# A Study of the Limestone Hydrology of the St. Dunstan's Well and Ashwick Drainage Basins, Eastern Mendip, Somerset

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## A. INTRODUCTION

(1) *Geology*. The area examined lies on the northern flank of Beacon Hill, the most southerly and easterly of the Mendip periclines, between Little London in the west (ST 625473) and Leigh-on-Mendip in the east (ST 683472).

The post-Carboniferous strata have only partly been removed in this area—isolated deposits of Inferior Oolite and Lower Lias rocks occurring around Oakhill village (ST 635473). To the east of Leigh-on-Mendip the Jurassic cover is complete.

The geological structure of the area is relatively simple: an east–west orientated, elongated outcrop of Old Red Sandstone (Devonian) forms the core of the pericline and is flanked successively by the Carboniferous Limestone series and (to the north) the Coal Measure series. The Old Red Sandstone is approximately 410 m. thick with dips varying between 75° at Stoke Lane (ST 664468) and 40° at Little London. The sandstones rest unconformably on Silurian tuffs and andesitic lavas which are exposed at Moon's Hill Quarry, Stoke Lane (ST 663461). The Carboniferous Limestone, 910 m. thick, outcrops as a band varying in width from

1 km. near Stoke Lane to 1.6 km. near Oakhill. The dip of the limestones varies between 80° at Stoke Lane and 35° further west. Major bedding partings occur at intervals of 0.96 m.–1.92 m. especially in the Clifton Down and Hotwells Limestone, components of the Carboniferous Limestone. In the latter formation partings attain a thickness of 30–54 cm. and appear to act as major drainage conduits within the area.

Two major faults exist within the region, both trending S.S.W.–N.N.E.;—the Withybrook Fault with a downthrow to the west, and the Oakhill Fault with a downthrow to the east. Patches of Head overlie the Old Red Sandstone and Lower Limestone Shales to a depth of 1.9 m. between Oakhill and Withybrook (Green and Welch 1965). The geology is summarized in *Fig.* 65 and a cross-section through the pericline near Stoke Lane is given in *Fig.* 66.

(2) *Landforms*. The northern flank of Beacon Hill exhibits five distinct physiographic units: (i) The slopes of the Old Red Sandstone core rising to 290 m. O.D. at the watershed, (ii) A slight depression feature corresponding to the mechanically weaker Lower Limestone Shales, (iii) A gently undulating plateau-like area on the limestones (200–225 m. O.D. in the west, 180–205 m. O.D. in the east), (iv) A steep scarp-like feature (mean gradient 20°) descending 30–60 m. into, (v) The deep, strike-orientated valley of the R. Mells, flowing W.–E. to join the R. Frome. The valley is excavated in the base of the Coal Measures.

Five valleys run across the area from S.–N. or S.W.–N.E., all containing streams in their upper reaches but dry for most of their course across the limestone. From east to west they are: East End Valley, Stoke Lane Valley, Combe Wood Valley, Fairy Lane Valley and Ashwick Grove Valley. All exhibit a marked steepening in gradient in their lower reaches and they "hang" above the main Mells valley into which they drain. This is probably related to the downcutting of the Mells during the period when surface streams have been absent from the lower sections of these valleys.

Soils in the area are largely surface water gleys and poorly drained brown earths (50–70 cm. thick) on the sandstones and freely drained brown earths (70–100 cm. thick) on the limestone.

(3) *Drainage*. The surface hydrology of the area is shown in detail on *Fig.* 67. There are two main sets of risings in the area—those at St. Dunstan's Well at 146 m. O.D. (St. Dunstan's Well East and West—two separate risings 2 m. apart) and those at Ashwick Grove (a higher set at 168 m. O.D. and a lower set at 160 m. O.D., together with a third, independent small rising, the Wishing Well, a few metres from the lower set and at the same altitude). The resurgences are fed by a series of streams draining off the sandstone slopes and sinking at or near the Lower

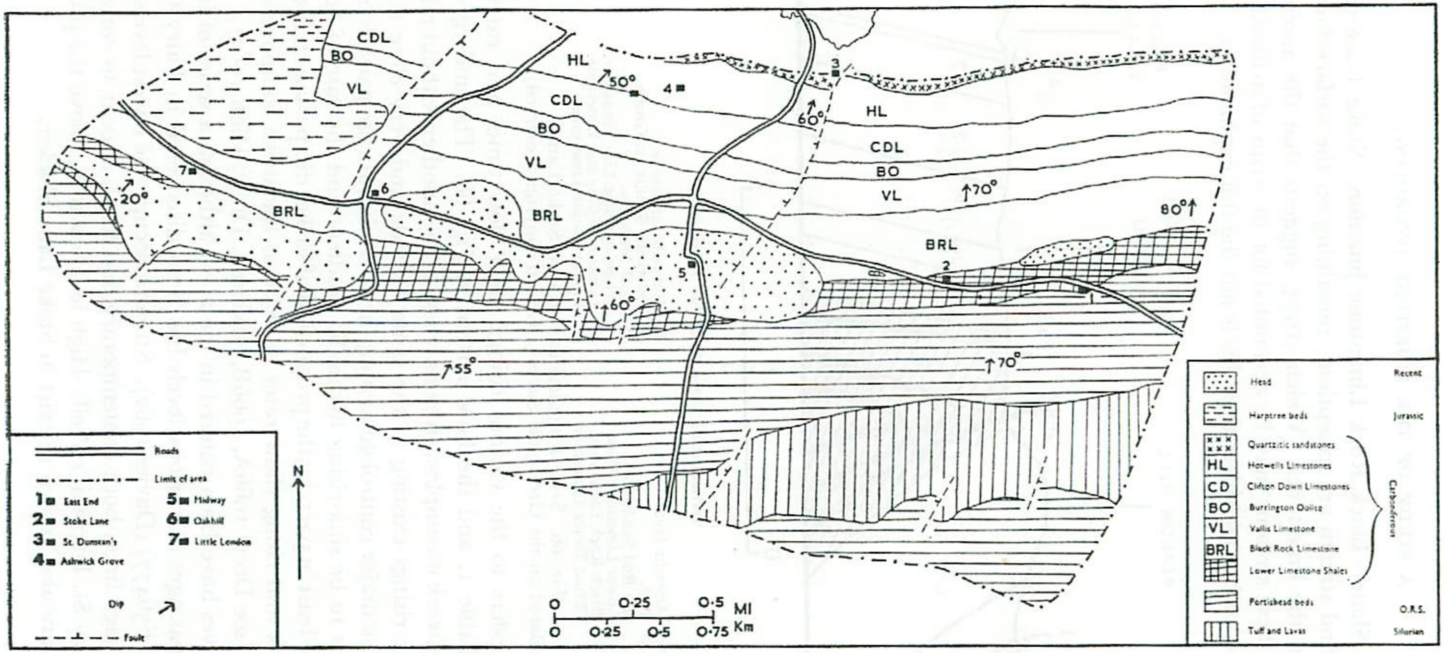
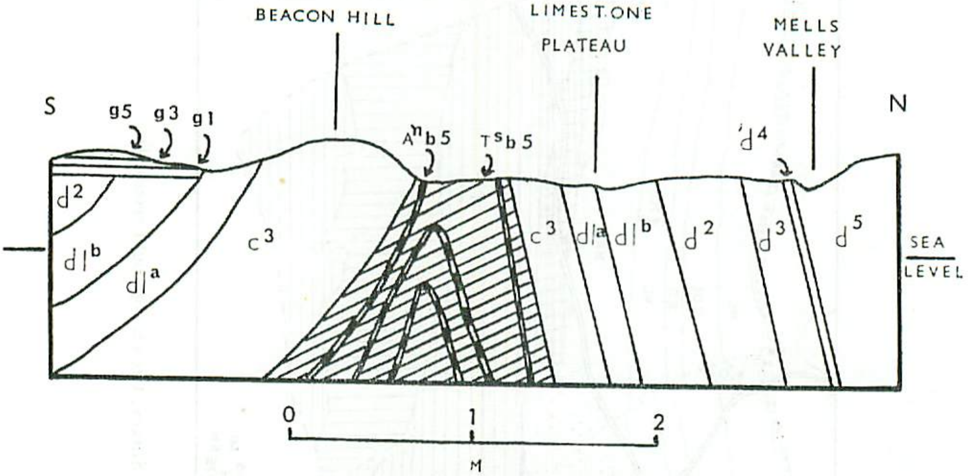


