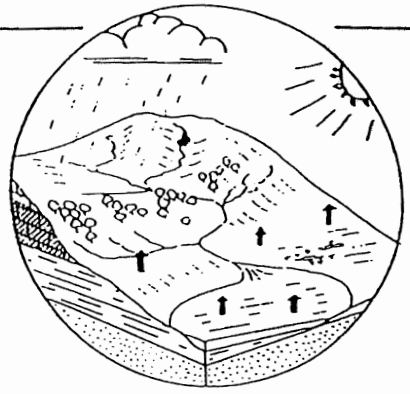
Hydrological Summary for Great Britain



APRIL 1991

Rainfall

The April total for GB approached 120% of the 1941-70 average but spatial variations were large and rainfall was very unevenly distributed through the month.

River flows

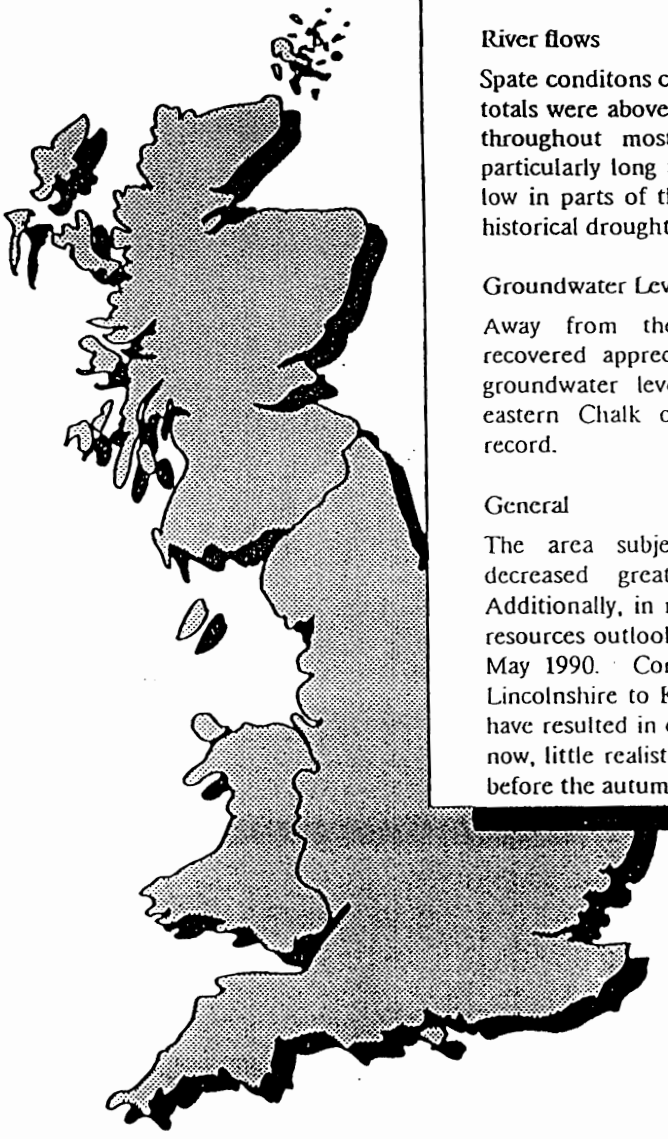
Spate conditons characterised western Scotland and runoff totals were above average or well within the normal range throughout most of Britain. However flows - and particularly long term runoff accumulations - remain very low in parts of the English lowlands albeit usually above historical drought minima.

Groundwater Levels

Away from the eastern lowlands water-tables have recovered appreciably since late-1990. By contrast groundwater levels in a substantial proportion of the eastern Chalk outcrop are close to the minimum on record.

General

The area subject to severe drought conditions has decreased greatly since the late-autumn of 1990. Additionally, in most regions, the hydrological and water resources outlook is appreciably more encouraging than in May 1990. Concern currently focuses on a zone from Lincolnshire to Kent where long term rainfall deficiencies have resulted in exceptionally low groundwater levels with, now, little realistic prospect of further significant recharge before the autumn.



Institute of Hydrology

British Geological Survey

HYDROLOGICAL SUMMARY FOR GREAT BRITAIN APRIL 1991

Data for this report have been provided principally by the regional divisions of the National Rivers Authority in England and Wales, the River Purification Boards in Scotland and by the Meteorological Office. Reservoir contents information for England and Wales has been supplied by either the Water Services Companies or the NRA. The recent areal rainfall figures are derived from a restricted network of raingauges (particularly in Scotland) and a proportion of the river flow data is of a provisional nature.

A map (Figure 4) is provided to assist in the location of the principal monitoring sites.

Rainfall

Weather patterns in April were typically capricious - a few warm interludes punctuated extended periods dominated by cool, overcast conditions. Relatively dry conditions - with light, patchy showers bringing meagre rainfall to the lowlands - obtained throughout the greater part of the month. However, widespread and persistent rainfall occurred during the first week and also on the 29/30th when an exceptionally slow moving depression tracked eastwards across southern Britain bringing continuous, moderate rainfall over periods of up to 30 hours. For some localities in the South-East, the 29th (09.00 - 09.00) was the wettest April day this century.

The within-month temporal contrasts in rainfall were allied to considerable spatial variability. Parts of the west coast of Scotland recorded up to twice the April average whereas along England's northeastern seaboard totals of around half the mean were more typical. Some accentuation in the normal west-to-east rainfall gradient could also be recognised in southern Britain but local variability was considerable especially in those eastern districts where the drought remains most severe.

On a ***regional basis*** provisional rainfall figures indicate that for 1991 thus far, and for the period beginning in December 1990, accumulated totals have generally been a little above average (the Anglian region is an exception). Rainfall over the last four to six months has served to greatly reduce, albeit sluggishly, the areal extent of the drought in England and Wales. Overall, the amelioration was maintained in April but the improvement in parts of the lowlands was rather marginal and in a few districts, for instance in Lincolnshire, rainfall deficiencies actually increased.

Longer term rainfall accumulations (Table 2) emphasise the exceptional wetness of parts of Scotland and the remarkable spatial variation throughout Great Britain. Only very modest droughts can be recognised away from the English lowlands where the rainfall figures confirm that the current drought is primarily a legacy of the large rainfall deficiencies established in 1990, 1989 and, in some areas, 1988. The very extended nature of the drought is evident from the accumulations presented in Table 2 which identifies the Anglian, Thames and Southern regions as suffering the greatest long term deficiencies. For the Thames region, the rainfall total for the 14 months from March 1990 is only a little above the minimum on record (for that specified period) - approximately 560 mm registered in both 1943/44 and 1975/76. Importantly, the three-year accumulation is also comparable with the lowest on record; in this timeframe the major rainfall deficiencies beginning in 1899, 1919, 1941, 1962 and 1971 provide reasonably close analogies and more realistic comparative yardsticks than the more intense but less durable droughts of, for instance, 1959, 1975/76 and 1984.

Evaporation and Soil Moisture Deficits (SMDs)

Temperature and sunshine hours for April were well within the normal range throughout Great Britain. Correspondingly, evaporative losses were close to the long term mean and typically a little below those calculated for April 1990. The return to more familiar winter temperatures since the end of last year, has left accumulated evaporation totals for 1990/1991 appreciably below the (often record) totals established for the corresponding periods in 1989/1990.

