjacent to The Haven will result from alteration to habitat type or through increased disturbance. After construction, bankside habitat and floral communities are likely to remain largely unchanged, providing the banksides are re-landscaped to their original condition.

Sensitive saltmarsh areas and their associated communities may be at risk from an increase in water table level. The change to sedimentation patterns in the vicinity of the estuary mouth may also influence mudbank and saltmarsh habitats. Any alteration to the saltmarsh, particularly the less widespread upper saltmarsh could have a significant impact on the species composition in those habitats. Current information is insufficient to predict the likely effects on the saltmarsh or mudflats.

Impacts on the bird communities are inter-related with those of the sensitive habitats they utilise, and may also be influenced by increased disturbance levels. Loss of feeding grounds on the estuarine mudflats and alteration of mudflats in the vicinity of the estuary will potentially affect the wader and wildfowl communities. The displaced birds will have to relocate, increasing the density of birds at other feeding and roosting grounds. The increased feeding density may reduce the availability of food and decrease chances of survival. Increased pressures for roosting space may also have a detrimental effect. These impacts are species specific, as each species occupies an exclusive niche. The magnitude and significance of the impacts is currently unknown, but is thought to be potentially large.

The loss or alteration of saltmarsh habitat represents a further potentially significant impact. Many of the bird species using the Wash and The Haven do so because they provide specialised habitat in a relatively undisturbed setting. Increased public access

and shipping movements may further exacerbate the situation. The importance of this area is recognised by its international designation, and should be protected from undue disruption.

The effects of the Barrage on the habitat colonised by the *Equisetum ramosissimum* is currently unknown. The sensitive nature of this species and its susceptibility to habitat change and disturbance make a thorough investigation of the potential impacts necessary.

Areas adjacent to The Haven, including the extensive arable farming land, may be influenced by changes in groundwater levels, particularly if seepage of saline water into the groundwater occurs. Pumping regimes for water level maintenance in the drains will have to be altered to compensate for the changes in water levels in The Haven, and their effects on conservation in the drains may require investigation. The use of the groundwater for irrigation will require investigation.

The impact of the Barrage development on other faunal assemblages cannot be predicted as insufficient data on occurrence and distribution is available.

6.3.2.2 Impacts on Water Quality

Surface Waters

The impoundment of water by the Barrage may have significant impact on the water quality of The Haven, both upstream and downstream of the Barrage. Discharges of contaminants from freshwater inputs, industrial sources and the Boston STW will be afforded reduced dilution and dispersion, leading to potential increases in microbiological and other contaminant concentrations. A potentially greater problem will be the periodic discharge of combined sewer overflows during heavy rainfall. The main outfalls at London Road and East Side may discharge untreated sewage effluent to the impounded water which could severely affect the water quality. No data are available on microbiological concentrations in the wastewater or estuary, and no modelling of impacts could be undertaken.

Preliminary modelling has been carried out on the wastewater discharge from Boston STW with and without the Barrage (using Option 1, see Figure 3.6), using the NEWEST 1 dimensional estuarine model. The modelling has established that impoundment of water and restriction of tidal movement may increase the BOD

upstream and downstream of the discharge by approximately 30 to 40%. Initial results suggest that tidal flow dominates water movement and low freshwater input has relatively little influence on dispersion. Caution must be used with interpretation of these preliminary findings as estuarine modelling of this nature is necessarily complex and will require detailed investigation.

Downstream of the Barrage the flow regime will be altered, which may also influence dilution and dispersion of contaminants. When combined with potential water quality effects upstream of the Barrage the influence on water quality in the estuarine reaches of The Haven and Wash may also be significant.

Sedimentation characteristics in The Haven and adjacent areas of the Wash may change, and could cause significant impacts on water quality. Impounded waters will tend to increase sedimentation rates of suspended solids upstream of the Barrage, which may have a concomitant effect on its hydraulic capacity and exert an increased oxygen demand on the system. Increased sedimentation of contaminated particulate matter may increase localised pollutant loads within the impoundment.

Downstream of the Barrage changing flow characteristics may alter deposition and erosion zones. Any proposed flushing regime to minimise the impact of increased sediment deposition in shipping channels may have significant effect on regional sedimentation patterns. Dredging activities may also influence water quality. The disposal of dredged material to land or to other waters may have consequences for the receiving environment. Restrictions to the disposal route may be required after consultation with the local waste regulation authority and/or MAFF.

The changes to the hydraulic regime and consequent salinity changes may have a significant impact on water quality in the impounded area, and may also affect the river and drains. The formation of a halocline, with fresh water overlying denser saline water, may lead to oxygen depletion in the bottom waters and consequent water quality and ecological impacts. The formation of a thermocline in the summer could potentially exacerbate this situation. In Cardiff Bay potential water quality problems with a similar Barrage proposal have prompted the NRA to stipulate a 5 mg/l minimum dissolved oxygen level on the impoundment, which has significant ramifications for the active management of the water body to maintain these levels. Anaerobic conditions in the hypolimnion (the region below the halocline) encourage the release of nutrients and contaminants such as certain heavy metals from the sediments. On mixing of the water column contaminants and nutrients would be

remobilised.

Insufficient data of salinity profiles in The Haven were available for any modelling of likely salinity in the impoundment. Low summer freshwater flows may allow significantly higher salinities into the impoundment during summer, with reduced salinity in periods of high freshwater runoff in winter. Modelling of the salinity regime in the impoundment will require more detailed salinity measurements.

The potential for impounded waters to be dominated by high salinity during drought conditions will have significant consequences for saline ingress into both surface waters and groundwater. The longer residence time afforded by the Barrage may encourage seepage of saline waters through lock gates and sluices to a greater extent than is currently experienced. Certain Barrage operating regimes, for example periodic low level flushing, and even shipping movements may reduce these problems.

Any secondary urban development planned for the Boston area as a result of the Barrage may have a negative influence on water quality if not sufficiently well planned. Surface water should not be allowed to run off in large volumes into the impoundment, as reduced dilution and flushing may influence dispersion. Adequate sewerage capacity and routing should be provided to alleviate the possibility of contaminated discharges into the impoundment.

Litter, refuse and debris could be a significant problem if it were retained in the impoundment. However, the MRL of 1.3m AOD allows some tidal flushing on almost every tide and collection of surface material should not be a problem.

Groundwater

The increase in water level in the impoundment upstream of the Barrage may have an effect on the groundwater regime in the surrounding catchment. Groundwater levels and saline intrusion limits may be altered, although prediction of the likely effects is difficult without detailed assessment modelling.

Potentially increased groundwater levels in the Boston urban area may result in seepage and flooding of low ground, and into excavated structures such as basements, tunnels and sewers which could compromise foundations. Rising groundwater may influence the migration of leachates from any landfill sites in the vicinity of The Haven, and has the potential to influence leaching of contaminants

from contaminated industrial sites. Insufficient data is available at present to predict likely impacts.

6.3.2.3 Impacts on Geology

Impacts on the geology and geological formations in the region are currently unknown, but are expected to be insignificant. There is a moderate potential for impacts from raised groundwater levels and future urban development.

6.3.2.4 Human Impacts

The major positive impacts on the local population may result from an increase in employment prospects and increased amenity value of The Haven. Balanced against these are the increased traffic disturbance, reductions in air quality, potential for rise in groundwater levels and the health and safety/hazard considerations from utilisation of the impounded waters.

The secondary urban development which may result from increases in commercial activity in the region are seen as a significant benefit, providing sufficient housing and community services are planned.

6.3.2.5 Impacts on Air Quality

The development itself is expected to have no significant effect on air quality. The encouragement of trade and amenity by the development may increase transport and industry in Boston, with an associated negative impact on local air quality. The magnitude of the air quality affects is currently unknown and will be a product of the predicted traffic increases.

6.3.2.6 Impacts on Noise and Vibration

No figures are currently available for the potential increases of noise and vibration associated with the port development and concomitant increase in traffic. The disturbance to the population, and potentially increased disturbance of sensitive habitats in previously remote areas from shipping movements and improved public access, represent a potentially significant impact. Recreational activities such as water skiing and jet boating also have the potential to cause nuisance although speed limits imposed by the NRA may restrict or preclude these activities.

The operation of pumps at the Black and Maud Foster Sluices should not constitute a noise problem. A similar system of submerged electric pumps is in place at the Hobhole Sluice and has not created problems for adjacent householders.

6.3.2.7 Impacts on Cultural Heritage and Archaeology

There are nine ancient monuments listed in the Boston area which English Heritage consider may be impacted by the scheme, although the distance of Algarkirk, Swineshead and Wrangle from The Haven make direct impacts unlikely. There are three sites in Boston, at Wyberton, Hussey Tower and Hospital Bridge Lane footbridge, and two at Fishtoft, at Rochford Tower and Cowbridge iron footbridge. Few details are currently available on any other listed buildings, cultural sites and archaeologically important sites in the area. Lincolnshire Heritage is not aware of any archaeological sites within the area, although medieval maritime and prehistoric sites could be present. The effect on the sites located cannot currently be quantified but may be considered minimal.

The flood protection afforded by the scheme is seen as a positive benefit to the Boston area, protecting potentially vulnerable buildings, although flood protection would be provided by alternative schemes in any case. The raising of groundwater levels may however have an impact, particularly on foundations and any buried remains. The scale of the problem is unknown.

Increased levels of traffic stimulated by greater commercial activity may have an effect on listed buildings, primarily from vibration. The potential for disruption to foundations is currently unknown.

6.3.2.8 Impacts on Landscape and Visual Amenity

The raised water level in the impoundment will be perceived by many as an aesthetic improvement to The Haven. The provision of a reasonably constant level water body is seen as one of the benefits of the scheme, and is often associated with increased amenity value. The proposed increase in shipping and leisure craft may enhance the situation, as these are often associated with positive visual amenity.

Some opposition to this generally held view has been expressed, as the changing visual aspect provided by a tidal system may be perceived as more suitable. The building associated with waterside developments may be advantageous, as with

leisure complexes, or may result in the construction of industrial areas with the potential for negative landscape value. Thorough planning of the scheme should stipulate the types of development necessary to enhance visual amenity. Existing unattractive flood protection structures in Boston could be dismantled if the Barrage is installed. Proposed increases in the height of flood protection structures, to prevent 1 in 100 or 1 in 200 year floods, would be unnecessary. Removal of flood protection structures would have a positive impact on visual amenity within Boston.

The location of the pumping stations at Black and Maud Foster Sluices should be comparatively unobtrusive, using existing structures where possible to minimise impact.

Potential for decline in visual amenity may arise from surface debris in the impoundment. Algal scums and debris are often associated with impoundments of this nature and can cause a decline in visual amenity and unpleasant smells. However, with an MRL of 1.3m AOD some tidal flushing will occur on almost every tide and collection of surface debris should not be a problem.

6.3.2.9 Impacts on Recreational Opportunities

Recreational opportunities may often be increased by the creation of a large body of impounded water, provided the water quality is maintained to a reasonable level. At present, The Haven has limited use for recreation, although pleasure boats and yachts may use the estuary as a safe anchorage. Other water sports are generally limited by the tidal fluctuations. The banks of The Haven provide access and opportunity for walkers and others to enjoy the area, aided by the provision of a picnic area at the Pilgrims Memorial. Ornithologists and biologists also benefit from the large areas of nature reserves adjacent to The Haven.

The provision of an area of impounded water upstream of the Barrage may encourage its use for water sports. Schemes to encourage sports such as windsurfing, rowing, sailing and boating may be applicable. The potential problems with water quality, especially with regard to microbiological quality, may limit the full utilisation of the water for contact water sports unless stringent water quality criteria are upheld. The NRA has proposed environmental quality standards for faecal coliforms and streptococci of 2000 and 100/100ml respectively to protect immersion sports participants from significant health risk. Microbiological concentrations in the impoundment are not yet known, but modelling of the system should indicate what

types of water sports may be encouraged. Non contact and low risk water sports such as angling and rowing are thought to exhibit less of a health risk and can be promoted in relatively poorer quality water.

The large area of water may also be managed to create a viable fishery, providing the salinity regime and water quality are sufficient to maintain appropriate fish species. The type of fishery which may be encouraged cannot be assessed until detailed modelling has indicated the expected salinity and water quality.

The improved visual amenity provided by the increased water level in The Haven may encourage recreational opportunities centred on the attraction of the water environment. Development of leisure amenities such as restaurants, public houses and walkways may be encouraged.

A potentially significantly negative impact of the impoundment on recreation may result from the potential reduction in wildlife. The disappearance of natural estuary, reduction in mudbank area, increased disturbance and consequent decline in birds and other biota may reduce the recreational value of the region for ornithologists and conservationist.

6.3.2.10 Health and Safety/Hazard Impacts

The increased trade encouraged by the development may have several effects on both health and safety and increased hazard potential. From a health and safety aspect the potential decline in water quality will be of concern, particularly the problems associated with microbiological concentrations in the impoundment where recreation is to be encouraged. Another serious health consideration must be the increased chance of contracting Leptospirosis (Weil's Disease), which is often associated with impounded water developments. Furthermore the potential for algal blooms and the problems associated with skin and digestive tract infections must be considered.

Hazards from increased trade include shipping incidents and those associated with increased traffic movements. The potential for shipping accidents and spillages of contaminants may increase, which may be compounded if hazardous cargoes are to be carried. Handling and storage of hazardous and/or contaminating chemicals in the port may also present problems. Greater numbers of traffic movements brought about by increased commercial activity may increase the potential for accidents and spillages in the Boston region.

However, the extended period for shipping movements as a consequence of Barrage operation may have a positive influence on shipping safety. At present the window for shipping movement is restricted to high tide, when several ships may be in close proximity while attempting to use the Port. With an extended access/exit period for the Port the potential for congestion and subsequent accidents may be diminished.

6.4 Consideration of Alternative Options

6.4.1 Selection of Preferred Option

The four options for siting of the Barrage are shown in Figure 3.6. Consideration and prioritisation of each option is based on its relative (potential) impact on the selected environmental categories. A summary of the relative environmental priority of the Barrage options is given in Table 6.2.

Each environmental category was assigned a rank according to its relative environmental importance. The ranking was qualitative, with each category assigned a value as a proportion of 100. Air quality and cultural heritage were not considered as the alternative options were deemed to have no relative difference in impact. The options were then qualitatively assessed and each site designated a number from 1 to 4, indicating its relative impact on the particular environmental category. Number 1 indicated the most suitable site and number 4 the least suitable site for the four options. The total for each option was calculated by adding the score (product of rank x relative number) for each environmental category. It must be noted that the procedure was largely a subjective assessment, as insufficient data were available for definitive predictions.

Only environmental categories where there was a potential difference from the location of the Barrage were considered and only operational impacts were assessed. It was assumed that each potential impact would be realised and no mitigation measures were implemented. The impacts of pumping station developments at Black Sluice and Maud Foster were not considered as they would be similar for each option.

6.4.1.1 Consultation

The consultation phase of the selection procedure was restricted by the project deadline and was therefore necessarily short. The replies to the consultation have been carefully considered, and any significant benefits or disadvantages of the various options which were raised have received attention. In certain cases the consultation has added detail or drawn our attention to certain aspects which have subsequently been added to the main text. Each representation is considered in more detail in Section 6.4.4, which covers the requirements and likely objections to the Barrage of the consultees.

6.4.1.2 Selection of Preferred Option

The criteria for consideration when selecting the preferred environmental option are given in Table 6.2, and represent a summary of the potential impacts identified in Chapter 6.3.