*Fig.* 65. (Based on the Geological Survey. Crown copyright reserved).

Limestone Shale—Black Rock Limestone junction. Stoke Lane stream and East End stream are exceptions, remaining on the surface for some distance on the limestones. Welch (1933) suggests that the anomalous courses of these streams may be accounted for in terms of artificial conduiting, the author considers that this is not the full explanation.



Vertical scale three times the horizontal

KEY

| | |
|---|---|
| Anb5 | Andesite lava. |
| Tsb5 | Tuff. |
| c3 | Old Red Sandstone. |
| d1a | Lower Limestone Shale. |
| d1b | Black Rock Limestone. |
| d2 | Clifton Down Limestone. |
| d3 | Hotwells Limestone. |
| d4 | Quartzitic Sandstone Group. |
| d5 | Coal Measures. |
| g1 | White and Blue Lias Limestone. |
| g3 | Lower Lias Clay and Limestone. |
| g5 | Inferior Oolite Limestone. |

*Fig.* 66. S–N Geological section near Stoke Lane. (Based on the Geological Survey. Crown copyright reserved).

The feeders to the various risings, their flow times and rates are shown in Table 1, and the flow pattern in *Fig.* 68. The underground drainage network is complex, streams crossing one another without mixing and discrete risings existing at the same altitude and very close to one another. The major control governing the overall drainage pattern in the area appears to be sink-rising hydraulic gradient and the rate of flow is governed, at least in part, by the proportion of strike: dip passage traversed between sink and rising (flow rates increase as the strike component increases):— (see Drew 1966A, 1966B, Atkinson, Drew, High 1967).

Few caves have been entered in the area, although a series of interconnected passages at various levels has been discovered in Fairy Cave Quarry (ST 656477) (Davies 1962). Streams occupy the lowest levels and all the drainage lines, both contemporary and fossil, appear to converge on the nearby St. Dunstan's Well. High level cavities, above the present streamway, are also known to exist in Stoke Lane Slocker.

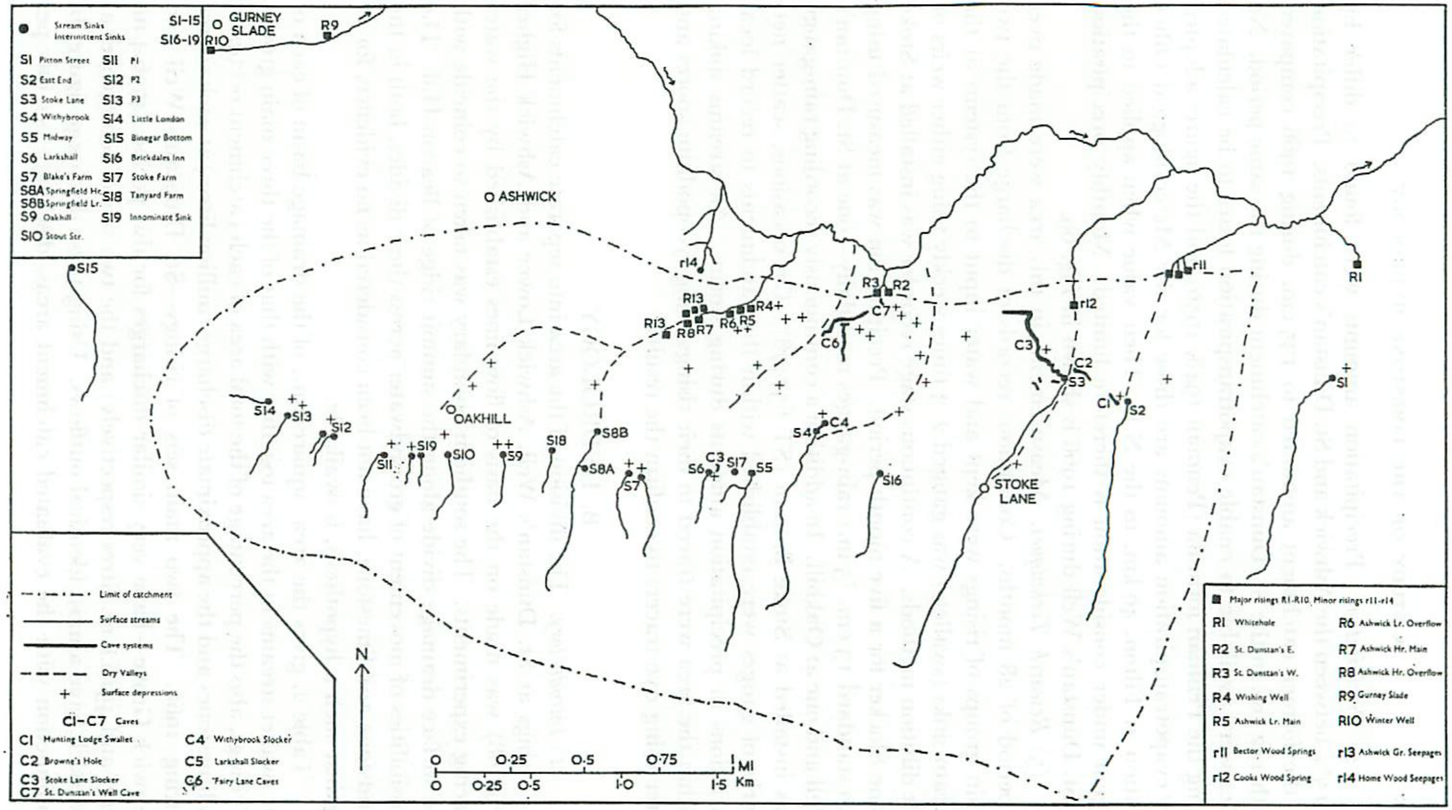


*Fig.* 67. Surface Hydrology E. Mendip.