Soil moisture conditions varied considerably throughout the month but - entering May - were generally close to the long-term average; typically, in southern Britain deficits were 10-15 mm below the

long-term average and, commonly, 40-60 mm below those calculated for the same time in 1990. From a hydrological viewpoint the build-up of modest deficits in mid-April was of considerable importance - SMDs exceeded 30 mm over wide areas of the lowlands by the end of the third week. They served to rob the substantial rainfall at the month-end of much of its effectiveness and, with little rainfall early in May, the expectation is that significant further infiltration will not occur before the autumn (see below).

Runoff

Mean river flows in April were either above average or well within the normal range throughout most of Great Britain. Regional contrasts were however considerable and although the geological character of individual catchments exerted an obvious influence, clear evidence of an exaggeration in the normal west-to-east runoff gradient could readily be discerned - a recurring hydrological theme over the past three years.

Spate conditions were experienced in many rivers draining from the west of Scotland. The Tay (at Ballathie) and Clyde (at Daldowie) registered new maximum April runoff totals in 40-year and 28-year records respectively. Very healthy runoff rates also typified the more maritime regions of England and Wales; typically mean flows were the highest, for April, since 1985. Hydrologically, the situation deteriorates in an easterly, or south-easterly, direction with notably depressed flow rates exhibited by rivers supported principally from groundwater in the eastern lowlands. In a few, isolated, instances the April minimum established in 1976 were superseded; examples include the River Lymn in Lincolnshire. More generally, lowland flows were often comparable with those of April 1990 and substantially greater than those of April 1976 - commonly, the April runoff totals for the drought years of 1973 and 1965 were also exceeded.

Contrasts in the geological characteristics of lowland catchments, and the prevailing soil moisture conditions, conspired to produce large local differences in response to the April rainfall. Very brisk upturns in flow rates were reported from some mainly impervious catchments in and around London at the end of the month. By contrast, the Mimram (Hertfordshire), which is dependent almost entirely on spring sources, maintained a flow rate very close to its April minimum.

The accumulated runoff totals presented in Table 3 confirm the relatively limited extent but extraordinary persistence of the 1988-91 drought. In Lincolnshire, the River Lud has remained below average since November 1988 and the 24-month runoff total (to April) is lower than for any 24 month accumulation over the preceding record. A zone of maximum drought intensity may be traced southwards through the central Anglian region incorporating the eastern Chilterns and extending through the lower Thames Valley into Kent. For many rivers in this zone flows have exceeded the average for four, or less, months since the summer of 1988. A remarkable measure of regional runoff variability in this timeframe may be deduced from the exceptionally abundant runoff from the Tay and Clyde catchments.

Current storage - expressed as a percentage of useable capacity - for a representative set of major reservoirs is given in Table 4. Apart from Yorkshire, stocks generally showed a further improvement during April - in marked contrast to 1990 when demand considerably exceeded the meagre replenishment and drawdowns were well established early in the spring. In the west and north, reservoir contents are close to capacity. A more uneven picture emerges in the lowlands but stocks are generally comparable with, or a little greater, than at the same time in 1990.

Groundwater

The stuttering growth in SMDs during April, and a steadier increase in early May, is likely to signal the end of the 1990/91 recharge season at least in the lowlands. Provisional assessments of the overall winter replenishment (see Table 5) indicate that recharge to aquifers over the country as a whole have been substantial and in much of the Midlands and northern England it has been above average.

Significant increases in groundwater levels occurred through April in most areas leaving water-tables

generally approaching or exceeding the seasonal means. However, in the Chalk of East Anglia and parts of the South-East, levels remain at or near to the lowest on record (see Table 6). Even where considerable recharge has occurred over the 1990/91 winter, the very low base from which the recoveries needed to be generated has left groundwater levels well below the seasonal average.

In the Anglian region levels in the Chalk remain at, or near, the minimum recorded level for the month at the Redland Hall, Fairfields and Washpit Farm sites. The hydrograph for the latter borehole provides an excellent illustration of the combined effects of limited rainfall and sustained high SMDs on groundwater levels in an area where even in an average year recharge is very modest. At Fairfields, where the summer recession appears to have begun, the winter recovery, although indicating about 70% of the mean annual replenishment, has still left the groundwater level below the previous minimum for the spring (note, however, that the borehole record commences after the severe groundwater drought of 1973). At the Holt site, in the headwaters of the Lea system, the recovery in levels has been very moderate, and the April level, is close to the seasonal minimum. Even if it is assumed that the replenishment in these eastern districts will be of the order of 50% to 60% of the annual average, the summer recessions will be commencing at a very low level, often comparable with that recorded in 1973. It would seem possible that, by the onset of recharge in autumn 1991, the groundwater levels at some sites will be unprecedentedly low.

In the Chalk of eastern Yorkshire and of Lincolnshire, where the drought of 1990 was particularly severe, the situation is greatly improved. The winter replenishment appears to have been from 100% to 125% of the annual mean. At Dalton Holme, the groundwater level is near to the seasonal mean, and at Little Brocklesby it is now well above the seasonal minimum. In eastern Kent, the water-table at Little Bucket Farm has recovered nearly to the level reached in the spring of 1990. Westwards, a clear improvement is evident with groundwater levels generally well up towards, and sometimes above, the seasonal means.

In the Permo-Triassic sandstone aquifer, levels in the West Country continued to rise in April (see Bussels) and are now well within the normal range. A modest increase was reported for Llanfair DC borehole in North Wales but levels remain depressed. Similarly, at the Morris Dancers (Nottinghamshire) and Weeford Flats (Staffordshire) boreholes the water-table stands at its lowest since 1976/77.

In summary, although there is reason for serious concern in parts of the eastern Chalk, the country as a whole stands in better condition than might have been expected with groundwater levels near average or well above historical minima. Over large areas groundwater levels (where substantially unaffected by pumping) stand at least as high as at the beginning of the summer recession of 1990, and many areas are rather better than this. Since recharge has continued for so long into 1991, the summer recession has started equally late and, unless the onset of the 1991-92 recharge is greatly delayed, will be of relatively short duration.

