CAPEL FLEET

MOCKETTS PUMPING STATION

Project Ref 9780

Regional Engineer's Report

Volume 1

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Project Manager : SALLY SUDWORTH **Project Executive:** ALISON GARRETT

Author : BINNIE BLACK & VEATCH.

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Regional Engineer's Report

Volume 1

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Volume 2

Regional Engineer's Report

1 APPLICATION

LDW/CPW	39046.
Study/Scheme name	CAPEL FLEET - MOCKETTS PUMPING STATION
Promoting authority	ENVIRONMENT AGENCY
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2 SUMMARY & BACKGROUND

2.1 Introduction

2.1.1 The Capel Fleet is situated on the Isle of Sheppey in the County of Kent. It is classified as main river and drains 1520 ha of low-lying land largely devoted to arable agriculture through Mockett's Sluice, which in turn drains to the Swale. Figure 1 shows the location of Mockett's Sluice and the adjacent area. The collapse of the existing structure at Mockett's Sluice requires major works to maintain the drainage of the Capel Fleet

2.1.2 The area around the Capel Fleet is of great environmental importance, particularly for nature conservation, due to its mixture of saline and freshwater habitats. The key areas are summarised below:

- most of the Capel Fleet corridor is notified as a Site of Special Scientific Interest under section 28 of the Wildlife and Countryside Act 1981;
- Capel Fleet is included in the Swale Ramsar Site, an international designation under the Ramsar Convention on Wetlands of International Importance Especially as Wildfowl Habitat;
- the Capel Fleet is within the Swale Special Protection Area (SPA) which is a European Union designation, under the Habitats Directive 1992, for the conservation of habitats for vulnerable bird species and regularly occurring migratory species;
- within the SSSI the south east corner of the Isle of Sheppey has been designated as a National Nature Reserve (NNR) under Section 21 of the National Parks and Access to the Countryside Act 1949;
- the Capel Fleet corridor is also within the North Kent Marshes Environmentally Sensitive Area which is not strictly a conservation designation but is

acknowledged by the Ministry of Agriculture Fisheries and Food (MAFF) of the sensitivity of the area.

- there are also a number of sites with archaeological potential in the area, although none have yet been designated as Scheduled Ancient Monuments.

2.1.3 The Lower Medway Internal Drainage Board is the operating authority for the North Kent Marshes except for the Capel Fleet where the Environment Agency is responsible for operation and maintenance activities.

2.2 The Problem

2.2.1 There were a number of problems associated with poor drainage in the Capel Fleet prior to the collapse of Mockett's Sluice;

- regular water-logging and reduction in yields in areas draining into the Fleet;
- periodic over-topping of the Fleet banks leading to enforced shutdown of pumps draining the remaining areas;
- the need for additional pump capacity at Mockett's Sluice to drain flooded land in wet winters;
- the extent and quality of the rare habitat types within the SSSI and other environmentally sensitive areas were at risk.

2.2.2 These problems were caused by the inadequate capacity of Mockett's Sluice due to tide locking and siltation in the outfall channel to seaward. Since the collapse of the existing structure a temporary dam has been constructed which effectively seals off the outlet and prevents saline intrusion. Temporary pumps are now in place adjacent to the site of the collapsed sluice.

2.3 Feasibility Study

On the 1st September 1994 the Southern Region of the National Rivers Authority appointed Binnie & Partners to carry out a feasibility study into the improvements to Mockett's Sluice. The study was initiated because of the problems of drainage and flooding in recent years arising from the silting up of Mockett's Sluice.

2.4 Water Level Management Plan

The study brief was extended on the 11 November 1994 to include the development of a Water Level Management Plan (WLMP) in order to ensure that the interests of farmers and environmental bodies are adequately represented and to facilitate the implementation of the preferred scheme. The WLMP was written after full consultation with English Nature, Lower Medway IDB, RSPB and local landowners. The WLMP states the preferred water level regime which satisfies the objectives of the interested parties.

2.5 The Solution

The feasibility of a new gravity outfall together with other options, the likely future benefits of arable agriculture and the environmental benefits associated with grazing marshes were considered in great detail. Out of five options, a new pumping station was found to be the preferred option. It is the most cost effective solution which best satisfies the objectives of the WLMP, provides safeguarded protection and flexibility for sustaining the existing rare habitat types . The approximate cost of the pumping station and associated structures is in the region of £317,000 and has a benefit cost ratio of 8.15.

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3 THE PROBLEM

3.1 Description of the problem

3.1.1 The Capel Fleet area suffered from increasingly ineffective drainage due to the progressive silting of the gravity outfall. This has lead to a variety of environmental, economic and social impacts including regular waterlogging of fields, flooding low lying areas which drain by gravity into the Fleet and enforced shutting down of the Harty and Leysdown pumps which drain the remaining areas. The bird and waterfowl habitats are also greatly affected by the ineffectiveness of the drainage system

3.1.2 There is also concern that some of the current modifications to drainage practices are not sustainable on a long term basis. Water from the area north of Mockett's Sluice is currently redirected to the nearby pumping station on Bells Creek serving the adjacent drainage catchment area. This significantly reduces the capacity of these pumps to cope with the flows for which they were designed. The Harty and Leysdown pumping stations within the Capel Fleet system are also serving considerably greater areas than they were originally designed.

3.1.3 Problems of poor drainage and flooding in Capel Fleet were brought to a head in August 1995 when Mockett's Sluice, controlling discharge from Capel Fleet into Bell's Creek, collapsed at the end of its design life. The sluice had been subject to siltation on numerous occasions, and, combined with the effects of tide lock, the efficiency of the sluice has been considerably reduced. In addition, during periods of heavy rainfall, flooding of the low lying land occurs seriously affecting the environmental and agricultural interests within the Capel Fleet corridor. The problem is exacerbated by a lack of storage in the Capel Fleet.

3.1.4 The maintenance of water level requirements for farmers, landowners and environmental interests in the area has clearly been a difficulty. Eventually, without maintenance, temporary pumping and emergency works on the sea wall and the Fleet would mean that the sea wall would collapse and the Fleet would return to a tidal channel. Flooding would also lead to the severance of the main access road to the Isle of Harty at Capel Gate. In abandoning sea wall maintenance, the defences would eventually fail, resulting in the widespread loss of crops, ancient grazing marshes and the Fleet as well as the loss of current SSSI conservation interest.

3.2 History of flooding

3.2.1 The gravity outfall system at Mockett's Sluice has been hampered by siltation in the past. There has been a persistent problem with poor drainage over the years and thus there is concern for the long term stability of the system. To alleviate this problem, the Environment Agency previously carried out dredging in the tidal channel although the success of this operation was limited.

