Annual report : 1st (1935/36) / Inland Water Survey Committee.

FIRST ANNUAL REPORT OF THE INLAND WATER SURVEY COMMITTEE 1935-36

LONDON
PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE
To be purchased directly from H.M. STATIONERY OFFICE at the following addresses:
Adastral House, Kingsway, London, W.C.2; 120 George Street, Edinburgh 2;
York Street, Manchester 1; 1 St. Andrew's Crescent, Cardiff;
80 Chichester Street, Belfast;
or through any Bookseller
1936
Price 3*d*. Net

INLAND WATER SURVEY COMMITTEE

FIRST ANNUAL REPORT 1935–6

To the Right Honourable Sir KINGSLEY WOOD, M.P.,
Minister of Health, and

To the Right Honourable Sir GODFREY COLLINS,
K.B.E., C.M.G., M.P., Secretary of State for
Scotland.

GENTLEMEN,

We have the honour to submit the following report on our work for the period ended the 31st March, 1936:—

1. There has been a growing demand in recent years for more reliable information regarding the water resources of the country. Such information is of importance to a variety of interests—agriculture, land drainage, fisheries, industry, navigation, sewage disposal and water supplies—and this variety of interests is reflected in the reports of numerous Royal Commissions and Committees, including the Royal Commissions on Salmon Fisheries, 1902, Sewage Disposal, 1908, and Canals and Waterways, 1910, the Select Committee on the Water Supplies Protection Bill, 1910, the Water Power Resources Committee, 1921, and the Committee on Scottish Health Services, 1934, where comment is made on the imperfect state of knowledge on the subject and on the need for improved measurement and recording and the correlation and publication of the results.

Following the meeting of the British Association held at York in September, 1932, a Research Committee of the Association was appointed to enquire into the position of Inland Water Survey in the British Isles and the possible organisation and control of such a survey by some central authority. The Committee came to the conclusions that a systematic survey of the water resources of Great Britain is urgently required, and that the survey, to be of maximum utility, should be conducted by a central organisation, preferably under a Government Department, independent of any interest in the administration, control, or use of water. The British Association then investigated, in conjunction with the Council of the Institution of Civil Engineers, the possibility of starting an investigation in a small way financed by subscriptions from individuals and bodies interested, but owing to the adverse response as regards finance, this was found to be impracticable.

The urgent need for such a comprehensive survey gained fresh prominence during the severe drought of the years 1933 and 1934, and in 1934, a joint memorandum was addressed to the Government by the British Association and the Institution of Civil Engineers urging the carrying out of a national survey; a deputation from these bodies was received by the then Minister of Health. As a result, the Government decided that an Inland Water Survey for Great Britain should be carried out, and we were appointed in January, 1935, by the Minister of Health and the Secretary of State for Scotland, as a Committee

> "to advise on the Inland Water Survey for Great Britain, on the progress of the measures undertaken and on further measures required and, in particular, to make an annual report on the subject."

2. In the past such information has been collected at intervals and to a limited extent. As long ago as 1872, the British Association appointed a Committee to investigate the circulation, quantity and character of underground water, and annual reports of those investigations were published up to 1895. The Secretary, Mr. C. E. de Rance, published in 1882 a book " The Water Supply of England and Wales " with particulars of geology, underground circulation, surface distribution and rainfall.

The Geological Survey in the course of their normal work have acquired much information about wells and bore-holes, and some of this information has been published in memoirs relating to a number of Counties. Much of the information in the possession of the Geological Survey requires verification, expansion and correlation with other records before it can be utilized as part of an Inland Water Survey. The Ministry of Health also in the discharge of their functions relating to public water supplies have accumulated a good deal of information on the subject of existing public water undertakings. Generally speaking, however, it may be said that such records as exist have been kept mainly for the individual use of those immediately concerned, and that no comprehensive effort has hitherto been made to collect records of overground and underground water centrally and to correlate them.

Object and Task of Survey.