Option 1 is considered the most environmentally acceptable site, although it may not be the best Option for all environmental considerations. Its location furthest upstream, adjacent to the boundary of the Ramsar/SPA/SSSI site, limits its impact on the sensitive ecological character of the lower estuary, and minimises the loss of estuary (see Section 6.4.3.3). However, the land take of designated area is greater at this site, at approximately 16000 m^2, than the other sites, which require between 12900 to 14300 m^2.

Table 6.2 Relative Environmental Priority of the Barrage Location Options

Environmental Consideration		Rank	Option 1	Option 2	Option 3	Option 4
Statutory Designations		20	1	2	3	4
Ecology		20	1	2	3	4
Water Quality	Surface Water	10	1	2	3	4
	Groundwater	5	1	2	3	4
Air Quality		0	0	0	0	0
Noise and Vibration		10	1	2	4	3
Traffic and Transport		5	1	2	4	3
Cultural Heritage and Archaeology		0	0	0	0	0
Landscape and Visual Amenity		10	4	3	2	1
Human Impacts		0	0	0	0	0
Recreation	Water Amenity	7	4	3	2	1
	Conservation	3	1	2	3	4
Health and Safety/ Hazards		10	4	3	2	1
Total ##		100	181	227	288	304

Key 1 Most Environmentally Acceptable ..... 4 Least Environmentally Acceptable

Total represents the addition of all environmental category scores (rank x number) for each option

Option 1 receives water from the river and drains upstream and the wastewater discharge from Boston STW. However, all other options have the added burden of the wastewater discharge from Fishtoft STW, located on the Hobhole Drain upstream of its confluence with The Haven. The relatively larger area for stagnation and input of high nutrient freshwaters indicate that water quality problems are progressively greater towards Option 4. Option 1 could be made more advantageous with a suitably designed outfall from Boston STW to downstream of the Barrage. Groundwater impacts would become more extensive as the length and volume of the impoundment increases, reflected in the choice of Option 4 as the least favourable groundwater quality alternative.

The relative effect of the alternative options on air quality, cultural heritage and human impacts are considered insignificant.

Noise and vibration is to a large extent tied to traffic and transport, as reflected in the similar designation of the options for these categories. The lower estuary and the associated ecologically sensitive areas may be particularly susceptible to disturbance from noise and vibration, from lock and Barrage operations, increased shipping and recreational activity. Option 3, adjacent to the middle of the nature reserves is considered most likely to be impacted, while Option 1 represents the least nuisance.

Landscape and visual amenity, together with waterborne recreation, will derive greatest benefit form the Barrage by extending the area of the impoundment to a maximum. Option 1 is least favourable and Option 4 the most beneficial using these criteria. However, for conservationists and bird watchers the greater disruption to the existing environment from Option 4 dictates that it would be the worst choice. From a recreational perspective, taking into account numbers of people participating, the water contact and passive recreational users would probably outnumber the bird watchers and are allotted greater priority.

Finally health and safety/hazards are considered most likely to impact on Option 1, primarily because of its relative distance to Boston and the smaller volume of impounded waters to dissipate contaminant spillages. With the other options the proximity of the Barrage, where collision and accident are most likely to happen, to sensitive ecological areas could produce significant detrimental impacts which should also be considered.

6.4.2 Potential Mitigation Measures

6.4.2.1 Construction Impact Mitigation

At present detailed construction methodology has not been determined. The following mitigation measures are therefore a general recommendation of suitable techniques that may be employed.

Access to the construction site is currently by low grade metalled road. New or upgraded access roads may be required for movement of construction materials to the site. Careful routing of construction traffic will minimise disturbance in residential areas. Scheduling of traffic movements to avoid congestion at peak times and avoidance of nuisance by stipulation of working hours should be considered. Heavy plant and materials may be moved by water to reduce traffic impacts on local roads.

Site choice and management should consider measures to minimise visual and noise disturbance. Screening of the site and soundproofing (if found to be necessary) should minimise noise and may restrict migration of dust. Noise impacts will be limited by applying the requirements of BS 5228 Noise Control on Construction and Open Sites.

Many potential sources of contamination can result from the construction site, which can be reduced or alleviated by careful management.

The sensitive ecological nature of the area surrounding the site may dictate that certain construction activities, such as dredging, be scheduled to take advantage of "windows of opportunity". Potentially damaging impacts can therefore be minimised by restricting activities during sensitive lifestages or breeding periods of vulnerable biota.

The construction programme should be designed to minimise environmental conflict by selection of environmentally compatible building techniques and adhering to relevant codes of construction practice. Monitoring of the construction phase will be required to ensure compliance with the various conditions and consents stipulated by the regulatory authorities.

6.4.2.2 Operational Mitigation Measures

Several potentially significant impacts of the Barrage have been identified in section 6.3. The following subsection suggests methods and techniques which may be applicable for reducing or alleviating these predicted problems. The mitigation measures should be considered for whichever option is finally chosen.

Ecology

The provision of alternative aquatic estuarine habitat to compensate for that lost to the development is considered impracticable, given the lack of a suitable alternative site. Enhancement of existing habitat or creation of new saltmarsh/mudflat habitats may be appropriate to compensate for any losses to the estuarine environment and increase the ecological value of adjacent areas.

The estuary downstream of the Barrage has the potential to suffer from reduced flows as a result of the impoundment. Barrage operation will have to be managed to provide a minimum acceptable flow in the estuary for the maintenance of estuarine biota. The potential variation in salinity regime of the impoundment may make biotal colonisation difficult. The active management of the contained water to maintain a freshwater or low salinity ecosystem may prove beneficial for biotal communities and provision of a reasonable fishery. Techniques to enhance aquatic environments, such as provision of spawning areas, reefs and marginal habitat should be incorporated. Management of the impoundment and the estuary to maximise their ecological potential is seen as central to the proposed development.

The provision of a fish pass is usually required in tidal structures with the potential to restrict movement of migratory fish species. The Grand Sluice already acts as a barrier to fish migration and it is unclear whether a fish pass would be required in the Barrage. Consultation with the NRA will be necessary to confirm the need for a fish pass. The provision of a fish pass at Grand Sluice would then allow the passage of migratory species into the River Witham and drains, which could represent a significant benefit of the scheme.

The potential for fish impingement at the pumping stations on the Drains is unclear. Careful design of the pump intakes, as described in *Diversion and Entrapment of Fish at Water Intakes and Outfalls (NRA 1992b)*, should alleviate any potential problems.

Water Quality

Impoundment of fresh or brackish water with periodic influx of denser high salinity water has serious implications for water quality. Layering of the water column, through formation of an halocline and/or thermocline, should be prevented. Mixing of the water body to prevent stratification, by fixed or mobile aerators and/or other devices, and reprofiling of the bathometry to remove depth variations as a result of channelling may be necessary to restrict formation of pockets of higher salinity water and thermal stratification. Management of the Barrage either to flush or to restrict access of high salinity waters may be considered,for example on high spring tides.

The discharge of wastewater from Boston STW, combined sewer overflows and other untreated sources into the impoundment may be prohibited to safeguard water quality and health considerations. Re-routing or pretreatment of the discharges will probably be required, involving considerable capital expenditure.

Dredging within the impoundment and in the estuary should be managed to reduce its impact on the environment. Use of techniques to minimise substrate disruption and spread of sediment plumes should be stipulated. The use of excavated material and dredgings for marsh replenishment may prove to be beneficial for habitat conservation and creation. This option may be particularly relevant in view of the proposed ban on dumping at sea.

Groundwater levels should be monitored after impoundment to establish changes to the groundwater regime. Any increases in groundwater levels that adversely affect foundations and low lying areas will require remedial action. Increased leachate production from infiltration of groundwater into contaminated areas, such as landfills, will require evaluation. Removal of leachate or contaminated soil to prevent water contamination may be required.

Traffic and Transport

Traffic routing and access should be considered to minimise visual and noise and vibration impacts. Provision of sufficient and suitable roads to take the predicted increases in commercial and recreational traffic will be required, as will suitable parking facilities for both traffic categories.

Landscape and Visual Amenity

Landscaping of the impoundment and Barrage to enhance their visual amenity is an important consideration. Suitably designed walkways and amenity areas within the boundaries of the impoundment and the profiling of the Barrage to limit its obtrusion should be provided. Unsightly algal scums are difficult to restrict, but for an MRL of 1.3m AOD some tidal flushing will occur on almost every tidal cycle and collection of surface material should not be a problem.

Noise and Vibration

The Barrage and the associated infrastructure has the potential to generate considerable noise and vibrational disturbance. Planning of access routes to the port and recreational areas should consider the likely increases in disturbance, and determine routes and methods to minimise their impact. Shielding of sensitive locations by noise barriers etc. and provision of double glazing to impacted housing can be used as a secondary noise limitation strategy. The cultural heritage of Boston, and particularly the impact on listed building, should be considered and remedial action to foundations, facia etc. proposed.

Human Impacts

The expected increases in commerce and trade within the Boston area may result in an influx of people to take up the greater employment opportunities. Sufficient housing will be necessary, as will the provision of suitable community amenities. Impacts on local communities should be considered and measures taken to incorporate the incoming population into existing communities.

Recreation

The projected increases in recreational opportunities as a result of the Barrage will have to be scheduled and zoned to avoid potential conflicts of interest, for example fishermen and sailing. The encouragement of recreation will require provision of suitable access and facilities for the various activities to be encouraged.

The range of sports and recreational pursuits to be encouraged within the impoundment will require careful consideration. Pathogens from faecal pollution can present a significant health risk for certain immersion sports, such as swimming and

bathing. Rerouting of contamination sources can minimise these inputs. The public should be made aware of the potential pollutants in the watercourse through posters and leaflets, and particularly pathogens such as Leptospirosis, so that they have sufficient information to make a reasoned choice on their level of water contact.

Health and Safety/Hazards

Certain health and safety aspects of water contact have been dealt with above. Provision of structures to minimise accidental entry to the impounded water, particularly in areas of public access, should be provided, along with sufficient safety equipment (lifebuoys etc).

The hazards associated with shipping should be minimised by restriction of non recreational shipping to seaward of the port and clear designation of rights of way. Suitable safety equipment and procedures should be in place in the port to deal with all potential accidents and hazards. Procedures should be devised for immediate response to spillages in the impoundment area, and suitable methods employed to minimise spread of any contamination.

Monitoring

Measures which are implemented to minimise Barrage impacts will require monitoring during both the construction and operational phases. Specific monitoring programmes will be required for each phase, within which each environmental discipline will be considered. During construction detailed monitoring will include, but not be limited to, the ecology, surface and groundwater quality, air and noise effects. Operation of the Barrage will require regular monitoring of the ecology and surface/groundwater quality (for example dissolved oxygen, BOD, ammonia, other physical/chemical/microbiological parameters as required), and other disciplines as deemed necessary by further investigation.

6.4.3 Development on Environmentally Designated Sites

The national and international designations placed on the lower stretch of The Haven and the Wash dictate that any development within the area or in areas adjacent to the designated site be subject to stringent planning control. To this end proposed and implemented guidance from the Department of the Environment is available for planning authorities when making decisions on planning applications. The following

subsection briefly describes the relevant legislation relating to the development, the planning implications and an indication of the number of developments accepted for development within designated sites within England and Wales. The potential loss of designated area from the Barrage is then detailed and the implications for Barrage development discussed.

6.4.3.1 Statutory Designations and Planning Guidance

The legislation under which SSSI, Ramsar and SPA designations are implemented was detailed briefly in Section 6.2.2. The designation of sites to protect, manage and potentially create new biotypes is a general duty of member states of the European Union, particularly for sensitive or vulnerable habitats. The EU Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) is due to be implemented in the UK during 1994, which places a duty on the government to designate sites as "special areas of conservation" (SAC). This designation will increase the stringency of planning controls within the designated boundary. No areas have been designated as SACs to date, but the international importance of the Wash should make it a good candidate. At present planning guidance for designated areas is covered by DoE circulars, which are due to be superseded by the planning policy guidance note detailed below.

Draft Planning Policy Guidance Note: Nature Conservation

This planning Policy Guide is currently in draft form and should be published by April 1994. It is understood that it will supersede earlier circulars 27/87 and 1/92 on planning policy for designated areas. The interpretation below is based on the draft document which aims to consolidate and enhance the above circulars. The guidance note sets out the principles and policies that apply to the reflection of nature conservation priorities in land use planning.

The guidance note confirms the requirement for developers to consult with English Nature when planning a development within, or within the consultation area of, an SSSI, SPA or Ramsar Site. The authority will be required to consult English Nature who will advise whether the proposed development would significantly affect the ecological objectives for which the site was designated and will suggest any measures they consider appropriate to apply in such circumstances. The Secretary of State would normally call in planning applications which affect the above types of site and the following points should be considered:

(1) Whether, in the light of the advice from English Nature, the effect on the site is likely to be significant (in terms of the ecological objectives for which the site was designated), either individually, or in combination with other projects;

(2) Whether a fuller impact assessment is required;

(3) Where a significant effect on the site is likely, whether there are likely to be alternative suitable and available sites for the proposed development, or different approaches which would have a lesser or insignificant effect;

(4) Whether in the case of SPAs there are **imperative reasons of overriding public interest for the proposed development, in terms of social or economic needs or of human health or safety or wider environmental consequences which should take precedence over the international importance of the site.**

(5) Whether, where sites host priority habitats and species the proposed development should be allowed for reasons of human health and safety or wider environmental consequences.

Secretaries of State will follow this approach and may consult the European Commission.

Planning permission should only be granted if the effects on the site will not be significant, or the importance of the development in the terms set out in (4) or (5) above overrides the ecological importance of the international designation. Whether or not the authority is minded to allow the development, the decision should indicate clearly that the above factors have been fully addressed. Any requirements necessary and appropriate to minimise the effects on the site should be clearly set out in the conditions to ensure there is least possible damage. Environmental assessments would be required for Schedule 1 and 2 projects which affect international sites.

6.4.3.2 Development on Designated Sites in the UK

Development on designated SSSI will usually result in loss or partial denotification of the site. Between 1985 and 1990 only one SSSI was totally lost. During this period a further 237 were partially lost or suffered long term damage, out of a total of approximately 3700. Estuarine SSSIs in Britain, of which there are over 330, are particularly susceptible to damage, with 56 reported to have been damaged between

1986 and 1989. Most of the damage resulted in long-term or permanent destruction. The most recent English Nature report on damage to SSSIs suggests that developments given planning permission, which have been the most frequent cause of long term damage, were responsible for only a relatively small area of damage (English Nature 1993). It is not clear whether this is a function of more careful development or a reduction in planning permission for development in SSSIs. Figures for the denotification or damage of Ramsar/SPA areas are currently unavailable, but will be considerably less than for SSSIs.

Several notable barrage and coastal schemes have received planning permission within SSSIs, such as the Cardiff Bay and Tawe barrages, the Poole harbour development and the Felixstowe Docks. A feature of these developments was a compensatory agreement to provide an alternative area to promote conservation, to replace the area lost. In certain cases the planning application may go to public inquiry, with an associated increase in time and money before a decision can be made.

6.4.3.3 Implications of the Wash Conservation Designations for the Boston Barrage

Estimations have been made of the permanent loss of designated areas and estuary as a result of the Barrage (see Table 6.3). Figures indicate that land take and permanent loss of designated area as a result of the impoundment will range from 5,800 m^2 (0.58 ha) with Option 1 to greater than 80,000 m^2 (8 ha) for Option 4, at the mouth of The Haven. The lock structure has a designated land-take of 12,000 m^2 (1.2ha) regardless of Option. The Sluice and Barrage structure requires the greatest land-take with Option 1 at 4,000 m^2 (0.4ha), cutting across a section of saltmarsh, and the least land-take with Options 3 and 4.

