Interim Report R&D Project 0317

River Maintenance Evaluation

Silsoe College
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R&D ~~306~~/4/ST
317

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CHAPTER 1

INTRODUCTION

1.1 Background

The first Interim Report, (R&D 306/3/ST September 1992) provided the background to this River Maintenance Evaluation Project. The project commenced in March 1992 with Stage I, the baseline survey. The objective of the baseline survey was to collect information on channel hydraulics, land use, conditions of flooding and waterlogging and points of environmental interest prior to the river maintenance work. This has now been completed.

Stage II of the study began in October 1992 with the second set of site visits. This stage involves the ongoing monitoring and evaluation of sites post-maintenance over three farming years. Where the scheduled maintenance work has taken place, the post-maintenance field surveys have been completed. In the case of Braunton Marsh and the Hilton Brook where maintenance work has not been carried out in 1992, the farmer surveys were still undertaken.

The final stage of the project, Stage III, comprises data analysis and formulation of guidelines for the appraisal of river maintenance.

1.2 Aims and Objectives

The aims and objectives of the study are detailed in the first Interim Report, (R&D 306/3/ST). Stage II will involve the ongoing monitoring of the 12 selected sites over a three year period.

The objectives of Stage II are :-

1. To assess the impact of river maintenance on drainage conditions, farming practice and performance.

2. To assess the changes in river characteristics following river maintenance.

3. To identify the impacts on environmental and related features.

1.3 Report Structure

The aims, objectives and methodology of Stage II are summarised in this report. The second chapter summarises the data requirements and methods of collection. The impact assessment of changes in water table depth are also discussed.

A summary of the river maintenance work on the 12 sites is presented in the third chapter. The benefit area is discussed in chapter four whilst chapter five deals with sedimentation and erosion modelling. The phasing of the next stage of the work and financial details are presented in chapter six.

CHAPTER 2

DATA REQUIREMENTS, COLLECTION METHODS AND IMPACT ASSESSMENT

2.1 Introduction

The data requirements are the same as those in the baseline survey. Data has been collected on land use and management, channel hydraulics, climate and the environment.

2.2 Data Requirements and Collection Methods

2.2.1 Agricultural Data

This first site visit within Stage II enabled a more thorough discussion with some farmers to update the data from the baseline surveys and to clarify the area of benefit.

A questionnaire (Appendix I) provided the basis for a structured discussion with farmers who have land within the benefit area. Detailed information was collected on land use over the summer and autumn period of 1992.

2.2.2 Hydrological Data

Flow data from gauging stations and water level readings from gauge boards are being collected on a regular basis and stored in a database. Where data are available, flow exceedence curves are being produced and flood return periods calculated.

Details concerning any flood events since the last site visit, together with information on land drainage conditions were obtained from the farmer questionnaires.

2.2.3 Climatological Data

Daily rainfall records and evapotranspiration values are being collected from the nearest meteorological station to each site. This information is being collated and stored in a data base. Long term rainfall records are being analysed to assess the probability of experiencing a wet, dry or average spring, summer and autumn.

2.2.4 Environmental Data

The English Nature River Corridor Survey has been repeated for each reach following the maintenance work to enable the situation pre- and post-maintenance to be compared. Farmers views on the environmental impact of the river maintenance work were obtained through general discussions.

2.3 Impact Assessment Methods

The impact of maintenance operations on channel dimensions, water table levels, flooding, land drainage and agriculture are being monitored through site survey and computer modelling.

2.3.1 Hydrological Impacts

Channel capacities and stage/discharge curves for the pre-maintenance situation have been calculated using survey data provided by the NRA engineers, (see Appendix II for example). In the case of the sites where desilting is taking place, the cross-sections will be re-surveyed at the same points as the pre-maintenance sections to enable a comparison of capacities and stage/discharge relationships to be made.

2.3.2 Groundwater Impacts

The principals of the 'Freeboard Model' were outlined in the first Interim report, (R&D 306/3/ST Appendix 5). This water table model will be used to assess the influence of river and ditch water levels on water table levels and thereby the drainage status of land within the benefit area.