3. It was stated in answer to questions in the House of Commons that the object of the present survey would be to collect reliable records of river flow and underground water and to correlate them, so that fuller information of water resources may be gained, that the information required for the purposes of the survey would be obtained from Water Undertakers, Catchment Boards and other bodies and persons and that measures would be taken to encourage the keeping of the necessary records where they are desirable but are not now kept.

4. The purpose of the survey is to correlate the information at present obtained from all sources, to extend and increase the sources of information, and to make the information readily available for the use of the interests concerned. With the problems of the allocation of water to the various interests the survey is not concerned.

5. An adequate survey such as is now in contemplation involves systematic measurement over long periods of both overground and underground water, the collection and recording of the measurements in a uniform manner and the publication of the records together with rainfall statistics so that the relation between the precipitation of water, the run-off, underground storage, and losses due to absorption and evaporation may be ascertained.

6. For overground water, the problem is largely one of securing the provision at suitable points of the measuring apparatus best adapted to the local conditions and of making the calculations from which accurate records of the discharge may be obtained. In view of the frequent changes in the flow of water passing the gauging points, continuous recording will in most cases be essential.

7. Underground water presents a complex and difficult problem, and the survey in this case is largely a matter of research—the observation of a great variety of data and drawing inferences from them.

Underground water may be regarded as being contained in porous strata and fissured rock forming a series of reservoirs, in which the quantity of available water varies according to local geological and other conditions. In this country, the area, thickness, depth below the ground-surface and capacity of the strata which constitute these reservoirs are at present only partly known.

An adequate survey of underground water can be carried out only by the correlation of the geological and hydrological data, and for this purpose it is necessary to determine the water-bearing and non-water-bearing areas; to estimate the depths below the surface, and the thicknesses and changes in thickness from place to place, of water-bearing strata; to consider the water-bearing capacity of individual beds; to consider the effects of changes of rock types and of structural features such as faults and folds; and to identify areas where waters have a special quality such as salinity, alkalinity, etc.

Procedure and Progress of Survey.

8. The Committee's work during this first year has necessarily been of an exploratory nature. The first task was to endeavour to ascertain where records are being kept and measurements of water are now being made, how the results are recorded and what methods and apparatus are used. With this object, a questionnaire (see Appendix to this report) was issued at our request by the appropriate Government Departments to all Local Authorities, Water Undertakers, Catchment Boards, Fishery Boards, Electricity Undertakers, Navigation Authorities and Industrial concerns and others known to be using water. At the same time, an attempt was made by inquiry of Local Authorities to complete the list of industrial undertakings and private individuals abstracting water for other than private domestic or agricultural purposes.

9. We have been impressed by the readiness of persons to place information in their possession at our disposal, and by the general desire to assist in the work. One interesting example of this desire to help has been the offer of the British Speleological Association of assistance in the tracing and measurement of underground streams, a work of importance in the study of water resources.

10. Replies to questionnaires have so far been received from some 3,000 bodies and persons. The replies show that there is in the Country a good deal of information, but that it is varied in type and date, is insufficient, and lacks that measure of co-ordination and distribution which would enable it to be used as the basis of a general survey without revision and much amplification. It is therefore necessary to build up a much improved system of gauging and recording, and we have turned our attention to the means by which this may be secured.

11. From the returns which relate to overground water, it is found that there are relatively few instances where information goes beyond a simple record of water levels of rivers and streams, and therefore where the gauging stations, which have been installed for particular local purposes, are also suitably situated from the point of view of a general survey, it will usually be necessary to make other measurements in order to convert the level readings into records of volumes discharged. The experience we have already gained indicates, however, that the number

and distribution of existing gauging points are altogether insufficient to provide the information which is essential for an adequate survey of overground water. Many new gauging stations will be required, and their positions will have to be carefully selected.

