Hydraulics Research
Wallingford

FLOOD DISCHARGE ASSESSMENT

Current UK Practice

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Report No SR 111
February 1987

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SUMMARY

Hydraulics Research Limited, funded by the Ministry of Agriculture, Fisheries and Food, are studying methods of improving flood discharge assessment with the co-operation of the Water Authorities of England and Wales.

This interim report outlines the methods currently adopted by the Water Authorities in measuring flood discharges and the uncertainties associated with these measurements based on replies received by Hydraulics Research Limited.

Proto-typical and experimental work is highlighted that confirms the need for greater accuracy in flood flow measurement. A brief literature review relating to flow measurement and flood discharges is listed.

CONTENTS

1 INTRODUCTION

The Water Resources Act 1963 placed on the Water Resources Board the duty of collecting data relating to the demand for water and the actual and prospective water resources for England and Wales. Consequently, many gauging stations were primarily designed to establish the quantity of water available for the community. The provision of flood data was originally considered to be of secondary importance.

When a flow measurement structure or rated channel section is out-flanked by a flood flow the uncertainties associated with flow measurement rise from 3-10% for in-bank flow conditions to 30% or more for out-of-bank flood conditions. Uncertainties of this magnitude can have a profound impact on the return period associated through standard statistical techniques with a particular discharge. They may also lead to the design of a flood protection scheme being too conservative with associated economic losses, or alternatively inadequate with the benefits of the proposed scheme not being achieved.

Reporting upon the errors in Flood discharge measurement the Wolf Report (1985) stated:

"A research programme should be set up to develop new methods for measuring or estimating flow particularly over a flood plain. The objective of the project should be to produce a method which is inexpensive and effective and can possibly be applied after the event."

These recommendations formed the basis for the present study.

2 FLOOD DISCHARGE ASSESSMENT

The first step in the study was to write to all the Water Authorities in England and Wales, see Appendix 1. Their replies, contained in Appendix 2, have provided the basic information on techniques currently in use to assess or measure flood discharges as we report below.

The extrapolation of the rating curve for a gauging site or rated section is the method adopted most frequently to assess flood discharge. The types of rated section most commonly used including their advantages, disadvantages and approximate accuracy are detailed in Table 1.

TABLE 1: Type of rated section

Rated Section	Advantages	Disadvantages	Approx accuracy
Structure - weir, flume etc.	Discharge/water level relationship predictable in-bank flows	Discharge assessment restricted to flow in-bank	± 3-5%
Velocity - Area	Measurement of in-bank and over-bank flows. Accurately calibrated flow meters used	Dependent upon type of flow measuring exercise can be time consuming or influenced by channel and flow characteristics, i.e. silt, secondary flows, vegetation	± 5-10%
Slope - Area	Requires measurement of stage and cross-section only	Requires uniform channel section and accurate assessment of channel roughness and stage measurement.	± 15-20%
Bridge Arch/ Overspill embankment	Stage measurement only required	Non-standard structures calibrated theoretically	± 20-30%
		- calibrated using model	± 5-10%

In a majority of cases the extrapolation has been checked by an alternative means of determining the flow other than applying a purely theoretical extrapolation to the rating. These checks take many forms and indicate the diversity of methods employed in an attempt to determine flood flows. They can, however, be divided into two main categories, which we term direct and indirect methods.

Direct methods are objective, using instruments to measure flow, calibrate or check the calibration of rated sections. Flows are measured within the

boundary of natural sections or by confining the flow between artificially constructed embankments. Methods of velocity measurement are detailed in Table 2.

TABLE 2: Methods of velocity measurement

Measurement method	Advantages	Disadvantages	Approx accuracy
Rotating element current meter	Simple design, easily replacable	Prone to damage or blockage by debris	± 20% at 0.03m/s ± 5% at 0.10m/s ± 2% > 0.15m/s
Electro-magnetic current meter	Non-moving reading head	Calibration stability dependent upon size of instrument. Resolution dependent upon application	Field 300mV/1m/s Laboratory 1000 mV/1cm/s
Laser Doppler Anemometer	Non-moving reading head. Very high accuracy	Restricted to laboratory use	± 0.1%
Electro-magnetic gauging method	Non-intrusive in flow	Applicable to limited channel width. Accuracy dependent upon calibration method	± 10%
Ultrasonic gauging method	Non-intrusive in flow	Acoustic signal influenced by temperature gradients, secondary flow, suspended solids.	± 10%

Indirect methods of assessing extreme floods with the exception of modelling, are also based on observation in that they rely upon measuring wrack levels after the subsidence of a flood, surface debris velocity estimation, or photographs of flooded extent. The theoretical extrapolation of the rating curve for a gauging site is essentially an indirect method, see Table 3.

TABLE 3: Methods of assessing extreme floods

Method	Advantages	Disadvantages	Approx accuracy
Extrapolation of existing rating	Channel dimensions accurately surveyed Use of measured velocities of depths	Reliant in a small number of measured flows. Mean velocities or depths used in calculations. Ignores complex flow interaction under flood conditions.	±15-20%
Visual estimation	Observations taken from safe vantage point during flood or in case of wrack levels after flood.	Very subjective. Visual assessment of flow velocity with associated estimate of position within cross-section	±15-30%
Computational modelling	Based on accurate field data for in-bank flows. Extrapolation to out of bank flows using accurate level data.	Most models developed to assess flood discharges, one dimensional	Assessment difficult, see below
Physical modelling	Based on accurate field data for in-bank flows. Extrapolation to out of bank flows using accurate level data.	Models three dimensional though representation of flow processes in floodplains not necessarily proto-typical	Assessment difficult, see below

Assessing extreme flood discharges is difficult and prone to error. Accurately measured flood discharge information is sparse but comparing these few data with estimations based on extrapolations or visual observations indicates that the error in discharge assessment ranges from 15-30%.

The engineer using both computational and physical models of flood discharges, faces a different dilemma. Both models accurately represent in-bank flows after proving the model against field data. Frequently, however, for out-of-bank flows the model discharge for

a flood event disagrees with the proto-typical data even though the model has been calibrated against observed level information.

A brief resume of the methodology employed in proving models will illustrate the difficulty in resolving the differences between model and prototype discharges for flood events.

In respect of a physical model, once a model has been proved in-bank, roughness to simulate flood plain levels can generally only be added to represent local features i.e. hedgerows. A computational model is similarly proven in-bank. For out of bank flows the calibrated channel roughness is unchanged and the floodplain roughness and discharge coefficients, for flow over the banks are adjusted to produce the levels for a given event. Hence the calibration parameters depend upon the accuracy of the flood flow data.

It is when other flood flows are simulated that the main differences usually occur between the model and field observations. However, as can be seen from above there is little room for manoeuvre to accommodate the differences once a model has been proved. Consequently, whereas the accuracy of the proto-typical in-bank data is generally beyond doubt the accuracy of the out-of-bank data must often be questioned. It is this divergence between assessed and predicted discharge values that identifies the need to understand the flow processes involved in flood discharges and to develop one more accurate predictive method of assessing extreme floods.

Finally, Table 4 gives details of the methodology of flood discharge assessment adopted by individual water authorities along with an indication as to the estimated error of flood discharge measurement values

and the number of gauging sites or rated sections that are by-passed under flood conditions.

The Bibliography contains references relating to British and International Standards methods of flow measurement most frequently adopted in assessing flood discharges.

TABLE 4: Methods adopted by UK Water Authorities

Water Authority	Methods	Error	Problem sites
Anglian Water Colchester Division	Extrapolation of gauged rating. Theoretical calibration of bank depression as a rated spillway using broad crested weir analysis	± 20%	23
Anglian Water Norwich Division	Extrapolation of gauged ratings	-	Several
Anglian Water Oundle Division	Wrack levels Velocity estimates Photography Comparison of discharge Assessment with run-off totals and peak discharge rates from similar catchments	-	11
Northumbrian Water	Extrapolation of gauged rating. Examination of mean velocity/ stage relationship. Estimated mean velocity Applied to flood plain with allowance for reduced velocity outside main channel	± 15-20% at peak stage	6
Severn Trent Water	Cableway metering Ultrasonic technique Flood control embankments	-	Several
Thames Water	Current metering	-	5
Wessex Water Avon & Dorset	Extrapolation of gauged ratings. Rating of bridge structures	-	7
Wessex Water Bristol & Avon	Extrapolation of gauged rating. Model rating by consultants	-	15
Wessex Water Somerset	Flood flow gauging Wrack, debris levels Flood stage assessment Educated guess	-	7

3 FIELD AND LABORATORY WORK ON FLOOD DISCHARGES

The problem facing Water Authorities in assessing flood flows and for the consultants calibrating models based on field data was demonstrated by the physical model constructed to investigate the effect of the proposed A46 Newark relief road on flooding, see Hydraulics Research (1983). When proving this particular model under flood conditions it was necessary to increase the rated discharge of the River Trent by 13% and a tributary, the River Devon, by 134%.

The descrepancies in the original discharge estimates were caused by structures which were no longer operating under design conditions and to flows which by-passed the structures under flood conditions. At one of the structures the flow that by-passed it over the floodplain had been assessed by visual inspection of the flow width using binoculars. It is the use of such methods, often the only ones available at the time, that can lead to large errors in flood discharge assessment.

During major floods significant discharge occurs in both the main channel and along the floodplain flows. The effect of the interaction between these two components of flow on the total discharge has been identified in research work, Zheleznyakov 1965; Barishnikov, Ivanov and Sokolov 1971; Pasche, Evers and Rouve, 1983; Knight, Demetriou annd Hamed, 1984. Research work is continuing in an attempt to understand the mechanism of flow interaction and quantify its effect using the Science and Engineering Research Council Flood Channel Facility at Hydraulics Research. As part of this investigation a literature

search into the flow structure of open channels was sponsored by the Ministry of Agriculture, Fisheries and Food under the strategic research commission, 13A, at Hydraulics Research Limited; see Hollinrake, 1987.

The development of one dimensional flood routing models, such as the Hydraulics Research Limited FLUCOMP model of Samuels and Gray (1982) have accommodated flood discharge prediction to some extent, though some inconsistency still exists, Tagg (1985). These inconsistencies are mainly due to the description in the model of the interaction between channel and flood plain flow and that the physics of its change with stage and discharge is not bet fully understood. Future developments using information from the SERC Flood Channel Facility will enable computational models to predict stage discharge relationship to a higher degree of accuracy.

4 DEVELOPMENT OF NEW METHODS

The key objectives for any new method of assessing flood discharge are that:

(a) the method can be applied after the event,

(b) no appreciable afflux is caused by the method

(c) the method is cheap,

(d) the error in discharge assessment is not greater than ± 10%.

5 ACKNOWLEDGEMENTS

This work was sponsored by the Ministry of Agriculture, Fisheries and Food, as part of the strategic research commission, 13F, at Hydraulics Research Limited.

The authors carried out the work in Dr P G Samuels section in the River Engineering Department at Hydraulics Research, headed by Dr W R White.

The authors are grateful to the Hydrological and Hydrometric Engineers of the Water Authorities who have co-operated in supplying information regarding flood discharges and their measurement.

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A P P E N D I X 1

I Ramsden Esq
General Manager
Anglian Water
Oundle Division
North Street
OUNDLE
PETERBOROUGH
PE8 4AS

Our Ref : R/S/0013F

28 October 1986

Dear Mr Ramsden

FLOOD DISCHARGE ASSESSMENT

I am currently engaged on a research project, sponsored by MAFF, which is concerned with the assessment of flood discharges and the effect this has on flood ratings and the design of flood alleviation works. The aim of the project will be to produce guidelines, for use in the UK water industry, for the estimate or assessment of flood flows at gauging sites from data that can be obtained after a flood has receded. There is a need for such guidelines because of the difficulty of gauging large flows, especially when there is substantial flow on the flood plain which bypasses the recording site.

One important aspect of the project will be to identify the number of gauging sites where this problem exists, and the procedures or measures currently used by water authorities, if any, to overcome it. I would, therefore, be grateful if you could supply any information which may be relevant to this project; in particular, if you have sites where gauging or assessing flood flows is difficult or uncertain, and what methods you employ to improve the estimation of discharge.

It will also be necessary to identify and set up suitable experimental sites which will be monitored over several years, and which will be used to test alternative methods of discharge measurement, in conjunction with laboratory and computational models of the same area. Your co-operation in helping to identify possible sites within your control will be much appreciated.

I shall be happy to provide you with further information on this project if you require it, or to discuss any of the points raised above.

