I N S T I T U T E
O F
H Y D R O L O G Y

URBAN HYDROLOGY PROJECT : COLLECTION AND ARCHIVE OF UK HYDROLOGICAL DATA

by

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ABSTRACT

Due to the scarcity of hydrological data relating to the above-ground phase of urban runoff, the Institute of Hydrology has embarked on a data collection programme. This report describes the development of appropriate instrumentation, data collection systems, and subsequent field experiments. The data thus generated, in addition to those deriving from other investigations into sewered catchments in the UK, have been collated into a computer-based archive, available to any organisation which might have need of it.

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1. INTRODUCTION

In 1973, the Institute of Hydrology began a research programme in urban hydrology. One of the aims of the project was the development, in conjunction with the Hydraulics Research Station, of improved methods of storm sewer design. The major innovation was to separate the analytical treatment of the above-ground (principally hydrological) and the below-ground (pipe routing) phases of the rainfall-runoff process. A large proportion of the Institute's research effort was aimed at the first of these two phases, and the scarcity of relevant data led to the work described in this report.

Within the United Kingdom, the principal source of hydrological data for fully-sewered catchments is the Road Research Laboratory's research effort during the 1950s (Watkins, 1962). The flows here were measured at the outflow of sewer systems, and is thus a function of pipe routing as well as surface routing. One of the problems in the development of mathematical models has been to know whether a 'correct' answer has been achieved by a combination of two correct simulations or by a combination of two incorrect but compensating simulations.

The prime requirement for the Institute's study has therefore been the collection of data at the interface between the two phases, or where the water goes underground. Since this particular environment (a road gully) suffers from restrictive space and hostile conditions, measurement of flow is not possible by means of conventional instrumentation; it was necessary to develop new techniques for this purpose. The development of appropriate instrumentation and logging equipment is described in Section 2 of this report. Section 3 then goes on to describe the experiments which were undertaken. At the time of writing (1979), some experiments are continuing. In addition to these field experiments, laboratory catchment data were also collected, as described in Section 4.

To the authors' knowledge, the only previous attempt at such data collection was performed by Johns Hopkins University in Maryland, USA (Schaake, 1969). As the Institute's work progressed, it became clear that a number of European research groups were tackling the same problem, and, in April 1978, these groups were brought together at an International Workshop at the Institute of Hydrology (Kidd, 1978). This workshop permitted analyses to be undertaken on a more extensive data base than would otherwise have been available. The data from Sweden and from the Netherlands is also available in the Institute's archives, although specific permission will be required from the relevant authority before these data are released.

Despite being unsuitable for the separate study of the above-ground phase, the hydrological data from larger catchments (such as those studied by the Road Research Laboratory) are particularly suitable from

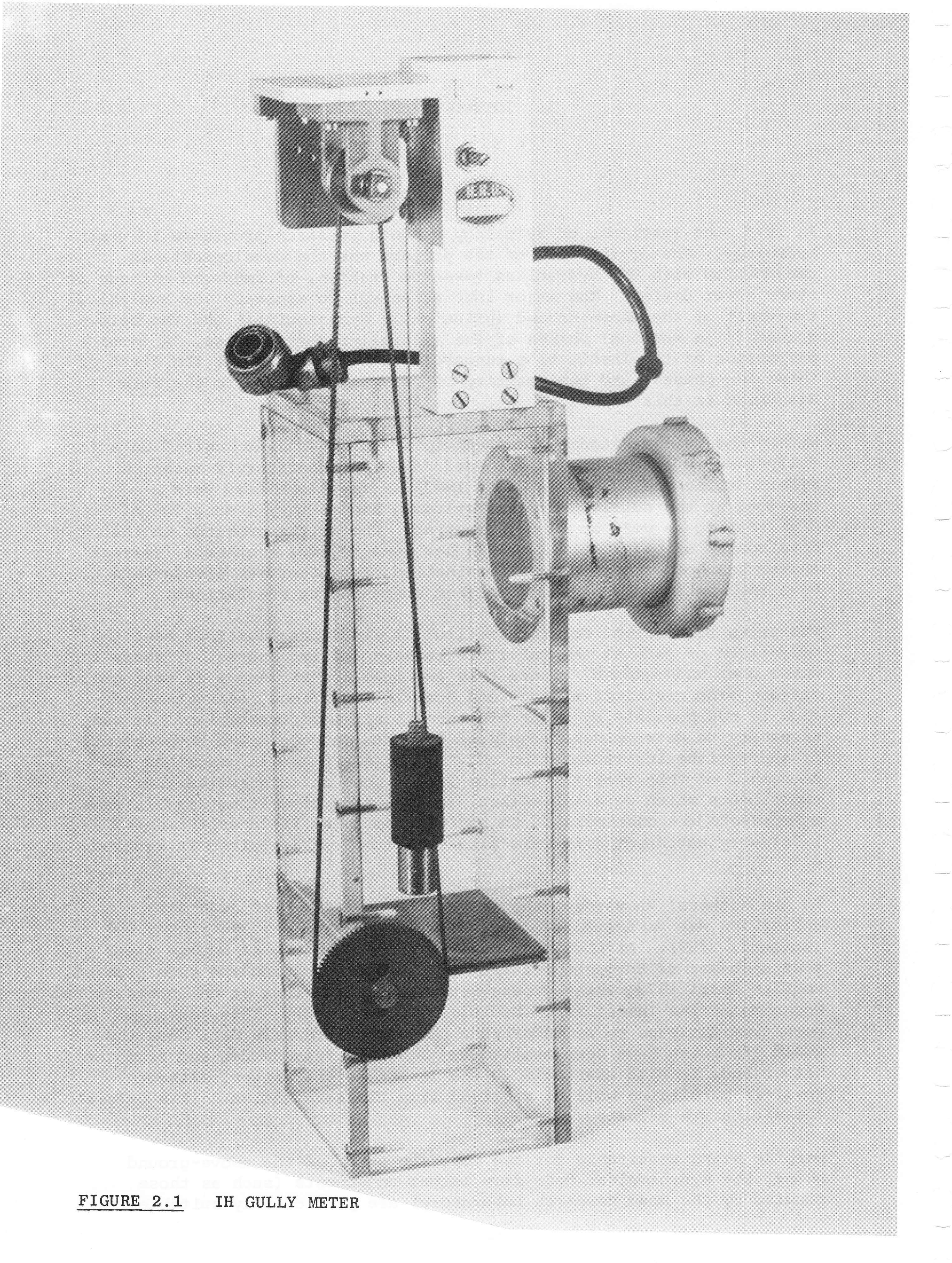


FIGURE 2.1 IH GULLY METER

the point of view of runoff volume estimation (Stoneham and Kidd, 1977; Kidd and Lowing, 1979). The Institute has therefore created a computer-based archive of data (not to be confused with the subcatchment data described above) from fully-sewered catchments. Section 5 describes this archive.

2. INSTRUMENTATION

A variety of instruments have been used in the urban hydrology data collection programme. Before describing the experiments themselves, it is appropriate to describe these instruments. The most important component in the programme has been the development of the IH gully meter.

The IH gully meter

The IH gully meter was developed for measuring discharge through a road gully. The history of this development is described in detail by Blyth and Kidd (1977) but a brief description of its operation is given here, as it will put into perspective the subsequent modifications.

Figure 2.1 is a photograph of the gully meter and Figure 2.2 is a schematic diagram of the meter as installed in a road gully. The meter is cantilevered onto the adaptor, and water entering the gully can only leave through the overflow arm. Adaptors are custom-built to suit a given road gully, so that any of the production batch of 24 meters can be fitted into it. The adaptor is fixed into the rodding eye with an expanded rubber ring seal. The whole meter is surrounded by an assembly, the top half of which acts as a protective metal cover and the bottom half of which is made of expanded metal mesh and acts as a filter. A 500 micron bag over this mesh provides a finer filter.

The basic mechanism of the meter relies on a hinged gate in the square vertical section of the main body of the instrument. The head in the gully causes water to flow up this section, thus opening the gate. A cog and toothed-belt mechanism allows the deflection of the gate to be translated into a rotation of a barrel potentiometer, and a relationship between this deflection and the discharge is used as a calibration. In the original design, sprung ptfe seals ensured a snug fit between the hinged gate and the walls of the square section. Calibration of the meter was achieved on a special rig constructed by the Hydraulics Research Station, in which known discharges could be passed through a typical gully in the laboratory. The original calibration is shown in Figure 2.3.

Since the installation of the gully meters in various catchments in

VARIATION IN
GULLY DIMENSIONS

DIM	MIN	MAX
A	250	450
B	600	1200
C	100	165

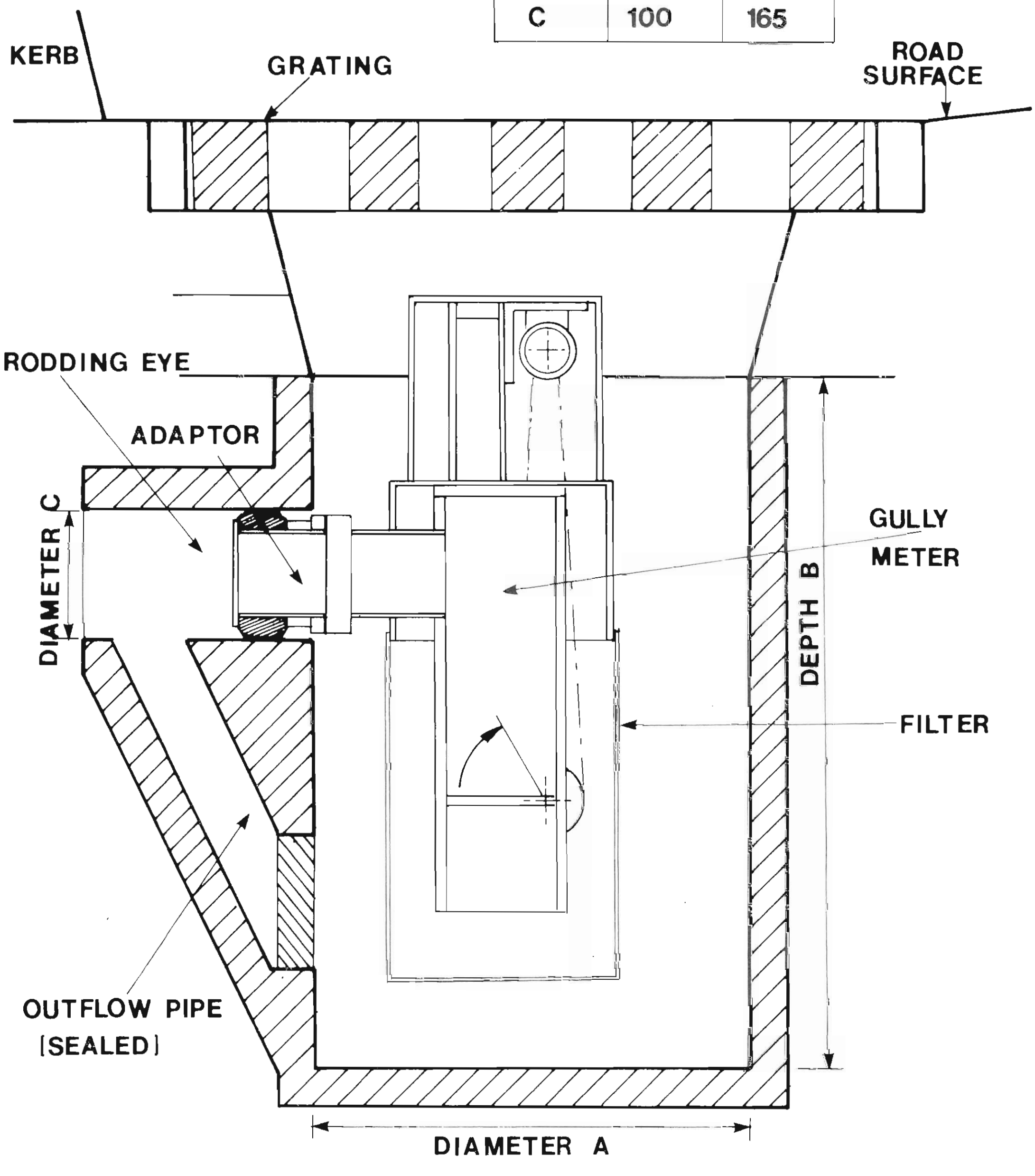


FIGURE 2.2 SCHEMATIC DIAGRAM OF IH GULLY METER INSTALLED IN A ROAD GULLY

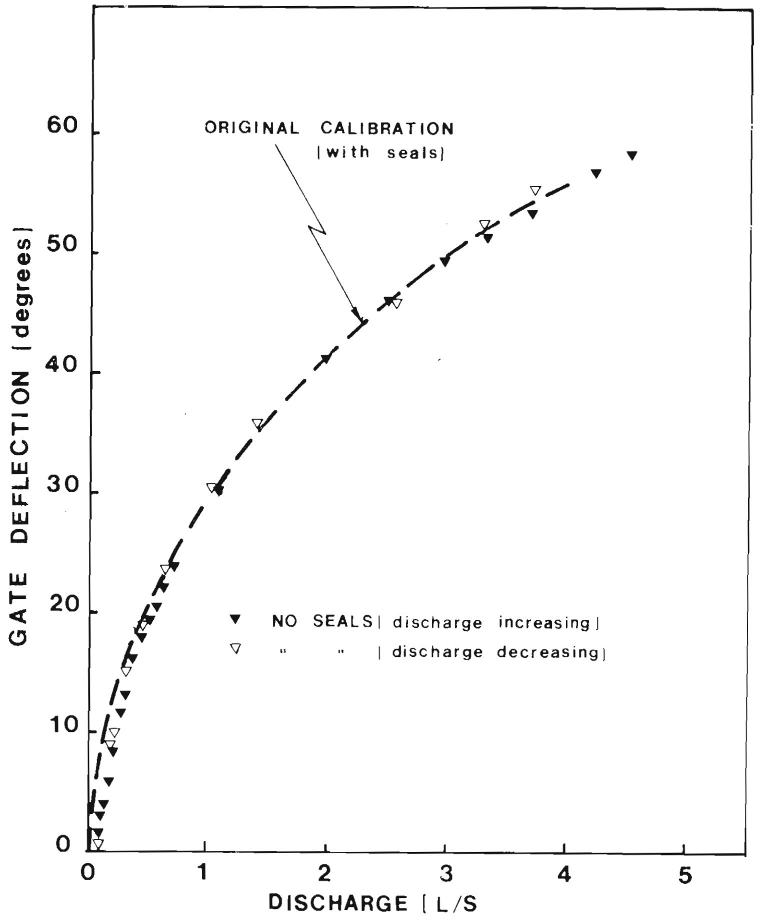


FIGURE 2.3

CALIBRATION CURVE OF IH GULLY METER

May 1976 some modifications have been made to the original specification described above. The first major modification was made in September 1976 when it was found in field operation that large quantities of silt were building up on the gate seals causing the gate to stick (either open or closed). The first attempt at a solution was to use a finer mesh filter bag (150 microns). Field trials showed that a build-up of slime on the outside of this filter resulted in the meters causing a total blockage. At the same time, tests on the HRS laboratory rig demonstrated a much increased friction effect in the production meters in comparison to that observed in the prototype.

Examination of the meter led to the conclusion that the majority of the friction was in the ptfe seal/wall interface, and therefore tests were made to quantify the loss of definition caused by the removal of the seals. The gap left at each side of the gate (0.6 mm) is geometrically equivalent to 9° of flap opening. After removing the gate seals the instruments were recalibrated on the HRS rig and the new calibration proved to be insignificantly different from the original for flap openings in excess of 25°. Below this figure, there is a gradual divergence, as demonstrated in Figure 2.3. Flows below .08 l/s do not cause any deflection of the gate. The loss of the low flow definition has meant that identification of the exact start and end of runoff is difficult, and attempts to regain definition by further modifications have proved unsuccessful. This drawback is not too serious for the kind of heavy storm events of particular interest to the Institute's urban study; but it does mean that the meter could not be used, for instance, for water balance studies.

Since the removal of the seals, field operation of the gully meter has been much improved; a certain quantity of sediment can now be passed and there is now no longer the need for the use of filter bags.

It is important to know what storage effects are caused by the inclusion of the meter in a road gully. Tests to investigate these effects were made on the HRS test rig, and the storage-outflow relationships are shown in Figure 2.4 for conditions with and without the meter. A hypothetical hydrograph was then routed through these two relationships to observe what effect the meter might have. The results of these analyses are shown in Figure 2.5, and, on the basis of these results, it may be assumed that the inflow to the gully and the outflow of the meter are effectively the same (another way of saying this is that the introduction of the meter has a negligible storage effect).

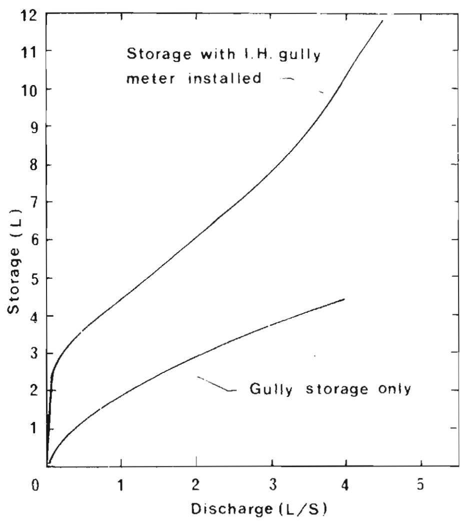


FIGURE 2.4

STORAGE/DISCHARGE RELATIONSHIP OF ROAD GULLY + METER

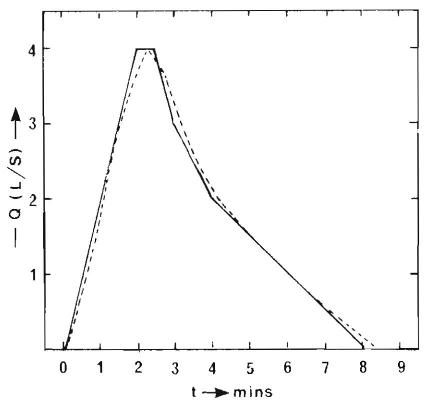


FIGURE 2.5

ARTIFICIAL HYDROGRAPH ROUTED THROUGH ROAD GULLY + METER

Rainfall measurement

The need for a high resolution and discrimination of rainfall intensity on the small subcatchments monitored in this study was satisfied by the use of Rimco autographic tipping-bucket gauges (with .1 mm buckets) logged at 30 s intervals. Figure 2.6 shows such a gauge with the collector removed.