12. A characteristic of many British rivers is the frequent occurrence of mills, weirs, navigation locks and other means of controlling the flow of the river, and these control works tend to make discharge measurements a difficult matter. Whilst it is true that discharge measurements can be made at a control work, if both the upstream and downstream levels are known as well as the depth over the weir crest or the size of opening of the sluice, in practice the control work often has a crest of irregular level or is a structure that is in bad condition and leaky; moreover, it is common for the river when in flood to overflow its banks and circumvent the control work. The control work may consist of any or all of the following—a weir, a mill-sluice, a navigation lock, a fish-pass and a bye-pass for emptying the weir pool if work on the structure is necessary. There may therefore be at any one control-work several points at which measurements would have to be made.

In any system of gauging stations for the purposes of the survey, it will be necessary, if expense and effort are to be economised, to adopt as gauging stations some structures not originally designed for the purpose, and to secure discharge measurements from broad-crested and/or drowned weirs as well as from sharp-edged weirs with clear overfalls. The formulae applicable to broad-crested weirs are capable of improvement, and it is satisfactory to record that some investigations to this end are being made at both the University of Manchester and the Imperial College of Science and Technology in London.

13. It appears to us that in England and Wales the Catchment Boards established under the Land Drainage Act, 1930, are the appropriate bodies to instal gauging stations and make and record measurements of the flows of the rivers which they control. Indeed, it would seem that the ascertainment in some detail of river flows and their variation by Catchment Boards is necessary for the carrying out of their land drainage functions. This is recognised by the Minister of Agriculture and Fisheries, and we understand that where gauging installations are provided by Catchment Boards as part of proposed improvement works, the cost of the installation may be included in the cost of the improvement works eligible for grant under the Act; further, that where gauging installations are provided by Catchment Boards for the purpose of obtaining information preliminary to the formulation of a scheme of improvement, the cost of installation may, if the scheme matures, be included for grant purposes in the cost of the scheme. We reached the conclusion that endeavour should be made to secure the early co-operation of the Catchment Boards in installing such additional river gauging stations as may be found to be necessary for the survey, and the progress already made in this direction encourages us to hope for the ready co-operation of all Catchment Boards.

There is also a large area in England and Wales which does not come under the control of the existing Catchment Boards; this should be included in the scope of the Inland Water Survey at a later period, but for the present we are concentrating our attention on the areas for which Catchment Boards have been appointed.

14. As regards underground water, the success of the survey depends not only on the completeness and accuracy of the records of strata obtained by boring or sinking, but also very largely on the numbers and distribution of wells in which measurements of rest-levels and/or pumping levels may be taken. A large number of the replies received to the questionnaire show that the local records are lacking in some branches of information required, and that further enquiries, local investigation and field work will have to be undertaken.

The distribution of underground water is dependent upon the geological structure, and a survey of underground water involves work for which special knowledge is required. In the circumstances, it appears to us that the work of examining and correlating, and securing the amplification of the information on this subject could best be done by the Geological Survey who have on their staff persons with the necessary knowledge and experience. We are, therefore, glad to report that the Committee of the Privy Council for Scientific and Industrial Research have agreed that the Geological Survey should assist in this work.

15. At an early stage it became clear that the examination in some detail of the conditions existing in the various catchments would be necessary before it could be decided whether existing gauging stations for measuring overground water were of any real value, and at what points additional stations were desirable and practicable for the purpose of the survey, and that, while the ground work of the survey proceeds generally, it was desirable to arrange a programme for this detailed examination. We selected the Rivers Nene, Thames and Clyde as the first to be thus dealt with. Reference is made below to the extent and results of examination of these three rivers, and progress has alsb been made with similar examinations of the Catchment Areas of the Avon and Stour, Bristol Avon, Cheshire Dee, Cheshire Rivers, Medway, Severn, Tay, Trent and Wye.

Athough underground circulation of water may sometimes have little relationship to surface drainage, it is not contemplated that any difficulty will arise in basing the study of underground water on approximately the same geographical areas as the Catchment Areas, and it is proposed that the survey of underground water should be by Catchment Areas, the areas being studied and the results published in the same order and as far as possible at the same time for both branches of the survey.

