HYDROLOGICAL SUMMARY FOR ENGLAND AND WALES - AUGUST 1989

Data for this review have been provided, principally, by the regional divisions of the National Rivers Authority and by the Meteorological Office.

The rainfall figures are derived from a restricted network of raingauges and some of the flow data are of a provisional nature. A significant proportion of the featured hydrometric data may thus be subject to later revision.

For a fuller appreciation of the water resources impact of the current drought, this hydrological review should be considered alongside assessments of the current reservoir storage and water demand situations in each region.

Summary

The synoptic conditions during August were generally similar to those that have determined weather patterns over Great Britain for much of the last 16 month period. Low pressure systems tended to skirt the western seaboard bringing abundant rainfall to western Scotland and parts of north west England. Few active depressions penetrated to southern and eastern areas where - as a consequence - the drought has increased in intensity. Over the period since late-April a severe drought has developed in large parts of southern Great Britain and substantial longer term rainfall deficits exist over a large proportion of lowland England and in Northumbria. These deficits are particularly notable in the Southern NRA region and are of a significantly lesser magnitude in parts of East Anglia. Except in a few locations, and over selected periods, the drought severity - in hydrological terms - does not approach that of 1976.

River flows throughout most of England and Wales are well below average and in many catchments similar to those registered towards the end of the 1984 drought. Typically the August 1989 runoff totals might be expected once every five to ten years. Somewhat longer return periods are associated with runoff rates in some relatively impervious southern catchments - especially in the South West - and also in a few chalk or limestone catchments where baseflows have declined considerably in response to the very limited infiltration since early 1988.

No significant recharge to major aquifers normally occurs in the late summer and groundwater levels have continued their seasonal recession. Water tables are generally well below average but significantly above historical minima partly as a consequence of the beneficial (albeit limited) late infiltration in the spring.

Both the 1976 and 1984 droughts were terminated by heavy and sustained autumn rainfall. The magnitude and impact of the 1989 event, and the water resources prospects for 1990, will be heavily influenced by precipitation amounts over the next three months. Considerable rainfall will be required to satisfy the large soil moisture deficits and generate the normal seasonal upturn in runoff and recharge rates.

Review

The passage of several frontal systems - especially around the 10th and the 25th - brought widespread rainfall, heavy in places, to most areas of England and Wales. However these wet interludes failed to greatly disturb what has become a familiar pattern during the current drought. August rainfall totals north-west of a line roughly from Dyfed to Cleveland were generally above average. Elsewhere, few areas exceeded 75 per cent of the mean and less than half the average rainfall was received in some eastern and southern districts.

Many ares of England and Wales have recorded below average precipitation for all but five of the last 17 months (see Figure 1). Although below average, summer (June-August) rainfall over England and Wales was unexceptional being about twice the corresponding figure for 1976 and also greater than in 1975, 1981, 1983 and 1984. However, a different picture emerges if May is included. The four-month period ending in August is the second driest this century (after 1976) and in some districts the associated return period is in excess of 100 years. The regional variations in intensity may be judged by reference to Tables 1 and 2. With the exception of the North West, substantial deficits exist in all regions for the ten-month period beginning in November 1988.

Although on the four-month timescale there are certain affinities with the 1976 drought any general comparisons remain inappropriate. The 'Great Drought' has no modern parallel in terms of its duration and severity. Relative to average rainfall, the percentage shortfalls for durations in the two to eighteen month range (see Figure 2) serve to illustrate both the important temporal variations in the severity of the 1988/89 drought and its lesser magnitude compared to the extreme conditions experienced in 1975/76. In the current event, for England and Wales as a whole, no durations exceed a 50 year return period; in 1975/76 return periods associated with almost all durations were well in excess of 200 years. The 1988/89 profile for the South West NRA region confirms the intense nature of the drought over the May-August period; the associated return period being about 100 years. The development of the 1988/89 winter drought is also evident together with the important amelioration which took place is the spring. For the Southern NRA region the 1988/89 drought profile shows the characteristic two phases (winter and summer) but reveals also a substantial rainfall deficit over durations from 12-18 months.

Mean temperatures and sunshine hours were above average in August and open water evaporation losses were high. However, with soils already exceptionally dry the potential for further increases in soil moisture deficits was small. In contrast to some parts of western Scotland, where a return to field capacity occurred in August, calculated SMDs for most areas of England and Wales were above 100 mms at the month's end; in southern England deficits of 125 mm were typical. A few localities in North Wales and the North West registered below average end-of-summer SMDs but, in the south, they exceeded the seasonal mean by 20-80 mm and were, over wide areas, similar to the deficits obtaining towards the end of the 1984 drought. Such deficits are equivalent to about two months of average autumn rainfall and will clearly delay the onset of aquifer recharge and any substantial upturn in runoff rates.

River flows continued their seasonal decline in almost all parts of England and Wales and catchment runoff totals for August were substantially below average, markedly so in parts of the South (see Table 3 and Figure 3). However, in much of the English lowlands the benefit - in terms of baseflow support - of the belated spring recharge is still evident with flow rates in most catchments considerably above historical minima. Broadly speaking, flows have declined to rates expected about once every 5-10 years (on average) and are similar to those recorded in August 1984. Somewhat more extreme flows characterise areas like the South West and South Wales where only limited natural storage exists to sustain flows through drought periods. For instance the River Cynon (South Wales) recorded an August mean flow approaching the 1976 minimum and the Kenwyn (Cornwall) - which does have an appreciable baseflow - also registered an August mean with a return period in the 15-20 year range. Notably low flows were also recorded in some rivers draining predominately pervious catchments where baseflows have been depressed for over a year. The Yorkshire Derwent and the Hampshire Itchen fall into this category. Flows in the latter, when adjusted to account for the recently increased augmentation from groundwater, are comparable to those recorded in 1976 and correspond to about a 40-50 year return period. The Thames which drains a geologically diverse catchment registered its third lowest August runoff since 1949 - nonetheless naturalised flow rates were still twice those recorded in August 1976. The accumulated runoff totals presented in Table 3 further emphasise the broad extent of the drought, its uneven geographical impact and, in most regions, its moderate severity relative to the 1976 event.

Whilst in most catchments, August runoff compared favourably with corresponding totals in 1976 and 1984 a continuation of dry, or even average, conditions into the autumn will certainly see 1989 flows fall below those experienced in 1976 and 1984 when heavy September rainfall paved the way for a subsequently brisk increase in discharge rates.