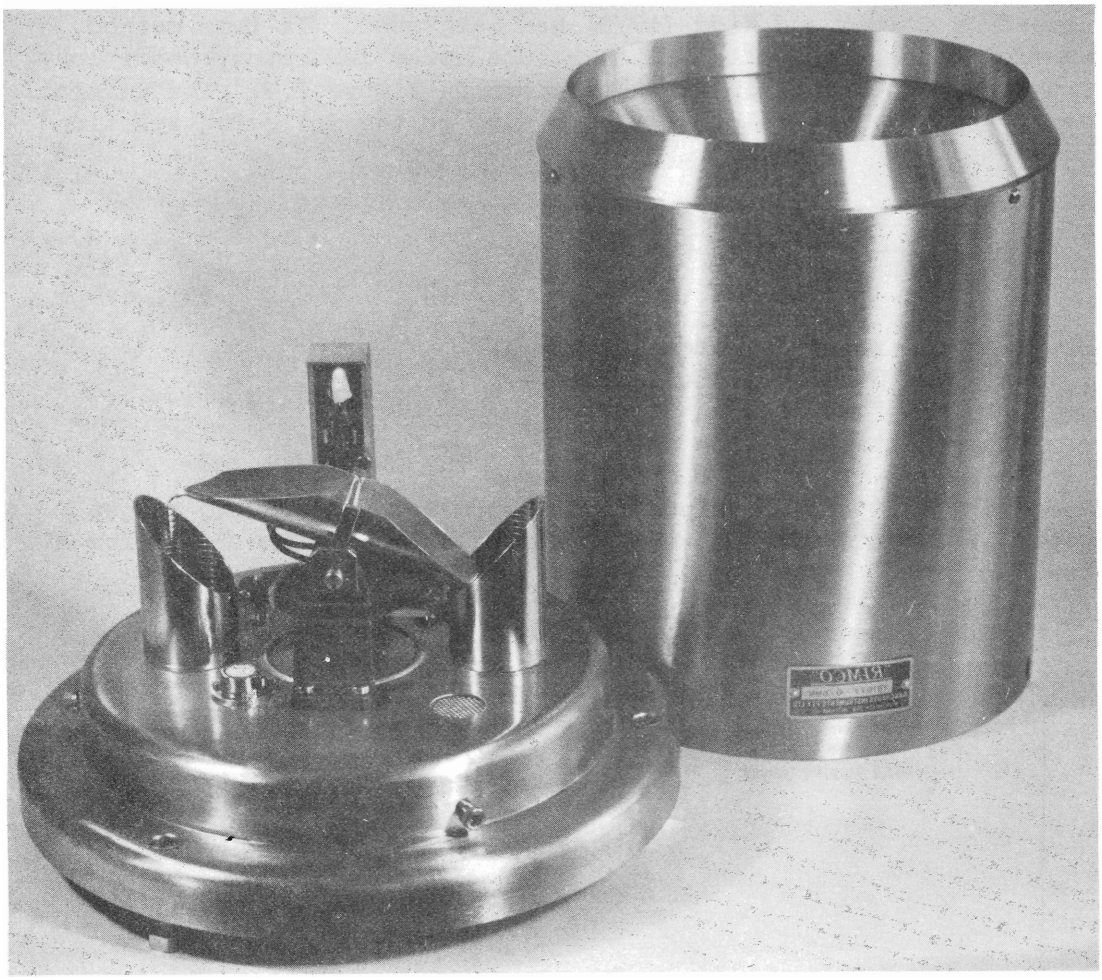


FIGURE 2.6 RIMCO RAINGAUGE WITH COLLECTOR REMOVED

The siting of raingauges in urban areas presents special problems; when a gauge is required close to, or within a subcatchment, the location of a correctly exposed but secure site can be difficult. In siting the raingauges for this project the main criteria for the choice of location were as follows:

(a) the gauge should be very close (within 100 m) to the catchment;

(b) the gauge should be capable of connection to the same logger as the gully meters, and

(c) the site should be well protected from vandalism. As described later, the choice of site varied from residents' front lawns to Electricity Board sub-stations. Where possible, daily-read standard gauges in convential positions have been used to check the performance of the Rimco gauges.

The use of such small buckets (.5 mm buckets are more usual) leads to the time between tips being short for high rainfall intensities (the maximum number of observed tips in a 30 second interval is 15). A dynamic calibration for each gauge is thus required and the method described by Calder and Kidd (1978) has been used. In this method, known flow rates are applied to the gauge under laboratory conditions. An example of such a calibration is shown in Figure 2.7. The rainfall intensity can then be calculated according to the following relationship:

$$I = \frac{V}{T + t} \times 3600$$

where I is the rainfall intensity (mm/hr)
V is the bucket volume (mm)
T is the time between tips (s)
t is the tipping time (s)

Parameters V and t are obtained from Figure 2.7 for the two gauges plotted. A tipping-time of approximately .5 seconds was found for all gauges.

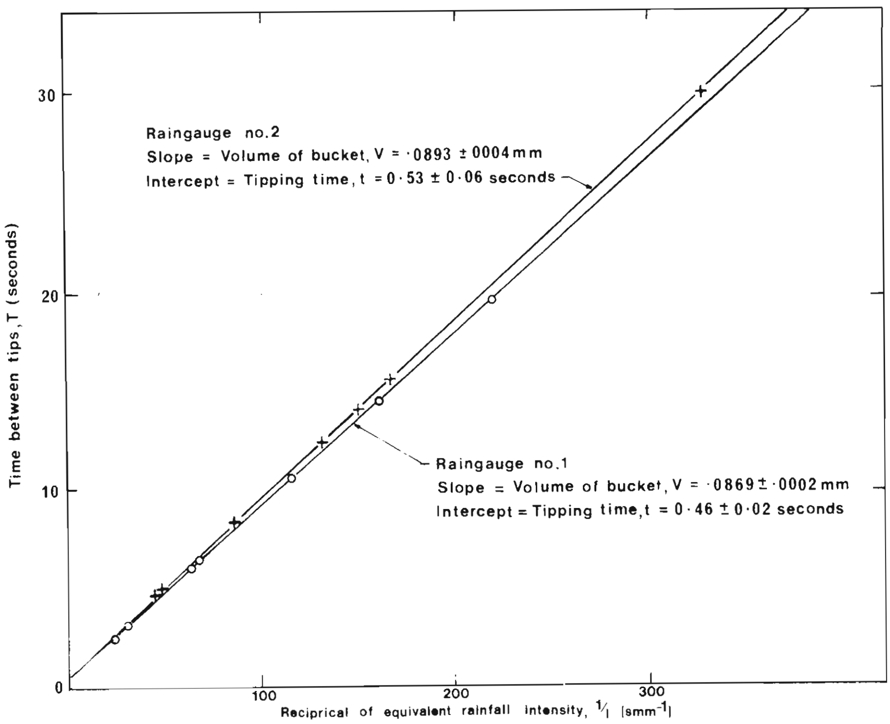


FIGURE 2.7 CALIBRATION OF RAINGAUGE, AFTER CALDER AND KIDD

Water-level measurement

Water level sensors (WLS) were used to monitor level in stilling-basins of the outfall flumes of the Shephall, Oxhey, Wildridings and Southampton catchments. The instrument (see Figure 2.8) consists of a central axle and gear box with a pulley (200 mm circumference) mounted on it. Each end of the axle drives a barrel potentiometer, and the gearbox drives a third potentiometer at $^1/20$ the speed of the main axle. This configuration allows good discrimination over a large range. The axle is driven by the float wire which passes over the pulley. A full description of the instrument and its operation is given by Strangeways and Templeman (1974).

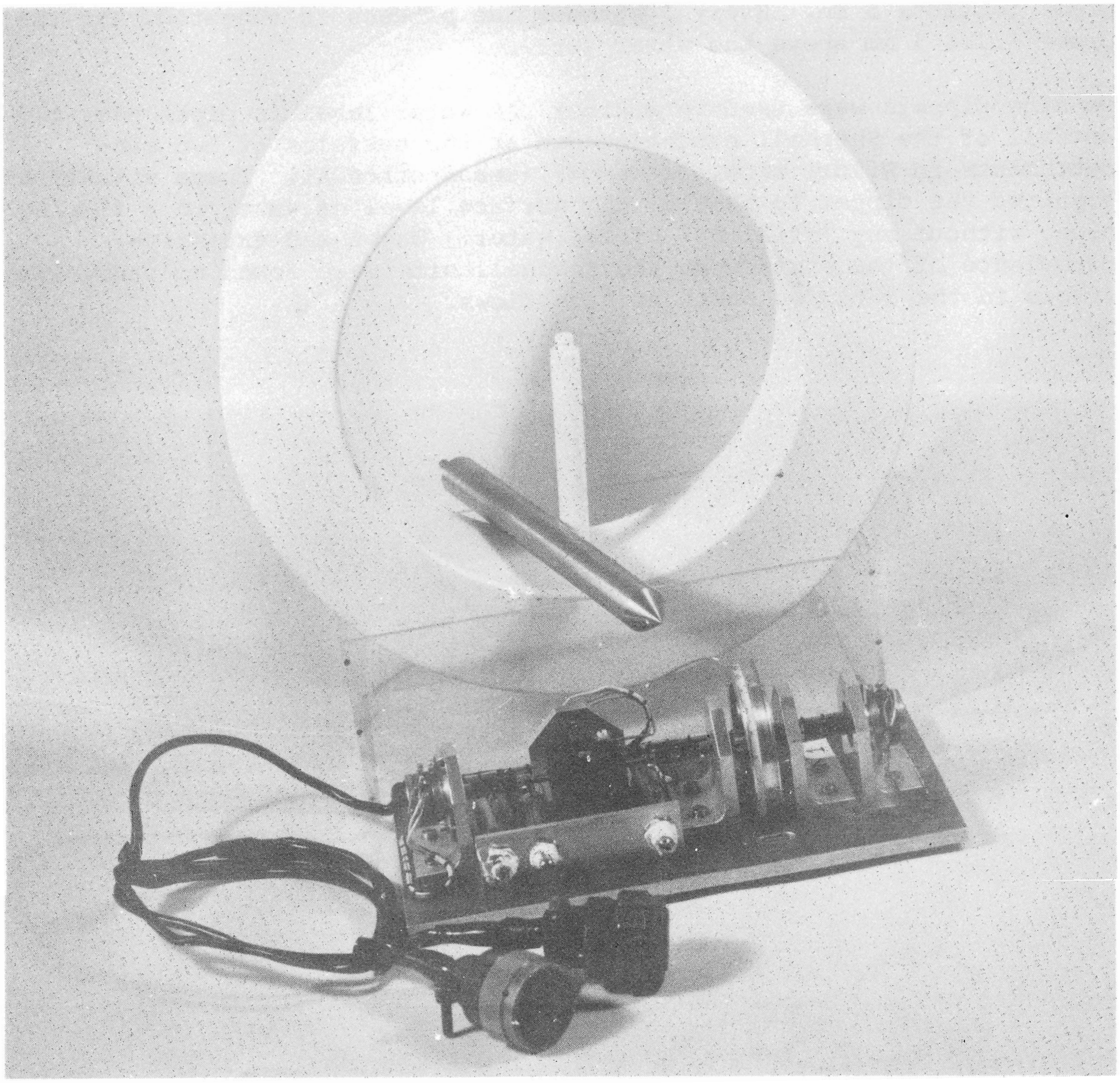


FIGURE 2.8 WATER LEVEL SENSOR

As an alternative to the conventional measurement of water-level in stilling-basins, a device called a Manning Dipper was tested at some sites. This operates by continuously hunting for the water surface with an electrical probe. This instrument was supplied by the Manning Environmental Corporation, and was modified to be compatible with the Microdata logging system. The modification involved the removal of the supplied potentiometer and replacing it with the WLS system of 3 potentiometers and gearbox (the modification does not affect the operation of the instrument). Figure 2.9 shows one of the dippers.

The dipper consists of a 225 mm pulley, driven by a 12 V motor, around which is wound an insulated stainless steel cable. A steel probe is attached to the end of the cable which is lowered until it touches the water surface. On contact with the water a circuit is closed and the probe retracts 5 mm. Every 5 seconds the process is repeated, and the probe idles 5 mm above the water surface

Manning dippers were used to monitor the water level in pipes near the outfall of the Shephall catchment and at the outfalls of two sub-catchments in Wildridings, Bracknell (see Section 5). These situations required the dipper to monitor the surface level of water in a flowing pipe, without any 'stilling' of the water. Waves and excessive turbulence of the surface at the Shephall site were found to cause large errors in the recorded depth at high flows.

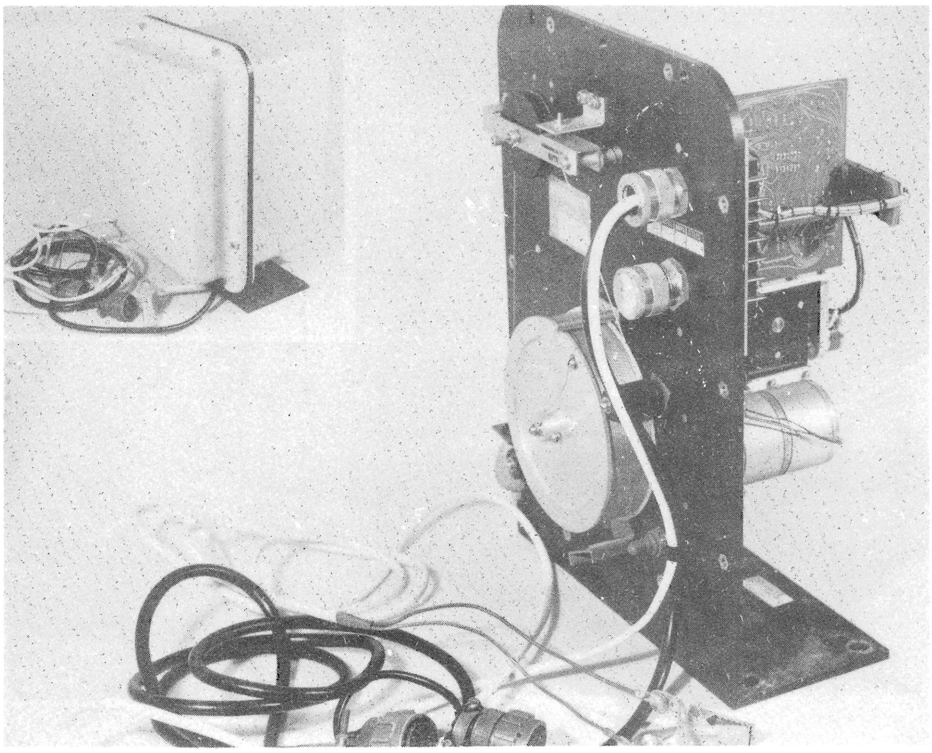


FIGURE 2.9 MANNING DIPPER

Data collection systems

Problems of definition of catchment boundaries led to the conclusion that cul-de-sac type locations would be most suitable for monitoring. The policy was to locate a well-defined catchment area and then to install a meter in each gully within the area, leading to monitoring systems of up to 4 gully meters. The need for accurate synchronisation of rainfall and runoff records meant that where possible the gully meters and raingauge were recorded on a central logger.

School Close, Stevenage (see Figure 2.10) shows the typical arrangements adopted for this data collection programme. The raingauge is a ground level Rimco with .1 mm discrimination set under a 4 foot square steel grid to protect the gauge from vandalism. The gully meters are connected with 3-core heavy duty cables through the sewer system to manhole S22 from where the cables run underground to the raingauge site. The raingauge and gully meter output are recorded on a Microdata digital logging system at 30 s intervals.

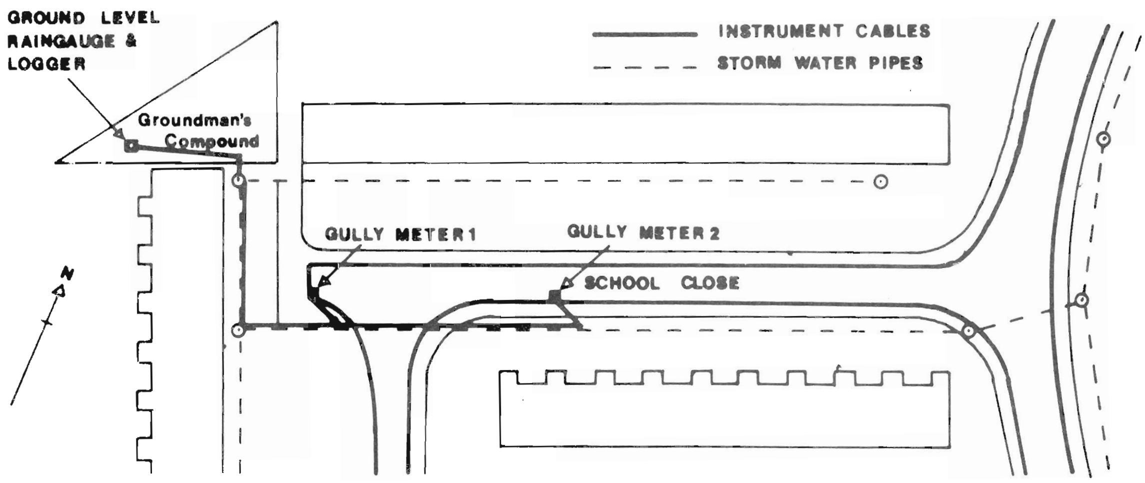


FIGURE 2.10 SCHEMATIC DIAGRAM OF SCHOOL CLOSE DATA COLLECTION SYSTEM

The Microdata digital logging system (Figure 2.11) is well documented elsewhere (Strangeways and Templeman, 1974; Microdata Ltd). The system collects electrical records (0 to 240 mV) on up to 12 channels at pre-set intervals of 2 s to 1 hour and records the data on cassette magnetic tape. In most cases in this study, the scanning interval used is 30 s - typically, 3 data channels at 30 s intervals fills a C90 cassette (80,000 words) in approximately 6½ days. Although an automatic trigger mechanism was considered, it was felt that it would provide another source of possible breakdown. Now that the remainder of the system has been proved, such a mechanism may be incorporated in the future.