16. Arrangements have been made with the Air Council for the assistance of the Meteorological Office in the survey. The British Rainfall Organisation of the Meteorlogical Office relies in the main on information supplied by voluntary observers who purchase their own instruments. It is estimated that there are 50 stations in the British Isles in which the observers are whole-time or part-time employees of the Meteorological Office, 300 stations where rainfall is measured as part of the routine of general climatological work, 1,000 stations maintained by public authorities or companies concerned with water supply or water power and 4,000 stations maintained by others, mostly private individuals.

As the information is supplied mainly by voluntary observers the tendency naturally is for the rain gauges to be fewer in the areas more remote from the towns. The establishment of rain gauges in these remoter parts, will, however, be of moment to the survey, particularly as the rainfall there is usually heavier than in the adjacent towns. We understand that from the experience gained in the Meteorological Office

there is good prospect of securing, with the aid of private individuals, Local Authorities, and Catchment Boards, the establishment of rain gauges, at points selected by the Meteorological Office, in areas where their distribution is at present insufficient for the purposes of the Inland Water Survey. One of the difficulties in the past has been to get into touch with the right type of observer, and in this we have no doubt that Local Authorities and Catchment Boards will assist the Meteorological Office as they have done in a number of instances in the past.

17. It is proposed that the distribution of the existing rainfall stations, the reliability of the records, and the additional information and stations likely to be required for the survey shall be examined in detail for each Catchment Area, the examination of Catchment Areas for this purpose being carried out at the same time and in the same order as the examination of the areas from the point of view of overground water and underground water referred to in paragraph 15 above. This work is proceeding.

18. In England, underground water is a valuable source of supply for domestic and trade purposes in many areas, for example, those on the Chalk and the Bunter Sandstone, where it forms the only readily available source of supply for large populations, and about one-fourth of the total population is supplied from underground sources. In Scotland, however, the position is essentially different in that there is a general plenitude of surface water and comparatively little use is made or is likely to be needed or made of underground sources of supply. For practical purposes, therefore, the Inland Water Survey in Scotland except for the Midland Valley will deal for the most part with overground water.

19. As regards existing records of overground water the replies to the questionnaire issued show the position in Scotland generally to be much the same as in England and Wales, namely, records have been kept mainly for individual purposes, there is a good deal of information available but it is insufficient for the purposes of the survey. The evaluation and correlation of existing records is being carried out by the Scottish Departments. There is only one Catchment Board in Scotland (operating under a special Act of Parliament) but the Department of Agriculture for Scotland have general powers comparable to those conferred on Catchment Boards in England, whilst certain Scottish County Councils by reason of special Acts of Parliament have powers to impound and distribute water for domestic purposes. It is believed that, with the co-operation of County Councils and Water Undertakers in Scotland, which has already to some extent been forthcoming, the difficulty in securing the installation of additional gauging stations on rivers and streams where needed for the survey may be overcome.

The Nene.

20. The River Nene has a catchment area of approximately 645 square miles above the tidal limit at Peterborough. At present, records of river levels are kept by the Peterborough Town Council at Peterborough, by the Nene Catchment Board at Northampton, Wellingborough and Oundle, and by the Northampton Electric Light and Power Company at Northampton. The Northampton Town Council have an impounding reservoir at Ravensthorpe where they gauge the content of the reservoir

and the quantity of water discharged. The Higham Ferrers and Rushden Water Board also have an impounding reservoir at Sywell where records are kept of the height of water in the reservoir, the overflow and the yield of the gathering ground.

There are numerous mills, weirs and navigation locks affecting the flow of the main river, and making discharge measurements a difficult matter.