Three water table levels have been defined in terms of agricultural productivity levels. The water table depth and corresponding drainage condition and level of productivity are set out below:-

Table 2.3.2.1 Drainage Standards and Agricultural Productivity Levels

Production level	Water table level (m below surface)	Land drainage condition
normal	> 0.5	good
low	0.3 - 0.5	bad
breakdown	< 0.3	very bad

The model will be modified to suit local conditions for each of the 12 sites and will be run for each block of land within the benefit areas. An example of the input required for each block within the benefit area is shown in Appendix III.

The output takes the form of graphs, detailing rainfall levels, evapotranspiration values and water table depths for each week of the study, (see Appendix III). The number of weeks land is under normal, low and breakdown conditions of productivity can be determined from these graphs.

2.3.3 Flooding Impacts

Flood frequency and area inundated will be used to assess the impact of flooding. The flood frequency will be determined by using the peaks over threshold method in which the number of times flow exceeds bank-full capacity will be calculated. The peaks over threshold values will be plotted using the Gringorten Scale.

The flooded area will be calculated using information on flood plain topography and reports from farmers on areas inundated and flood frequency. The area inundated is proportional to the flood magnitude in lowland valleys which have a wide, flat flood plain. The majority of sites within the study have this type of flood plain and a close relationship between flood magnitude and area flooded can be assumed.

2.3.4 Agricultural Impacts

The three production scenarios (normal, low and breakdown) will effect the agricultural financial impact assessment. SCADE (Silsoe College Agricultural Drainage Evaluation Model), will provide the basis for determining the financial returns associated with good, bad and very bad drainage. Appendix IV provides details of the input and output costings calculated within SCADE.

Differences in financial returns attributed to different drainage conditions indicate the benefits of maintaining drainage status at a given level and thus avoiding losses due to deteriorating drainage conditions.

The results can be extrapolated beyond the study period to determine the benefits of river maintenance under average, wet or dry climatic conditions.

CHAPTER 3

RIVER MAINTENANCE SUMMARY

3.1 Work Programme

The table below (Table 3.1) indicates the type of maintenance work which has been performed or is scheduled to take place on the 12 study sites within the current financial year, (before the end of March 1993).

Table 3.1 Maintenance Programme

Watercourse	Maintenance Type	Date of Work
River Sence	weed clearance desilting	Aug. 1992 as required
Hilton Brook	weed clearance	none 1992
River Wampool	weed clearance	Aug./Sept. 1992
Broadfleet/Pilling Water	weed clearance	Aug./Sept. 1992
River Yarty	tree & bush	Sept. 1992 & ongoing
Braunton Marsh	weed clearance	within 1992-93 financial year
River Arrow	tree & bush	Sept./Oct. 1992
Drenewydd/Broadway Reen	weed clearance desilting	Nov. 1992 in 1992-93 financial year
Dysynni Low Level Drain	weed clearance	July/Aug. 1992
Woldgrift Drain	weed clearance	Aug. 1992
River Yare	weed clearance desilting	Aug. 1992 within 1992-93 financial year
River Wensum	weed clearance	July/Aug. 1992

River maintenance work has been completed on seven of the 12 selected sites at this time and has begun on a further one, the River Yarty. On the River Yarty, the tree and bush maintenance work is following an ongoing programme and will be completed over the following year. At the present time 500 m has been maintained working downstream from Long Bridge, the upstream limit of the study reach.

In the case of the Drenewydd/Broadway Reen and River Yare weed clearance has taken place but the desilting has not. This has been included in the work programme and is scheduled to take place within the next few months.

The reason for the delay on the River Yare is that discussions are still taking place between various bodies concerning the diversion of the river through the Bawburgh/Colney gravel workings. A large single lake for recreation purposes is proposed. The river will have to be diverted to accommodate this change. The project has received approval in principle and it is proposed to carry out the channel diversion and desilting at the same time.