IH/BGS

14/5/91

TABLE 1 1990/91 RAINFALL AS A PERCENTAGE OF THE 1941-70 AVERAGE

		Apr 1990	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan 1991	Feb	Mar	Apr 1991
England and	mm	38	25	72	35	46	53	100	65	97	92	63	73	72
Wales	%	66	37	118	47	51	64	120	67	108	107	97	124	124
NRA REGIONS														
North West	mm	57	49	99	58	73	86	164	68	142	97	86	89	75
	%	74	60	119	56	58	70	139	56	118	87	106	124	97
Northumbria	mm	25	51	69	40	53	53	106	61	109	85	114	84	42
	%	45	80	113	52	52	66	141	65	145	106	173	162	77
Severn Trent	mm	30	19	63	27	37	46	93	52	92	78	41	59	65
	%	58	30	113	42	46	69	143	66	131	113	77	113	124
Yorkshire	mm	25	29	83	32	47	39	92	55	121	72	89	62	47
	%	45	48	143	46	52	54	133	62	163	94	139	117	83
Anglia	mm	34	16	45	21	31	32	51	52	48	44	39	29	46
	%	85	34	92	37	48	62	98	84	91	85	93	73	115
Thames	mm	35	7	47	17	35	34	59	34	65	80	39	45	59
	%	76	13	90	28	50	55	91	47	99	129	83	98	129
Southern	mm	48	10	61	13	33	38	105	59	63	98	40	59	57
	%	100	18	122	22	45	54	135	63	77	129	70	113	118
Wessex	mm	35	12	62	31	41	49	87	52	74	105	43	88	75
	%	65	18	115	50	50	62	106	54	83	125	73	152	138
South West	mm	46	25	99	61	59	69	126	107	112	151	82	127	102
	%	65	30	152	73	58	66	112	80	83	117	91	151	144
Welsh	mm	48	34	98	53	64	85	149	109	152	150	96	125	119
	%	56	37	120	56	54	68	116	76	105	110	100	144	138
Scotland	mm	96	54	128	75	119	149	211	101	184	146	83	128	92
	%	107	59	139	67	92	109	142	71	108	107	80	139	102
RIVER PURIFICATION BOARDS														
Highland	mm	136	54	140	93	156	234	220	144	236	173	70	141	130
	%	119	52	127	73	105	148	118	85	120	105	53	124	114
North-East	mm	45	49	110	43	75	86	138	94	89	56	77	80	48
	%	74	64	157	47	70	99	142	91	87	62	104	129	79
Tay	mm	61	44	128	38	73	68	187	65	136	164	89	117	93
	%	81	46	154	37	62	59	153	55	101	139	97	143	124
Forth	mm	55	39	125	49	83	68	185	57	137	120	84	104	80
	%	81	46	167	50	72	63	175	53	126	121	109	151	117
Tweed	mm	31	46	106	52	61	69	159	52	148	107	103	93	63
	%	51	61	156	58	54	74	181	50	164	115	149	160	103
Solway	mm	72	76	121	74	106	81	216	79	189	140	108	153	133
	%	82	83	134	67	82	54	150	54	125	100	116	168	151
Clyde	mm	127	57	138	96	151	172	297	90	223	181	88	162	160
	%	123	59	134	74	106	98	162	54	120	112	78	154	155

Note: The recent monthly rainfall figures for England and Wales for 1991 are based upon MORECS figures supplied by the Meteorological Office. Earlier areal figures are derived from a far denser raingauge network.
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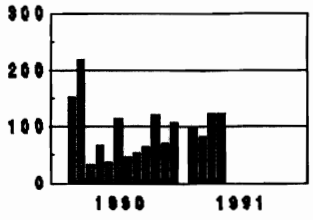
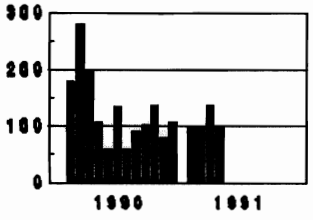
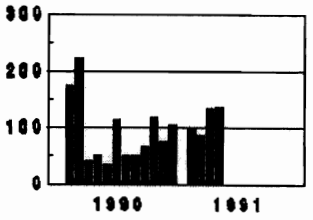
FIGURE 1. MONTHLY RAINFALL FOR 1990-1991 AS A PERCENTAGE OF THE 1941-1970 AVERAGE



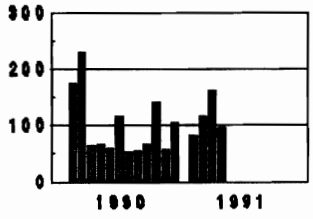
England and Wales



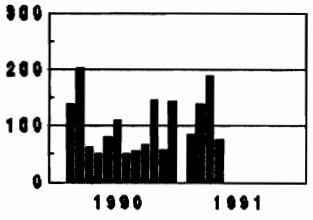
Scotland



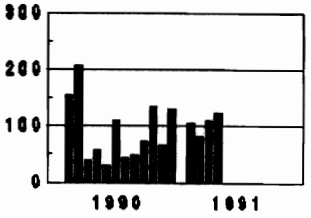
Welsh Region



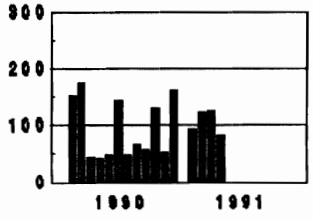
North West Region



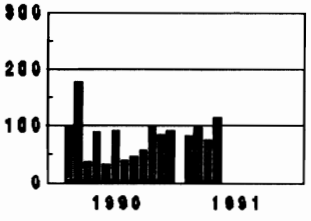
Northumbria Region



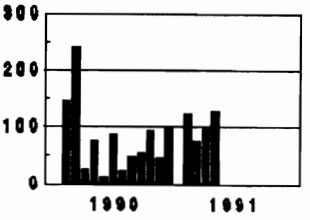
Severn-Trent Region



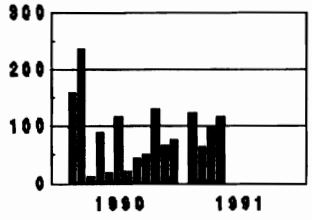
Yorkshire Region



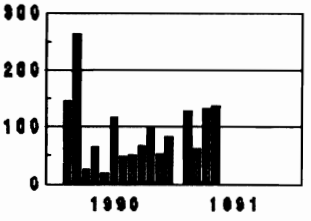
Anglian Region



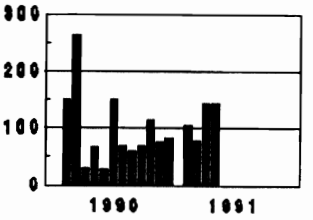
Thames Region



Southern Region



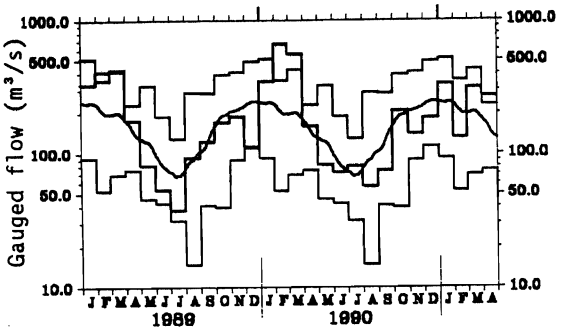
Wessex Region



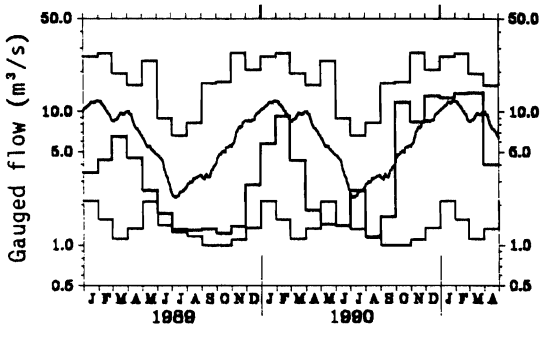
South West Region

FIGURE 2 MONTHLY RIVER FLOW HYDROGRAPHS

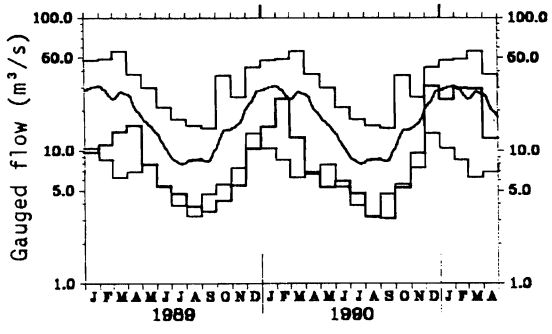
015006 Tay at Ballathie
Monthly mean flows for Jan 1989-Apr 1991
+ extremes and 30 day running mean for 1952-1988