Table 6.3 Potential Loss of Designated Site and Estuary as a Result of the Boston Barrage Development. Figures are in m^2 with hectares alongside in brackets.

	Option 1	Option 2	Option 3	Option 4
Permanent Loss of Designated Site				
Lock	12000(1.2)	12000(1.2)	12000(1.2)	12000(1.2)
Barrage	4000(0.4)	2300(0.23)	900(0.09)	1200(0.12)
Impoundment	5800(0.58)	31850(3.19)	59000(5.9)	81500(8.15)
Permanent Loss of Estuary	234000(23.4)	263000(26.3)	290500(29.05)	312500(31.25)

The permanent loss of estuary is significantly greater than that of the designated area, at between 234,000 and 312,500 m^2 (23.4 to 31.25ha) for Options 1 to 4 respectively. Although loss of both designated area and estuary are relatively small in comparison to the area of the Wash, The Haven (and the other estuaries feeding the Wash) represent a sensitive and highly specialised environment which cannot be replaced. It is the realisation of this fact that has resulted in the statutory designations and consequent stringent planning requirements.

It is clear that planning consent for the development will not be straightforward. The possible ramifications of the Boston Barrage on the environment, and in particular the internationally designated areas, will require careful consideration by the regulatory authorities. Insufficient information is currently available to give a reasoned indication of potential impacts of the scheme and an environmental assessment would be advisable, and probably statutory, prior to further development. Consideration must be given to moving the Barrage upstream beyond the designated area.

6.4.4 Requirements and Objections of Statutory Authorities and Interested Parties

There are several statutory authorities which have an interest in estuarine development, and whose policies and/or strategies dictate that they consider barrage developments and their implications. Similarly the scheme will impinge on a variety of interested parties and individuals whose opinion should be sought and considered.

As part of the consultation process information detailing the preferred option and the possible significant impacts was circulated to the statutory authorities and interested bodies (those having replied to the first consultation). The following subsection details the replies to this situation, detailing possible requirements of the statutory authorities and comments from the other consultees.

6.4.4.1 National Rivers Authority

The NRA are charged with safeguarding the aquatic environment, and have an obligation to further and promote conservation, while aiming to achieve an overall improvement in quality of controlled waters. Growing interest in estuarine barrage projects, with at least 14 schemes in England and Wales, has prompted the NRA to look more closely at this type of development and its implications.

Barrage promoters must satisfy the NRA that water quality standards will be achieved. Provision for measures to ameliorate any deterioration in water quality will be required, in combination with adequate Powers of Direction and liability cover. Environmental quality standards (EQS) will probably be set for the impoundment depending on the user group classification, as with the Cardiff Bay Barrage, that will require careful management of the water body. The EQS will probably follow the recommendations in Environmental Quality Standards to Protect Identified Uses of Controlled Waters (NRA 1992). As a minimum requirement limits may be set for dissolved oxygen, temperature, suspended solids, algal growth, and ammonia concentrations to safeguard aquatic biota and maintain water quality.

A further and potentially significant stipulation may be the requirement to stop storm water discharges into the impounded area, or at least to treat the discharge to a level enabling compliance with water quality objectives. In combination with potential restrictions imposed on the Boston STW discharge, particularly to limit ammonia concentrations, the costs for improvements to the wastewater treatment facilities would be large.

The statutory duty to consider fisheries and conservation will also have cost implications for the project. The occurrence and distribution of migratory fish species is unclear. If migratory species are present the NRA may require that a fish pass is incorporated into the barrage design, and provision made for fish to pass by the Grand Sluice, which is impassable at present. The duty to protect special conservation features also means that the NRA will object to a scheme unless the developer can demonstrate that the Barrage will not adversely affect designated sites, or that reasonable opportunity to enhance conservation has not been incorporated.

6.4.4.2 English Nature

English Nature have recently launched their Estuaries Initiative, as part of the Campaign for a Living Coast. The Estuaries Initiative aims to retain an irreplaceable natural resource, whilst maintaining the overall value of Britain's estuaries for wildlife, and offsetting any unavoidable losses by ensuring compensatory gains elsewhere (English Nature, 1992). English Nature intends to achieve the sustainable use of estuaries by establishing estuary management plans. The international importance of the Wash for conservation means that it was one of the first to be targeted, and now

has a Steering Committee and draft management strategy. Responsibility for the Wash Management Group has recently passed over to Lincolnshire and Norfolk County Councils, but adheres to the general principles set out by English Nature.

The Wash Management Strategy is still in draft form, and has been circulated as a consultation document. The strategic goals of the Strategy are to provide a framework for the wise and sustainable use of the Wash within which:

- ☐ the Wash as a natural resource of international nature conservation value is recognised, maintained and enhanced;
- ☐ economic activities that need to operate in the area are able to do so in harmony with the previous goal and with other uses;
- ☐ distinctive landscapes and archaeological and historic features are safeguarded;
- ☐ recreational activities are managed in such a way that the natural beauty of the area can be enjoyed without conflict with the first goal and other uses; and
- ☐ all parties active within the Wash are encouraged to co-operate in the future in using the various powers and rights under which they operate to further these goals.

Specific issues have been identified as important by the Strategy, including planning and development, landscape, ports and navigation, agriculture, and saltmarsh and waterfowl conservation. Each aspect is considered in relation to the others and a compromise sought between economic development and deterioration in the natural environment.

The Wash Management Strategy in the Ports and Navigation section, as agreed between the four Wash ports, set out their goals as:-

(1) To contribute to the viability and efficiency of port and harbour operations.
(2) To minimise the environment impact of port and harbour operations.
(3) To endeavour to enhance the natural environment should the opportunities arise.

English Nature will object in principle to the development of the Boston Barrage within

the Ramsar/SPA/SSSI, indicating that the development runs contrary to the government's commitment to protecting areas of national and international importance for nature conservation. Siting the scheme outside the designated areas is suggested, provided that a rigorous evaluation of impacts and mitigation showed no adverse consequences. The need for an Environmental Assessment to consider the implications of the proposal is strongly recommended.

6.4.4.3 Royal Society for the Protection of Birds

The RSPB are in agreement with the appraisal of the significant impacts, particularly those relating to the loss of estuary and designated site, impacts on flora and fauna, and impacts on water quality. A further impact identified was the potential for increased erosion in the vicinity of the Barrage, with loss of saltmarsh and vegetation.

The RSPB will object to the four Barrage options as they all involve physical loss of a designated Ramsar/SPA/SSSI site. Option 1 involves the largest amount of saltmarsh land take and is therefore the most unacceptable.

6.4.4.4 Anglian Water Plc

All four options for Barrage location will impose a detrimental impact on water quality in the impoundment as a result of wastewater discharges. A £2.5 million scheme to increase capacity and improve wastewater treatment has recently been initiated at Boston STW. Discharge of wastewater would probably require stringent discharge consents from the NRA, including ammonia limits, which could not be met with the current improvements and would require significantly increased investment. A combination of Option 1 and a 1.7 km 700 mm pipeline and associated pumping mains entering the estuary downstream of the Barrage could potentially reduce the impacts. Financial contributions would be required for the pipeline, and increased operating costs would have to be considered. Benefits would be the removal of microbiological and nutrient sources from the impoundment, although dilution and dispersion of the discharge downstream of the Barrage would require careful evaluation.

6.4.4.5 Countryside Commission

Loss of estuary and habitat are both of concern, as are the intrusions to landscape caused by the Barrage in the vicinity of Countryside Stewardship sites. Groundwater

levels and their impact on paths (particularly for the disabled), picnic sites, the car park and disabled persons nature trails at the Pilgrims Memorial site should be considered.

6.4.4.6 Boston Fishermen's Co-operative Ltd

Options 1 and 2 would allow the fisherman to continue operating without major alterations. Options 3 and 4 could significantly impact the water quality of abstracted water used in the shellfish purification plant at Cut End. Costs of finding a new water supply would have to be met by the Barrage developers. Members also expressed concern generally about the development and the effects it would have on their livelihood.

6.4.4.7 Boston Borough Council

Principal concerns regarding the development are the water quality and groundwater implications. The change of water level in the impoundment will impact on wastewater outlets in Boston, which would require revision before impoundment. Concern is also raised at the continued use of storm water overflows and the discharge from the STW into the impoundment. Groundwater level increases could cause problems with building stability in low lying areas. Impacts on the shellfish treatment plant mentioned previously should also be considered.

6.4.4.8 MAFF

MAFF recorded the comments of commercial fishermen from the Boston area and passed them on. Generally a raised level of water in The Haven is seen as beneficial, although potential increases in mooring and locking fees, together with an influx of "yachties and yuppies" may restrict smaller commercial ventures. Congestion and crowding of locks, and consequent increases in accidents, are also seen as a potential problem. Careful marine control may overcome these problems.

6.4.4.9 Boston and Spalding Pilots Association

Many of the points made by the Pilots are factually incorrect or inappropriate. The content of the reply is geared to indicate that Option 4 is the only feasible location, and other impacts are small or should not be considered. General points raised, however, are that the loss of estuary and designated site is minimal; wastewater

discharge quality is reasonable and will not effect water quality; saline ingress will not effect water quality; groundwater rises will not occur; cultural heritage will be increased by improving visual amenity at the Pilgrims Memorial; recreation will benefit; Option 1 would result in saltmarsh land take; the landscape will benefit from increased water levels; employment opportunities will increase; traffic already runs at night and future development may be away from residential areas; and increased traffic will only involve operation staff. Furthermore the shellfish purification plant has not been in use (to their knowledge) for several years and would not be impacted.

6.4.4.10 Eastern Sea Fisheries Joint Committee

Primary concern is for the wellbeing of the shellfishery from the estuary adjacent to the mouth of The Haven. The reduction or erratic flow of food sources, and the potential changes to the sedimentation pattern as a result of flow alteration will require evaluation. Impacts on landings, which totalled 9114 tonnes and a value of £1.2 million in 1991, should be carefully considered.

6.4.4.11 Sea Fish Industries Authority

The Barrage development should require a full Environmental Assessment, taking into account hydrographic information, sedimentology, and the ecological consequences of the scheme, as insufficient data is currently available to make a reasoned decision.

6.4.4.12 British Association of Shooting and Conservation

The BASC are concerned at the impacts of the Barrage on tidal flows, and their effects on the saltmarshes and lower grazing areas. The reduction in area may affect the feeding and roosting patterns of migratory wildfowl and waders.

6.4.4.13 ADAS

ADAS have identified several potential impacts of the scheme, which have been dealt with in the main text. These include groundwater rises, drainage discharges, salinity of irrigation waters, disposal of dredged material and compatibility of water uses.

6.4.4.14 Parish Council of Wyberton

The Council have expressed concern about the water level coming out of the pumping

station at Wyberton.

6.4.4.15 Witham Forth Internal Drainage Board

Any proposal upstream of the Hobhole Drain may have implications for sedimentation around the outfall which should be investigated.

6.4.4.16 Other Objections

Mr Ian Martin of Derby voiced objections centred on the perceived change to tidal fluctuations, effects of dredging, limitation of free access up The Haven, difficulties with queuing at the lock and the necessity for river licences. Furthermore he points to the disruption to navigation under bridges in town from raised water levels, and the needless capital outlay from the NRA on recent flood defence works. The loss of tidal river and wildlife are also seen as an unnecessary loss.

6.5 Scoping for an Environmental Assessment

6.5.1 Statutory Requirements

Barrage schemes are classified under the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 as Schedule 2 developments which may require a formal environmental statement, as judged by the relevant planning authority. Private or hybrid Bills have been the usual route for consideration of barrage project to date, and a Standing Order now requires that an Environmental Statement be submitted as part of the procedure. However, under new provisions in the Transport and Works Act 1992, which may be used to promote barrage schemes in the future, the Secretary of State has the power to waive the normal Environmental Statement requirements. The international environmental designations assigned to The Haven and the sensitive nature of the barrage proposal dictate that an Environmental Statement will be required, probably under the Land Drainage Improvement Works (Assessment of Environmental Effects) Regulations 1988 SI No 1217.

The scope for this environmental assessment has been developed from guidelines in the Department of the Environment "Environmental Assessment - A Guide to Procedures" (HMSO 1989) and guidance from the Institute of Environmental Assessment, including the Institute Review Criteria, which currently represent best practice standards.

6.5.2 General Requirements

The scope of work should be used to define the project, but may require modification after consideration by statutory and non-statutory consultees. The recommendations for methodologies and procedures should be assessed by the appointed consultant and may be subject to detail alteration if justified.

The environmental statement should be available to all interested bodies, and should contain a non-technical summary for ease of understanding. Comment on the environmental statement should be sought from statutory consultees and other interested bodies, if feasible, prior to finalisation. Objections to the scheme should be acknowledged and explained in the text. Benefits and disadvantages of the scheme should be identified and conclusions should be clearly defined.

6.5.3 Outline Requirements for the Environmental Statement

The major components that may be required for the environmental assessment of the Boston Barrage are given below. For each component a full description with justification of any choices taken should be included. The full scoping study for the Boston Barrage environmental assessment is detailed in Appendix 2. The scope covers:

- ☐ Need for the Proposed Barrage
- ☐ Requirements for an Environmental Assessment
- ☐ Description of the Existing Environment
- ☐ Consideration of the Alternative Options and the Selection of a Preferred Option
- ☐ Description of the Preferred Option
- ☐ Identification of Significant Impacts
- ☐ Mitigation and Enhancement Measures for Significant Impacts
- ☐ Project and Post-Project Monitoring
- ☐ Public Consultation
- ☐ Conclusions and Non-Technical Summary

6.5.4 Description of Monitoring and Modelling Requirements for an Environmental Assessment

The scoping study for an environmental assessment identifies the requirements for a description of the baseline and predictions of likely impacts.
The preliminary feasibility study has identified several areas where insufficient data are available on certain environmental aspects from which to define the baseline condition or to predict a potential impact.

The following subsection outlines the further monitoring and modelling that may be required. The sections are divided into options, each of which may be stipulated as part of the environmental assessment. Costings for each option are necessarily approximate and show the likely range of costs, depending on the level of detail required. The final scope of the environmental assessment should be decided during the detailed brief description, at which time representative costings can be calculated.

6.5.4.1 Further Monitoring

- ☐ Habitat and Ecology
  - Phase 1 habitat surveys (Nature Conservancy Council 1990) or Coastwatch survey methods (Hiscock 1990), with a more detailed survey if considered necessary, should describe saltmarshes, mud/sandbanks, other significant habitats (for example Countryside Stewardship sites).
  - Faunal surveys (mammalia, reptilia, amphibia, plankton etc)
  - Fishery survey
  - Algal community survey
  - *Equisetum ramosissimum* investigation

- ☐ Water Quality
  - Salinity profiling over a full range of tidal conditions.
  - Microbiological (bacteria, viruses, other pathogens) concentrations in The Haven and feeder river/drains over a full range of tidal conditions.
  - Groundwater quality and level, including characterisation of the aquifer, dependant on the availability of information and boreholes.

- ☐ Traffic and Associated Noise, Vibration and Air Quality

An increase in traffic volume has been postulated as a likely impact of Barrage development. The magnitude of the impact is currently unknown. Any large increases in traffic or increased congestion may result in noise, vibration and air quality problems which will require definition. It is suggested that initial prediction of future traffic volume and likely congestion be made, from which a decision can be made on the necessity for noise, vibration and air quality monitoring. Assessment of the need for noise and air quality studies should be taken by application of the Department of Transport *Design Manual for Roads and Bridges, Chapter 11 (Environmental Assessment)* (DOT 1993). It may, then, be necessary to monitor the following:

- Traffic flow and volume - ambient levels at junctions and roads leading to the Port, on feeder routes and in the vicinity of the Barrage.