Whilst groundwater levels through the late winter and early spring of 1989 were the lowest since 1976 over wide areas, the subsequent infiltration, although limited compared with winter recharge in a normal year, boosted groundwater resources at a time when a seasonal decline in levels is generally under way. Consequently, in early summer, water tables stood at around average levels in some regions (see, for instance, the Compton and Rockley traces - Figure 4), although most observation boreholes showed levels somewhat below the average for June. However, only in parts of the Chalk aquifer in Sussex, Kent and Yorkshire were levels reported comparable with those registered in June 1976; increased abstraction rates as well as the meteorological conditions are an important factor in some of these localities.

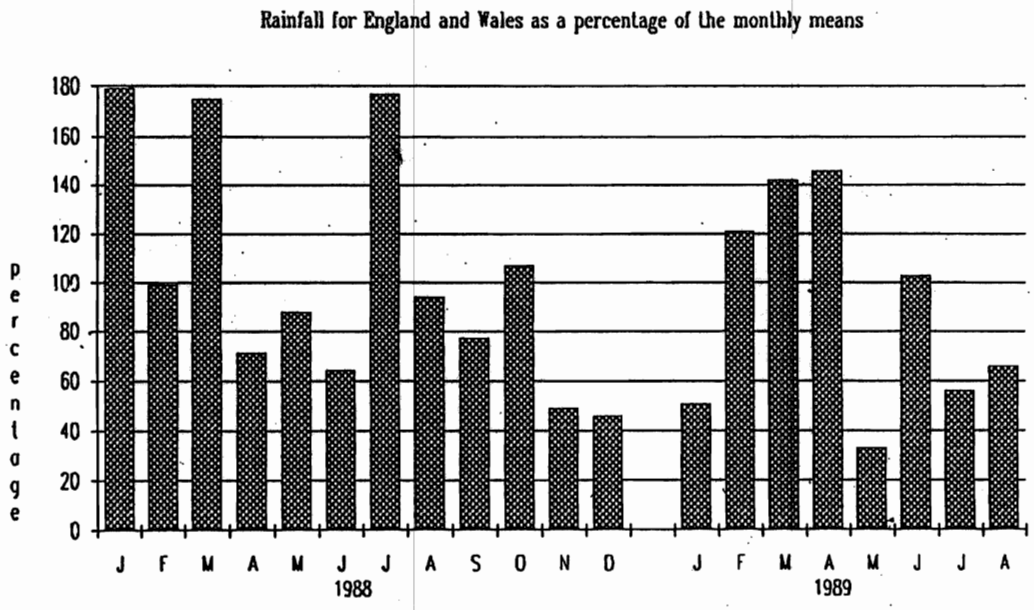
Infiltration appears, generally, to have ceased by June, and groundwater hydrographs are now, typically, showing a normal summer recession. The set of groundwater level hydrographs appended to this report illustrate that even where the 1988-89 recharge has been very modest, at Dalton Holme for example, groundwater levels remain above, and in general considerably above, the minimum on record. No significant recharge to major aquifers is likely before October, when rainfall may normally be expected to exceed evaporation losses.

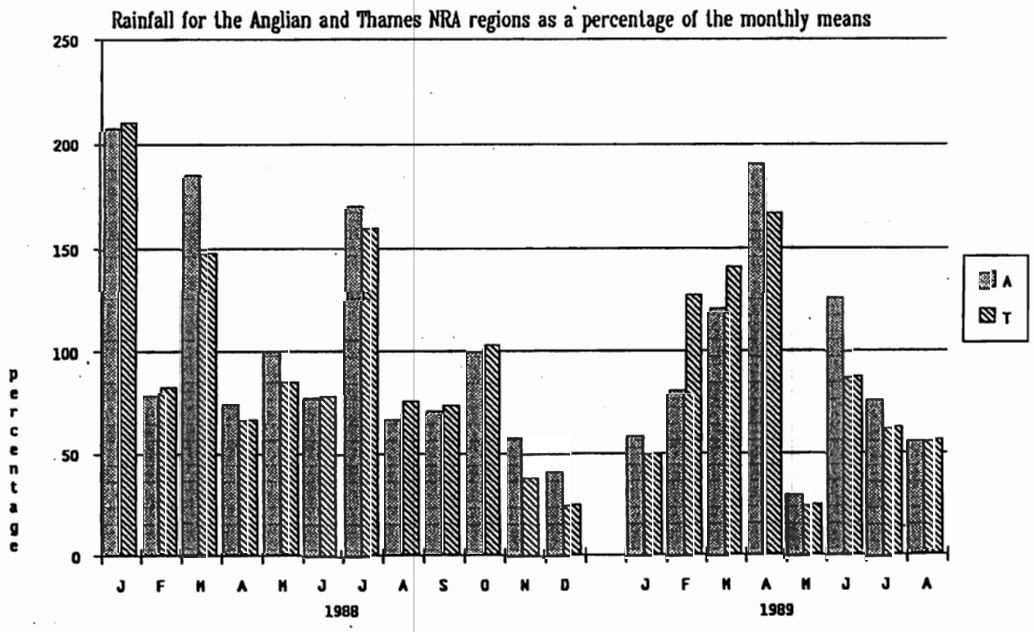
Groundwater shortages, other than those of a localised nature, may be anticipated only if, as happened in 1988, autumn and early winter rainfall is inadequate to allow normal recharge to produce a substantial upturn in groundwater levels.