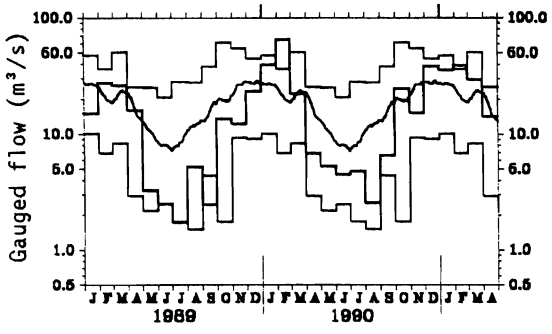
021022 Whiteadder Water at Hutton Castle
Monthly mean flows for Jan 1989-Apr 1991
+ extremes and 30 day running mean for 1969-1988



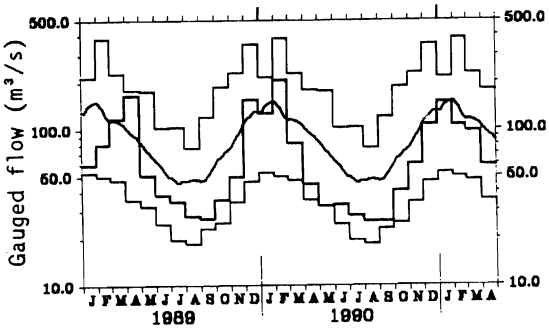
027041 Derwent at Buttercrambe
Monthly mean flows for Jan 1989-Apr 1991
+ extremes and 30 day running mean for 1973-1988



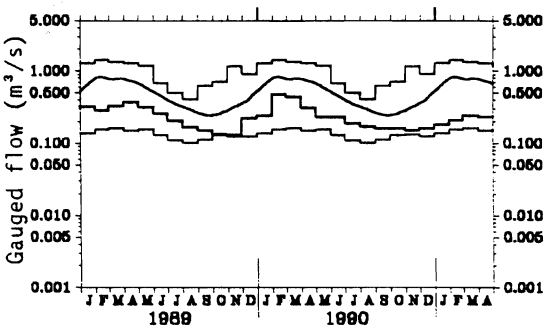
023004 South Tyne at Haydon Bridge
Monthly mean flows for Jan 1989-Apr 1991
+ extremes and 30 day running mean for 1962-1988



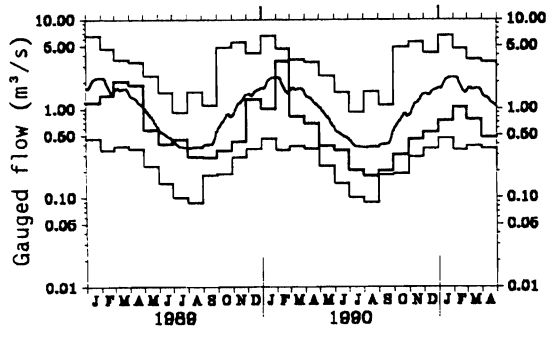
028009 Trent at Colwick
Monthly mean flows for Jan 1989-Apr 1991
+ extremes and 30 day running mean for 1958-1988



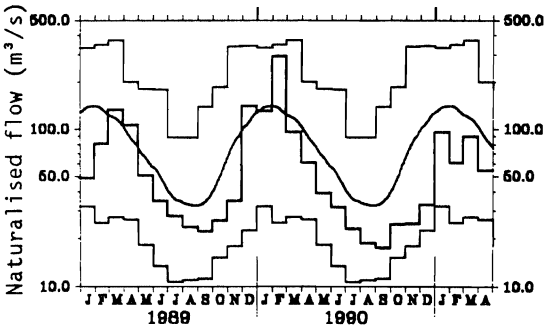
029003 Lud at Louth
Monthly mean flows for Jan 1989-Apr 1991
+ extremes and 30 day running mean for 1968-1988



037005 Colne at Lexden
Monthly mean flows for Jan 1989-Apr 1991
+ extremes and 30 day running mean for 1959-1988

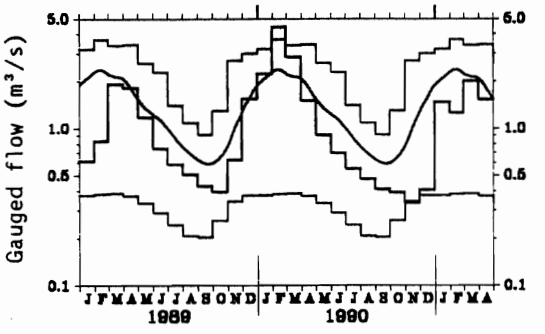


039001 Thames at Kingston
Monthly mean flows for Jan 1989-Apr 1991
+ extremes and 30 day running mean for 1883-1988



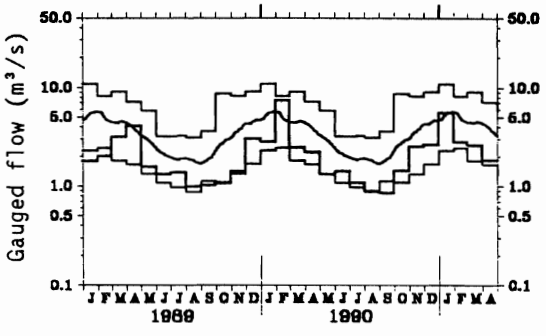
039020 Coln at Bibury

Monthly mean flows for Jan 1989-Apr 1991
+ extremes and 30 day running mean for 1963-1988



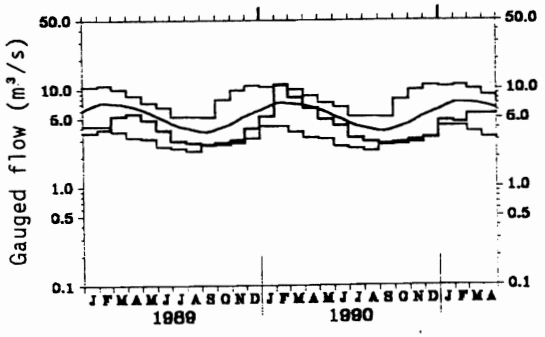
040011 Great Stour at Horton

Monthly mean flows for Jan 1989-Apr 1991
+ extremes and 30 day running mean for 1964-1988



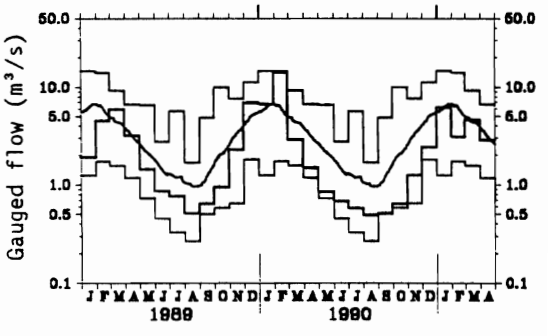
042010 Itchen at Highbridge+Allbrook

Monthly mean flows for Jan 1989-Apr 1991
+ extremes and 30 day running mean for 1958-1988



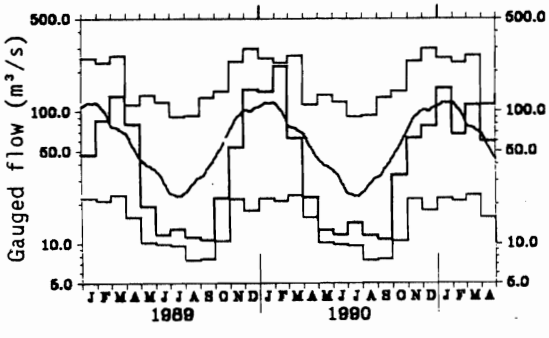
052005 Tone at Bishops Hull

Monthly mean flows for Jan 1989-Apr 1991
+ extremes and 30 day running mean for 1961-1988