3.2.2 Due to the recent collapse of the sluice, a temporary dam has been constructed across the outlet at Mockett's Sluice, effectively sealing the Fleet. Temporary pumps have been installed to allow excess water to be over pumped into the tidal channel as required. To

maintain the integrity of the sea defences and prevent tidal inundation into the Fleet, the sluice has been sealed off with clay to control water levels. However, a permanent solution is urgently required.

3.2.3 As with any flood defence/drainage scheme, works carried out in emergency conditions could have major, often irreversible, environmental impacts as they would not be subject to the stringent mitigation measures which permanent structures demand.

3.2.4 Further problems have arisen following seawater ingress through the structure, causing particular difficulties for cattle watering due to the high salinity levels in the Fleet. This was compounded by low rainfall levels in 1995/96 which minimised the dilution capacity of the Fleet.

3.3 Probability of damage in a 'do nothing' scenario

3.3.1 The present temporary arrangements at Mockett's Sluice have worked satisfactorily to date. However, they are likely to prove expensive in the longer term and provide less satisfactory drainage than Mockett's Sluice prior to its collapse and are not considered appropriate to meet the overall water level objectives of the Water Level Management Plan.

3.3.2 If nothing is done to alleviate the problem, a medium or long term rise in the water table, resulting from the inability of the Fleet to discharge to the sea, would increase the areas of open water, marsh and wet meadow. Existing areas of marsh and meadow may become inundated and water logging may increase. The loss of agricultural land and increased water logging may have economic implications for farmers. Furthermore, it is likely that a large ponded area would be created behind the counter wall which could have two major implications;

(i) The main access road to the Isle of Harty may be severed at Capel Gate.

(ii) Increased pressure on the sea wall and counter wall embankments may threaten their integrity

3.3.3 If outflow ceased or reduced significantly, reduced aeration would occur in the Fleet, allowing little water movement and circulation. This could result in stagnation, eutrophication and increased anaerobic conditions in the sediments, particularly if stratification occurred. This would also occur in the localised ponded areas.

3.3.4 It is likely that some sea water will penetrate the silted sluice structure and continue to enter the Fleet. In the long term, the system may become increasingly brackish as the effects of net freshwater inputs diminishes. This could lead to the development of a halocline giving rise to anoxic saline water overlain by freshwater. In the short and medium term, it is likely that the brackishness of the system will decrease. Changes in the salinity of the system would affect the water quality and, as a result, the aquatic and marginal communities. Although changes would be gradual, a decrease in salinity may result in short to medium term loss of brackish species.

3.3.5 Cessation of sea wall maintenance, which currently includes occasional raising and regular mowing, will have short term benefits because the existing habitat will establish a stronger footing. In the long term, sea wall failure could result in the loss of crops which would have social and economic implications. In addition, the loss of brackish fleet and adjacent grazing marshes would be to the detriment of the current SSSI status of Capel Fleet. Failure of the sea defence would also result in localised erosion on both the existing mud flat and within the newly created tidal inlet. In the long term, the Fleet is likely to return to a tidal creek with areas of current grazing marsh reverting back to salt marsh.

3.4 Scope of the problem

3.4.1 The impacts of the problem will extend across Capel Fleet which is in an area with a unique landscape character of a semi brackish, old tidal channel. The grazing marshes are flat, low lying and exposed. The land within the study area is almost exclusively agricultural and the lower slopes and valley bottom are mainly grazed with moderately high intensity arable farming on the higher elevation slopes.

3.5 Other assets at risk

3.5.1 There are a number of non-use assets which are at risk in the area and Capel Fleet is subject to a number of conservation designations;

- Site of Special Scientific Interest (SSSI)
- Ramsar Site (part of the Swale site)
- Special Protection Area (part of the wider Swale SPA)
- The south east corner of the Isle of Sheppey has been designated as a National Nature Reserve
- North Kent Marshes Environmentally Sensitive Area (ESA)
- Part of the North Kent Marshes Special Landscape Area.

3.5.2 Furthermore, although there are no scheduled Ancient Monuments within the Capel Fleet area, the County Sites and Monuments Record indicates that there are a number of areas of archaeological potential within the Capel Fleet area.

3.6 Need for the Scheme

3.6.1 The results of an Environmental Assessment are reported in the Environmental Statement prepared in early 1997. In addition, the Capel Fleet Outfall Improvements Feasibility Study was prepared in February 1996 and a Water Level Management Plan (WLMP) was prepared in January 1996 for the Capel Fleet, following full consultation with English Nature, Lower Medway IDB, the RSPB, English Heritage and local landowners.

3.6.2 The Water Level Management Plan for the Capel Fleet area was developed to provide a means by which the water level requirements for a range of activities, including agriculture, flood defence and conservation, can be balanced and integrated. The most appropriate permanent outfall arrangement which best satisfies the objectives of all the interested parties is the installation of a pumping station at the existing Mockett's Sluice

site. The Water Level Management Plan sets out the water level objectives for Capel Fleet that the permanent outfall should meet.

3.6.3 There is a clear need to improve the discharge arrangements in the area, following the collapse of the Mockett's Sluice in 1995. The problem could potentially create a number of negative impacts for farmers, landowners, wildlife and habitats unless permanent alleviation action is taken.

3.6.4 Solutions to achieve the objectives of the Water Level Management Plan have been appraised on technical, environmental and economic grounds. A number of studies have already been carried out and the development of the current proposals has been carried out in full consultation with local landowners and interested parties who would be affected by them. The selection of a preferred option was carried out using the methods described in the Ministry of Agriculture Fisheries and Food (MAFF) 'Project Appraisal Guidance Notes' (PAGN).

4 ALTERNATIVE SCHEMES

4.1 During the course of the Water Level Management Plan development a feasibility study was carried out in February, 1996. A number of alternative options for improvements to Capel Fleet were considered and these are outlined below;

* Option I - Do nothing
* Option II - Closure of sluice
* Option III - Seal Mockett's Sluice and continue temporary pumping
* Option IV - Refurbishment of existing sluice and continue increased dredging
* Option V - New pumping station
* Option VI - New outfall

4.2 *Option I - Do nothing*

4.2.1 If no action is taken to improve Capel Fleet, then a short term reduction in the propensity for rapid water level changes would improve the stability of the marginal habitats by reducing the current transient conditions. This would improve the quality of the marginal habitats and hence the wildlife value of the area.

4.2.2 A medium or long term rise in the water table, resulting from the inability of the Fleet to discharge to the sea, would increase the areas of open water, marsh and wet meadow. Existing areas of marsh and meadow may be inundated and water logging may increase. The loss of agricultural land and increased water logging may have economic implications for farmers.

4.2.3 It is likely that a large ponded area would be created behind the counter wall which may have two major implications:

(i) The main access road to the Isle of Harty may be severed at Capel Gate

(ii) Increased pressure on the sea wall and counter wall embankments may threaten their integrity

4.2.4 Reduced aeration would occur in the Fleet if outflow ceased or reduced significantly leading to little water movement and circulation. This could result in stagnation, eutrophication and increased anaerobic conditions in the sediments, particularly if stratification occurred. This would also occur in the localised ponded areas.