Yours sincerely

ANDREW F TAGG
River Engineering Department

A P P E N D I X 2

TEES DIVISION
P.O. Box 40
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Northumbrian Water

This matter is being attended to by

Your Ref R/S.0013F
Our Ref IMacM/JM
Date 30 October 1986

(1) WRW WRW
(2) PGS
(3)

Mr A F Tagg
River Engineering Department
Hydraulics Research Ltd
Wallingford,
Oxfordshire
OX10 8BA

Dear Mr Tagg

FLOOD DISCHARGE ASSESSMENT

Thank you for your letter of 28 October 1986 which I have forwarded to Mr. P Johnson at Northumbrian Water's head office at:

Northumbria House
Regent Centre
Gosforth,
Newcastle upon Tyne
NE3 3PX

Mr Johnson as Head of Operations Investigations is responsible for the river gauging stations in our area and the assessment of flood flows. He is therefore in a better position to assist with the information you request.

I wish you well with your work particularly as we have recently had some difficulty in analysing the effects of a peak flow in the River Tees.

Yours sincerely

I MacMILLAN
Divisional Operations Manager

Anglian Water

MARTIN ELDER OPERATIONS MANAGER
CAMBRIDGE DIVISION

Great Ouse House
Clarendon Road
Cambridge CB2 2BL
Tel: Cambridge (0223) 61561

Our Ref PMS/VMP/702/1

Your Ref

This matter is being handled by P M SONES

MR A F TAGG
RIVER ENGINEERING DEPARTMENT
HYDRAULICS RESEARCH LIMITED
WALLINGFORD
OXFORDSHIRE
OX10 8BA

Date 31 OCTOBER 1986

Dear Andrew

FLOOD DISCHARGE ASSESSMENT

Thank you for your letter of 28 October 1986.

We are very interested in your flood discharge assessment research project and would like to cooperate with your work. As you know from the Great Ouse Drainage System Model project a few of our recording sites produce poor data during flood events.

I will prepare a comprehensive list of sites, problems and methods we currently use to estimate discharge and we could discuss the project when we meet on 11 November.

Yours sincerely

Patrick M. Sones.

P M SONES
SENIOR ENGINEER (HYDROLOGY)

Tunbridge Division.

Thornborough 2 gates + weir - could spill - gates lifted clear. drowns

Capperham drowns badly

N Pagnell Spills + drowns, - Mill weir drowns before main. compound weir drowning?

Harrold could spill - 3 weirs - no drowning connection

Beckford Could spill - Ratings extended using causeway current metering

Roxton Drowns - Spills occasionally

Bluntham could spill - No D/S recorder. Drowning incorp. in RT. using D/S GS levels.

Stuffard could spill - drowns badly

Hemingford Spills annually. Drowns badly. Incorp in RT.

Brampton Ditto

Wimpole could spill (Bridge D/S). Drowns badly + incorp in RT.

Burnthill Ditto

Chesterford Spilled 1968.

Dernford. Drowns mainly

Linton Drowns + Spills frequently

Shepreth Drowns badly + spills. RT incorp drowning

Battisham 2 gates + weir - gates lifted clear. drowns mainly 100%

Ickham could spill

Eastbridge " " drowns mainly

Aldeby Heath Drowns - Spilled badly 1968.

Burdsham - could spill

Redbridge - hypothesised badly in 1968

Northwold - drowns - could spill

Whitebridge - drowns

Tower Sluice - Sates would be lifted clear with no measurable afflux.

Mid Sluice - Tidal D/S. guillotine + flap gates - Flow not calculated.

St. Neots.

Henslow Farm + Brampton only sites to Stroll reasonably.

Main difficulty is drowning - at times no measurable difference in level.*
Not possible to ascertain high drowning ratios from U/S + D/S charts.

As a compromise drowning is built in to some tables thus a study of past U/S + D/S levels.

Structure limits a normally exceeded by small amounts only. For these cases the rating table is simply extended - sometimes by current metering or using constant velocities.

We do not reduce modular flows by more than 50%

SEVERN TRENT WATER

Severn-Trent Water
Abelson House
2297 Coventry Road
Sheldon
Birmingham
B26 3PU.

Telephone: 021-743 4222
Telex: 339333

My Reference: RAB/PDW/411.01.12 (4399T)

Your Reference:

3 November 1986

1) MGW wfp
2) PGS
3)

Dear Mr Tagg

Hydraulics Research - Flood Discharge Assessment

Your letter of 28 October has been passed to me for attention, because my section deals with all surface water aspects of Severn-Trent's business. I note that your aim is to produce guidelines on the methods of assessing out-of-bank flood flows that bypass gauging stations.

We have a number of gauging stations where this takes place, although for the stations constructed in the last 20 years we have endeavoured to construct flood control embankments to ensure that flood flows pass through a measuring reach underneath a substantial cableway.

I presume you have contacted the Institute of Hydrology who have records of the construction of our gauging stations and notes provided on the assessment of flood plain flows.

You may know that we have already set up an experimental site on the river Soar to measure flood plain flows by ultrasonic techniques. Jim Waters is the Senior Resources Officer responsible for hydrometric measurements and he will be able to provide you with further information.

In recent years we have carried out an extensive hydrological and hydraulic exercise on flood flows which has been supervised by Dr John Pirt, Senior Resources Officer. We will be pleased to co-operate with your research project and, in the first instance, will be able to advise you on an informal basis, free of charge. If there is substantial effort required on experimental sites or on further studies then our normal charging rates will apply.

I hope this information is helpful to you and will be pleased to discuss any of the points with you.

Yours sincerely

R A Bailey

Dr R A Bailey
Principal - Surface Water Resources
Department of Technical Services

When telephoning or writing please contact
Dr R A Bailey Extn 2237

A P Tagg Esq
River Engineering Department
Hydraulics Research
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OX10 8BA

Anglian Water

Malcolm Raymer *OPERATIONS MANAGER*
NORWICH DIVISION

Yare House,
62-64 Thorpe Road,
Norwich NR1 1SA
Tel: Norwich (0603) 615161

This matter is being handled by D Chapman Our Ref. DC/GNW/K193/1 Your Ref.

RB
PCS

A F Tagg
River Engineering Department
Hydraulics Research
Wallingford
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OX10 8BA

11 November 1986

Dear Mr Tagg

Flood Discharge Assessment

I thank you for your letter of 2 October 1986 addressed to Mr Buckley.

A large number of gauging sites within this Division were installed with low flow gauging particularly in mind and as a consequence a number of those sites are bypassed by flood flows. Estimation of high flows at these sites relies largely on rating curves, the detailed computations of which are left largely hidden from everyday view. However, much of the detail of the analysis and the assumptions on which these calculations are based are available on file and you are welcome to examine these should you wish to do so.

I also have a number of stations in the Division which appear to me to be particularly suitable as experimental sites and I would be delighted to co-operate with any programme of monitoring you propose within the constraints of available funding. Mr D J Watling heads the Divisions Hydrometry Section and I have asked him to assist you with your researches wherever possible. Meanwhile I look forward to your further correspondence in due course.

Yours sincerely

S J Hayman
Principal Engineer (Operations)

Anglian Water

Roy Pointer *TECHNICAL MANAGER*
OUNDLE DIVISION

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This matter is being handled by Peter Stott

Our Ref. PCS/JCS/562.01 PCS

Your Ref. R/S/0013F

14 NOV

WALLINGFORD

7th November 1986

(1) WRW WRW
(2) RWP PCS
(3)

Mr. Andrew F. Tagg,
River Engineering Dept.,
Hydraulics Research Ltd.,
WALLINGFORD,
Oxon. OX10 8BA.

Dear Mr. Tagg,

Flood Discharge Assessment

Thank you for your letter of 28th October 1986 addressed to Mr. Ramsden - who has left Anglian Water. Peter Cotton is now the General Manager, and he has asked me to reply.

Your project seems very useful and I hope that we can co-operate. I attach annotated schedules of gauging sites, which I hope you will find helpful. Any further information on your project would be very welcome.

Yours sincerely,

Malcolm Gibb
Planning Engineer

METHODS OF ASSESSING FLOOD DISCHARGES IN EXCESS OF GAUGING STATION CAPACITIES

Dundle Division identifies three types of fluvial gauging station:-

1. Low-flow weir
2. Full-range weir
3. Flood-flow river section

Low flow weirs typically measure less than 1 cumec. They are overtopped at higher flows, and at bankfull stage cause no visible fall in water level.

Full-range weirs measure low flows and flood flows, but can be by-passed in floods more severe than, say, 1 in 5 years. A small number of such stations can gauge more severe floods.

Flood-flow river section stations, two in number, have permanent cableway installations and measure up to at least the 1 in 25 year flood.

No attempt is made to assess flood flows at low flow weirs, and there has been no occasion since 1947 when a flood-flow river section station has been beaten. Our efforts are concentrated on estimating flood flows at full-range weirs.

Methods used are relatively crude. Wrack lines are identified and depths of water assessed. Estimates of velocity are made from visual observations or photographs if available, and the by-passing discharge is calculated. Usually, it is a small proportion of the gauged discharge. Cross-checks are made by comparing the result with runoff totals and peak discharge rates from similar catchments.

Peter Stott
7th November 1986

LF = low flow
FR = Full Range
RS = River Section
✳ = Possible study site

GAUGING STATION DETAILS : RIVER NENE

B-CHMENT	STATION NAME	NATIONAL GRID REFERENCE	STATION NUMBER		DRAINAGE AREA KM²	TYPE OF MEASUREMENT	CREST LENGH (M)	S/G ZERO M.O.D.	RATED TO (M)	RECORDS COMMENCED	COMMENTS
/1	Dodford	SP 6270 6070	032008	✳	107.0	Simple crump	-	79.2	1.402	MAR 1945	FR suffers bypassing often.
/2	Upton Mill	SP 7208 5920	032006		223.0	Standing wave flume	3.200	61.6	1.210	NOV 1939	FR } some bypassing.
	Upton Bypass	SP 7170 5927	032206		223.0	Simple crump	5.901	-	1.000	NOV 1939	FR }
/3	Brixworth	SP 736 707	032026		58.0	Simple crump	-	28.5	0.350	NOV 1970	LF
	St. Andrews Mill	SP 748 613	032007		232.8	Standing wave flume	-	59.4	1.390	OCT 1939	} FR some bypassing.
	St. Andrews Bypass	SP 747 617	032207		232.8	Broad crested	-	-	0.998	OCT 1939	}
/4	Wootton Park	SP 726 577	032031		73.8	Triangular Profile Flat-Vee Weir	-	-	-	SEP 1982	Replaced Lady Bridge FR no bypassing, but non-modular at high flow (commenced 1968)
/5	Wollaston	SP 887 647	032013		644.9	Weir	-	43.1	-	JUN 1944	LF
/6	Harrowden	SP 898 715	032004		194.0	Flat Vee	5.940	45.4	1.828	DEC 1943	FR some bypassing
	Slade Brook	SP 872 763	032019		58.3	Simple crump	-	56.2	0.300	AUG 1970	LF
	Barford Bridge (New)	SP 861 831	-		-	Triangular Profile Flat-Vee Weir	-	-	-	-	LF Replaced site with reco from 1969
/7	Harpers Brook	SP 983 799	032003	✳	74.3	Compound crump	-	30.3	1.676	DEC 1938	FR some bypassing
/8	Corby South	SP 901 886	032016		7.6	Simple crump		89.6	0.304	AUG 1969	LF
	Corby Central	SP 898 892	032015		7.1	Simple crump	-	96.7	0.304	AUG 1969	LF
	Willow Brook	TL 067 933	032002	✳	89.6	Standing wave flume	-	15.2	1.948	OCT 1938	FR suffer bypassing often
/9	Lilford	TL 025 838	032014		125.8	Simple crump	-	21.8	0.500	AUG 1970	LF
	Wansford	TL 080 995	032010		1528.1	Current meter	-	7.9	28.3+	MAY 1939	RS
/10	Orton U/S	TL 166 972	032001		1634.3	Weir & Sluices	-	4.3	-	OCT 1940	LF