- Ambient noise levels for sensitive receivers at the Port, on feeder routes and in the vicinity of the Barrage.

7. LEGAL REQUIREMENTS AND RESPONSIBILITIES

7.1 Flood Defence

The NRA is required to exercise a general supervision over all matters relating to flood defence (refer to Water Resources Act 1991, section 105).

Although this does not constitute a statutory obligation to defend all property against flooding the "supervision" and "permissive powers" conferred on the NRA mean that the maintenance of the capacity of this river system and the protection of the land from sea flooding will continue to be one of NRA's main priorities. They will not contemplate any changes which are perceived to reduce in any way the level of service of the flood defences.

7.2 Navigation

The navigation authority for the Haven and the western half of the Wash is the Port of Boston. The relevant legislation for this authority is the Boston Dock Act 1881 and the Boston Corporation Act 1935.

The navigation authority upstream of Grand Sluice is British Waterways. NRA must maintain adequate depth of water for navigation purposes.

7.3 Conservation

The NRA has a duty of furthering and enhancing the environment (refer to section 16 of the Water Resources Act 1991).

As stated in section 6.2 the Haven is classified under several national and international designations mostly as part of the larger Wash Conservation area.

These designations require that any proposed developments must be subject to rigorous environmental assessment. An application for the construction of a barrage and sea lock would automatically be opposed within these areas to ensure the maximum amount of assessment of impacts and consultation.

7.4 Fishing

The Salmon and Freshwater Fisheries Act 1975 requires that uninterrupted passage to fish be provided if a river has a salmon run. This has also been interpreted as meaning that, if there has historically been a salmon run which due to adverse circumstances has not occurred in recent times, then provision should be made when new projects are proposed.

Investigation into the provision of a fish pass for salmon, eel etc at the barrage is considered worthy of inclusion in the project appraisal stage. Provision of these facilities coupled with similar, provisions at the Grand Sluice may be another positive benefit of this scheme and further assist with its overall approval.

7.5 Crown Land

The Crown Estate includes all intertidal land around the coast and any developments or constructions that have any effect on this land must be approved by the Crown Estate.

Enquiries have been made to the agents for the Crown Estate and it is considered that there would be no objections to the development on the Crown's behalf and that any annual charges, if required, would be minimal. There may even be a case for 'betterment' of the Crown land with the new regime.

7.6 Barrage Construction

The planning approval and subsequent construction of a barrage may now be authorised using the provisions of the Transport and Works Act 1992. This act replaces Private Bills which previously required separate passage through Parliament.

The promoter or promoters would make an application to the Secretary of State for the Environment for an order to authorise construction. The scheme would require consideration at a public inquiry, at which the planning aspects are fully considered prior to the order being made. Procedure rules made under the Act require an Environmental Statement, unless the Secretary of State grants a waiver.

8. ECONOMIC EVALUATION

8.1 Project Costs

8.1.1 Capital Costs

The capital costs of the project have been identified as:-

(i) Lock and barrage including all related capital dredging, raising of training banks, etc.

(ii) Pumping stations at - Black Sluice
- Maud Foster Sluice

(iii) Sewerage amendments (for Anglian Water)

The lock and barrage estimated construction costs were detailed in section 3.6. The total costs are estimated at between £22 and £31 million depending on the prevailing ground conditions, the location and depth of lock. An additional £800,000 to £900,000 would be expended if a secondary lock for small boats were provided rather than subdivision of the main lock into two smaller chambers.

The new pumping stations have been costed as follows:-

(i)	Black Sluice (with 4 No. 2.1m³/sec pumps)	£560,000
(ii)	Maud Foster Sluice (with 3 No. 2.3m³/sec pumps)	£420,000

Two amendments to Anglian Water's sewerage system:-

(i)	additional storage tanks at East Side Pumping Station	£350,000
(ii)	extension to effluent pumping main from sewage treatment works	£110,000 to £575,000 (depending on barrage location)

It is assumed for financial appraisal purposes that the construction of the works shall be carried out in the years 1999 and 2000, with the sea lock commencing operations in January 2001.

8.1.2 Operating Costs

The major items of operating and maintenance costs for this project are:-

(i) sea lock(s) and sluices

(ii) maintenance dredging of the Haven and channel through Cut End Bar

(iii) pumping stations at Black Sluice, Maud Foster Sluice and Hobhole

The sea lock(s) and sluices would be manned on a 24 hour basis with a controlling officer and two attendants. Together with annual mechanical maintenance costs the overall cost of operation of the facility is estimated at £300,000.

Maintenance dredging costs are dependent on the chosen depth of lock sill and thus the depth of channel leading to it. The costs are detailed in section 3.6.3 and vary between £100,000 and £400,000.

The electricity and maintenance costs of the additional pumping required are given in section 3.6.4.

8.2 Project Benefits

8.2.1 Capital Benefits

The barrage will remove the requirement for tidal defences along the Haven and through the town of Boston. It has been shown in section 3.4 that the estimated cost of raising the defences to a 1 in 200 year standard is £1.5 million. With the construction of a tidal exclusion barrier this £1.5 million becomes a capital benefit.

Other capital benefits of the construction of a barrage are seen to be an increase in land values for industrial, commercial or even housing use and an increase in existing property values both generally and especially those close to the river.

Although land may have a theoretical value when undeveloped it is only when the land is actually purchased for use that it's value is realised. The construction of a barrage may well be the catalyst that sees development progressing and land achieving its theoretical value.

The capital increase in land value is therefore seen as the difference in land value between agricultural and industrial land that would not otherwise be developed. An estimate of 35 hectares of land at Slippery Gowt and Fishtoft (for possible marina) with an increased value of £100,000 per hectare results in a total increase capital value of £3.5 million.

Property values of an area increase with general prosperity, employment opportunities and a general positive 'feeling' in the community - a good place to live. The converse is also true. Boston has approx 12,000 dwellings and 2,000 commercial premises. An increase of £500 on the value of each property because

of increasing prosperity to the town would produce a total increased capital figure of £7 million.

Specific properties (and some vacant lots) close to the river would become highly desirable as private or commercial projects and those existing desirable properties would have added value with the increased amenity. The Johnson's warehouse site could become a multi million pound development with realised existing value of at least £0.5 million. Other properties along the river would have property value increases - say 50 properties at £20,000 each giving £1 million.

8.2.2 Annual or Revenue Benefits

The annual or recurring benefits of this proposed project have been identified as the following:-

(i) Increase in Port trade.

(ii) Increase in fishing profits.

(iii) Increase in leisure boating.

(iv) Increase in tourism to Boston.

(v) Increase in income to Borough through increased council tax, etc.

Figure 8.1 shows the anticipated mechanism of these and the community based capital benefits.

The port trade is envisaged to remain broadly constant until the proposed barrage is built and then increase annually by 150,000 tonnes. The detailed analysis of this is given in section 4.5.2 and tabulated in Table 4.8.

Possible increase in fishing profits have been calculated as £64,500 per boat (refer para 4.5.3). For the 50 boat fleet this would mean a total increase in profits of over £3 million. For the sake of the benefit/cost analysis a more moderate figure of £1 million per annum has been adopted.

The increase in leisure boating as a result of the sea lock produces additional mooring fees as well as provisions, chandlery etc as detailed in para 4.5.3. The annual benefit is calculated at £136,000.

It is estimated that tourism currently brings £6.7 million annually to the Boston Borough (figure from East Midlands Tourist Board). With the improved aesthetics and amenity value of a usable waterway through the town an increase in the

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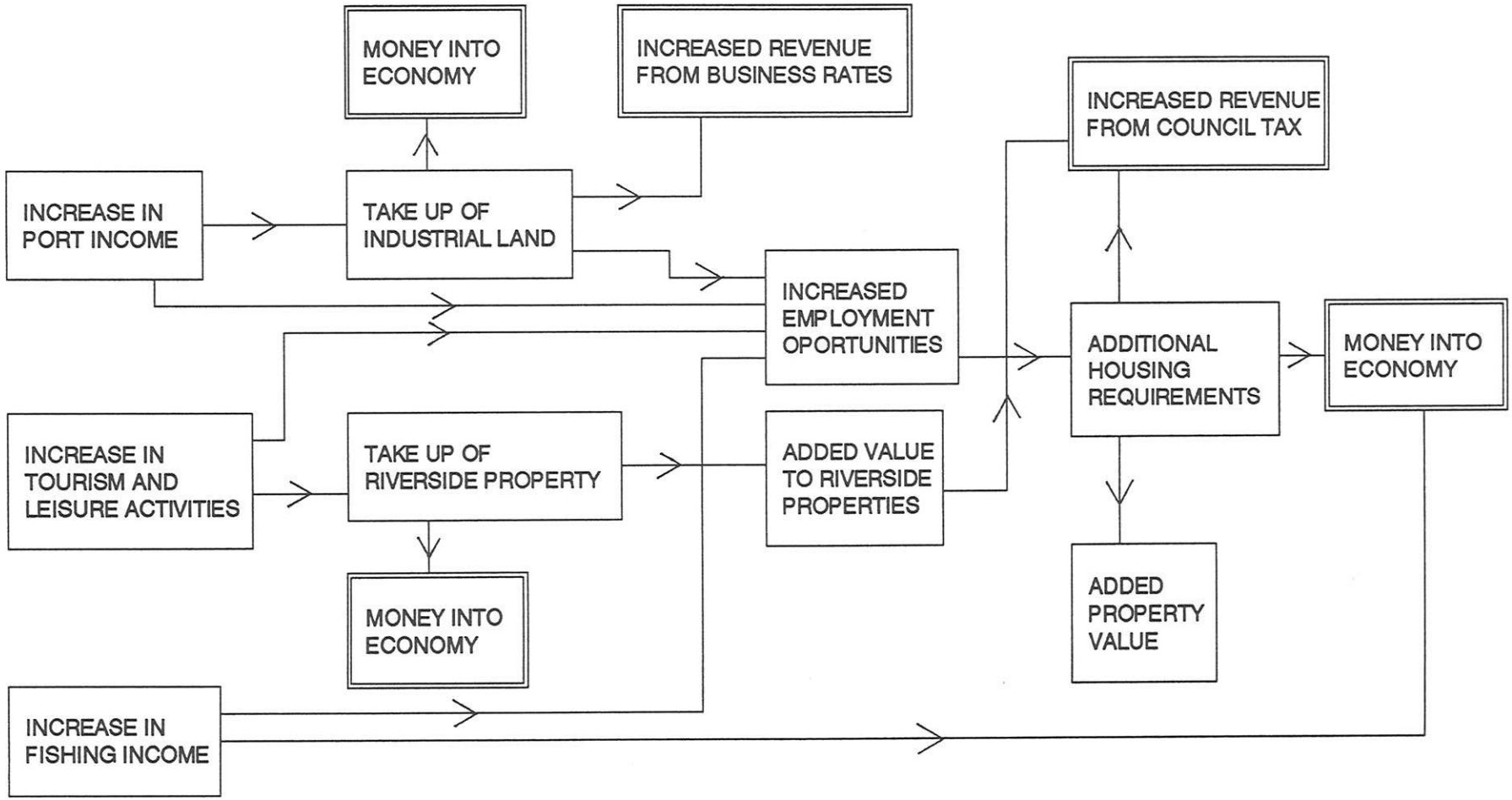


FIGURE 8.1 – FLOW CHART SHOWING SCHEME BENEFITS

tourism figure is readily envisaged. An effective increase of £0.3 million annually has been taken as the increase due to this project.

With an increase in employment there is a resultant increase in council taxes from additional housing and uniform business rates from new commercial premises.

Assuming the project is directly responsible for 300 extra houses over 3 years then council tax @ £500/dwelling gives a total annual increase of £150,000.

The uniform business rate attributable to the land uptake detailed in the previous section would be in the order of £800,000. Assuming approximately 25% is returned to the Borough from central government then an annual increase of £200,000 would be envisaged.

Increased council tax from higher valued properties as a result of barrage construction, has been noted as a potential benefit in section 4.4.2 and is taken as an additional £10,000 per annum.

8.3 Benefit/Cost Analysis

The benefits and costs described in sections 8.1 and 8.2 have been discounted to present Values (1994) using a discount rate of 6% per annum.

The cost of the project appraisal has not been included in the analysis as this expenditure is independent of the decision to proceed with the scheme or not.

The results of the Benefit/Cost Analysis are shown in Table 8.1 parts 1 and 2. Where a range of estimated costs have been identified in section 8.1 the upper end of the range has been used for the benefit/cost analysis, thereby producing the lowest benefit/cost ratio.

The benefit/cost analysis indicates a break-even point in 2015 and a benefit:cost ratio of 1.41 in 40 years time (2033).

DISCOUNT RATE (%) 6.00

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
DISCOUNT FACTOR	1.00	0.94	0.89	0.84	0.79	0.75	0.70	0.67	0.63	0.59	0.56	0.53	0.50	0.47	0.44	0.42	0.39	0.37	0.35	0.33
COSTS:																				
Maximum values of cost ranges used																				
PROJECT APPRAISAL		0																		
DETAILED DESIGN					300															
SUPERVISION						100	100													
CONSTRUCTION:																				
lock and barrage						15500	15500													
pumping stations							980													
Anglian Water costs							925													
ADDITIONAL OPERATING COSTS:																				
lock(s) and sluices								300	300	300	300	300	300	300	300	300	300	300	300	300
pumping stations								199	199	199	199	199	199	199	199	199	199	199	199	199
dredging								400	400	400	400	400	400	400	400	400	400	400	400	400
PORT INVESTMENT							700													
TOTAL COSTS	0	0	0	0	300	15600	18205	899	899	899	899	899	899	899	899	899	899	899	899	899
NPV COSTS	0	0	0	0	238	11657	12834	598	564	532	502	474	447	421	398	375	354	334	315	297
CUMULATIVE NPV COSTS	0	0	0	0	238	11895	24729	25327	25891	26423	26925	27398	27845	28267	28664	29039	29393	29727	30042	30339
BENEFITS:																				
HOUSE PRICES INCREASE								7000												
LAND PRICES INCREASE								3500												
RIVERSIDE PROPERTY PRICE INCREASE								1500												
FLOOD DEFENCE SAVING								1500												
PORT TRADE PROFIT INCREASE (from Table 4.8)								201	601	1002	1402	1794	1934	2073	2213	2352	2492	2631	2771	2910
FISHING PROFIT INCREASE								1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
BOATING FEES REVENUE INCREASE								136	136	136	136	136	136	136	136	136	136	136	136	136
TOURISM BENEFIT								100	200	300	300	300	300	300	300	300	300	300	300	300
COUNCIL TAX/ BUSINESS RATE BENEFIT								120	240	360	360	360	360	360	360	360	360	360	360	360
TOTAL BENEFITS	0	0	0	0	0	0	0	14937	1937	2438	2838	3230	3370	3509	3649	3788	3928	4067	4207	4346
NPV BENEFITS	0	0	0	0	0	0	0	9934	1215	1443	1585	1702	1675	1645	1614	1581	1546	1510	1474	1436
CUMULATIVE NPV BENEFITS	0	0	0	0	0	0	0	9934	11149	12592	14177	15879	17553	19198	20812	22393	23939	25450	26924	28360
NPV	0	0	0	0	-238	-11895	-24729	-15393	-14741	-13830	-12748	-11520	-10292	-9068	-7852	-6646	-5454	-4277	-3118	-1979
BENEFIT:COST	ERR	ERR	ERR	ERR	0.00	0.00	0.00	0.39	0.43	0.48	0.53	0.58	0.63	0.68	0.73	0.77	0.81	0.86	0.90	0.93