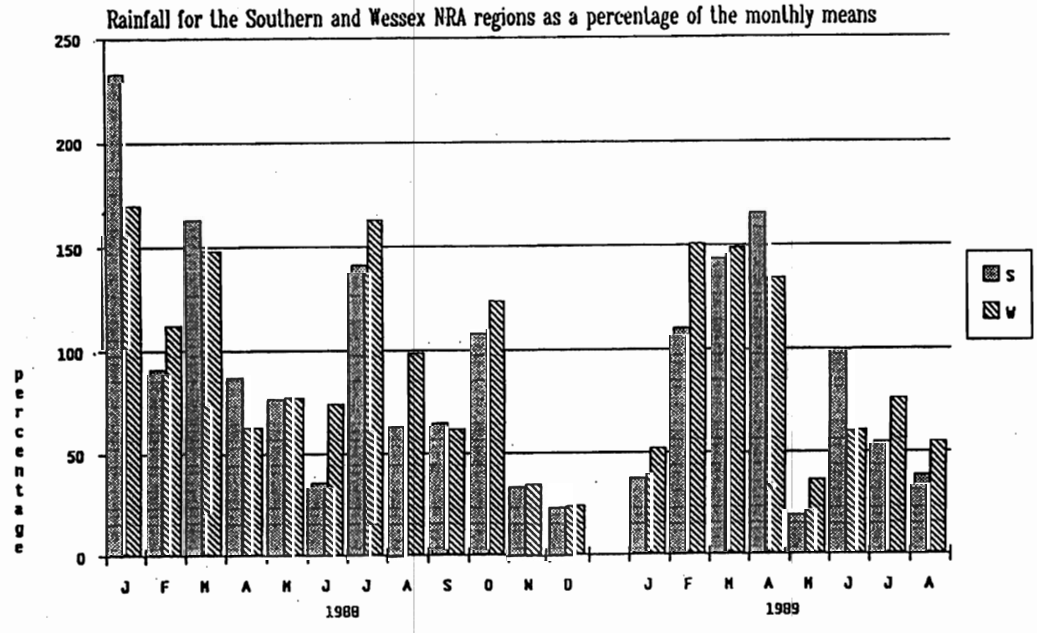
IH/BGS

14.9.89

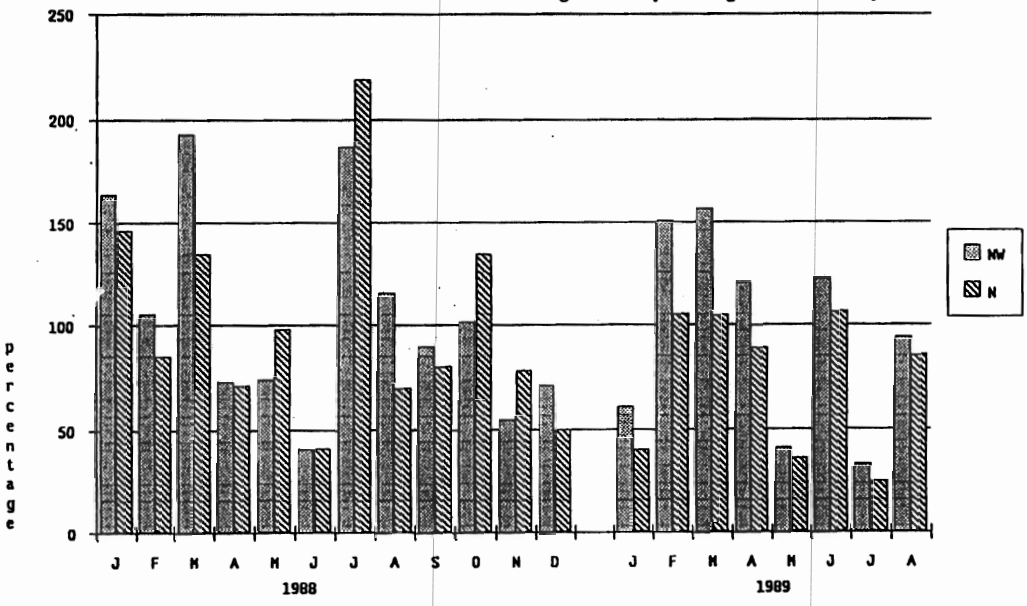
FIGURE 1 MONTHLY RAINFALL - JANUARY 1988 TO AUGUST 1989



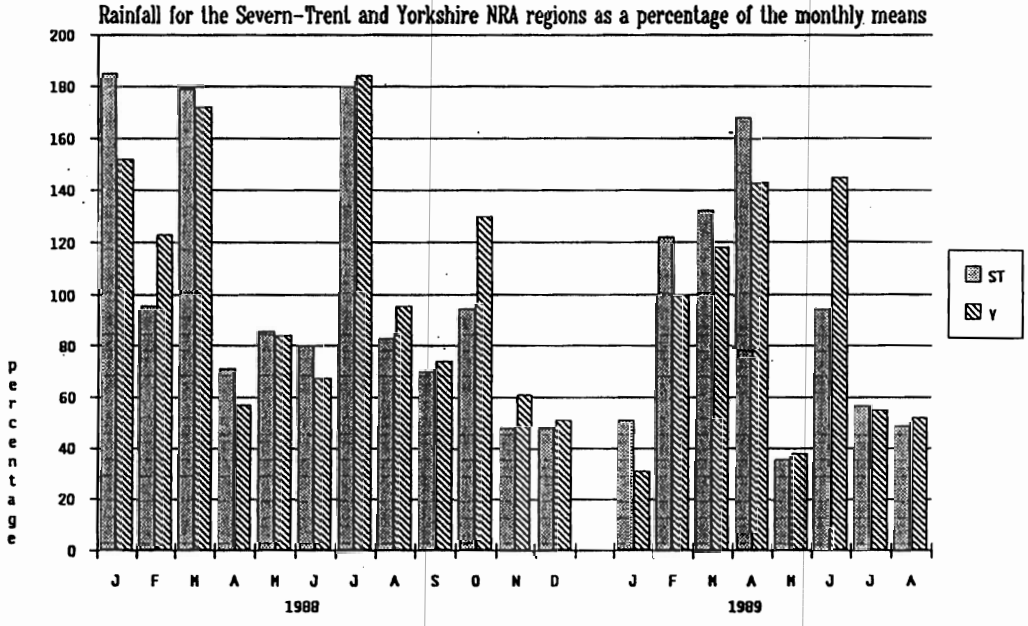




Rainfall for the North West and Northumbrian NRA regions as a percentage of the monthly means



Rainfall for the Severn-Trent and Yorkshire NRA regions as a percentage of the monthly means



Rainfall for the South West and Welsh NRA regions as a percentage of the monthly means