The weed clearance scheduled for Braunton Marsh has not taken place as yet but is included within the work programme and should be performed before the end of the current financial year.

Desilting on the River Sence is carried out as required and is not included within a regular work programme. The emphasis is changing from regular desilting towards annual weed clearance in an attempt to reduce the need for desilting work.

In the case of the Hilton Brook, no river maintenance work has been performed or is scheduled for 1992-93 financial year. The reason for this is that water levels have remained low and weed growth has been limited.

All the weed clearance has been performed using a Bradshaw Bucket and on the Woldgrift Drain using a weed boat. All the rivers on which weed maintenance has been performed have had their banks flail mown.

3.2 Timing of Maintenance Works

The timing of maintenance activities is largely dependent upon the nature of the work. Weed clearance is performed towards mid to late summer when the growth is at its peak. By following this pattern, re-growth after the cut is minimal as the growing season is drawing to a close.

Land use of the fields adjacent to the watercourse also determines the timing of operations. Where arable fields are planted right up to the river bank such as along parts of the Woldgrift Drain, access to the river is restricted until after the harvest.

Tree and bush maintenance work can take place throughout the year but is easier in autumn and winter when the amount of biomass to be removed is reduced through lack of leaves However, at this time water levels are usually higher and so if access is required from the river bed maintenance operations may be delayed until lower flow conditions prevail.

CHAPTER 4

BENEFIT AREA

4.1 Introduction

The benefit area is the area of land deriving a benefit from the river maintenance in terms of its effect on land drainage and flooding. The size of the benefit area depends upon local topography, drainage network and the nature of the maintenance work.

4.2 Benefit Areas

The benefit area of each site has been delineated through discussions with farmers on land drainage condition and flood areas and through site survey.

The size of the benefit area for each scheme is listed in Table 4.2.1 below.

Table 4.2.1 Size of Benefit Area

Scheme	Size of Benefit Area (ha)	Area of BA Surveyed (ha)
R. Sence	132	132
Hilton Brook	94	94
R. Wampool	173	173
Broadfleet/Pilling Water	150	142
R. Yarty	91	70
Braunton Marsh	242	207
R. Arrow	285	285
Drenewydd/Broadway Reen	279	216
Dysynni Low Level Drain	297	206
Woldgrift Drain	267	267
R. Yare	98	98
R. Wensum	41	41

The schemes with the largest benefit area such as the Dysynni Low Level Drain and Braunton Marsh correspond to the areas which have a large wide flat flood plain. In addition to the low lying nature of the area, the benefit area of these two schemes is further increased by the complex nature of the inter-connecting drainage system. The maintenance

work on the main river channel can effect drainage and flooding conditions over a wide area due to the 'backing up' effect of water in the drainage ditches. Water levels in ditches and channels draining into the main river are artificially controlled with sluice gates.

On the River Yarty for example, the benefit area is closely confined to the vicinity of the channel due to the nature of the topography.

CHAPTER 5

SEDIMENTATION AND EROSION MODELLING

5.1 Introduction

Hydraulics Research Ltd (HR) have been contracted by Silsoe College to provide additional information to support the River Maintenance Evaluation Project. The first phase of their input has been completed.

5.2 Objectives

The main objective of the HR work is to provide methods for predicting the effect of river maintenance activities on river morphology and the hydraulic performance of the channel.

The rates of river morphological change following river maintenance and the longevity of maintenance procedures will also be investigated.

5.3 Aims

The specific aims of the work are :-

1. To develop a broad typology for rivers.

2. To predict sediment movement, deposition and erosion due to cross-sectional changes.

3. To investigate the relationship between vegetation cutting and sedimentation using changes in channel roughness.

4. By means of an idealised channel model to create guidelines for maintenance work.

5. To apply the guidelines to specific sites using data collected in stage I and II.

The typology of rivers has now been developed and tables detailing the morphological impacts of maintenance work produced. A copy of HR's interim report has been placed with the NRA Project Leader.