TABLE 8.1 – BENEFIT / COST ANALYSIS (Part 1)

DISCOUNT RATE (%) 6.00

YEAR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
DISCOUNT FACTOR	0.31	0.29	0.28	0.26	0.25	0.23	0.22	0.21	0.20	0.18	0.17	0.16	0.15	0.15	0.14	0.13	0.12	0.12	0.11	0.10
COSTS:																				
PROJECT APPRAISAL																				
DETAILED DESIGN																				
SUPERVISION																				
CONSTRUCTION																				
ADDITIONAL OPERATING COSTS:																				
lock(s) and sluices	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
pumping stations	199	199	199	199	199	199	199	199	199	199	199	199	199	199	199	199	199	199	199	199
dredging	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
PORT INVESTMENT																				
TOTAL COSTS	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899
NPV COSTS	280	264	249	235	222	209	198	186	176	166	157	148	139	131	124	117	110	104	98	93
CUMULATIVE NPV COSTS	30619	30884	31133	31369	31591	31800	31998	32184	32360	32526	32683	32830	32970	33101	33225	33342	33452	33556	33655	33747
BENEFITS:																				
HOUSE PRICES INCREASE																				
LAND PRICES INCREASE																				
RIVERSIDE PROPERTY PRICE INCREASE																				
FLOOD DEFENCE SAVING																				
PORT TRADE PROFIT INCREASE	3050	3189	3329	3468	3608	3747	3886	3886	3886	3886	3886	3886	3886	3886	3886	3886	3886	3886	3886	3886
FISHING PROFIT INCREASE	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
BOATING FEES REVENUE INCREASE	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136
TOURISM BENEFIT	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
COUNCIL TAX/ BUSINESS RATE BENEFIT	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360
TOTAL BENEFITS	4486	4625	4765	4904	5044	5183	5322	5322	5322	5322	5322	5322	5322	5322	5322	5322	5322	5322	5322	5322
NPV BENEFITS	1399	1360	1322	1284	1246	1208	1170	1104	1041	982	927	874	825	778	734	692	653	616	581	548
CUMULATIVE NPV BENEFITS	29759	31119	32441	33725	34971	36179	37349	38452	39493	40476	41402	42276	43101	43879	44613	45305	45959	46575	47156	47705
NPV	-861	235	1308	2357	3380	4378	5351	6268	7133	7949	8720	9446	10131	10778	11388	11963	12506	13018	13502	13957
BENEFIT:COST	0.97	1.01	1.04	1.08	1.11	1.14	1.17	1.19	1.22	1.24	1.27	1.29	1.31	1.33	1.34	1.36	1.37	1.39	1.40	1.41

TABLE 8.1 – BENEFIT / COST ANALYSIS (Part 2)

8.4 Funding

8.4.1 MAFF Grant Aid

The contribution toward this project in the form of MAFF grant aid depends on the benefit that accrues from reduced maintenance of flood defences in the Haven and in particular from the fact that the defences along the Haven would not require raising to provide the acceptable level of protection.

The estimate of cost savings is produced in section 3.4 and for 1 in 200 year protection is £1.5 million.

Further studies may conclude that the flood defence benefits of a barrage are not only in the Haven but that the flood risk above Grand Sluice is reduced by the ability to exclude high tides from the Haven.

8.4.2 EC and UK Government Grants

Moneys are made available from time to time from EC and UK government funds to aid development projects which satisfy specific criteria.

Such a fund, known as Objective 5B (regeneration of employment in rural areas) is currently being advertised and applications are being made by government departments and councils in the area.

This particular initiative, or similar ones, would appear to be eminently appropriate as the project would benefit a broad spectrum of the community.

It is understood that The East Midlands office of the Department of Trade and Industry are intending to include the Boston Sea Lock as an indicative project in their 'single programming document' for the years 1994 to 2000.

8.4.3 Cash Loans

There will inevitably be a shortfall in the total required money for the completion of a barrage from the aforementioned sources. Loans from lending institutions may be required, taken out by one or more of the scheme proposers, with repayments made from the anticipated increased benefits.

8.4.4 Operating Charges of Sea Lock

It is envisaged that charges will be made, by some method, for use of the lock.

The commercial fishermen have already strongly disputed this right to charge for passage up the Haven. They believe that a 'charter' gives them the perennial rights of both free passage and free mooring within the Haven.

Any charges that are made to help to defray operating costs of the sea lock must be considered reasonable by the users so not to limit its potential benefits.

8.4.5 No Additional Costs to I.D.B's

Additional pumping costs due to the MRL of the Haven have been discussed in section 3.6. Black Sluice pumping station and the new station at Maud Foster are or will be the responsibility of the NRA whereas the Hobhole pumping station is part of the Witham Fourth Internal Drainage Board's system.

Because there are no benefits to individual landowners in Internal Drainage Board areas it is imperative that their rates should not increase as a result of the proposed sea-lock project. There is concern that rates could rise as a direct result of additional pumping costs or because contributions to the NRA may increase.

9. EVALUATION OF OPTIONS

The study brief asked for possible sites to be investigated between "Pilgrims Memorial" and Tabs Head. Although a barrage could be built at almost any location along this 4km length of The Haven four indicative locations were chosen for study purposes - refer to figure 9.1.

These alternative locations are now discussed from the following aspects:-

(i) Navigation

(ii) Engineering

(iii) Environmental

(iv) Cost

An overall analysis using "weighted average multi-criterion analysis" has been carried out covering all relevant criteria. The importance weighting of these four areas has been initially apportioned as follows:-

(i)	Navigation	30%
(ii)	Engineering	15%
(iii)	Environmental	40%
(iv)	Cost	15%
		100%

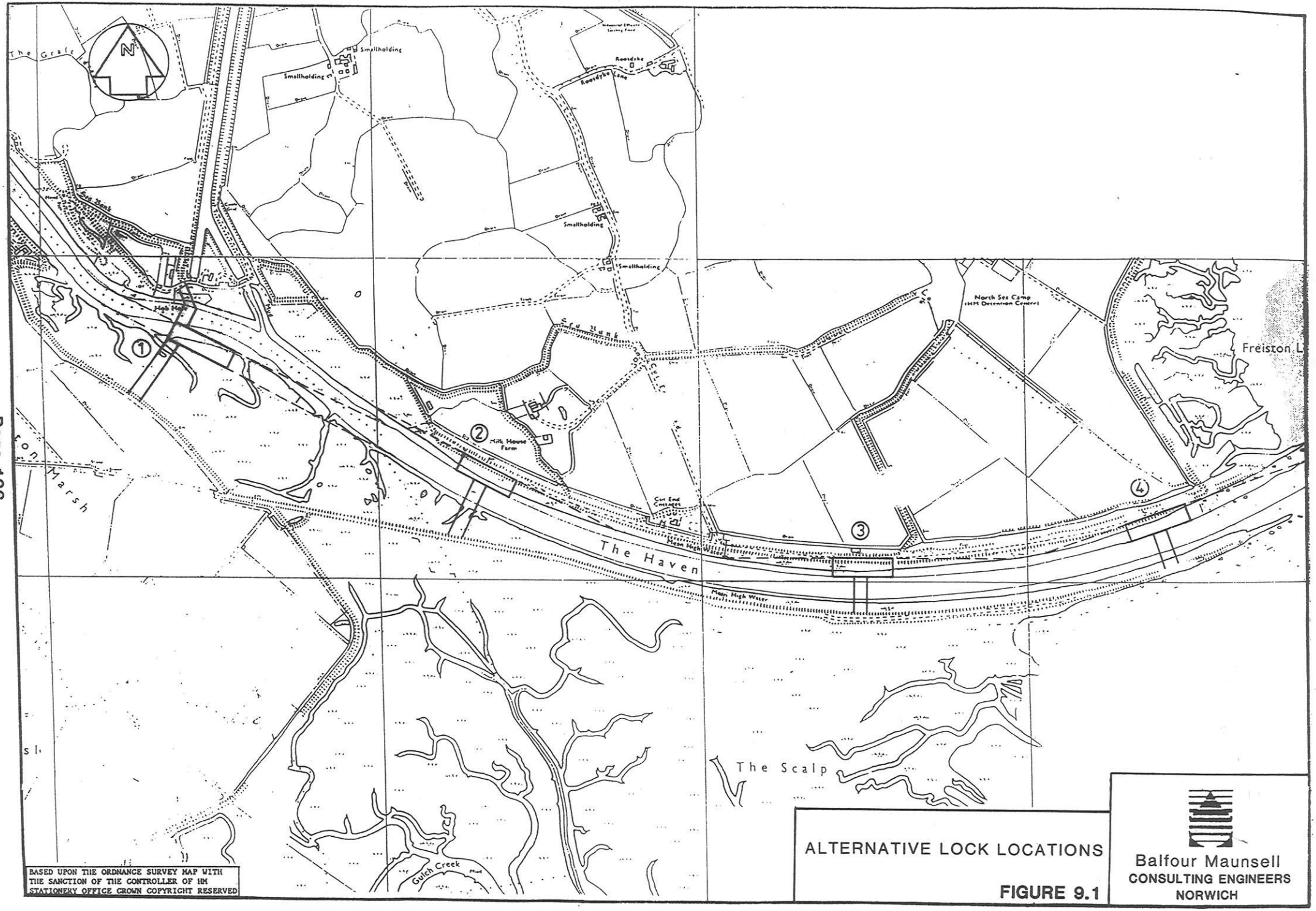
This weighting and individual scores for criteria have already been queried during the draft report stage. The weighting and scores can be adjusted by mutual agreement to reach a consensus of opinion as the project appraisal progresses.

9.1 Navigation

The officers of the Port of Boston consider that a location as close to Tabs Head as possible to be the preferred site. Because there would always be more or equal water upstream of the barrage then it is considered that congestion would be less with a barrage near to Tabs Head.

The scaling of the four options has been assigned the following points:-

Location 1	40 points	only just acceptable
Location 2	57 points	
Location 3	73 points	
Location 4	90 points	preferred location



ALTERNATIVE LOCK LOCATIONS

FIGURE 9.1

Balfour Maunsell
CONSULTING ENGINEERS
NORWICH

Note that the scale of 0-100 points in this analysis runs from 0 which is undesirable to 100 points which is highly desirable.

9.2 Engineering

The engineering studies are discussed in chapter 3 and the alternative sites in section 3.1.4. The criteria and their percentage of points used for evaluation of the options from an engineering aspect are:-

(i)	ease of construction	20%
(ii)	Hobhole drainage	30%
(iii)	sewage effluent disposal	10%
(iv)	final river alignment	20%
(v)	downstream dredging	20%
		100%

There is not a substantial difference between the sites in terms of construction difficulty. Location 1 is arguably slightly preferable as the lock position is generally further away from the river channel. The other three sites are considered to be sensibly similar.

The only site which is advantageous for Hobhole drainage is location 1. This option has minimal effect on the operation of Hobhole drainage system. The allocated points reflect this advantage.

Again Location 1 is the preferred site from the sewage effluent disposal aspect. The locations downstream require progressively more difficult and expensive solutions to this problem.

The final river alignment is extremely important from navigation and flood discharge considerations as well as erosion and accretion along the banks. Although straightening of the river curves opposite Hobhole is included as a cost for all the options, location 1 would result in a better final alignment than the other 3 locations.

Dredging downstream of the barrage within the trained river section is undesirable. Dredging of this section would aggravate congestion and be a continuing maintenance expense. Location 4 is therefore preferable and Location 1 least preferable for downstream dredging.

The percentage points allocated to the different locations from the engineering aspect are:-

	Maximum Points	Location 1	Location 2	Location 3	Location 4
ease of construction	20	15	12	12	12
Hobhole drainage	30	27	3	3	3
sewage effluent disposal	10	8	6	4	2
final river alignment	20	16	10	10	10
downstream dredging	20	2	7	13	18
TOTALS	**100**	**68**	**38**	**42**	**45**

The aggregate of allotted points give the engineering preferred option as location 1 (68 points) and the least preferred option as location 2 (38 points).

9.3 Environmental

The environmental arguments relating to the alternative locations are set out in section 6.4. The weighting and scores for the various criteria have been analysed and show improved acceptance as the locations move away from the Wash. The scale of marks would range from 100 (most environmentally acceptable) to 400 (least environmentally acceptable). These marks have been converted to analysis points as follows:-

Location 1	68 points	(preferred option)
Location 2	56 points	
Location 3	40 points	
Location 4	36 points	(least preferred option)

9.4 Costs

The barrage construction costs are detailed in section 3.6.1. There is very little difference in costs at this stage between the options. The variation in foundation

costs depending on ground conditions is an order of magnitude greater than any estimated cost difference for other reasons. It is therefore, at this stage, most appropriate to give all locations a similar score which can be adjusted when ground conditions are better known (following site investigations). The score chosen for all locations is a median figure of 50 points.

9.5 Preferred Location

The following table sets out the details of the weighted average multi-criterion analysis:-

Criteria	Navigation	Engineering	Environment	Cost	Multicriterion Index
Importance Weight	30	15	40	15	
Location 1	40	68	68	50	56.9
Location 2	57	38	56	50	52.7
Location 3	73	42	40	50	51.7
Location 4	90	45	36	50	55.7

This analysis indicates that the preferred option when all criteria are considered is location 1 (56.9 points). Location 4 is next preferred with 55.7 points and locations 2 and 3 are least preferred (52.7 and 51.7 points).

This analysis, conducted at this preliminary stage, may be considered as a first attempt at reaching an agreed location preference. Different weightings and different points within each criteria category can be argued as the appraisal continues. More information will become available as the studies progress to enable a better assessment of the allotted points and the relative weightings.

No consultees or project proponents, at this stage, have stated emphatically that either one location is definitely not acceptable or another is the only acceptable location. If this were the case then the analysis presented above becomes almost futile. Far better that all positive and negative arguments for each location be reasonably discussed and the optimum solution achieved.

10. STUDY CONCLUSIONS AND RECOMMENDATIONS

ENGINEERING

The Barrage

1. A barrage of the type which can exclude the sea at any state of the tide is considered to be the most appropriate type for this project.

2. A review of the type of devices available for controlling water level behind the barrage showed that fish belly flap gates are the most suitable type of gate.

3. Hydraulic studies indicated that 2 gates each 17.5m wide with an invert level 0m AOD, provide the required degree of water level control.

4. To maximise access to the Port of Boston whilst still affording access under bridges for leisure craft, a minimum retained water level (MRL) behind the barrage would be 1.3m AOD. Tides exceeding the MRL would be allowed to enter the Haven to afford greatest navigational freedom. Further studies should investigate the hydraulic benefits of lower MRL's and the variation in MRL at different times of the year.

The Lock

5. From a review of maximum length of vessel likely to use the Port and future trends in vessel widths a lock with a length and a width of 150m and 22m respectively, is considered most appropriate.

6. Options for a single lock to deal with both commercial vessels and leisure craft and for separate locks to deal with each have been considered. The lock for leisure craft would have a length of 30m and a width of 10m.

7. Sill levels in the lock ranging from -4.2m AOD to -5.7m AOD have been investigated. For a vessel with a 4m draft access times vary between 13 and 24 hours for a neap tide and 12 to 16 hours for a spring tide, depending on the different lock depths.

8. To provide equivalent approach channel depth from the Wash to the lock,

excavation and dredging works vary from a minimum of 115,000 m^3 for a lock sill level of -4.2m AOD for a Tabs Head option to 423,000 m^3 for a sill level of -5.7m AOD at Hobhole.

Location

9. Four sites between Pilgrims Memorial and Tabs Head have been considered for the sea lock and barrage.

10. From engineering considerations the site near Hobhole is the preferred site at this stage. From navigational reasons sites further towards Tabs Head are preferred since they have shorter river sections subject to low tides and reduce the possibility of shipping congestion and lower maintenance dredging costs.