21. The Catchment Area of the Nene divides itself naturally into nine compartments (see outline map opposite):

	Catchment Area. Square miles.
1. The Upper Nene	123
2. Brampton Branch	95
3. Nene, between the Brampton Branch and the River Ise	63
4. River Ise	91
5. Nene, between the Ise and Harper's Brook ..	66
6. Harper's Brook	27
7. Nene, between Harper's Brook and Willow Brook	75
8. Willow Brook	38
9. Nene, between Willow Brook and Peterborough	67

22. After consideration of reports of the detailed examination of this Catchment Area we came to the conclusion that it was desirable for gauging stations to be installed for measuring the discharge of the Upper Nene, the Brampton Branch, the River Ise, Willow Brook, and the main river near Peterborough (see outline map). Records from these gauging stations would give the total discharge of each of four tributaries, the total discharge of the whole system above Peterborough and, by deduction, the combined discharge of the Nene proper and Harper's Brook (298 square miles). In view of the number of works affecting the flow of the main river it seems impracticable, at any rate at the present time, to instal any other useful gauging stations on the main river itself. We are pleased to say that the Nene Catchment Board are installing gauging stations at these five points. It is possible that additional arrangements for gauging will be made at Dog-in-a-Doublet a few miles downstream from Peterborough, which would serve as a valuable check on the measurements upstream.

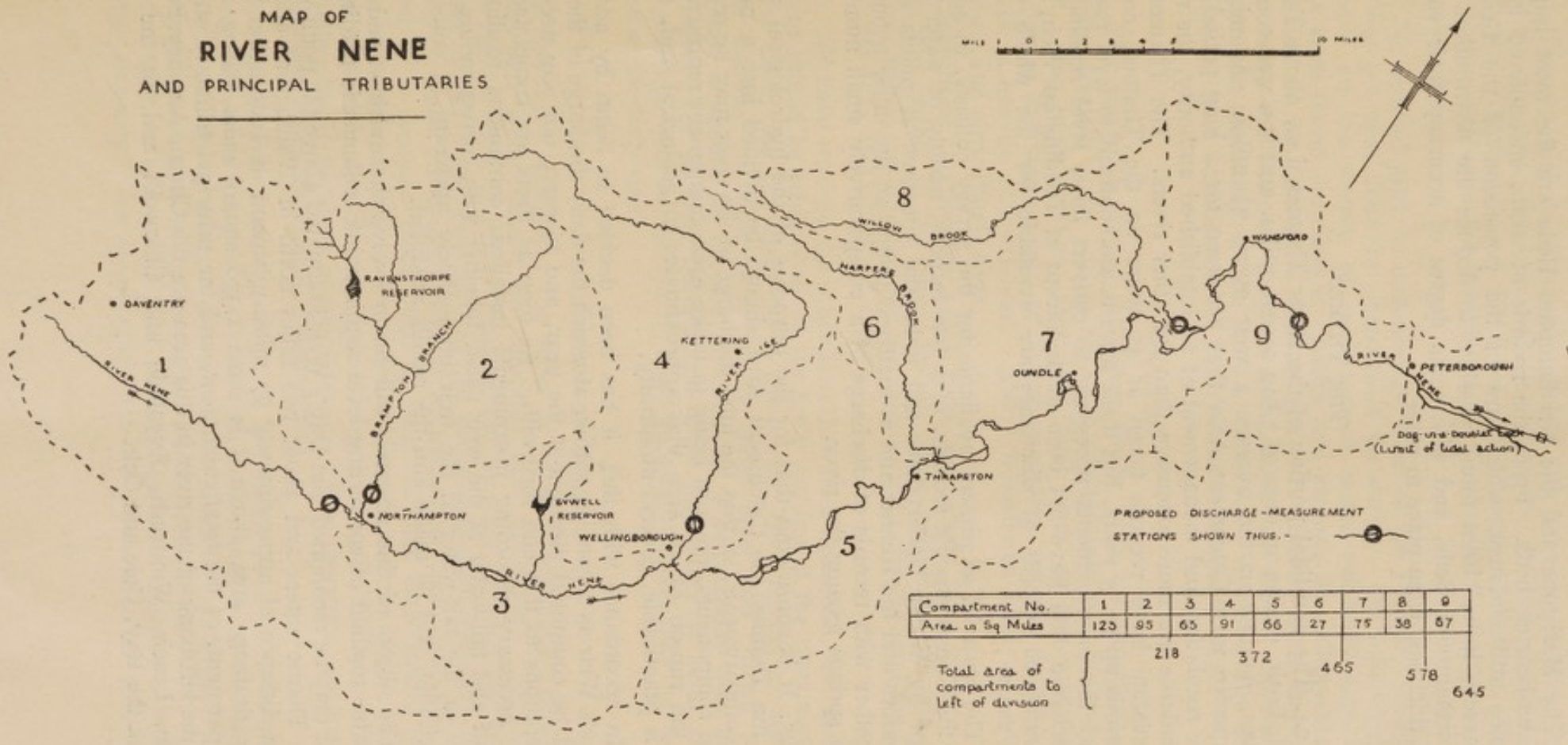
23. The geological strata which outcrop in the Nene Catchment Area are, in downward sequence, as follows: Superficial Deposits (gravels, boulder clay, etc.), Oxford Clay, Cornbrash, Blisworth Clay, Great Oolite, Upper Estuarine Clay, Lincolnshire Limestone, Northampton Beds, Upper Lias, Middle Lias (or Marlstone) and Lower Lias. Of these, the Cornbrash, Great Oolite, Lincolnshire Limestone, Northampton Beds (except the uppermost portion) and the Marlstone are water-bearing. Superficial deposits also give supplies locally.