The remaining part of HR's input will address the temporal and spatial aspects of vegetation cutting, partial cutting and no cutting practices.

CHAPTER 6

PHASING AND PLANNED PROGRESS

6.1 Phasing of the Study

The monitoring of each site will continue with repeat site visits at the beginning (spring) and end (autumn) of each farming year.

Data analysis and modelling will proceed in order to generate relevant databases and benefit scenarios. Literature and secondary data sources will be continually reviewed.

6.2 Financial Details

Details of actual expenditure under the R&D Project 0317 are presented in Appendix V. The budget values have been updated in accordance with the contractual terms, following the RPI values of 130 in January 1991 and 135.6 in January 1992, (inflation rate 4.3 %). Table V(i) details actual expenditure within the third quarter of the current financial year, to 31/12 92.

A record of the cumulative spending costs to 31/12/92 are presented in Table V(ii), and an estimate of spending from 1/1/93 to 31/3/93 is given in Table V(iii).

All spending costs are recorded under the same categories to aid comparison and for ease of accounting. These categories are staff, travel and subsistence, consumables and reporting costs.

APPENDIX I

FARMER SURVEY

FARMER SURVEY

AUTUMN 1992 - POST MAINTENANCE

River

Farm Code

Flooding / Waterlogging

Flooding / Waterlogging since last visit?

Field number, duration etc.

Reacton to River Maintenance

What are your feelings on the maintenance work?
- unnecessary
- too severe
- about right
- not sufficient

Do you feel alternative measures could have been taken?

What are your feelings on the consequences of maintenance activities?
eg. machinery on land, spoil etc.

- strongly opposed
- accept as part of the job

Do you feel alternative measures could be taken?
If so, what?

Field details

Field number

Crop 1992
Crop 1993
Expected yield
Actual yield

Reason for difference
- climate
- pests / disease
- Change in land management
- other (please specify)

Stock

Field number

Type
Turnout date
Yarding date

Main factor influencing turnout / yarding dates:-
- state of land
- shortage of feed
- earliest possible date
- traditional date
- turned out after lambing

Grass Conservation

Nitrogen rate

Main reason for nitrogen rate?
- climate
- grazing / conservation strategy
- soil type
- set policy
- environmental conservation scheme eg. ESA

Who selects nitrogen rate?
- Yourself
- ADAS advisor
- manufacturers advice
- Government eg. env. scheme restricts use (ESA etc.)