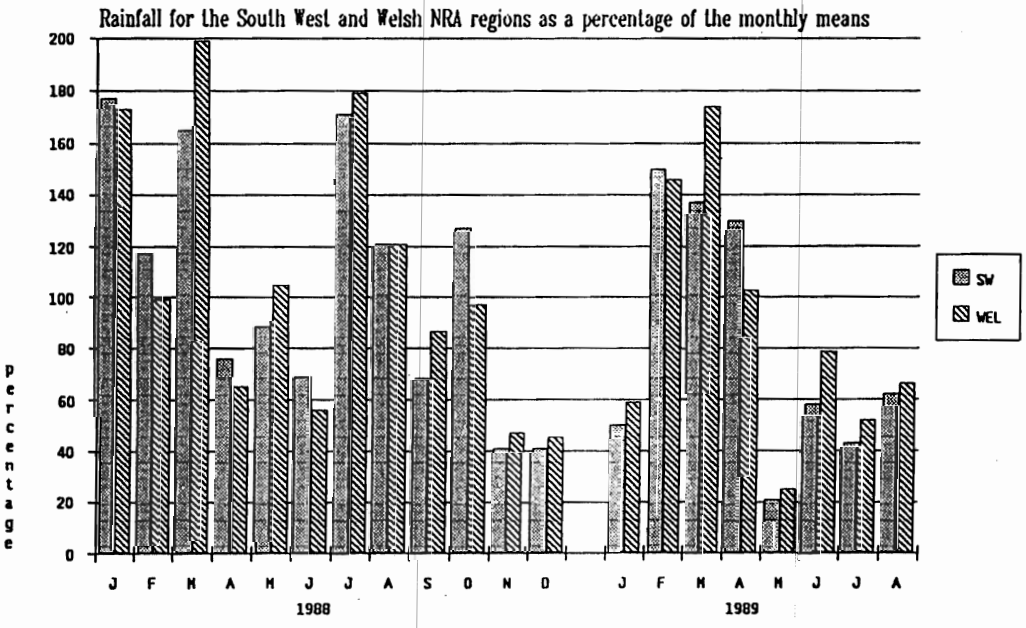


TABLE 1 1988/9 RAINFALL IN MM AND AS A PERCENTAGE OF THE 1941-70 AVERAGE

		Oct 1988	Nov	Dec	Jan 1989	Feb	Mar	Apr	May	Jun	Jul	Aug	Oct-Aug	Approx Return* Period	Oct 75-Aug 76
England and Wales	mm	89	48	47	44	78	84	85	22	63	41	60	661	15	468
	%	107	49	52	51	121	142	146	33	103	56	66	80		56
WATER AUTHORITIES															
North West	mm	120	69	117	68	123	113	92	33	102	34	118	986	<5	722
	%	102	55	97	61	151	157	120	40	123	33	94	90		66
Northumbria	mm	101	74	53	32	70	55	49	25	65	19	87	629	10-15	488
	%	135	79	71	40	106	105	89	38	107	25	86	79		61
Severn Trent	mm	62	38	33	35	65	69	87	23	53	37	40	542	15-20	394
	%	95	48	47	51	122	132	168	35	95	57	49	77		56
Yorkshire	mm	90	55	47	24	64	63	79	24	84	38	47	614	10	485
	%	130	62	63	31	100	118	140	40	145	55	52	81		64
Anglia	mm	52	35	22	31	34	48	74	14	62	44	37	454	10	307
	%	100	57	41	59	81	121	186	30	127	77	57	81		55
Thames	mm	66	28	16	31	68	65	77	14	46	38	40	481	15-20	281
	%	103	38	24	50	129	141	167	25	88	63	57	75		44
Southern	mm	84	32	19	29	62	75	81	11	50	32	28	503	30-50	316
	%	108	34	23	38	109	144	169	20	100	55	39	70		44
Wessex	mm	101	33	22	44	89	87	74	25	33	47	45	601	15-20	355
	%	123	35	24	52	151	149	137	36	61	76	55	76		45
South West	mm	144	55	59	65	135	115	92	18	38	36	63	820	20	580
	%	127	41	44	50	151	137	130	21	58	43	62	75		53
Welsh	mm	125	69	73	80	140	151	89	23	65	49	78	940	15-20	664
	%	97	48	50	59	146	174	103	25	79	52	66	78		55

Note: January to August rainfalls are based upon MORECS figures supplied by the Meterological Office.

* Return period assessments are based on tables provided by the Meteorological Office; the estimates assume a sensibly stable climate.

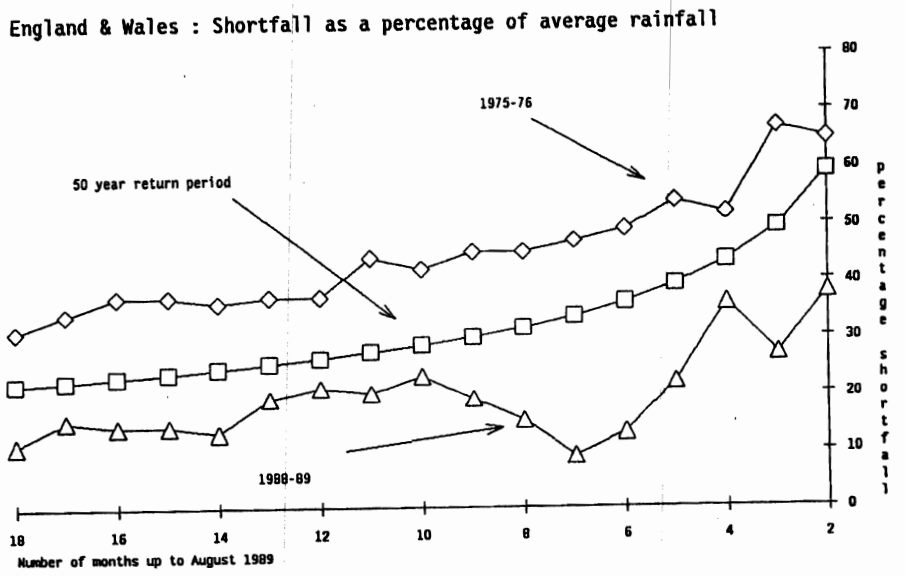
TABLE 2 RAINFALL RETURN PERIOD ESTIMATES

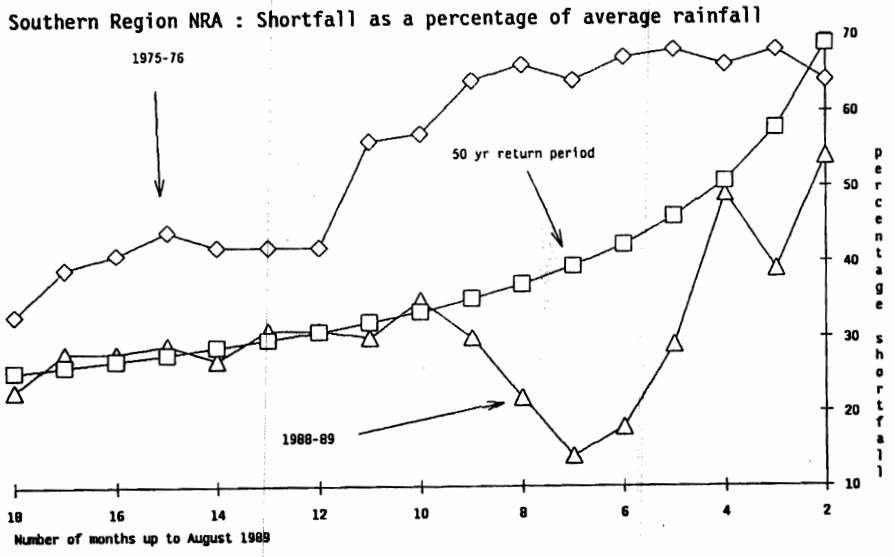
		MAY–AUG 1989	Est. Return Period	JAN–AUG 1989	Est. Return Period	NOV–AUG 1988–89	Est. Return Period	AUG–AUG 1988–89	Est. Return Period
England and Wales	mm	186		477		572		809	
	% LTA	64							
WATER AUTHORITIES									
North West	mm	286		683		869		1245	
	% LTA	73	5–10	93	2–5	89	2–5	94	2–5
Northumbria	mm	196		402		529		764	
	% LTA	65	15–20	72	20–30	73	30–35	80	20–25
Severn Trent	mm	153		409		480		656	
	% LTA	58	20–30	83	5–10	75	15–20	78	15–20
Yorkshire	mm	193		423		525		754	
	% LTA	69	10–15	80	5–10	76	15–20	83	<10
Anglia	mm	157		344		401		533	
	% LTA	72	5–10	88	2–5	79	10–15	80	10–20
Thames	mm	138		371		415		580	
	% LTA	58	15–20	84	<5	72	20–30	76	15–20
Southern	mm	121		368		419		595	
	% LTA	51	30–50	78	5–10	65	50–100	70	50–70
Wessex	mm	150		444		499		729	
	% LTA	56	25–35	85	<5	70	25–35	78	10–20
South West	mm	155		562		676		1013	
	% LTA	46	80–100	79	5–10	69	30–50	79	10–20
Welsh	mm	215		675		817		1195	
	% LTA	56	30–50	85	5	76	20–30	84	5–10