Hydraulic Regime

11. The barrage would have the effect of attenuating the tidal wave in the Haven. High spring tides would be attenuated by 0.3m and the phase difference between Tabs Head and the Port of Boston increased by 50 mins. The barrage has little attenuating effect on neap tides but phasing differences for high water are similar to those for spring tides.

12. Tidal velocities in the Haven would be substantially reduced by the barrage. Peak velocities are approximately halved and quiescent periods (velocities <0.3 m/sec) increased from 2.5 hours to more than 8 hours on a spring tide.

13. The barrage reduces the average tidal flux (i.e. the volume of water passing) by 60 % on a spring tide and by 93% on a neap tide.

14. To maintain the existing drainage regime in the South Forty Foot and Maud Foster Drain for the proposed MRL in the Haven, a new pumping station at Maud Foster Sluice and an extension to the pumping station at Black Sluice would be required.

15. Control of water levels behind the sea lock and barrage during times of extreme fluvial flood can be controlled by the gates in the barrage alone or by a combination of both gates and sea lock. The latter provides the most economic approach and has been assumed for this study.

16. The design flood event for the River Witham has not been defined for this study. An assumed fluvial flood event for the Haven which corresponds to a return period of between 20 and 50 years has been shown to be comfortably contained within normal tidal levels by using both gates and sea lock. Further studies to investigate barrage operation in times of fluvial flood are necessary.

17. It is possible that by appropriate operation of the barrage, real benefits to flood control in the River Witham will be achieved. Further investigation is required.

Siltation

18. The Haven carries a heavy silt load, the great majority of which is believed to enter from the Wash. The flux of sediment into the Haven on flood tides is substantially reduced by the Barrage by possibly as much as 73% on spring tides and 95% on neap tides.

19. Since the barrage would effect a substantial reduction in velocities in the Haven, conditions would be more favourable for siltation. Approximate calculations show that siltation rates in the Haven would be unlikely to change significantly with the barrage, however the siltation patterns may be significantly different and will require further study.

20. Periodically retaining a high tide upstream of the barrage and releasing it at low tide to induce flushing of sediments is a possibility. Suitable flow velocities could be generated but their effectiveness in scouring settled silt which may have consolidated needs further investigation as will the impact on navigation and moored craft.

21. Downstream of the barrage, tidal flushing would be substantially reduced. The channels would be dredged to depths which provide equivalent access to those afforded by the sea lock and would be deeper than at present. Substantial maintenance dredging is anticipated in the range 25,000m^3 to 100,000m^3 per annum.

Flood Defence

22. The hard defences through Boston are constructed at 6.0m AOD and the older soft defences in the Haven are at 6.4m AOD. Current MAFF guidelines suggest a 1 in

200 year standard of flood protection for areas such as Boston. The current 1 in 200 year still water level at Boston is estimated at 6.01m AOD. The minimum level for hard defence is therefore 6.01m AOD and for soft defences is 6.41m AOD.

23. To achieve protection against a 1 in 200 year event up to the year 2040, allowing for sea level rise, will require walls and embankments to be raised 300mm. For a 1 in 100 year level of protection walls and embankments need to be raised 150mm. At present values the cost of the works would be £900,000 for the 1 in 100 year standard and £1,500,000 for the 1 in 200 year standard.

24. The barrage would obviate the need for raising the flood defences and would permit the lowering of hard defences in Boston where they are currently perceived to be obtrusive.

Construction and Operation

25. Ground conditions are of major significance to the cost of the structure and depending on substrates, foundation costs have been estimated to be between £1.8m and £7.0m.

26. Depending on location and foundations the cost of the sea lock and barrage is estimated to be in the range of £22.1m to £30.1m with an additional cost of between £0.8m and £0.9m if two locks are preferred to a single lock.

27. Operating costs are estimated to be around £300,000/annum.

28. Maintenance dredging costs are likely to increase from present values by between £100,000 and £400,000 per annum.

29. Other associated costs for additional and extended pumping stations and for possible control of sewage overflow and diversion of effluent outfall pipelines are in the range of £1.5m to £2.0m.

PORT, FISHING AND BOATING

The Port

30. The Port trades almost exclusively with ports in the North Sea mainly in grain, steel and container traffic. Trade has begun to decline recently and currently stands at 1.4m tons/annum.

31. The effects of the recent GATT Agreement and the likely policy of the EU to reduce grain production could result in a decline in trade. The sea lock will provide a better opportunity to retain the trade available to the port.

32. Boston's steel trade consists principally of imports, mainly from similarly sized Continental and Scandinavian ports. Provided the sources remain unchanged, trade seems reasonably secure. However, the sea lock would provide insurance against the trade moving into bigger ships.

33. Boston's trade in containerised goods consists mainly of imports and represents only about 1% of east coast container traffic. It has retained its share whilst other similarly size ports have lost out to major ports to the north and south. Container and Ro-Ro vessels are getting bigger and if Boston is to maintain or increase its market share the new sea lock is essential.

34. The sea lock together with improved storage and handling facilities on shore will allow the Port to return to its recent share of total east coast traffic of 1.4%. In the interim Boston's trade is expected to remain constant at 1.3m tons/annum.

Fishing

35. The local fishing industry, although having some apprehension about the new development, should benefit from the sea lock by allowing the fishing grounds to be reached earlier and left later.

36. The net additional profit is hard to gauge and, because of fixed quotas, is effectively that which can be gained from fishing brown shrimps over a five month season. It is estimated to be between £1m and £3m/annum for the whole 50 vessel fleet.

Leisure Boating

37. Leisure boating would be a net beneficiary of the sea lock and barrage. The raised water levels in the Haven will allow better access to the Wash and would encourage greater use of the Haven by leisure craft.

38. It is estimated that the present local fleet size of 250 craft could double. The resulting annual benefit to local shop keepers and marine operators would be approximately £136,000/annum.

PLANNING

39. The wider range of services and the additional number of ships that could be handled by the Port of Boston would potentially enable it to provide more employment and act as a catalyst for the development of other industries in the town. This could boost the local economy and lessen the present dependence upon a limited number of firms to provide employment in the Town.

40. Vacant land exists within the existing port for further development of services. Should there be a demand for further land to accommodate port related uses, then there is substantial supply of vacant land elsewhere in the town, particularly at Slippery Gowt Farm that could be utilised. Slippery Gowt not only has potential for substantial commercial developmentf but could be developed for new wharfage and port related industries by virtue of its frontage to the Haven. There would also appear to be potential for further development at Slippery Gowt beyond the present allocation if further land is required.

41. If the expansion of the port were to facilitate the development of the Slippery Gowt area, this could hasten the construction of the A16 link road to the industrial area. This could potentially relieve traffic congestion in Boston particularly if there was a development of the port on this bank of the Haven. In the longer term, increased development of the port might also facilitate the construction of a further bridge across the Haven which could also serve the existing industry located to the east of the town.

42. An improved visual appearance and better access to the Haven in Boston resulting from higher water levels might encourage greater appreciation of the river resulting in the gradual re-orientation of existing vacant or derelict sites in the town centre

possibly by means of mixed developments incorporating access to the river in the scheme. This could improve the built environment of the centre which in parts is in quite a run-down state. A more accessible river allied to such riverside development might also provide a focus for tourist and visitors to the town which could be of benefit to the local economy.

43. The stability of water levels to allow continuous navigation of the Haven will encourage greater use by leisure craft and possible pressure for improved moorings. There is scope in planning terms for the development of a marina on the Haven between the Port and the Wash although this would require a careful assessment in terms of its impact on the surrounding countryside and the local environment.

44. In planning terms it would appear that the development of a sea lock and barrage could directly create considerable potential for the development of derelict or vacant land bordering the Haven, much of which has already been identified for development by the Borough Council. There may also be potential for secondary development arising from the sea lock project in other parts of the town or the Borough such as the provision of new housing to accommodate new employees and the consequent demand for an improved infrastructure. Whilst it is not possible to directly evaluate the secondary impact of the project at this stage there would appear to be considerable scope in planning terms in Boston and this part of Lincolnshire for further development subject to normal planning considerations.

THE ENVIRONMENT

45. The sea lock and barrage may have a significant impact on the environment, particularly on the internationally important Ramsar/SPA/SSSI Wash conservation area and the habitats associated with the loss of estuary.

46. Initial indications suggest that the major potential impacts will include:

- Destruction/impairment of habitat and ecological damage, including:

  - Loss of intertidal habitat in The Haven and potential loss/change to sensitive saltmarsh.
  - Disturbance or reduction of internationally important bird populations.
  - Alteration, reduction or destruction of aquatic biota, such as

macroinvertebrates and shellfish communities.

- Water quality problems in the impoundment and downstream of the barrage, including:

  - Alteration of the salinity regime
  - Reduced dilution and dispersion of wastewater discharges
  - Dissolved oxygen deficiencies
  - Changes to sedimentation patterns
  - Increase in algal blooms
  - Groundwater level increases

- Increased disturbance of sensitive receivers from noise and commercial traffic.

47. Environmental benefits of the sea lock and barrage arise from the provision of additional recreational facilities and the improved visual amenity of the area. The potential for increased commerce and employment in the region also exist.

48. Location of the sea lock and barrage at the site near Hobhole, is considered the most environmentally acceptable at this stage. This option minimises disturbance of the Ramsar/SPA/SSSI site and reduces the loss of fully tidal estuary and inter tidal area and allows effluent from the Boston STW to be most easily rerouted to the fully tidal zone. This option also affords the least volume of impounded water for quality management.

49. Planning permission for the sea lock and barrage would currently be opposed in principle by statutory authorities, including English Nature, and interested parties, such as the RSPB. English Nature has indicated that further information on environmental impacts and mitigation measures would be required for a satisfactory and reasoned judgement to be made on the application.

50. For a planning application to succeed, the economic advantages of the scheme would have to considerably outweigh any negative environmental impacts. Reduction of the impacts to a minimum and provision of sufficient mitigation, enhancement and compensatory measures could increase the likelihood of success. Careful consideration of the MRL, evaluation of hydrographic, sedimentation and water quality modelling and quantification of impact on habitat and ecology will need to be made.

51. An environmental assessment should be undertaken on the scheme proposal, leading to an Environmental Statement. The environmental assessment should be based on the scoping study contained in this report and should incorporate detailed consultation with all interested parties.

52. In further development of this study it may be appropriate to consider a further sea lock and barrage option upstream of the Ramsar/SPA/SSSI boundary. It should be noted that any environmental impact which impinges on the designated area, even if the structure is located outside the boundary, may still represent a serious restriction to planning approval.

BENEFIT/COST

53. Costs have been referred to earlier in the conclusions (25-29). Benefits are summarised as follows:-

Savings in not having to raise defences in the Haven		£1.5m
Capital increase of land values in the Boston area		£3.5m
General increase in property values in the Boston area		£7.0m
Increase in value of waterfront property		£1.5m
Increase in port trading revenue/annum	up to	£3.9m
Increase in fishing profit (lower band assumed)/annum		£1.0m
Increased leisure boating/annum		£0.14m
Increase in tourism/annum		£0.3m
Increase in council tax/annum		£0.16m
Increase in business tax (realised by Borough)/annum		£0.20m

54. Benefits and costs have been discounted to present values using a discount rate of 6%/annum. The benefit/cost ratio has been calculated to 1.41.

The analysis also shows a payback period of only 15 years after the barrage and sealock is in operation.

There are considered to be other benefits of an intangible and knock-on nature which are extremely difficult to quantify but which would further enhance the economic viability of the scheme.

OPTION EVALUATION

55. A weighted average multi-criterion analysis has shown that when navigation, engineering, environment and cost are weighted 30%, 15%, 40% and 15% respectively a sea lock and barrage at Hobhole is marginally the preferred option at this stage.

PROJECT DEVELOPMENT

56. The project should proceed to Appraisal Stage. Recommendations for project development are made in Section 11.

11. PROJECT DEVELOPMENT

11.1 Introduction

This chapter describes the anticipated stages of development of the Boston Sea Lock or Boston Barrage project.

11.2 Feasibility study

If the recommendations of this preliminary feasibility study are adopted, the project will proceed to detailed feasibility study, referred to as Project Appraisal by the NRA.

The brief for Project Appraisal will cover the three main areas reported on in this study:-

- Engineering and Navigational Feasibility
- Commercial, Planning and Economic Feasibility
- Environmental Assessment

The following paragraphs identify the key areas requiring further investigations.

11.2.1 Engineering and Navigation

Numerical Modelling

It is imperative that the consequences of construction and operation of a barrage on the entire Witham system be fully investigated. The major items are:-

- Develop a numerical model of the Haven to link with the Witham model, currently being prepared, to investigate the detailed effects of a barrage and sea-lock at alternative locations.
- Use the model to investigate fluvial flood events to determine the optimum size and configuration of sluice gates and the appropriate mode of operation. This could also incorporate the use of the lock as an additional flow path for high return period events. The effects of high fluvial flood events combined with high surge tides and long period flood events should also be considered.
- Use the model to determine the requirements and operational options for the passage of fluvial flood events during the construction phase of the project.

- Use the model to determine whether any benefits to flood control in the River Witham upstream of Grand Sluice can be achieved.
- Use the model to investigate whether there are any flood, scour and environmental (see section 11.2.3) benefits from lower MRL's or a variation of MRL at different times of the year.

Siltation Studies

A barrage would have a significant impact on both the amount of sediment moving into and out of the Haven and also on the water velocities that produce scour or allow settlement of sediment. Detailed siltation studies should cover:-

- Aquisition of data regarding suspended sediments entering the Haven. Sampling will be required throughout the tidal cycle, and over the water column.
- Undertake sediment modelling to estimate siltation rates and total quantities of silt deposition.
- Investigate the effect of fluvial flows throughout the year on resuspending sediments and transporting them downstream to the Wash.
- Investigate impact of flushing through the barrage, both upstream and downstream of the barrage. Investigate the effect on settled silt, taking into account consolidation, and the impact on navigation and moored craft.
- Investigate by numerical modelling the effects of a barrage, at the alternative sites, on the downstream regime both within the Haven and from its confluence with the Welland through the channels to deep water at Clay Hole. The barrage effects are required for the various depths of dredged channel which have been suggested. Sediment and bed sampling would also be required to determine quantities and gradings to input into the model.

This last item, studying siltation at the outfalls of the Witham and Welland, may also be being investigated as part of NRA's 'Shoreline Management Plan' and an input from this barrage study would be appropriate.

Site Investigation

Much of the uncertainty of estimating the costs of the barrage has been related to the unknown depths to satisfactory founding material at the alternative sites. To reach a decision on preferred location of the sea-lock and barrage the ground conditions at each site must be determined. The following or similar investigations are recommended:-

- Marine seismic investigation over the last 4km of the Haven to identify the

interface between the boulder clay and the overlying sands and silts. This should also identify positions of any discontinuities or buried valleys in the boulder clay.

- Boreholes - say, 5 or 6 to a depth of 20-25m located along the north and south embankments of this lower section of the Haven. These will provide accurate local information as well as controls for the seismic investigation detailed above.

11.2.2 Commercial, Planning and Economic Feasibility

Commercial and Port Studies

Further work is required to confirm the benefits assessed in the preliminary study. As the potential improvement to Port trade is one of the major benefits of the project, the confidence of the trading estimates is essential to confirm viability. Further confirmation of future vessel sizes is also required to ensure that proposed lock sizes are adequate. In particular the following research is recommended:-

- Steel
  - Future movements of steel and factors influencing this movement between EC and other North Sea and Baltic countries.
  - Viability of existing sources and ports that currently trade with Boston.
  - Future trends in ship sizes for this commodity.