Hay / silage

Field number

Number of cuts hay / silage

Date stock taken off land

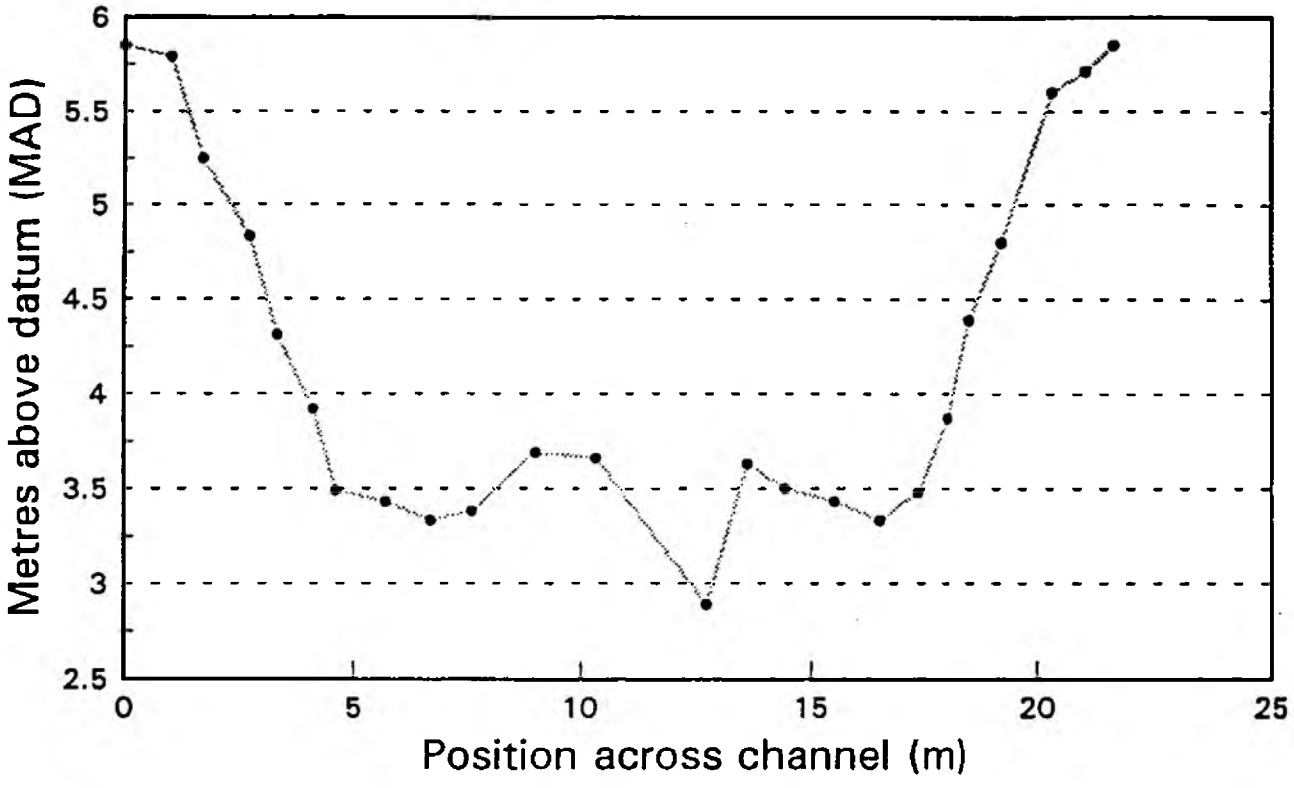