(4) *Precipitation.* Precipitation amounts were found to differ by 5–15% between the Ashwick and St. Dunstan's catchments. Precipitation in the former catchment amounted to 135 cm. during 1966 compared with 142 cm. in the St. Dunstan's catchment during the same period. No data were available to enable evapotranspiration losses to be calculated using the Penman formula (Penman 1948, 1950) and the figures adopted for evapotranspiration amounts are those for the Meteorological Office Station at Filton, 40 km. to the N.E. Their value when applied to the region under consideration is therefore limited. Monthly precipitation at St. Dunstan's Well during 1966 is shown in *Fig.* 69.

(5) *Research Techniques.* Measurements in this area were made over a period of 28 months. Continuous records of discharge from the two main groups of risings were kept and water input to the systems at the stream sinks (swallets) was gauged 2–3 times weekly using either weirs or salt dilution methods. A continuous stage recorder was installed at Stoke Lane Slocker for a five month period. Precipitation was measured using two standard 13 cm. (5 in.) rain-gauges read daily—one at St. Dunstan's Well and one at Oakhill. In addition a continuously recording rain-gauge was installed at Stoke Bottom (ST 657478). On occasions, scatter networks of gauges were established within the catchments to record local variations in precipitation amounts during storms. All streams sinking within the area were traced to their risings using lycopodium spores and later using dye tracers to confirm the results.

## B. HYDROLOGY

(1) *Introductory.* The division of the area into separate catchments for the risings at St. Dunstan's Well, Ashwick Lower and Ashwick Higher (*Fig.* 68) was made on the basis of flow lines established by the water tracing experiments. The southern boundary was taken to coincide with the surface drainage divide along the summit ridge of Beacon Hill. The possibilities of movement of groundwater across these divides, both in the sandstone and limestone, have not been considered as no evidence, for or against such a hypothesis, is available.

Table 2, gives the area (square km.) of the drainage basin of each of the swallet streams in the area together with that of the three main groups of risings, also the percentage of the total area of each catchment occupied by limestones and the approximate discharge (million litres) at each source during 1966. The two main sets of risings—St. Dunstan's Well and Ashwick Grove—have very similar discharges for this period (4796.4 m. litres and 4916.8 m. litres respectively) and the two sets of resurgences at Ashwick have almost identical outflows. Using these discharge figures in conjunction with the evaluated catchment areas, discharge per day per

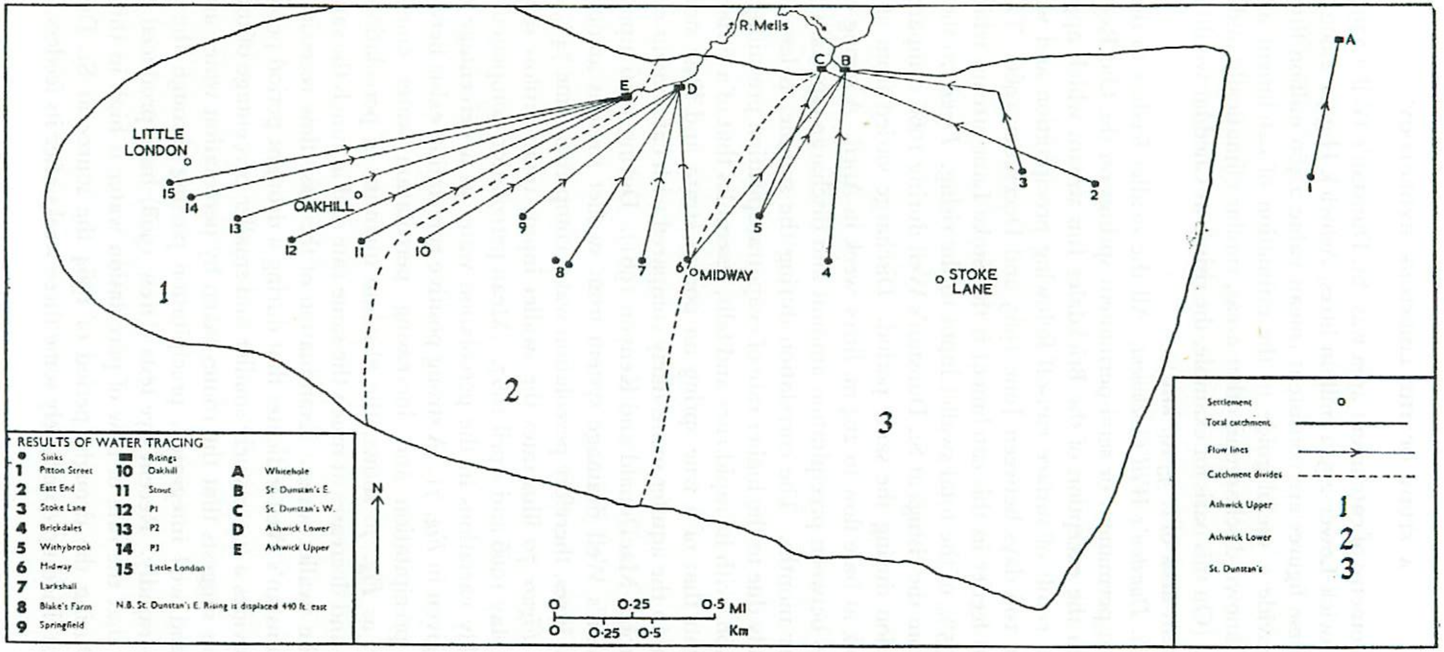


*Fig.* 68. Flow pattern E. Mendip.

square kilometre of catchment area was: St. Dunstan's Well 2.279 million litres, Ashwick Lower 2.542 million litres, Ashwick Higher 2.602 million litres. These figures are consistent (mean value 2.460 million litres) and might provide a useful guide to the estimation of catchment areas for risings of known discharge in other areas, similar climatically and hydrologically. (On this basis for example, the risings at Cheddar would require a catchment area of *c.* 35 sq. km.).