GAUGING STATION DETAILS : RIVER WELLAND

SUB-CATCHMENT	STATION NAME	NATIONAL GRID REFERENCE	STATION NUMBER		DRAINAGE AREA KM^2	TYPE OF MEASUREMENT	CREST LENGH (M)	S/G ZERO M.O.D.	RATED TO (M)	RECORDS COMMENCED	COMMENTS
31/1	River Jordan	SP 740 867	031022		20.8	Simple crump	1.470	75.3	0.355	APR 1970	LF
31/2	Market Harborough	SP 733 870									RS new - no rating
31/5	Medbourne Brook	SP 798 939	031019		27.9	Simple crump	1.820	65.7	0.306	APR 1970	LF
	Hallaton	SP 795 959	-			Level only					RS new - no rating
31/6	Ashley	SP 819 915	031021	✳	250.7	Simple crump	6.970		1.800	OCT 1970	FR bypassed at least
31/7	Eye Brook	SP 857 942	031001		23.2						FR, but marina d/s of reserv
31/8	Fosters Bridge	SK 961 030	031010		68.9	Compound crump - Low Flow Notch		38.4	1.605	JAN 1968	FR some bypassing
31/9	Barrowden	SP 948 999	031007		398.9	Simple crump	3.040		0.744	JAN 1962	LF
	Tixover	SP 971 998	031005		404.0	Current Meter	-		3.200		RS
	Tinwell	TF 018 060									LF
31/10	North Brook	SK 957 089	031016		36.5	Simple crump	2.360	50.4	0.584	FEB 1969	LF
	Belmesthorpe	TF 038 097	031006		150.0	Simple crump	8.500	24.0	1.210	APR 1967	FR no bypassing
	Manton	SK 875 051	031025	✳	24.5	Flat Vee			1.400	AUG 1978	FR some bypassing in severe even
	Egleton	SK 878 073	031026		2.5	Flat Vee	- - -		1.000	OCT 1978	FR no bypassing.
	Church Bridge	SP 7263 5775	031028		0.0	Compound Crump Weir	-		2.000	OCT 1982	FR d/s of reservoir.
31/11	Burton Coggles	SK 987 261	031011		31.6	Flat Vee		61.4	0.484	FEB 1969	LF
	L. Bytham Main	TF 0115 1776				Triangular profile Flat-Vee Weir	6.975			LF	) Replaced site with) records from 1969

GAUGING STATION DETAILS : RIVER WELLAND

SUB-CATCHMENT COMMENCED	STATION NAME / COMMENTS	NATIONAL GRID REFERENCE	STATION NUMBER	DRAINAGE AREA KM²	TYPE OF MEASUREMENT	LENGH	CREST ZERO (M)	S/G TO M.O.D.	RATED RECORDS	
1/11	L. Rytham Bypass	TF 0125 1776			Rec'ular Plate Weir	1.000				) LF
	Shillingthorpe	TF 074 113	031009	173.0	Simple crump		13.8	0.520	JUL 1968	LF
	Holywell Brook	TF 026 148	031024	22.3	Simple crump	2.498	27.0	0.494	DEC 1971	LF
	Easton Wood	SK 965 259	031023	4.4	Flat Vee - Crump Profile	8.050	81.0	0.900	FEB 1972	FR no bypassing
[illegible]	[illegible]ham	TF 038 273	031013	71.5	Simple crump	1.820	42.6	0.304	FEB 1969	LF
	Manthorpe	TF [illegible]8 160	031008	136.2	Flat Vee		15.6	0.520	OCT 1968	LF
1/13	Kates Bridge	TF 106 149	031002	341.9	Flat Vee		6.1	0.998	OCT 1960	} FR no bypassing
	King Street	TF 109 106	031202	341.9	Standing Wave Flume			1.158		}
	Tallington Main Weir	TF 095 078	031004	717.4	Compound Broad Crested		13.1	2.035	OCT 1967	FR " "
	Lolham	TF 094 078	031404	717.4	Simple crump			0.488	1966	LF
	West Deeping	TF 096 078	031204	717.4	Simple crump			0.488	OCT 1966	LF
1/13	Bourne Mill	TF 106 198	031027	10.6	Sluice			0.498	NOV 1981	FR no bypassing

South West Water
PENINSULA HOUSE, RYDON LANE, EXETER, EX2 7HR.
Tel: Exeter 219666
Telex: 42604
Telefax: 349?6

R.E. BEARDSALL
M.Sc., C.Eng., M.I.C.E.,
M.I.W.E.S., F.I.P.H.E.
Regional Operations Planner

When telephoning please ask for:
Miss S Turner
Extn. 2512

Your Ref: R/S/0013F
Our Ref: SCT/8990/14/ST/SJB

Date: 13 November 1986

(1) RB (2) PGS

(3) Dear Mr Tagg

FLOOD DISCHARGE ASSESSMENT

I refer to your letters dated 28 October 1986 to the Head of Engineering and Operations and the Head of Environmental Services regarding the above.

We do have sites where the problems you are studying occur, however to even outline them would produce lengthy dossiers. If you wish to pursue the matter I suggest that you visit our Head Office and discuss the matter with Miss S Turner, the Hydrometric and Measurement Engineer, who will make relevant files and data available for you to peruse. I must point out, however, that we are extremely busy and would be unable to undertake any work in addition to our normal monitoring, though we would be interested to be kept appraised of your progress.

Yours sincerely

R E Beardsall
Regional Operations Planner

Mr A F Tagg
River Engineering Department
Hydraulics Research Ltd
Wallingford
Oxfordshire OX10 8BA

Anglian Water

Peter Bullock
DIRECTOR OF TECHNICAL SERVICES

Ambury Road, Huntingdon,
Cambs. PE 18 6NZ
Tel. Huntingdon (0480) 56181

This matter is being handled by

Our Ref. AHB/AJC/SB/5

Your Ref:

12th November 1986

RB
PGS

A.F.Tagg, Esq.,
River Engineering Department,
Hydraulics Research,
Wallingford,
Oxfordshire OX10 8BA.

Dear Mr Tagg,

Flood Discharge Assessment

Thank you for your letter of 28th October 1986. I apologise for the delay in my reply which was occassioned by annual leave. The information which you request will be available from our Divisions and this has been requested. In principle we would be very pleased to assist/be concerned with your research project and I hope I will be able to give you a detailed reply to your letter at the beginning of December.

Yours sincerely,

Andrew Hunter-Blair
Principal Engineer Rivers - Strategy

Wessex Water

Wessex House
Passage Street
Bristol
BS2 0JQ

Telephone (0272) 29[illegible]
Telex 44[illegible]

Andrew F Tagg Esq
River Engineering Department
Hydraulics Research
WALLINGFORD
Oxon
OX10 8BA

OPS/LI/5101/22

R/S/0013F

17 November 1986

Dear Mr Tagg

With reference to your letter of 28 October I enclose copies of responses from each of our 3 Divisions on the subject raised in your second paragraph.

If you wish to use any of our sites for experimental purposes we shall be pleased to co-operate.

If you have any further queries or wish to pursue any particular sites further it would be convenient if you would communicate directly with the appropriate Division as follows:-

M A Hillyer
Div. Planning Engineer
Wessex Water
Bristol Avon Division
P O Box 95
Quay House
The Ambury
Bath, BA1 2YP
Tel. Bath (00225) 313500

G M West
Div. Engineer (P & D)
Wessex Water
Avon & Dorset Division
2 Nuffield Road
Poole
Dorset
BH17 7RL
Tel. (0202) 671144

B A Tinkler
Somerset Division
P O Box 9
King Square
Bridgwater
TA6 3EA
Tel. (0278) 457333

Yours sincerely

Mary C. Jones

J A Tinkler
Operations & Land
Drainage Manager

3331o/JAT/T

WESSEX WATER AUTHORITY

BRISTOL AVON DIVISION

Memorandum

To: J. A. Tinkler
Wessex House

Date: 6th November 1986

From: M. A. Hillyer
Quay House

Ref: JHP/MS/A200CB/D31 Your Ref: OPS/LD/S101/22

Subject: Flood Discharge Assessment

In reply to your memorandum of 30th October 1986, the information requested in the second paragraph is as follows:

The majority of Bristol Avon Division's primary gauging structures were constructed for low to medium flows only and were not rated for flood flows.

There are some 15 sites at which work is currently being undertaken to improve high flow measurement. This work is in house hydraulic investigations and hypothetical extensions of rating curves, the use of consultants for model rating and the installation of cableways or bridges at gauging structures to physically measure flood flows.

There is no reason why we should not offer one of our sites.

- I suggest Tellisford (R. Frome)

M. A. Hillyer
Divisional Planning Engineer

1508m/JHP/T

W.W.A.
10 NOV 1986
J. A. TINKLER
File Ref.....

A B B2 0013

Bristol Avon Division

AVON & DORSET DIVISION

WWA Memo Subject: flood disch. 86-11-05 Page

Issued by:
275 JTINKLER/MARYJONES OPERATIONS

= WW.MWEST M WEST/S GALLON 245/2
--- RECEIVED FROM WW.MWEST PLANNING & DEV 86-11-05 13:12
- WW.JTINKLER JTINKLER/MARYJONES 275
Flood Discharge Assessment

I refer to your memo of 30 October requesting information on the gauging sites which are bypassed at flood flows. We have a number of stations in our Division within this category:

River Wylye at South Newton
River Stour at Hammoon
River Stour at Throop
River Frome at East Stoke
River Frome at Dorchester
River Avon at Upavon
River Avon at East Mills, Fordingbridge

At Hammoon and Throop high flow rating curves have been established by gauges taken off downstream bridges where the whole of the flow has been confined. At other sites the existing stage/discharge curve has simply been extended at the same gradient; we have assumed that any flow bypassing the station is not significant.

I see no reason why we cannot offer facilities for Andrew Tagg's experiments as requested.

M West

FLOOD DISCHARGE ASSESSMENT

WESSEX WATER
SOMERSET DIVISION

Sixteen river gauging stations are currently operated where continuous flow data is collected. Of these, ten sites are required to gauge flood flows and eight of these are in regular use as real time flood warning sites. All ten flood gauging sites have weir structures and are calibrated for the full in-bank range. This has been achieved by flood gauging using permanent cableways or from foot bridges.

Extension of gauging station ratings to include out of bank flow is required at seven sites. However, only five sites have substantial out of bank flows and are identified as being priority sites. Stage is recorded at all sites and can cover all but catastrophic events.

Plans are in hand to extend the rating at two sites to include flood plain flow. Land surveys have been carried out and velocity profiles will be measured when suitable events occur with a current meter.

Flood flows of past events have been assessed by:

i) Chart/telemetry stage information for flood peak.

ii) Post event inspection of debris, levels, rack marks etc to assess the extent of flood plain flow, bypass flows.

iii) Estimate of flow velocity by:

a) Gauging during event.

b) Educated guess.

There are three sites which may be suitable for study if Hydraulics Research are interested and further details can be provided if necessary.

L AUCOTT (HYDROLOGIST)
12 NOVEMBER 1986

Anglian Water

John Sansby
OPERATIONS MANAGER
COLCHESTER DIVISION

3[illegible] Sheepen [illegible],
Colchester, Essex, CO3 3LB
Phone (0206) 43344 Telex [illegible]196
Fax (0206) [illegible]62

matter is
g handled by Mr Dines

Our Ref. SD/JS/565-3

Your Ref. B/C/0013F

19 November 1986

A.F. Tagg,
er Engineering Dept.,
raulics Research Ltd.,
lingford,
ordshire,
) 8BA.

r Sir,

od Discharge Assessment

efer to your letter of 28 October 1986 and would be very interested in the
come of your research project since the majority of the gauging stations
rated by this Division are subject to gauging problems under high flow
ditions. I have attached an extract from a 1984 thesis which describes
efly the problems encountered and the attempts which are made to estimate
flood flows. The calculation of spillway flows present particular
ficulties, and estimates are frequently revised.

you wish to discuss this further or maybe visit the Division to examine
records please contact Mr Dines at this office.

rs faithfully,

rations Manager.

Anglian Water

John Sansby OPERATIONS MANAGER
COLCHESTER DIVISION

With Compliments

33 Sheepen Road,
Colchester, Essex, CO3 3LB
Phone (0206) 69171 Telex 98196
Fax (0206) 68401

2.3 River Flow Gauging

Prior to 1960, a very limited amount of flow gauging was carried out by the water supply undertakings. As the principal aim of these measurements was to determine water resources, the gauging stations were situated at the lower ends of the rivers. During the 1960's, as a result of the Water Resources Act (1963), a more detailed network of gauging stations was established by the Essex River Authority. Again the principal purpose was water resource analysis and this coupled with the generally flat terrain which causes the gauging structures to drown out easily, means that there are very few stations in the area which will accurately gauge flood flows. The full gauging network is shown in Figure 2 and Table 1 gives details of the gauging limits attached to each station.