The strata generally are gently inclined towards the south-east; the oldest formations therefore come to the surface in the north-western part of the catchment, but occur at some depth below the ground surface in the south-eastern part, where they are overlain by younger deposits. In places the strata are considerably dislocated by fractures or " faults ".

MAP OF

RIVER NENE

AND PRINCIPAL TRIBUTARIES



Compartment No.	1	2	3	4	5	6	7	8	9
Area in Sq Miles	125	93	65	91	66	27	75	38	57
Total area of compartments to left of division			218		372		465	578	645

The Marlstone and the Northampton Beds are the most important water-bearing beds. From the records of strata encountered in bore-holes and sinkings, which are in the possession of the Geological Survey, it has been found possible to deduce the distribution of the Northampton Beds, and with some degree of accuracy their variation in thickness from place to place.

The Thames.

24. The non-tidal portion of the River Thames, i.e., above Teddington Lock, drains an area of 3,812 square miles, and is a well-controlled river, having on the average a weir every 3½ miles. As might be expected in a Catchment Area that has been for a long period under the regulation and management of an established authority, the records available are more extensive than for other rivers. The Thames Conservancy have records taken at 45 weirs on the Thames, covering periods up to 53 years, but these records are confined to level readings, and the measurements necessary to convert these level readings into discharge data have not been made except at Teddington Weir, where continuous records of discharge are available for the whole of the 53 years.

The material at present available for the survey consists, in addition to the Conservancy's records, of a few records, mainly of water levels, kept by Water Undertakers and industrial concerns at points on the Thames and the Kennet and at scattered points on the other tributaries, together with records of discharge of a comparatively small number of the springs feeding the river.

25. It is considered that for the purposes of the hydrological survey of the Thames the Catchment Area should be divided into a number of compartments, so that the total discharge of the river may be resolved into components, the aim being to make each component representative of the run-off of an area that approximates to geological and, so far as is practicable, general uniformity.

In accordance with this, it has been decided to begin by adapting Day's Weir as a gauging station at which the daily discharge of the river will be computed throughout the year, and to carry out any necessary alterations to this end forthwith. As soon as these are completed and the necessary recording instruments installed, continuous readings of head and tail-water at the weir itself, together with corresponding readings of the tail-water of the weir immediately upstream, if considered advisable, will be made and the results analysed.

The object of this research will be to evolve the quickest and most reliable method of converting level readings into volumetric readings.

It may be mentioned that Day's Weir is situated above the point where the Thame enters and about two miles north of Wallingford and lies at a distance of approximately 77 miles upstream of Teddington Weir. The drainage area above it is some 1,330 square miles, being about 35 per cent. of the total catchment, and the principal tributary streams on the left bank of the river in this area are the Churn, Ampney Brook, Coln, Leach, Windrush, Evenlode and Cherwell, and on the right bank the Ray, Cole and Ock.