(2) *St. Dunstan's Well Catchment.* All the swallet feeders to these two come from permanent or semi-permanent springs on the Old Red Sandstone with the exception of the Brickdales Inn stream which appears to arise as a result of surface run-off following precipitation and was only active for 106 days between June 1965 and December 1966. The most important feeder in this catchment is the Stoke Lane stream which contributes 75% of the total swallet input to the rising. *Figure* 70 shows discharge from the risings at St. Dunstan's Well during 1966 compared with precipitation during the same period. Discharge varied from 36–45 m. litres/week at base flow to 264 m. litres/week in April. A strong correlation exists between precipitation amount and discharge especially during the winter months. The correlation during the summer is less marked, presumably due to the higher rate of evapotranspiration prevailing. The hydrograph, with its rapid rises and falls, resembles that of a surface river rather than that of a true spring on porous strata and little storage of water within the aquifer seems likely compared with catchments on chalk (Ineson 1962, MacDonald and Kenyon 1961). During 1966 input to the St. Dunstan's Well drainage system from swallet streams amounted to 1204.0 m. litres, therefore percolation water comprised some 74% of total outflow. *Figure* 70 illustrates the swallet input: total outflow quantities between May 1966 and April 1967. (Mean percolation component 65%). The weekly variations in the percolation water as a percentage of total flow are given in *Fig.* 71. A strong positive correlation exists between increasing precipitation and increasing percolation water component. However, as *Fig.* 70 shows, the absolute quantity of percolation water increases and decreases at much the same rate and at much the same time as does the swallet water. Examination of the base flow recession curve for St. Dunstan's Well indicates that during a drought period percolation water provides a successively smaller and smaller percentage of total outflow. This suggests that the routes taken by percolation water are fairly mature and well integrated, precipitation passing through the aquifer relatively rapidly. Recent dye tests (Drew 1968) have produced positive evidence that the rate of flow of percolation water is high in this catchment. During the drought period of 1964 the source at St. Dunstan's Well West dried up completely some three weeks after its feeders stopped

flowing, implying that this may be the storage limit for water within the limestones drained by this spring.

(3) *The Ashwick Risings Catchment.* All the feeders to the Lower Ashwick Risings have been known to become dry under conditions of severe drought. During the period June 1965–December 1966 the swallets were active for the following percentages of the time:—Midway 92%, Larkshall 80%, Blakes Farm Swallets 89%, Springfield Higher 99%, Springfield Lower 92%, Oakhill 74%. The pattern is the same for the swallet feeders to the Upper Ashwick Rising, $P_1$, $P_2$, $P_3$ and Little London sinks being active for 73% of the time during 1966 (Stout Slocker stream did not cease to flow, discharge reaching a minimum of 3150 litres per hour). The smaller size of the swallet streams in the Upper Ashwick catchment is related to the smaller mean size of the catchment compared to those of the Lower Ashwick and St. Dunstan's catchments but also appears to be related to the higher percentage of limestone in the catchments—the mean percentage is 36% compared with 25% in Ashwick Lower and 23% in St. Dunstan's. More water will percolate into the ground directly as the limestone component increases. This factor may also help to explain the lower relative increase in discharge at the swallets following a heavy storm over all the catchments—200–300% in the Ashwick Higher compared with 500% at Withybrook and 400% at East End.

As is the case at St. Dunstan's Well, continuous discharge records are only available for the combined outflow from the Ashwick Grove Risings. However, discharge amounts and variations are very similar for the two groups. *Figure* 69 shows the total discharge from the Ashwick risings during 1966 together with precipitation. A similar discharge: precipitation correlation exists as at St. Dunstan's Well. Base flow from the risings varies between 41.5 and 54 million litres/week and the peak flow during the year was 220.5 million litres/week during January. The Upper and Lower risings have different reaction times to storm water—the Upper rising taking 2–3 hours longer to respond to precipitation than the Lower rising and the flow persisting above base flow level for several days longer than the Lower rising. The initial time lag may be accounted for by the longer sink—rising distances in the Upper catchment and the prolongation of high discharge may be a result of the well integrated subterranean drainage channels:—this tends to militate against the "capture" theory for the origin of the Lower rising.

During 1966 swallet input in the Ashwick Lower catchment was 400.4 million litres with a resurgence output of 2458.4 million litres—a percolation component of 82%; the corresponding value for the Upper rising was 88%. Monthly variations in the quantities of swallet water and total outflow at the Lower rising are shown in *Fig.* 72 (May 1966–April

1967). *Figure* 71 shows percolation water as a percentage of total outflow for the same period in relation to precipitation.

The correlation between precipitation and percolation water component is largely negative—during periods of heavy precipitation the proportion of percolation water decreases. However, the proportion of percolation water increases as total discharge decreases and reaches a maximum during June, July, August and October when swallet feeders supplied only 9% of total outflow. This relationship (the opposite of that prevailing at St. Dunstan's Well) suggests that a degree of water retention does occur in the Ashwick catchments (the Upper rising exhibits the same characteristics), probably related to the slow rates of flow of percolation water rather than ponding behind the risings.

(4) *The Sandstone Aquifer.* The Old Red Sandstone forming the core of Beacon Hill acts as the aquifer for the swallet streams. It has a porosity of 6·6% against 0·18% for the Carboniferous Limestone and 10·4% for the Oolite and thus has some degree of primary permeability. Tratman (1963) suggests that on Blackdown Hill (the extreme westerly Mendip pericline) the sandstone is effectively impermeable and that the water feeding the swallet streams is derived from the overlying superficial deposits including peat. This does not appear to be the case on Beacon Hill as several water-yielding wells have been sunk into the sandstone and the overlying deposits are relatively thin.

In an attempt to gauge the duration of the lag between precipitation falling and groundwater level responding and thus affecting the overflow springs, regular readings were taken of the height of standing water in three disused wells on the sandstone between Stoke Lane and East End (236–248 m. O.D.) between July and September 1966. No correlation was found between these fluctuations, precipitation and outflow at the overflow springs except for a rise in groundwater levels towards the end of September which may correspond to heavy precipitation during August. Sampling over a longer period would be required before the interrelationship between these three parameters can be established.

(5) *Area Water Budgets.* In view of the quantity of data available for precipitation and discharge an attempt was made to complete water budgets for 1966 using swallet input and rising output discharges together with precipitation less evapotranspiration (a figure of 40% was arrived at for the latter) rather than the more complex method described by Alley (1963A, 1963B).

On the basis of this method the St. Dunstan's Well catchment shows virtually a perfect water balance for 1966—water input to the basin being only 0.2% greater than output. However, the Ashwick basins both show a markedly positive balance; in the Lower catchment output exceeds input by 13% and in the Upper catchment by 14%.