2.4 Limitations of Flow Measurement Structures

All continuous flow measurement in the Division is carried out by measuring the head over a control structure (weir or flume) for which the relationship between upstream head and flow has been derived from theoretical or experimental analysis. Due to the flat topography of the area, it has been difficult to design structures which can measure the higher flows without unacceptable effects on the land drainage upstream. The accuracy of a real time flood forecasting

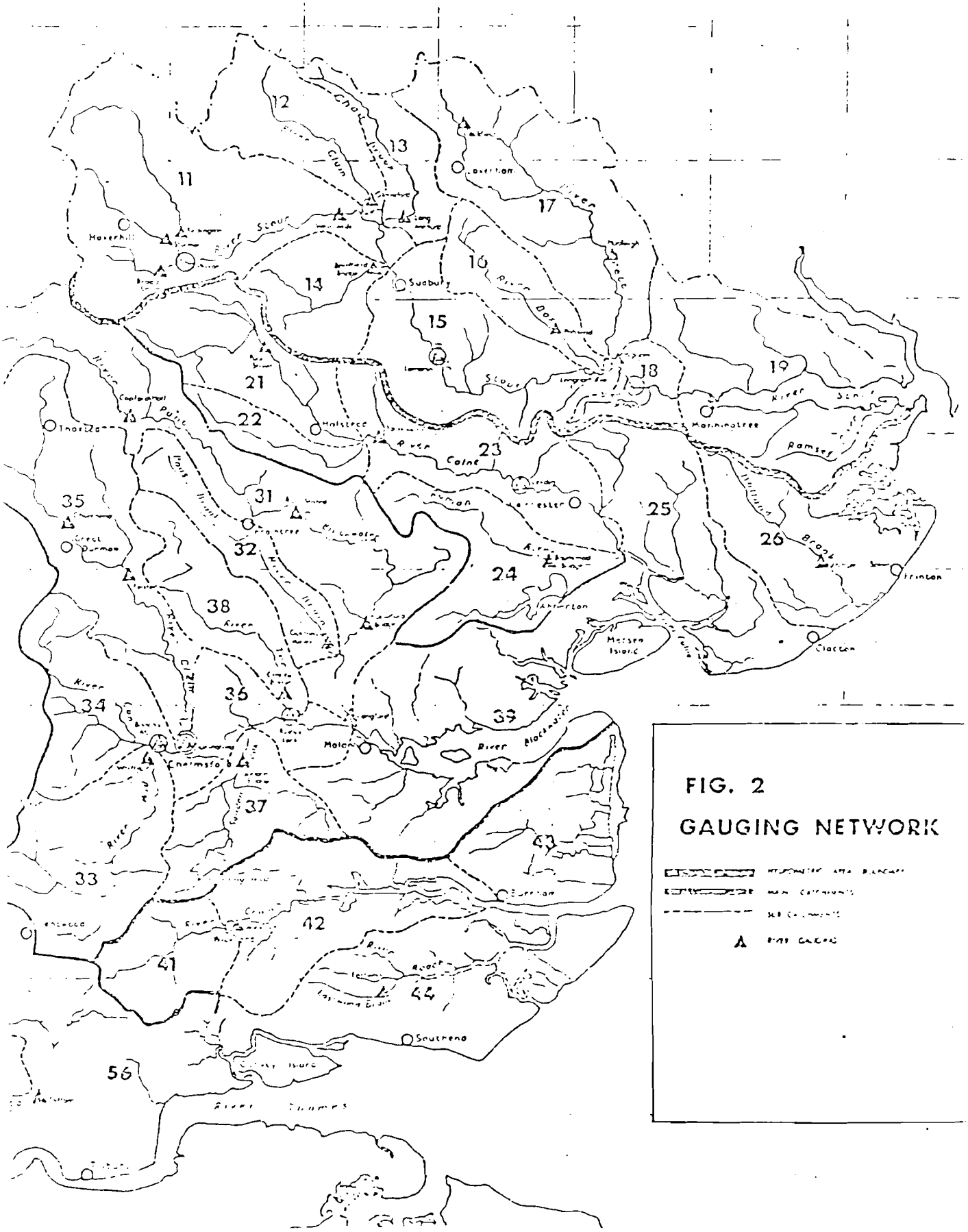


FIG. 2

GAUGING NETWORK

Table 1

GAUGING LIMITS

River	Gauging station	Grid ref	Catchment area (KM^2)	Modular limit (m^3/s)	Start of spillway flow (m^3/s)	Start of flood plain storage (m^3/s)	Approximate upper limit of gauging (m^3/s)	Remarks
Stour Brook	Sturmer	TL695441	34.5	5.0	None	6	7	Modular limit uncertain due to reversal occurring at high flows
Bumpstead Brook	Broad Green	TL689418	28.2	3.0	7.5	7.5	8	
Stour	Kedington	TL708450	76.2	1.4	None	10	12	
	Westmill	TL827463	224.5	20	9.0	16	33	Summer possibly different
	Lamarsh	TL897358	477.8	6.0	None	45	45	Modular limit provisional due to lack of data
	Langham	TM020344	578.0	Full range	36.0		55	
Glem	Glemsford	TL846472	37.3	4.8	9.0	8	14	
Chad Brook	Long Melford	TL868459	47.4	Full range	14.0	15	20	
Box	Polstead	TL985378	53.9	12.0	13.0	4	20	Minimum drowning
Brett	Cockfield	TL914525	25.7				10	Estimated from Design Report
	Hadleigh	TM025429	156.0	8.0	30.0	14	35	More flood gauging required above $20/m^3/sec$
Belchamp Brook	Bardfield Bridge	TL848421	58.6	Full range	None	4.6	11.5	Summer possibly different
Roman	Bounstead Bridge	TL985205	52.6				2.5	Estimated from Design Report
Colne	Poole Street	TL771364	65.0	6.0	6.8	7	10	
	Earls Colne	TL855298	154.2	3.6	None	9	15	
	Lexden	TL962261	238.2	12	16	12	40	Summer possibly different
Pollend Brook	Thorpe le Soken	TM179212	54.9				4.5	Estimated from Design Report
Pant	Copford Hall	TL668313	62.5	4.0	12	6	16	
Blackwater	Stisted	TL793243	139.2	5.0	None	9	10	
	Appleford Bridge	TL845158	247.1	8.0	20	16	30	
Brain	Guithavon Valley	TL818147	60.7	Full range	18	7	20	Drowns early but with minimal effect
Ter	Crabb's Bridge	TL783107	77.6	3.0	None	7	10	
Chelmer	Church End	TL639233	72.6	6.0	9	13	15	
	Felsted	TL670193	132.1	5.0	None	9	11	
	Springfield	TL713071	190.3	Full range	None		25	
Can	Beech's Mill	TL690072	228.4	3.0	30	25	35	
Ter	Writtle	TL666060	135.3	Full range	23		35	
Wid[illegible] Brook	Sandon Bridge	TL755035	60.6	0.4	None	10	13	Drowns early,

model is to a large extent dependent on the accuracy of the data which is the basis of its derivation and operation, and it is therefore necessary to include here a brief account of some of the problems encountered in obtaining these measurements.

Although head discharge relationships have been derived for all measuring structures, this relationship breaks down when the structure drowns out. This happens at a comparatively early stage at many sites in Essex. Furthermore, when bank-full conditions are reached, many stations are bypassed resulting in further uncertainties in the flow estimates. An extreme example of these problems is shown in Figure 3.

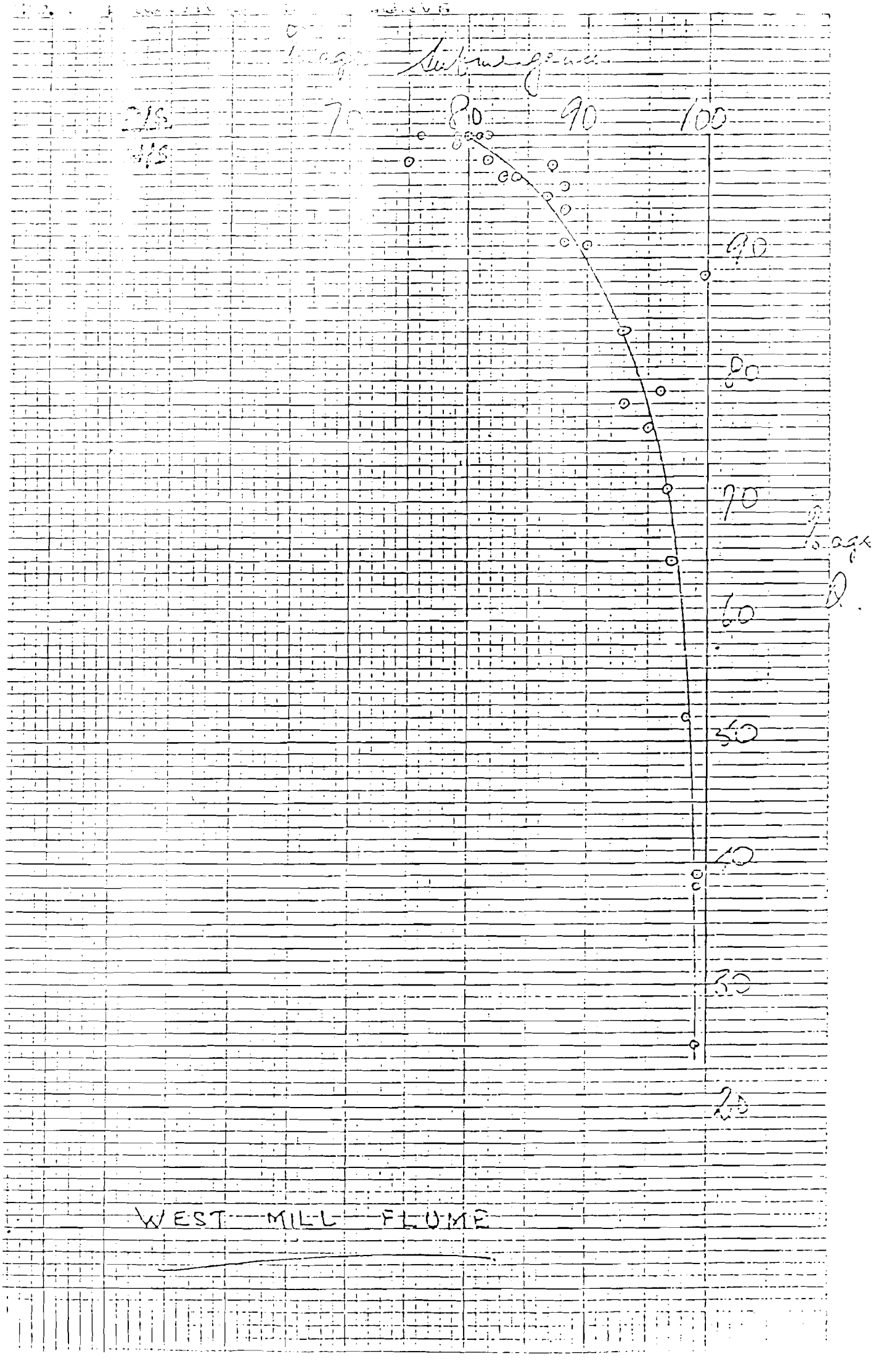
(i) Drowning

A structure is said to be drowned when the level downstream increases to such an extent that the relationship between upstream head and flow breaks down. For a given flow, the head necessary to force that flow over the structure is increased by the need to overcome the "backing up" effect of the downstream water level. Conversely, for a given upstream head, the flow under drowned conditions is less than would be expected under modular flow conditions. The true flow is obtained by applying a percentage reduction, which is derived from the downstream head/upstream head ratio, to the theoretical flow. An example of a drowning curve, which has been derived from experiment, is shown in Figure 4.