Return period assessments are based on tables provided by the Meteorological Office; the estimates assume a sensibly stable climate.

FIGURE 2 ACCUMULATED SHORTFALLS (EXPRESSED AS A % OF THE AVERAGE RAINFALL) FOR THE 2 TO 18 MONTH PERIODS ENDING IN AUGUST.

PROFILES FOR THE 1988/89 AND 1975/76 DROUGHTS ARE SHOWN TOGETHER WITH A TRACE OF THE 50 YEAR RETURN PERIOD SHORTFALL.





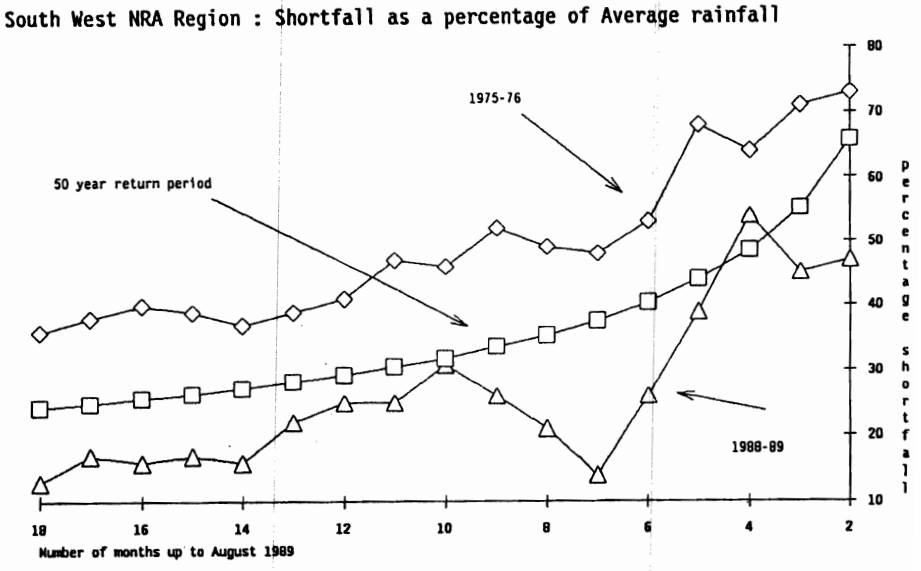


TABLE 3 CATCHMENT RUNOFF IN MM AND AS A PERCENTAGE OF LTA

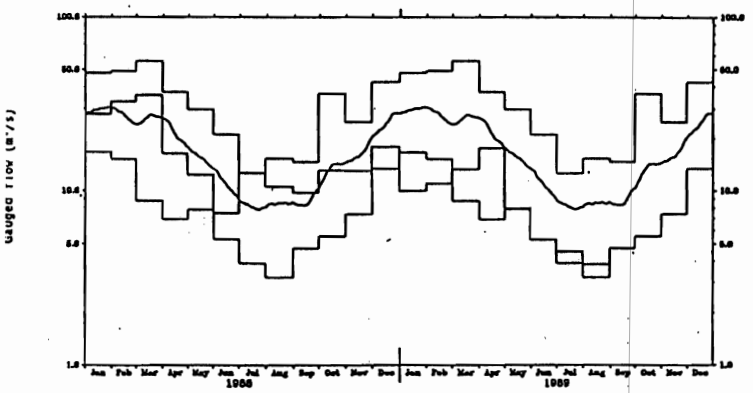
River/Station Name		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Oct 88-Aug 89	Rank/No. of Years	Oct 75-Aug 76	May 89-Aug 89	Rank/No. of Years	May 76-Aug 76
		1989													
Wharfe at Flint Ml	mm	42	64	95	71	15	13	10	14	541	5/34	399	52	3/34	59
	%	43	84	127	131	39	51	37	34	80		59	40		45
Derwent at B'crambe	mm	17	17	22	29	13	9	8	6	193	2/16	176	36	1/16	41
	%	33	39	49	85	52	51	59	47	58		53	52		69
Trent at Colwick	mm	21	26	42	57	18	13	12	10	268	5/31	147	53	4/31	35
	%	41	59	105	178	69	68	77	58	78		43	69		45
Lud at Louth	mm	15	12	16	17	15	12	10	9	150	4/21	72	46	4/21	29
	%	48	33	42	50	54	60	61	66	57		27	58		37
Witham at Claypole	mm	8	8	12	31	14	8	6	4	110	5/30	38	32	14/31	7
	%	31	28	46	148	92	80	90	62	61		21	80		18
Ouse at Bedford	mm	13	23	37	46	13	7	7	4	188	25/56	36	31	30/57	5
	%	36	85	119	242	101	94	125	83	88		17	97		16
Colne at Lexden	mm	13	14	23	20	6	4	5	3	116	10/30	44	18	8/30	7
	%	59	74	128	154	75	82	129	85	85		32	82		32
Thames at Kingston (nat)	mm	13	19	36	26	13	9	7	6	170	27/106	84	35	28/107	17
	%	35	59	116	118	76	75	75	70	72		35	73		35
Kennet at Theale	mm	16	19	31	29	22	16	13	10	204	3/28	100	61	4/28	20
	%	46	32	82	94	78	76	77	67	72		35	76		25
Coln at Bibury	mm	15	19	48	44	30	18	15	13	250	4/26	90	76	6/26	26
	%	30	56	91	102	89	86	67	73	65		23	78		27
Medway at Teston	mm	7	17	27	41	7	6	4	3	136	2/27	99	20	3/30	9
	%	14	47	83	185	47	54	55	47	50		36	54		24
Ouse at Gold Bridge	mm	8	12	44	37	16	9	10	6	169	2/28	144	41	6/29	16
	%	13	25	98	109	60	56	106	51	44		37	67		26
Itchen at Highbrdge	mm	26	26	41	40	36	23	22	21	326	3/31	281	102	3/31	77
	%	53	46	79	85	83	66	70	72	73		63	75		57
Stour at Throop	mm	19	28	57	39	15	11	8	6	242	2/16	116	40	2/17	20
	%	31	51	110	118	63	66	70	58	62		30	66		33
Kenwyn at Truro	mm	41	65	102	42	21	12	8	6	512	5/21	457	47	3/21	38
	%	36	66	132	98	75	62	64	47	84		75	66		54
Taw at Umberleigh	mm	54	95	107	36	15	5	4	3	517	6/31	300	27	3/31	16
	%	46	116	162	80	48	31	30	15	77		45	33		20
Tone at Bishops H	mm	25	54	80	40	19	11	10	7	335	5/28	158	47	2/29	24
	%	31	75	138	107	66	60	65	53	73		34	64		32
Severn at Bewdley	mm	29	48	77	48	12	7	8	7	340	13/68	185	34	3/69	27
	%	41	84	168	152	49	41	35	39	79		43	47		37
Yscir at Pont'yscir	mm	92	130	182	72	18	10	11	8	719	2/16	483	47	3/18	38
	%	64	123	160	120	41	33	58	26	78		52	37		30
Dee at New Inn	mm	134	217	337	131	23	34	23	35	1350	3/20	1134	115	2/20	127
	%	55	139	194	122	31	57	35	36	81		68	39		43
Lune at Caton	mm	94	167	196	82	20	14	12	44	994	11/25	725	90	2/27	97
	%	65	192	207	106	37	35	24	63	95		70	42		46