4.2.5 It is likely that some sea water will penetrate the silted sluice structure and continue to enter the Fleet. In the long term, the system may become increasingly brackish as the effect of net freshwater inputs diminishes. This could lead to the development of a

halocline giving rise to anoxic saline water overlain by freshwater. In the short and medium term however it is likely that the brackishness of the system would affect the water quality and, as a result, the aquatic and marginal communities. Although changes would be gradual, an increase in salinity may result in the short to medium term loss of brackish species.

4.2.6 Cessation of sea wall maintenance, such as occasional topping and regular mowing, will have short term benefits as the existing habitat will establish a stronger footing. In the long term however, the sea walls will eventually fail and these habitats will be lost. In addition, sea wall failure could result in the loss of crops which could have social and economic implications. The loss of brackish Fleet and adjacent grazing marshes would be to the detriment of the current SSSI status of Capel Fleet. Failure of the sea defence would also result in localised erosion on both the existing mud flat and within the newly created tidal inlet.

4.2.7 In the long term, the Fleet is likely to return to a tidal creek with areas of current grazing marsh reverting back to saltmarsh.

4.3 *Option II - Sluice closure* — ***Benefit cost ratio 20.8***

4.3.1 This option comprises the abandonment of the sluice but maintenance of the sea wall. The consequence of this option is that the freshwater drainage arrangements would cease to function and water levels throughout the area would rise. As a result, there would be a considerable increase in the area of open water, wet shallows and marginal areas. Such areas are one of the main reasons for the SSSI designation of the Capel Fleet corridor and any increase in their total area would be a nature conservation benefit.

4.3.2 The increased surface water area and lack of outfall would reduce the present tendency for rapid fluctuations in water levels although the seasonal variations could be greater. The overall effect of this would be improved stability of the marginal habitats and hence the conservation value of the Capel Fleet corridor. An increase in areas of open water and water logged fields would allow the Fleet corridor to sustain larger populations of wildfowl and other wildlife.

4.3.3 This option would result in the many areas reverting from arable production to grazing marsh, possibly encouraged by payments from the ESA scheme.

4.3.4 Reduced aeration would occur in the Fleet as a consequence of reduced movement and circulation due to the closure of the sluice. This could result in stagnation and eutrophication, and could lead to the development of a halocline giving rise to anoxic saline water overlain by freshwater. In the long term, the closure of the sluice could reduce the brackish nature of the Fleet system although there are conflicting opinions as to the major source of chlorides to the Fleet ie. Whether saline intrusion through the sluice, saline intrusion beneath the sea wall or leaching and sea spray are the main source. If saline intrusion through the sluice is the major source of chloride into the Fleet, long term changes would be gradual, a decrease in salinity may result in the short to medium term loss of brackish species.

4.3.5 The generally higher water levels resulting from this option would lead to areas of archaeological interest being flooded more frequently, and in some cases, permanently. This would affect the ease of future excavation, but would however prolong the preservation of archaeological features in situ.

4.3.6 Increased flooding, in terms of the extent and frequency, would create access problems to the Isle of Harty.

4.3.7 Overall this option would have significant advantages for nature conservation compared with the present situation provided the loss of saline intrusion through the sluice does not adversely affect the existing communities within the Fleet. There would however be significant implications on the farming community in the area as the viability of arable cultivation would significantly decrease.

4.4 *Option III - Seal Mockett's Sluice and continue temporary pumping*

Benefit cost ratio 5.65

4.4.1 This option is primarily maintenance of the status quo together with the construction of an adjustable weir in the upstream section of the Capel Fleet. In winter it would be prudent to draw down water levels within the upstream section of the Fleet as much as possible to provide maximum storage for winter floods as evacuation of major floods would take longer than in the past when the gravity outfall operated correctly. This would significantly reduce the environmental value of the Fleet to overwintering wildfowl as generally drier conditions would occur. In exceptionally wet winters there may be increased flooding than under the gravity outfall regime as the temporary pumps would be less reliable.

4.4.2 The noise of the diesel pump is likely to disturb the tranquillity of the area and the bird populations unless measures were taken to abate noise from equipment. Disturbance to wildfowl would be further increased by the need for regular operation and maintenance visits to temporary pumps. The presence of diesel operated pumps also increases the risk of fuel and oil spillages into the Fleet and/or tidal creek.

4.5 *Option IV - Refurbishment of existing sluice and continued dredging*

Benefit cost ratio 5.76

4.5.1 The major, short term, temporary impact of this option is that there will be construction disturbance relating to the scheme. Within the Capel Fleet system there will be a continuation of the present processes with the additional benefit of reduced risk of flooding. This reduced risk would improve the economic aspects of farming activities and would reduce the tendency for nesting areas to be flooded. Continuing with the present sea wall maintenance regime will ensure the existing conditions are maintained.

4.5.2 The major environmental implication of this option is the necessity for dredging. Dredging disturbs and in some cases, destroys benthic communities which then has secondary impacts on birds and marine life feeding in the affected area. It is worth noting that the mudflats in the area are the only station in Britain for the polychaete worm *Clymenella torquata*, one species which has led to the SSSI designation. Recolonisation after dredging is a slow process and regular dredging could prevent recovery. A further difficulty associated with dredging activities is the disposal of arisings due to the requirements of the Ramsar site. The only beneficial effect of dredging is that the sluice becomes clear to allow greater saline intrusion which is important to maintain the brackish environment of the Capel Fleet system.

4.5.3 Dredging activities would lead to localised noise disturbance from the machinery. Once the area has been dredged the material removed must be disposed of appropriately. Marine dumping could affect other benthic communities whilst dumping on land could destroy terrestrial habitats and degrade the aesthetics of the area.

4.6 *Option V - New pumping station and control weirs* *Benefit cost ratio 8.15*

4.6.1 Construction of the pumping station would create some disturbance to wildlife in the immediate area around Mockett's Sluice although it would be of relatively short duration and long term detrimental effects are unlikely.

4.6.2 This option would allow the present agricultural regime to continue with the benefit of reduced risk of flooding in arable areas and raised (and maintained) water levels in grazing marsh areas. Greater water level control will lead to reduced water level fluctuation which will reduce the risk of nesting chicks drowning in the marsh and wet meadow areas. However, reduced winter field inundation will lead to less wildlife interest in the area as, under the current operation of the drainage system, inundated fields (including arable fields) attract a large number of birds in the area.

4.6.3 As outlined above, this option would provide the facility to reduce the risk of rapid water level fluctuations and maintain the present peak water level draw down rate which would create a more stable marginal ecology along the Fleet. The potential for the water levels to be drawn down to ecologically unacceptable levels would be minimised by the installation of two weirs on the Fleet and appropriate minimum water level specification for the operation of the pumps. The implementation of the proposed WLMP will ensure that a sustainable, and ecologically acceptable operational procedure is established.