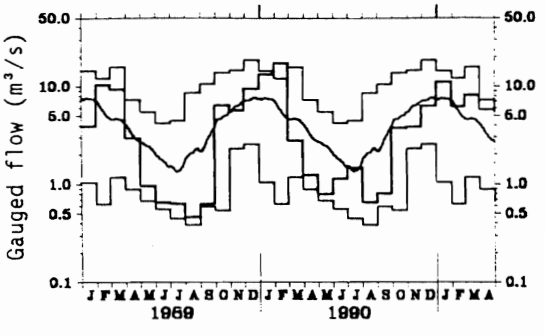
054001 Severn at Bewdley

Monthly mean flows for Jan 1989-Apr 1991
+ extremes and 30 day running mean for 1921-1988



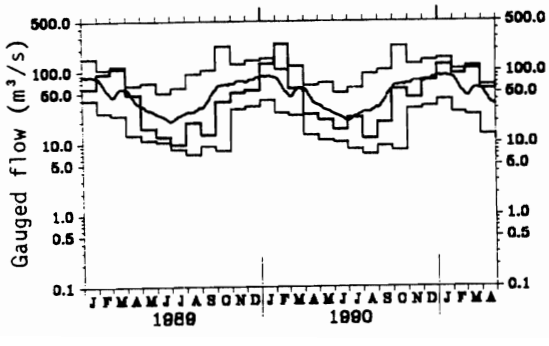
057004 Cynon at Abercynon

Monthly mean flows for Jan 1989-Apr 1991
+ extremes and 30 day running mean for 1957-1988



076007 Eden at Sheepmount

Monthly mean flows for Jan 1989-Apr 1991
+ extremes and 30 day running mean for 1967-1988



084013 Clyde at Daldowie

Monthly mean flows for Jan 1989-Apr 1991
+ extremes and 30 day running mean for 1963-1988

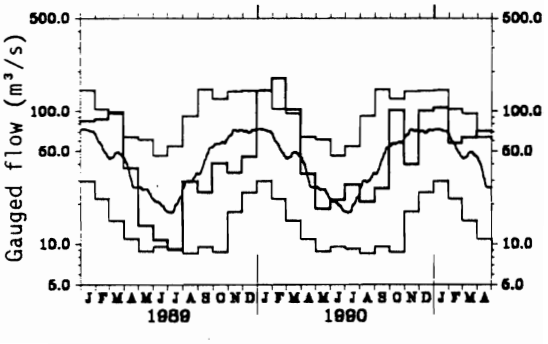


TABLE 3 RUNOFF AS MM. AND AS A PERCENTAGE OF THE PERIOD OF RECORD AVERAGE WITH SELECTED PERIODS RANKED IN THE RECORD

River/ Station name	Jan 1991	Feb	Mar	Apr 1991		10/90 to 4/91		3/90 to 4/91		5/89 to 4/91		8/88 to 4/91	
	mm %LT	mm %LT	mm %LT	mm %LT	rank /yrs	mm %LT	rank /yrs	mm %LT	rank /yrs	mm %LT	rank /yrs	mm %LT	rank /yrs
Dee at Park	83 92	59 79	149 162	80 104	10 /19	579 98	8 /18	846 88	5 /18	1335 84	2 /17	1978 87	2 /16
Tay at Ballathie	193 135	69 60	180 142	152 183	39 /39	901 107	24 /39	1523 114	32 /38	2565 114	32 /37	3975 124	35 /36
Whiteadder Water at Hutton Castle	67 114	65 134	74 149	21 57	5 /22	402 131	20 /22	477 99	9 /21	623 79	6 /20	872 77	5 /19
South Tyne at Haydon Bridge	127 130	125 172	105 125	49 91	13 /29	682 120	27 /29	867 96	11 /27	1443 94	9 /25	2035 92	5 /23
Derwent at Buttercrambe	41 89	45 113	49 120	20 64	8 /30	232 94	12 / 30	300 75	5 /29	439 66	2 /28	628 66	1 /27
Trent at Colwick	53 106	34 78	35 87	20 62	6 /33	216 82	9 /33	311 72	2 /32	570 79	4 /31	817 80	2 /30
Lud at Louth	9 30	9 26	12 33	11 34	2 /23	63 36	2 /23	146 45	1 /22	253 49	1 /21	387 53	1 /21
Witham at Claypole Mill	19 74	19 71	21 80	11 52	8 /32	88 64	8 /32	143 62	5 /31	264 71	6 /31	354 68	5 /30
Bedford Ouse at Bedford	18 50	12 35	24 76	10 49	18 /59	83 46	8 /58	130 49	5 /58	341 78	15 /57	519 82	15 /56
Colne at Lexden	8 35	10 54	8 43	5 37	4 /32	46 42	4 /32	77 46	2 /31	168 62	2 /30	274 70	2 /29
Mimram at Panshanger Park	7 60	6 51	6 45	6 47	5 /39	41 54	2 /38	103 68	3 /38	191 76	3 /37	284 82	6 /36
Thames at Kingston (natr.)	26 70	15 45	24 77	14 62	24 /109	101 54	12 /108	177 59	7 /108	378 77	21 /107	532 76	15 /106
Blackwater at Swallowfield	35 98	21 71	29 98	18 78	13 /39	146 76	6 /39	246 78	7 /38	499 94	13 /37	697 93	11 /36
Coln at Bibury	37 72	29 53	50 92	37 85	9 /28	181 65	5 /28	363 74	4 /27	668 84	5 /26	869 78	3 /25
Great Stour at Horton	43 106	20 58	20 59	14 52	3 /26	148 68	5 /25	226 63	1 /24	389 65	1 /23	543 64	1 /21
Itchen at Highbridge+Allbrook	35 73	30 61	40 77	39 83	5 /33	212 70	2 /33	449 80	2 /32	760 82	2 /31	1021 80	1 /30
Stour at Throop Mill	59 99	26 43	58 112	35 102	9 /19	216 68	3 /18	324 68	2 /18	697 88	5 /17	927 82	2 /16
Piddle at Baggs Mill	36 69	29 49	53 93	47 111	18 /28	205 69	4 /27	374 74	3 /26	677 83	4 /24	886 77	2 /22
Exe at Thorverton	160 123	71 67	106 125	52 92	19 /35	632 93	13 /35	770 79	4 /34	1444 87	8 /34	2112 87	6 /33
Tone at Bishops Hull	82 103	37 49	60 104	36 93	17 /31	272 71	4 /30	370 65	2 /30	816 86	6 /29	1140 83	3 /28
Severn at Bewdley	91 128	37 64	68 147	35 111	45 /71	338 95	29 /70	427 80	13 /69	810 90	20 /69	1180 91	20 /68
Wye at Cefn Brwyn	226 92	196 113	171 97	192 153	33 /37	1561 107	22 /36	2176 92	10 /32	3965 95	9 /27	5802 98	10 /24
Cynon at Abercynon	280 147	140 101	204 172	141 189	32 /33	1110 112	23 /33	1330 91	10 /31	2673 106	19 /29	3750 130	16 /27
Dee at New Inn	175 72	164 96	147 82	166 161	18 /22	1350 97	10 /20	1748 83	5 /21	3256 89	5 .20	4928 94	7 /20
Lune at Caton	146 98	183 183	135 136	89 121	21 /29	860 103	15 /27	1139 87	6 /27	2099 92	10 /25	3247 100	11 /23
Clyde at Daldowie	150 142	73 96	89 119	96 232	28 /28	745 129	26 /28	1093 123	27 /27	1805 118	24 /26	2613 118	24 /25