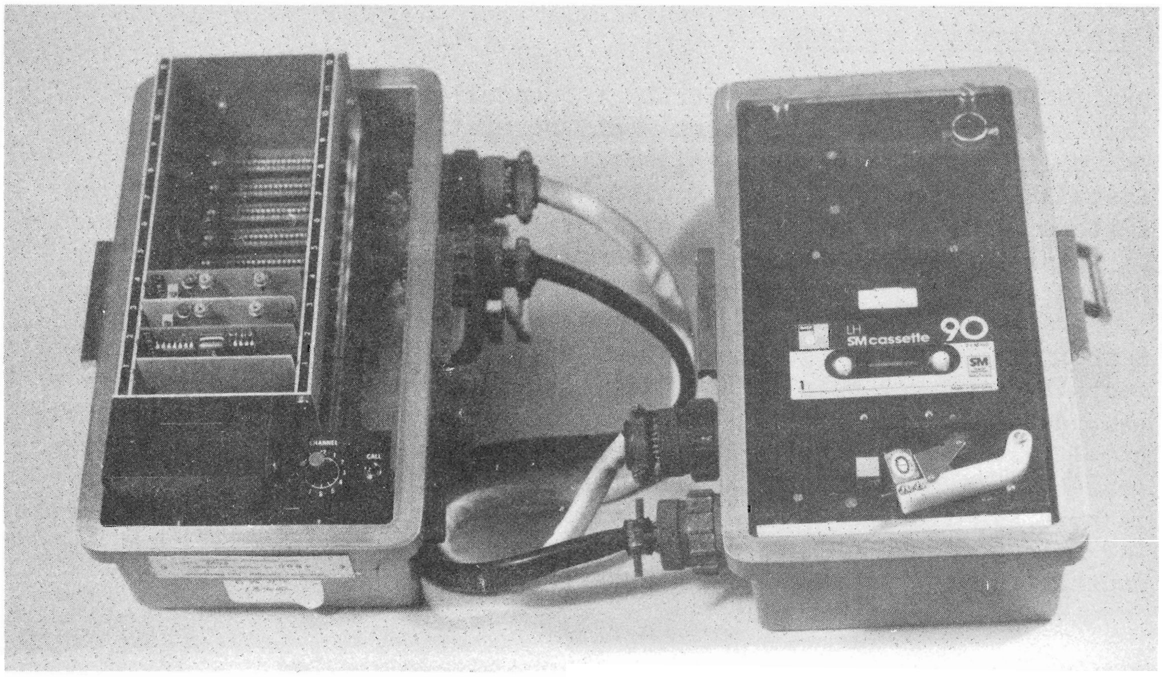


FIGURE 2.11 MICRODATA LOGGER AND INTERFACE

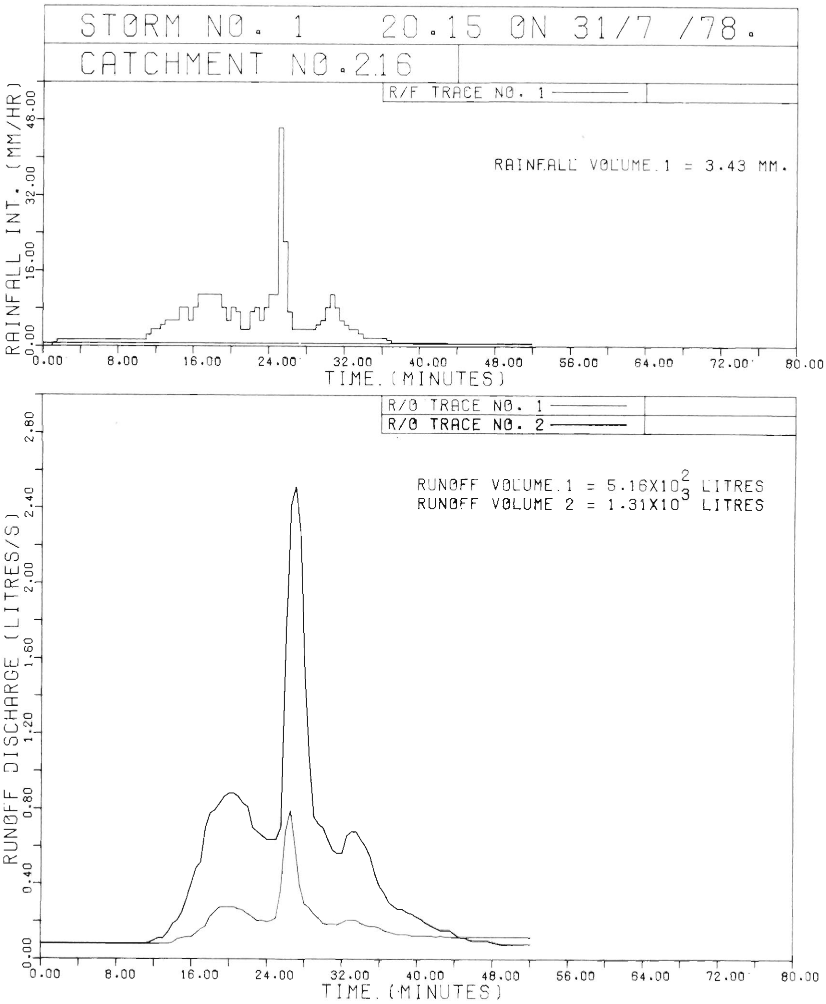
Data processing

Due to the large quantity of raw data being collected from the field experiments (up to 14 cassettes/weeks) it was necessary to have an efficient processing system. It was decided to opt for a three stage processing system. The first two stages are concerned with reducing the data to a visual form such that the quality of the data and the operation of the field instruments could be checked quickly. This permits rapid fault finding and enables remedial work to be undertaken at the next site visit. The conversion of selected parts of the data to a rainfall-runoff record (Stage 3) can then be undertaken at a later date.

Stage 1: This consists of translating the data from the logger cassettes onto a seven track computer compatible tape. This is done using the Institute's PDP8 and PDP8a mini-computers. A cassette record occupies one file on the 7-track tape, and one tape contains up to 50 files. At this stage it is possible to monitor the logger recording head condition by watching the cassette output on an oscilloscope (logger battery failures are also evident on the 'scope'). Once the cassette has been translated to 7-track tape the cassette is freed for re-use.

Stage 2: At this stage the 7-track record is converted to a 9-track tape and an identifying header block (station number, start and end times, dates etc) is written to each file. In the conversion process each scan is checked for data channel failures and a summary of the quality control procedures and a list of the files contained on the tape are written to the line printer. The data are now plotted using the Calcomp plotter to give the first visual record. These plots are used for swift appraisal of instrument performance as well as providing means of event selection for stage 3 of the processing system. The plotting routines also identify significant rainfall events and output a summary of these events to the line printer. An example of one of these plots is shown in Figure 2.12 overleaf.

Stage 3: Stage 3 of the system can be done at a convenient later date. Using the Calcomp plot produced at stage 2 (and the summary of events from that stage) significant events are identified and abstracted from the 9-track record and written to a mass storage file in the form of a synchronised rainfall (mm/hr) and runoff (l/s) record. The program also produces a listing of the 'converted' and 'raw' data as well as providing the option for an A4-sized Calcomp graph of the event. Figure 2.13 is an example of a plot produced by this program - it comes from the record shown in Figure 2.12.



<u>FIGURE 2.13</u> EXAMPLE OF PLOTTED EVENT

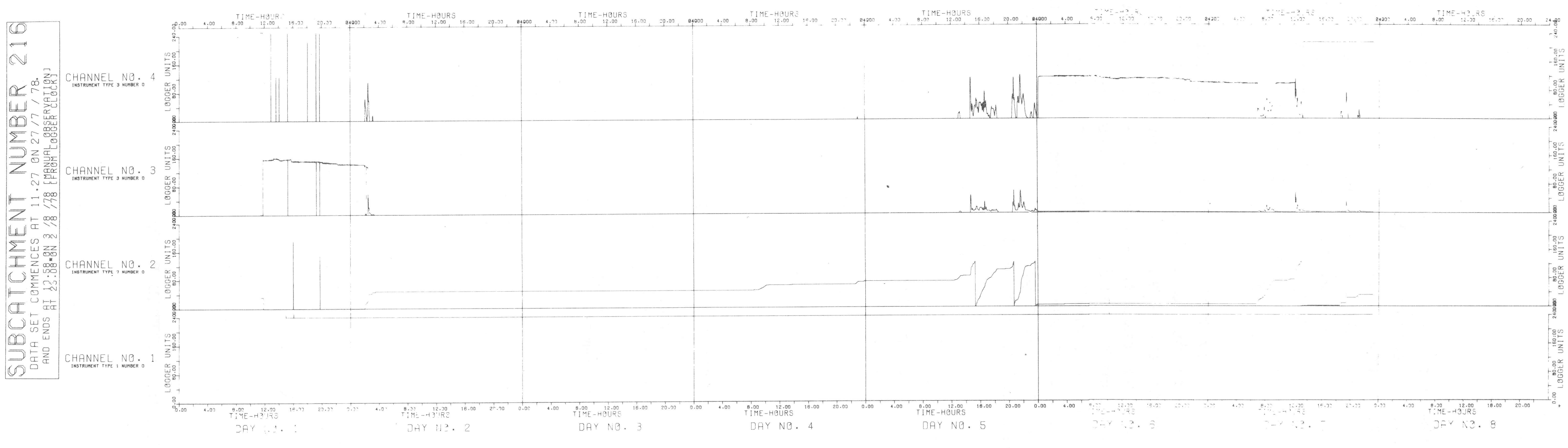


FIGURE 2.12 EXAMPLE OF PART OF WEEKLY DATA PLOT

This program is written in interactive mode. The process can be done from a demand terminal, and the user will be asked to specify certain run specifications and data inputs (such as instrument calibrations parameters) as appropriate. The calibration of the various instruments used is either implicit in the program or is fed into the system when requested by the processing program.

A data processing manual (Makin, 1979) is available which describes in detail the operation of all the programs described above.

Data storage and retrieval

Two copies of the raw data are kept on 9-track magnetic tapes at the Institute of Hydrology. Only one of these tapes is used for processing (the other is a back-up unit in case of the main tape being damaged in a 'tape wreck' or being accidentally overwritten). Calcomp plots of each file stored on tape are kept and are used to identify possible events for further processing. These plots form the only visual record of the raw data available.

An archive of reduced data is maintained, and it is in this form that the data are most useful. These are the individual rainfall-runoff events processed under stage 3 above. A calcomp plot of each storm is also kept. There are up to 40 events for any given catchment in this form and a further reduced data set is also available. This comprises up to the 15 largest events for each subcatchment and is stored in a custom-built direct-access data base which is convenient for analytical purposes. It is recommended that the last form of the data is likely to be the most useful to anyone who might want to use the data. These data are stored in a file called URBDATA, which comprises an element for each subcatchment plus an element (called URBDATA.INDEX) which contains an index. The data is available from the Institute of Hydrology in any of the above forms on request. Under normal circumstances, a charge will have to be made for the work involved in supplying data.

3. SUBCATCHMENT EXPERIMENTS

Following the development of the gully meter and its extensive trials using a prototype instrument, a production batch of 24 meters were constructed during the winter of 1975/76. These meters were installed in a number of subcatchment experiments which ran approximately from May to December in 1976 and 1977 (so few significantly intense events occur between January and April that this period was not monitored).

TABLE 3.1 List of subcatchment experiments

SUBCATCHMENT NUMBER	SUBCATCHMENT NAME	LOCATION	NUMBER OF GULLIES	NUMBER OF PROCESSED EVENTS	TOTAL AREA TO GULLY (m^2) 1	2	3	4	PERIOD OF EXPERIMENT	COMMENTS
202	Ennerdale One	Bracknell	5	-	912 (total)				1976-1977	Data not used
203	Ennerdale Two	Bracknell	3	15	118	358	90		1976-1977	
204	Bishopdale	Bracknell	2	11	167	591			1976-1977	
205	Hyde Green North	Stevenage	2	9	485	844			1976-1977	
206	School Close	Stevenage	2	13	459	717			1976-1977	
208	Curlew Close	Southampton	2	-	521	228			1976-1977	Inferior quality data
214	Hawthorn Close	Wallingford	4	11	215	145	176	206	1977-1978	No data from Gully 3
215	Hyde Green North (78)	Stevenage	1	12	1329				1978-1978	As 205, but 1 gully blocked
216	School Close (78)	Stevenage	2	17	500	802			1978-1978	As 206, but road widened
301	Twyford Gardens	Nottingham	2	3	475	-			1978-	Experiment continuing

Since then, these experiments have been curtailed or modified and others have been instigated. Table 3.1 is a list of subcatchment experiments, showing a summary of details and appropriate comments. There now follows a brief description of each experiment under separate headings.

Subcatchment 206 : School Close One, Stevenage (1976-77)

School Close is a post-war residential cul-de-sac in Stevenage New Town and forms part of the Shephall catchment (see Section 5). A plan of the catchment is shown in Figure 3.1. The catchment is drained by two road gullies with subcatchment areas of 459 m^2 (206/1) and 717 m^2 (206/2) with average slopes of 1.8% and .9% respectively. The road surface is laid with hot rolled asphalt - the asphalt has a low sand content and the data suggests that there is a fairly high rate of infiltration. The road is bounded by footpaths constructed of concrete (in the form of either paving slabs on a sand sub-base or mass concrete) or by asphalt of a lower standard than the road surface. 40 to 45% of the area of the catchment has a permeable surface (ie lawn or road verges).

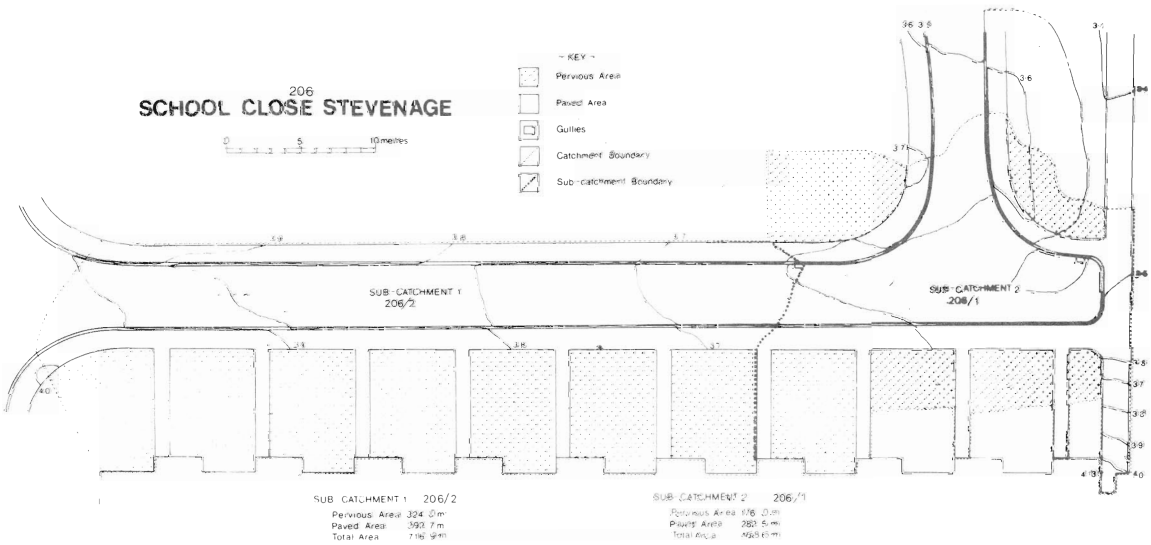


FIGURE 3.1 **PLAN OF SCHOOL CLOSE ONE**

School Close was instrumented in the early part of 1976 with a gully meter in each of the subcatchments and a ground level raingauge in the groundsman's compound of Peartree Park. The ground level raingauge was selected for this site due to the protection from vandalism afforded by the heavy metal grid. Data logging equipment was installed in an aluminium box under the grid.

The drought conditions of 1976 and the instrumentation problems described earlier resulted in little usable data being collected between May and September. A number of good events were observed between October and December 1976, when monitoring was discontinued due to the raingauge pit becoming flooded. The gully meters were re-installed for the period July to September 1977, although rainfall data were collected for the Hyde Green experiment (subcatchment 205) until December 1977.

Table 3.2 shows brief details of the major events which have been fully processed to an event record for subcatchment 206. Asterisks in the peak flow column indicate that data is not available for that meter.

TABLE 3.2 Brief details of School Close events

Event Number	Time	Date	Dur (Min)	R'F Vol (mm)	Runoff Peak (l/s) 2061	2062	Antecedent condition
206013	19.04	28/2/76	44	1.45	0.22	*	Dry
206015	19.52	11/10/76	23	2.35	1.12	0.70	Dry
206016	06.00	14/10/76	26	1.71	0.30	0.36	Wet
206017	07.45	14/10/76	62	2.86	0.31	0.39	Wet
206018	12.40	14/10/76	25	0.63	0.25	*	Wet
206019	00.40	6/11/76	30	1.81	*	0.55	Dry
206020	11.05	6/11/76	27	0.97	*	0.27	Wet
206021	19.50	19/7/77	25	1.00	0.13	0.30	Dry
206024	18.25	6/8/77	100	16.00	0.78	1.70	Dry
206025	23.13	6/8/77	47	1.81	0.23	0.49	Dry
206026	18.28	24/8/77	34	1.60	0.46	0.66	Wet
206027	23.40	24/8/77	21	1.37	0.46	0.80	Dry
206028	14.47	26/8/77	25	2.11	0.49	0.83	Dry

In September 1977, work commenced on widening School Close, which effectively created a new catchment. The catchment was re-instrumented in 1978 and the 'new' catchment is described under subcatchment 216.