The most probable hypotheses explaining this discrepancy are:—

(*a*) Experimental error in measurement of the parameters, wrong delimitation of the catchment areas, an incorrect evapotranspiration rate.* All of these sources of error should also apply to the St. Dunstan's Well catchment however, where the balance is perfect.

(*b*) Percolation water may pass freely in large quantities across the apparent catchment boundaries. If this is the case no attempt can be made to formulate a water balance on any but a regional basis.

(*c*) Within the Ashwick catchments there may be a considerable time lag between precipitation falling and all of it reaching the rising. Thus a water balance study based on a one year period is not long enough, if the lag occurs in the Ashwick catchments the excess discharge during 1966 could be explained in terms of water falling in 1965 (an exceptionally wet year) being discharged. It has previously been noted that the Ashwick drainage systems are rather less well integrated overall than the St. Dunstan's system and this condition would favour the retention of percolation water. Also percolation water makes up a higher percentage of total outflow at the Ashwick risings (82% and 88%) than at St. Dunstan's Well (73%).

Similar water budgets were evaluated for the non-calcareous parts of the individual catchments, again with anomalous results. In the St. Dunstan's Well catchment input exceeded output by only 1%—a difference readily explicable in terms of experimental error. However, this catchment is not typical for the Mendips and differs from the Ashwick basins in that the amount of sandstone is low for impermeable andesite forms 40% of the surface streams' gathering grounds. Presumably there is a much greater degree of surface run-off on this outcrop. This may explain the disproportionately high flow in the Stoke Lane stream.

The Ashwick catchments show a large discrepancy between inputs and outputs. In the Lower Ashwick catchment output is only 41% of input and in the Upper catchment output is only 37% of input—both considerable negative balances. These differences seem too considerable to be accounted for in terms of experimental error and the discrepancies between swallet output and precipitation input are almost certainly due to the excess water being absorbed by the sandstone. However, all this water must eventually reach the risings as is indicated by the overall water budgets for the catchments, and the most likely explanation is that the

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* Data recently available from automatic met. stations on and near Mendip suggest that 40% is probably a reasonably accurate figure for evapotranspiration.

water passes as underground seepage through the Lower Limestone Shales into the limestones and thence to the resurgences as percolation water. This implies that the Lower Limestone Shales do not form an impervious barrier but that water can pass through them (perhaps along fault lines) instead of being forced to the surface at overflow springs. Thus the Old Red Sandstone, Lower Limestone Shales and Carboniferous Limestone must be treated as one hydrological unit and the compilation, for any one segment, of water budgets is not realistic. The overall input deficit in the Ashwick Grove catchments may therefore be accounted for by the slow movement of water from the sandstone aquifer into the limestone, as well as by "storage" within the limestone itself.

## C. CONCLUSIONS

(1) *Eastern Mendip.* The characteristics of the limestone hydrology of the St. Dunstan's Well and Ashwick catchments may be summarised as follows:—

(i) Each of the major catchments (St. Dunstan's Well, Ashwick Upper and Lower) has a reasonably well defined catchment area but there is a very low degree of coincidence between the surface and subterranean basins. No apparent surface or geological features exist to explain the occurrence of two groups of independent risings at St. Dunstan's Well and Ashwick and in the former case no differentiation may be made between the catchments for the two sources.

(ii) The flow pattern shows a high degree of complexity, streams crossing one another within a limited thickness of limestone without mixing of waters and not uniting until comparatively near the risings. A close relationship exists between the hydraulic gradients and drainage pattern. The rapid flow-through rate of swallet water together with the high rate of evacuation of flood water from the systems suggest that flow is predominantly "vadose" and at no great depth.

(iii) Percolation water forms a high proportion of total discharge at each of the risings and such water appears to pass freely from the sandstone to the limestone via the shales.

(iv) Changes in the flow pattern and chemical characteristics of the water tend to increase progressively from east–west across the area especially if individual catchments rather than individual streams are considered as the units of analysis. Although flow rates increase westwards, the rate of flow-through and transmission of flood pulses decreases. Percolation water constitutes a higher percentage of total outflow westwards and surface indications are that the swallets feeding the Ashwick risings are less well developed (integrated with respect to underground flow) than those draining to St. Dunstan's Well. This suggests a tendency for catchments to become less well developed westwards and this may be explained as being due to the influence of the eastward-flowing Mells River which acts as the local base level for drainage. Changes occurring in the rate of downcutting of the Mells River will thus affect the eastern part of the area first.

(2) *East Mendip Hydrology* in relation to Theories of Limestone Hydrology. Theories of limestone hydrology are almost as numerous as limestone area studies, although in many cases the theories evolved are not comparable as the techniques used in their evaluation have varied. Also the theories have often been based on a detailed investigation of one particular area and the fact that conditions may vary widely in other areas has not been fully appreciated.

Concepts of karst drainage have long been dominated by advocates of water tables in limestones (Grund 1903, Davis 1930, Davies 1960, Bedinger 1966) and by those favouring flow in discrete passages, sink to rising (Katzer 1909, Martel 1910, 1921)—the majority of other workers in the field tending to adopt compromise positions (Cvijic 1918, Lehmann 1932, Gèze 1965)—the last mentioned suggesting that water tables will exist in areas of highly fractured rock and will be absent in limestones where fissuring is more localized. A related approach to the study of limestone hydrology is the study of individual caves with respect to their genesis and the induction of general principles of karst drainage from the conclusions drawn. This is essentially an anthropocentric approach and relies heavily on the assumptions that:—

(i) The drainage carried by caves accessible to man is both significant in total quantity, and behaves in comparable fashion to water in inaccessible conduits.

(ii) The accessible portions of the cave system are representative of the remainder of the system.

(iii) The processes acting in limestone areas are understood.

(iv) The subterranean water courses behave similarly to surface watercourses (e.g. with respect to changes in base level).

As yet, none of these assumptions may be considered valid and whilst such studies may "explain" individual caves or groups of caves, rarely are they of use in helping to determine the broader principles governing the flow of water in limestones.

The concept of a water table in limestones (other than those exhibiting high primary permeabilities) is open to considerable doubt and assertions of its existence are more often based on negative than positive evidence.

(The conventional approach is adopted by Ford (1966) where he contours the "water table" in the Castleton area, Derbyshire, assuming that hitherto impenetrable sumps correspond to a water-table level).