4.6.4 In the long term, the pumps may create noise disturbance to wildlife although measures can be taken to reduce the noise levels. The pumping station could be a visual intrusion on the landscape although the design philosophy has taken this into account with maximum roof levels no higher than the counter wall and power supply taken underground from existing supplies at Bell's Creek pumping station.

4.7 *Option VI - Long outfall* *Benefit cost ratio 6.10*

4.7.1 This option would have the greatest construction impacts as the outfall would require realignment along the intertidal mudflats and work would be required on the existing structure at Mockett's Sluice. Construction of the outfall along the mudflats would damage the benthic communities along the outfall alignment and possibly beyond. Reconstruction of the ditch and work around Mockett's Sluice would result in temporary loss of habitat although this would recolonise with time.

4.7.2 The outfall structure itself could pose a visual intrusion during low tides when the pipe is exposed. This may be visible from the Saxon Shoreway Route which is a strategic footpath along the Kent coast.

4.7.3 The long term effects of this option on the Capel Fleet system would be similar to those for option III : the main difference is that dredging would no longer be required.

5 COSTS OF OPTIONS

This chapter presents the estimated capital and operating costs of each of the options considered in detail. More detailed information about the cost estimates can be found in Capel Fleet Outfall Feasibility Report of February 1996.

5.1 Basis of Cost Estimates

5.1.1 The cost estimates have been prepared in accordance with the recommendations of the MAFF PAGN, with the base date being taken as 1st January 1996. In general capital costs have been based on unit rates taken from contracts including similar items of work, from the Wessex Database (1994) or from manufacturer's quotations.

5.1.2 Allowances for Preliminary and General items (15%), Contingency (10%) and Design and Construction Supervision (10%) have been added to costs built up from unit rates. Operation and maintenance costs have been based on actual expenditure in recent years for most items with pumping costs being based on the total estimated annual discharge from the pumping station. Present value costs have been determined using a discount rate of 6% and an assumed project life of 50 years, with no terminal value.

5.2 Capital Costs

5.2.1 The capital costs associated with each option are given in Table 1. These costs are assumed to be incurred at the mid-point of Year 0 unless stated otherwise.

Table 1. Capital Costs of Options

Item	Capital Cost £,000's					
	I Do Nothing	II Abandon Outfall	III Temporary Pumps	IV Gravity Outfall	V Pumping Station	VI Long Outfall
Seal Existing Sluice	0	11	11	11	11	11
New adjustable weir	0	0	25	25	25	25
Capital Works for Outfall	0	0	0	187	0	760
Capital Works for Pumping Station	0	0	0	0	250	0
Replacement of Pumps	0	0	0	0	31	0
Totals	0	11	36	223	317	796

5.2.2 Detailed costings for each of the Options are presented in the Capel Fleet Outfall Feasibility Study Report of February 1996.

5.3 Recurrent Costs

5.3.1 Recurrent (operating) costs are shown in Table 2. In general these costs are assumed to occur each year, with pump operating costs starting the year after the pumping station is built.

Table 2. Recurrent Costs of Options (Operations and Maintenance)

Item	Annual Cost £,000's					
	I Do Nothing	II Abandon Outfall	III Temporary Pumps	IV Gravity Outfall	V Pumping Station	VI Long Outfall
Maintenance of Seawall and Capel Fleet	0	5	5	5	5	5
Maintenance of Drainage System	0	10	15	15	15	15
Dredging of the Rillway	0	0	0	38	0	0
Running and Maintenance Costs of Pumps	0	0	53	0	15	0
Maintenance of Outfall	0	0	0.5	1	0.5	0.5
Totals	0	15	73.5	59	35.5	20.5

5.3.2 Further details of the Recurrent costs are presented in the Capel Fleet Outfall Feasibility Study Report, February 1996.

5.4 Present Value of the Capital and Recurrent Costs

5.4.1 The present value of the costs for each option, taking both capital and recurrent costs into account, are shown in Table 3. Note that for Options IV, V and VI allowance for one year's temporary pumping has been made at the rate shown in Table 2 (£53,000/year).

Table 3. **Present Value of the Capital and Recurrent Costs and the Totals for Each Option**

Item	Present Cost £,000's					
	I Do Nothing	II Abandon Outfall	III Temporary Pumps	IV Gravity Outfall	V Pumping Station	VI Long Outfall
Seal Existing Sluice	0	11	11	11	11	11
New adjustable weir	0	0	25	25	25	25
Capital Works for Outfall	0	0	0	187	0	760
Capital Works for Pumping Station	0	0	0	0	250	0
Replacement Cost of Pumps in Year 25	0	0	0	0	7	0
Dredging Outside Seawall	0	0	0	635	0	0
Maintenance of Seawall and Capel Fleet	0	84	84	84	84	84
Maintenance of Drainage System	0	84	250	250	250	250
Running and Maintenance Costs of Pumps	0	0	885	53	288	53
Maintenance of Outfall	0	0	8	16	8	8
Totals	0	179	1263	1261	923	1191

5.5 Accuracy and Sensitivity of Estimates

5.5.1 Some costs are sensitive to changes in assumed parameters. The cost of Option IV, in particular, depends on the assumed frequency and quantity of dredging needed to maintain levels in the sluice outfall channel. This is difficult to estimate; the channel was dredged in the early 1980's, with apparently limited effect, and was dredged again in 1991. However, this dredging was clearly insufficient to maintain adequate drainage during the winters of 1993/4 and 1994/5 when temporary pumps were brought in to lower water levels in Capel Fleet. We have, therefore, assumed dredging will take place every year, with 2500m^3 of material being removed on each occasion. The estimate assumes that the depth of material removed varies from 1m at the sluice outfall to zero at the seaward end of the outfall channel.

5.5.2 There are reports of increasing rates of siltation in both Bells Creek and the neighbouring Windmill Creek. This suggests there is a risk that in future years the quantity of dredging each year will need to be greater to have the same impact. The sensitivity of the present value to the quantity of material dredged is tested in Table 4 by assuming a 1% increase in dredging quantity each year, showing that this results

in an 8.2% increase in present cost.

Table 4. Sensitivity Test of Dredging Quantity with Option IV

Item	Present Cost £,000's	
	Option IV Dredging Constant	Option IVS Dredging Quantity Rises 1%pa
Seal Existing Sluice	11	11
New adjustable weir	25	25
Capital Works for Outfall	187	187
Dredging Outside Seawall	635	734
Maintenance of Seawall and Capel Fleet	84	84
Maintenance of Drainage System	250	250
Maintenance of Outfall	16	16
Total	1208	1307
Increase		99

6 BENEFITS OF ALTERNATIVE SCHEMES

6.1 Basis of Economic Impact Estimates

6.1.1 The economic impacts of the options considered in detail have been assessed in terms of their effect on both agricultural benefits and amenity value. These are summarised in this chapter and given in detail the Capel Fleet Outfall Feasibility Study Report.