Subcatchment 205 : Hyde Green North, Stevenage (1976-77)

Hyde Green North is similar in character to School Close and is only some 50 m distant. A plan of the catchment is shown in Figure 3.2.

This cul-de-sac catchment is drained by two gullies, with subcatchment areas of 485 m^2 (205/1) and 844^2 (205/2) with average slopes of 2.4% and 1.2% respectively. The road surface is similar to School Close, and again results suggest a high rate of infiltration through the road surface. The road is bounded by concrete pavements and grass verges; on one side of the road a steep grass bank drains to the pavement and thence to the road. 43% of the catchment has a pervious surface.

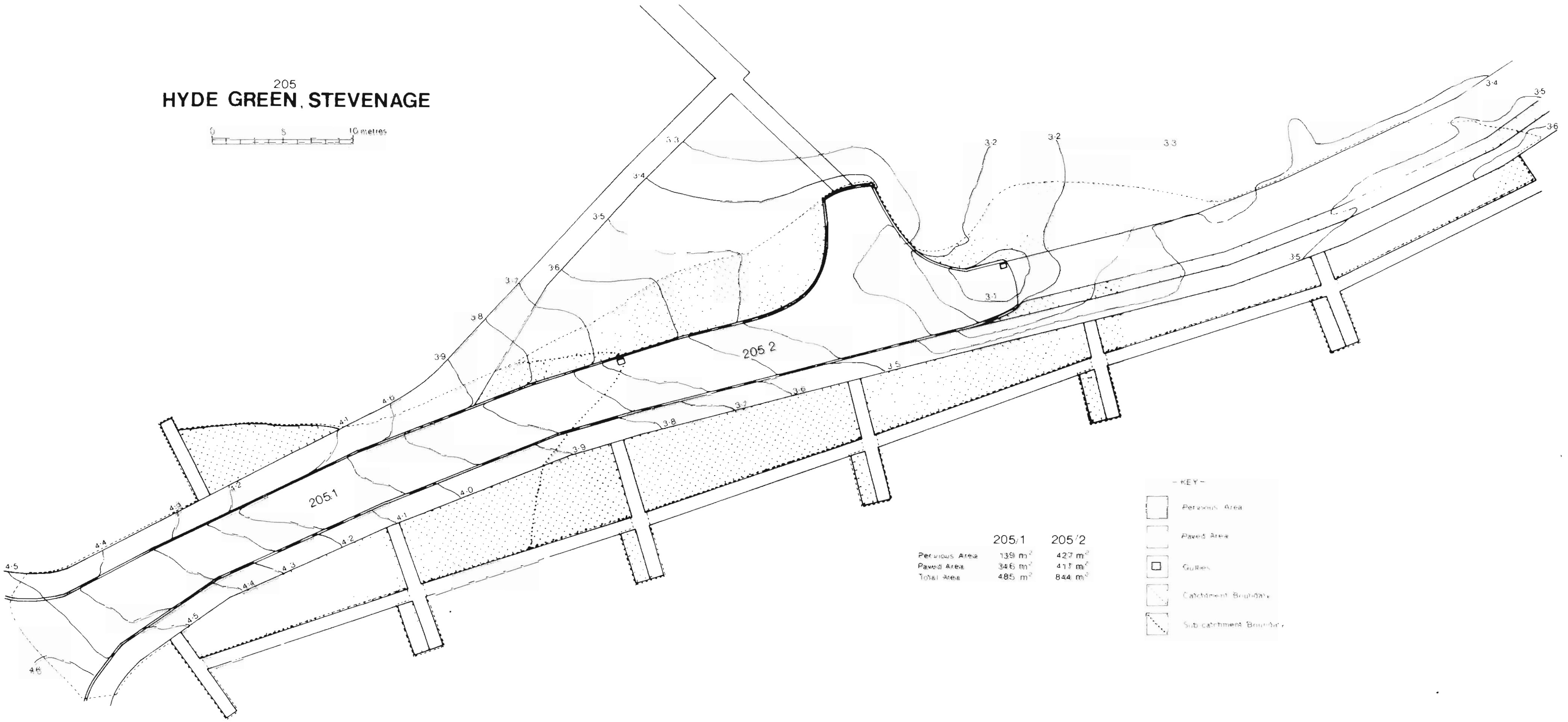
Hyde Green was instrumented in the early part of 1976 with a gully meter in each of the subcatchments. However, due to the difficulty of obtaining a suitable location for a raingauge, it was decided that the rainfall record from the School Close gauge could be used. The raingauge is approximately 75 m from the catchment. Careful synchronisation of the two logging systems has been practised to ensure that the records are suitable for analytical processing.

A number of good events were observed in late 1976 but as the School Close raingauge records were used for this site, monitoring stopped in December when the raingauge flooded. Monitoring re-started in July 1977 and was stopped in December when the raingauge was again flooded. Table 3.3 shows brief details of the major events which have been fully processed to an event record for subcatchment 206.

TABLE 3.3 Brief details of Hyde Green North events

Event Number	Time	Date	Dur (Min)	R'F Vol (mm)	Runoff Peak (l/s) 2051	2052	Antecedent condition
205004	19.04	28/8/76	44	1.45	0.29	0.37	Dry
205005	00.27	25/9/76	33	8.70	0.34	0.87	Dry
205006	08.45	30/9/76	23	0.66	0.26	0.52	Dry
205008	18.40	31/10/77	40	1.72	0.33	0.36	Dry
205009	10.10	4/10/77	36	1.47	*	0.85	Dry
205010	14.10	8/10/77	45	4.42	0.78	0.98	Dry
205013	18.40	9/10/77	49	2.51	0.57	0.64	Dry
205014	22.50	20/10/77	100	10.95	1.27	1.63	Dry
205015	09.33	21/10/77	87	10.57	1.04	1.42	Wet

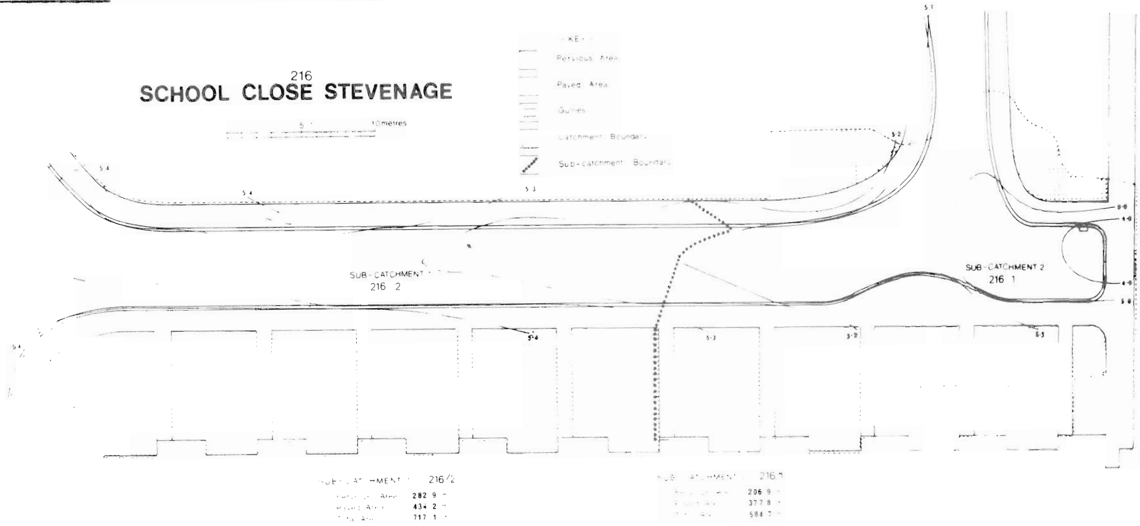
FIGURE 3.2 PLAN OF HYDE GREEN NORTH



Subcatchment 216 : School Close Two, Stevenage (1978)

This catchment was formed from the old 206 subcatchment when the road was widened in 1977. A plan of the catchment is shown in Figure 3.3.

FIGURE 3.3 PLAN OF SCHOOL CLOSE TWO



The form of the catchment is basically as described earlier; however, the subcatchment areas of 500 m^2 (216/1) and 802 m^2 (216/2) with average slopes of .6% and 1.0% respectively are different.

Data have been collected from these subcatchments since May 1978 and 22 events have been fully processed. Table 3.4 gives brief details of the major events.

TABLE 3.4 Brief details of School Close Two events

Event Number	Time	Date	Dur (min)	R'F Vol (mm)	Runoff Peak (l/s) 2161	Runoff Peak (l/s) 2162	Antecedent condition
216001	18.00	10/6/78	34	1.90	*	0.49	Dry
216002	14.05	4/6/78	24	10.75	3.01	6.71	Dry
216003	13.10	21/6/78	30	1.85	0.27	1.04	Dry
216004	12.45	22/6/78	50	3.51	0.30	1.56	Dry

216005	16.00	22/6/78	20	2.08	0.90	3.88	Dry
216006	16.25	22/6/78	50	6.79	1.30	4.11	Wet
216007	01.40	28/7/78	19	1.59	0.10	0.80	Dry
216008	02.00	28/7/78	26	2.19	0.53	2.18	Wet
216009	14.10	31/7/78	35	3.13	0.53	2.52	Dry
216010	16.12	31/7/78	37	2.16	0.31	1.10	Wet
216011	19.55	31/7/78	48	3.39	0.80	2.42	Dry
216012	20.45	31/7/78	80	8.69	0.76	2.89	Wet
216013	11.40	2/8/78	45	3.84	0.68	2.37	Dry
216014	13.20	3/8/78	18	1.22	0.24	1.04	Dry
216016	14.45	8/8/78	60	7.16	1.46	4.79	Dry
216017	15.55	15/8/78	20	5.31	1.24	3.32	Dry

Subcatchment 215 : Hyde Green North Two, Stevenage (1978)

This is the same catchment as described earlier (205), but with only one gully outlet operating. The higher gully (205/1) being sealed for the duration of this experiment, caused the runoff to be diverted to 205/2. This has given a new catchment area of 1329 m^2 with an average slope of 2.1%. The catchment plan is given previously in Figure 3.2

Data have been collected since May 1978 and some 20 events have been processed. Table 3.5 gives brief details of the major events.

TABLE 3.5 Brief details of Hyde Green North Two events

Event Number	Time	Date	Dur (min)	R'F Vol (mm)	Runoff Peak (l/s) 2151	Antecedent condition
216003	13.10	21/6/78	30	1.85	0.70	Dry
216004	12.45	22/6/78	50	3.51	1.13	Dry
216005	16.00	22/6/78	20	2.08	3.73	Dry

216006	16.25	22/6/78	50	6.79	3.59	Wet
216007	01.40	28/7/78	19	1.59	0.36	Dry
216008	02.00	28/7/78	26	2.19	1.24	Wet
216009	14.10	31/7/78	35	3.13	2.10	Dry
216010	12.12	31/7/78	37	2.16	0.98	Wet
216011	19.55	31/7/78	48	3.39	2.10	Dry
216014	13.20	3/8/78	18	1.22	0.96	Dry
216015	18.10	6/8/78	21	2.04	2.05	Dry
216016	14.45	8/8/78	60	7.16	3.88	Dry

Subcatchment 208 : Plover Close, Southampton (1976-77)

Curlew Close is a recently built cul-de-sac in the Lordshill area, a private estate, on the outskirts of Southampton. The subcatchment is close to the two small catchments (described in Section 5) gauged by the Civil Engineering Department, University of Southampton. Much of the establishment and maintenance of the experiment was undertaken by the University. The subcatchment drains to two gullies, and Figure 3.4 is a plan of the site.

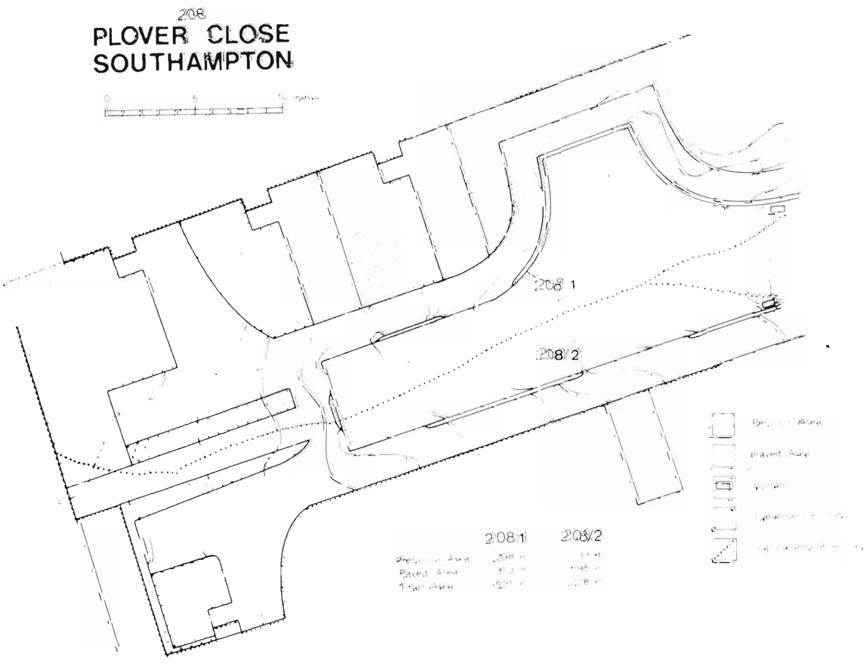


FIGURE 3.4 PLAN OF PLOVER CLOSE

The areas draining to area 208/1 and 208/2 are 521 m^2 (313 m^2 paved) and 228 m^2 (195 m^2 paved) respectively, and the average catchment slopes are 3.1% and 3.2% respectively. All the paved surfaces are hot-rolled asphalt containing a low proportion of sand - the data collected suggest that there is a very high infiltration rate through the asphalt. Pervious surfaces consist mainly of well-graded front lawns, and cover 40% and 14% of the two areas respectively.

A tipping-bucket raingauge is sited in an exposed position on a front lawn, and a cable is run underground to an instrumentation box (from the raingauge and from the two gully meters) sited next to a garage.

The experiment was undertaken during the summers (May-December) of 1976 and 1977, during which time 26 events were fully processed. As time went on, it became clear that, at high flows, there was a substantial quantity of water bypassing both gullies. To overcome this problem, a special experiment was undertaken in an attempt to quantify the percentage of bypassing at any given measured flow-rate. Known flow-rates (using a fire hydrant discharging through a V-notch tank) were applied to the road just above each gully. This allowed an estimate of the bypassing to be made for each gully, the results of which are shown in Figure 3.5. The extent of bypassing is variable at a given flow, depending primarily on the quantity of loose material on the road; as such, the relationships in Figure 3.5 are approximate. Corrections to the discharge hydrographs were made on the basis of these relationships, but the quality of the data must be recognised as being inferior to those data collected on subcatchments where no bypassing occurred.

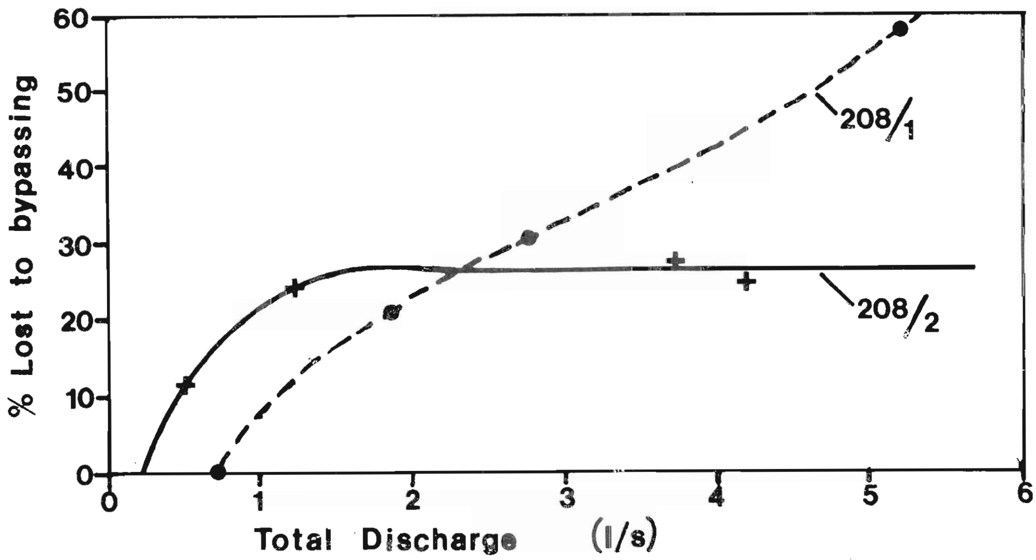


FIGURE 3.5 BYPASSING RELATIONSHIPS FOR PLOVER CLOSE GULLIES

Subcatchment 204 : Bishopdale, Bracknell (1976-77)

Bishopdale is a cul-de-sac within the Wildridings catchment which is described in Section 5. Wildridings is a recently built area of Bracknell New Town. Figure 3.6 is a plan of the subcatchment.

The subcatchment comprises two types of surface, concrete (which drains the garage areas) and hot-rolled asphalt elsewhere. The asphalt has a high sand content, and the data collected suggests that these surfaces may be considered as almost completely impermeable. 204/1 has a contributing area of 167 m^2 (fully paved) and drains approximately half the garage area, and 204/2 has a contributing area of 591 m^2 (450 m^2 paved) and drains the remainder of the subcatchment. Average catchment slopes are 3.4% and 2.4% respectively.