Date of 1st cut

APPENDIX II

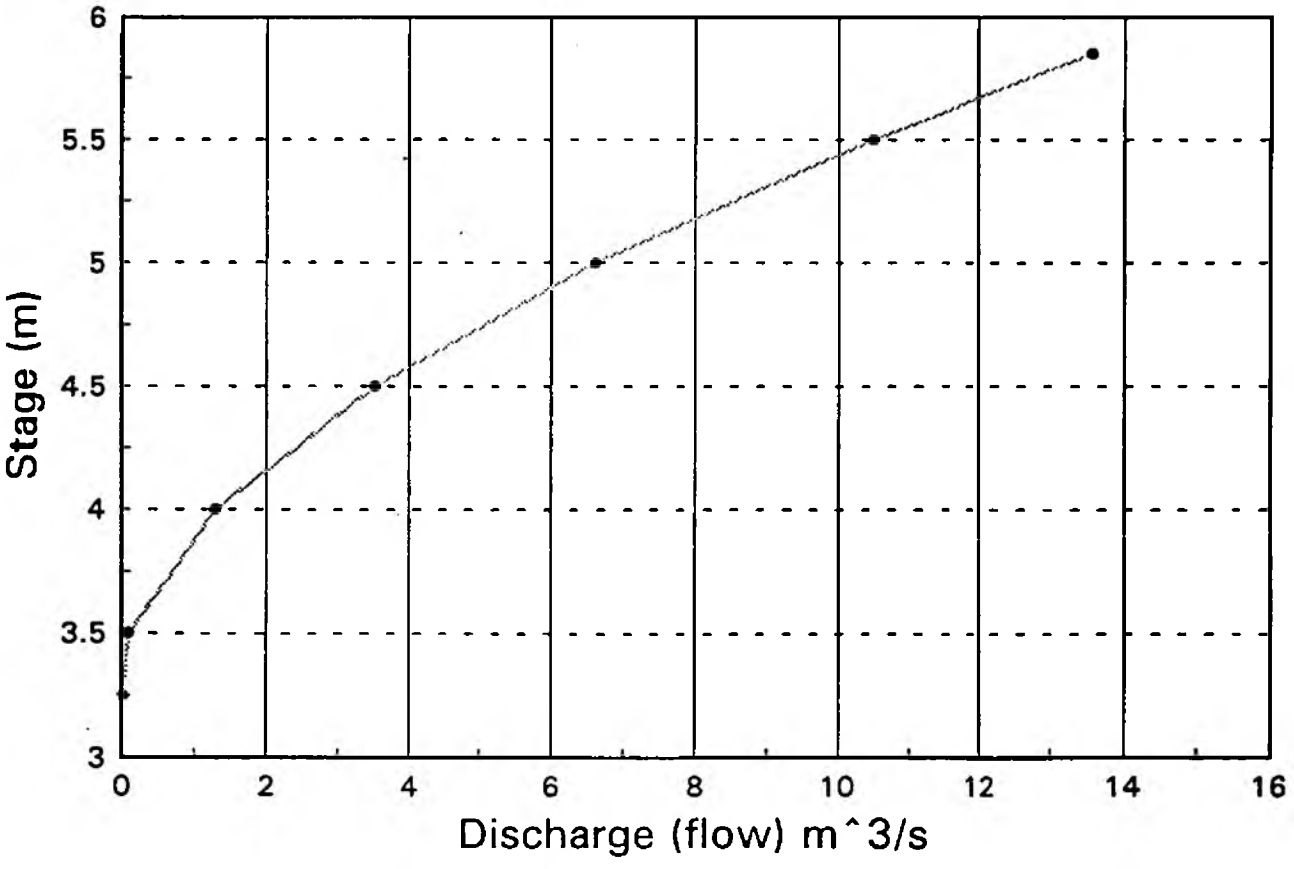
CHANNEL CAPACITY & STAGE/DISCHARGE CURVE