Figure 3: Felsted Gauging Station

(i) Under low flow conditions

(ii) Under flood conditions


70
80
90
100
90
80
70
60
50
40
30
20
WEST MILL FLUME

(ii) Empirical curves

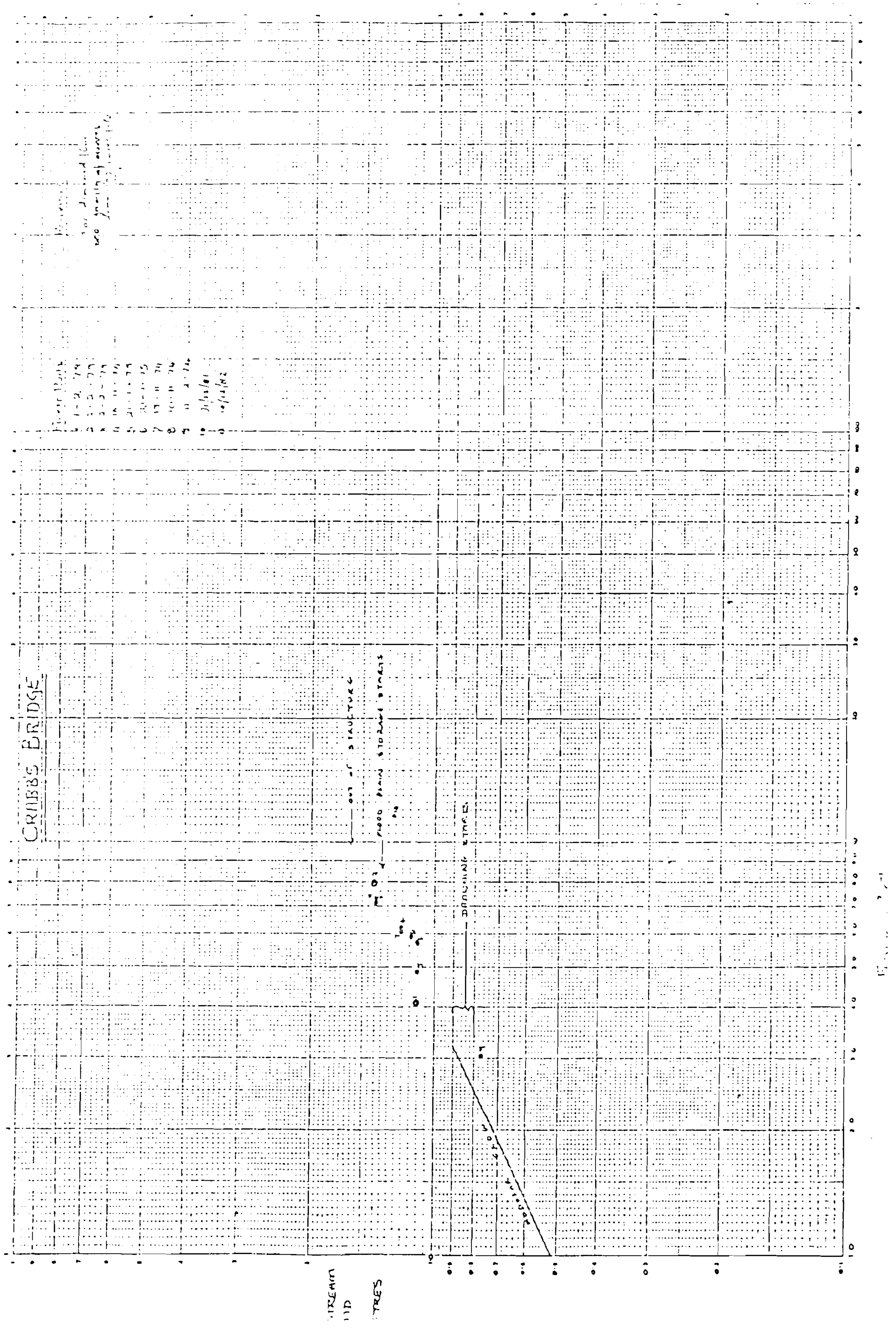
In theory, the flow through the structure under drowned conditions can vary with both upstream and downstream head. In practice, however, as the weir forms part of a river system, there is a relationship between upstream and downstream head and thus a relationship between upstream head and flow, albeit different from and less reliable than the relationship for modular flow. This fact has been used as the basis for the 'empirical' curves (Figure 5) by which the ratings of the gauging stations have been extended beyond the modular limit. The curves have been derived from field measurements.

For archive purposes, it is desirable that the drowning curves be used to calculate the flow since variations in local conditions can affect the relationship between upstream and downstream heads, but for river management and flood warning purposes, the empirical curves offer an approximate assessment of flow (eg through the telemetry) at the time of the event when the downstream level may not be available.

(iii) Spillway flows

At some stations, the flow bypassing the structure at high flows is estimated using a rated spillway. These usually consist of a depression in the bank which has been calibrated theoretically using a broad

FIG 3 E.'PIRICAL' CUR.'E



created weir type of analysis. The accuracy of this flow measurement cannot be considered to be greater than ± 20% but would usually be less than about 10% of the total flow through the station.

A P P E N D I X II

Table 1 : Gauging Station Characteristics

Gauging Station No:		
Type of Station :	CR	Crump Weir
	CCR	Compound Crump Weir
	FV	Flat Vee profile
	BC	Broad crested profile
	SC	Sharp crested profile
	FL	Flume
Recording Equipment	O	Ott water level recorder
	FP	Fischer and Porter punched tape recorder
	SE	Shaft Encoder
	1235	Dynamic Logic (multifunctional)

Table 2 : Summary of Gauging Station and Data Quality

GAUGING STATION NO.	SUB-CATCHMENT	RIVER	GAUGING STATION	NATIONAL GRID REF.	CATCHMENT AREA		TYPE OF STATION	RECORDS COMMENCE	RECORDING EQUIPMENT			
					GAUGED (KM²)	% OF TOTAL			HEAD	CREST	TAIL	TELEMETRY
039822	36	Crane	Marsh Farm	TQ 154 734	81.0		CR	10.01.39	FP-1/74 O -7/78	-	-	Tel
039057	36	Crane	Cranford Park	TQ 10327784	61.65		BC	24.01.74	O -1/74 FP-5/74	-	-	Tel
039083	36	Yeading Brook	Brookside Park	TQ 117 812	?		River section only - no structure	11.04.80	O -4/80 FP-7/80 1235-86	-	-	Tel
039055	36	Yeading Brook West	Yeading West	TQ 08388464	17.575		FV	08.03.74	O -3/74 FP-7/75	-	-	Tel
039849	36	Yeading Brook East	Yeading East	TQ11178453	9.62		FV	13.03.74	O -3/74	-	-	will be installed upon station improvement
039836	36	Duke of Northumb-erlands	Mogden STW	TQ15317536	35.0		CR	17.06.64	FP-4/77 O -3/78	-	-	-
039848	36	Duke of Northumb-erlands	Baber Bridge	TQ11207435	?		BC	26.10.73	O-10/73	-	-	-
039838	36	Longford	Bedfont (Feltham)	TQ08517419	30.0		River Section only - no structure	06.01.61	O-3/77	-	-	Tel
039834	38	Brent	Hanwell	TQ15138015	132.0		River Section only - no Structure	21.02.61	O-10/73	-	-	Tel
-	38	Brent	Costons Lane	TQ152822	?		FV	1985 (?)	O - 85 1235-86	-	-	Tel
039821	38	Brent	Monk's Park	TQ202850	117.6		FL	14.01.38	FP-1/74 O - 9/77	-	-	Tel
039856	38	Wealdstone Brook	Wembley	TQ19288623	21.75		FV	22.09.76	FP-9/76 O - 9/76	-	-	Tel
039084	38	Upper Brent	Brent Cross	TQ23618802	?		CCR	?	1235-86	-	-	Tel

GAUGING STATION NO.	NO.	RIVER	GAUGING STATION	NATIONAL GRID REF.	GAUGED (KM)	% OF TOTAL	TYPE OF STATION	RECORDS COMMENCE	HEAD	CREST	TAIL	TELEMETRY
039049	38	Silk Stream	Colindeep Lane	TQ217985	29.0		FV	14.11.73	0-10/73	-	-	Tel
039820	38	Dollis Brook	Hendon Lane	TQ240895	25.1		CCR	14.02.52	0 - 9/73 FP-1/76	-	-	Tel
039005	40	Beverley Brook	Wimbledon Common	TQ216717	43.5		FL	27.09.62	FP-3/73 0 - 4/74	-	-	Tel
039003	41	Wandle	Connolly's Mill	TQ265705	176		FL	05.10.62	FP-7/73 0-10/78	-	-	Tel
039004	41	Wandle (Croydon Branch)	Beddington Park	TQ296655	122		(BC) modified 6/64 CCR	27.09.62	FP-2/73 0-10/78	-	-	Tel
039832	41	Wandle (Carshalton Branch)	Carshalton Ponds	TQ279647	1.0		SC	27.09.56	0-10/78	-	-	Being installed Dec. 1956
039082	41	Graveney	Longley Road	TQ27147089	16.7		Ott Bubble recorder in river section no structure	02.06.78	-	-	-	Tel
039056	43	Ravensbourne	Catford Hill	TQ37237324	67.65		CR	02.12.74	0-12/74 FP-9/75	-	-	Tel
039058	43	Pool	Winsford Road	TQ37187252	38.33		CR	04.12.74	0-12/74 FP-7/75	-	-	Tel
039824	43	Ravensbourne (East)	Bromley South	TQ405687	10.3		FL	31.10.62	0 - 6/78		-	-
039825	43	Ravensbourne (West)	Hayes Lane	TQ40596792	4.3		SC	14.08.63	0 - 9/77	-	-	Tel
039828	43	Quaggy	Manor House Gardens	TQ394748	33.5		FL	02.05.61	0-6/78 FR6/78	-	-	
039829	43	Quaggy	Chinbrook Meadows	TQ41027205	15.0		FL	29.04.63	0-6/79 SE- ? 1235-80	-	-	Tel

GAUGING STATION NUMBER	SUBCATCHMENT No.	SUBCATCHMENT RIVER	GAUGING STATION	REMARKS
039822	36	CRANE	MARSH FARM	MOST DOWNSTREAM LOCATION OF THE GAUGING STATIONS ON THE CRANE. SMOOTH CRESTED CRUMP WEIR, APPROXIMATELY 3 METRES WIDTH. LEVEL OF STATION 7.4 METRES A.O.D. AVAILABLE DATA VERY LIMITED EVEN AFTER THE PROCESSING OF INSTITUTE OF HYDROLOGY TAPE. CURRENT RECORDS BEING PROCESSED.
039057	36	CRANE	CRANFORD PARK	MEASURES THE DISCHARGE UPSTREAM OF THE CONFLUENCE OF DUKE OF NORTHUMBERLAND AND CRANE RIVERS. BROAD CRESTED WEIR. NUMEROUS CALIBRATION GAUGINGS CARRIED OUT 1972-1979. LEVEL OF STATION 22.9 M A.O.D. AVAILABLE DATA VERY LIMITED EVEN AFTER PROCESSING OF INSTITUTE OF HYDROLOGY TAPE. CURRENT RECORDS BEING PROCESSED.
039083	36	YEADING BROOK	BROOKSIDE PARK	NO STRUCTURE. EXTREMELY POOR STATION AND DATA QUALITY. RECORDS ARE VERY SUSPECT DUE TO EXCESSIVE SILTATION OF STILLING WELL. THE PROBLEM IS DUE TO A BADLY DESIGNED INLET PIPE AT THE RECORDER HOUSE. NO DATA AVAILABLE FROM INSTITUTE OF HYDROLOGY. DYNAMIC LOGIC 1235 RECENTLY INSTALLED FOR ALARM CALLS, FOR FLOOD WARNING.
039055	36	YEADING BROOK (WEST)	YEADING WEST	MEASURES INPUT OF YEADING BROOK (W) INTO THE CRANE. FLAT VEE CRUMP PROFILE WEIR. RECENT WORK INDICATES AN ERROR IN LEVEL OF THE ORDER OF 64 MM. GAUGE BOARD IS INACCURATE. EXTREMELY POOR STATION AND DATA QUALITY. NO PROCESSING CURRENTLY BEING CARRIED OUT. LOW STAGE CONTROL AND THEREFORE DROWNING OCCURS AT FLOWS IN EXCESS OF 10 CUSECS - EFFECTIVE CONTROL FOR MOST FLOWS IS EITHER CULVERT ENTRANCE OR DOWNSTREAM CHANNEL CONVEYANCE CHARACTERISTICS. A SMALLER CHANNEL HERE IS NOT RECORDED - DISCHARGE MAY BE SIGNIFICANT (0.2 CUMECS). PEAK FLOWS AND LAG TIMES ALSO REDUCED FOLLOWING LARGE SCALE MAINTENANCE WORK UPSTREAM, NOVEMBER 1982 - FEBRUARY 1983. LEVEL OF STATION 32 METRES A.O.D.
039849	36	YEADING BROOK (EAST)	YEADING EAST	MEASURES INPUT OF YEADING BROOK (E) INTO THE CRANE. FLAT VEE CRUMP PROFILE WEIR. NO CHECK POINT, NO CREST PLATE. CONCRETE CREST APPEARS UNEVEN. CHART RECORDING FACILITY ONLY. MINIMAL DROWNING EVEN IN FLOOD, DUE TO WEIR CREST HEIGHT. RECORDS ARE ASSUMED VERY POOR. NEEDS RATING. STATION LIKELY TO BE DEVELOPED IN FUTURE. LEVEL OF STATION 31.5 METRES A.O.D.
039836	36	DUKE OF NORTHUMBER-LANDS	MOGDEN S.T.W.	DOUBLE NOTCH RECTANGULAR WEIR WITH CONCRETE WALLS, EARTH BED, CENTRAL PEIR. NO WEIR PLATE, NO CHECK POINT, NO MAINS POWER SUPPLY. AVAILABLE DATA LIMITED, EVEN AFTER PROCESSING OF INSTITUTE OF HYDROLOGY TAPE. CURRENT RECORDS ARE BEING PROCESSED. LEVEL OF STATION 8.7 METRES A.O.D.