The evidence gathered on Eastern Mendip refutes any idea of general zones of standing water in the area or even of partial water tables. Work by Zötl (1957, 1960/61) in Austria and Greece led him to draw similar conclusions, and this type of drainage pattern may be the rule rather than the exception. The existence or non-existence of a water table in a limestone will obviously depend on the number of initially open fissures in the rock mass and their degree of integration. In the initial stages of karstification this secondary permeability is likely to be low—(White and Longyear (1962) cite a threshold value of 5 mm. for conduits to develop)—and as soon as flow-through is initiated in the limestone mass the tendency will be for the preferred lines of flow to be rapidly established, the process continuing until the area is drained by a limited number of master-conduits:—East Mendip has not yet reached this stage as streams still pursue independent courses to their risings. When the master-conduit stage of drainage evolution is attained the streams feeding a rising will be graded to a local base level (that of their outlet), but to suggest that this level constitutes a water table is to distort the accepted meaning of the term as used in conjunction with porous rocks.

White and Longyear (op. cit.) criticise the dependence of so many theories of limestone hydrology on the existence of a water table and state:

> "The water table does not control the zone of maximum limestone removal (the cave). Discussion of cavern development should be couched in terms of hydraulic gradient and the geological factors which control it."

This approach would seem relevant to the interpretation of flow patterns on Eastern Mendip. In some respects flow lines in this area are analogous to those of surface streams—flow in channels of varying degrees of grade to the lowest available outlet, the controls being local geological structure and surface morphology. The "zone of saturation" corresponds only to local base level (c.f. the sea for a surface stream) and need have no lateral or vertical extent.

If the water-table concept is abandoned the terms "vadose" and "phreatic" are representative only of Gravity and Equilibrium flow conditions respectively and a complete absence of air surface is not necessarily required for flow to be phreatic in this sense. Similarly gravity flow may also occur in completely water-filled passages if conduit area is insufficient, or only just sufficient to cope with the flow. The absence of an area water-table renders the theory of drainage capture by adjacent catchments difficult to justify in practical terms.

Future research into limestone hydrology might profitably be concerned with a detailed investigation into the processes acting upon a karst area (e.g. solution rates, differential solubilities, corrosion versus corrasion) and the evaluation of the broad principles governing flow in limestone aquifers by deductive rather than inductive means—for example, the degree of initial porosity of the strata, the mode of origin and development of resurgences, present day drainage patterns, and the behaviour of percolation water.

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*Table* 1

FLOW LINES, TIMES, RATES OF FLOW, EAST MENDIP

| Swallet | Rising(s) | Time (hours) | Flow Rate (m. per hr.) |
|---|---|---|---|
| Pitten Street | Whitehole | 4·5 | 185 |
| East End | Dunstans West | 6.0 | 250 |
| Stoke Lane | Dunstans East | 8.0 | 168 |
| Brickdales | Dunstans East | 4.0 | 240 |
| Withybrook | Dunstans East | 4.0 | 215 |
| Withybrook | Dunstans West | 6.0 | 140 |
| Midway | Dunstans East | 2.5 | 490 |
| Midway | Ashwick Lower | 4.0 | 225 |
| Larkshall | Ashwick Lower | 4.0 | 230 |
| Blakes Farm | Ashwick Lower | 5.0 | 215 |
| Springfield | Ashwick Lower | 5.0 | 245 |
| Oakhill | Ashwick Lower | 5·5 | 275 |
| Stout | Ashwick Upper | 6.0 | 255 |
| $P_1$ | Ashwick Upper | 7.0 | 267 |
| $P_2$ | Ashwick Upper | 8.0 | 270 |
| $P_3$ | Ashwick Upper | 8.0 | 288 |
| Little London | Ashwick Upper | 8.5 | 290 |

*Table* 2

CATCHMENT AREAS, LIMESTONE COVER, 1966 DISCHARGE OF MAIN STREAMS, EAST MENDIP

| Catchment Area | Area Km□ | % Floored With Limestone | Discharge 1966, Million Litres |
|---|---|---|---|
| East End | 0.871 | 14% | 61 |
| Stoke Lane | 1.678 | 19% | 1078 |
| Brickdales | 0.178 | 30% | 22 |
| Withybrook | 0.643 | 35% | 103 |
| Midway | 0.392 | 18% | 53 |
| Larkshall | 0.284 | 26% | 33 |
| Blakes Farm | 0.357 | 30% | 84 |
| Springfield | 0.514 | 21% | 224 |
| Oakhill | 0.357 | 31% | 30 |
| Stout | 0.264 | 27% | 117 |
| $P_1$ | 0.238 | 45% | 30 |
| $P_2$ | 0.157 | 27% | 22 |
| $P_3$ | 0.286 | 26% | 28 |
| Little London | 0.235 | 61% | 25 |
| St. Dunstan's Well | 5.78 | 46% | 4796 |
| Ashwick Lower | 2.64 | 53% | 2398 |
| Ashwick Higher | 2.58 | 46% | 2398 |
| Ashwick Total | 5.22 | 49% | 4916 |