River Wampool

Cross-section 1 Chainage 0 m



Stage/Discharge Curve



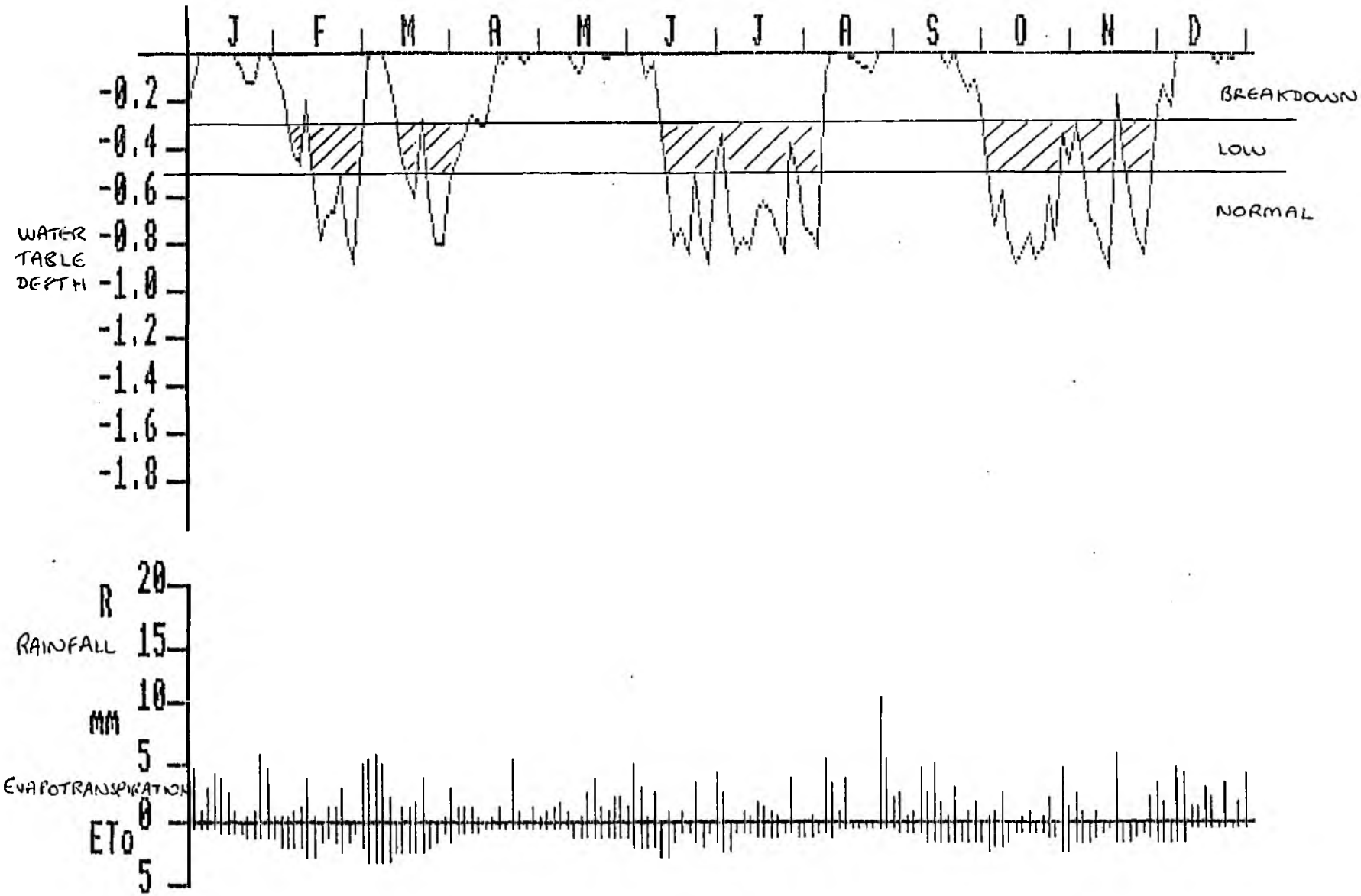
APPENDIX III

WATER TABLE MODEL INPUT & OUTPUT

INPUT DATA FOR WATER TABLE MODEL

Ditch spacing (m)
Depth to impermeable layer (m)
Geometrical factor for ditch system
Initial water table depth (m)
Hydraulic conductivity of topsoil (m/day)
Hydraulic conductivity of subsoil (m/day)
Soil boundary depth (m)
Topsoil specific yield (m/m)
Subsoil specific yield (m/m)
Unsaturated hydraulic conductivity exponent
Surface elevation (m AOD)
Ditch base elevation (river bed level) (m AOD)
Set ditch base water levels? 1 = yes, 0 = no
Is there irrigation? 1 = yes, 0 = no
Draw ditch water levels? 1 = yes, 0 = no

SAMPLE OUTPUT FROM WATER TABLE MODEL



APPENDIX IV

SCADE COSTINGS

RIVER WAMPOOL

Block code.....301.00	Block Size (Ha).....23.60
Site Class.....GOOD	Scenario.....INCREASED STOCKING
Flood Area (%).....35.00	
Flood Frequency (Pre).....1.00	Flood Duration.....ONE WEEK OR LESS
Flood Frequency (Post).....1.00	Flood Duration.....ONE WEEK OR LESS

PRE-SCHEME

CROP TYPE.....GRASS	No. of Years.....0
Drainage Class.....SP	Nitrogen Level (Kg/Ha).....0
No. Cuts.....0	Conservation System.....NONE
Fixed Costs (Pasture).....SEMI	Fixed Costs (Cons.).....NONE
Grass Type.....PERMANENT	Ley Length (years).....0
Stock Type.....DAIRY COWS (MED)	Weighting Factor.....1.00
Fixed Costs (Labour).....SEMI	Fixed Costs (Machinery).....SEMI
Fixed Costs (Buildings).....SEMI	
Start of Grazing.....MID TO LATE APR	End of Grazing.....MID TO LATE OCT
Recurrent Extras (Ha/Yr).....0	