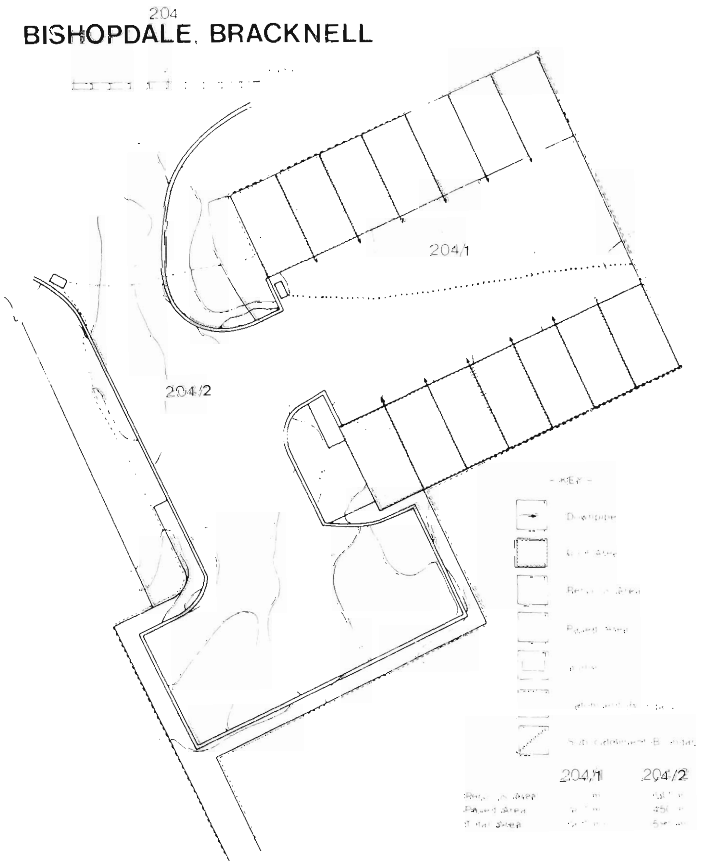


FIGURE 3.6 PLAN OF BISHOPDALE

A tipping-bucket raingauge was sited in an Electricity Board sub-station about 50 m from the subcatchment. The site is far from perfect, surrounded by 6 ft high walls at a distance of approximately 6 ft. However a check on its performance could be made from a daily-read gauge about 300 m away. The logging system was also housed in this substation, with wires run from the gully meters through the sewer system to a gully adjacent to the substation.

The summers of 1976 and 1977 yielded a total of 37 events which have been fully processed, and Table 3.6 lists the major events. A minor degree of bypassing was observed, and Figure 3.7 shows the relationships developed in the same was as described earlier for subcatchment 208. Corrections have been made to the runoff hydrographs based on these relationships, but the limited extent of bypassing has meant that the quality of the data has not been significantly impaired as it was for subcatchment 208.

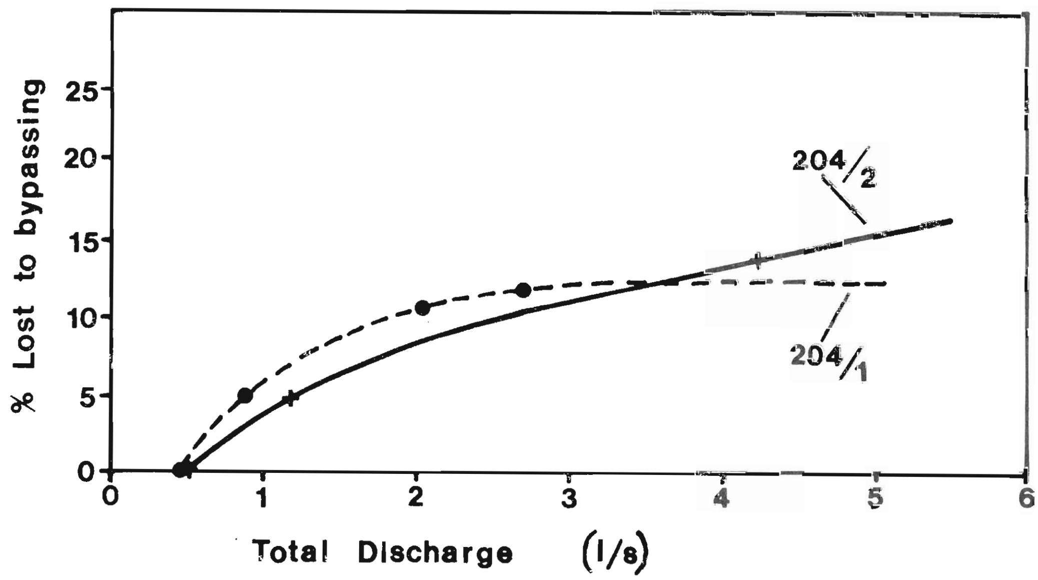


FIGURE 3.7 BYPASSING RELATIONSHIPS FOR BISHOPDALE GULLIES

TABLE 3.6 Brief details of Bishopdale events

Event Number	Time	Date	Dur (min)	R'F Vol (mm)	Runoff Peak (l/s) 2041	Runoff Peak (l/s) 2042	Antecedent condition
204001	00.35	16/7/76	35	5.24	*	2.64	Dry
204017	06.35	2/10/76	40	3.16	*	0.73	Dry
204018	10.25	2/10/76	55	3.14	*	1.42	Dry

204019	17.10	2/10/76	130	13.70	*	1.45	Dry
204020	20.25	2/10/76	30	1.24	*	0.73	Wet
204021	22.05	2/10/76	50	2.17	*	1.38	Dry
204022	23.04	2/10/76	50	2.73	*	1.68	Wet
204023	01.24	6/10/76	35	1.32	*	0.76	Wet
204026	09.15	11/10/76	60	2.41	*	1.18	Dry
204030	12.30	1/11/76	20	1.27	*	0.78	Dry
204031	16.38	6/12/76	22	1.17	*	0.65	Dry

Subcatchment 202 : Ennerdale One, Bracknell (1976-77)

Ennerdale One is a subcatchment in the Wildridings district of Bracknell New Town, and the development is very similar to that described previously for Bishopdale (Subcatchment 204). The subcatchment differs from the other subcatchment experiments in that it is drained by five road gullies, and the outfall was monitored by means of a Manning Dipper sited over a 225 mm diameter pipe in manhole SO342. Figure 3.8 shows a plan of the subcatchment, including the monitoring manhole. The area of the subcatchment is 912 m^2 (781 m^2 paved). A further Manning Dipper monitoring the outflow from another pipe draining a pitched roof was also located in the same manhole.

Rainfall was measured with a tipping-bucket gauge in an Electricity Board substation. The same limitations apply as for subcatchment 204 but in this case the standard gauge is 200 metres away. A wire connects the gauge through the sewer system to the logging equipment which is sited in the monitoring manhole. The two dippers and the raingauge are logged on the same system.

It was the intention to monitor the water level in the two pipes, and to convert this to discharge by means of a theoretical rating in conjunction with a field calibration. The results of this are shown in Figures 3.9. Unfortunately, the poor performance of the Dippers (particularly with respect to zeroing) in conjunction with the poor discrimination of the stage-discharge relationships (small changes in stage are associated with relatively large changes in discharge) means the data have little or no value. It is not intended to use or to publish these data, although the original records are still available.

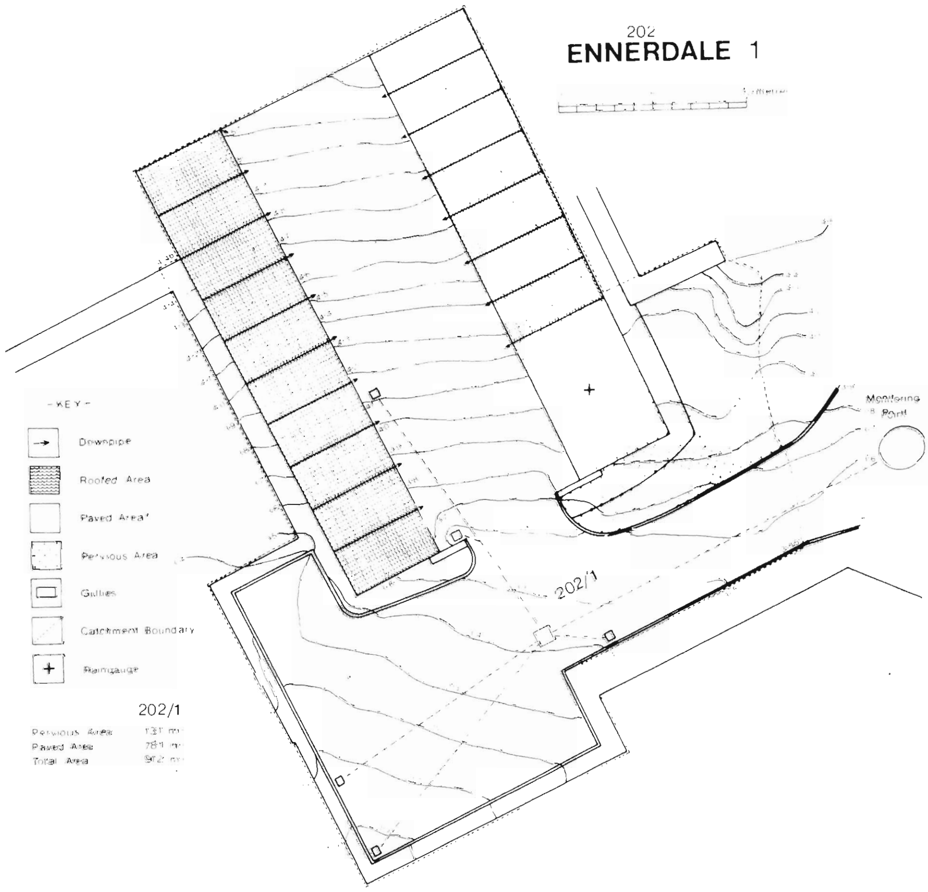


FIGURE 3.8 PLAN OF ENNERDALE ONE

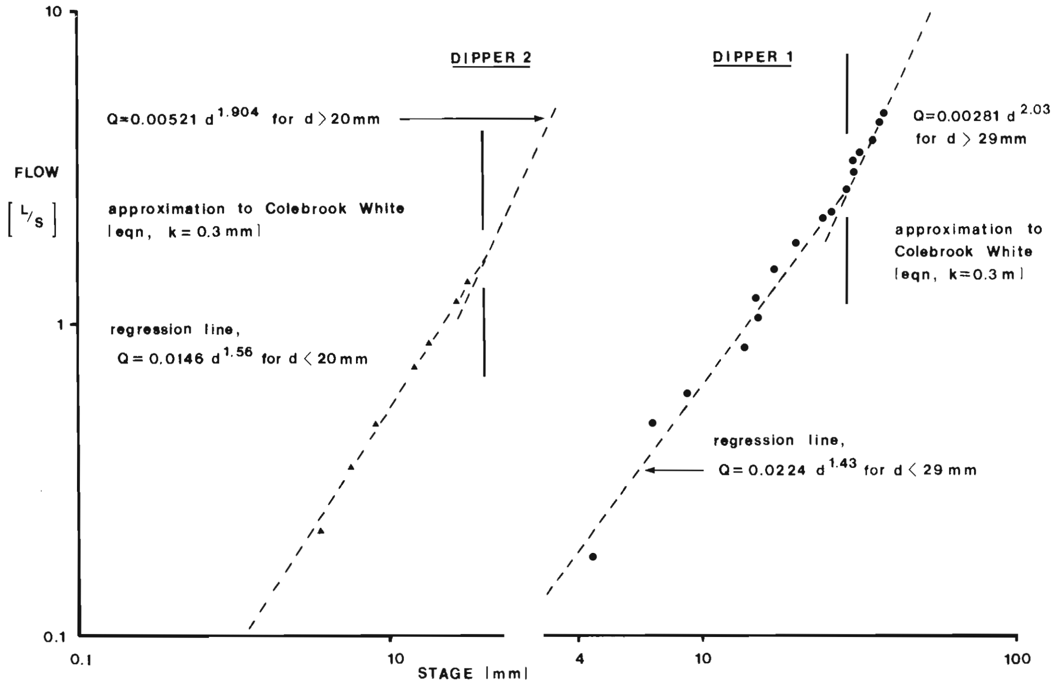


FIGURE 3.9 DIPPER CALIBRATIONS FOR ENNERDALE ONE

Subcatchment 203 : Ennerdale Two, Bracknell (1976-77)

Ennerdale Two is a cul-de-sac within the Wildridings catchment at Bracknell (see page 45). Figure 3.10 is a plan of the subcatchment. The Ennerdale Two subcatchment comprises two surface types; concrete in the garage area and hot rolled asphalt elsewhere. The subcatchment is drained by three gullies with areas of 118 m^2 (203/1), 358 m^2 (203/2) and 90 m^2 (203/3) with average slopes of 5.3%, 1.2% and 2 5% respectively.

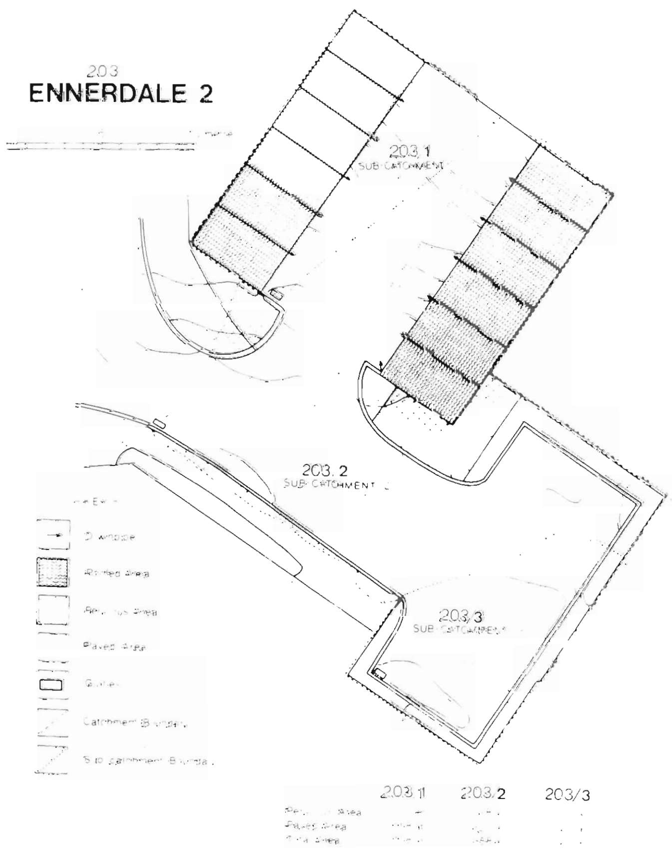


FIGURE 3.10 PLAN OF ENNERDALE TWO

Rainfall was monitored in an SEB sub-station and logged to the sub-catchment 202 logger. Careful synchronisation of the loggers have ensured the data is suitable for analytical use.

TABLE 3.7 Brief details of Ennerdale Two events

Event Number	Time	Date	Dur (min)	R'F Vol (mm)	Runoff Peak (l/s) 2031	2032	2033	Antecedent Condition
203001	00.35	16/7/76	21	4.74	*	1.80	*	Dry
203002	01.40	16/7/76	24	4.24	*	2.07	*	Dry
203003	02.20	16/7/76	23	1.81	*	0.48	*	Wet
203004	06.30	16/7/76	33	2.33	*	0.50	*	Dry
203005	07.20	16/7/76	51	5.98	*	2.16	*	Wet
203006	08.13	16/7/76	18	1.21	*	0.73	*	Dry
203007	13.30	20/7/76	37	14.58	*	*	1.21	Dry
203008	11.15	28/8/76	35	1.17	*	*	0.28	Dry
203009	05.15	2/10/76	14	1.82	*	*	0.29	Dry
203010	16.50	2/10/76	20	1.48	*	*	0.30	Dry
203013	16.20	23/10/76	15	1.55	*	*	0.16	Dry
203014	16.38	6/12/76	17	1.17	*	*	0.17	Dry
203015	09.20	7/12/76	40	2.25	*	*	0.20	Dry
203016	13.25	7/12/76	35	1.35	*	*	0.27	Dry
203017	16.35	7/12/76	25	1.62	*	*	0.17	Dry

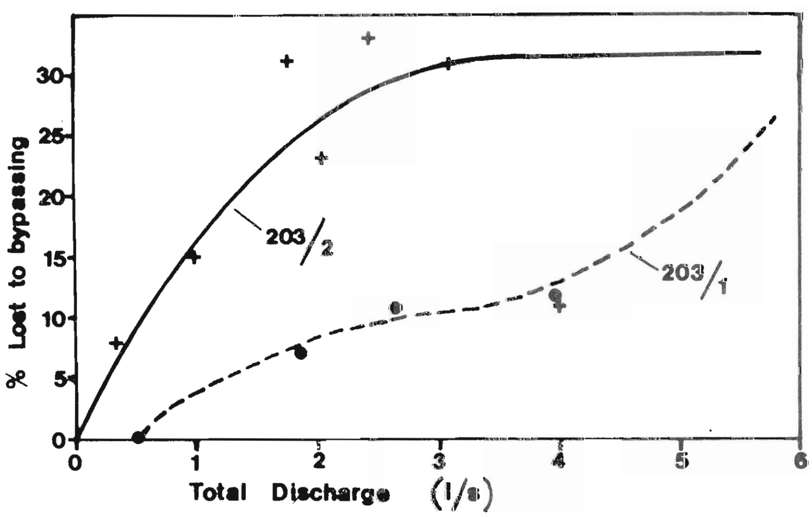


FIGURE 3.11

BYPASSING RELATIONSHIPS OF ENNERDALE TWO GULLIES

The summers of 1976 and 1977 yielded a total of 17 events which have been fully processed; Table 3.7 lists brief details of the major events. Severe bypassing of the gully in subcatchment 203/1 has rendered the data of little or no value, and therefore no reliable events have been abstracted for this subcatchment. The relationship shown in Figure 3.11 has enabled the data from 203/2 to be corrected to account for bypassing as described in subcatchment 204; 203/3 has not suffered from bypassing, and both 203/2 and 203/3 have been included in the data archive.

Subcatchment 214 : Hawthorn Close, Wallingford (1977-78)

This subcatchment is in a newly-developed residential area of Wallingford. A plan of the catchment is shown in Figure 3.12.