6.1.2 The economic impact estimates have been prepared in accordance with Appendix G of the MAFF PAGN, using information from the Farm Management Pocket Book (1996) by John Nix and arable crop prices for November 1996 delivery. Present values have been determined using a discount rate of 6% and an assumed project life of 50 years.

6.1.3 It has been assumed that the current profitability of arable and livestock agriculture will remain unchanged for the whole of the project life. These conditions are such that the adjusted net margin for arable agriculture, based on the existing crop pattern, is £206/ha. The adjusted net margin for grazing, based on the existing sheep/beef ratio, is - £76/ha, indicating a net economic loss to the country. This loss is not felt by a grazier in the area as he receives subsidies for livestock production and is entitled to enter the ESA scheme.

6.1.4 The adjusted net margin for arable agriculture includes an allowance for gypsum application every 5 years to land that is susceptible to clay deflocculation and therefore to drainage problems. It also allows for the existing drainage system to be replaced over a period of 40 years (ie a replacement rate of 33 ha/year). Provided these works are undertaken arable agriculture is assumed to be sustainable for the life of the project. The crop yields, however, are assumed to fall by 25% for one year in every five as a result of adverse weather conditions which interfere with cultivation and harvesting.

6.1.5 The current profitability of arable agriculture is likely to remain reasonably constant in the short term. It is impossible to predict how it will vary in the long term since this will depend on both the future levels of area aid for crops and the future prices. For sensitivity purposes high and low values for the adjusted margin of £316/ha and £40/ha have been estimated.

6.2 Economic Impacts for Agriculture

6.2.1 The estimated annual economic returns to agriculture with each option are given in Table 5. These returns are based on the assumed impacts set out in Chapter 4 and are summarised below:

Option I All low-lying land converts to salt marsh and is abandoned.

Option II 90% of low-lying land converts to freshwater grazing marsh.

Option III Current agriculture unchanged. Flood losses as at present.

Option IV Low-lying land presently draining to Bells Sluice converts to freshwater grazing marsh, remainder unchanged. Flood losses half their present value.

Option V Current agriculture unchanged. Flood losses one quarter their present value.

Option VI Current agriculture unchanged. Flood losses half their present value.

6.2.2 The annual value of agricultural benefits and flooding damage with each Option are set out in Table 5.

Table 5. Economic Benefits of Capel Fleet Catchment

Item	Annual Value £,000's					
	I Do Nothing	II Abandon Outfall	III Temporary Pumping	IV Gravity Outfall	V Pumping Station	VI Long Outfall
Grazing Marsh (ha)	0	1413	250	250	250	250
Arable Land (ha)	0	157	1320	1320	1320	1320
Agriculture						
Arable	-	32.3	271.9	271.9	271.9	271.9
Livestock	-	-106.8	-18.9	-18.9	-18.9	-18.9
Total	0	-74.5	253.0	253.0	253.0	253.0
Flood Damage	-	-	-15.2	-7.6	-3.8	-7.6
Net Agricultural Benefit	-	-74.5	237.8	245.4	249.2	245.4
Amenity						
Wildfowling	-*	102.7†	20.8	20.8	20.8	20.8
Birdwatching	-*	44.1†	18.2	18.2	18.2	18.2
Net Amenity Benefit	-	146.8	39.0	39.0	39.0	39.0
Overall Economic Benefit	-	72.3	276.8	284.4	288.2	284.4

* Considering existing species only.
† Change in amenity value based on figures in Table 6.

6.3 Amenity Benefits

6.3.1 The other quantifiable benefits of the Capel Fleet catchment are primarily related to the amenity value of the grazing land for birdwatching and wildfowling. The results are incorporated into Table 5 and show that with Option III, IV, V and VI the amenity value is around one seventh of the agricultural value. In Option II, where there is a large reversion to grazing marsh, the amenity value is dominant.

6.3.2 Although the amenity value is relatively small, this is because it is associated with a relatively small area of grazing marsh. If the amenity and agricultural values are compared for a unit area as in Table 6, the importance of amenity in assessing the economic benefit of the grazing marsh becomes evident. Although arable production has the greatest economic value, the value of grazing marsh is significant. We have not included intrinsic environmental value within this analysis but note that the North Kent Tier 1a ESA payments of £165/ha is not dissimilar to the difference in benefit of grazing marsh and arable land. The Tier 2 ESA payment of £240/ha is also not dissimilar to the difference in benefit between arable land and extra grazing marsh.

6.3.3 The birdwatching amenity associated with an increase in the grazed marsh area in Table 6 is set at a relatively low level because the number of birdwatchers is only likely to change a little unless new species become established or the numbers present rise noticeably. The wildfowling benefit is assumed to remain constant on a unit area basis because the benefit is controlled by the need to avoid any increase in disturbance.

6.4 Present Value of Economic Benefits

6.5 The present values of the economic benefits associated with each Option are set out in Table 7. The present value is calculated assuming the annual benefit given in Table 5 is accrued each year for 50 years with a discount rate of 6%. For Option I (Do Nothing), the 1570 ha in the low lying part of the catchment would be abandoned. The value of this abandoned land is set at £1600/ha or 40% of the present market value assumed to be £4000/ha.

6.6 The present values of the benefits of each option in relation to Option I (Do Nothing) are set out in Table 7. For Options III, IV, V and VI, this benefit ranges between £7.14M and £7.33M. The benefits associated with Option II (Abandon Outfall) are about half this value at £3.7M.

Table 6 Comparison of Economic Benefit Associated with Arable agriculture and Grazing Marsh at Capel Fleet

	Arable Agriculture Benefit £/ha	Existing Grazing Marsh Benefit £/ha	Increased Area of Grazing Marsh Benefit £/ha
Agricultural Production	206	-76	-76
Amenity for Wildfowling	0	73	73
Amenity for Birdwatching	0	83	20
Overall Economic Benefit	206	80	17
Difference Relative to Arable Agriculture		126	189

Table 7. Present Value of Benefits

	Present Value £,000's					
	I Do Nothing	II Abandon Outfall	III Temporary Pumping	IV Gravity Outfall	V Pumping Station	VI Long Outfall
Economic Benefits (Table 5)	-	1207	4623	4749	4813	4749
Abandoned Land	-2432*	-	-	-	-	-
Benefit Relative to Option I		3719	7135	7261	7325	7261

* 1520ha abandoned valued at £1600/ha.

7. CHOICE OF SCHEME

7.1 Introduction

7.1.1 The choice of the preferred scheme which fulfills the objectives of the Capel Fleet Water Level Management Plan has been based on an appraisal of the technical, environmental and economic merits of the different options. In this chapter the respective issues are presented and then consideration given to the options leading to the selection of a preferred scheme.