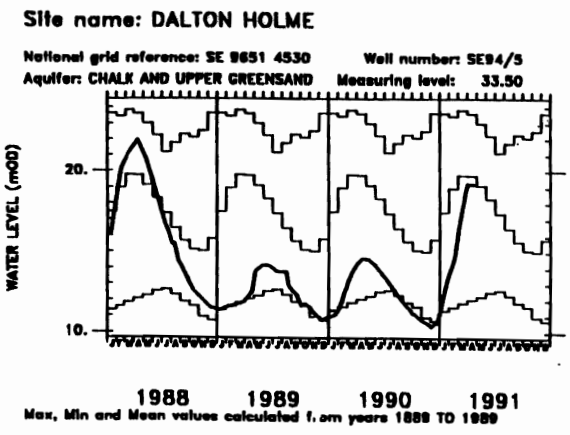
Notes (i) Values based on gauged flow data unless flagged (natr.), when naturalised data have been used.
(ii) Values are ranked so that lowest runoff as rank 1;
(iii) %LT means percentage of long term average from the start of the record to 1989. For the long periods (at the right of this table), the end date for the long term is 1990.

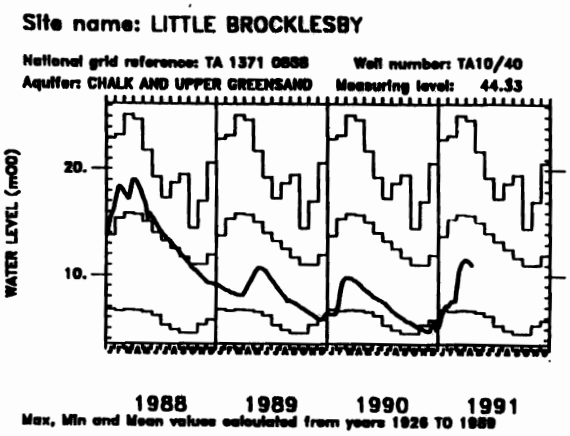
TABLE 4 START-MONTH RESERVOIR STORAGES UP TO MAY 1991

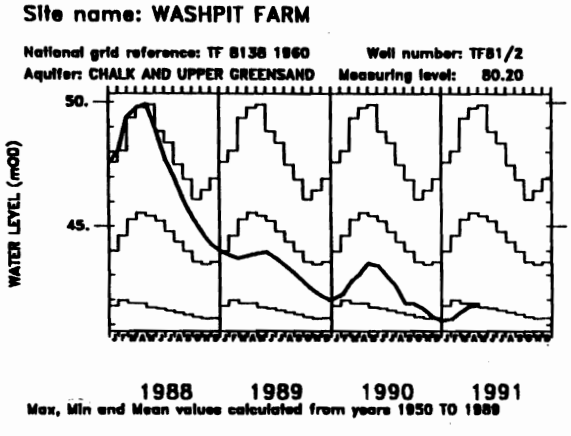
Area	Reservoir (R)/ Group (G)		Capacity[1] (Ml)	1991 Jan	Feb	Mar (%)[2]	Apr	May	[1990 May]
North West	Northern Command Zone[3]	(G)	133375	95	89	98	99	90	
Northumbria	Kielder	(R)	200000						
Severn Trent	Clywedog	(R)	44922	91	89	96	95	97	94
	Vyrnwy	(R)	55166	96	91	100	99	96	92
	Derwent Valley[4]	(G)	39525	100	94	99	97	91	93
Yorkshire	Washburn[5]	(G)	22035	64	86	96	99	91	82
	Bradford supply[6]	(G)	41407	90	95	100	98	92	87
Anglian	Grafham	(R)	58707	61	70	76	85	91	95
	Rutland	(R)	130061	60	68	71	78	80	86
Thames	London[7]	(G)	206232	60	87	90	89	91	86
	Farmoor[8]	(G)	13843	71	82	64	95	100	98
Southern	Bewl	(R)	28170	44	56	60	68	79	74
	Ardingly	(R)	4627	72	100	100	100	100	100
Wessex	Clatworthy	(R)	5185					96	81
	Bristol WW[9]	(G)	36620					95	85
South West	Colliford	(R)	28540	73	81	85	92	94	95
	Roadford	(R)	34500	68	81	87	94	98	55[10]
	Wimbleball[11]	(R)	21320	48	68	74	82	84	95
	Stithians	(R)	5205	49	85	98	100	96	83
Welsh	Celyn + Brenig	(G)	131155	92	96	100	100	99	98
	Brianne	(R)	62140	100	100	100	100	97	99
	Big Five[12]	(G)	69762	71	83	93	95	96	87
	Elan Valley[13]	(G)	99106	100	99	100	99	97	95

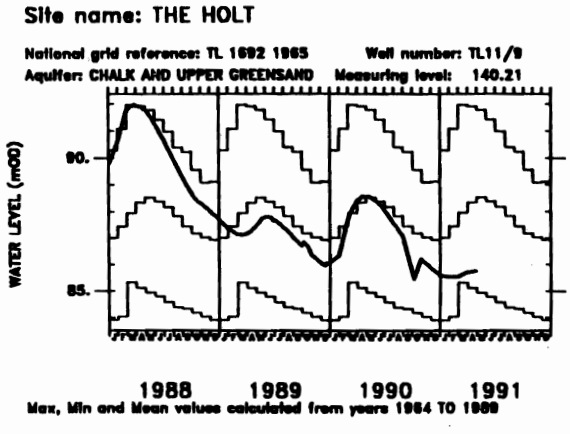
1. Live or useable capacity.
2. Percentage of live or useable capacity in storage at or close to the beginning of the month according to data availability.
3. Includes Haweswater, Thirlmere, Stocks and Barnacre.
4. Howden, Derwent and Ladybower,
5. Swinsty, Fewston, Thruscross and Eccup.
6. The Nidd/Barden group (Scar House, Angram, Upper Barden, Lower Barden and Chelker) plus Grimwith.
7. Lower Thames (includes Queen Mother, Wraysbury, Queen Mary, King George VI and Queen Elizabeth II) and Lee Valley (includes King George and William Girling) groups -- **pumped storages.**
8. Farmoor 1 and 2 -- **pumped storages.**
9. Blagdon, Chew Valley and others.
10. The new Roadford reservoir was still filling after impounding.
11. Shared between South West (river regulation for abstraction) and Wessex (direct supply).
12. Usk, Talybont, Llandegfedd **(pumped storage)**, Taf Fechan, Taf Fawr.
13. Claerwen, Caban Coch, Pen y Garreg and Craig Goch.