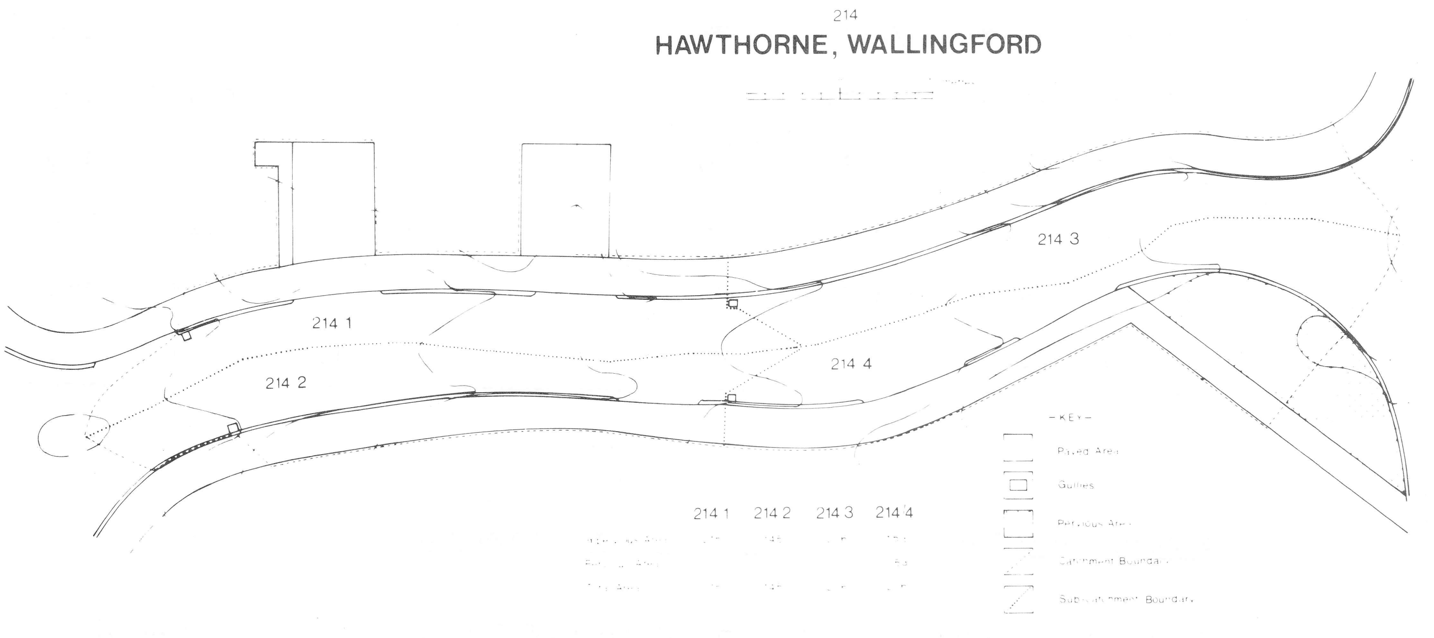


FIGURE 3.12 PLAN OF HAWTHORN CLOSE

Hawthorn Close is a cul-de-sac, although the upper end of the road is not included in the drained area. The monitored area is drained by four gullies with subcatchment areas of 215 m^2 (214/1), 145 m^2 (214/2), 176 m^2 (214/3) and 206 m^2 (214/4) with average slopes of 1.1%, 1.3% and .9% respectively. The road surface is constructed of hot rolled asphalt bounded by footpaths of lower quality asphalt. 214/4 is the only subcatchment with any contributing pervious area.

The subcatchment was instrumented in late 1977 and the first usable data were obtained in summer 1978. A .1 mm Rimco raingauge is located in an exposed position on a front lawn just outside the subcatchment boundary and is logged to the same cassette as the four gully meters. Table 3.8 gives brief details of the major events that have been processed from subcatchment 214.

TABLE 3.8 **Brief details of Hawthorn close events**

Event Number	Time	Date	Dur (min)	R'F Vol (mm)	Runoff Peak (l/s) 2141	2142	2144	Antecedent Condition
214001	21.05	22/6/78	52	2.07	0.21	0.18	0.16	Dry
214002	00.00	23/6/78	33	1.34	0.18	0.15	0.12	Dry
214003	12.40	23/6/78	17	1.84	0.46	0.43	0.39	Dry
214004	15.20	23/6/78	32	4.93	1.52	1.18	1.36	Dry
214005	12.30	30/7/78	47	8.65	1.00	0.87	0.87	Dry
214006	20.30	1/8/78	72	3.09	0.36	0.30	0.33	Dry
214007	17.50	2/8/78	34	2.14	0.30	0.25	0.33	Dry
214008	06.15	3/8/78	40	1.99	0.34	0.29	0.33	Dry
214009	13.20	7/8/78	16	4.75	2.10	1.81	2.14	Dry
214010	19.40	7/8/78	23	2.18	0.29	0.24	0.28	Dry
214011	20.15	12/8/78	30	6.94	*	1.15	1.18	Dry

Subcatchment 301 : Twyford Gardens, Nottingham (1978, continuing)

This subcatchment, in a residential area of Clifton Grove, Nottingham, has been established in conjunction with the Civil Engineering Dept of Trent Polytechnic who have undertaken much of the installation and maintenance of the experiments in the Nottingham area. Figure 3.13 is a plan of this catchment.

Twyford Gardens is a cul-de-sac drained by two gullies, one of which has a subcatchment area of 475 m^2 (301/1) and average slope of .5%; the other gully (301/2) drains only an area of pervious surface and has not yet yielded data. The road surface is of hot rolled asphalt and is bounded by asphalt pavements and grassed verges. A raingauge has not been installed on this catchment as it was felt that such an instrument would be too vulnerable to vandalism. The raingauge record for the College Car Park site (302) is used, being 500 metres away; careful synchronisation of loggers is practised to ensure the records are suitable for analytical processing.

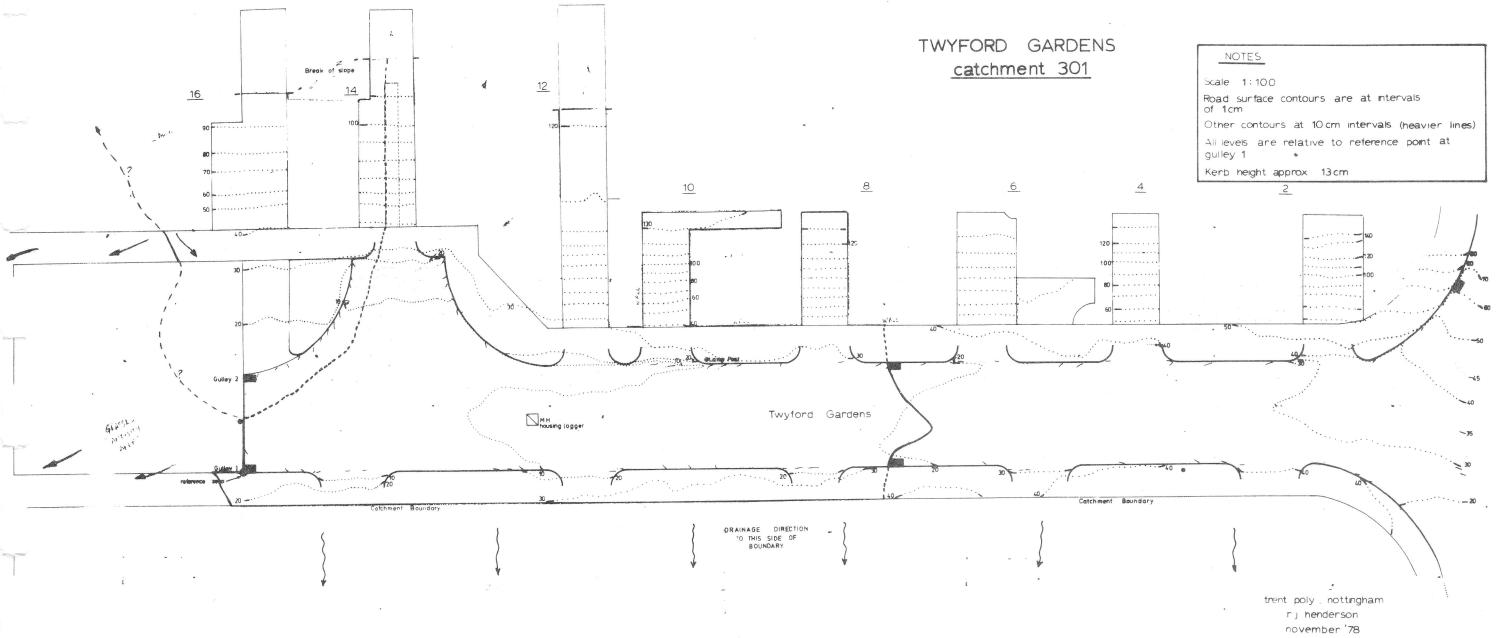


FIGURE 3.13 **PLAN OF TWYFORD GARDENS**

To date, only three events have been processed, and Table 3.9 shows brief details of the events. However, this experiment is continuing and should yield more data in 1979.

TABLE 3.9 Brief details of Twyford Gardens events

Event Number	Time	Date	Dur (min)	R'F Vol (mm)	Runoff Peak (l/s) 3011	3012	Antecedent condition
301001	06.00	30/7/78	42	4.39	0.64	*	Dry
301002	07.05	30/7/78	45	2.94	0.50	*	Wet
301003	08.05	30/7/78	35	3.01	1.42	*	Wet

4. LABORATORY CATCHMENT EXPERIMENTS

In 1976 a contract (F60/Cl/12) was given to the Civil Engineering Department of Imperial College, London University, for the collection of rainfall-runoff data under artificial conditions. This was achieved on the Imperial College laboratory catchment facility which comprises a rainfall simulator over a concrete basin and means of rainfall and flow measurement. Technical details of the installation are given by Hall (1970). These experiments were designed to complement the field data collection described in Section 3.

The original specification for the contract was to investigate the rainfall-runoff process over a wide variety of storm inputs, surface types (concrete, asphalt, grass and combinations thereof), surface areas and surface slopes. Technical problems resulted in a drastic reduction of the original programme. In brief, various rainfall inputs were applied to five different catchment areas (ranging from 18 m^2 to 45 m^2) on two different catchment slopes (.7% and 1.4%) on a concrete surface. Comprehensive details of the work done under this contract are provided by Pavlov (1978) and Johnston and Wing (1978)

These data have been archived at the Institute in two ways: firstly, as supplied, 107 events with data at 2 second intervals; and secondly, the same events in the same format as the subcatchment data described in Section 3 but at 10 second intervals.

5. CATCHMENT DATA ARCHIVE

This section relates to data from larger fully-sewered catchments. The archive holds a computer-based record of reduced storm events from a number of urban catchments. Copies of drainage plans and any other relevant information have been obtained where available.

Rainfall-runoff data processing

Rainfall and runoff charts are obtained from the relevant gauging authority and copies taken of storm events. The storm events are selected, normally by choosing an arbitrary minimum peak flow, such that approximately 10-15 events are available from each year's data. The relevant sections of the rainfall and runoff charts are microfilmed and then returned to the owner. Particular attention is paid to timing marks on the charts and such marks are transported into the frame covered by the microfilm, to ensure synchronisation of the rainfall and runoff trace. The events are converted to a digital form using the Institute's d-Mac digitiser. This is then transferred to a disc file record on the Institute's Univac computer as a time series of rainfall intensity (mm/hr) and runoff (l/s) values at either one or five minute intervals depending upon the resolution of the time scale of the original data charts. Data are then synchronised, using chart timing marks, and output as a rainfall/runoff record in both tabular and graphical form (Figure 5.1).

FIGURE 5.1

EXAMPLE OF
GRAPHICAL OUTPUT

Catchment	Sponsor	Total Area (ha)	%age impervious (%)	Period of data	No.of events	Quality of rf/ro data	Quality of Catchment data	Comment
Blackpool	RRL	4.82	42	1953-58	46	Good	A	
Oxhey Housing Estate	RRL	247	20	1953-59	19	Good	D	
Oxhey Road	RRL	.78	60	1954-59	39	Good	A	
WPRL, Stevenage	RRL	1.38	50	1955-59	15	Good	B	
Kidbrooke, Kent	RRL	3.42	68	1953-58	70	Good	B	
Doncaster	RRL	5.14	30	1955-58	19	Good	B	
Leicester	RRL	59.	36	1958	6	Good	D	
Derby	DOE	10.	49-53	197[illegible] cont	45	Moderate	A	3 nested catchments
Shephall, Stevenage	DOE	142	24	1973 cont	50	Moderate	A	
Bracknell Wildridings	DOE	11.1	46	1974 cont	20	Good	A	Outflow from 2 other catchments also monitored
Lordshill 1,Southampton	Soton U	0.60	41	1974 cont	20	Good	A	
Lordshill 2,Southampton	Soton U	0.80	42	1974 cont	15	Good	A	
Lordshill 3,Southampton	Soton U	3,42	39	1978 cont	3	Good	B	
Crawley	Crawley DC	200	25	1950 cont	200	Moderate	C	1950-1963 under development
Nottingham	Trent Poly.	62.0	31	1974	7	Moderate	D	

Figure 5.2 shows the location of the catchments included in the data archive at present and Table 5.1 gives brief details of the catchments available. In Table 5.1 a grading is given to each catchment. This grading denotes the catchment information available in the IH archive, as follows:

A : Plans available showing details of area, surface types and pipe system.

B : Plans available showing catchment area, pipe system or land use

C : Area plan only available.

D : No plan available from archive - reference to external source.

This grading only relates to the catchment data and is not a reflection on the quality of the rainfall/runoff records.

The remainder of this section gives more details of each catchment in turn.

TABLE 5.1 Brief details of catchment data

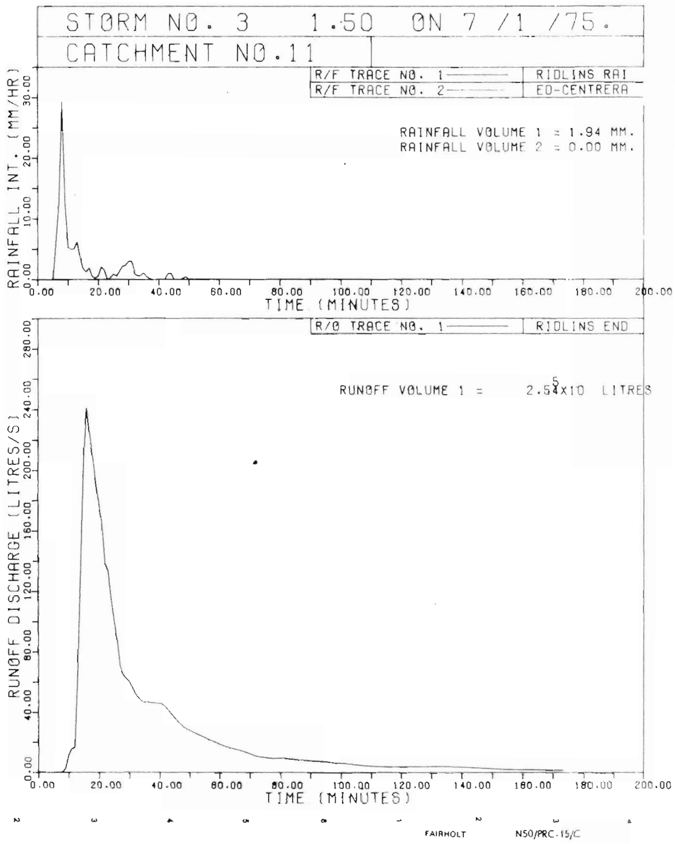
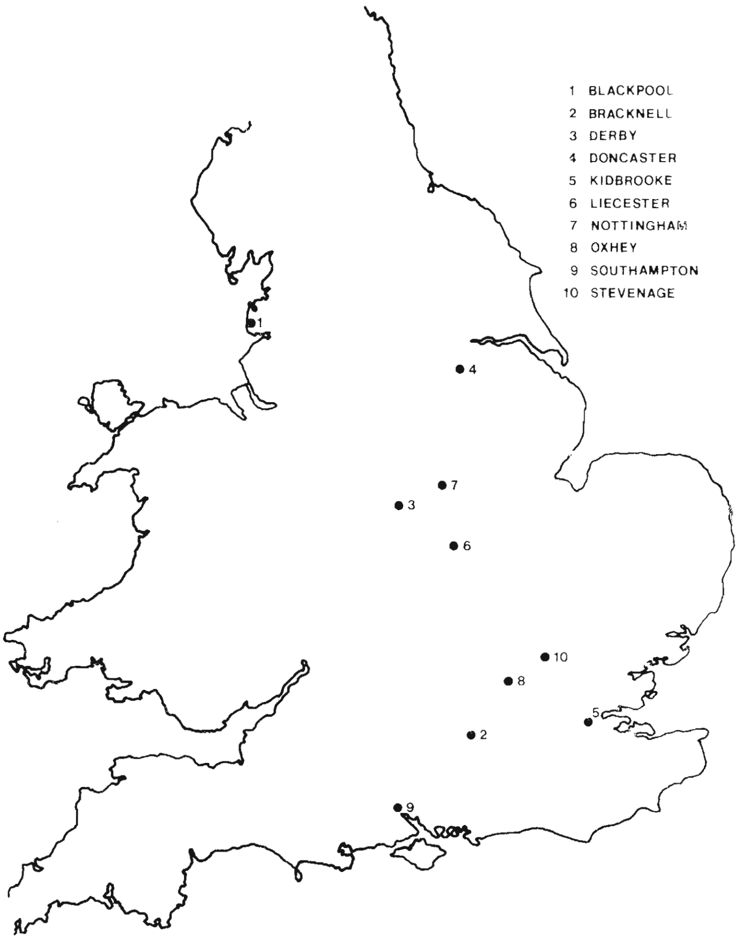


FIGURE 5.2

MAP OF CATCHMENT LOCATIONS



Catchment Data Archive

BLACKPOOL (RRL - 1953-58) 4.82 ha.

The Grange Park catchment in Blackpool was instrumented by the Road Research Laboratory (RRL) in conjunction with Blackpool Borough Council during the early 1950s. Grange Park is a small steeply sloping, roughly north to south, residential area built in the 1930-1940s. The houses have steeply pitched roofs. All the roads in the catchment are concrete with the exception of Dinmore Avenue. Figure 5.3 shows a plan of the catchment.