Note : Because of changes in the pattern of water utilisation in certain catchments and the effect of measures to counteract the impact of a drought on river flow rates, direct comparisons between historical low flow sequences need to be undertaken with caution.

FIGURE 3 MONTHLY HYDROGRAPHS

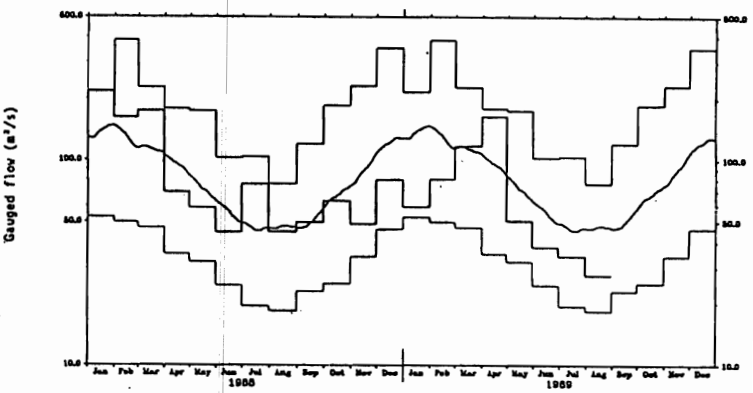
027041 Derwent at Buttercrambe

Monthly mean flows for 1968-1989
+ extremes and 30 day running mean for 1973-1987



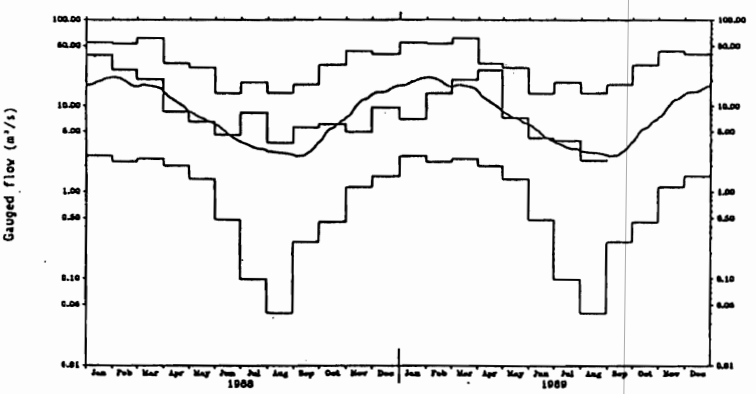
028009 Trent at Colwick

Monthly mean flows for 1968-1989
+ extremes and 30 day running mean for 1956-1987



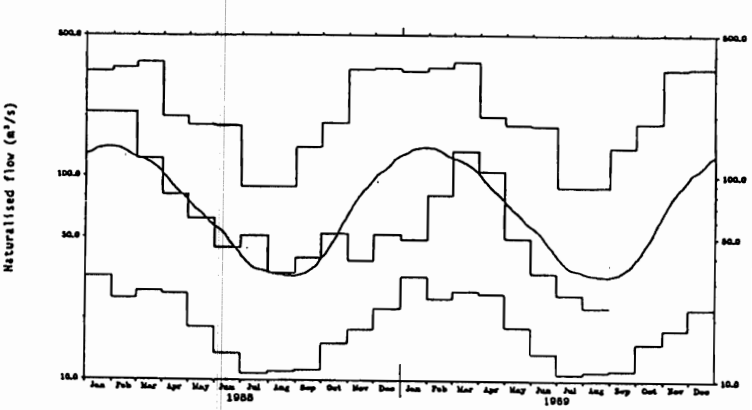
033002 Bedford Ouse at Bedford

Monthly mean flows for 1968-1989
+ extremes and 30 day running mean for 1933-1987



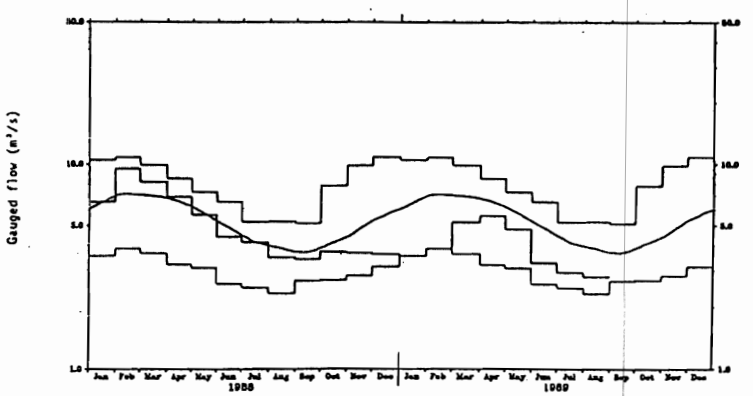
039001 Thames at Kingston

Monthly mean flows for 1968-1989
+ extremes and 30 day running mean for 1883-1987



042010 Itchen at Highbridge+Allbrook

Monthly mean flows for 1968-1989
+ extremes and 30 day running mean for 1958-1987