GAUGING STATION NUMBER	SUBCATCHMENT No.	SUBCATCHMENT RIVER	GAUGING STATION	REMARKS
039848	36	DUKE OF NORTHUMBER-LAND	BABER BRIDGE	MEASURES INPUT OF DUKES RIVER TO THE CRANE. LOCATION IS UPSTREAM OF OLD MILL GATE WHICH FORMS A SHARP CRESTED RECTANGULAR WEIR - THE NOT ...LY CALIBR...D. CHART RECORDING FACILITY ONLY. STATION IS OF REASONABLE QUALITY, COULD BE IMPROVED TO BE SUPERIOR TO MOGDEN. LEVEL OF STATION 20.8 M A.O.D.
039838	36	LONGFORD	BEDFONT	LOCATION IMMEDIATELY DOWNSTREAM OF A CONNECTION BETWEEN DUKE'S AND LONGFORD RIVERS. GAUGING USES A RIVER SECTION ONLY. NO GAUGE BOARD, CHECK POINT OR STRUCTURE. CONTROL IS PROVIDED BY THE CHANNEL FOR HIGH FLOWS AND BY CONSTRUCTION BY TWO BRIDGES ROAD BRIDGE FOR LOW FLOWS. NOT CURRENTLY IN USE. RECORDS ARE OF POOR QUALITY AND LIMTED PERIOD. THERE IS SOME DEBATE CONCERNING REINSTATEMENT.
039834	38	BRENT	HANWELL	MEASURES ENTIRE DISCHARGE OF RIVER BRENT UPSTREAM OF CONFLUENCE WITH GRAND UNION CANAL. NO STRUCTURE, GAUGED SECTION ONLY. CONSIDERABLE BACKWATER AFFECT FROM THE CRAND UNION CANAL AT LOW DISCHARGE. IT IS IMPRACTICABLE TO CALIBRATE THIS STATION. THE FISCHER PORTER HAS BEEN REMOVED AND THE STATION IS TO BE MAINTAINED FOR FLOOD WARNING ONLY. THERE IS NO CONTROL HERE, BED LEVELS ARE CONSTANTLY VARIABLE WITH A MAJOR SILTATION PROBLEM. AVAILABLE RECORDS ARE EXPECTED TO BE OF LITTLE VALUE. LEVEL OF STATION 8.8 METRES A.O.D.
-	38	BRENT	COSTONS LANE	NEWEST STATION IN THE NETWORK. WORK COMMENCED FEBRUARY 1984, ONLY COMPLETED LATE 1985. NO PUNCHED TAPE RECORDS. FLOW, ALARM (AND EXCESS RAINFALL) INFORMATION PROVIDED BY DYNAMIC LOGIC 1235. WIDE, SHALLOW VEE CRUMP WITH STEEL CREST PLATE. GOOD STATION, LIKELY TO PROVIDE THE BEST IN THE LONDON AREA. DATA OBVIOUSLY LIMITED TO DATE. FLOWS VARIABLE DUE TO DISCHARGE FROM WELSH HARP RESERVOIR. THE STATION ALSO MISSESS SIGNIFICANT DISCHARGE FROM COSTON'S BROOK IMMEDIATELY DOWNSTREAM. LARGE RECTANGULAR DRAINAGE BUNG IN MAIN CHANNEL (FOR WEIR MAINTENANCE) WOULD APPEAR TO HAVE DISRUPTIVE INFLUENCE ON HEAD WATER LEVELS. LEVEL OF STATION 12.866 METRES A.O.D. GAUGE BOARD CURRENTLY VANDALISED
039821	38	BRENT	MONK'S PARK	MEASURES DISCHARGE OF BRENT, DOWNSTREAM OF CONFLUENCE WITH WEALDSTONE BROOK. CRITICAL DEPTH FLUME IN CONCRETE CHANNEL. GENERALLY GOOD STATION. LIMITED DATA AVAILABLE FROM INSTITUTE OF HYDROLOGY TAPE, BUT LONG PERIOD OF RECORDS HAVE BEEN MADE. GAUGE BOARD OUT BY 10 MM. LEVEL OF STATION 24.5 METRES A.O.D. CURRENT RECORDS ARE BEING PROCESSED.
039856	38	WEALDSTONE BROOK	WEMBLEY	WEIR LOCATED IN CULVERT, CHANNEL NOT VISIBLE FROM HUT. NO CHECK POINT. FLAT VEE CRUMP. LIMITED DATA AVAILABLE FROM INSTITUTE OF HYDROLOGY TAPE. LEVEL OF STATION 29.1 METRES A.O.D. CURRENT RECORDS ARE BEING PROCESSED.

GAUGING STATION NUMBER	SUBCATCHMENT No.	SUBCATCHMENT RIVER	GAUGING STATION	REMARKS
039084	38	UPPER BRENT	BRENT CROSS	MEASURES DISCHARGE DOWNSTREAM OF THE MUTTON AND DOLLIS BROOKS. COMPOUND SHARP CRESTED WEIR. PART OF THE RIVER BRENT FLOOD ALLEVIATION AREA. GOOD MODULAR RANGE UP TO 520 CUSECS, BANK FULL AT 1.67 STAGE. DATA BELIEVED TO BE OF REASONABLE LEVEL OF ACCURACY. CONSIDERABLE BACKWATER AFFECT FROM BRIDGE 50 FEET DOWNSTREAM HAS BEEN DESCRIBED - NOW BELIEVED TO HAVE BEEN REMOVED. FISCHER PORTER RECENTLY REPLACED WITH DYNAMIC LOGIC 1235 FOR 15 MINUTE LOGGING, ALARM (AND EXCESS RAINFALL) INFORMATION. NO DATA ON INSTITUTE OF HYDROLOGY TAPE.
039049	38	SILK STREAM	COLINDEEP LANE	MEASURES ENTIRE DRAINAGE OF NORTHWEST CATCHMENT OF BRENT RESEVOIR. FLAT VEE CRUMP PROFILE WEIR. STATION LOCATED IN REFUSE DUMP COMPOUND. ACCUMULATION OF DEBRIS IN THE CHANNEL AS A RESULT, HAS PROVED A PROBLEM IN THE PAST. HOWEVER THIS IS A GOOD STATION, THE ONLY ONE IN THE LONDON AREA USED BY INSTITUTE OF HYDROLOGY. ALL DATA WILL BE AVAILABLE ON THEIR MAGNETIC TAPE. LEVEL OF STATION 39.9 M A.O.D. CURRENT RECORDS ARE ALSO BEING PROCESSED.
039820	38	DOLLIS BROOK	HENDON LANE	MEASURES DISCHARGE OF DOLLIS BROOK AND TRIBUTARIES. COMPOUND SHARP AND BROAD CRESTED WEIR. SHARP CREST IS VERY HIGH WITH 4-5 METRE DROP IMMEDIATELY DOWNSTREAM. NO DROWNING HERE AS A RESULT. DESILTING GATES PROVIDED ON BOTH SIDES OF THE WEIR. HOWEVER SILT ACCUMULATION UPSTREAM IS A PROBLEM WITH 0.8 METRES AT THE STRUCTURE AND 2 METRES FURTHER UPSTREAM. LIMITED DATA AVAILABLE FROM INSTITUTE OF HYDROLOGY TAPE. LEVEL OF STATION 46.6 METRES A.O.D. CURRENT RECORDS ARE ALSO BEING PROCESSED.
039005	40	BEVERLEY BROOK	WIMBLEDON COMMON	SOLE RECORDER IN THIS CATCHMENT. LARGE CRITICAL DEPTH FLUME 1.5 METRE THROAT, 2.5 METRE DEPTH. RELATIVELY LONG PERIOD OF RECORDS FROM INSTITUTE OF HYDROLOGY - ALTHOUGH INTERMITTENT. PROCESSING CURRENTLY BEING CARRIED OUT. REASONABLE LEVEL OF ACCURACY. LEVEL OF STATION 11 METRES A.O.D.
039003	41	WANDLE	CONNOLLY'S MILL	MOST DOWNSTREAM LOCATION OF THE GAUGING STATIONS IN THE WANDLE. CRITICAL DEPTH FLUME. RELATIVELY LONG PERIOD OF RECORDS FROM INSTITUTE OF HYDROLOGY - ALTHOUGH INTERMITTENT. PROCESSING CURRENTLY BEING CARRIED OUT. REASONABLE LEVEL OF ACCURACY. LEVEL OF STATION 10.4 METRES A.O.D.
039004	41	WANDLE (CROYDON)	BEDDINGTON PARK	RECORDS DISCHARGE FROM CROYDON AREA. SMOOTH CRESTED COMPOUND CRUMP WEIR, EARTH BANKS AND BED. LONG PERIOD OF RECORDS FROM INSTITUTE OF HYDROLOGY. PROCESSING CURRENTLY BEING CARRIED OUT. RECENT WORK SUGGESTS GAUGE BOARD INACCURATE. LEVEL OF STATION 33 METRES A.O.D.

NUMBER	NO.	RIVER		
039832	41	WANDLE (CARSHALTON BRANCH)	CARSHALTON PONDS	RECORDS DISCHARGE FROM CARSHALTON PONDS. RECTANGULAR THIN PLATE WEIR. CHART RECORDING FACILITY ONLY. LONG PERIOD OF RECORDS. RECENT WORK SUGGESTS GAUGE BOARD INACCURATE.
039082	41	GRAVENEY	LONGLEY ROAD	RECORDS DISCHARGE FROM EAST SECTION OF WANDLE CATCHMENT BY MEANS OF AN OTT BUBBLE - RECORDER IN CONCRETE RIVER SECTION. DIFFICULT TO CALIBRATE, NO STAGE DISCHARGE RELATIONSHIP ESTABLISHED. LEVEL OF STATION 14.92 METRES A.O.D.
039056	43	RAVENSBOURNE	CATFORD HILL	RECORDS DISCHARGE BELOW CONFLUENCE OF THE RAVENSBOURNE AND POOL. CRUMP WEIR. LIMITED DATA WILL BE AVAILABLE FROM INSTITUTE OF HYDROLOGY. PROCESSING IS CURRENTLY BEING CARRIED OUT. REASONABLE LEVEL OF ACCURACY. NUMEROUS CALIBRATION GAUGINGS 1975/76. LEVEL OF STATION 14.5 A.O.D.
039058	43	POOL	WINSFORD	RECORDS INPUT OF POOL TO RAVENSBOURNE. CRUMP WEIR. LIMITED DATA AVAILABLE FROM INSTITUTE OF HYDROLOGY TAPE. PROCESSING CURRENTLY BEING CARRIED OUT. LEVEL OF STATION 16.95 METRES A.O.D.
039824	43	RAVENSBOURNE (EAST)	BROMLEY SOUTH	CRITICAL DEPTH FLUME. CHART RECORDING FACILITY ONLY. LEVEL OF STATION 44.3 METRES A.O.D.
039825	43	RAVENSBOURNE (WEST)	HAYES LANE	RECTANGULAR THIN PLATE WEIR. CHART RECORDING FACILITY ONLY. LEVEL OF STATION 46.2 METRES A.O.D.
039828	43	QUAGGY	MANOR HOUSE	CRITICAL DEPTH FLUME. LIMITED DATA AVAILABLE FROM INSTITUTE OF HYDROLOGY TAPE. PROCESSING CURRENTLY BEING CARRIED OUT. REASONABLE LEVEL OF ACCURACY. LEVEL OF STATION 13.3 M A.O.D.
039829	43	QUAGGY	CHINBROOK MEADOWS	SMALL CRITICAL DEPTH FLUME LESS THAN 1 METRE HIGH. TWO KIOSKS, CONTAINING AN OTT RECORDER AND SHAFT ENCODER RESPECTIVELY. CHANNEL IS CURVED IN THE BED AND STRUCTURE PRONE TO DEBRIS ACCUMULATION AT THE FLUMES 100 MM UPSTAND. DEBRIS CLEARING IS NECESSARY AFTER EVERY FLOOD - FULL DAYS WORK FOR A TEAM OF TWO. LEVEL OF STATION 35.1 METRES A.O.D. DYNAMIC LOGIC 1235 RECENTLY INSTALLED FOR 15 MINUTE LOGGING OF FLOWS, AND ALARM CALLS FOR FLOOD WARNING.

(1) DWE/WRW
(2) PGS

Thames Water

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Date 21st November, 1986

Your Ref:
Our Ref: TS 2680/WDR/SJB
Please reply to: Mr. Rylands

(3) A. F. Tagg, Esq.,
River Engineering Department,
Hydraulics Research,
WALLINGFORD,
Oxfordshire. OX10 8BA

Dear Mr. Tagg,

Your letter has just been forwarded to me, and your project would appear to be of great interest to us, as we have several gauging stations where there are problems in measuring flood flows accurately. I have enclosed a list of our gauging stations which contains an indication of their suitability for flood gauging.

At present in the Thames area (the catchment as far downstream as Teddington), the primary means of data collection is by charts, although loggers are gradually being introduced. Almost all stations that become non-modular in high flows are equipped with tail and/or pressure tapping recorders. Non-modular flows are calculated manually, and converted back to a non-modular level which is drawn on the chart before processing.