7.2 The Technical Case

7.2.1 This section assesses the technical effectiveness of the options to meet the water level objectives of the interested parties, as identified in the Water Level Management Plan and the extent to which they address the problems identified in Chapter 2. This includes an assessment of their reliability and sustainability in the long term.

7.2.2 Neither Option I (Do Nothing) nor Option II (Sluice Closure) address the technical problems in the area; poor drainage and periodic flooding. They therefore do not meet the overall requirements of the Water Level Management Plan.

7.2.3 Option III (Temporary Pumping) is an emergency measure to maintain drainage until a more permanent solution is commissioned. Continuing this temporary arrangement is likely to lead to a continued high frequency of flooding as additional temporary pumps will need to be brought in during wet weather. This Option will not address the technical problems in the area; poor drainage and periodic flooding and therefore does not meet the requirements of the Water Level Management Plan.

7.2.4 Option IV (Renew Mockett's Sluice and continue dredging) will provide some improvement to the current drainage and flooding problems. However, in the future its effectiveness is likely to decline, partly as a result of sea level rise and partly as a result of the perceived increase in the rate of siltation in the area. This is difficult to quantify but is widely reported by those responsible for drainage arrangements locally. Sea level rise will increase the extent to which the sluice is tide-locked and cannot be avoided. Increased siltation will tend to raise bed levels in the outfall channel and may be countered by increasing the quantity dredged each year. In the long term, therefore, this Option is likely to become more costly to sustain and does not provide the flexibility of control required by the Water Level Management Plan.

7.2.5 Option V (New pumping station) will provide independence from the effects both of tide-locking and of the bed levels in the outfall channel. As such it will enable much closer control of water levels in the Capel Fleet, avoiding in particular the periods of low water level and the rapid fluctuations in level that occur at present. This best matches the objectives of the Water Level Management Plan. In addition it will allow the internal drainage arrangements to be improved and will reduce the incidence of flooding in the area.

7.2.6 Option VI (New Outfall) will largely avoid the problems of siltation experienced by Option IV but not the problems of tide-locking. It will therefore provide some improvement to the drainage and flooding conditions experienced but not as much as provided by Option V. The periods of low water level in the Fleet and the rapid fluctuations in level will continue. There is a risk of siltation occurring in the outfall pipe if the tide flap at the discharge point does not operate properly. This would be difficult to remove and, if unchecked, would seriously impede the system's drainage. This therefore does not meet all of the requirements of the Water Level Management Plan.

7.2.7 On balance, therefore, it is concluded that Option V is the most appropriate permanent outfall arrangement to meet the water level objectives set out in the Water Level Management Plan for the Capel Fleet Area. On technical grounds this option is followed by Option VI and then Option IV.

7.3 The Environmental Case

7.3.1 The environmental implications of the options considered are presented in detail in Chapter 4. The following sections compare the impacts of these options on different aspects of the local environment and how they affect the successful implementation of the Water Level Management Plan.

The Physico-chemical Environment

7.3.2 Option I would have a major impact on the topography, fluvial regime and drainage patterns, and the water quality in the area. After a number of years the area would revert to saltmarsh, its state before the land was reclaimed. This does not comply with the overall habitat protection and enhancement objectives of the Water Level Management Plan.

7.3.3 Option II would also have a major impact on the topography, fluvial regime and drainage patterns in the area as a result of the change from arable to grazing marsh. The change in water quality would not be as marked in Option I since conditions would remain generally fresh rather than becoming saline. There would probably be a reduction in nutrients, however, associated with reduced use of fertilisers in the area. This would therefore not comply with the overall habitat protection and enhancement objectives of the Water Level Management Plan.

7.3.4 Option III would have no significant impact on the physico-chemical environment as conditions would be largely unchanged. This option would not, however, comply with the long term sustainability of the Water Level Management Plan Objectives.

7.3.5 Options IV, V and VI would also have little effect on the physico-chemical environment. Small changes in the drainage patterns may occur but these would have little impact on conditions in the Fleet. The elimination of salt water leakage through the sluice may affect the salinity of the Fleet but this could be overcome by allowing a small backflow if this was found to be detrimental to the local habitat.

Nature Conservation

7.3.6 Superficially Option I appears to offer significant benefits to nature conservation since it would lead to the replacement of existing arable land with unmanaged saltmarsh. There are large uncertainties about the time needed to achieve a stable condition, however, and in practice extensive management is likely to be needed to ensure that the process of change and the final result are acceptable (assuming that this is possible). The brackish and freshwater habitats along the Capel Fleet, which are the reasons for its designation as a SSSI, would be lost as would the Harty National Nature Reserve. This would not meet the objectives of the Water Level Management Plan.

7.3.7 Option II also appears to offer significant benefits to nature conservation since the arable land would be replaced by freshwater grazing marsh (the objective of the ESA scheme). Again, however, there are large uncertainties about the time needed to achieve a stable condition and about the behaviour of an essentially undrained (and therefore potentially stagnant) system. This would not meet the long term objectives of the Water Level Management Plan.

7.3.8 Option III would probably lead to little change within the area drained by Mockett's Sluice, but would not meet the long term objectives of the Water Level Management Plan.

7.3.9 Option IV would lead to little change in conditions within the area drained by Mockett's Sluice though flooding should be less frequent. The problems associated with low water levels and rapid level fluctuations in Capel Fleet would continue. Regular dredging of the outfall channel would have significant disadvantages due to the likely physical disruption and impact on the benthic flora and fauna. This would not meet the long term nature conservation objectives of the Water Level Management Plan.

7.3.10 Option V would offer long-term benefits as a result of the improved flexibility of operation, particularly due to the avoidance of the low water level and rapid level fluctuation problems referred to above. This option would be capable of meeting the overall objectives of the Water Level Management Plan.

7.3.11 Conditions within the area draining to Mockett's Sluice would be largely unchanged by Option VI, which would not give the increased flexibility of operation associated with Option V. There would be major dis-benefits associated with the construction of the outfall pipeline across the foreshore. This would not meet the objectives of the Water Level Management Plan.

The Human Environment

7.3.12 The impact of Option I on the human environment would be very great, involving the large scale abandonment of land, damage to existing infrastructure and possible loss of sites of archaeological interest. There may be some increase in recreational value depending on the access facilities. This would not meet the objectives of the Water Level Management Plan.

7.3.13 Option II would also have a major impact on the human environment, probably involving significant loss of capital investment on the part of the current landowners or occupiers. Some individuals may be unwilling to convert from an arable to a grazing regime due to lack of livestock experience and may therefore be forced to sell their land, at a much lower price than they would expect to obtain if it was in arable production. This would be offset to some extent by the increased interest of the area to bird watchers and wildfowlers. This option does not meet the overall objectives of the Water Level Management Plan.