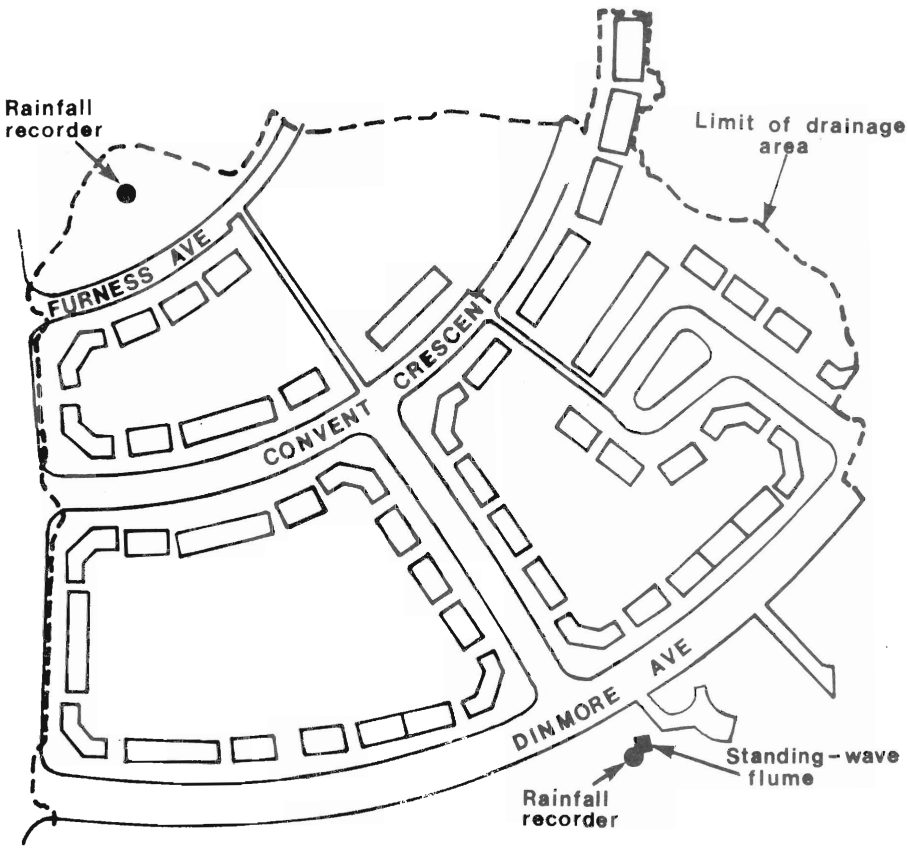


FIGURE 5.3 PLAN OF BLACKPOOL DRAINAGE AREA

Flow was monitored in the 18" (.5 m) outfall culvert of the combined system of the catchment using a flume, a theoretical calibration being used. Rainfall was measured at the Grange Park School using a Dines tilting syphon and a RRL intensity/tilting syphon gauge with an open scale chart. A standard check gauge was also sited at the school. The raingauge site was in flat open ground but 'suffered from the natural energies of children' when first installed.

The RRL used a total of 26 storms from this catchment in their analysis for the design method for urban storm sewers (Watkins, 1962). Some 46 events have been abstracted from the original data for the IH urban data archive.

The data archive contains five catchment plans of the Grange Park Estate drainage showing details of the area, land use and sewer networks. Brief details of the plans are given in Appendix B.

OXHEY HOUSING ESTATE (RRL - 1953-59 and IH/TWA 1977) 247 ha

The Oxhey residential area was the largest urban catchment investigated by the RRL in the 1950s' study. The development comprised houses, schools, shops and public buildings. No industrial developments were within the area - the housing areas being typical of development of that time, having areas of grassed verges, gardens and open spaces

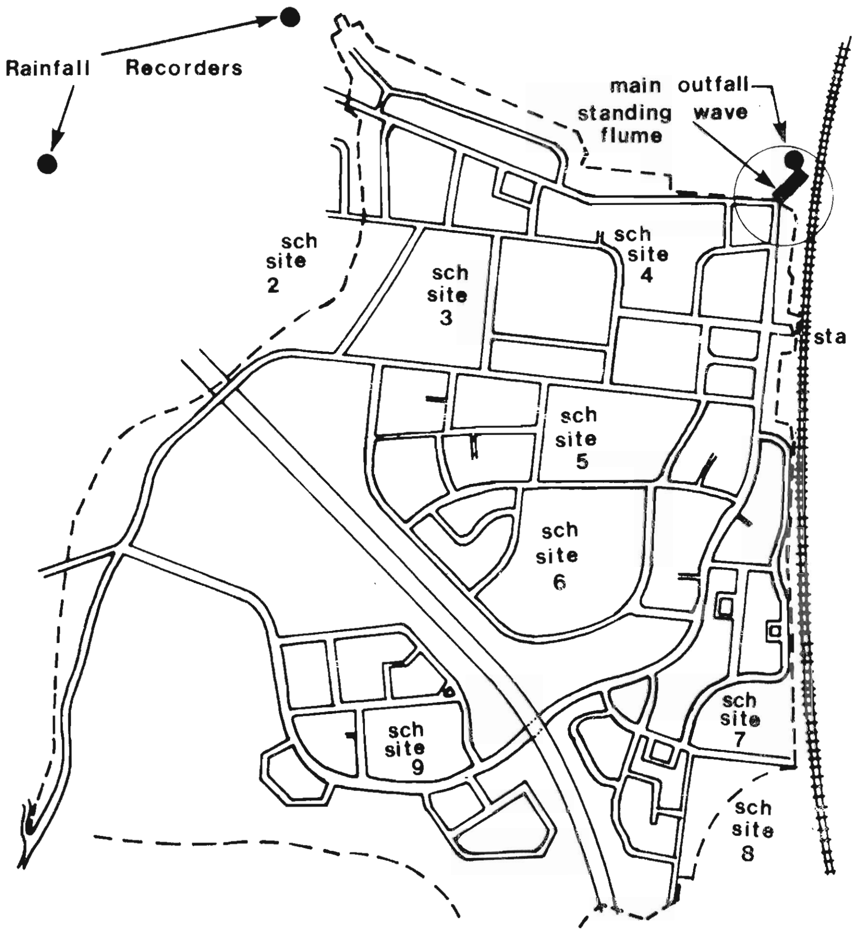


FIGURE 5.4 OXHEY DRAINAGE AREA

within the catchment. The Oxhey catchment gradient becomes steeper the further from the outfall and large wooded areas are included in the catchment area farthest from the outfall. Runoff was monitored by a standing wave flume at the outfall of the catchment to the Hartsbourne River, the flume being calibrated by the Kent Instrument Company.

Rainfall was monitored at a golf course, the flume site and a school within or close to the catchment, using either Dines tilting syphon gauges or the RRL intensity/tilting syphon gauge with open scale charts.

At the end of the RRL project on storm sewer design the Oxhey flume was allowed to fall into disrepair. In 1977 it was decided that it would be useful to re-establish the Oxhey catchment and after negotiations with the Thames Water Authority, a joint monitoring system was set up between IH, the TWA and Middlesex Polytechnic. TWA maintain the site and a water level recorder; Middlesex Polytechnic supplied the flume hut and maintain a water quality project at the site and IH maintain a water level recorder and tipping bucket raingauge.

The RRL analysed 25 storms from the Oxhey Housing Estate catchment from the period 14.7.53-10.7.59. The Institute has included 19 events from this period in its archive. Collection of data is continuing for inclusion in the expanding data archive.

No plans of this catchment are available in the data archive at the time of writing. The only plan of this area is in Technical Paper 55 (Watkins, 1962) and is reproduced in Figure 5.4.

OXHEY ROAD (1954-1959) .78 ha

This catchment consists of a length of road approximately 400 m long by 10 m wide with a 3 m grass verge separating a 2 m wide footpath. The road forms one access to the Oxhey housing estate previously described. The outfall of both areas enter the Hartsbourne River at the same place. Runoff was monitored using a V-notch tank. Rainfall data were obtained from the gauges used for the Housing Estate investigation.

The RRL analysed some 47 events, and 39 events from this catchment have been included in the IH data archive.

The plan in Figure 5.5 reproduced from Technical Paper 55 (Watkins, 1962) is sufficiently detailed for the data to be considered comprehensive.

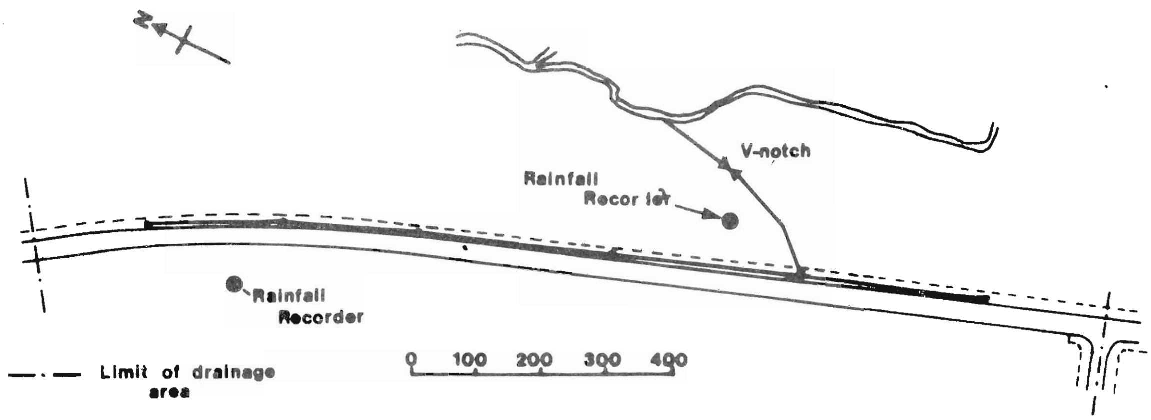


FIGURE 5.5 OXHEY (ROAD ONLY) DRAINAGE AREA

WATER POLLUTION RESEARCH LABORATORY, STEVENAGE (RRL - 1955-59) 1.38 ha

This catchment (WPRL) consists of a small factory type area without the large open concrete yards that characterised the Kidbrooke factory area (see below). Figure 5.7 shows a plan of the catchment. Runoff was monitored in a purpose-built V-notch chamber in the outfall pipe of the storm sewer. Rainfall was recorded at two locations within the catchment boundary using Dines and RRL raingauges. Fifteen storm events were processed by the RRL in the 1950s and these events have been included in the IH data archive.

Plans of the catchment area and drainage networks are available for this catchment. However, no detailed information about surface types are known. Figure 5.6 is reproduced from Technical paper 55.

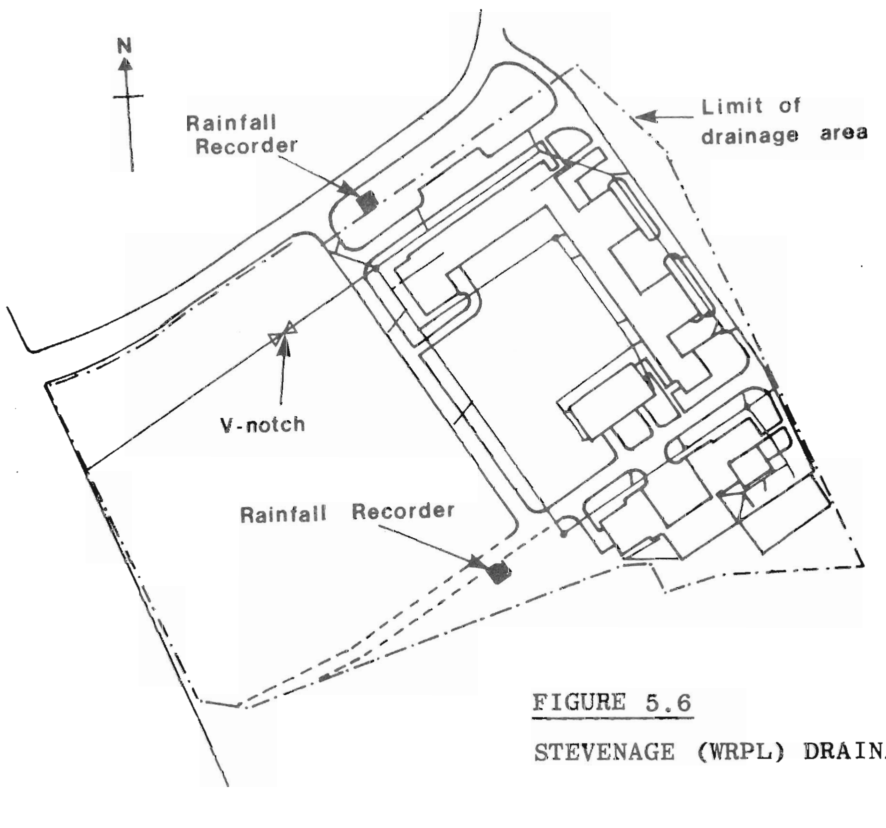


FIGURE 5.6

STEVENAGE (WRPL) DRAINAGE AREA

KIDBROOKE (RRL - 1953-58) 3.42 ha

This catchment in Kent again consists solely of a small industrial development (see Figure 5.7) characterised by large concrete yards. Runoff was monitored using a standing wave flume in the outfall pipe and rainfall by Dines and RRL gauges within the catchment boundaries. The RRL processed 62 event records in the 1950's work, and 70 events have been extracted and included in the IH data archive.

Two plans showing drainage area and pipe numbering system are available for the Kidbrooke catchment.

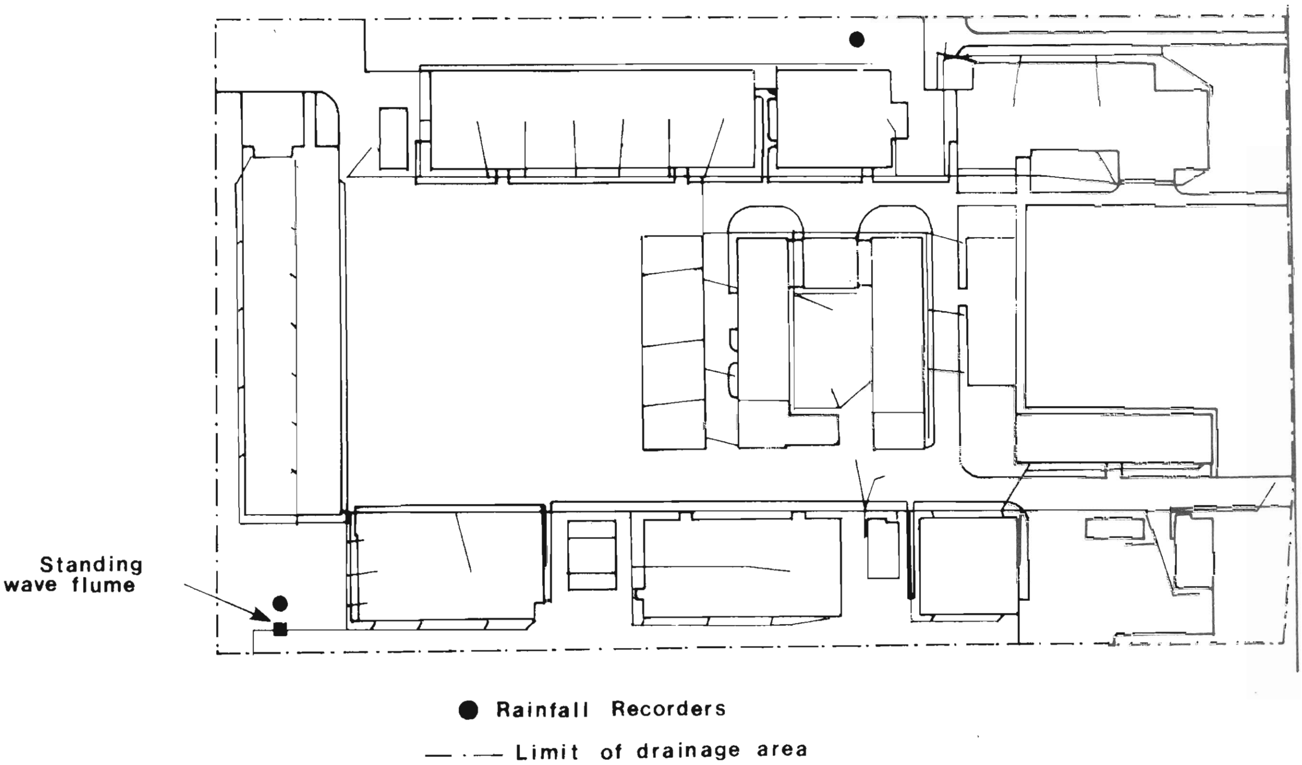


FIGURE 5.7 KIDBROOKE GOVERNMENT TRAINING CENTRE

DONCASTER (RRL 1955-58) 5.14 ha

This catchment is a residential area typical of the type being developed in the 1950s, including shops and open areas within the catchment boundary. Runoff was monitored by a standing wave flume at the catchment outfall and rainfall at two sites close to the catchment boundary using RRL autographic gauges. 19 events have been included in the RRL work and in the IH urban data archive.

Catchment details are limited to the single plan reproduced from Technical Paper 55 (Figure 5.8).