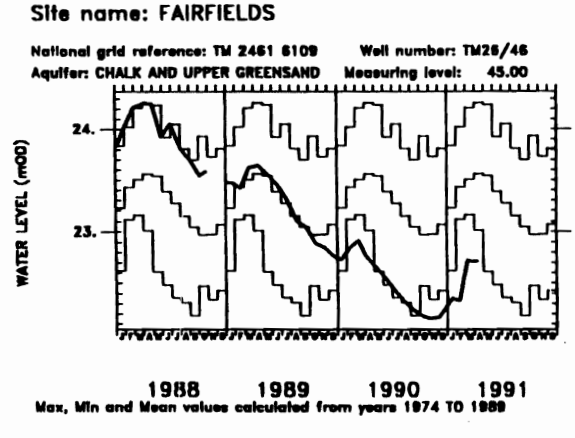
FIGURE 3 GROUNDWATER HYDROGRAPHS

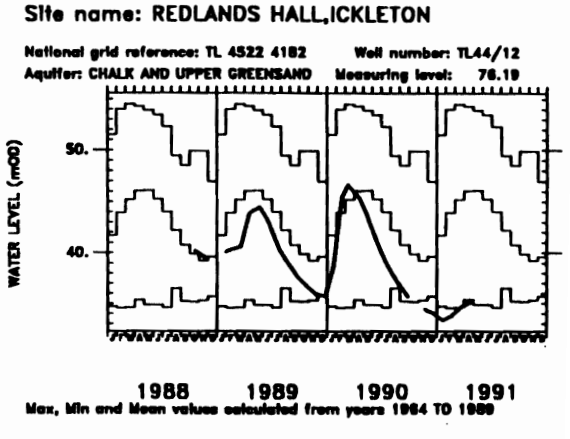


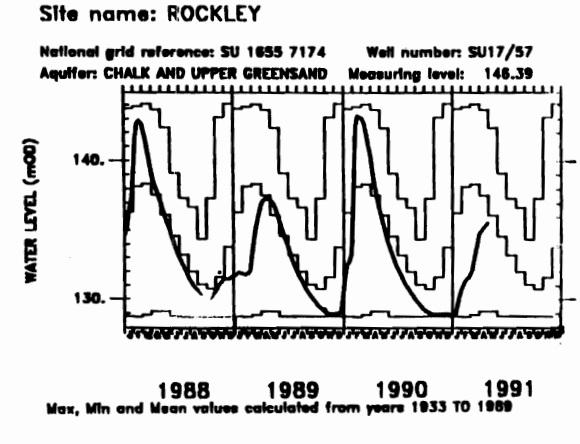


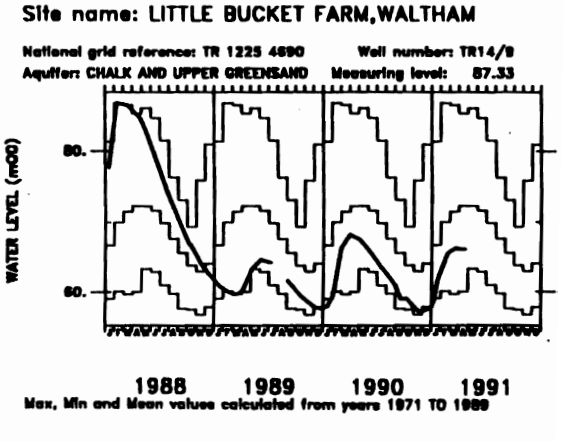






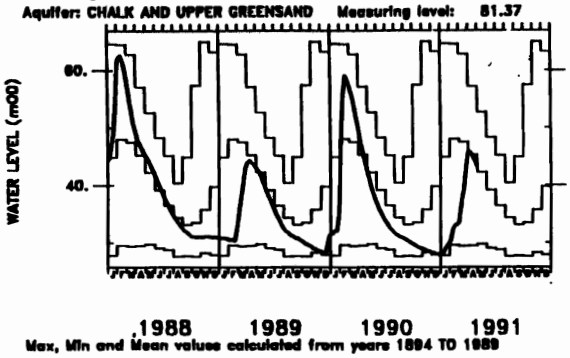






Site name: COMPTON HOUSE

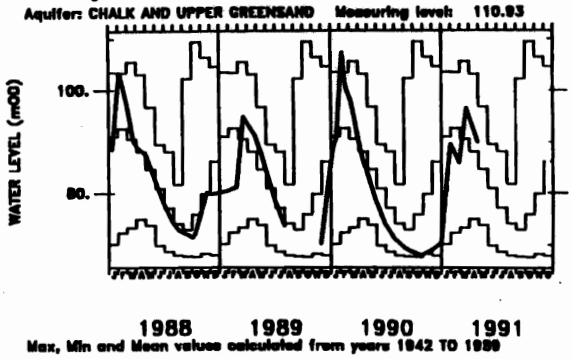
National grid reference: SU 7755 1490 Well number: SU71/23
Aquifer: CHALK AND UPPER GREENSAND Measuring level: 81.37



Max, Min and Mean values calculated from years 1984 TO 1989

Site name: WEST WOODYATES MANOR

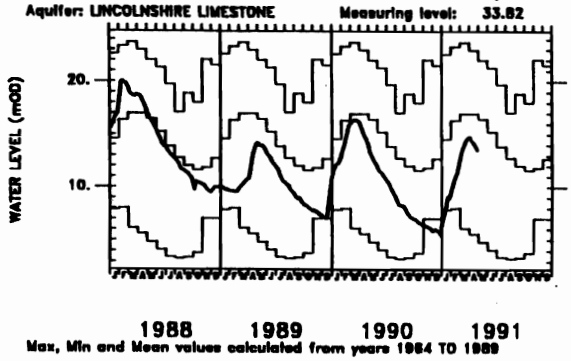
National grid reference: SU 0160 1980 Well number: SU01/58
Aquifer: CHALK AND UPPER GREENSAND Measuring level: 110.93



Max, Min and Mean values calculated from years 1942 TO 1989

Site name: NEW RED LION

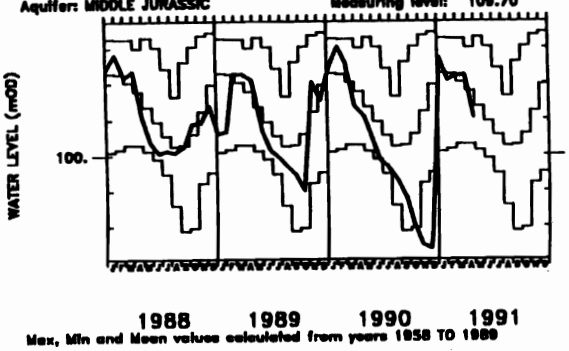
National grid reference: TF 0885 3034 Well number: TF03/37
Aquifer: LINCOLNSHIRE LIMESTONE Measuring level: 33.82



Max, Min and Mean values calculated from years 1984 TO 1989

Site name: AMPNEY CRUCIS

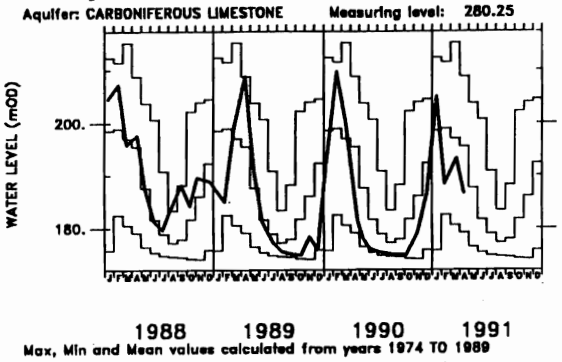
National grid reference: SP 0585 0190 Well number: SP00/62
Aquifer: MIDDLE JURASSIC Measuring level: 109.70



Max, Min and Mean values calculated from years 1958 TO 1989

Site name: ALSTONFIELD

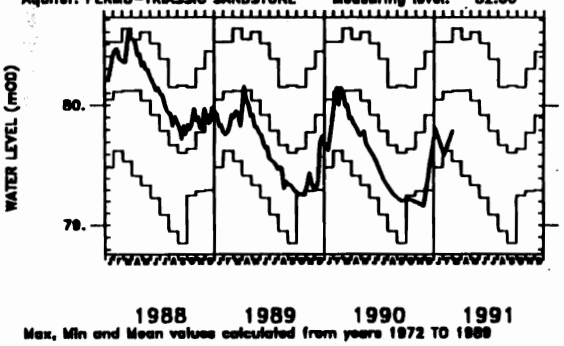
National grid reference: SK 1292 5547 Well number: SK15/16
Aquifer: CARBONIFEROUS LIMESTONE Measuring level: 280.25