- Grain
  - Future movements of grain and factors influencing this movement around the North Sea and Baltic (including EC regulations and the GATT agreement).
  - Viability of small ports which take grain ships from Boston.
  - The policy of ship owners towards vessel size.

- Container, Ro-Ro
  - Complete list of all North Sea services including ports served, frequency, vessel size etc.
  - Key features of the above operations determining their potential to move some or all of their services to Boston.
  - The policy of ship owners and operators to vessel sizes.
  - The type of goods carried and the key locations of demand in UK.
  - Comparison of transport costs from Boston, Hull and Felixstowe to main areas of demand.

- Port Costs
  - Detailed analysis of anticipated operating costs for different levels of traffic. These costs should cover capital equipment, maintenance and labour.

Professional Fishing

A more rigorous investigation of possible and probable fishing profit increases should be carried out involving MAFF, Eastern Sea Fisheries and the local fishing community.

Investigation and clarification of the 'charter' which allegedly gives fishermen free right of access and free mooring in the Haven is required.

Leisure Boating

Further information is required to support the forecast of a doubling of the local leisure boating population. This information should include:-

- location of existing marinas and moorings on the East coast
- history of numbers and types of boats moored at the above locations
- locations of individuals using these existing facilities
- participation rates in boating within the area compared to nationally
- proportion of the boating population that goes to sea rather than inland
- breakdown of turnover of companies servicing the boating population to estimate local value added
- detailed study of viability of large off-river marina - development costs, revenue capacity and associated commercial ventures

Tourism

The East Midlands Tourist Board has produced reports on Boston's tourist activities (see refs. 18 and 19). It is recommended that these reports be reviewed, updated and expanded in the light of the current proposals. A more accurate estimate of potential tourism increase and the associated boost to the local economy as a result of the sea lock project is required.

Planning

Follow up planning studies are required to ensure that increased port facilities, improved road access, possible marina ventures and future industrial and commercial initiatives are given the best opportunity for successful developments.

Economic Feasibility

The capital and operating costs and benefits of the scheme require more accurate estimation as the more detailed studies continue. The benefit/cost analysis should be prepared in accordance with MAFF project appraisal guidelines.

Benefits should be divided between community benefits, which may not be readily translated into cash to pay for construction, and direct benefits such as MAFF grant aid contributions which could be used directly for construction. Methods of funding the scheme and in particular the EC Objective 5B fund, require further investigation.

11.2.3 Environmental Assessment

An environmental statement will be required and the contents of this statement should be agreed with statutory consultees prior to commencement of work.

The environmental assessment to determine the effects of the proposals must proceed as an integrated part of the project appraisal with constant liaison between all involved. Assessment of alternative locations, MRL levels, modes of operation and construction methods is required. The engineering, operational and planning proposals must progressively take account of environmental preferences, concerns and mitigation measures such that optimum alternatives can be identified.

The following major items of study are anticipated:-

Monitoring

- Habitat and ecology survey of the Haven covering all sensitive habitats, fauna, fish, algae and the unique species, Boston Horsetail, at Slippery Gowt.
- Water quality surveys covering salinity profiling and microbiological concentrations over a full range of tidal conditions.
- Noise, vibration and air quality monitoring on roads leading to the Port and industrial areas. The amount of monitoring would depend on the estimated increases in traffic flow and volume as a result of the construction of the sea lock.

Modelling

- Habitat and biotic community impacts of barrage construction.
- Water quality modelling including salinity, dissolved oxygen, BOD, ammonia,

nutrients, microbiological concentrations, and impacts of dredging. This modelling work should be integrated with that undertaken for the engineering study.

- Noise, vibration and air quality modelling to assess impacts from the proposals.

11.2.4 Study Duration and Budget Cost

This is a major study. All aspects must be thoroughly investigated such that the arguments can be sustained under careful scrutiny during the public inquiry. It is considered that emphasis on complete and thorough investigation at this appraisal stage could both reduce the time required for the inquiry and help to produce the most successful design of the entire scheme.

The duration of the project appraisal and preparation of the environmental statement is estimated to be at least 15 months and could be as long as 18 months.

The estimated cost of this stage of the project is approximately £300,000 being made up as below:-

Engineering Studies	100,000.00
Site Investigation	20,000.00
Commercial, Planning & Economic Studies	30,000.00
Environmental Assessment	150,000.00
	£300,000.00

11.3 Public Inquiry

Following a decision to proceed with the project, after the results of the project appraisal have been considered, an application must be submitted to the Secretary of State for the Environment. It is envisaged that, even following comprehensive consultations during the appraisal stage, objections to the proposal will still be substantial enough to warrant a public inquiry. The Secretary of State will make arrangements for this to be held.

The public inquiry follows procedural rules and a timetable for the various stages. An allowance of eighteen months has been made in the estimated programme for the whole process culminating in an order being issued but depending on the

amount and type of objections it could take a shorter or longer period of time.

11.4 Detailed Design

When the order to allow the project to proceed has been issued the proponents must reach various decisions regarding the method of arranging for design, construction, financing etc.

The two basic procurement options are conventional contract where construction is to a detailed design procured separately by the proponents or some form of design/construct/finance contract which may also include maintenance.

On the assumption that a conventional approach will be followed a twelve month design period has been programmed at this stage which should allow sufficient time for detailed ground investigations, mechanical equipment design and civil engineering design.

11.5 Construction

Again on the assumption of a conventional contract approach, a two year construction period to allow for two separate phases of construction has been programmed.

To enable navigation to continue at all times the lock and perhaps a portion of the barrage must be constructed first while shipping continues along the existing main channel. Only when the main lock has been completed can the shipping be diverted through the lock (with open gates) and the remainder of the barrage and sluices across the main channel can be completed.

11.6 Project Programming

A programme for the whole project at this early stage is very much subject to change and should be used solely as an early indication of possible timescales.

With total co-operation of all parties and very few objections the timescales could conceivably be reduced but if, as often occurs, delays and unforeseen events occur then the programme would be extended.

The activities and anticipated completion times are as follows:-

decision to proceed	3 months
letting of project appraisal contract	3 months
project appraisal	15 months (could be 18 months)
decision to proceed	3 months
public inquiry	18 months
detailed design	12 months
construction	24 months
	78 months (6½ years)

Figure 10.1 indicates the sequence of tasks envisaged with the estimated times given above. This programme shows a completion of the sea-lock and barrage by the end of the year 2000.

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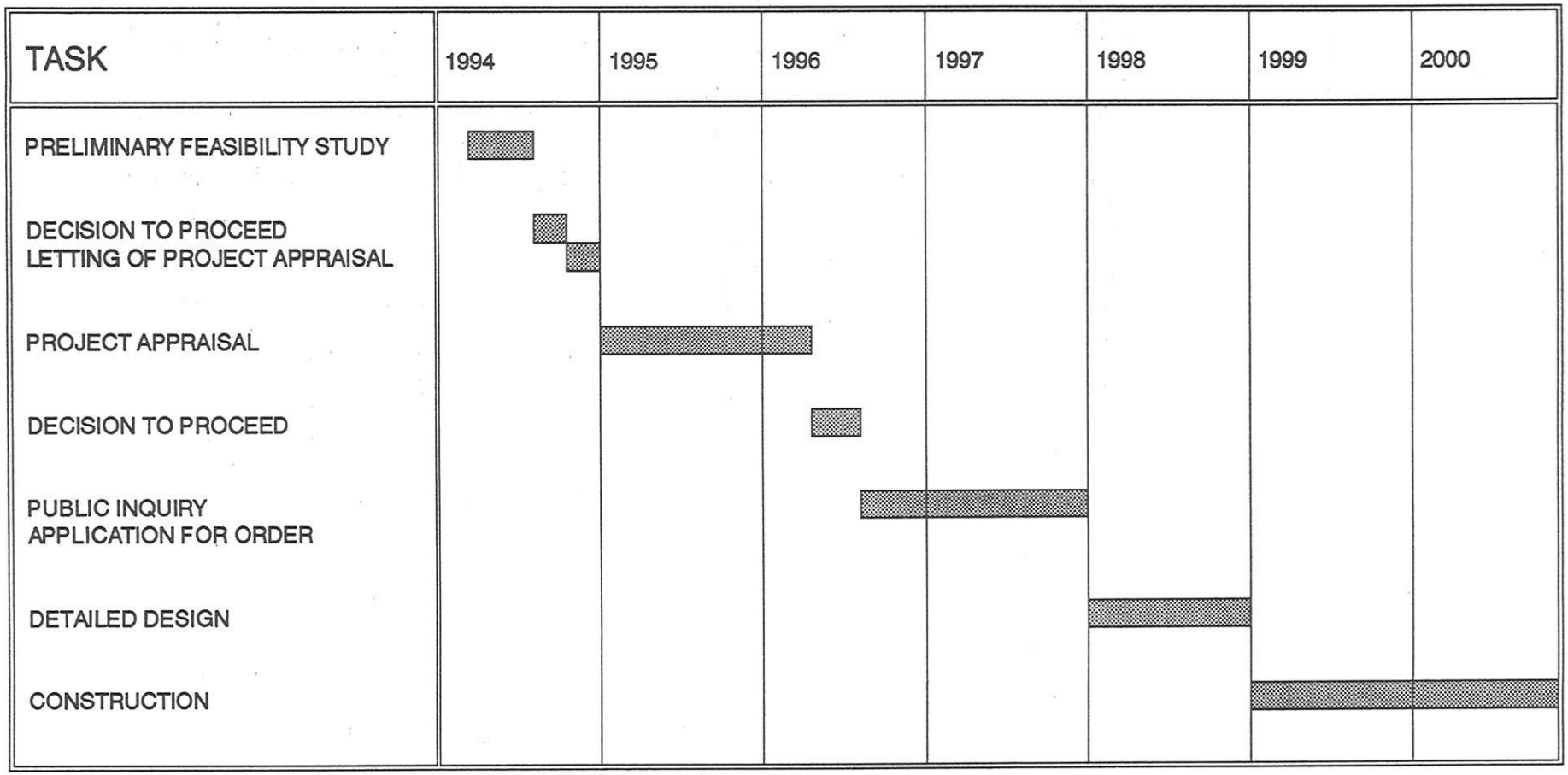

FIGURE 10.1 – PROJECT PROGRAMME

12. REFERENCES

GENERAL

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APPENDICES

Photo 1 - Windows and doors at or below existing flood defence level
- Compare full river with photo 5

Photo 2 - Progressively raised flood defence levels
- Note increasing access difficulty
- Weed growth suggests little use

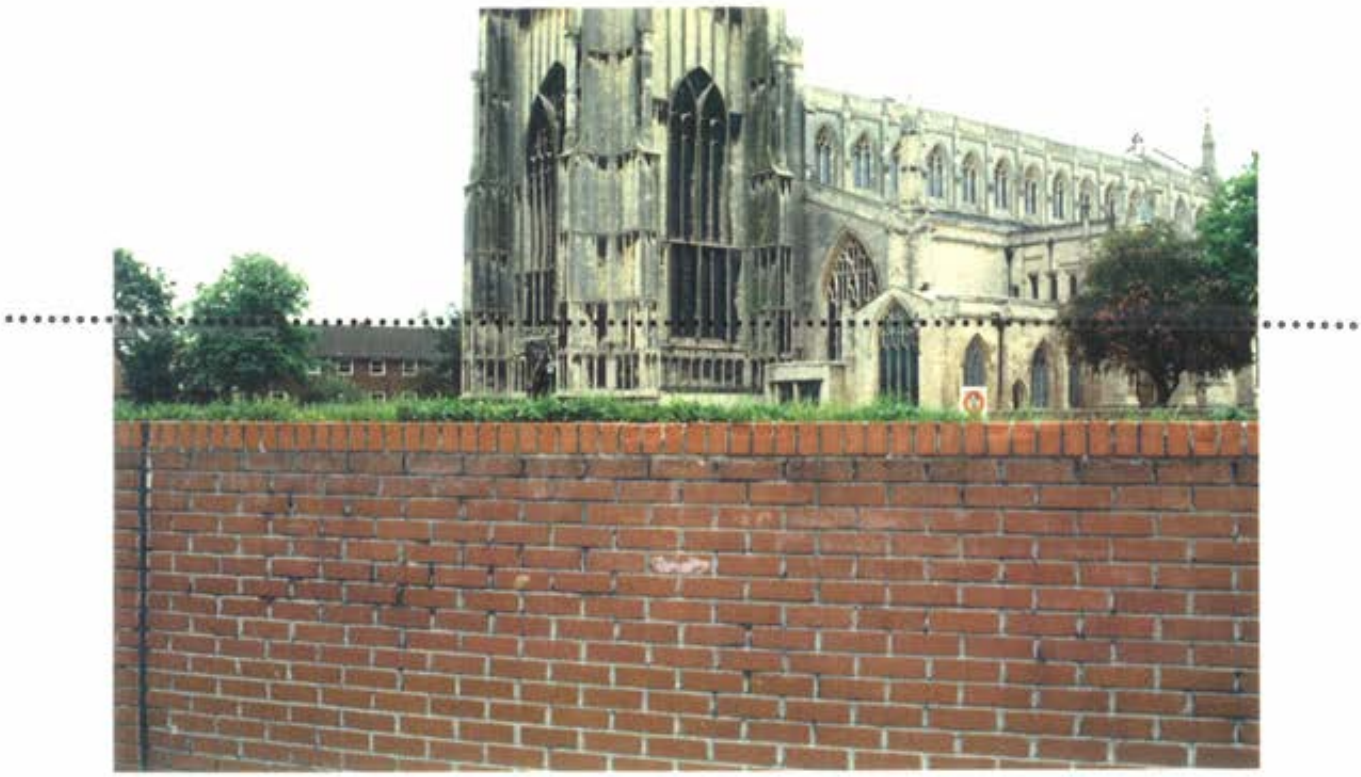

Photo 3 - High wall opposite St. Botolph's Church
- Dotted line indicates 300mm increase

Photo 4 - 300mm increase to wall will reduce visual amenity

Photo 5 - "mud lined channel flanked by stark and ugly walls"

Photo 6 - Low tide view from Town Bridge looking upstream.

Photo 7 - View from Custom House Quay at low tide

Photo 8 - View from Custom House Quay at approximately proposed MRL.

Photo 9 - View towards Grand Sluice at low tide.

Note full river above the sluice.

Appendix 2 Scoping Study for the Environmental Assessment of the Boston Barrage Project

The following Section describes the major components of the environmental assessment. Each component details the minimum requirements for that Section within the environmental assessment.

The scope for this environmental assessment has been developed from guidelines in the Department of the Environment "Environmental Assessment - A Guide to Procedures" (HMSO 1989) and guidance from the Institute of Environmental Assessment, including the Institute Review Criteria, which currently represent best practice standards.

Need for the Proposed Barrage

A brief description of the project, including the proposing authorities, should indicate the justification and rationale for the scheme. The advantages of the scheme should be listed and quantified where possible, for example if an increase in commerce is envisaged. A review of the local and regional planning strategies (for example the local structure plan) should be included, indicating how the project fits into the planning framework.

Requirement for an Environmental Assessment

The statutory requirement for the environmental assessment should be described, with details of the legislation included. The scope of assessment should be included together with the proposed procedures. Methods to be employed including data acquisition, modelling, consultations etc. should be clearly stated.

Description of the Existing Environment

A brief description of the Boston area, incorporating The Haven, should be given. Details of centres of population, proximity of residential areas to The Haven, economic status of the area, transport facilities, agricultural and rural land use, planning designations, etc should be included and estimates of future trends indicated.