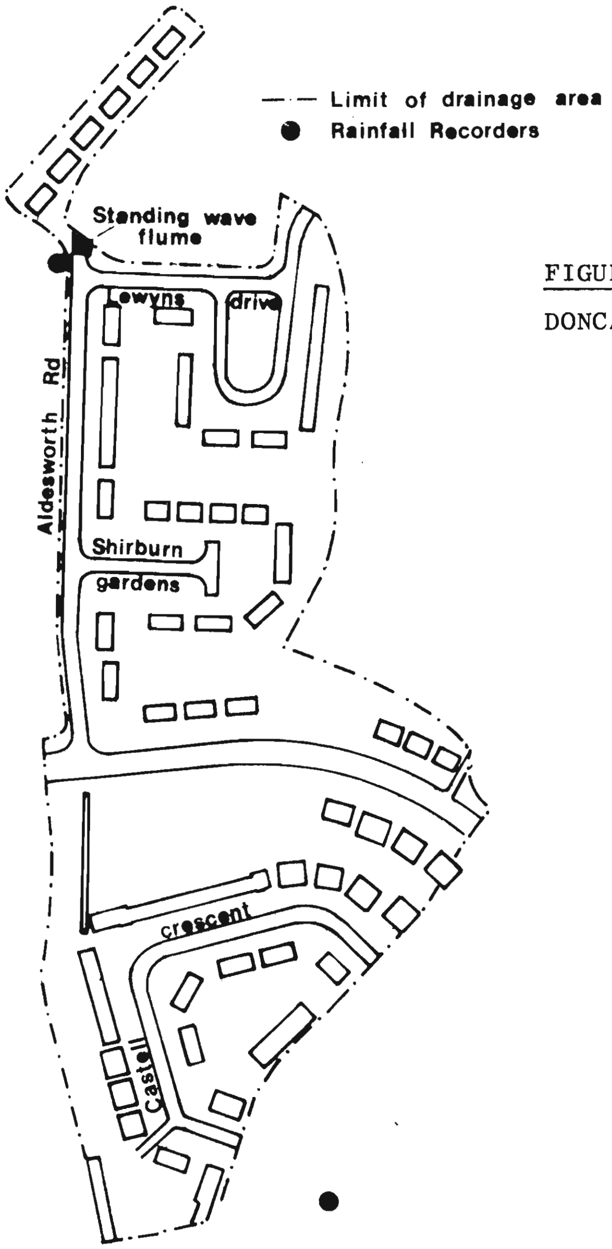


FIGURE 5.8

DONCASTER DRAINAGE AREA

LEICESTER (RRL 1958) 59.5 ha

This is a mixed development consisting of high density old developments near the outfall, large houses standing in spacious gardens further from the outfall and open parkland and school playing fields furthest from the outfall.

Runoff was monitored in the combined sewer system using a standing wave flume. Two autographic raingauges were installed on the catchment by the RRL. Seven events were analysed by the RRL team, and six were extracted and processed for inclusion in the IH data archive.

Catchment data are limited to the plan in Figure 5.9 reproduced from Technical Paper 55 (Watkins, 1962).

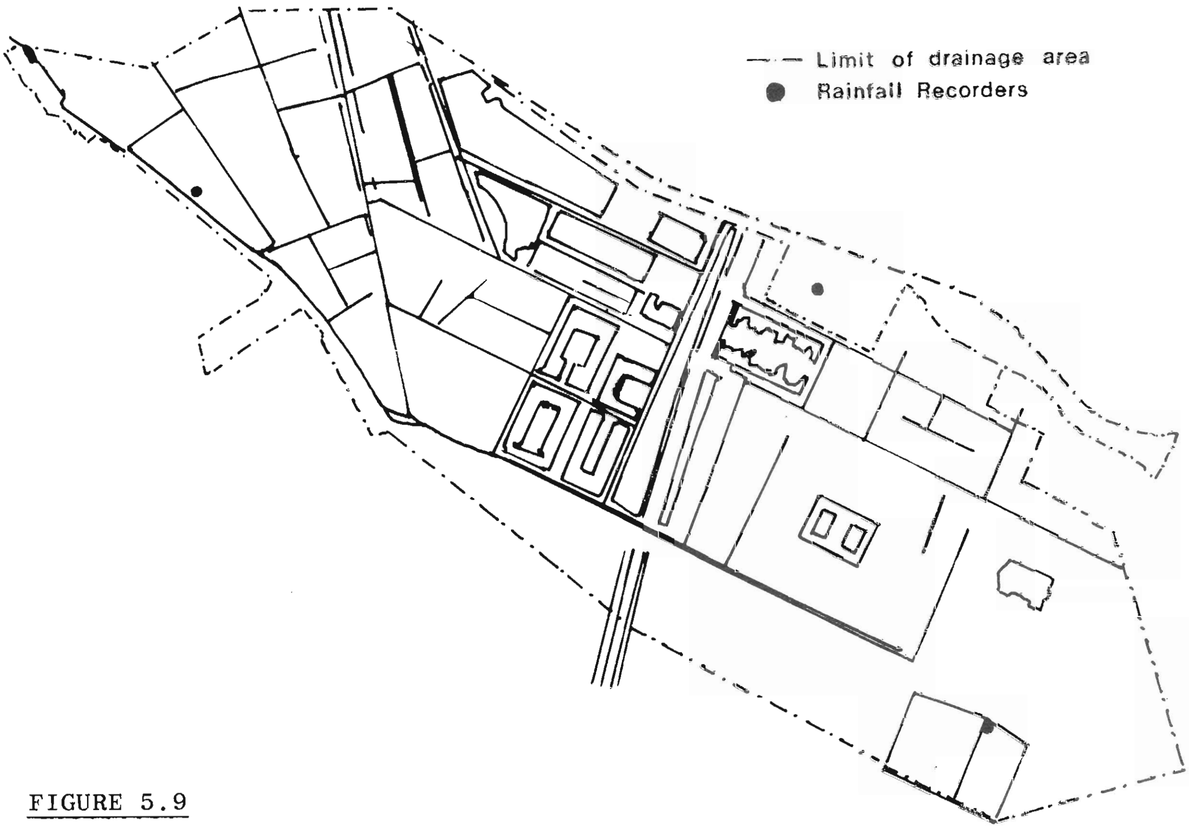


FIGURE 5.9

LEICESTER DRAINAGE AREA

DERBY (DGWE/DOE 1973 continuining) 10 ha

This experimental site consists of three nested catchments in a mixed residential area, the development being of mixed age property. The catchment is on the flood plain of the River Trent and is generally very flat. Runoff is monitored at the outfall of each catchment by an Arkon air purge system. Rainfall records are obtained from recording gauges in the vicinity of the catchment and an open scale Dines tilting syphon gauge has been installed in 1978. Initial problems of rainfall/runoff synchronisation have been cured by regular time marking of the charts. 45 events have been abstracted from the data for inclusion in the data archive.

Catchment details are good and plans of surface types, pipe system, gully positions and areas are available from the archive. The detailed preparation of the catchment data was done by the Hydraulics Research Station, and these data are also in digital form.

SHEPHALL, STEVENAGE (DGWE/DOE 1973 continuing) 142 ha

This catchment is a 1940s residential development comprising houses, shops, schools and open grassed areas. The catchment is on a mild slope and is drained by a separate sewer system. The catchment was monitored in conjunction with Stevenage Development Corporation who did the instrument maintenance until April 1978 when the Drainage Division was disbanded. The Stevenage Laboratory of the Water Research Centre has taken over the instrument maintenance. The area of impervious surfaces drained by the sewer system was increased slightly in 1978 by the connection of the garage yards to the storm drainage system.

Runoff has been monitored at the manhole upstream of the outfall using an Arkon air purge system since 1973. The accuracy of high flow measurement (in excess of .3 m depth) has, until April 1978, been very poor (assumed to be caused by non parallel flow lines due to the geometry of the gauging site). A change of air supply equipment to the gauge appears to have cured this problem. A critique of the use of Arkons in general and this problem in particular is given by Forty(1978).

In May 1977 a critical depth flume became operational downstream of the Arkon site. Depth of flow is monitored (a) by an Institute of Hydrology water level sensor logged to a Microdata logger and (b) by a Fischer and Porter punched tape recorder. A theoretical calibration for the flume and the Arkon site have been produced.

In the period 1976-78 data were also collected from road gullies in the Shephall catchment (205, 206, 215, 216, described earlier). The Water Research Centre collected water quality data for storm events during this period. Rainfall has been monitored with autographic gauges at two sites, both using Dines tilting syphon gauges with open-scale (6 inches/hr) charts. In the 1976-78 period rainfall was also monitored at the 206/216 site (see Section 3) during the summer months using a .1 mm bucket Rimco gauge logged at 30 s intervals.

Approximately 50 events have been abstracted and included in the data archive. Comprehensive catchment details are available in the archive, consisting of area, pipe network and surface types plans. The detailed preparation of the catchment data was done by HRS, and these data are also in digital form.

BRACKNELL WILDRIDINGS (DGWE/DOE 1974 continuining) 11.1 ha

Wildridings is a modern residential area including houses with gardens, shops, a school and open grassed area. The catchment has a steep ground slope and a separate sewer system.

The catchment is monitored in conjunction with the Bracknell Development Corporation who undertake the data collection. Runoff is monitored with a critical depth flume at the outfall of the catchment, depth being monitored by an IH water level sensor and also by a Kent gauge reading in flow (l/s) from a float driven cam assembly. The Kent gauge reading is relayed to a central recording cabin where three other flumes, the outflow from the lake, the Great Hollands' and Easthamstead/South Hill Park catchments, are also recorded. Rainfall is monitored at the school site within the catchment using a Dines tilting syphon gauge (open scale 6 inches/hr), and also at a number of other nearby sites.

In the 1976-77 period runoff was monitored at a number of gullies in the Wildridings catchment (202, 203 and 204, described earlier). Rainfall was also monitored at the 202 and 204 site using .1 mm bucket Rimco logged at 30 s intervals. However, the gauges were badly sited and the observations on page   should be noted.

Twenty events have so far been included in the data archive. Comprehensive plans of the Wildridings sewer network, land use and catchment area are available from the data archive. The catchment data preparation was done by HRS, and these data are also available in digital form. Little detailed catchment information is known about the Easthamstead and South Hill Park catchments.

SOUTHAMPTON LORDSHILL 1 and 2 (Southampton University 1974 continuing) 0.6 ha and 0.8 ha

These are two small residential catchments in a modern development consisting of houses, with open plan front lawns and enclosed rear gardens, and a school. Both catchments are drained by separate sewer systems; one has a steep ground slope, the other moderate. Figure 5.10 shows a plan of the two catchments.

Runoff is monitored at the outfall of each catchment by an Arkon air purge system in a prefabricated Venturi flume. The depth of flow in each flume is recorded at a central monitoring cabin onto one chart to ensure good record synchronisation. Rainfall is monitored using a Cassella .5 mm tipping bucket gauge, the output of which is recorded on a Cassella chart and repeated to the Arkon chart to give a synchronised rainfall/runoff record. A standard gauge is sited a short distance away to check the 'catch' of the tipping bucket gauge which is sited on the roof of the recording cabin.

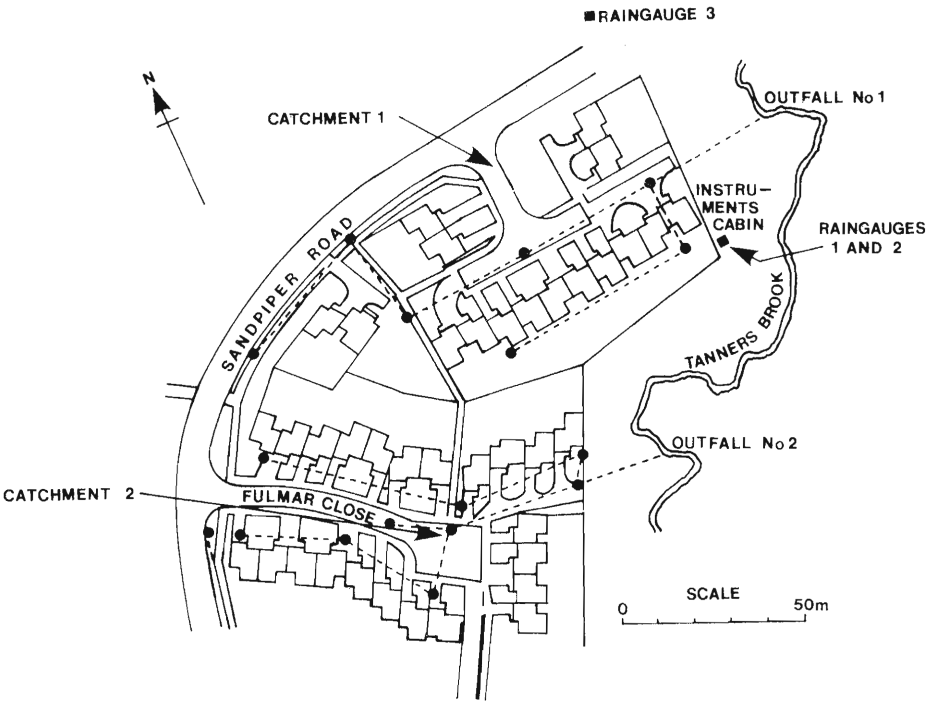


FIGURE 5.10 LORDSHILL CATCHMENTS, SOUTHAMPTON

Due to increased development on the receiving stream upstream of the two catchment outfalls, both have become susceptible to drowning out at high floods, but some remedial action should alleviate this problem in the future.

Some 20 and 15 events have been included in the data archive for Lordshill 1 and 2 respectively. Comprehensive catchment details are available, and a more detailed description of the catchments and the instrumentation may be found elsewhere (Kidd, 1976).

SOUTHAMPTON LORDSHILL 3 (Southampton University 1978 continuing) 3.42 ha

A third catchment (larger than, and adjacent to, the other two catchments) has been monitored since mid-1978. Runoff is monitored with an Arkon air purge system at a purpose-built prefabricated trapezoidal flume at the outfall of the sewer system. The record is synchronised with the other Arkon by regular time marking of the traces. Rainfall is not recorded on the catchment. However, the raingauge at the Lordshill 1 and 2 site is approximately 200 metres away.

Only three events have been extracted to date and as the project is continuing, more data will become available in 1979. Catchment data is limited at the time of writing.

CRAWTERS BROOK AT WOOLBOROUGH ROAD, CRAWLEY (1950 continuing) 200 ha

This catchment is located near the centre of the Crawley New Town, development having occurred in the 1950s and early 1960s. The development is predominantly residential but does include part of the shopping centre and an industrial area. The catchment is estimated to be 25% paved.

Runoff is monitored by a flume in a box-culvert, and rainfall is obtained from two autographic gauges approximately 1 mile from the centre of the catchment. Approximately 200 storm events have been abstracted and included in the data archive.

Catchment details are limited to general area plans.

RISE PARK, NOTTINGHAM (1974) 62 ha

This catchment is a modern residential development on the outskirts of the City of Nottingham. It is approximately 31% paved. Rainfall was recorded by a tipping bucket gauge sited a short distance away from the catchment and runoff was measured by gulp-injection dilution gauging. The quality of the runoff data is moderate. Water quality measurements were also taken. The data (7 events) were extracted from the Trent Polytechnic M.Sc. Thesis of Tucker (1974).

ACKNOWLEDGEMENTS

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1. The Hydraulics Research Station; the Stevenage Laboratory of the Water Research Centre; Southampton University (Civil Engineering Department); Trent Polytechnic (Civil Engineering Department) and Middlesex Polytechnic (Geography Department) for their active assistance in various of the data collection projects.

2. Stevenage Development Corporation; Stevenage Borough Council and Bracknell Development Corporation for their assistance in establishing the subcatchment experiments in their respective areas.

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APPENDIX I

CATCHMENT PLANS AVAILABLE AT IH

CATCHMENT	PLAN TITLE	SCALE	DATE	INDEX NOS	COMMENTS
Blackpool	Grange Park Estate ESDA Basic Area Plan	1:500	June 1950	011	Grade A
	Grange Park Estate ESDA Sewer Plan		June 1950	012	
	Grange Park Estate ESDA Land Use Plan		June 1950	013	
	I/H Drawing Sewer System Pipe Numbering overlay			014	
	I/H Drawing Contributing Impermeable Area Overlay			015	
Bracknell	Bracknell Development Corporation Area Drainage Plan	1:500		101	Grade A
	Bracknell Development Corporation Area Drainage Plan continued	1:500		102	
	Bracknell Development Corporation Area Plan for Land Use Calculations	1:500		103	
	Bracknell Development Corporation Area Plan for Land Use Calculations	1:500		104	
	Bracknell Development Corporation Area Natural Catchments Drainage Procedures			105	

CATCHMENT	PLAN TITLE	SCALE	DATE	INDEX NOS	COMMENTS
Bracknell (cont'd)	Bracknell Development Corporation Main Drainage Proposals Stage II Natural Catchments	1:10560		106	
	Bracknell Main Surface Types			107	
	I/H Drawing Wildridings plan Bracknell	1:1000	Sent 1975	108	
	Bracknell Area Aerial Coverage			109	
	Bracknell Area Aerial Coverage			110	
	Bracknell Area Aerial Coverage			111	
Derby	County Borough of Derby Small Scale Area Plan	1:2500	Nov 1970	121	Grade A
	Basic Plan	1:2500		122	
	Main surface types	1:2500		123	
	Distribution impervious surface			Plan 1	
	Type Impervious Surface			Plan 2	
	Position of Gullies			Plan 3	
	Sewer Lengths, Gradients, Diameter			Plan 4	
	County Borough of Derby Eastern Intercepting Sewer Cowsley Road Drainage Area MoHALG Investigation				

CATCHMENT	PLAN TITLE	SCALE	DATE	INDEX NOS	COMMENTS
Doncaster	Doncaster Drainage Area Showing Sewer Plan and Numbering of Branches and Sections	1:1920			Grade B
Kidbrooke	BTTC Large Scale Drainage Plan	1:384	June 1945	061	Grade B
	I/H Drawing Sewer System Pipe Numbering Overlay			062	
Stevenage Shephall	Stevenage Development Corporation O/S Maps Coverage of Area		July 1971	211	Grade A
	DOE Sewer Research Project Map TL 2622 NE O/s 1:1250 coverage			2112	
Stevenage WPRL	WPRL Map Site Plan	1:500	Jan 1974	091	Grade B
	WPRL Map Drainage Plan	1:500	Aug 1952	092	
Oxhey Housing Estate	Figure in Tech Paper 55 (Watkins, 1962)		1962		Grade D
Oxhey Road Road	Figure in Tech Paper 55 (Watkins, 1962)		1962		Grade A
Crawley	Instrumented Catchments in the Crawley Area	1:50000	1975	URB001	Grade C
	Crawters Brook at Woolborough Road	1:10000		URB002	