054001 Severn at Bewdley

Monthly mean flows for 1968-1989
+ extremes and 30 day running mean for 1921-1987

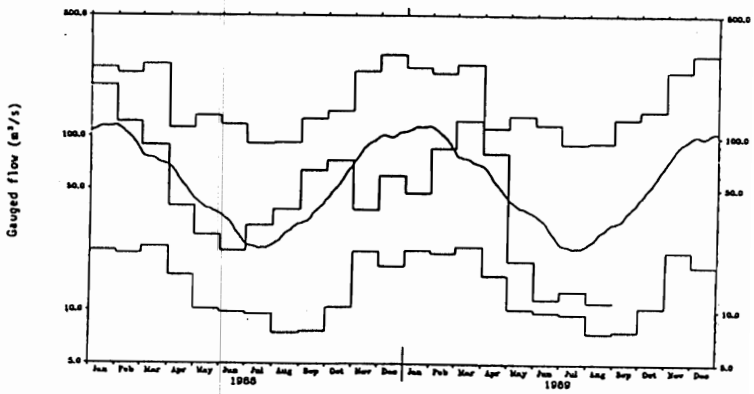
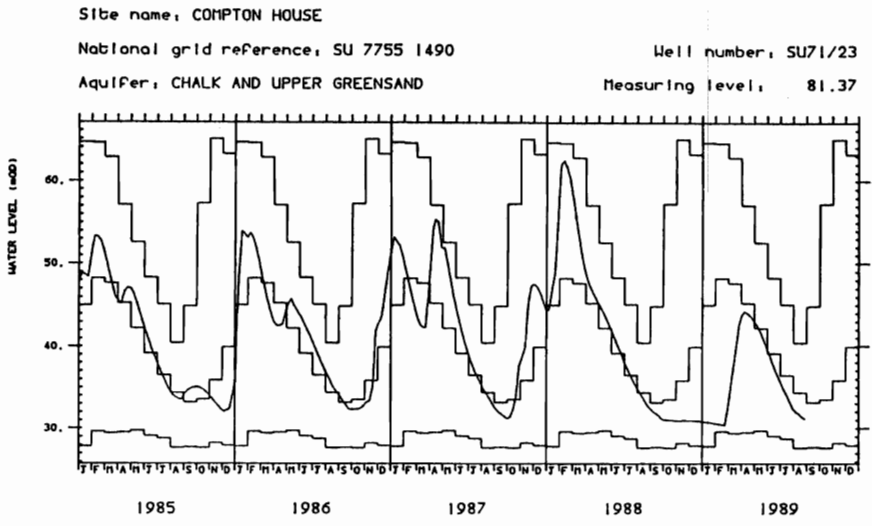
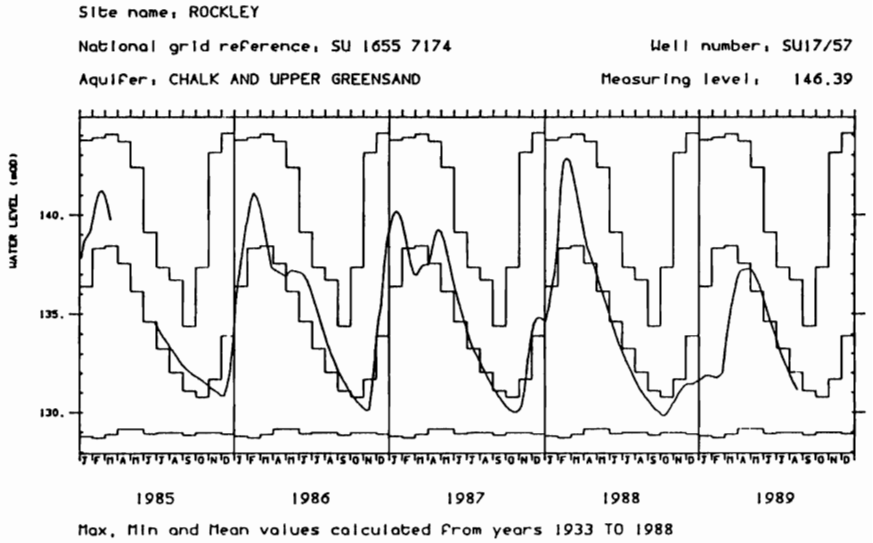
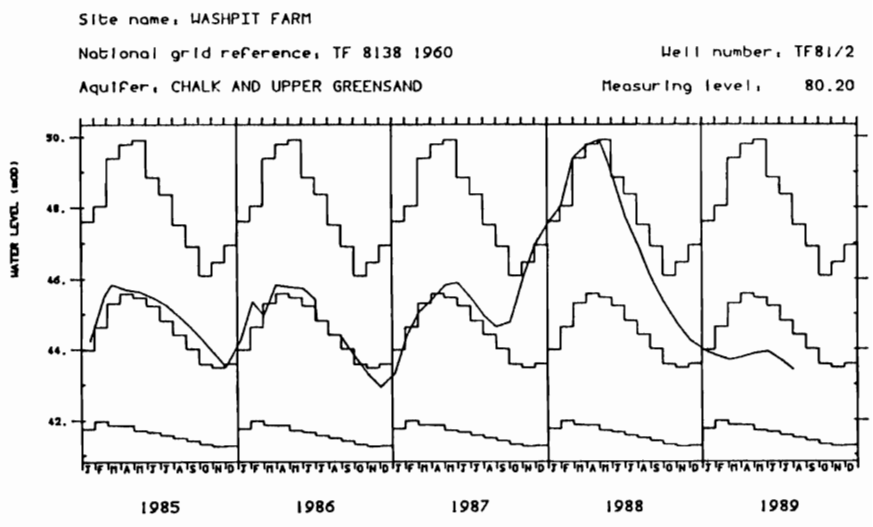