POST-SCHEME

CROP TYPE.....GRASS	No. of Years.....0
Drainage Class.....SP	Nitrogen Level (Kg/Ha).....0
No. Cuts.....3.00	Conservation System.....SILAGE
Fixed Costs (Pasture).....SEMI	Fixed Costs (Cons.).....SEMI
Grass Type.....PERMANENT	Ley Length (years).....0
Stock Type.....DAIRY COWS (MED)	Weighting Factor.....1.00
Fixed Costs (Labour).....SEMI	Fixed Costs (Machinery).....SEMI
Fixed Costs (Buildings).....SEMI	
Start of Grazing.....MID TO LATE APR	End of Grazing.....MID TO LATE NOV
Recurrent Extras (Ha/Yr).....0	One-off Extras (total).....0

Silsoe College Agricultural Drainage Evaluation Model
Version 4.1 (IBM Compatible)
May 1987

RIVER WAMPOOL

BLOCK No. : 301 BLOCK SIZE : 23.6Ha. 1991/92 Financial Prices

CROP TYPE	YIELD	GROSS MARGIN	FORAGE V.COST	GRASS F.COST	ST/CRP F.COST	EXTRA (+/-)	NET RETURN	FLOOD COST
Pre-Scheme								
DAIRY	18259	409.81	7.90	0.00	104.43	-12.93	284.51	1.78
Average		409.81	7.90	0.00	104.43	-12.93	284.51	1.78
Post-Scheme								
DAIRY	23421	525.68	7.90	35.42	134.02	-10.68	317.66	2.95
Average		525.68	7.90	35.42	134.02	-10.68	317.66	2.95

Silsoe College Agricultural Drainage Evaluation Model
Version 4.1 (IBM Compatible)
May 1987

APPENDIX V

FINANCIAL DETAILS

TOTAL EXPENDITURE

NRA River Maintenance Evaluation
Total for 1991/92
Actual expenditure to 31/12/92

		actual	budget	variance
Staff				
J Morris	17	8567.7		
D C Sutherland	70	8212.14		
J A L Dunderdale	260	24072.26		
E Youngs	3	900		
P B Leeds-Harrison	0			
Staff total		41752.1	47114	5361.9
Other Costs				
Travel and subsistence		13013.5	11370	1376.5
Consumables		6254.27	2050	-4204.27
Reporting		746	821	75
Total other costs		19013.77	16241	44361.23
Total		60765.87	63375	2609.130
Cumulative Spend.		66338.45	73923.87	9585.42

(updated according to inflation rate 4.3 % & RPI at 130 Jan. 1991
& 135.6 Jan. 1992)

Actual Expenditure to 31/12/92

NRA River Maintenance Evaluation
Quarter 3
Actual expenditure to 31/12/92

			actual
Staff			
J Morris	312.9	3	938.7
	(arrears)		129
D C Sutherland	121.62	0	0
	(arrears)		50.14
J A L Dunderdale	121.62	30	3648.6
	(arrears)		601.66
E Younge	312.9	0	0
P B Leeds-Harrison	312.9	0	0
Staff total			5368.1
Other Costs			
Travel and subsistence			564.5
Consumables			100
Reporting			271
Total other costs			935.5
Total			6303.6
Cumulative Spend.			61916.91

ESTIMATED EXPENDITURE

Antipicated Expenditure to 31/3/93

NRA Maintenance Evaluation
Quarter 4
Anticipated expenditure to 31/3/93

			actual
Staff			
J Morris	312.9	3	938.7
D C Sutherland	121.62	0	0
J A L Dunderdale	121.62	16	1945.92
E Younge	312.9	0	0
P B Leeds-Harrison	312.9	0	0
Staff total			2884.62
Other Costs			
Travel and subsistence			399
Consumables			24
Reporting			50
Total other costs			472
Total			3356.62