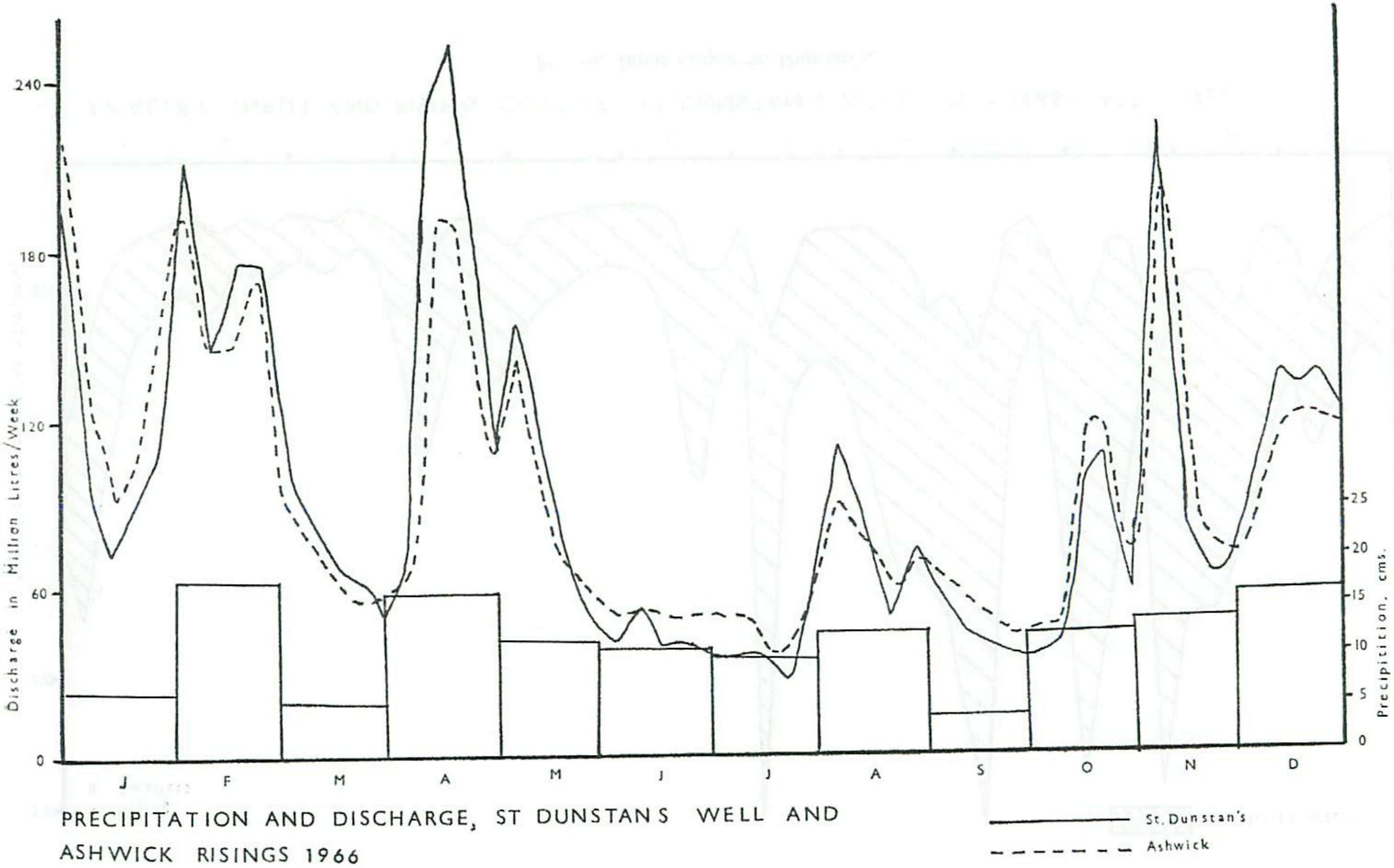
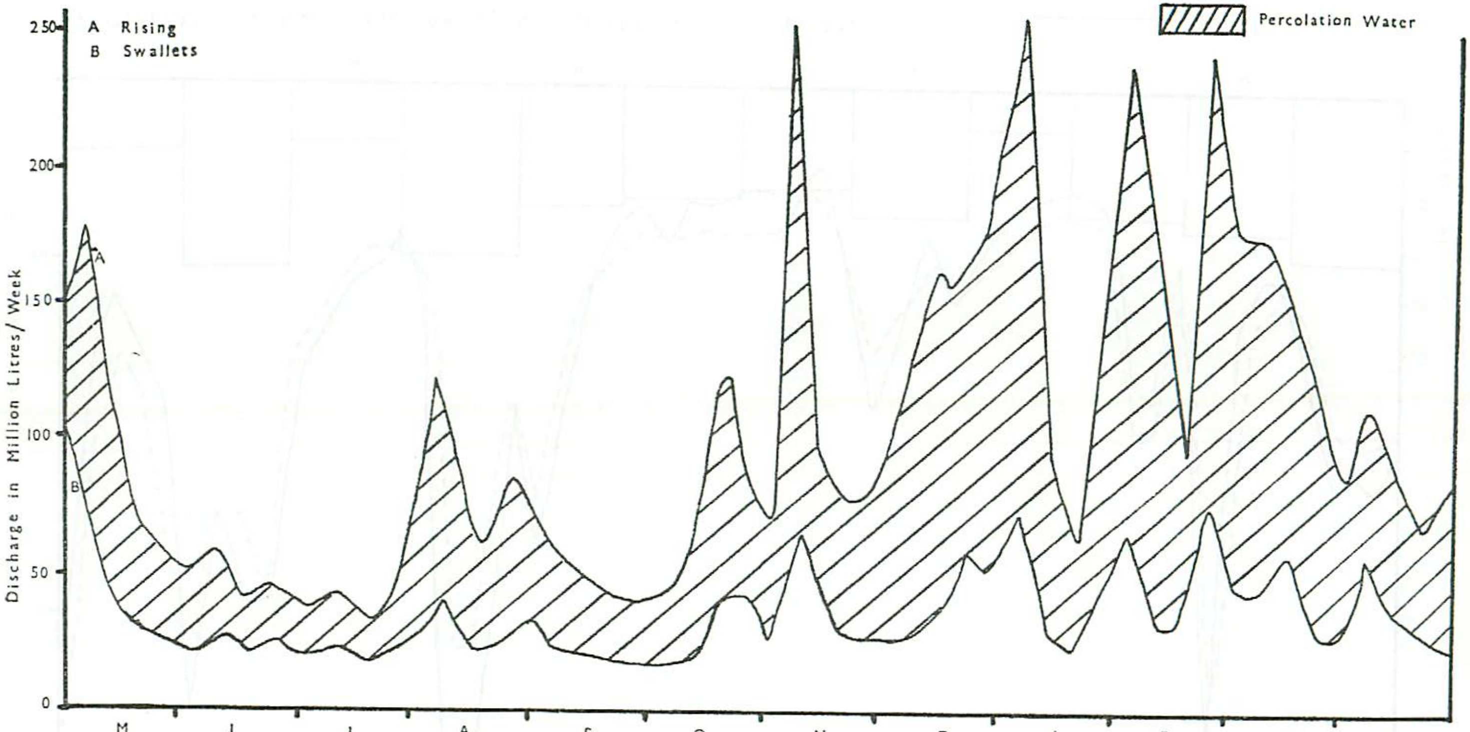
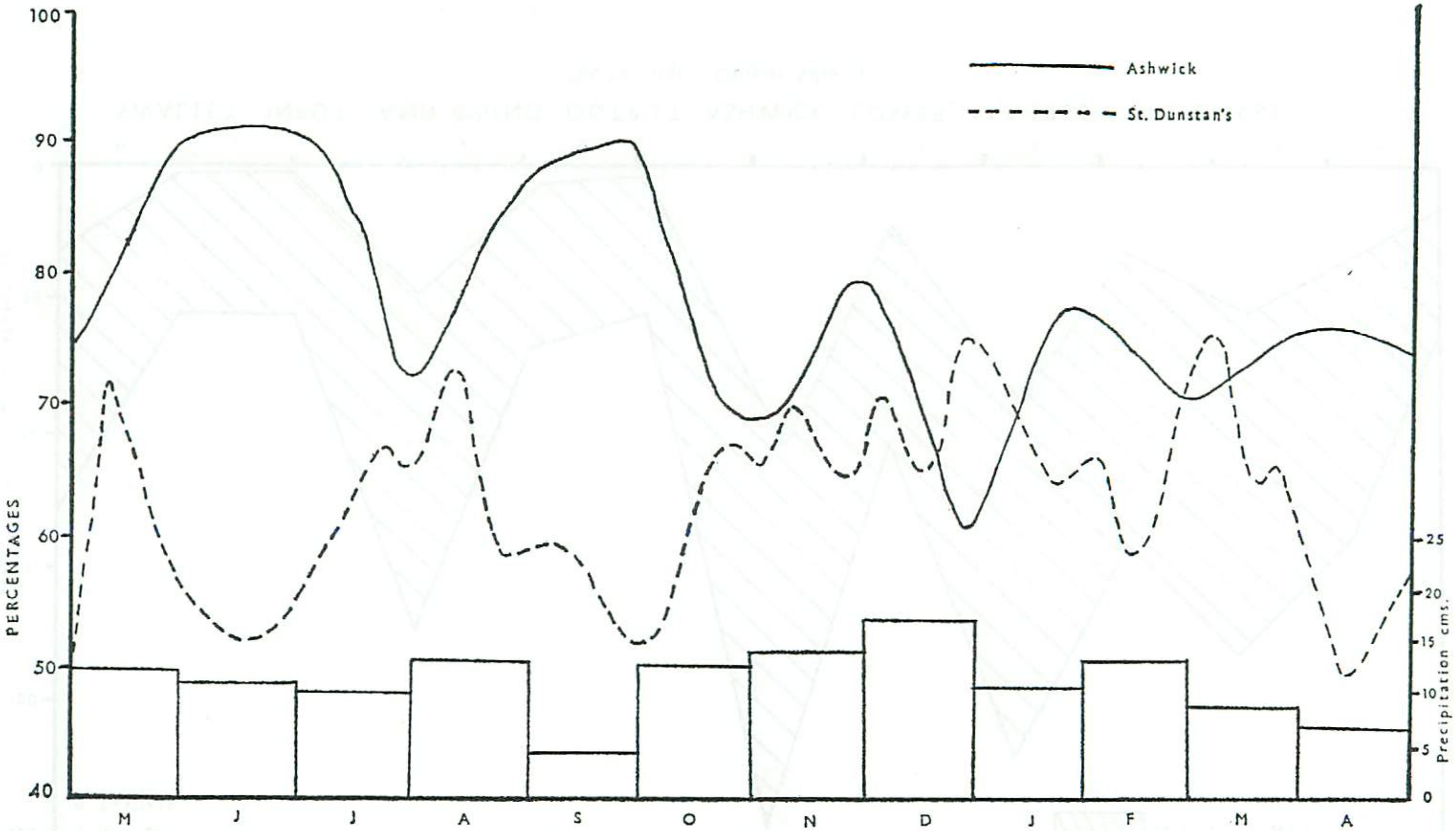