The Haven and the water courses which influence the estuary should be described. Any national and international designations (SSSI, Ramsar, SPA etc) in the area should be described, including the reasons for the designations and any associated restricted activities. Areas designated for recreational and amenity value, such as country parks and countryside stewardship sites should be identified.

The habitats and terrestrial and aquatic ecology of The Haven and areas likely to be affected by the proposed scheme should be described. Description of the baseline ecology can follow the Guidelines for the Baseline Ecological Inputs to Environmental Assessment in the UK (Draft for Consultation) issued by the Institute of Environmental Assessment (1994). The NRA river corridor survey for The Haven can be used, supplemented by a phase 1 habitat survey of areas which may be affected by the Barrage but have not been investigated, for example the saltmarsh and mudflats. Fauna and flora of national and international importance should merit detailed consideration, as highlighted in the Preliminary Feasibility study. Fin fish and shellfish exploitation in the area should be identified. Maps, diagrams and photographs should be used where possible to illustrate pertinent features.

Initial investigation has identified several areas where insufficient data are available to predict likely consequences of the project. Further research into the availability of data, or additional surveys should include:

- ☐ Description of mammals (including seals), reptiles, amphibia, fish, plankton.
- ☐ Detailed description of sensitive habitats, including saltmarshes.

The water quality of The Haven and freshwaters flowing into the estuary should be described. Uses of each water body should be detailed, including both commercial and recreational utilisation. Sufficient data should be available from the NRA to determine baseline conditions for most physical and chemical parameters. Microbiological concentrations in The Haven have not been monitored regularly and will require additional survey work.

A brief description of the geology and any geomorphological features in the area should be made.

Traffic and transport assessment should identify all routes which will be affected by increased traffic flow during construction. The types of road, their daily utilisation (as average annual daily flows), the carrying capacity, accident records etc should be identified. The likely growth in traffic without the Barrage construction should be estimated and any proposed changes to the affected road network detailed.

Noise levels should be measured over a 24 hour cycle at the nearest sensitive receiver to the port and Barrage construction site. Statistical noise measurements should include L_{90}, L_{10} and L_{eq}. Vibration should be assessed if traffic or construction is to pass close to a listed building, or susceptible feature of cultural heritage.

Consideration should be given to a description of the air quality of the Boston area, providing sufficient reliable data are available. If data are unavailable, then background air quality data may be required from a monitoring exercise. The requirement for air quality monitoring should be decided after consideration of predicted traffic volume and the consequent potential for significant increases air emissions.

The cultural heritage and archaeology of the Boston area should be described. Details of listed buildings and other features of heritage value in the Boston district should be identified. Any archaeological sites of interest, particularly of a medieval maritime or prehistoric nature, should be identified.

Landscape and visual amenity of the existing site and The Haven generally should be described, with topographical and built features illustrated from a variety of views.

The recreational activities of water users, walkers, bird watchers and others using The Haven and its vicinity for recreation should be detailed. Numbers of users and frequency of use for each category should be described.

Health and Safety/Hazard considerations of the port and on The Haven generally should be described, including procedures for response to major accidents and spillages. Chemical storage and handling procedures at the port should be specified.

Sources of all data should be listed. Surveys should be undertaken to provide data where gaps in the baseline data set have been identified. Any areas where data are insufficient to draw firm conclusions should be reported and discussed.

Consideration of Alternative Options and Selection of Preferred Option

This section should outline the discussion given in the Preliminary Feasibility Study. Alternative option locations should be described and any differences in construction and operational designs. Criteria for assessing the alternatives should be indicated, together with an explanation of the rationale behind the ranking and prioritisation procedures. The scoring of each option should be included, leading to a selection of a preferred option. Rationale for the scoring and selection of the preferred option should be specified. Any options not considered in the Preliminary Feasibility study should be identified and rigorously investigated prior to ranking against the existing options.

Description of Proposed Project

A detailed description of the project should be sufficient to give a full understanding of the nature of the works. The construction methodology and operations involved should be specified, including caisson placement, dredging, spoil disposal, plant storage etc. Timing and duration of the project, with details of the phasing, should be included. Access arrangements for construction traffic should be identified, and provision for shipping during construction considered. Mitigating measures to minimise construction impacts, such as dust and noise emissions, should be listed. Management procedures to deal with accident/hazard situations should be stipulated. The description should include maps and plans of the site, access routes and landscape.

Identification of Significant Impacts

The impacts of the Barrage on the receiving environment and concomittent structures, for example pumping stations at the Black and Maud Foster Sluices, should be described in this section. Both construction and operational impacts should be considered. Key issues should be identified and an indication of their magnitude and significance given, with details of any uncertainties in the predictions. Lesser impacts should be briefly discussed, in line with their relative importance. All direct and major indirect impacts should be considered. Maps, plans and photographs should be used to illustrate location of impacts wherever possible.

The range and area of habitat to be lost or impacted should be identified. Impacts of key construction and operational aspects, such as dredging, should be included. The effects of habitat loss on the terrestrial and aquatic ecology of the region should be estimated, with particular emphasis on species responsible for statutory designations in the vicinity. Potential new habitats, such as the impoundment, should be described and their predicted habitat utilisation and community development identified. The significance of the habitat and biotal community changes in a regional, national and international context should be discussed.

The water quality changes as a result of the Barrage should be predicted for a range of physical, chemical and microbiological parameters, and should incorporate any known discharges into The Haven. The water quality effects should include impacts on the impounded water, the estuary downstream and effects on the Wash (if shown to be significant). Particular emphasis should be placed on the predictions of salinity, dissolved oxygen, BOD, ammonia, nutrients (nitrogen and phosphorus) and microbiological quality. Consideration should be given to metal levels and organic contaminants, such as insecticides and herbicides. Predictions of water quality in the impoundment should include the likelihood of eutrophication, and the consequent production of nuisance algal blooms.

Groundwater quality and levels should be investigated and predictions made of likely changes to each. Implications of groundwater changes to the surrounding environment should be detailed, including water table impacts on habitats (for example saltmarshes), foundations and built structures, abstractions, flooding, increased leaching from contaminated sites etc.

The potential impacts on geology/geomorphology, human population and air quality should be described. The detail required should be commensurate with their likely significance to the Barrage project.

Traffic volumes and types for each phase of the construction and operation of the Barrage and associate commercial activities should be predicted. Routes used, variations in hours and seasonal activity should be identified. The increases in anticipated traffic should be added to the existing traffic flow. Any problems with the increased traffic flow should be identified, including potential bottlenecks, noise and vibration problems, potential accident increases and impacts on local communities.

Noise and vibration impacts should be estimated for the each phase of Barrage construction and operation. Estimates of noise should include plant emissions,

construction noise (piling, dredging etc), likely operational noise generation at the Barrage and port, etc. Noise levels at the nearest sensitive receivers, whether adjacent to the Barrage or port, should be calculated. The number of sensitive receivers experiencing noise elevations of over 3 dB(A) should be identified.

The requirement for air quality modelling will be reliant on the predicted increases in traffic volume and movement. Significant increases in traffic volume or increased congestion adjacent to sensitive receivers may warrant the modelling of likely air quality impacts.

Cultural heritage and archaeological impacts should be estimated with reference to direct effects on specified sites or the indirect effect of the Barrage scheme such as the movement of traffic past listed building.

Landscape and visual amenity impacts should be estimated by preparation of a visual envelope map. Potentially sensitive locations should be identified and their significance assessed. Photographs of the significant positive and negative impacts should be prepared for consultation.

Recreational impacts will be both positive and negative and should be identified as such. The potentially increased recreational amenity of the impounded area should be described, together with the potential reduction in conservation value of the region. Estimates of user numbers and the significance of each recreation type should be identified. Consideration should be given to the proposed uses and the water quality requirements.

Health and Safety/Hazards should be described for the proposed scheme, outlining the changes and their relative impact on the baseline case. Emergency procedures and responses should be described, placing emphasis on the Barrage and port facilities.

Any areas where data are insufficient to draw firm conclusions, or where modelling assumptions have resulted in wide confidence limits, should be reported and discussed.

Mitigation and Enhancement Measures for Identified Impacts

Mitigation and/or enhancement measures should be described for each identified impact of the project. Procedures to avoid or reduce impacts should be detailed, with an indication of the likely success of the measures. Compensatory measures, if any, should be described and their benefit to the development assessed.

Project and Post-Project Monitoring

Monitoring should be specified to cover both the construction and operational phases of the project. The monitoring programme should cover each significant impact, and be sufficiently detailed to establish any deterioration below predetermined limits. Provision for suspension/alteration of work should be made prior to starting construction. Monitoring programmes should cover *inter alia* habitat and ecology, water quality, noise and vibration, air quality. Other significant impacts which may be established during the EA should also be monitored. Post-construction monitoring should establish whether the environment has adapted as predicted, and if not remedial measure consistent with improving the environment to predetermined levels should be instigated.

Frequency of reporting, availability of data, co-ordination of monitoring programmes and procedures for changing monitoring as required should be detailed before the project commences.

Public Consultation

The results of the EA and investigations should be included in discussions with statutory and non-statutory authorities and the public. The EA should seek to maintain maximum feasible consultation with all interested parties, incorporating views and recommendations where possible. Methods of consultation and comments should be acknowledged and presented.

Conclusions and Non-Technical Summary

Conclusions of the EA should include benefits and disbenefits of the scheme, incorporating clear and concise non-technical summary.

Appendix 3 Statutory Designations of Relevance to the Boston Barrage Project

A3.1 Sites of Special Scientific Interest (SSSI)

SSSI are areas of land which in the opinion of English Nature are of special interest by reason of their flora, fauna or geological or physicogeological features and details of which the Council has notified to the owners, occupiers, local planning authorities and the Secretary of State under the provision of Section 28 of the Wildlife and Countryside Act as amended. Planning controls are governed by local planning authorities, which often set out development plans listing policies and proposals for controlling development in their area. In 1990, the Nature Conservancy Council and the Countryside Commission issued a joint publication called *Countryside and Nature Conservation Issues in District Local Plans* as guidance to planning authorities, and many plans include policies which offer strong protection against development on SSSIs.

On receipt of an application for a development on an SSSI, the planning authority is statutorily required to consult English Nature and to take their views into account in arriving at their decision. This statutory duty is to be extended in the near future by requiring consultation on developments likely to affect an SSSI.

General guidance to local authorities on nature conservation can be found in DoE Circular 27/87 (which will be replaced later in 1994 by a Planning Policy Guidance Note (PPG)). Local planning authorities are encouraged to give recognition to nature conservation issues, and prospective applicants for planning permission should consult with the authorities and English Nature at as early a stage as possible.

The provisions for protection from development in SSSIs are strengthened when the site also has international designations such as Ramsar/SPA. These are discussed more fully below.

A3.2 Directive on the Conservation of Wild Birds (79/409/EEC)

Requirements

A general duty is placed on Member States to maintain the population of all "species of naturally occurring birds in the wild state" in the European Territory "at a level which corresponds in particular to ecological, scientific, and cultural requirements, while taking account of economic and recreational requirements".

Member States are to preserve, maintain or re-establish a sufficient diversity and area of habitats for birds. This is to be done primarily by creating protected areas, managing habitats, re-establishing destroyed biotypes and creating new ones.

Member States are to classify the most suitable territories (both land and sea) as **Special Protection Areas (SPAs)** for the conservation of these species. Particular attention is to be paid to the conservation of wetlands. Member States are to strive generally to avoid pollution or deterioration of habitats, but in respect of special protection areas, they are to take appropriate steps to avoid pollution or deterioration of the habitats or any disturbance affecting the birds.

Implementation

Notwithstanding the existence of the Protection of Birds Act 1954-67, the requirements of the Birds Directive were incorporated into UK legislation under the Wildlife and Countryside Act 1981. The more significant changes brought about by the Act concern habitats. Section 29 of the Act refers to compliance with international obligations as a reason for the making of nature conservation orders. This can be taken as a reference to the Berne and Bonne Conventions and the Ramsar Convention of 1971 concerned with wetlands, as well as the EC Bird Directive.

A3.3 *Ramsar Convention (Convention on Wetlands of International Importance Especially as Waterfowl Habitat (1975))*

Requirements

The Ramsar Convention requires signatory states to protect wetlands that are of international importance by the designation of national wetlands and wetland reserves. Ramsar sites are designated by the Secretary of State. The requirements of the Ramsar Convention include formulation and implementation of planning policies to promote the conservation of the wetlands in the designated list and, as far as possible, the wise use of wetlands. Alternative sites should be designated if any of the existing sites become developed in the "urgent national interest".

Implementation and Development Within Ramsar Sites

The Ramsar Convention can be considered to be incorporated into UK legislation in the Wildlife and Countryside Act 1981, where, in Section 29, compliance with

international obligations is mentioned. Implementation of the Bird Directive is also covered by this act and consequently, Ramsar sites and SPAs are all existing SSSIs and tend to have similar boundaries. The implications of development in Ramsar sites will have the same requirements as for SPAs.

A3.4 *Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC)*

Requirements

The measures fall into two main parts: the conservation of habitats and the protection of species. A series of measures is to be taken which will result in the establishment of a "coherent-European ecological network" of sites of Community importance to be known as Natura 2000. Three categories of site will be included in this network:

1) Habitat types of Community Importance (Annex I)
2) Sites comprising the habitats of certain animal and plant species of Community Importance listed in Annex II
3) Special Protection Areas for Birds (SPAs), classified under the birds directive.

For (1) and (2) above, Member States are required to contribute to the network in proportion to the representation within their territories. To this end they must designate sites in each category as **"special areas of conservation (SACs)"**. The first step in the designation process is to submit to the Commission by June 1995 a list of sites within their territories which are potentially of Community importance. The outcome will be a list for each member state of sites classified according to the relative conservation value insofar as they occur within the European territory of the state. The next step is for the Commission, in agreement with each Member State to draw up a draft list of sites of importance. The third step is the designation of sites selected as being of Community importance as SACs by the Member State concerned. This is to be done as soon as possible and within 6 Years at the latest. member States must protect all those sites on the Commission's list, irrespective of whether they have been designated as SACs:

1) They must take appropriate steps to avoid the deterioration of the habitats concerned and any disturbance of those species for which the areas have been designated.

2) Any plans or projects which are likely to have a sufficient effect on sites, but are not directly related to their management, are to be subject to an appropriate assessment of the implications for the conservation value of the site. Given the results of this assessment and the considerations given in (3) below, the competent national authority shall permit the plan or project **only if they have established that it will not adversely affect the integrity of the site and, if appropriate, having consulted the public.**

3) Where an assessment indicates that a project will damage the conservation interests of a site, and there are no alternative solutions, but it must be carried out for imperative reasons of overriding public interest, including those of an economic or social nature, the Member State must take all compensating measures necessary to protect the overall coherence of Natura 2000.

   In the case of sites hosting priority habitat types, the grounds for proceeding with damaging projects are restricted to those of human health or public safety, environmental improvements of primary importance or other imperative reasons of overriding public interest on which the Commission has given an opinion.

These three obligations are extended to all SPAs designated under the bird directive. Formally these obligations replace those arising in Article 4 of the bird directive. There are other obligations for species conservation which are not directly relevant to this study.

Implementation and Development Within SACs

The Habitat Directive is a recent EC initiative (notification date June 1992) and formal compliance is not required until June 1994. Consequently the requirements of the Directive have not yet been enacted in UK legislation. The implications for development within designated and proposed SACs are likely to be similar to those for SPAs designated under the birds directive, although development constraints may be stricter. It is not known whether the Wash will be designated as an SAC, although its international importance would suggest that it is a good candidate.