7.3.14 Option III would increase activity and disturbance around Mockett's Sluice because of the need for daily visits to refuel and maintain the temporary pump. This would not meet the overall objective of the Water Level Management Plan.

7.3.15 Options IV, V and VI would lead to small improvements to drainage and flood control, so improving the quality of the land, but would have no other significant effect.

Overall Impact

7.3.16 Overall, the environmental benefits associated with both Options I and II appear to be outweighed by the environmental disadvantages. This is particularly the case with Option I. With Option II the balance between advantages to nature conservation and disadvantages to the human environment is more difficult to draw. With regard to the remaining options the differences are largely associated with nature conservation. The improved flexibility of operation offered by Option V and the increased dredging of the saltmarsh associated with Option IV are both seen as environmental disadvantages whereas the periodic flooding which is associated with Option IV and the ability to maintain high, stable water levels in spring with Option V are seen as environmental advantages. As a result, it is considered that Option V best meets the environmental objectives of the Water Level Management Plan.

7.4 The Economic Case

7.4.1 The economic costs and benefits of each option are described in Chapters 5 and 6 and presented in Table 8. This table also shows the overall benefit-cost ratios for each option and the incremental benefit-cost ratios, where these can be calculated.

7.4.2 The very high benefit-cost ratio of Option II is because this Option safeguards the economic value of the land for agriculture and amenity but does not satisfy the requirements of the WLMP. Option V has an incremental benefit cost ratio of 5.11. The remaining Options III, IV, and VI are all economically unviable with increasing costs for no extra benefits.

7.5 The Preferred Option

7.5.1 Consideration of the technical and environmental cases suggests that the main choice is between Option IV (Renew Mockett's Sluice and continue dredging) and Option V

(New pumping station). Although there are some environmental benefits to be gained from Option IV due to the periodic flooding, these need to be weighed against the dis-benefits associated with dredging the outfall channel and the benefits of improved water level control, as required by the Water Level Management Plan, given by Option V.

7.5.2 For the Environment Agency as an operating authority, there are clear benefits with the more certain conditions and costs associated with a pumping station (Option V). The need for regular dredging with a new gravity sluice (Option IV) will mean that any saving in initial capital cost will inevitably commit the Agency to a high level of revenue expenditure and staff time involvement to ensure the gravity sluice remains an effective drainage outfall.

7.5.3 Conservation interests are divided whether a pumping station will cause an improvement or deterioration in the conservation value of Capel Fleet. A pumping station, with its greater flexibility, clearly provides more opportunity for both environmental enhancement and deterioration. If a new gravity outfall is built there is unlikely to be any environmental deterioration within Capel Fleet though Bells Creek will suffer significantly due to the annual dredging. There are also unlikely to be opportunities for enhancement unless poor drainage leads farmers to change from arable to grazing.

7.5.4 The Internal Drainage Board and local farmers both strongly favour a pumping station. They correctly see that a pumping station will give them more reliable drainage and so allow them to manage their land more effectively with lower risks of flood damage. A pumping station also offers the flexibility to meet the objectives of the Water Level Management Plan.

7.5.5 The choice on technical and environmental grounds between a new pumping station and a new gravity outfall is difficult, but in the longer term, maintaining a gravity outfall is likely to become progressively more difficult as Bells Creek continues to silt up and as sea level rise increases the period when a gravity outfall is tidelocked. Once the economic case is taken into consideration as well, the argument for adopting Option V becomes very strong. The conclusion of this feasibility study therefore is that as major works are essential, this is the appropriate time to make the change from gravity to pumped drainage. This would also facilitate the full implementation of the Water Level Management Plan for the Capel Fleet Area.

Table 8. Benefit Cost Ratios of Options

	Present Value £,000's					
	I Do Nothing	II Abandon Outfall	V Pumping Station	VI Long Outfall	IV Gravity Outfall	III Temp. Pumping
Benefit	0	3719	7525	7261	7261	7135
Incremental Benefit	0	3719	3806	neg	0	neg
Cost	0	179	923	1191	1261	1263
Incremental Cost	0	179	744	268	70	2
Benefit/Cost Ratio	-	20.8	8.15	6.1	5.76	5.65
Incremental Benefit/Cost Ratio	-	20.8	5.12	neg	0	neg

** Does not meet WLMP objectives

8 THE PROPOSED SCHEME

8.1 The proposed scheme is Option V, a pumping station at Mockett's Sluice. This option, coupled with additional water level control structures, provides the most reliable and economic means by which the current objectives of the Water Level Management Plan can be achieved. In addition, a habitat enhancement area is proposed on land adjacent to the Fleet which will provide additional habitat and shelter for nesting birds and other fauna on the Fleet.

8.2 Proposed structures

8.2.1 The proposed improvements to the Mockett's Sluice outfall comprise a new pumping station, associated delivery pipework, a new outfall structure and two level control weir structures across the Capel Fleet to maintain water levels in accordance with the Water Level Management Plan.

8.2.2 The proposed pumping station comprises a two bay sheet piled intake structure with concrete base slab, close coupled pumps with submersible motors, switchboard enclosure and an operational vehicle standing area. Twin discharge pipes with sufficient flexible joints will connect the intake structure to the outfall tidal flat valve discharge structure. A chain link fence with three strand barbed wire and concrete posts will be erected around the pumping station to provide a secure enclosure. A double gate will be provided for vehicular access together with a single personnel access gate.

8.2.3 The plan and general arrangement of the pumping station, discharge pipework and outfallstructure are shown in drawings 5222-01 to 5222-07.

8.2.4 The maintained water levels in the Capel Fleet have been identified as being between +0.6 and +0.8m AOD; the working level for the pumping station has therefore been set at +1.60m AOD, with an entry floor invert level of -1.20m AOD and a sump invert level of -2.2m AOD. (See drawing 5222-03)

8.2.5 The two level control structures will comprise sheet pile walls across the Capel Fleet, with concrete capping beam and central adjustable stop board openings to control upstream water levels. Access to the stop boards will be along the top of the capping beam, hand railing will be provided for this purpose.

8.2.6 The plan and general agreement for weir 1 are shown on drawing 5222-05 and for weir 2 on drawing 5222-06.

8.3 Proposed habitat enhancement

8.3.1 A habitat enhancement area, comprising reeds and islets, is proposed adjacent to Capel Fleet on Mr Maceldon's land. These proposals are subject to final agreement between Mr Maceldon and the Environment Agency's estates office and cannot therefore be finalised.

8.3.2 These are currently outline proposals and further investigative work will be carried out to finalize the arrangements for the creation of this enhancement. The outline proposals are intended to provide additional shelter and breeding areas for important bird species such as the Marsh Harrier, as well as improving the habitat diversity of the Capel Fleet corridor. Overall, this feature will benefit the conservation value of the study area.