When a weir becomes totally drowned with little, if any, drop in water level over it, flow calculation becomes much more difficult. If the channel downstream remains reasonably constant, then the rating can be extended by current meter gauging of flood flows. Flow over the flood plain can also be measured and taken into account, although, of course, there may be a very large increase in flow for a very small increase in head once the river is out of its channel. Examples of this type of station are Kinnersley Manor on the Mole and Tilford on the Wey. The Cherwell at Enslow never goes over the wing walls at the weir, but does overflow upstream and bypass the weir through flood arches in a railway embankment.

The problem with flood gauging is that it takes several years to get enough points to establish an extended rating, and there is always a possibility that conditions will change in that time.

Gauging stations on tributaries close to the confluence (e.g. Water Eaton on the Ray and Meysey Hampton on the Marston Meysey Brook) are affected by the backwater from the main channel. At these sites, comparison has to be made with neighbouring stations and rainfall figures to try and ascertain which peaks are caused by flood flows in the river and which are the result of high levels in the main channel.

This is rather problematic and so consideration is being given to using ultrasonic or electromagnetic gauging stations at important sites.

Problems in the Lee area are much the same. The Cripsey Brook and High Ongar are examples of stations which drown and go out of banks. Flood flow measurement at the London gauging stations does not appear to have received very high priority in the past.

If you would like to discuss your project further, please contact me and I will arrange a meeting with our Hydrometric Section.

W D Rylands

W. D. RYLANDS

Flood Hydrologist

Thames Water

Gauging Station No.	Sub-Catchment No.	Sub-Catchment River	Gauging Station	National Grid Reference	Catch Area (Km^2)	Type of Station	Records Commence	Recording Equipment: Head	Crest	Tail	Telemetry	Use of Stn	Flood Studies Stn Grading	Qual. of Data	Stn. Class'n.	Comments
1200		THAMES	EYNSHAM	SP446087	1616	MIS	1951	2M		M		CLOR	A1	G	1	
1290	12	EVEN-LODE	CASSINGTON	SP448099	430	CC CR BC	1968	2M, 2FP				CO	A1	G	1	
1420	14	CHERWELL	BANBURY	SP458411	199.4	CC	1966	M,FP				DO	A1	G	2	
1439	14	SOR BROOK	ADDERBURY	SP475346	106	CR	1967	M		M		CO	A2	G	3	Weir reconstructed 1982
1460	14	CHERWELL	ENSLOW	SP482183	552	CC BC	1965	2M,FP				C	B	G	1	By-passed at high flow
1761	17	LETCOMBE BROOK	LETCOMBE BASSETT	SU375853	2.7	FV	1971	M				O	A1	G	3	Weir reconstructed 1982
1790	17	OCK	ABINGDON	SU486969	234	CR	1962	M		M		CD	A1	G	1	Weir reconstructed 1979 and moved
1800		THAMES	SUTTON COURTENAY	SU516946	3414	US	1973	EM			Radio	(CF)	A2	I	1	Possible future alternative to Days
1900		THAMES	DAYS WEIR	SU568935	3445	MIS	1938	M		M		CL	A1	G		
1970	19	THAME	SHABBINGTON	SP670055	443	BC	1968	M				C	B	I	1	New station required then 4
1995	18	EWELME BROOK	EWELME	SU642916	13.4	FV	1971	M				L	A1	G	3	Weir reconstructed 1995
2000		THAMES	BENSON	SU613912		MIS		M		M			A2		4	Not yet calibrated
2190	21	PANG	PANGBOURNE	SU634766	171	CR	1968	M,FP	M			C	A2	G	1	
2210	22	KENNET	MARLBOROUGH	SU187686	142	CR,BC	1972	M,FP	M			R	A1	G	3	
2219	22	OG	POULTON FARM	SU194697	59.0	FV	1980	M		M		R	A2	G	2	
2229	22	ALD-BOURNE	RAMSBURY	SU288717	53.1	2 FV	1982	2M		2M		R	A2	G	2	
2230	22	KENNET	KNIGHTON	SU295410	295	2 CR	1962	2M		M		ROL	A2	I	2	Frequently drowned
2239	22	DUN	HUNGERFORD	SU321685	101	CR	1968	M,FP				R	A1	G	3	
2253	22	LAMBOURN	EAST SHEFFORD	SU390745	154	CC	1966	M		M		RO	A2	G	2	Frequently drowned Closed 1992

Gauging Station No.	Sub-Catchment No.	Sub-Catchment River	Gauging Station	National Grid Reference	Catch Area (Km^2)	Type of Station	Records Commence	Recording Equipment: Head	Recording Equipment: Crest	Recording Equipment: Tail	Recording Equipment: Telemetry	Use of Stn	Flood Studies Stn Grading	Qual. of Data	Stn. Class'n.	Comments
2255	22	LAMBOURN	WELFORD	SU411731	176	CC	1962	M					A1	G	4	Closed 1982 Not needed
2264	22	WINTER-BOURNE	BAGNOR	SU453694	49.2	CR	1962	M		M	Radio	RO	A2	G	2	
2269	22	LAMBOURN	SHAW	SU470682	234	CR	1962	EM		EM	Radio	CRO	A2	G	1	
2279	22	ENBORNE	BRIMPTON	SU568648	148	CC	1967	M,FP			Radio	CFO	A1	G	1	Telemetry in hand
2290	22	KENNET	THEALE	SU649708	1033	CR	1961	EM	EM	EM	Radio	CQOF	A2	G	1	
2420	24	LODDON	SHEEPBRIDGE	SU720652	164	2.CR	1965	EM,M			Tel	CF	A1	G	1	
2442	24	WHITE-WATER	LODGE FARM	SU731523	44.6	CR	1957	M	M	M		RO	A2	G	2	
2458	24	HART	BRAMSHILL	SU755598	84	CR	1972	M,FP	M	M		C	A2	G	3	
2469	24	BLACK-WATER	SWALLOWFIELD	SU731648	355	2.CR	1952	2M,2FP	2M		Radio	CQF	A1	G	1	Telemetry in hand
2590	25	WYE	BEDSOR	SU896867	137	CR	1964	M			Radio	CQF	A1	G	1	Telemetry in hand
2600		THAMES	BRAY	SU909797	6915	MIS	1953	M		M			B	P	4	
2620	26	THE CUT	BINFIELD	SU853713	50	MIS	1957	M				C(D)	A1	G	2	
2700		THAMES	ROYAL WINDSOR PARK	SU982773		US	1979	M,FP			Radio	CFO	A1	G	1	
2819	28	VER	HANSTEADS	TL151020	132	CC	1956	M,FP				R	A1	G	1	
2830	28	COLNE	BERRYGROVE	TQ123982	352	SC	1934	M				C	B	I	2	By-passed at medium flow
2841	28	GADE	BURY MILL	TL053077	48.2	FL	1968	M					B	I+	4	Excessive tail water control
2842	28	BUL-BOURNE	WATERS ROAD	TL055059	61.1	FL	1969	M					B	I-	4	" "
2844	28	BUL-BOURNE	OLD FISHERY LANE	TL039062	56.9	FL	1969	M					B	I-	4	" "

Gauging Station No.	Sub-Catchment No.	Sub-Catchment River	Gauging Station	National Grid Reference	Catch Area (Km^2)	Type of Station	Records Commence	Recording Equipment: Head	Recording Equipment: Creat	Recording Equipment: Tail	Recording Equipment: Telemetry	Use of Stn	Flood Studies Stn Grading	Qual. of Data	Stn. Class'n.	Comments
2849	28	GADE	CROXLEY GREEN	TQ082952	184	CC BC	1970	2M,FP				CR	A1	I	1	
2859	28	CHESS	RICKMANSWORTH	TQ066947	105	CR	1974	M,FP				CR	A1	G	1	
2870	28	COLNE	DENHAM	TQ052864	743	BC	1953	M,FP			Radio	CFQO	A1	G	1	Telemetry in hand
2875	28	MIS-BOURNE	QUARRENDON MILL	SU975963	170	MIS	1978	M				R	A2	P	4	When investigation completed
~~2890~~	28	MIS-BOURNE	DENHAM				1983				Radio	CR			1	Under construction Telemetry in hand
3020	30	WEY (NORTH)	FARNHAM	SU838462	118.4	SC	1978	M		M		C	A1	G	2	Temporary site under review
3040	30	WEY	TILFORD	SU874434	396	CR	1954	M,FP	M		Tel	CF	A1	G	1	
3074	30	LAW BROOK	ALBURY	TQ045~~48~~ 468	16	TP	1968	M				OL	A1	G	3	
3079	30	TILLING-BOURNE	SHALFORD	TQ000478	59	CR	1968	M,FP	M			ROL	A1	G	2	
3090	30	WEY	WEYBRIDGE	TQ068641	1008	US	1979	M,FP			Radio	CFQO	A2	I		
3210	32	MOLE	GATWICK AIRPORT	TQ260399	31.8	F.L	1961	M				D	A1	G	3	
3229	32	GATWICK STREAM	GATWICK LINK	TQ285417	33.6	CR	1975	M	M			D	A2	G	3	
3230	32	MOLE	HORLEY	TQ271434	90	B.C	1961	M		M		D	A1	G	4	
3240	32	MOLE	KINNERSLEY MANOR	TQ262462	145	FL SC	1972	M			Radio	CFQ	A1	G	2	Telemetry in hand
3270	32	MOLE	CASTLE MILL	TQ179502	316	CR	1971	M,FP				CF	A1	G	2	
3290	32	MOLE	ROYAL-MILLS	TQ131654		US					Radio	CFO			1	Not yet commissioned
3390	33	HOGSMILL	KINGSTON	TQ182688	69	BC	1956	M				CO	A1	G	1	
3400		THAMES	KINGSTON	TQ177698	9948	US	1975	S			Radio	COLFQ	A1	G	1	
		THAMES	TEDDINGTON	TQ~~173713~~ 177714	9950	MIS	1883	M		M		COLQF	A2	I	2	Back-up to Kingston

Gauging Station No.	Sub-Catchment No.	Sub-Catchment River	Gauging Station	National Grid Reference	Catch Area (km^2)	Type of Station	Records Commence	Recording Equipment: Head	Recording Equipment: Creat	Recording Equipment: Tail	Recording Equipment: Telemetry	Use of Stn	Flood Studies Stn Grading	Qual. of Data	Stn. Class'n.	Comments
4640	46	LEE	LUTON HOO	TL118185	70.7	MIS	1960	M,LS			Tel	CRP	B	G	2	
4690	46	LEE	WATERHALL	TL299099	150	C	1971	M,FP			Tel	CLFQ	A1	G	1	
4730	47	MIMRAM	WHITWELL	TL184212	39.1	C	1970	M,FP				R	A1	G	3	
4770	47	MIMRAM	FULLING MILL	TL225169	98.7	C	~~1966~~ 1974	M,FP				RL	A1	G	3	
4790	47	MIMRAM	PANSHANGER	TL282133	133.9	FL	1952	M,FP			Tel	CRL	A1	G	1	
4827	48	STEVENAGE BROOK	BRAGBURY PARK	TL274211	36.	FV	~~1956~~ 1972	M,FP			Tel	CDP	A1	G	2	
4890	48	BEANE	HARTHAM	TL315131	175.1	FV	1979	M,LS			Tel	CRP	A1	G	1	
4939	49	QUIN	GRIGGS BRIDGE	TL392248	59.4	FV	1978	M,FP			Tel	CRP	A1	G	2	
4980	49	RIB	WADESMILL	TL360174	136.5	FL	1959	M,LS			Tel	CRLP	A2	G	1	
4990	49	RIB	HERTS TRAINING SCHOOL	TL335158	148.1	TP	1956	M,FP				L	A2	I	47	Low flows only
5080	50	ASH	HARLOCK	TL393148	78.7	FV	1939	M,LS			Tel	CRP	A2	G	1	
5090	50	ASH	EASNEYE	TL380138	85.2	TP	1960	M,FP				L	A1	I	47	Low flows only
5102 5104	51	STANSTED SPRINGS	MOUNTPITCHET	TL500246	N/A	2 TP	~~1962~~ 1963	2M,2FP				R	A1	G	3	
5129	51	STANSTED BROOK	GIPSY LANE	TL506241	25.9	FV	1977	M,LS			Tel	CP	A1	G	2	
5169	51	PINCEY BROOK	SHEERING HALL	TL495126	54.6	FV	1974	M,FP				CD	A1	G	2	
5180	51	STORT	BURNT MILL	TL445112	233	MIS	1953	M			Tel	FL	D	G	2	
5189	551	CANONS BROOK	ELIZABETH WAY	TL431104	21.4	FL	1950	O,FP			Tel	CD	A1	G	4	
5190	51	STORT	GLEN FABA	TL391092	280.2	US	1976	S			Tel	CP	A1	P	1	Station to be re-equipped
5280	52	LEE	RYE HOUSE			US					Radio				1	Not yet constructed