The Thames and its tributaries within this area draw their water from and flow over the Lias and Oolites of the Jurassic System and the Lower Greensand and Gault of the Cretaceous System, Day's Weir being situated at the junction of the Gault with the Upper Greensand and Chalk.

26. No detailed work on underground water of the Thames Catchment Area has yet been done for purposes of the survey. As a preliminary to work on the survey of underground water resources generally, it has been found desirable to classify and arrange the information in possession of the Geological Survey and that derived from the questionnaire on the basis of one-inch scale maps, the survey information is at present assembled on the basis of Counties. Work on this classification has been commenced for the Thames Catchment Area.

The Clyde.

27. The non-tidal part of the River Clyde, with a Catchment Area of approximately 1,200 square miles, is divided into two distinct portions. The lower portion, from the tidal limit at the weir above Glasgow to the famous falls at Stonebyres Linn, about 2 miles below Lanark is heavily industrialised. Above Stonebyres Linn it is purely a fishing and agricultural river.

Observations and records which have been made from time to time at various points in the river are available and these include continuous records made during the last three months of 1923, and the years 1924 and 1925 at Tulliford, Lanark.

28. We have reached the conclusion that, as a minimum, two gauging stations should be established on the lower portion of the river and one on the Daer, the principal upper tributary. The gauging at the two lower stations will necessarily be by water level and current meter readings; it should be possible to construct a rectangular weir across the Daer. The Scottish Departments have the matter in hand and it is hoped that the installation of these gauging stations may be undertaken at an early date.

Publication of Data.

29. We have considered the form in which information relating to overground water should be compiled and published. The actual observations taken at the gauging stations by local agencies will usually consist of (*a*) level readings and (*b*) occasional measurements of discharge. These observations should be treated as basic data and published in a compact form year by year so that each year's results may be compared and combined with those of previous years. In this form they will, even if accompanied by nothing in the way of commentary, be of value to many interests. We, therefore, contemplate publication annually of these observations.

30. The general need, however, is for information in a volumetric form. The usual practice is to use the measurements of discharge to prepare a table or curve from which the discharge corresponding to any level reading of the water surface can be computed. With the aid of this table or curve, the level readings are then converted into discharge statistics. We recommend that the preparation of such tables

or curves and the conversion of level readings into discharge statistics should be dealt with by the Ministry of Health and the Scottish Departments, and that the results should be published at intervals, preferably annually.

We also recommend that for the publication of basic data and primary deductions the statistical rather than the graphical form should be used, and that where records for any group of measuring stations are published the report should be illustrated by a schematic map or diagram showing the relation within the river system of the stations under review.

31. Any further or secondary deductions or studies, such as the relation between rainfall and run-off, which may, at a later stage, be prepared and published by the Central Departments should be published in such a way that they are obviously distinct from the basic data and primary deductions referred to in the preceding paragraphs.

32. Consideration of the form in which underground information should be published has been deferred for the time being.

33. The Committee view with satisfaction what it has been possible to accomplish in the first year and they are greatly indebted to the technical staff of the Departments concerned and to Catchment Boards, Local Authorities, Water Undertakers and industrial firms for assistance given and interest taken.

We have the honour to be, Gentlemen,

Your obedient Servants,

(Signed) H. G. LYONS (*Chairman.*)
CHAS. H. BIRD.
W. S. BOULTON.
GEORGE DALLAS.
G. J. GRIFFITHS.
F. HIBBERT.
CLEMENT D. M. HINDLEY.
S. R. HOBDAY.
W. A. MILLAR.
DAVID PAUL.
B. VERITY.

I. F. ARMER,
Secretary.

23rd April, 1936.

APPENDIX

INLAND WATER SURVEY FOR GREAT BRITAIN

Name or Description of Authority or Undertaking.....

Postal Address .....

.....

.....

(A) OVERGROUND WATER.

(I) (*a*) Do you take systematic records of levels of water in :—

(1) rivers ... ...