*Fig.* 69. Swallet input/Rising output.



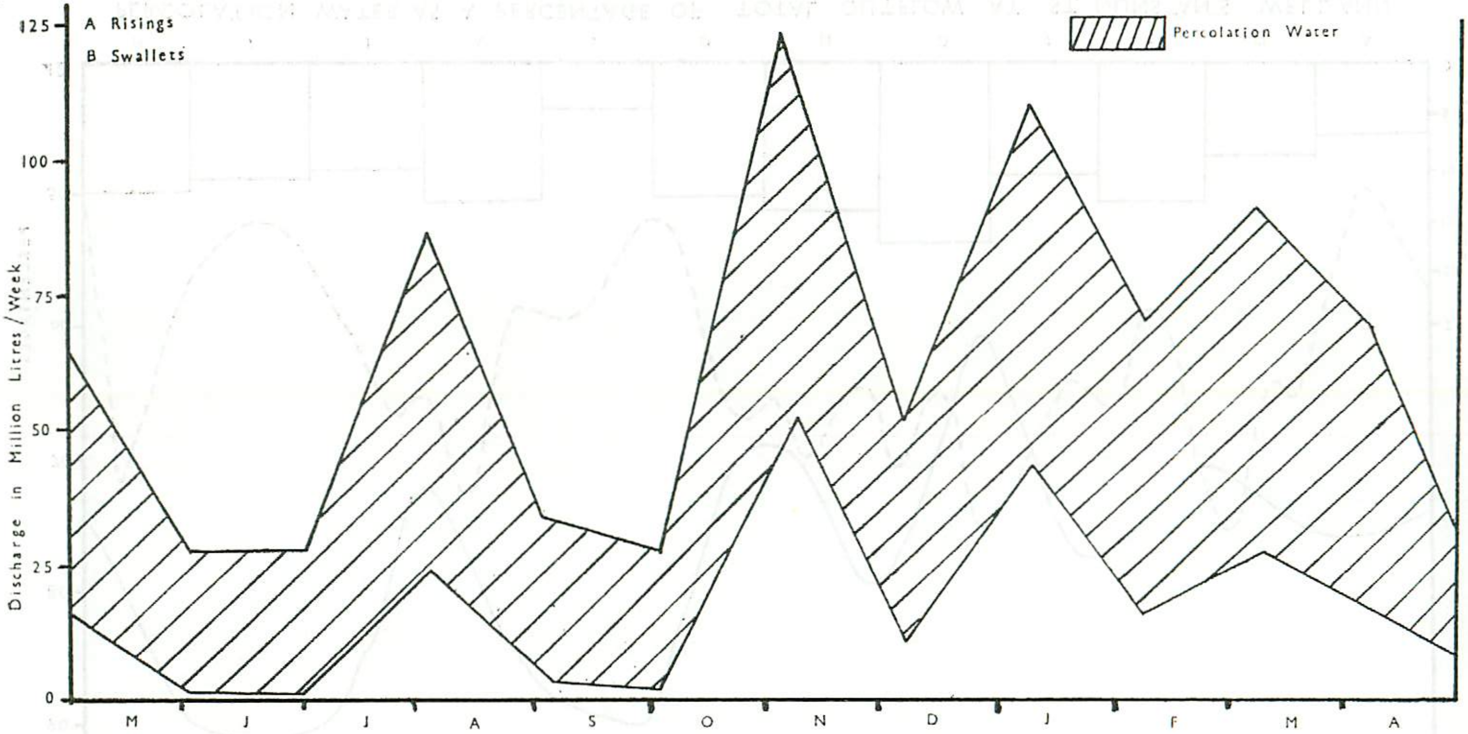
SWALLET INPUT AND RISING OUTPUT ST. DUNSTAN'S WELL, MAY 1966– APRIL 1967

*Fig.* 70. Input/output St. Dunstan's.



PERCOLATION WATER AS A PERCENTAGE OF TOTAL OUTFLOW AT ST. DUNSTAN'S WELL AND ASHWICK LOWER RISINGS MAY 1966 – APRIL 1967

*Fig.* 71. Percolation/Swallet comparison.



SWALLET INPUT AND RISING OUTPUT ASHWICK LOWER, MAY 1966 — APRIL 1967

*Fig.* 72. Input/Output Ashwick.