FIGURE 4 GROUNDWATER WELL OBSERVATION HYDROGRAPHS



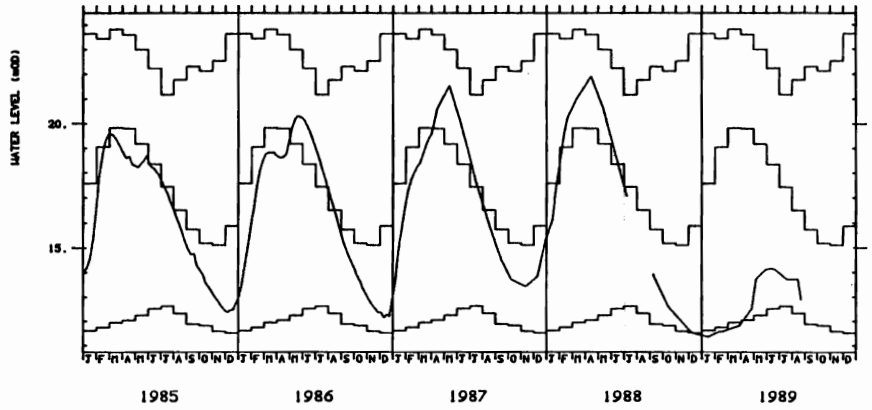




Site name: DALTON HOLME

National grid reference: SE 9651 4530 Well number: SE94/5

Aquifer: CHALK AND UPPER GREENSAND Measuring level: 33.50

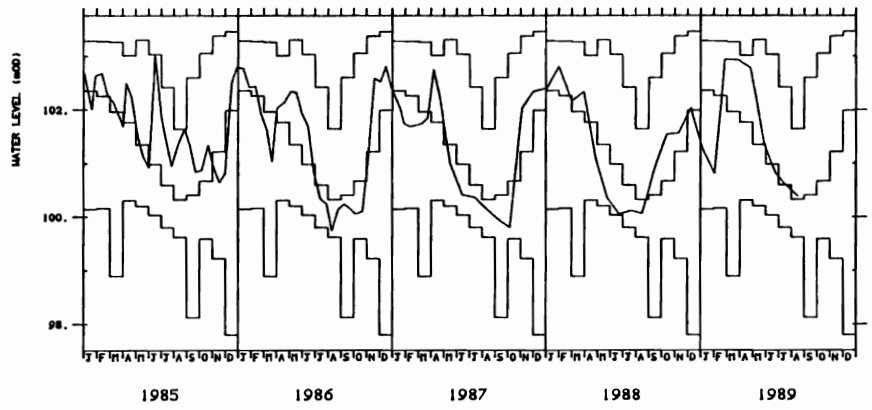


Max, Min and Mean values calculated from years 1889 TO 1988

Site name: AMPNEY CRUCIS

National grid reference: SP 0595 0190 Well number: SP00/62

Aquifer: MIDDLE JURASSIC Measuring level: 109.70

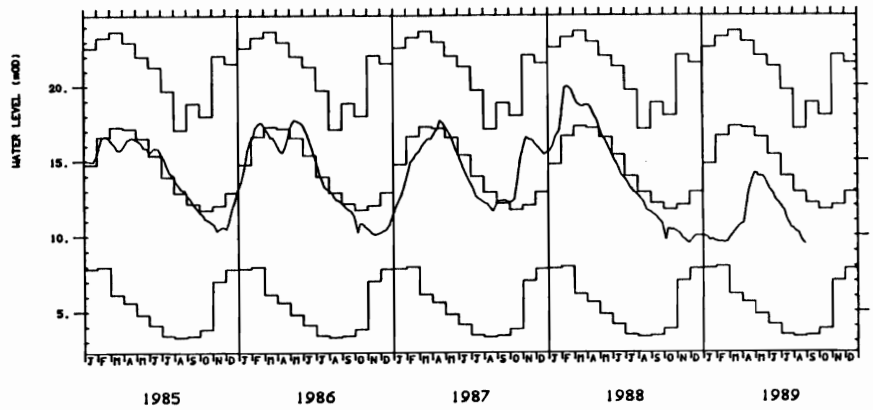


Max, Min and Mean values calculated from years 1958 TO 1988

Site name: NEW RED LION

National grid reference: TF 0885 3034 Well number: TF03/37

Aquifer: LINCOLNSHIRE LIMESTONE Measuring level: 33.82

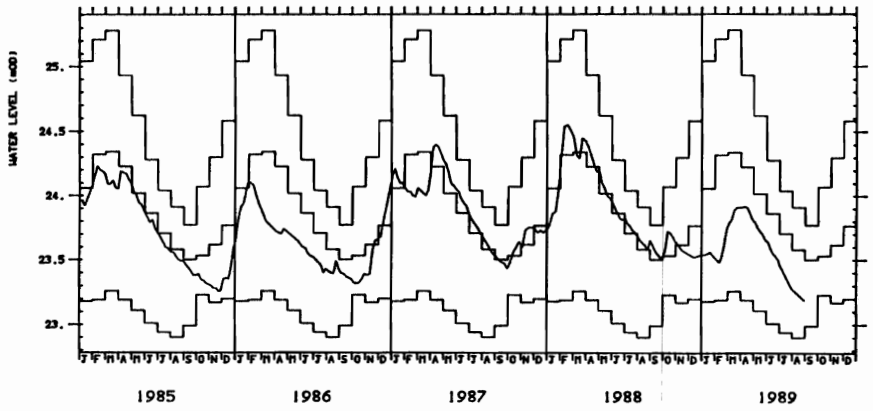


Max, Min and Mean values calculated from years 1964 TO 1988

Site name: BUSSELS NO.7A

National grid reference: SX 9528 9872 Well number: SX99/37B

Aquifer: PERMO-TRIASSIC SANDSTONE Measuring level: 26.07

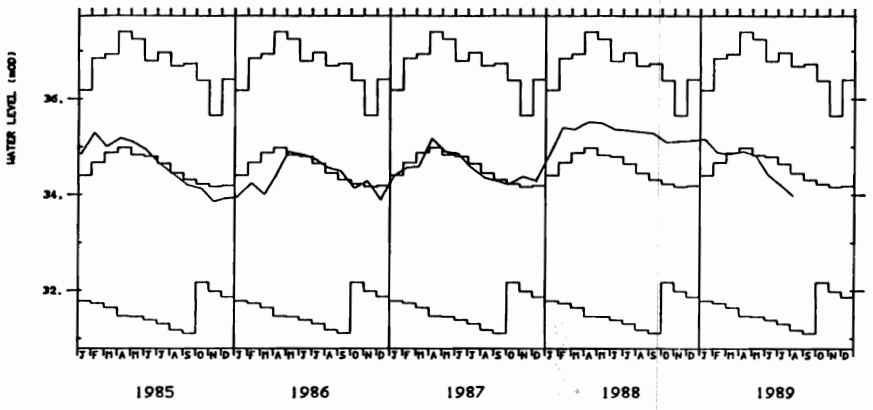


Max, Min and Mean values calculated from years 1971 TO 1988

Site name: PEGGY ELLERTON FARM,HAZLEWOOD

National grid reference: SE 4535 3964 Well number: SE43/9

Aquifer: MAGNESIAN LIMESTONE Measuring level: 51.40



Max, Min and Mean values calculated from years 1968 TO 1988

Site name: RUSHYFORD NORTH EAST,GREAT CHILTON

National grid reference: NZ 2875 2896 Well number: NZ22/22

Aquifer: MAGNESIAN LIMESTONE Measuring level: 92.53