(2) streams ... ...

(3) reservoirs ... ...

(4) lakes ... ...

(5) canals or navigable rivers ... ...

(*b*) If so, please give a short description of the method used.

(*c*) How often are the readings taken ?

(*d*) Exact points at which the records are taken. (A map or sketch would be helpful.)

(*e*) Have the levels been related to Ordnance Datum Level or to some other standard (in the latter case please specify standard) ?

(*f*) Are all the levels (*e.g.*, highest and lowest) covered satisfactorily by the records taken ?

(*g*) Are arrangements made for extra readings during rise and fall of floods, etc. ?

(II) What types of systematic records of discharge other than records of levels are kept as regards :—

(1) rivers ... ...

(2) streams ... ...

(3) reservoirs ... ...

(4) lakes ... ...

(5) canals or navigable waterways ... ...

(III) (*a*) Have measurements been made from which the data for levels can be converted to records of discharge of :—

(1) rivers and streams ... ...

(2) reservoirs ... ...

(3) lakes ... ...

(4) canals or navigable waterways ... ...

(*b*) If so, how have these measurements been made (*e.g.*, by current meters, velocities of floats, surveys of sections, calibration of weirs, records of water used for locking, etc.) ?

(IV) (*a*) Are records kept in the case of springs breaking overground of the amount of water yielded ?

(*b*) If so, what form of recording is used ?

(*c*) How often are readings taken ?

(*d*) Exact location of the spring. (A map or sketch would be helpful.)

(V) Since when have the records under I, II, III and IV been kept ?

(VI) Are past records available ?

(VII) Remarks.

(Please indicate here any further information or particulars which may be thought likely to assist in the survey.)

(B) UNDERGROUND WATER—(WELLS AND BORINGS).

(In each case please state whether a well and/or boring is in question.)

I. General.

1. Exact site of well or boring ... ...
(A map or sketch showing position would be useful.)

2. Surface level of ground above Ordnance Datum ... ... ft.

3. Date of construction ... ...

Wells.

4. Depth of well from surface level of ground (*i.e.*, 2 above). If top of well is below the surface level of the ground (*i.e.*, 2 above) state how much ... ... ft.

5. Depth of floor of galleries at site of well : also dimension and direction of galleries ... ... ft.

Borings.

6. Depth of boring from surface level of ground (*i.e.*, 2 above). If boring is in bottom of well, state depth of well... ... ft.

7. (*a*) Diameter of top of boring ... ... in.
(*b*) Diameter of bottom of boring ... ... in.

8. Tubed from top of boring to ... ... ft.

9. Lining tubes perforated at depths of ... ... ft.

10. Water struck during boring at depths of ... ... ft.

11. What was rest level on completion of boring ? ... ...

Wells and Borings.

12. Is the water raised by pump or air lift ? ... ...

13. Depth from top of well or boring to bottom of suction pipe ft.

II. If systematic measurements of water levels are made, state whether these include :—

(*a*) Pumping levels ..... (*b*) Rest levels .....

(*c*) Time of recovery to rest level on cessation of pumping .....

(*d*) Changes in pumping level, if rate of pumping is altered. ... ...

Also state : (*e*) at what intervals records are taken (*i.e.*, daily, weekly, etc.) ... ...

Please furnish a specimen graph of records taken over as long a period as available (up to 1 year).

III. If measurements are made only occasionally, please indicate what is, or has been, done in this respect and furnish examples of any graphs or figures available.

IV. YIELDS.

(1) Number of gallons pumped per hour ... ...

(2) Is pumping continuous ? ... ...

(3) If not, how many hours pumping per day ? ... ...

(4) Maximum daily yields available ... ...

Estimated ... ...

Based on actual tests ... .

V. If a section or record of strata can be given please attach to this form.

VI. (1) If a chemical analysis can be given please attach.

(2) If not state hardness ... ...

(3) For what purpose is the water used ? ... ...

(36177—26) Wt. 1404—9578 2,000 6/38 P. St. G. 372

S.O. Code No. 32—9999