Max, Min and Mean values calculated from years 1974 TO 1989

Site name: LLANFAIR DC

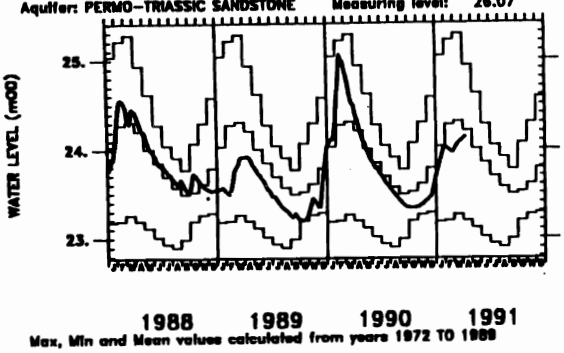
National grid reference: SJ 1374 5558 Well number: SJ15/15
Aquifer: PERMO-TRIASSIC SANDSTONE Measuring level: 82.00



Max, Min and Mean values calculated from years 1972 TO 1989

Site name: BUSSELS NO.7A

National grid reference: SX 9528 9872 Well number: SX99/378
Aquifer: PERMO-TRIASSIC SANDSTONE Measuring level: 26.07



Max, Min and Mean values calculated from years 1972 TO 1989

Site name: RUSHYFORD NORTH EAST,GREAT CHILTON

National grid reference: NZ 2875 2886 Well number: NZ22/22
Aquifer: MAGNESIAN LIMESTONE Measuring level: 92.53

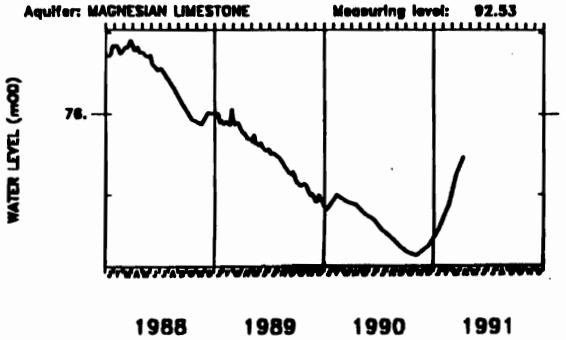


TABLE 5 AQUIFER RECHARGE DURING THE WINTER MONTHS OF 1990-91

SITE	AQUIFER	RISE IN METRES	MEAN ANNUAL RANGE IN METRES	PERCENTAGE OF MEAN ANNUAL	LEVEL STILL RISING AT LAST MEASUREMENT
Dalton House	C&UG	8.89	7.10	125	No
Little Brocklesby	C&UG	7.52	7.57	99	No
Washpit Farm	C&UG	0.60	2.95	20	Yes
The Holt	C&UG	0.96	2.42	40	Yes
Fairfields	C&UG	0.59	0.86	69	No
Redlands Hall	C&UG	1.75	9.08	19	Yes
Rockley	C&UG	6.74*	10.91	62	Yes
Little Bucket Farm	C&UG	9.09	11.44	79	No
Compton House	C&UG	17.78	21.76	82	No
West Dean Farm	C&UG	0.64	1.54	42	Yes
Lime Kiln Way	C&UG	0.31	0.92	34	Yes
Ashton Farm	C&UG	8.10	5.99	135	No
West Woodyates Manor	C&UG	32.10	26.67	120	No
New Red Lion	LLst	9.60	9.21	104	No
Ampney Crucis	MJur	5.48	3.07	178	No
Llanfair DC	PTS	0.87	0.74	118	No
Bussels 7A	PTS	0.87	1.17	74	Yes
Rusheyford NE	MgLst	1.20	0.72	167**	Yes
Peggy Ellerton Farm	MgLst	1.21	1.40	86	Yes
Alstonfield	CLst	35.00	31.55	111	No

Notes: *: The well at the Rockley site was dry at the beginning of the recovery in water levels; the percentage of the mean annual range is a minimum value only.

**: Variation in local pumping may possibly have exaggerated the rise in water levels at the Rusheyford NE site.

LEGEND

C&UG : Chalk and Upper Greensand
LLst : Lincolnshire Limestone
MJur : Middle Jurassic
PTS : Permo-Triassic sandstones
MgLst : Magnesian Limestone
CLst : Carboniferous Limestone

TABLE 6 A COMPARISON OF DECEMBER GROUNDWATER LEVELS: 1990 AND 1976

Borehole	Aquifer	First year of record	Av. Apr level	April/May 1976		April/May 1991		No. of years of record with Apr levels ≤ 1991	Lowest recorded level before 1991 for any month
				Day	level	Day	level		
Dalton Holme	C & U.G.	1889	19.72	24/04	14.30	24/04	19.19	41	10.34
L. Brocklesby	"	1926	15.75	08/04	6.82	23/04	10.99	3	4.56
Washpit Farm	"	1950	45.53	01/05	42.90	02/05	41.76	0	41.24
The Holt	"	1964	88.33	29/04	85.99	01/05	85.74	1	83.90
Fairfields	"	1974	23.56	27/04	23.01	12/04	22.71	0	22.15
Redlands Farm	"	1964	46.07	01/04	38.40	26.04	35.04	0	34.53
Rockley	"	1933	137.56	02/05	129.26	01/05	135.53	27	128.78 dry
L. Bucket Farm	"	1971	72.29	01/04	65.42	24/04	66.06	3	56.77
Compton House	"	1894	45.24	29/04	29.97	30/04	43.36	46	27.64
West Dean	"	1940	2.09	30/04	1.47	26/04	1.69	11	1.01
Limekiln Way	"	1969	125.56	12/04	124.49	24/04	124.91	2	124.09
Ashton Farm	"	1977	69.74	29/04	65.48	30/04	71.10	17	63.10
West Woodyates	"	1942	88.05	01/04	74.86	30/04	89.80	31	67.62
New Red Lion	L.L.	1964	16.97	09/04	5.73	29/04	13.50	4	3.29
Ampney Crucis	M.J.	1958	101.78	25/04	100.29	29/04	101.04	6	97.38
Dunmurry (N.I.)	PTS	1985	28.67	-	-	29/04	28.35	3	27.47
Llanfair D.C.	"	1972	80.12	01/04	79.42	30/04	79.61	1	78.85
Bussels 7A	"	1972	24.21	27/04	23.19	10/04	24.12	8	22.90
Rushyford N.E.	M.L.	1967	76.25	27/04	65.82	12/04	75.46	12	64.77
Peggy Ellerton	"	1968	34.97	26/04	31.46	15/04	33.61	3	31.10
Alstonfield	C.B.	1974	195.50	29/04	179.14	17/04	186.55	5	174.22

Groundwater levels are in metres above Ordnance Datum

C & U.G. Chalk and Upper Greensand;
L.L. Lincolnshire Limestone
PTS Permo-Triassic Sandstones
M.J. Middle Jurassic Limestone
C.B. Carboniferous Limestone
M.L. Magnesian Limestone

FIGURE 4 LOCATION MAP OF GAUGING STATIONS AND GROUNDWATER INDEX WELLS