Gauging Station No.	Sub-Catchment No.	Sub-Catchment River	Gauging Station	National Grid Reference	Catch Area (Km²)	Type of Station	Records Commence	Recording Equipment: Head	Crest	Tail	Telemetry	Use of Stn	Flood Studies Stn Grading	Qual. of Data	Stn. Class'n.	Remarks
5290	52	LEE	FEILDES WEIR	TL390092	1036	MIS	1858	M,FP		M,FP	Tel	CHOPL	B	G	1	
5302		EFFLUENT CHANNEL	RYE MEADS	TL392097	N/A	C	1977	M,FP				OQ	A2	G	2	
5329	53	COBBINS BROOK	SEWARDSTONE ROAD	TQ387999	38.4	FL	1971	M,FP			Tel	CFD	A2	G	2	
5338	53	SMALL RIVER LEE	ORDNANCE ROAD	TQ370988	41.5	FV	1973	M,FP	M,FP		Tel	C	C	G	3	Frequently drowned
5349	53	TURKEY BROOK	ALBANY PARK	TQ359985	42.2	FV	1971	M,FP			Tel	CF	A1	G	3	
5359	53	SALMONS BROOK	EDMONTON	TQ342937	20.5	FV	1956	M,FP				CD	A1	G	3	Upgrade to 2 if telemetered
5369	53	PYMMES BROOK	SILVER STREET	TQ340925	42.6	C	~~1954~~ 1971	M,FP	M,FP	M,FP	Tel	CFD	A2	G	2	
5380	53	R. LEE FLOOD CHANNEL	LOW HALL	TQ356880	1243	C	1972	M,FP			Tel	OP	A2		3	
5410	54	RODING	AYTHORPE RODING	TL582152	38.3	MIS	1963	M					B	I	4	Very poor structure
5420	54	RODING	HIGH ONGAR	TL561040	95.1	EW	1963	M,FP	M,FP	FP	Tel	CF	-	G	2	
5427	54	CRIPSEY' BROOK	CHIPPING ONGAR	TL548035	62.2	FV	1966	M,LS	M,LS		Tel	CF	A1	G	2	
5470	43	RODING	LOUGHTON	TQ442955	269	C	1971	M,LS	M		Tel	F	A1	P	4	Can no longer be used
5480	54	RODING	REDBRIDGE	TQ415884	303.3	EW	1950	M,FP			Tel	CRFO	A1	G	1	
5541	55	BEAM	BRETONS FARM	TQ515853	49.7	EW	1965	M,FP	M		-	CF	A1	G	1	
5550	55	INGRE-BOURNE	GAYNES PARK	TQ553862	47.9	C	1970	M,FP	M		Tel	CF	A1	G	1	
5640	56	DARENT	OTFORD	TQ525584	87.5	CC	1969	M		M		R	A2	G	2	
5660	56	DARENT	LULLINGSTONE	TQ531643	118	BC	1969	M				R		G	2	
5680	56	DARENT	HAWLEY	TQ551718	191	CR	1963	M				CR	A1	G	1	
5689	56	CRAY	CRAYFORD	TQ511746	122	CC	1969	M		M		C	A2	G	1	

Anglian Water

Mike Wakelin *OPERATIONS MANAGER*
LINCOLN DIVISION

P.O. Box 62.
Waterside North.
Lincoln LN2 5HA.
Tel: Lincoln (0522) 25231

Telex 56467
Fax Lincoln (0522) 44684

This matter is being handled by

Our Ref
MJW/LC/H5

Your Ref
R/S0013F

27th November 1986

Dear Mr Tagg

Flood Discharge Assessment

Thank you for your letter dated 28th October 1986.

A copy of your letter has been received by our Regional Headquarters and I have supplied certain information by that route.

If you have not received this information already, then it should be with you shortly.

Yours sincerely

Peter Flood

Operations Manager

A F Tagg Esq
River Engineering Department
Hydraulics Research Ltd
Wallingford
Oxfordshire
OX10 8BA

Anglian Water

Peter Bullock
DIRECTOR OF TECHNICAL SERVICES

Ambury Road, Huntingdon,
Cambs. PE 18 6NZ
Tel Huntingdon (0480) 56181

his matter is
eing handled by

Our Ref.
AHB/VJH SB/5

Your Ref:

25th November, 1986

WR/Disk
~~ERI~~ !?
PGS

Dear Mr. Tagg,

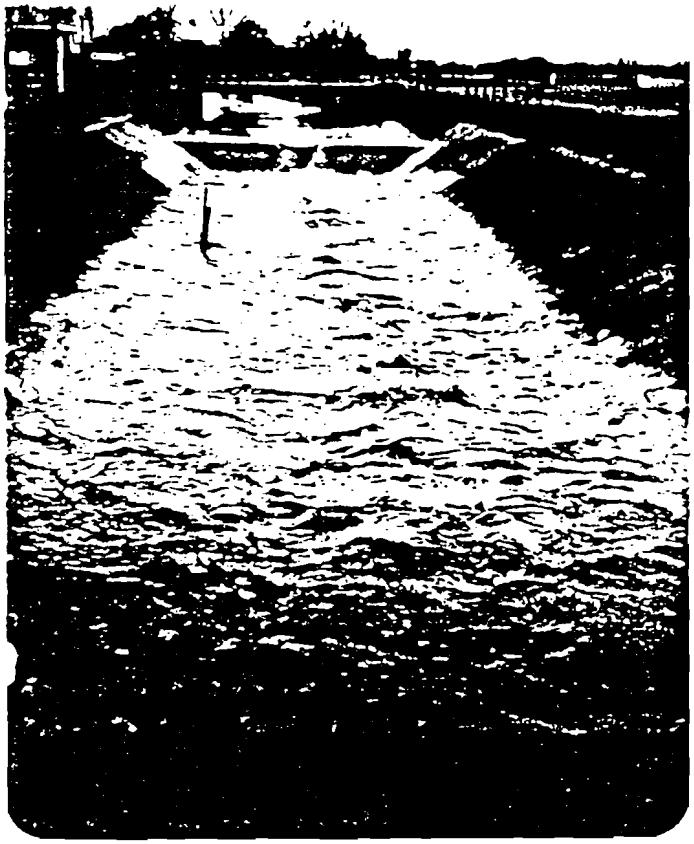
Flood Discharge Assessment

With reference to our previous correspondence on this topic, I understand that you have already written direct to our Divisions requesting assistance with your research. I believe you will have received replies direct from them by now, to which I would have nothing further to add.

Yours sincerely,

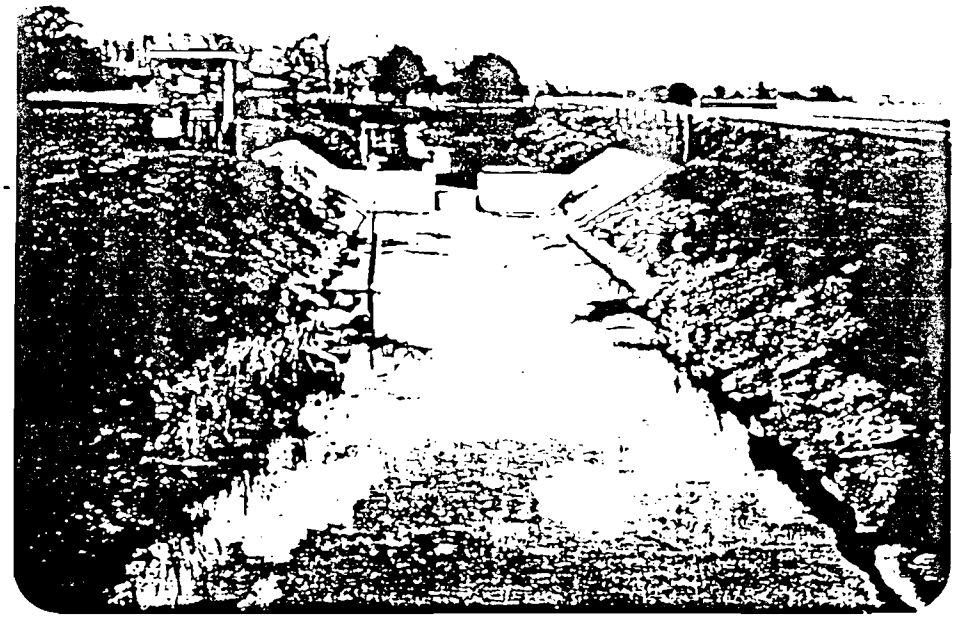
Andrew Hunter Blair
Principal Engineer (Rivers)
Strategy

. F. Tagg Esq.,
iver Engineering Department,
ydraulics Research,
allingford,
xon,
X10 8BA.

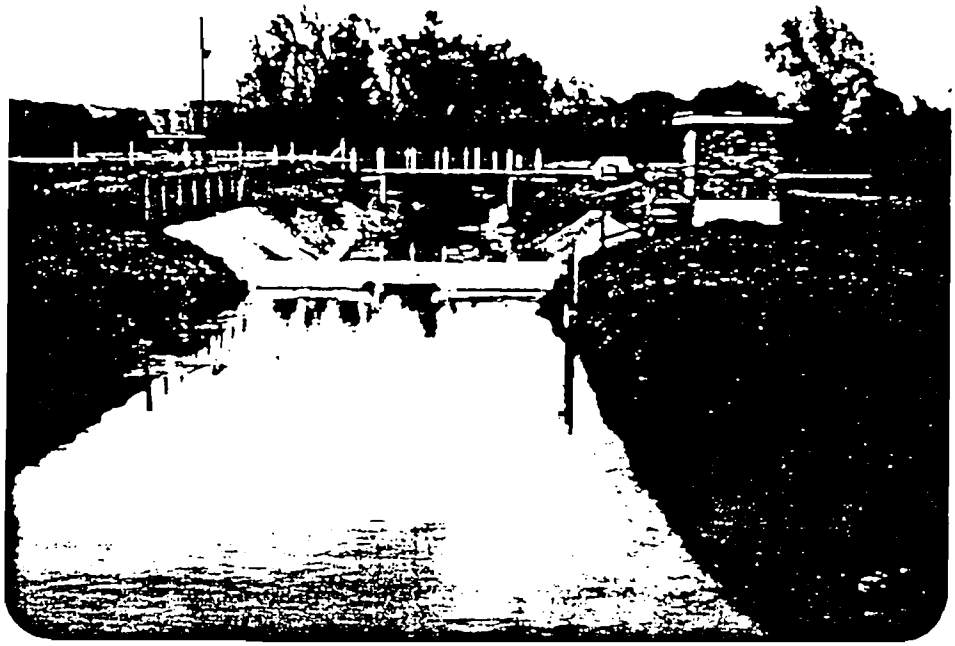


MARCH 1982 ; NO UPSTREM GAUGE BOARDS.

BRAMPTON WEIR ALCONBURY BROOK



D/S looking U/S



U/S looking D/S

(May 1980)

MEAGRE FARM WEIR

(River Kym)

U/S looking D/S

D/S looking U/S

(May 1980)

Northumbria House,
PO Box 4 Gosforth
Regent Centre,
Gosforth,
Newcastle upon Tyne NE3 3PX
Telephone: Gosforth (091) 284 3151
Telex: 537419

Northumbrian Water

Your Ref

Our Ref JMS/AS

Date 30 December 1986

This matter is being attended to by
Mr J M Storey : Ext 1420

Mr A F Tagg
River Engineering Department
Hydraulics Research Limited
Wallingford
Oxfordshire
OX10 8BA

Dear Mr Tagg

FLOOD DISCHARGE ASSESSMENT

Further to our recent telephone conversation regarding your research project, I am attaching details of gauging stations in this Authority's area for which there is some uncertainty in the rating at higher discharges. This is due to either a shortage of current meter gaugings at the relevant stages, significant flow on the flood plain at high discharges or in some cases, a combination of the two.

At present flood discharges are assessed at these stations by extrapolation of the gauged rating and examination of the mean velocity/stage relationship. Where there is significant flow on the flood plain the estimated mean velocity is applied to the surveyed cross-section with some allowance made for reduced velocity outside the main channel. It is recognised that these methods are not fully satisfactory and I look forward with interest to receiving further details of your proposed research in this important topic.

Yours sincerely

Mike Storey

J M STOREY
Hydrometrics Co-ordinator

ENCL

Station	River	Stage at bank - full Metres	Highest recorded stage Metres	Est. uncertainty at peak stage %
Mitford	Wansbeck	1.75	3.43	25
Haydon Bridge	South Tyne	3.40	3.99	15
Bywell	Tyne	5.40	5.9	15
Sunderland Bridge	Wear	1.6	3.0	25
Rutherford Bridge	Greta	1.52	2.86	30
Low Moor	Tees	4.45	6.22	25