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 The overall conclusions of the Regional Engineer's report may be summarised as follows:-

(I) The Capel Fleet drains some 1520 ha of low-lying land, largely devoted to arable agriculture and grazing, to the Swale Estuary.

(ii) The collapse of the existing structure at Mockett's Sluice requires major works to maintain the drainage of Capel Fleet and to meet the overall objectives of the Water Level Management Plan.

(iii) There were a number of problems associated with poor drainage in the Capel Fleet area prior to the collapse of Mockett's Sluice:-

- regular water-logging and reduction of yield in areas draining by gravity into the Fleet;
- periodic over-topping of the Fleet banks leading to enforced shut-down of the pumps draining the remaining areas (some 70% of the total area);
- the need for additional pump capacity at Mockett's Sluice to drain flooded land in wet winters.

(iv) These problems were caused by inadequate capacity of Mockett's Sluice due to tide locking and siltation in the outfall channel to seaward.

(v) The area around the Capel Fleet is of great environmental interest. The Fleet corridor is a Site of Special Scientific Interest (SSSI) and lies within the Swale Special Protection Area (SPA) and Ramsar site. Part of the area has been designated a National Nature Reserve and the whole area lies within the North Kent Marshes Environmetally Sensitive Area (ESA) and the North Kent Marshes Special Landscape Area (SLA). There are a number of sites with archaeological potential in the area although none have yet been designated as Scheduled Ancient Monuments.

(vi) A number of ways of overcoming the drainage and flooding problems in the area are possible. Preliminary examination suggested the following should be considered in some detail:-

Option I	Do nothing
Option II	Abandon Sluice
Option III	Continue temporary pumping
Option IV	Renew Mockett's Sluice and continue dredging
Option V	New pumping station
Option VI	Long Outfall through saltmarsh

(vii) Assessment of the technical, environmental and economic aspects of each option indicates the choice lies between Option IV and Option V. Both

options would meet the objectives of the Capel Fleet Water Level Management Plan.

(viii) The conclusion of this report is that the construction of a new pumping station to replace the existing collapsed Mockett's Sluice is the best way forward. A new pumping station has a higher initial capital cost but lower and more predictable running costs than a new gravity sluice which would commit the Environment Agency to regular dredging of Bells Creek. The preferred option has an overall benefit cost ratio of 8.15 and an incremental benefit cost ratio of 5.12, which are significantly higher than those of the alternative options.

(ix) A pumping station would satisfy the objectives of the Water Level Management Plan to sustain the existing environmental value of the Capel Fleet.

9.2 The recommendations of the report are as follows:-

(I) Construct a new pumping station of $1.5m^3/s$ capacity at Mockett's Sluice together with water level control structures across Capel Fleet as recomended by the Water Level Management Plan, at an estimated capital cost of £317,000.

(ii) Implement the monitoring and review proposals presented in the Water Level Management Plan for the Capel Fleet Area.

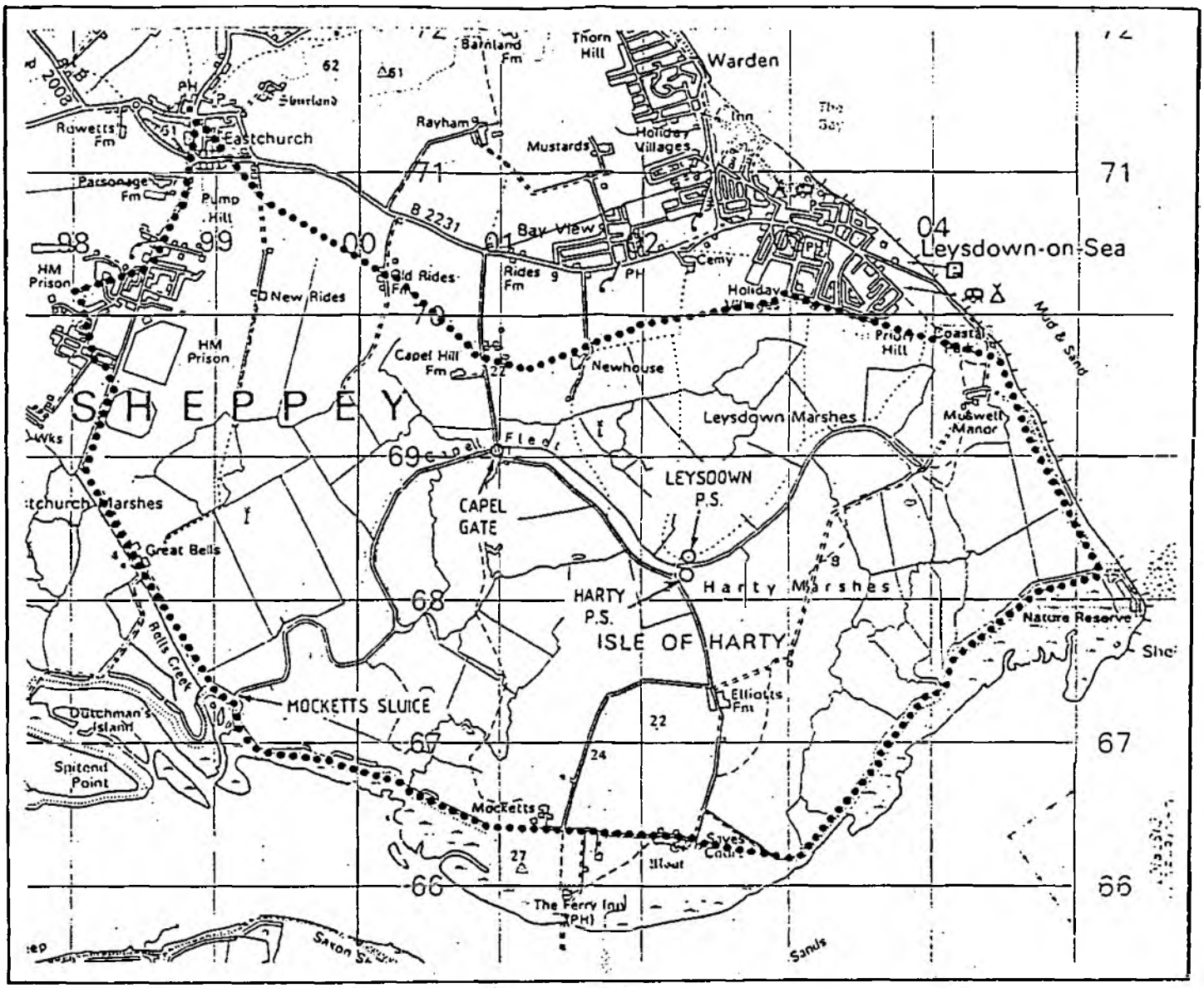

Figure 1. Location plan